Second Advanced Workshop on Model Codes for Spallation Reactions

Saclay, February 8-11, 2010

Results of the de-excitation code ABLA07

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ABLA07

see proceedings of the
“Joint ICTP-IAEA Advanced Workshop on Model Codes for Spallation Reactions„
held in Trieste, Italy, 4-8 January 2008

ABLA07

1.Emission of neutrons, LCP (Z=1, 2), IMF (Z>2) and γ is considered.

2.Particle decay widths based on Weisskopf-Ewing formalism, with:

- Energy dependent inverse cross sections based on nuclear potential
- Barriers for charged particles are calculated using the Bass potential
- Thermal expansion of the source is taken into account.
- Change of angular momentum due to particle emission is considered.

3.The fission decay width is described by including:

- An analytical time-dependent approach to the solution of the Fokker-Planck equation,
- The influence of the initial deformation on the fission decay width,
- The double-humped structure in the fission barriers of actinides,
- Symmetry classes in low-energy fission.

4. Particle emission on different stages, i.e. between ground state and saddle point, between the saddle and scission point, and from two separate fission fragments, of the fission process is calculated separately.

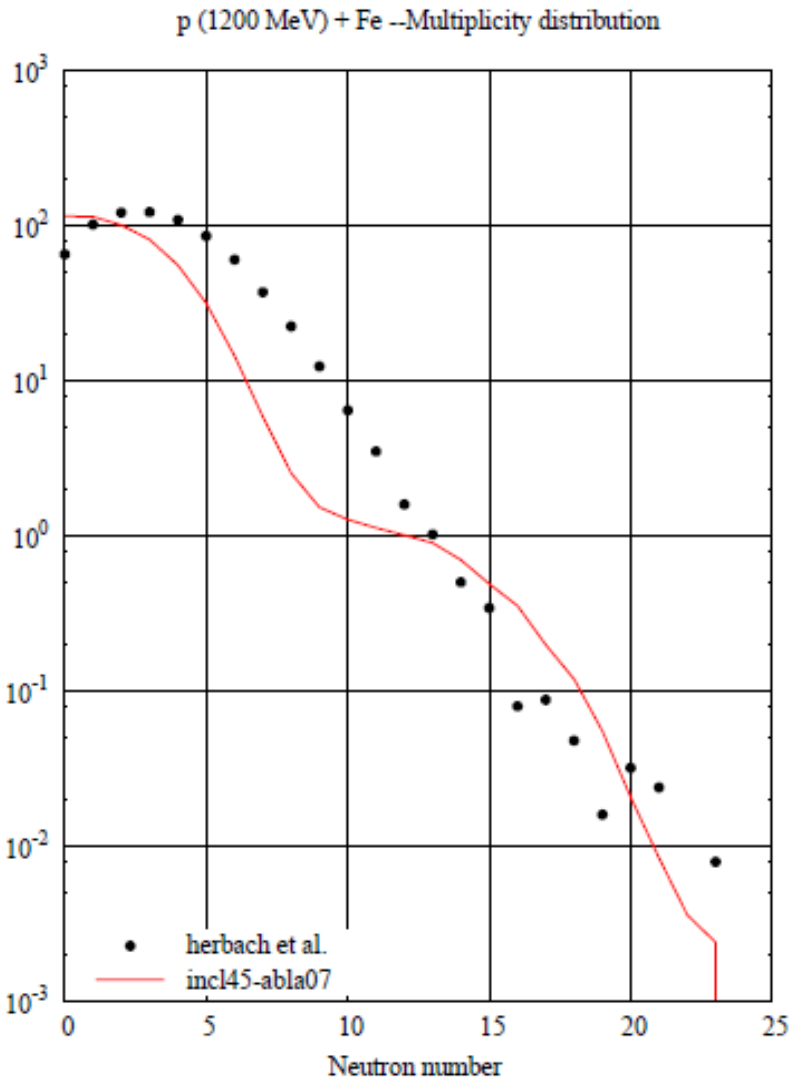
5. Kinetic-energy spectra from Maxwell-Boltzmann distribution

6. A stage of simultaneous break-up (MF) in the decay of hot excited systems is treated.

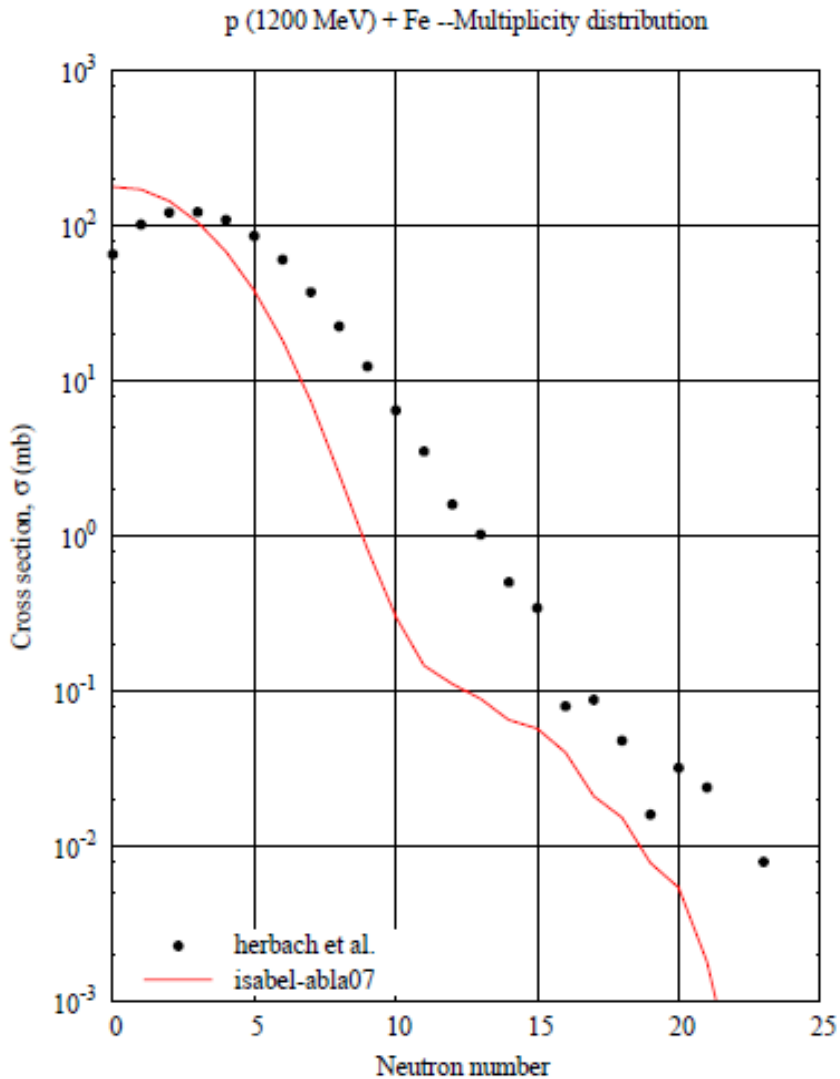
Neutron multiplicities

p(1200 MeV) + Fe – Neutron multiplicity distribution

INCL45-ABLA07



ISABEL-ABLA07

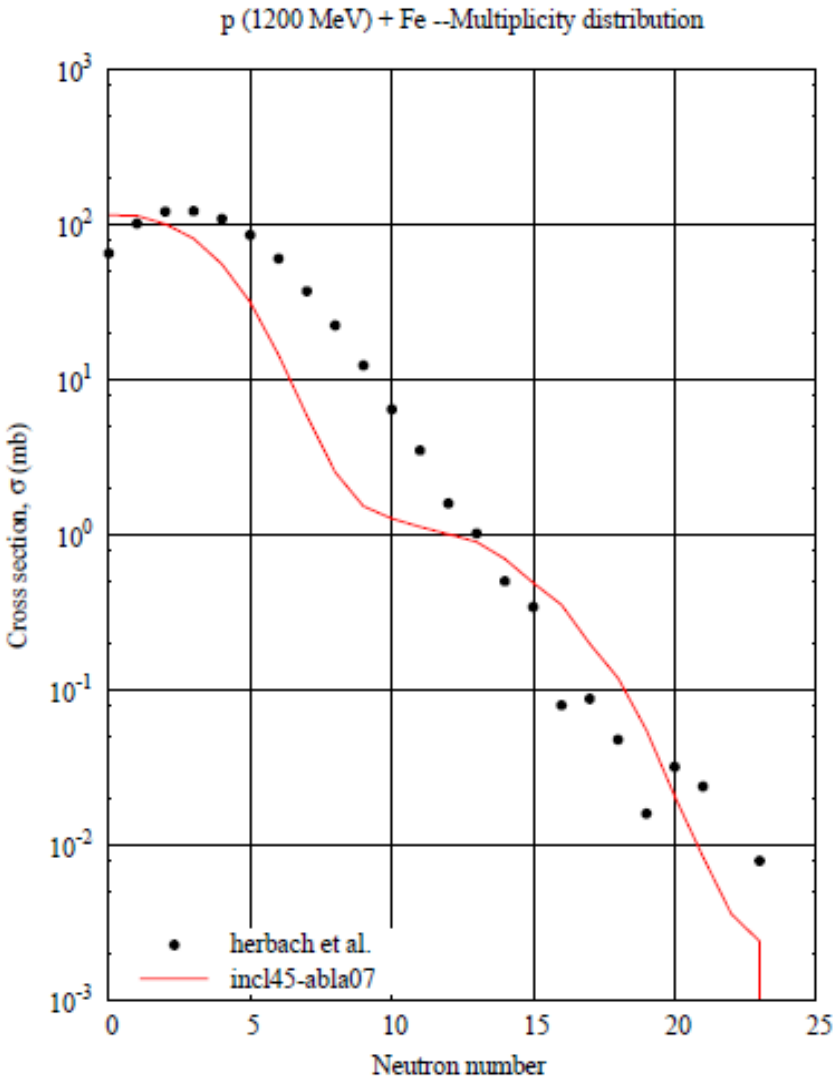


Cross section (mb)

neutron number

p(1200 MeV) + Fe – Neutron multiplicity distribution

INCL45-ABLA07



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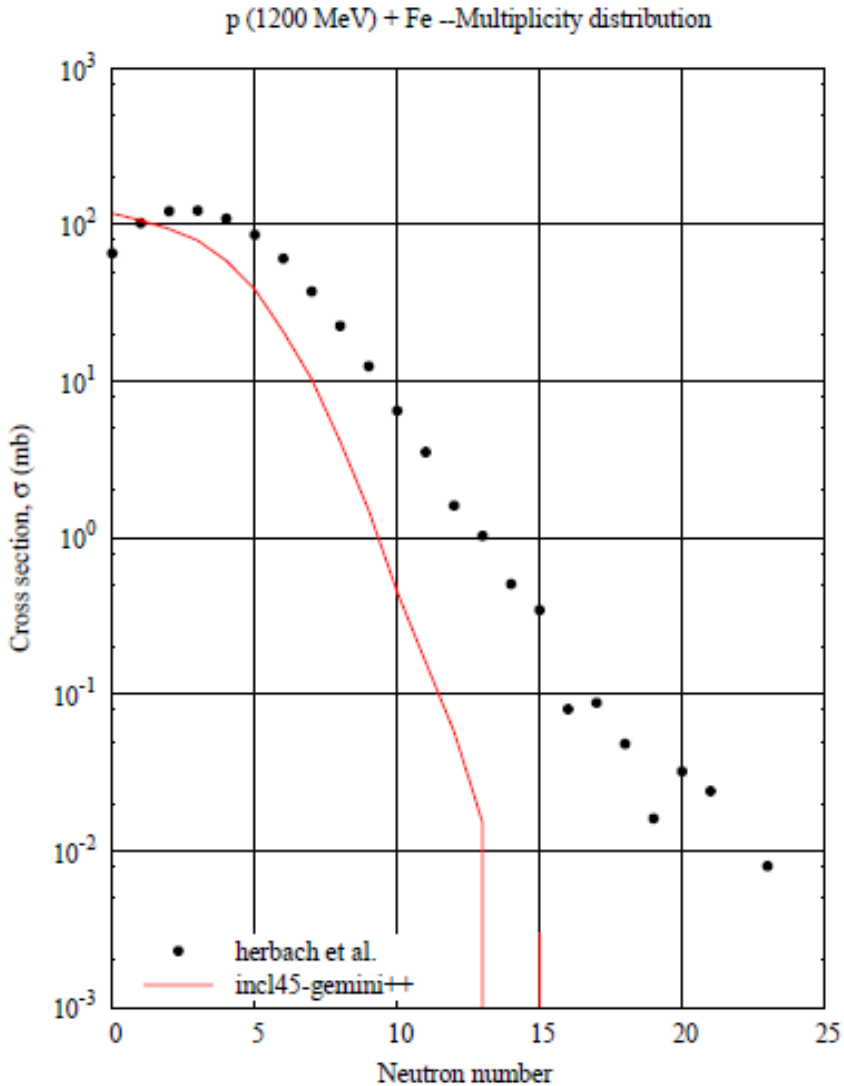

neutron number

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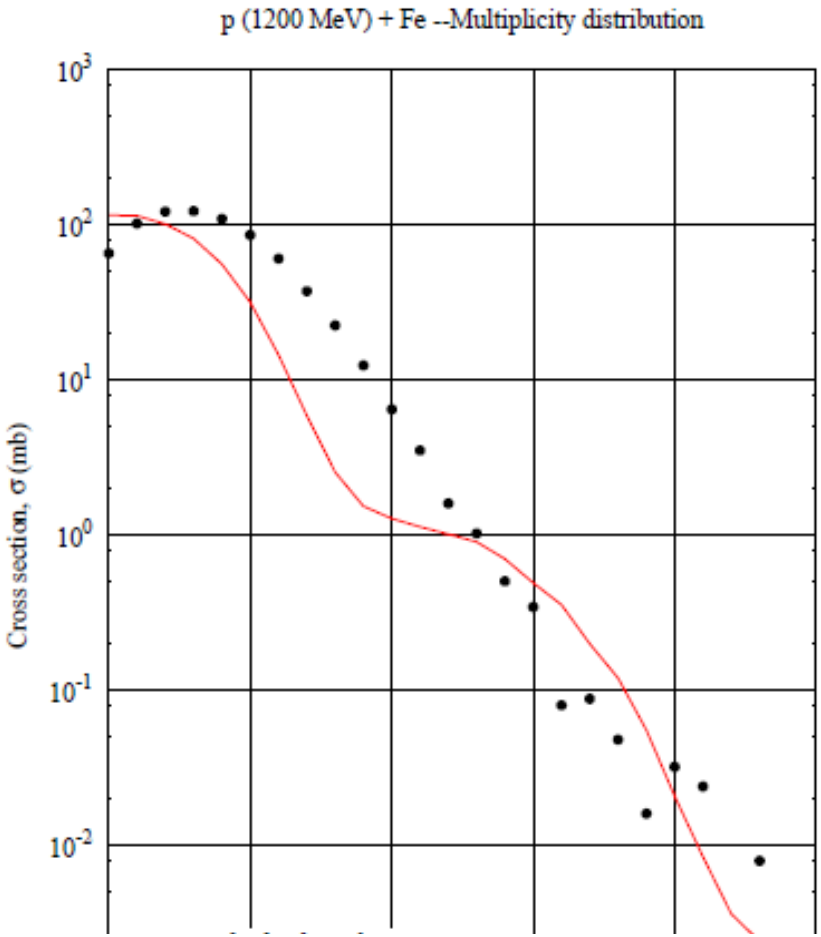
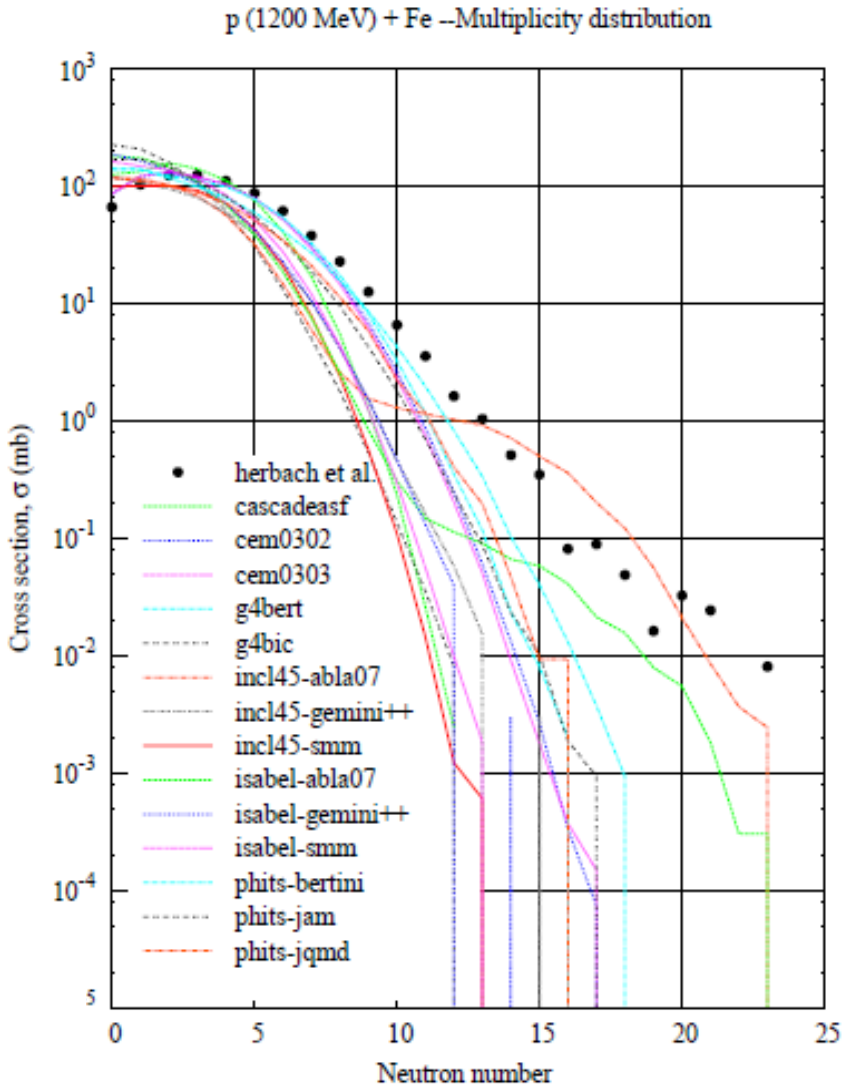


Strange shape: maybe multifragmentation?

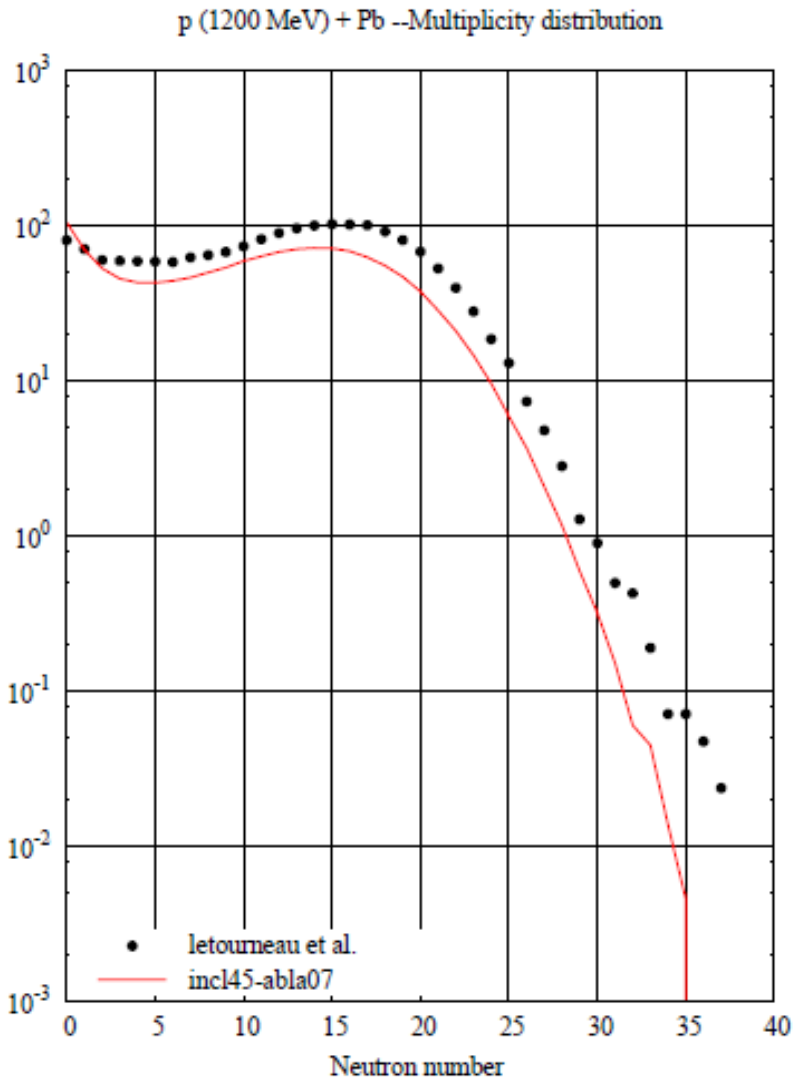
ALL MODELS



neutron number

p(1200 MeV) + Pb – Neutron multiplicity distribution

INCL45-ABLA07



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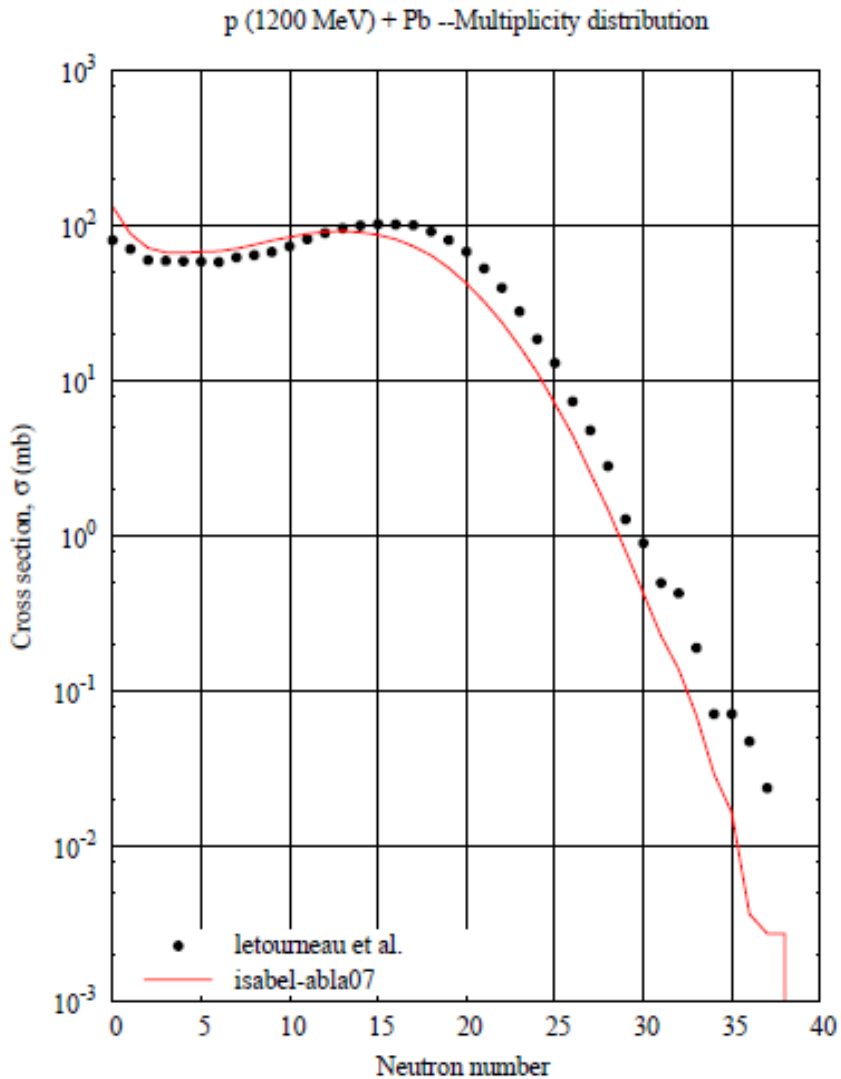

Cross section (mb)

neutron number

p(1200 MeV) + Pb – Neutron multiplicity distribution

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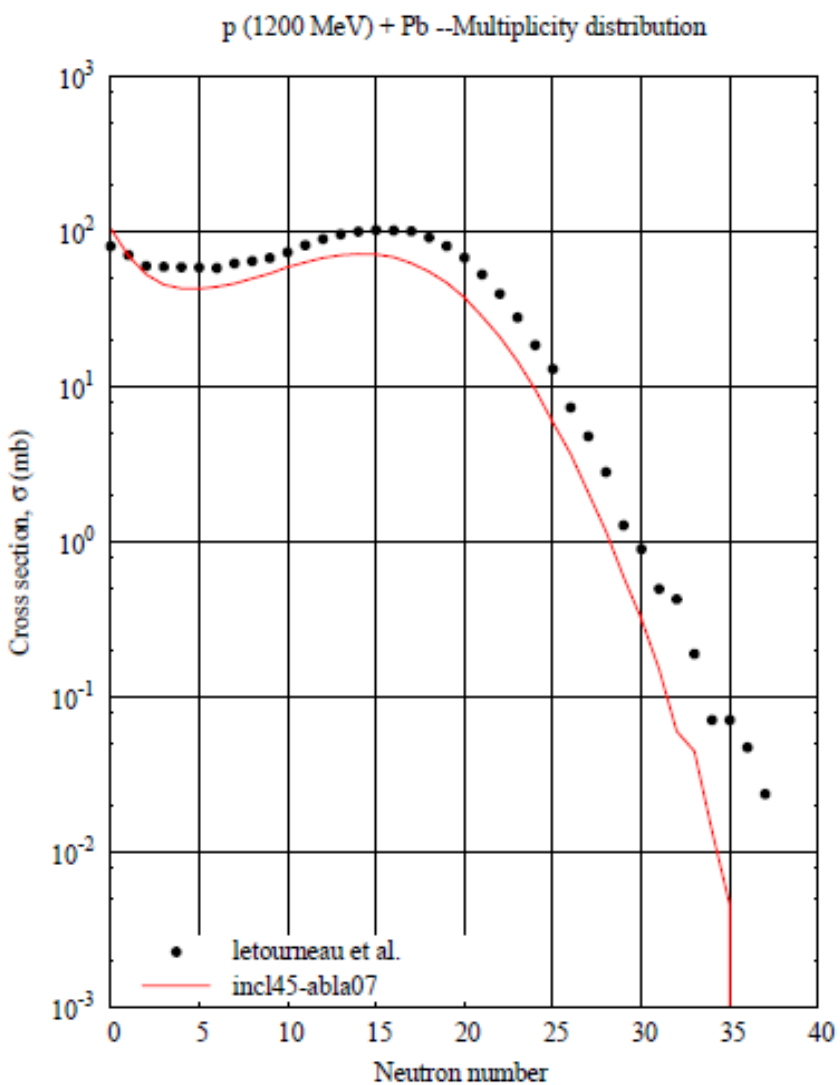

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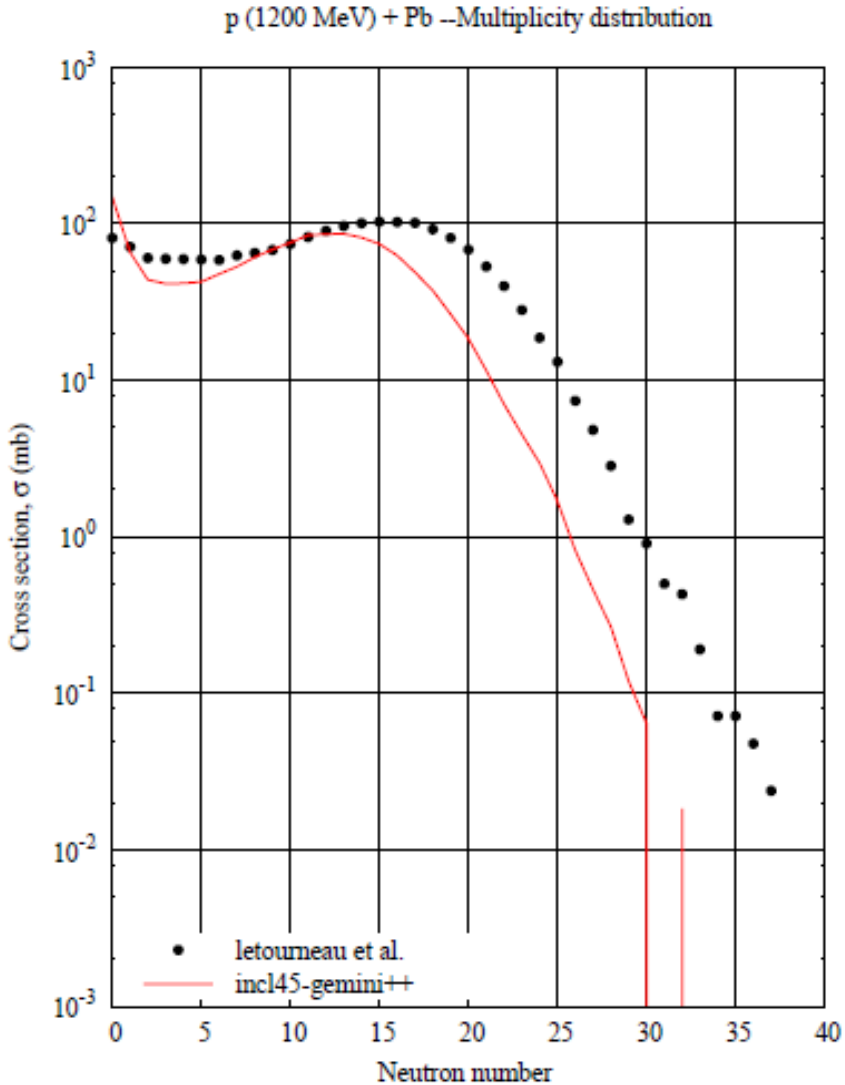
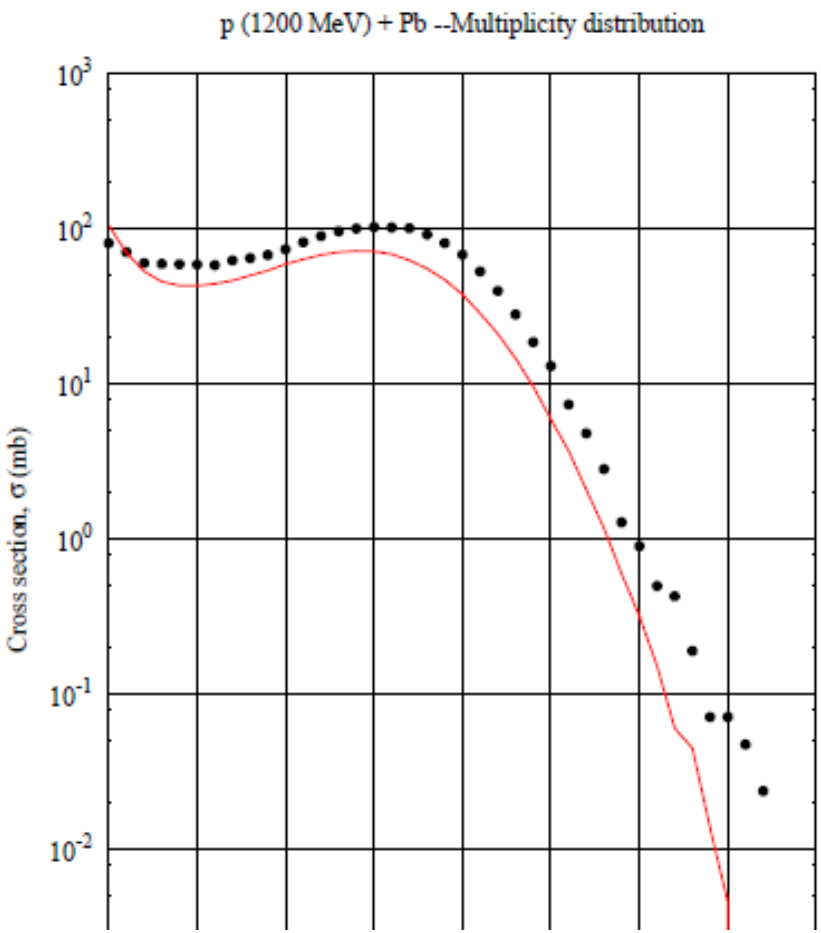


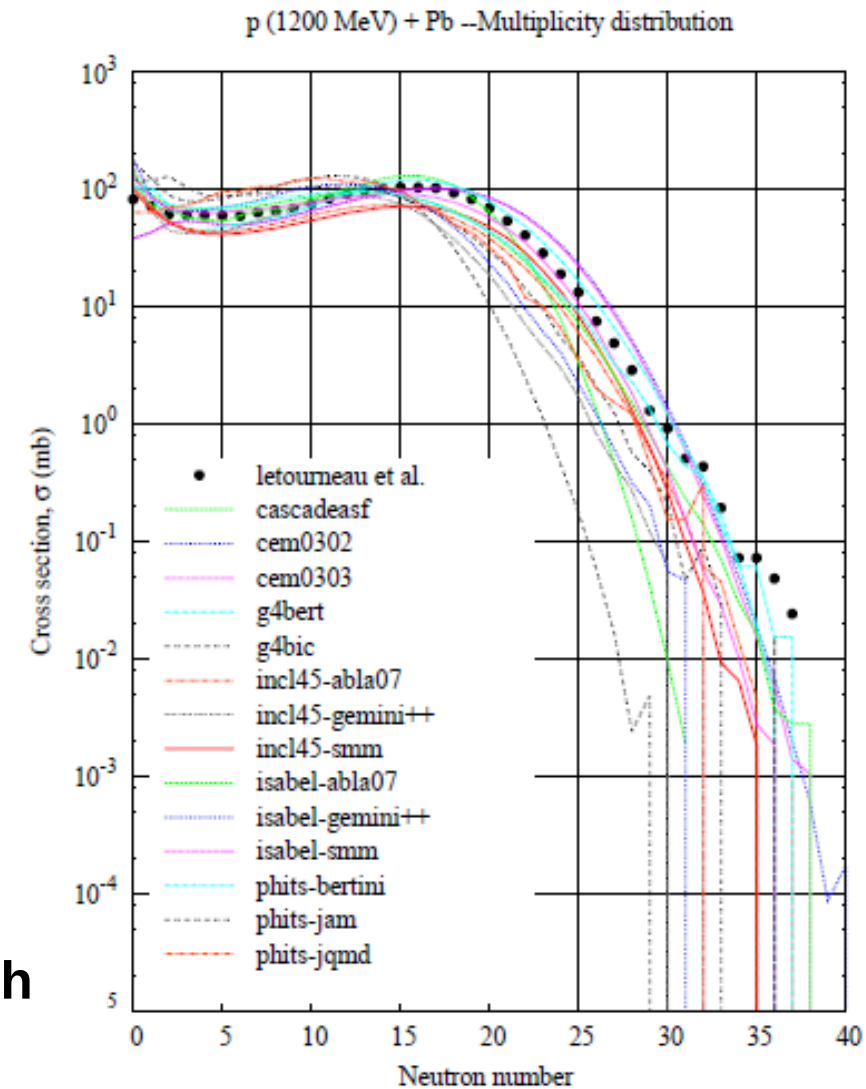
neutron number

p(1200 MeV) + Pb – Neutron multiplicity distribution

INCL45-ABLA07



ALL MODELS

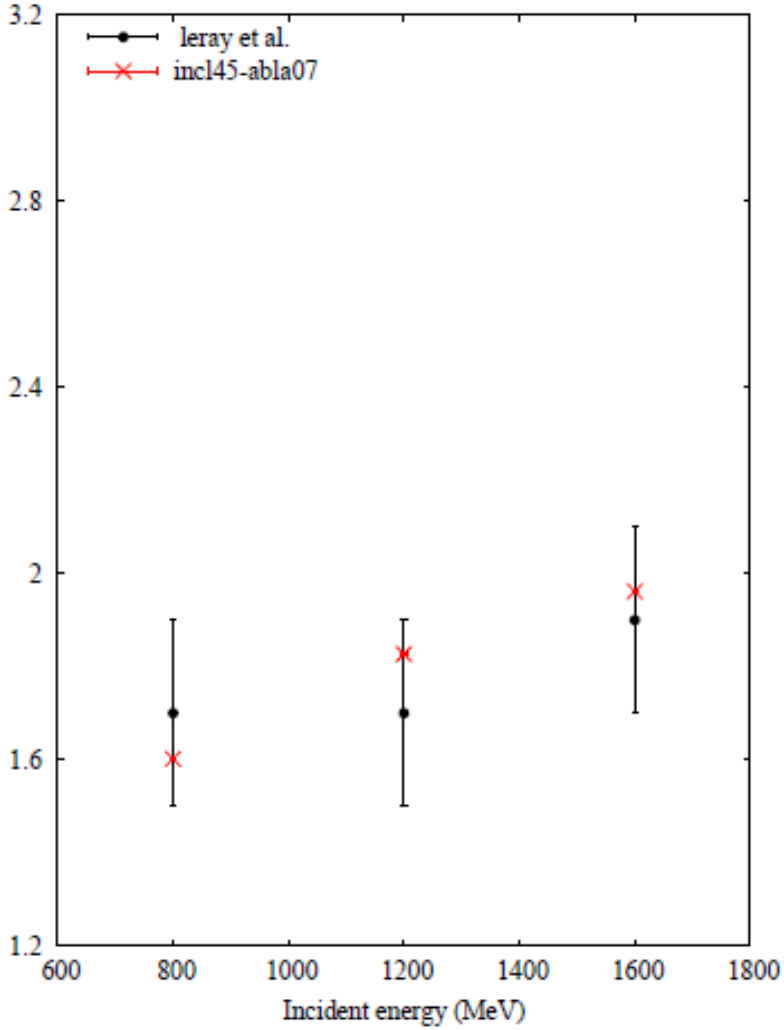


Practically all models: too low high neutron multiplicities

Maybe E* too low?

p + Fe – Average neutron (2-20 MeV) multiplicity

INCL45-ABLA07



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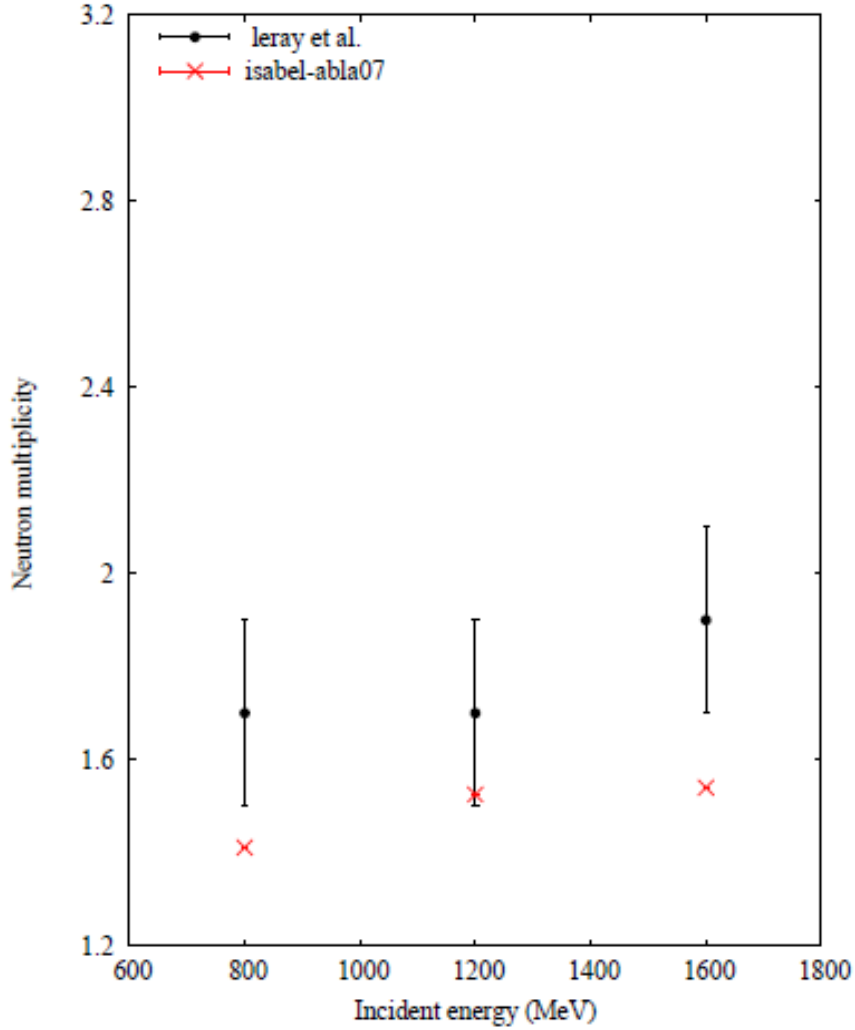


Neutron multiplicity

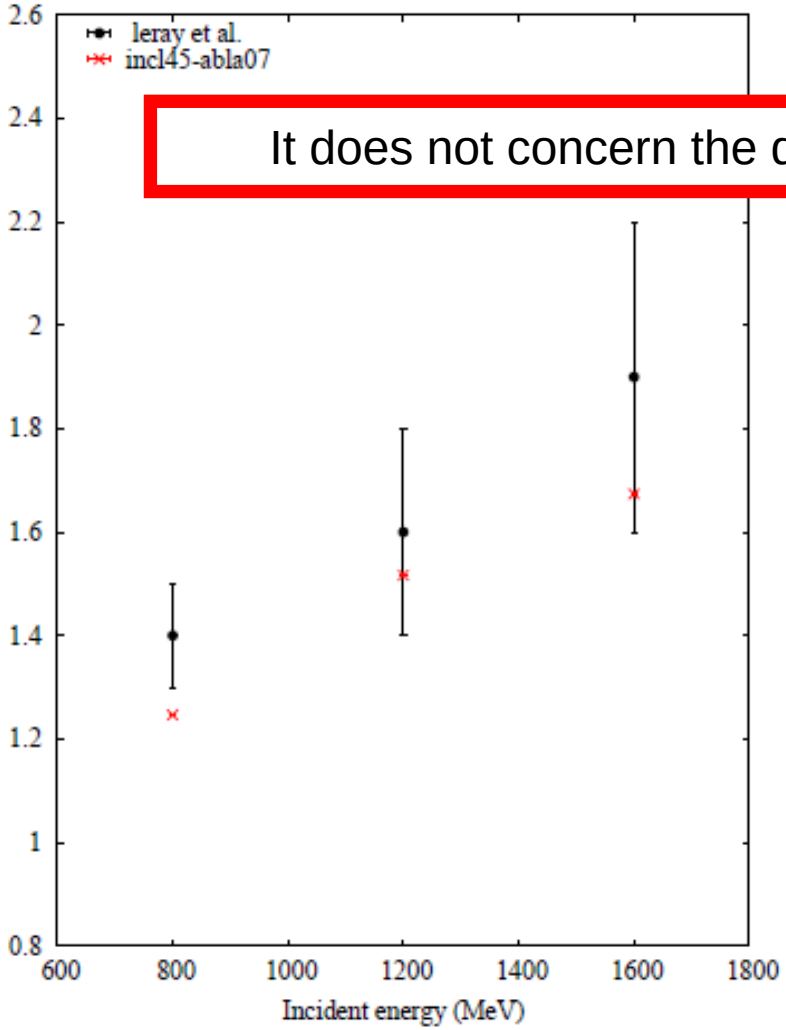
Incident energy (MeV)

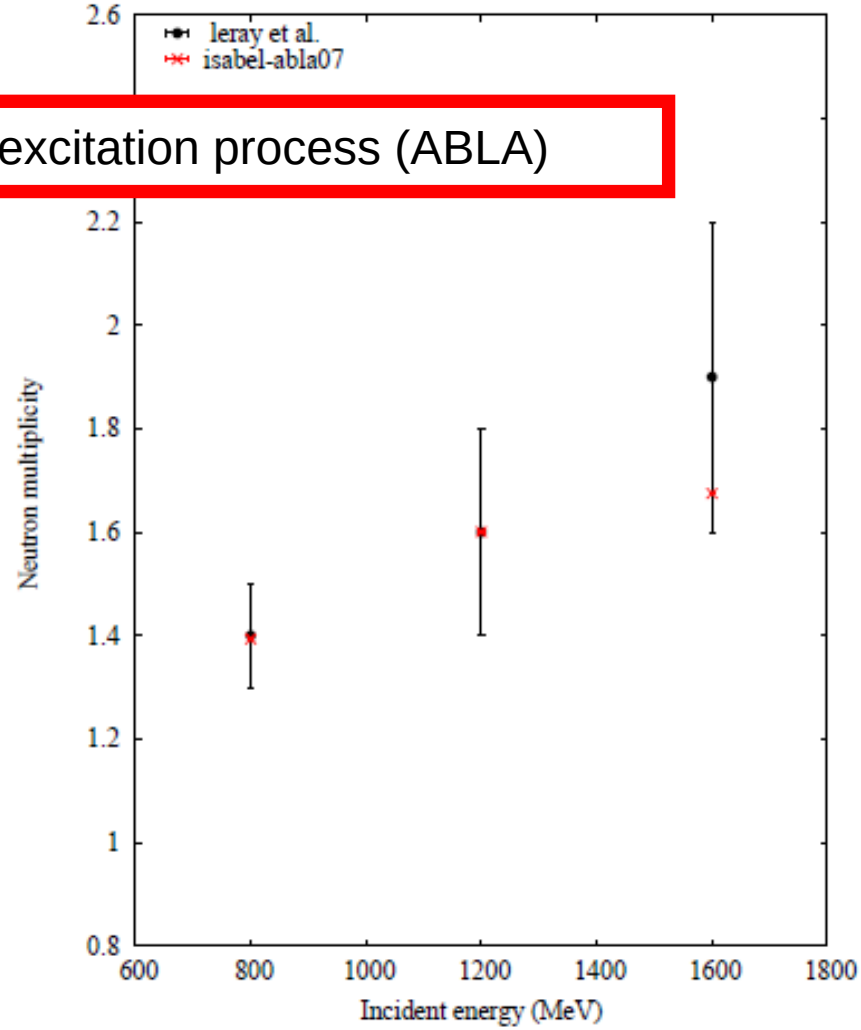
p + Fe – Average neutron (20+ MeV) multiplicity

INCL45-ABLA07

ISABEL-ABLA07

It does not concern the de-excitation process (ABLA)



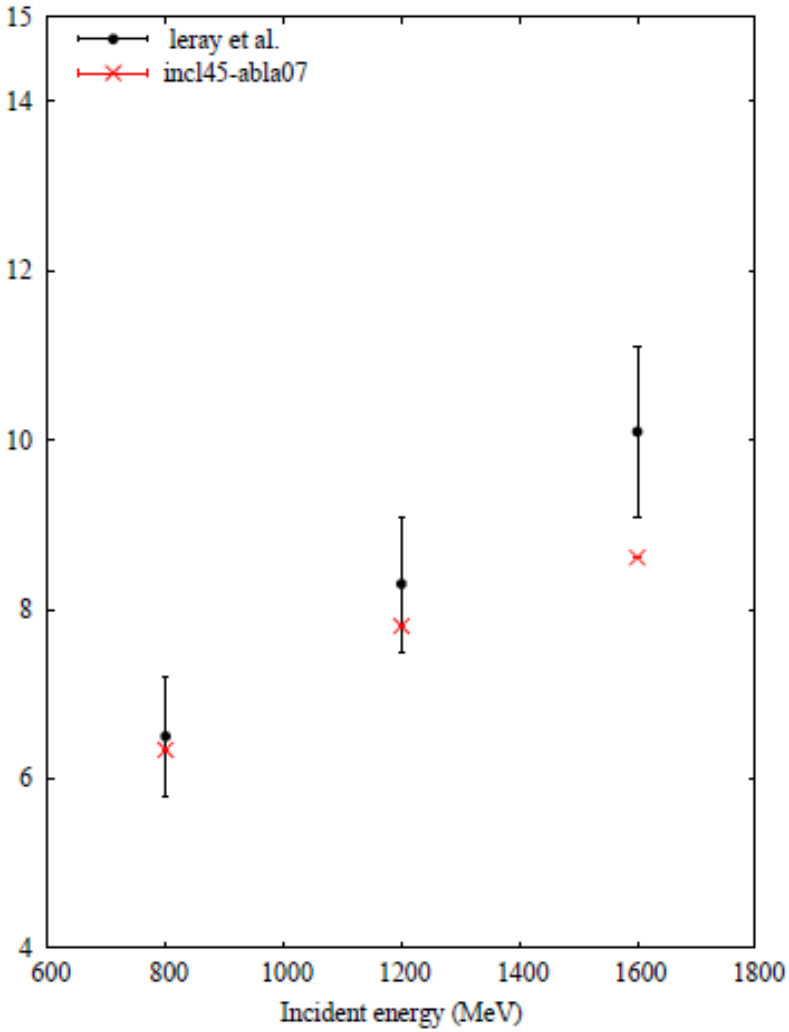


Neutron multiplicity

Incident energy (MeV)

p + Pb – Average neutron (2-20 MeV) multiplicity

INCL45-ABLA07



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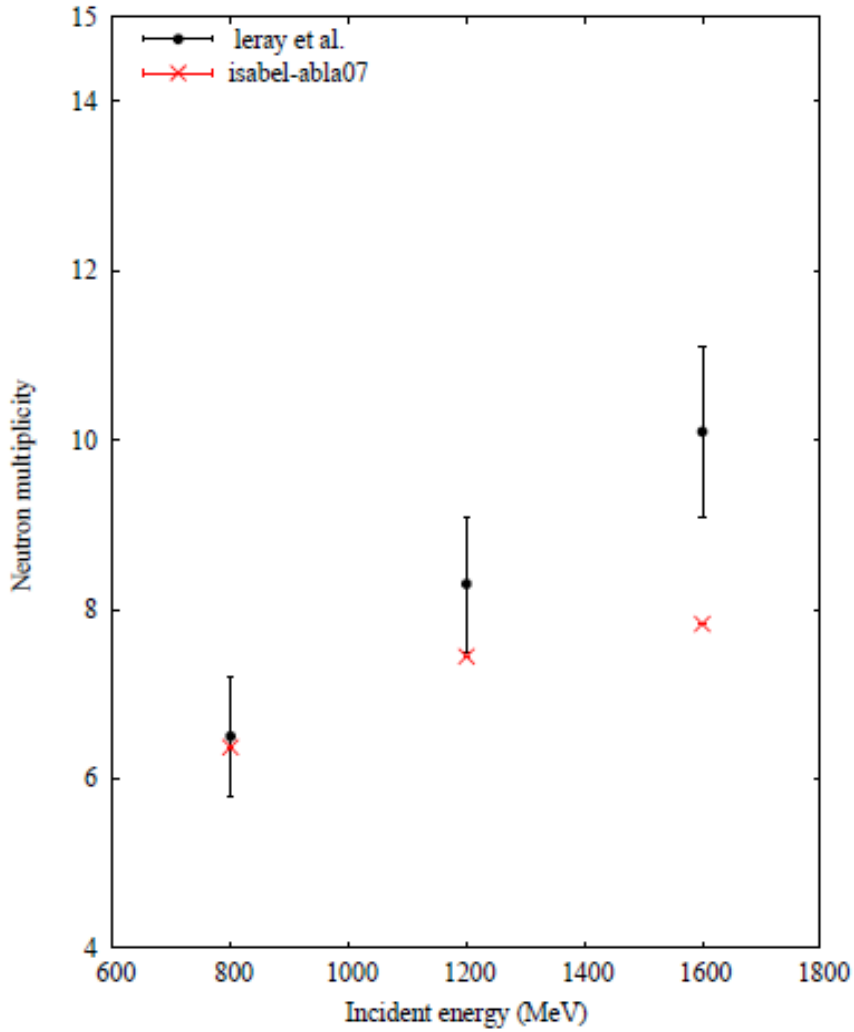

Incident energy (MeV)

p + Pb – Average neutron (2-20 MeV) multiplicity

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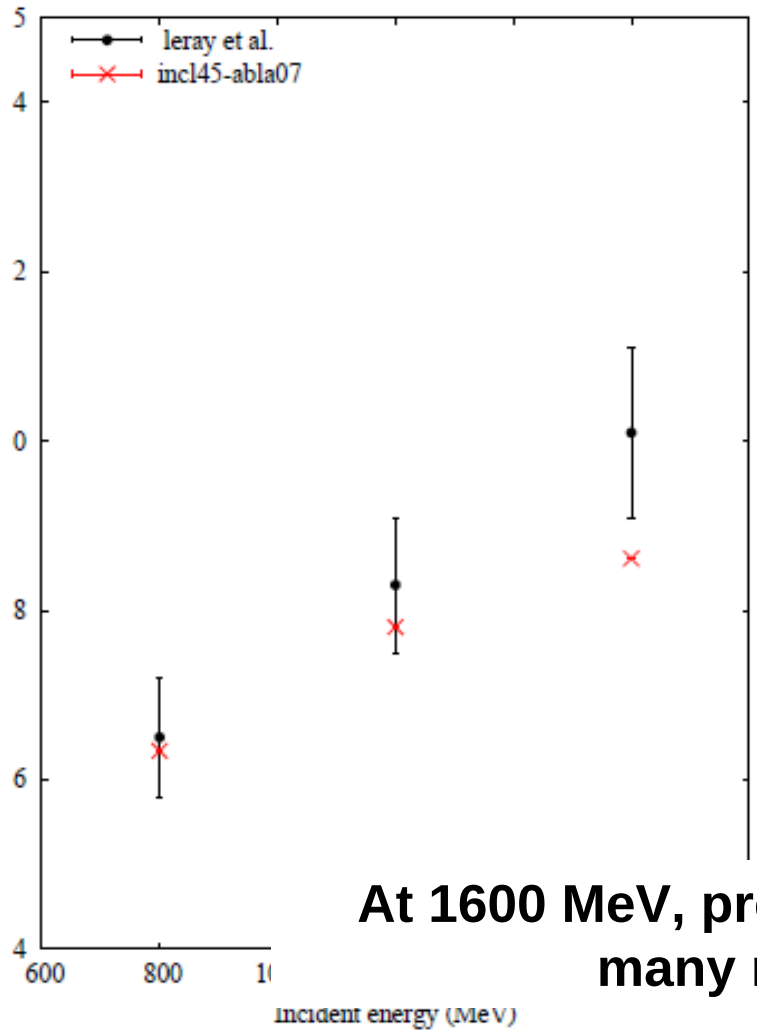
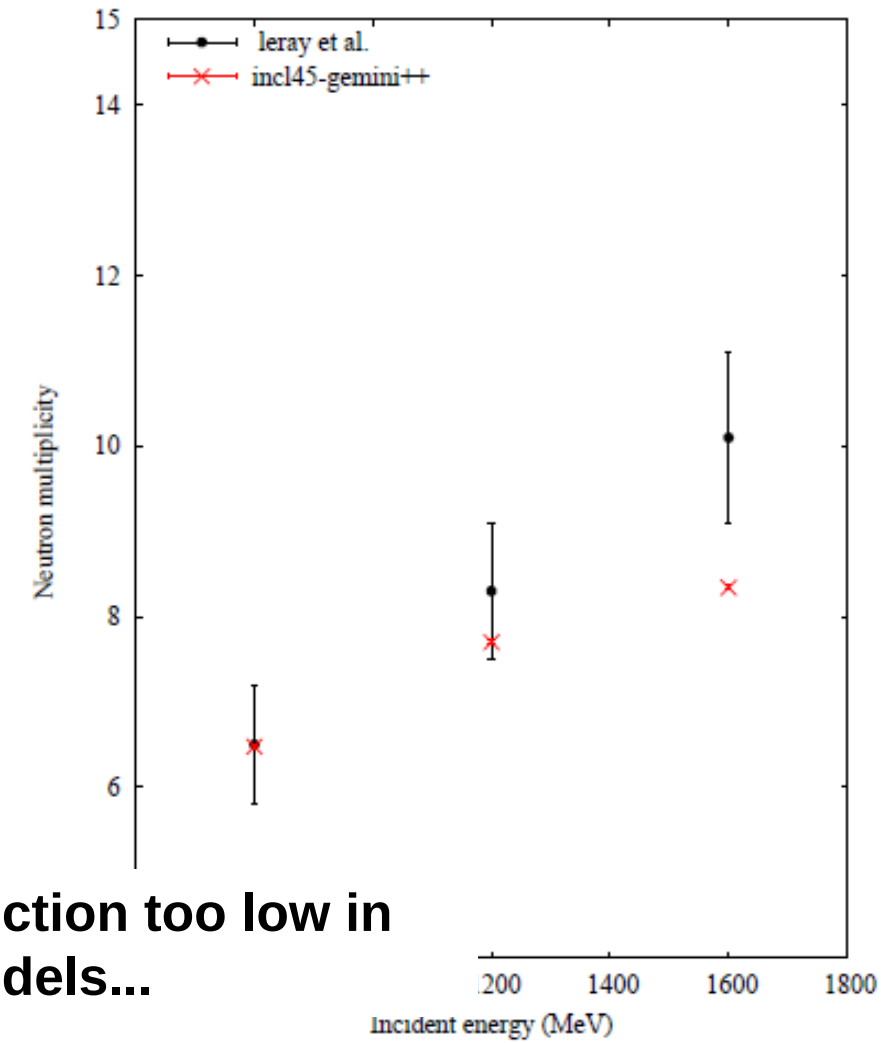


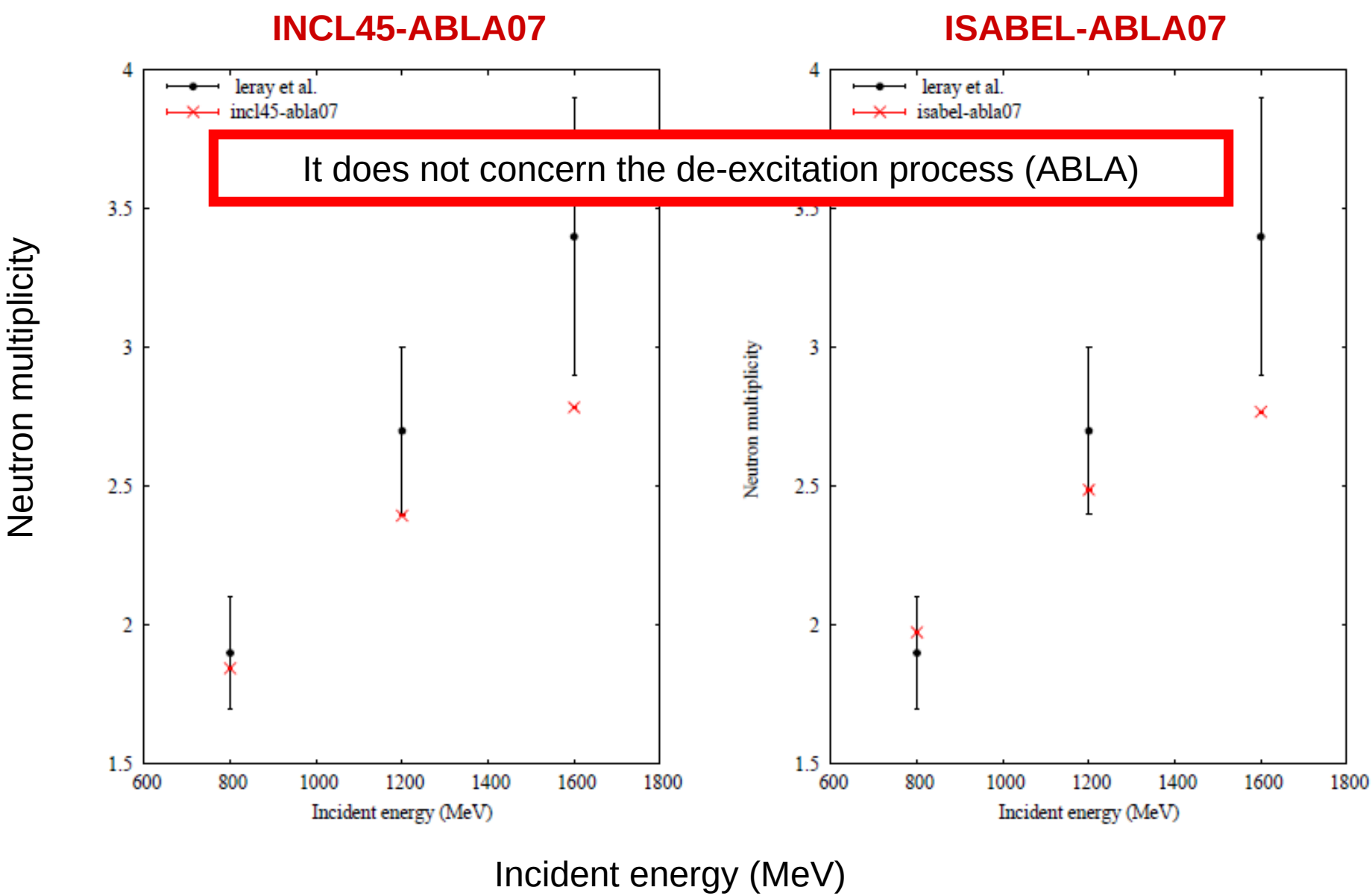
INCL45-GEMINI++



At 1600 MeV, prediction too low in many models...

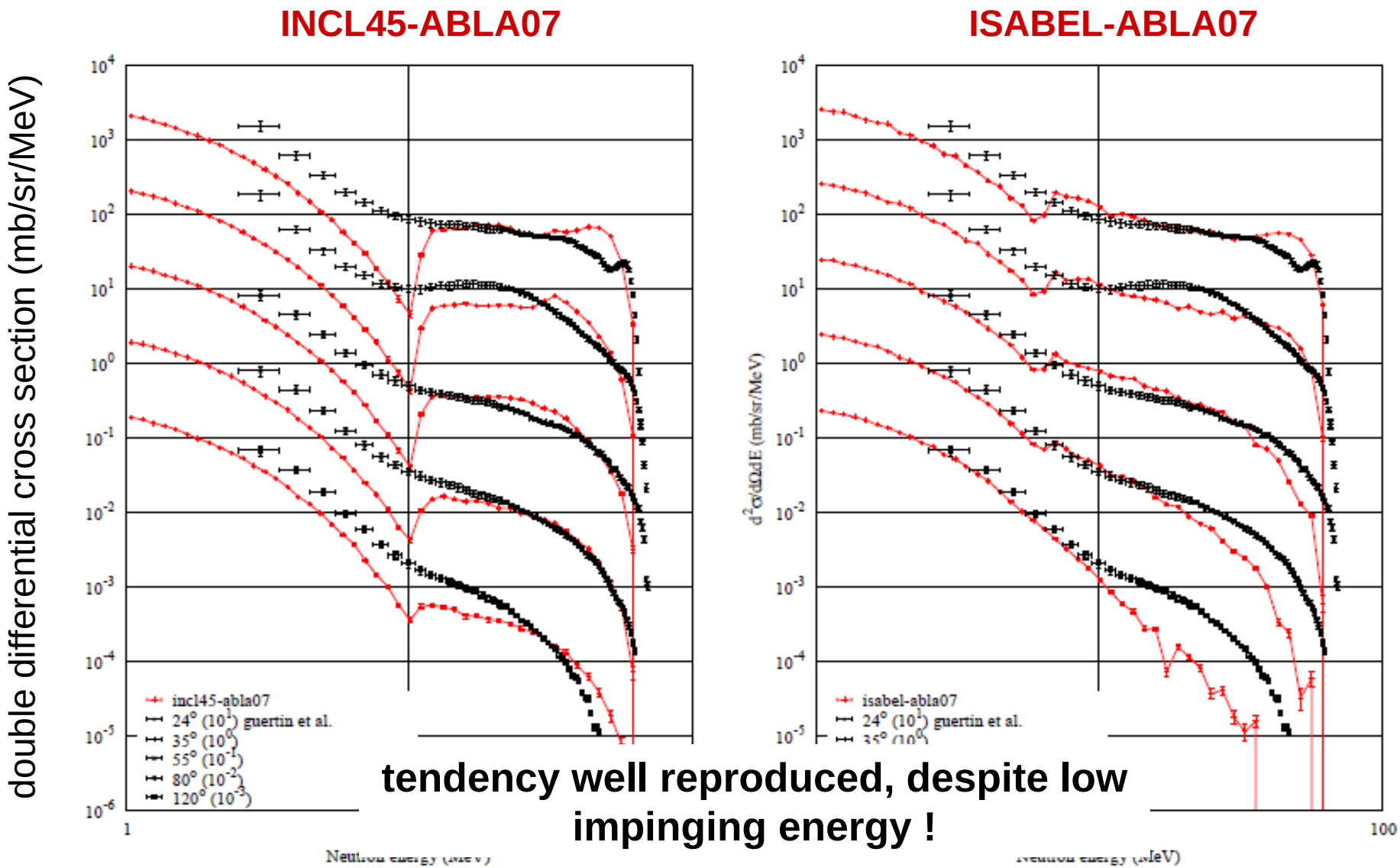
Incident energy (MeV)

p + Pb – Average neutron (20+ MeV) multiplicity



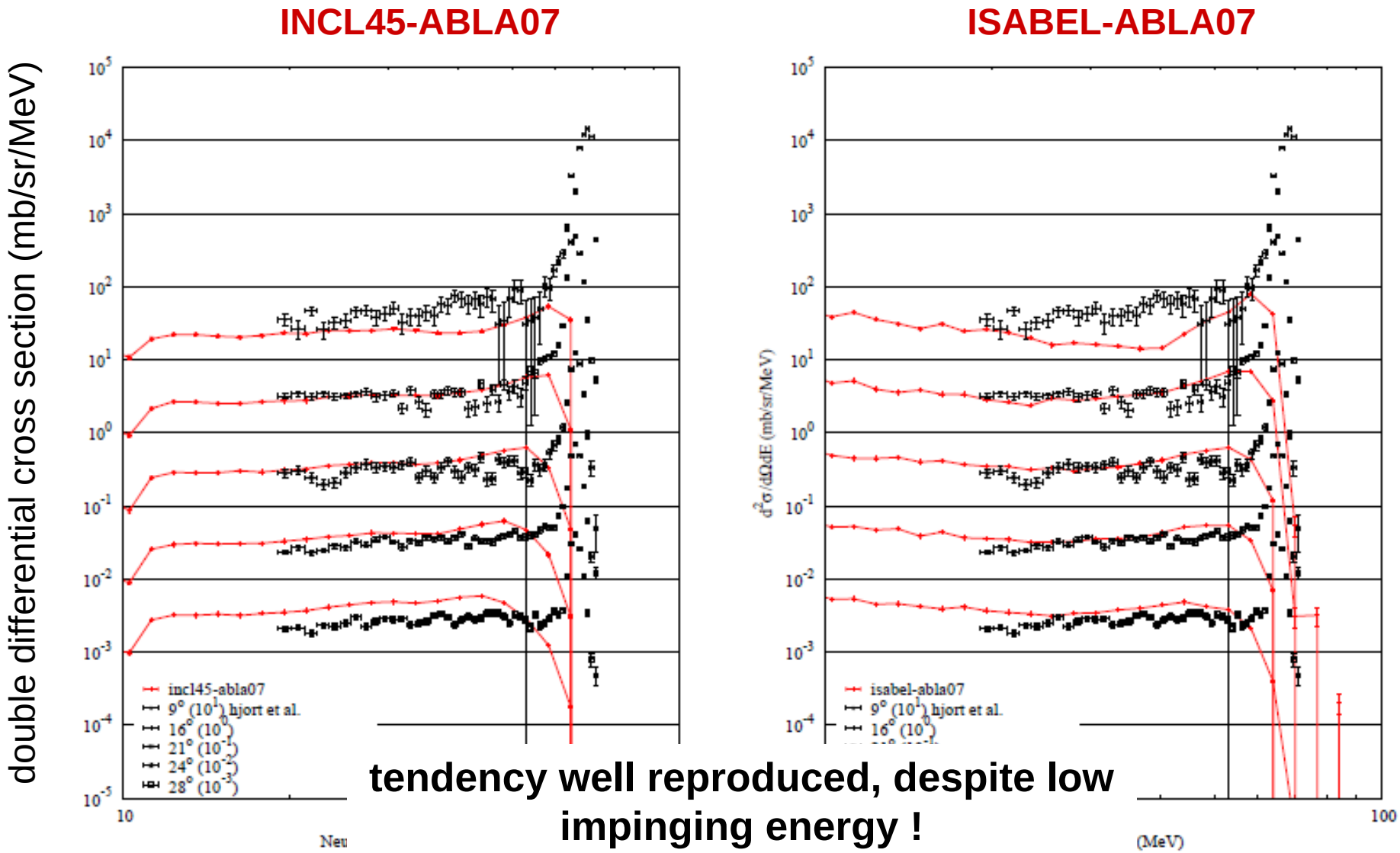
Neutron spectra

p(63 MeV) + ^{208}Pb – Neutron spectrum



tendency well reproduced, despite low impinging energy !

