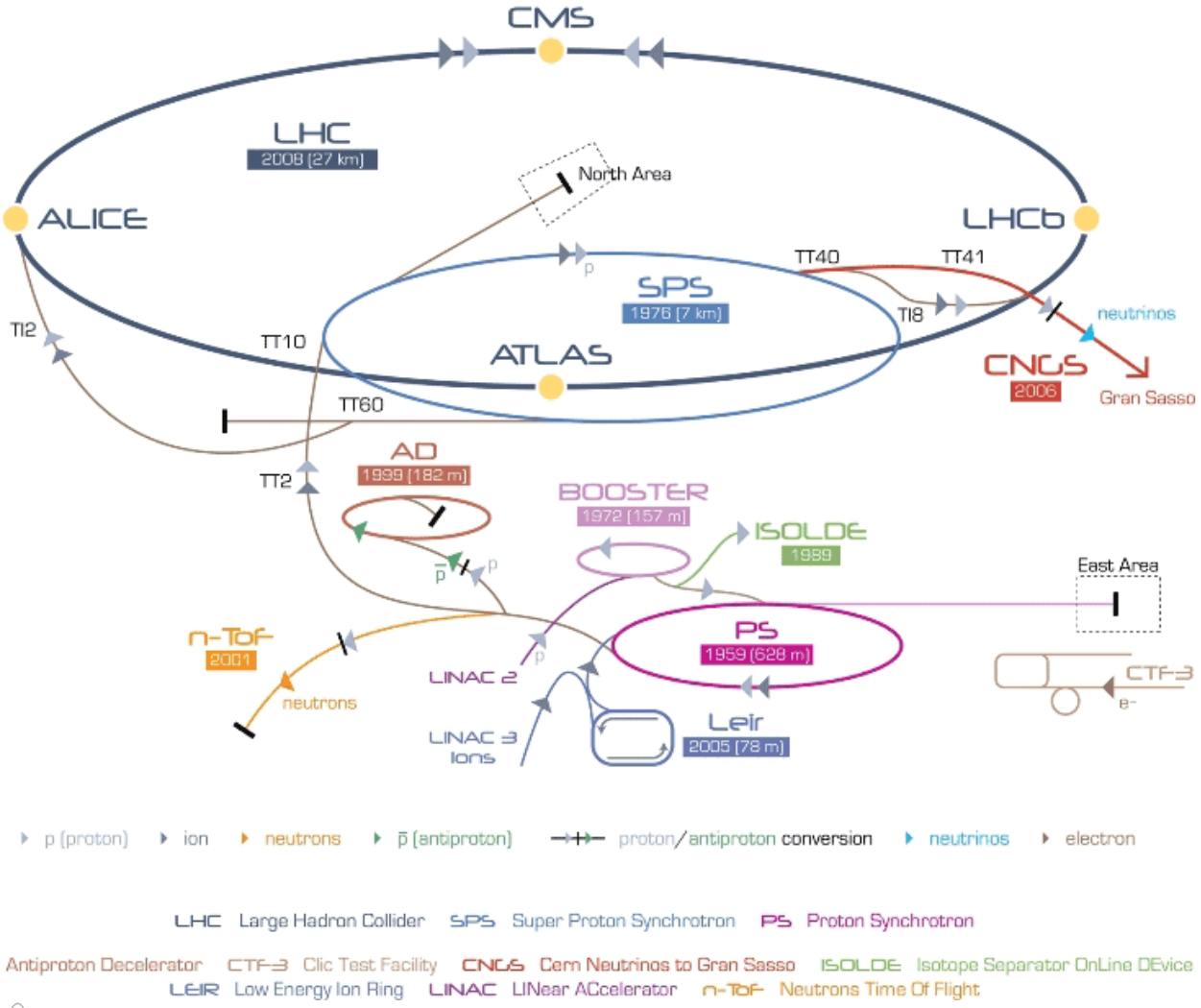
Set-up and test of a MicroMegas detector for the simultaneous measurements of (n,g) and (n,f) reactions in 235U at n_TOF

