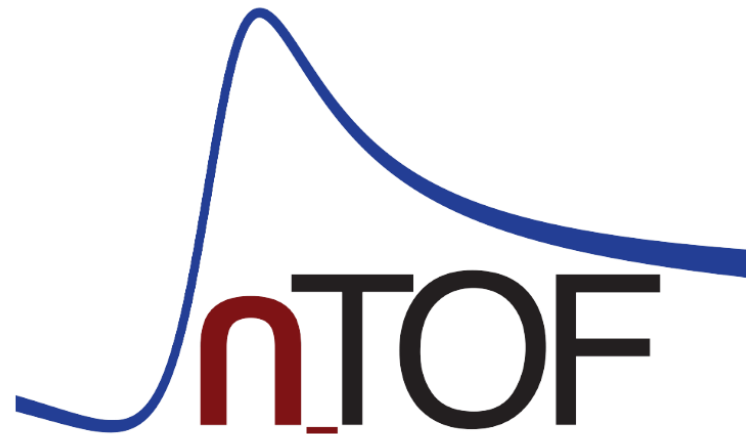
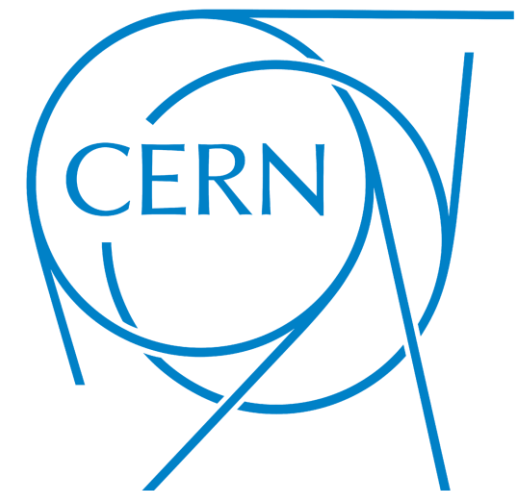


# 2023 n\_TOF Physics Programme

The n\_TOF Collaboration General Meeting 2023, Valencia, 22-24 November 2023

Nikolas Patronis

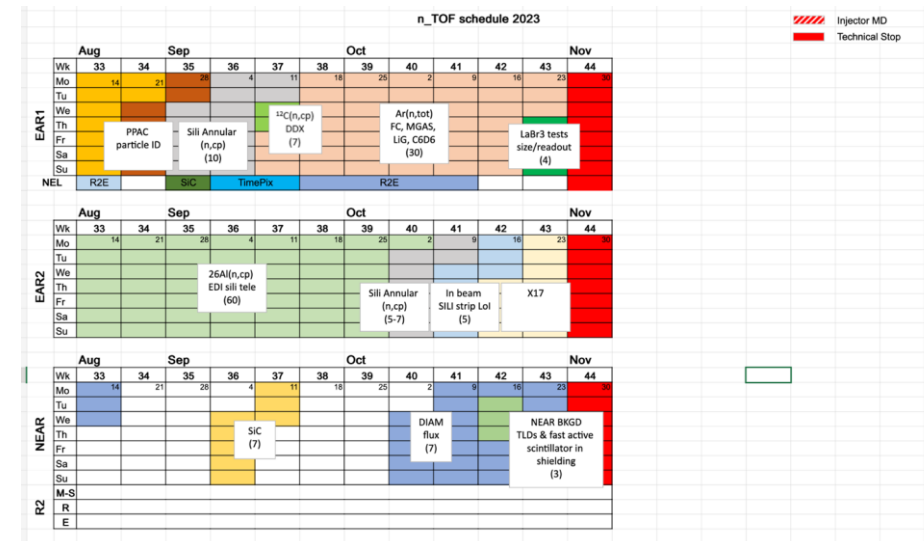
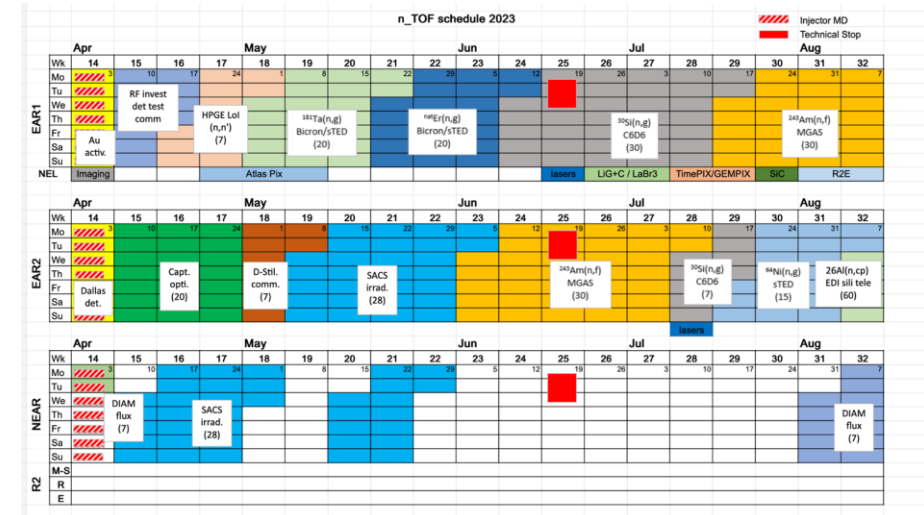
n\_TOF Physics Coordinator  
CERN & Univ. of Ioannina