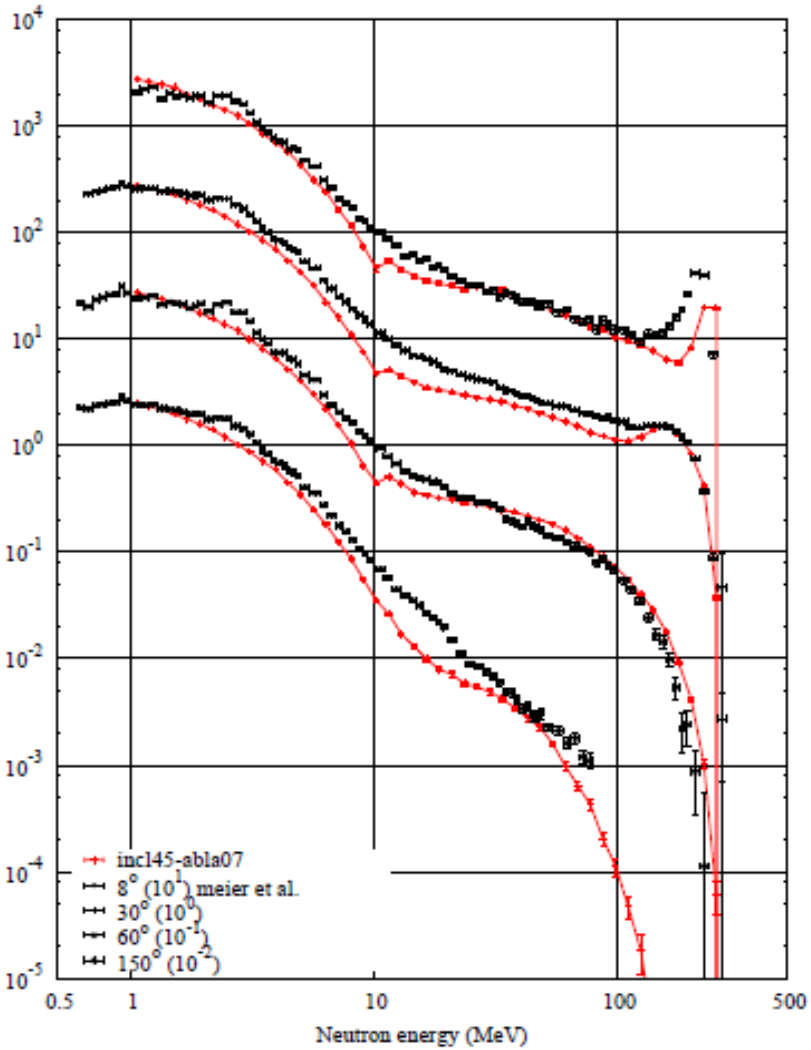
n(65 MeV) + Fe – Neutron spectrum



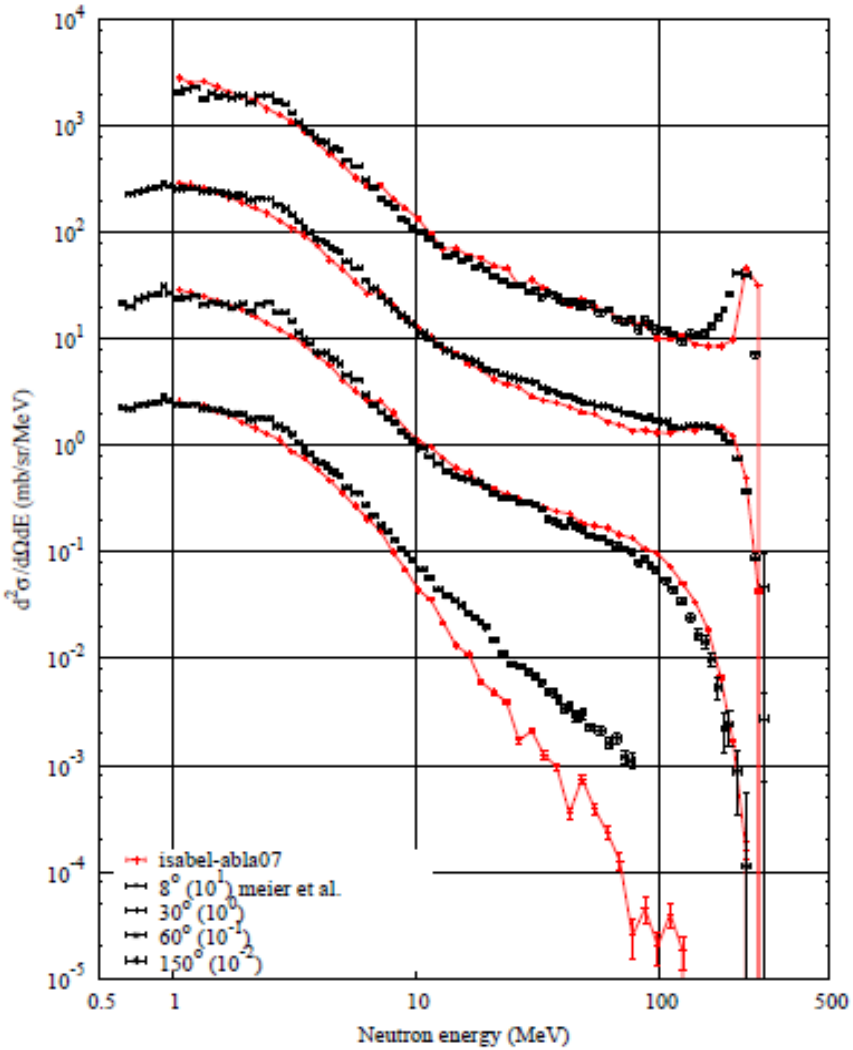
tendency well reproduced, despite low impinging energy !

p(256 MeV) + Pb – Neutron spectrum

INCL45-ABLA07



ISABEL-ABLA07

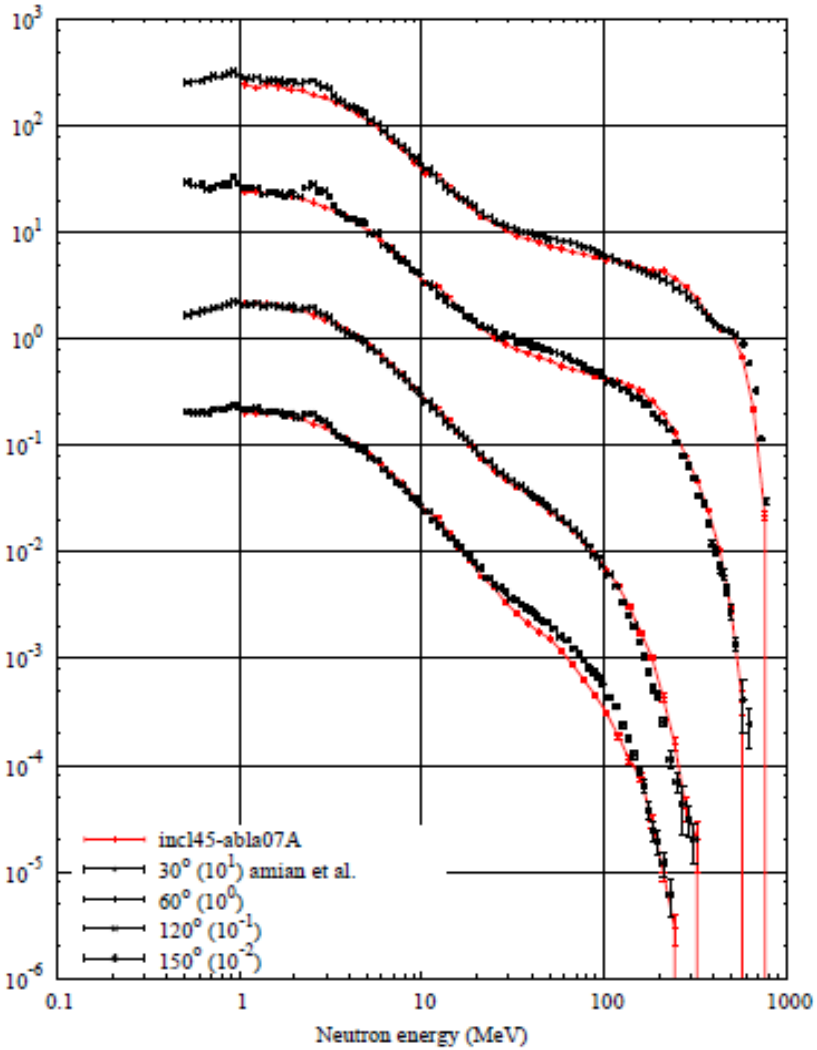


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(800 MeV) + Fe – Neutron spectrum

INCL45-ABLA07



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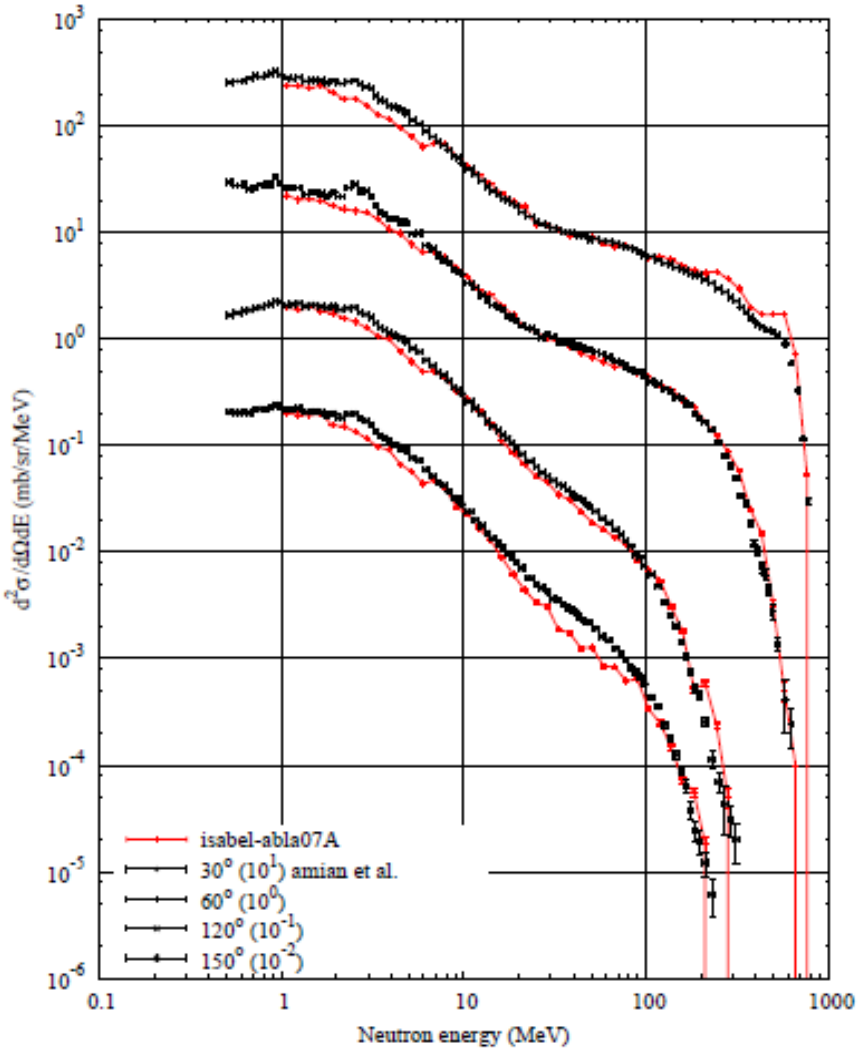

double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(800 MeV) + Fe – Neutron spectrum

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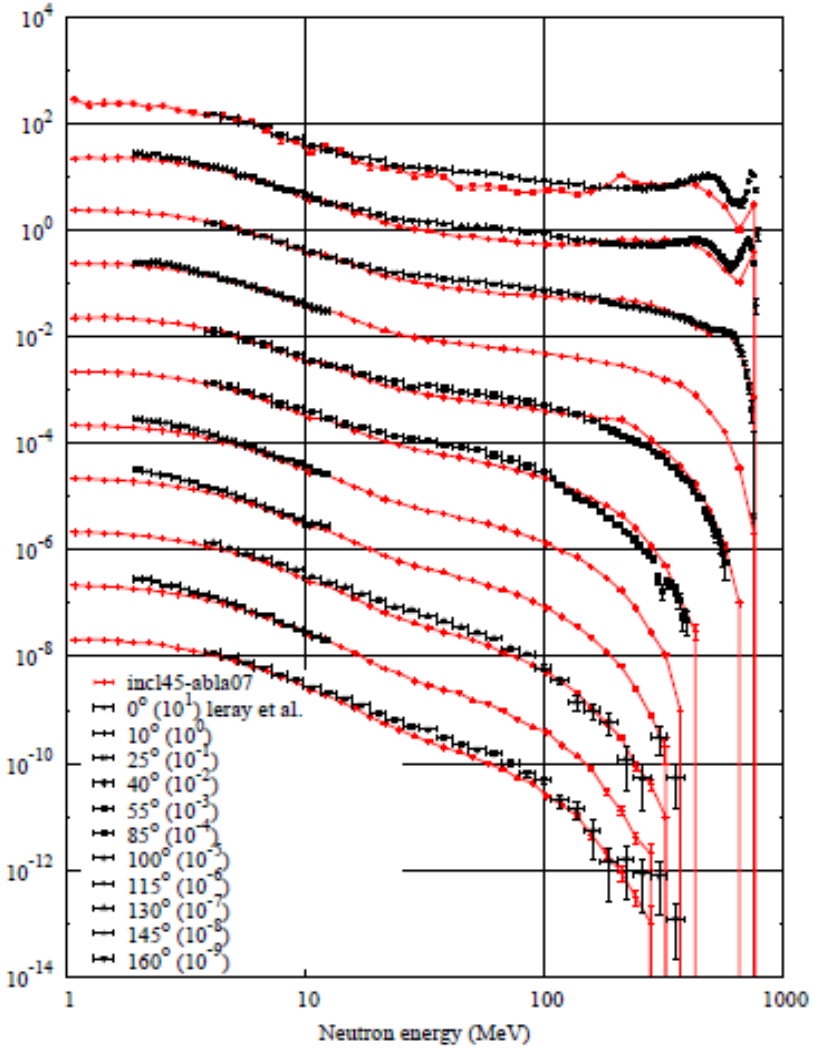

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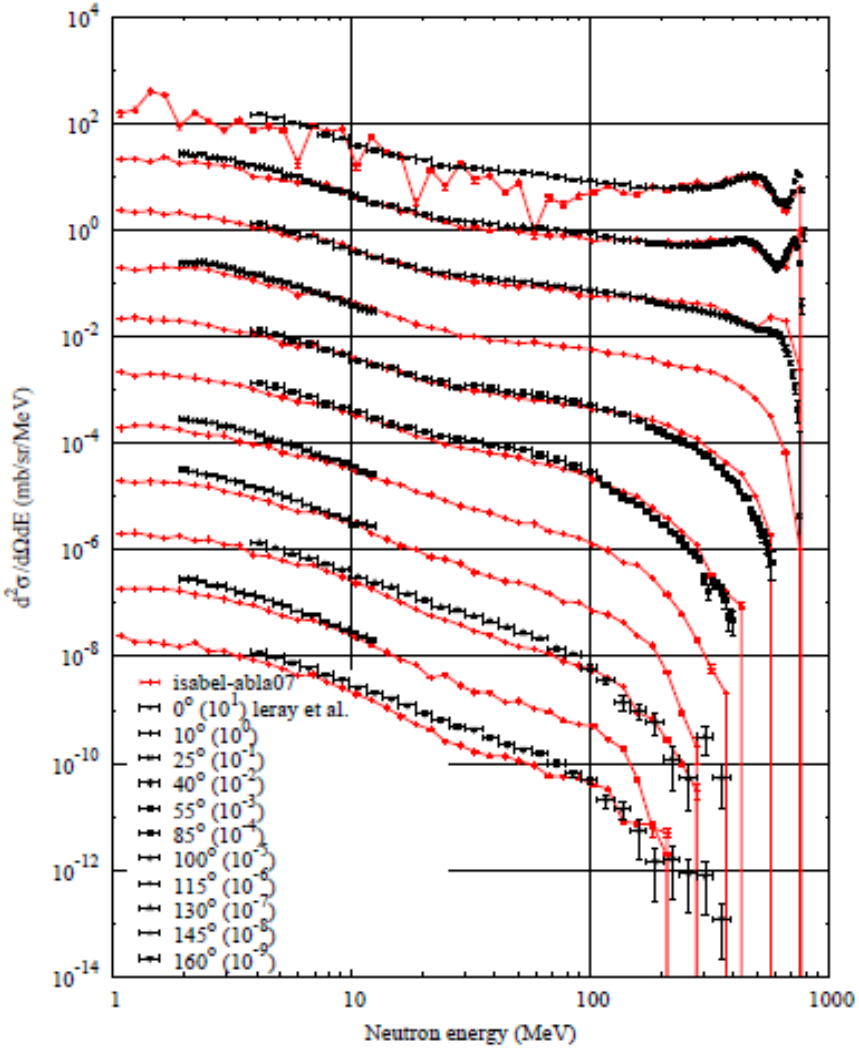
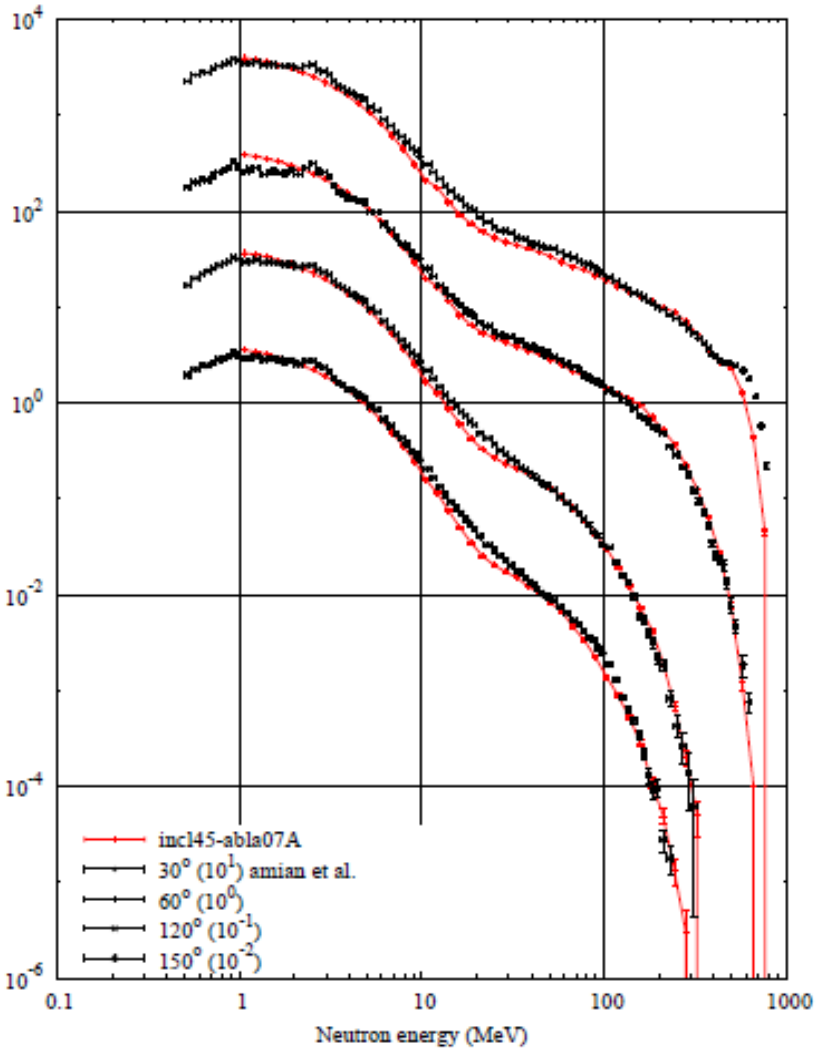


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(800 MeV) + Pb – Neutron spectrum

INCL45-ABLA07



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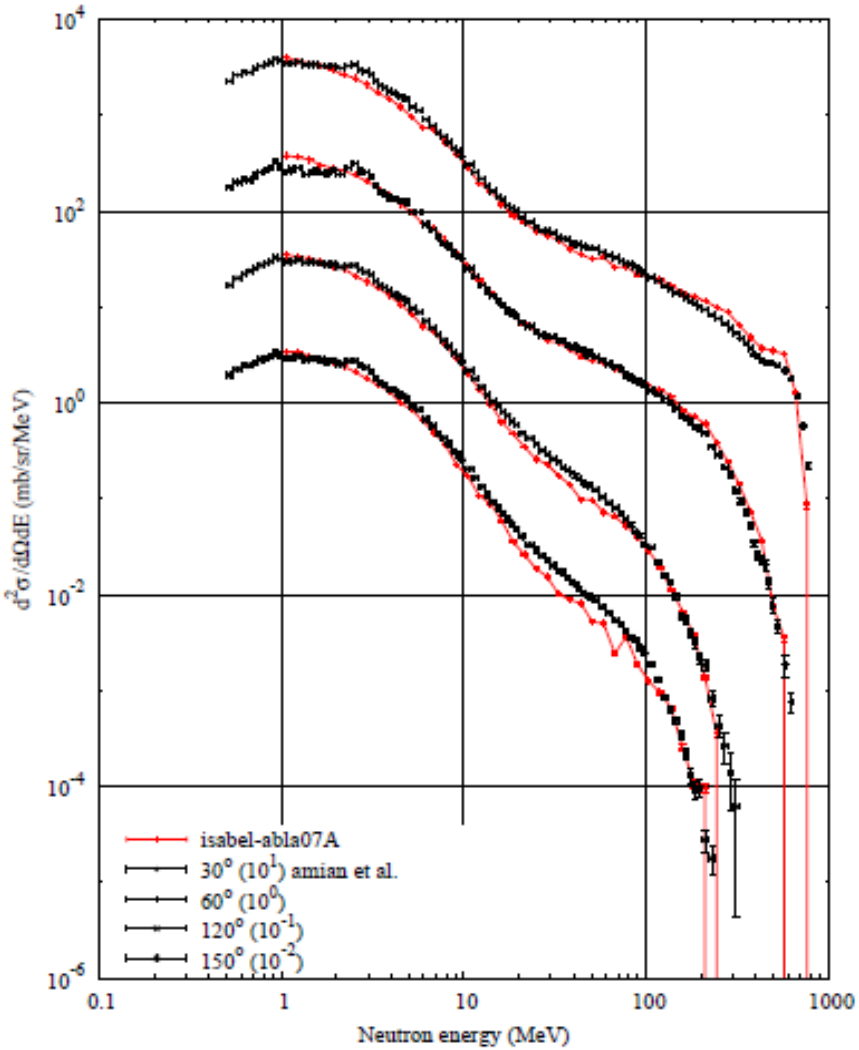
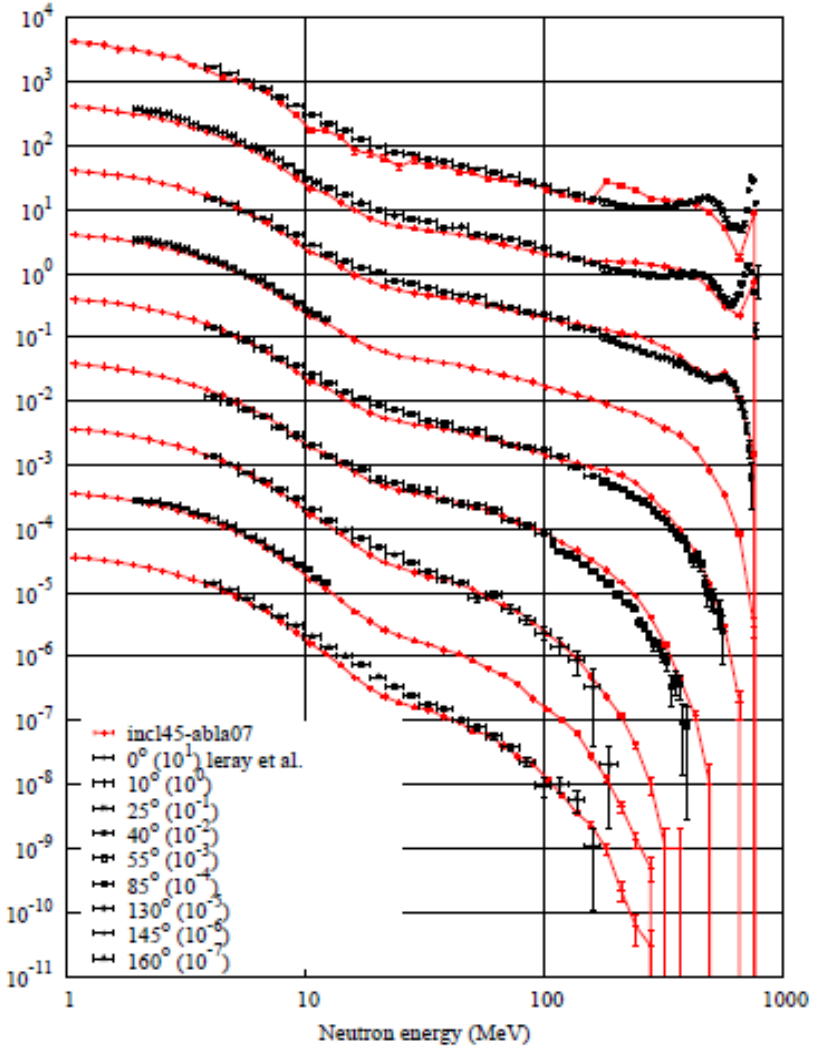


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(800 MeV) + Pb – Neutron spectrum

INCL45-ABLA07



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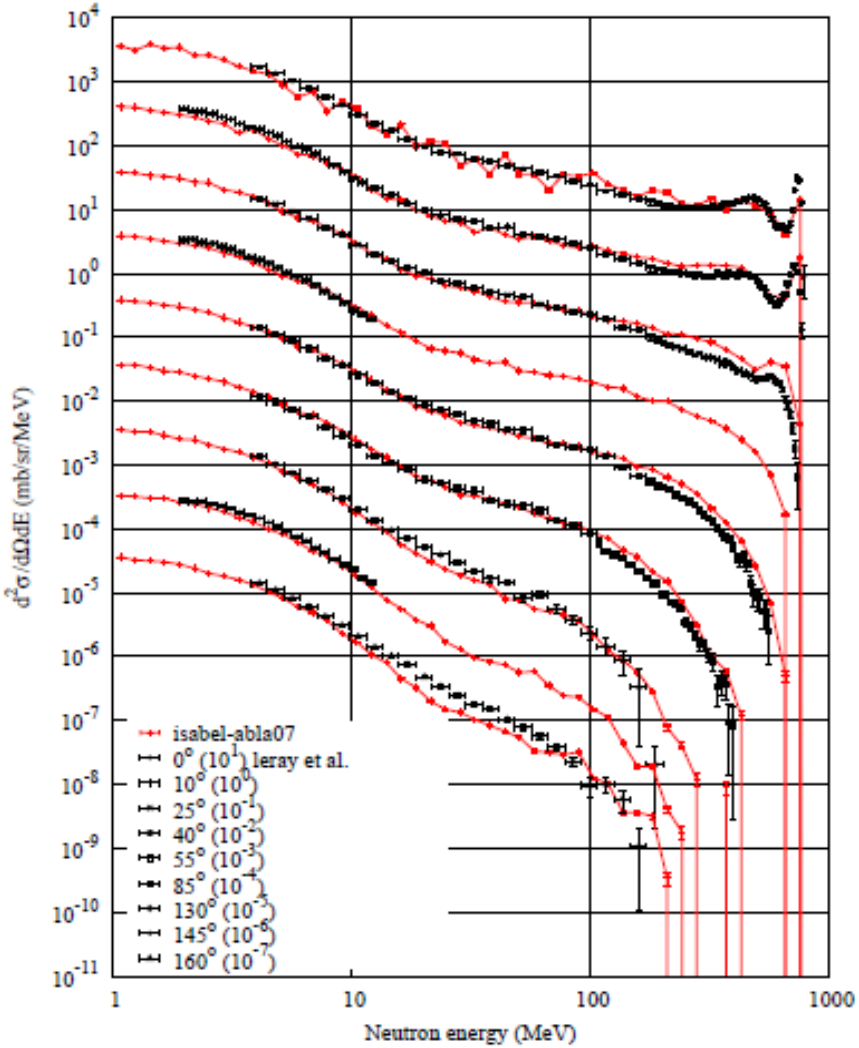
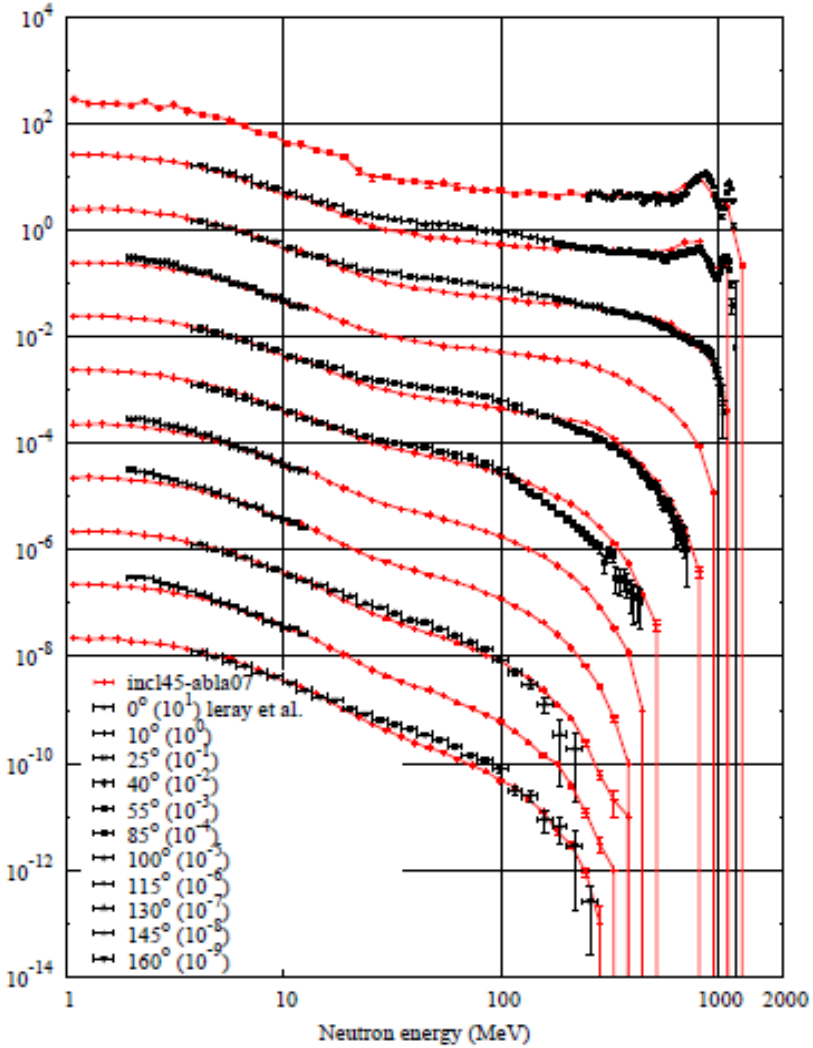


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(1200 MeV) + Fe – Neutron spectrum

INCL45-ABLA07



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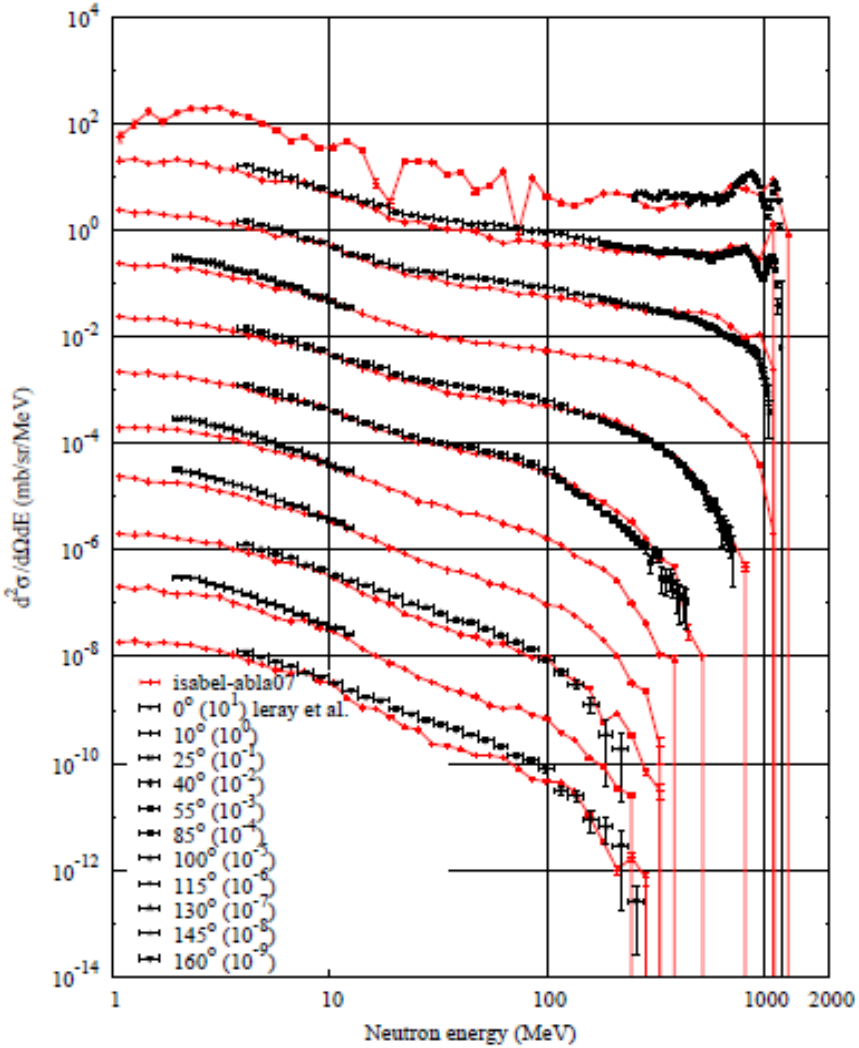
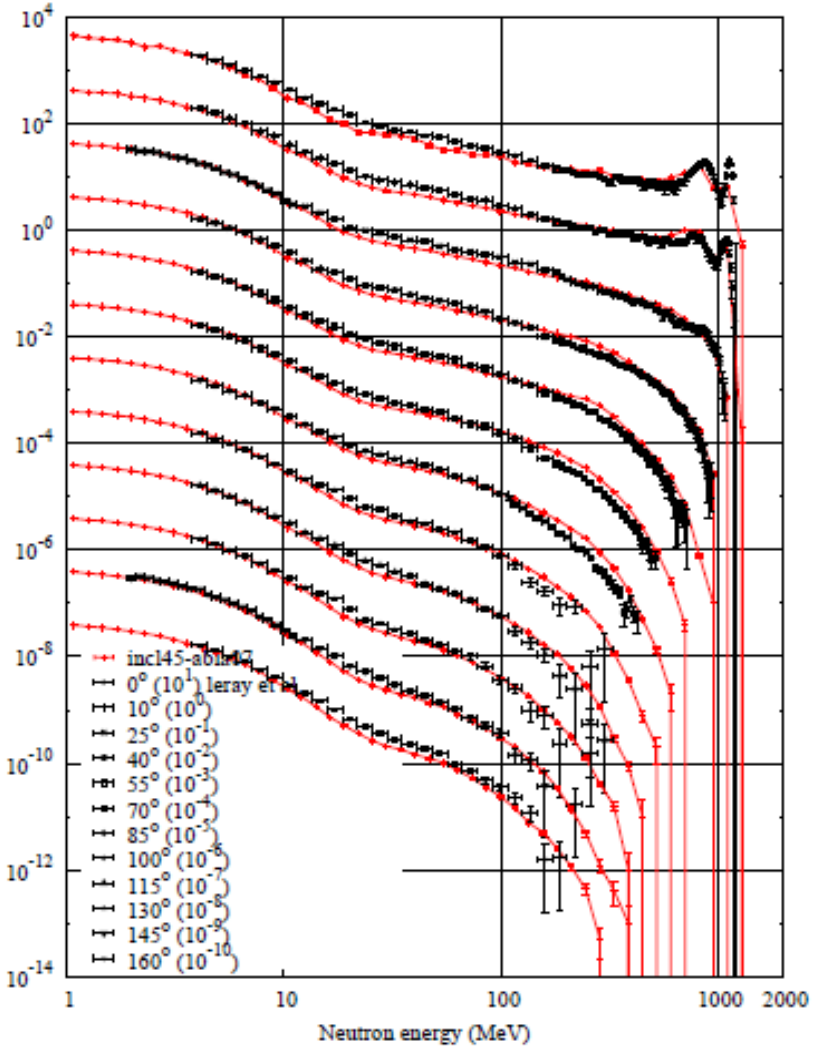


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(1200 MeV) + Pb – Neutron spectrum

INCL45-ABLA07



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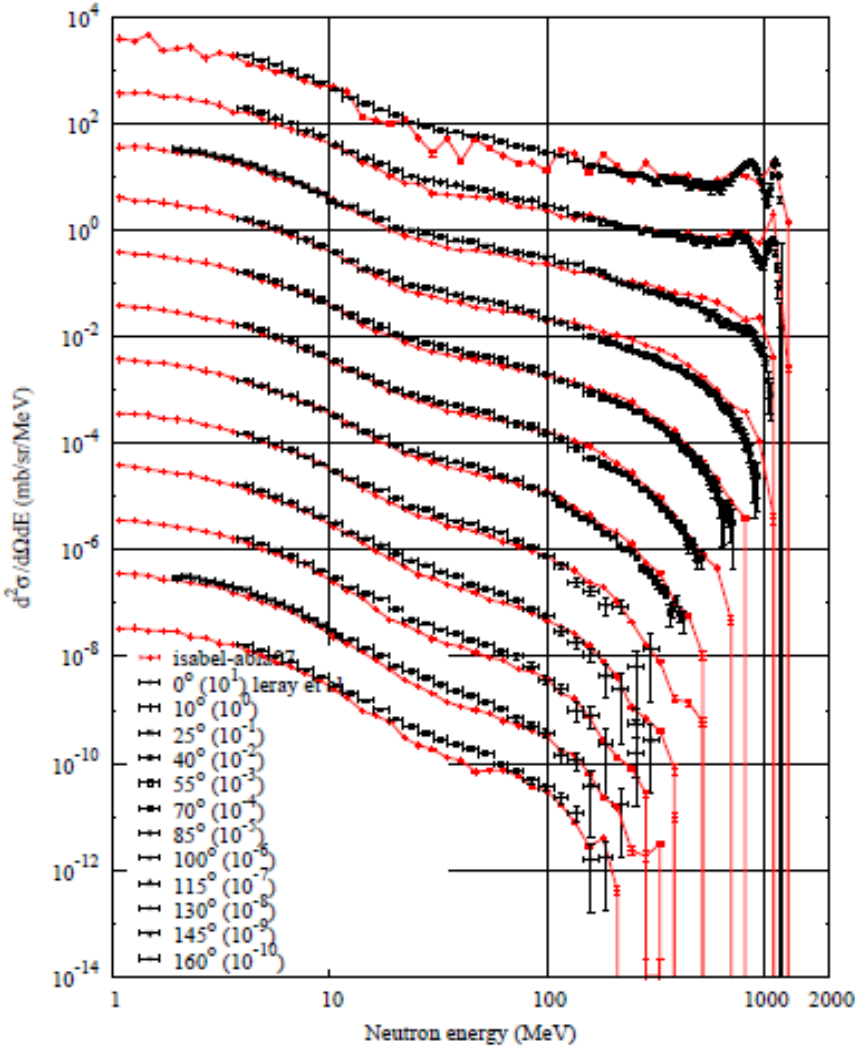
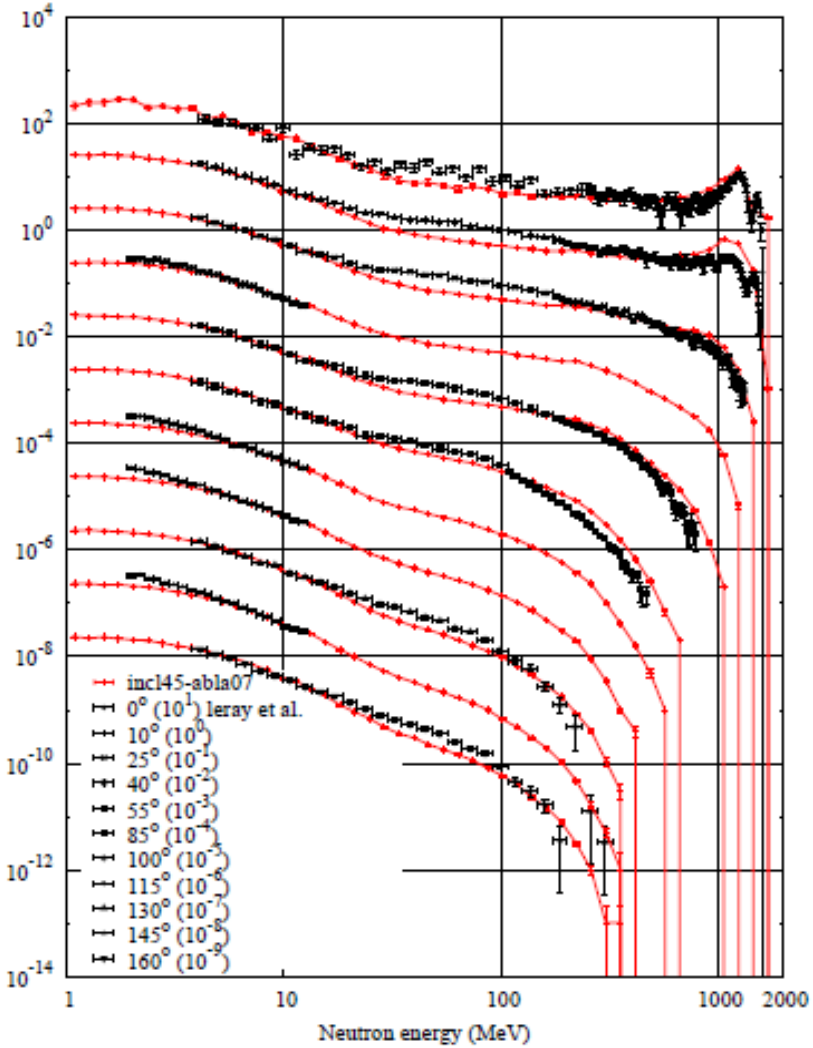


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(1600 MeV) + Fe – Neutron spectrum

INCL45-ABLA07



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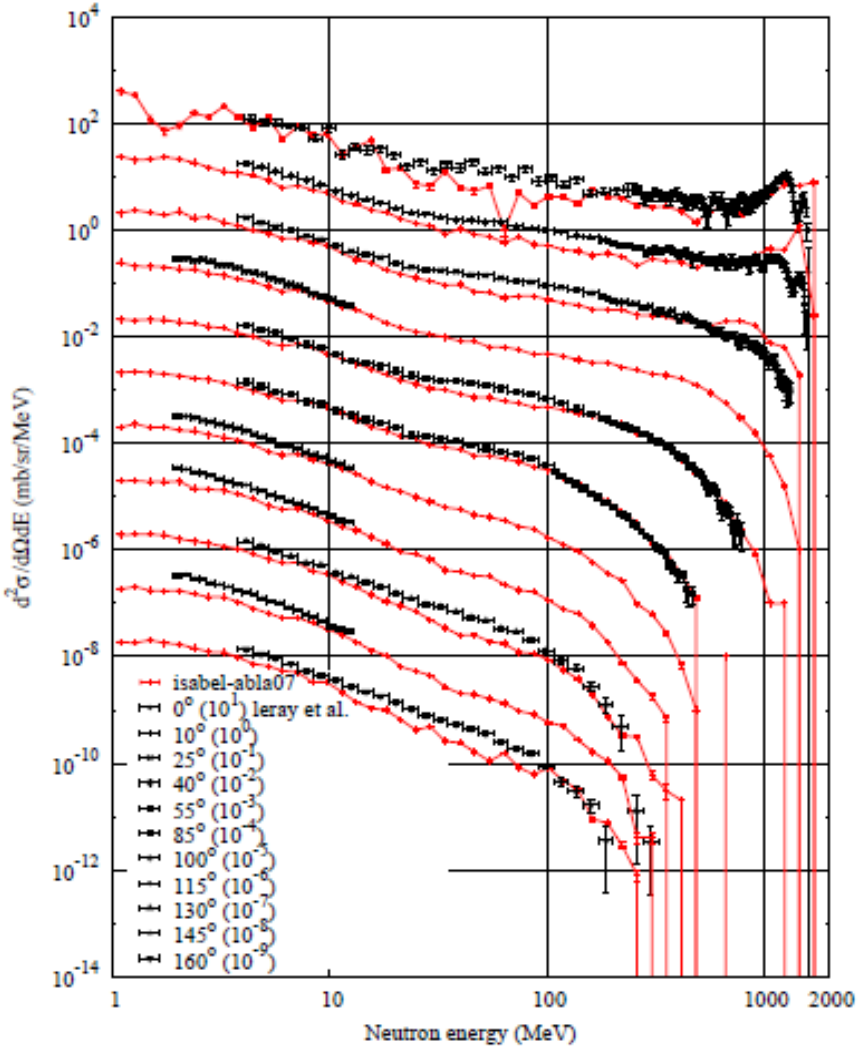
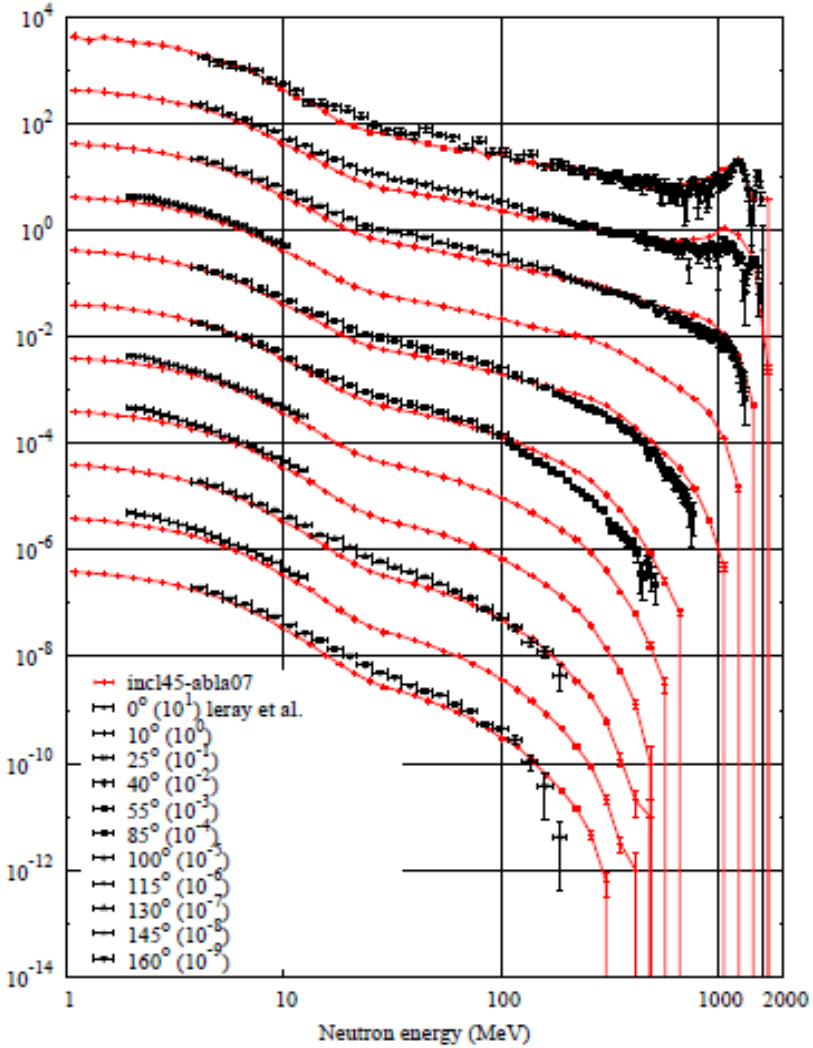


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(1600 MeV) + Pb – Neutron spectrum

INCL45-ABLA07



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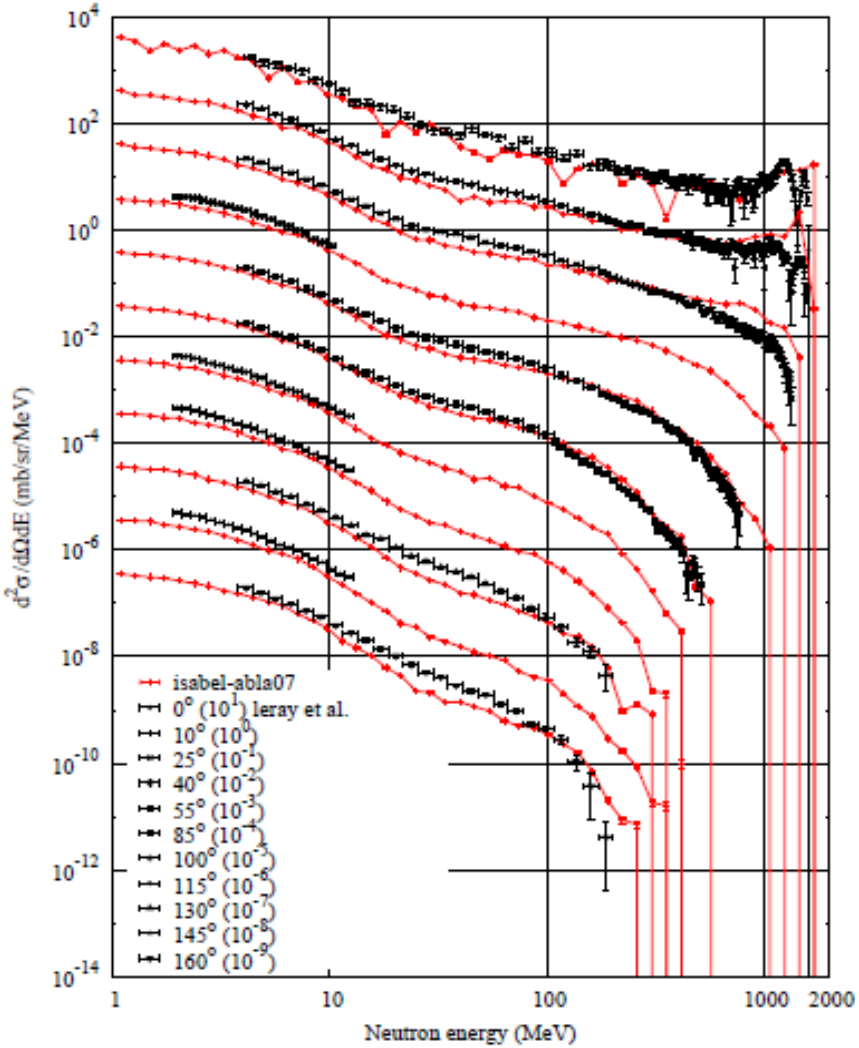
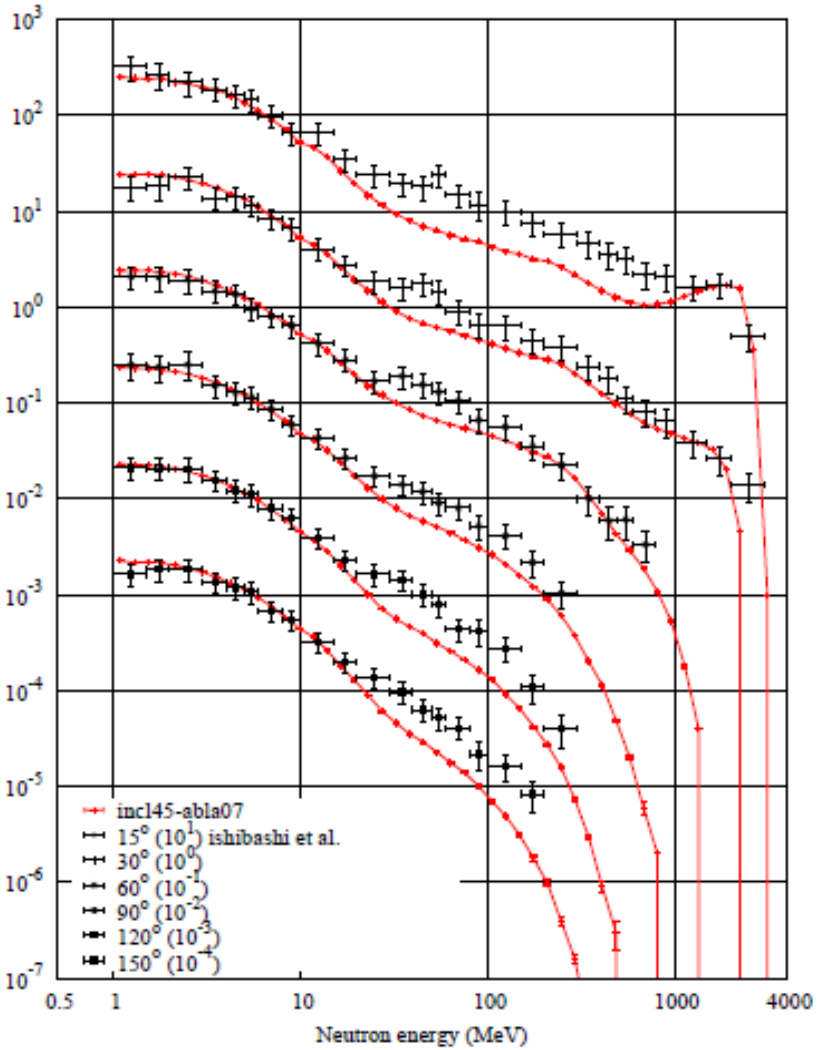


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(3000 MeV) + Fe – Neutron spectrum

INCL45-ABLA07



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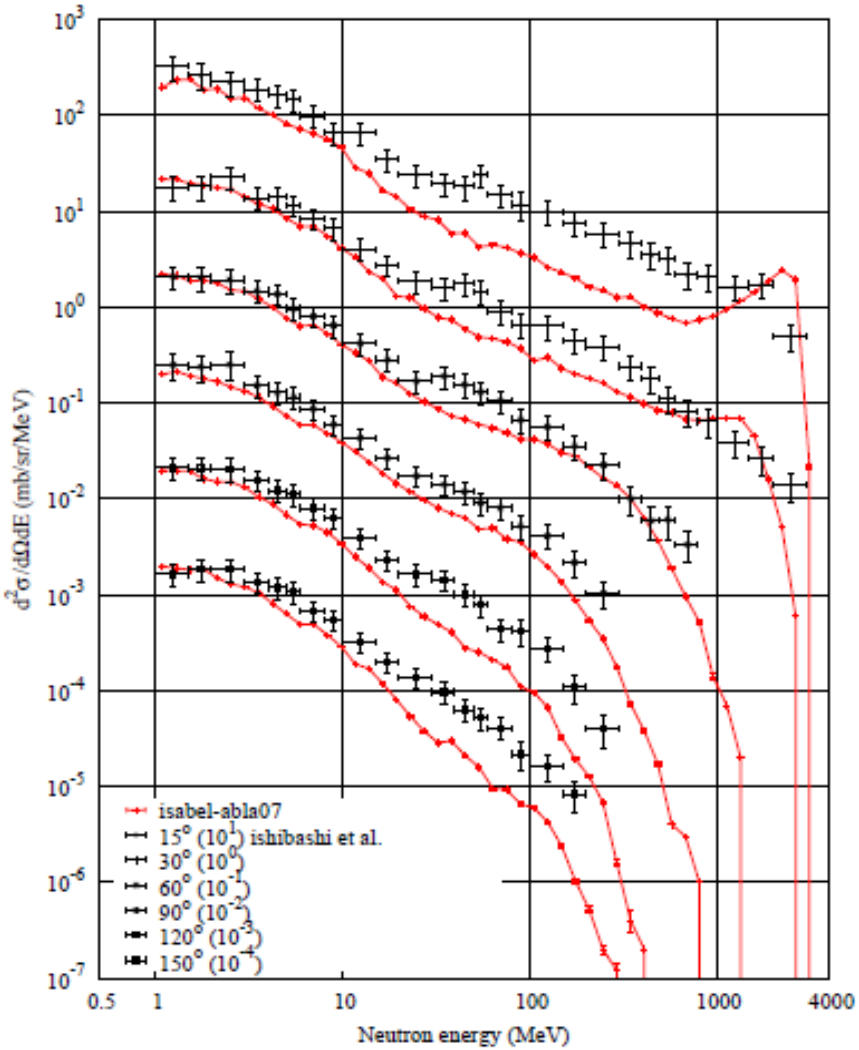
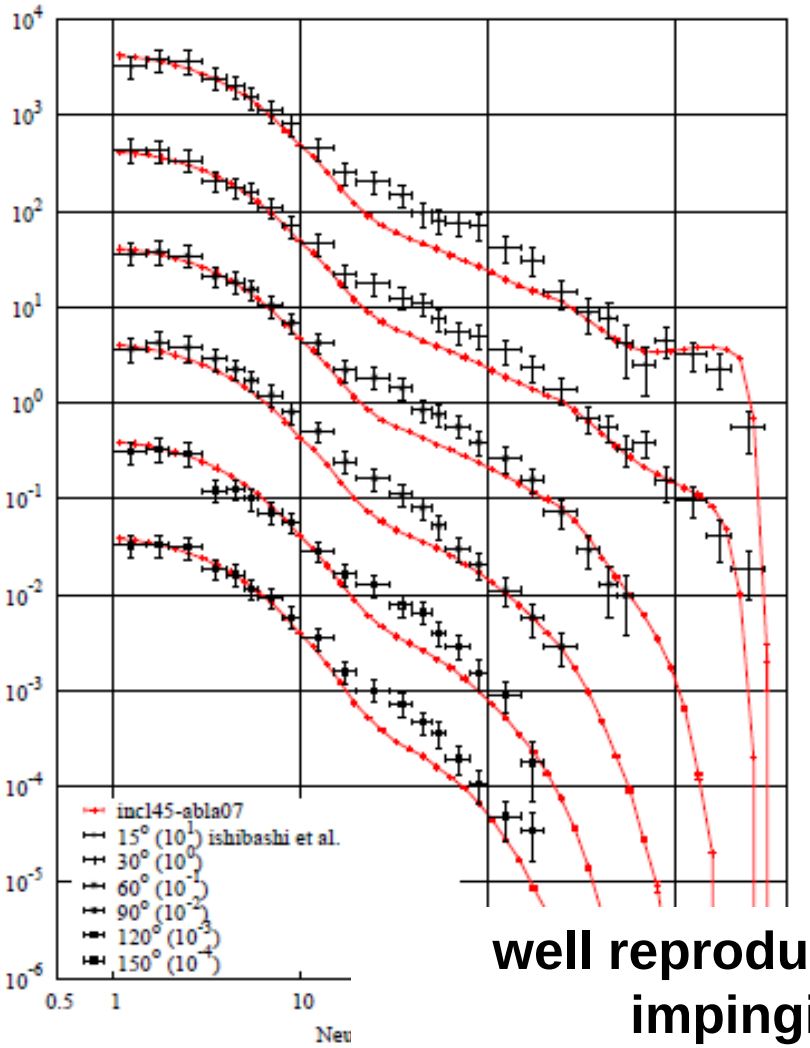


double differential cross section (mb/sr/MeV)

neutron energy (MeV)

p(3000 MeV) + Pb – Neutron spectrum

INCL45-ABLA07



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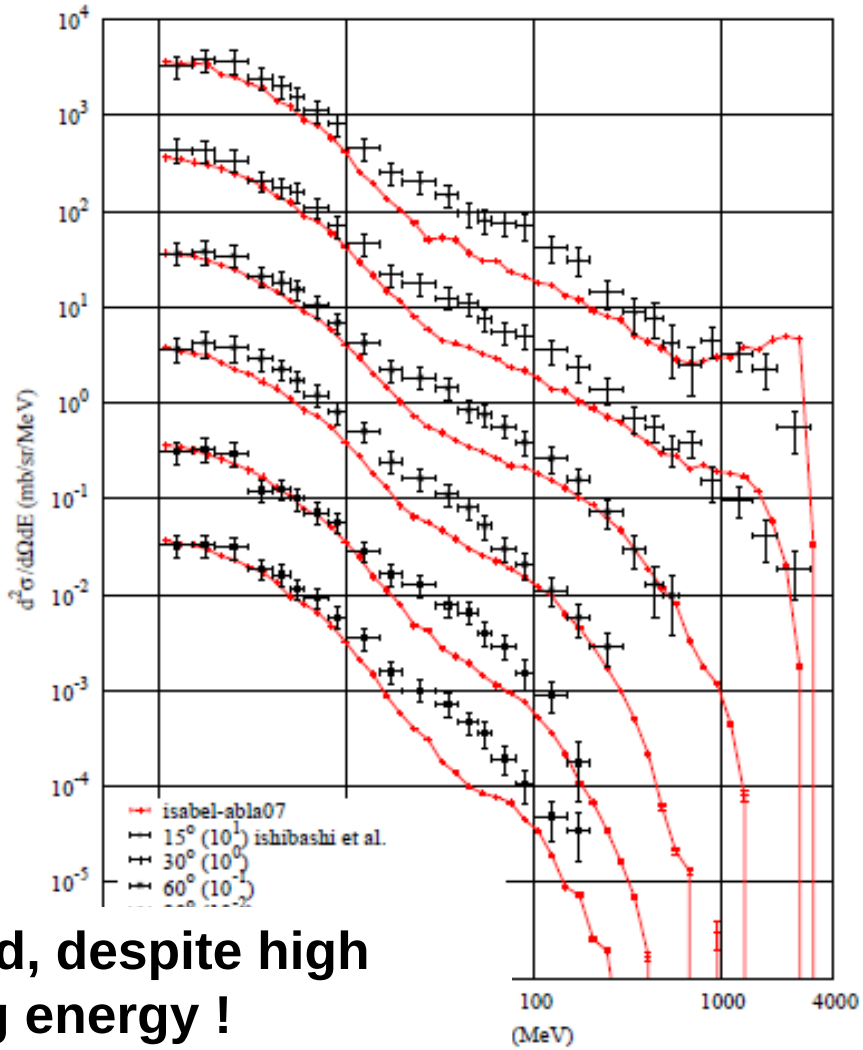


double differential cross section (mb/sr/MeV)

well reproduced, despite high impinging energy !

neutron energy (MeV)

Neutrons

Neutron average multiplicity

Status: Good
Improvement:?

Neutron multiplicity distribution

Status:
- INCL45+ any de-excitation and ISABEL+ any de-excitation: All models are too low at high neutron multiplicities (check E* coming from INC models?)
- p(1200 MeV) + Fe: strange shape (only with ABLA07); maybe break-up?

Improvement: Test break-up contribution. Test shape of spectra with modified initial E* distribution. Other?

Neutron double differential cross sections (starting from for $E_{neutron}$ = 256 MeV)

Status: Good

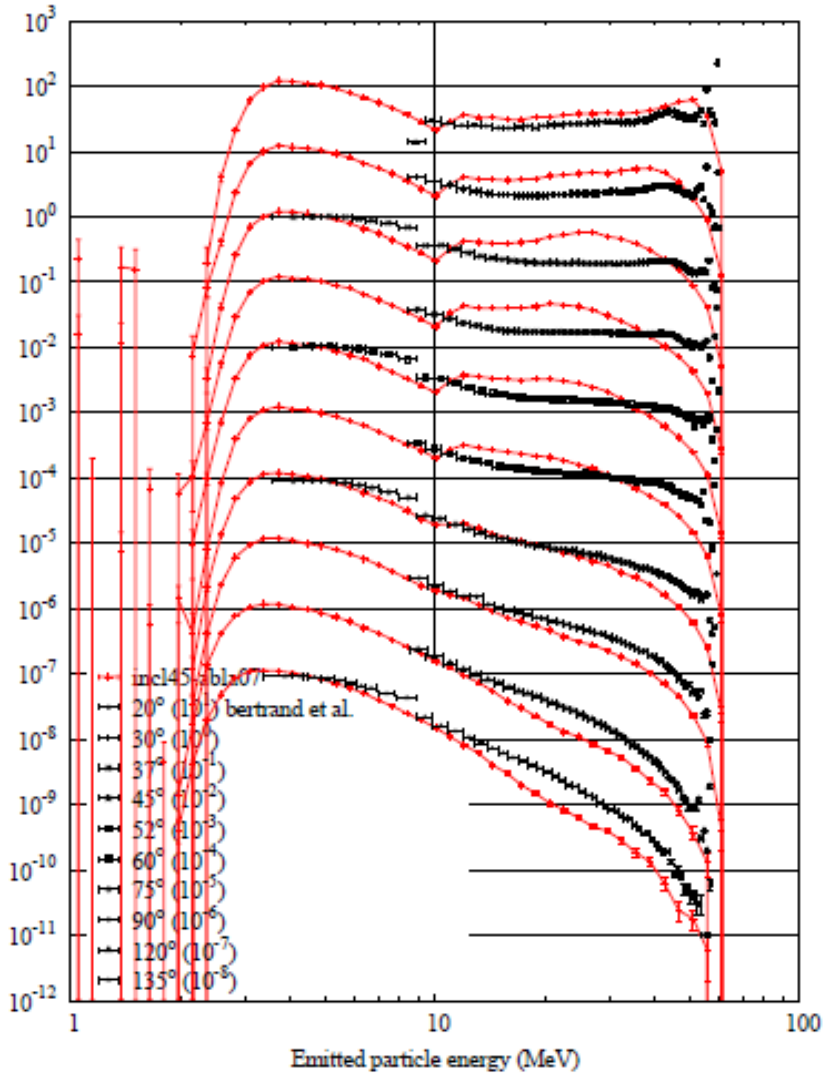
Improvement: INC models?

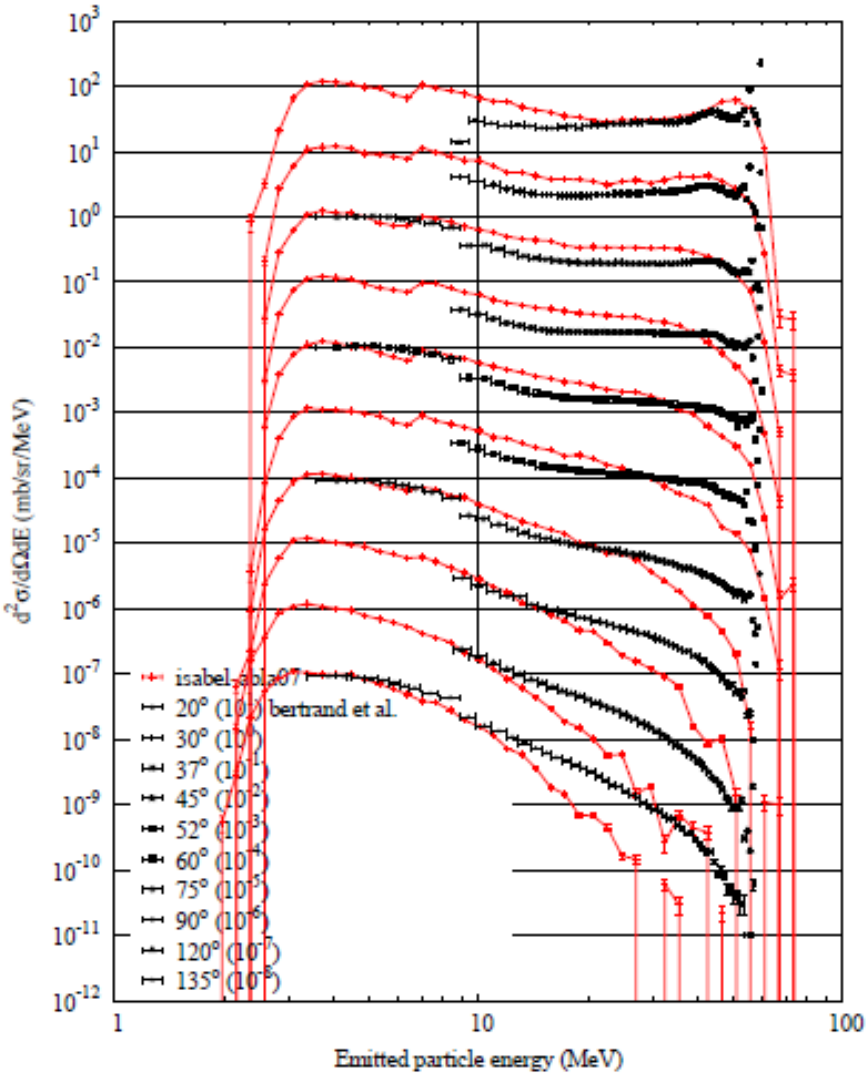
Proton spectra

p(62 MeV) + ^{56}Fe – Proton spectrum

INCL45-ABLA07

ISABEL-ABLA07



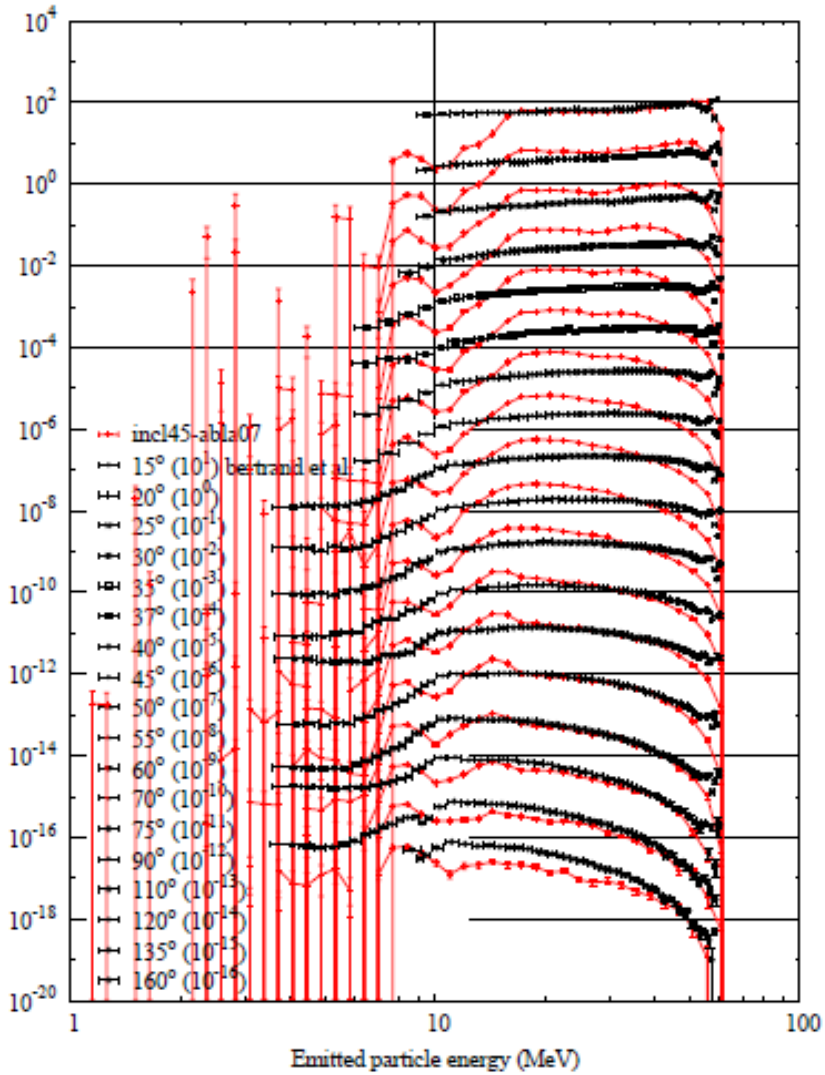


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(62 MeV) + Bi – Proton spectrum

INCL45-ABLA07



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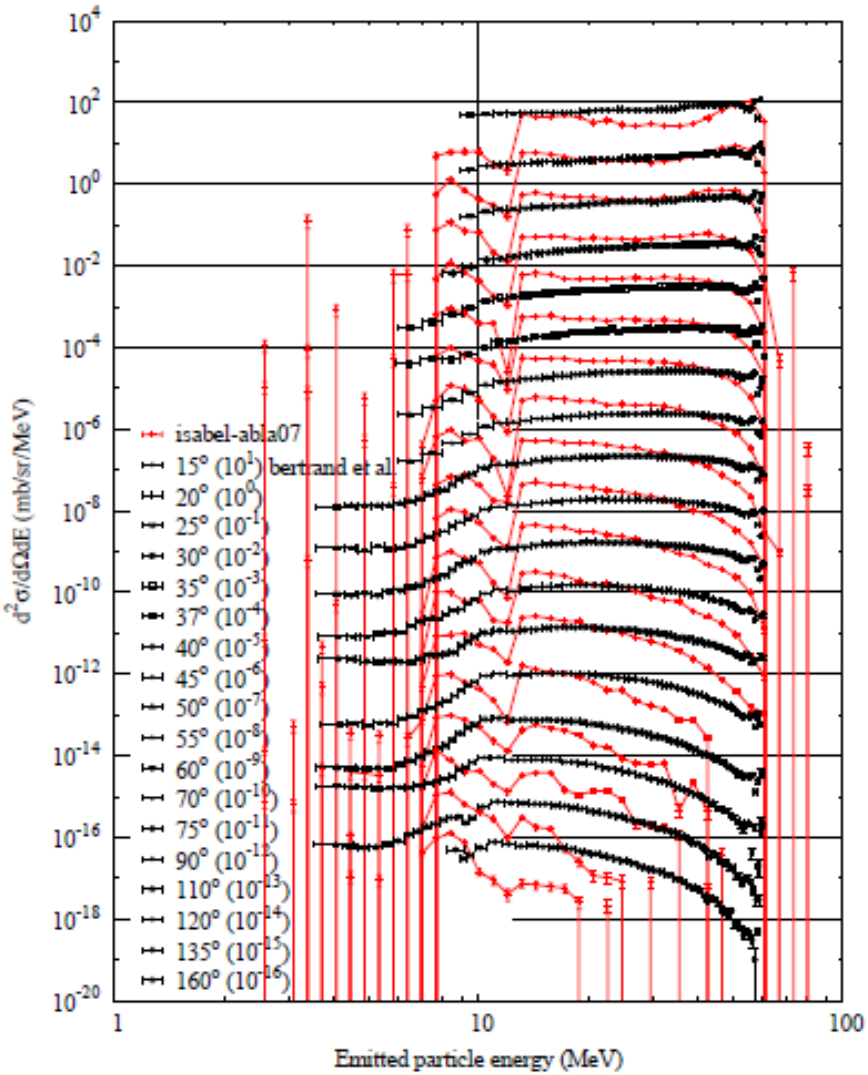
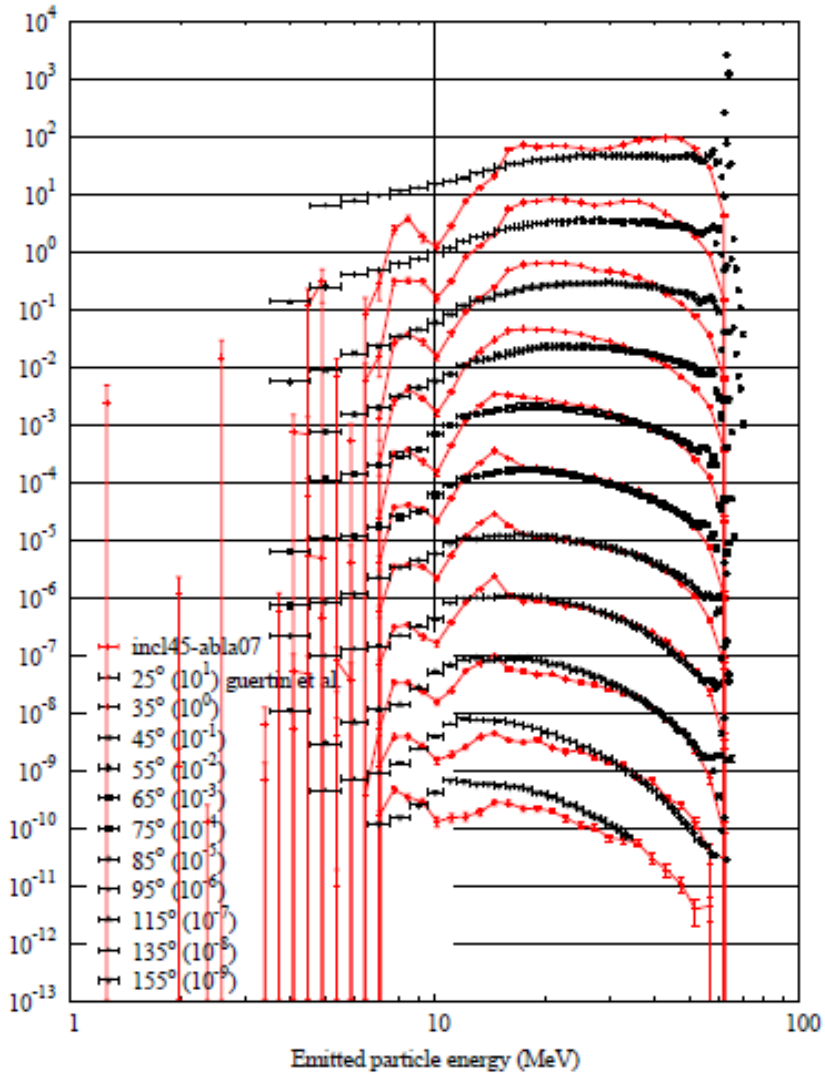


double differential cross section (mb/sr/MeV)

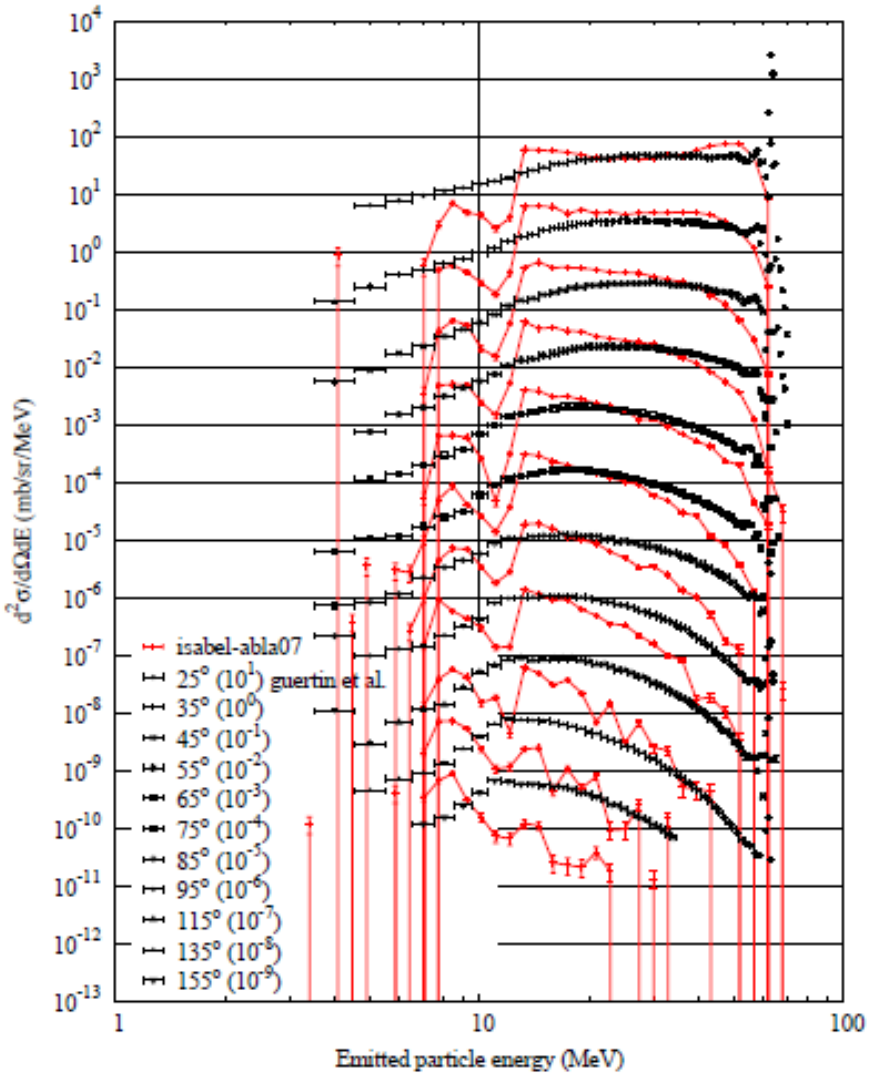
emitted-particle energy (MeV)

p(63 MeV) + ^{208}Pb – Proton spectrum

INCL45-ABLA07



ISABEL-ABLA07

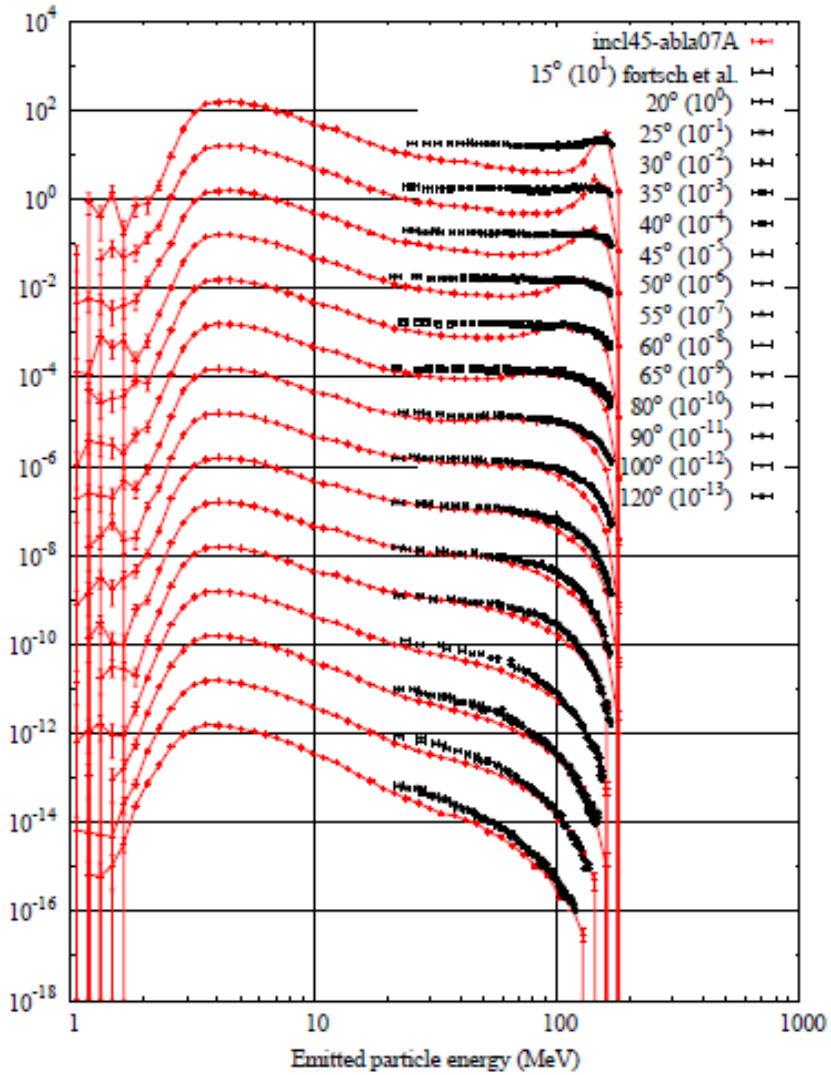


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(175 MeV) + Ni – Proton spectrum