Summer Student Program 2012 at n_TOF Collaboration

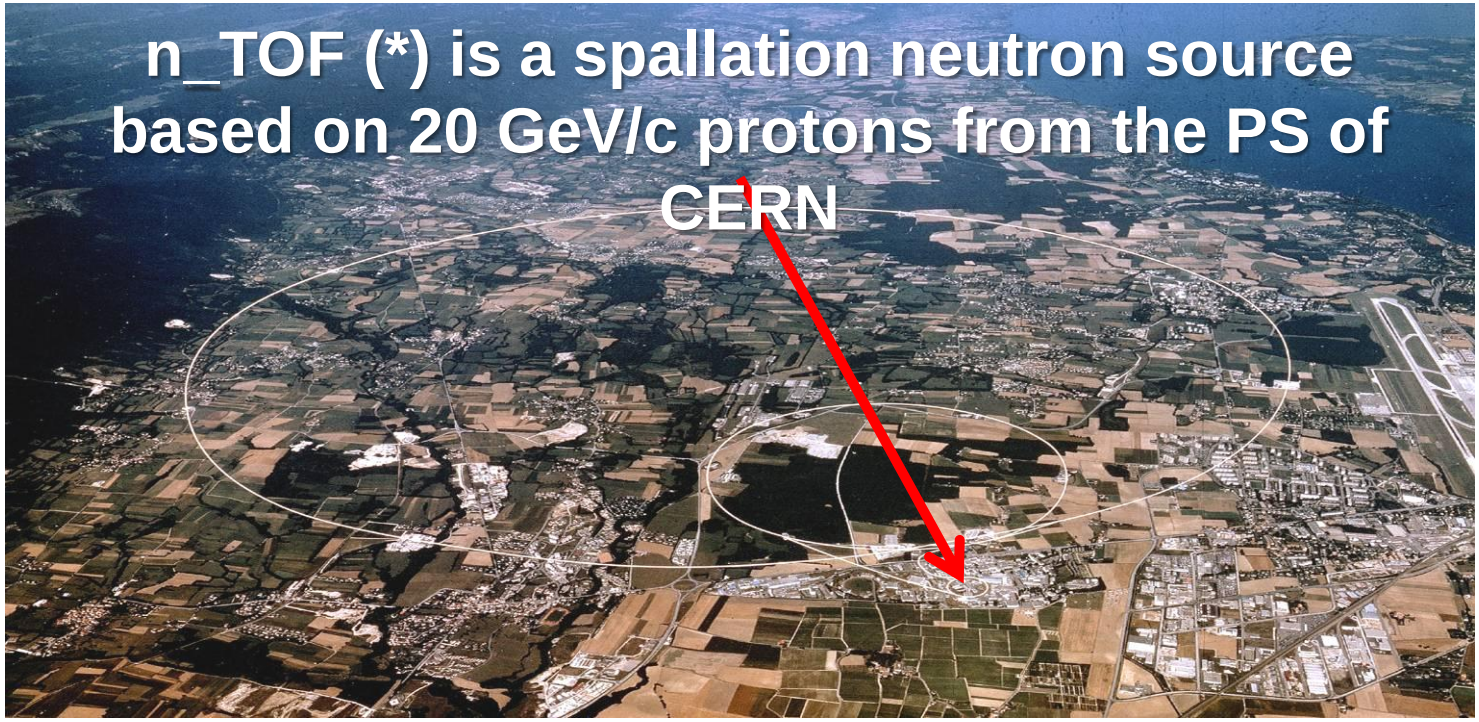
Universidad de Sevilla (Spain)

Sabaté Gilarte, Marta

CERN n_TOF (neutron_Time of Flight) facility

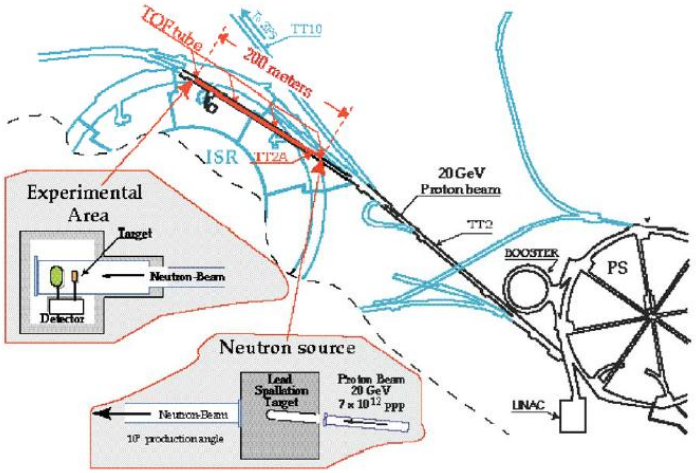


The n_TOF facility at CERN



(*) C Rubbia et al., A High Resolution Spallation Driven Facility at the CERN-PS to measure Neutron Cross Sections in the Interval from 1 eV to 250 MeV, CERN/LHC/98-02(EET) 1998.

n_TOF facility



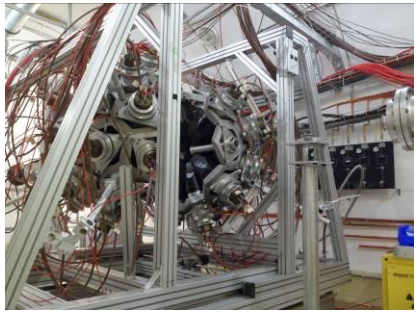
Main features of the n_TOF:

- Proton **intensity** *$8x10^{12}$ p/pulse*
- Proton beam **momentum** *20 GeV/c*
- Proton **pulse width** *6 ns (rms)*
- high **instantaneous n flux** *10^5 n/cm^2/pulse*
- wide energy **spectrum** *25 meV<E_n<1GeV*
- low **repetition** rate *< 0.8 Hz*
- good energy **resolution** *$\Delta E/E = 10^{-4}$*

Neutron beam + state-of-the-art detectors and acquisition systems make n_TOF UNIQUE for:

- measuring **radioactive isotopes**, in particular **actinides**
- identifying and studying **resonances** (at energies higher than before)
- extending **energy range** for fission (up to 1 GeV !).

