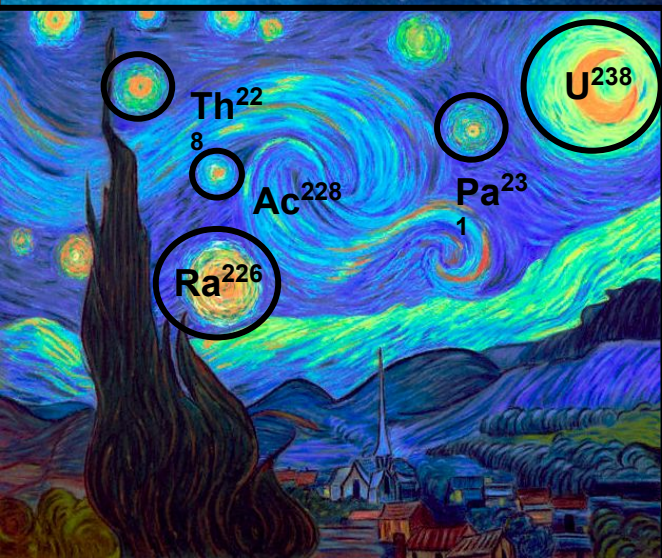


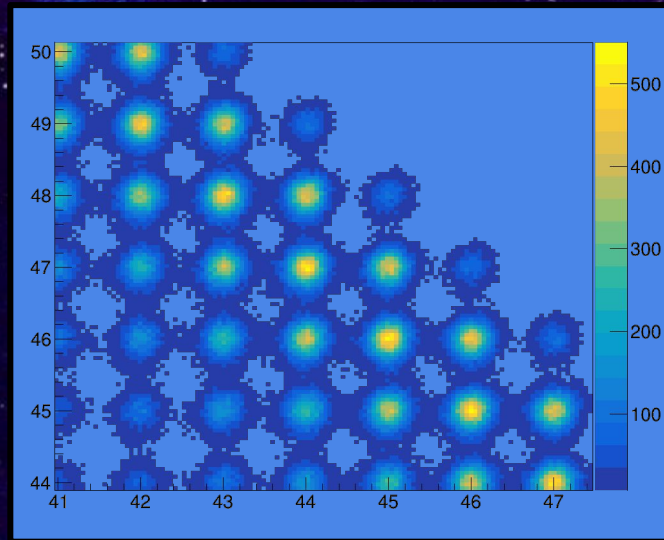
Quasi-free (p,2p) induced fission on ^{238}U

Current status of detector calibrations and data analysis from experiment s455.



Antía Graña González

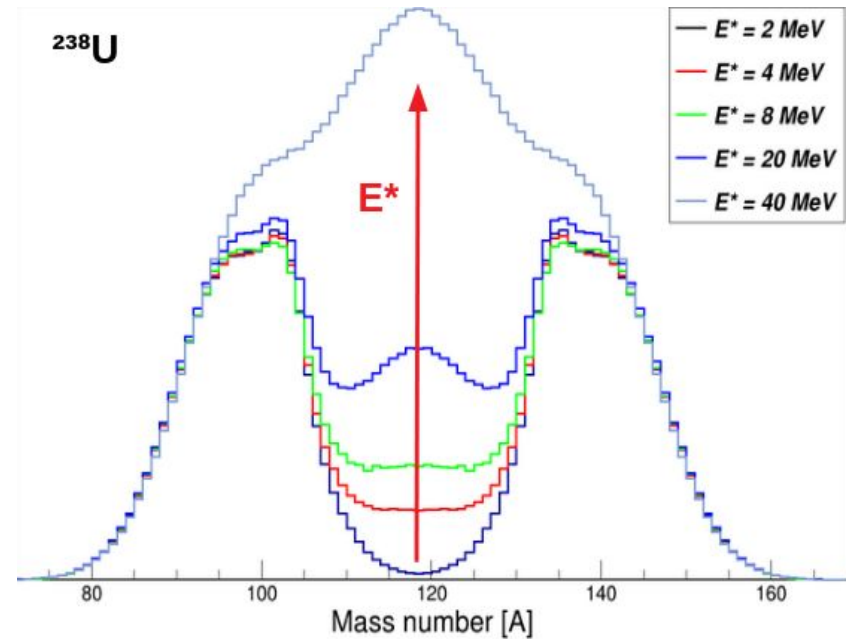
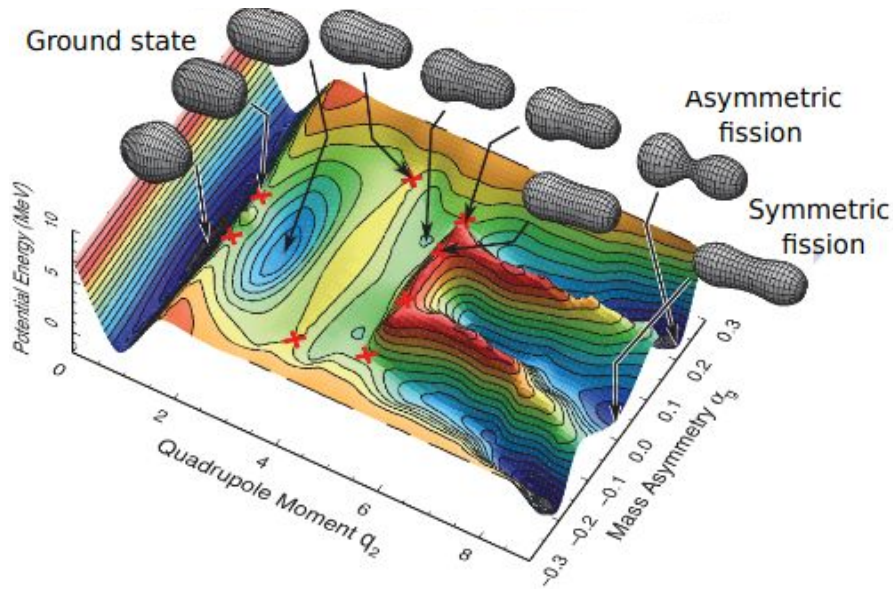
antia.grana.gonzalez@usc.es



1. Introduction

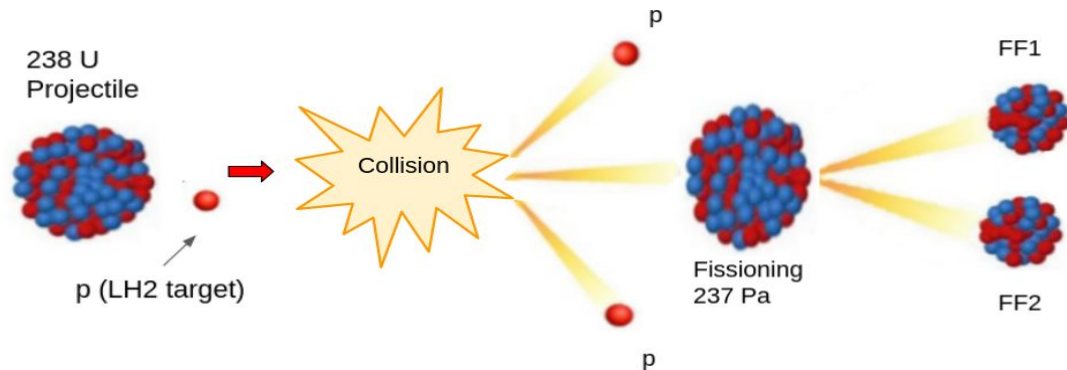
Experiment S455: (p,2p) - fission experiment.

Scientific goal: correlate the fission yields with the excitation energy. The excitation energy can populate different regions of the potential landscape, leading to different fission paths.



1. Introduction

New approach: obtain the **excitation energy of the fissioning nucleus**. Hence we induce fission via **(p, 2pf) reactions**. The measurement of the momenta of the outgoing protons allows to reconstruct the excitation energy.

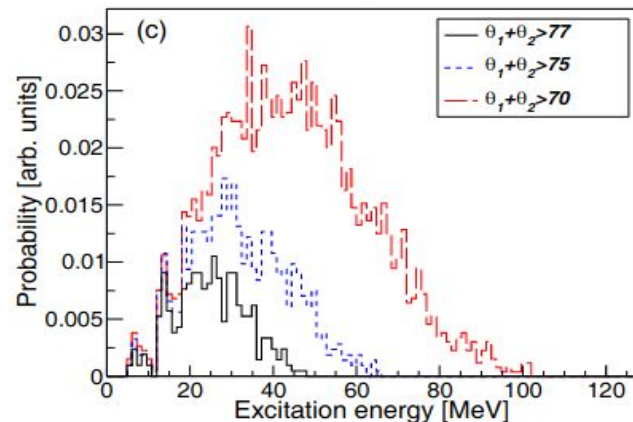
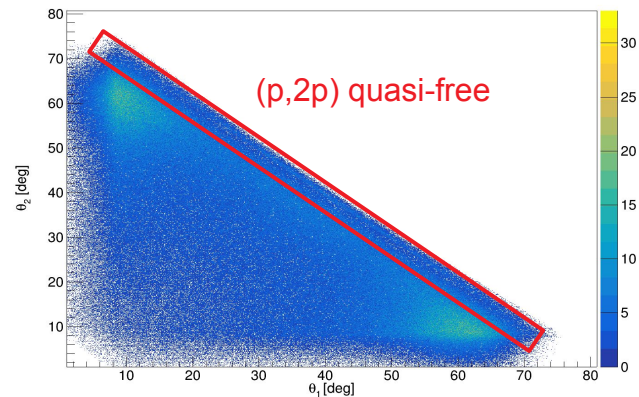


$$\vec{P}_{beam} + \vec{P}_{target} = \vec{P}_p + \vec{P}_p + \vec{P}_{fissioning\ nucleus}$$