INCL45-ABLA07



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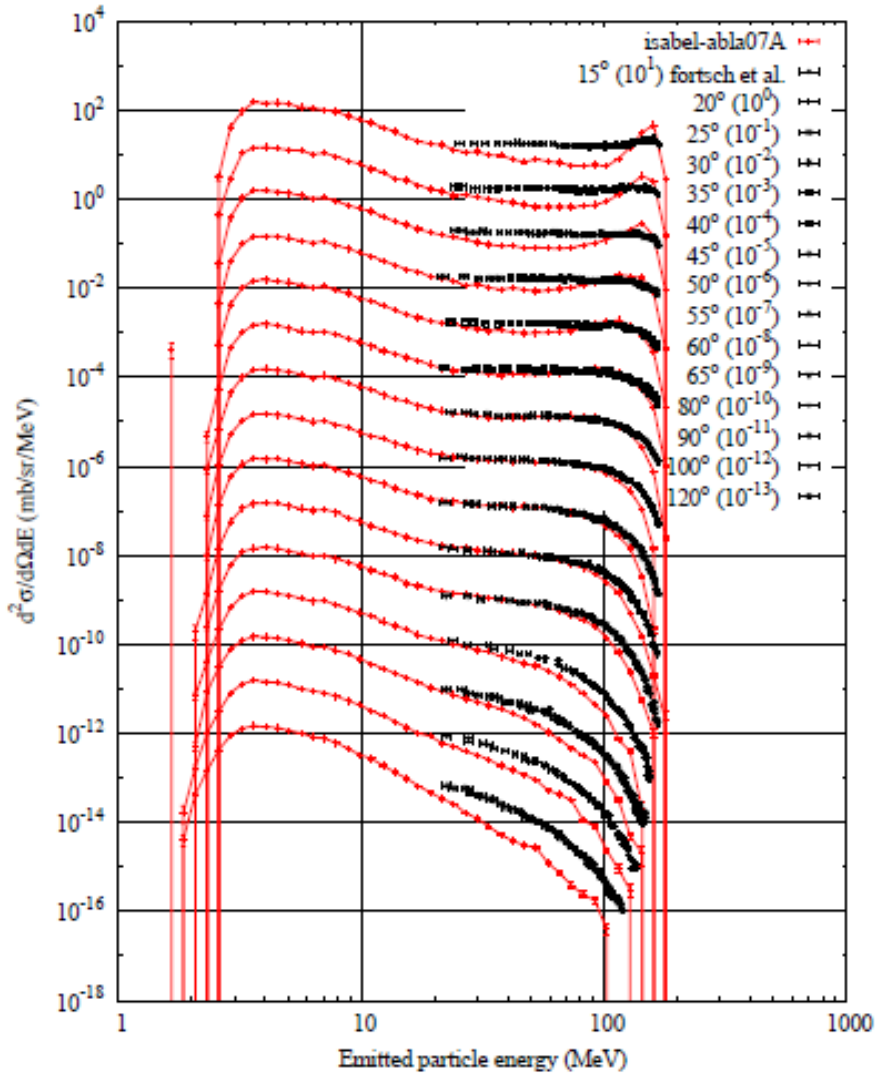
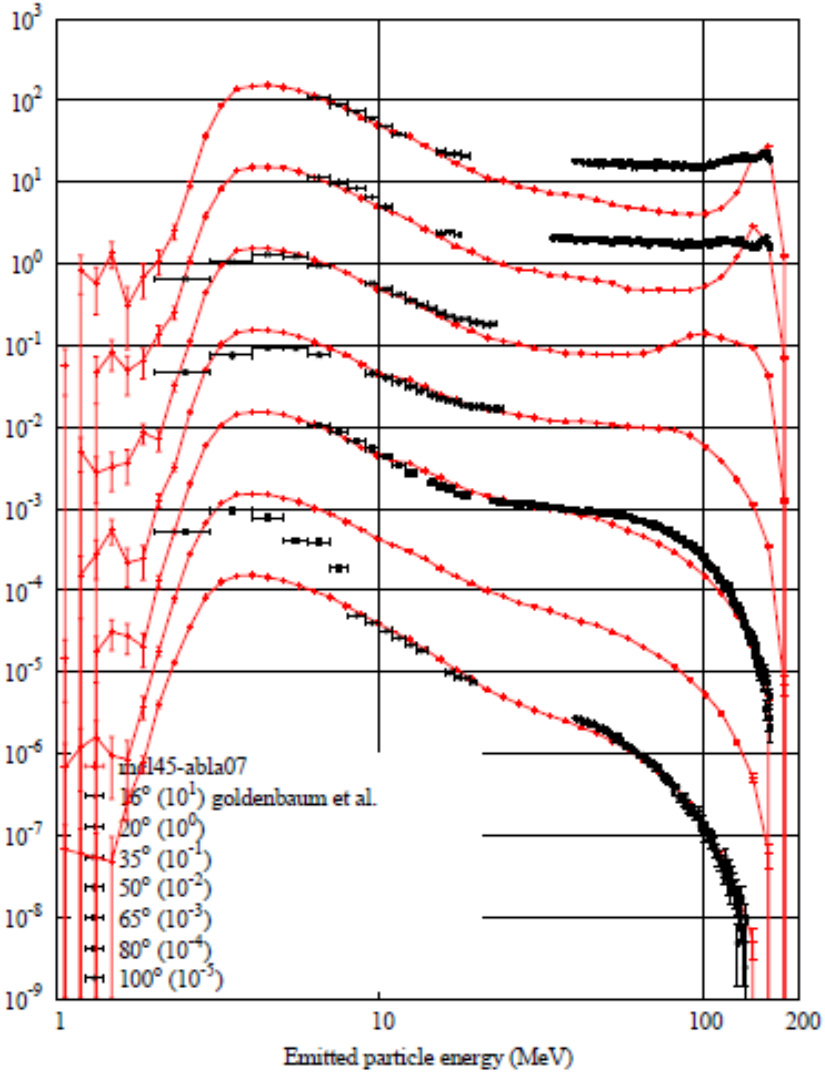


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(175 MeV) + Ni – Proton spectrum

INCL45-ABLA07



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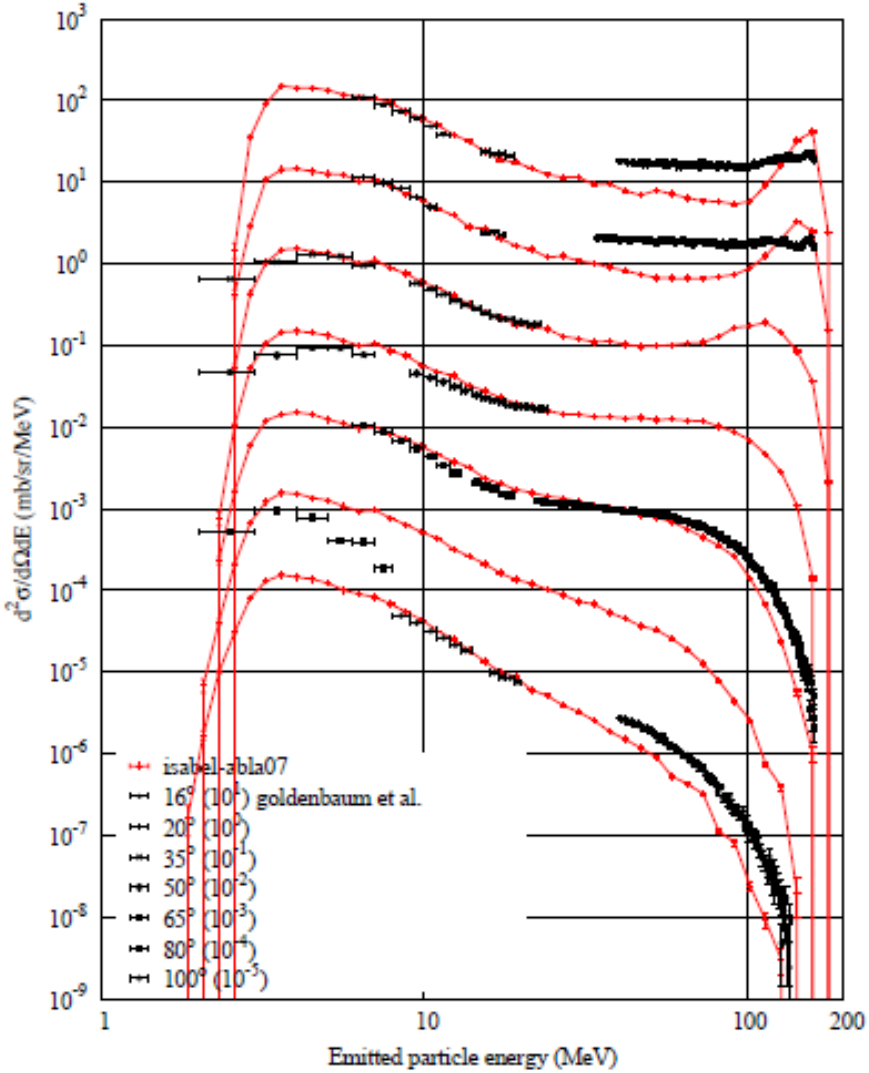
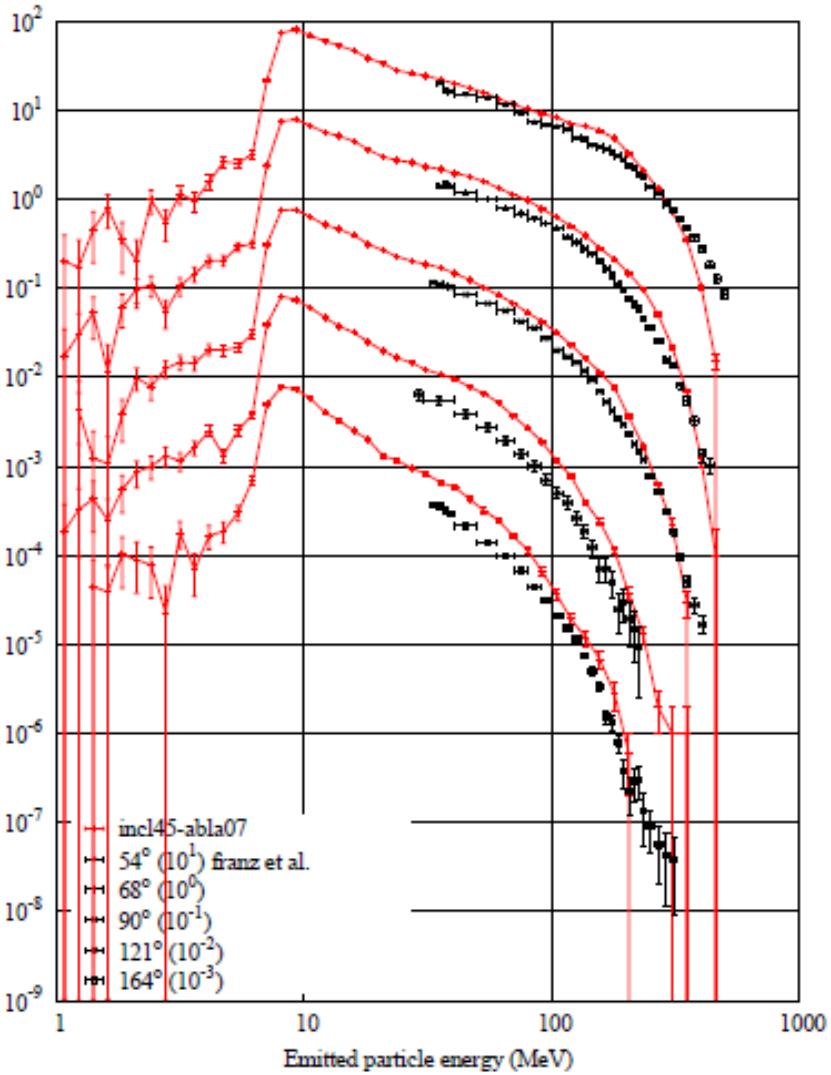


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

n(542 MeV) + Bi – Proton spectrum

INCL45-ABLA07



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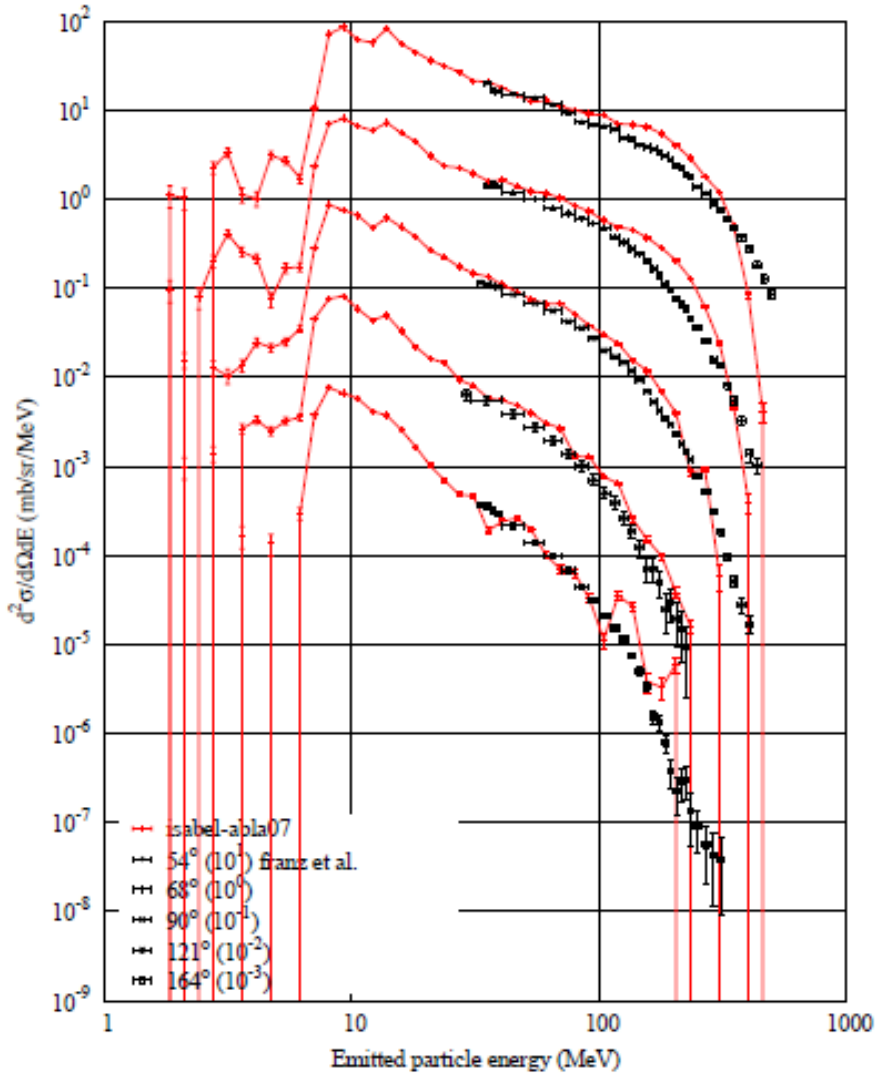
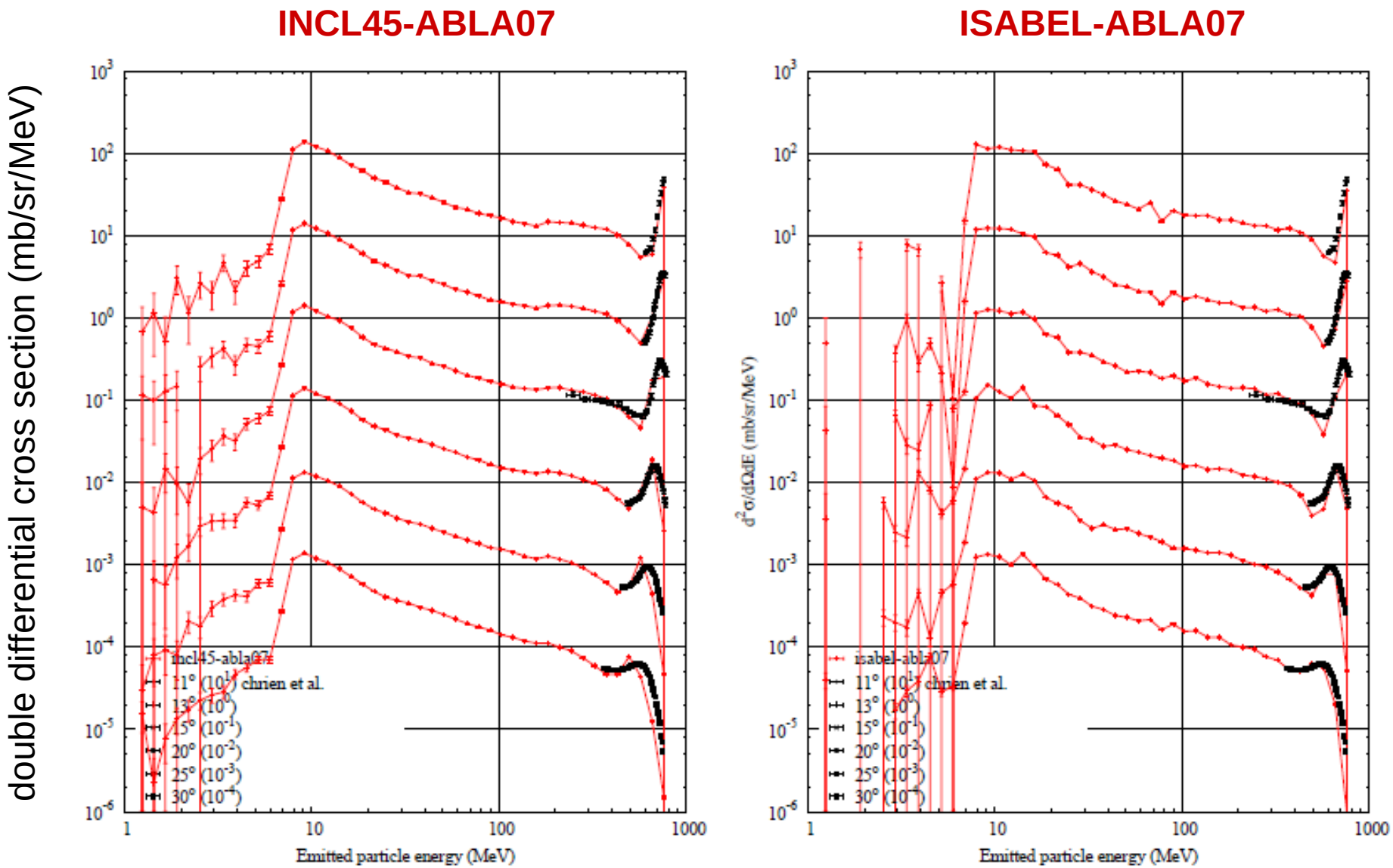


double differential cross section (mb/sr/MeV)

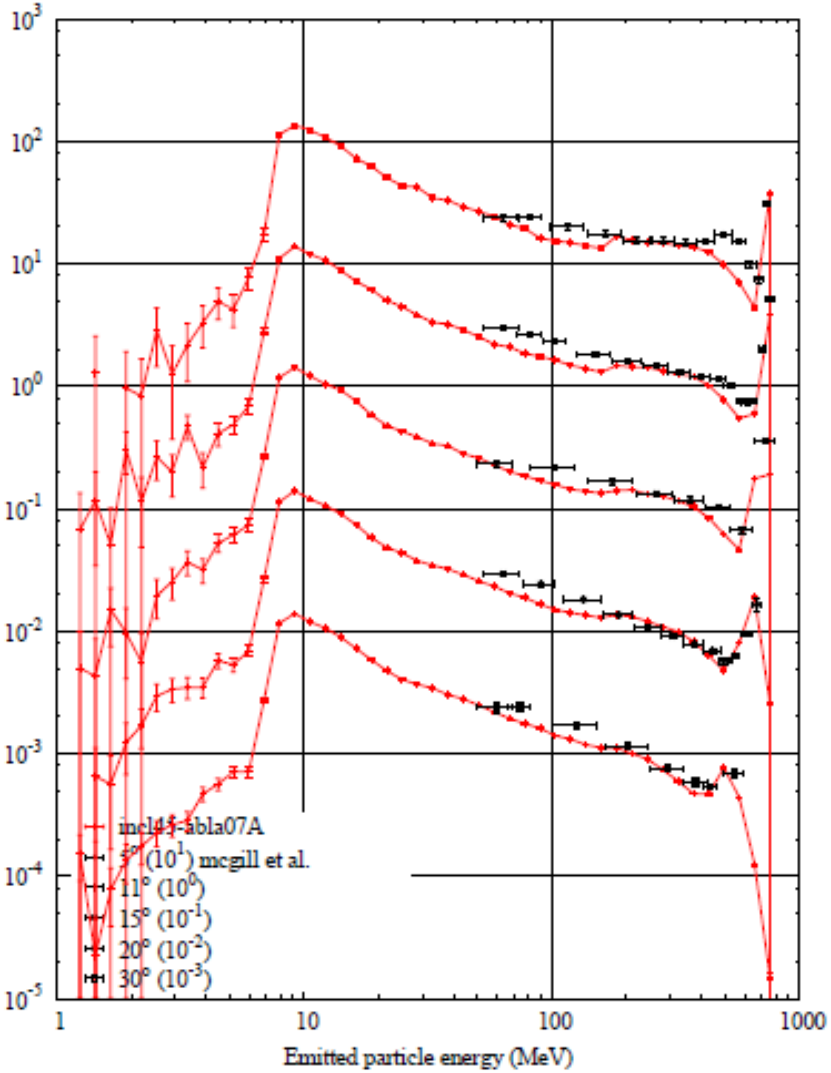
emitted-particle energy (MeV)

p(800 MeV) + ^{208}Pb – Proton spectrum



p(800 MeV) + ^{208}Pb – Proton spectrum

INCL45-ABLA07



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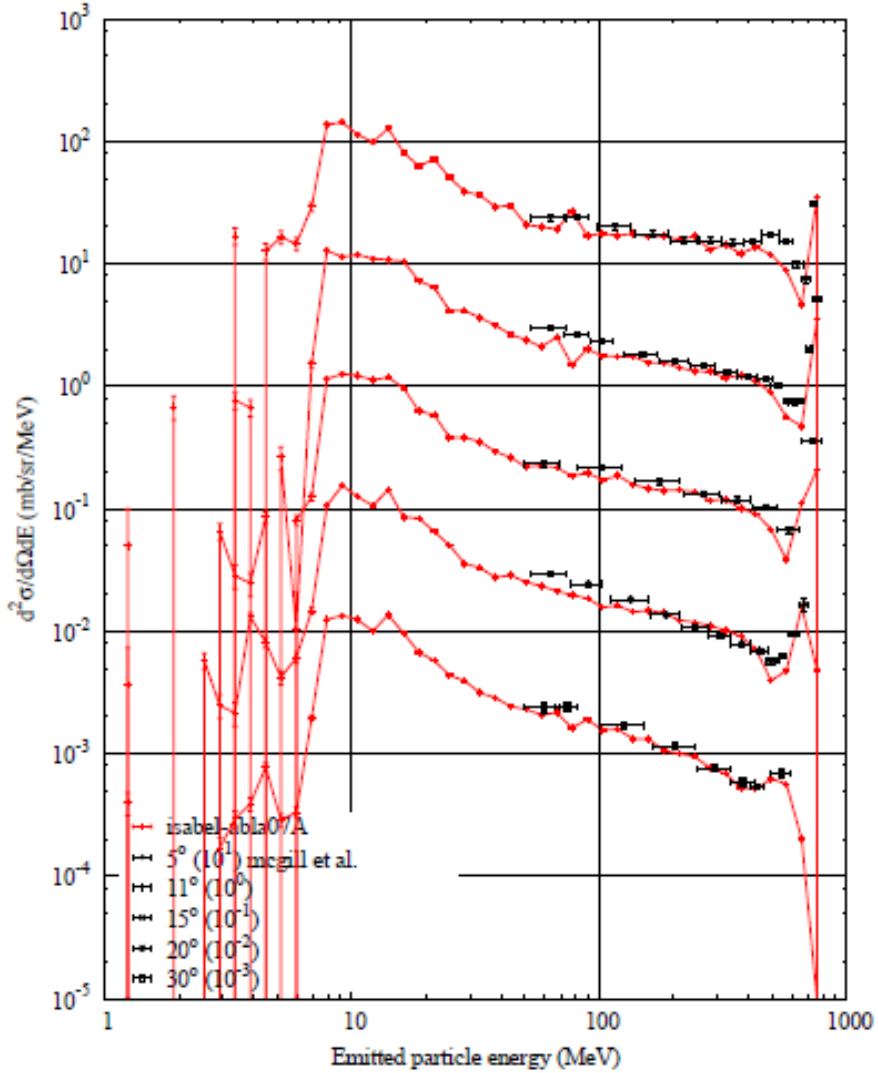
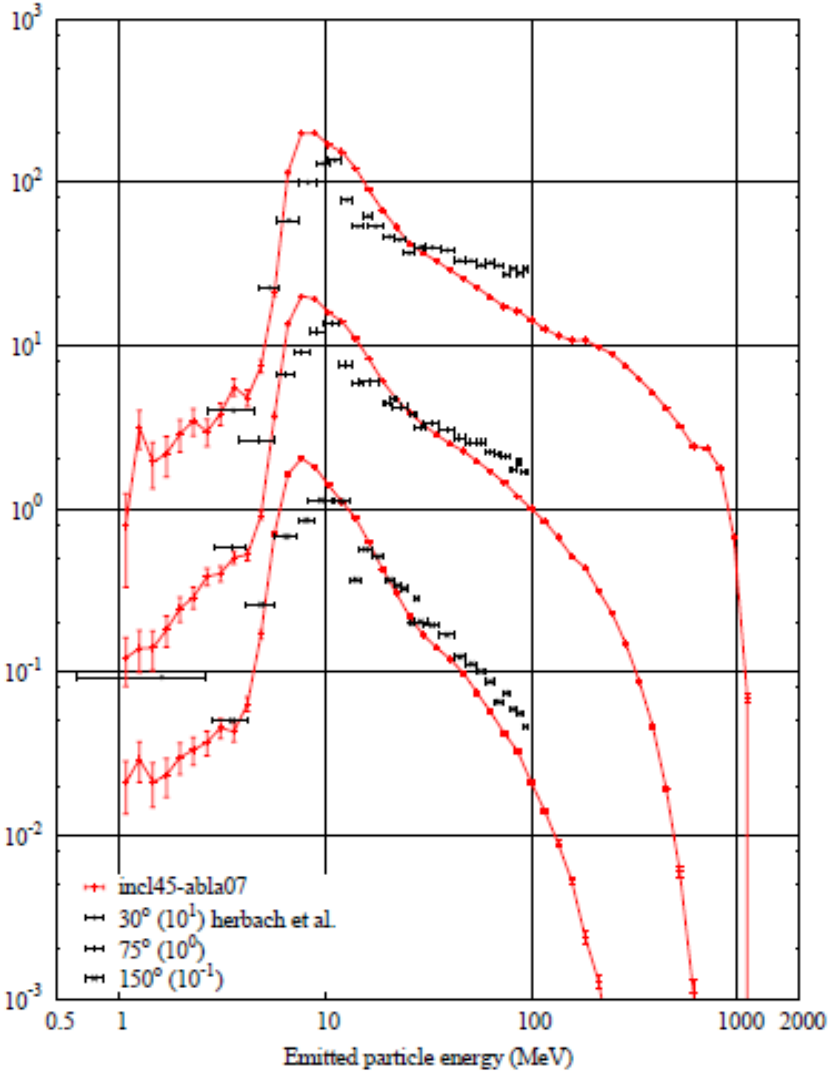


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Ta – Proton spectrum

INCL45-ABLA07



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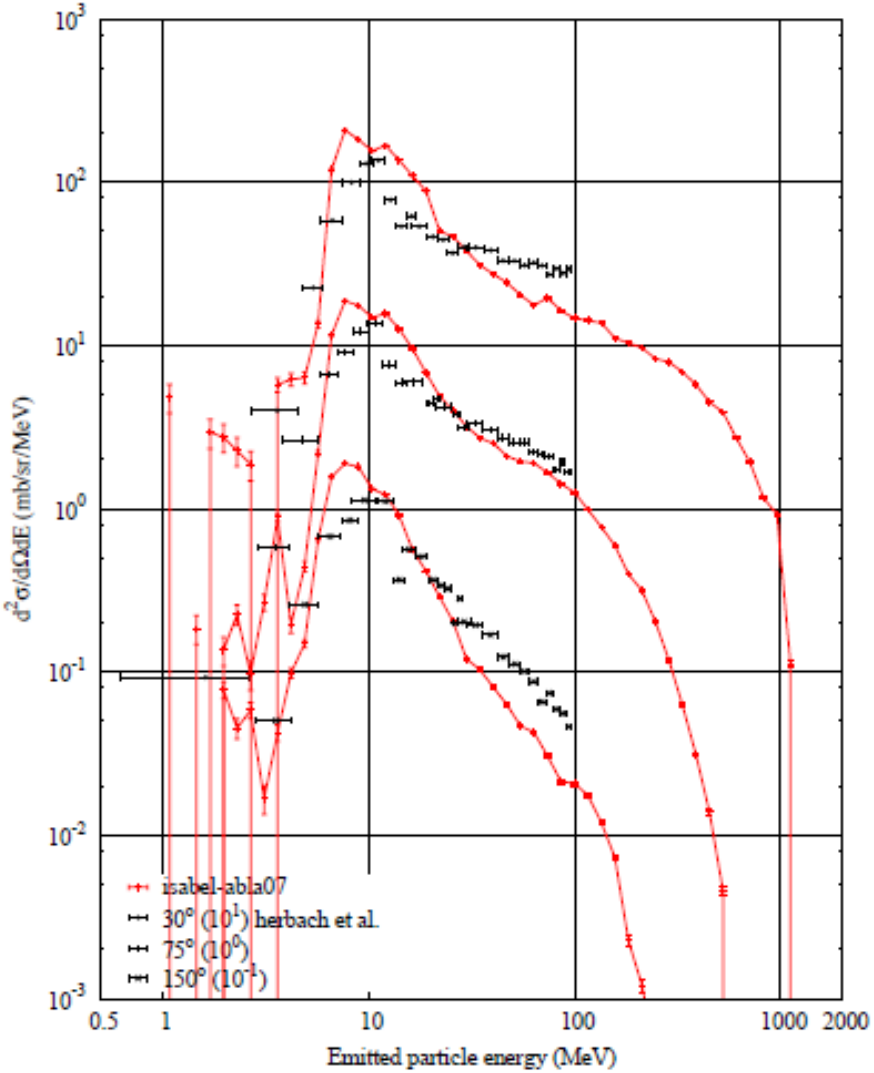
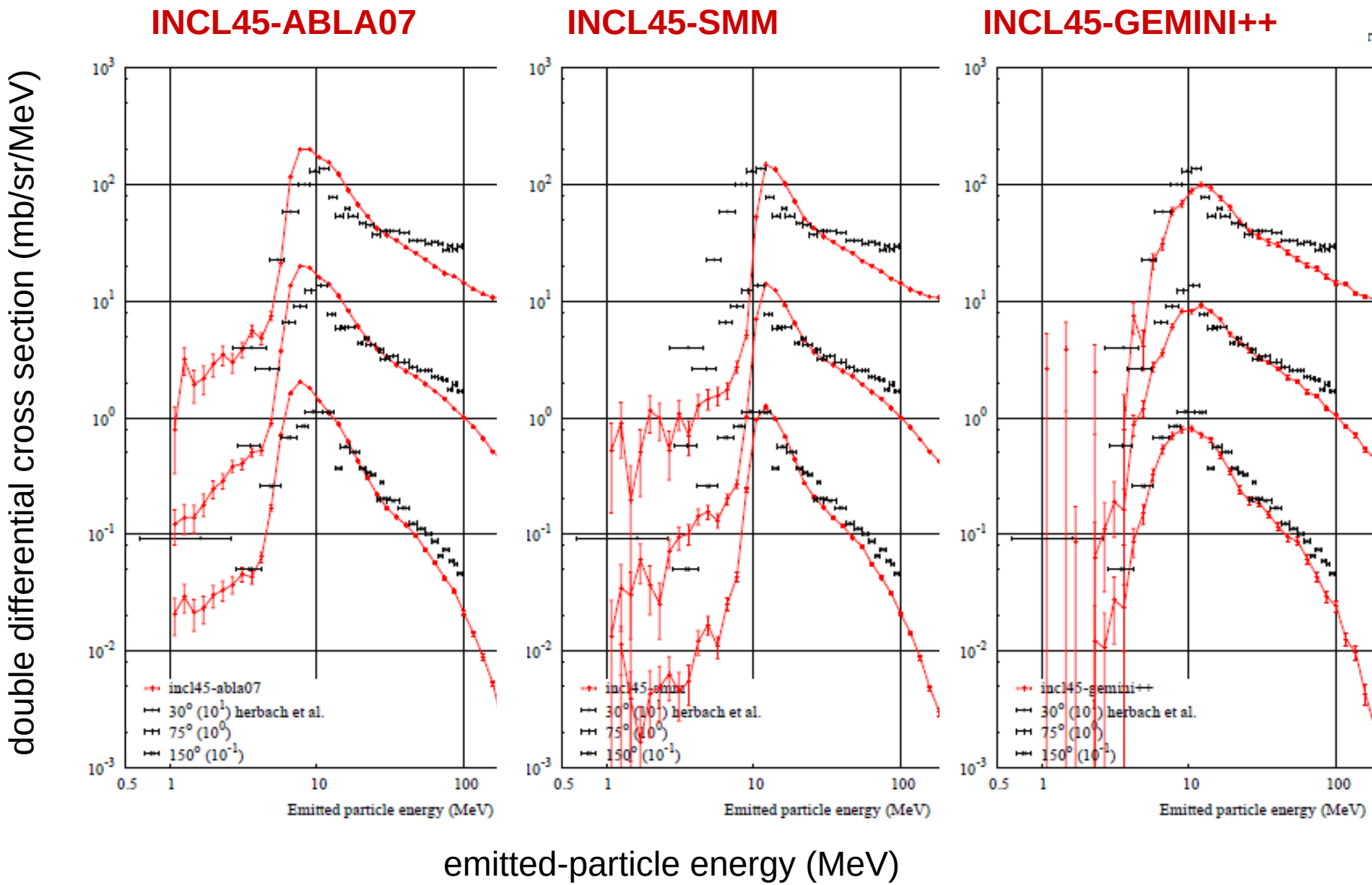


double differential cross section (mb/sr/MeV)

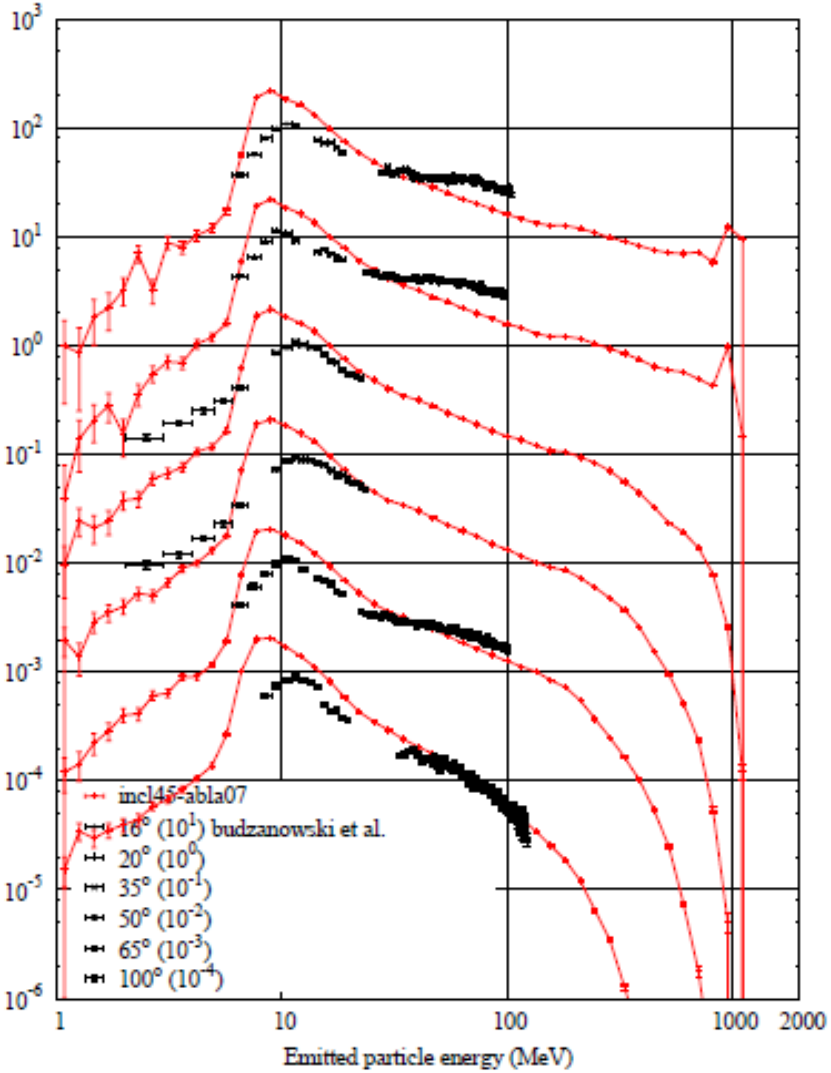
emitted-particle energy (MeV)

p(1200 MeV) + Ta – Proton spectrum



p(1200 MeV) + Au – Proton spectrum

INCL45-ABLA07



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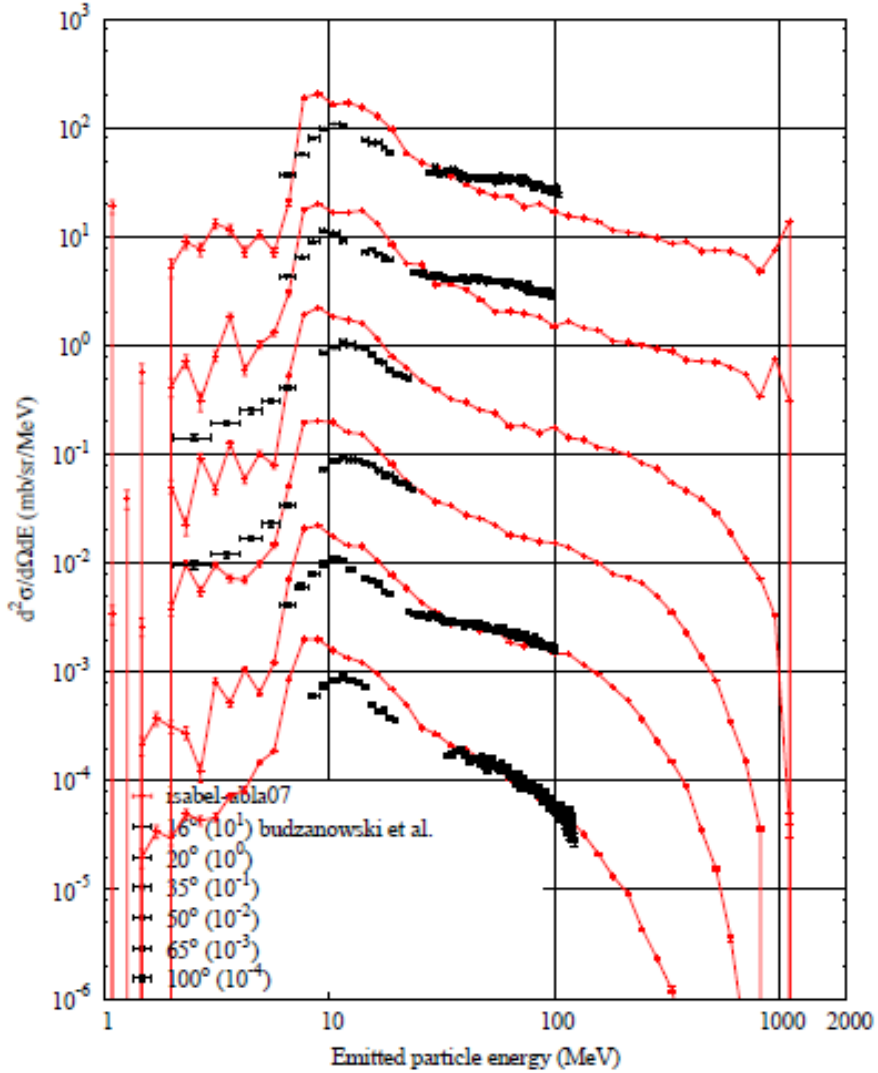
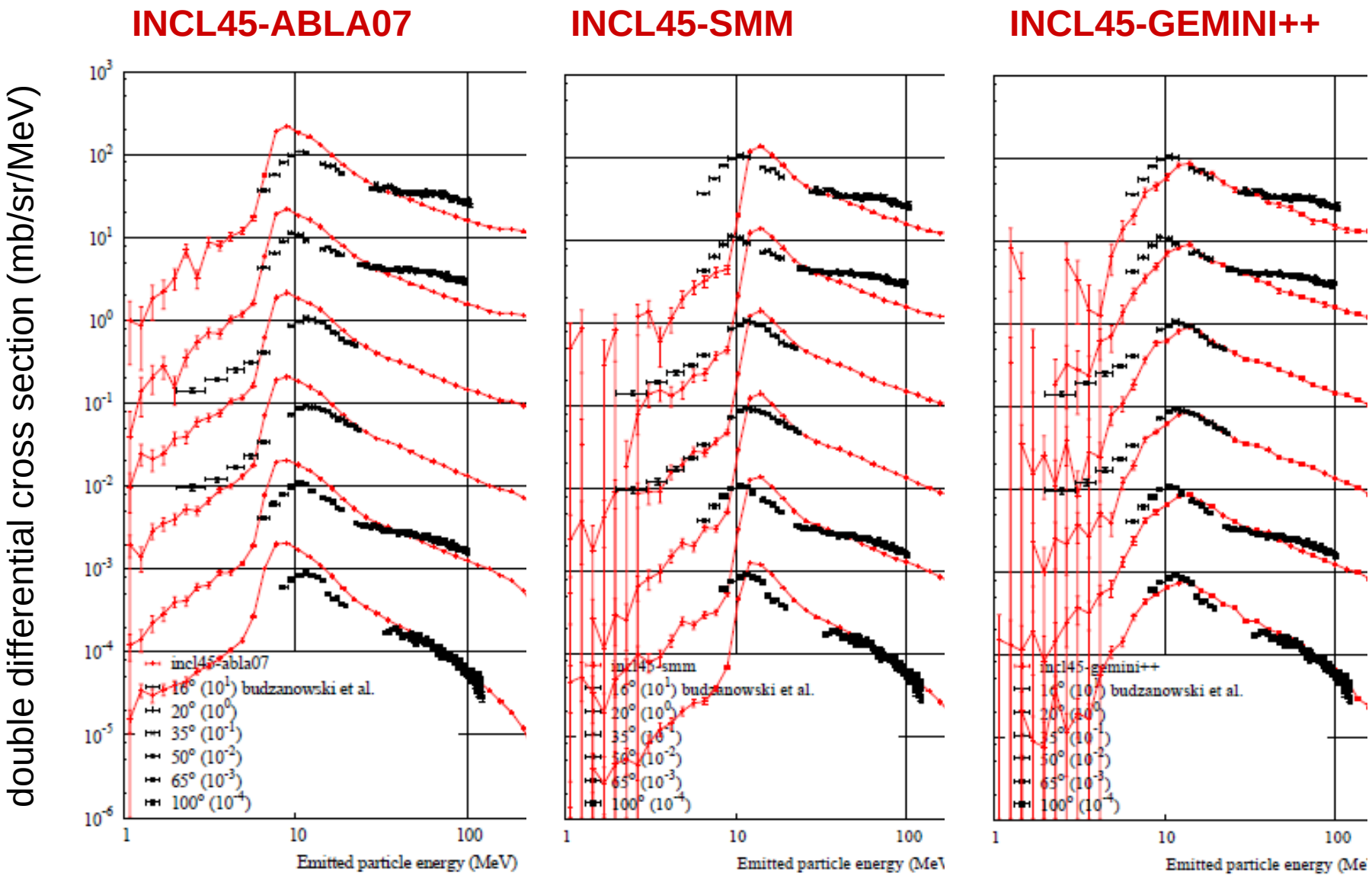


double differential cross section (mb/sr/MeV)

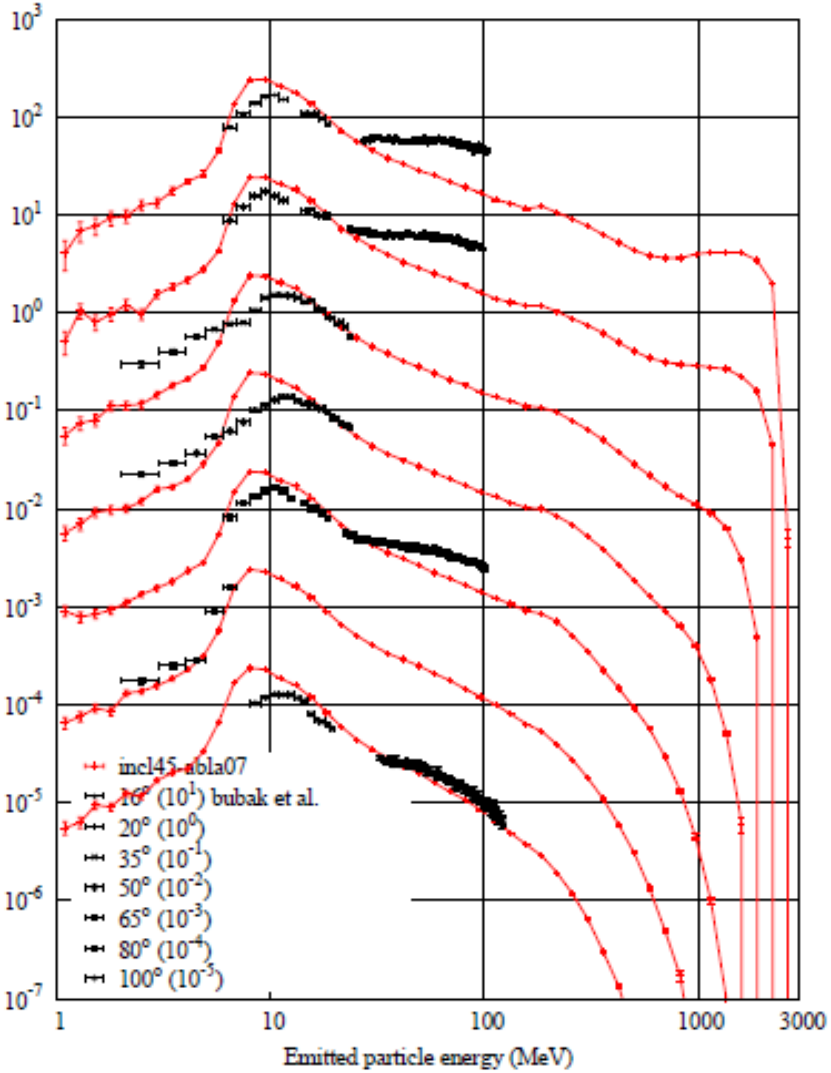
emitted-particle energy (MeV)

p(1200 MeV) + Au – Proton spectrum



p(2500 MeV) + Au – Proton spectrum

INCL45-ABLA07



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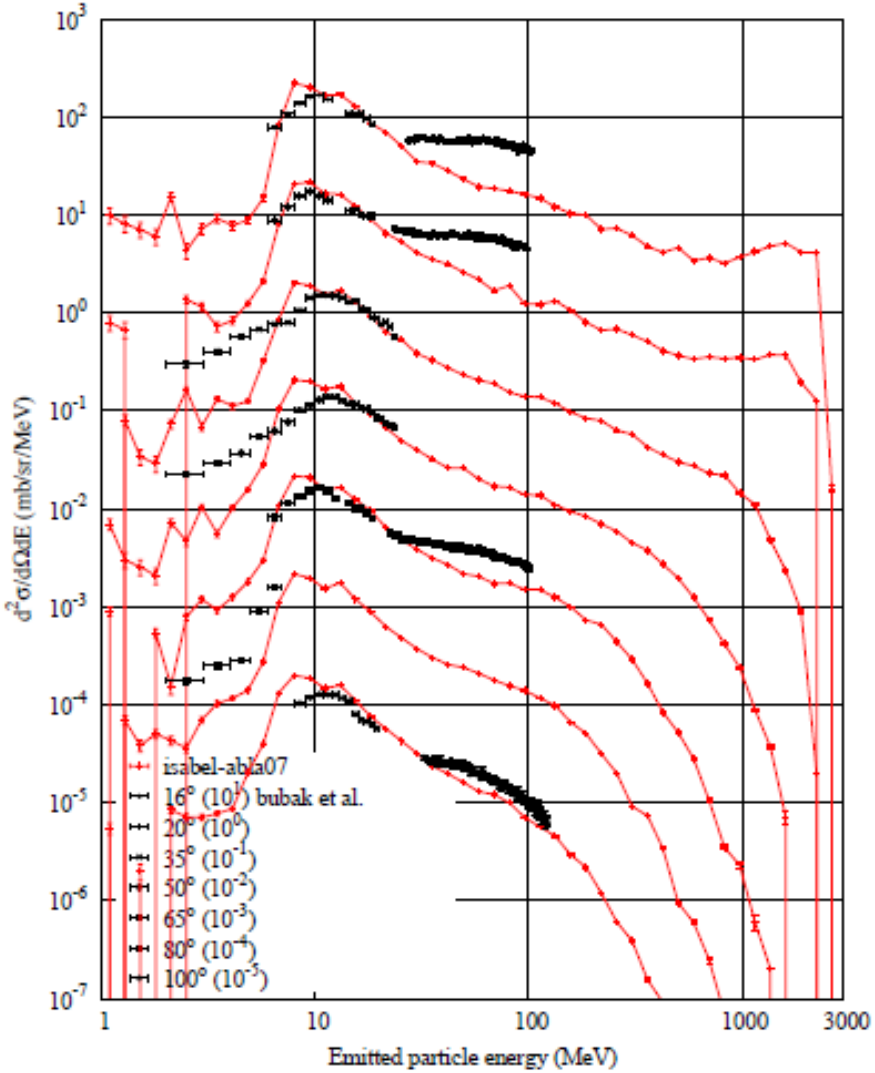
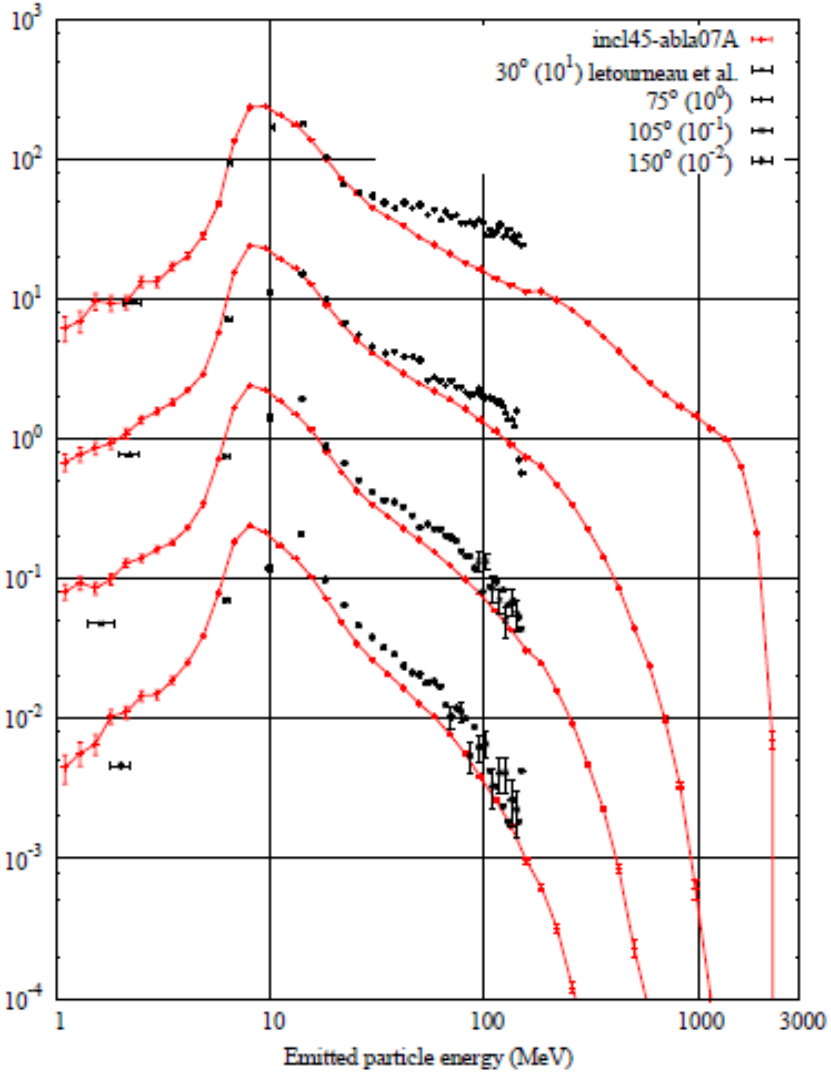


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – Proton spectrum

INCL45-ABLA07



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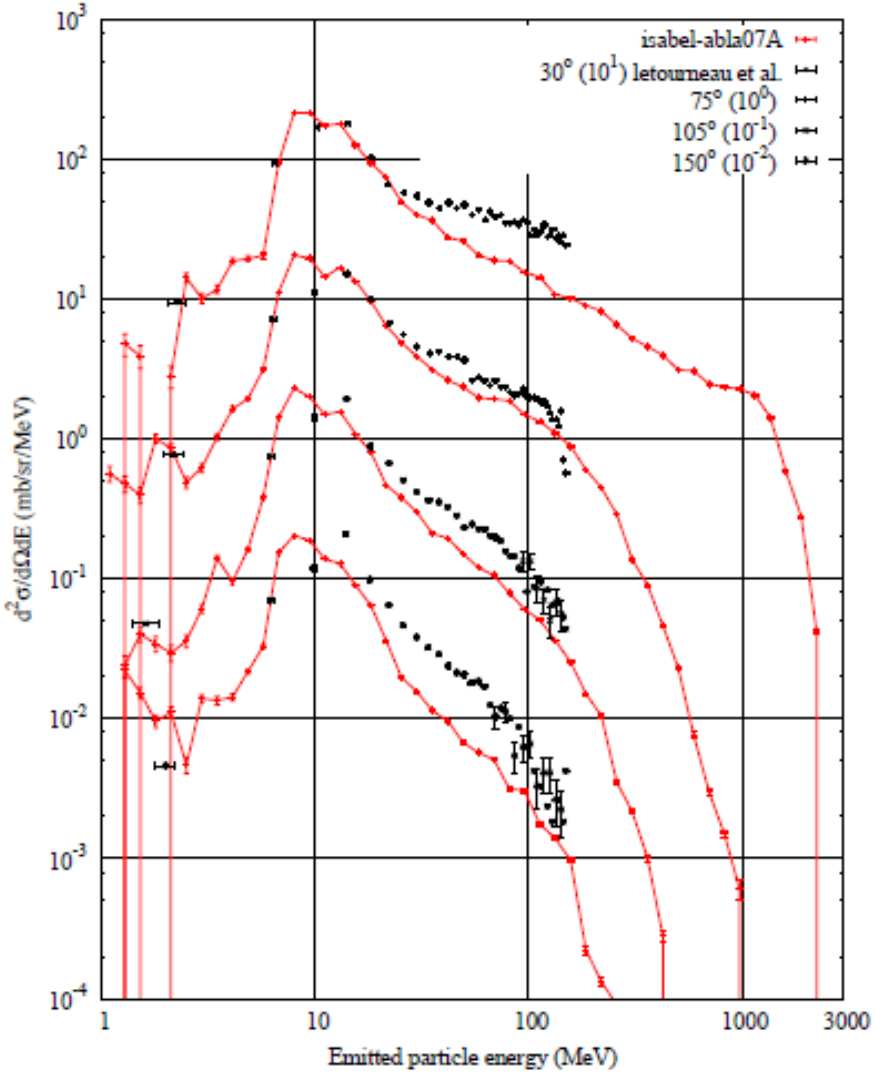


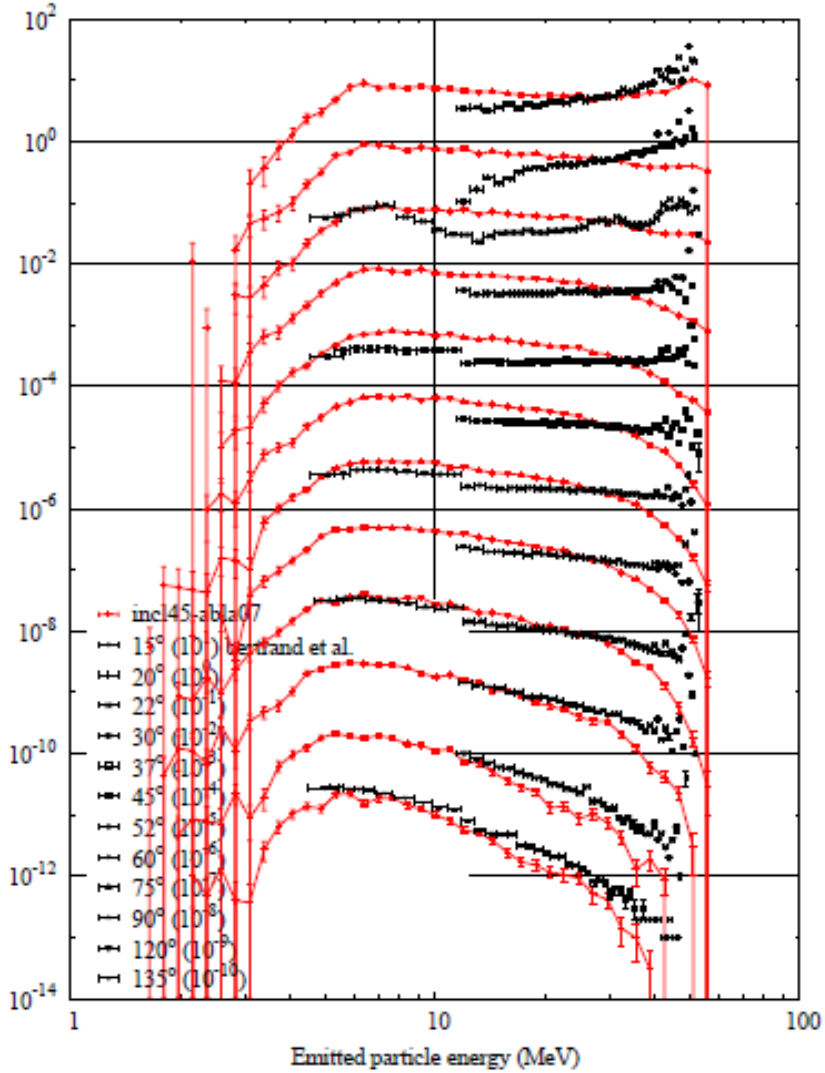
double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

Deuteron spectra

p(62 MeV) + ^{56}Fe – Deuteron spectrum

INCL45-ABLA07



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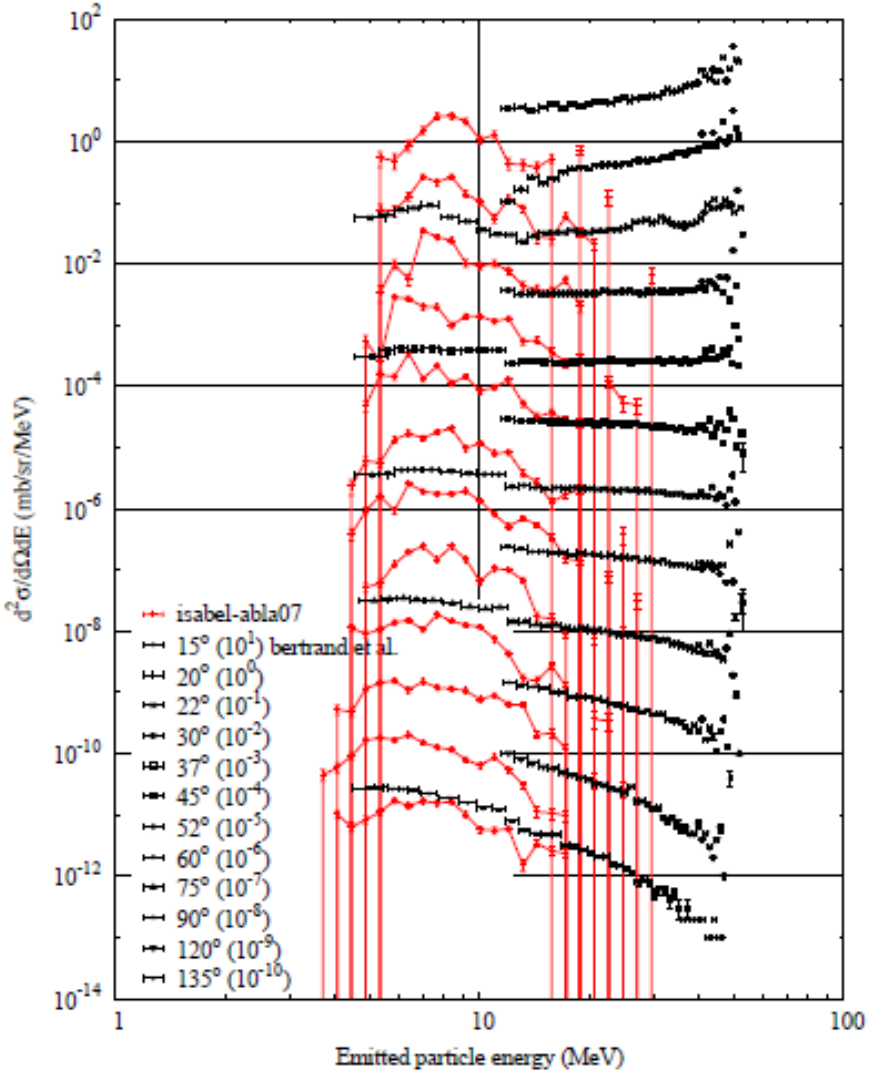
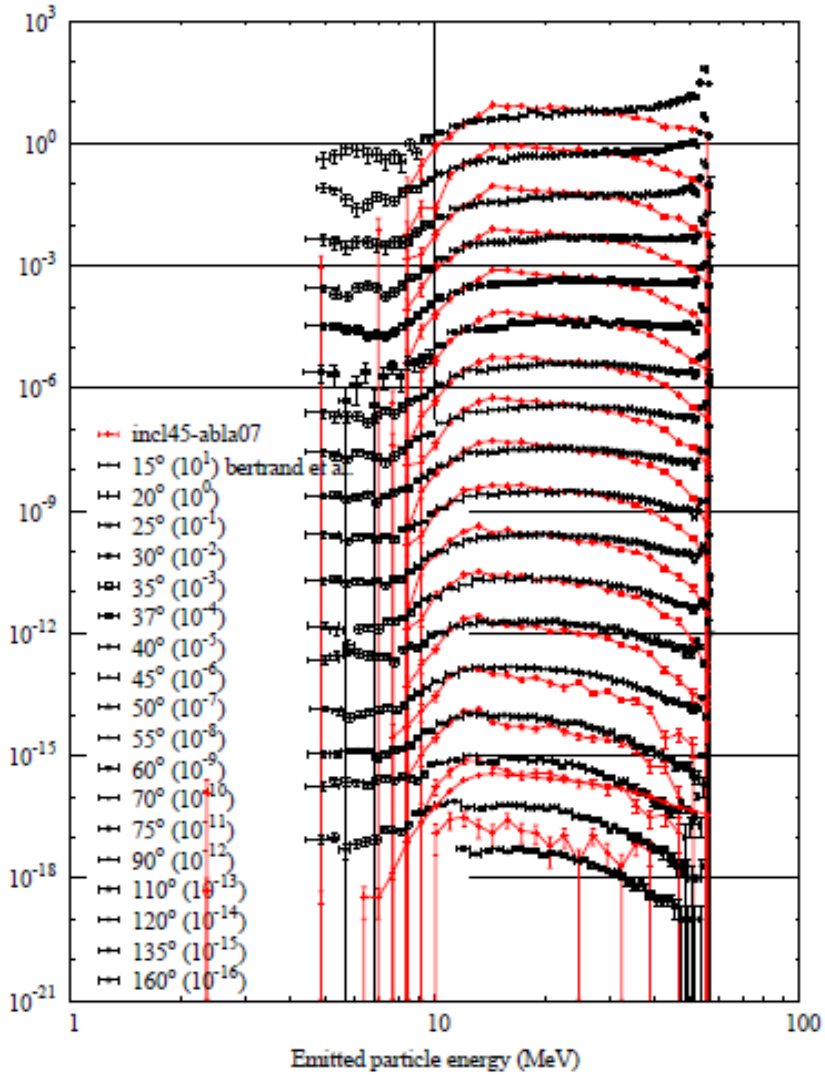


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(62 MeV) + Bi – Deuteron spectrum

INCL45-ABLA07



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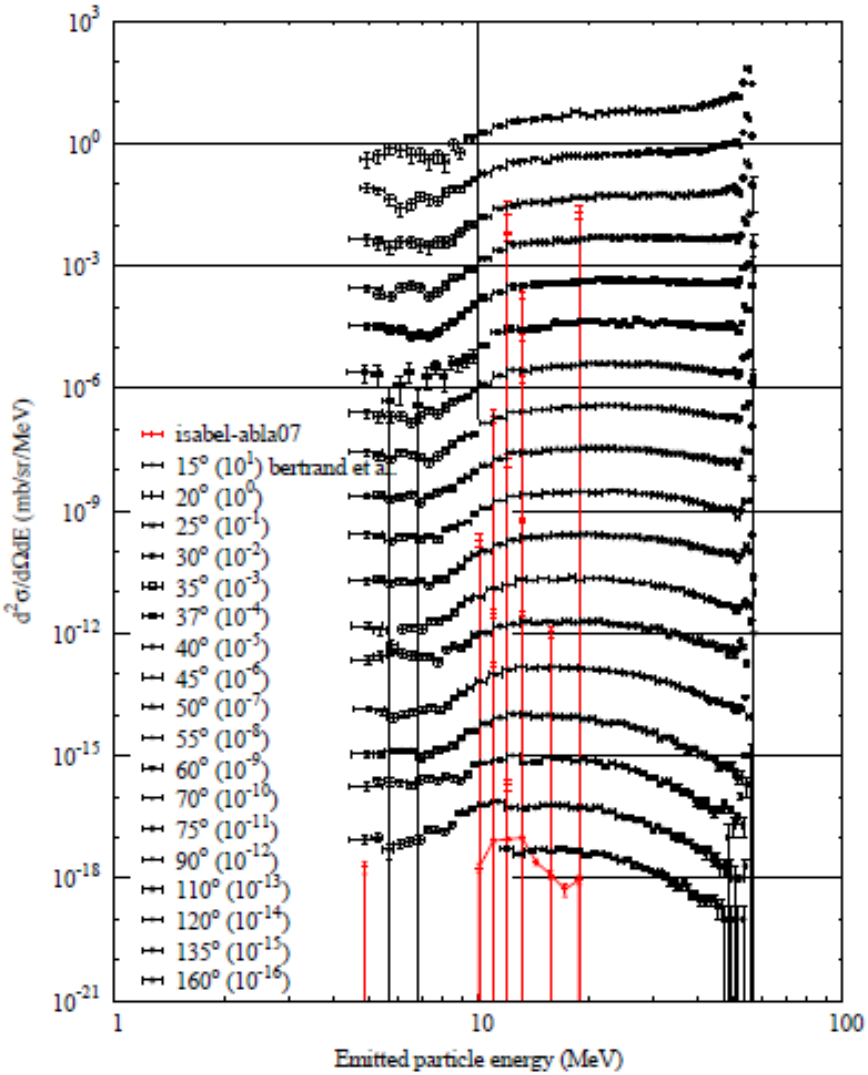
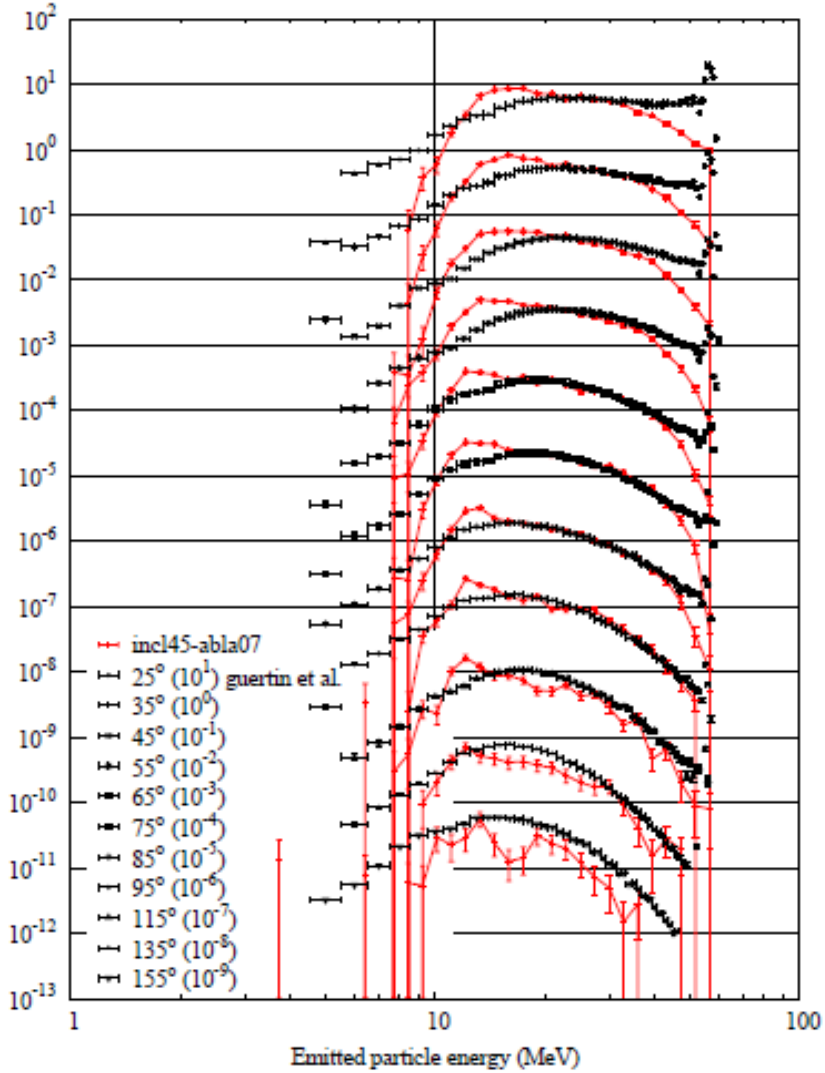


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(63 MeV) + ^{208}Pb – Deuteron spectrum

