Studies of fission fragments and prompt-fission neutrons

A. Al-Adili[1], K. Jansson[1], D. Tarrío[1], F.-J. Hambsch[2], A. Göök[2], S. Oberstedt[2], V. Rakopoulos[1], A. Solders[1], S. Pomp[1]

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NUSPRASEN 2018-01-22

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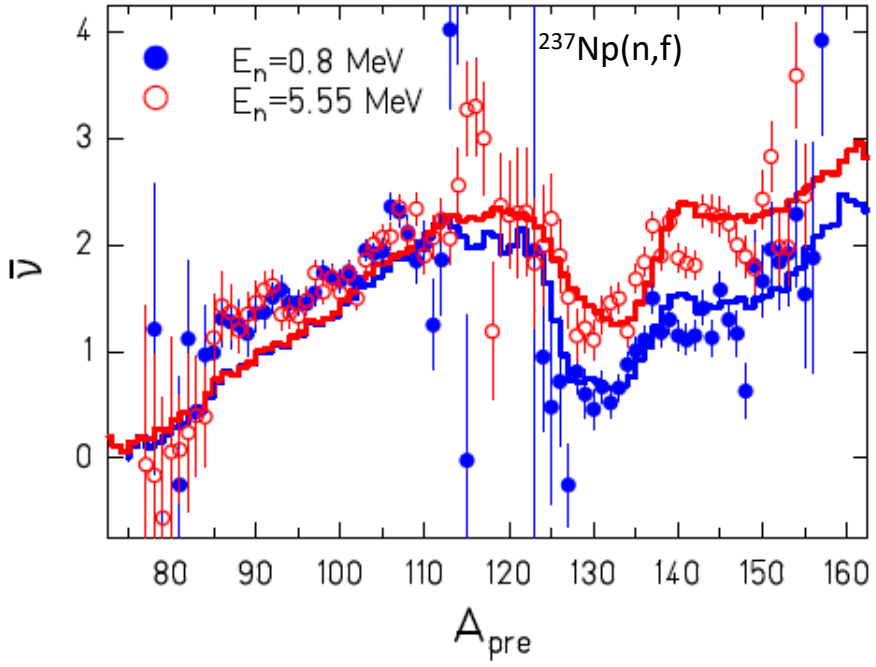
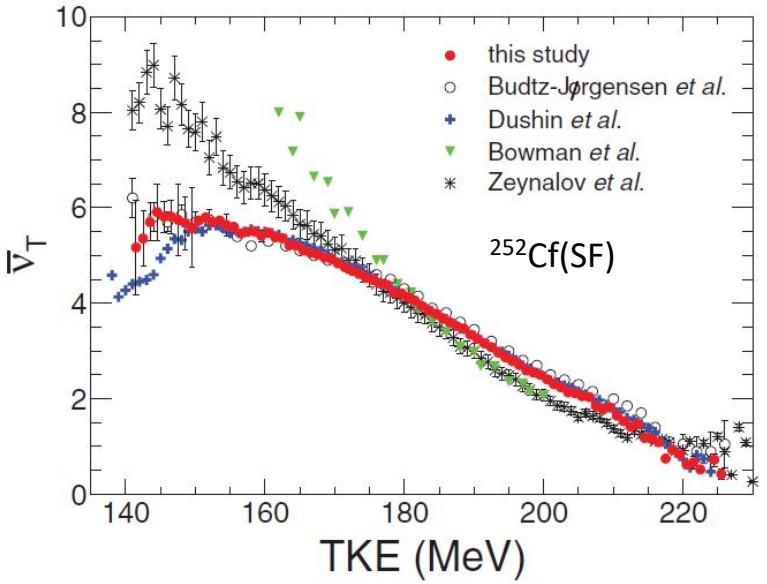
Motivation to neutron studies

Questions: Where does the excitation energy go?
Shell effects in fission fragments.
Do scission neutrons exist?



Few existing data sets!

A. Göök et al., PRC **90** (2014) 064611

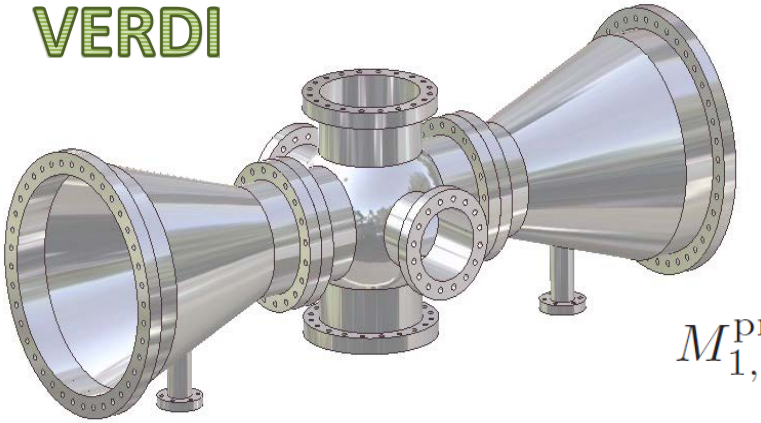


Instrumentation

2-E 2-v method

The method is expected to give excellent mass resolution (1-2 u)