# Highlights of the 2023 n\_TOF campaign

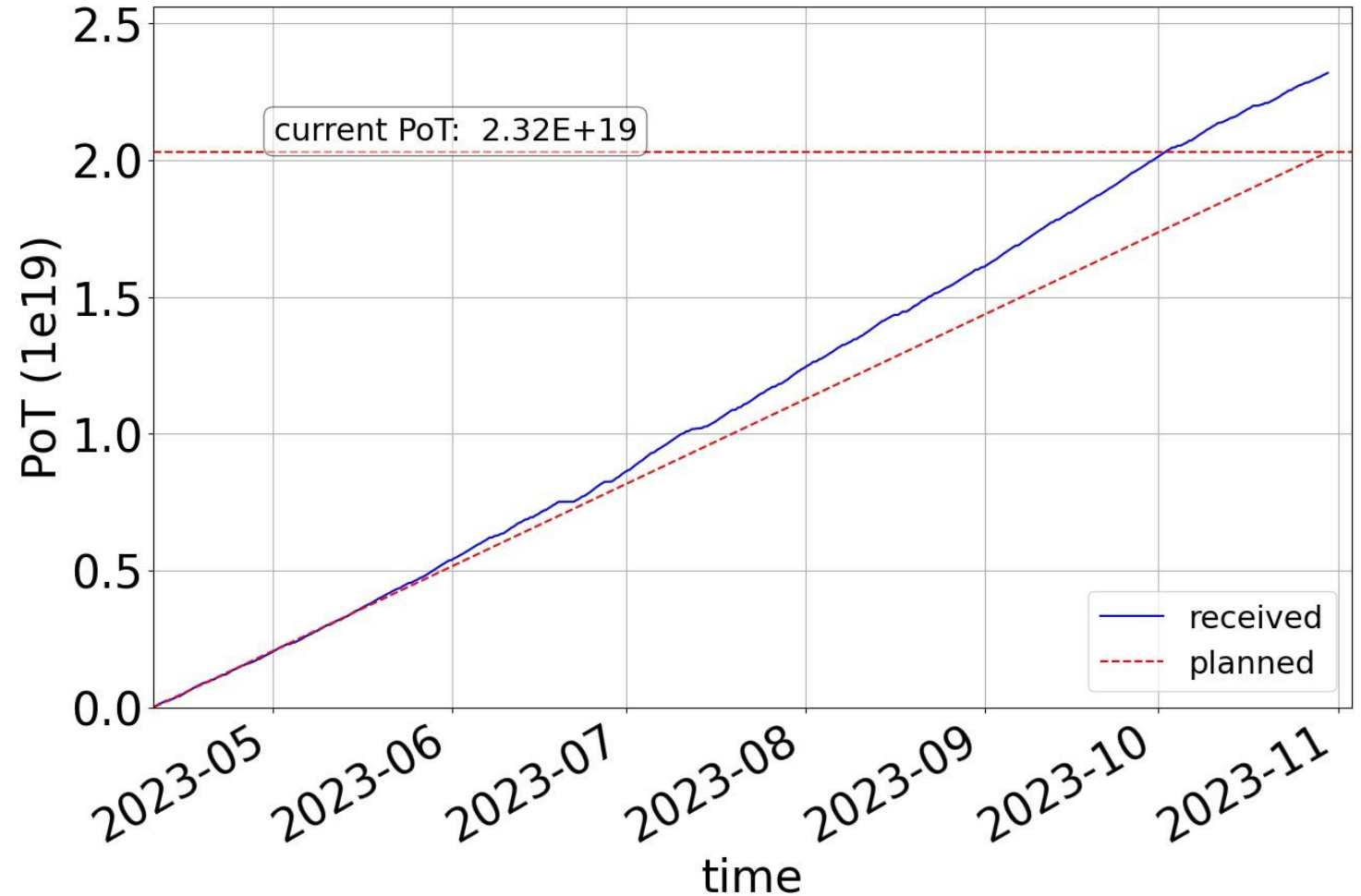
EAR1	EAR2	NEAR
<ul style="list-style-type: none"> <li>• HPGe test</li> <li>• <math>^{181}\text{Ta}(n,\gamma)</math></li> <li>• <math>^{nat}\text{Er}(n,\gamma)</math></li> <li>• <math>^{30}\text{Si}(n,\gamma)</math></li> <li>• <math>^{243}\text{Am}(n,f)</math></li> <li>• <math>^{12}\text{C}(n,p/d/a)</math> SADR</li> <li>• <math>^{12}\text{C}(n,p/d/a)</math> DDX</li> <li>• Ar-transmission</li> </ul>	<ul style="list-style-type: none"> <li>• <math>(n,\gamma)</math> optimization study</li> <li>• d-stilbene test</li> <li>• <math>^{197}\text{Au}(n,\gamma)</math> with 1cm &amp; 2cm B4C</li> <li>• <math>^{76}\text{Ce}(n,\gamma)</math> with 1cm &amp; 2cm B4C</li> <li>• <math>^{243}\text{Am}(n,f)</math></li> <li>• <math>^{30}\text{Si}(n,\gamma)</math></li> <li>• <math>^{64}\text{Ni}(n,\gamma)</math></li> <li>• <math>^{26}\text{Al}(n,p/a)</math></li> <li>• <math>(n,p/d/a)</math> SADR</li> <li>• Si det. test for <math>(n,cp)</math></li> <li>• X17 2nd part of in-beam test</li> </ul>	<ul style="list-style-type: none"> <li>• <math>^{197}\text{Au}(n,\gamma)</math></li> <li>• <math>^{140}\text{Ce}(n,\gamma)</math></li> <li>• <math>^{94}\text{Zr}(n,\gamma)</math></li> <li>• Diamond det. test</li> <li>• SiC</li> <li>• Background</li> </ul>

- 4 neutron capture reactions
- 2  $(n,cp)$  reactions
- $^{243}\text{Am}$  fission study covering 11 orders of magnitude of neutron energies
- 2 neutron capture reactions have been (further) studied at NEAR and EAR2 with different B4C filter configurations; Activation technique; MACS for different stellar temperatures;
- NEAR beam profile, flux and background measurements
- 9 detector development projects have been accomplished
- First transmission measurement at n\_TOF was realized

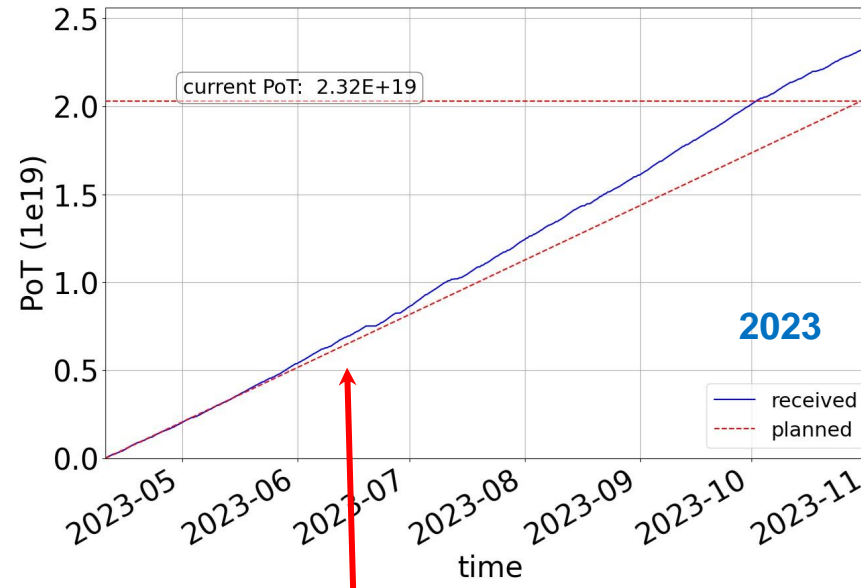
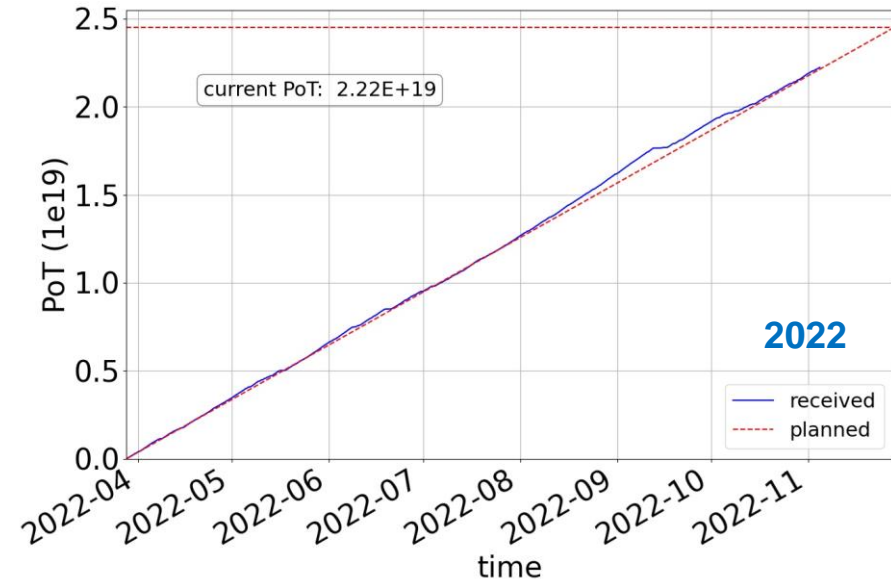


# PoT status

- We received (=2.3E19) more protons than expected (=2.03E19) = **1.14E17 p/day** 😊
- All experimental campaigns received the approved number of protons
- Flexibility on the pulse intensity
- Many thanks to the PS teams!