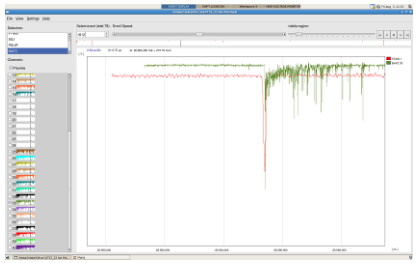
Simultaneous Measurement of Neutron - Induced Capture and Fission Reaction at CERN



- **Motivation:**

Measure with high accuracy the capture cross-section of fissile isotopes

Nuclear Technology:
- Design and operation of current and innovative nuclear system
- Reduction of the nuclear waste
- Accelerator Driven Systems (ADS) and Gen-IV reactors

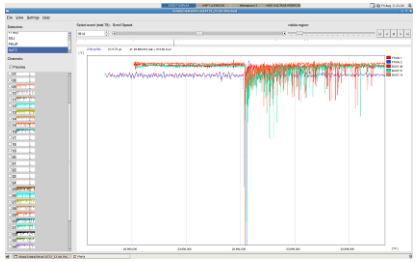


- **HOW?**
  - Combining two detectors:

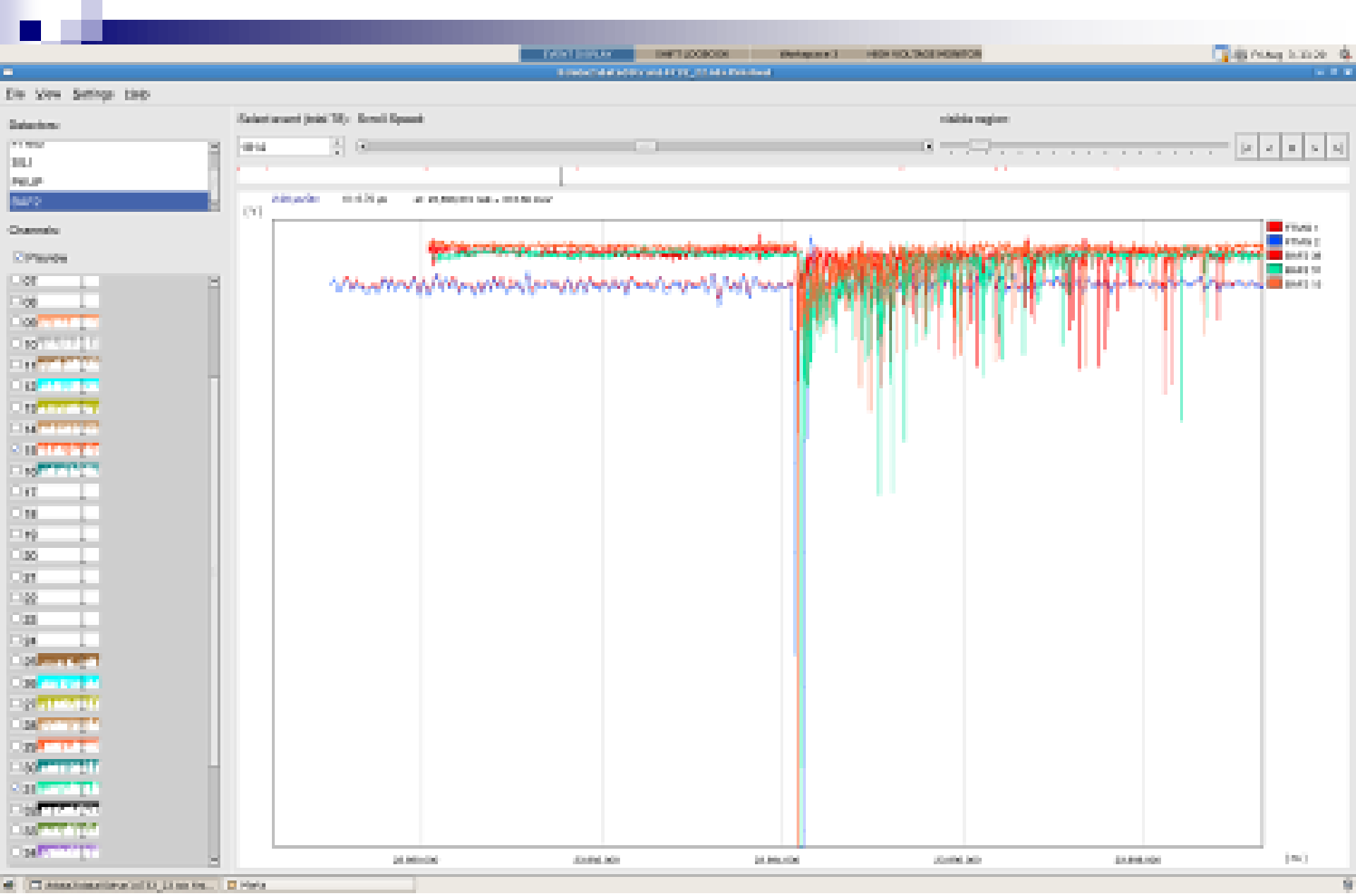
TAC (Total Absorption Calorimeter) neutron-capture
fission

MicroMegas (MGAS) fission fragments

→ signal in coincidence



  - Extract γ-ray background emitted in fission reaction
  - Calculate the α – ratio: $\alpha = \frac{radiative\,capture\,cross-section}{fission\,cross-section} = \frac{\sigma_\gamma}{\sigma_f}$



