INCL++ development for Geant4 10.0

Davide Mancusi

Geant4 collaboration meeting
Seville, 24th September 2013

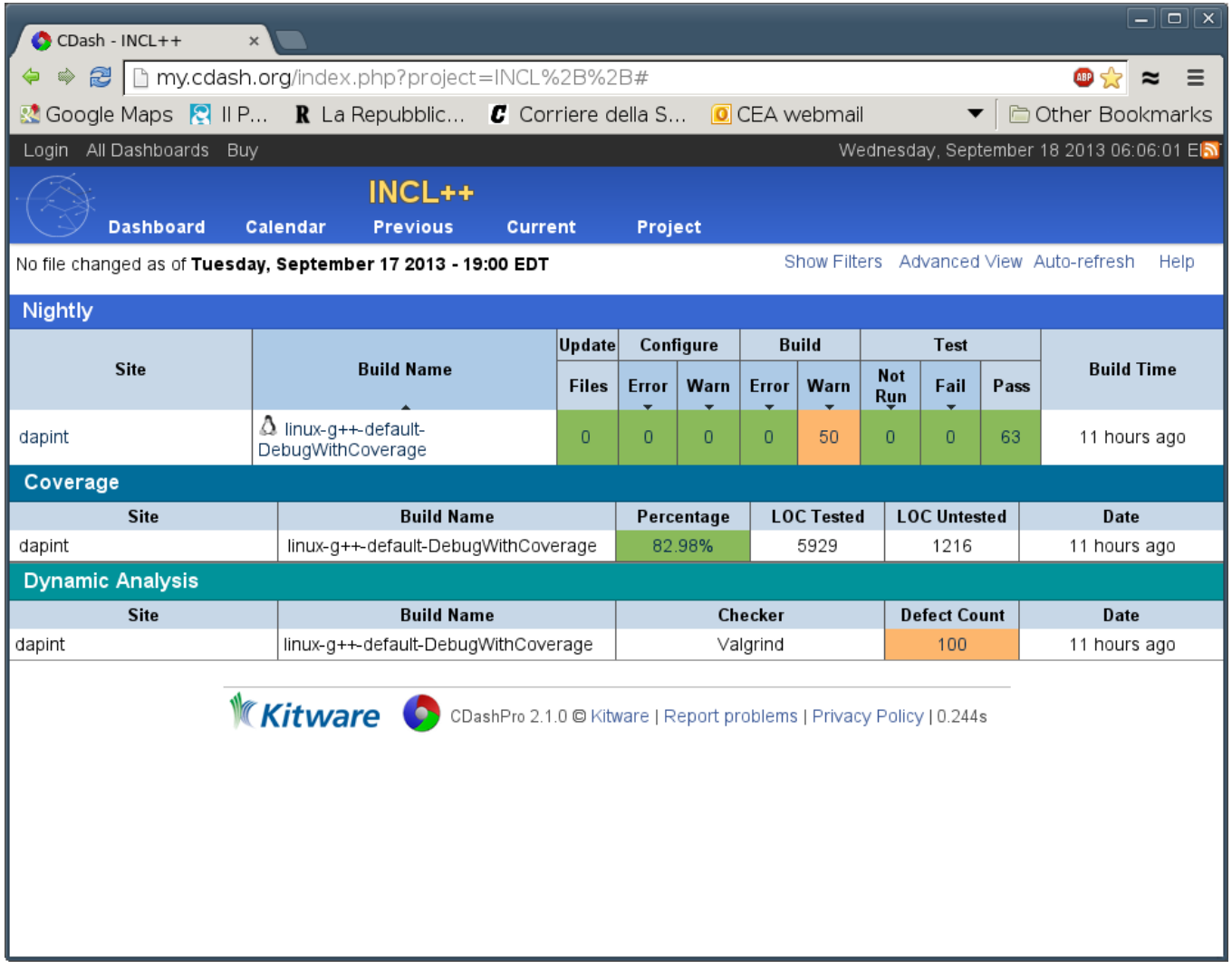
technical developments

physics developments

- nucleus-nucleus extension
- validation
- few-nucleon removal
- multipion extension

