Joint Research Centre

the European Commission's in-house science service

Serving society
Stimulating innovation
Supporting legislation

New Prompt fission γ-rays spectral data in response to a high priority request from OECD/NEA

Angélique Gatera

BPS2016 - UGent

European Commission

Curriculum

2011 : Engineer in applied physics and electronics, Ensicaen, France

2012 : Physics engineer at IBA (Ion Beam Applications), Louvain-la-neuve, Belgium

2104 : Ph.D student at UGent and research fellow at JRC- IRMM

Affiliation

European Commission

JRC : Joint Research Center

IRMM : Institute for Reference Materials and Measurent, Geel, Belgium

SN3S : Standards for Nuclear Safety, Security and Safeguards

European Commission

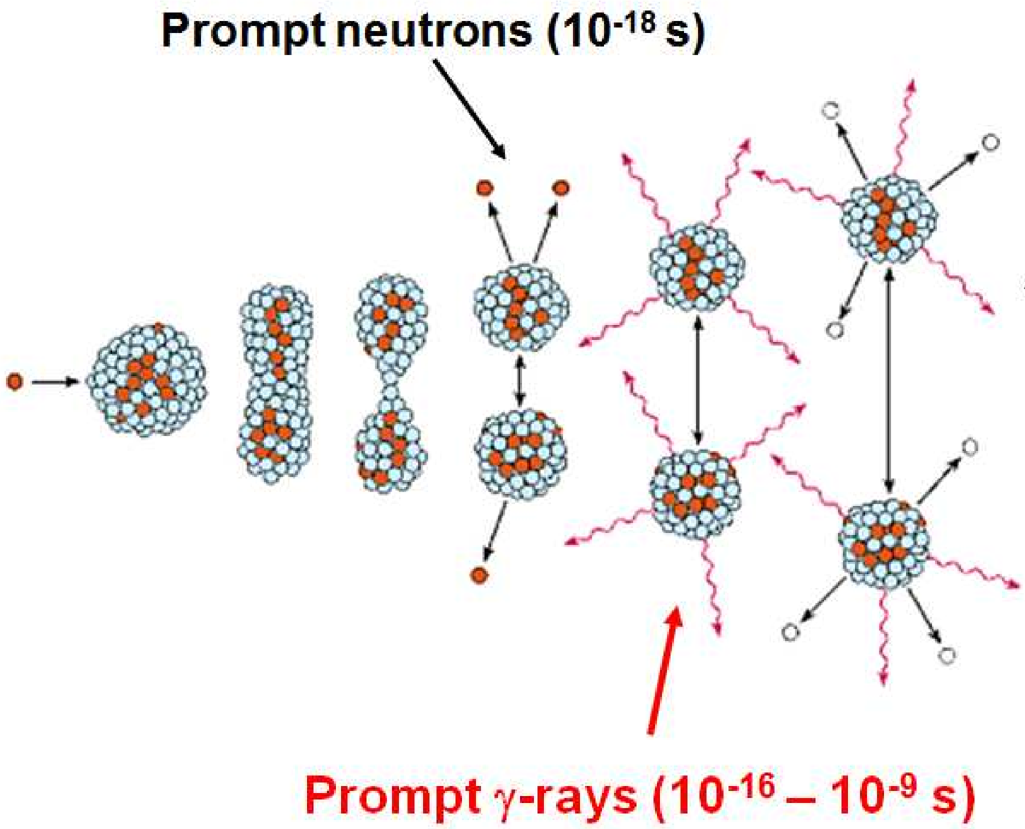
The JRC Nuclear Facilities

Table of content

- Introduction to prompt fission γ-rays (PFG)
- Motivations
- Experimental setup
- Data analysis
- Results and discussions
- Conclusion

European Commission

Introduction to prompt fission γ-rays



kinetic energy
prompt γ-rays
} heat

prompt neutrons
(delayed neutrons)
} chain reaction

- **Γ-heat: 10% of total released heat**
- **Prompt γ-rays: 40% of emitted γ-rays**

Motivations

- The study of fission fragment de-excitation is important for both nuclear applications and fundamental nuclear physics.