# PoT status



**Average proton beam intensity  
upper limit: 167E10 -> 220E10;  
09.06.2023**

**Many thanks to SY-STI, RP, and PS teams!**

PSB Fixdisplay - W 23 09-Jun-2023 14:43:49

Comments (08-Jun-2023 09:50:16)

Coordinator : GP Di Giovanni (167744)

Operator : CCC: 76671

BP	User	Pls	Inj.	Acc.	b.Ej.E10	Ej.E10	Dest.
2	MTE_2023	20	●●●●●	●●●	1097	1110	MTE_BB_23
3	TOF_2023	23	○●●○	○●●○	835	822	TOF_4BSW16_
4	EAST_T8_2023	2	○●●○	○●●○	356	360	EAST_T8_23
5	STAGISOGPS_2023	22	○●●○	○●●○	805	840	ISOGPS
6	TOF_2023	23	○●●○	○●●○	840	839	TOF_4BSW16_
7	TOF_2023	23	○●●○	○●●○	833	825	TOF_4BSW16_
8	TOF_2023	23	○●●○	○●●○	847	842	TOF_4BSW16_
9	STAGISOGPS_2023	22	○●●○	○●●○	795	832	ISOGPS
10	LHC25A_8b4e_202	6	●●●●●	●●●●●	585	585	LHC25#56b_8
11	LHC25B_8b4e_202	7	○●●○	○●●○	436	435	LHC25#56b_8
12	MD10043_MTE_202	32	●●●●●	●●●●●	394	393	BDUMP
13	DEGAUSS_1BP	1	○●●○	○●●○	751	754	LHC25#48b_3
	LHC25_36b_3eVs_						PS

14/34 No Message

CPS Tel:76677-W 23 CPS Fixdisplay 09 Jun 23 14:43:49

3 Colour range scales: 0.49 - 9 9 - 225 225 - 4500

E10 Charges Comments (09-Jun-2023 13:30:59)

1	MTE_BB_23	21	1096	P+	SFTPRO1
2	MTE_BB_23	21	1093	P+	SFTPRO1
3	TOF_4BSW16_23	23	819	P+	NTOF
4	EAST_T8_23	25	282.59.77	P+	NTOF+
6	TOF_4BSW16_23	23	823	P+	NTOF
7	TOF_4BSW16_23	23	816	P+	NTOF
8	TOF_4BSW16_23	23	827	P+	NTOF
9	DEGAUSS_1BP	16	-	-	-
10	LHC25#56b_8b4e	9	999	P+	LHC1
13	LHC25#48b_3eVs	10		P+	LHC1
/34	LHC25#48b_3eVs	10		P+	LHC

CCC: 76677  
Coordinator: A.Lasheen  
(162067)  
\*\*\*

# YETS 2023-2024 activities

- **RF - antenna analysis** has to be organized for early next year. The ringing problem was mitigated for some detectors (e.g. SADR) but the problem still exist in the experimental area (EAR1). Is a beam-related facility problem that was not there on 2021.
- **Vacuum improvements:** Replace o-rings vac. pipes (EAR1)
- **Optical fiber data line** is already scheduled (in both EAR's)
- **230 V UPS sockets** (in both EAR's)
- **Improvements on mounting of the sTED** holder-rods
- **Li-PE floor in EAR2**
- **Vacuum pipe compatible** with the “new” capture position in **EAR2**
- **Repair SIMON1**
- **DAQ:** migrate to **ALMA9** linux distribution, swap to **own domain**, double bunch pulse coupling with our DAQ, ...
- **Orders:** Vacuum pumps, 88Y sources, Oscilloscopes, tools, materials, ...
- **Repairs:** SPD cards, Oscilloscopes, ...
- ...

# Main works during YETS 23/24

EAR	Task
1	CLEAN THE AREA
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	Replace o-rings where needed in EAR1 vac. Pipes
1	RF – antenna analysis request
1	NEL top cable channel
1	optical data line
1	beam line with larger aperture for the second capture position
1	Kapton vac window for NEL (small colli)
1	laser for NEL
1	channel for cabling above NEL
1	230V UPS sockets
2	CLEAN THE AREA
2	Better mounting of the STED holder-rods
2	Cleanup & ordering new material (tools, gloves, cable binders, tape, pipe elements, ...)
2	optical data line
2	Order Li-PE / neutron shielding around collimator
2	vacuum pipe compatible with the new capture position
2	230V UPS sockets

*Many thanks to Oliver Aberle, Oscar Fjeld*

# Main works during YETS 23/24

NEAR	order B4C disks compatible with the previous ones as to <u>improve</u> the filtering of the beam
NEAR	
GEAR	230V UPS sockets
GEAR	
LAB	CLEAN LAB
LAB	missing tools & material

<b>Detectors</b>	
<u>HPGe</u>	<u>HPGe</u> and Beta spectrometer <u>DAQ</u> coupling
C6D6	Check for leaks
<u>uMegaas</u>	gas system for <u>umegas</u> and <u>ppacs</u>
SiMon1	Repair Simon1
<u>DAQ</u>	migrate to <u>linux alma 9</u> distribution
<u>DAQ</u>	swap to our own domain
<u>DAQ</u>	data transfer
<u>DAQ</u>	data processing chain/maintenance/cleanup
<u>DAQ</u>	<u>SPD</u> cards repair
Other	Update shifter manual
Other	Transmission measurement preparations
Other	<u>Oscilloscope</u> (new order)
Other	Vacuum pump - Dry (2 new are urgently needed)
Other	88Y sources (2)
Other	smelling pump

*Many thanks to Oliver Aberle, Oscar Fjeld*

# n\_TOF Physics about to come

Approved experiments	EAR1	EAR2	NEAR
40K(n,p/a)		X	
Er(n, $\gamma$ )	X		
28,29Si(n, $\gamma$ )	X		
Ce(n,f)	X		
MareX		X	
Dallas NiSoC		X*	
LaBr3 test	X		
146Nd(n, $\gamma$ )		X	
209Bi(n, $\gamma$ )		X	
238U(n, $\gamma$ )	X		
241Pu(n, $\gamma$ )	X (2025)		
135Cs(n, $\gamma$ ) SACS			X (2025)
...			