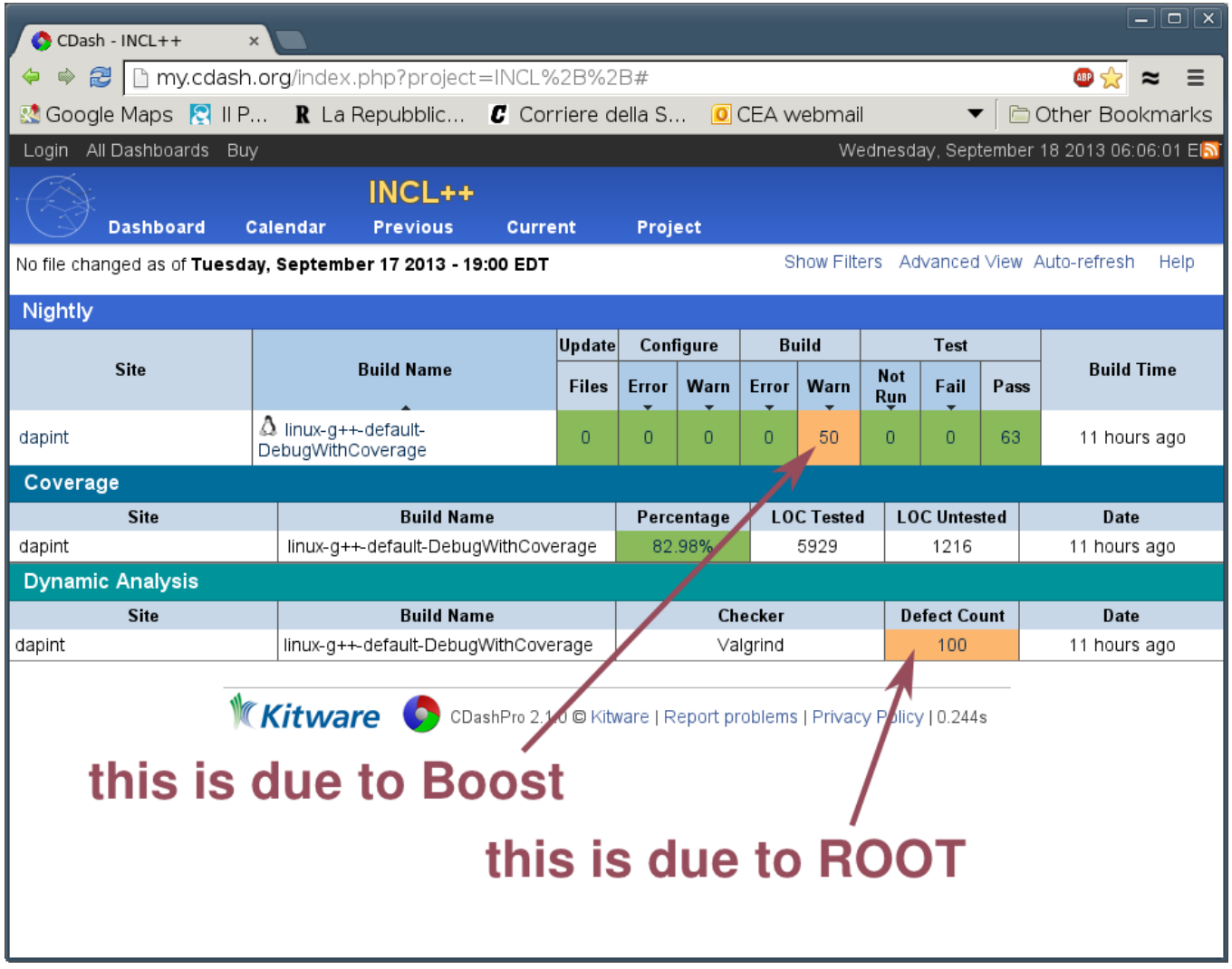
conclusions

CTest-CDash-based unit testing



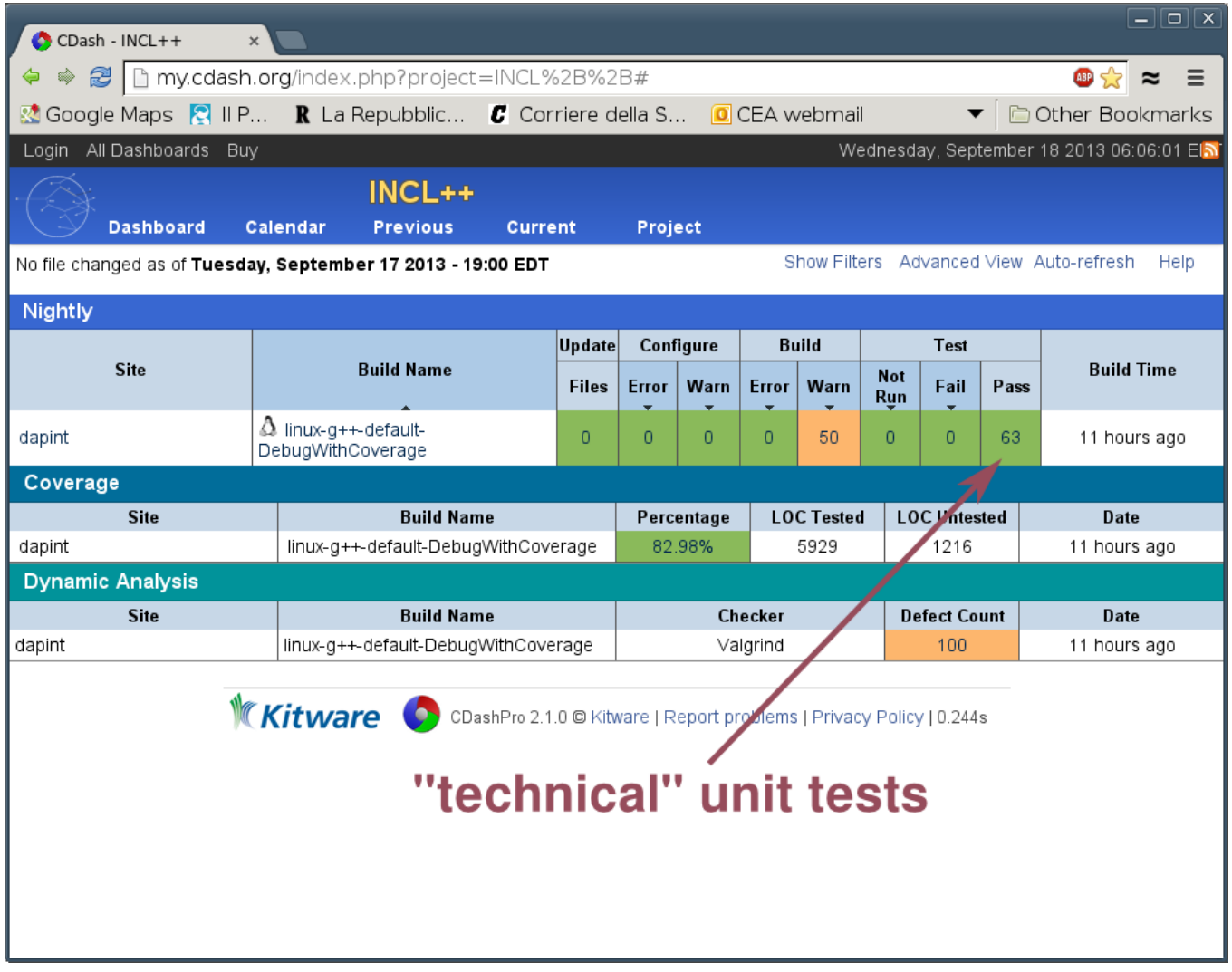
http://my.cdash.org/index.php?project=INCL%2B%2B

CTest-CDash-based unit testing



INCL++ is free from memory leaks

CTest-CDash-based unit testing



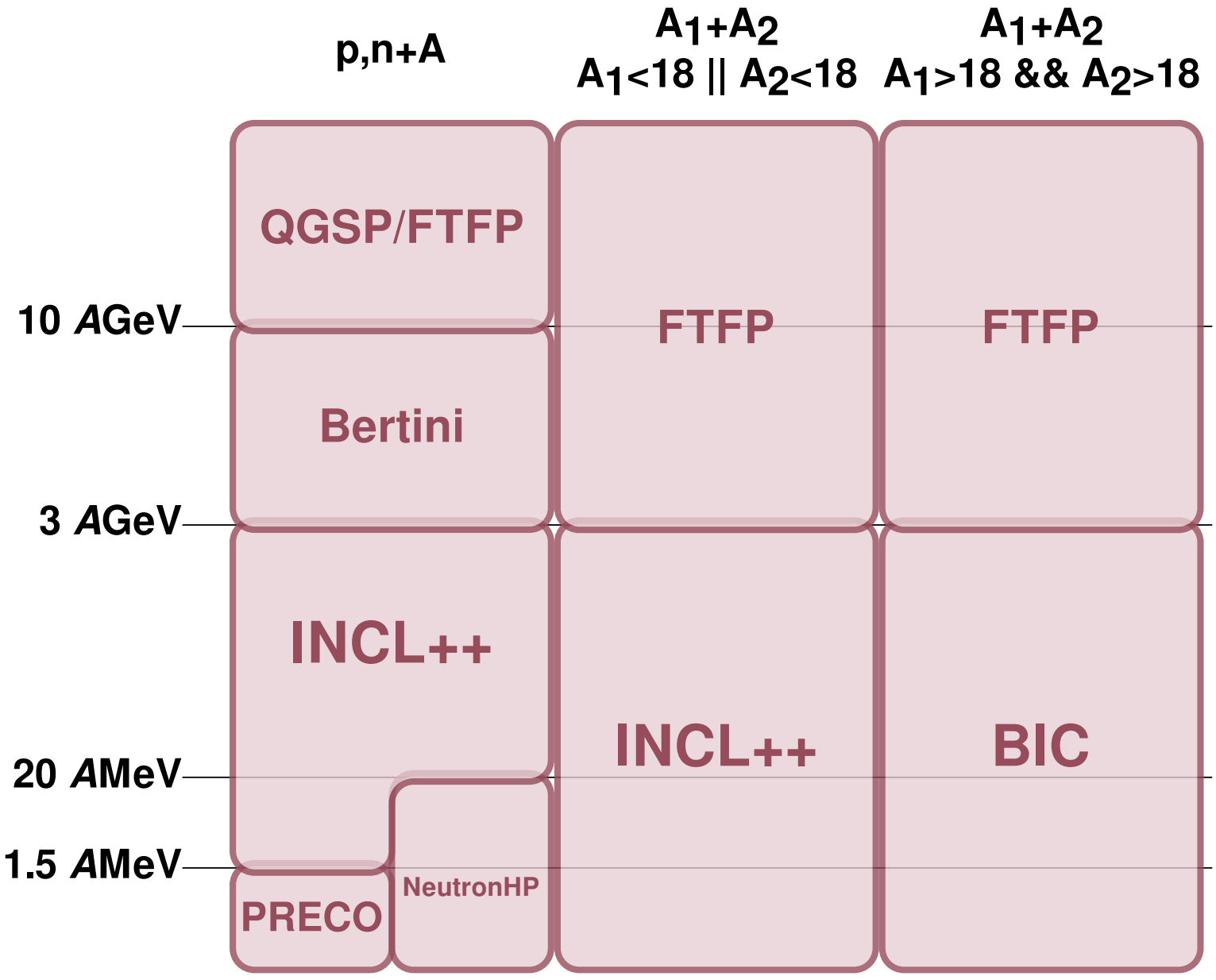
physics tests to be included soon

new INCL++-based physics lists

- QGSP_INCLXX
- QGSP_INCLXX_HP
- FTFP_INCLXX
- FTFP_INCLXX_HP

- involve them in testing/profiling?
  - please?!