- High quality of experimental data allows better understanding of the released heat during fission.

- Evaluated data from the 70's show **an under-prediction of γ-heating by 10 to 28%** for ^{235}U and ^{239}Pu.

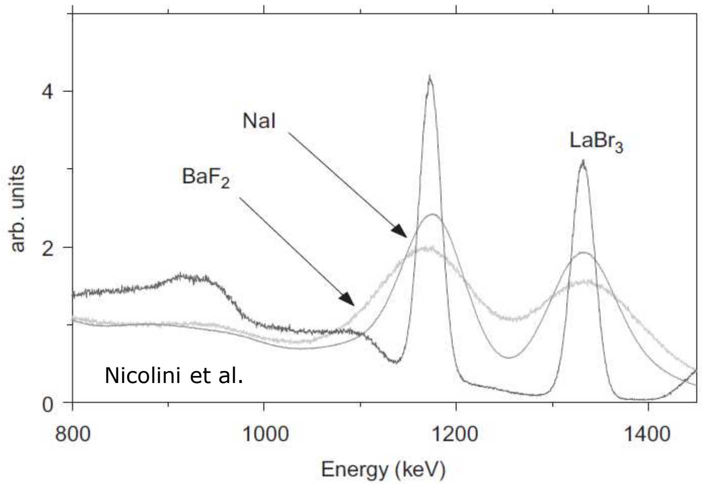
- Reduced error margins lead to cost effectiveness in design and construction of new innovative reactor systems.

European Commission

How to improve data precision?

Better detectors

- Higher intrinsic efficiency
- Better energy resolution
- Smaller timing resolution for neutron-γ separation



Better targets

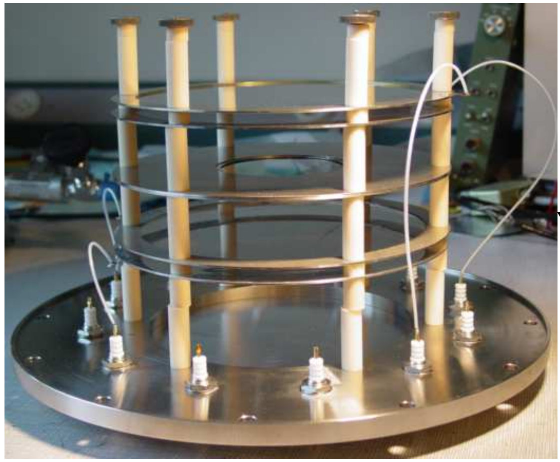
- High purity targets
- Spectroscopic targets to study correlation between fission fragments and γ-rays