VERDI

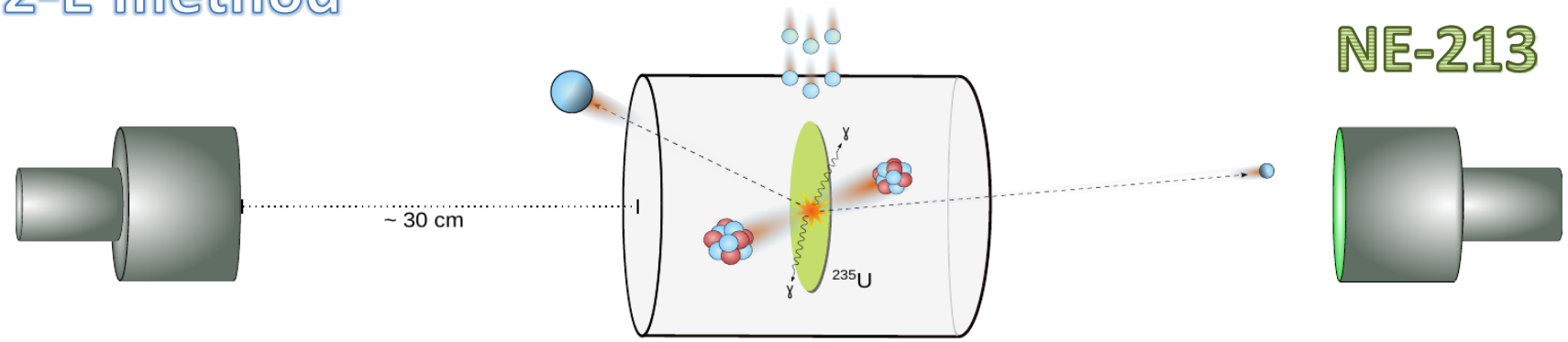


$M_{1,2}^{\mathrm{pre}}$

$M_{1,2}^{\mathrm{post}}$

2-E method

Neutron Det.
NE-213



FGIC

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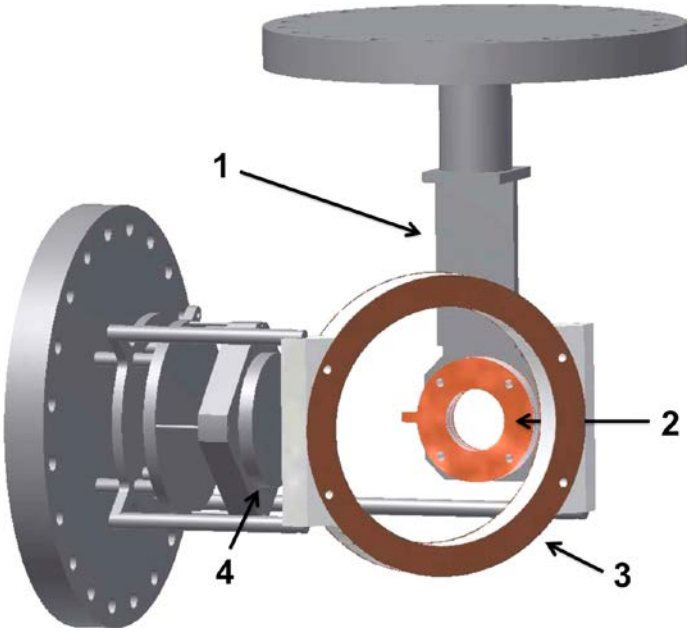
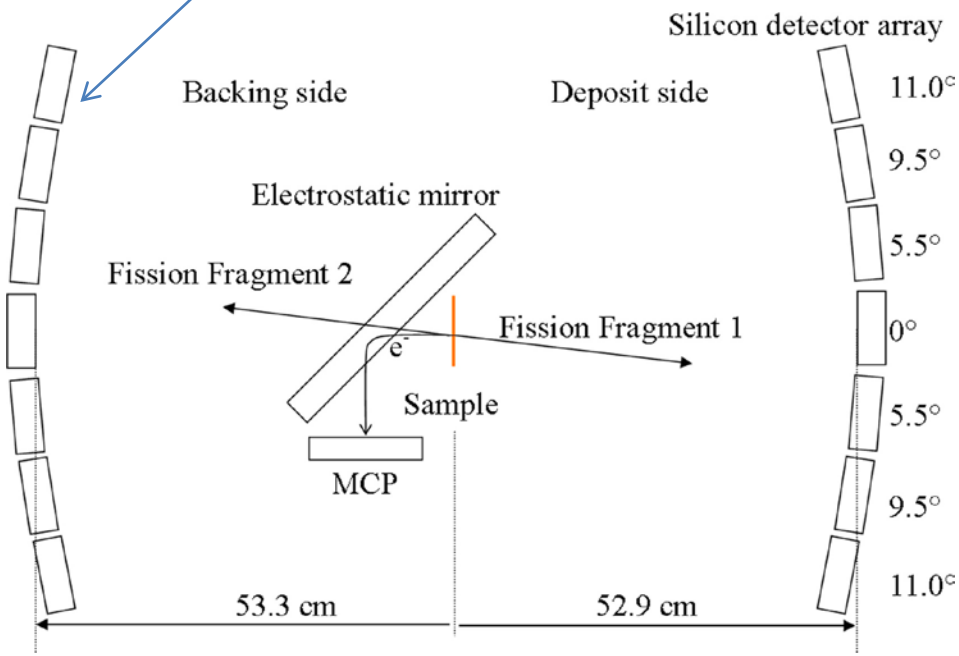
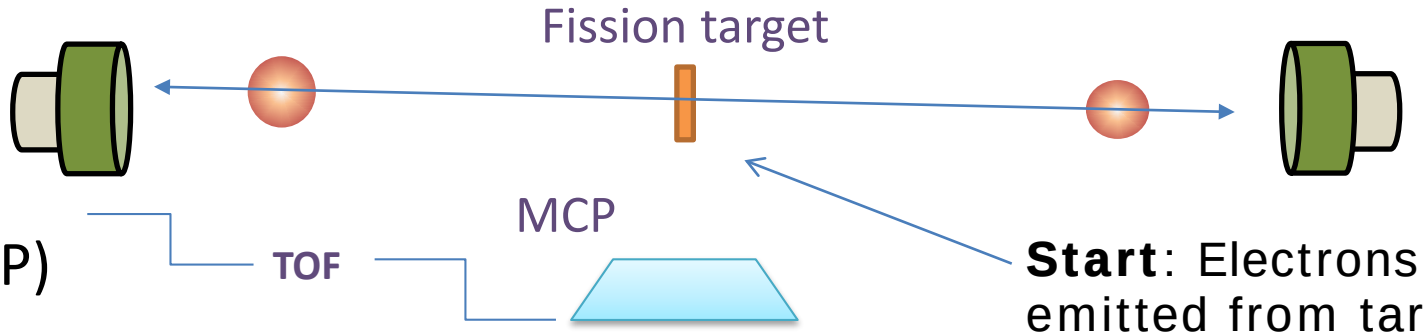
2E-2v

2 arrays of 16 Si (Energy)







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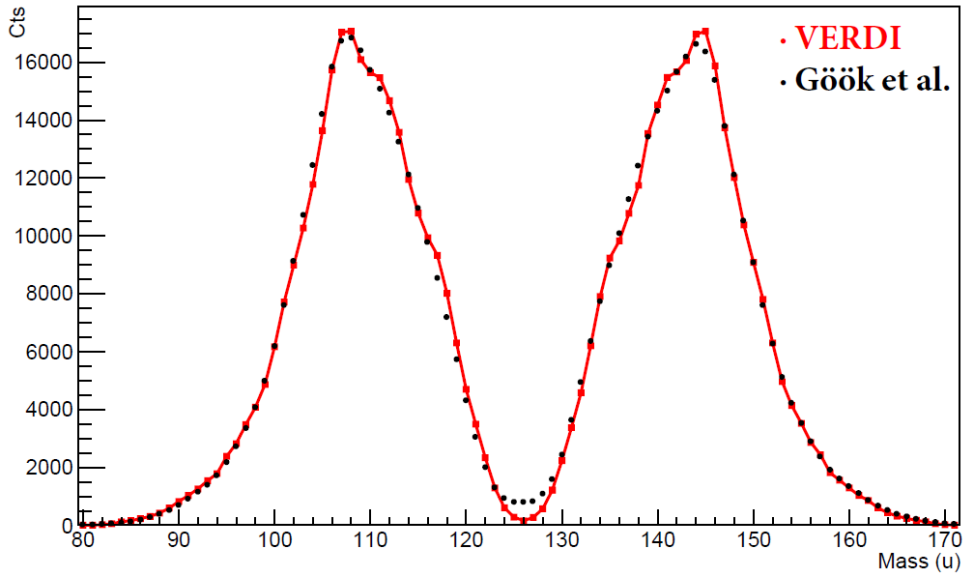
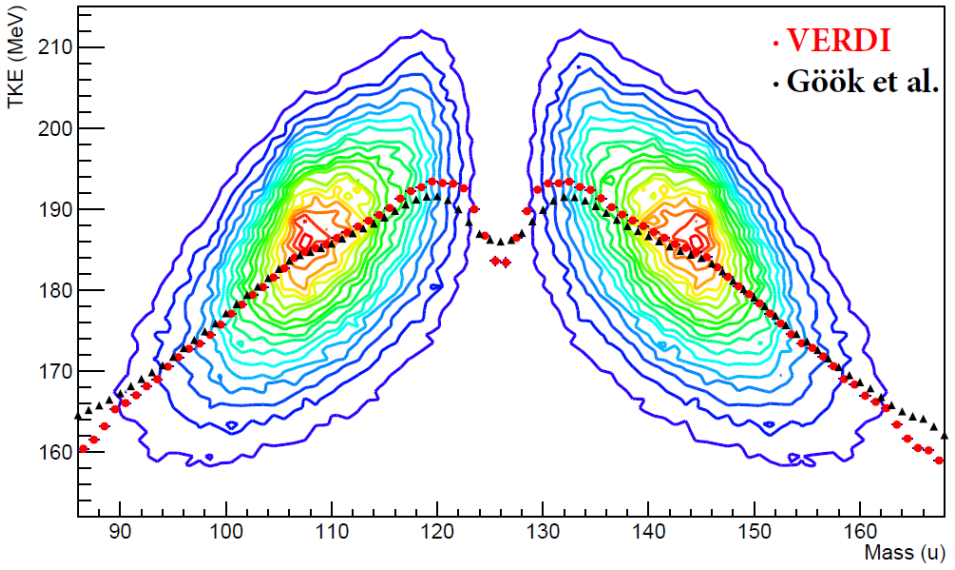
Results for ^{252}Cf(SF)

The data look promising !