hadronic model map



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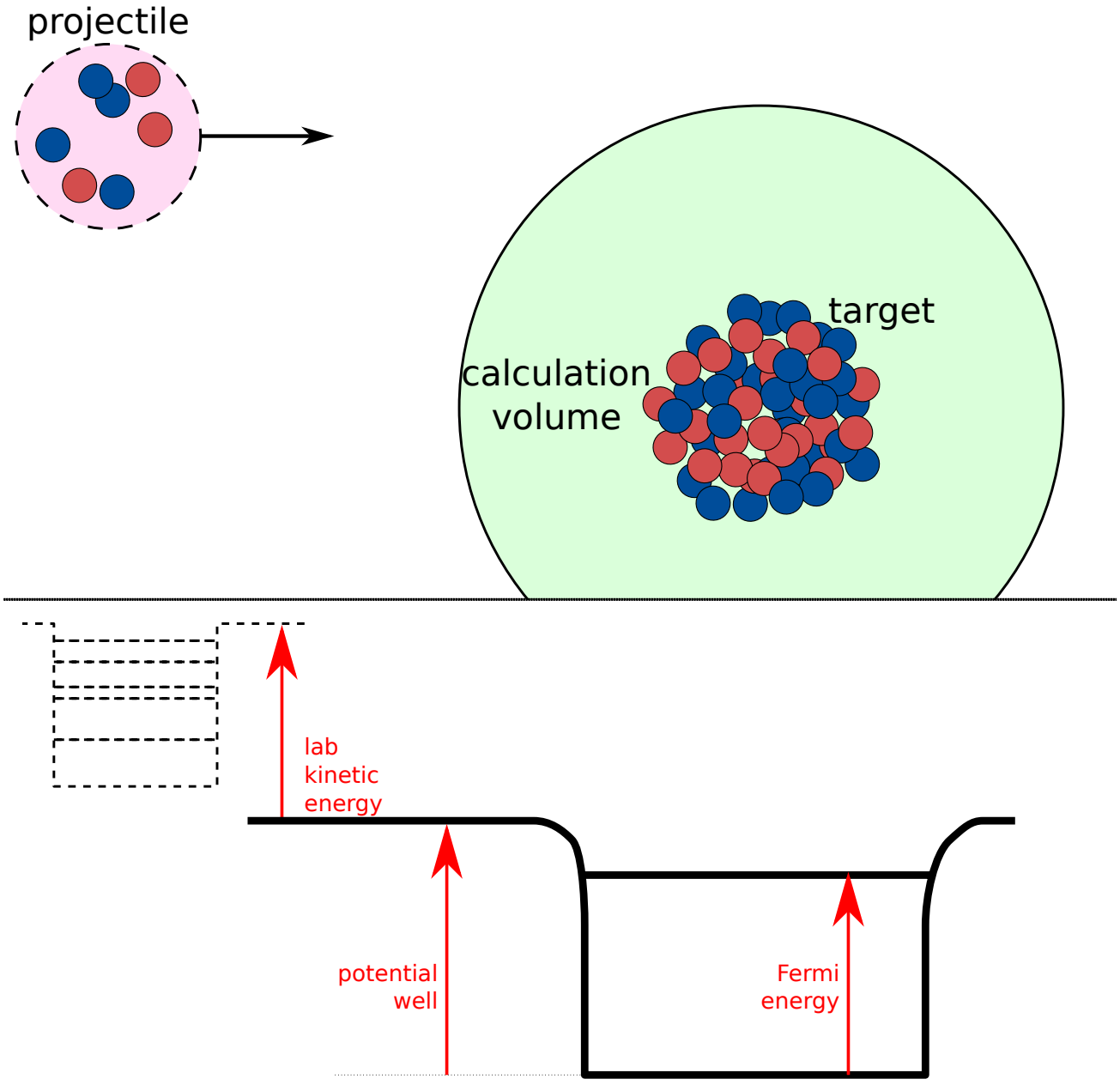
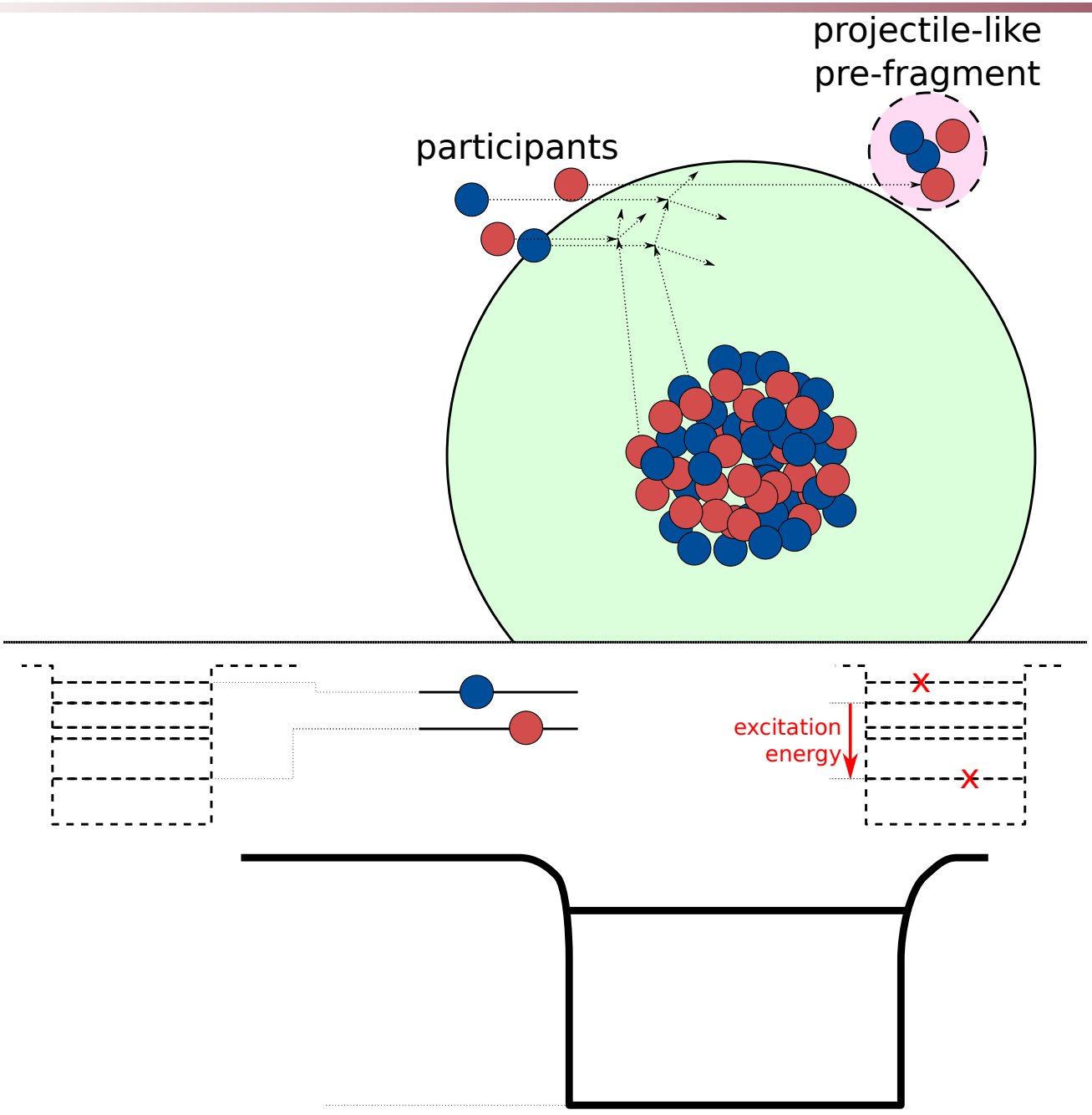
nucleus-nucleus extension: scheme