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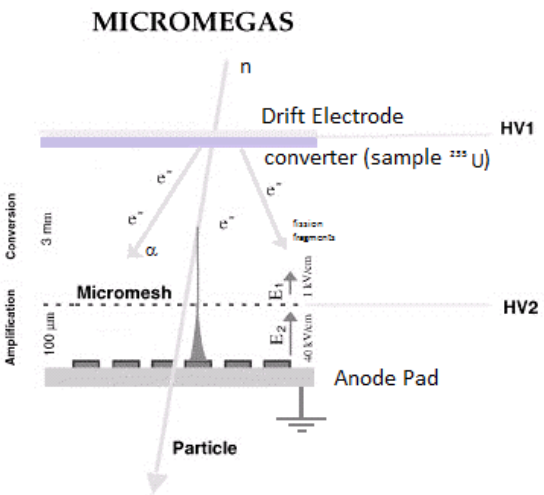
My Contribution: MGAS'test

- Mounting and testing the detector
- Studying the behavior of the signals
- Data analysis
  - Identify noise, α – particle region and fission fragment events
  - Get a very preliminary fission cross section of 235U
  - Compare with ENDF (Evaluated Nuclear Data File)
- Objetive:
  - Determination of (n,f) cross section of 235U to extract γ-ray background from the TAC's signal and, this way, obtain the (n,g) cross section

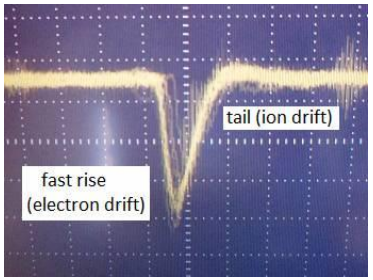
µMEGAS Detector Concept



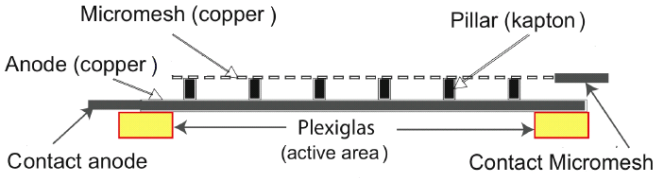
- µMEGAS is a gaseous parallel plate detector:
  - Anode Pad: conductor printed on a insulator board
  - Constant Gap over the active area
  - Cathode: thin metallic micromesh
  - Drift electrode parallel to the mesh defining a gas-filled region where electrons are drifted towards the mesh

    For neutrons and photons beam, it's necessary a converter in order to create charged particles which ionize the gas. This is the sample located on the drift electrode.

- Operating Principle
  - Ionization produced by the charged particles take place in the first region (~ 1 kV/cm)
  - Electrons produced are multiplied in an avalanche process in the second region (~ 50 kV/cm) resulting in a large number of electron-ion pair
  - Electrons are collected in the pad → fast current signal → fast rise
    Ions are collected in the mesh → charge signal → tail



- Micromesh and Microbulk technology



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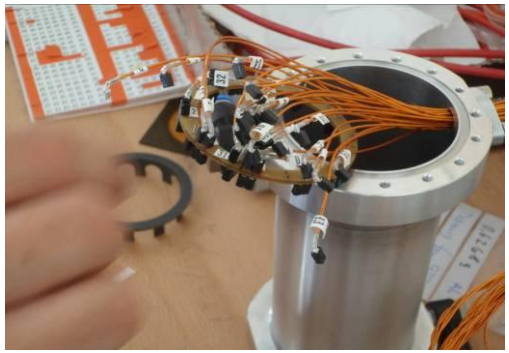
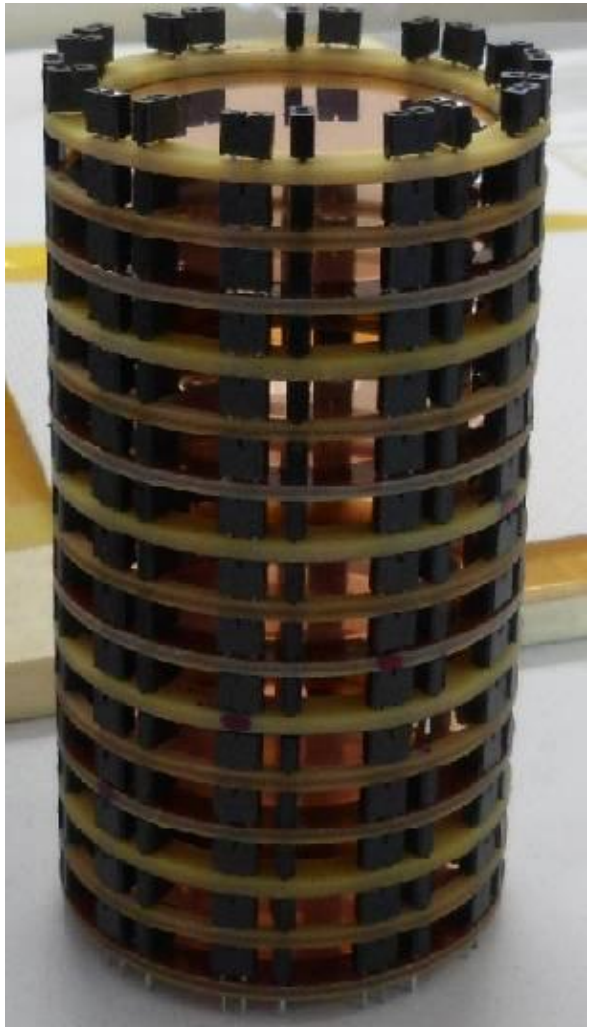
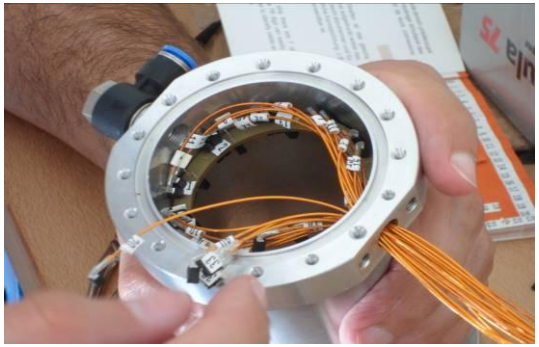
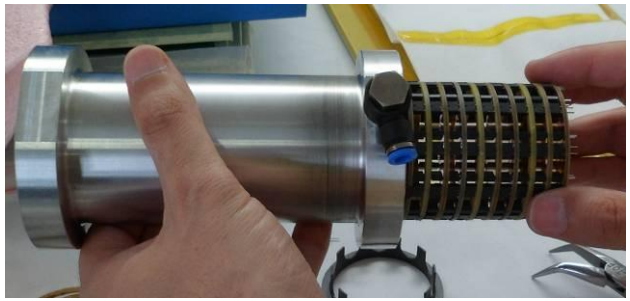
Detector Mounting

