2022 Physics Programme

The n_TOF Collaboration General Meeting 2022, Edinburgh, 13 December 2022

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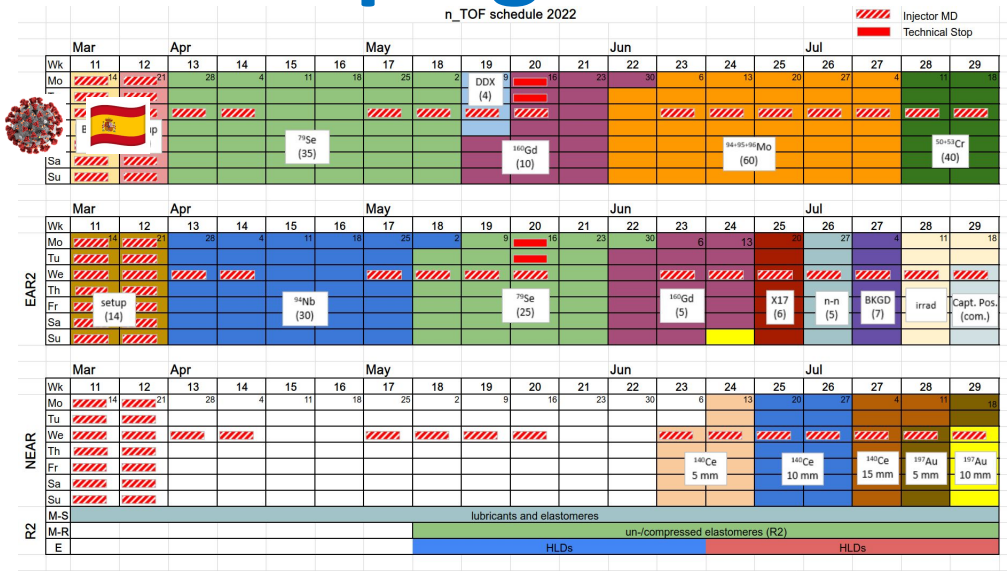
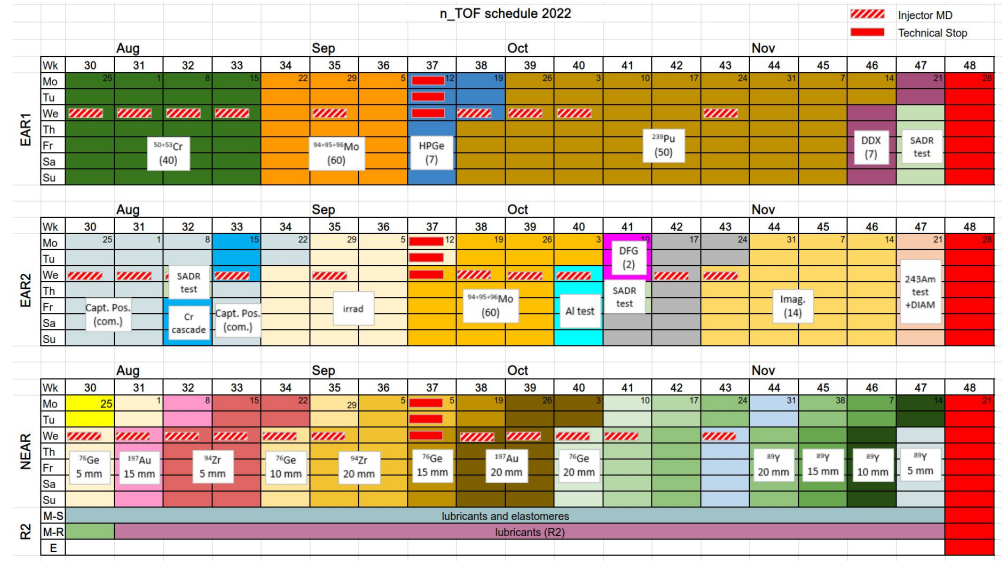
Highlights of the 2022 n_TOF campaign

EAR1	EAR2	NEAR
• ^{79}Se(n,γ) • ^{160}Gd(n,γ) • ^{94,95,96}Mo(n,γ) • ^{50,53}Cr(n,γ) • ^{239}Pu(n,γ)(n,f)(a-ratio) • DDX det. dev. • HPGe test (postponed)	• ^{79}Se(n,γ) • ^{94}Nb(n,γ) • ^{160}Gd(n,γ) • ^{94,95,96}Mo(n,γ) • X17 detector test • nn scattering det. test • neutron imaging • diamond det. test • BKG and other commissioning actions	• ^{197}Au(n,γ) • ^{140}Ce(n,γ) • ^{76}Ge(n,γ) • ^{94}Zr(n,γ) • ^{89}Y(n,γ)



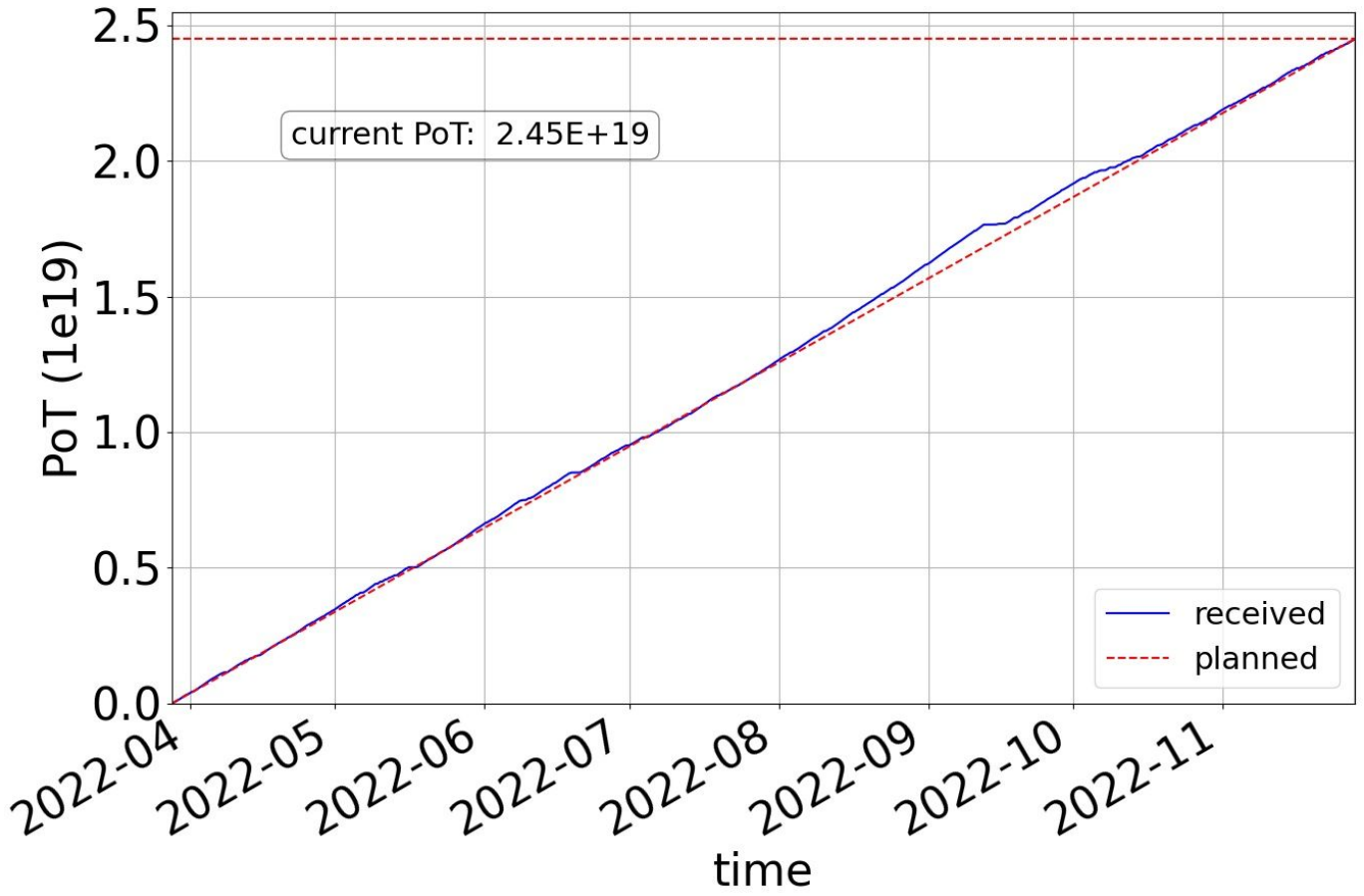
More than 20 actions were successfully accomplished