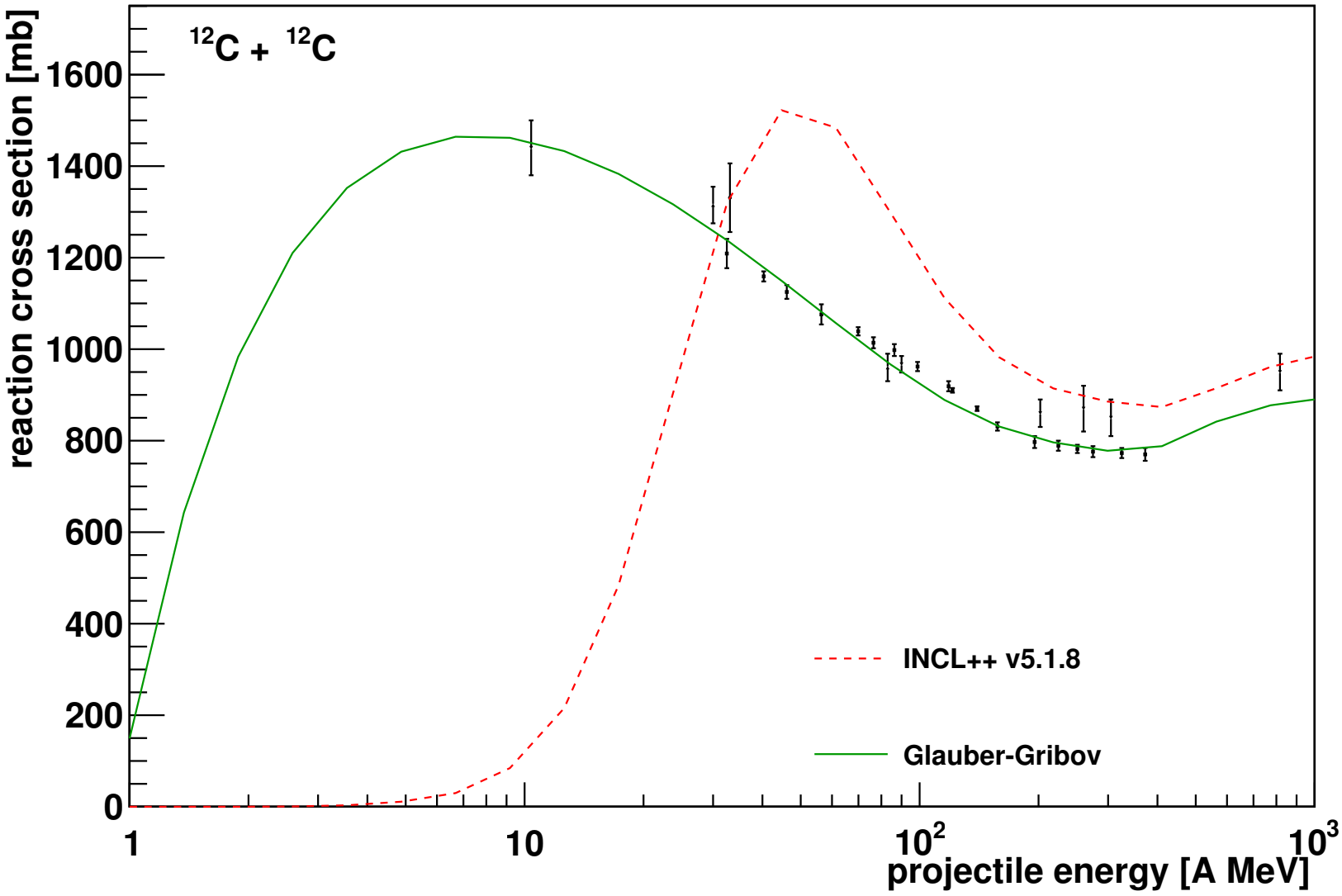
nucleus-nucleus extension: scheme



nucleus-nucleus extension: scheme

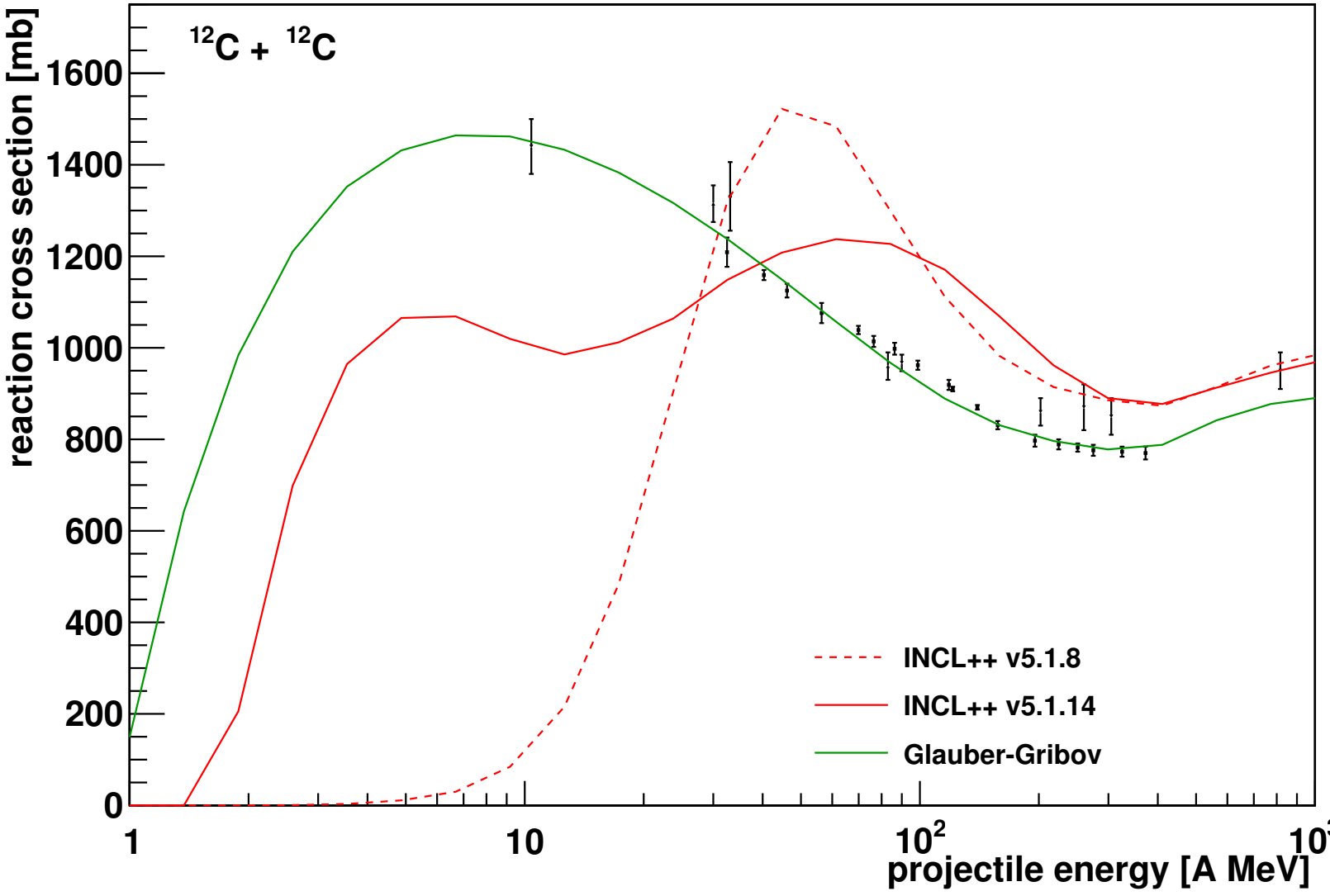
- fusion model at low energy
  - nucleons trying to enter below Fermi energy
- smooth transition between fusion and cascade
- but. . .

problem in low-energy fusion

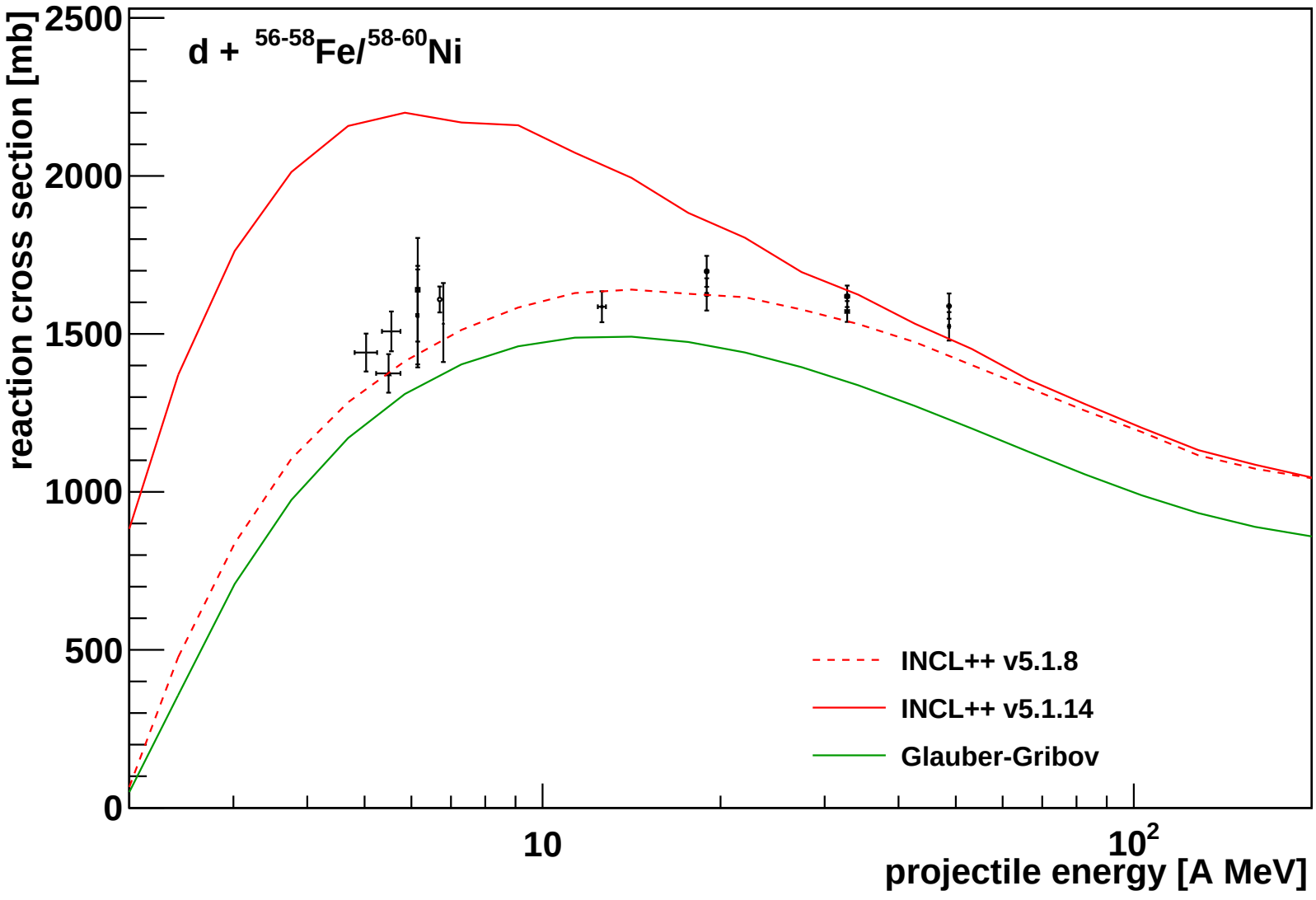


unsatisfactory fusion parameters (tuned for light charged particles)