**More details: Michi's presentation on 2024 planning.**



**Prepare your proposals asap. LS3 is scheduled for 2026 (last beam till October 2025)**





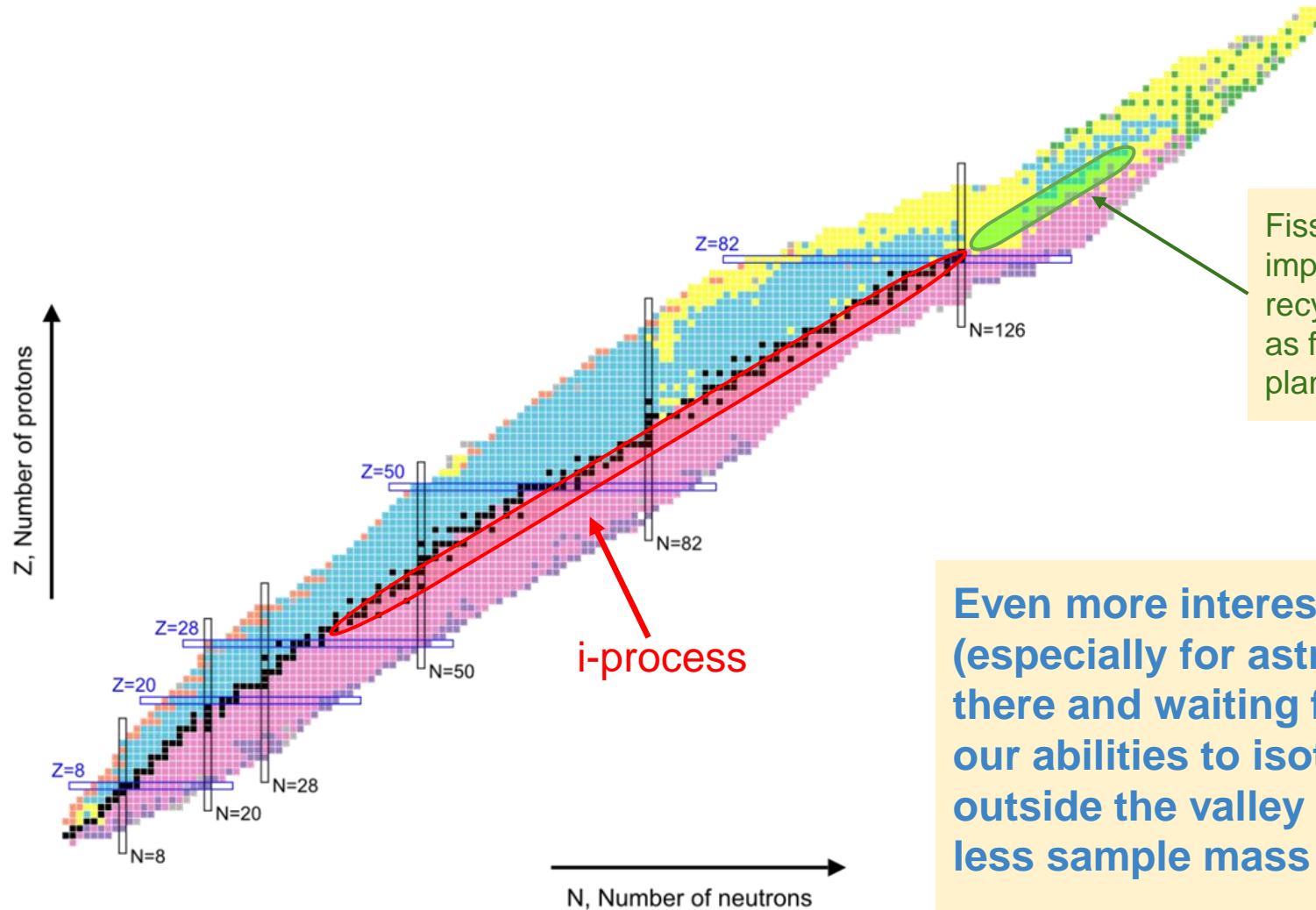
# 2024 n\_TOF Physics start

- **2024 Beam for n\_TOF (our request:  $217 \times 1.0E17 = 217E17$  protons or  $1.0E17$  protons/day)**
  - 18.3.2024 - for hardware commissioning (7 days)
  - 25.3.2024 - Physics Start
  - 28.10.2024 - beam off (217 days of physics)
- **Pulses of different intensities**
  - High intensity (dedicated):  $8.5E12$  ppp
  - Low intensity (parasitic):  $4.5E12$  ppp
  - A full variety of different pulses is available
- **Same (as 2023) spatial profile dimensions of the beam**
- **Better control of the proton beam spatial profile thanks to larger SEM grid with more channels**
- **Average proton beam intensity upper limit:  $220E10$  pps**
- **Pulse longitudinal dimension: 28 ns ( $\sigma \sim 7$ ns) without “tails” and pre-pulses**

# n\_TOF so far...



# n\_TOF future (High Power target #4)



Fission reaction studies are important for the role of fission recycling in nucleosynthesis as well as for the ongoing n\_TOF research plan in energy applications

Even more interesting physics cases (especially for astrophysics: i-process) is there and waiting for us! We have to extend our abilities to isotopes 2 or 5 mass units outside the valley of stability. That means less sample mass will be available.

# n\_TOF future (High Power target #4)

With a target able to accept higher proton beam intensity (x10) we can:

- **Extend significantly the abilities of both TOF experimental areas. Measurements ~10 times lower sample masses become feasible**
  - Detection efficiency:
    - **x2** or **x3** in gamma detection
    - **x6** in particle detection
  - **Average neutron flux for TOF measurements: x2 (or more) (Maintaining the nice single bunch parameters for TOF measurement)**
  - **Potential increase single bunch intensity x2 or x3** -> important improvement in S/N ratio!
- **Extend significantly the abilities of both NEAR: SACS measurements with ~100 times lower sample mass become feasible**
  - Detection efficiency: **x10** thanks (!) to Spanish HPGe Clover funding
  - Average neutron flux: **x10** (or more) by reducing single bunch properties and increase the average power on target (e.g. by directing to FTN all 4 PSB pulses)

# n\_TOF LRP Lol is endorsed from INTC

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Letter of Intent to the ISOLDE and Neutron Time-of-Flight Committee

n\_TOF

September 26, 2023

The n\_TOF Collaboration<sup>1</sup>

<sup>1</sup>CERN, CH-1211 Geneva - [www.cern.ch/n\\_TOF](http://www.cern.ch/n_TOF)

**Spokesperson:** A. Mengoni [[alberto.mengoni@cern.ch](mailto:alberto.mengoni@cern.ch)]

**Technical coordinator:** O. Aberle [[oliver.aberle@cern.ch](mailto:oliver.aberle@cern.ch)]

**Abstract:** Following the plans for the next operation and long-shutdown intervals of the CERN accelerator complex, the n\_TOF Collaboration has elaborated a planning for the short- to long-term period of activities. This has been based on a physics program which can be realized at the facility, taking into account the unique features offered by the n\_TOF neutron beams, as well as the foreseeable evolution of nuclear physics research activities worldwide and in Europe in particular. An initiative to elaborate physics cases and options for further improvement of the facility has been carried out by the n\_TOF Collaboration and is reported in this Letter of Intent, aiming at providing the basic information needed for an evaluation of the future experimental program and possible facility upgrades.

**Requested protons:** N/A  
**Experimental Area:** EAR1, EAR2 and NEAR Station

<http://cds.cern.ch/record/2872442?ln=en>



# n\_TOF @ Athens RECFA

<https://indico.cern.ch/event/1211715/overview>

Welcome to Athens, Greece!



Despina Galani

Starts 10 Nov 2023, 09:30  
Ends 10 Nov 2023, 19:00  
Europe/Athens

Paris Sphicas

<https://cern.zoom.us/j/68110377455?pwd=ZHEwSW9oUjVDMmdKYUg1Ym1ldEh2QT09#success>

NKUA  
"Argyriades" Auditorium  
Panepistimiou 30, 106 79 Athens  
Πανεπιστημίου 30, 106 79 Αθήνα

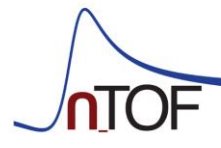
On Zoom: <https://cern.zoom.us/j/68110377455?pwd=ZHEwSW9oUjVDMmdKYUg1Ym1ldEh2QT09#success>  
Go to map

Zoom link:

## Nuclear Physics in Greece

RECFA, Athens-Greece, 10/11/2023

Nikolas Patronis  
n\_TOF Physics Coordinator  
CERN & Univ. of Ioannina



## The Hellenic Nuclear Physics community

### Institutes:

- National and Kapodistrian University of Athens, Department of Physics
- National Technical University of Athens, Department of Physics
- Aristotle University of Thessaloniki
- University of Ioannina
- Hellenic centre for marine research, Anavyssos
- NCSR "Demokritos", Athens



Faculty members,  
Researchers: 25

Our younger colleagues:  
BSc: ~40; MSc: ~15; PhD: ~25; post-docs: ~10



## The n\_TOF facility



### Is the "gluon" of the Greek Nuclear Physics Society:

- Uof and NTUA Nuclear Physics Groups are active and well involved members of the n\_TOF collaboration
- AUTH members have already expressed interest to join
- Currently: >5 faculty members, 3 Post-docs, 4 PhD students, 4 MSc students, 4 BSc students
- Previous years: >7 PhD, >15 MSc thesis, ...