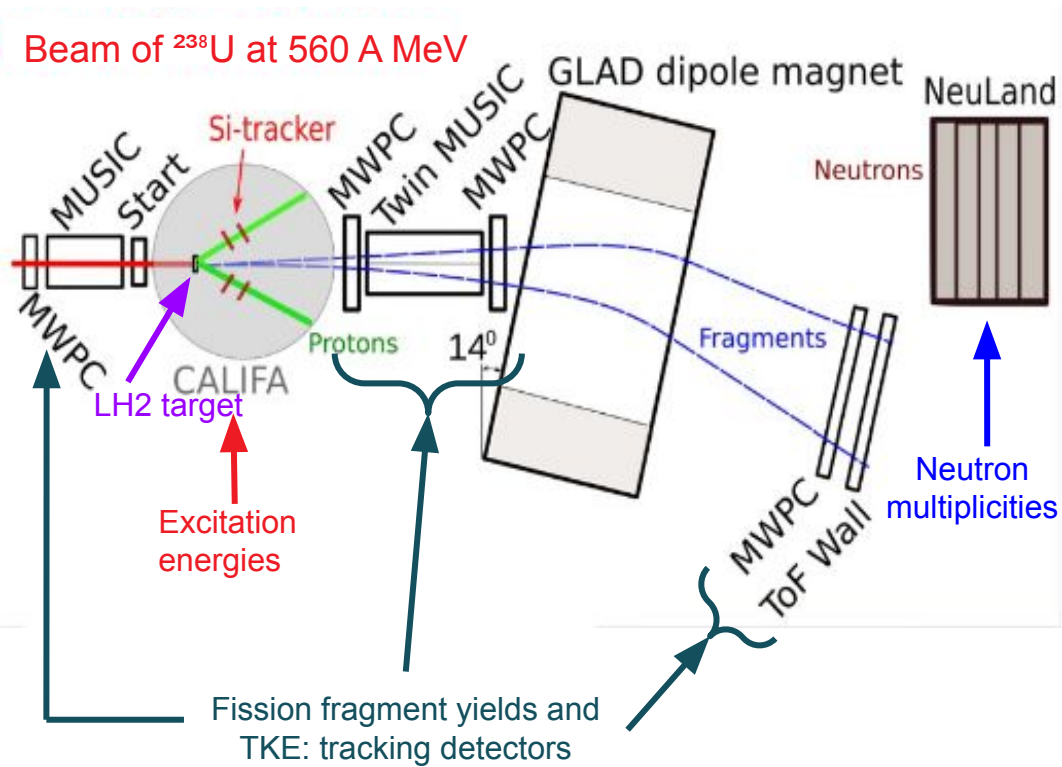
$$\begin{pmatrix} E_A \\ 0 \\ 0 \\ p_{zA}c \end{pmatrix} + \begin{pmatrix} m_{p1}c^2 \\ 0 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} E_{p1} \\ p_{xp1}c \\ p_{yp1}c \\ p_{zp1}c \end{pmatrix} + \begin{pmatrix} E_{p2} \\ p_{xp2}c \\ p_{yp2}c \\ p_{zp2}c \end{pmatrix} + \begin{pmatrix} E_{A-1} \\ p_{xA-1}c \\ p_{yA-1}c \\ p_{zA-1}c \end{pmatrix}$$

Missing energy method

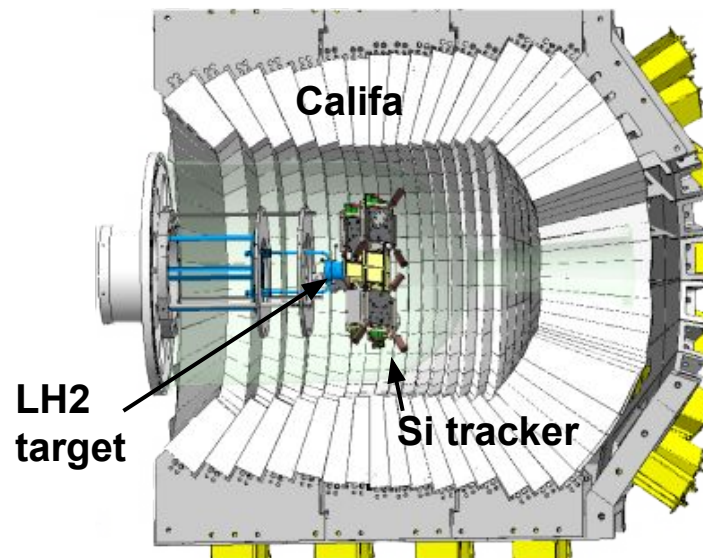
$$E^* = Q - m_{A-1}c^2$$



2. Set-up

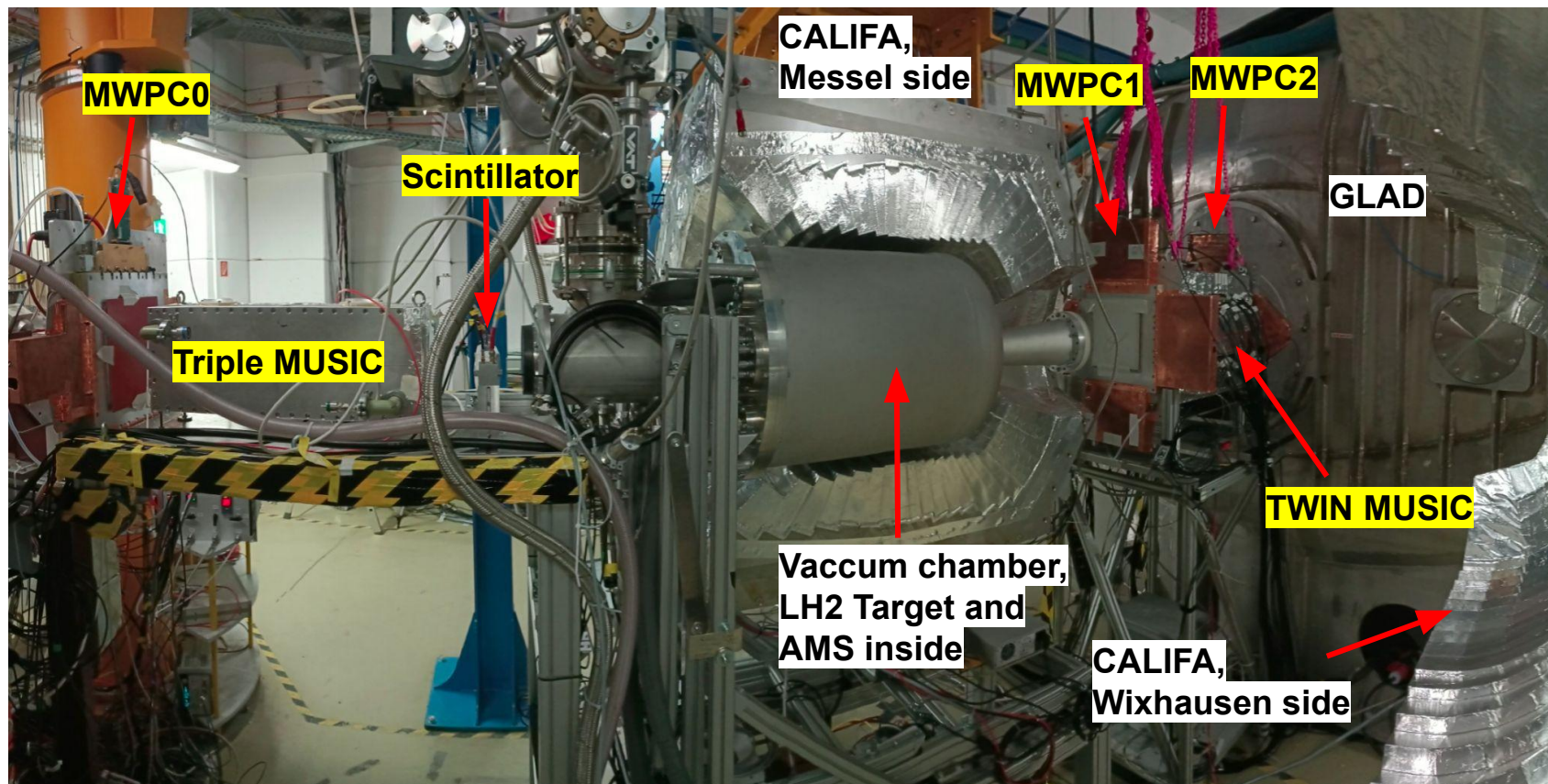


- **Excitation energy of the fissioning system: Califa and Silicon tracker surrounding the LH2 target.**
 - Energy res. protons(gamma)
1%(5.5% at 1.3 MeV)
 - Position res. 70 μ m



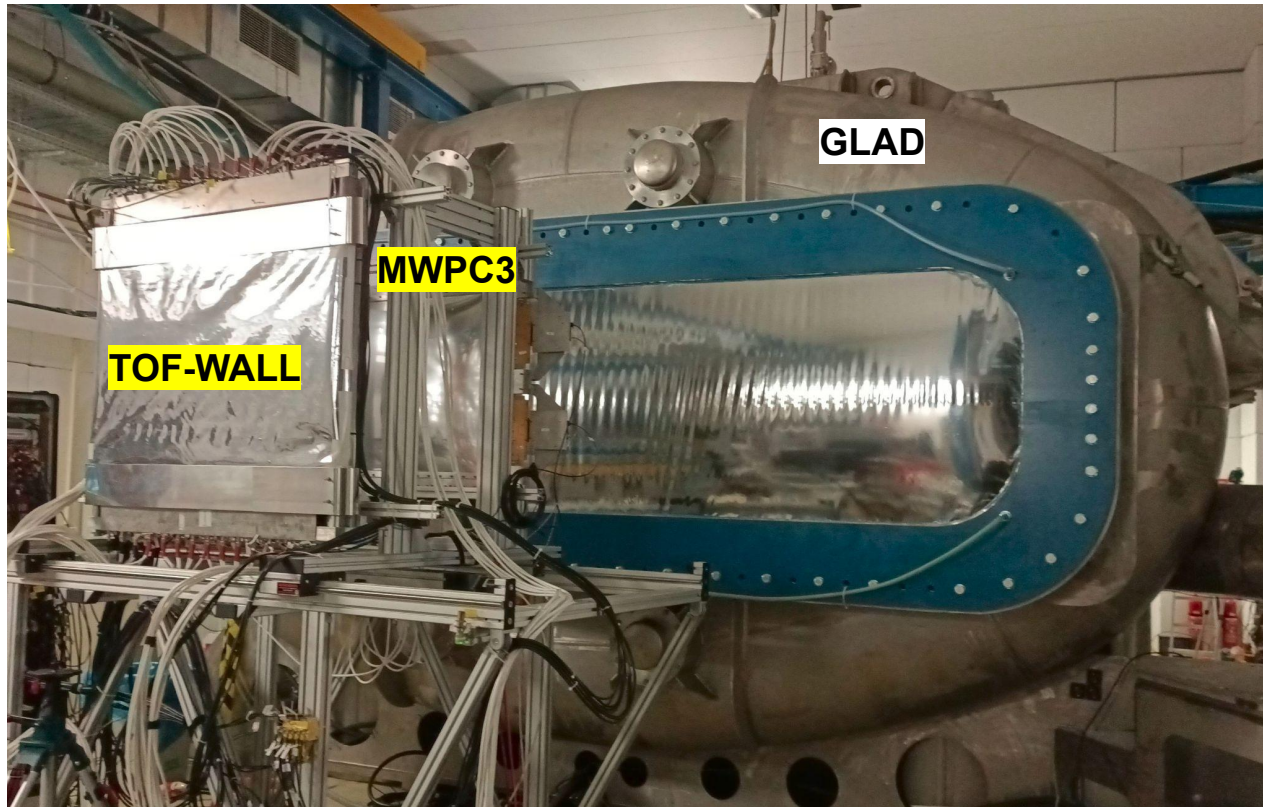
2. Set-up

Detectors before GLAD:



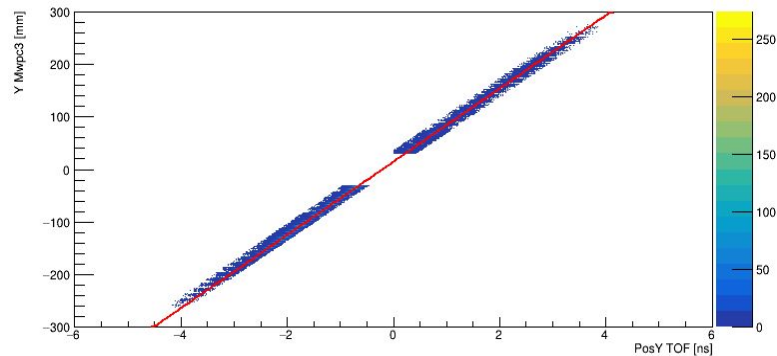
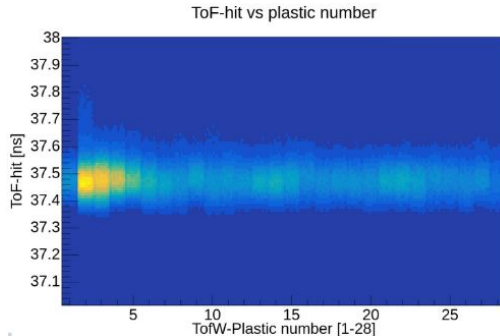
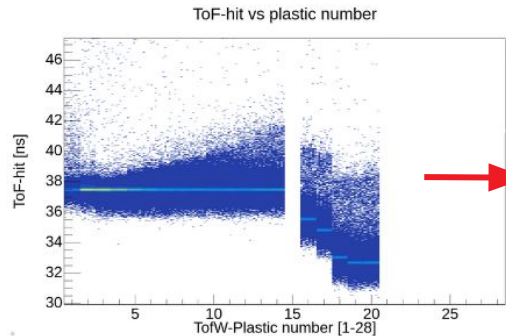
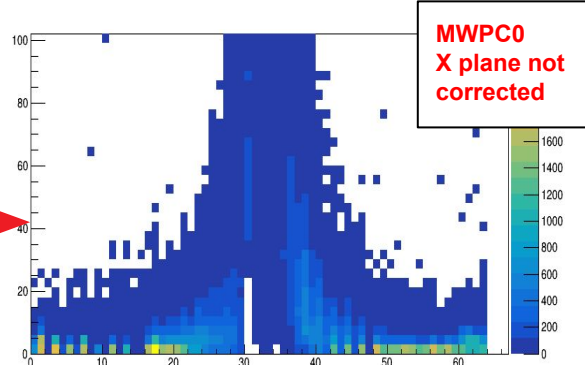
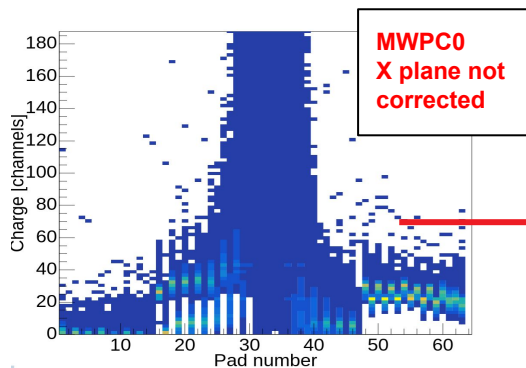
2. Set-up

Detectors after GLAD:



3. Analysis status

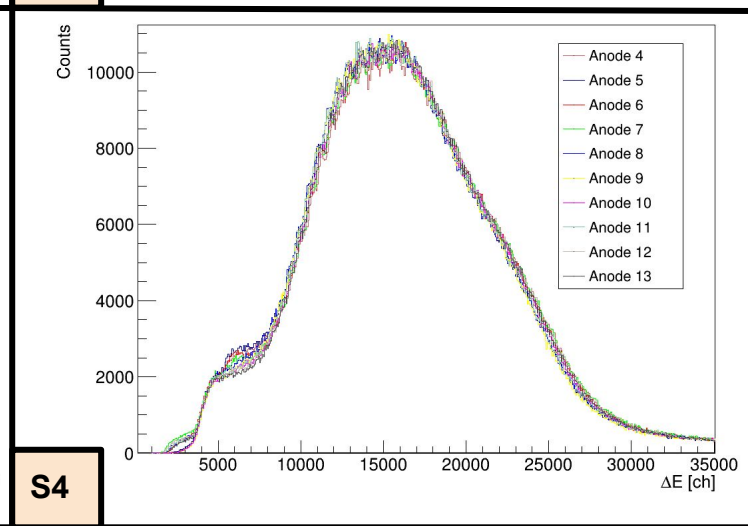
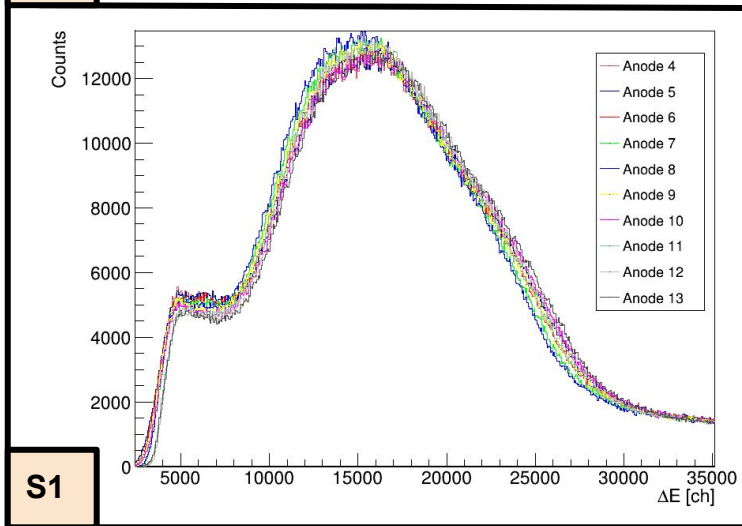
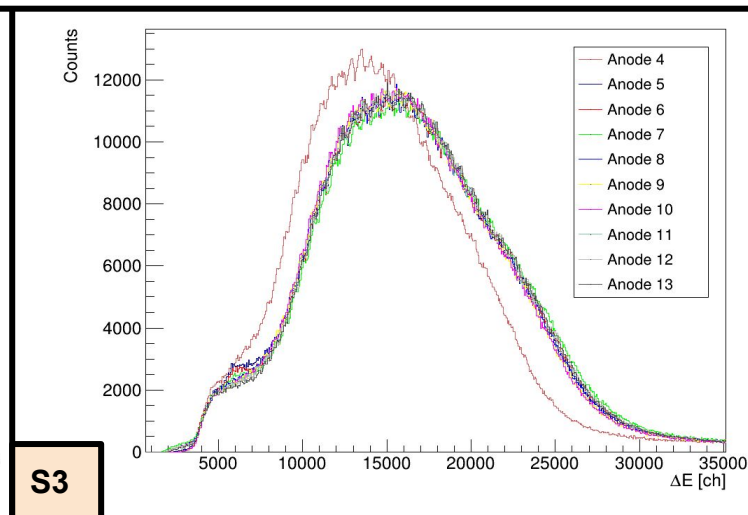
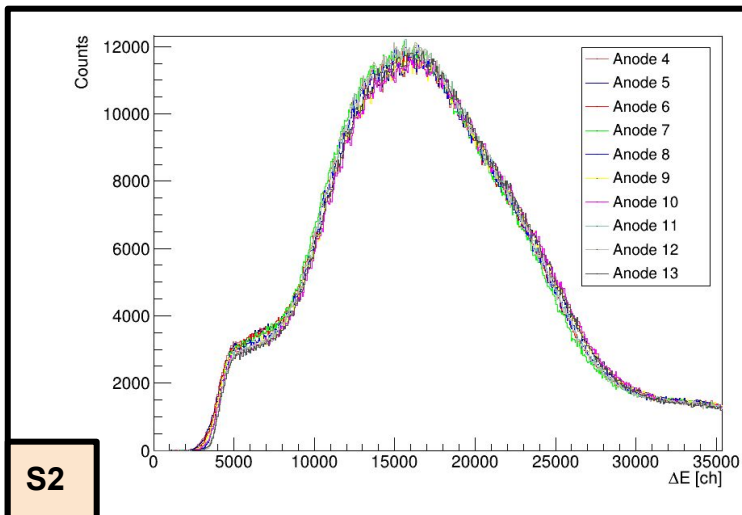
- MWPCs
- TOFWall



- TWIM
 - Anodes alignment
 - TOF correction
 - Drift time correction
 - Sections alignment