INCL45-ABLA07



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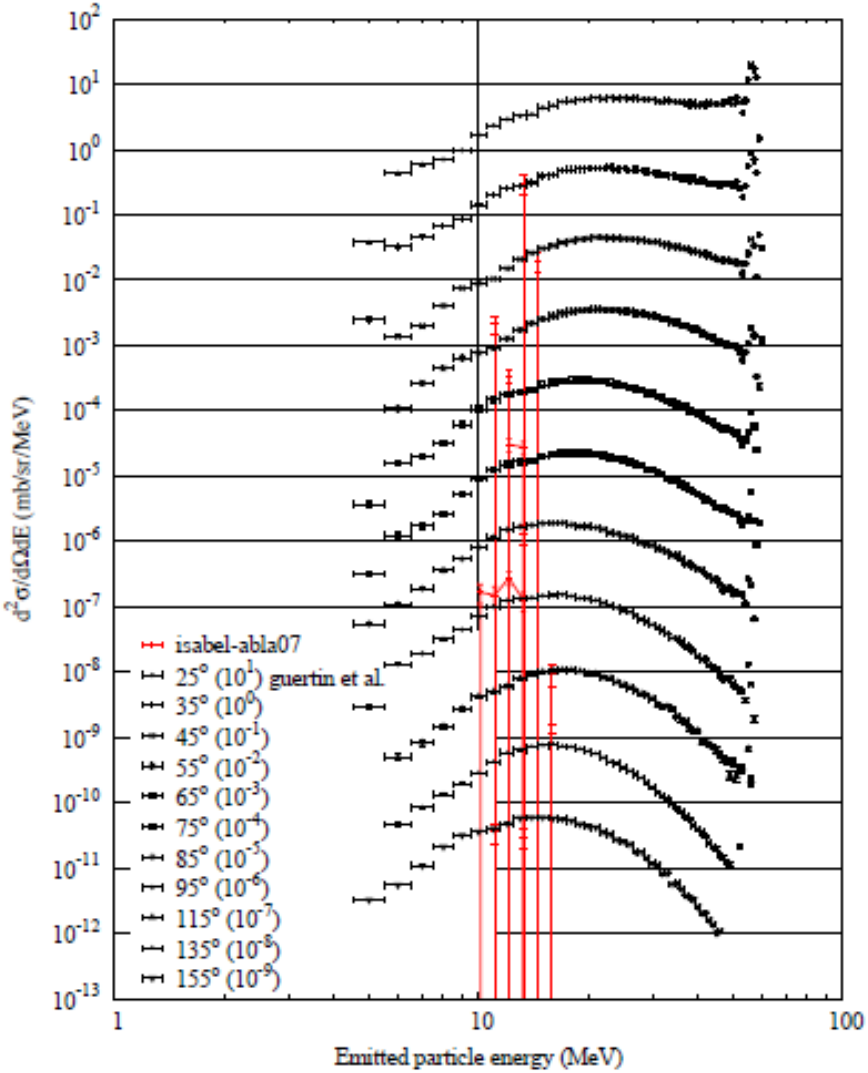
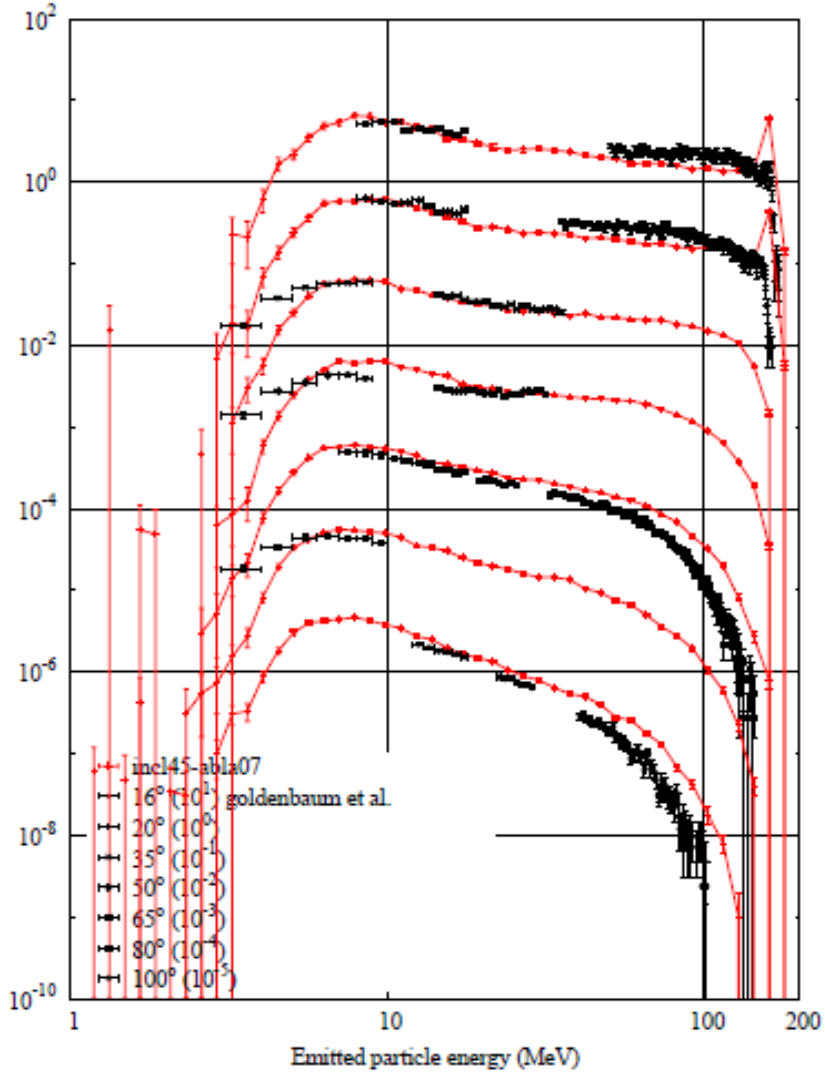


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(175 MeV) + Ni – Deuteron spectrum

INCL45-ABLA07



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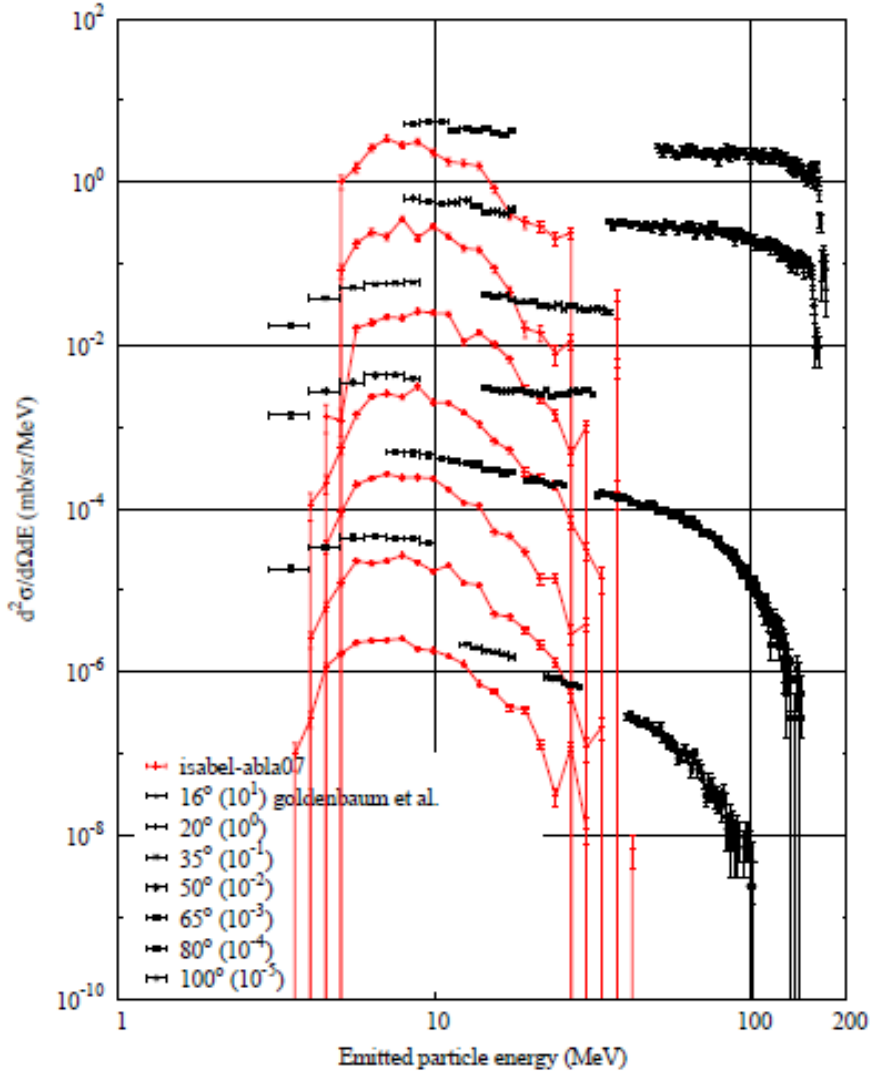
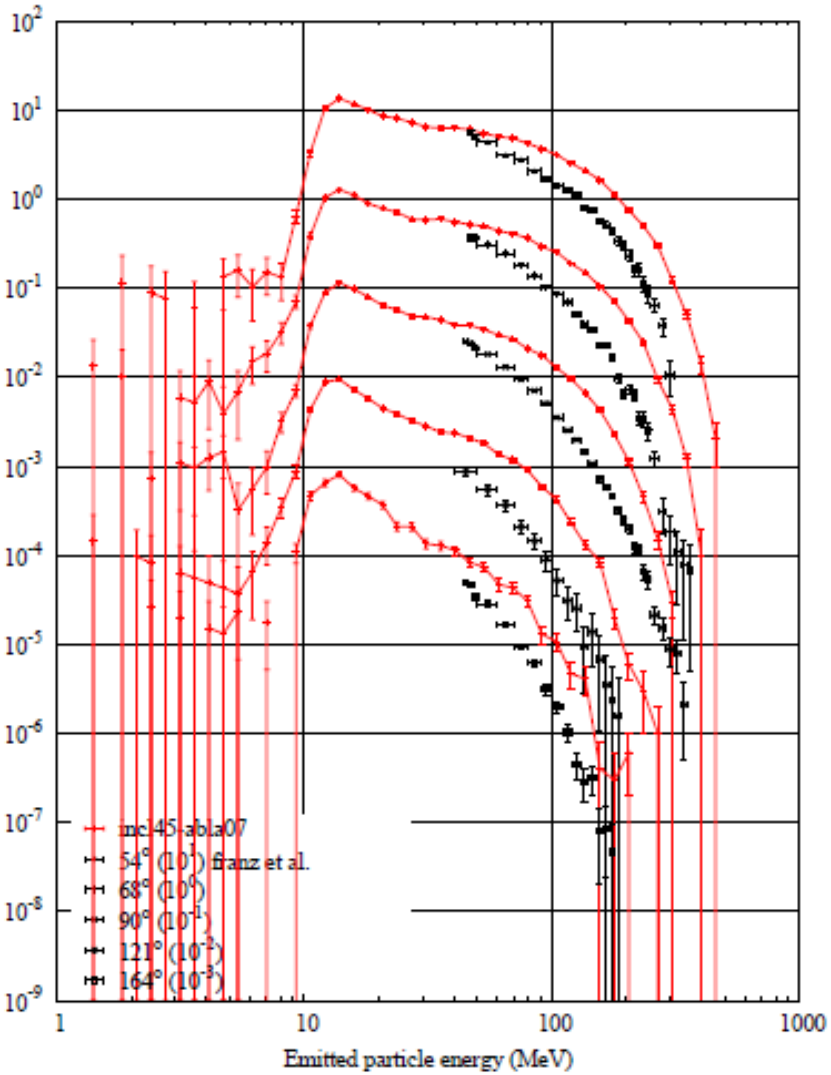


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

n(542 MeV) + Bi – Deuteron spectrum

INCL45-ABLA07



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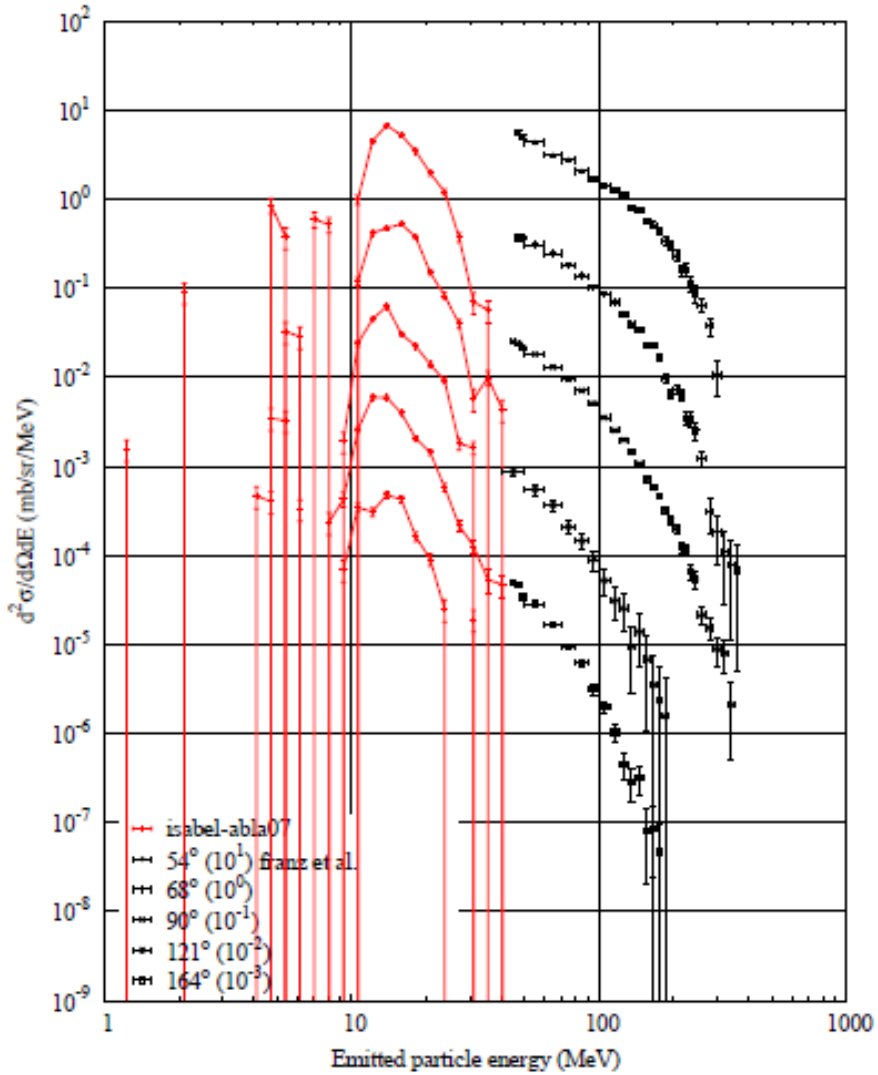
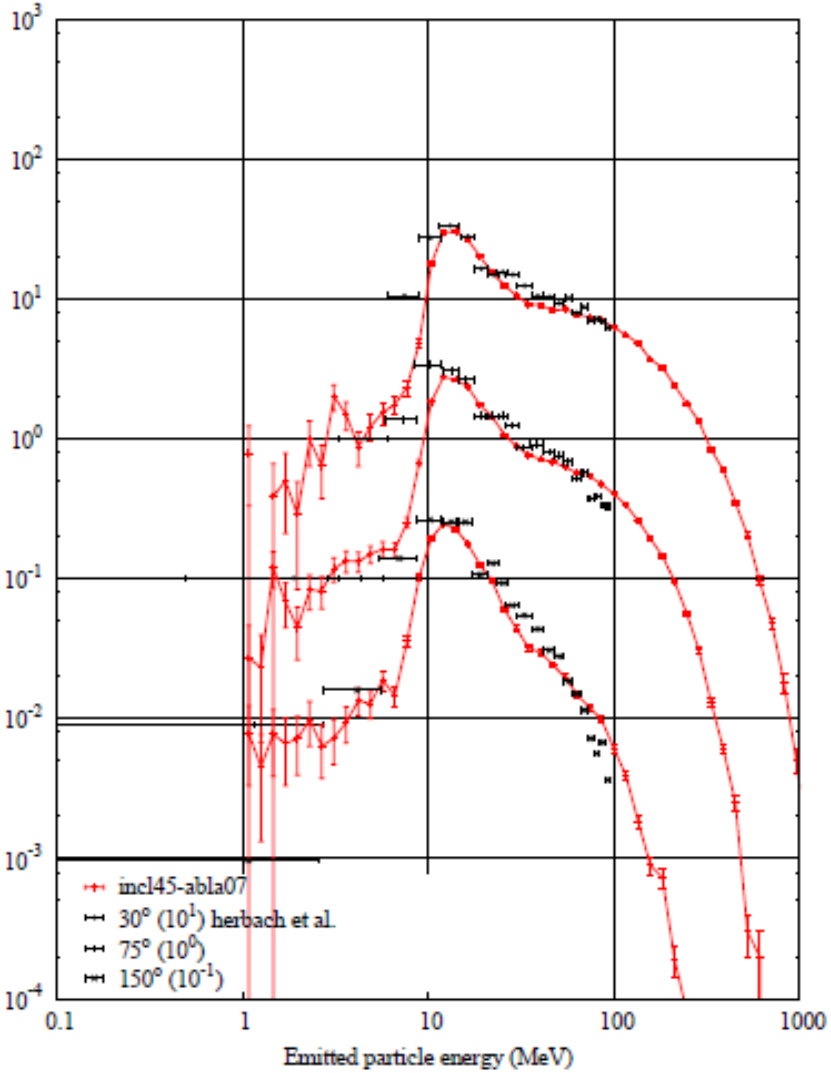


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Ta – Deuteron spectrum

INCL45-ABLA07



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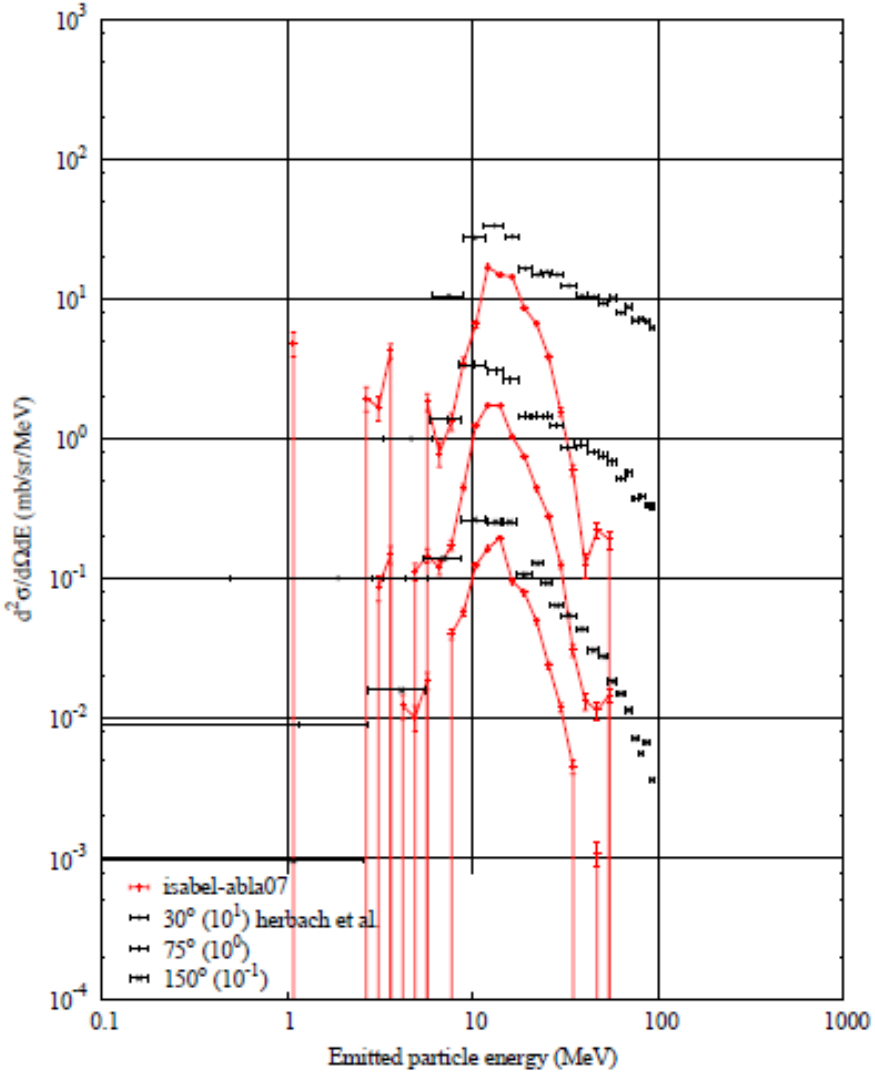
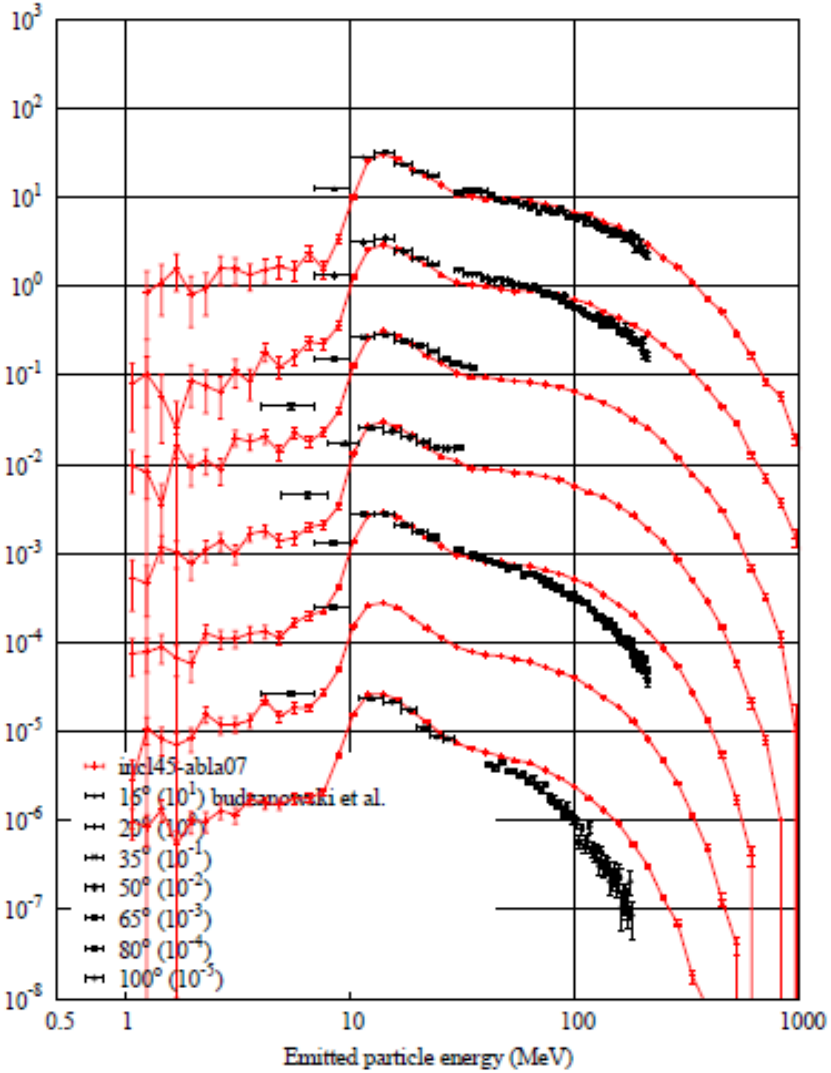


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Au – Deuteron spectrum

INCL45-ABLA07



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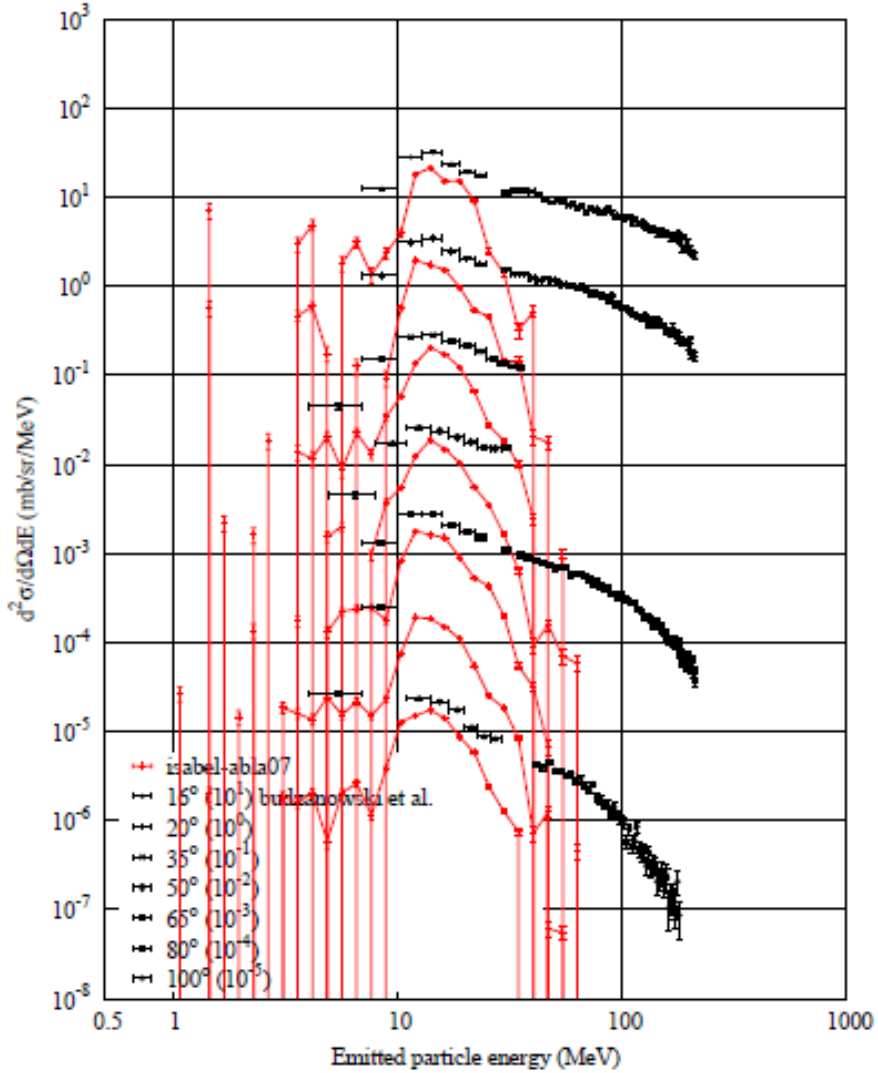
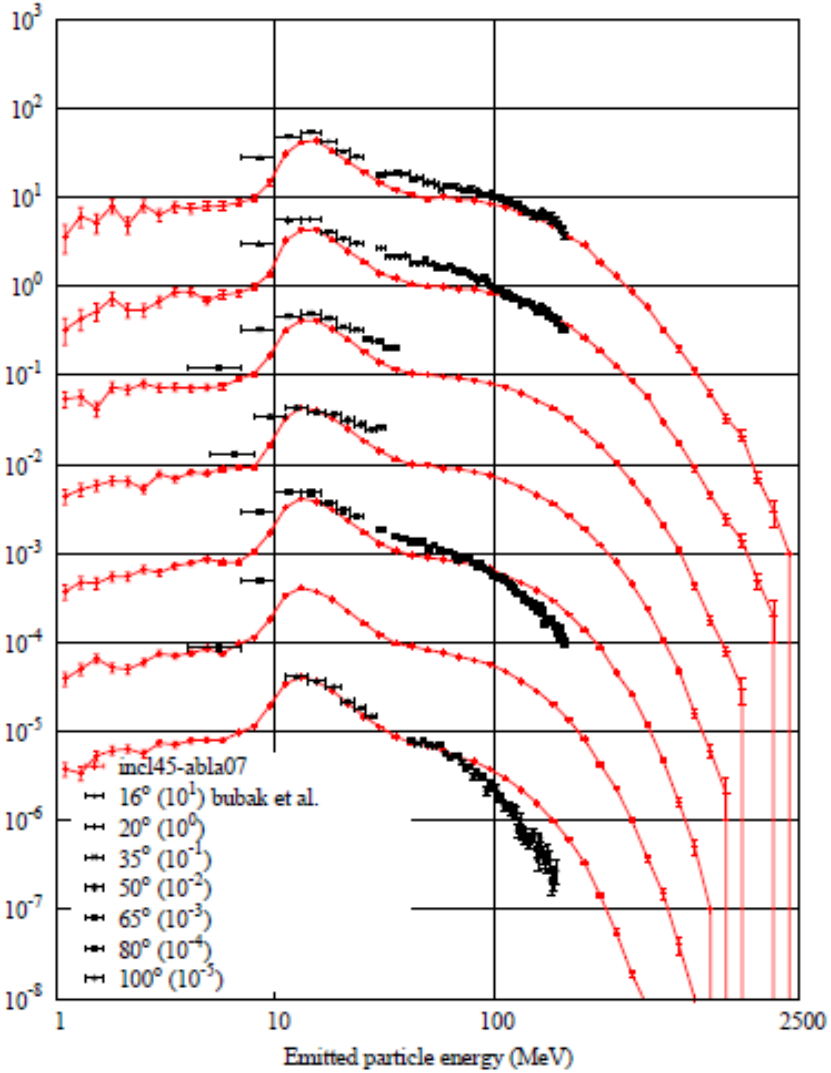


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – Deuteron spectrum

INCL45-ABLA07



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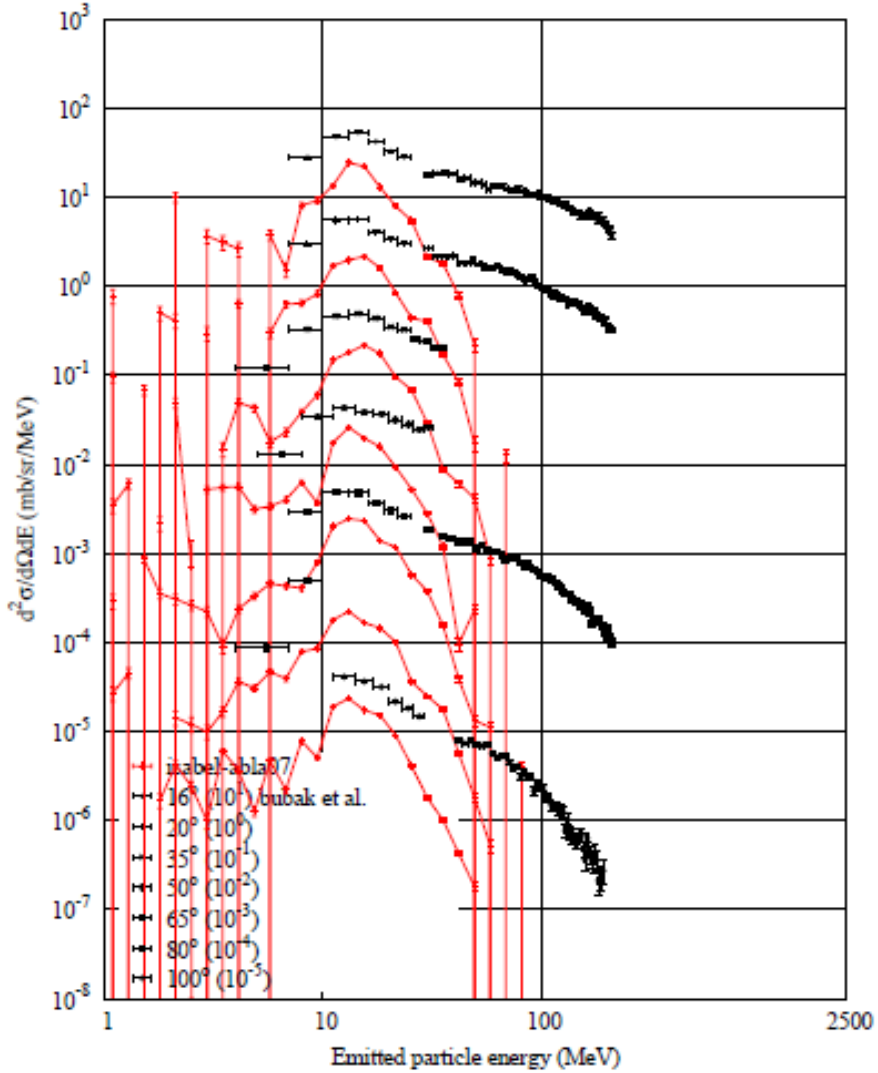
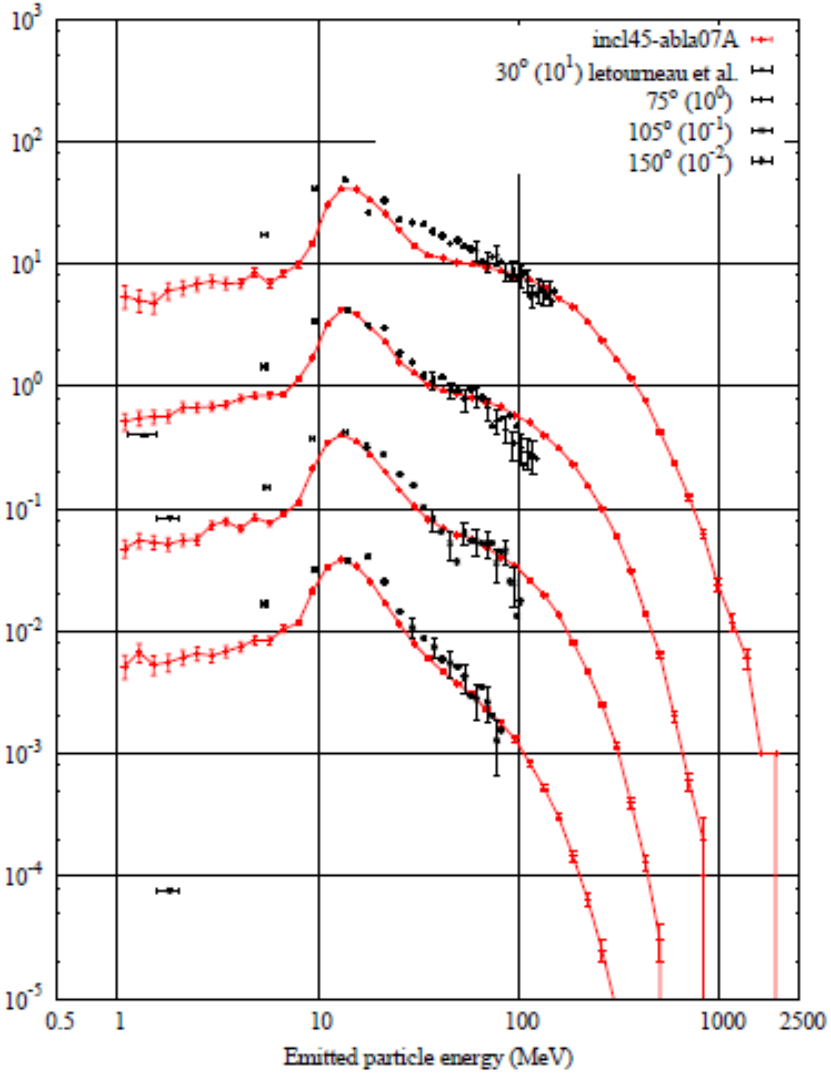


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – Deuteron spectrum

INCL45-ABLA07



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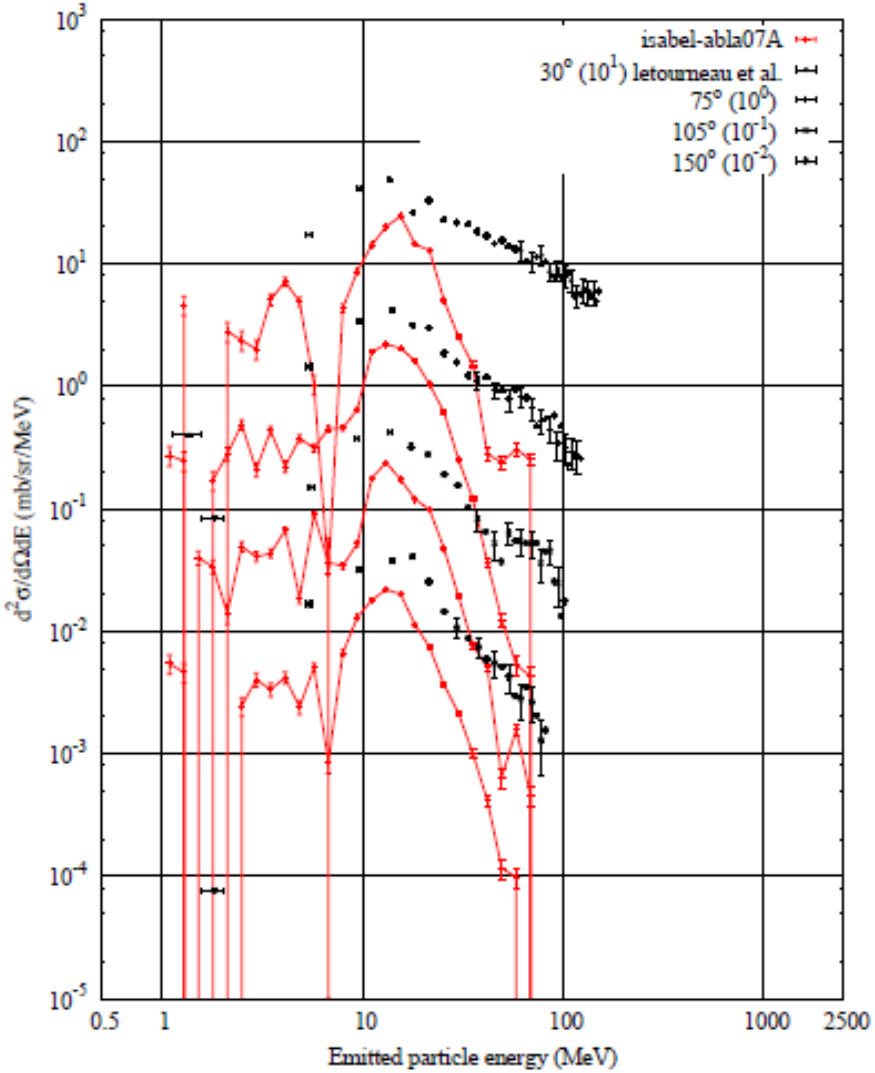


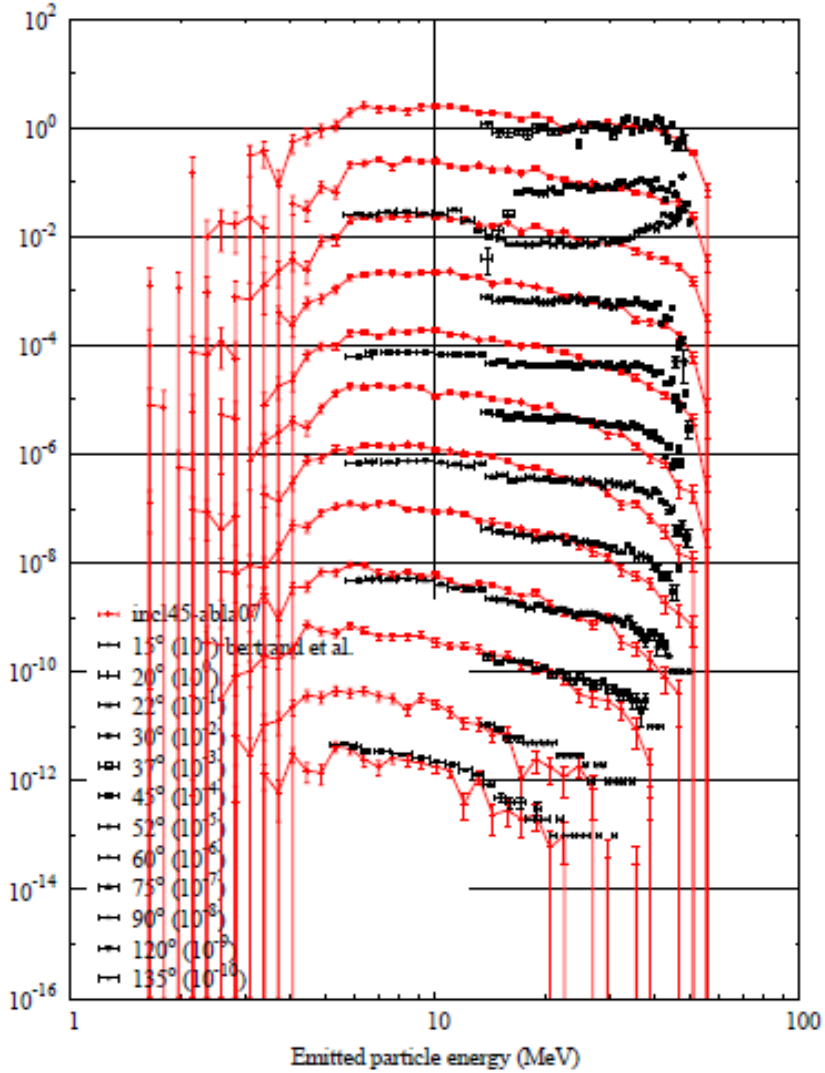
double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

Tritium spectra

p(62 MeV) + ^{56}Fe – Tritium spectrum

INCL45-ABLA07



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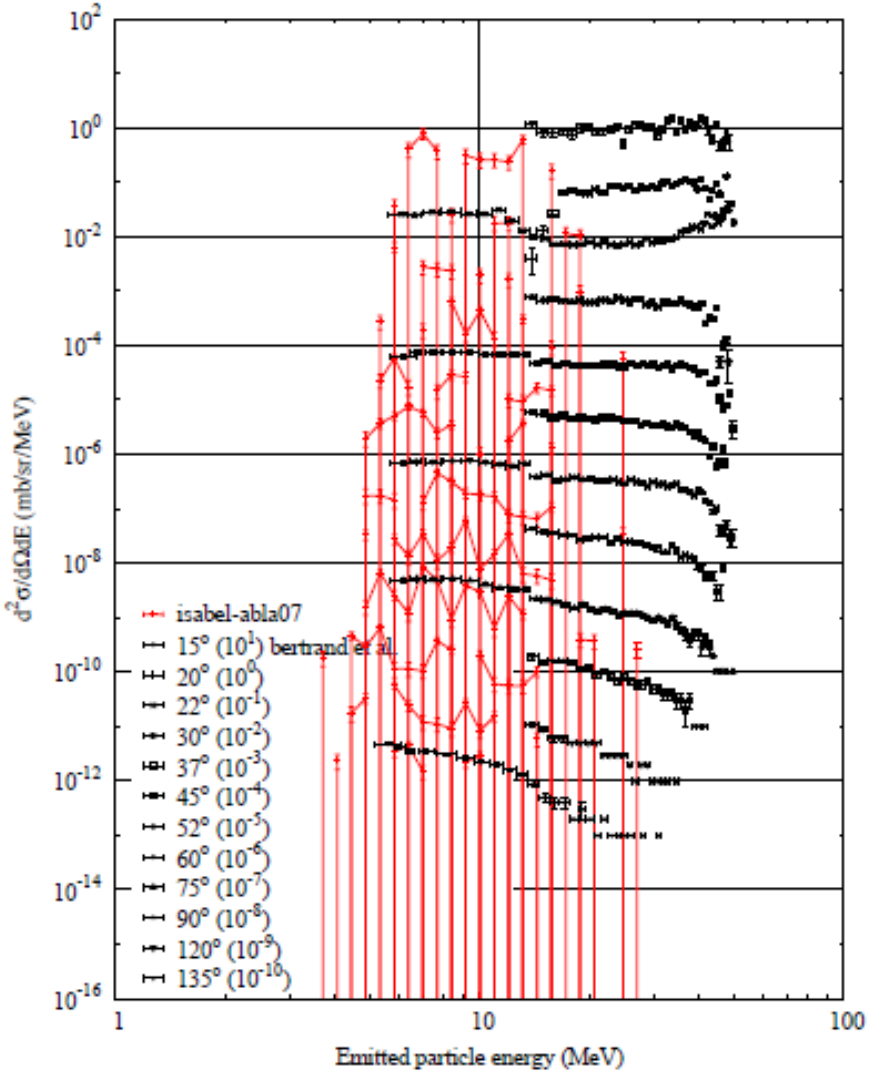
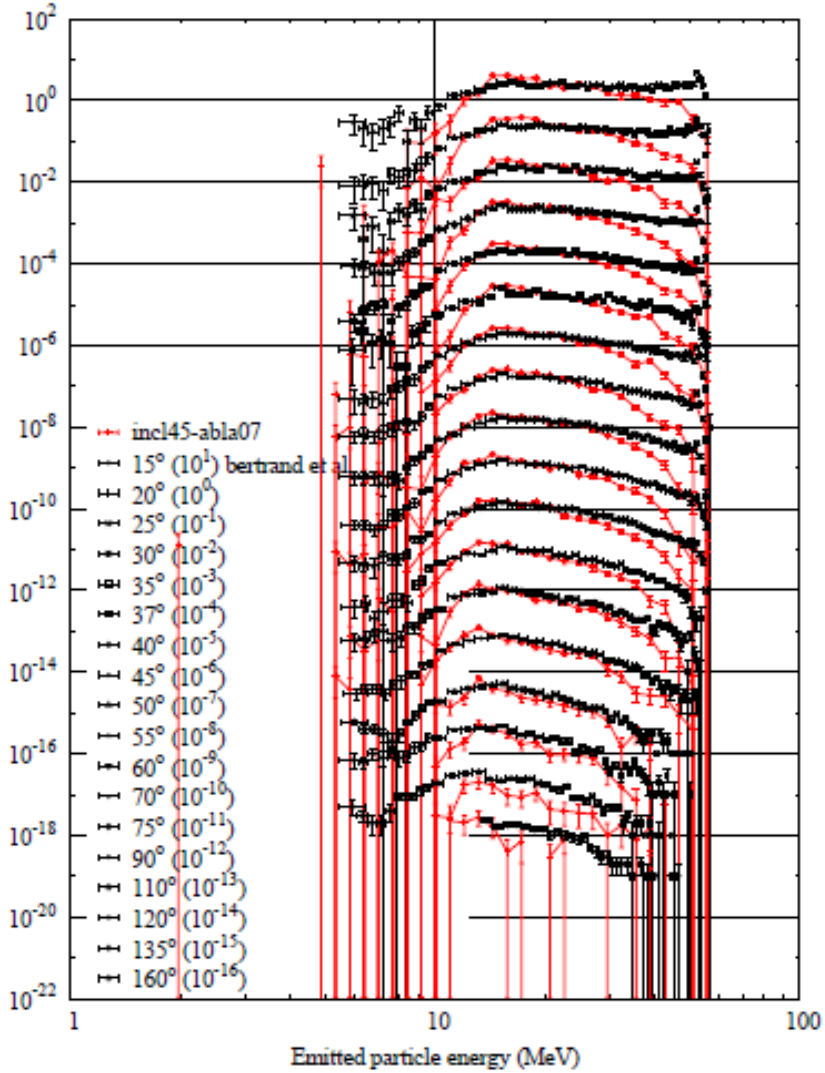


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(62 MeV) + Bi – Tritium spectrum

INCL45-ABLA07



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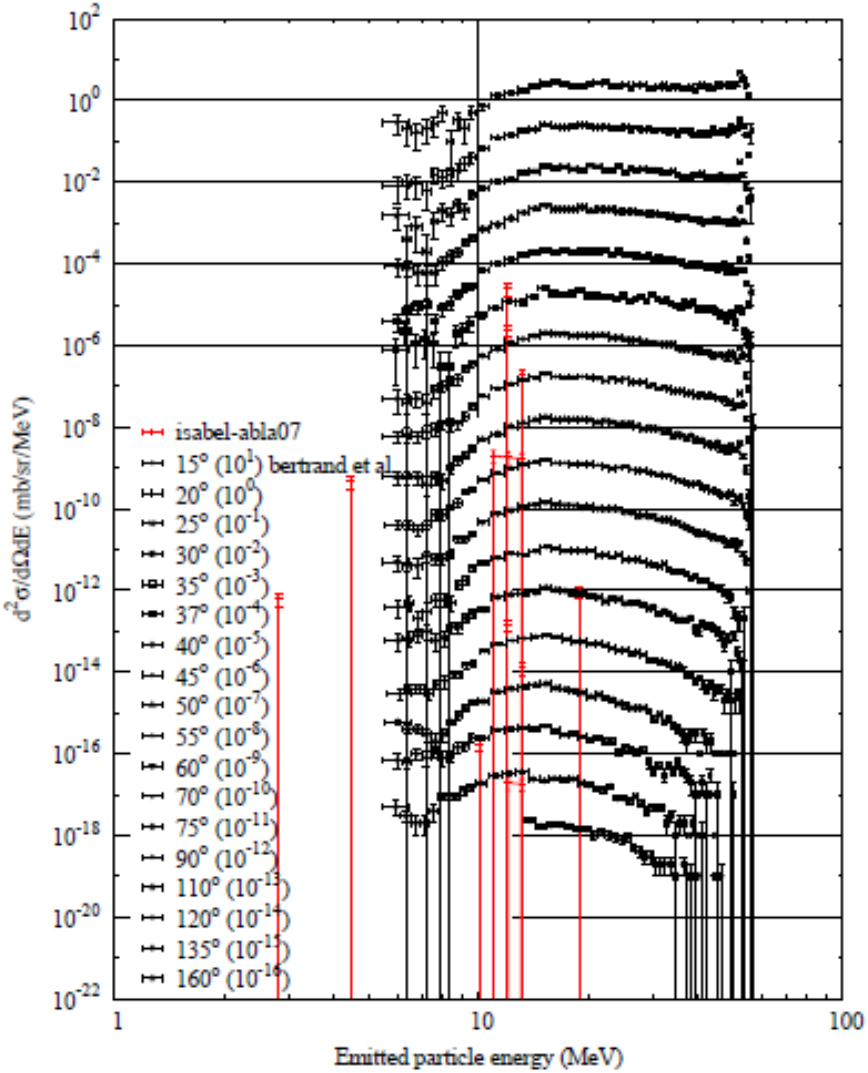
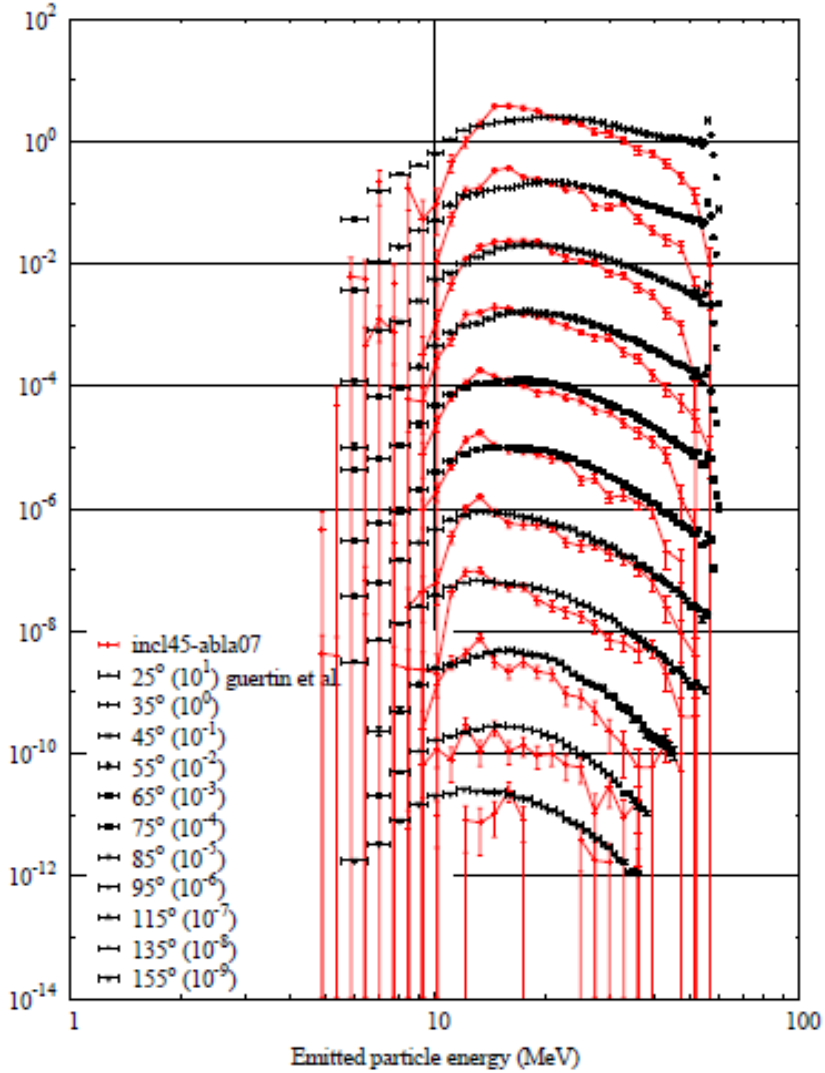


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(63 MeV) + ^{208}Pb – Tritium spectrum

INCL45-ABLA07



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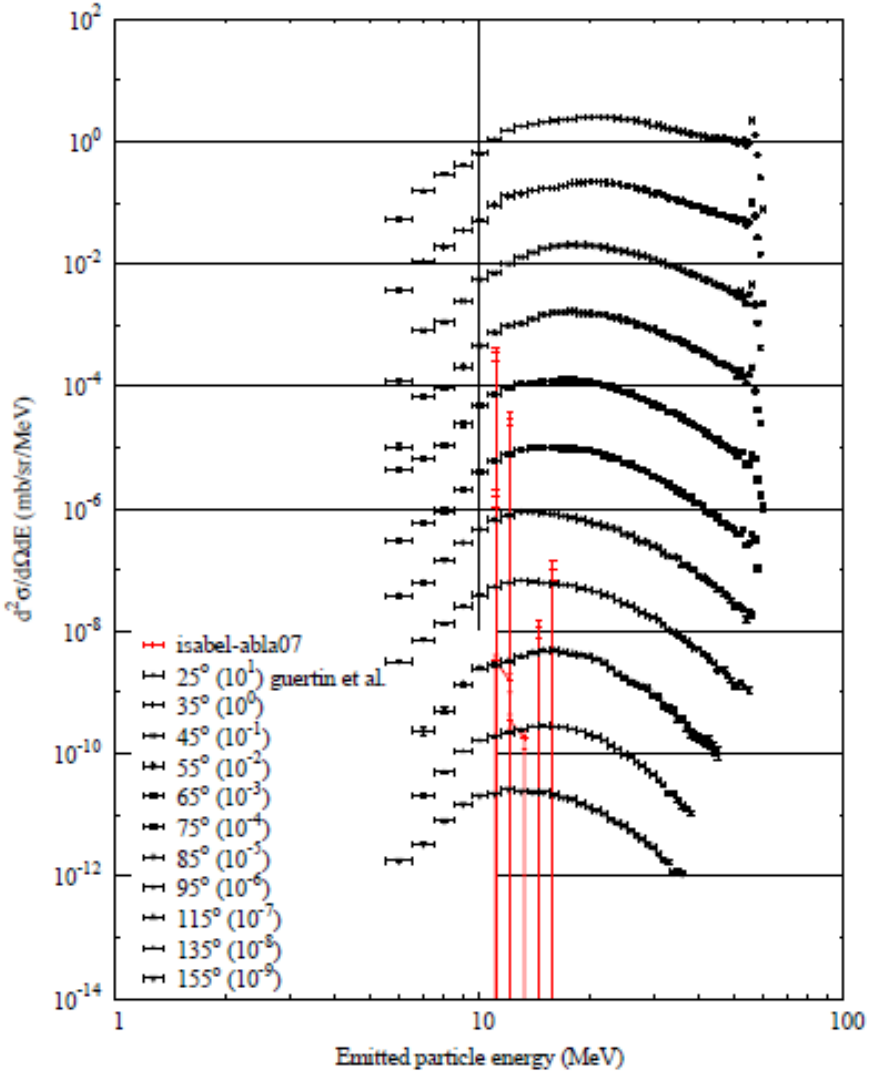
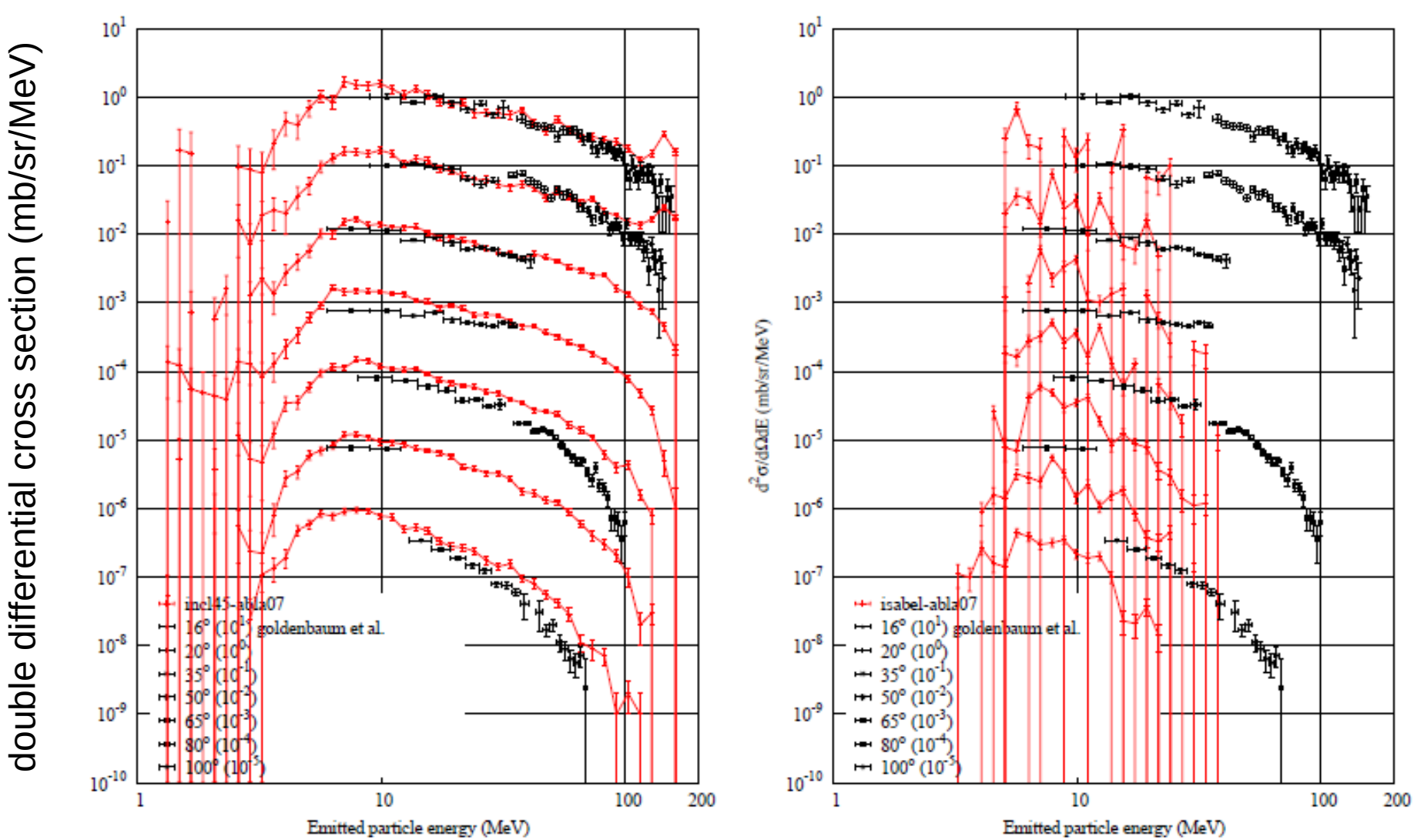


double differential cross section (mb/sr/MeV)

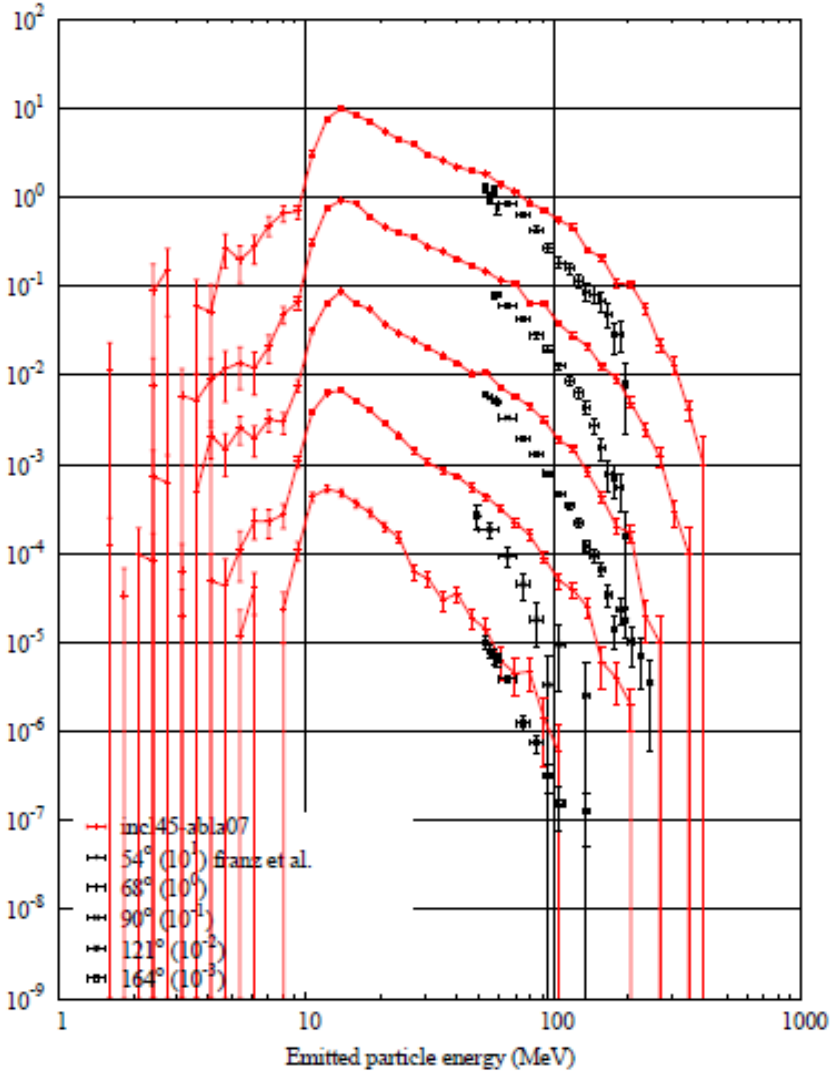
emitted-particle energy (MeV)

p(175 MeV) + Ni – Tritium spectrum



n(542 MeV) + Bi – Tritium spectrum

INCL45-ABLA07



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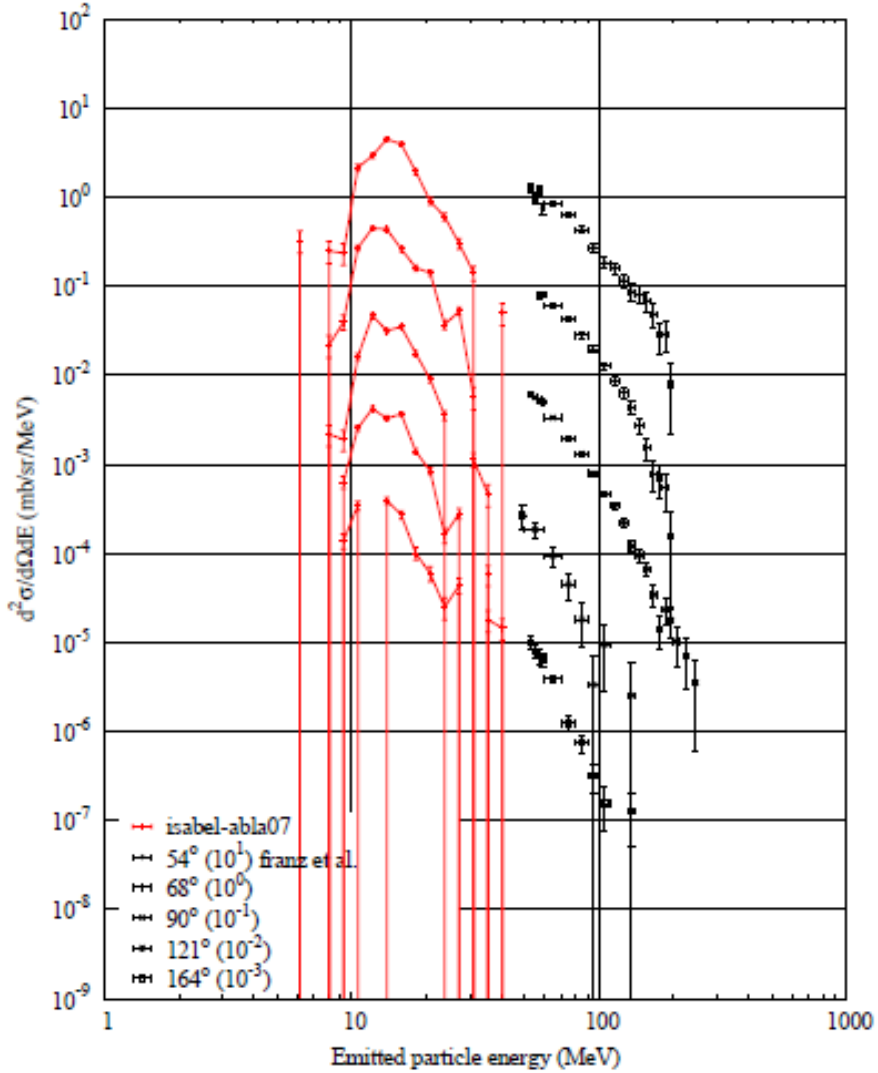
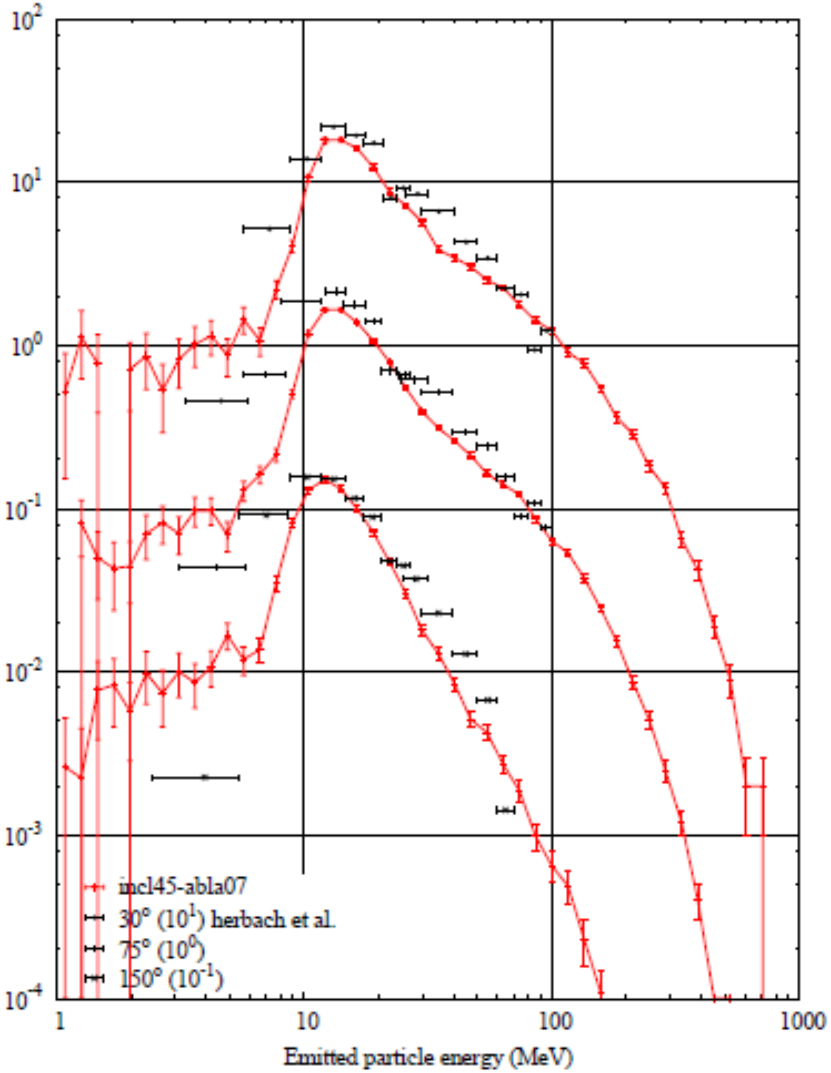


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Ta – Tritium spectrum

INCL45-ABLA07



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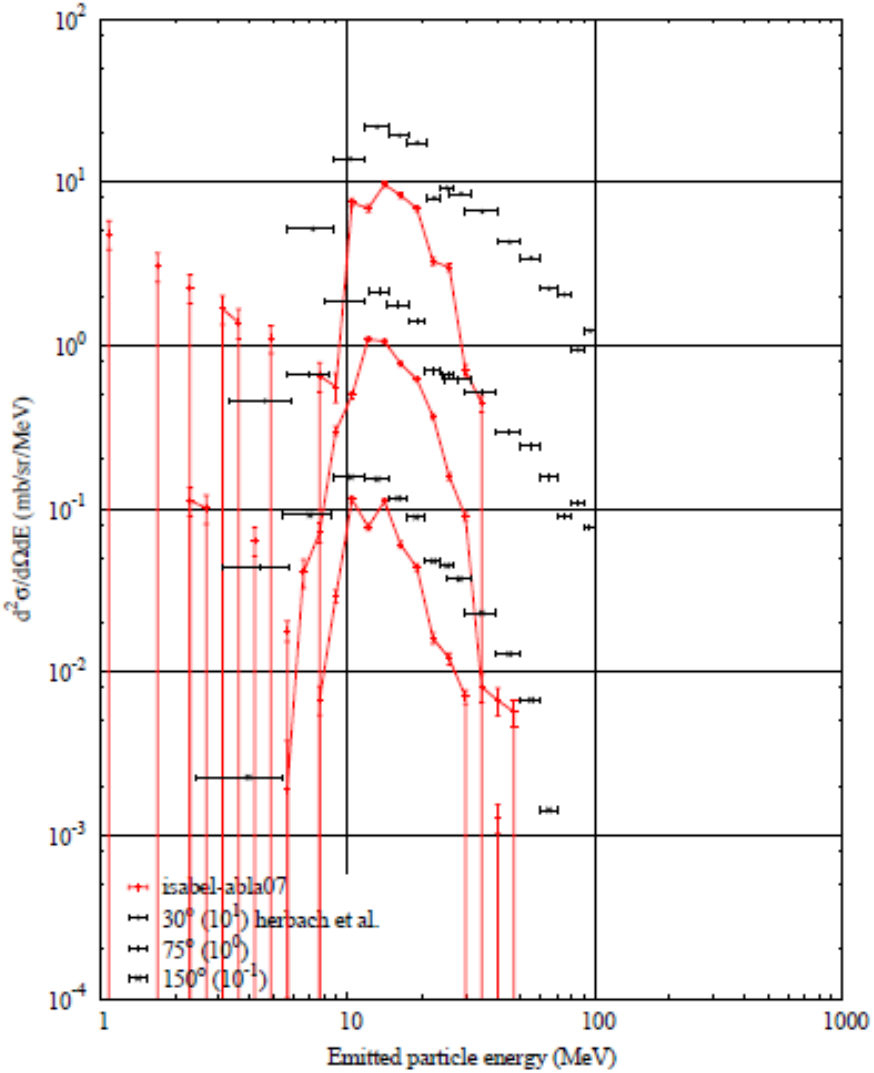
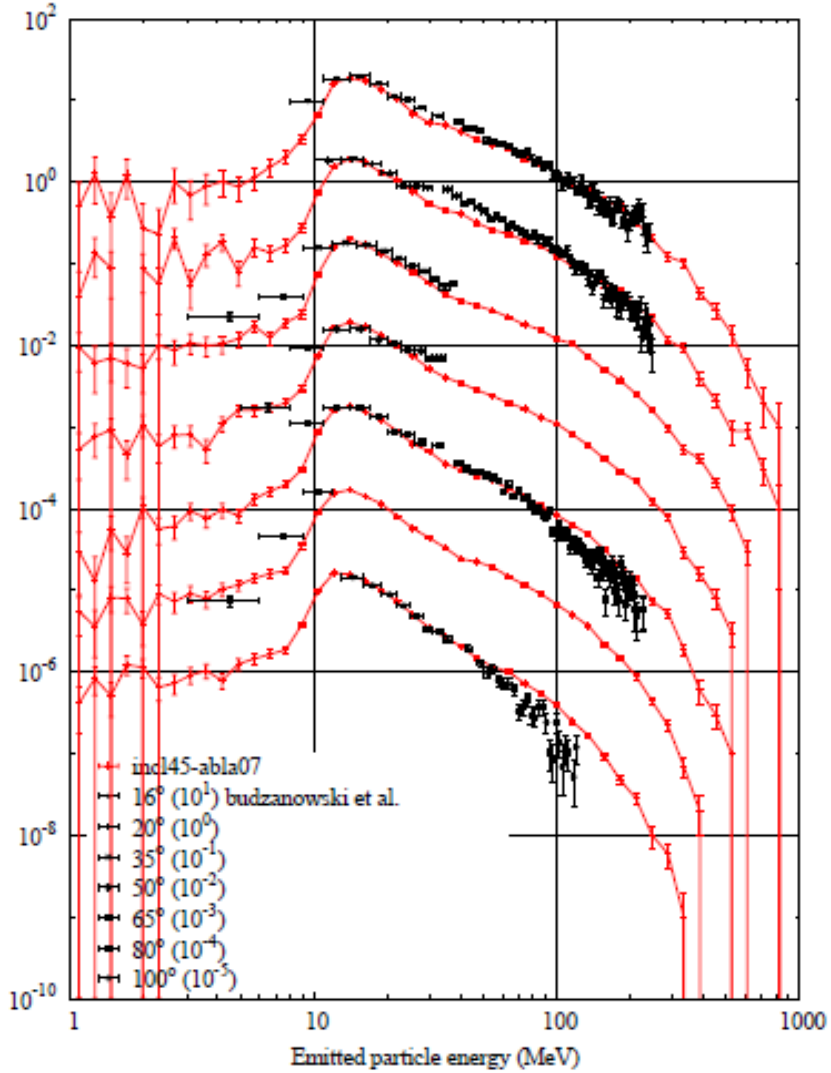


