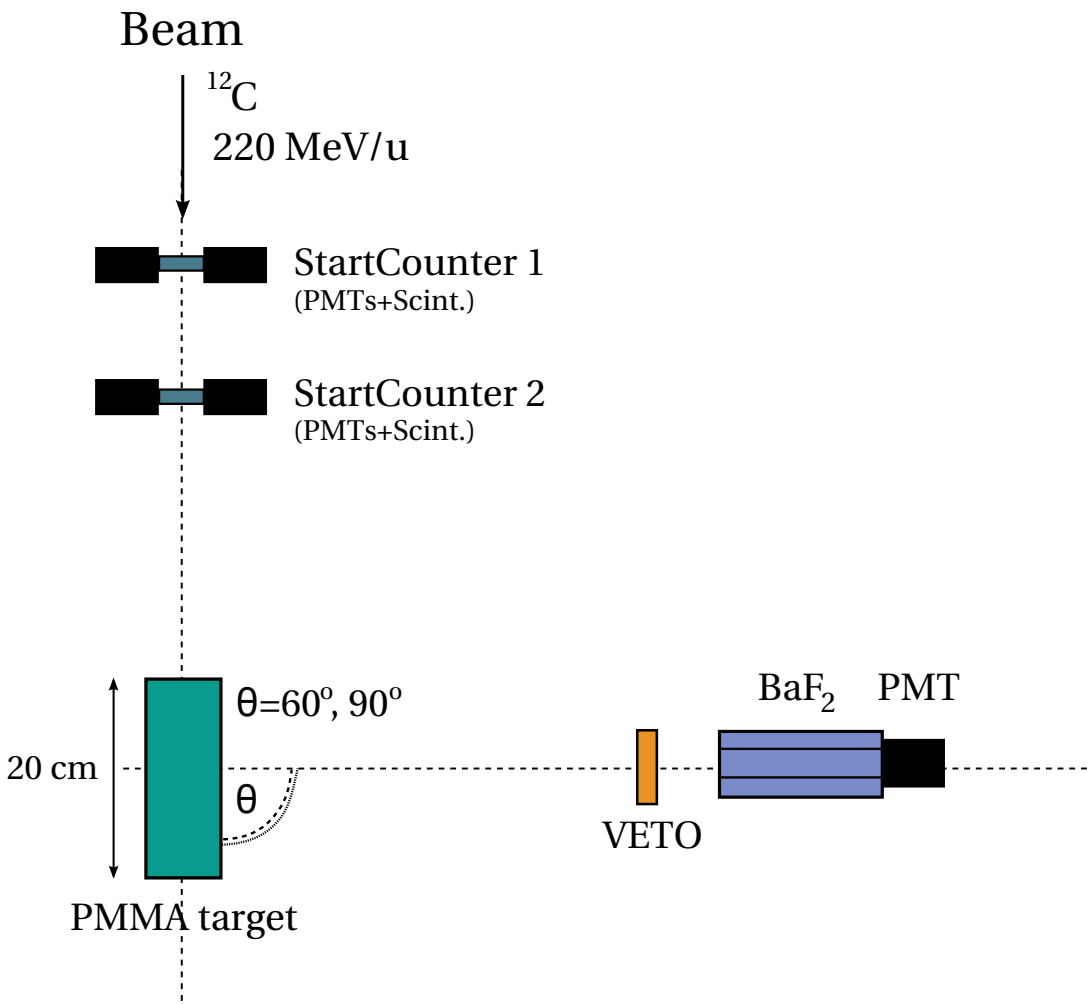
Prompt-γ analysis with the BaF_2

Marie Vanstalle

May 2015

The experiment

Scheme of the experimental setup

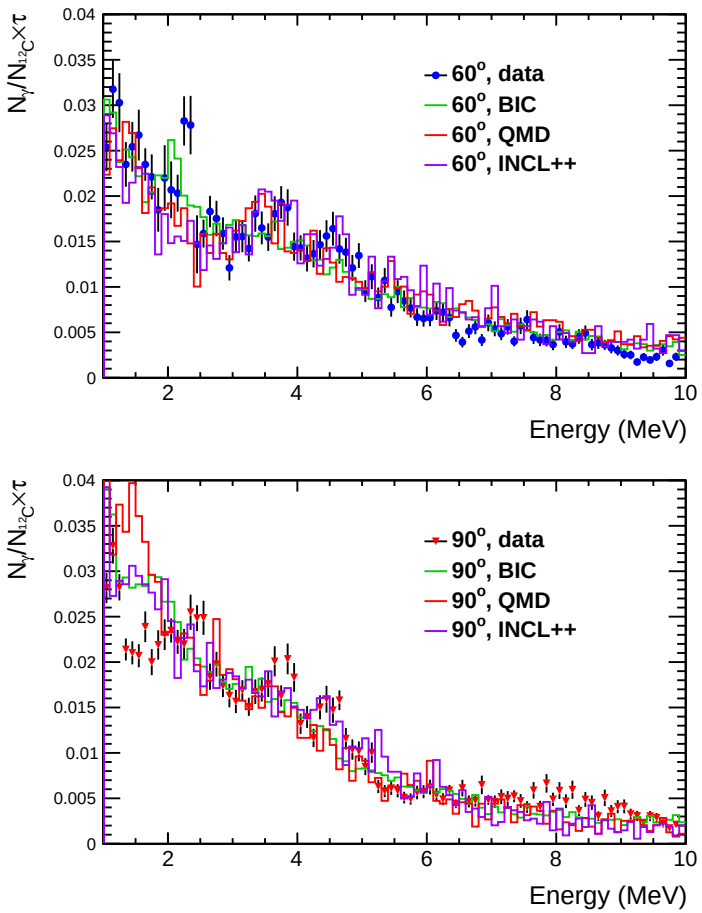


Dead time values

File	τ	ε_τ	N_{12C}
Gsi90deg-0BP-1MHz-2	0.01948	0.00478	5.97×10^{7}
Gsi90deg-0BP-1MHz-3	0.083089	0.000761745	5.52×10^{8}
Gsi90deg-0BP-1MHz-4	0.0897365	0.000551779	1.34×10^{9}
Gsi90deg-0BP-1MHz-5	0.0867246	0.00176858	1.43×10^{8}
Gsi+30deg-0BP-1MHz-Coll	0.20200	0.051	1.32×10^{9}
Gsi+30deg-0BP-1MHz-Coll-1	0.22080	0.059	1.02×10^{9}

Geant4 simulations

Comparison with "raw" data