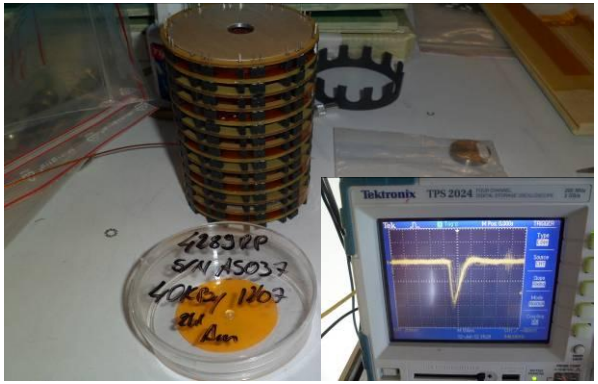


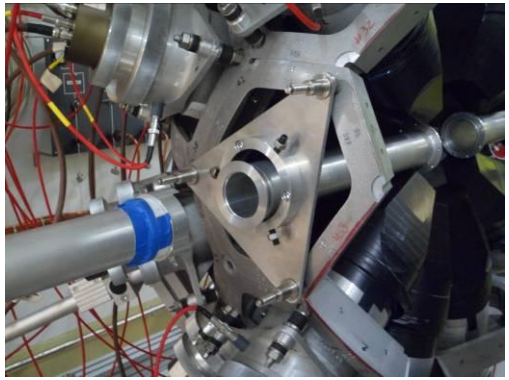


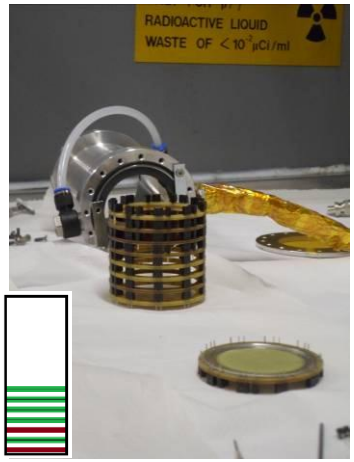


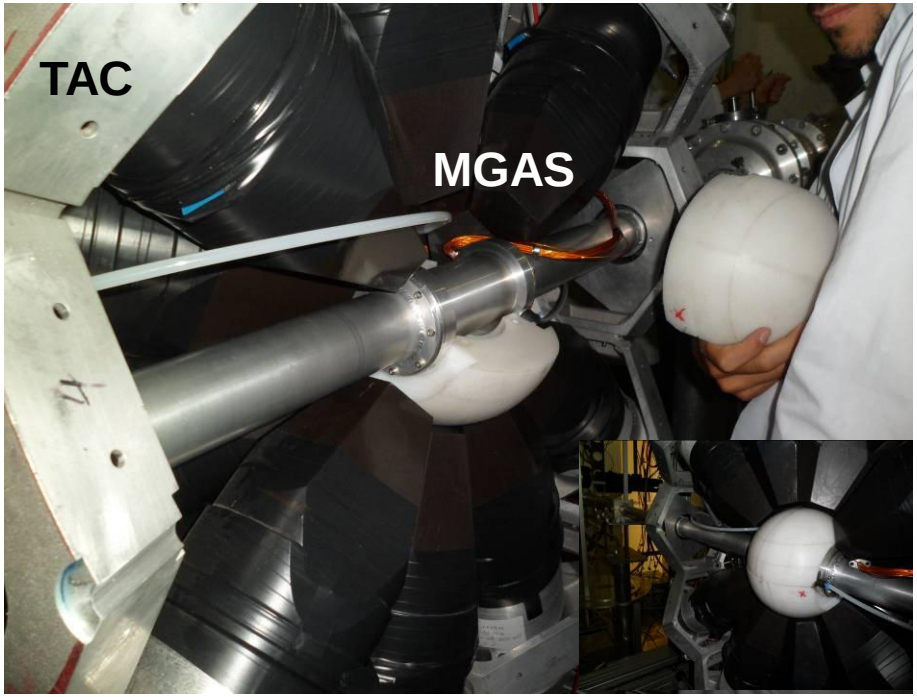


Testing and Installation