### Join forces for:

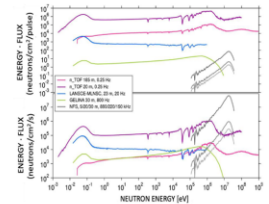
- Fission reaction studies (239Pu, 241Am, 230Th, ...)
- (n, cp) reactions (medical applications, fusion technology, basic research)
- Nuclear astrophysics

## The n\_TOF facility: Is a unique neutron facility

- neutron source instantaneous intensity and energy distribution
- repetition rate of the driver
- time (or neutron energy) resolution
- background conditions
- n\_TOF is @ CERN: ISOLDE a few tenths meter away, ...

Reaction	Energy	Research area	Reference
$^{171}\text{Tm}(n,\gamma)$	< 1 MeV	stellar nucleosynthesis	PRC 125, 142701 (2020)
$^7\text{Be}(n,p)$	< 1 MeV	big bang nucleosynthesis	PRC 121, 042701 (2018)
$^7\text{Be}(n,\alpha)$	< 1 MeV	big bang nucleosynthesis	PRC 117, 102701 (2016)
$^{48}\text{Ni}(n,\gamma)$	< 1 MeV	stellar nucleosynthesis	PRC 110, 022501 (2013)
$^{151}\text{Sm}(n,\gamma)$	< 1 MeV	stellar nucleosynthesis	PRC 93, 161101 (2004)
$^{232}\text{Th}(n,f)$ , $^{233}\text{U}(n,f)$	< 1 GeV	advanced fuel cycles	PRC 107, 044616 (2023)
$^{235}\text{U}(n,f)$	< 1 MeV	cross section standard	EPJA 55, 120 (2019)
$^{235}\text{U}(n,f)^{236}\text{U}(n,f)$	1 MeV - 1 GeV	cross section standard	PRC 93, 024602 (2015)
$^{232}\text{Th}(n,\gamma)$	< 1 MeV	advanced fuel cycles	PRC 86, 013902 (2012)
$^{244}\text{Cm}(n,f)$	< 1 MeV	transmutation of MA	PRC 85, 034616 (2012)

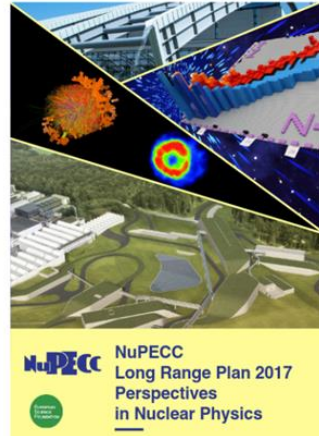
Neutron Physics with particle accelerators  
N. Colonna, F. Gossing and F. Kappeler  
Progress in Particle and Nuclear Physics, 188, 177 (2018)  
<https://doi.org/10.1016/j.pnpnp.2018.05.006>



Neutron physics data for 11 orders of magnitude of neutron energies

- The feedback from the n\_TOF presentation in front of the CERN management was very very positive!
- Chair of ECFA is planning to visit n\_TOF next week!

# n\_TOF @ NuPECC LRP



<p><b>TWG-1 Hadron Physics</b> coordinators  <a href="#">web site</a>                      C. Alexandrou (Cyprus Univ.)                      K. Schönning (Uppsala Univ.)</p>	<p><b>TWG-2 Strongly Interacting Matter under Extreme Conditions</b> coordinators  <a href="#">web site</a>                      L. Fabbietti (TU München)                      U. Wiedemann (CERN)</p>
<p><b>TWG-3 Nuclear Structure and Reaction Dynamics</b> coordinators  <a href="#">web site</a>                      S. Leoni (Univ. Milano)                      T. Rodriguez (UCM)</p>	<p><b>TWG-4 Nuclear Astrophysics</b> coordinators  <a href="#">web site</a>                      A. Kankainen (JYFL)                      J. Jose (Univ. Barcelona)</p>
<p><b>TWG-5 Symmetries and Fundamental Interactions</b> coordinators  <a href="#">web site</a>                      P. Delahaye (GANIL)                      P. Crivelli (ETH)</p>	<p><b>TWG-6 Infrastructures</b> coordinator  <a href="#">web site</a>                      W. Korten (CEA, Saclay)</p>
<p><b>TWG-7 Applications and social benefits</b> coordinators  <a href="#">web site</a>                      T. Cocollos (KU Leuven)                      C. Vandevoorde (GSI)</p>	<p><b>TWG-8 Nuclear Physics Tools</b> coordinator  <a href="#">web site</a>                      S. Dalla Torre (INFN)                      V. Bertone (CEA, Saclay)                      J. Günther (U. Wuppertal)</p>
<p><b>TWG-9 Open Science and data</b> coordinator  <a href="#">web site</a>                      A. Lemasson (GANIL)</p>	<p><b>TWG-10 Nuclear Science - People and society</b> coordinators  <a href="#">web site</a>                      M.G. Borge (Madrid)                      C. Diget (York)</p>

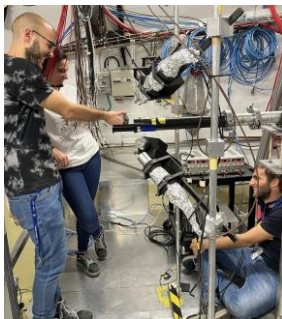
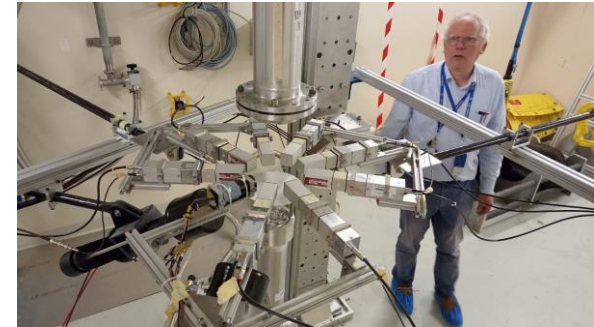
# Conclusions

- We had a very **smooth & productive 2023 n\_TOF campaign**
- 1 (n,f), 4 (n, $\gamma$ ), 2 (n,cp) reactions studies were studied over an extended energy range
- The **first transmission (test)** measurement was realized.
- **9 (!) 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 **increase of the average proton beam intensity upper limit from 167E10 to 220E10 pps had important effect**; allows for more compact time planning considering 1.1E17 protons per day (instead of 1E17) but according to PS-SPS Physics Coordinator next year EAST area will be super-busy and we have to stick to the **standard request 1E17 p/day**
- A lot of actions for the **n\_TOF future plans & visibility** have been done ...still many things to do
- A lot of data have to be analysed. Thankfully our **enthusiastic young colleagues are there** (Nikos, Jash, Stella, Matt, Michele...)



# Many thanks to the n\_TOF local team!

Alberto Mengoni, Michael Bacak, Alice Manna, Simone Amaducci, Adria Casanovas, Francisco Garcia Infantes, Jose Antonio Pavon Rodriguez, Elisso Stamati, Stella Goula, Zinovia Eleme, Michele Spelta, Riccardo Mucciola ...