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Au – Tritium spectrum

INCL45-ABLA07



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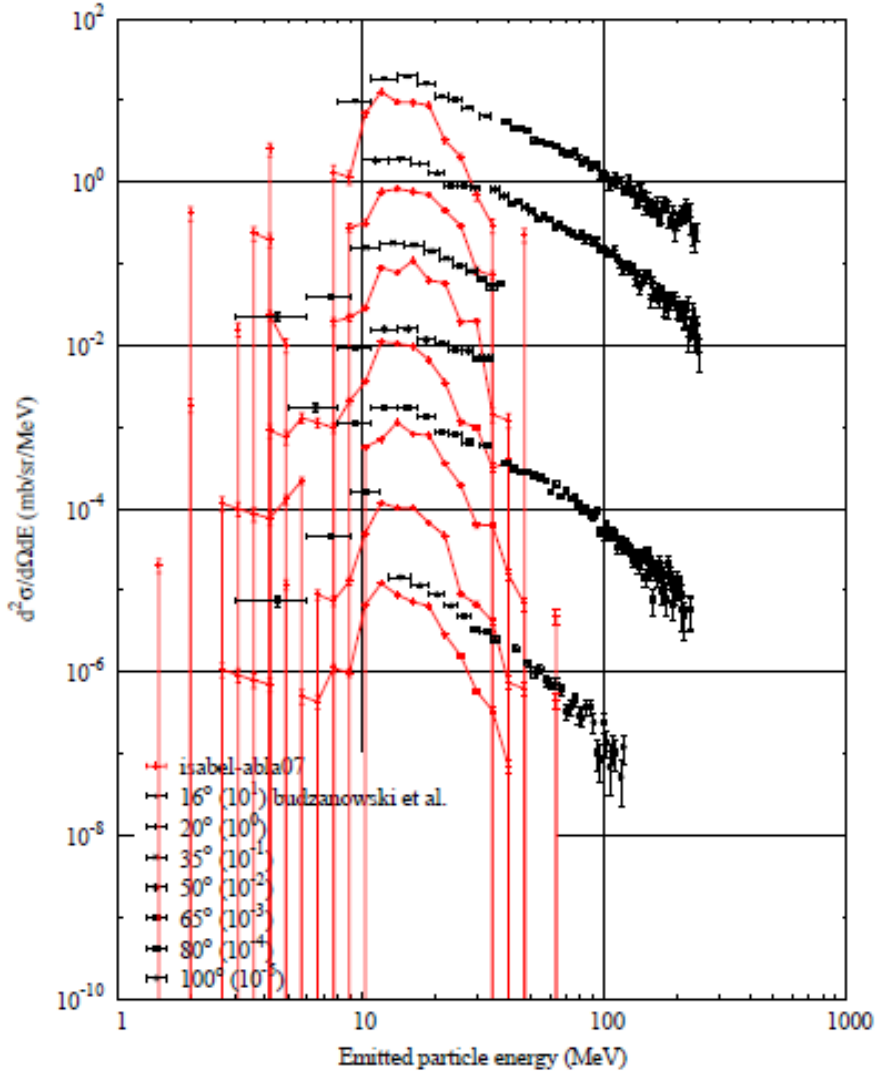
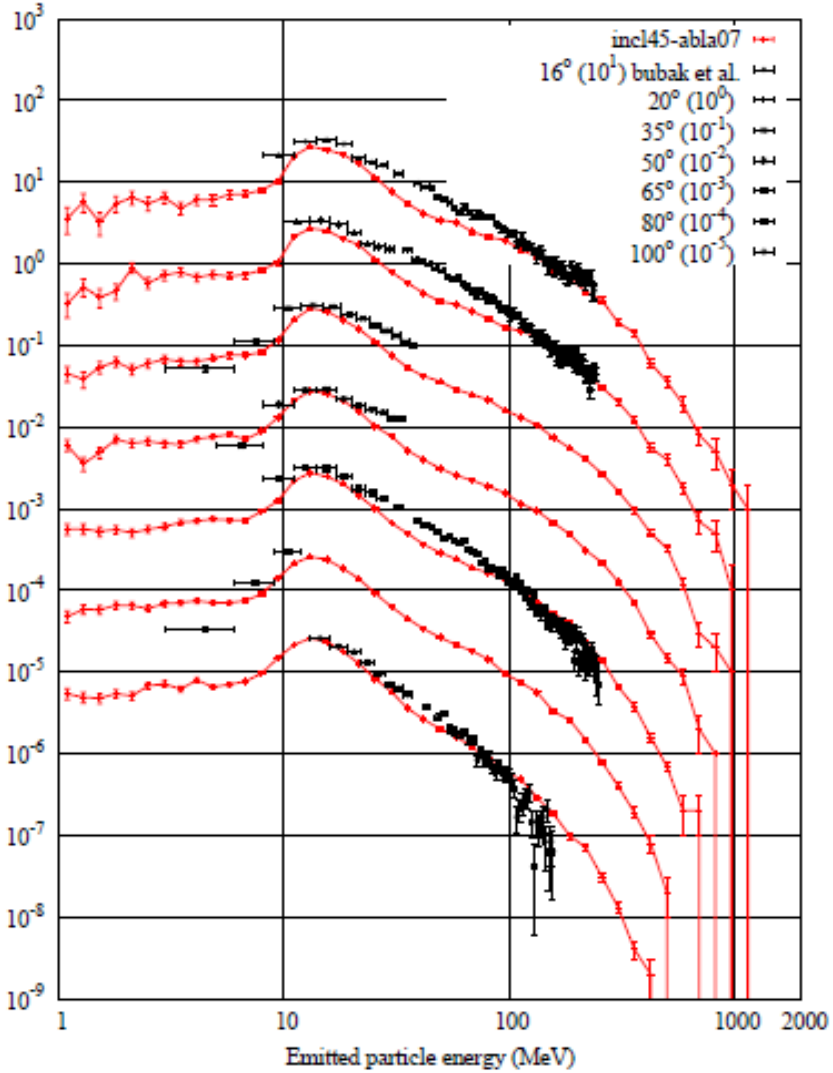


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – Tritium spectrum

INCL45-ABLA07



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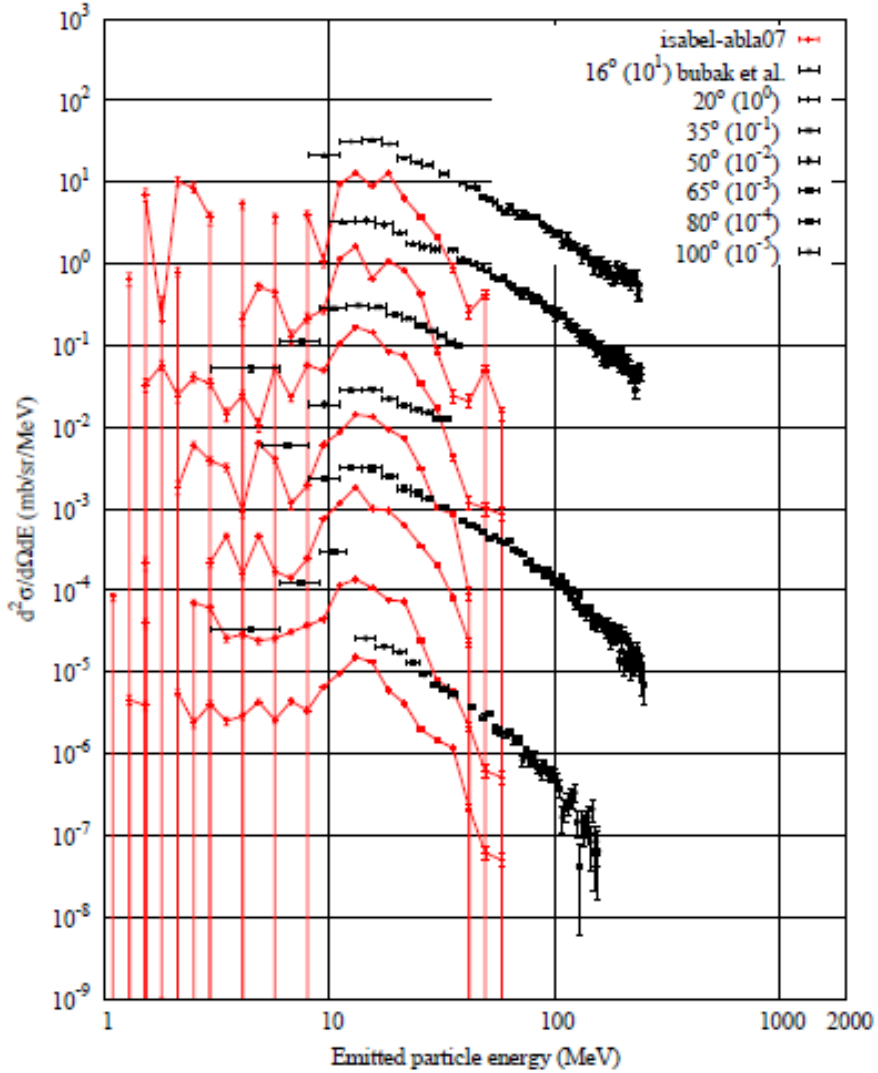
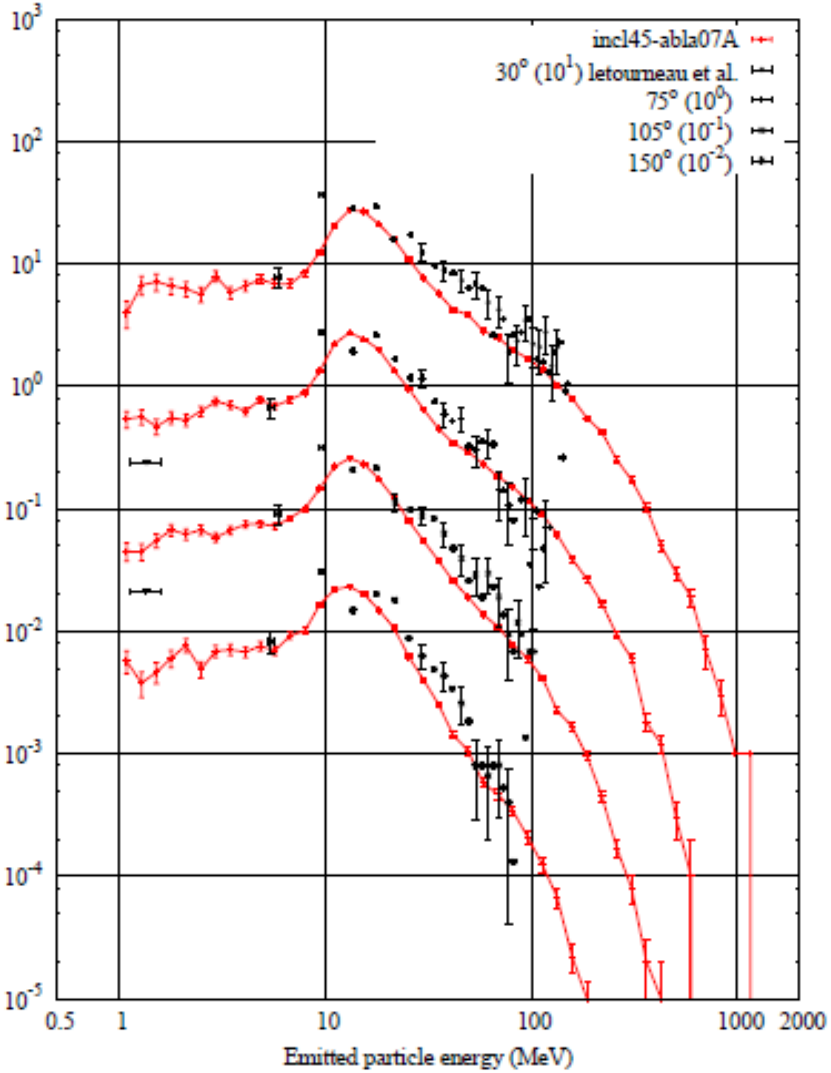


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – Tritium spectrum

INCL45-ABLA07



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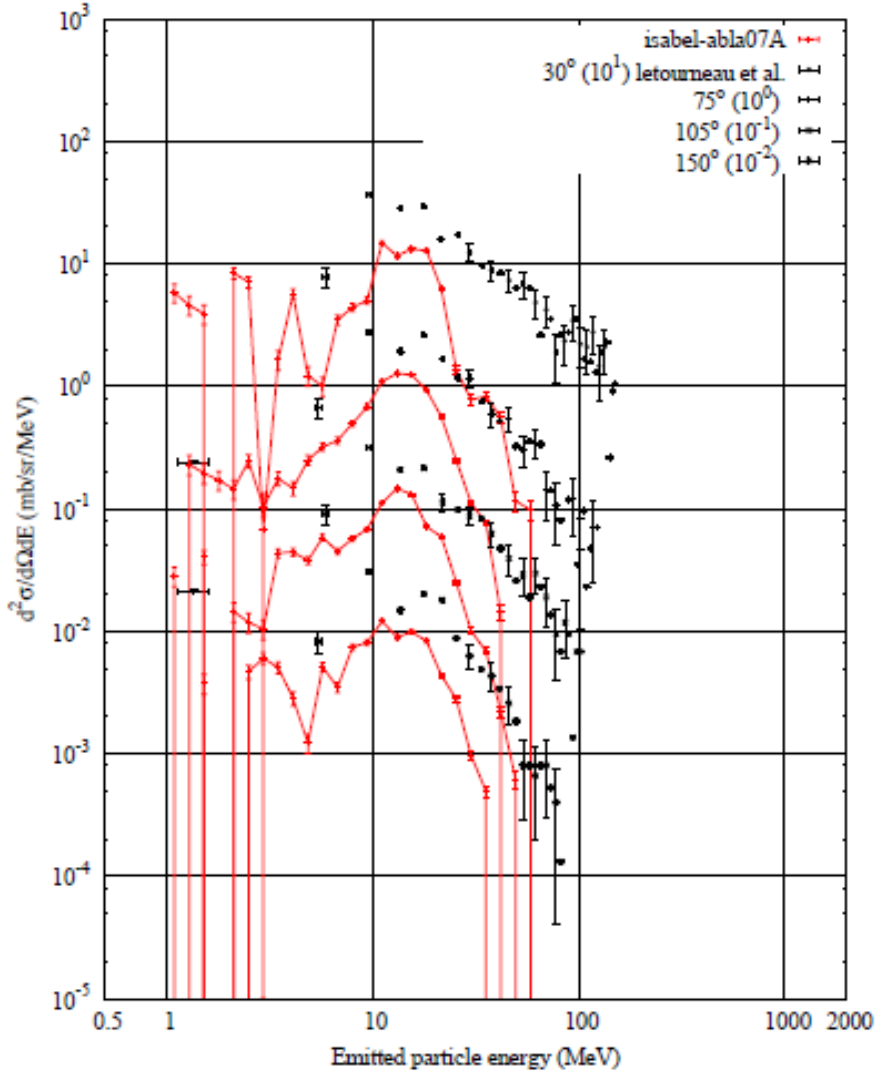


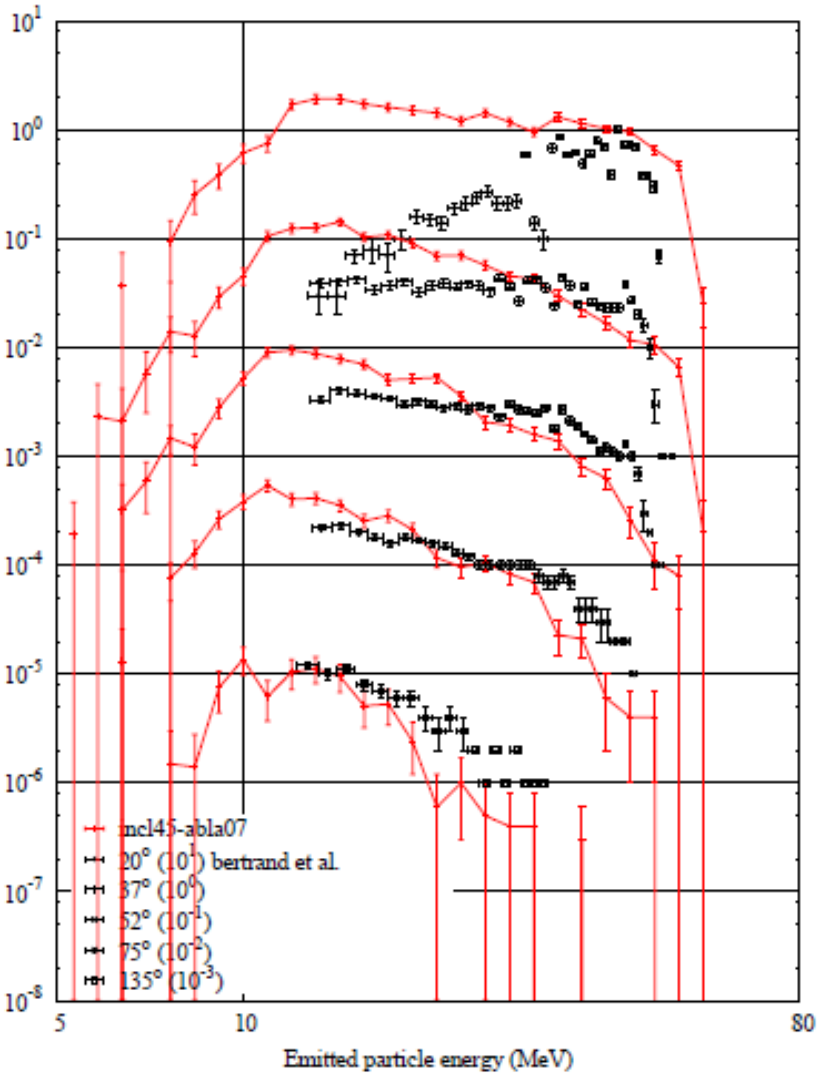
double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

^{3}He spectra

p(62 MeV) + Bi – ^{3}He spectrum

INCL45-ABLA07



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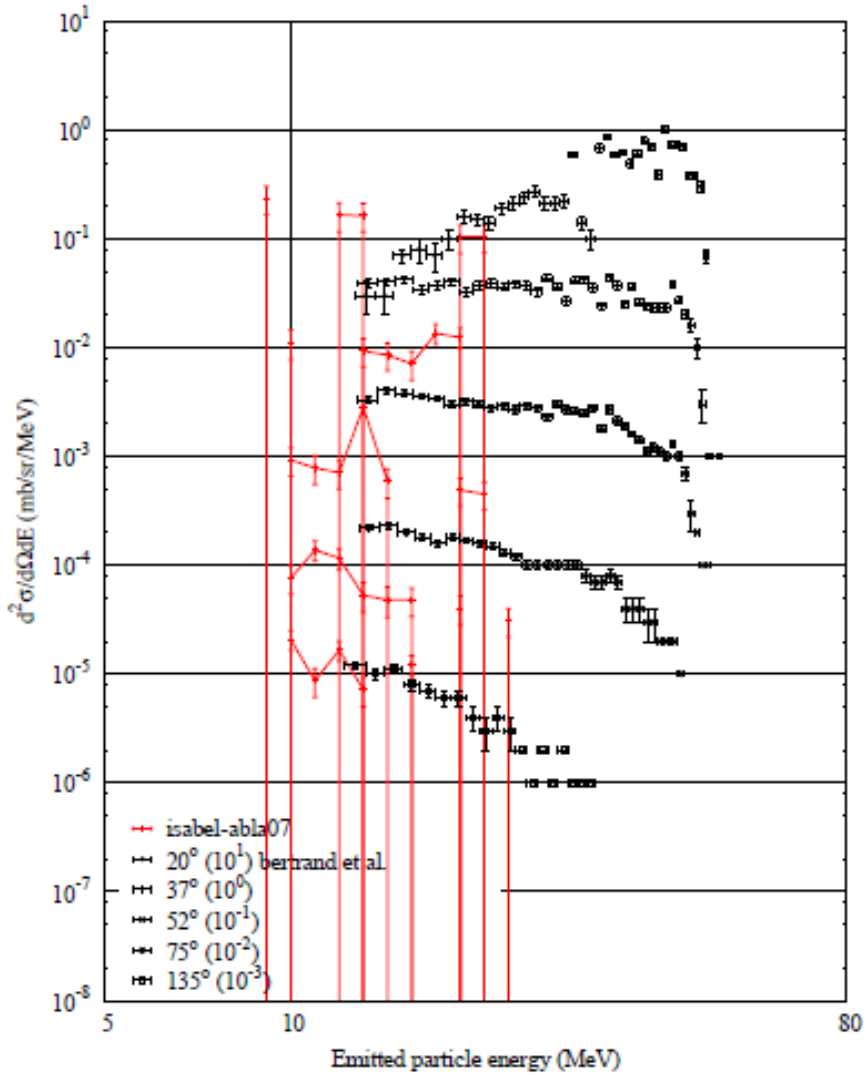

double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(62 MeV) + Bi – ^{3}He spectrum

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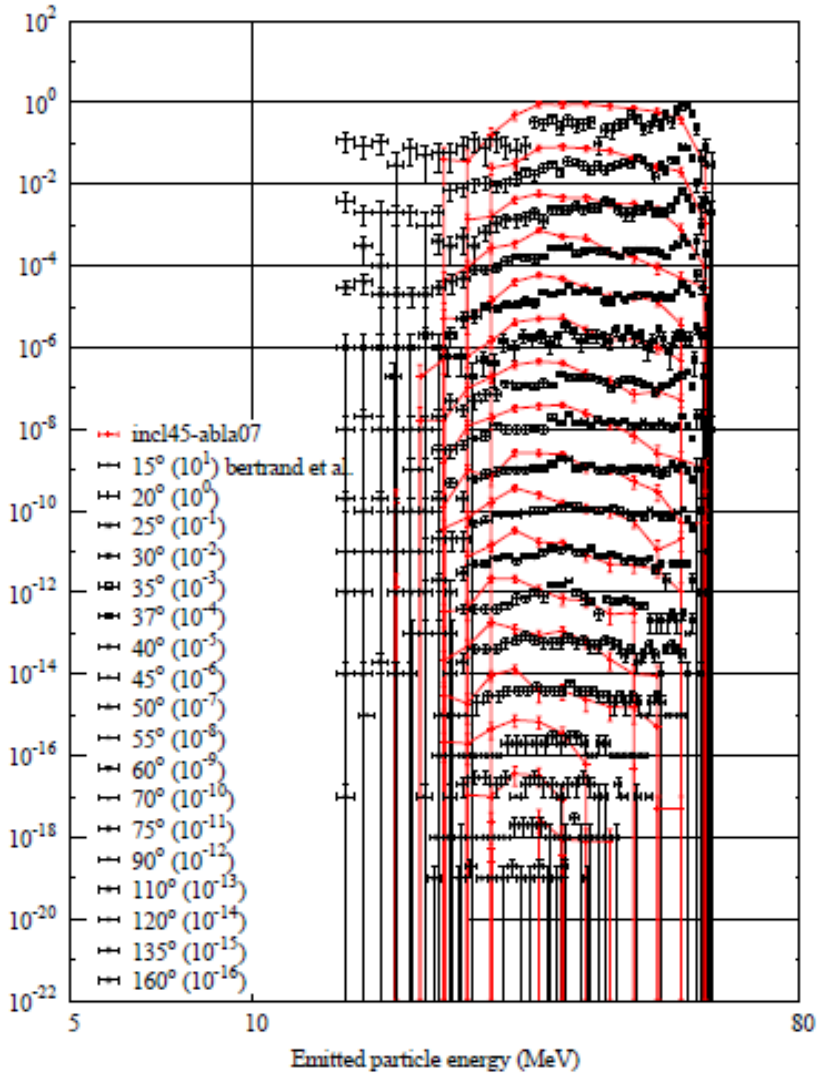

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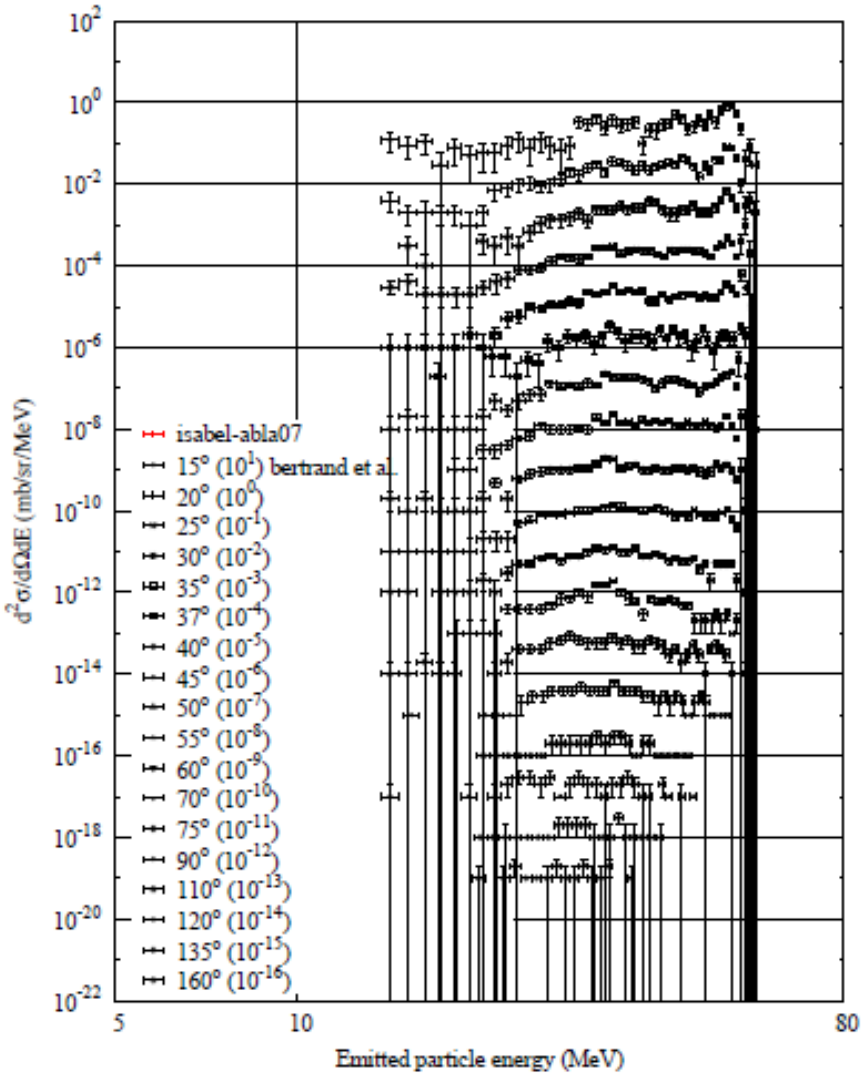
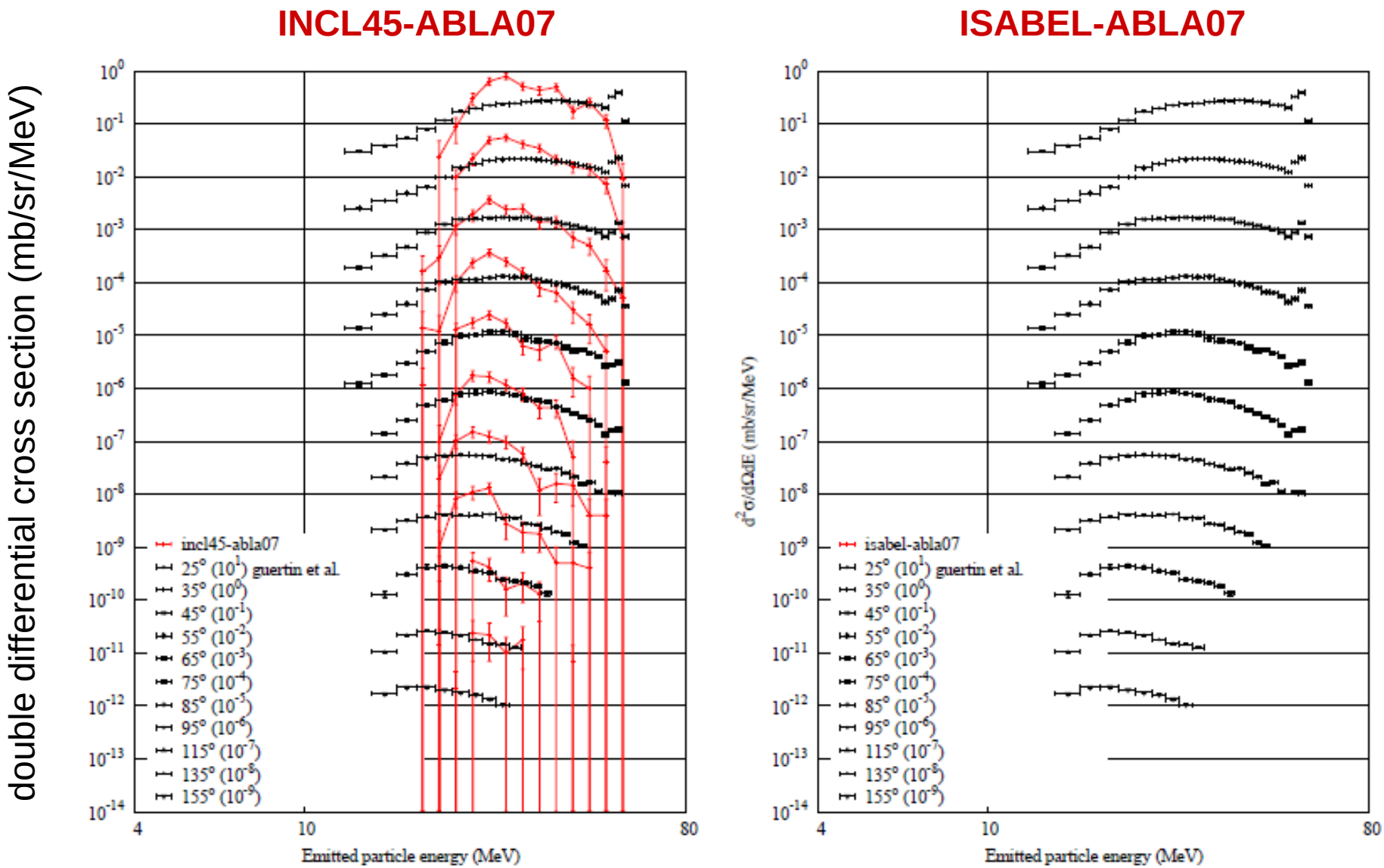


double differential cross section (mb/sr/MeV)

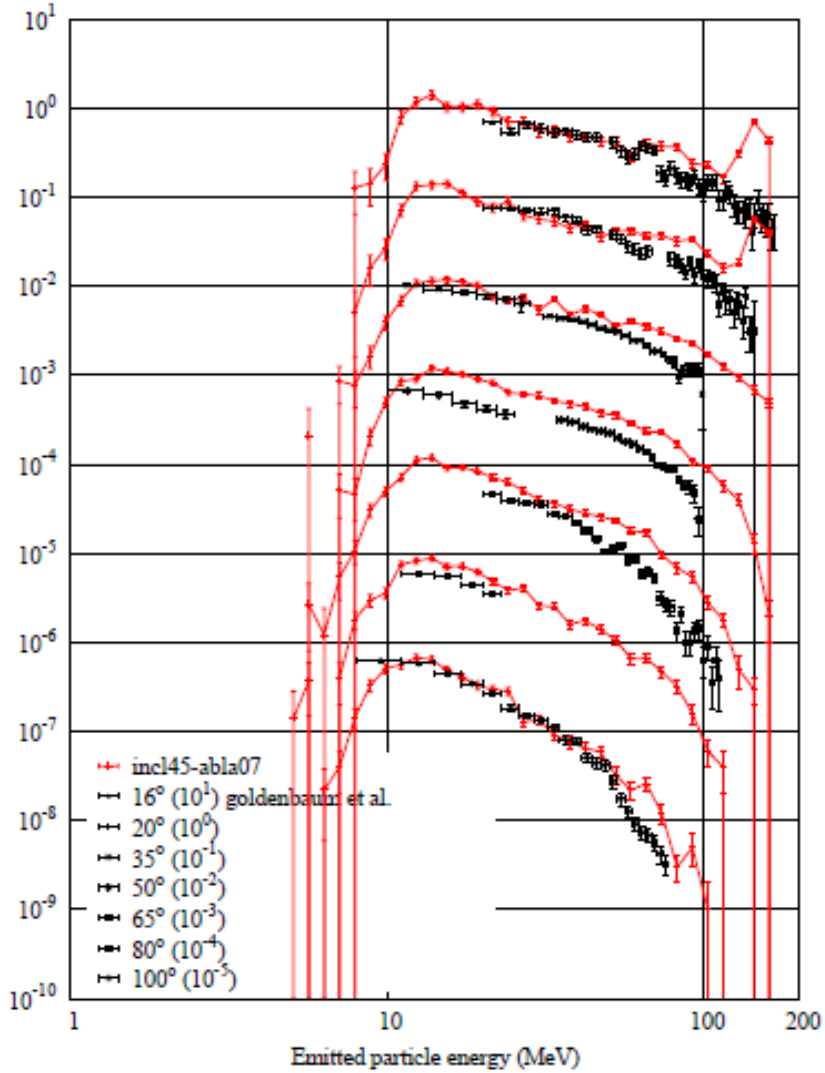
emitted-particle energy (MeV)

p(63 MeV) + ^{208}Pb – ^{3}He spectrum



p(175 MeV) + Ni – ^{3}He spectrum

INCL45-ABLA07



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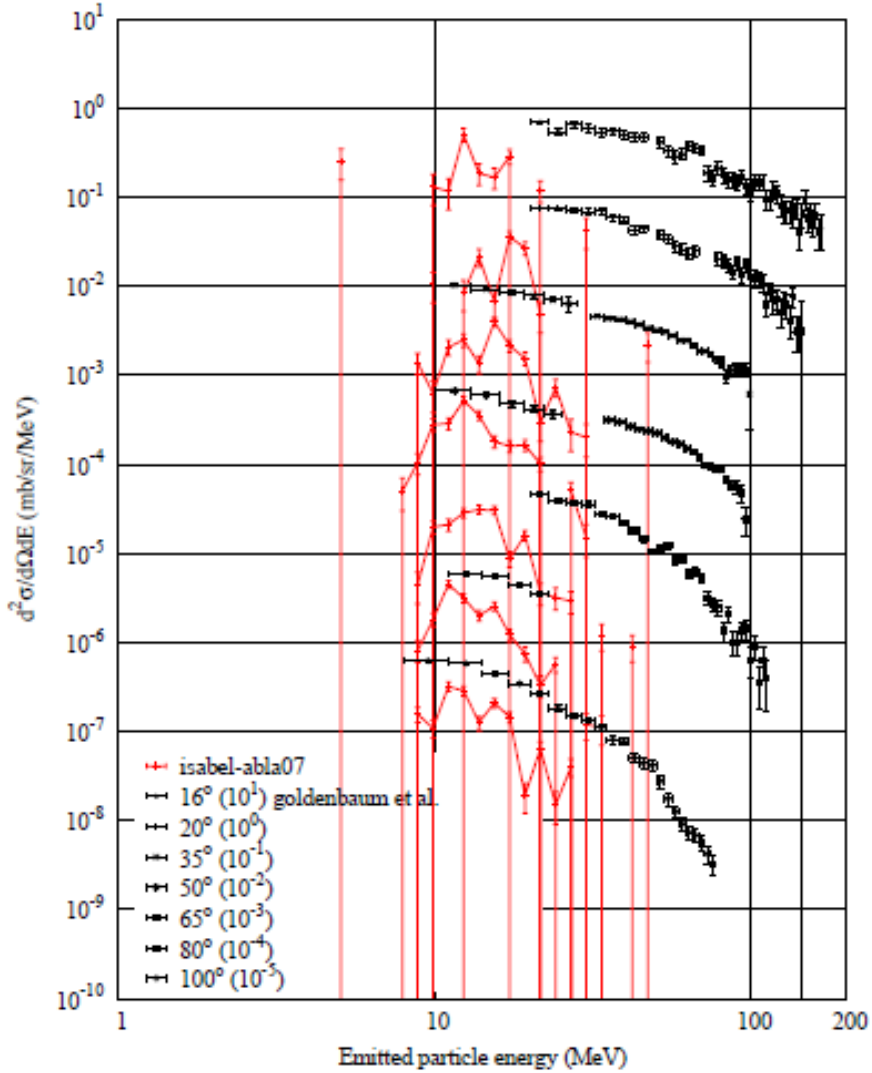
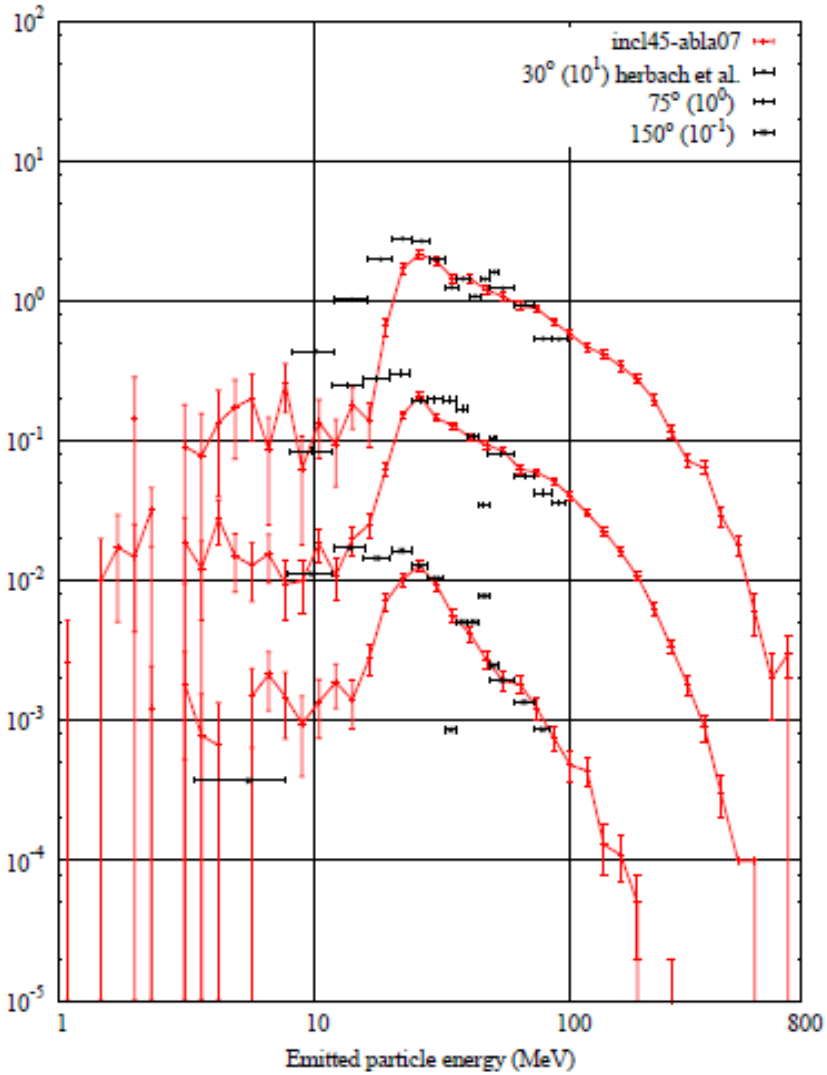


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Ta – ^{3}He spectrum

INCL45-ABLA07



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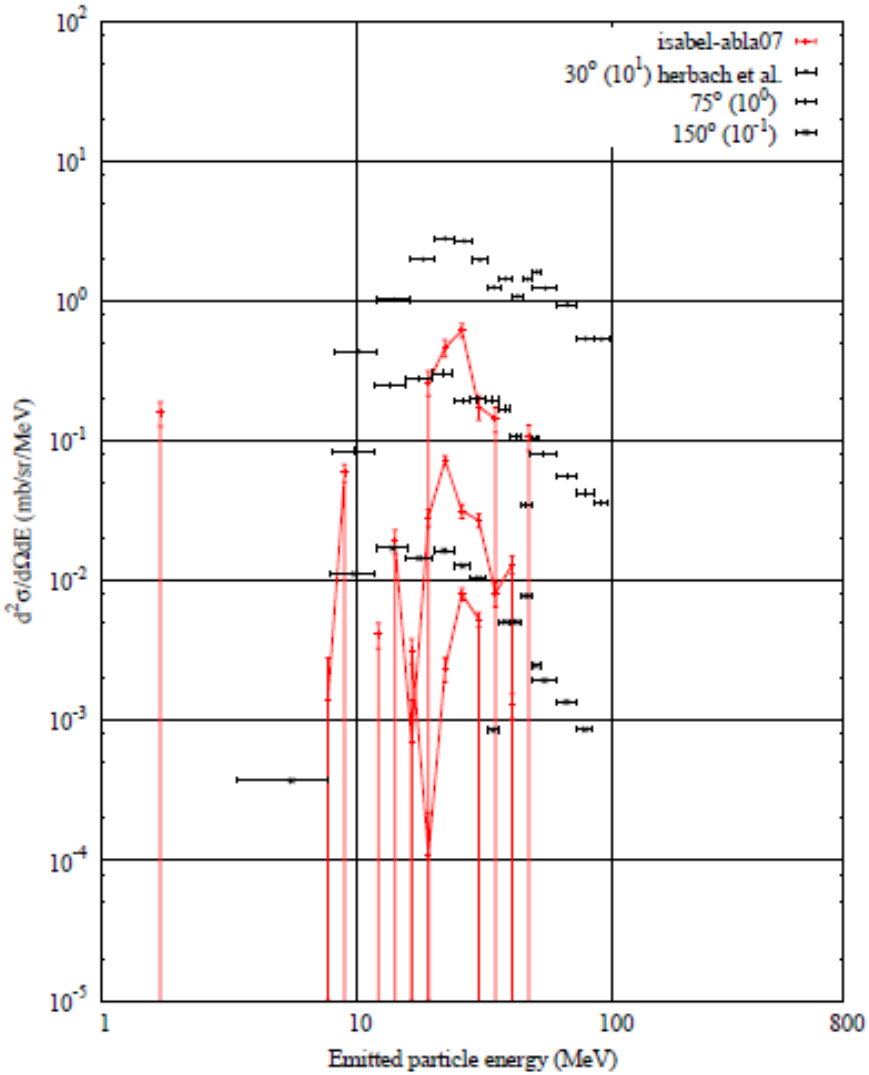
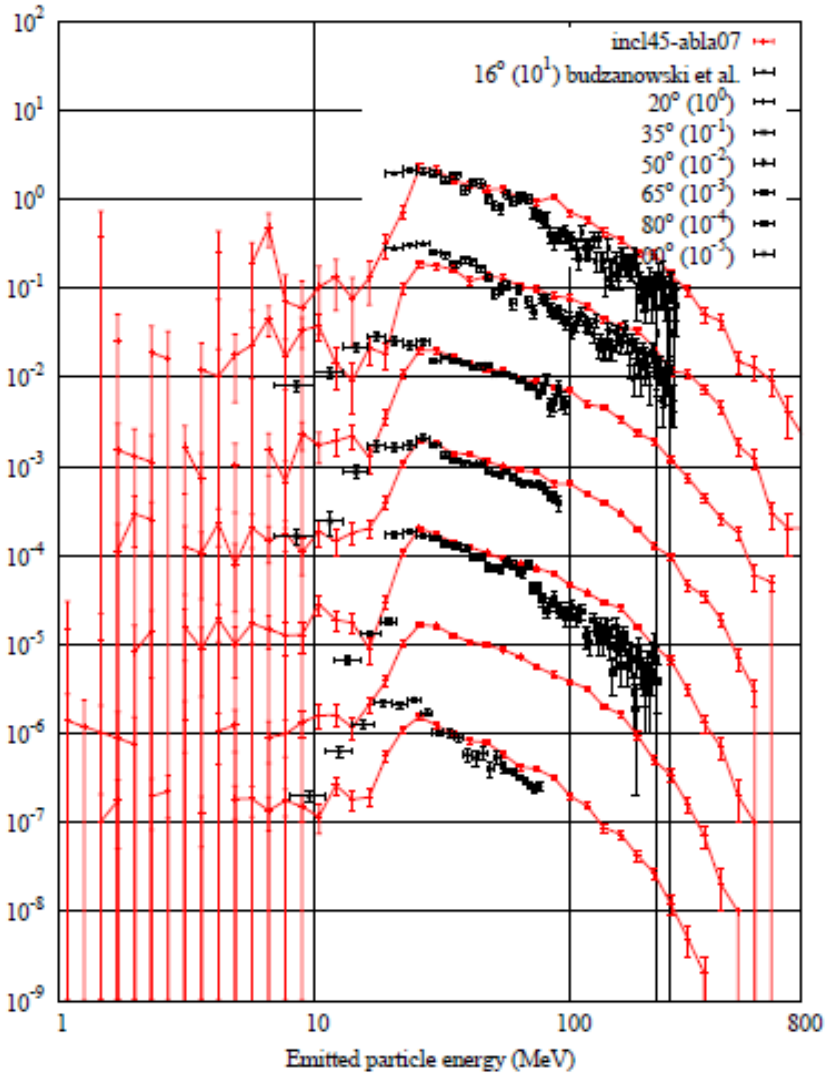


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Au – ^{3}He spectrum

INCL45-ABLA07



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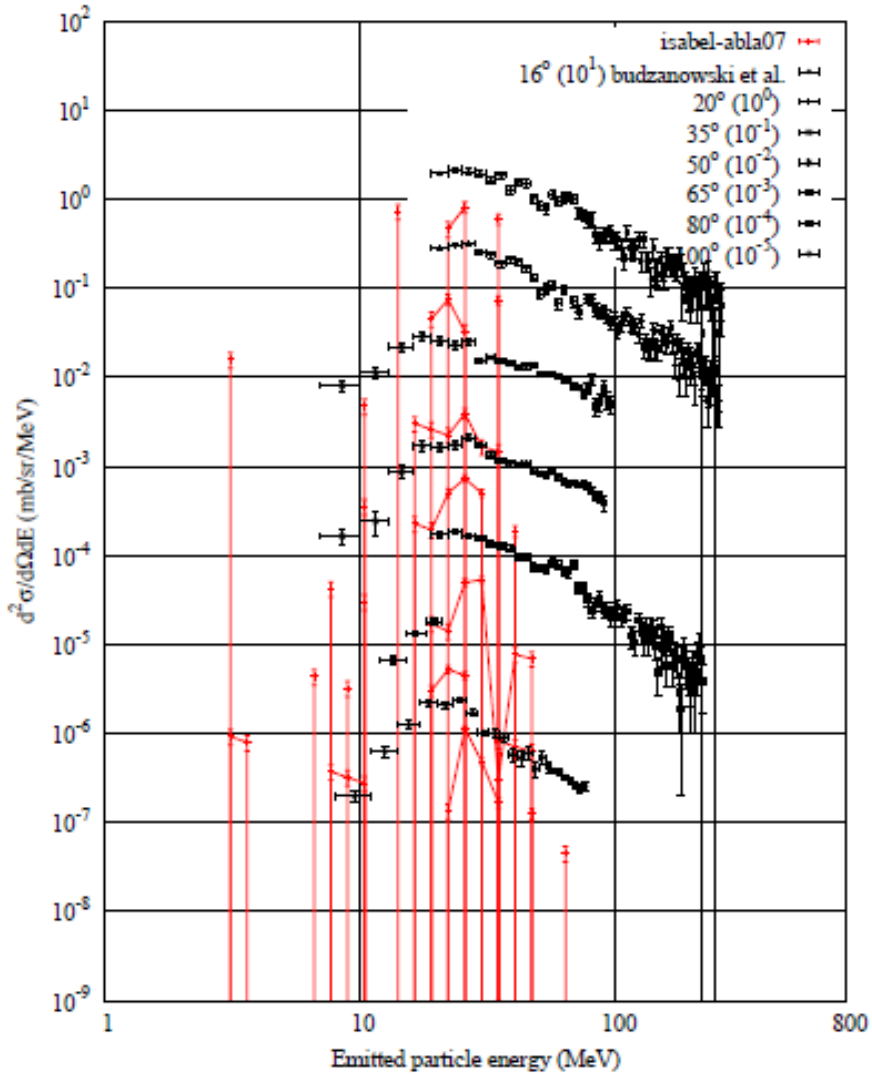
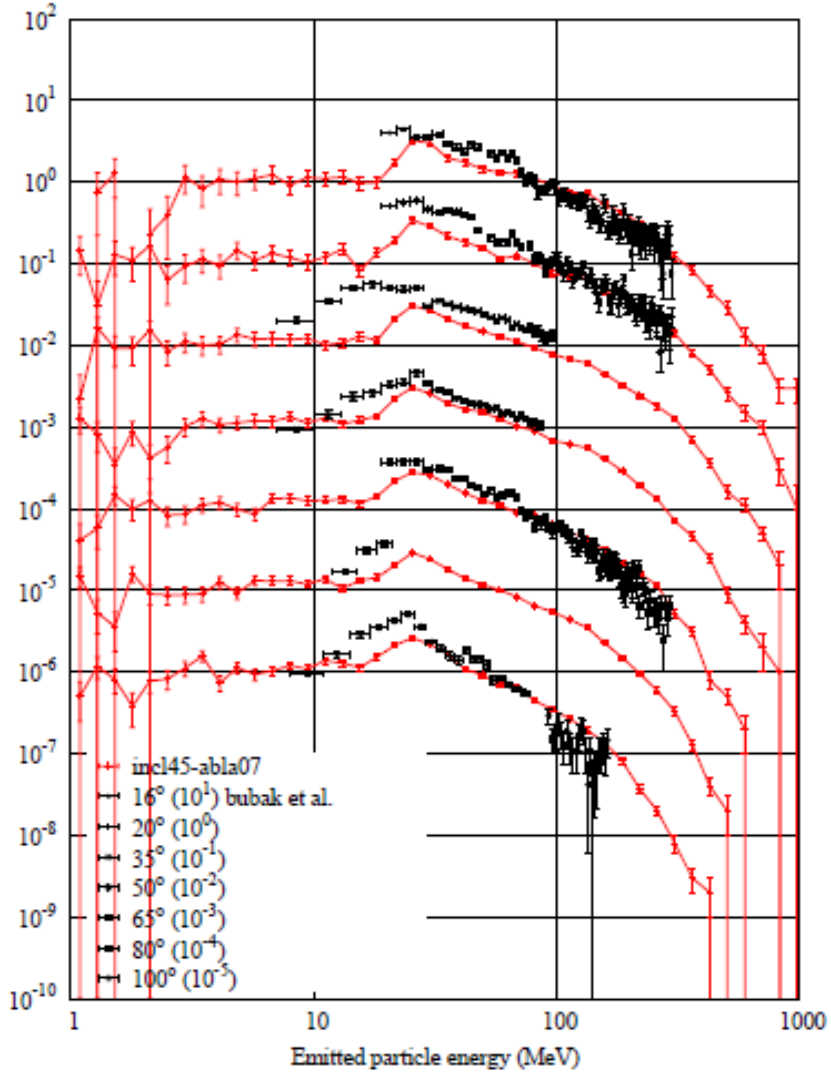


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – ^{3}He spectrum

INCL45-ABLA07



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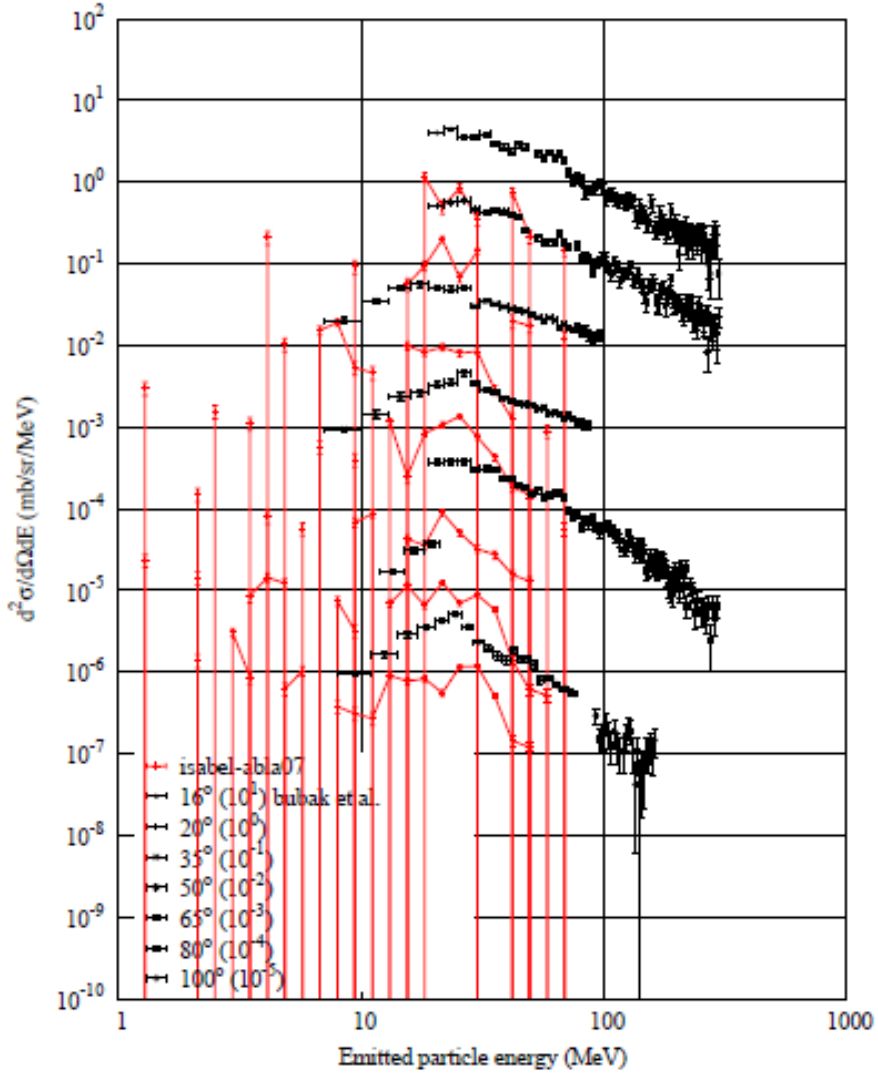
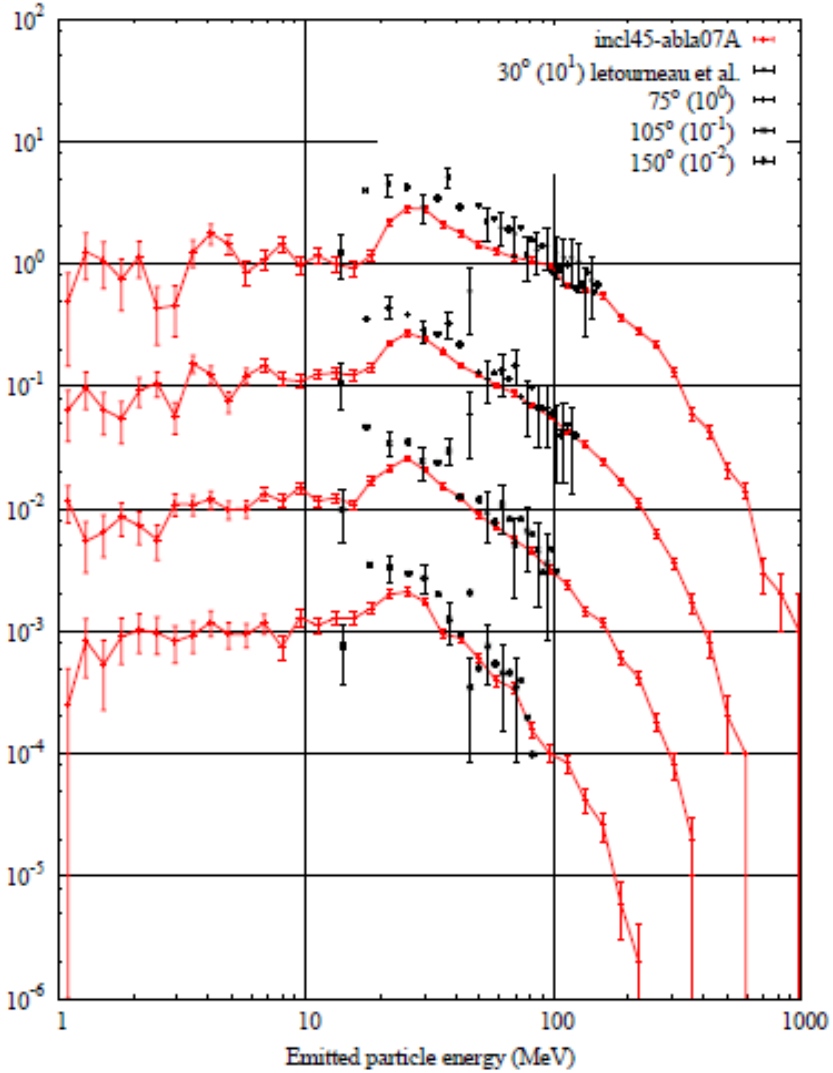


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – ^{3}He spectrum

INCL45-ABLA07



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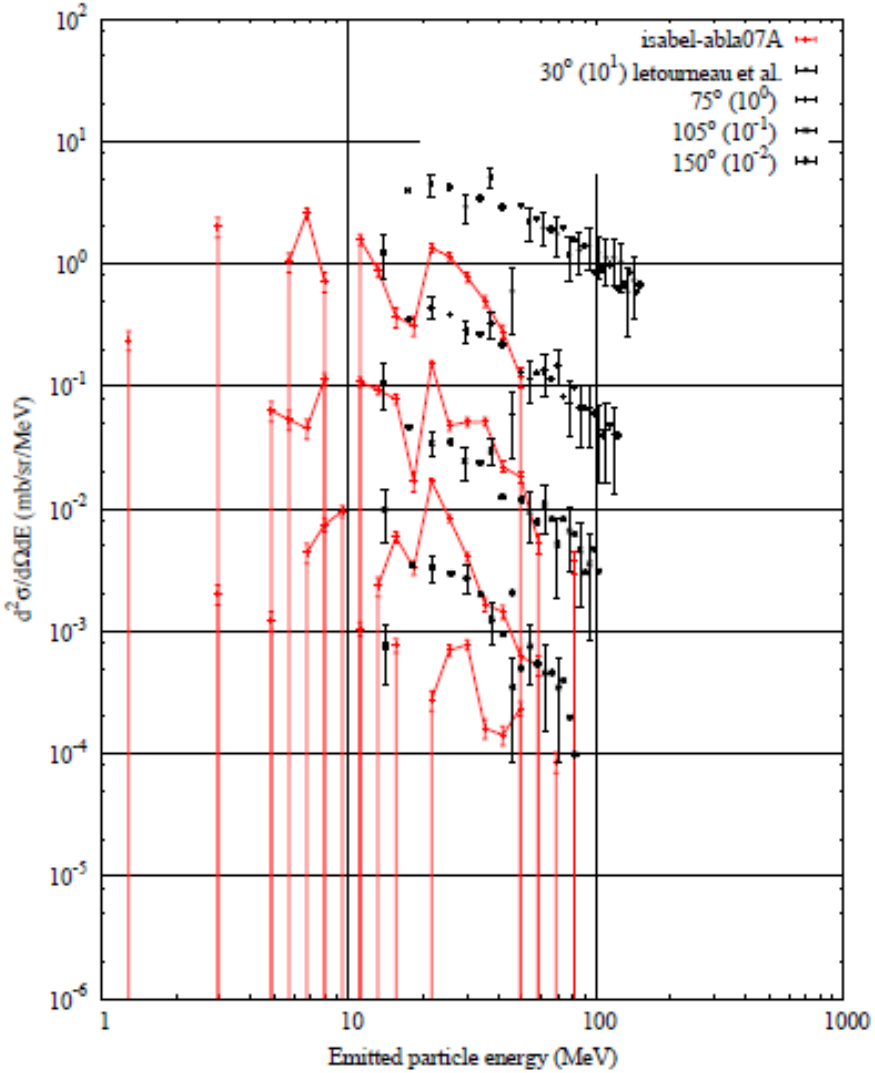


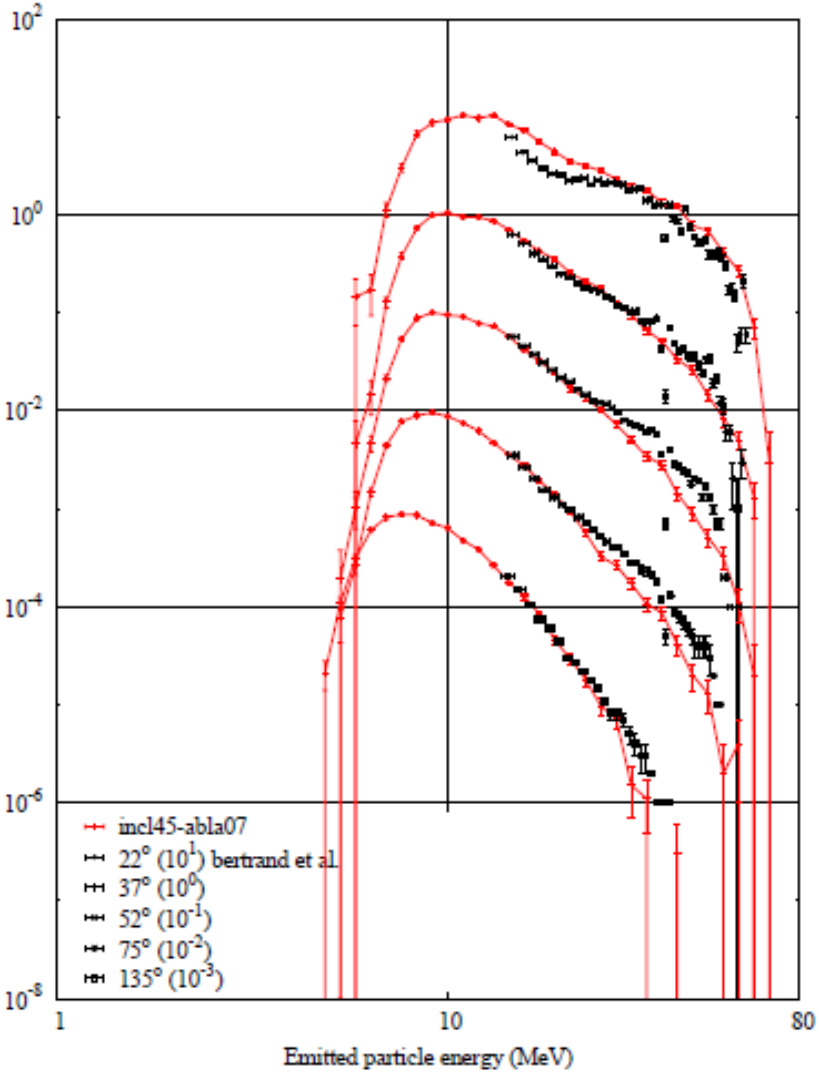
double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

^{4}He spectra

p(62 MeV) + ^{56}Fe – ^{4}He spectrum

INCL45-ABLA07



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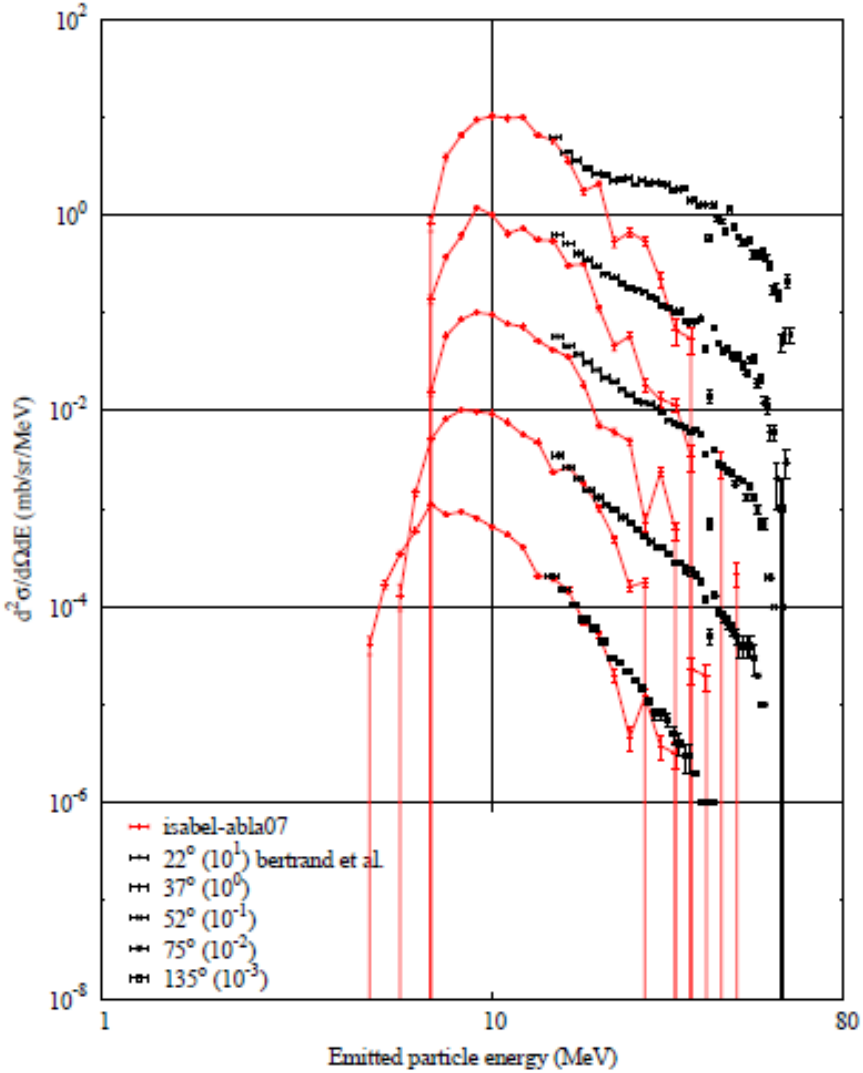
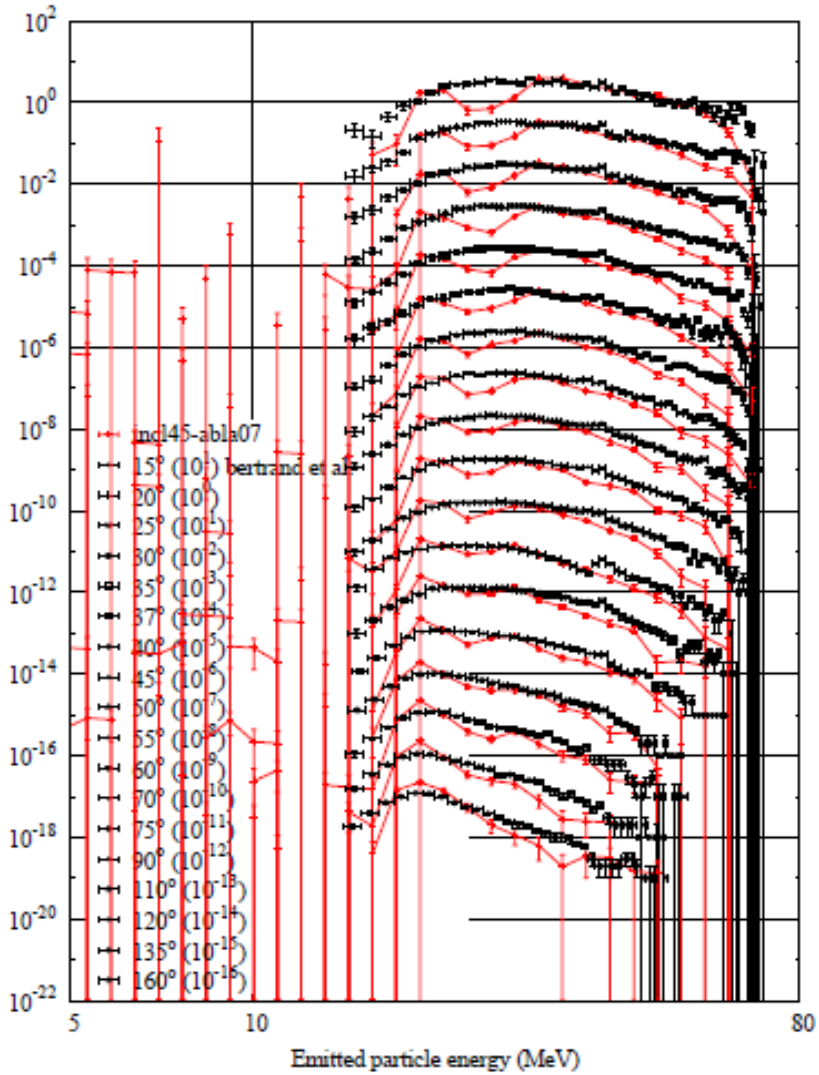


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(62 MeV) + Bi – ^{4}He spectrum

INCL45-ABLA07



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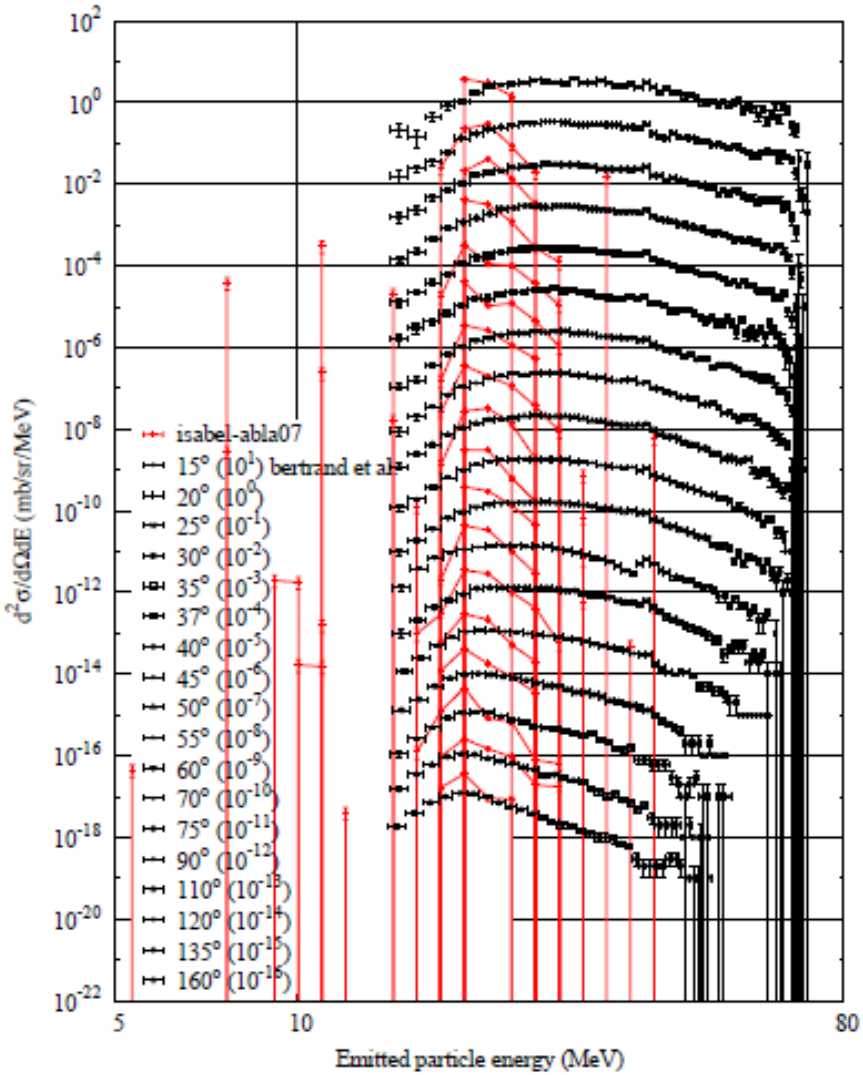
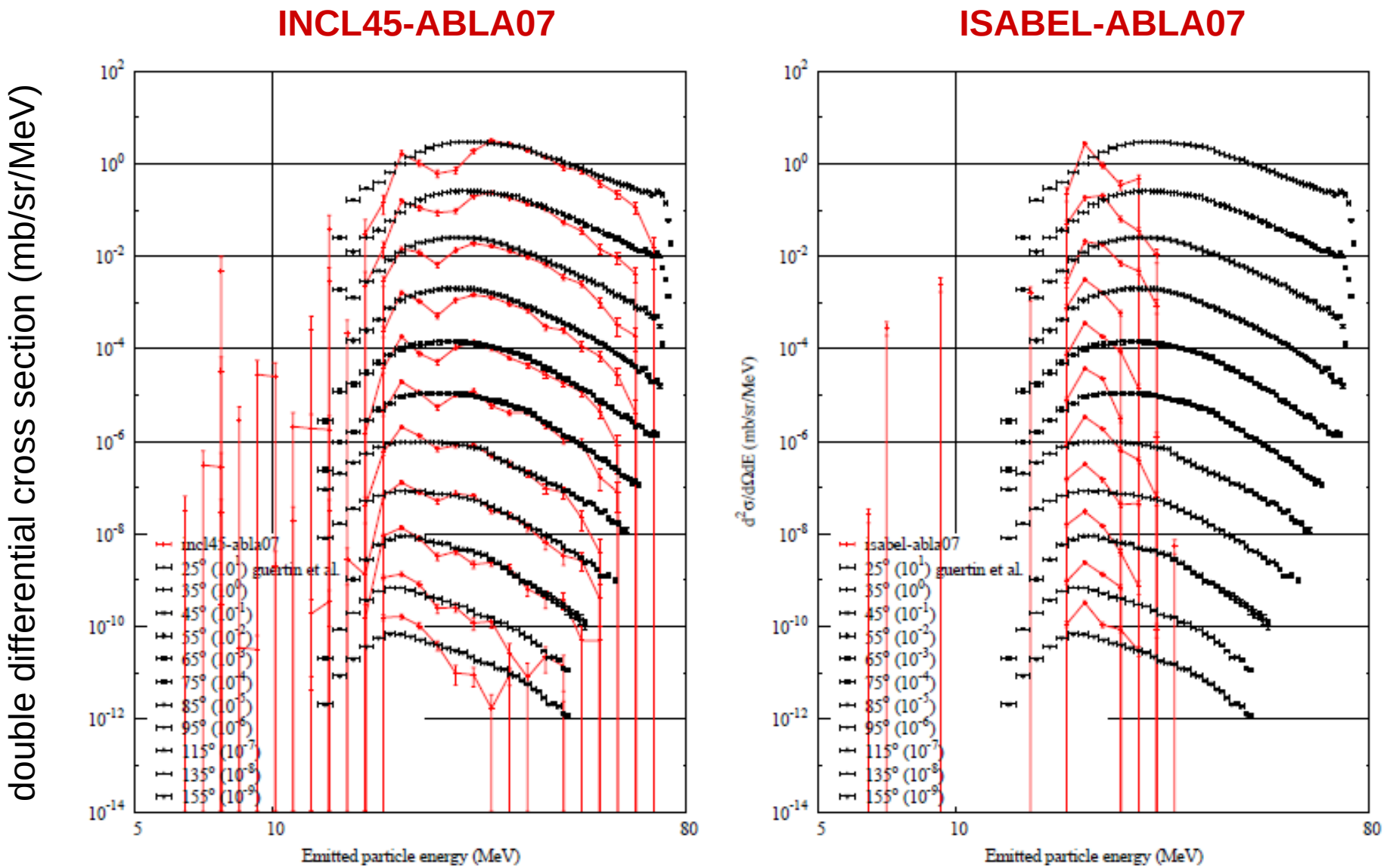