- BIC is the worst
- INCL has the better agreement with the data

Angle	χ^2(BIC)	χ^2(QMD)	χ^2(INCL)
60°	7.5	3.8	1.6
90°	11.1	6.6	2.9

Table : Reduced χ^2 between experimental and simulated photon yield at 60° and 90°. The values are calculated for energy bins above 2 MeV.

"Raw" energy spectra =normalized by N_{12C} and τ...

Prompt-γ spectra

Correction factors

All correction factors calculated with Geant4

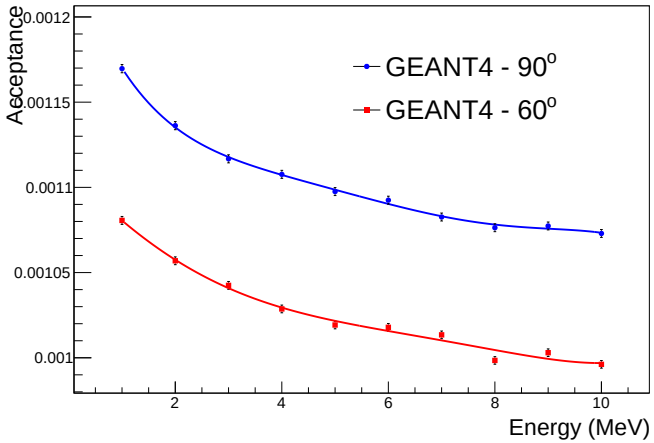
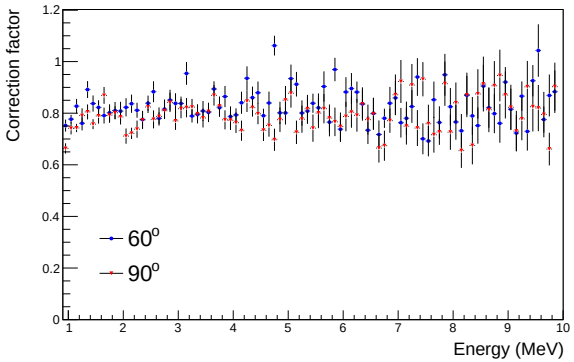


Figure : Barium fluoride geometrical efficiency as a function of the γ energy.