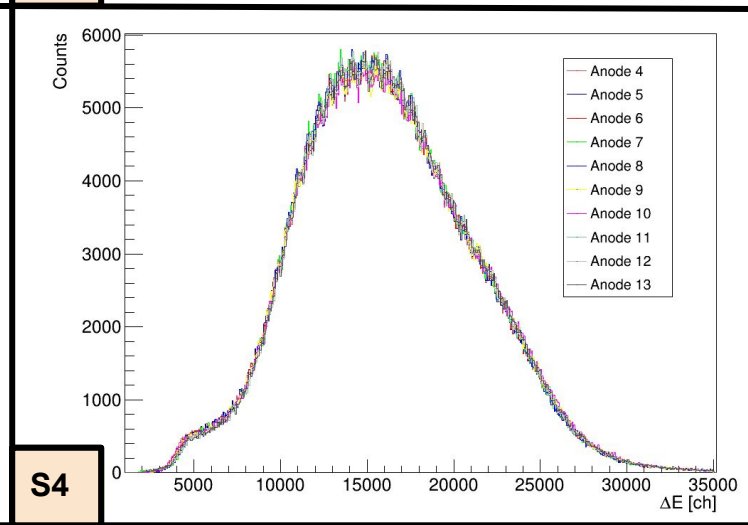
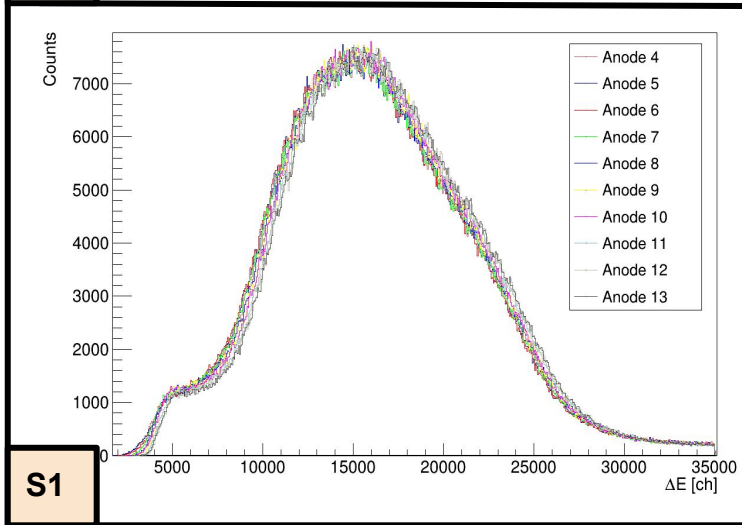
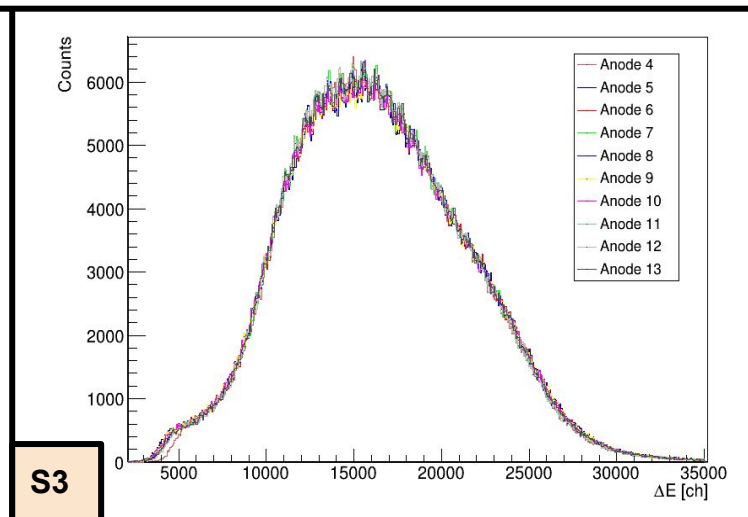
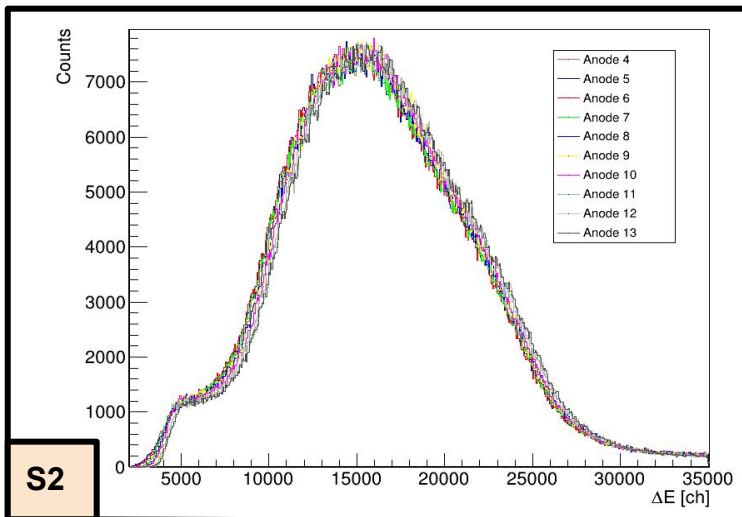
3. Analysis status

3.1 TWIM MUSIC Anodes de-aligned



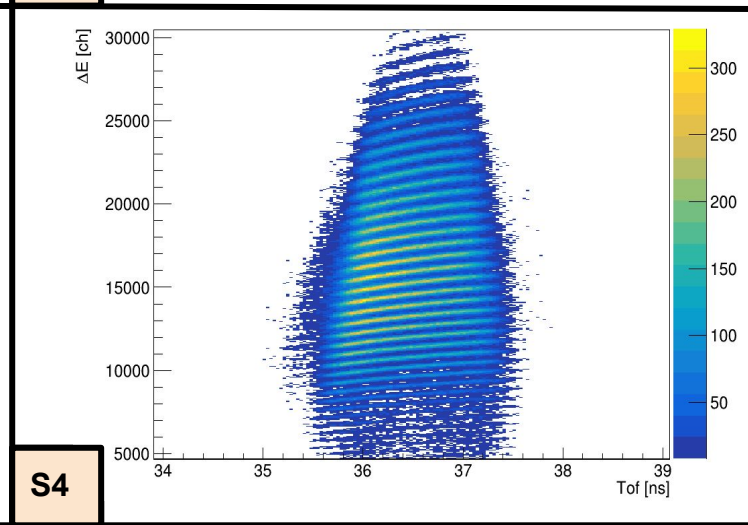
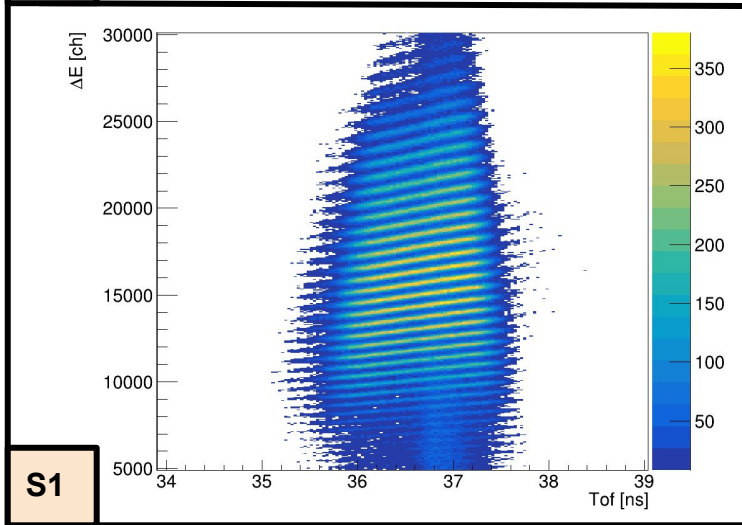
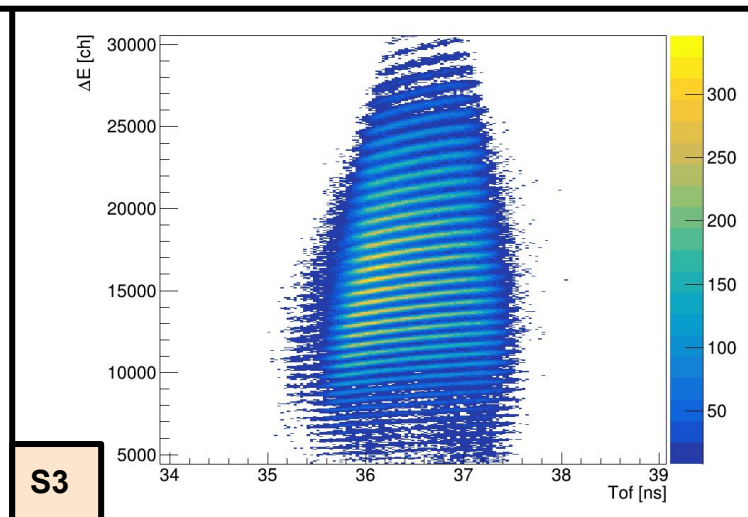
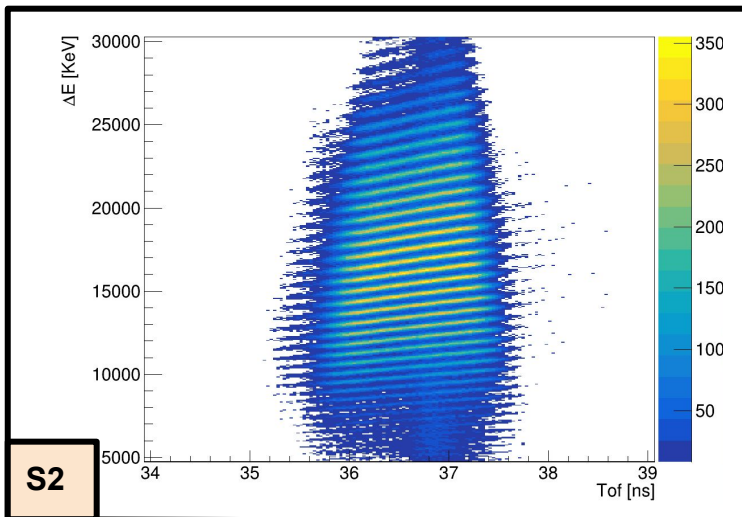
3. Analysis status