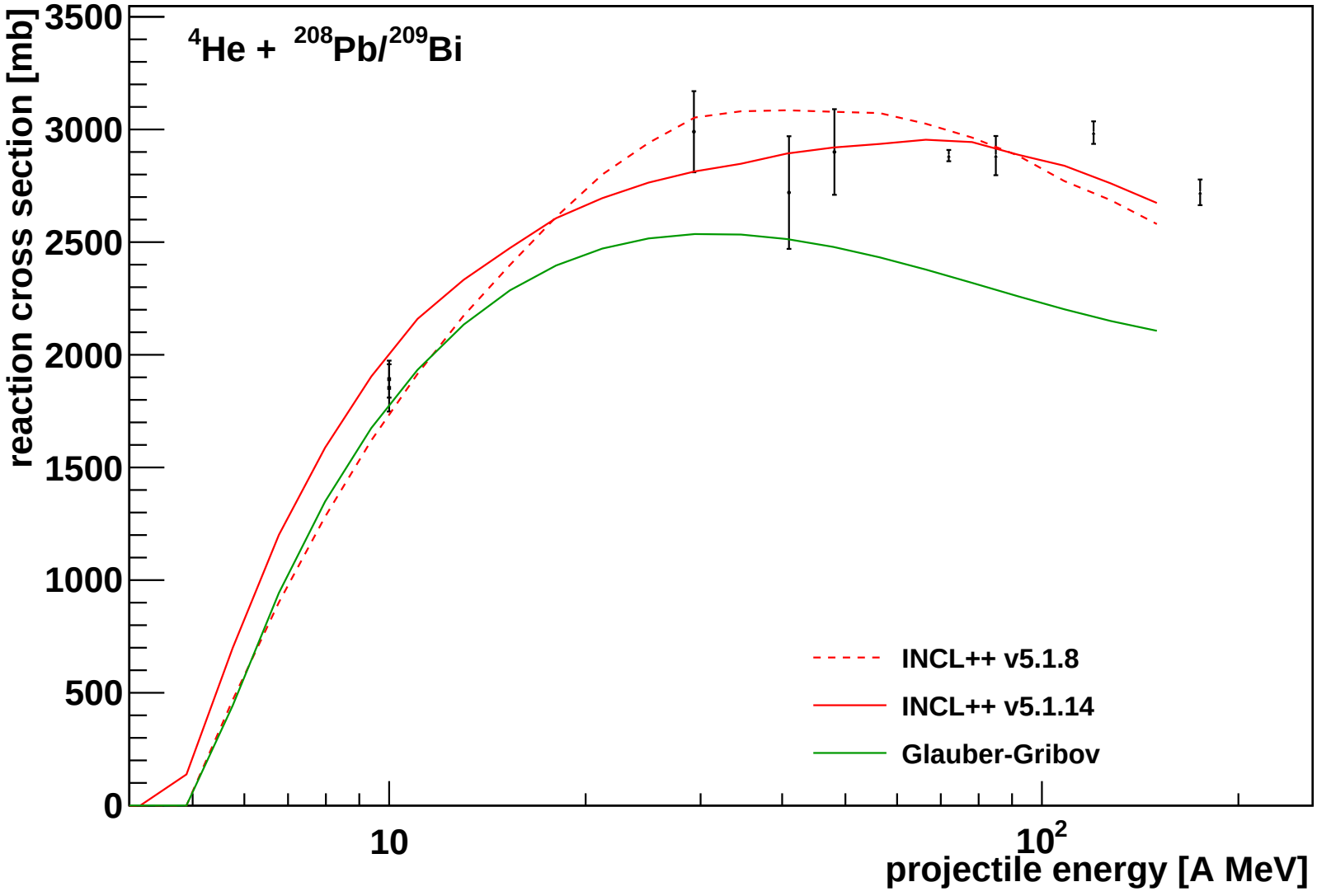
retuned model



retuned model

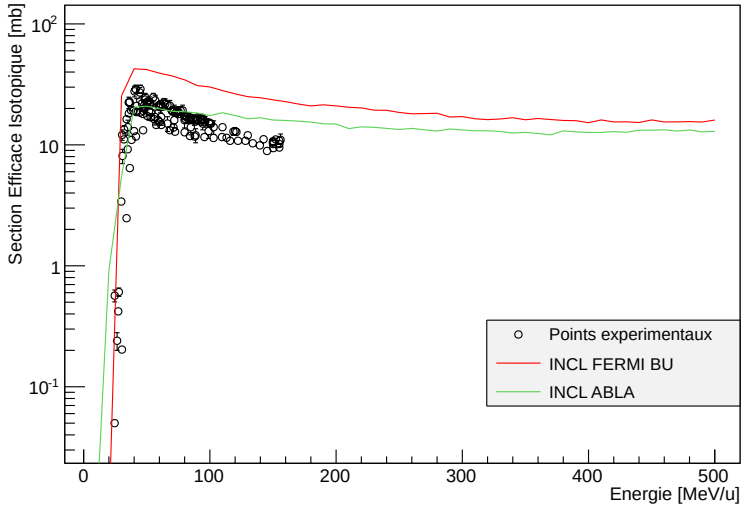


retuned model

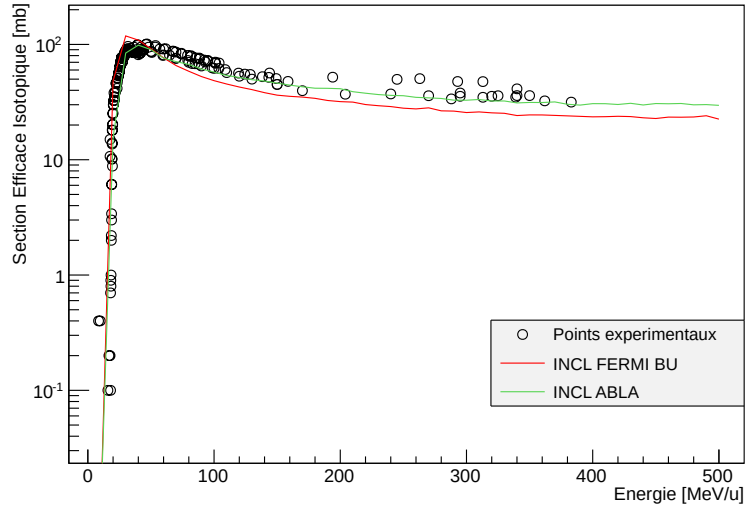


light-ion reactions (hadrontherapy)