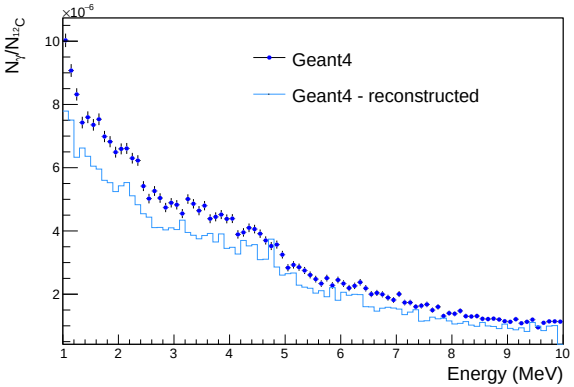
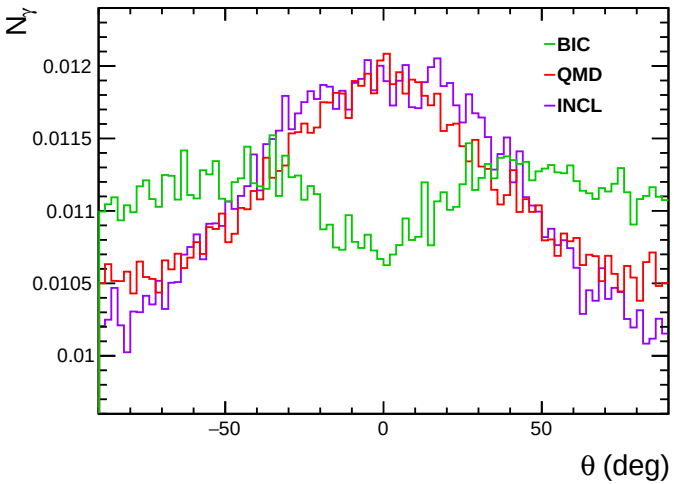


Figure : Correction factor of reconstruction method + comparison between simulated and reconstructed spectra.

Prompt-γ spectra

Correction factors

Problem with previous calculation of the acceptance : assumption was made that γ are isotropically emitted $\rightarrow$ WRONG !



New acceptance calculation with anisotropy implementation :

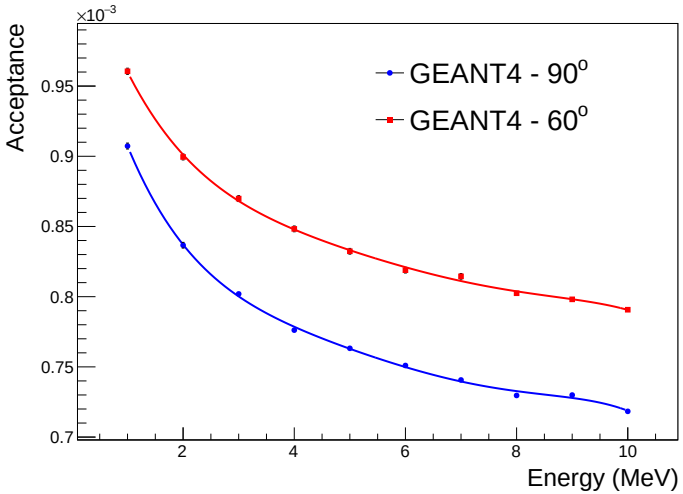


Figure : Angular distribution of prompt-γ, simulated by Geant4 (BIC, QMD and INCL).