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

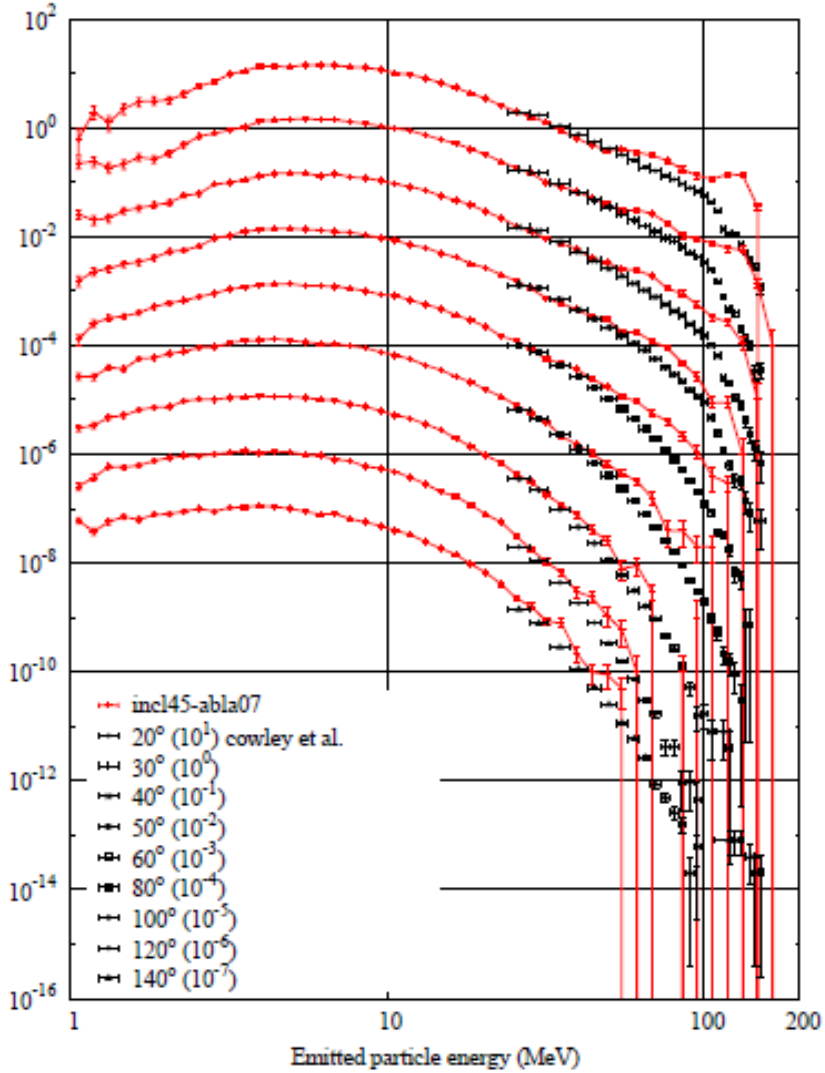
p(63 MeV) + ^{208}Pb – ^{4}He spectrum



emitted-particle energy (MeV)

p(160 MeV) + Al – ^{4}He spectrum

INCL45-ABLA07



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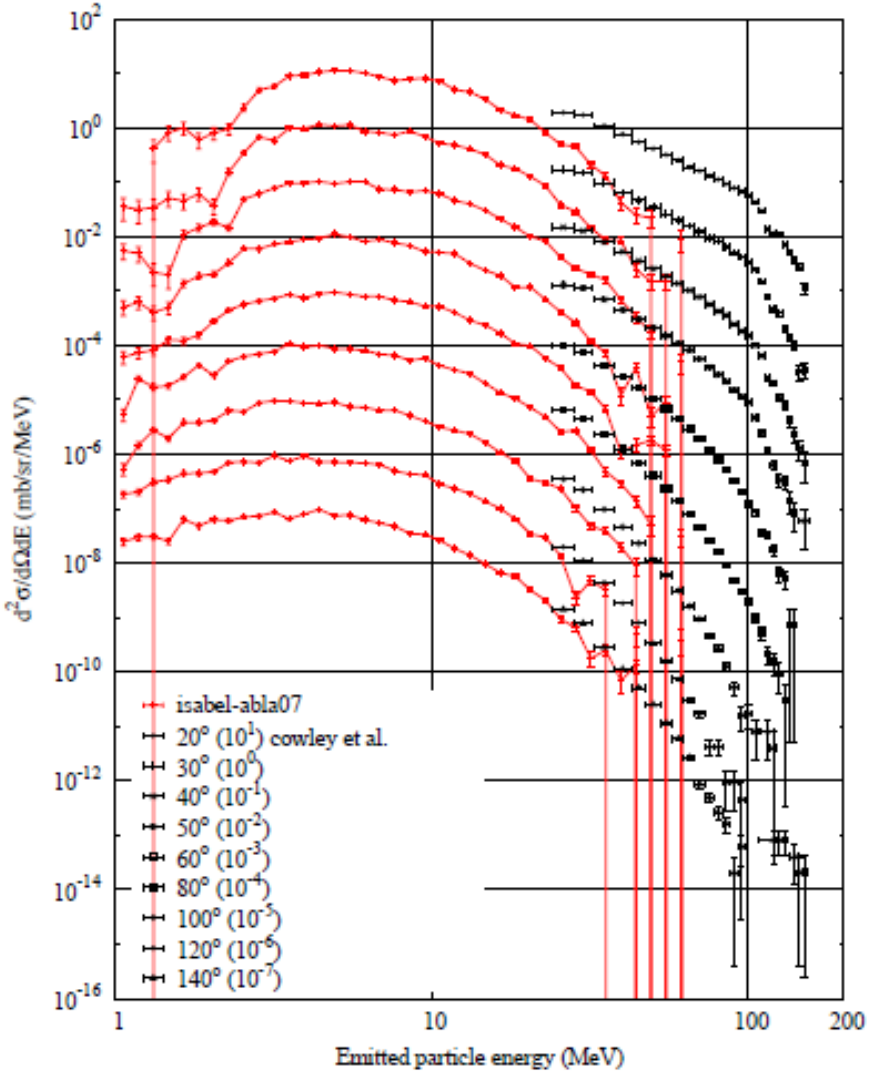
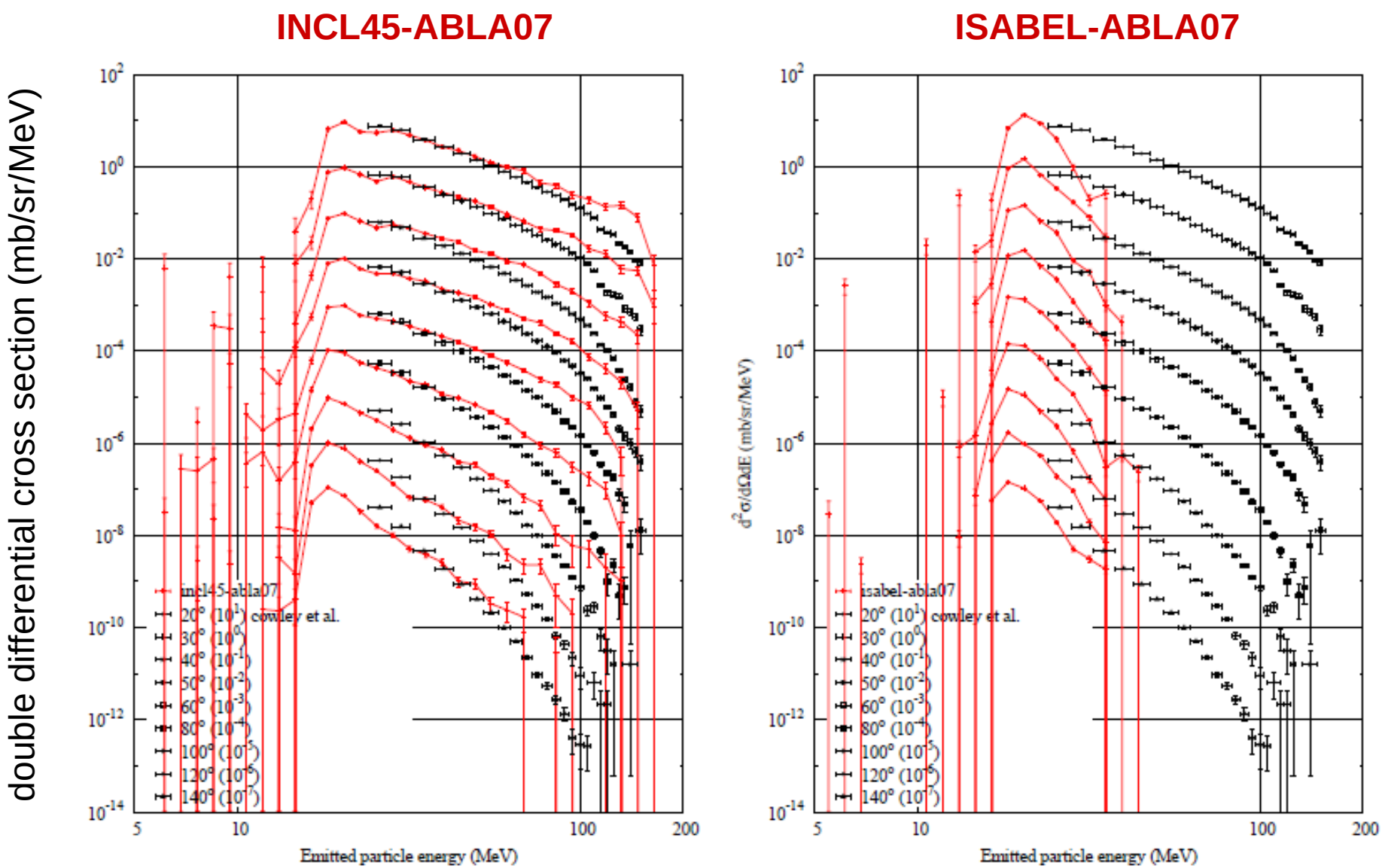


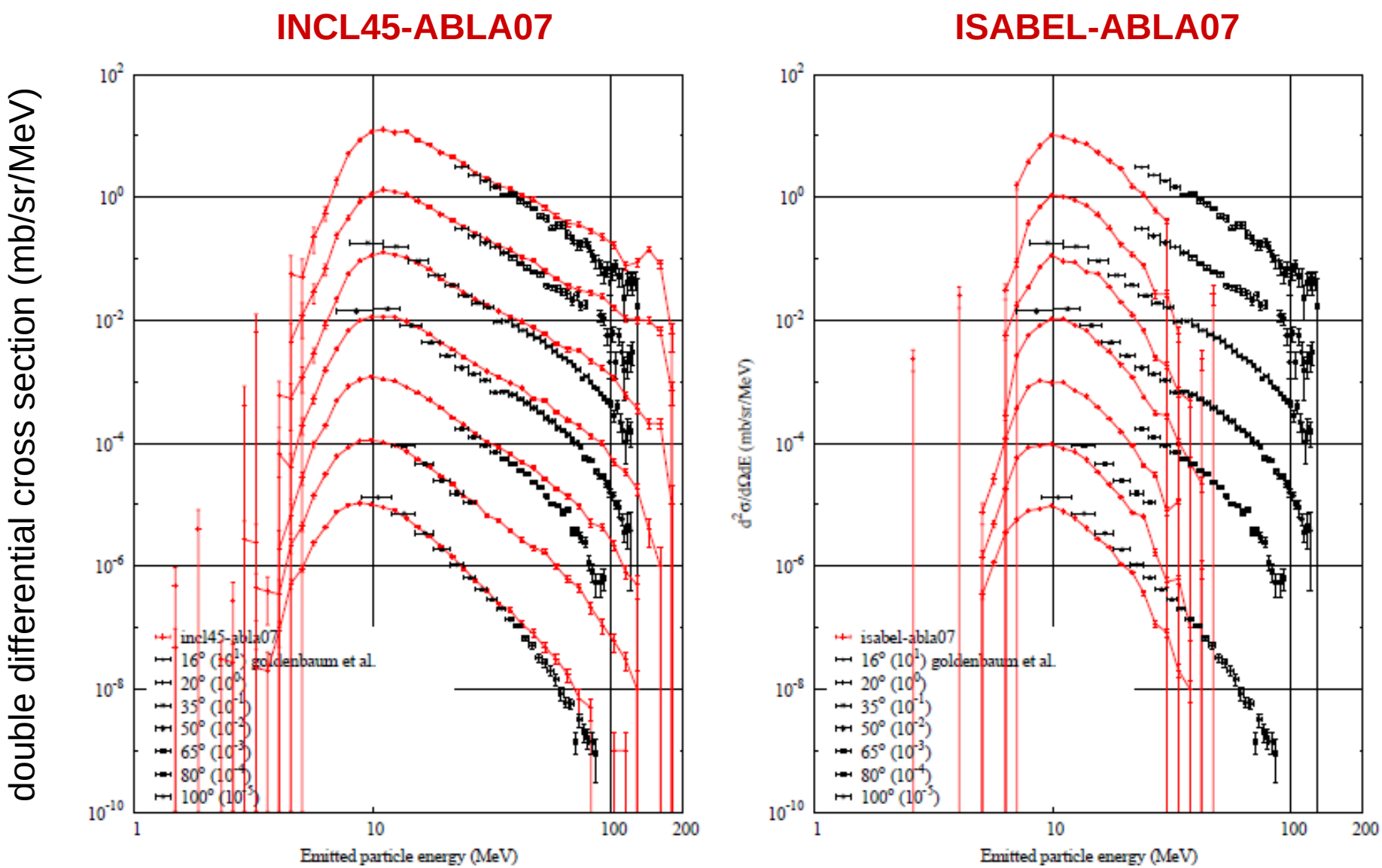
double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(160 MeV) + Au – ^{4}He spectrum

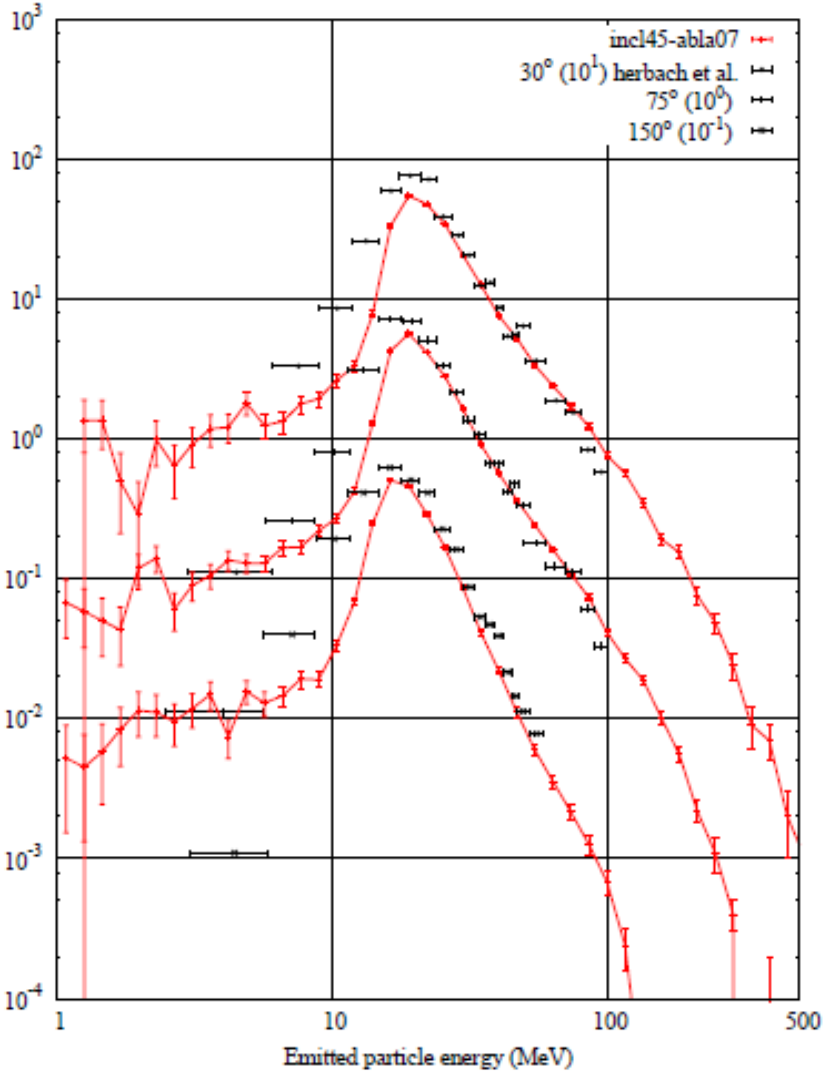


p(175 MeV) + Ni – ^{4}He spectrum



p(1200 MeV) + Ta – ^{4}He spectrum

INCL45-ABLA07



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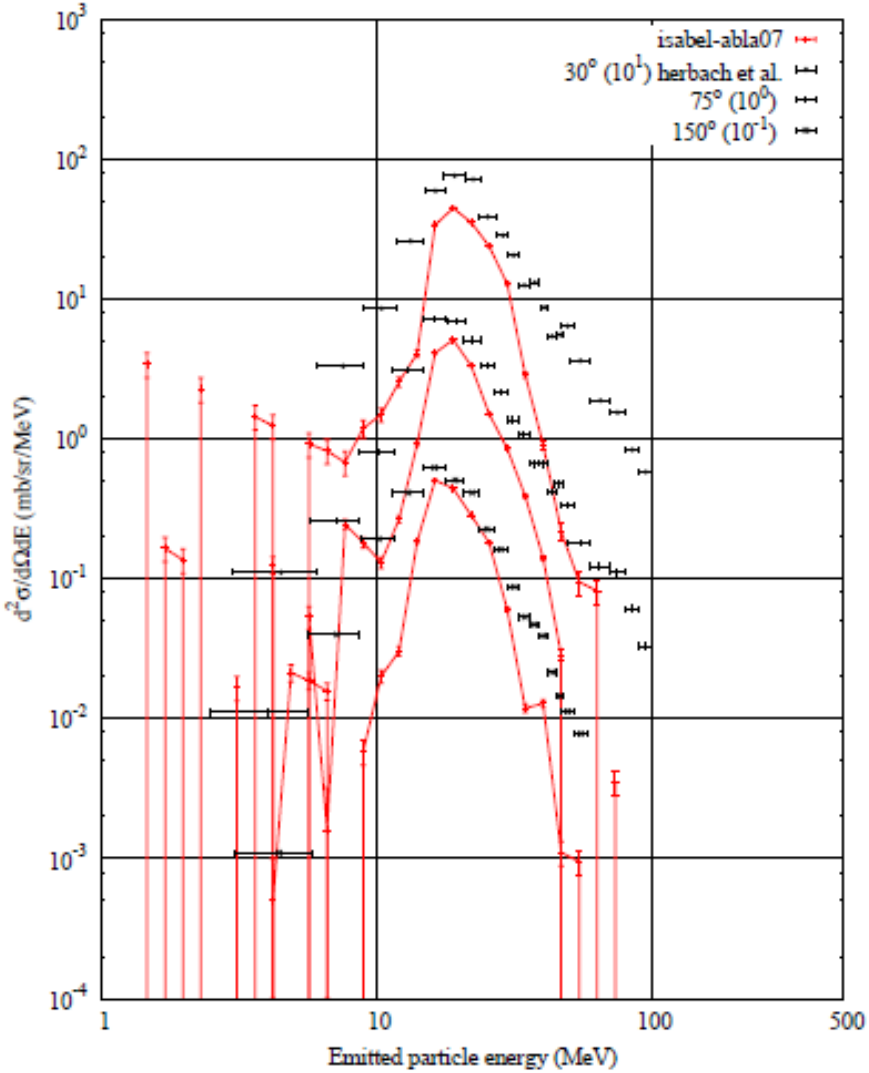
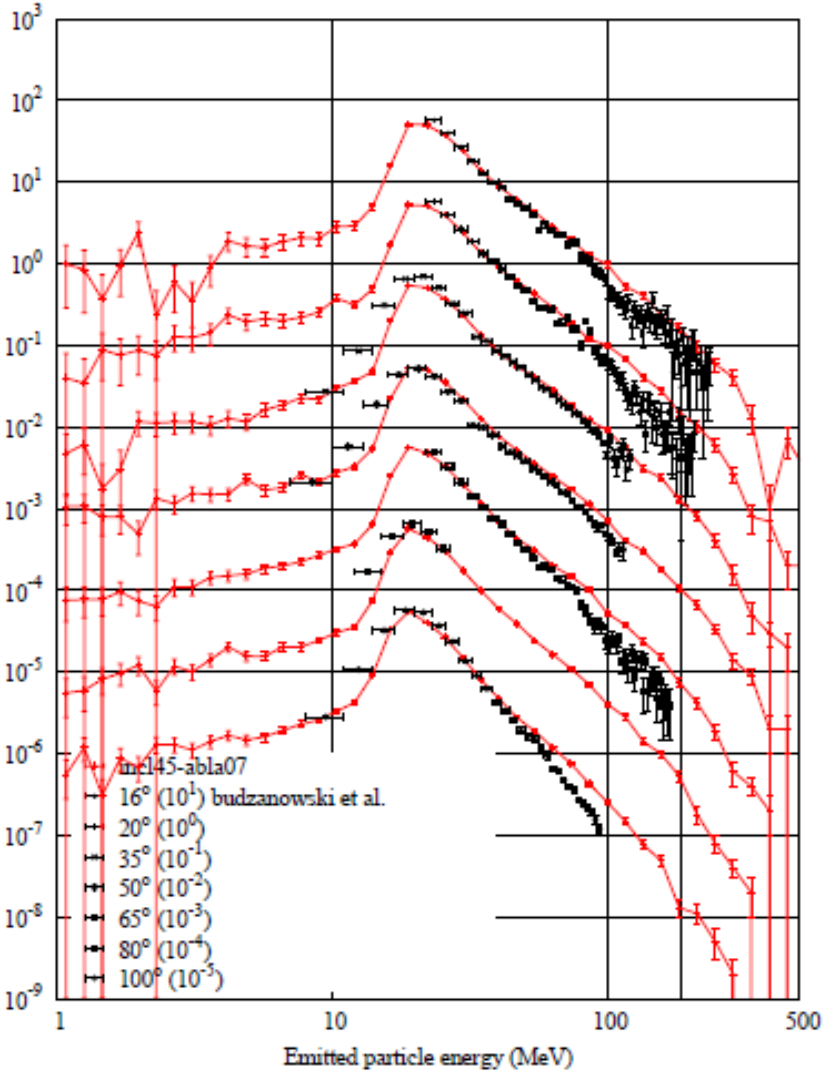


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(1200 MeV) + Au – ^{4}He spectrum

INCL45-ABLA07



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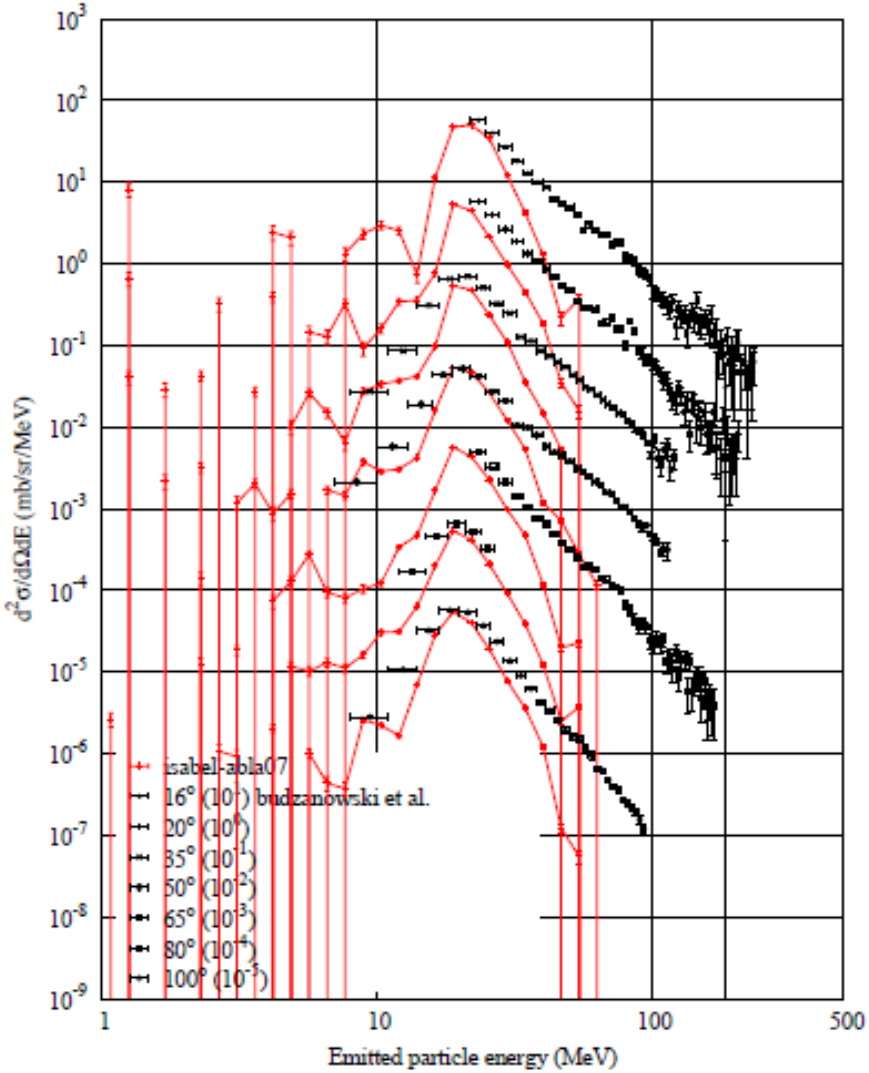
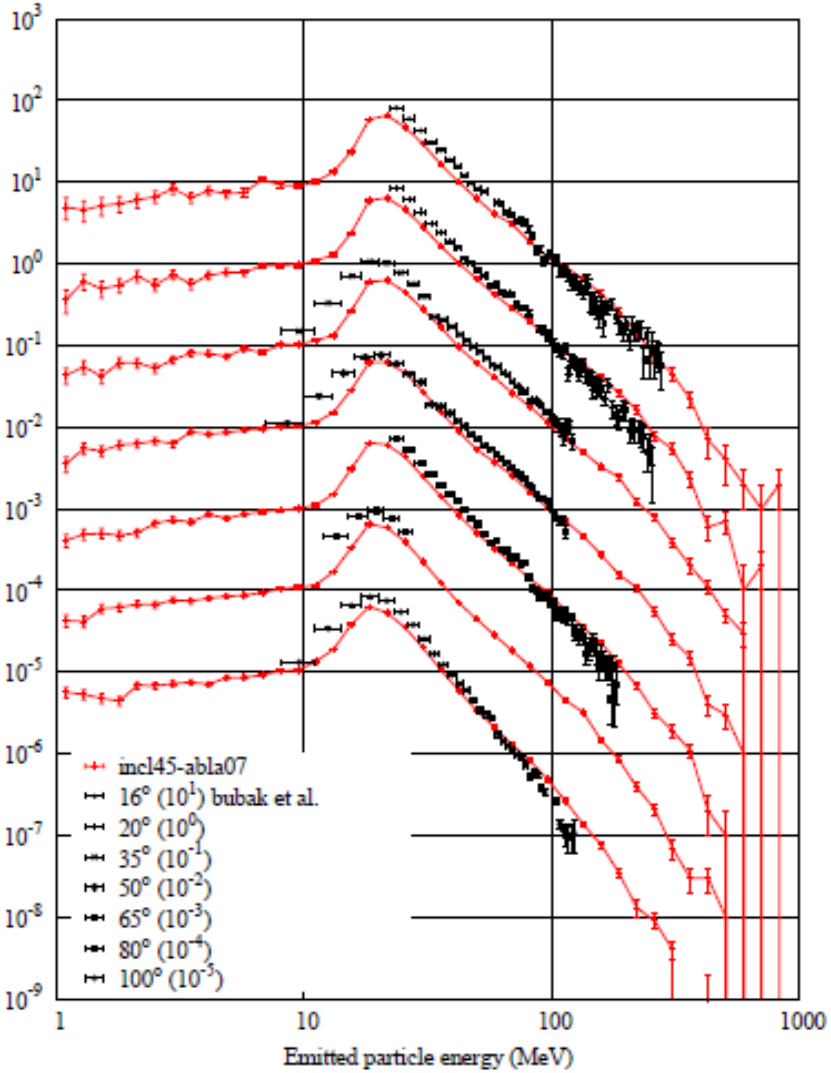


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – ^{4}He spectrum

INCL45-ABLA07



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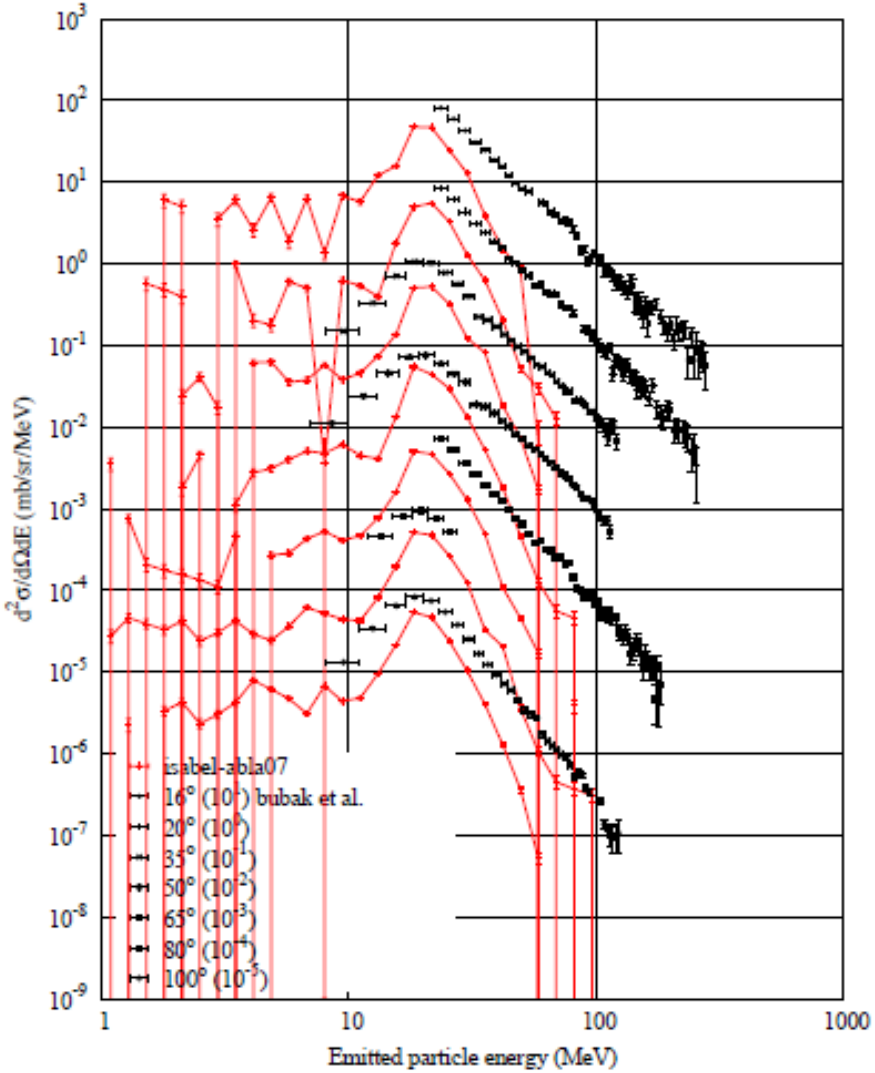
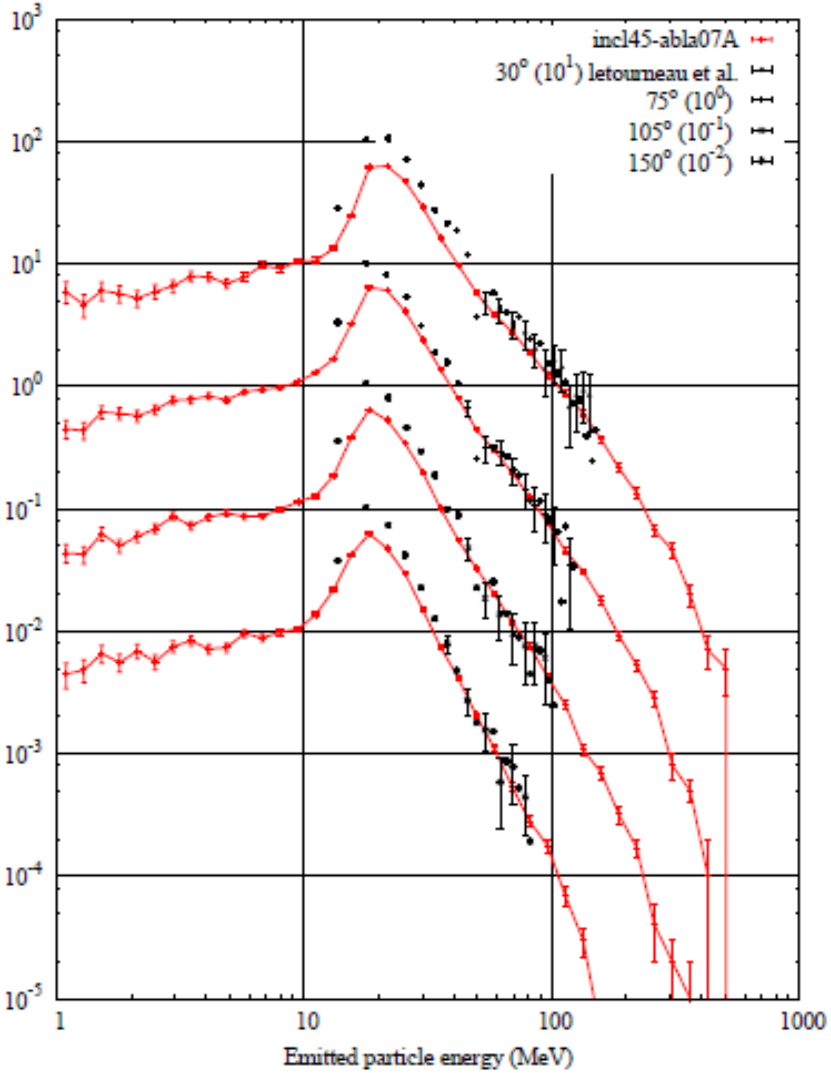


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

p(2500 MeV) + Au – ^{4}He spectrum

INCL45-ABLA07



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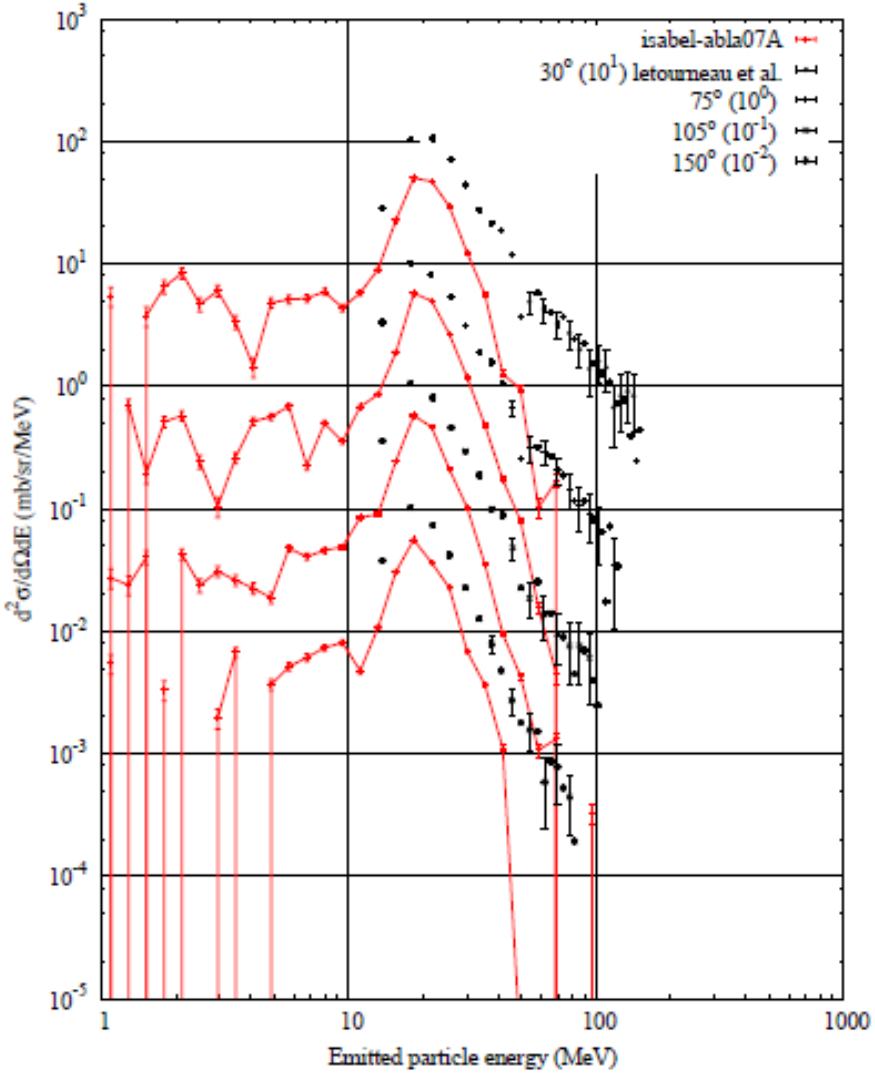


double differential cross section (mb/sr/MeV)

emitted-particle energy (MeV)

Light Charged Particles

LCP double differential cross sections (starting from E_{proton} = 175 MeV)

Status

- Not so good with ISABEL + ABLA07
- Quite good with INCL45+ABLA07 for light target; not that good for heavy target
- Visible differences between INCL45 plus ABLA07 / SMM / GEMINI++
- But the spectra depend also on the INC (even in the low energy part of the spectrum)

Improvement: Complicate!

Concerning ABLA07:

- Tunneling through barrier (now taken into account only for calculating decay widths)
- Coulomb barriers (from Bass prescription) could be adjusted
- Apparently, in evaporation from deformed nuclei the emission could not be isotropic (to be demonstrated)

The empirical nuclear potential of R. Bass

$$-V_N(s) = \frac{C_1 \cdot C_2}{C_1 + C_2} \cdot \frac{1}{A \cdot \exp\left(\frac{s}{d_1}\right) + B \cdot \exp\left(\frac{s}{d_2}\right)}$$

A = 0.333 MeV^{-1} fm, B = 0.007 MeV^{-1} fm,
d_1 = 3.5 fm, d_2 = 0.65 fm.

$$C_i = R_i \cdot \left(1 - \frac{(0.9984\text{fm})^2}{R_i^2}\right), \quad R_1 = \left(1.28 \cdot A_f^{1/3} - 0.76 + \frac{0.8}{A_f^{1/3}}\right)\text{fm},$$

$$R_2 = \left(1.28 \cdot A_2^{1/3} - 0.76 + \frac{0.8}{A_2^{1/3}} + d\right)\text{fm}, \qquad d = \begin{cases} 3\,\text{fm}, & 1\text{H} \\ 0\,\text{fm}, & 2\text{H} \\ 0\,\text{fm}, & 3\text{H} \\ 0\,\text{fm}, & 3\text{He} \\ 1\,\text{fm}, & 4\text{He} \end{cases}$$

Coulomb potential

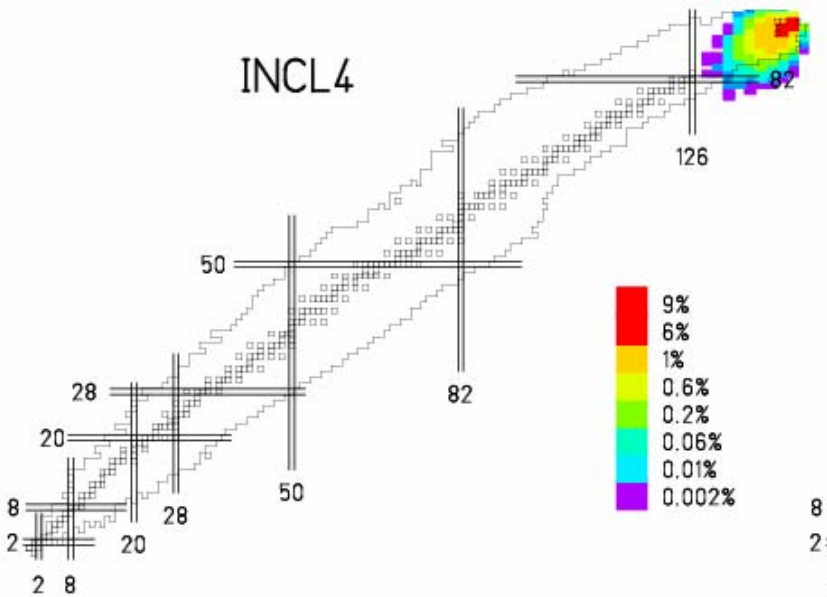
$$V_C = \begin{cases} 1.44 \cdot \dfrac{Z_1 \cdot Z_2}{r}, & r > R_C \\ 1.44 \cdot \dfrac{Z_1 \cdot Z_2}{2 \cdot R_C} \cdot \left(3 - \dfrac{r^2}{R_C^2}\right) & r \le R_C \end{cases}$$

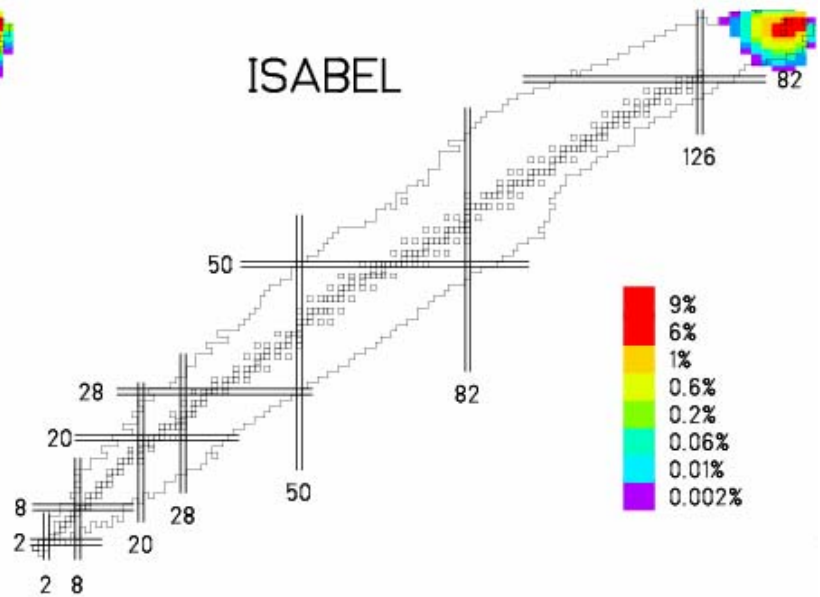
$$R_C = 1.3 \cdot \left(A_1^{1/3} + A_2^{1/3}\right) \text{ fm}$$

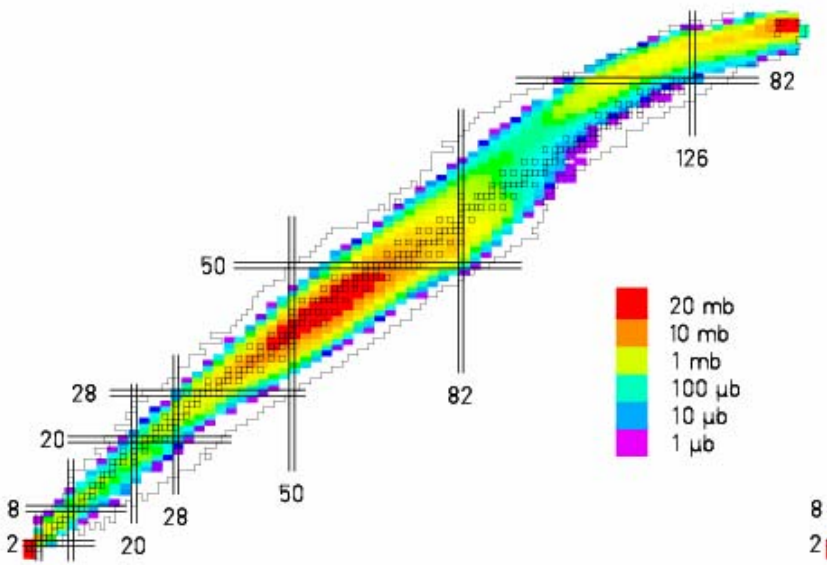
Residues

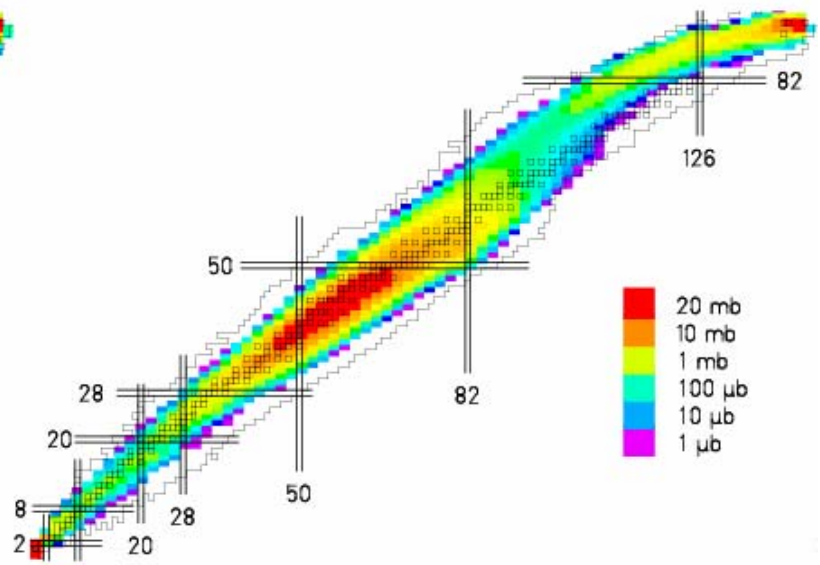
Fingerprints of the de-excitation process

1 GeV p + ^{238}U INCL4.5, ISABEL + ABLA07



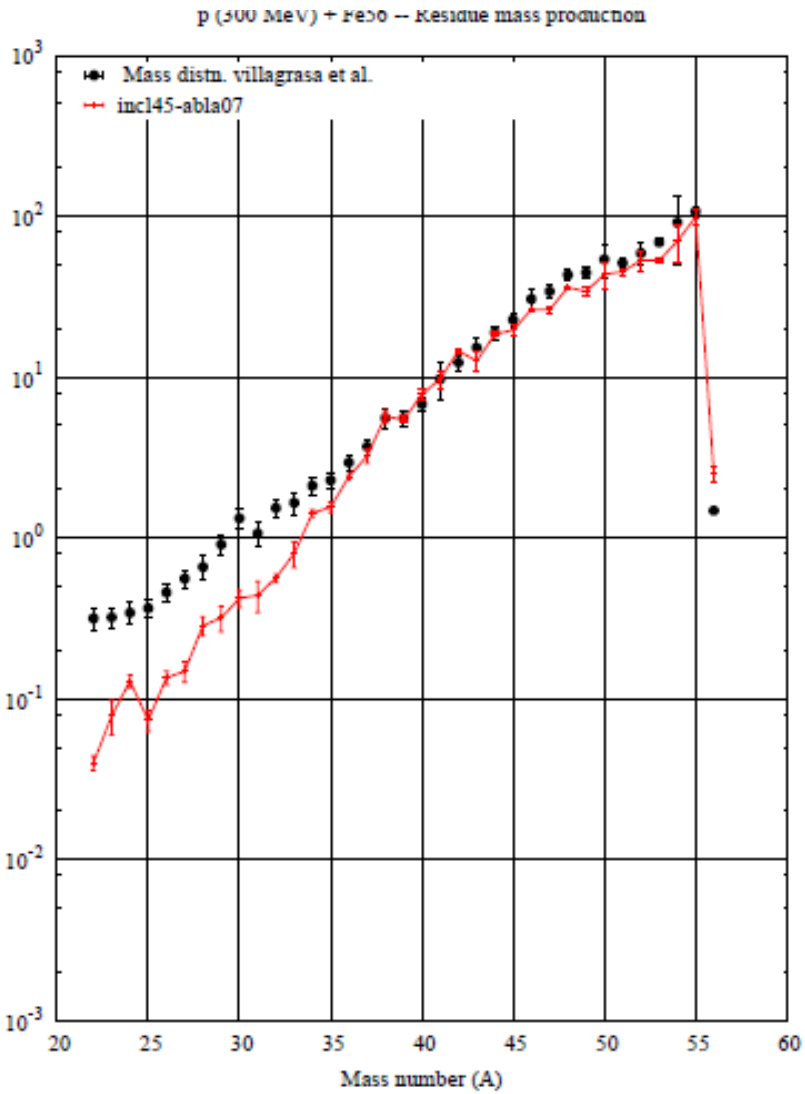




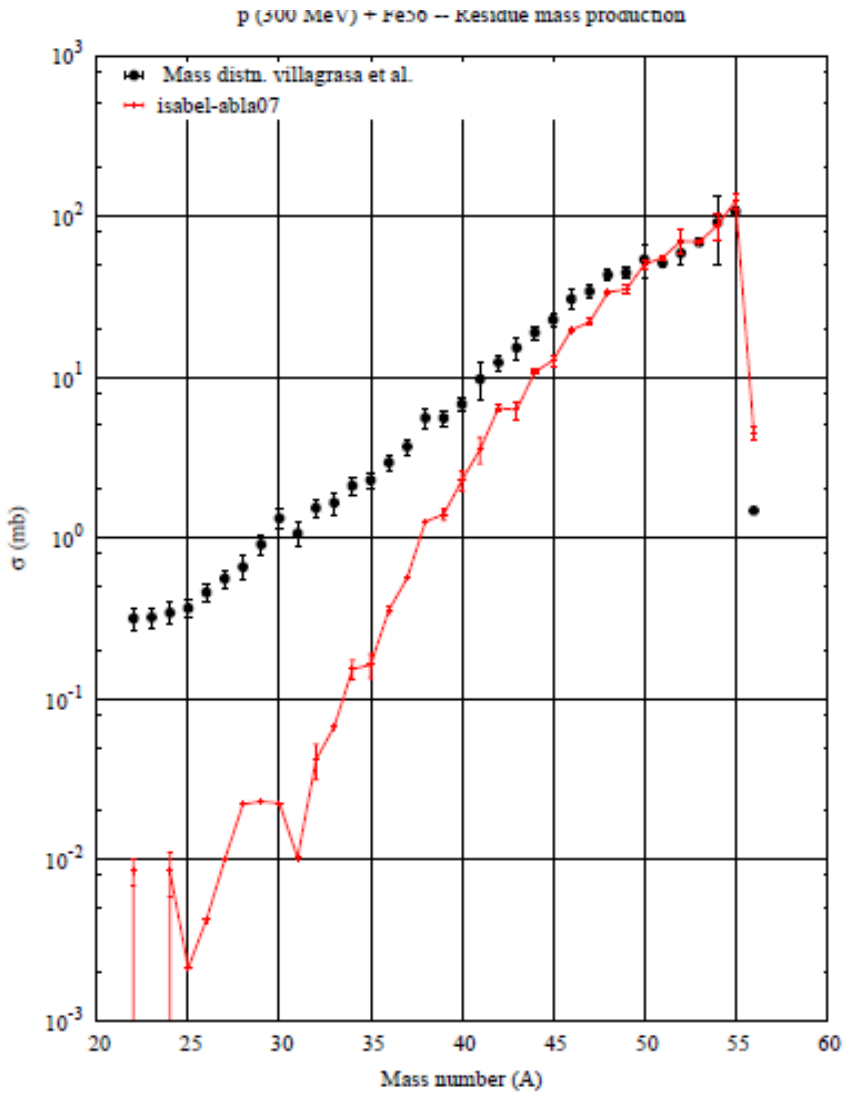


p(300 MeV) + ^{56}Fe – final residues

INCL45-ABLA07



ISABEL-ABLA07

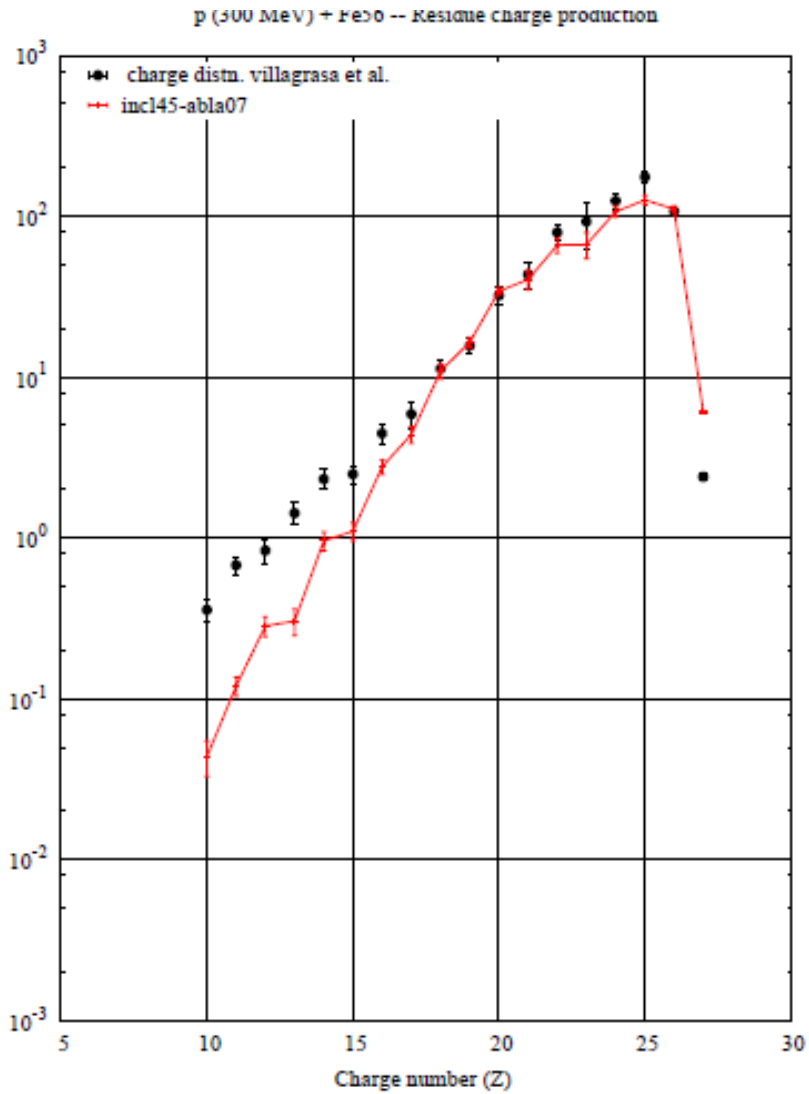


cross section (mb)

mass number A

p(300 MeV) + ^{56}Fe – final residues

INCL45-ABLA07



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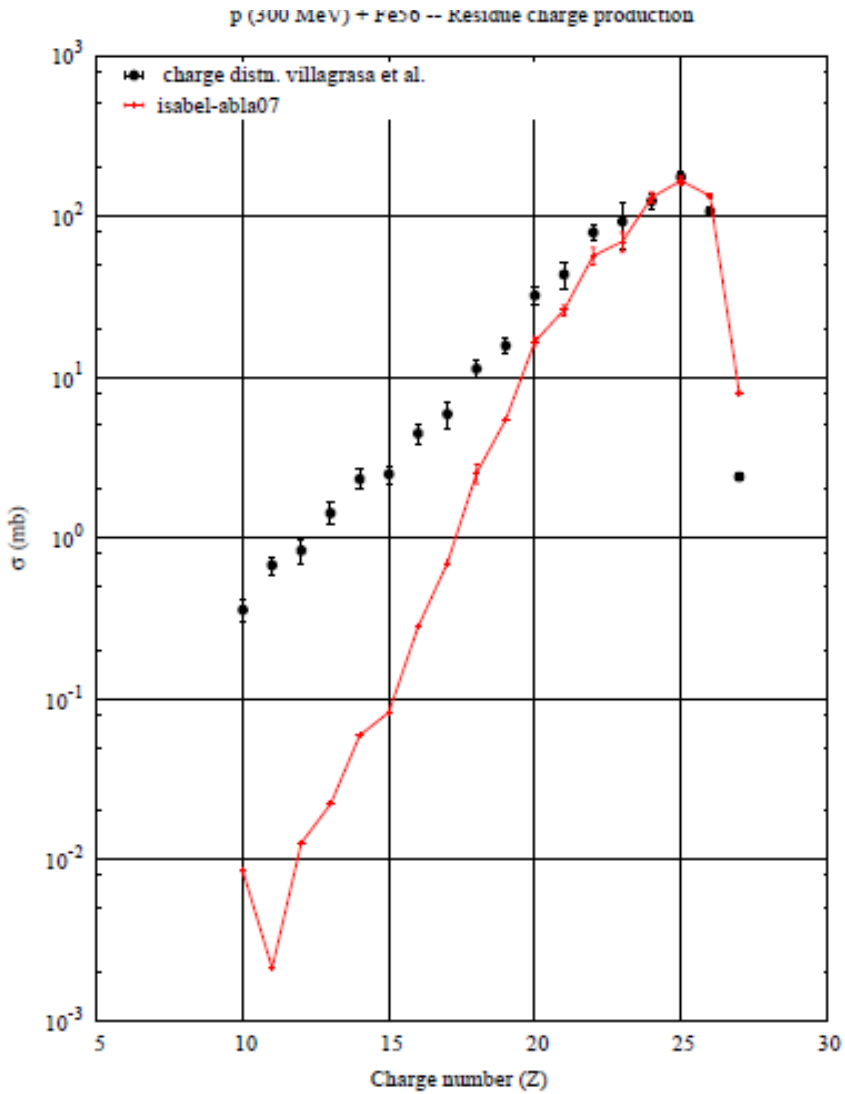
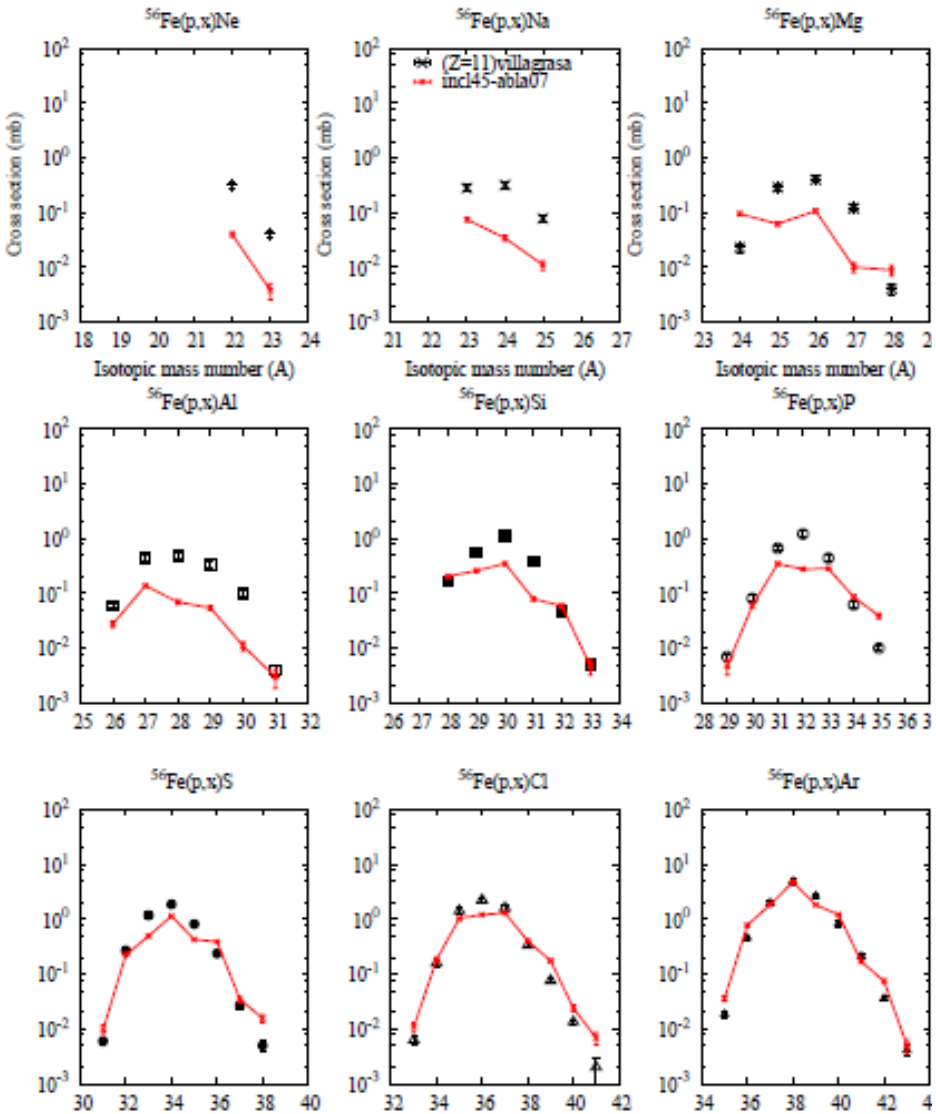


cross section (mb)

charge number Z

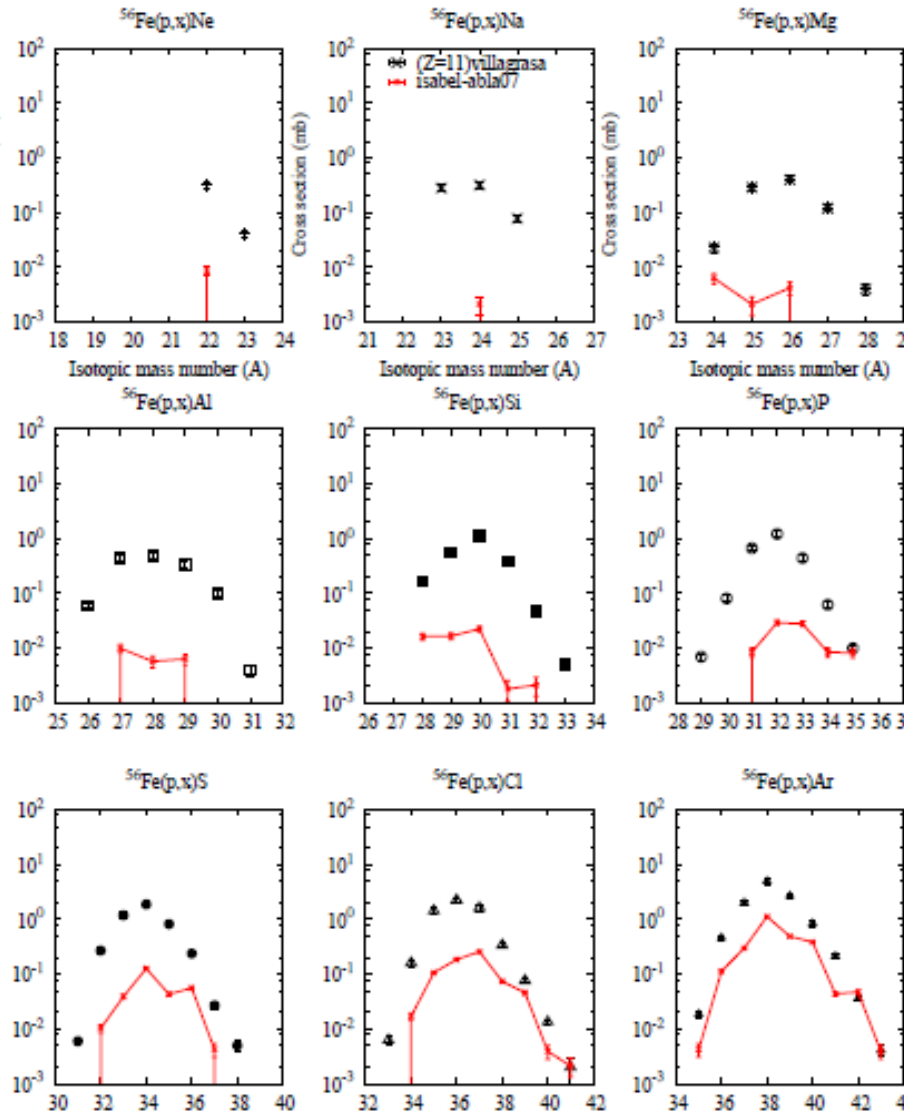
p(300 MeV) + ^{56}Fe – final residues

INCL45-ABLA07



mass number A

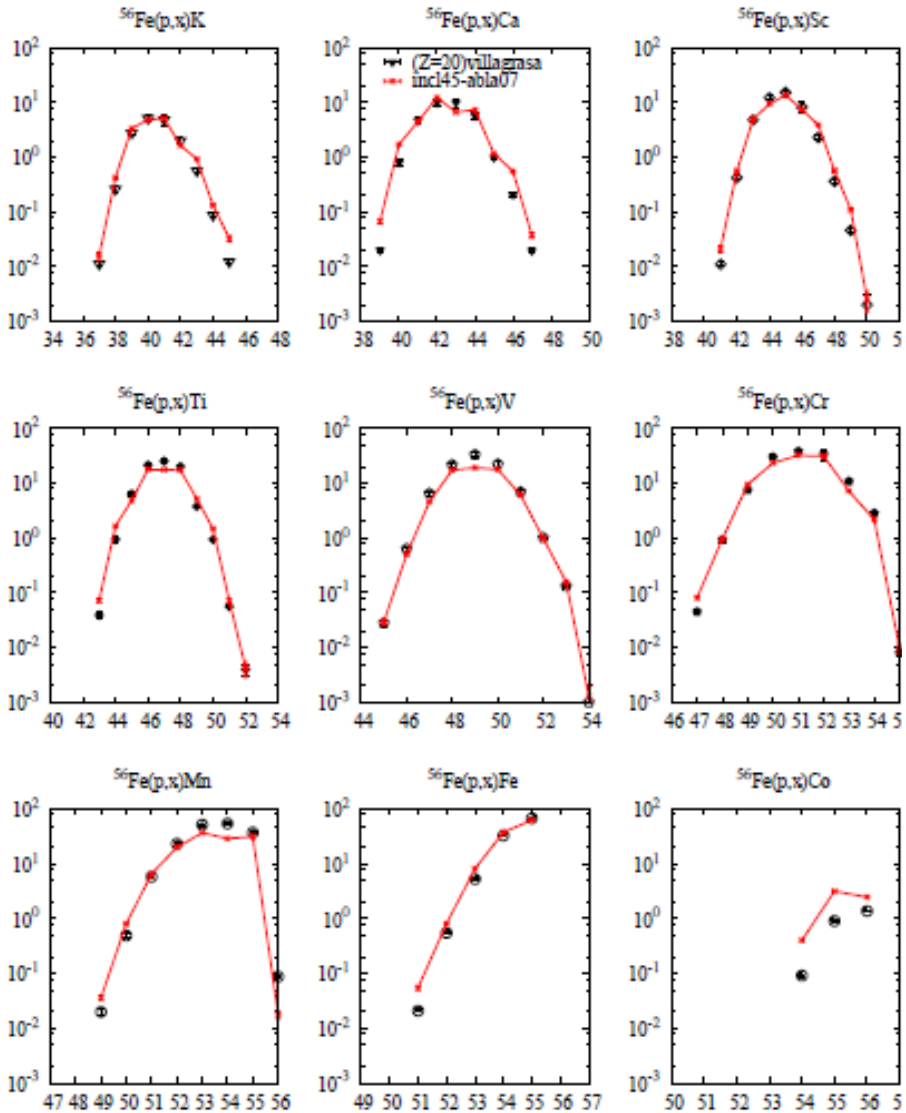
ISABEL-ABLA07



mass number A

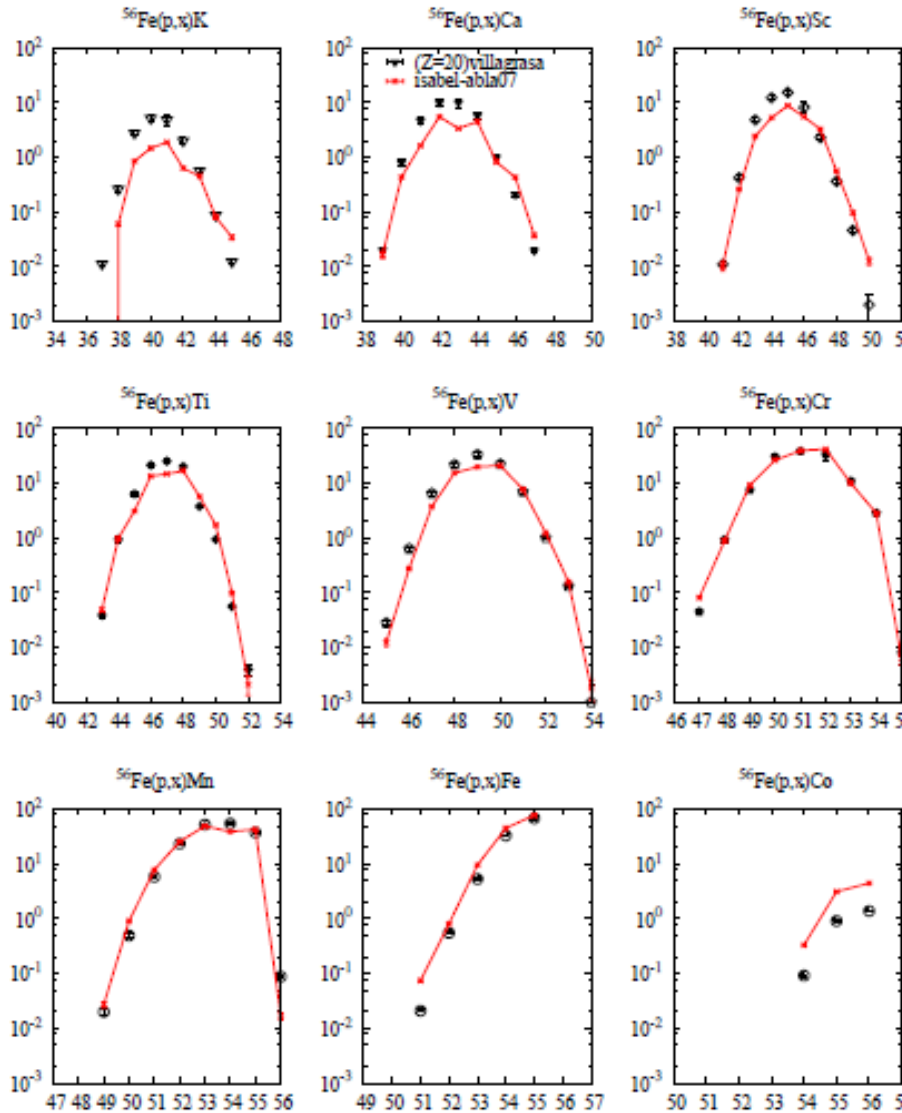
p(300 MeV) + ^{56}Fe – final residues

INCL45-ABLA07



mass number A

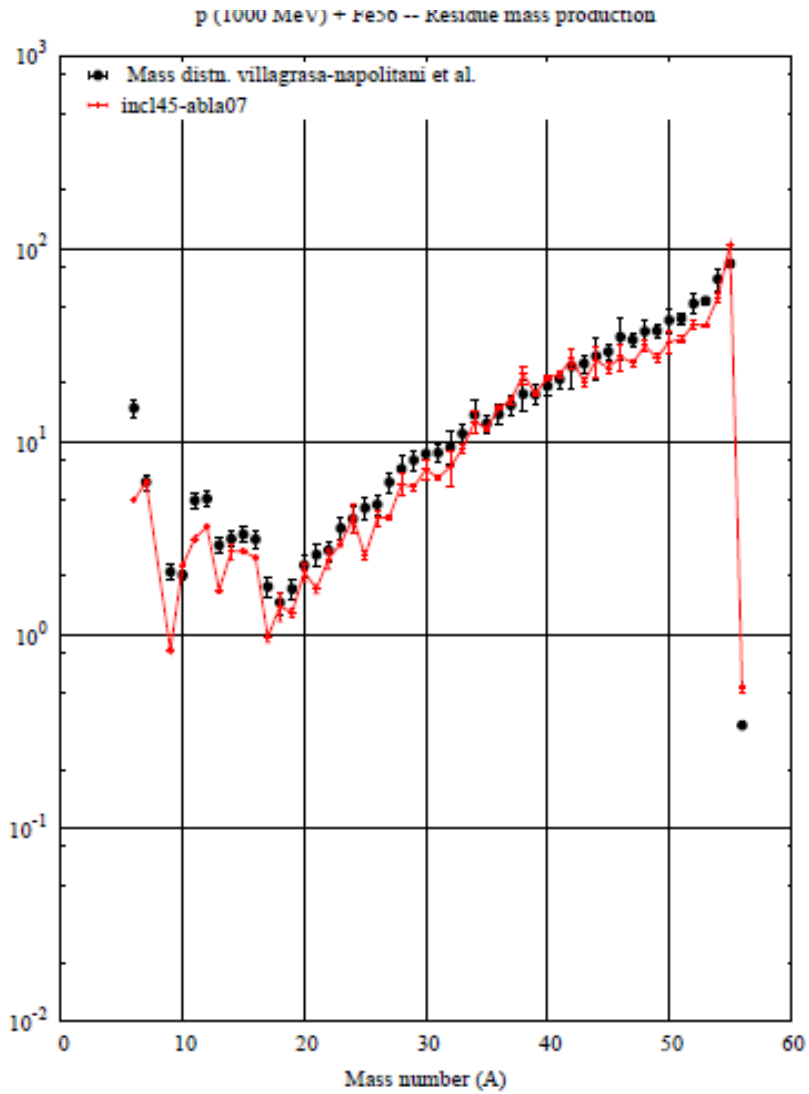
ISABEL-ABLA07



mass number A

p(1000 MeV) + ^{56}Fe – final residues

INCL45-ABLA07



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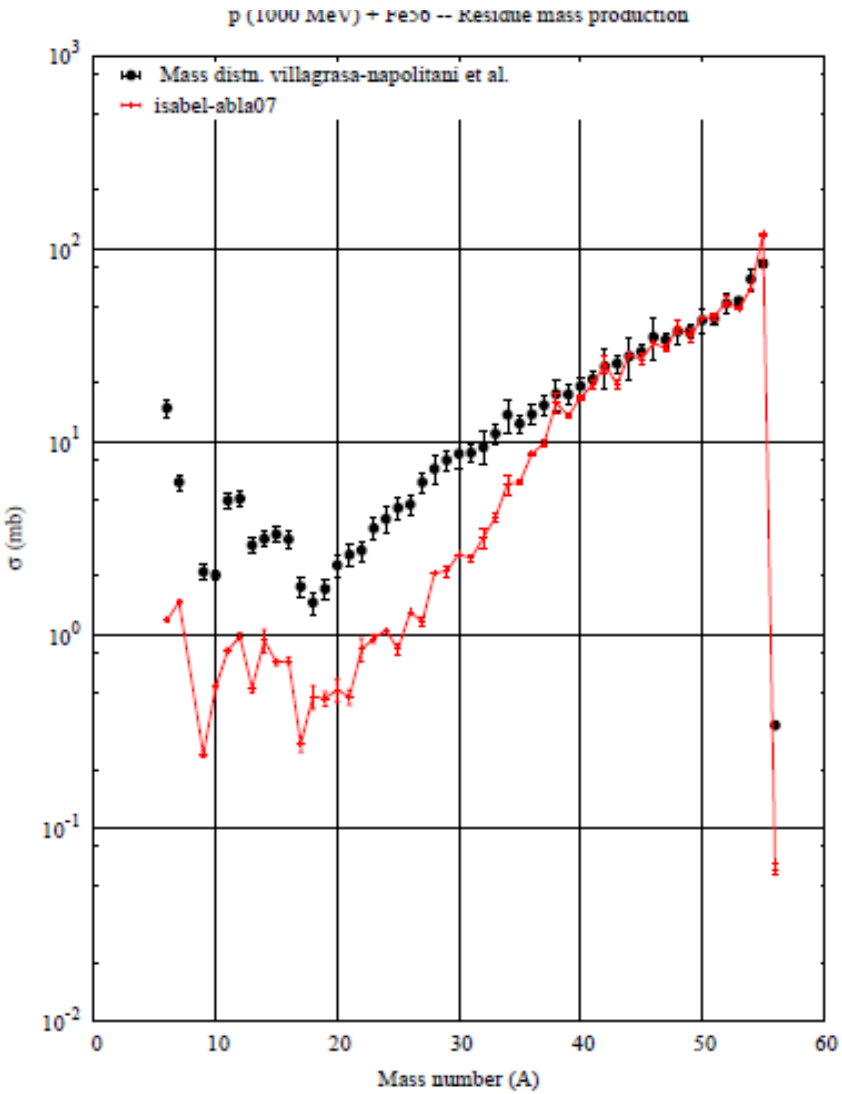
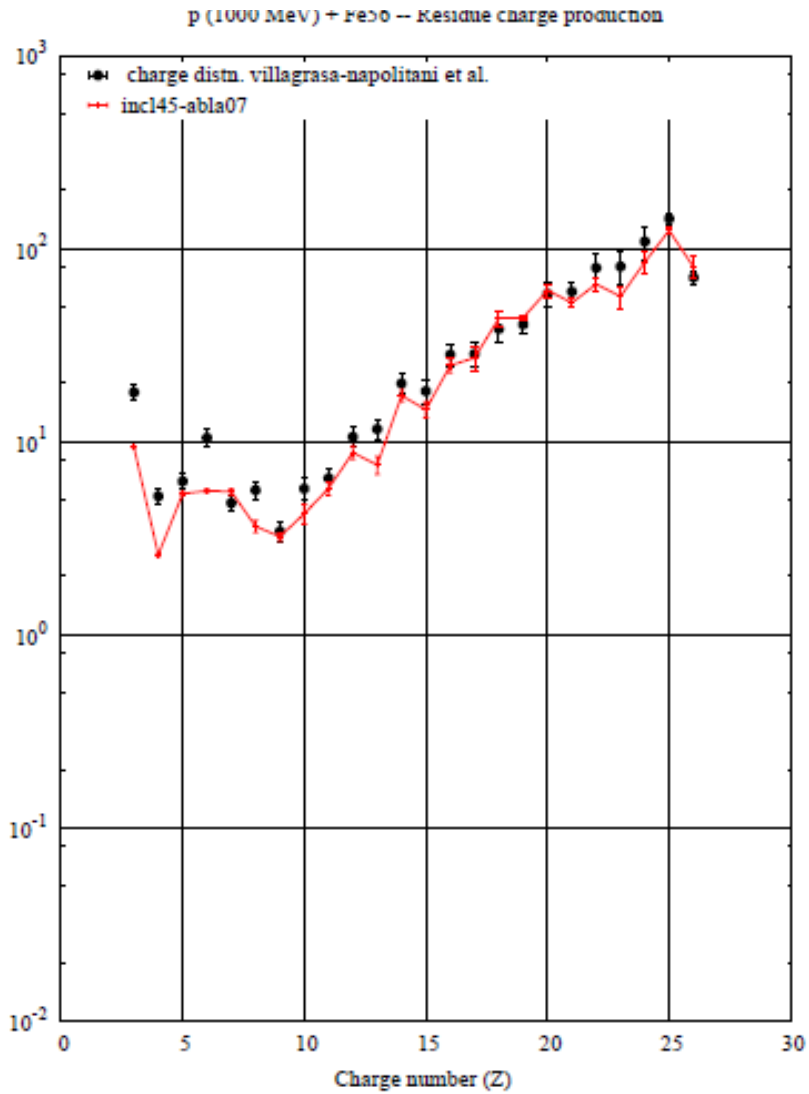