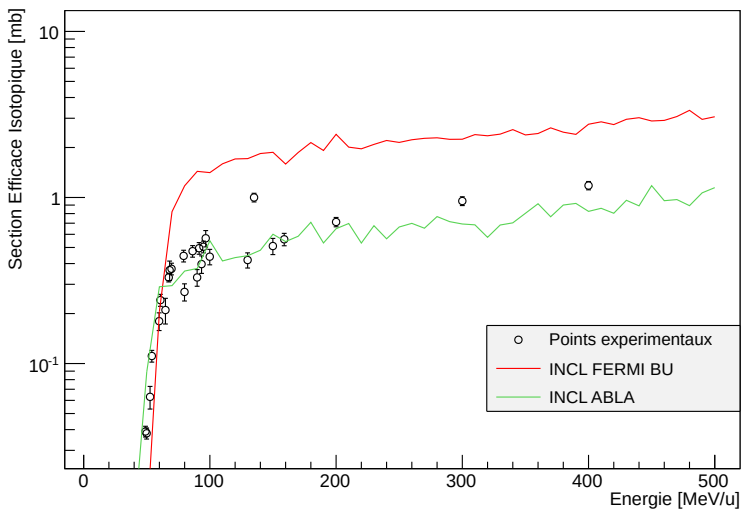
C12(p,X)Be7



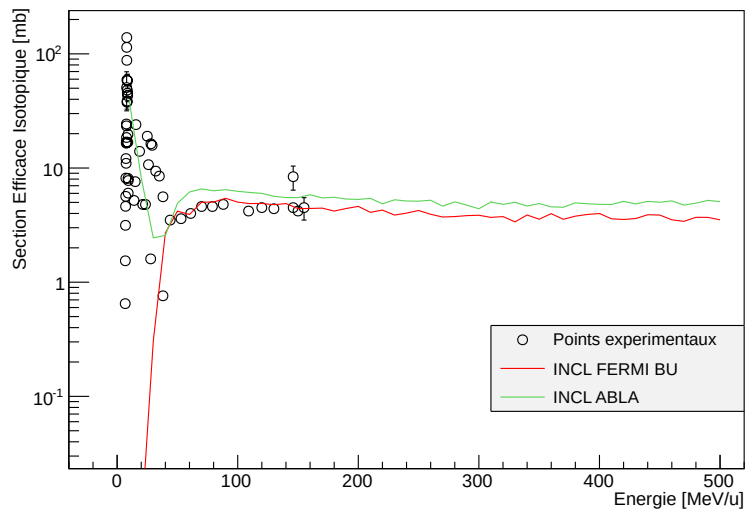
C12(p,X)C11



O16(p,X)Be10

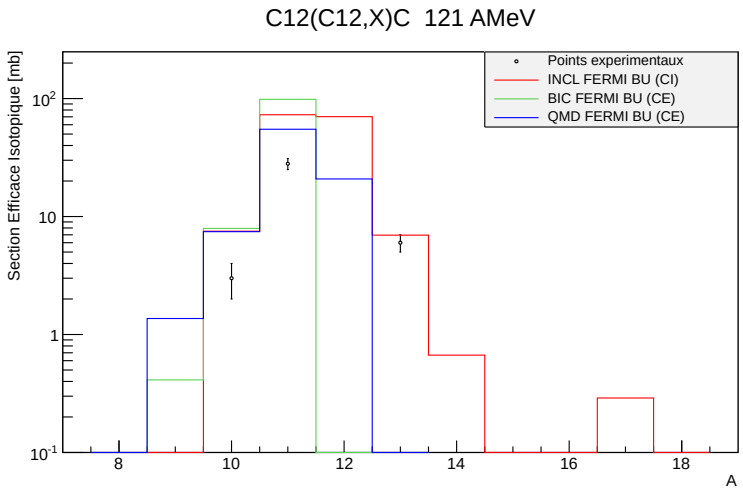


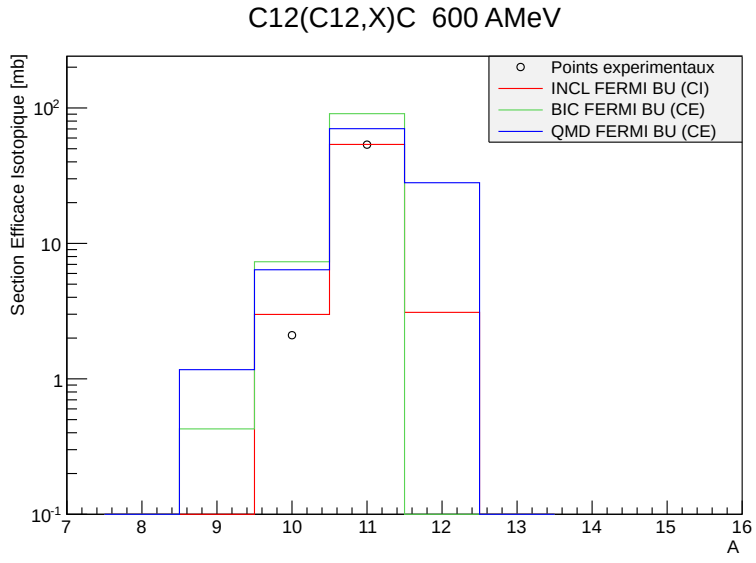
O16(p,X)N13

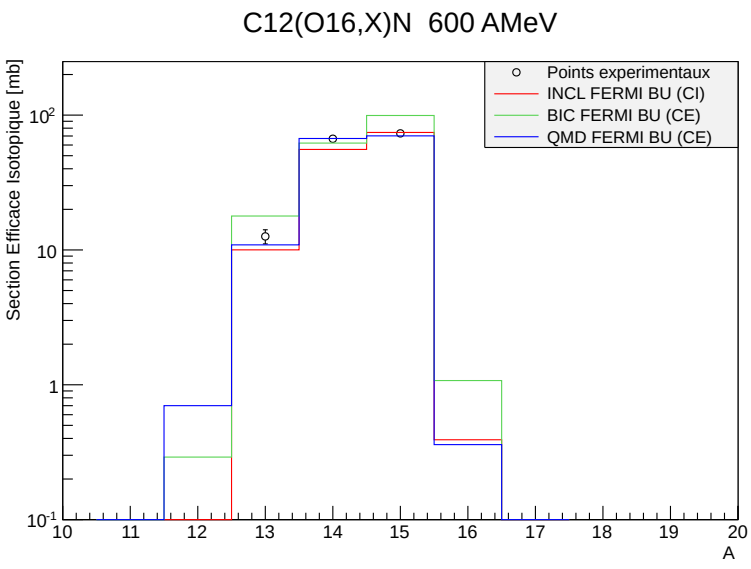


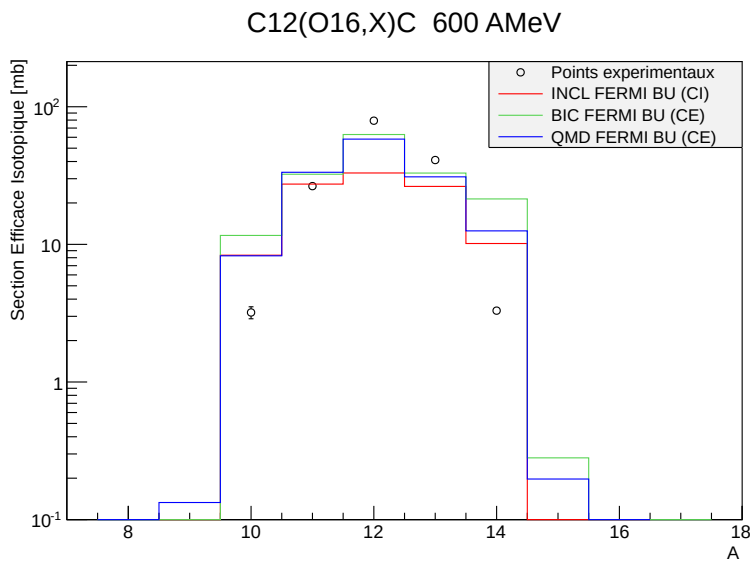
internship work by M. Delerin

light-ion reactions (hadrontherapy)









internship work by M. Delerin

light-ion reactions (hadrontherapy)

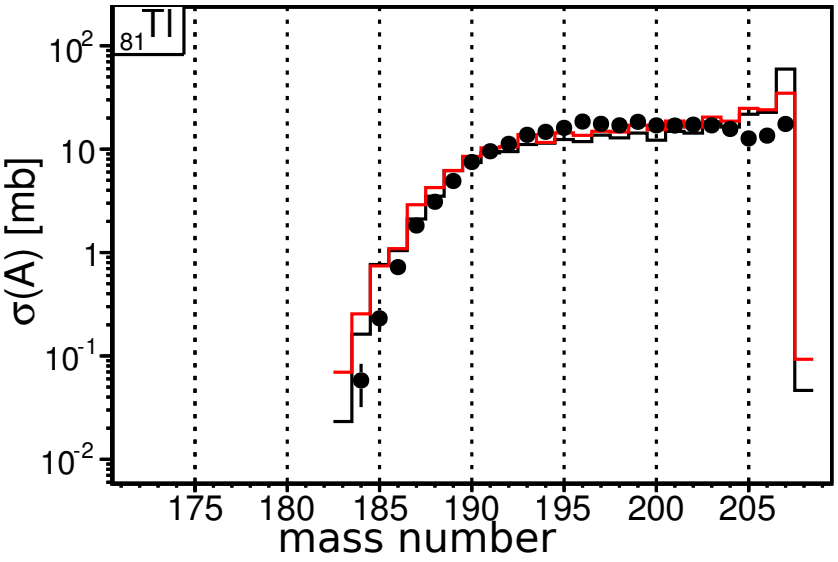
- sensitivity to de-excitation
  - ABLA07 better for $p + A$
- general agreement: QMD $>$ INCL++ $>$ BIC
  - CPU time: INCL++ $\simeq$ BIC $\simeq$ 0.01 $\times$ QMD!