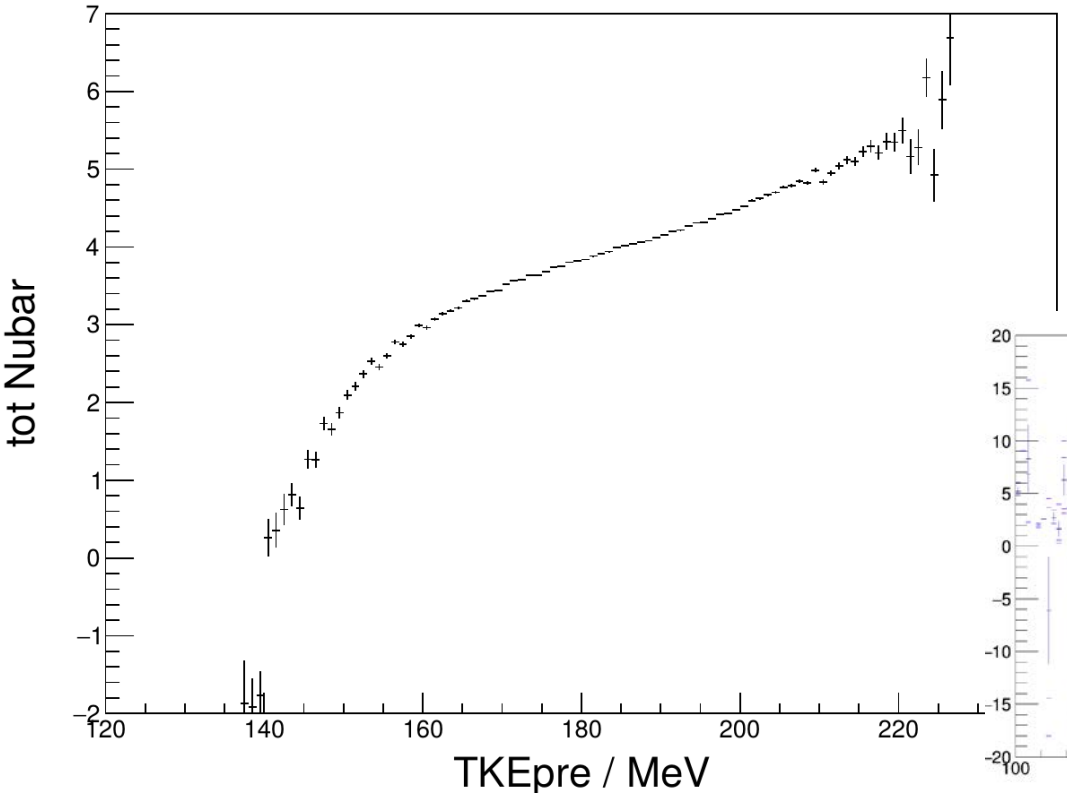


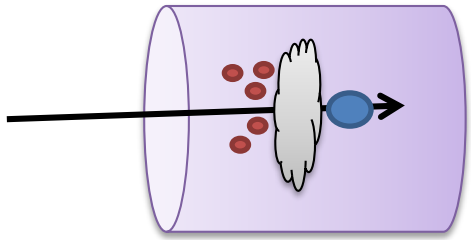


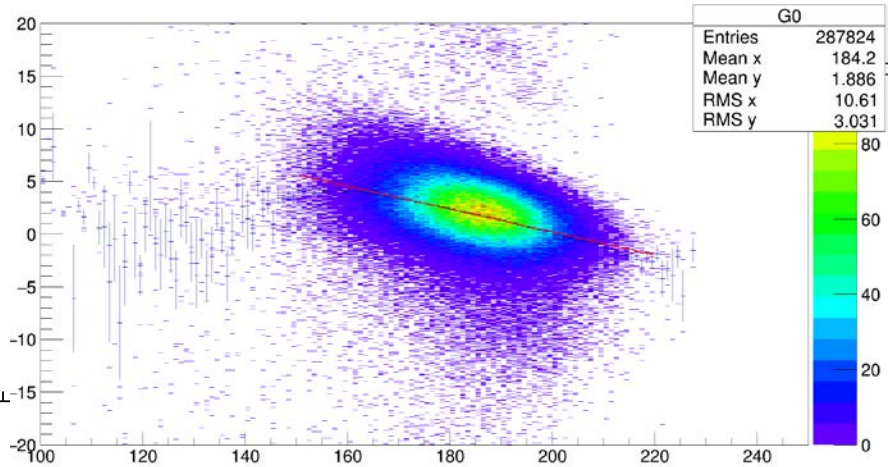
NOTE: In both distributions we can observe improved mass resolution compared to 2E.

Results for ^{252}Cf(SF)

However, further investigation showed that higher order correlation a rather strange trend. This is due to the plasma delay time!



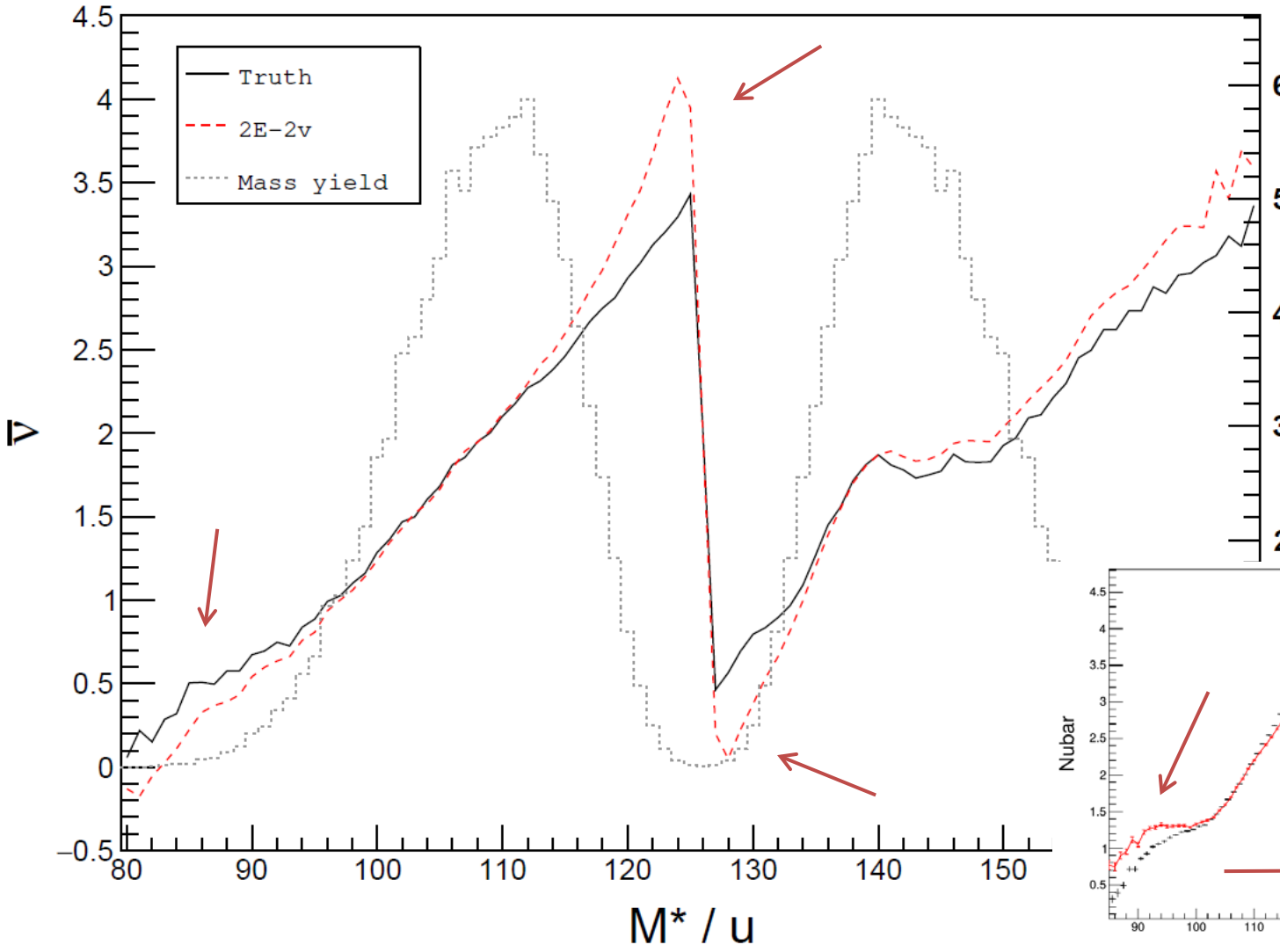




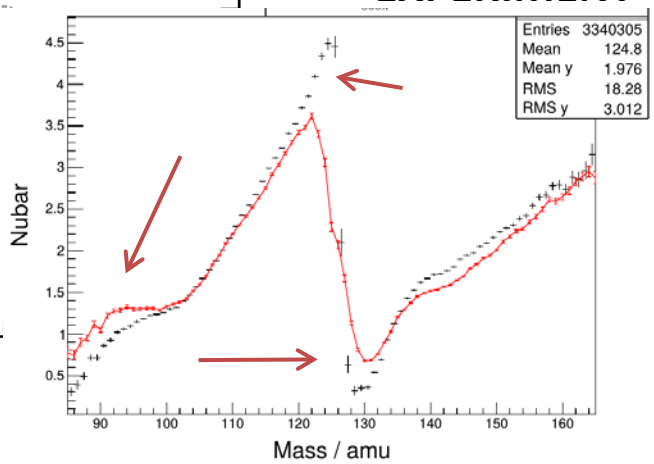
DEDICATED PDT MEASUREMENT NEEDED!

GEF simulations - Nubar (A)