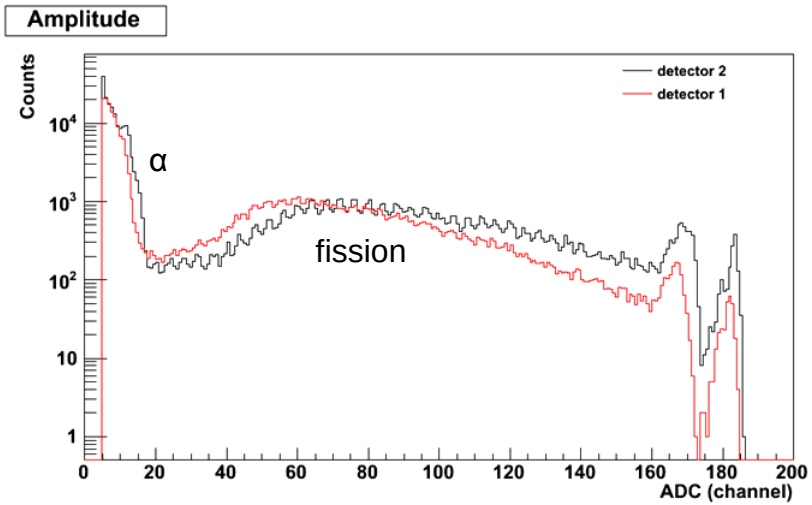


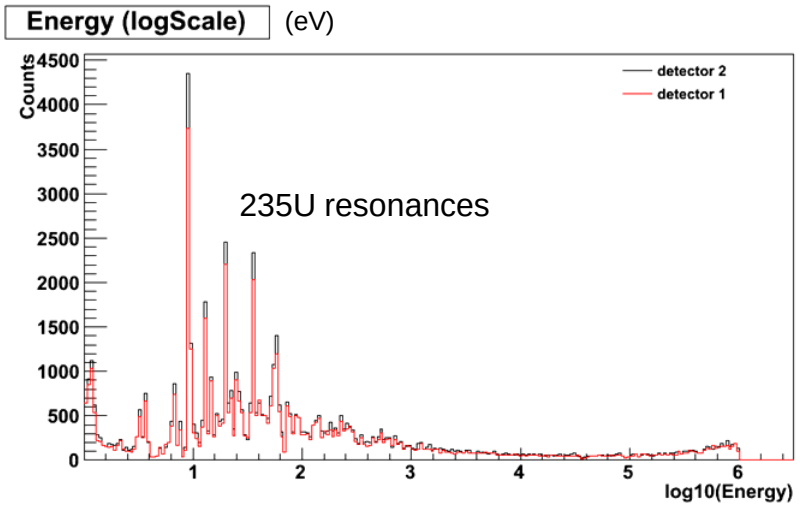


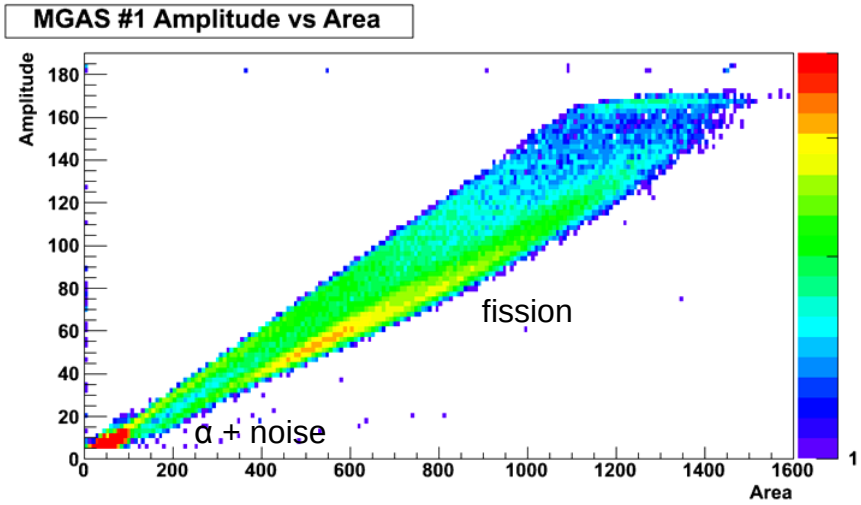
8 samples of 235U

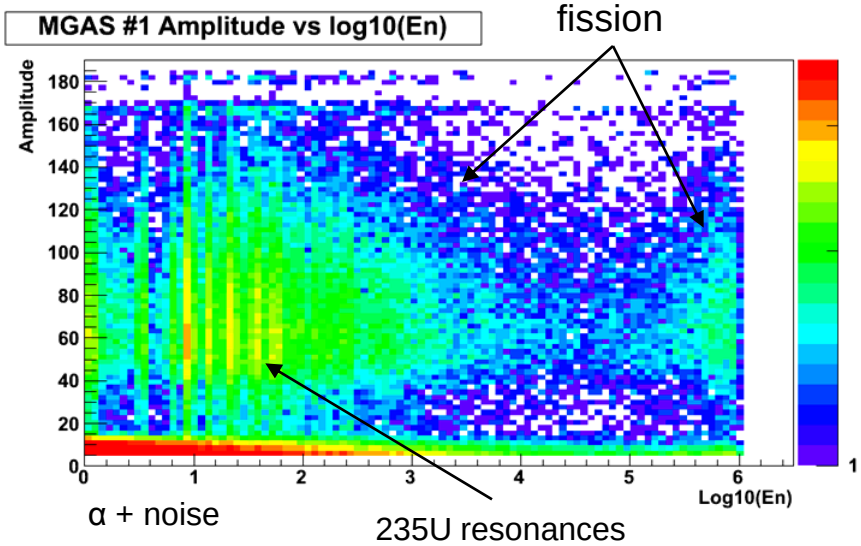
2 detectors with 2 samples back to back