3.1 TWIM MUSIC Anodes aligned



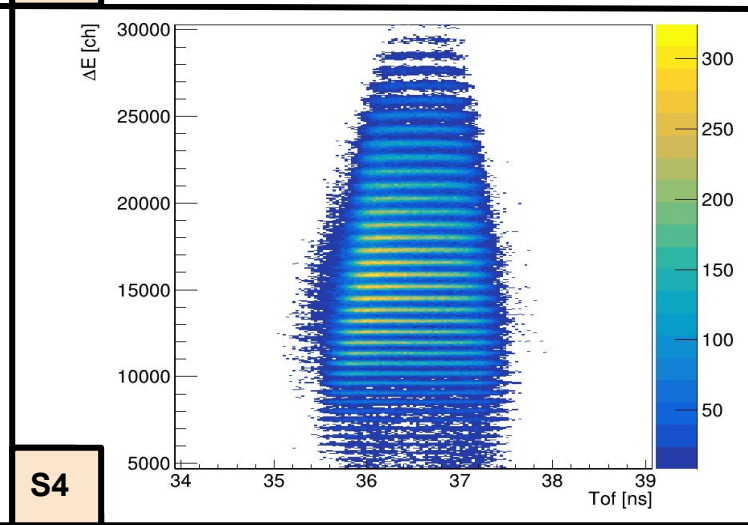
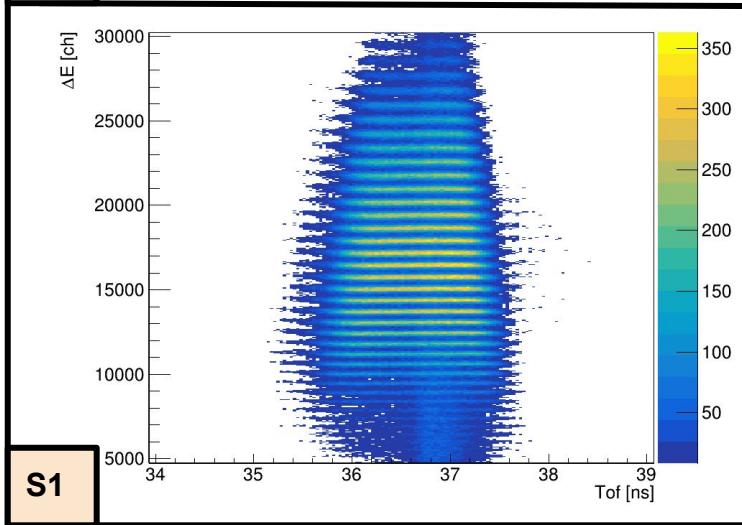
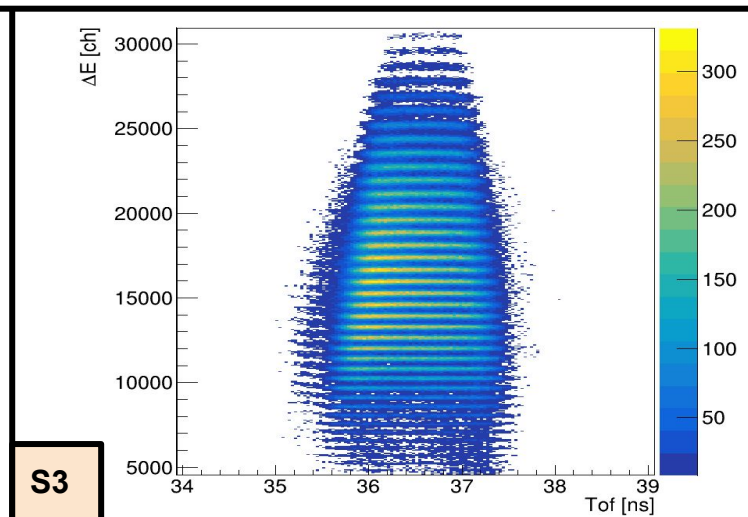
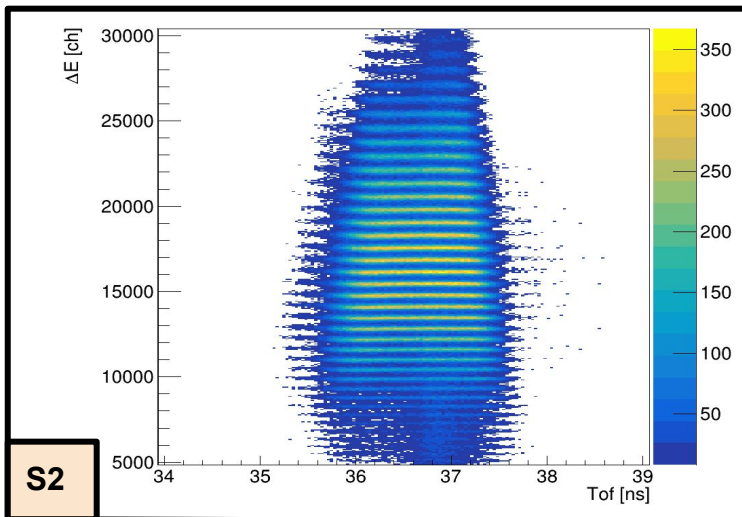
3. Analysis status