Changes of nubar! Note overshoot/undershoot effects



EXPERIMENT



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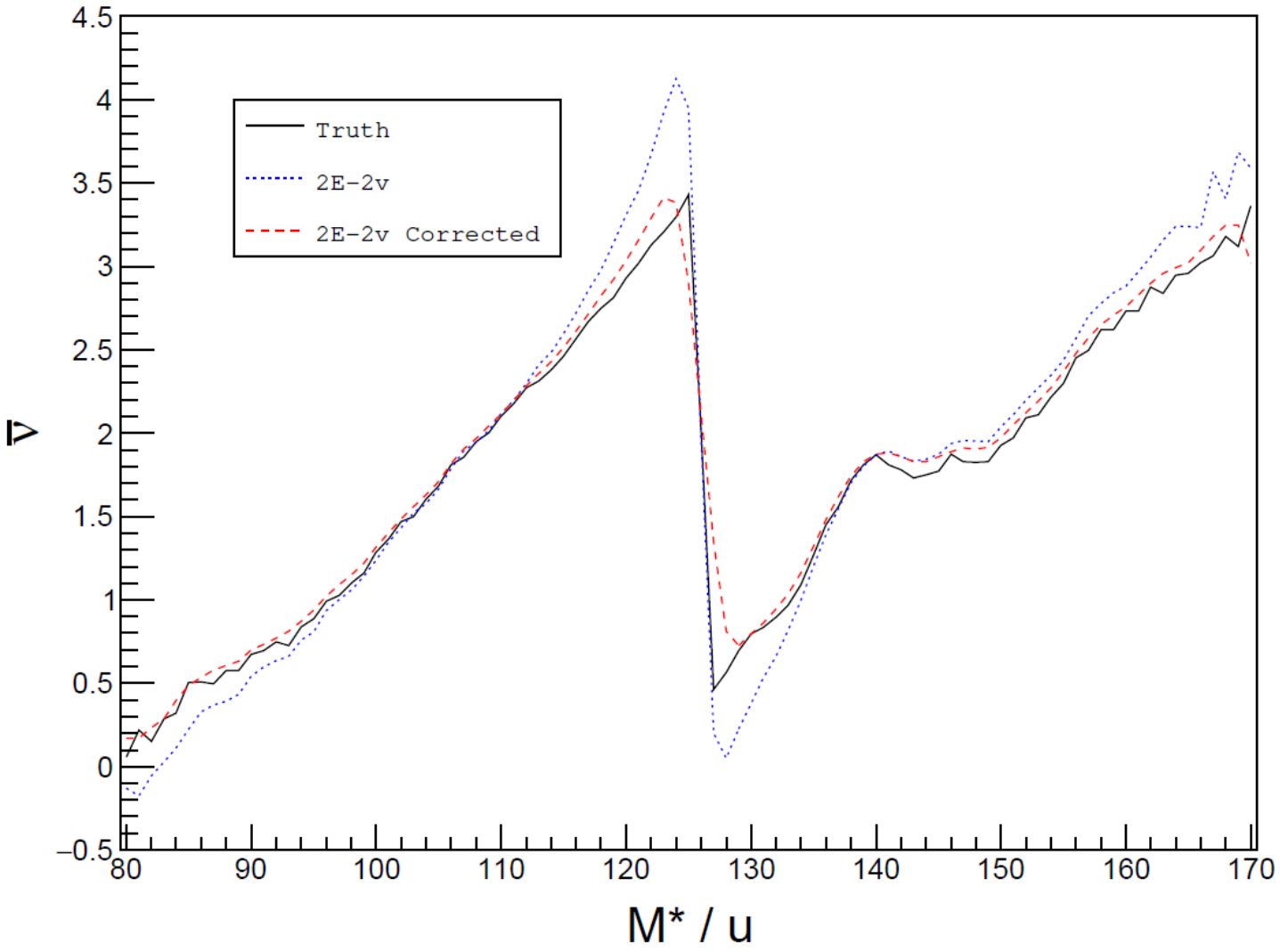
GEF simulations - Nubar (A)

Correction possible: here with inverse matrix unfolding



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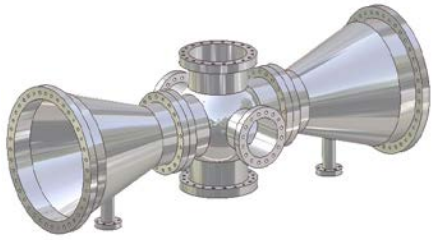
Summary on 2E-2v



1) Promising preliminary results from VERDI
2) Dedicated measurement on PDT still needed
3) Inherent effects due to method found and needs correction!

Studying fission neutrons with 2E-2v and 2E The new double energy-velocity spectrometer VERDI
Kaj Jansson, Marc Olivier Frégeau, Ali Al-Adili et al.
EPJ Web of Conferences **146**, 04056 (2017), ND2016

Studying fission neutrons with 2E-2v and 2E
A. Al-Adili, K. Jansson, et al.
In press, proceedings for THEORY-4: Scientific Workshop on Nuclear Fission dynamics and the Emission of Prompt Neutrons and Gamma Rays

Defective fission correlation data from the 2E-2v method
K. Jansson, A. Al-Adili, Erik Andersson Sunden, Alf Göök, Stephan Oberstedt, and Stephan Pomp
Submitted to EPJA (2017), arXiv:1709.07443

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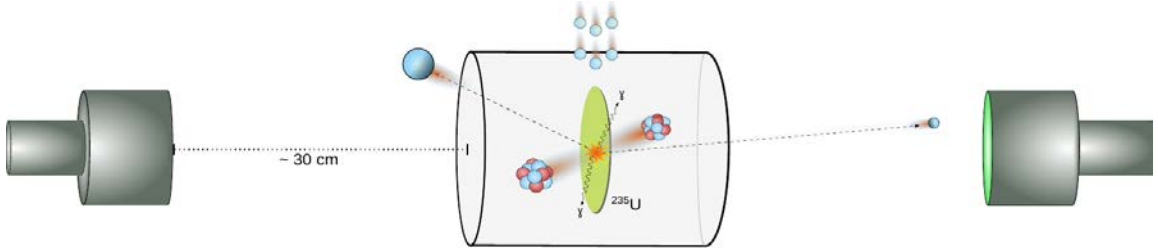
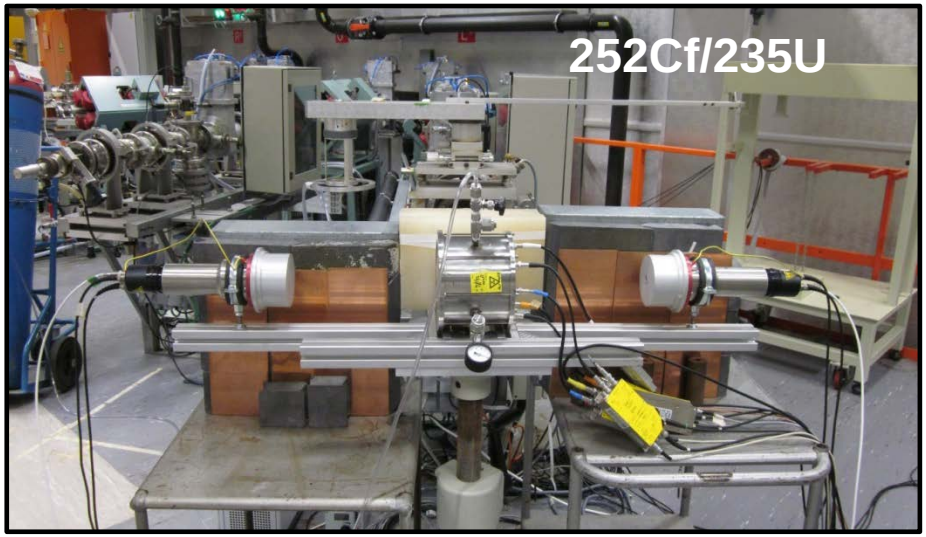
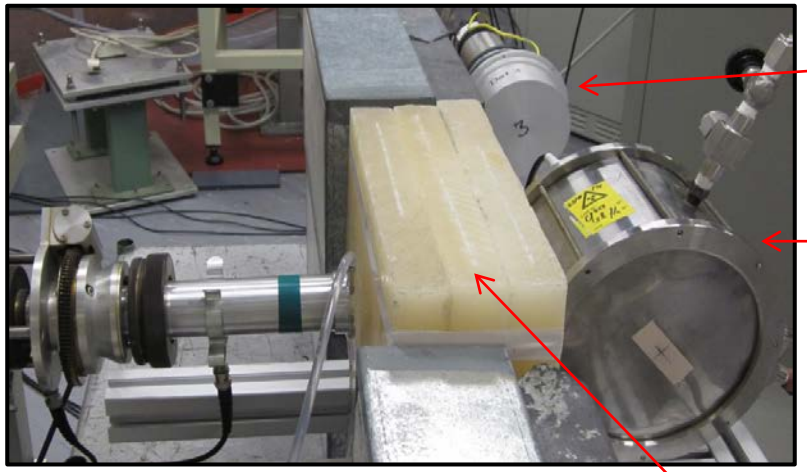
2E (proof of principle experiment)







Cf-252: To extract a neutron-detector efficiency (via the Mannhart evaluation).

U-235: To measure first the thermal fission of 235U before 5 MeV.

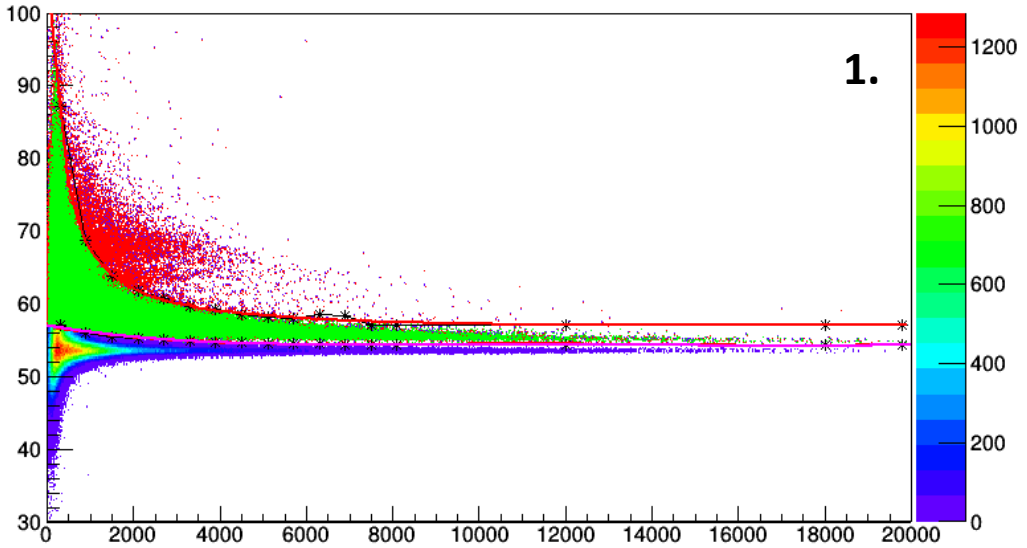
Neutron data (Cf-252)