Signal Behavior









$$number\ of\ protons = 1.44605\ 10^{17}$$

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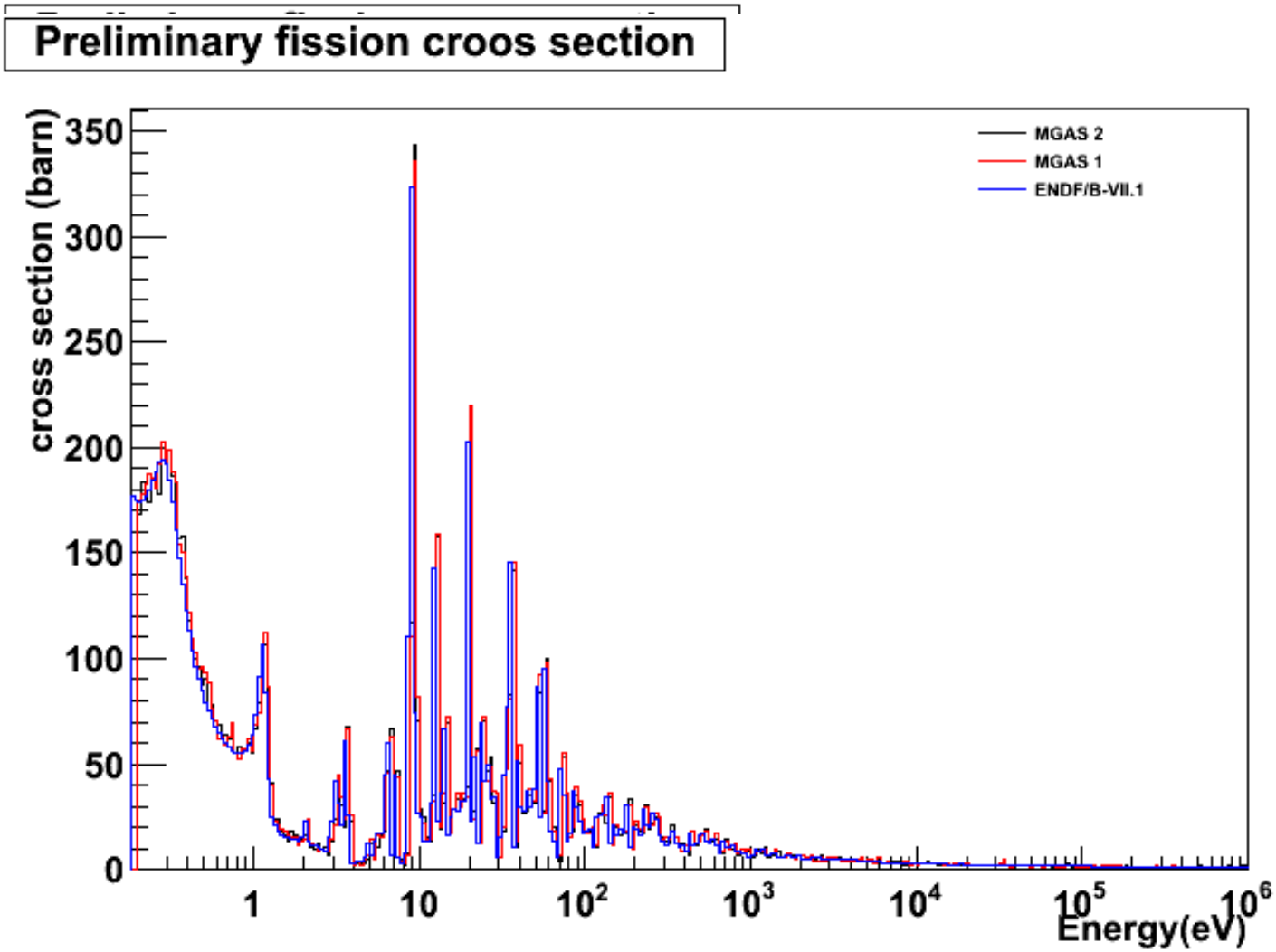
Very Preliminary Results: 235U fission Cross - Seccion