3.2 TWIM
MUSIC
TOF non corrected



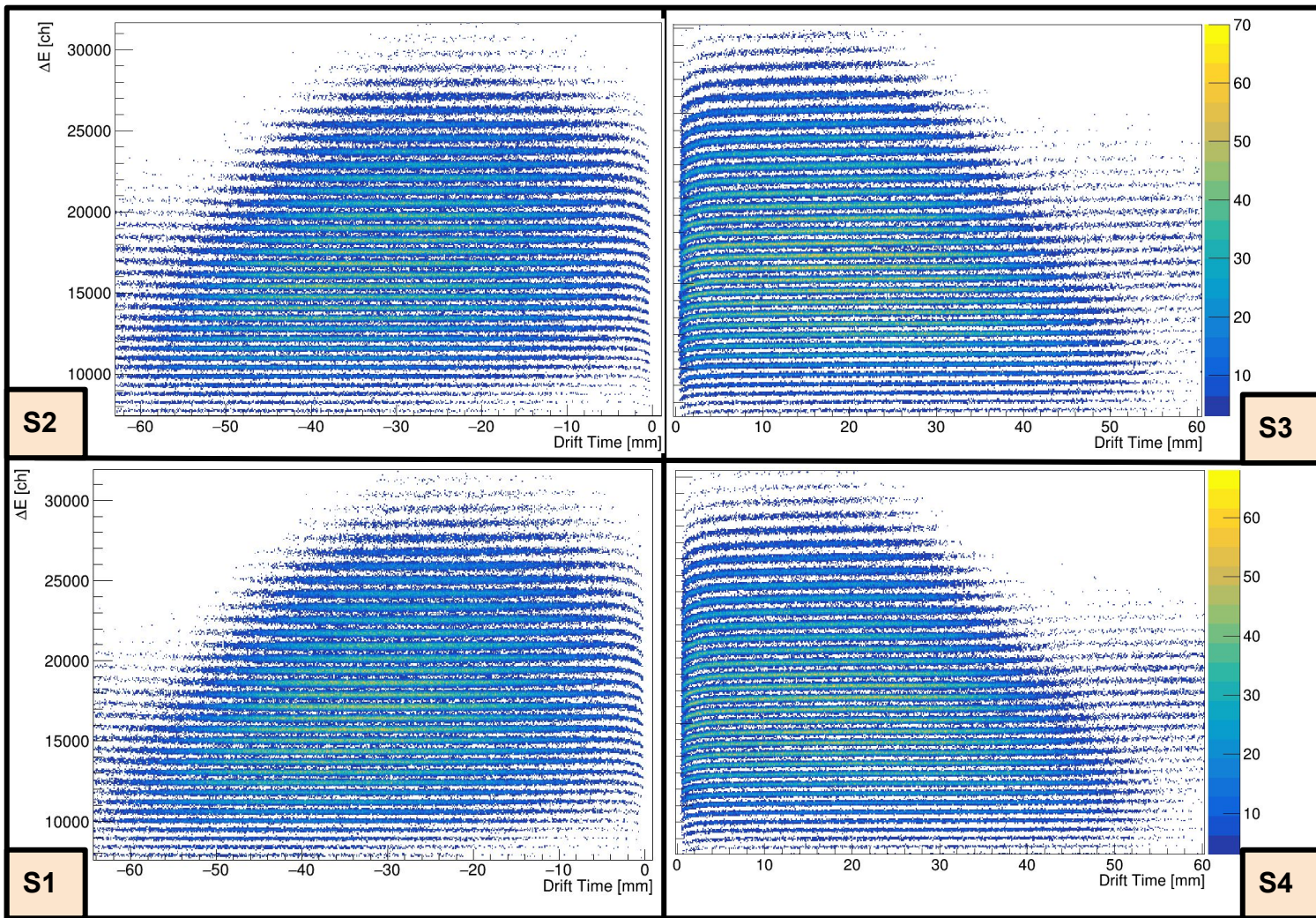
3. Analysis status

3.2 TWIM
MUSIC
TOF
corrected



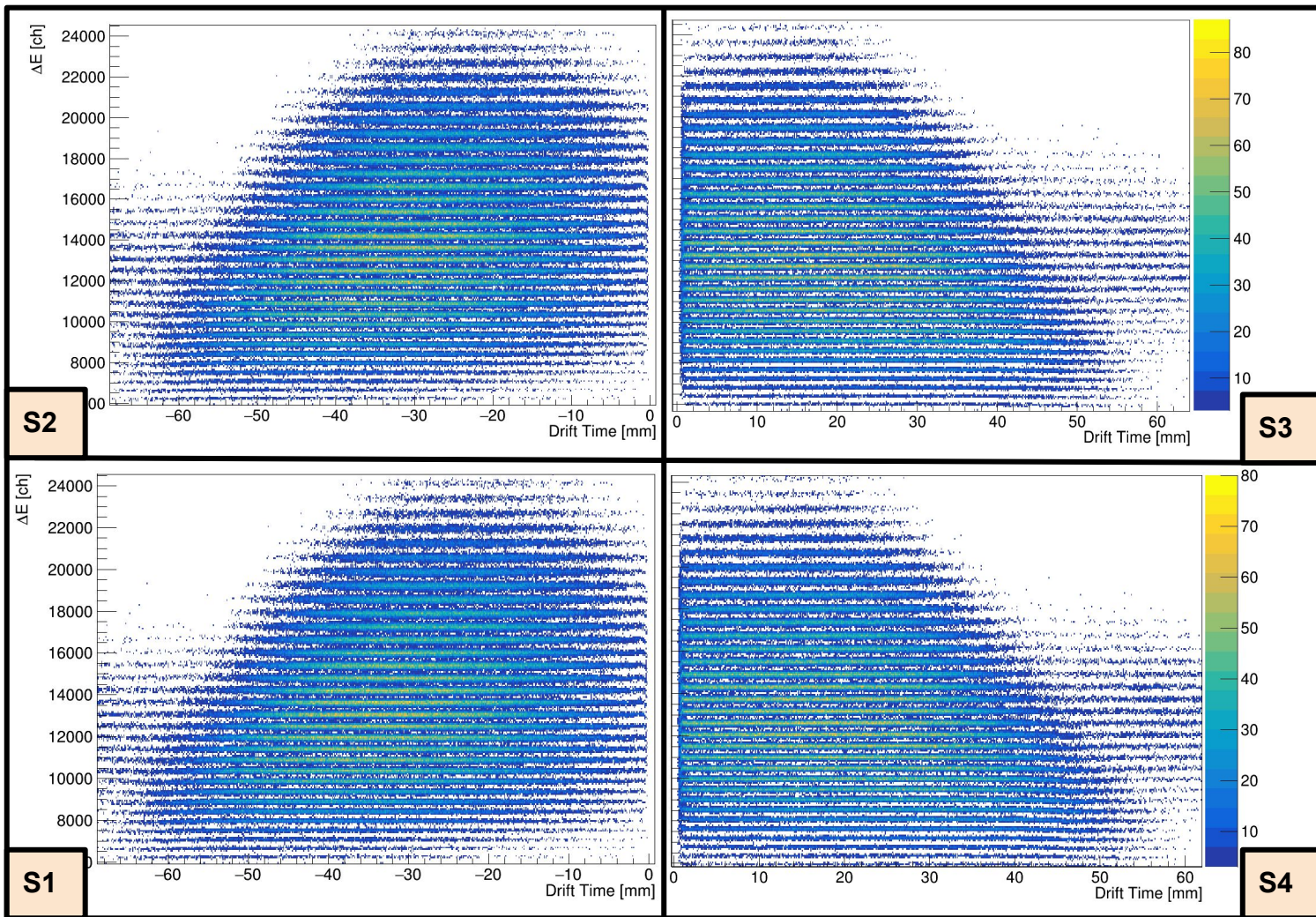
3. Analysis status

3.3 TWIM MUSIC Drift time non corrected



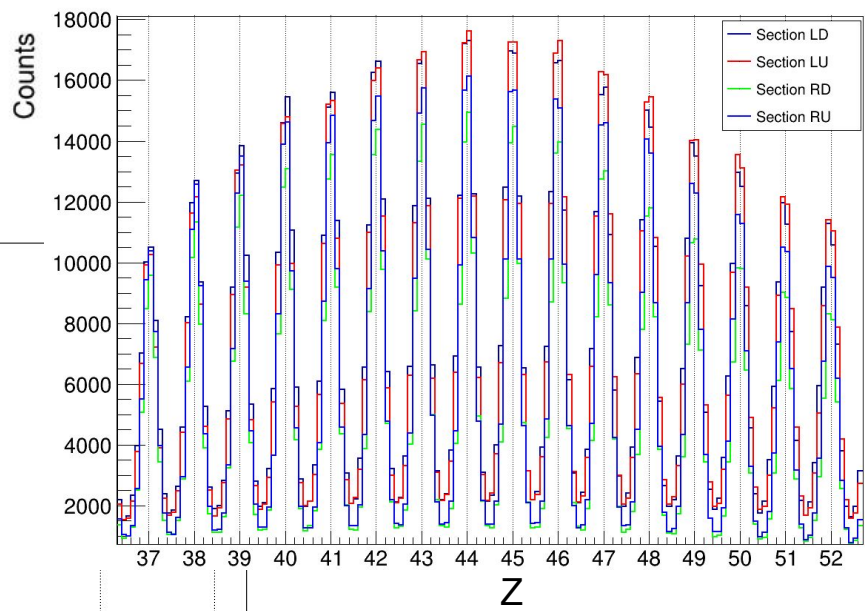
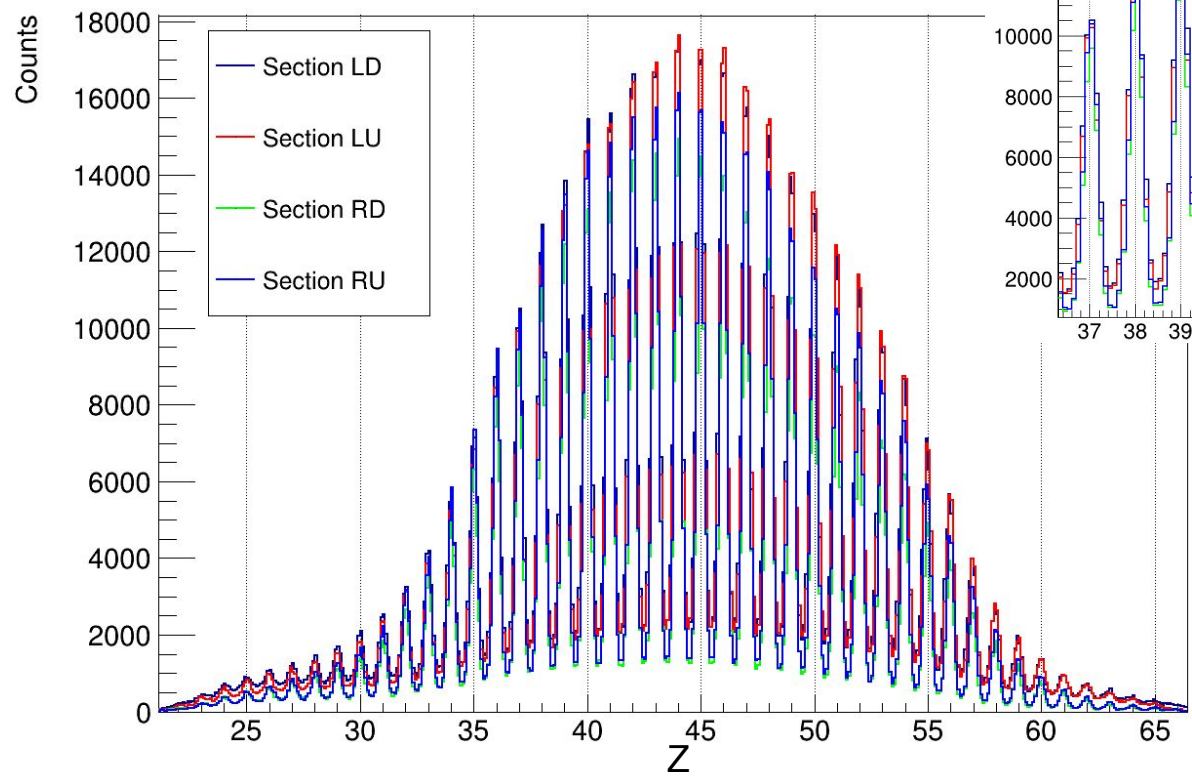
3. Analysis status

3.3 TWIM MUSIC Drift time corrected



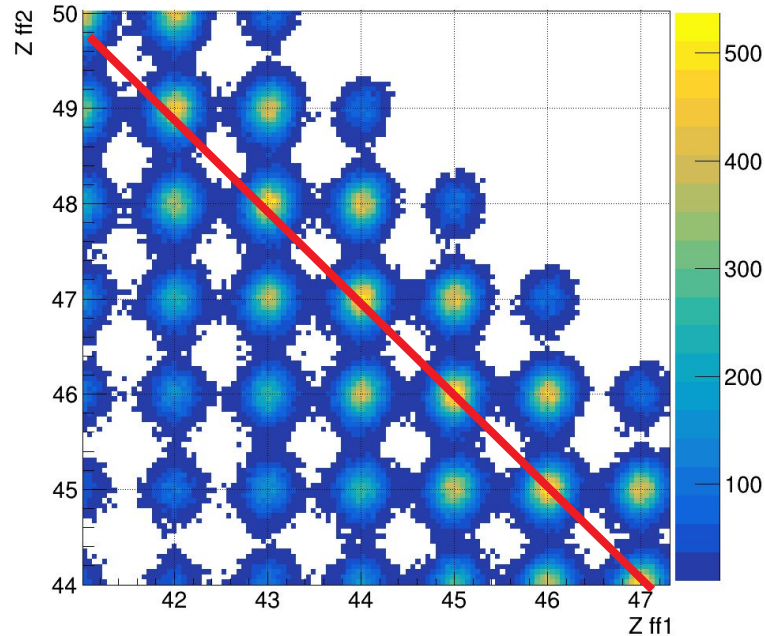
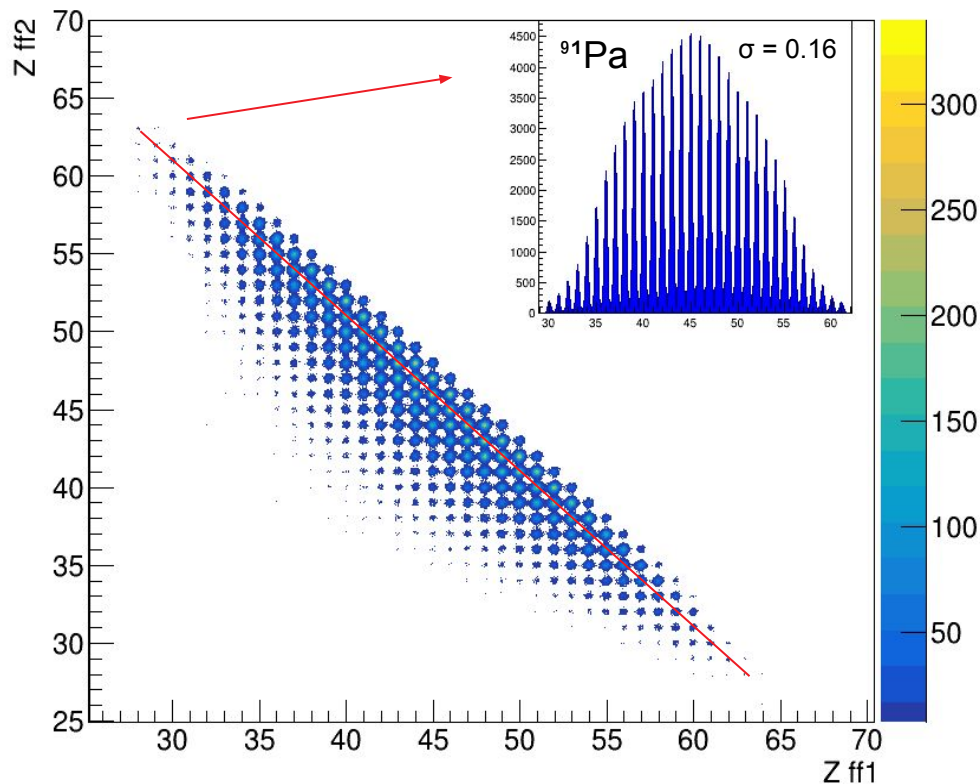
3. Analysis status

3.4 Sections aligned



4. First results

4.1 Charge identification

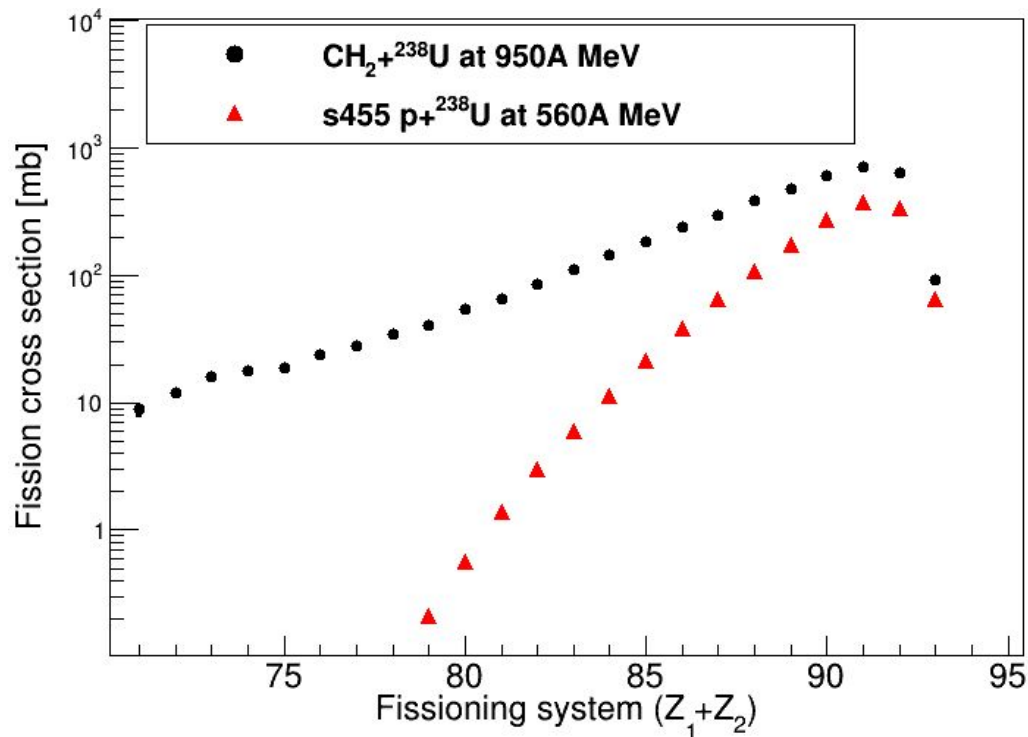


4. First results

4.2 Fission cross sections

Cross section of each fissioning system obtained multiplying the yields by the fission cross section.