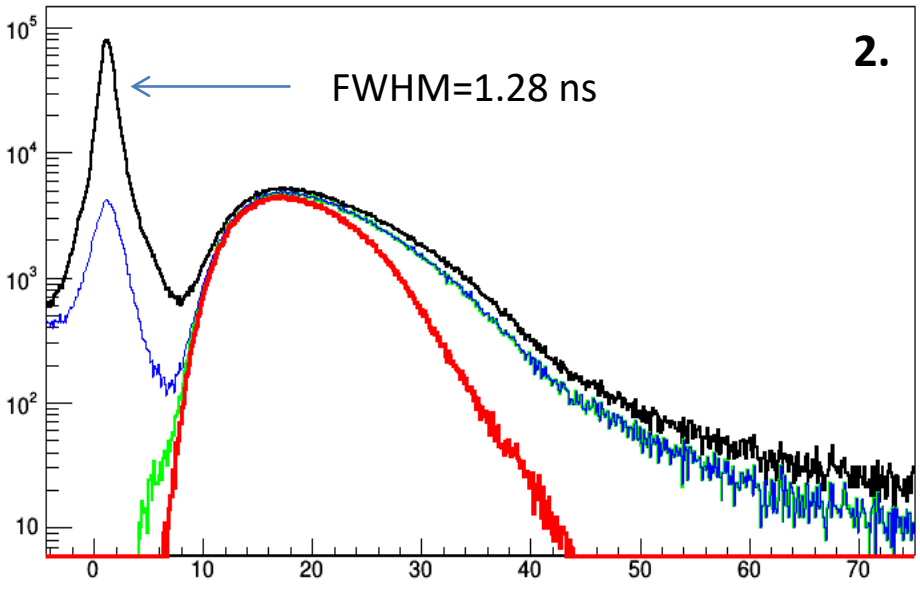
1. Pulse shape discrimination.

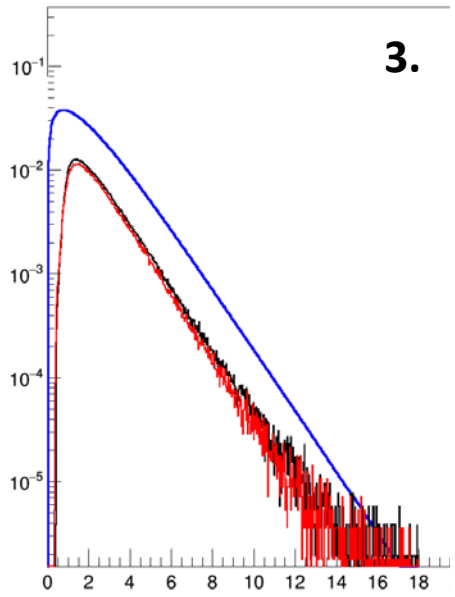
2. TOF and cuts.

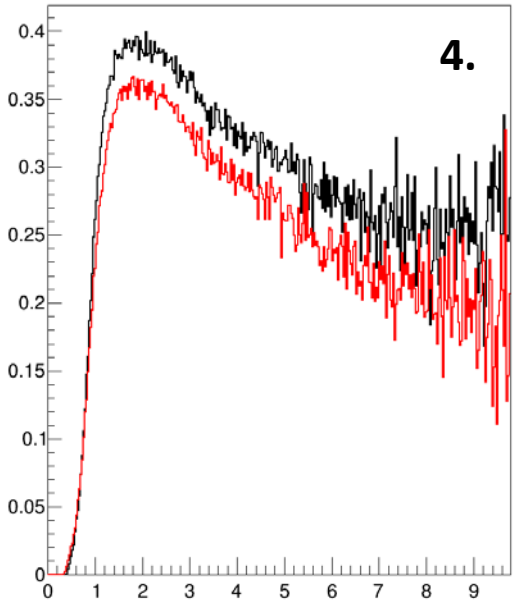
3. Neutron energy.

4. Detector efficiency



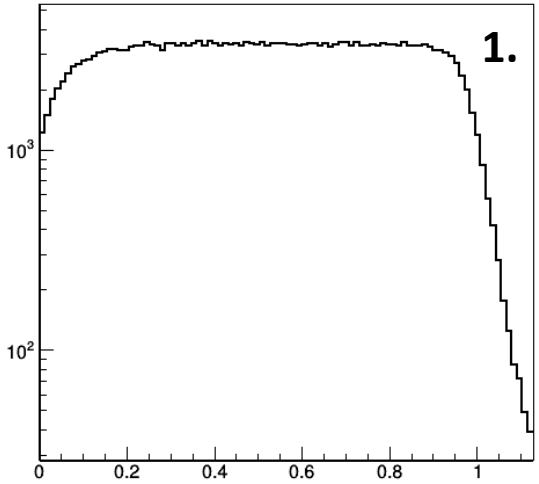


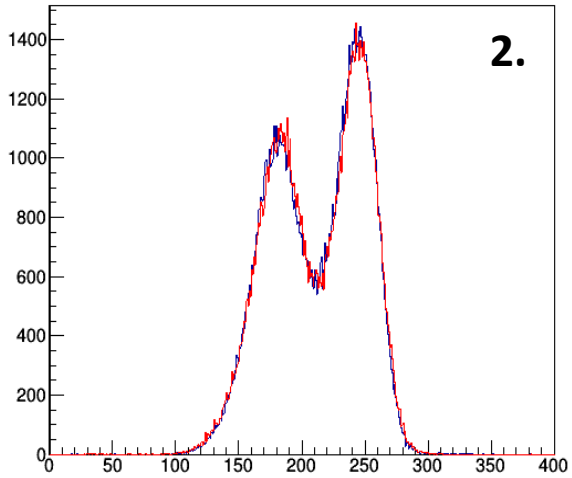




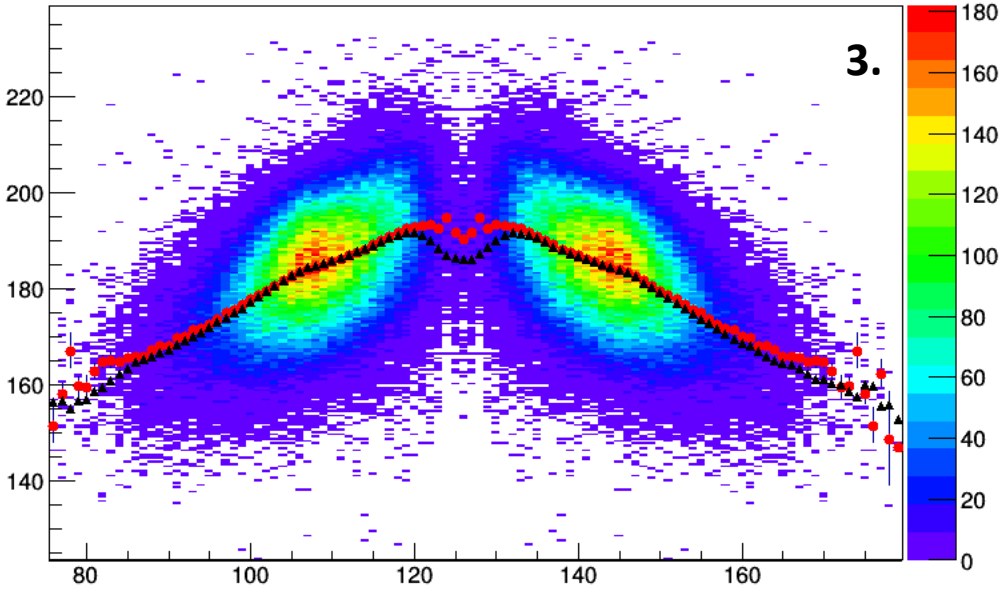
Analysis

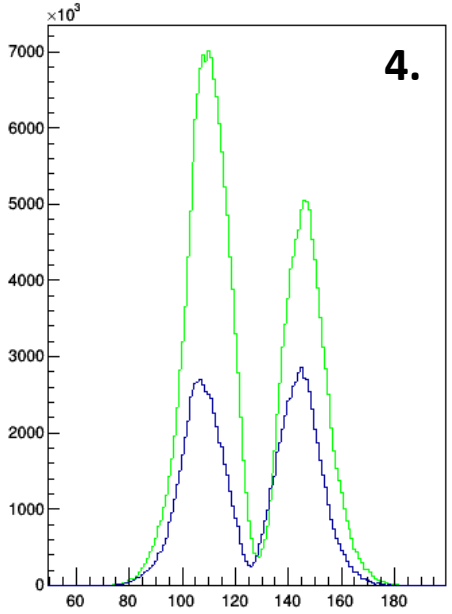
1. Cosine(θ)
2. FF Pulse Heights
3. Mass vs TKE
4. Coincidence mass distribution