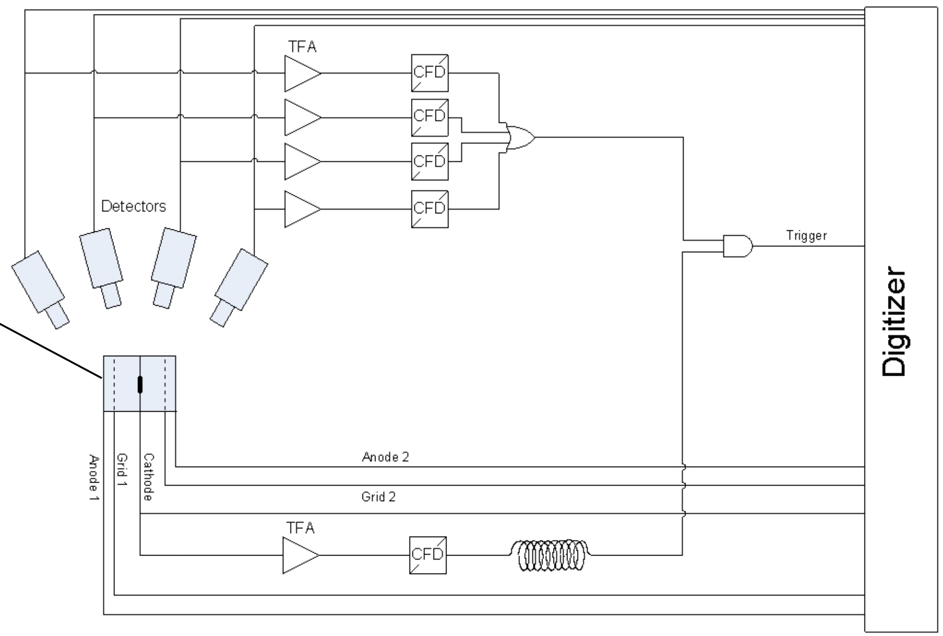
Better data processing

- Deal with the high alpha activity
- Pile-up rejection
- Multiple detectors for higher statistics and reproducibility check

Experimental Setup

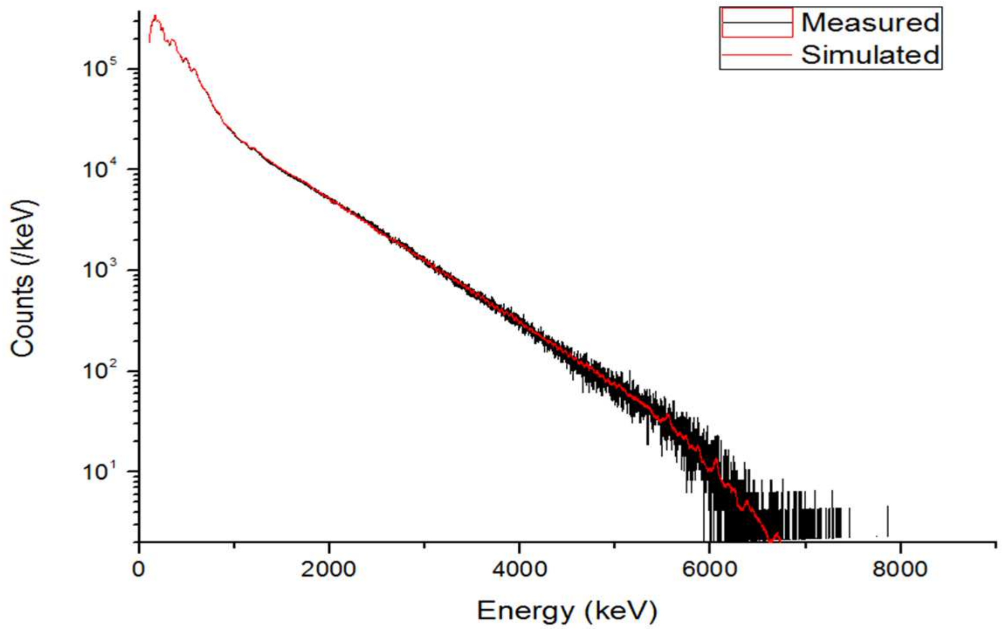
- 4 $LaBr_3(Ce)$ detectors
- A target mounted on the cathode of a Twin Frisch Grid Ionisation Chamber (TFGIC)
- Digital data acquisition system