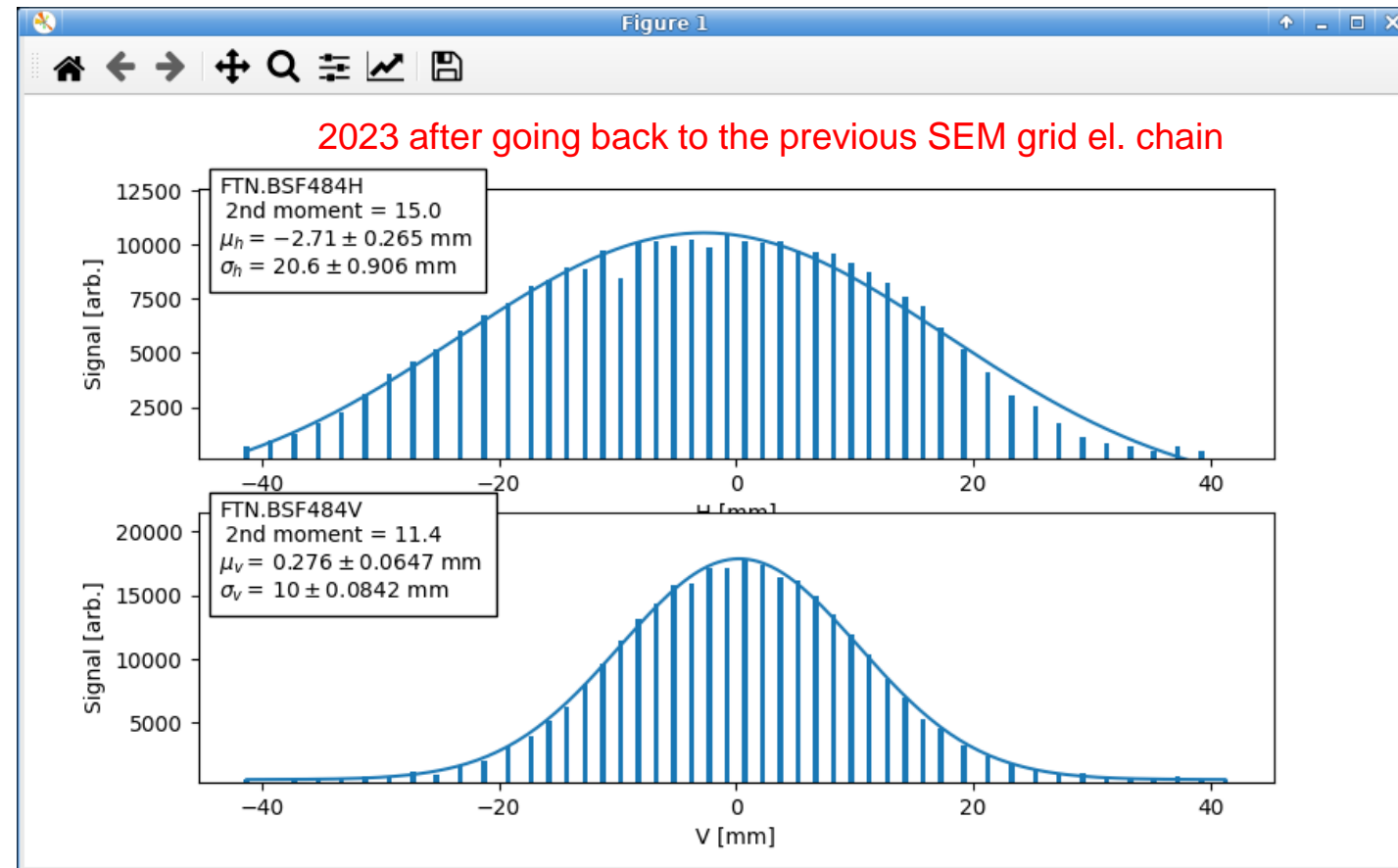
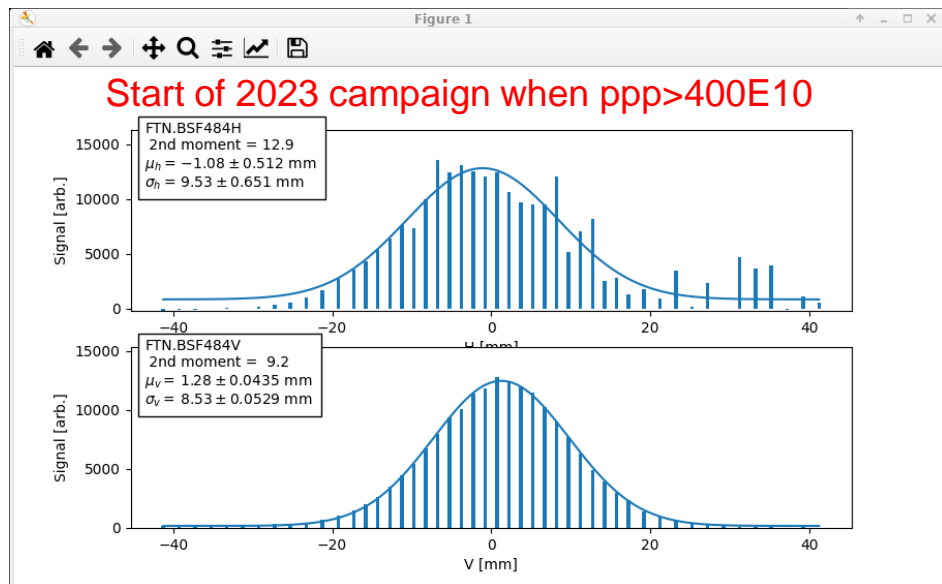
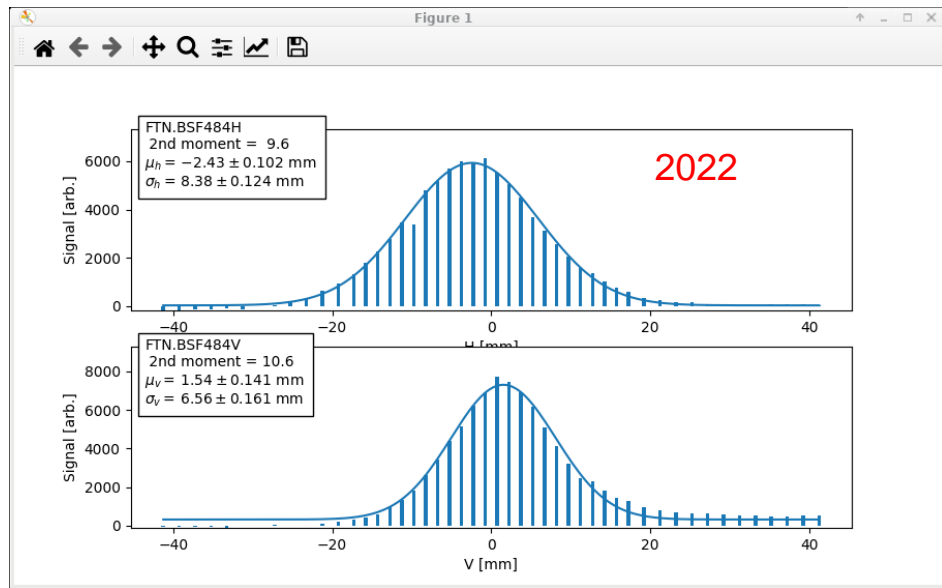