TKE vs mass compared to Göök





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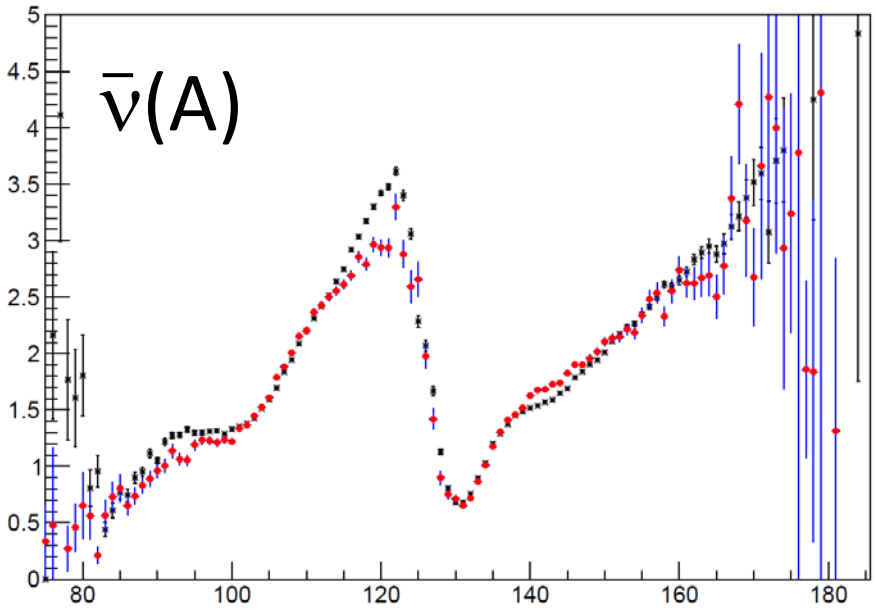
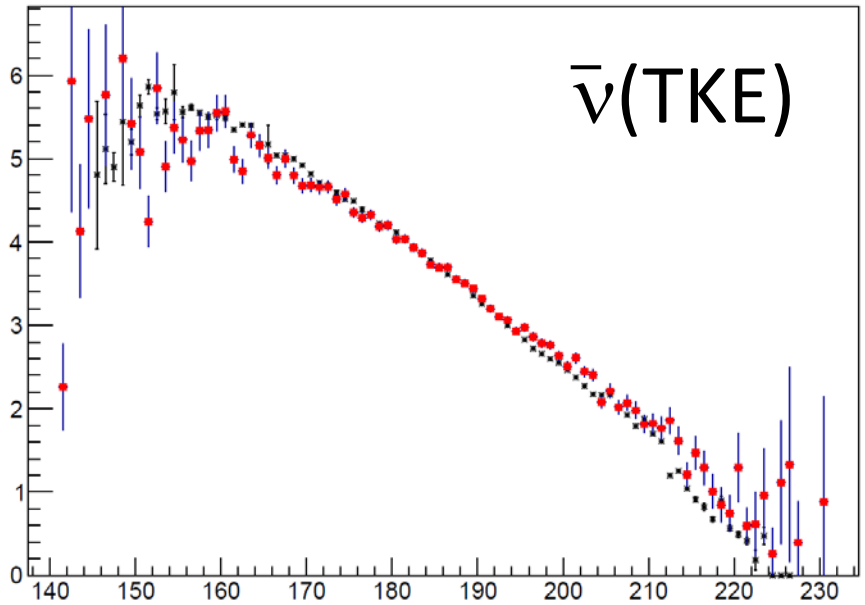
Results for ^{252}Cf(SF)

Good agreement with the data of Göök et al. (SCINTIA, black dots)





Minor differences due to:

- **Lower quality of ^{252}Cf source.**
- **Less statistics.**

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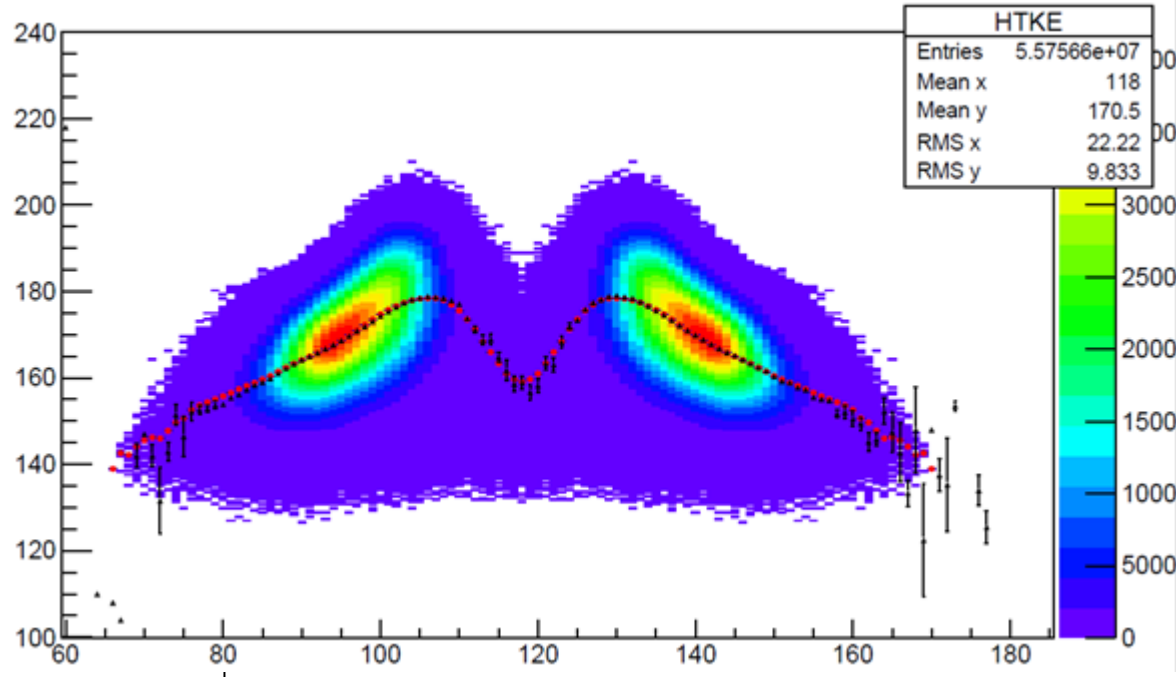
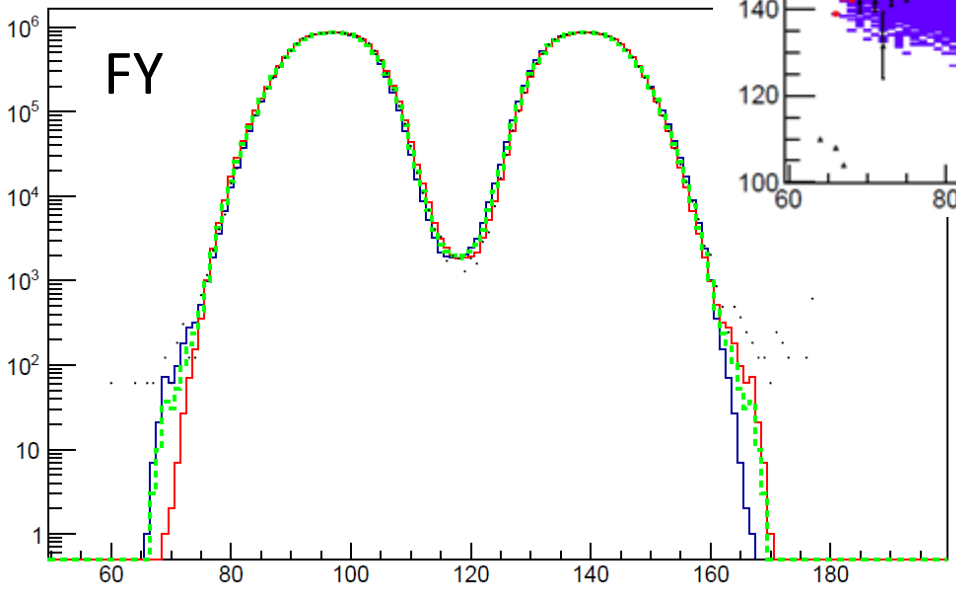
Results for $^{235}U(n_{th},f)$

Good agreement with FF data from Göök et al. (plotted in black) with SCINTIA@GELINA