The fission cross section (1500 mb) was taken from Eur. Phys. J. Plus 132, 120 (2017)



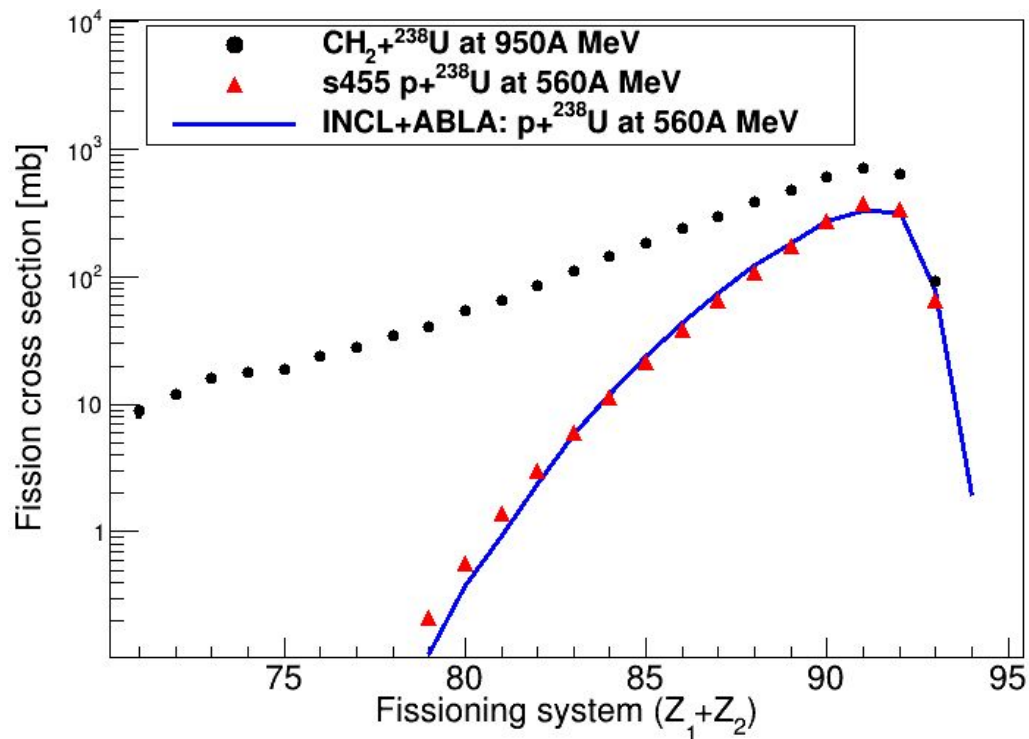
As expected, the fission cross sections for the p,2pf reactions (spallation) are lower than the ones from fragmentation reactions. Since less nucleons are removed for the spallation reactions, its fissioning system range is shorter (differentiable peaks between ~79-93).

4. First results

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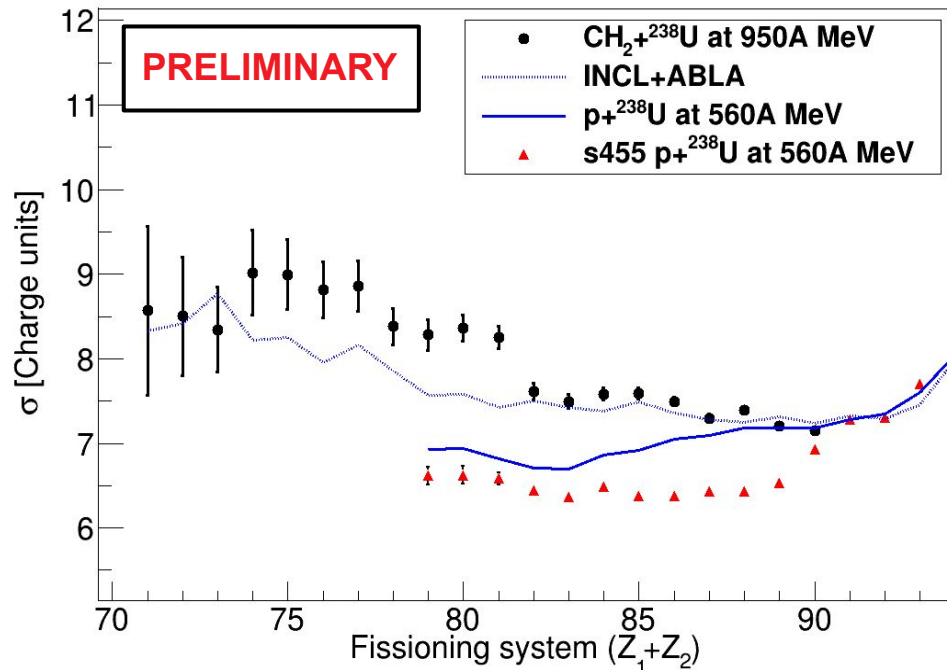
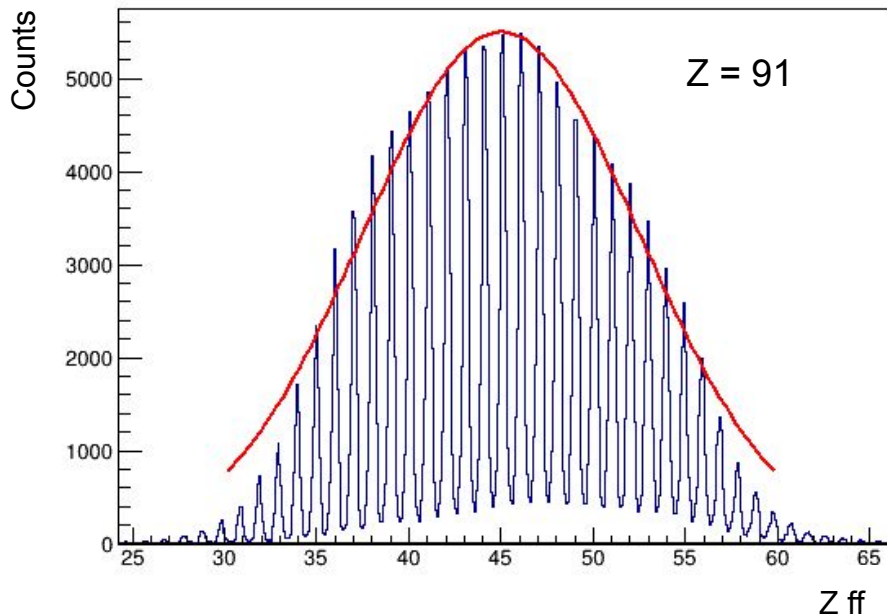
Results are compatible with the theoretical calculations from INCL+ABLA.

4. First results

4.2 Fission fragments charge distribution widths

Widths depend on the fissioning system and temperature

$$\sigma_Z^2 = Z_{fiss}^2 \cdot T^{sad} / (16 \cdot d^2 V / d\eta^2)$$



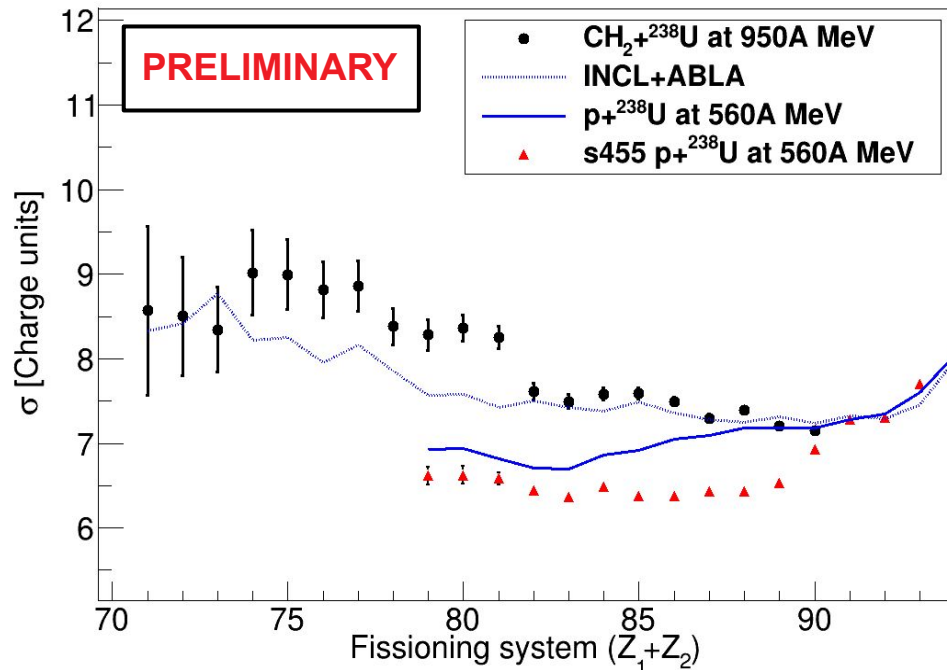
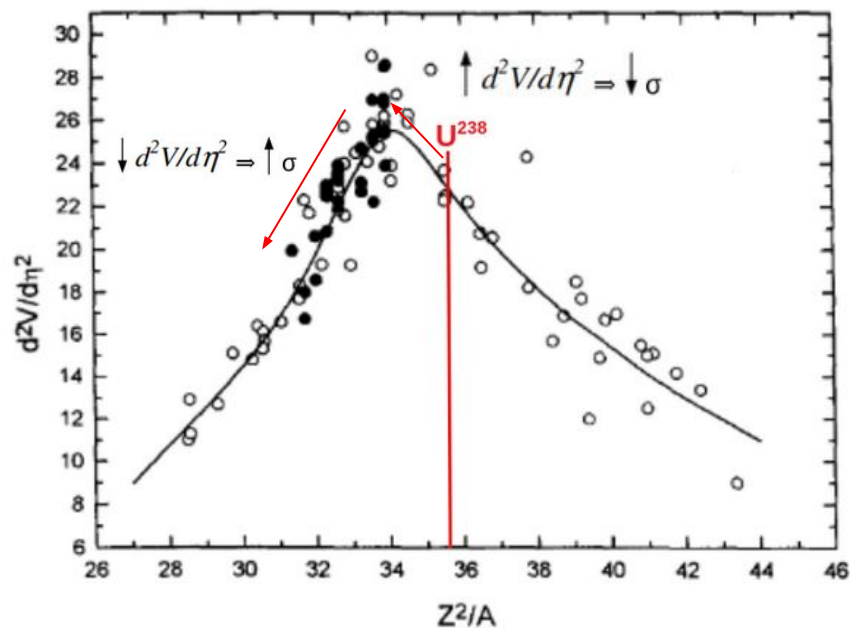
*Correct by geometrical efficiency of GLAD