**Thank you so much !**

# Extra slides

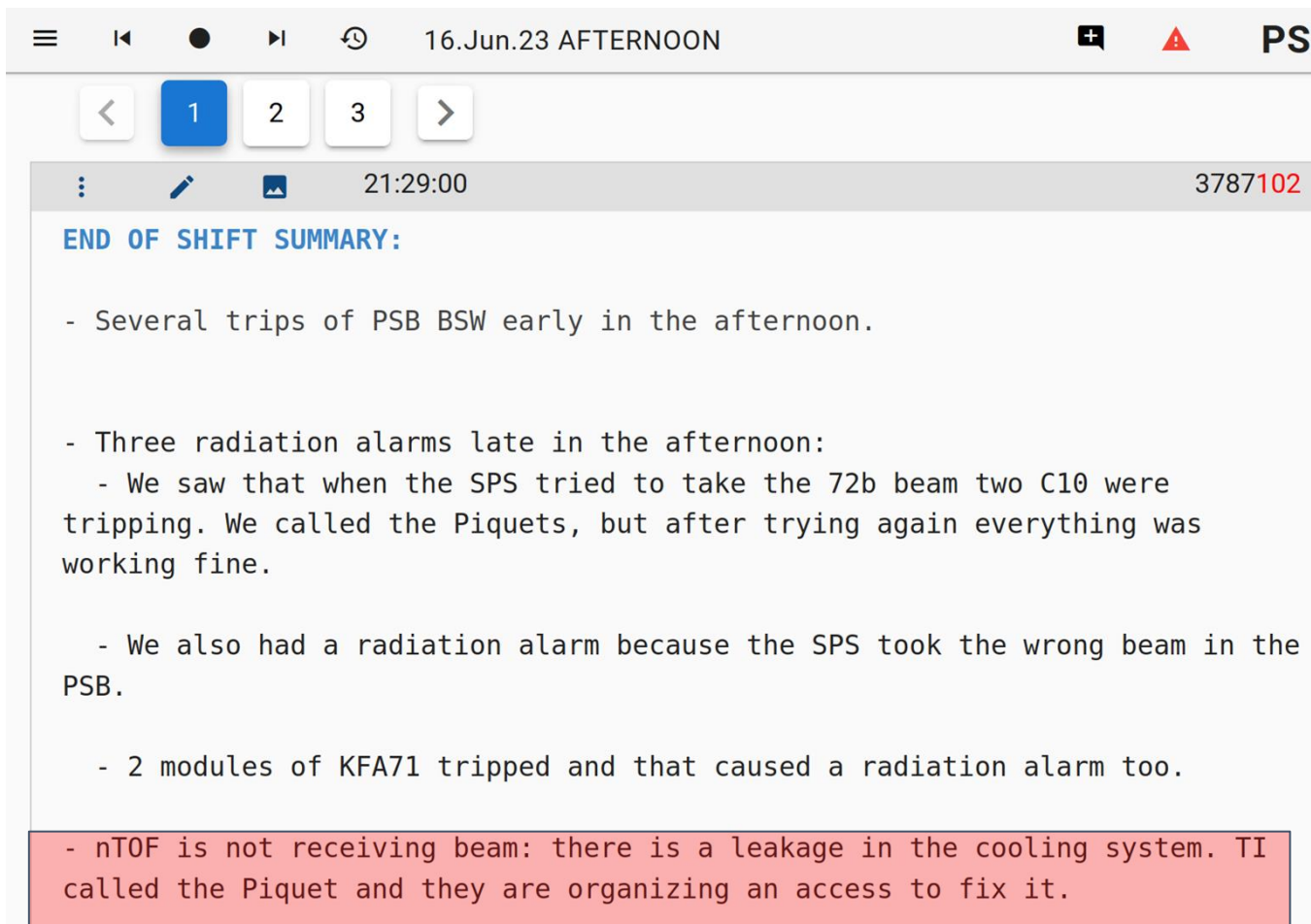
# Some problems with SEM grid at the start of 2023 run

Beam start at 03.04.2023 - FTN line commissioning



# Issues during the 2023 campaign

**n\_TOF target borated water filter leak on 16/6/2023:** Thankfully a backup filter was available!  
Many thanks to: Ch. Saury, N. Roget, Cl. Pruneau for the successful intervention!

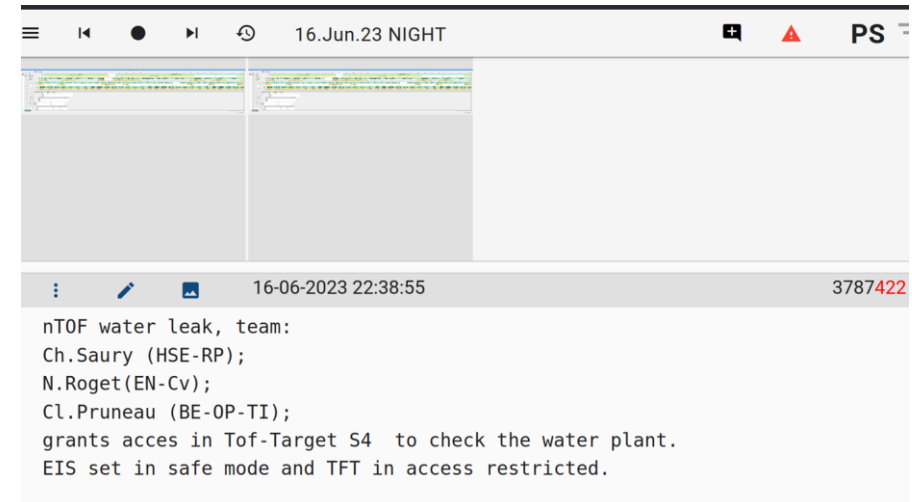


16.Jun.23 AFTERNOON

21:29:00 3787102

**END OF SHIFT SUMMARY:**

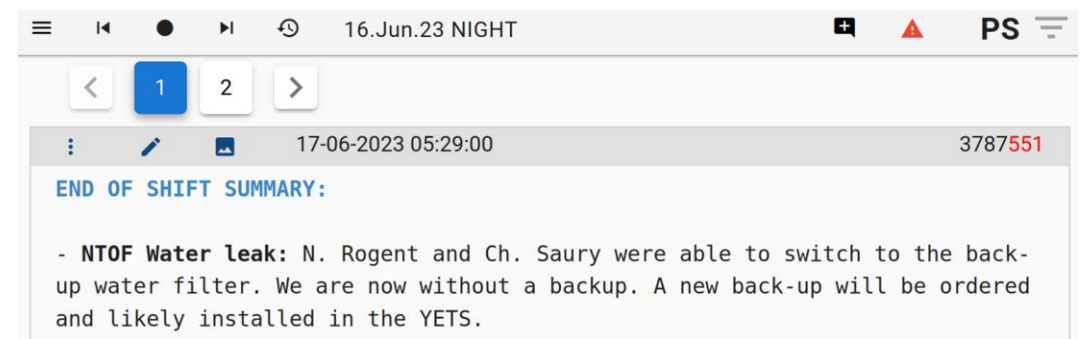
- Several trips of PSB BSW early in the afternoon.
- Three radiation alarms late in the afternoon:
  - We saw that when the SPS tried to take the 72b beam two C10 were tripping. We called the Piquets, but after trying again everything was working fine.
  - We also had a radiation alarm because the SPS took the wrong beam in the PSB.
  - 2 modules of KFA71 tripped and that caused a radiation alarm too.
- nTOF is not receiving beam: there is a leakage in the cooling system. TI called the Piquet and they are organizing an access to fix it.