TKE



M_{pre}



M_{pre}

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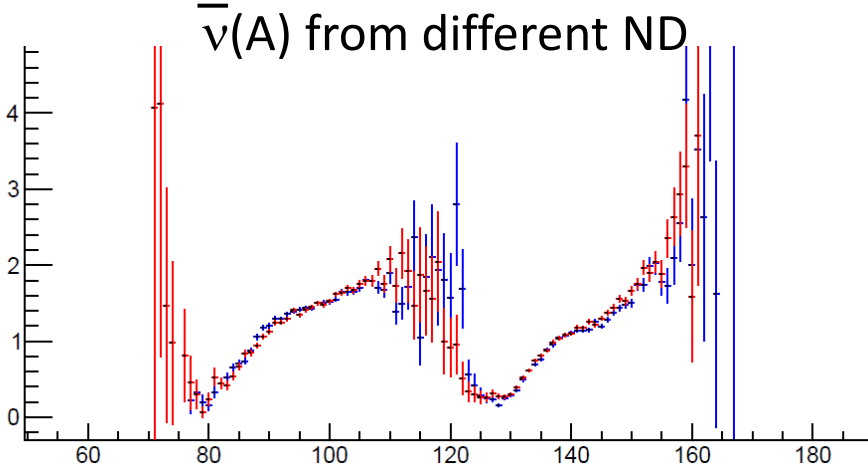
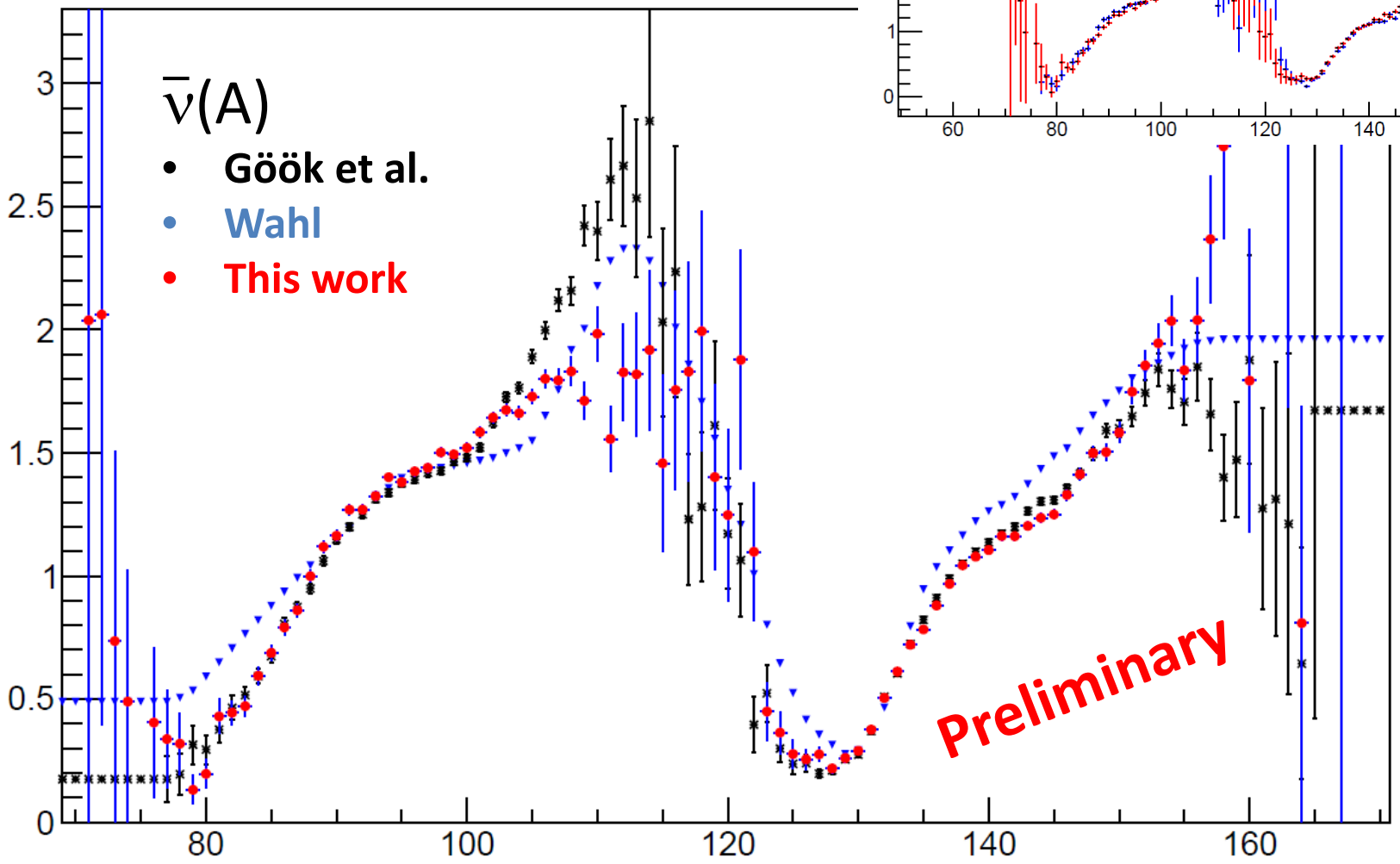
$^{235}U(n_{th},f)$





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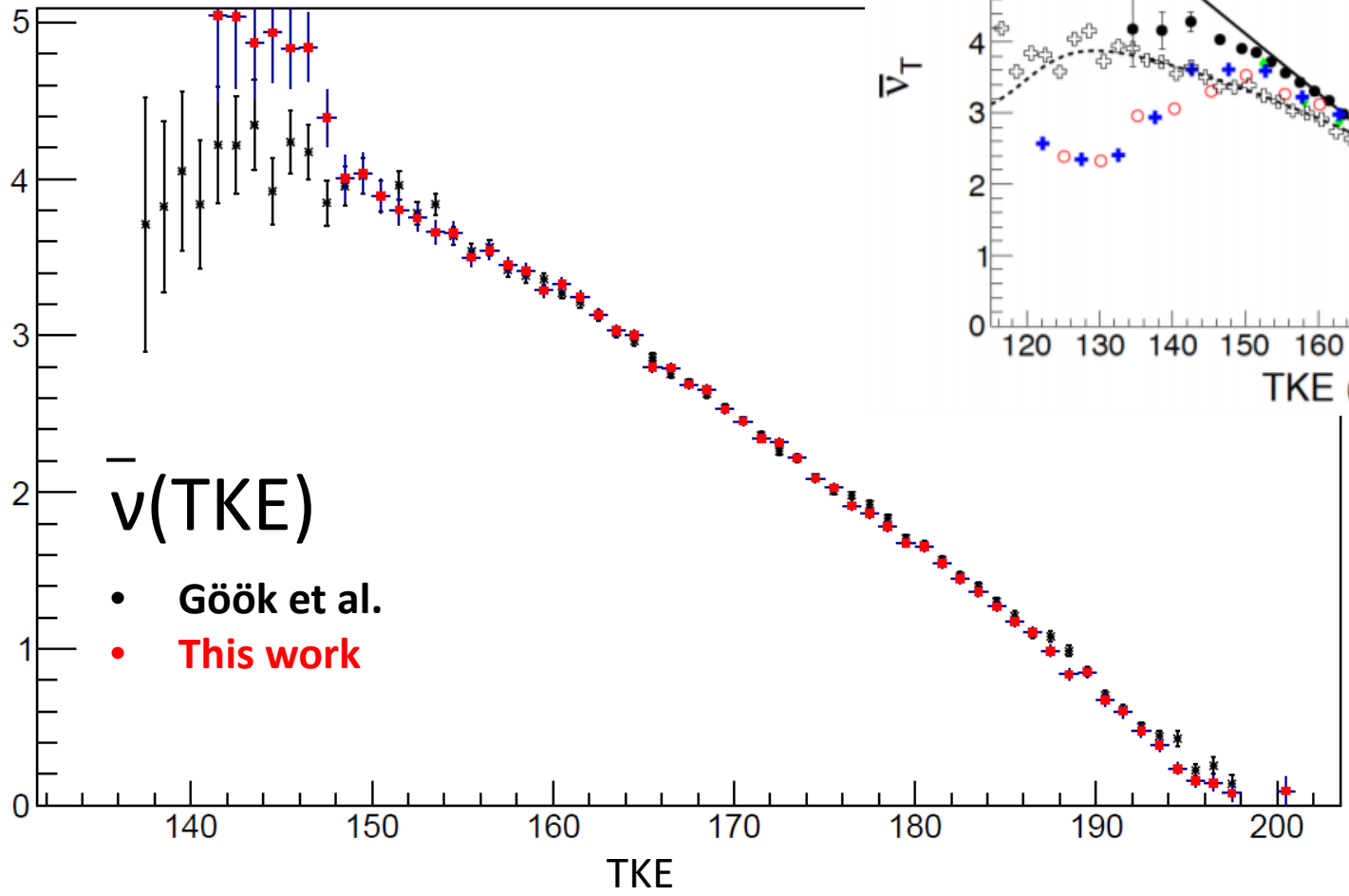
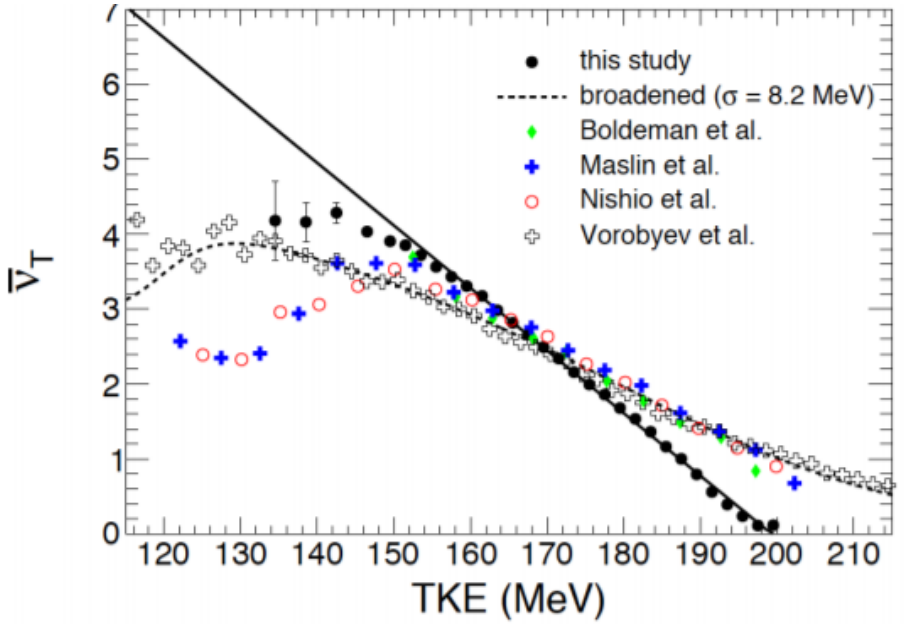
Results for $^{235}U(n_{th},f)$