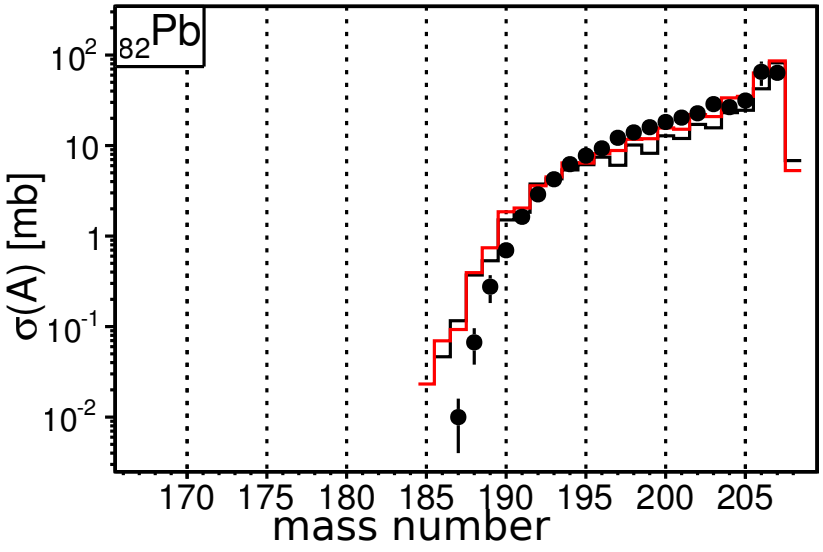
internship work by M. Delerin

partial conclusions

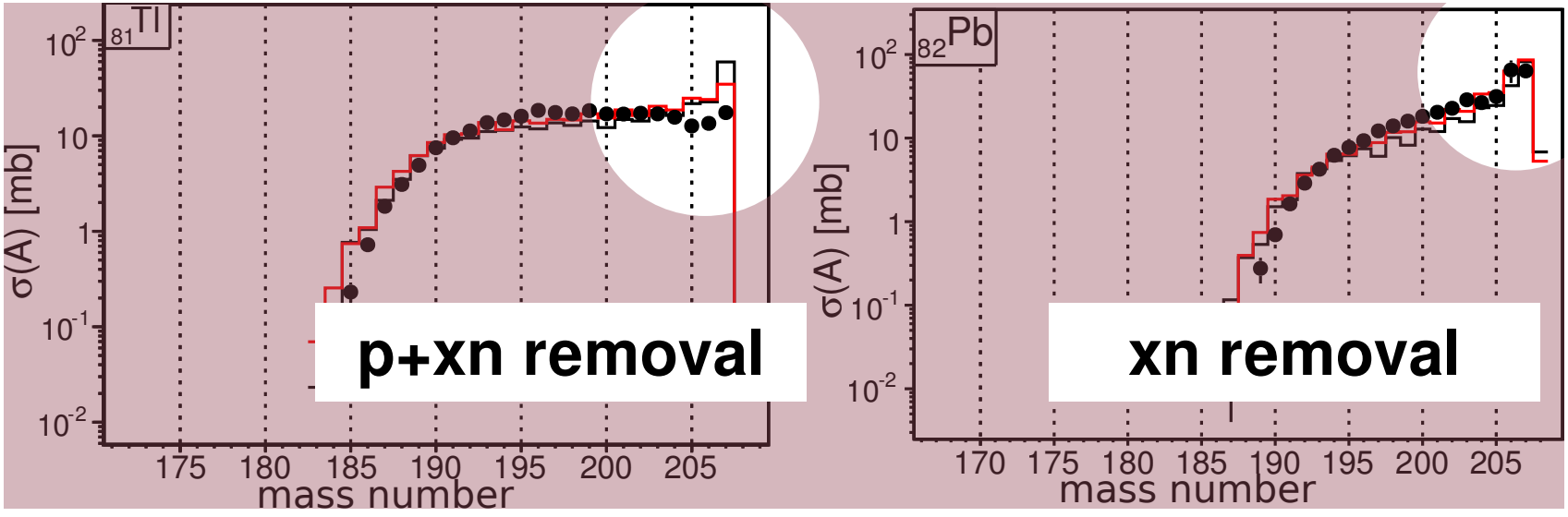
- de-excitation is important
- INCL++ good compromise between accuracy and CPU time

1-GeV p+^{208}Pb


81Tl
σ(A) [mb]
mass number
175 180 185 190 195 200 205

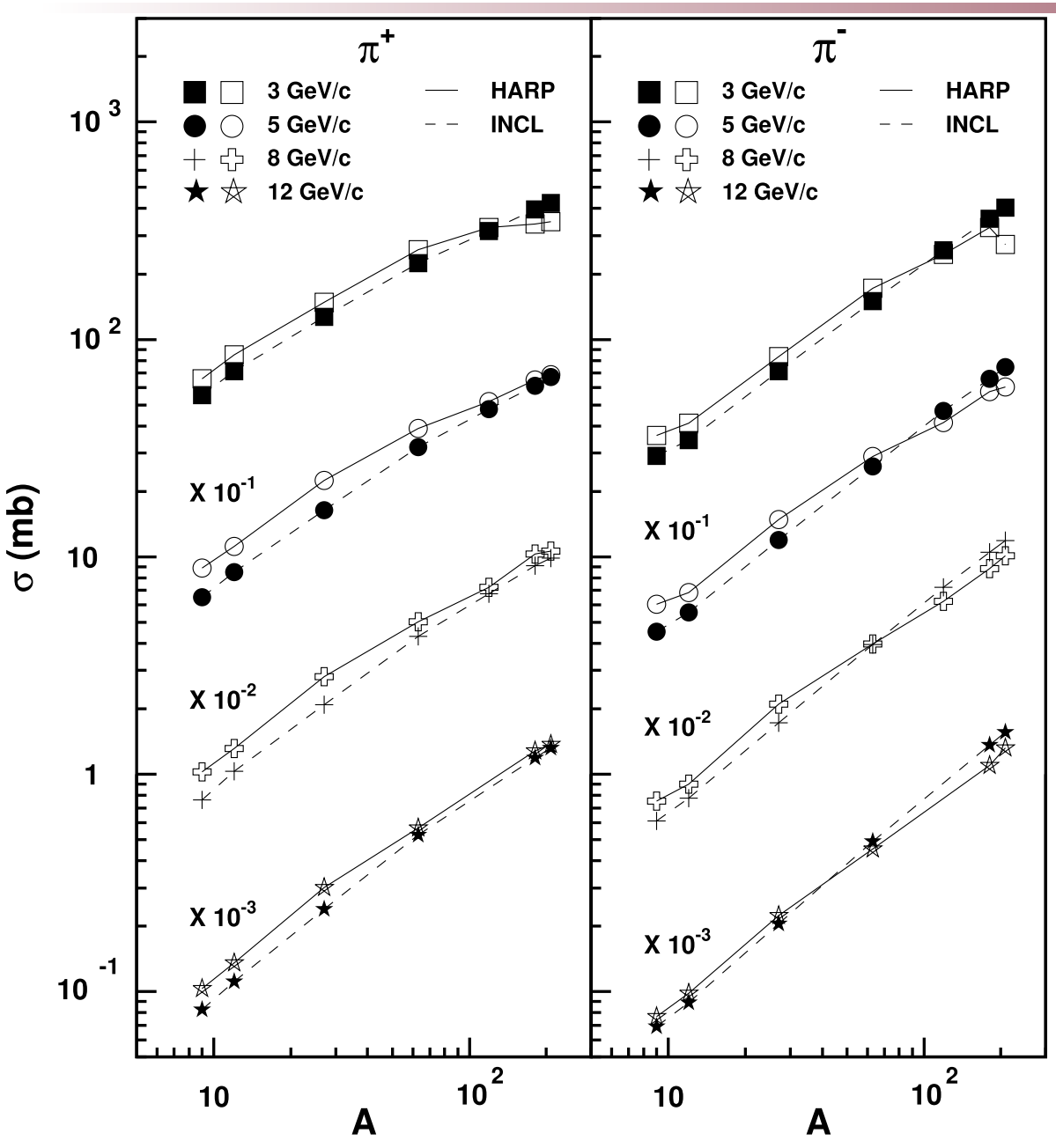

82Pb
σ(A) [mb]
mass number
170 175 180 185 190 195 200 205

1-GeV p+^{208}Pb



- common defect of all INC/QMD models
- connected with the energy content of the nuclear surface
- improvement under way