cross section (mb)

mass number A

p(1000 MeV) + ^{56}Fe – final residues

INCL45-ABLA07



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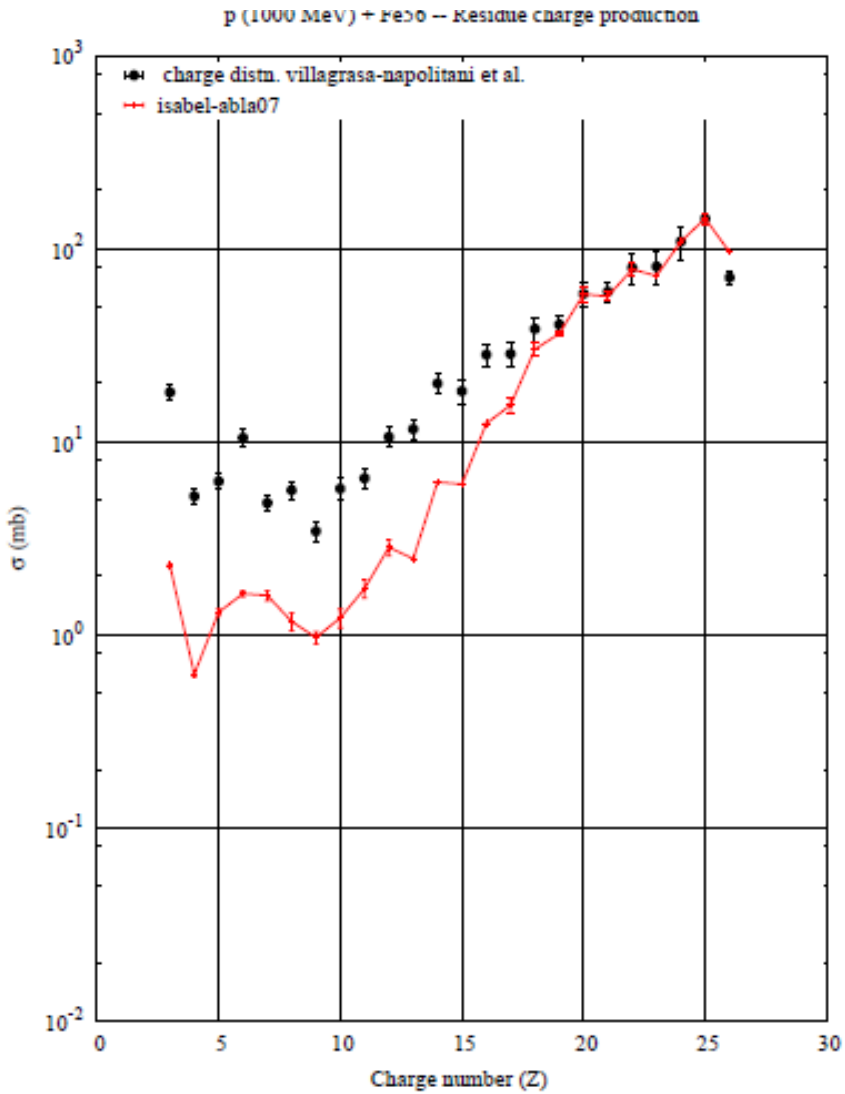

cross section (mb)

charge number Z

p(1000 MeV) + ^{56}Fe – final residues

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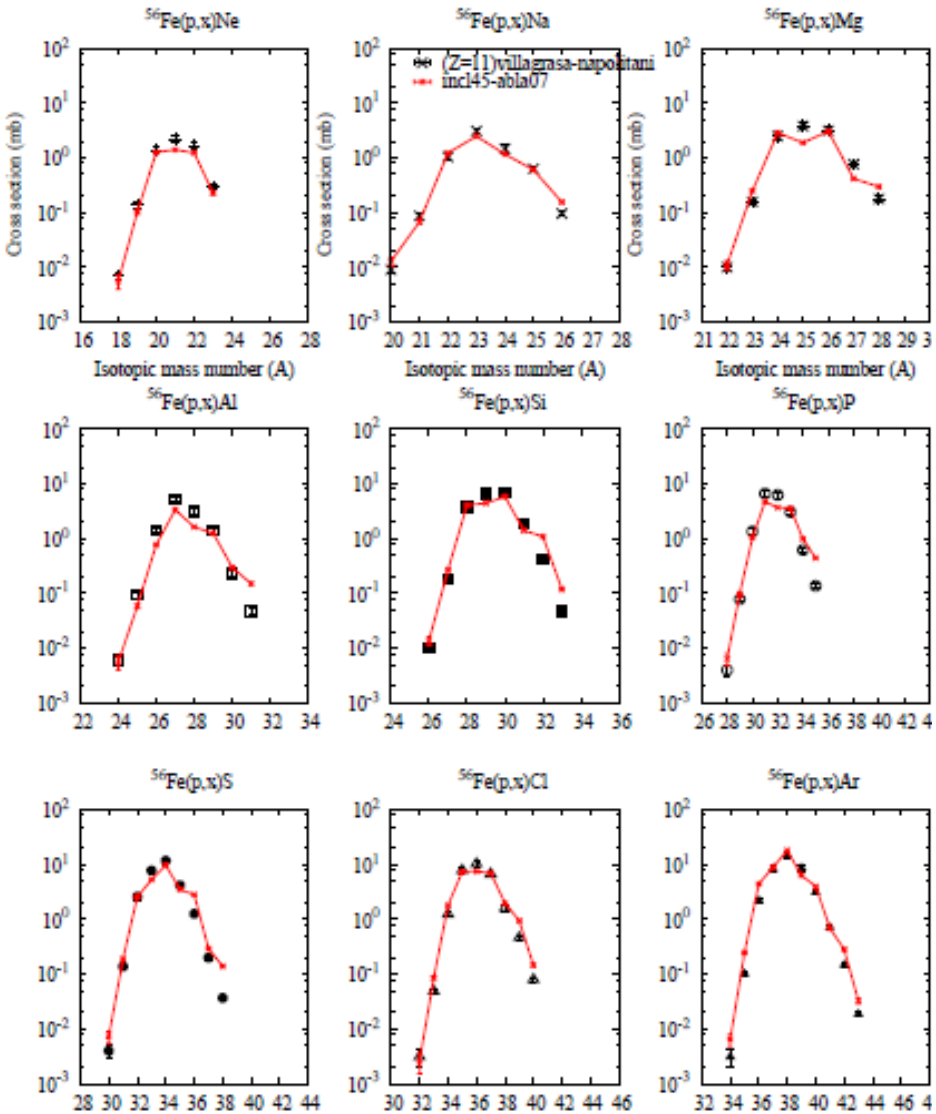

mass number A

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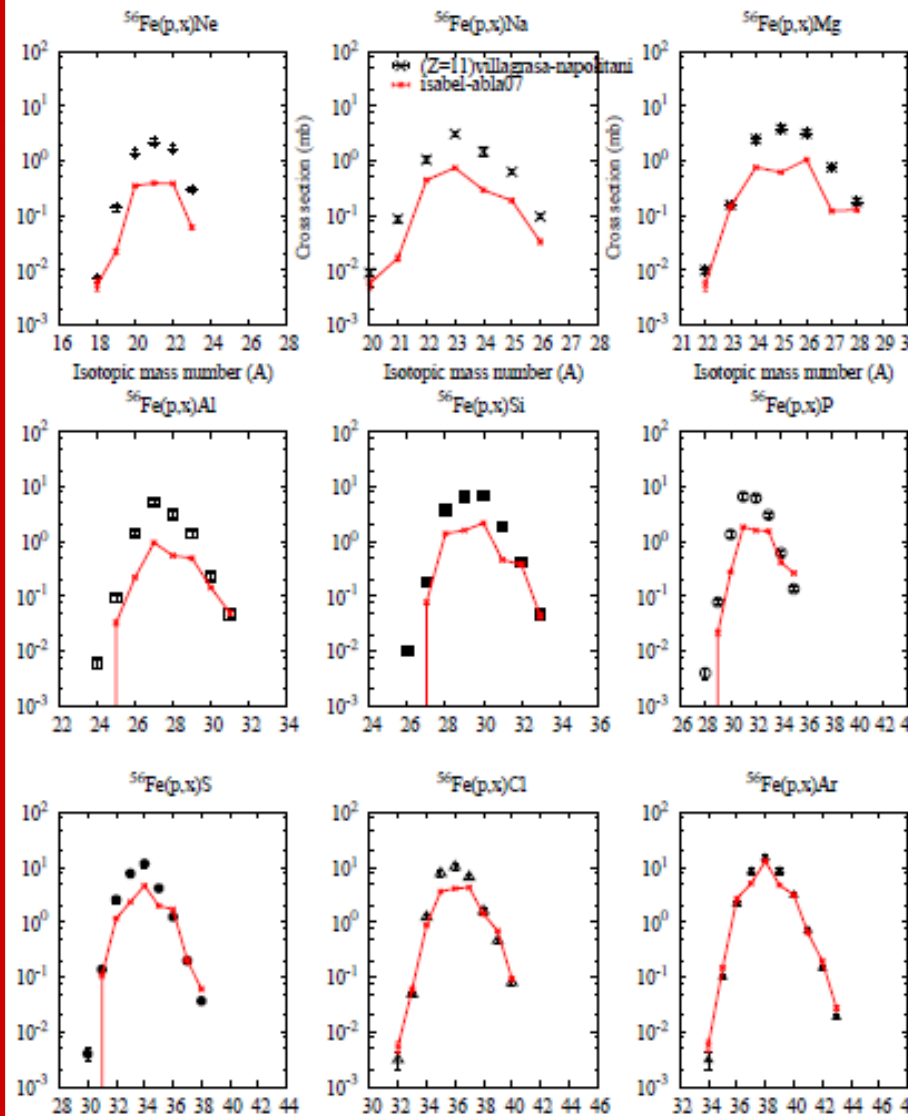

mass number A

p(1000 MeV) + ^{56}Fe – final residues

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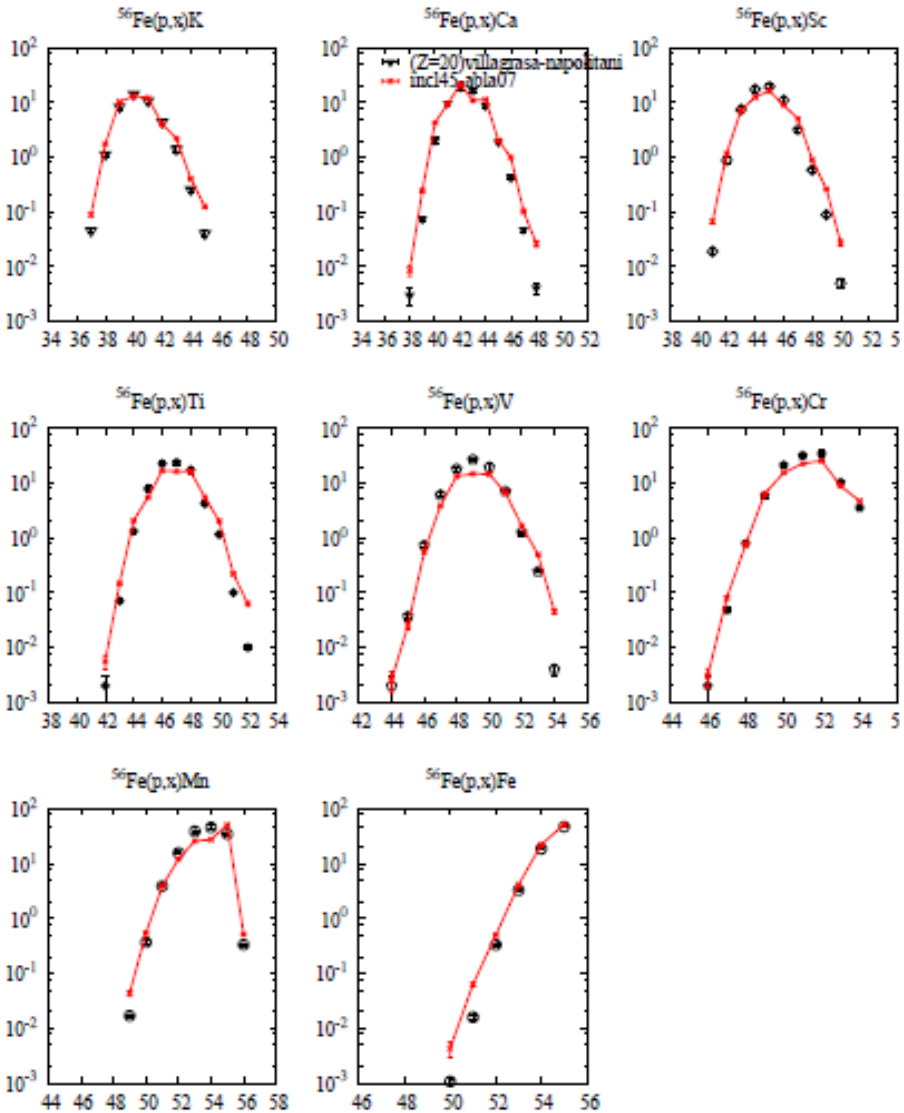

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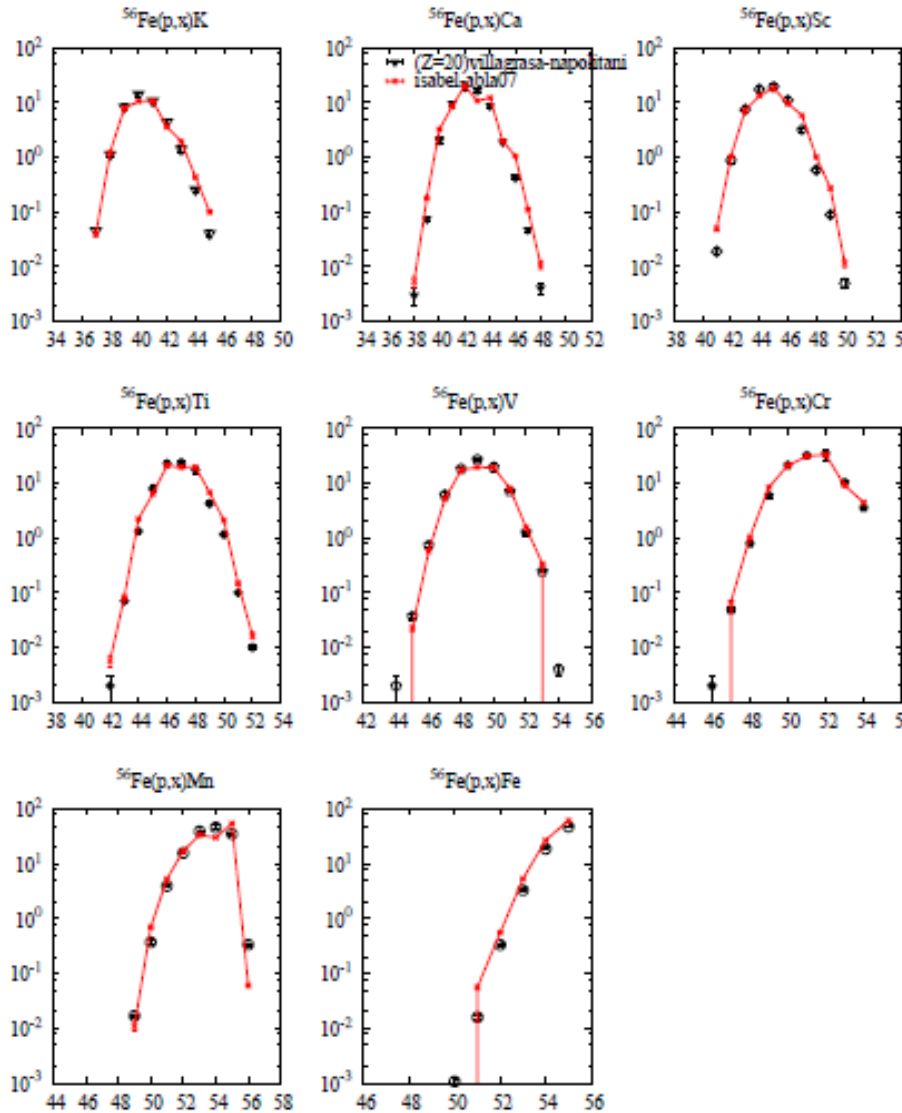

mass number A

p(500 MeV) + ^{208}Pb – final residues

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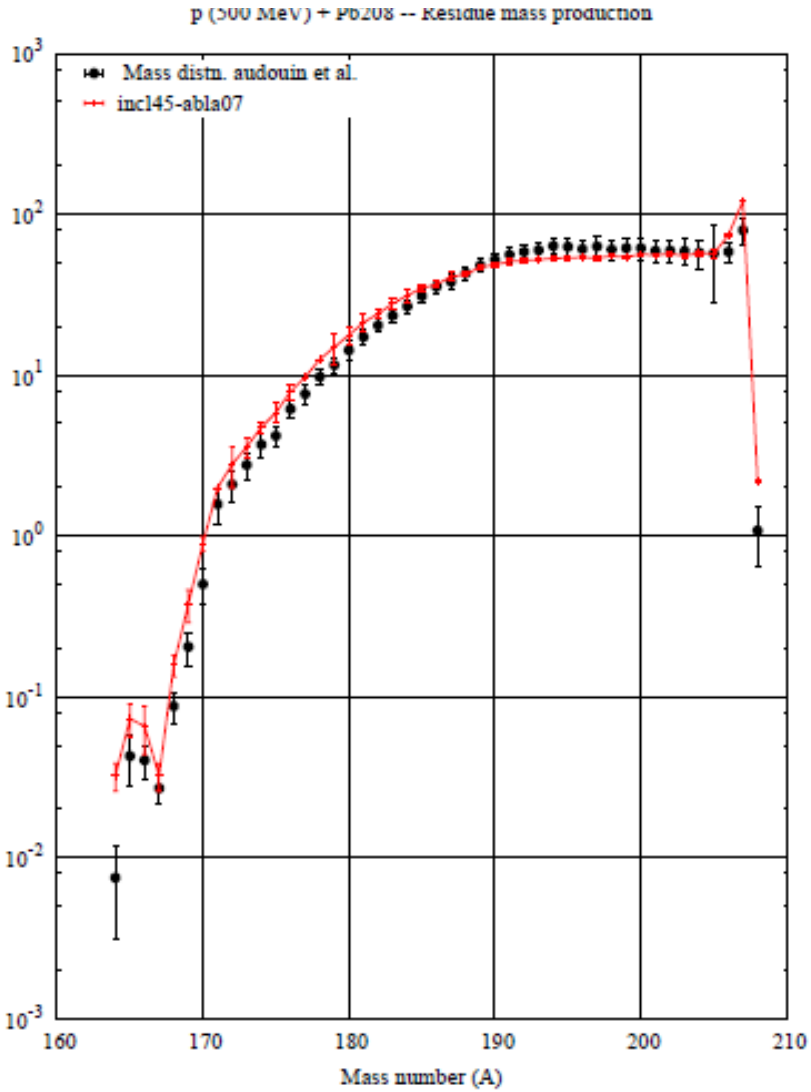

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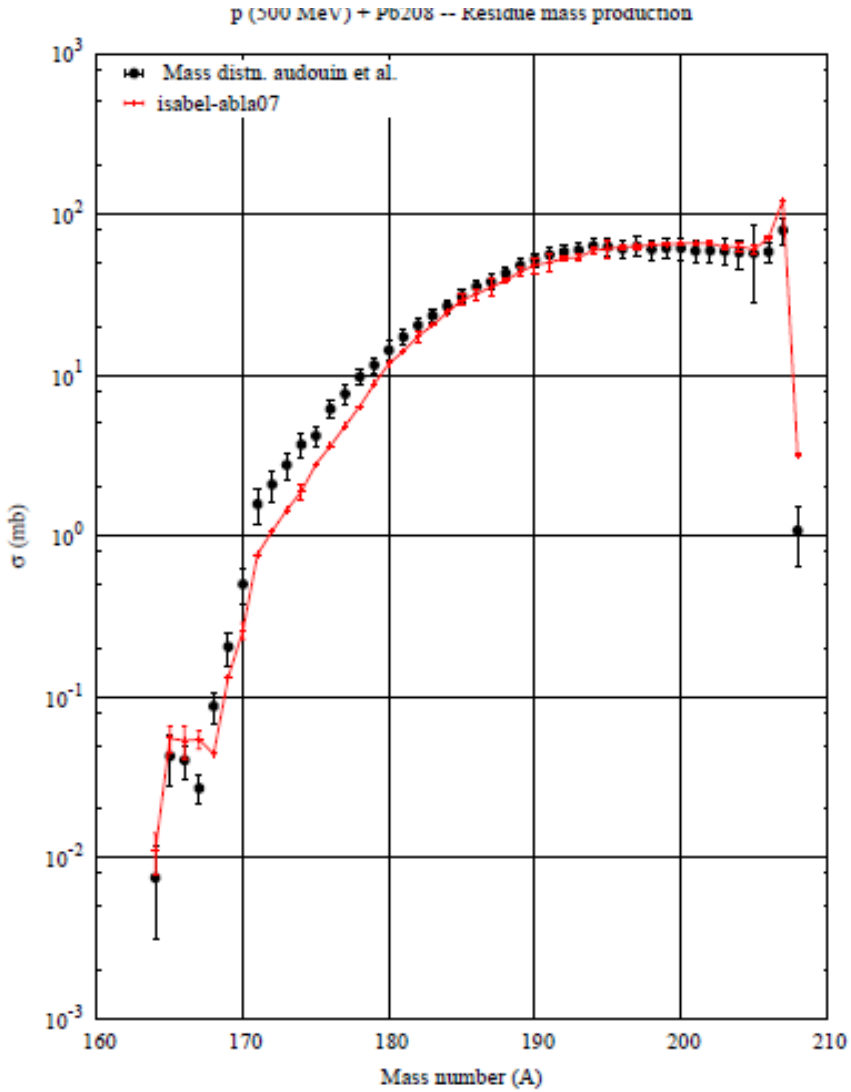

cross section (mb)

mass number A

p(500 MeV) + ^{208}Pb – final residues

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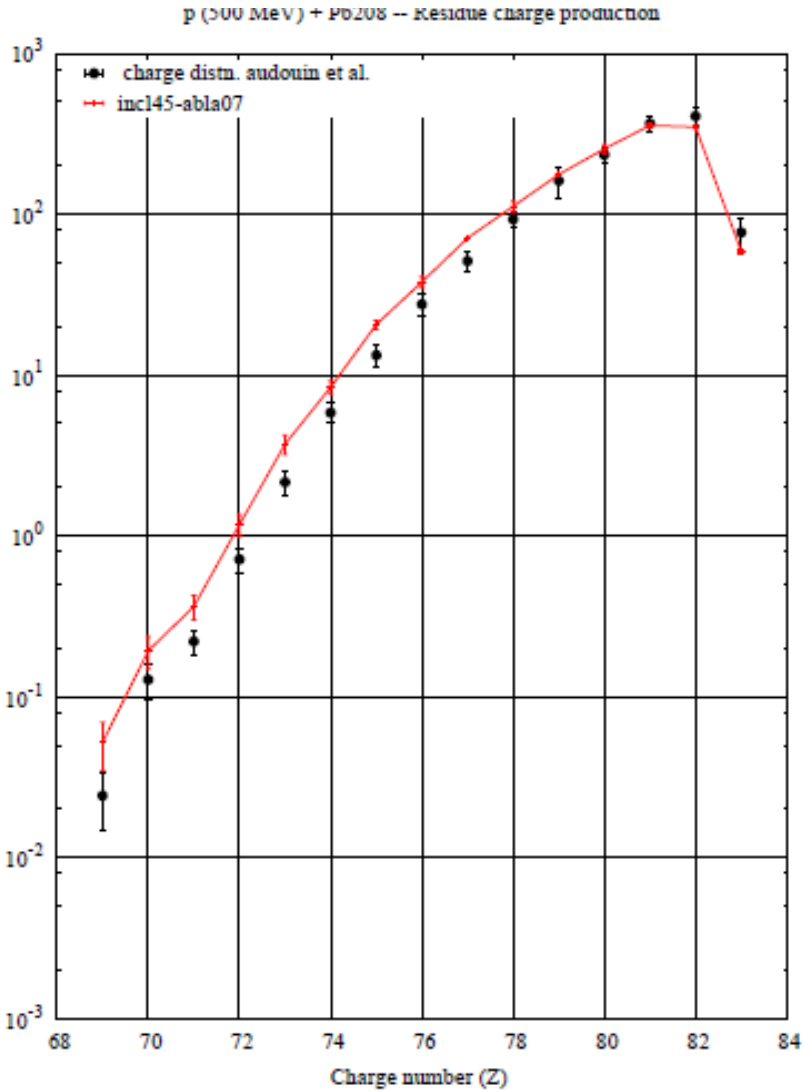

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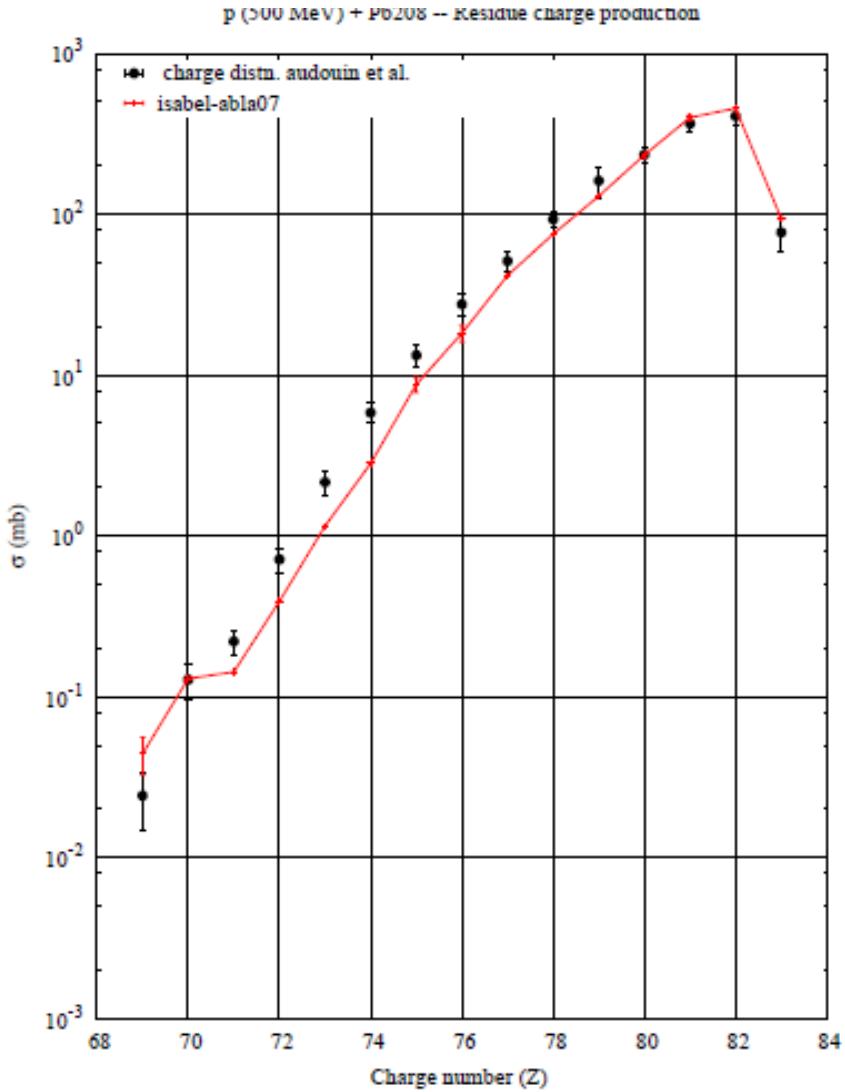

cross section (mb)

charge number Z

p(500 MeV) + ^{208}Pb – final residues

INCL45-ABLA07

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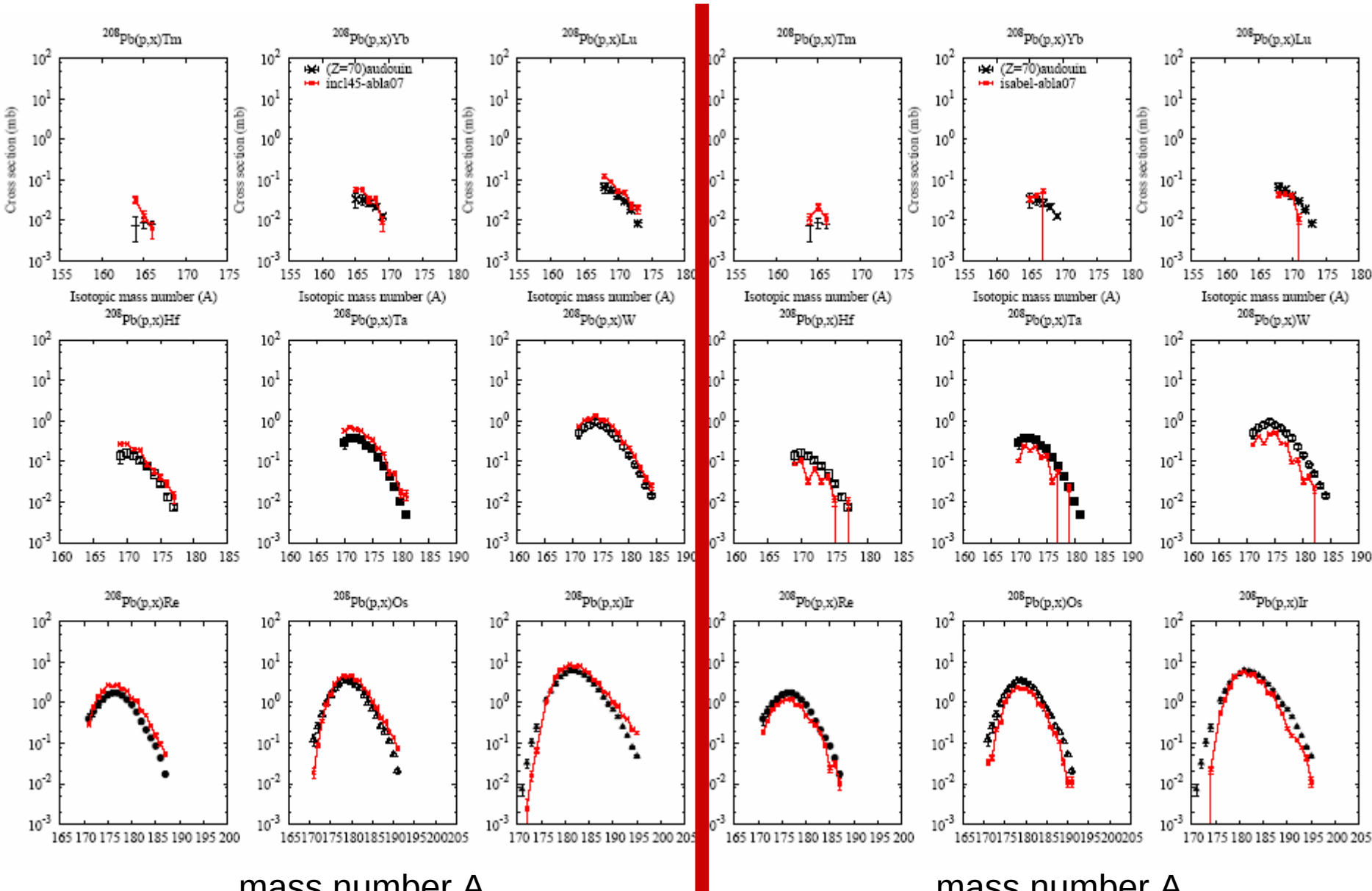

mass number A

mass number A

p(500 MeV) + ^{208}Pb – final residues

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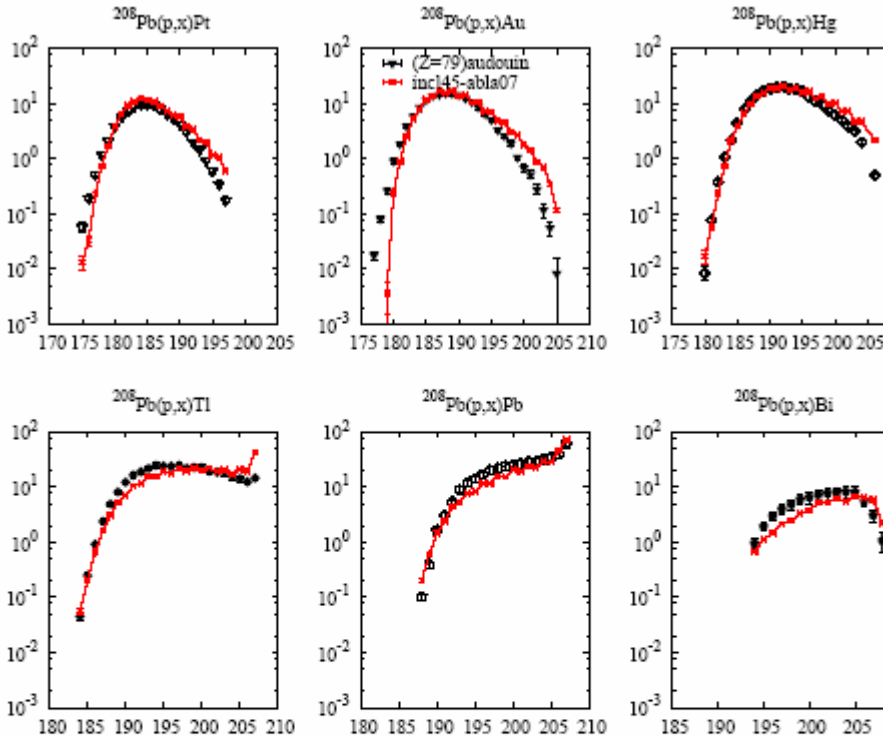

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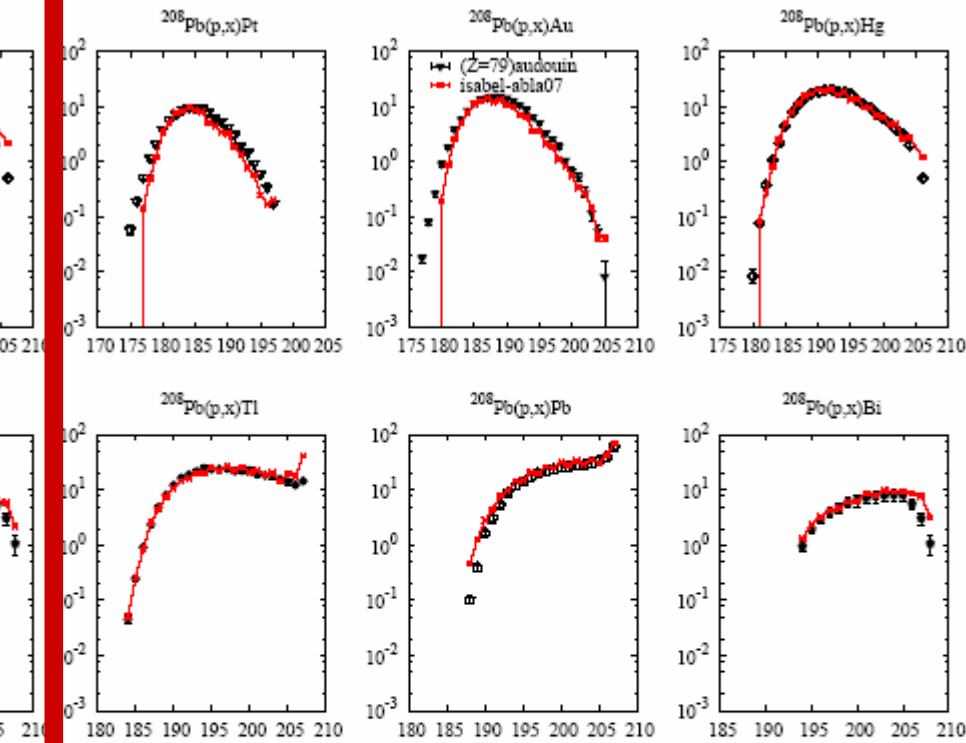

mass number A

p(1000 MeV) + ^{208}Pb – final residues

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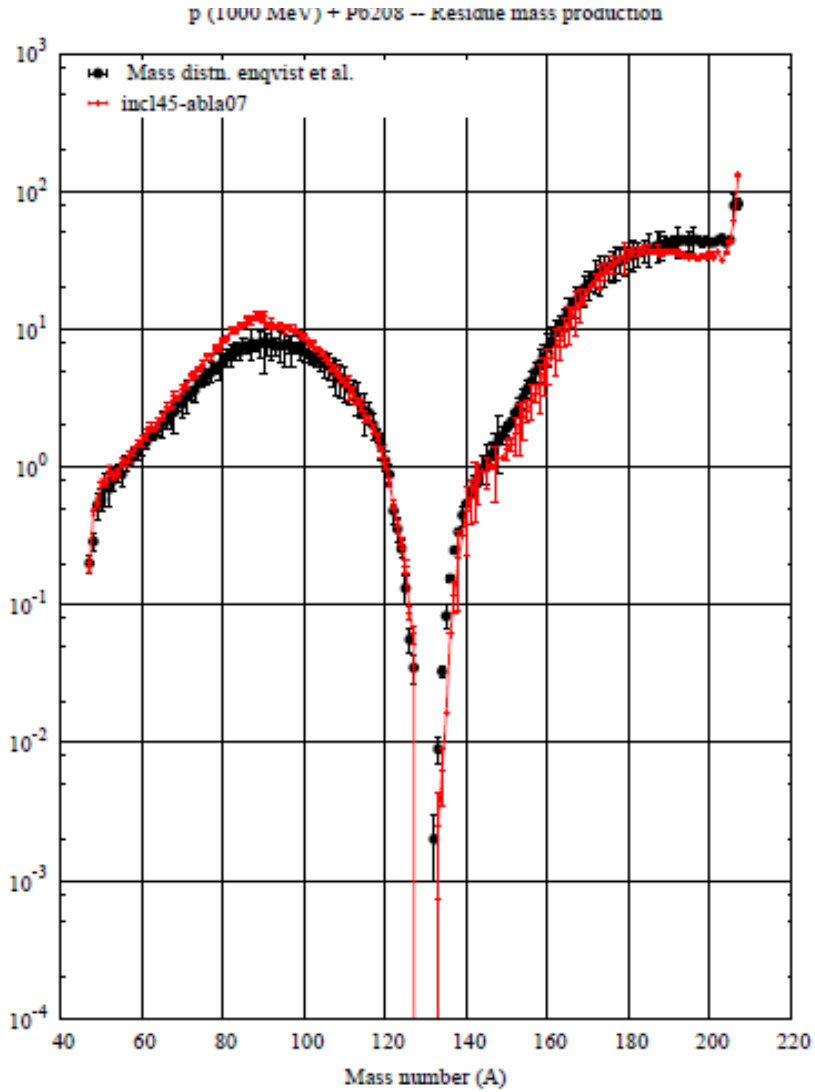

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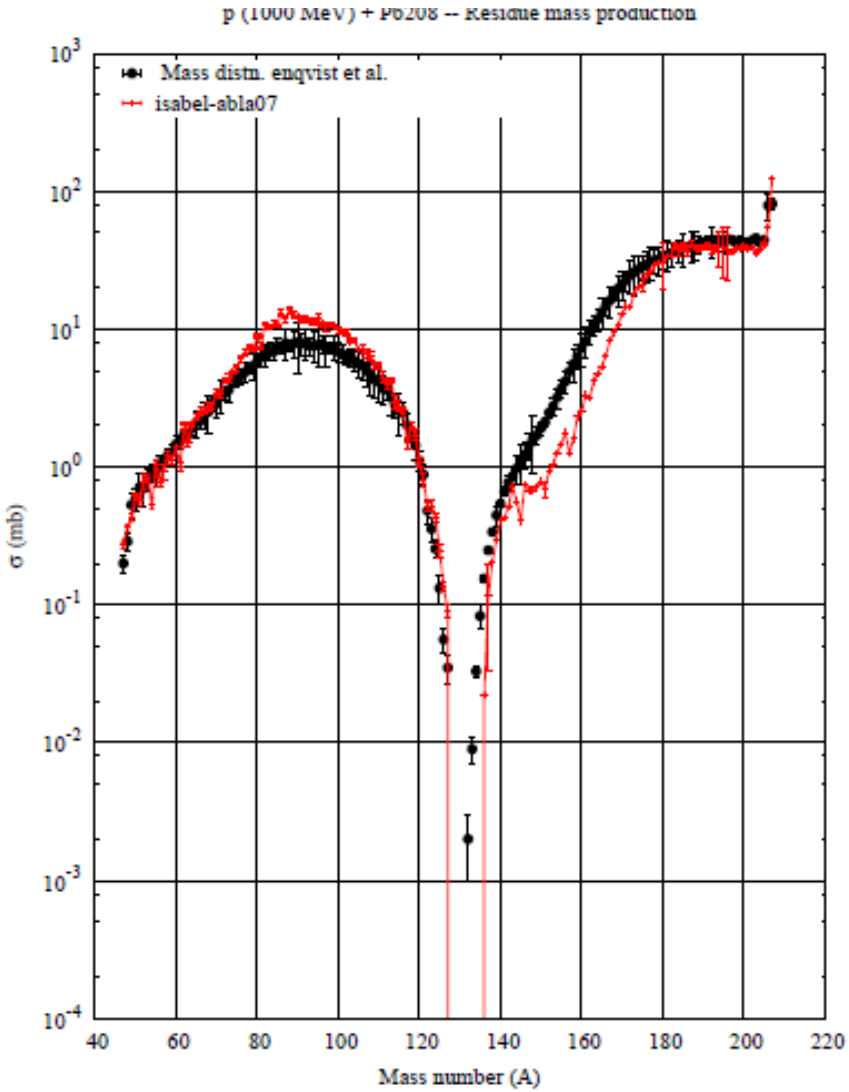
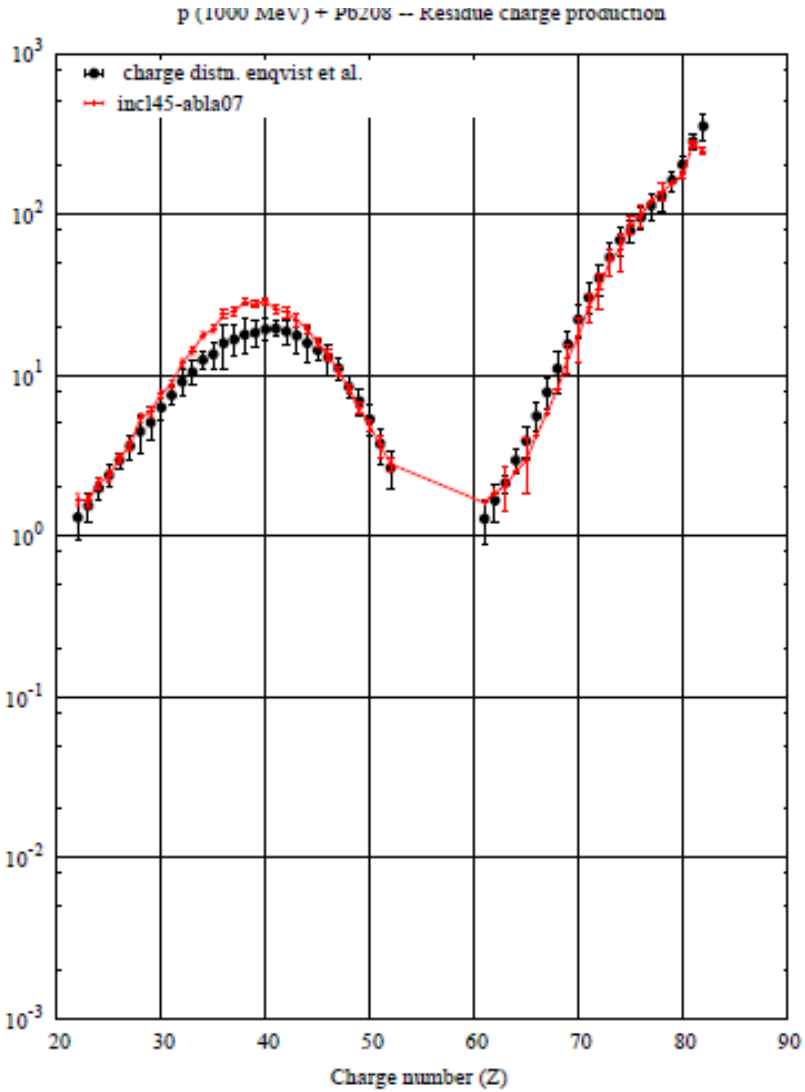


cross section (mb)

mass number A

p(1000 MeV) + ^{208}Pb – final residues

INCL45-ABLA07



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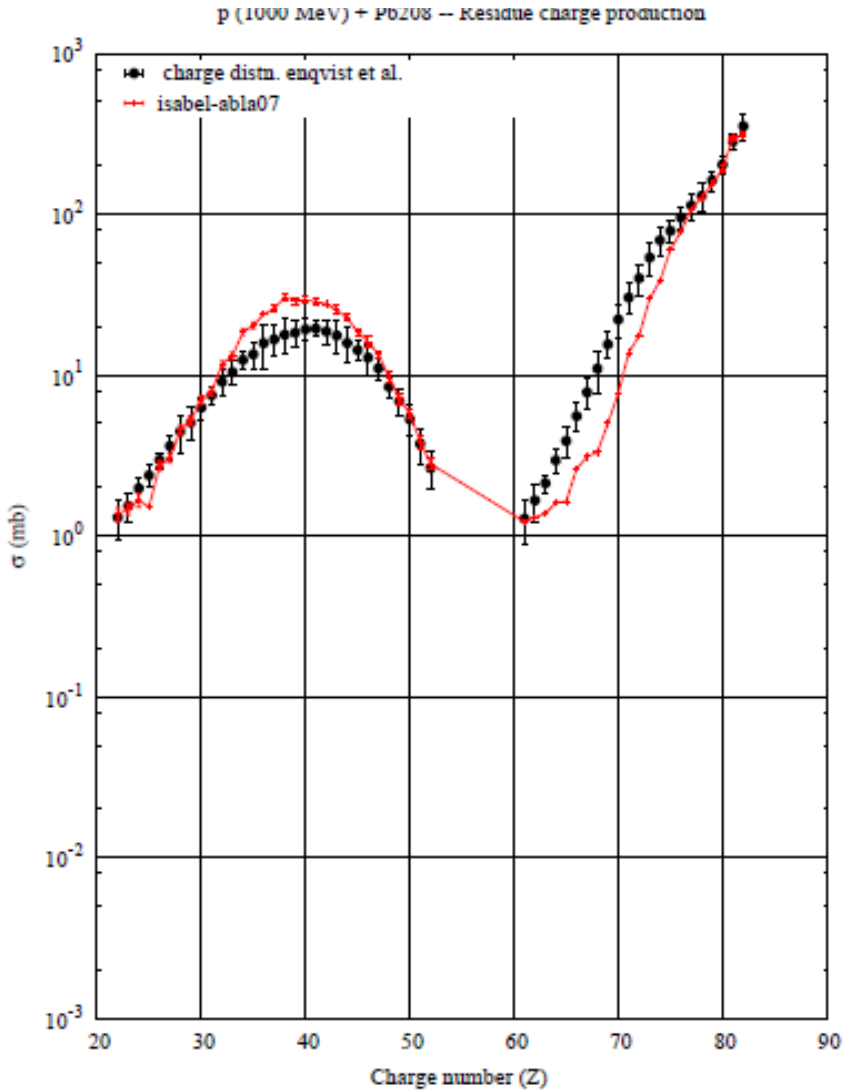


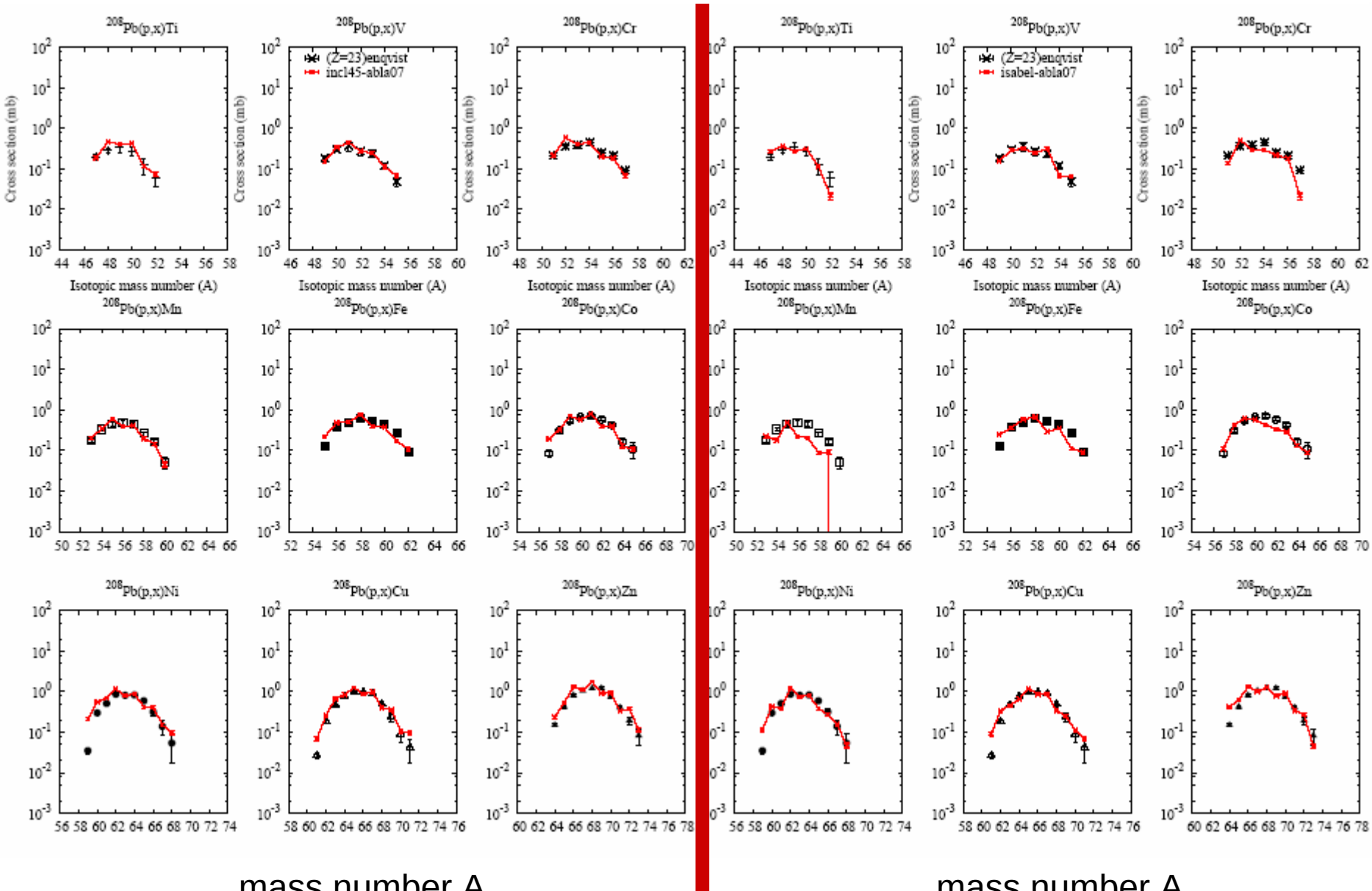
cross section (mb)

charge number Z

p(1000 MeV) + ^{208}Pb – final residues

INCL45-ABLA07

ISABEL-ABLA07



mass number A

mass number A

p(1000 MeV) + ^{208}Pb – final residues

INCL45-ABLA07

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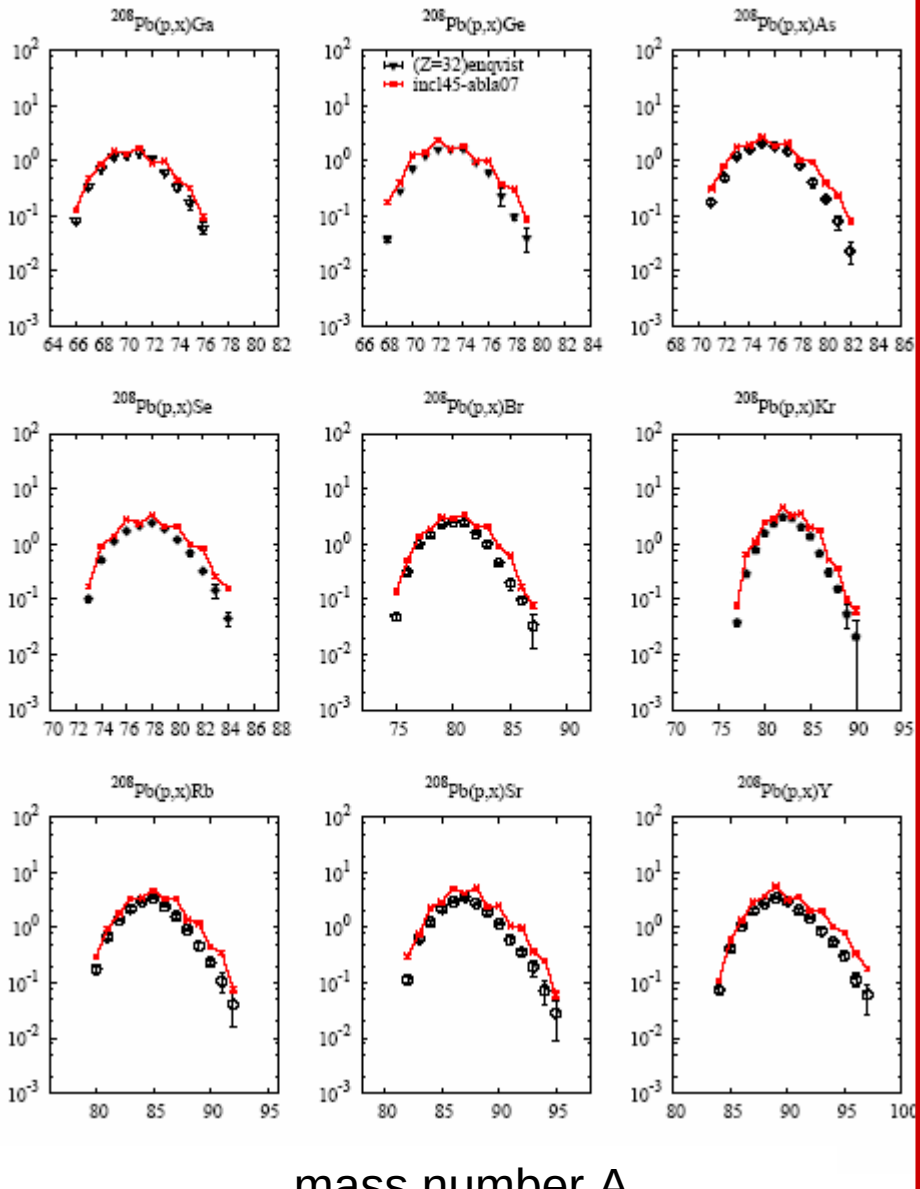

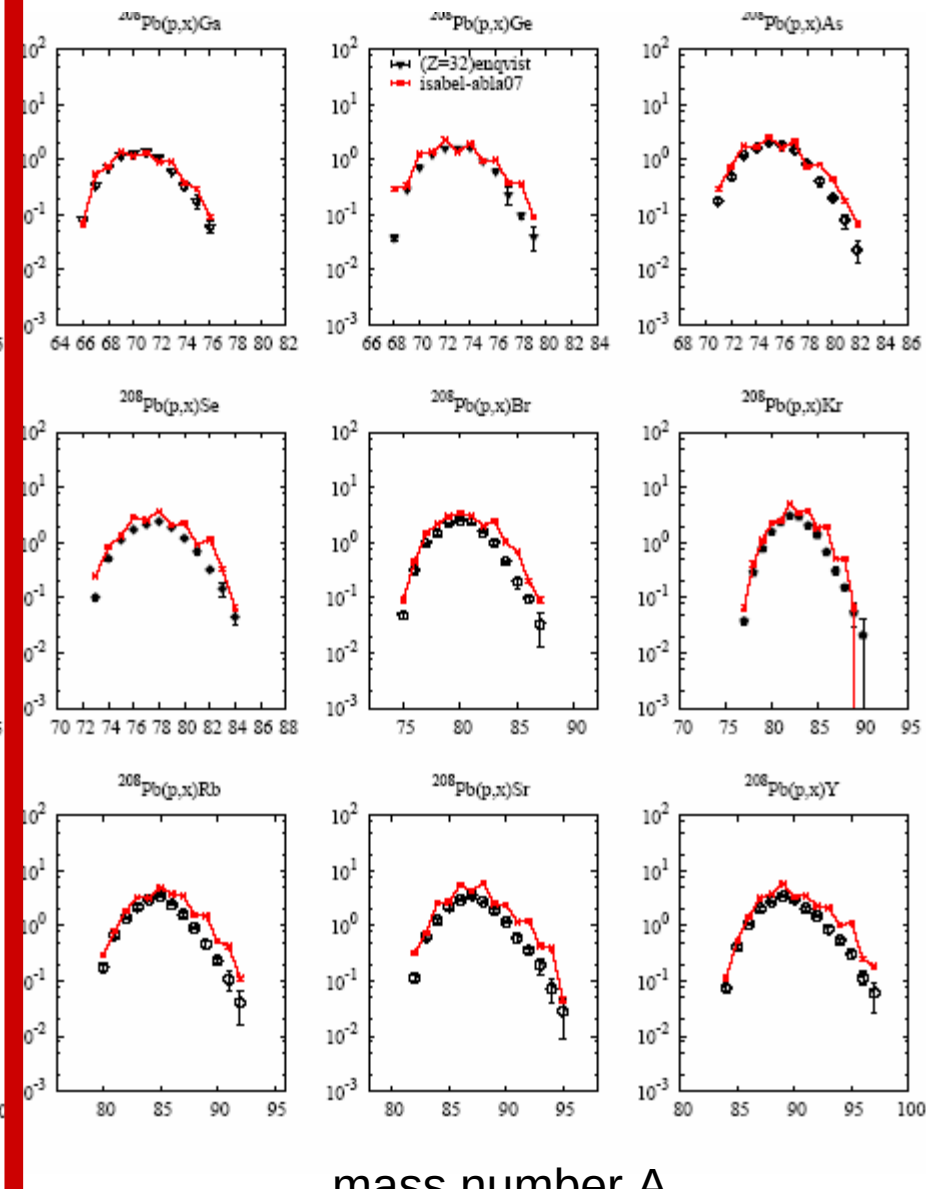

mass number A

mass number A

p(1000 MeV) + ^{208}Pb – final residues

INCL45-ABLA07

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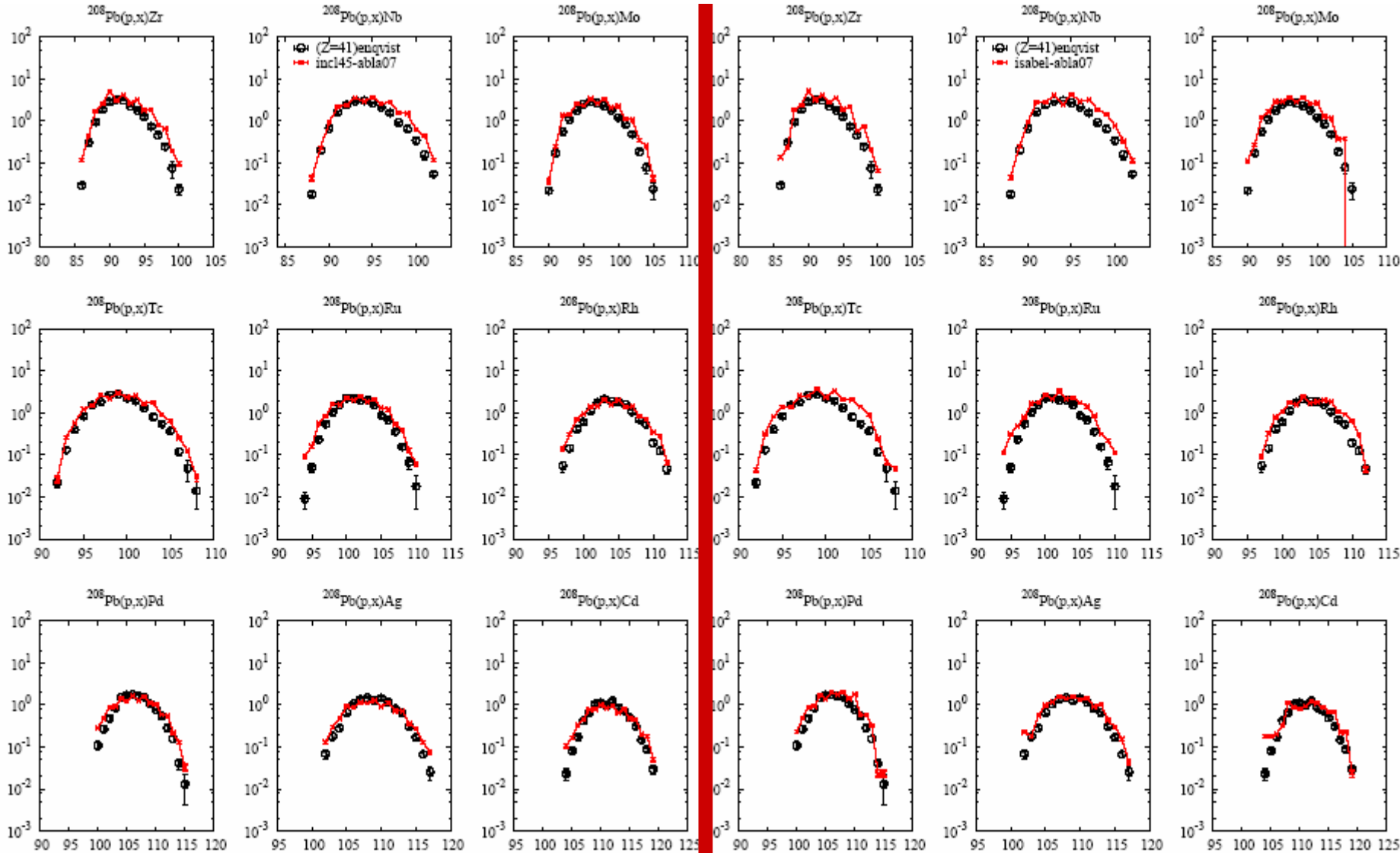

mass number A

mass number A

p(1000 MeV) + ^{208}Pb – final residues

INCL45-ABLA07

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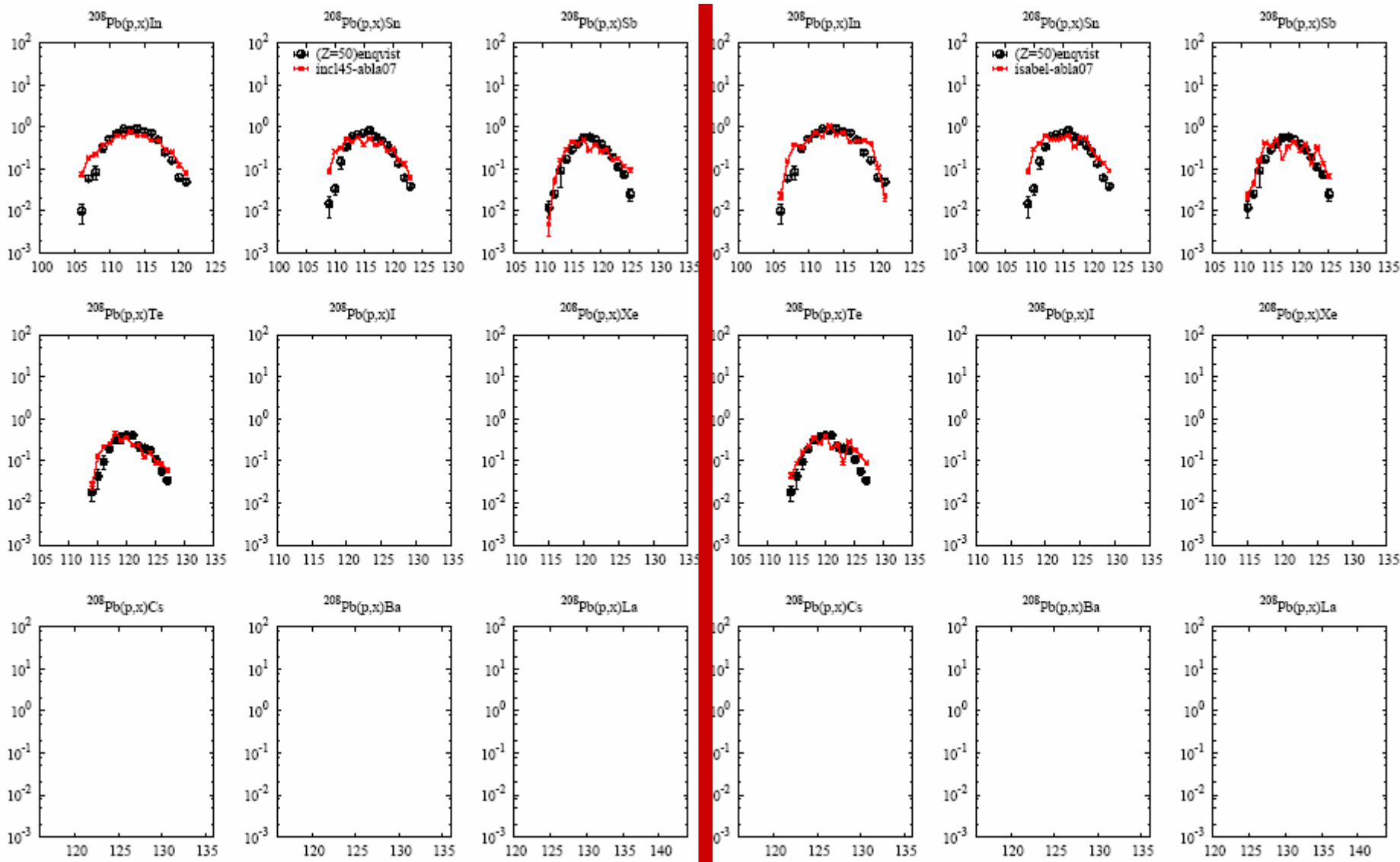

mass number A

mass number A

p(1000 MeV) + ^{208}Pb – final residues

INCL45-ABLA07

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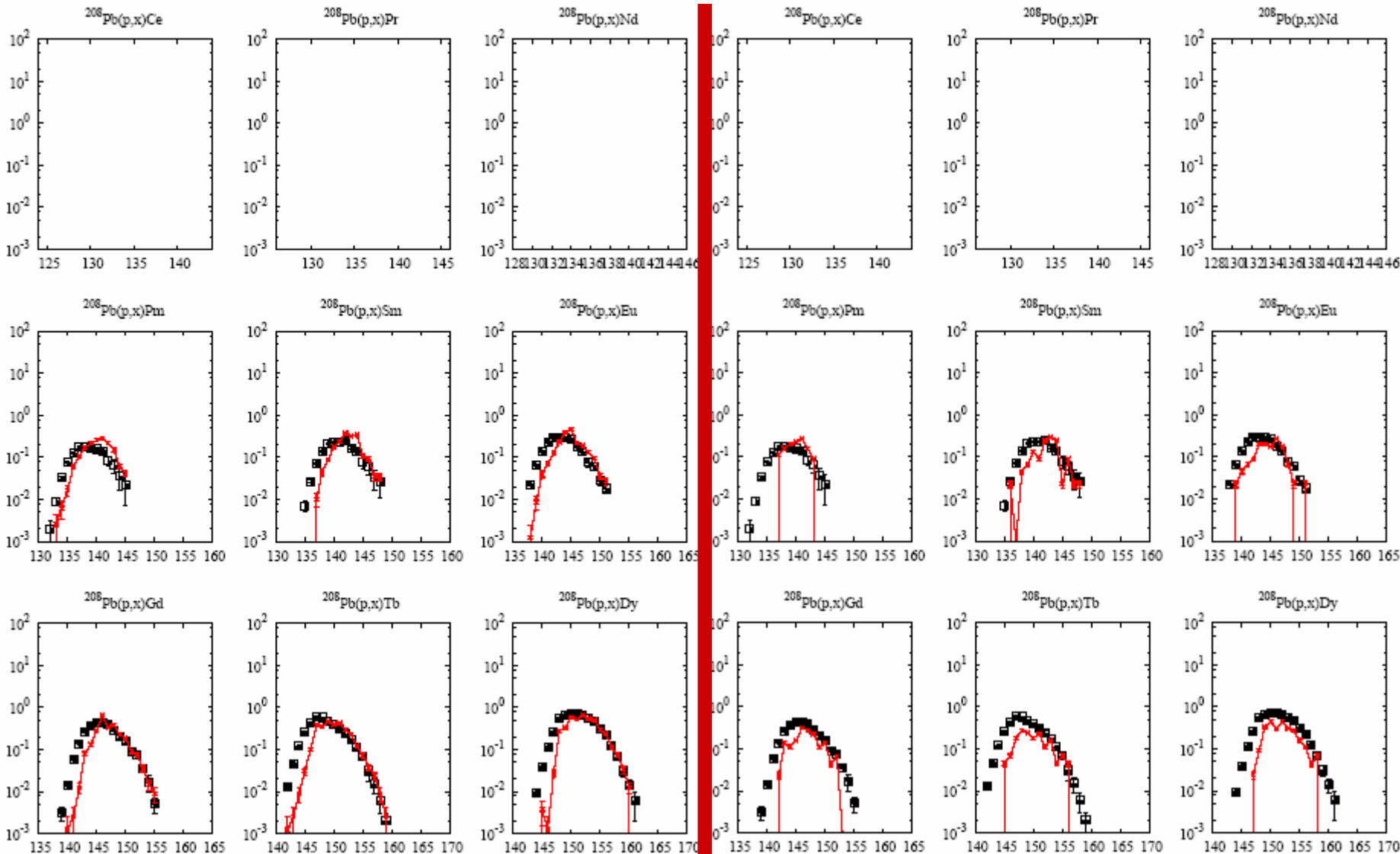

mass number A

mass number A

p(1000 MeV) + ^{208}Pb – final residues

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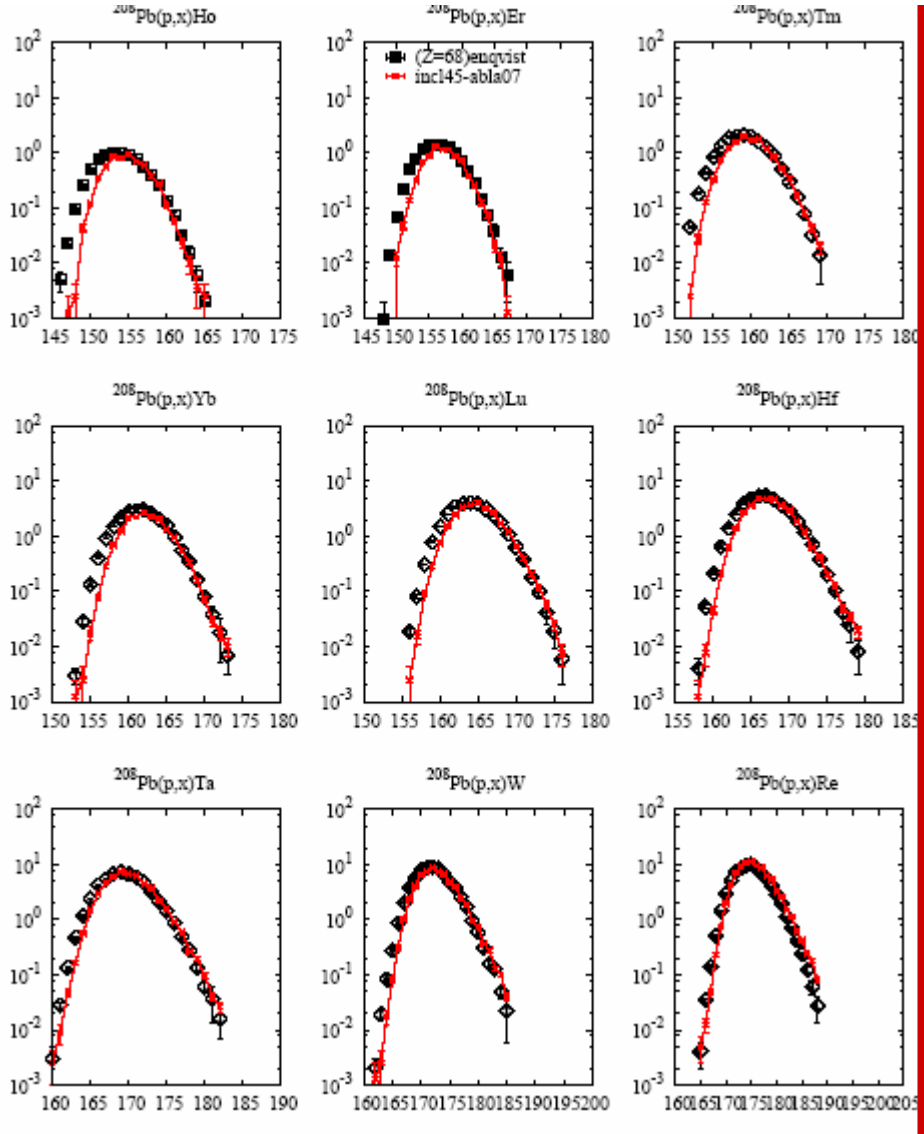