- **Beam on 14.03.2022, physics 28.03.2022 - 28.11.2022 - the longest ever run**
- **9 neutron capture reactions** have been studied: **2 of the for the first time** (Jorge, Javi, Riccardo, …)
- **^{239}Pu fission tagging** measurement successfully accomplished (had to be extended in time) - EAR1 (Adrian)
- **5 neutron capture reactions have been studied at NEAR with different B4C filter configurations**; Activation technique; MACS for different stellar temperatures; Some irradiations will continue on 2023 (Elisso)
- **4 detector development projects/test have been accomplished** (X17, DDX, neutron imaging, diamond detector) (Carlo, Michi, Mirco,Cristina,..)
- **4 new detector setups have been successfully applied for the first time** (iTED, sTED, GEAR HPGe, beta-detection for NEAR)
- **Stilbene detector** development is in progress (Maria-Grazia)

PoT report

- We received the expected number of protons
- No physics losses or compromised experiments
- The ^{239}Pu campaign had to be prolonged as to get the approved # protons.
- Cancellation of the actual HPGe detector test
- Many thanks to:
  - visiting teams
  - local team
  - PS teams



Working groups:

- Flux EAR1 (Michi, Nikos, Alice, Simone, Marta, …)
- Flux EAR2 (Jose, Alice, Simone, Marta, …)
- RF EAR1 & EAR2 (Adria, Jorge, Victor, …)
- NEAR neutron energy distribution unfolding (Mario, Nicola(+s), Elisso, Stella, Pablo, Javier, Roza…)
- EAR2 Capture setup (Cesar, Javi, Daniel, Jorge, Adria, …)
- uMegas (Marta, Jose, Nikos, Maria, Nikolas, …)
- Stilbene (Agatino, Cristian, Nikolas, Javi, Cesar, …)
- SADR (Simone, Stella, Gigi, Nikolas, …)
- DAQ (Eric, Frank, Michi, …)
- FLUKA simulations (Matteo, Jose, Fran, Giuseppe, Vassilis, …)
- GEANT4 simulations (MOIRA) (Vassilis, Jose, …)
- n_TOF - ISOLDE rabbit (Ana-Paula, Oliver, Simone G., Marco, Nikolas, Alberto…)
- …

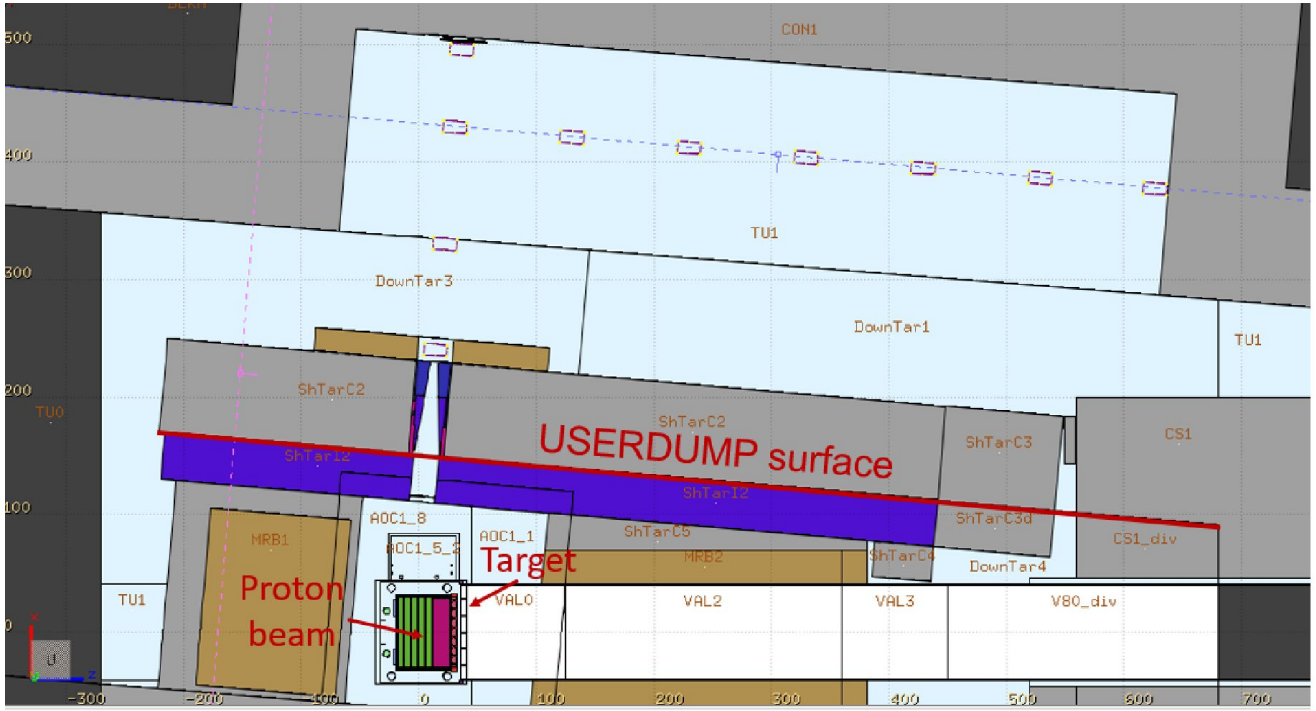
New NEAR FLUKA simulations

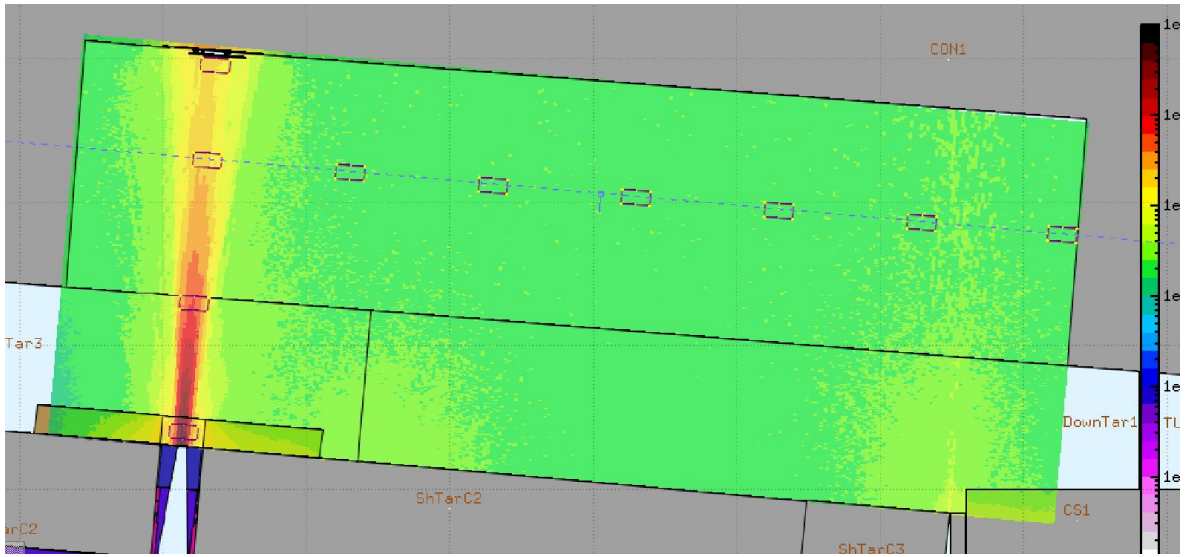
- NEAR simulations results available here:

/eos/experiment/ntof/simul/phase4_NEAR/NEAR_userdump_AtFeConcrete_MatteoCecchetto/

- EDMS file here:

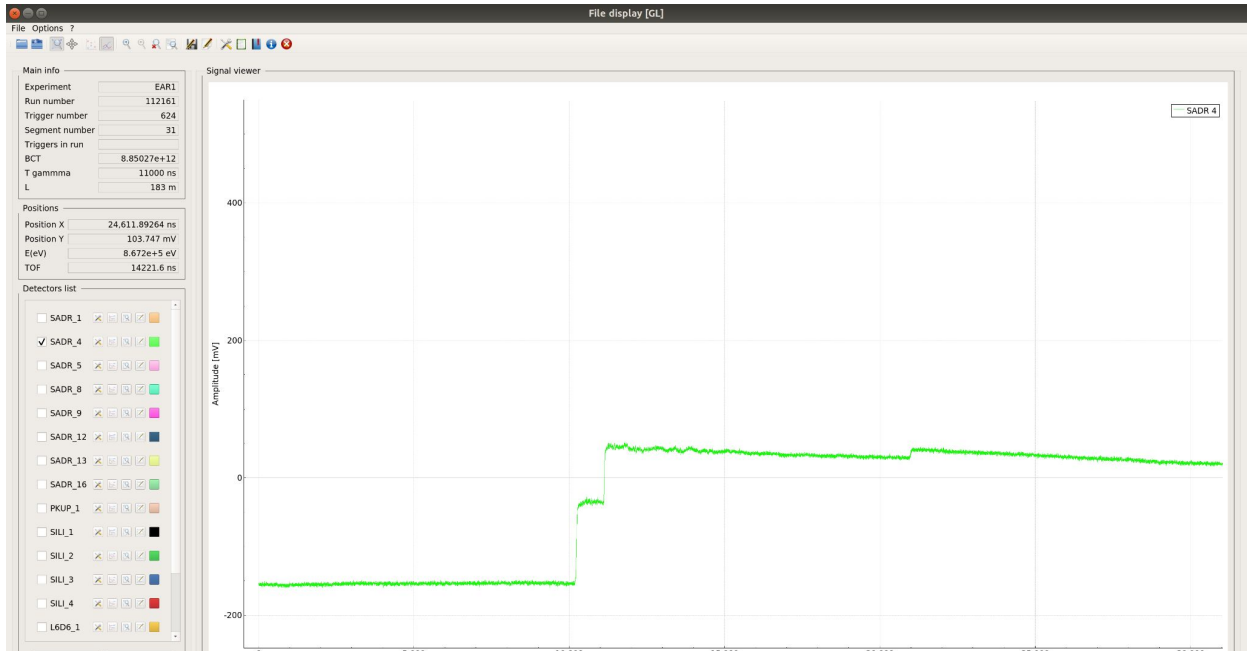
https://edms.cern.ch/ui/#!master/navigator/document?D:101128011:101128011:subDocs