16.Jun.23 NIGHT

16-06-2023 22:38:55 3787422

nTOF water leak, team:  
Ch.Saury (HSE-RP);  
N.Roget (EN-Cv);  
Cl.Pruneau (BE-OP-TI);  
grants access in Tof-Target S4 to check the water plant.  
EIS set in safe mode and TFT in access restricted.

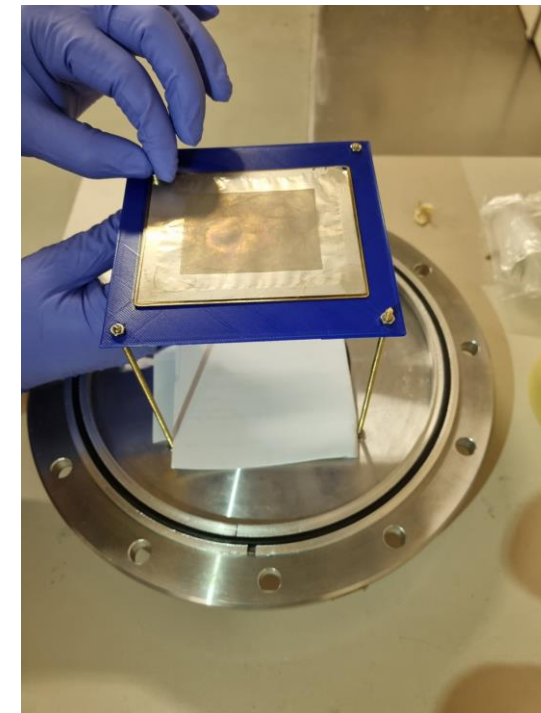
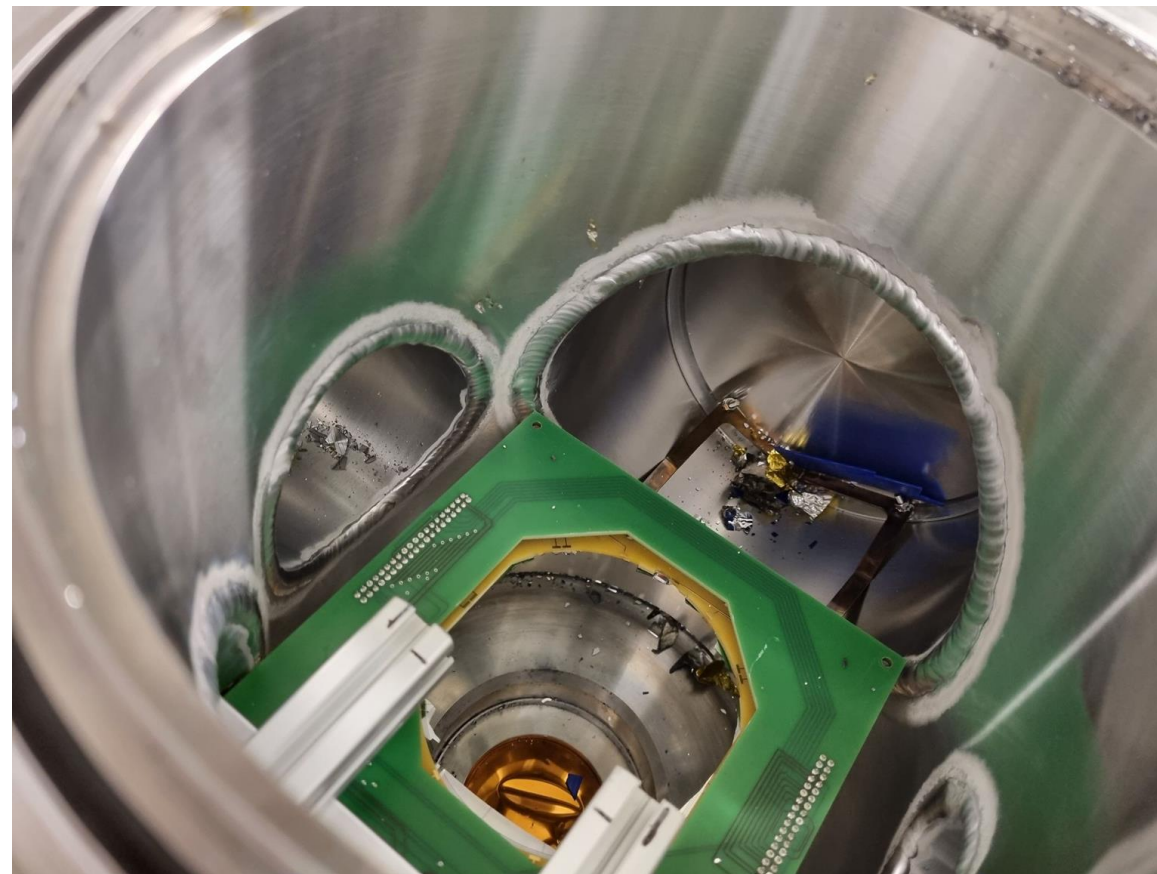
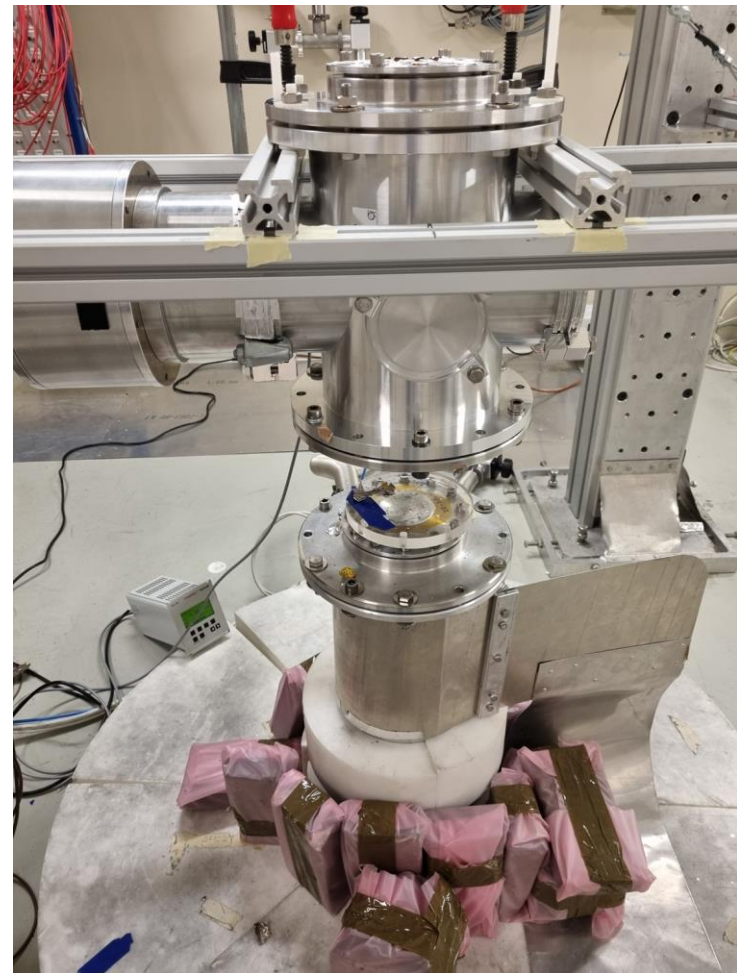


16.Jun.23 NIGHT

17-06-2023 05:29:00 3787551

**END OF SHIFT SUMMARY:**

- **NTOF Water leak:** N. Rogent and Ch. Saury were able to switch to the back-up water filter. We are now without a backup. A new back-up will be ordered and likely installed in the YETS.



2021

2022