extension to 10–15 GeV



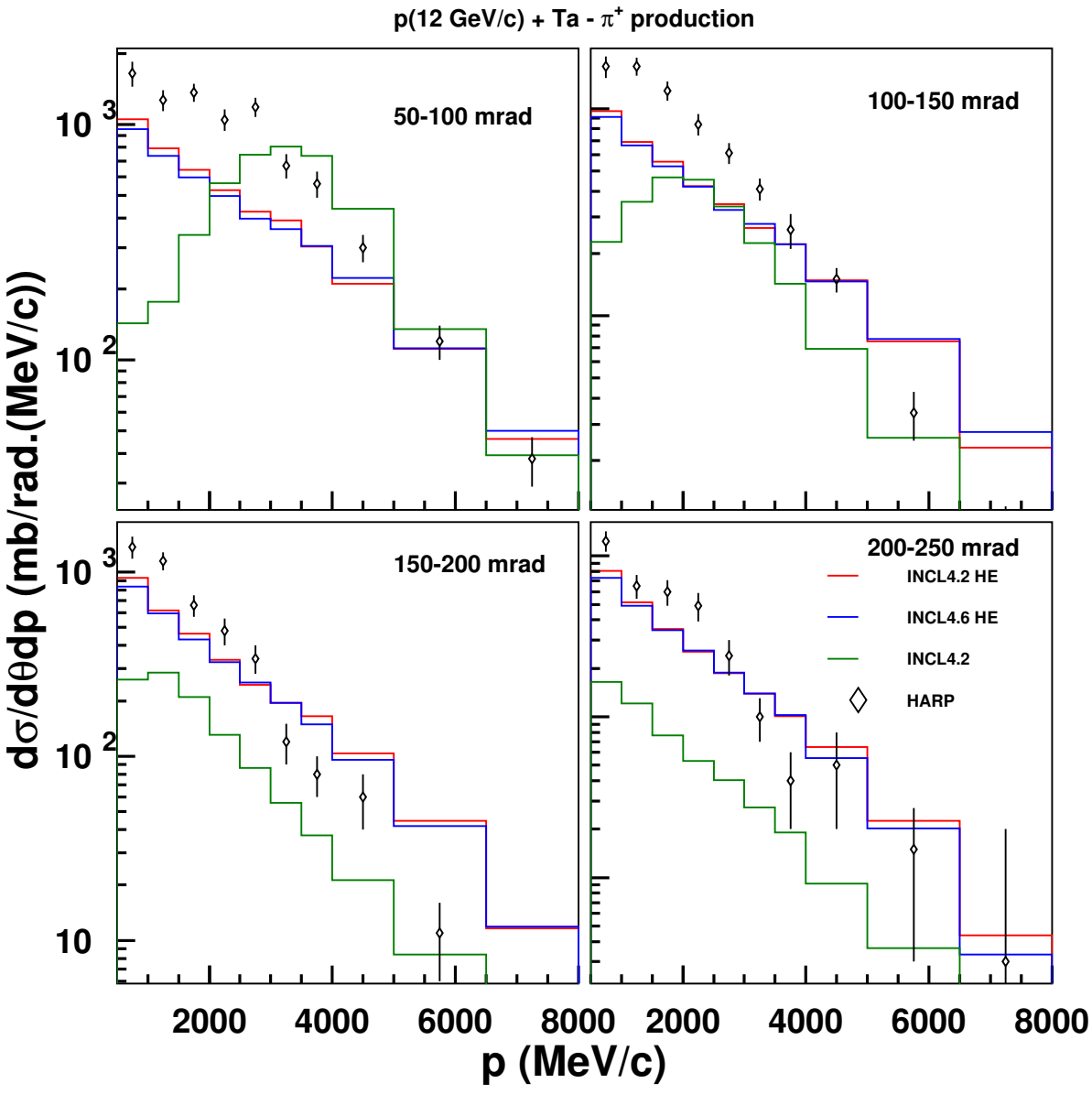
HARP collaboration

Phys. Rev. C77 (2008) 055207

Pedoux and Cugnon

Nucl. Phys. A866 (2011) 16

extension to 10–15 GeV



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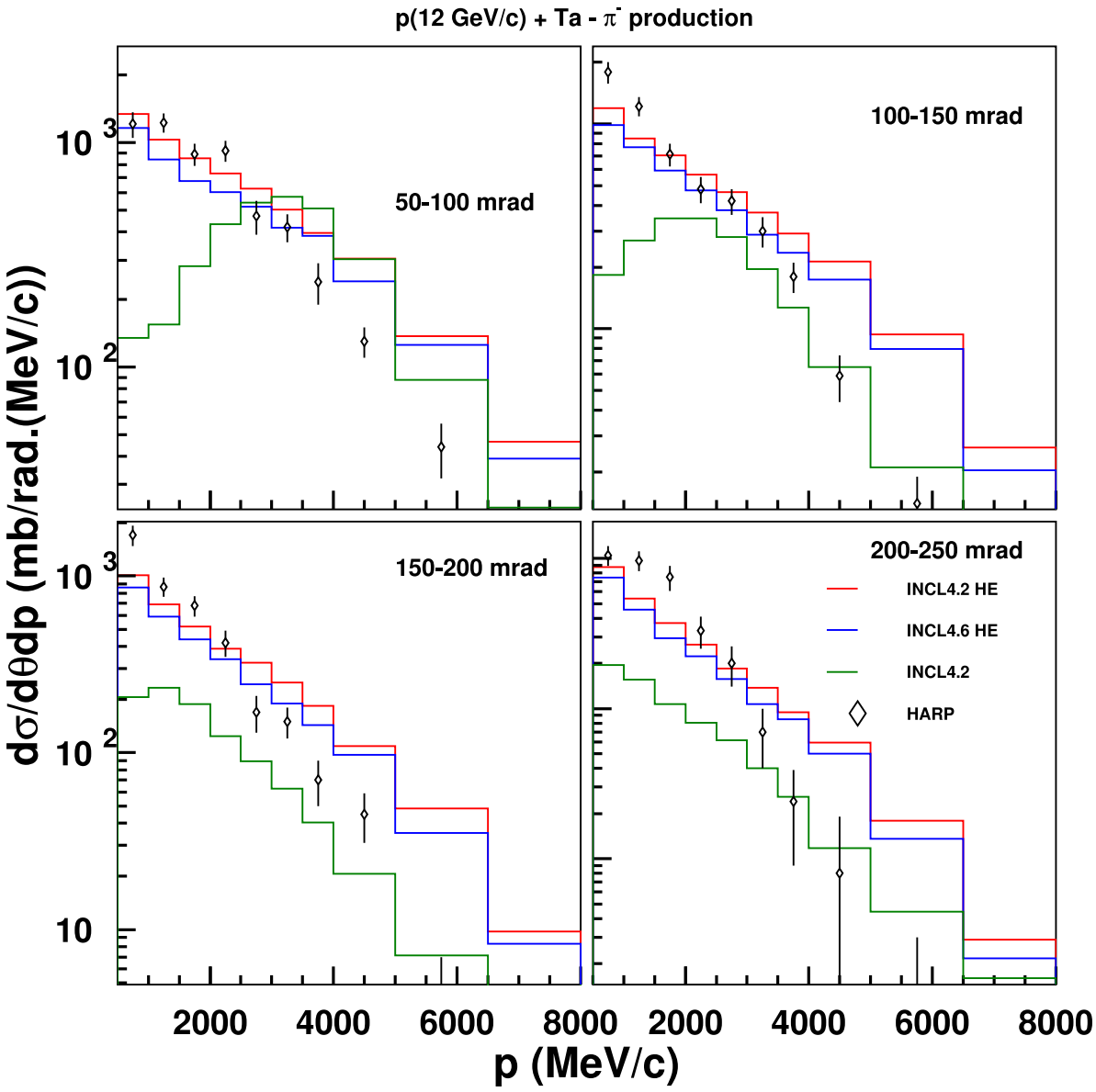
extension to 10–15 GeV



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conclusions and future plans

in `INCL++`:

- low-energy fusion retuned
- extensive validation on nucleus-nucleus data
- a bunch of fixes

in `INCL4.6` (soon in `INCL++`):

- improved cross sections for few-nucleon removal
- extension up to 10–15 GeV

future plans:

1. port high-energy extension to `INCL++`
2. strangeness production
3. automate physics testing
4. bring `ABLA++` back to life

. . . hopefully **3.** and **4.** by the end of 2013

the INCL++ team

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- Sylvie Leray
- Davide Mancusi

University of Liège, Belgium

- Joseph Cugnon