Data analysis

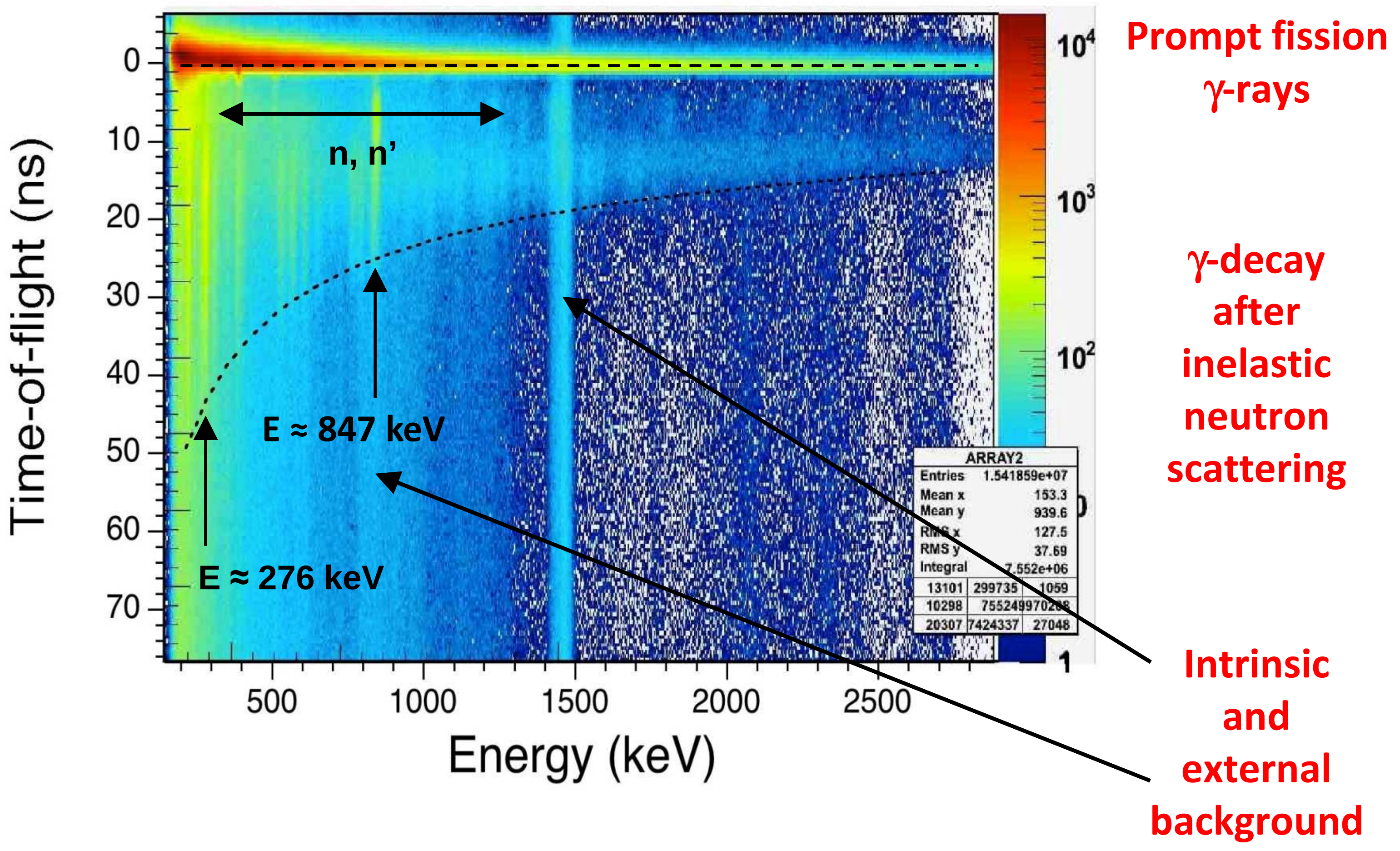
- The measured spectra are unfolded using superposed mono-energetic Monte-Carlo simulated detector's response.