4. First results

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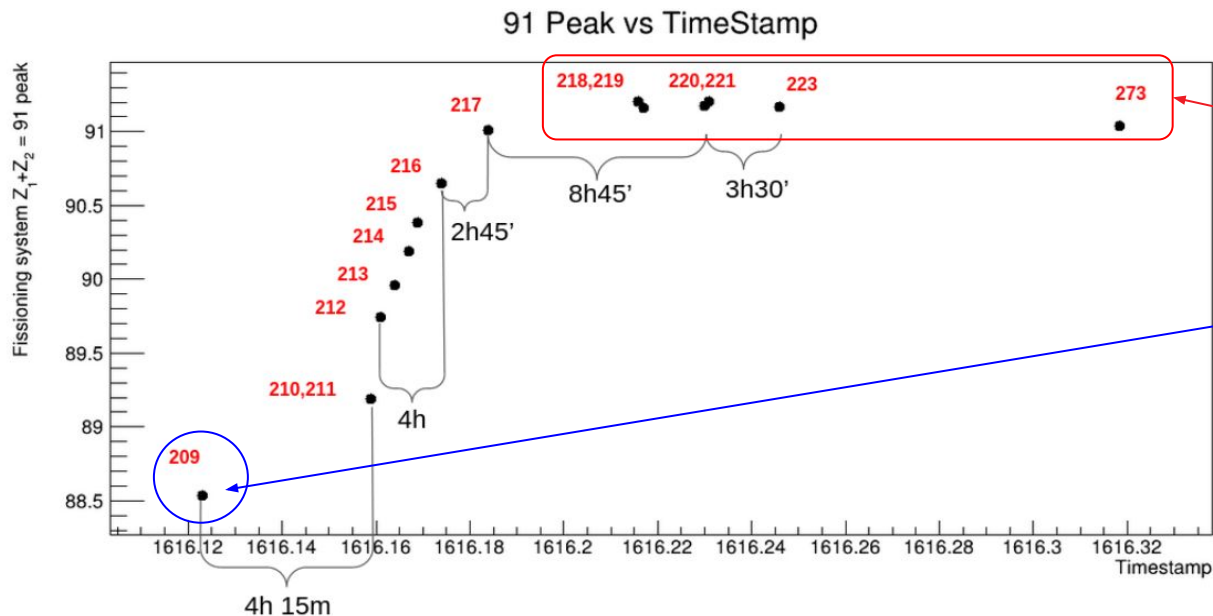
4. First results

4.3 Calibrated files

S455 (p,2p) Repository

Unpack data: /R3BParams_S455p2p/macros/exp/unpack/unpack_offline.C

Calibrate data: /R3BParams_S455p2p/macros/exp/unpack/cal_offline.C



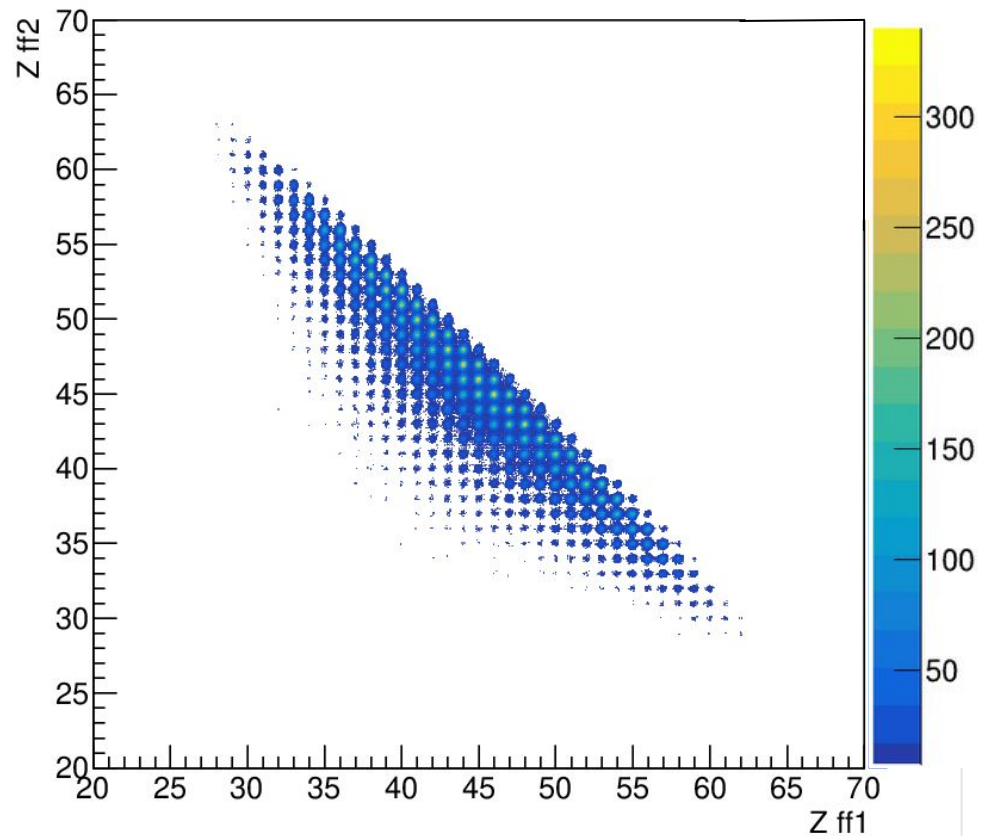
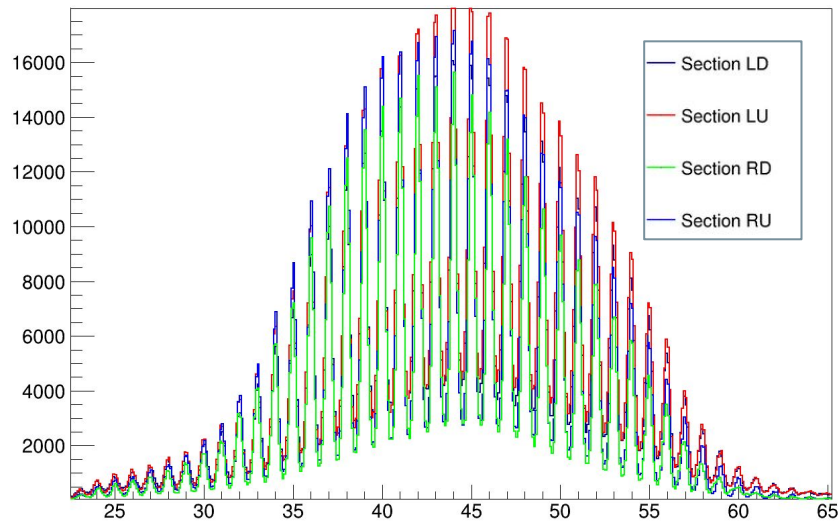
Parameters file for runs **223-274**:
/R3BParams_S455p2p/parameters
/CalibParam.par
273-> 108GB

Parameters file for run **209**:
/R3BParams_S455p2p/parameters
/CalibParam_209.par
209->91GB

4. First results

4.3 Calibrated files

Alignment and charge identification for 209+273

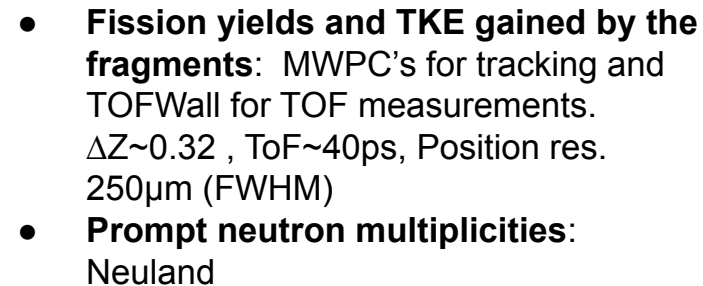


5. Summary and next steps

- First (p,2p)-fission experiment with ^{238}U to correlate the excitation energy with the fission yields:
 - Fission fragments identification.
 - Fission cross sections measured.
 - Fission fragments charge distribution widths.
- Isotopic identification of fission fragments.
- Fission yields dependence on fissioning system excitation energy.



1.3 Set-up



MWPC

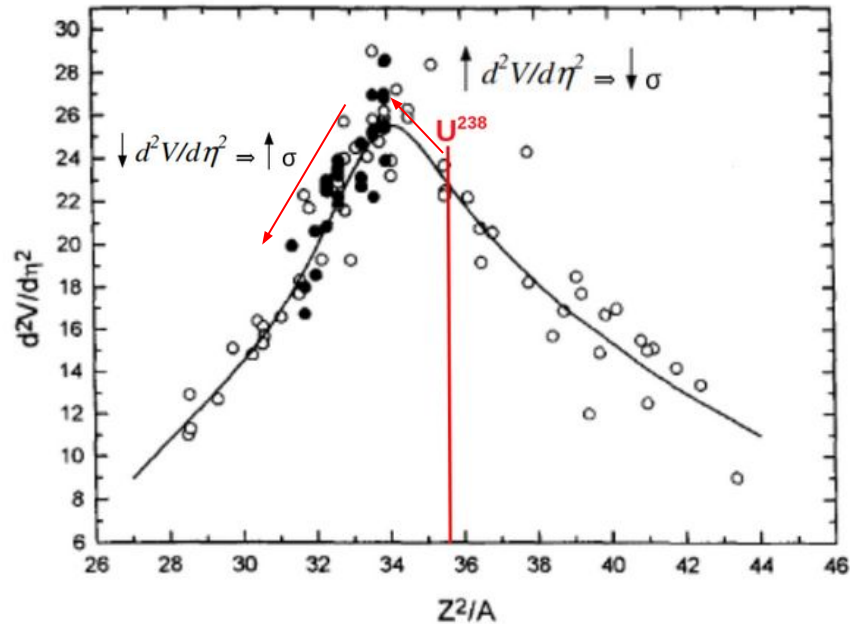


4. First results

4.2 Fission fragments charge distribution widths

Widths depend on the fissioning system and temperature

$$\sigma_Z^2 = Z_{fiss}^2 \cdot T^{sad} / (16 \cdot d^2V/d\eta^2)$$



Mass asymmetric
deformation:

$$n = (4/A_{fis}) / (M - A_{fis}/2)$$