Summary

- Response of the detectors:
  - Differences between detectors is caused by the gain and the mass of the samples. In addiction, we noticed that there is a systematic error associated with the signal in the detector 2
  - The shape of the signal is what we expect
  - We need to improve our analysis routine to remove some invalid signals
- We obtained a very preliminary fission cross section:
  - Our cross section is integrated with the size of the bin while ENDF-cross section is absolute value, therefore we can't compare directly our result → normalization → comparison
  - Resonances are well located but the height is not the same → normalization factor for each detector to compensate main systematic errors
- It is only the first step in the current experiment

Next step is study the signals from the TAC detector, select the windows of coincidence, analysis the data, compare and get the neutron capture cross section with accuracy for 235U
This is a job for a PhD

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- **MEASUREMENTS OF NEUTRON-INDUCED CAPTURE AND FISSION REACTIONS ON 235u: CROSS SECTIONS AND α RATIOS, PHOTONS STRENGH FUNCTIONS AND PROMPT γ-RAY FROM FISSION.** C. Guerrero, E. Berthoumiex, D. Cano-Ott and the n_TOF collaboration. *CERN-intc-2011-045/ INTC-P-309*

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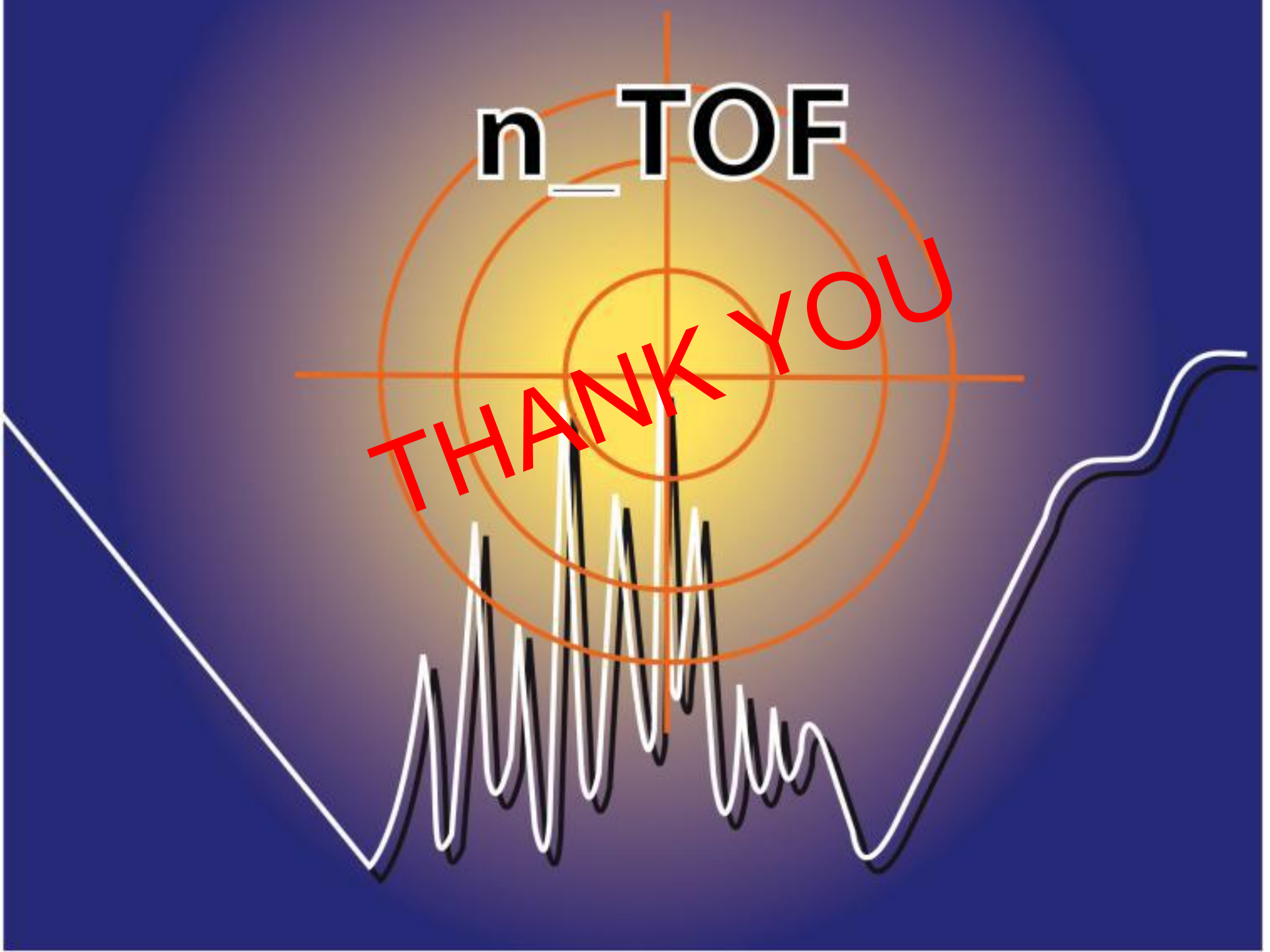
Summer Student Team and all students who like me came here to work and found more than an academic experience.

Thanks !!!


n_TOF
THANK YOU