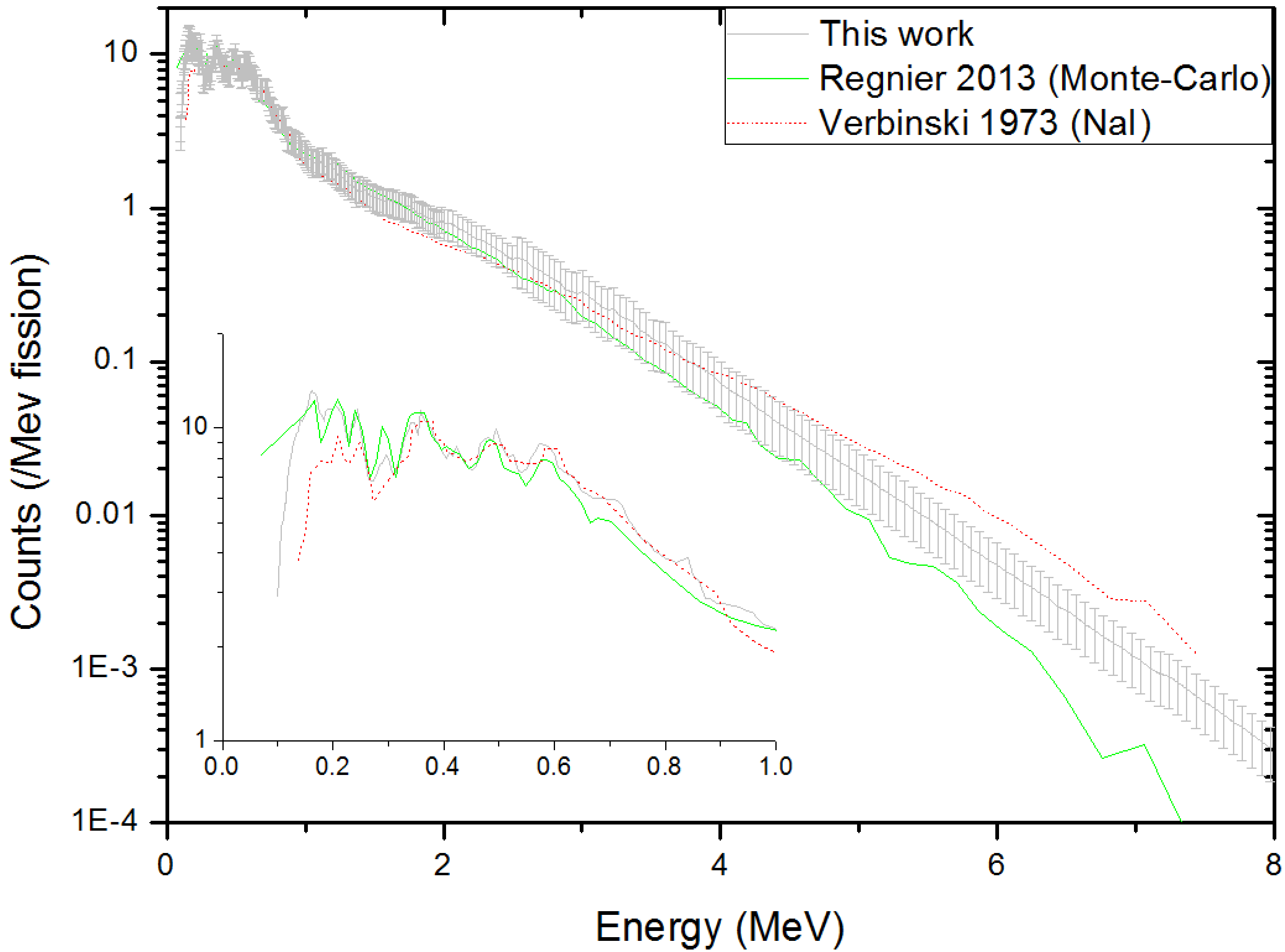
- The estimated emitted spectrum is used to calculate **average γ-multiplicities, total and mean energies**.