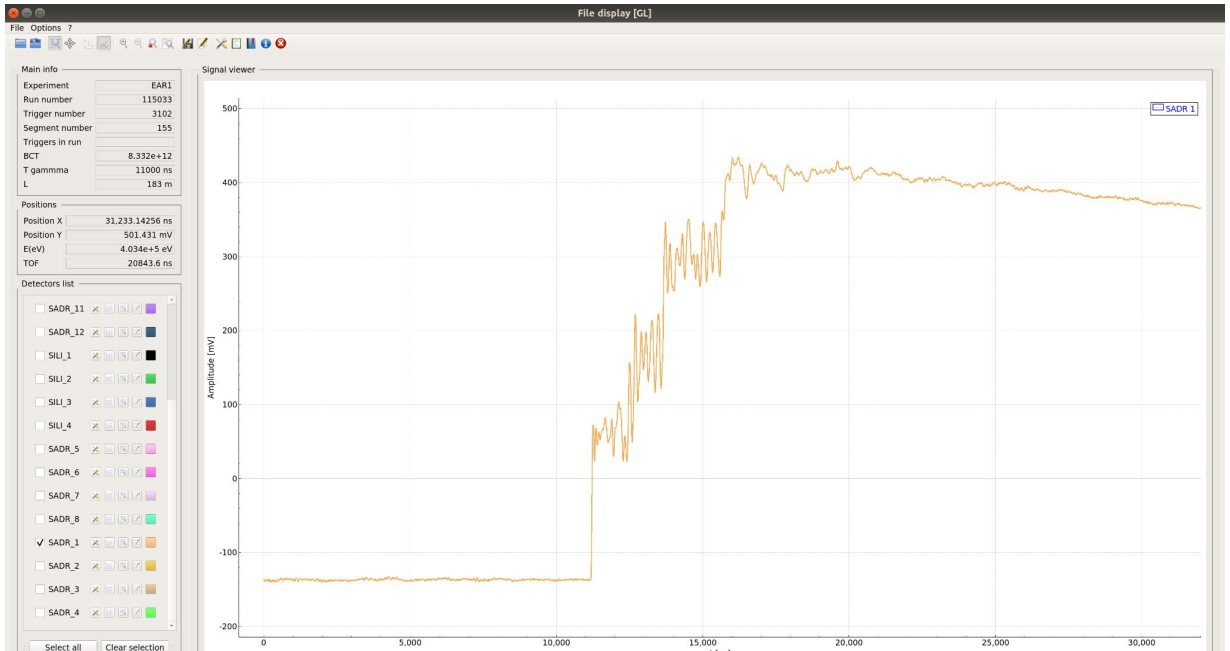




Some YETS 2022-2023 activities

- Study of el. noise in EAR1
  - Collect data and discuss experience between different detection systems
  - Collect information and diagrams about the electrical infrastructure
  - Track back changes in the beam line
  - beam off tests
  - beam on test (first week(s) of beam)
  - recover previous actions performed in the past for the same problem





Some YETS 2022-2023 activities

- Reduction of NEL length; more space for developments and tests
  - ~ 2m less length (a part of the beam pipe will be removed, reversable)
  - thinner window
  - low mass supporting table
- Target preparation laboratory at the old CR
  - pressing machine
  - encapsulation equipment: teflon, kapton, mylar encapsulation
  - scaler
- β-γ coincidence setup
- migration of the time machine to the technical network
- …

The full list of YETS 2022-2023 activities

EAR	Task
1	CLEAN THE AREA
1	Vac. pump el. noise (power on/off solved the problem)
1	PC's check what is working what is not; get switches to avoid recabling
1	fiber data connection
1	El. noise in EAR1 (pictures from SADR test) ? IF there is aproblem?
1	Sample changer - make it move
1	Sample changer - integrate it to the DAQ (if possible)
1	Sample changer - Carbon fiber arms
1	Cleanup & ordering new material (tools, gloves, cable binders, tape, pipe elements, ...)
1	Laser Allignement
1	Configurate new CAEN1081 module
2	CLEAN THE AREA
2	El. noise in EAR2 (pictures from SADR test)
2	fiber data connection
2	Check Laser alignement
2	Evaluate what goes in which storage room (material room, storage upstairs of EAR2)
2	Low mas sample holder & protection for pipe
2	Cleanup & ordering new material (tools, gloves, cable binders, tape, pipe elements, ...)
2	PC's check what is working what is not; get switches to avoid recabling
2	Lemo cable storage space is blocked by shelves --> move cables somewhere else
2	Change broken light in the bunker
2	Change collimator from fission to capture
2	Fix the opening of the concrete wall (it gets stuck if opened to much!)
NEAR	Diamond table
NEAR	Collimator reduction

The full list of YETS 2022-2023 activities

GEAR	Optimization of the plastic setup
GEAR	storage place, carbidge bin, cleaning, ...
LAB	Re-arrange the PCs
LAB	CLEAN LAB
LAB	missing tools & material
CR	Re arranegment of the screens
CR	room separation in the CR
CR	Cleaning concept of the CR, i.e. the keyboards (can the CERN cleaning take care of that?)
CR	New office supplies needed? Screens, keyboards, cables, envelopes, pens, ...
SPEAR	Target preparation Experimental ARea (pressing, scaler, encapsulation, lights, teflon foils, teflon thermal sealing, storage

The full list of YETS 2022-2023 activities

Detectors	
HPGe	HPGe and Beta spectrometer coupling (hardware mechanics + DAQ)
HPGe	fine-tuning at MIRION tecnologies -> the removal of the 2nd pre-amp
C6D6	extra holders for EAR1
C6D6	preparation, characterisation
SiMon	Check (and fix?) internal soldering
DAQ	SPD-02918 (problem validating triggers)
	SPD-02920 (strange baseline behaviour)
	m4 machine check at EAR2 after power failure
	Data processing issue
	Test of DAQ (especially in EAR2)
	Time machine migration from public network to technical network
Other	
	taking over the timepix detector; them work in all EARs and install all the necessary software;make them plug and play"
	NEL modification
	Update shifter manual
	Create shift leader manual
	RP sources
	Permanent UPS for GEAR (HPGe's)
	Document for the transport
	CLEAN the old CR
	Return not needed equipment back to EL POOL