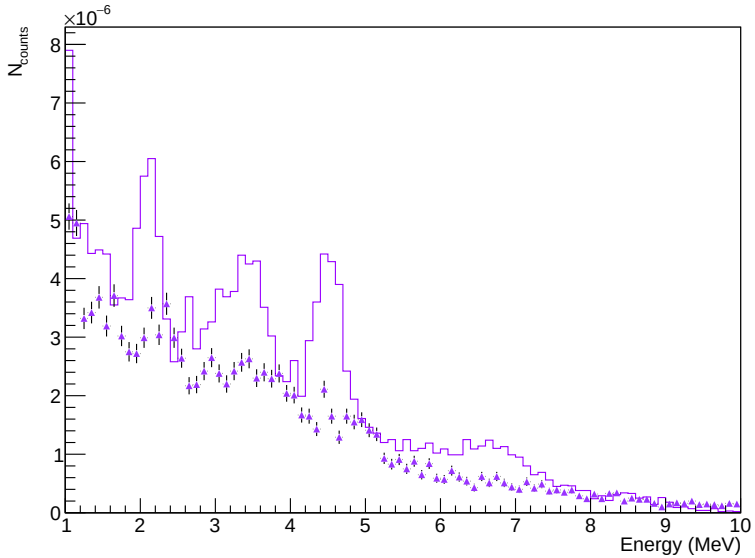
Barium fluoride efficiency

Efficiency estimated by Geant4 simulation $\rightarrow$ systematics error to be accounted !

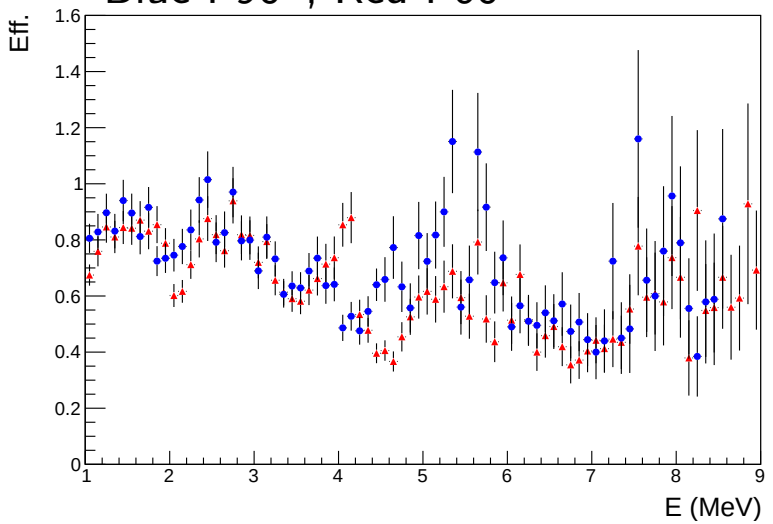
$60^\circ : \sigma_{\mathrm{sysG4}} = 0.09 \times 10^{-2}$