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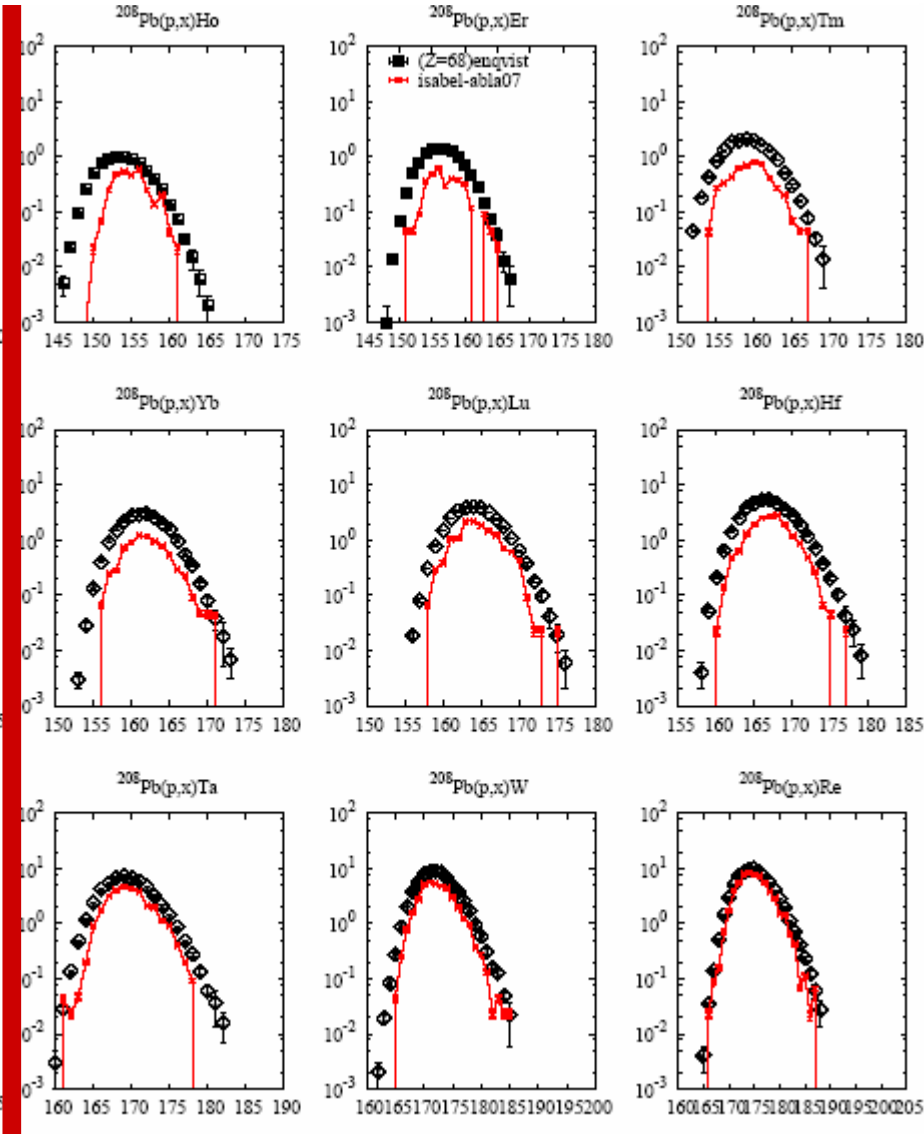

mass number A

p(1000 MeV) + ^{208}Pb – final residues

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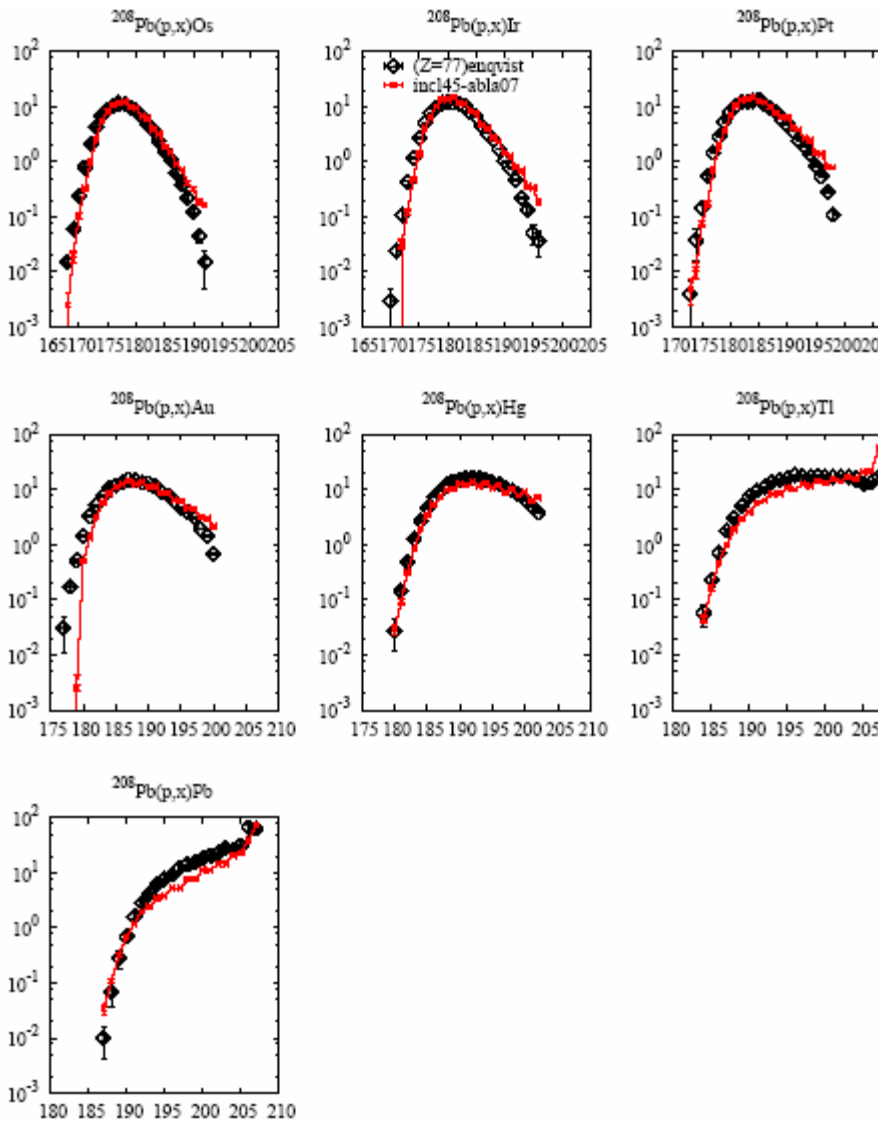

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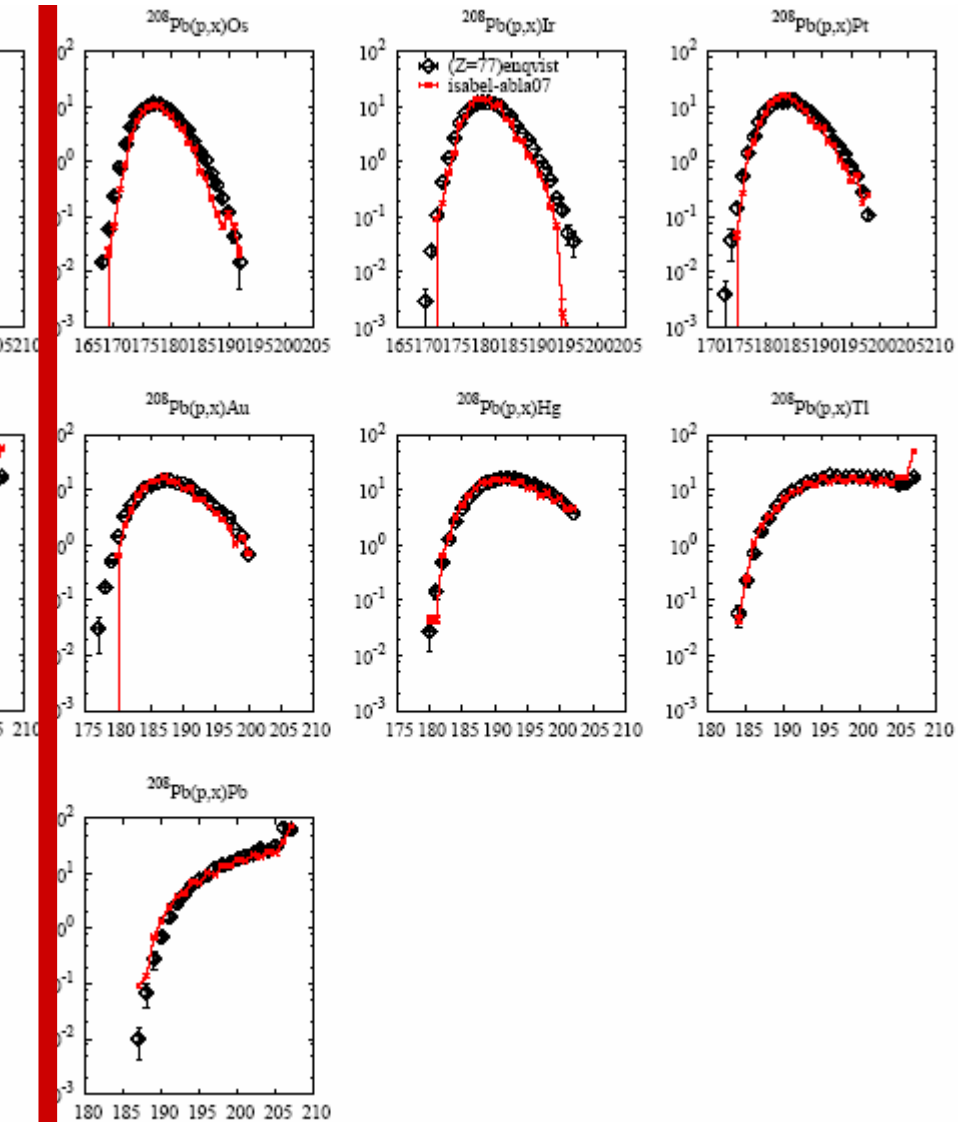

mass number A

mass number A

p(1000 MeV) + ^{238}U – final residues

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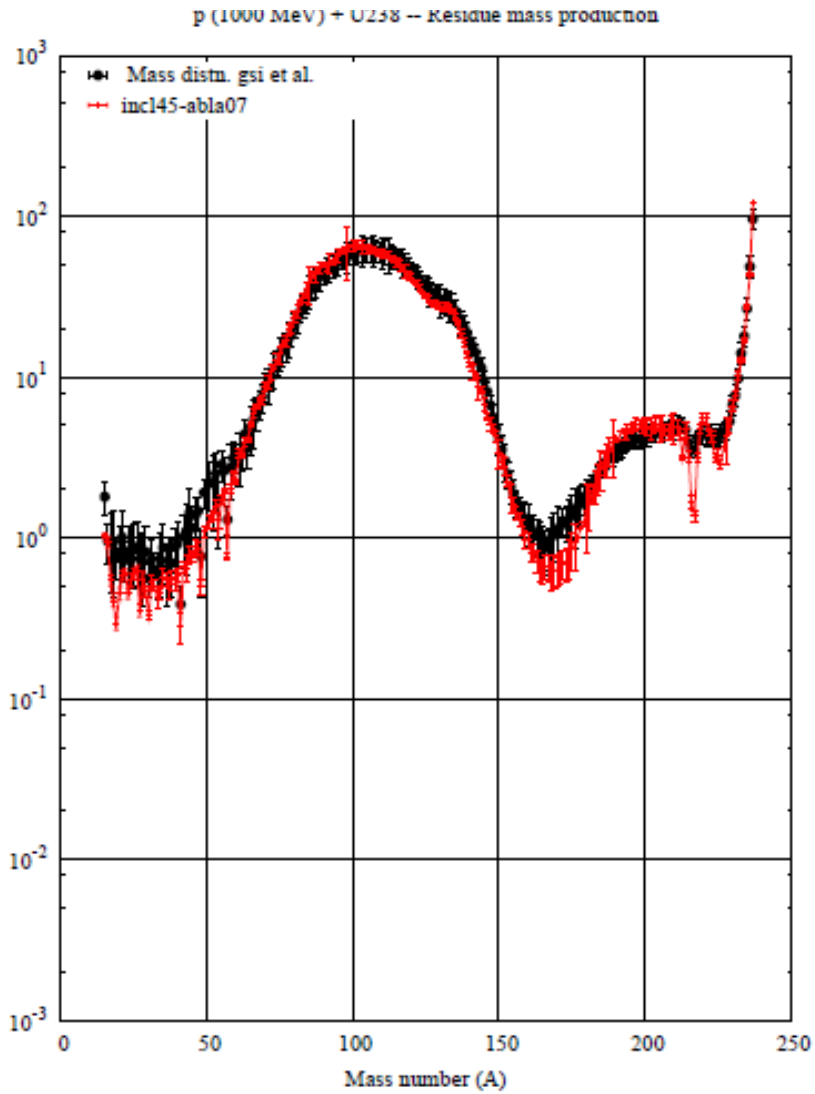

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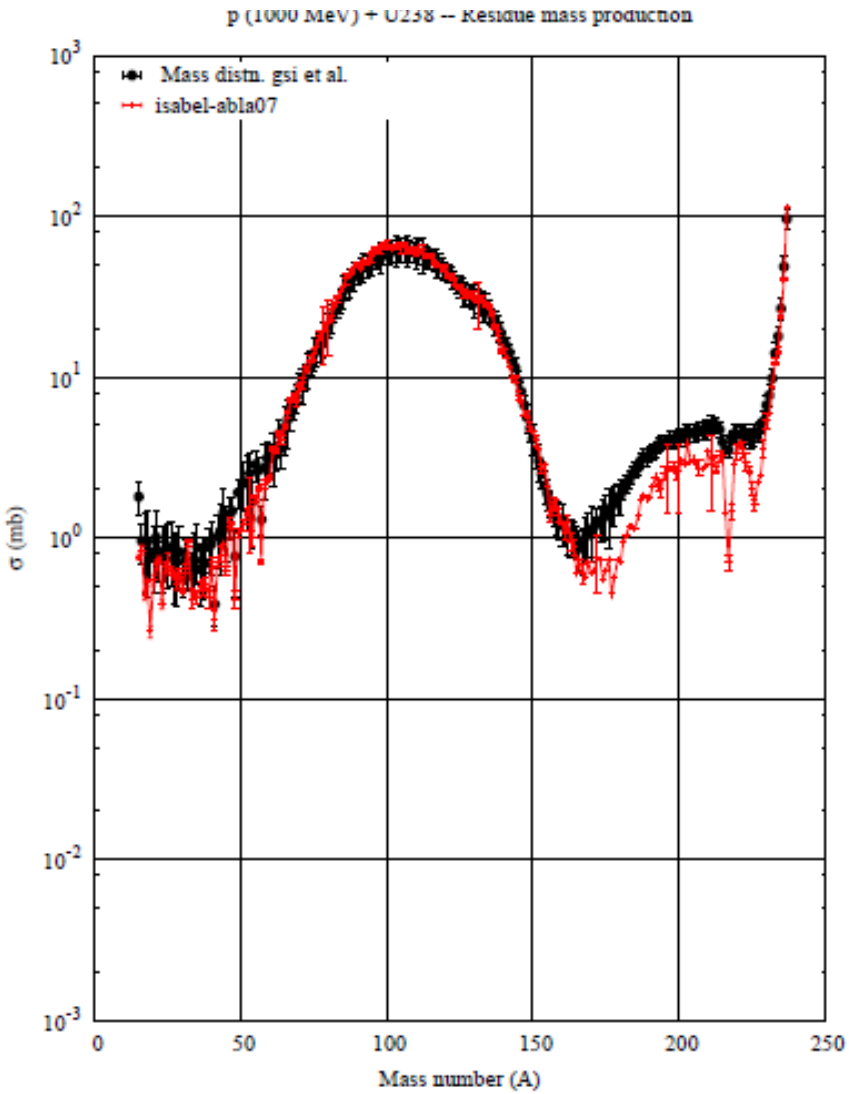

mass number A

p(1000 MeV) + ^{238}U – final residues

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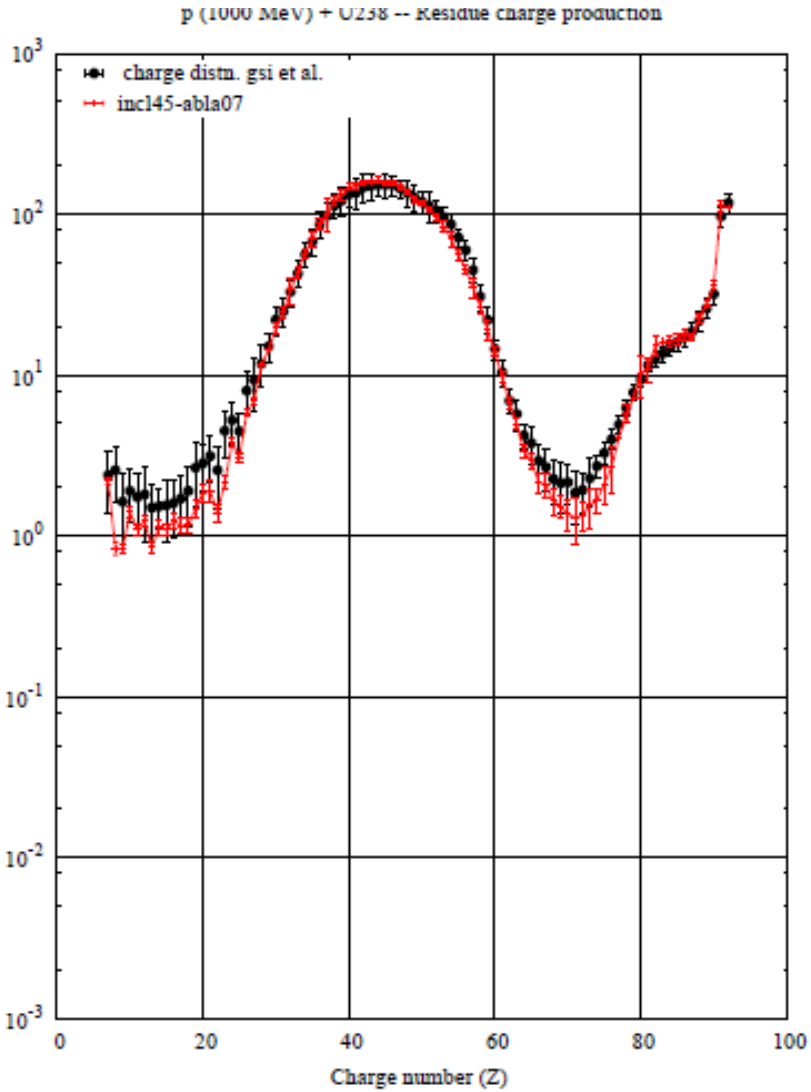

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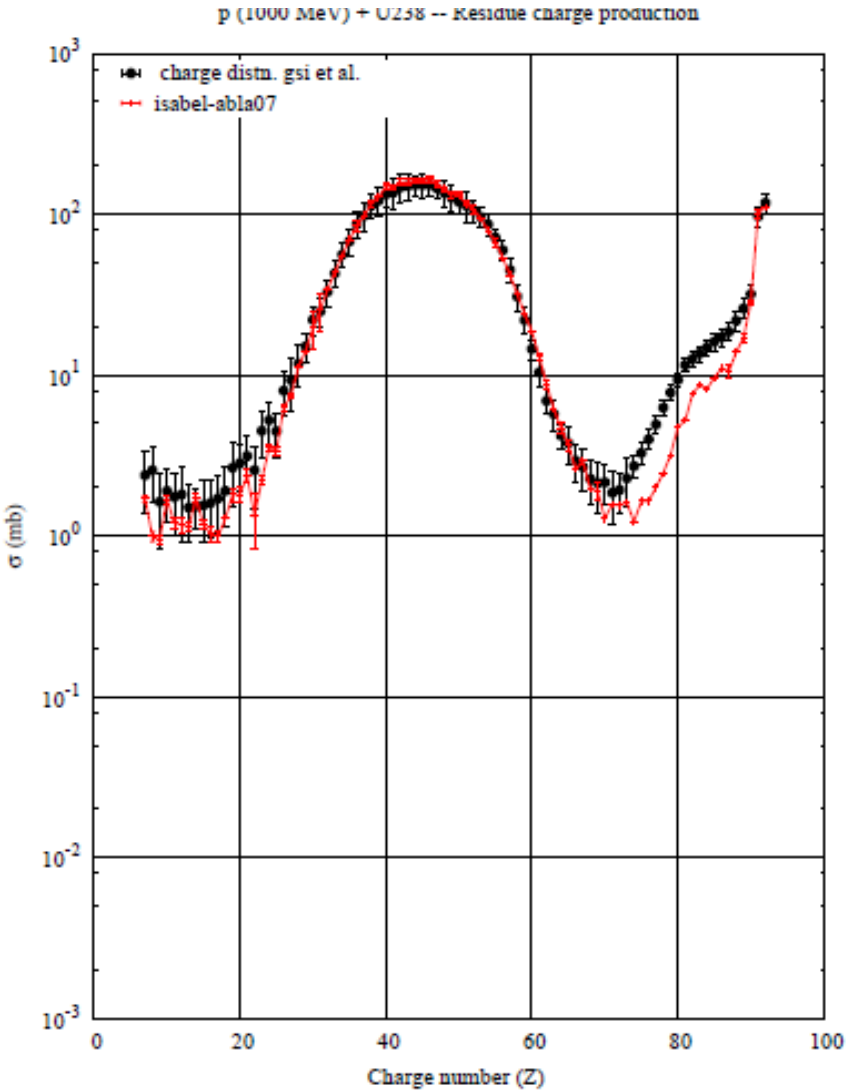


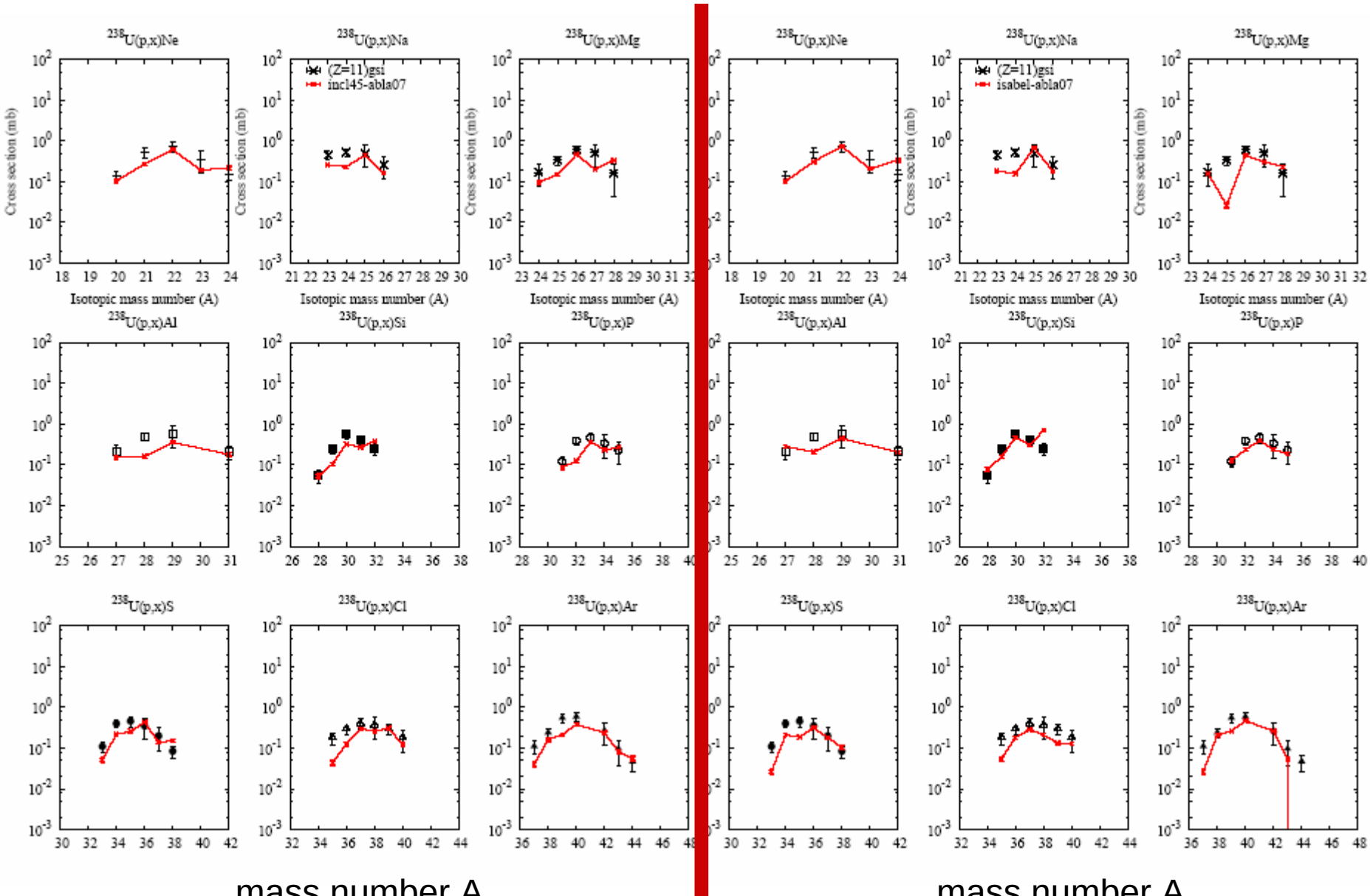
cross section (mb)

charge number Z

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07

ISABEL-ABLA07



mass number A

mass number A

p(1000 MeV) + ^{238}U – final residues

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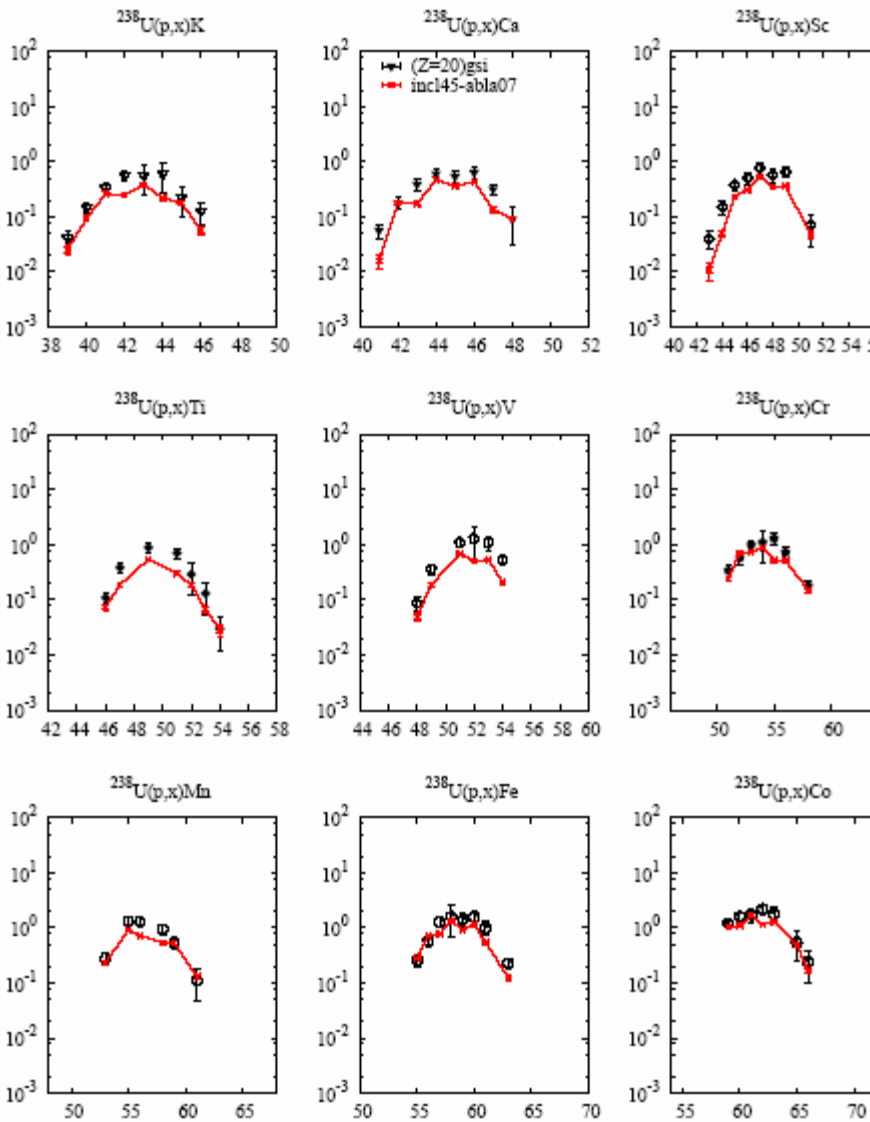

mass number A

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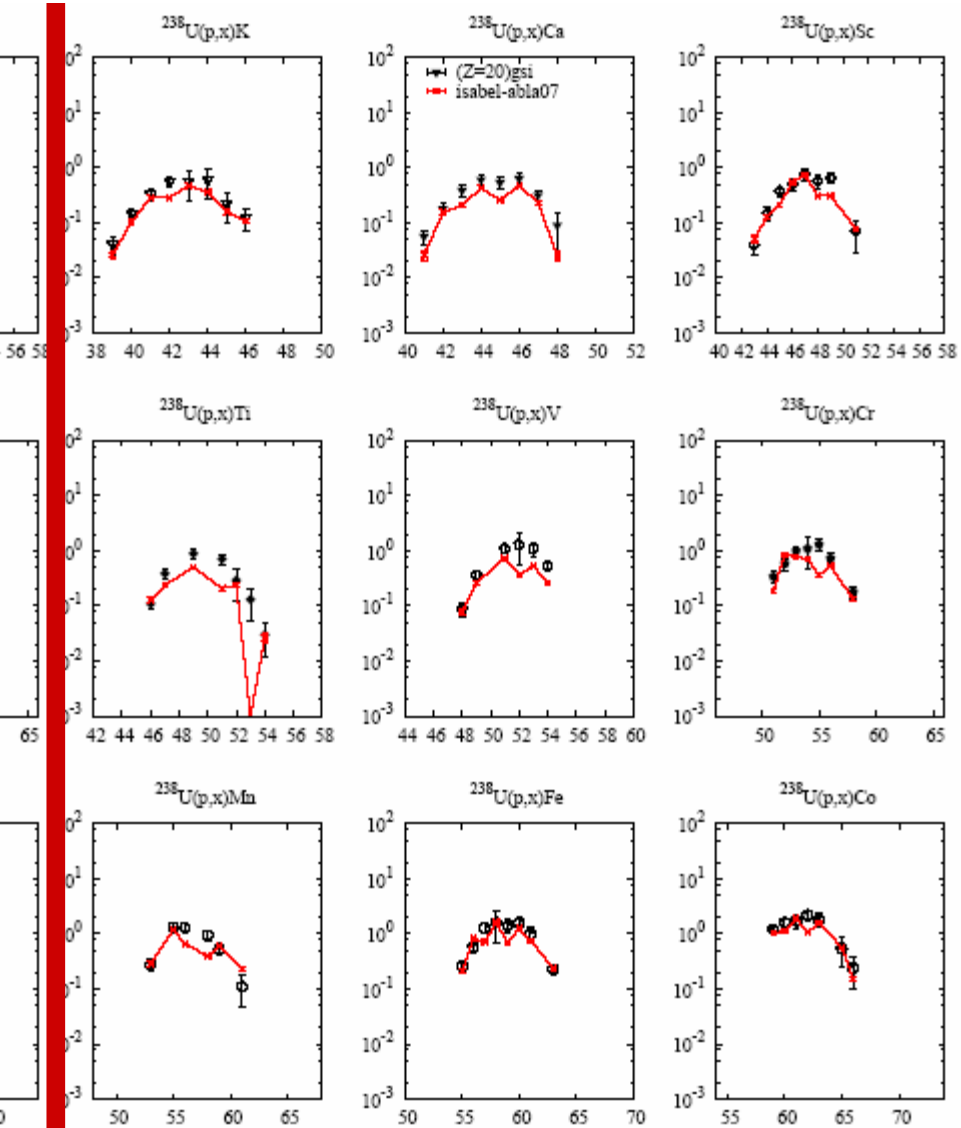

mass number A

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07

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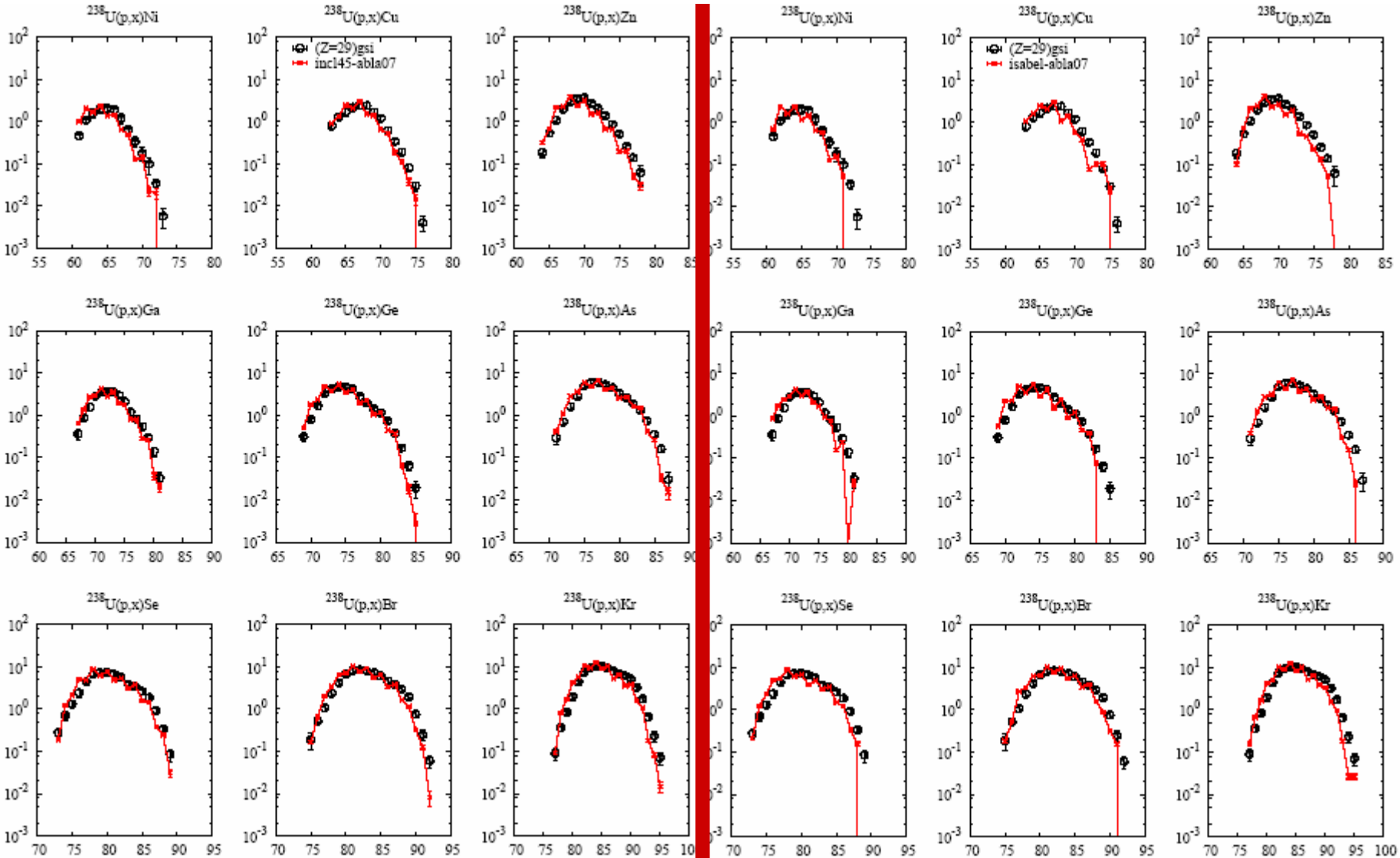


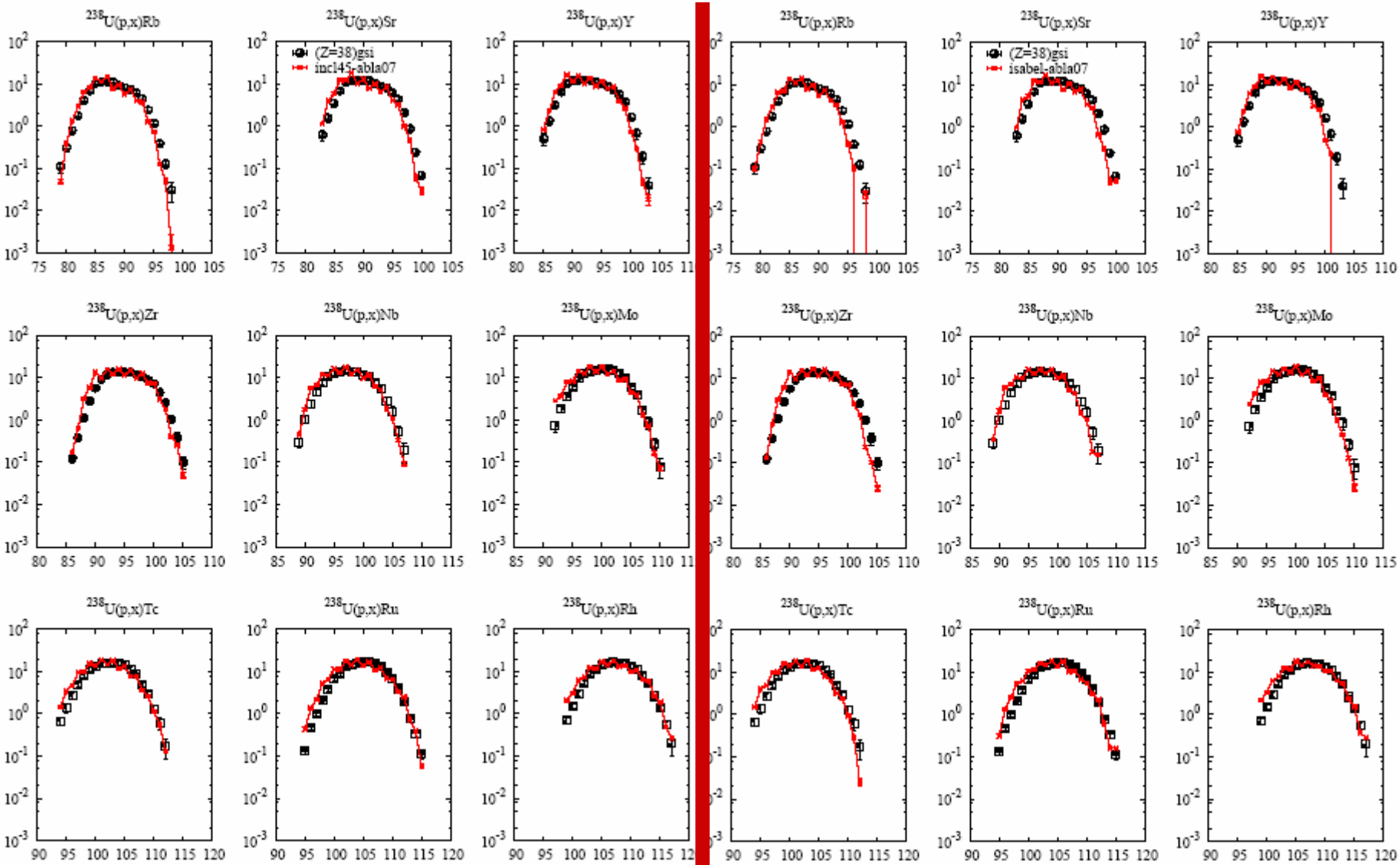
mass number A

mass number A

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07

ISABEL-ABLA07



mass number A

mass number A

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07

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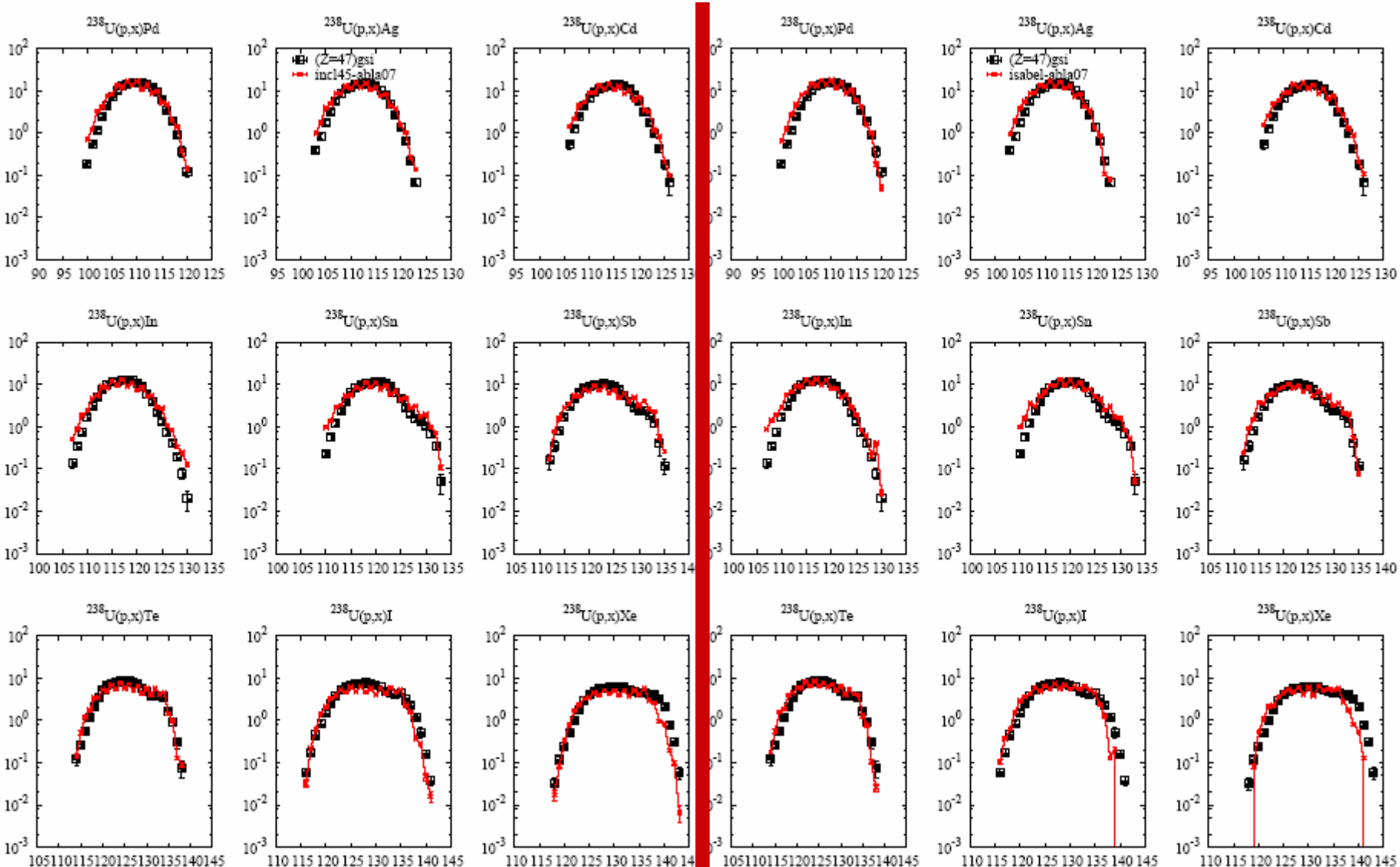

mass number A

mass number A

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07

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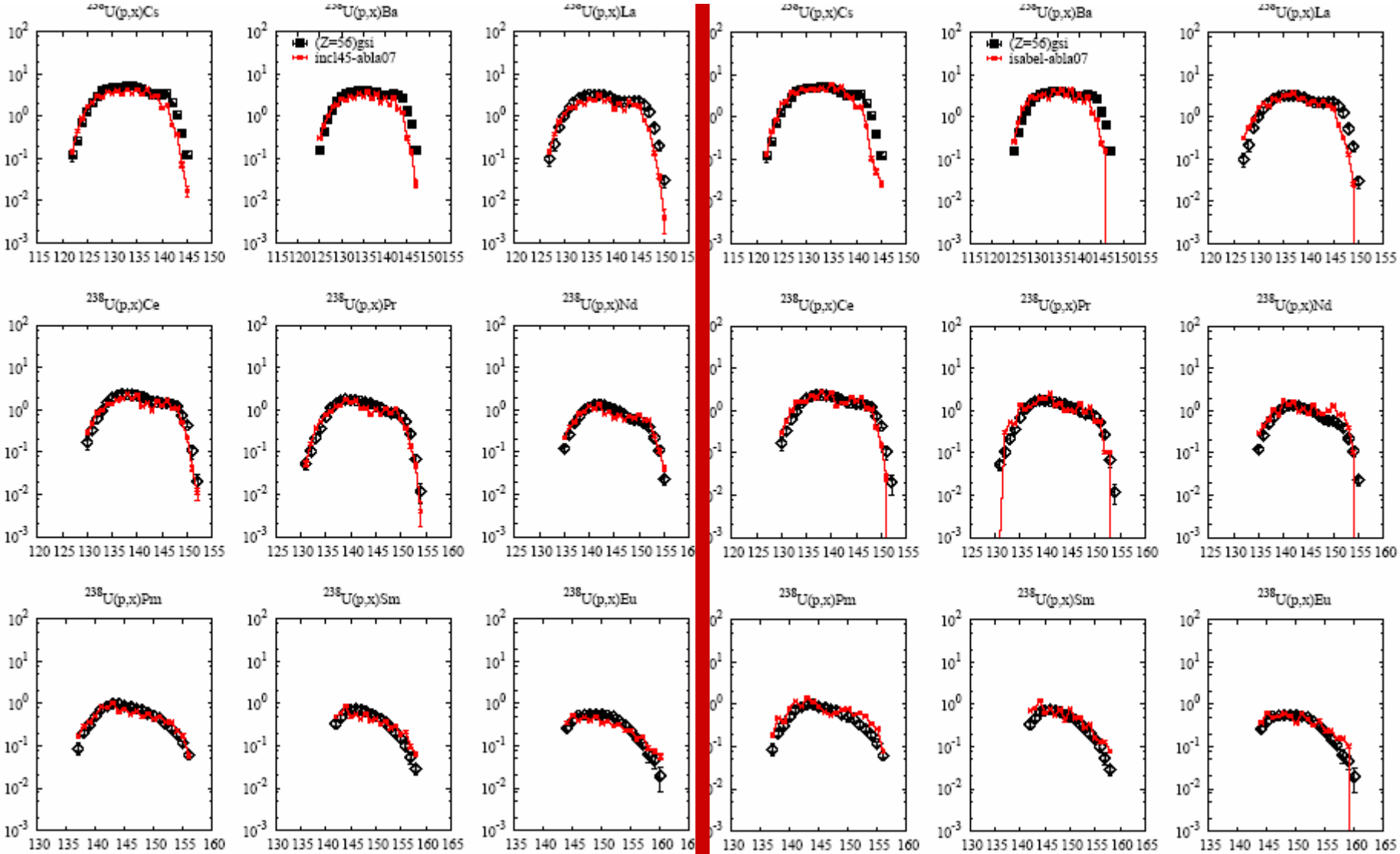

mass number A

mass number A

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07

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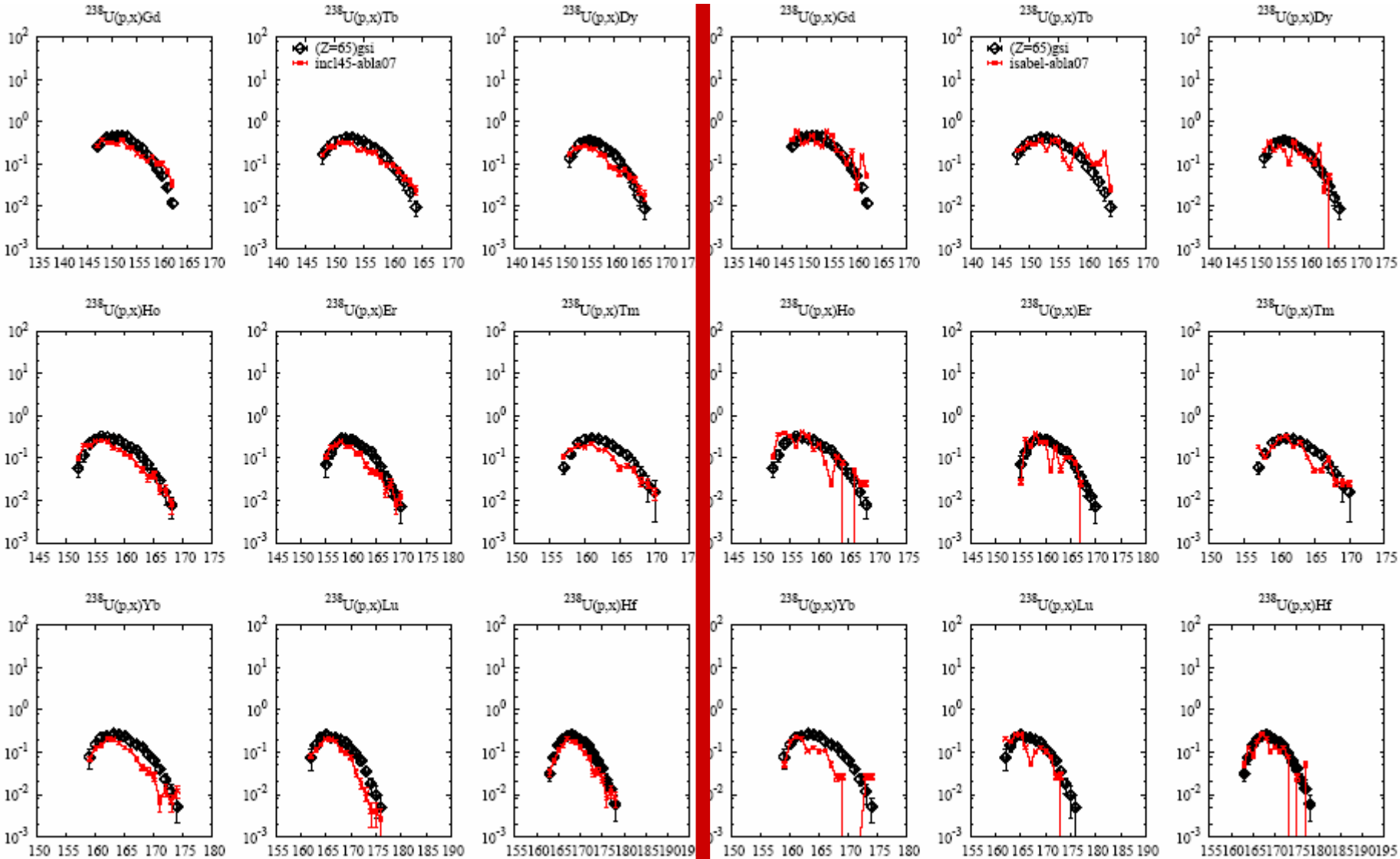

mass number A

mass number A

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07

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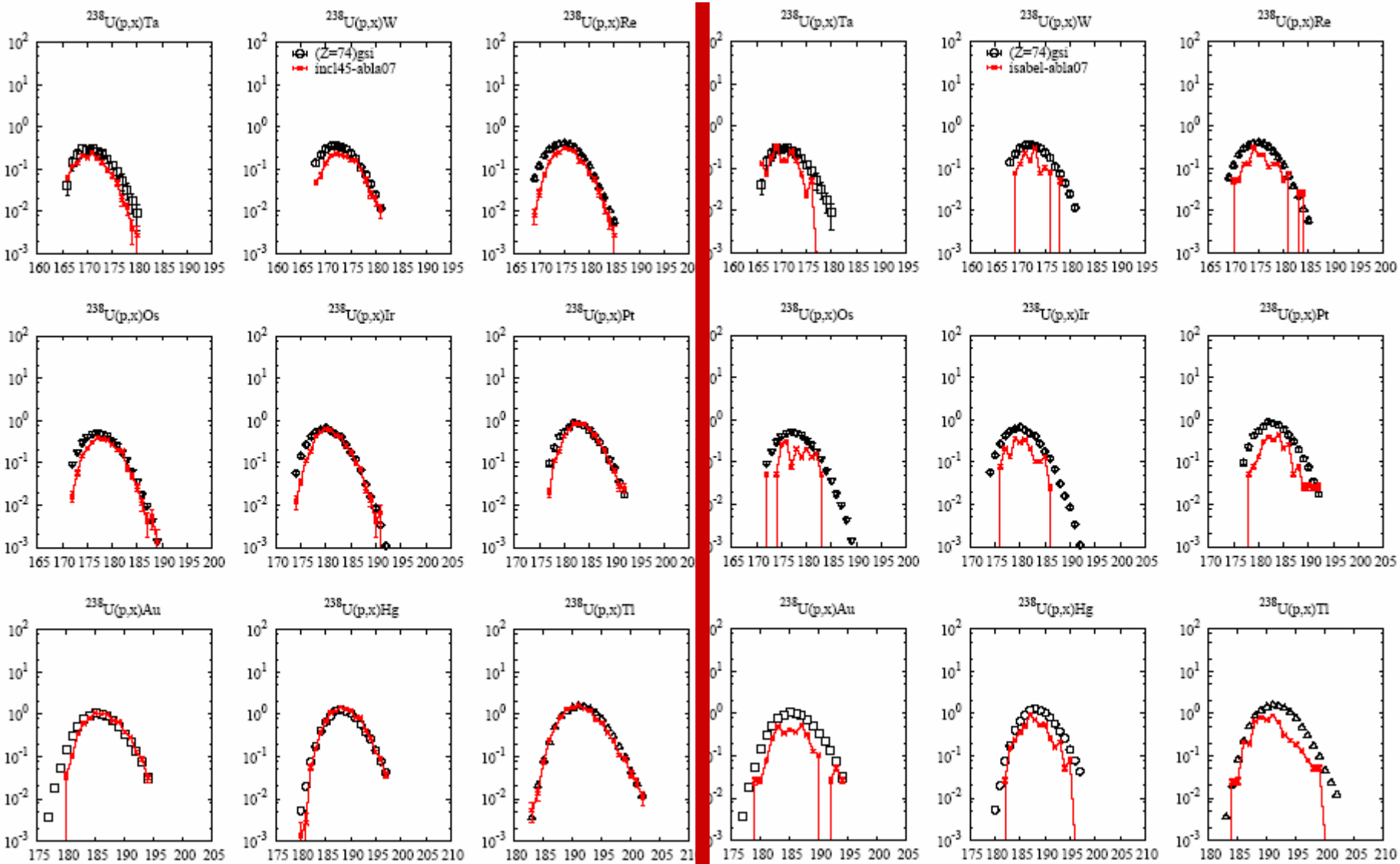
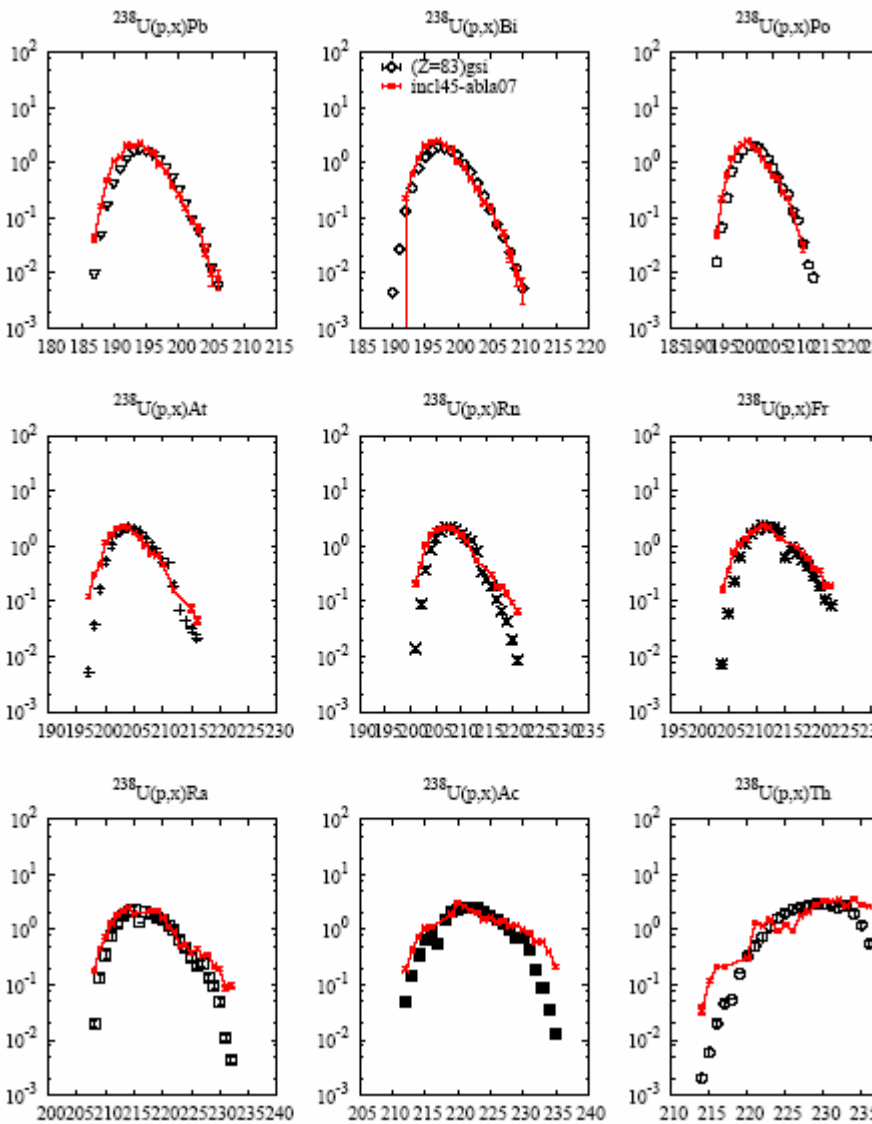


p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07



mass number A

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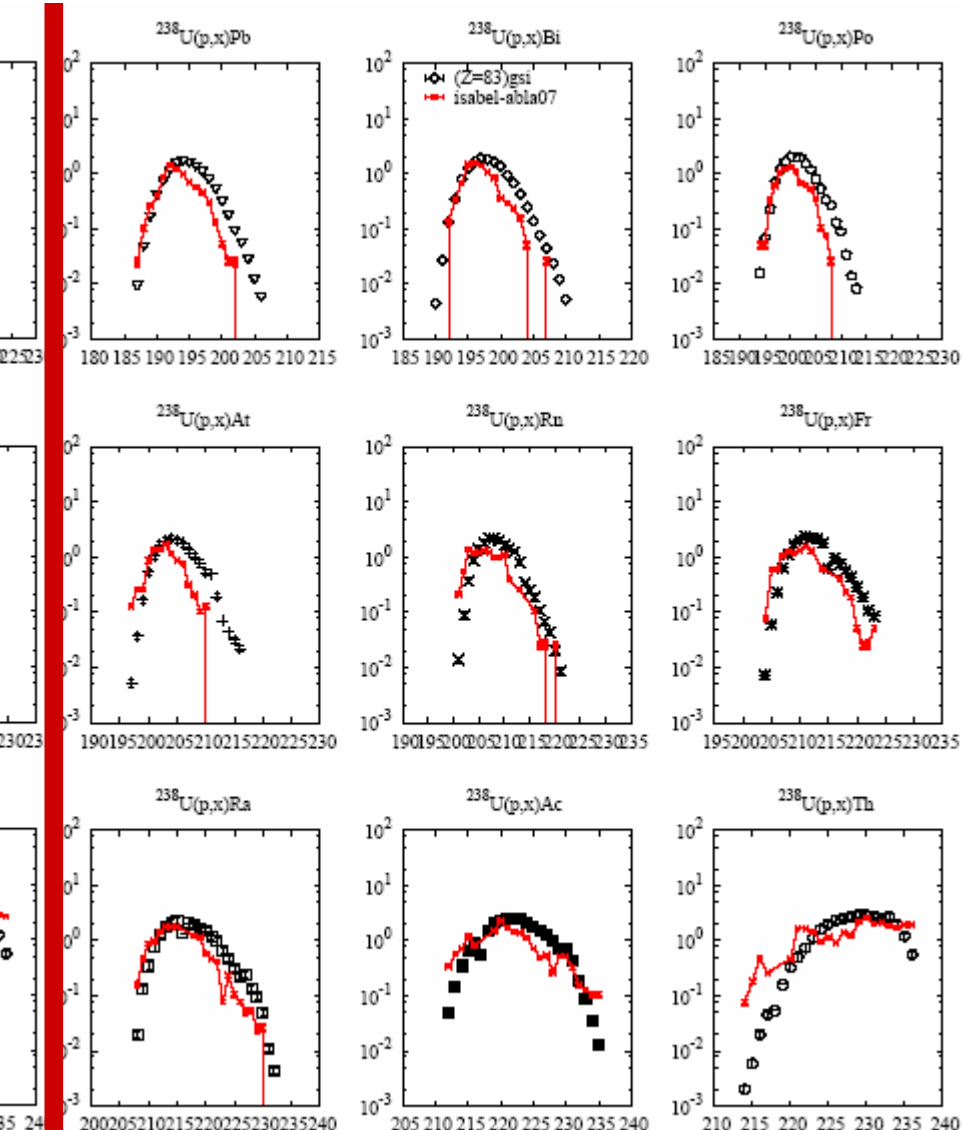
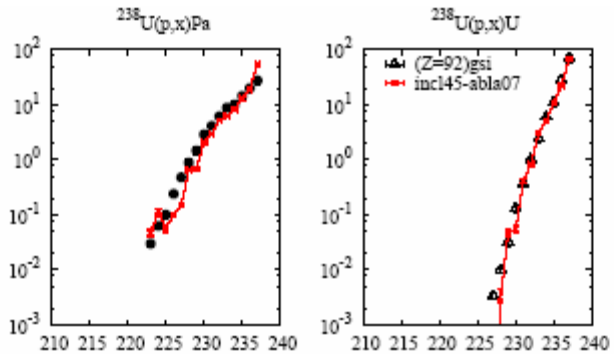


mass number A

p(1000 MeV) + ^{238}U – final residues

INCL45-ABLA07



mass number A

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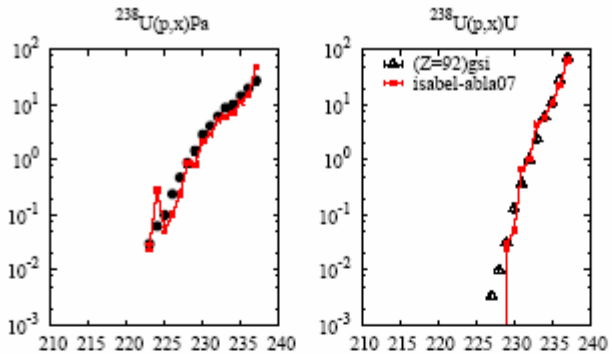


mass number A

Residues

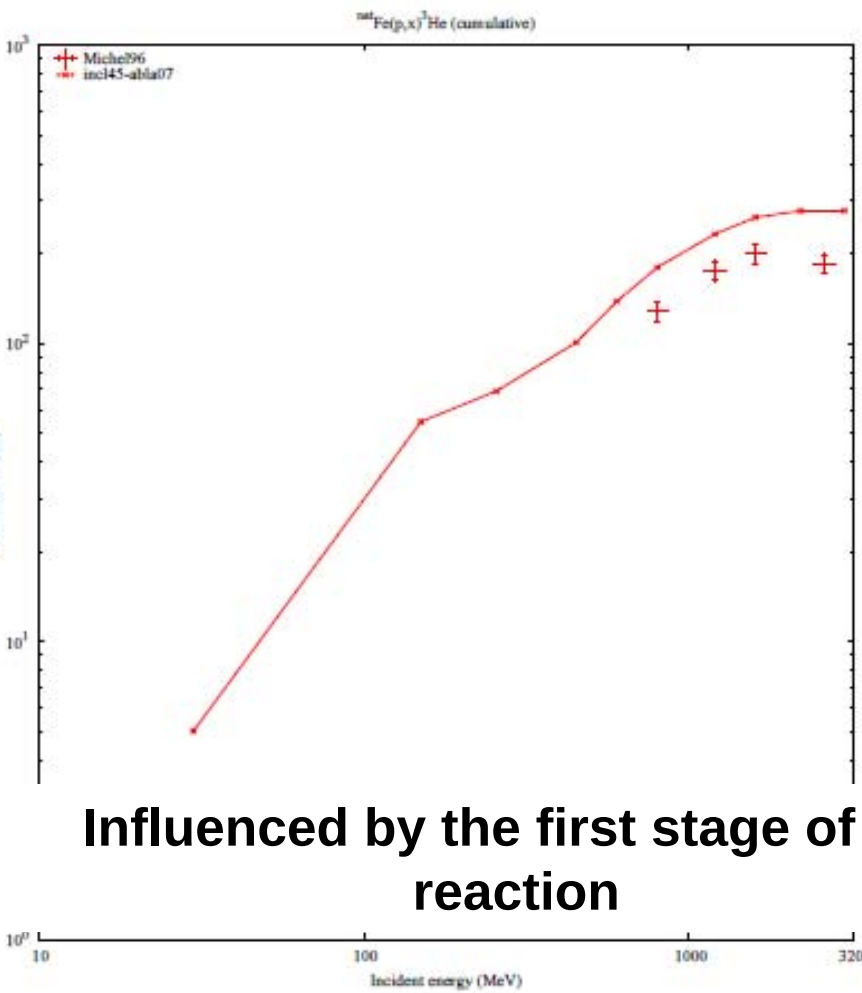
Status: Good
Improvement: Difficult to establish how to disentangle INC and de-excitation...

Concerning ABLA:
1) improve the description of even-odd (→ gamma decay strength)
2) improve structural effects (could be relevant for very light residues)
3) fission

Excitation functions

$^{nat}Fe(p,x)^{3}He$ (cumulative)

INCL45-ABLA07



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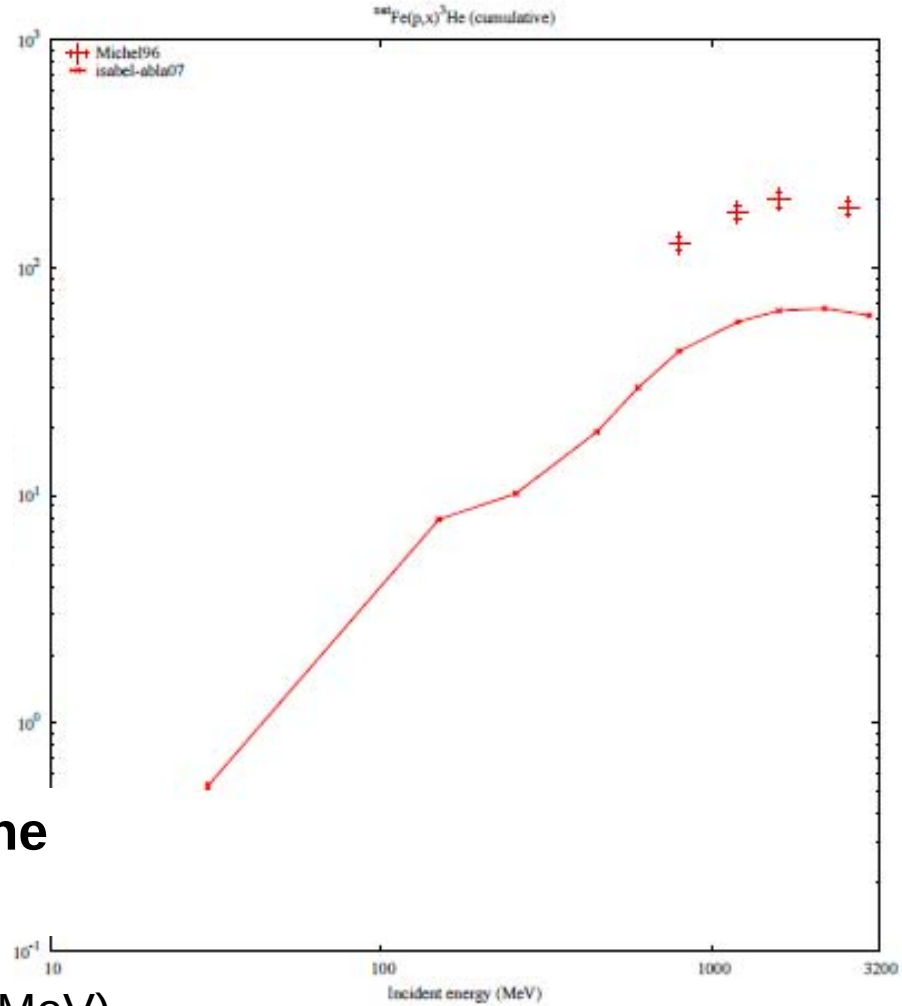


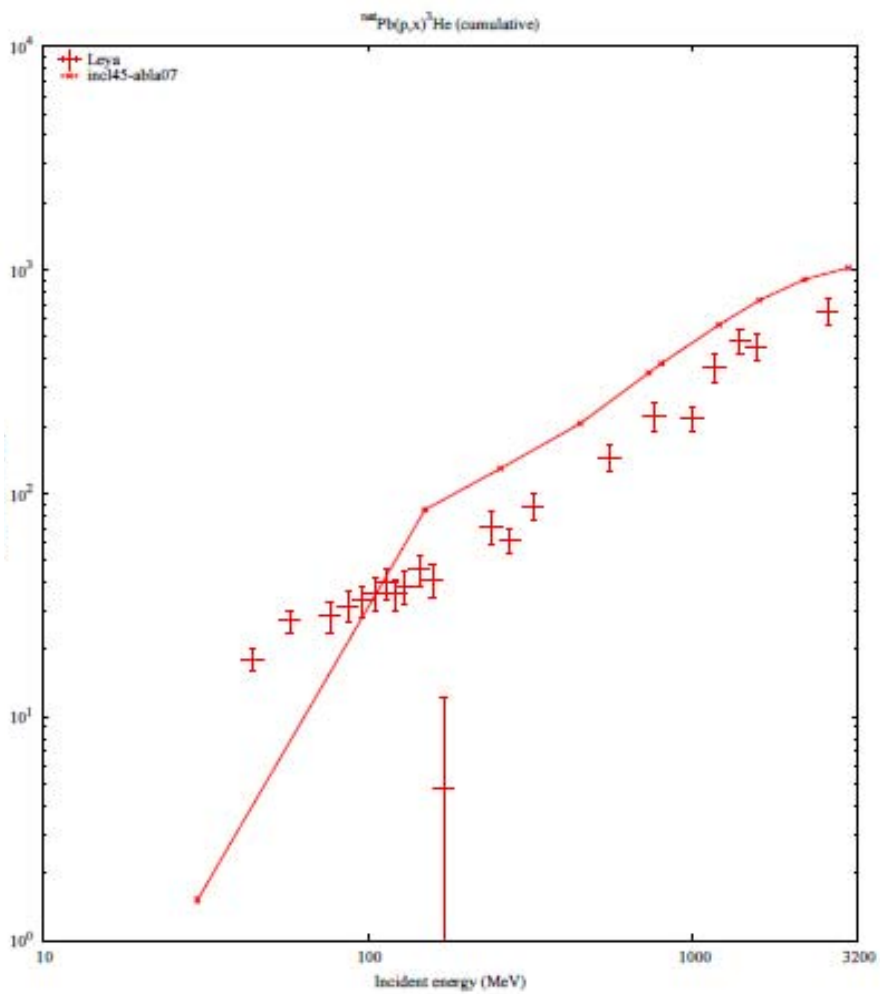
cross section (MeV)

Influenced by the first stage of the reaction

energy (MeV)

$^{nat}Pb(p,x)^{3}He$ (cumulative)

INCL45-ABLA07



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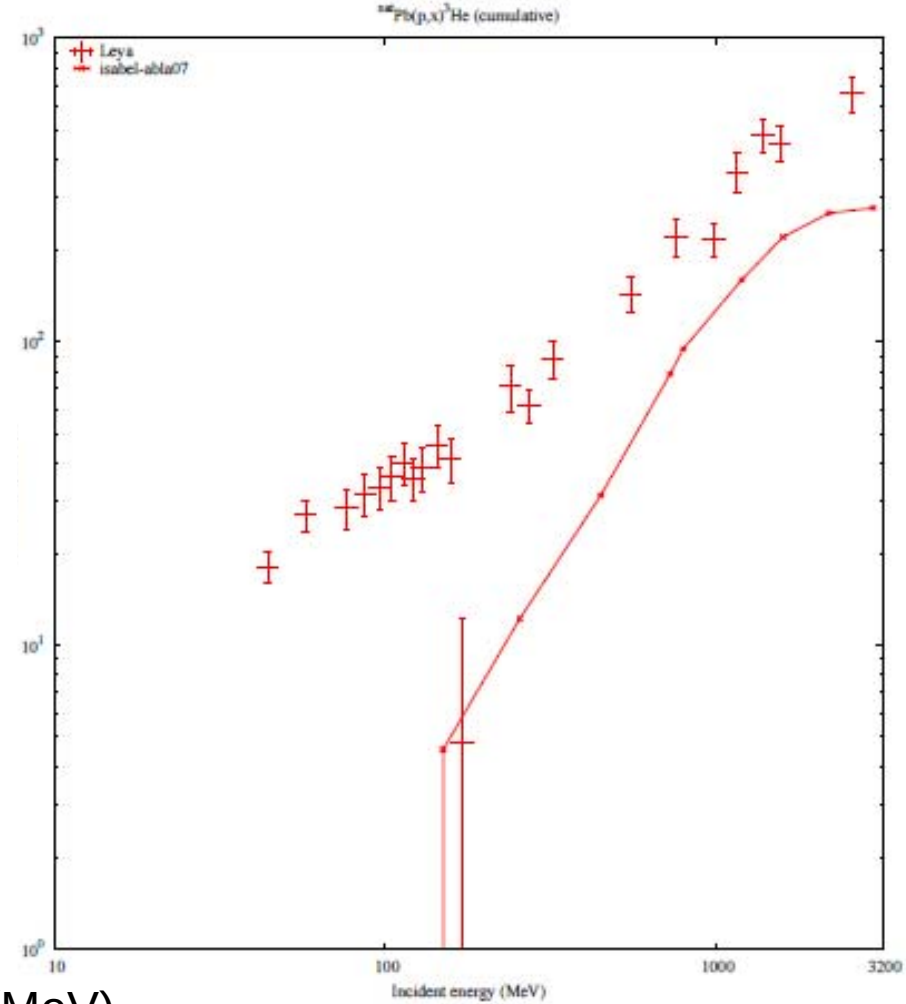

cross section (MeV)

energy (MeV)

General conclusions

We (all here in this workshop) did a good job!

General tendencies and behaviors are well reproduced
→ we have understood the main physics behind!

Left to do: refinements...

Concerning ABLA07
Overall behavior satisfactorily, but there is still work to do

- neutron multiplicity distributions (INC or de-excitation?)

- LCP spectra: barriers, tunneling, break-up?

- Residues: even-odd effect, structural effects, fission

Strength of ABLA07: high physics content
relatively low computing time (we want to keep this feature)

Thanks EU contribution (EUROTRANS)