

# LINAC & BTF

L. Foggetta on the behalf of

## ***LINAC/BTF Group***

### ***Researchers (5):***

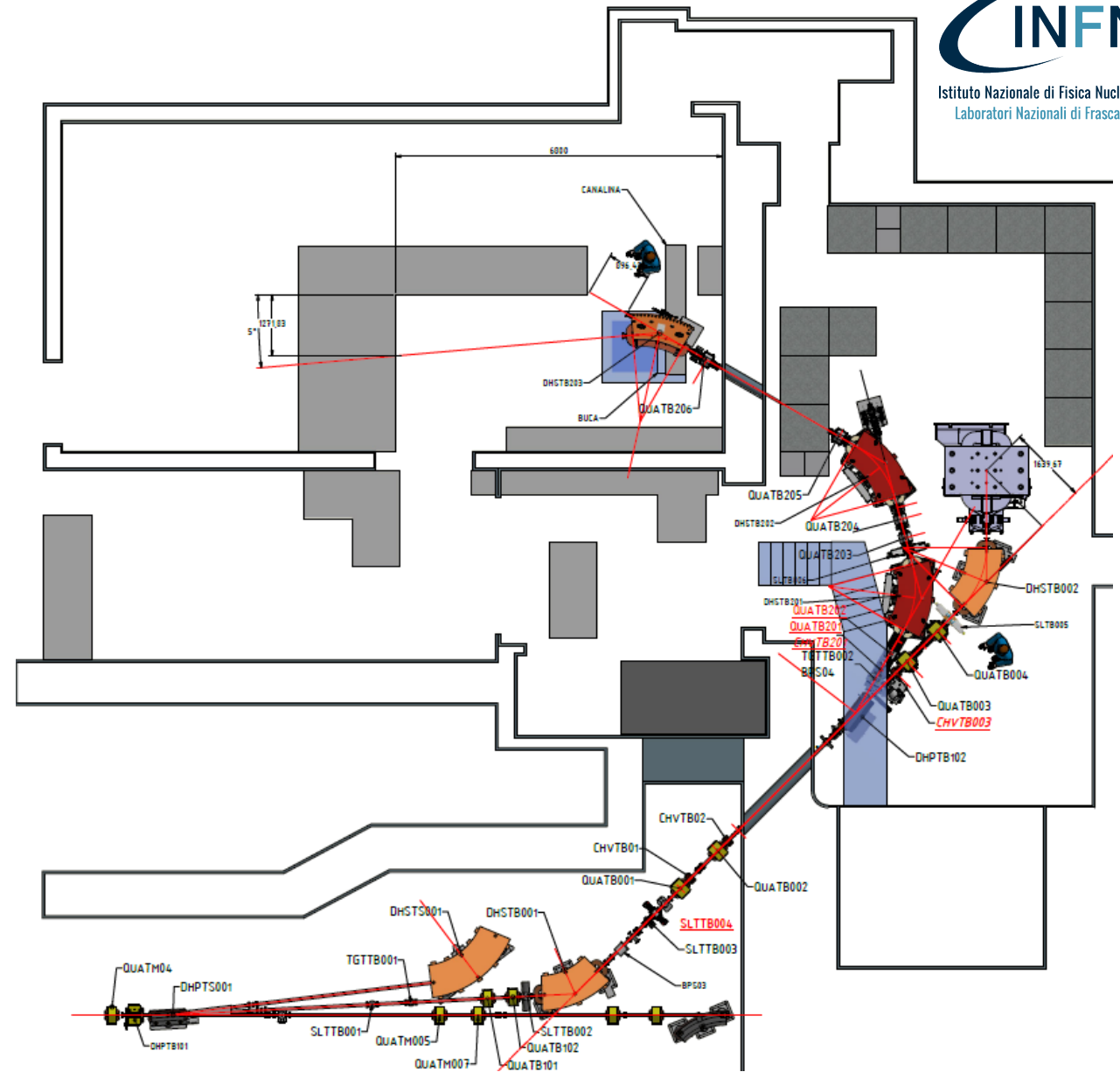
*B. Buonomo, F. Cardelli,  
D. Di Giovenale, C. Di Giulio,  
L. G. Foggetta*