$90^\circ : \sigma_{\mathrm{sysG4}} = 0.20 \times 10^{-2}$

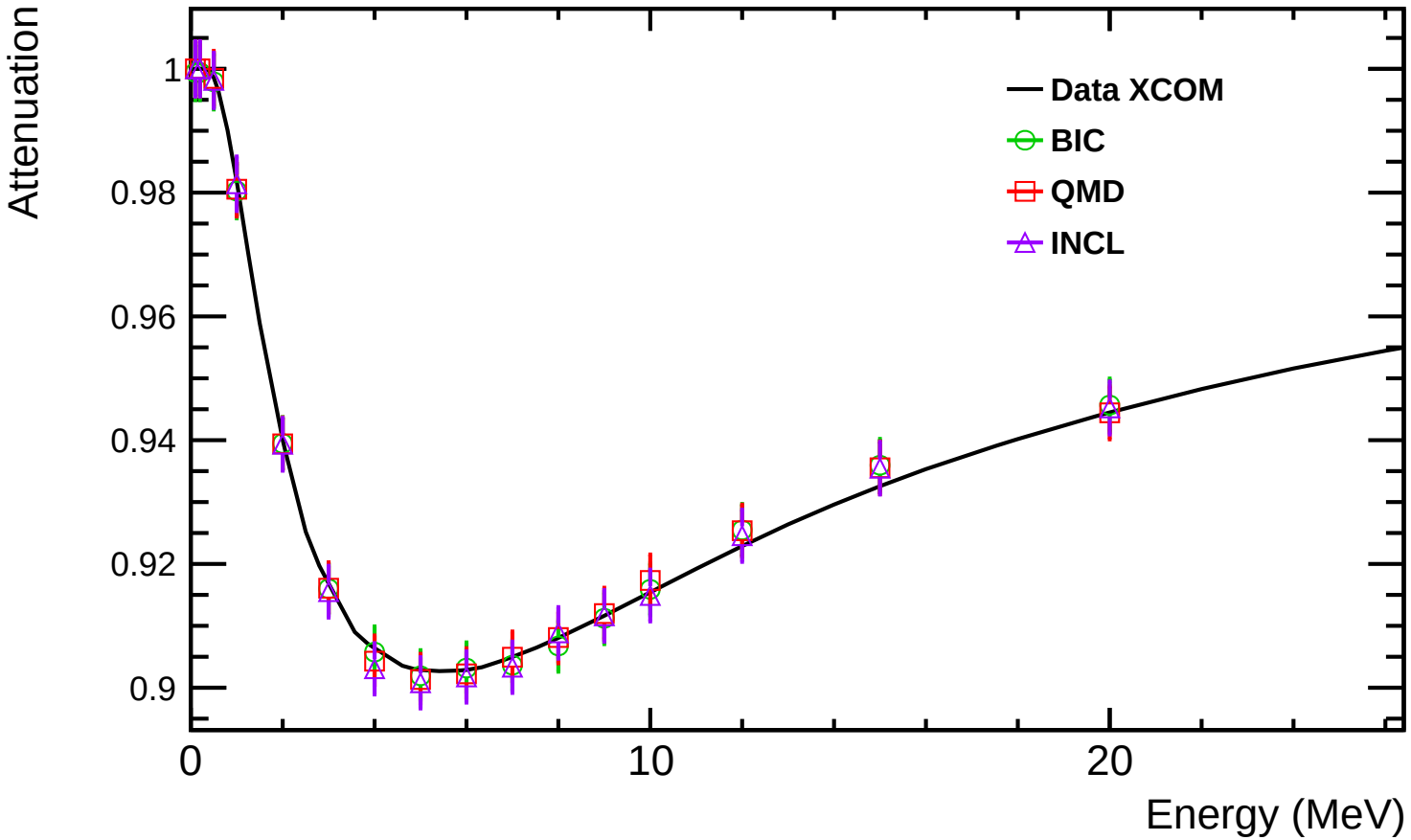
E_{kin} (line) vs E_{dep} (points) simulated with INCL for 60°



Blue : 90°, Red : 60°



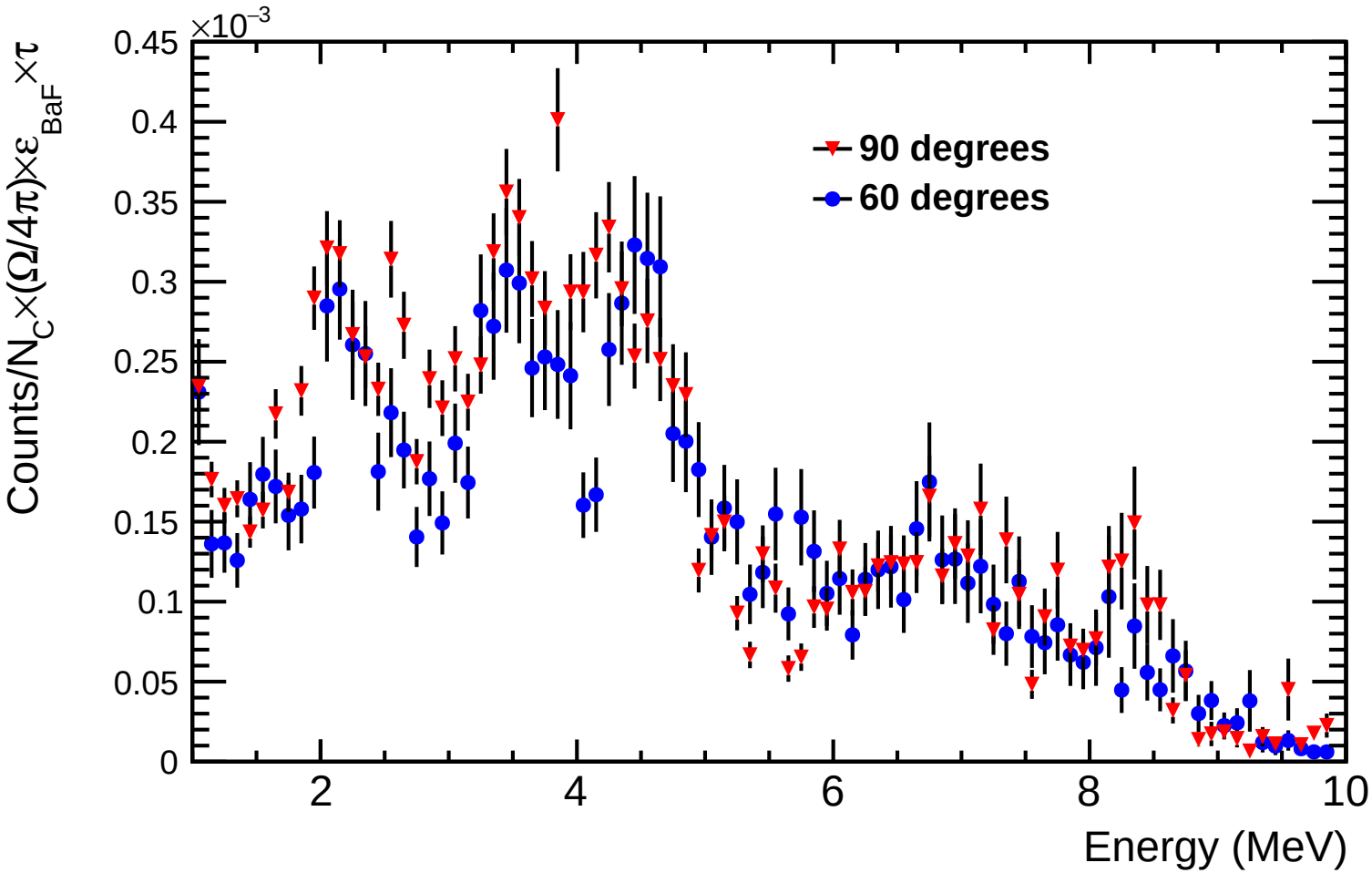
Does Geant4 reproduce well γ efficiency ?