Preliminary

Summary on 2E project

1. Experiment on Cf-252 show good agreement with reference data.
2. Prelimenary data on U-235 thermal data show that older reference data , again in good agreement with recent measurements at JRC Geel.
3. A new measurement is planned at 5 MeV at the new JRC Tandem Monnet.

Neutron-multiplicity experiments for enhanced fission modelling
A. Al-Adili, Diego Tarrío, F.-J. Hambsch, et al. EPJ Web of Conferences **146**, 04056 (2017), ND2016

Analysis of prompt fission neutrons in 235U(nth,f) and fission fragment distributions for the thermal neutron induced fission of 234U
A. Al-Adili, D. Tarrío, F.-J. Hambsch, et al. EPJ Web of Conferences **122**, 01007 (2016), CNR*15

Studying fission neutrons with 2E-2v and 2E
A. Al-Adili, K. Jansson, et al.
In press, proceedings for THEORY-4: Scientific Workshop on Nuclear Fission dynamics and the Emission of Prompt Neutrons and Gamma Rays

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Studies of fission fragments and prompt-fission neutrons

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1 Department of Physics and Astronomy, Uppsala University, Sweden

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NUSPRASEN 2018-01-22

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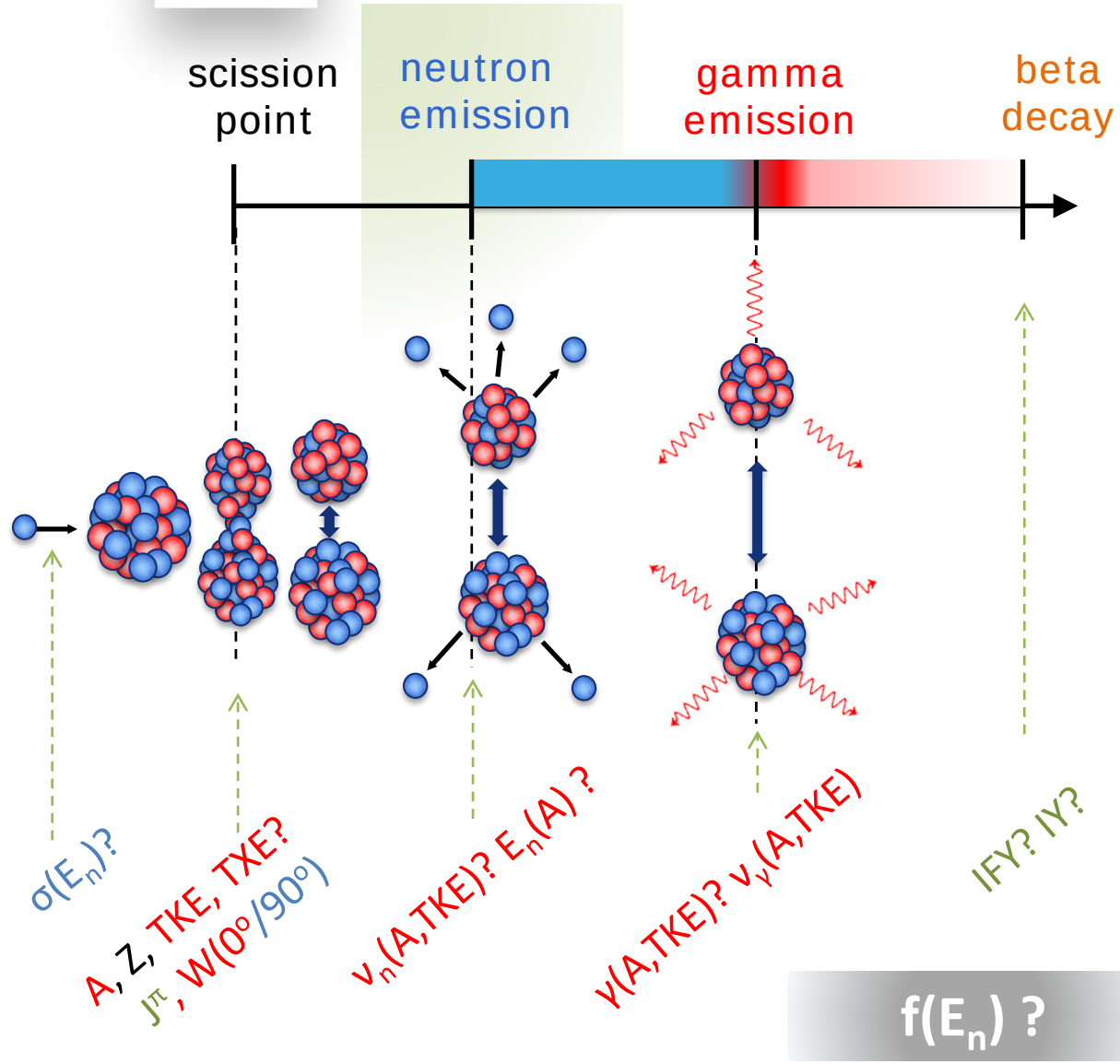
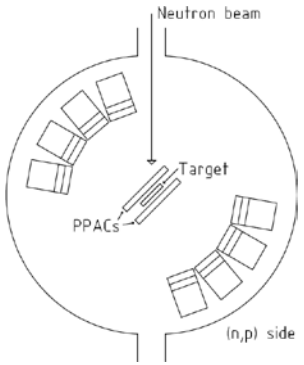
THANKS FOR YOUR ATTENTION

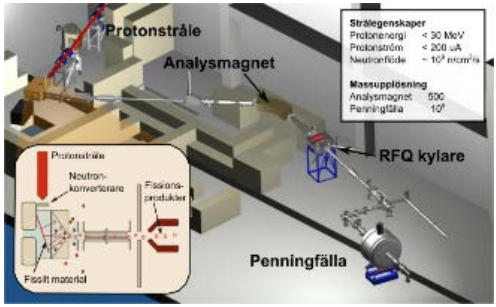
Our fission research





MEDLEY group
NFS, FRANCE

EC-JRC-GEEL GROUP,
Belgium

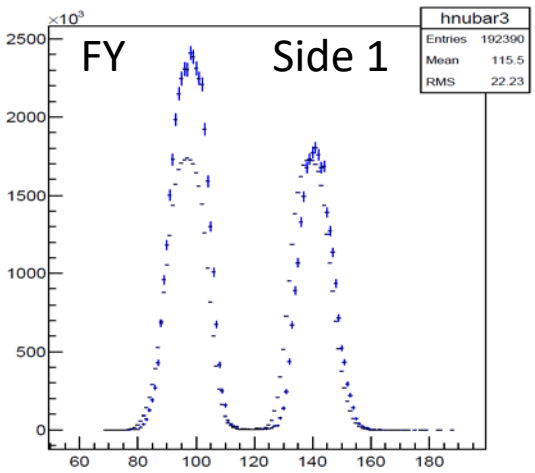


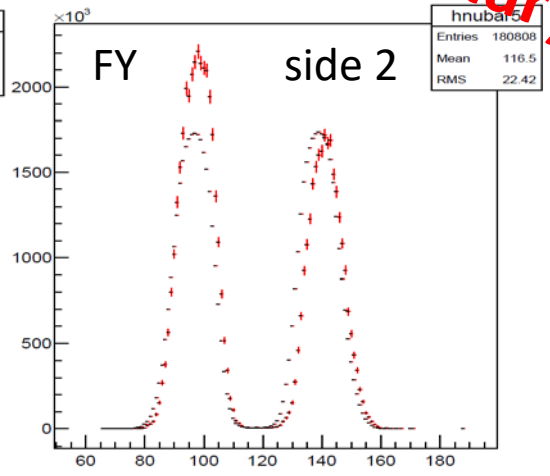
IGISOL GROUP
Finland

Results U-235 thermal data

Preliminary

- We confirm the data of Göök et al.





$\bar{\nu}(A)$