2023 n_TOF Physics start

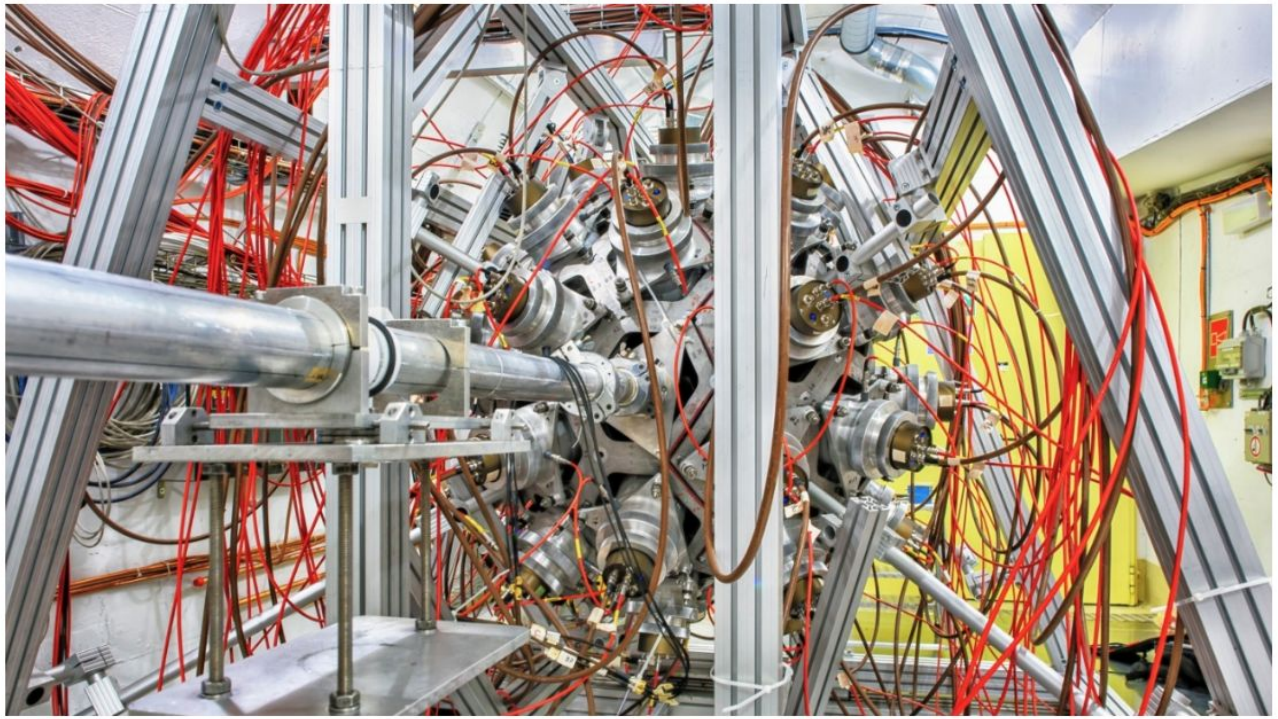
- **2023 Beam for n_TOF (our request: 210E17 or 1E17 protons/day)**
  - 03.04.2023 - for hardware commissioning (7days)
  - 10.04.2023 - Physics Start
  - 30.10.2023 - beam off (203 days of physics)
- **Pulses of different intensities**
  - High intensity (dedicated): 8.5E12 ppp
  - Low intensity (parasitic): 4.5E12 ppp
- **“Fixed” impact point on the lead target for both pulses**
  - ± 5 mm horizontal (centroid)
  - ± 3 mm vertical (centroid)
- **Same (as 2022) spatial profile dimensions of the beam**
- **Proton beam intensity: Raise interlock for avg. intensity from 167e10 p/s to 200-220e10 p/s is possible (still under investigation from SY-STI-TCD and HSE, from a technical standpoint as well as from RP)**
- **Pulse time length: back to 28 ns (σ ~ 7ns) without “tails” and pre- pulses**

Conclusions

- We had a fully successful 2022 n_TOF campaign: more than 20 actions (experiments and developments) were successfully accomplished
- 9 capture reactions were studied (astrophysics & energy applications); 2 of them for the first time!
- Measurements with low mass samples (mg) can be performed thanks to the development of new detection setups and thanks to neutron beam improvements in EAR2
- Several detector tests were successfully performed. From first results we are confident that n_TOF is ready to launch new type of measurements in the near future
- The n_TOF target works nicely and smoothly. We can even go from 167E10pps to 220E10 pps (Many thanks to SY-STI group!)
- The delivered protons fulfilled our expectations (many thanks to PS teams!)
- There is a long “things to do list” for the YETS.
- A lot of data have to be analysed. Many thanks to: Jose, Francisco, Elisso, Riccardo, Stella, Pablo, Adrian, ...

Highlights of the n_TOF 2022 data taking run

Nikolas Patronis (n_TOF Physics Coordinator, Univ. of Ioannina) 11th Dec 2022

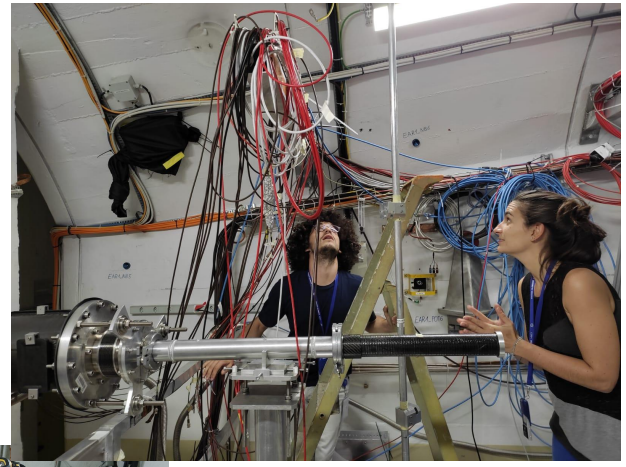


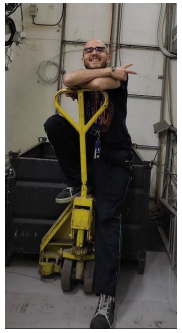
nTOF

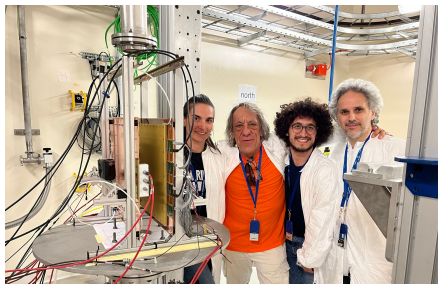
The outcome of the first year of data-taking after LS2 [1] was fruitful for n_TOF. The long beam-on period, along with the establishment of a third experimental area, the NEAR Station, resulted in a wealth of new experimental

Many thanks to the n_TOF dream team!

Alberto Mengoni, Oliver Aberle, Oscar Fjeld, Nikolas Patronis, Michael Bacak, Alice Manna, Simone Amaducci, Adria Casanovas, Victor Alcayne, Francisco Garcia, Jose Antonio Pavon Rodriguez, Elisso Stamati, Stella Goula, Roberto Zarrella, Jorge Lerendegui, …



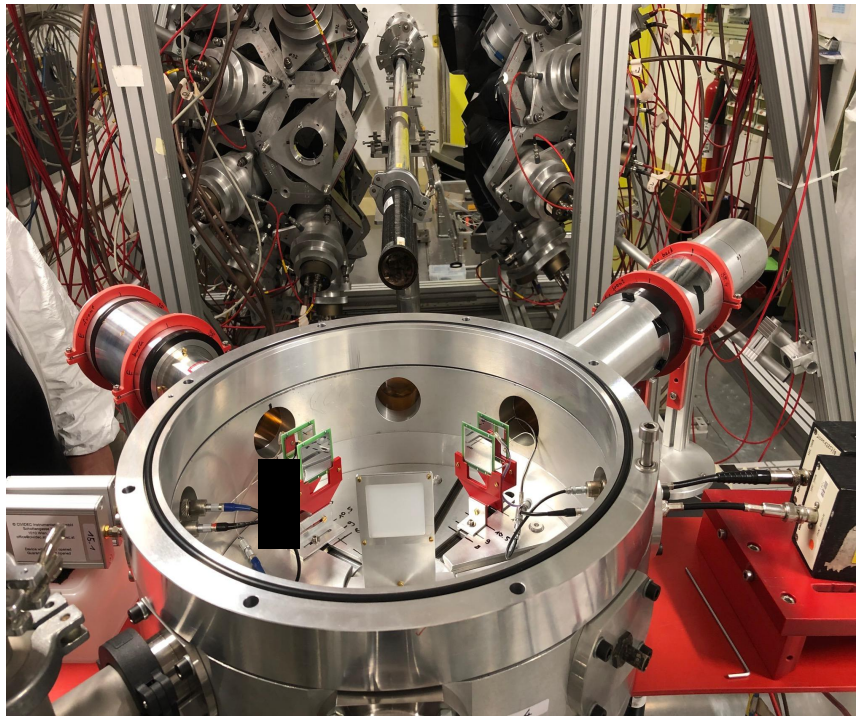
Thank you so much for attention!

Extra slide:

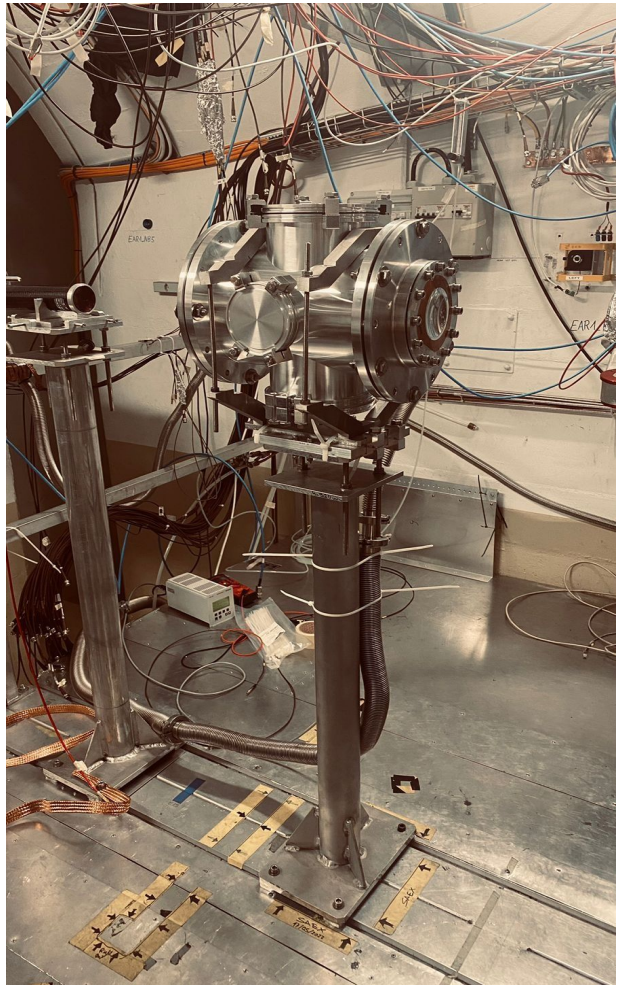
2023 n_TOF approved experiments

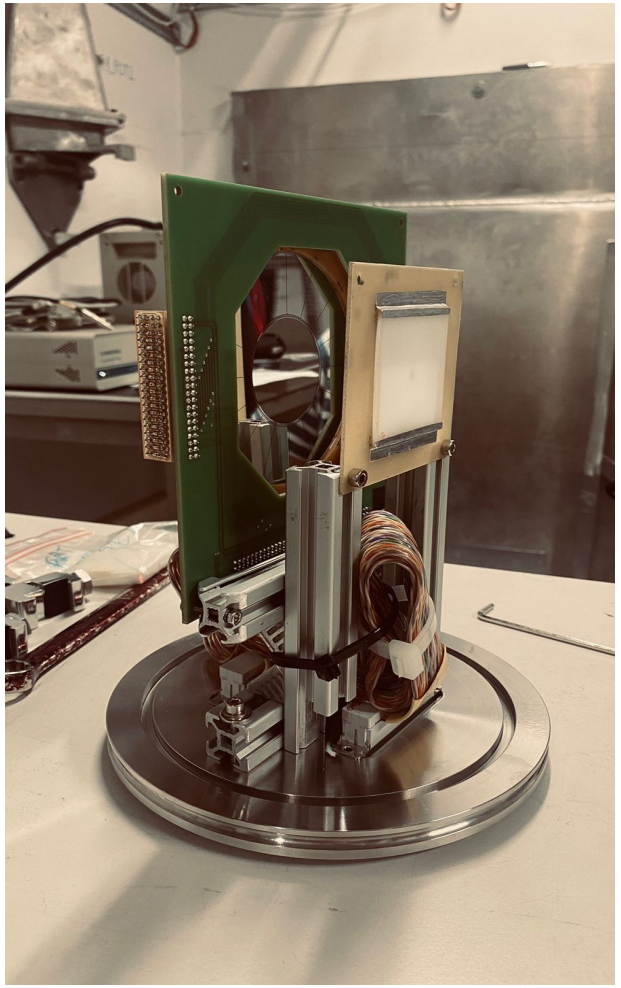
experiment	EAR1	EAR2	NEAR
MACS proof of principle			28
Diamonds			7
64Ni(n,g)		15	
Ta(n,g)	20		
135Cs(n,g)			40
12C(n,cp)	15	5	
243Am(n,f)	30	30	
40K(n,g)		50	
SADR	15	5	
HPGe	7		
Er	20		

Detector developments during 2022 n_TOF campaign: (n,cp) reactions



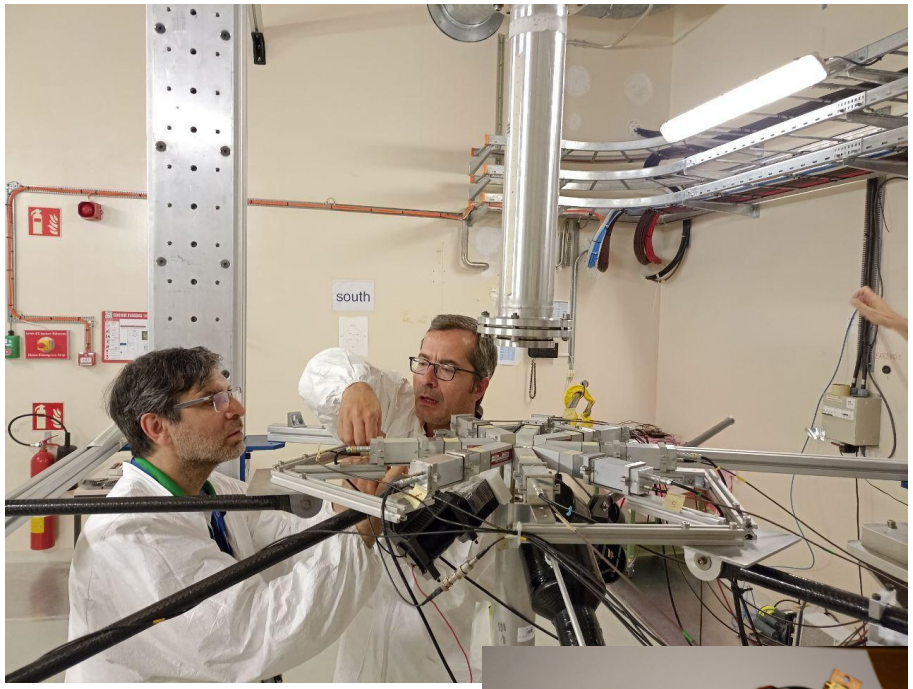
Mirco et al.



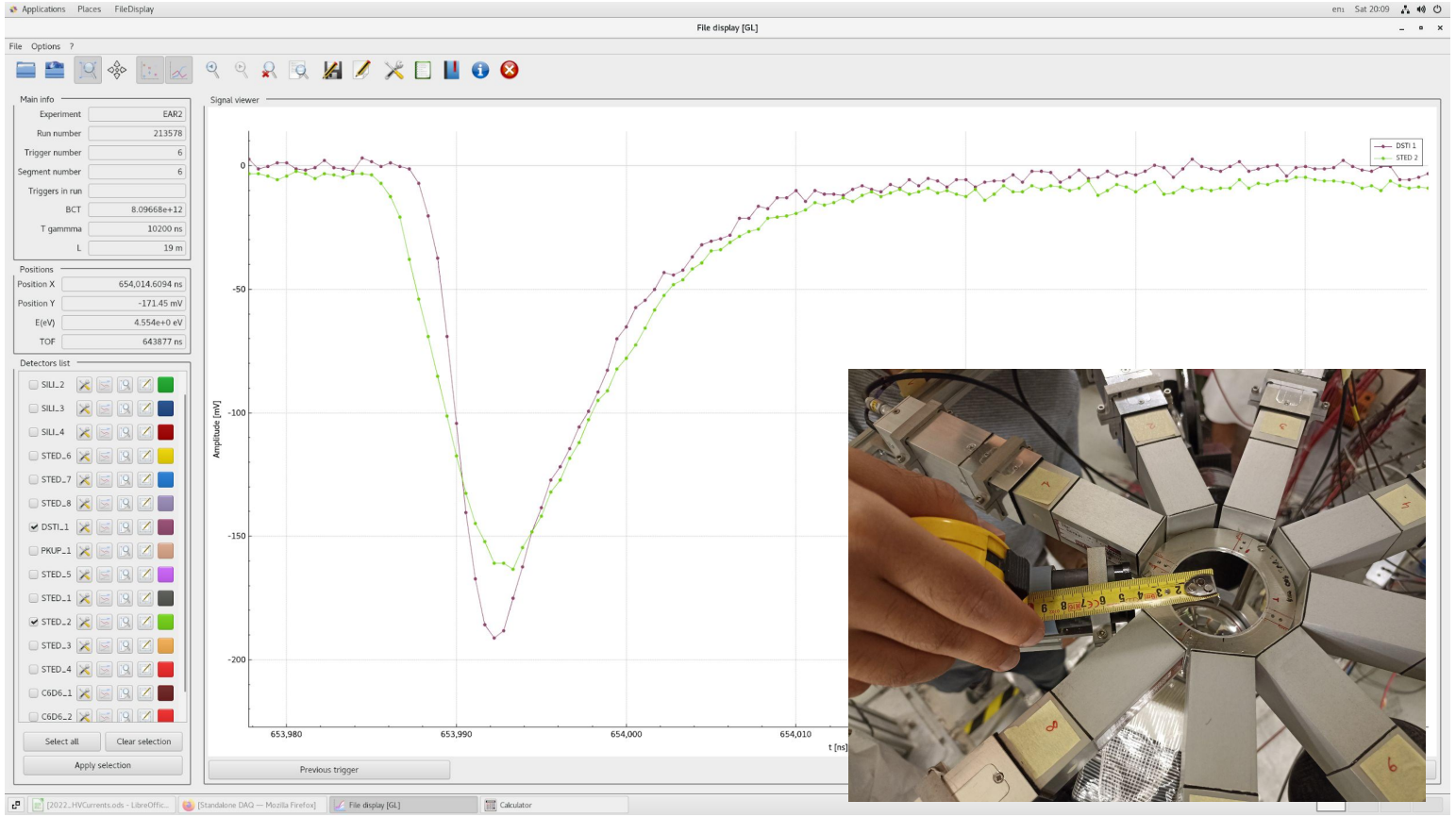


Simone, Stella et al.