European Commission

Results : photons in coincidence with fission fragments

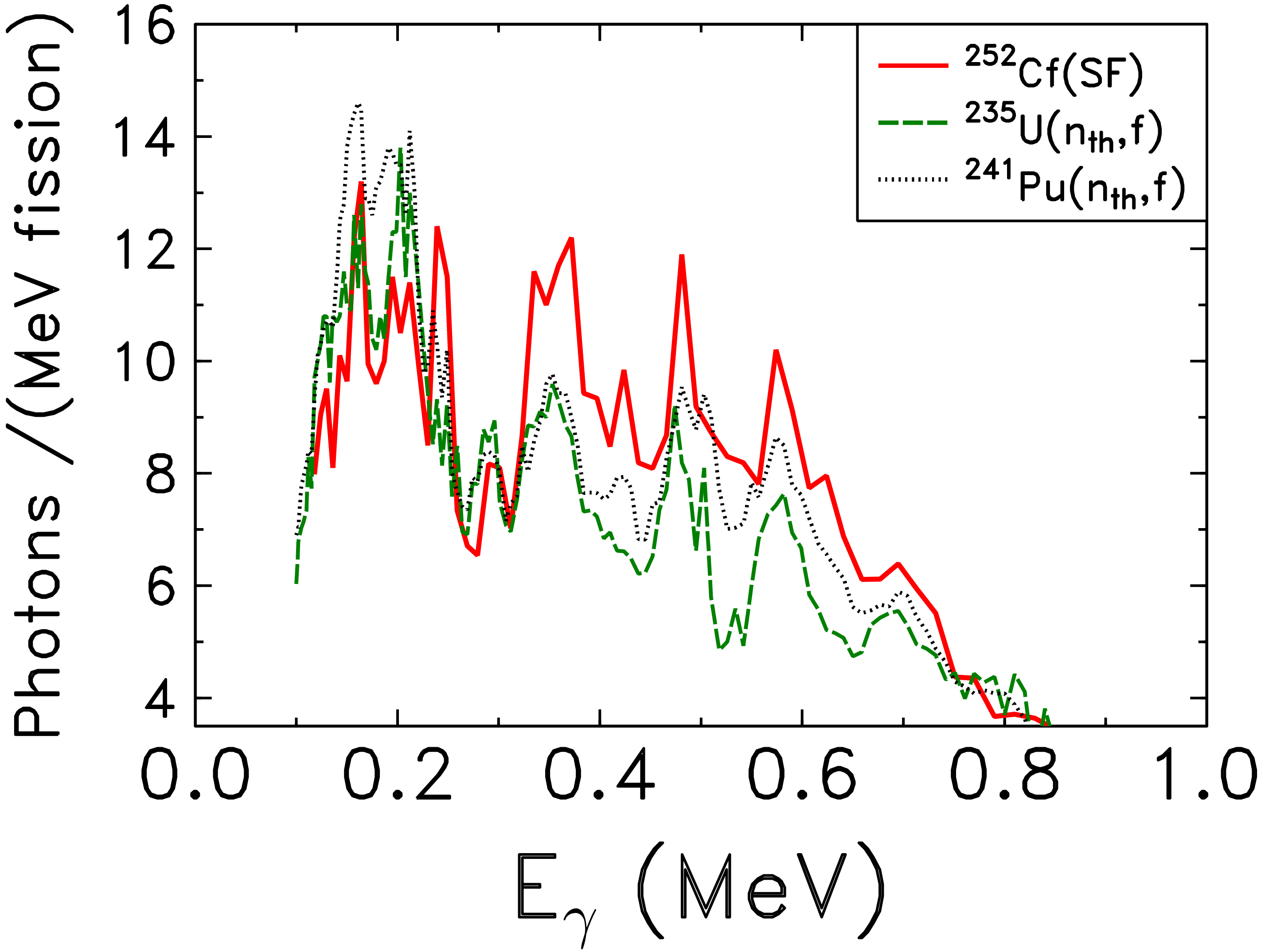


Results: Emitted spectrum for Cf-252



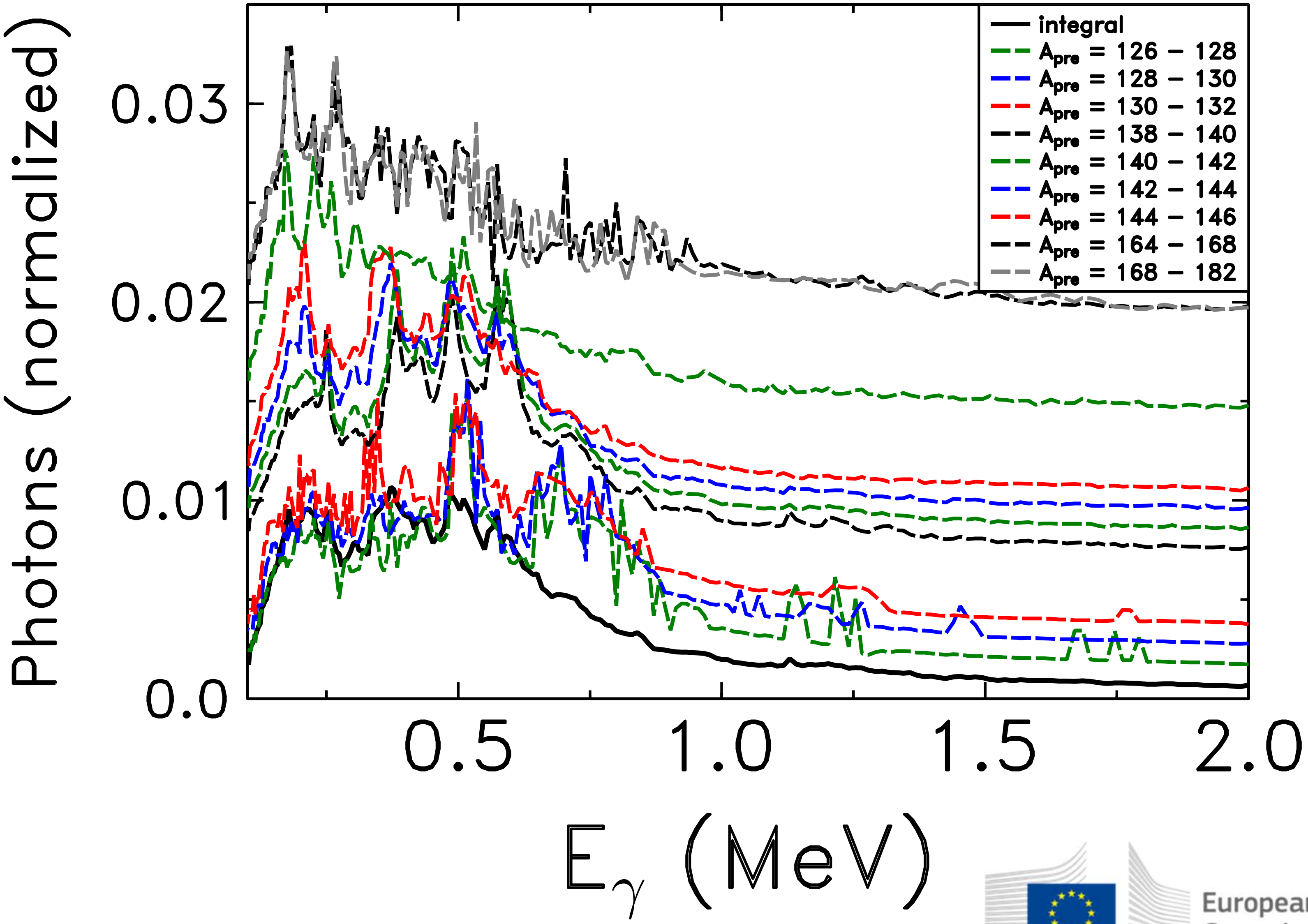
European Commission

Results: fission fragment dependencies



European Commission

Results : Correlation between γ-rays and fission fragments



European Commission

Conclusion

- We were able to provide data for ^{252}Cf(SF) , ^{235}U(nth,f), ^{241}Pu(nth,f), ^{240,242}Pu(SF), and recently ^{239}Pu(nth,f) with uncertainties below 5%.

- The observed increase in average total PFG energy can only partially explain the observed heat excess.

- To explain the rest of the heat excess other possibilities are being investigate, mainly fast neutron induced fission and (n,n'γ) induced photo-fission.

- We are putting extra effort into mass resolved PFG, to assess the precision of models in predicting de-excitation processes for neutron rich isotopes.

European Commission

Thank you !

S. Oberstedt, T. Belgya, R. Billnert, G. Sibbens,
W. Geerts, A. Göök, F.-J. Hambsch, M. Lebois,
A. Oberstedt, L. Szentmiklosi, M. Vidali, and …