Comparison between simulated and tabulated (XCOM) attenuation.

Prompt-γ spectra

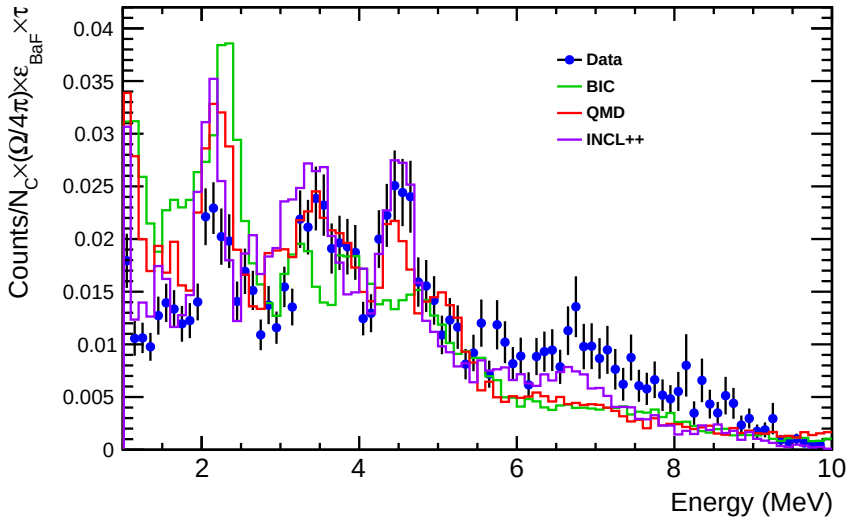
Corrected spectra



Prompt-γ spectra

Comparison with Geant4

- Good agreement in terms of shape for QMD and INCL
- Not so bad agreement for the yield
- BIC remains the worst