Detector developments during 2022 n_TOF campaign: (n,γ) reactions - (d) Stilbene detectors

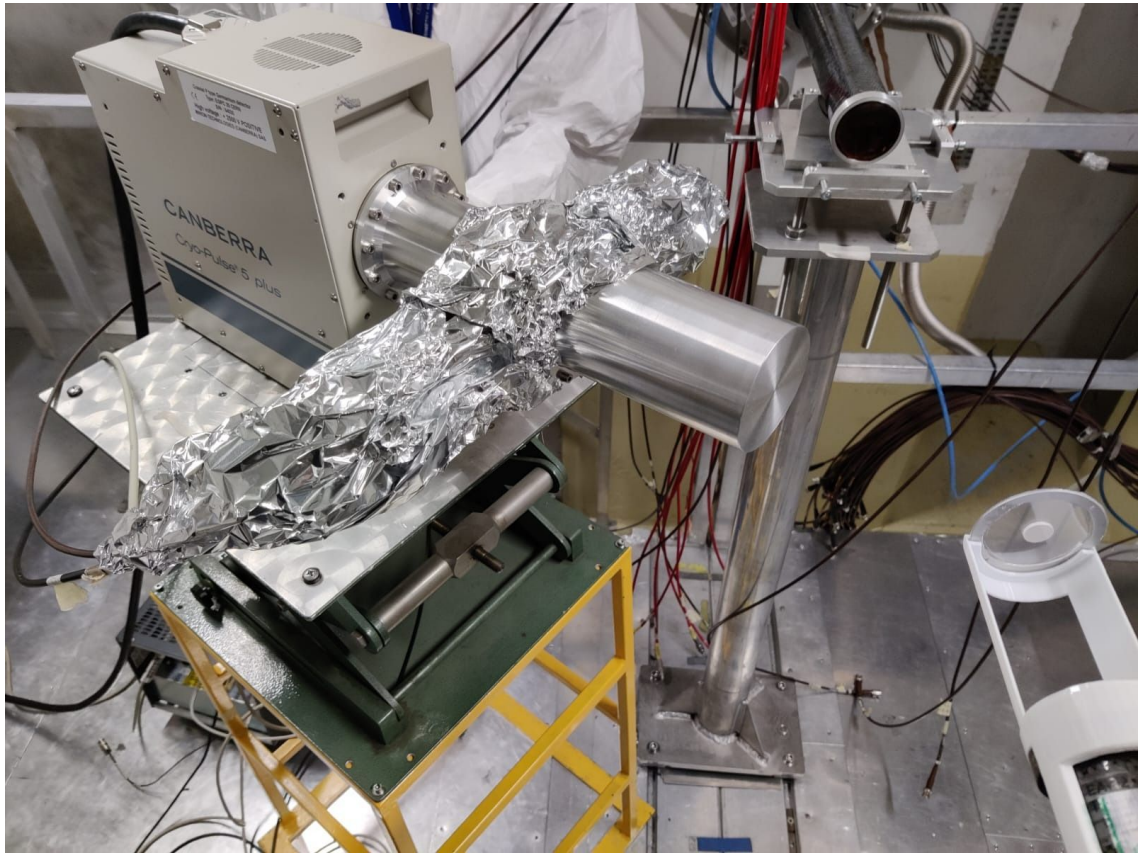


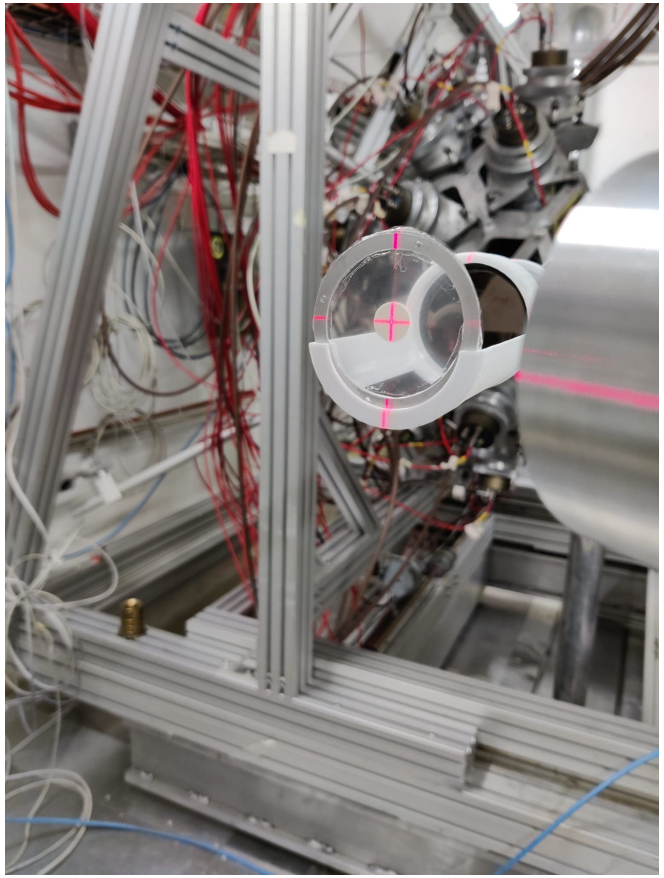
Agatino et al.



Detector developments during 2022 n_TOF campaign: (n,n'), (n,γ), fission isomers, nuclear structure

HPGe detector





Michi et al.

^{239}Pu(n,γ) with fission tagging

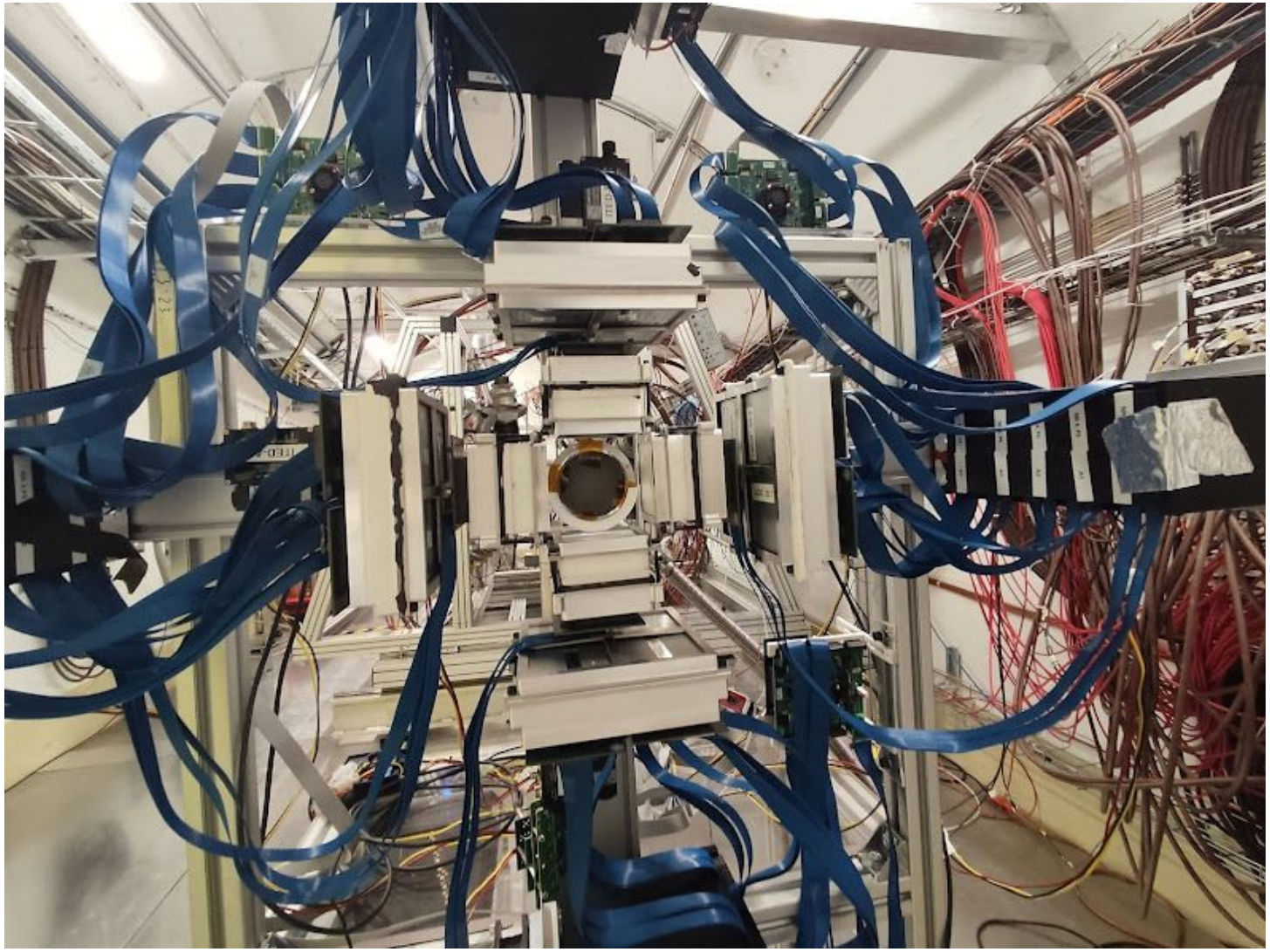
Motivation

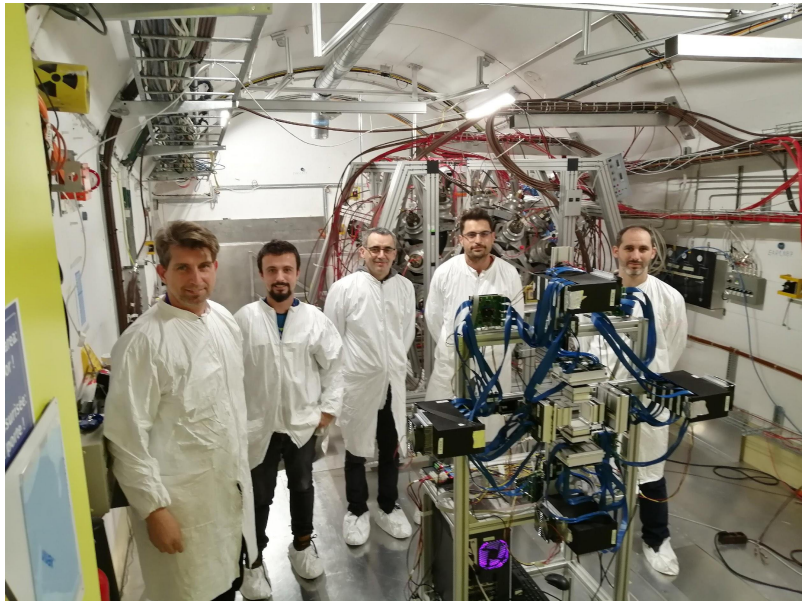
- 239Pu plays a central role in the operation of fast reactors
- More accurate 239Pu capture and fission cross section data are needed
- The **goal is to measure simultaneously the neutron-induced capture and fission rates**

Details of the experiment

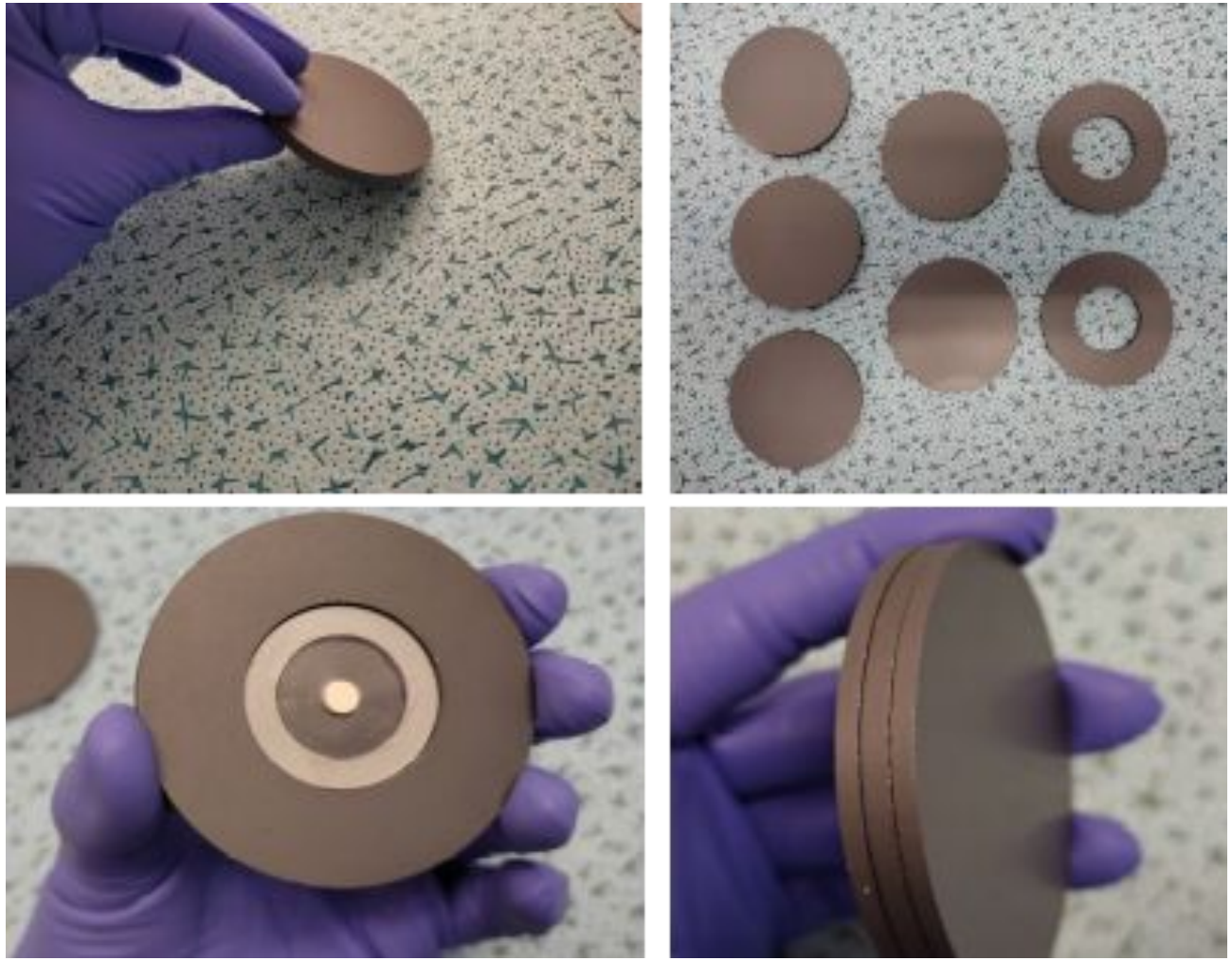
- **Objective**: measuring the ^{239}Pu (n,γ) and (n,f) cross section (α-ratio).
- **NEW fission chamber** (University of Lodz) with **~10 x 1mg ^{239}Pu targets** (JRC-Geel).
- **NEW thick ^{239}Pu (100 mg) encapsulated sample** (JRC-Geel)
- **NEW neutron absorber** (designed by CIEMAT and fabricated by CERN)
- **NEW pipes and structure material** for the fission chamber inside the TAC (made by O. Aberle and O. Fjeld)
- **NEW pulse shape analysis routine** for both Fission Chamber and Total Absorption Calorimeter
- Total protons: 5×10^8
  - 3×10^8 Fission Chamber configuration
  - 2×10^8 thick sample configuration

^{79}Se(n,γ) @ EAR1 & EAR2





Experimental method and setup



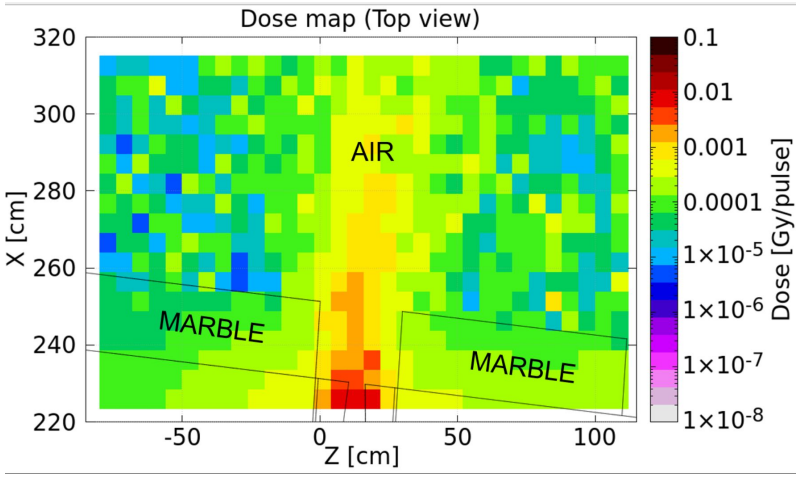
Reactions

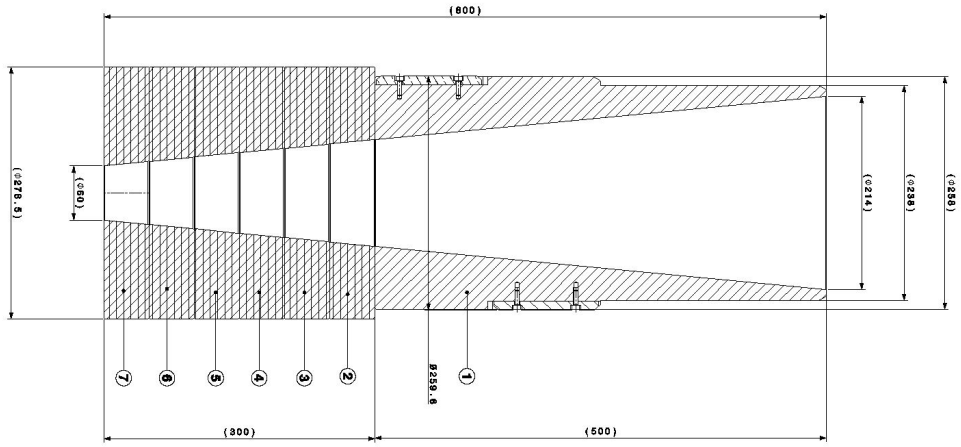
- $^{197}Au(n,\gamma)$
- $^{140}Ce(n,\gamma)$
- $^{76}Ge(n,\gamma)$
- $^{94}Zr(n,\gamma)$
- $^{89}Y(n,\gamma)$