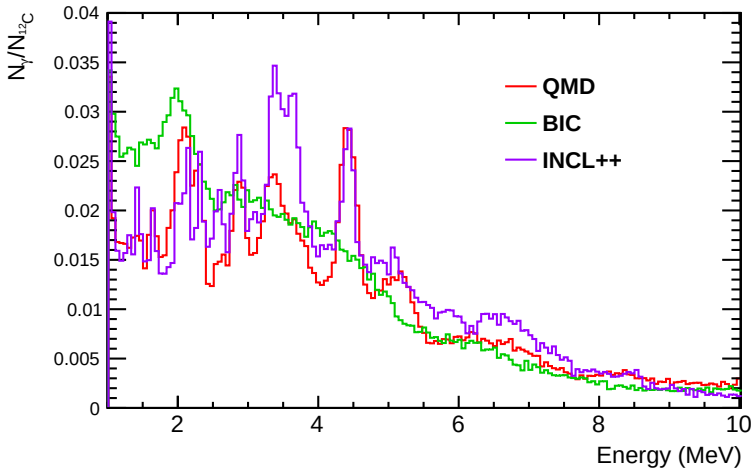


	60°	90°
Data	$(1.15 \pm 0.11)\times10^{-2}$	$(1.29 \pm 0.22)\times10^{-2}$
BIC	$(2.15 \pm 0.02)\times10^{-2}$	$(1.83 \pm 0.02)\times10^{-2}$
QMD	$(2.33 \pm 0.03)\times10^{-2}$	$(1.88 \pm 0.03)\times10^{-2}$
INCL	$(1.31 \pm 0.02)\times10^{-2}$	$(1.09 \pm 0.02)\times10^{-2}$

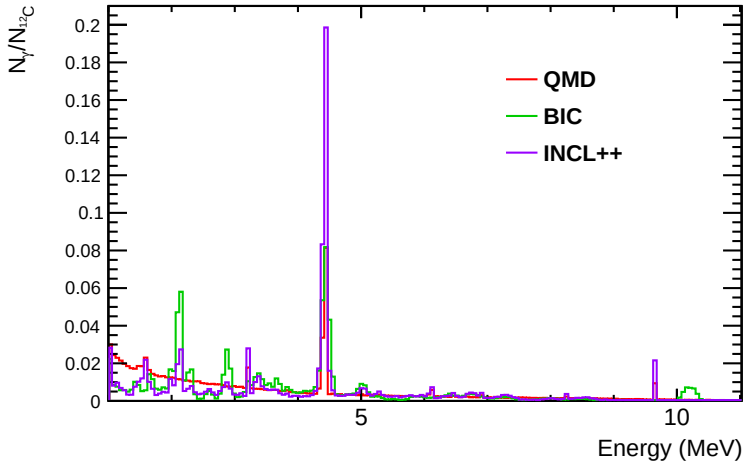
Prompt-γ spectra

Comparison with Geant4

Inelastic scattering ($^{12}C+^{12}C$)

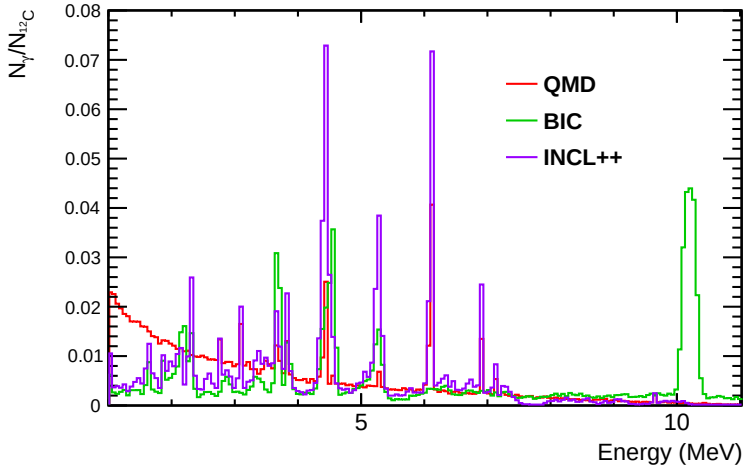


Neutron inelastic scattering $^{12}C(n,n')$



- BIC doesn't reproduce well coulex
- BIC fails to reproduce ^{16}O decays (6.05 MeV + 6.13 MeV)
- INCL seems the best model

Neutron inelastic scattering $^{16}O(n,n')$



Agreement with Catania data ?

Catania data (Agodi 2012) :
$\Phi_\gamma = 2.32 \times 10^{-3}$ sr^{-1}
This work :
$\Phi_\gamma = 1.15 \times 10^{-2}$ sr^{-1}
$\rightarrow$ factor 5 between both values
Geant4 predicts a factor 4.6 between 220 MeV/u and 80 MeV/u