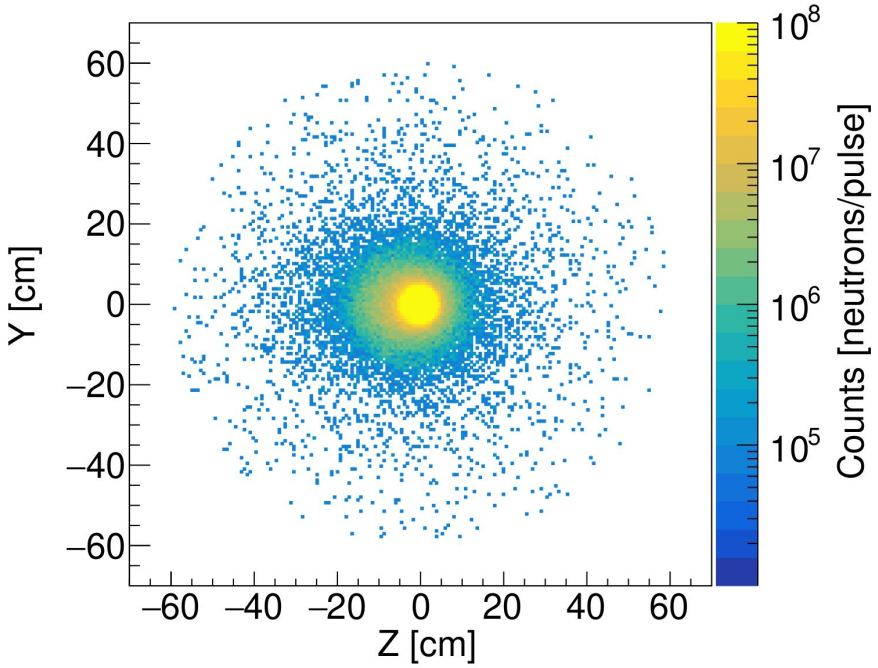
B4C filters

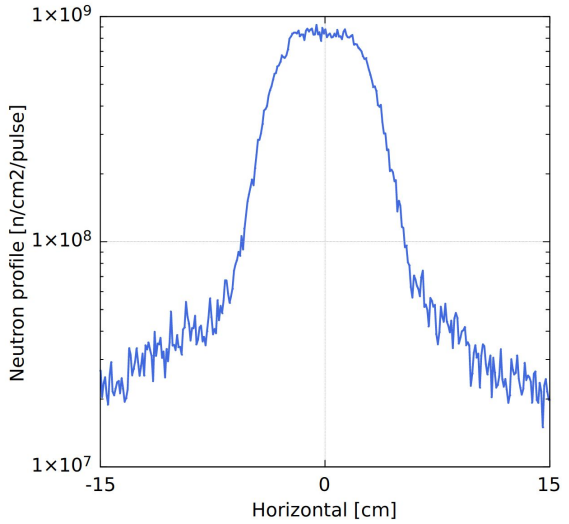
- 2.5, 5.0, 7.5, 10 mm thickness on both sides
- 60 mm in diameter
- 30 mm inner hole

The NEAR station

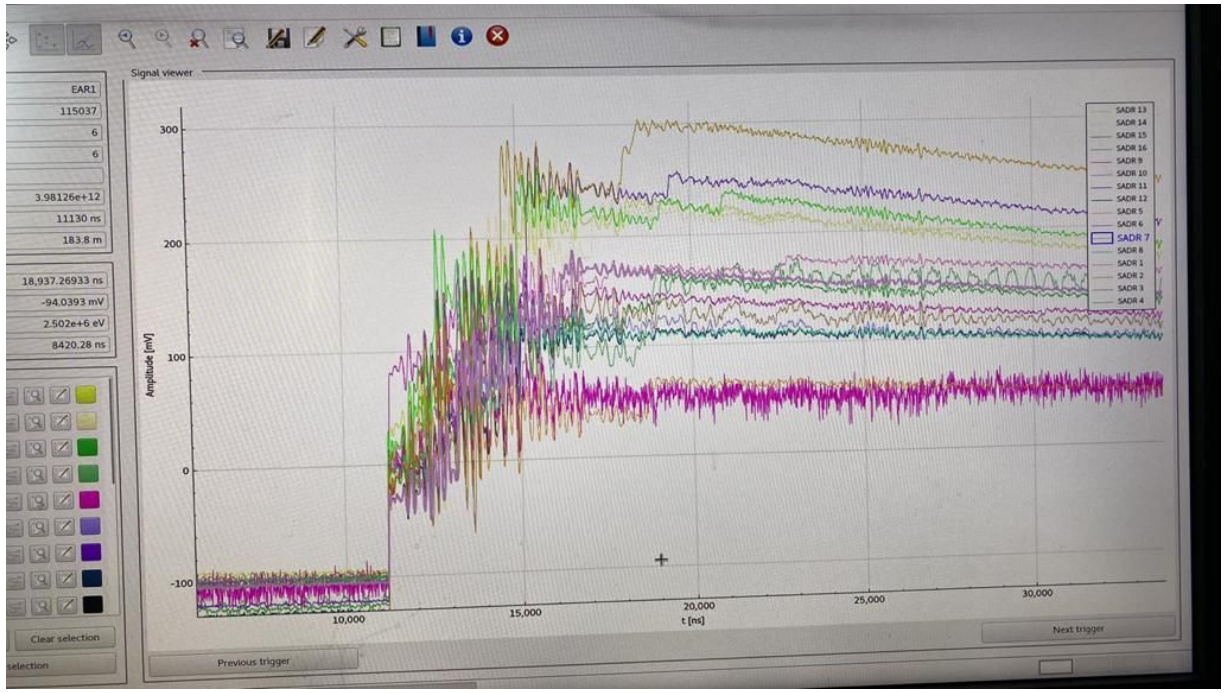


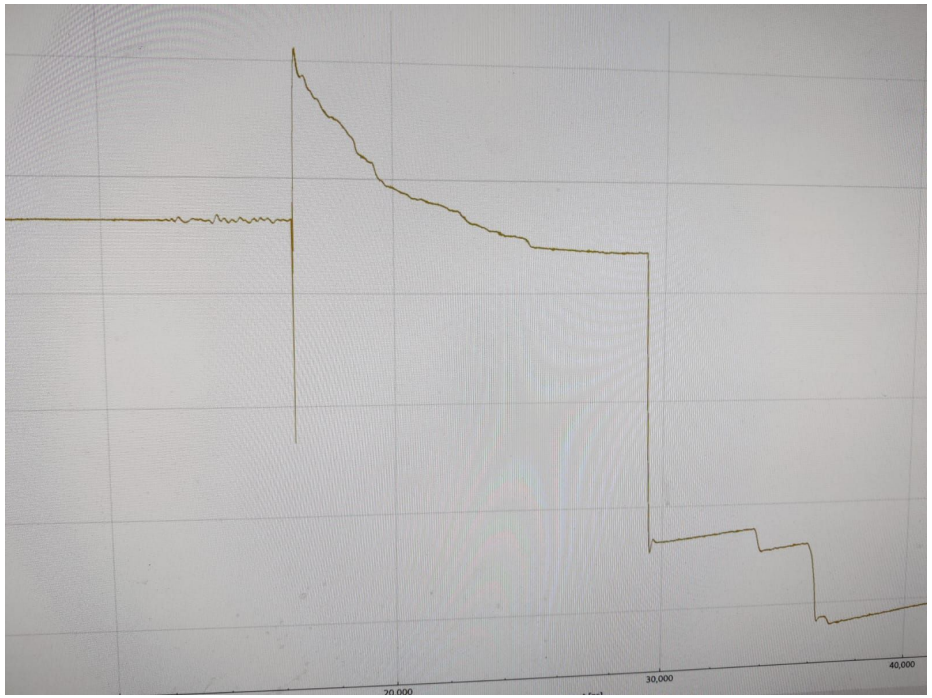






The EAR1 el. noise





The EAR1 el. noise