### ***Technicians (7):***

*R. Ceccarelli, A. Cecchinelli,  
M. Ceccarelli, G. Piermarini,  
A.L. Rossi, S. Strabioli, R. Zarlenga*  
***Retired:*** *M. Belli, R. Clementi*

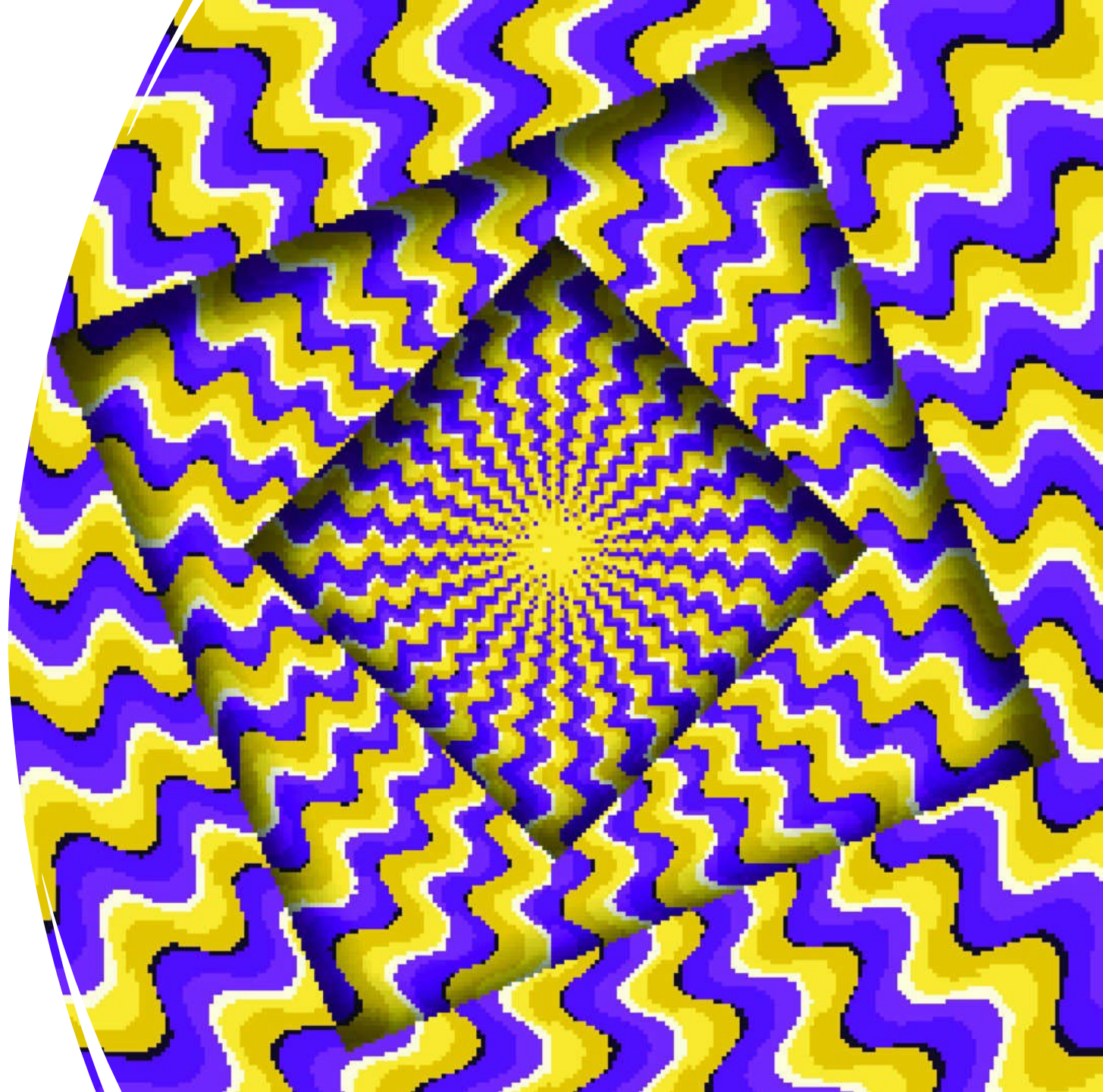
# OVERVIEW

- LINAC and BTF for X17 run
- BTF1, BTF2 for user run
- LINAC for SIDDHARTA and BTF user run
- LINAC and BTF projects



# BTF STATUS

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## BTFEH1 – BTF1 (2 lines)

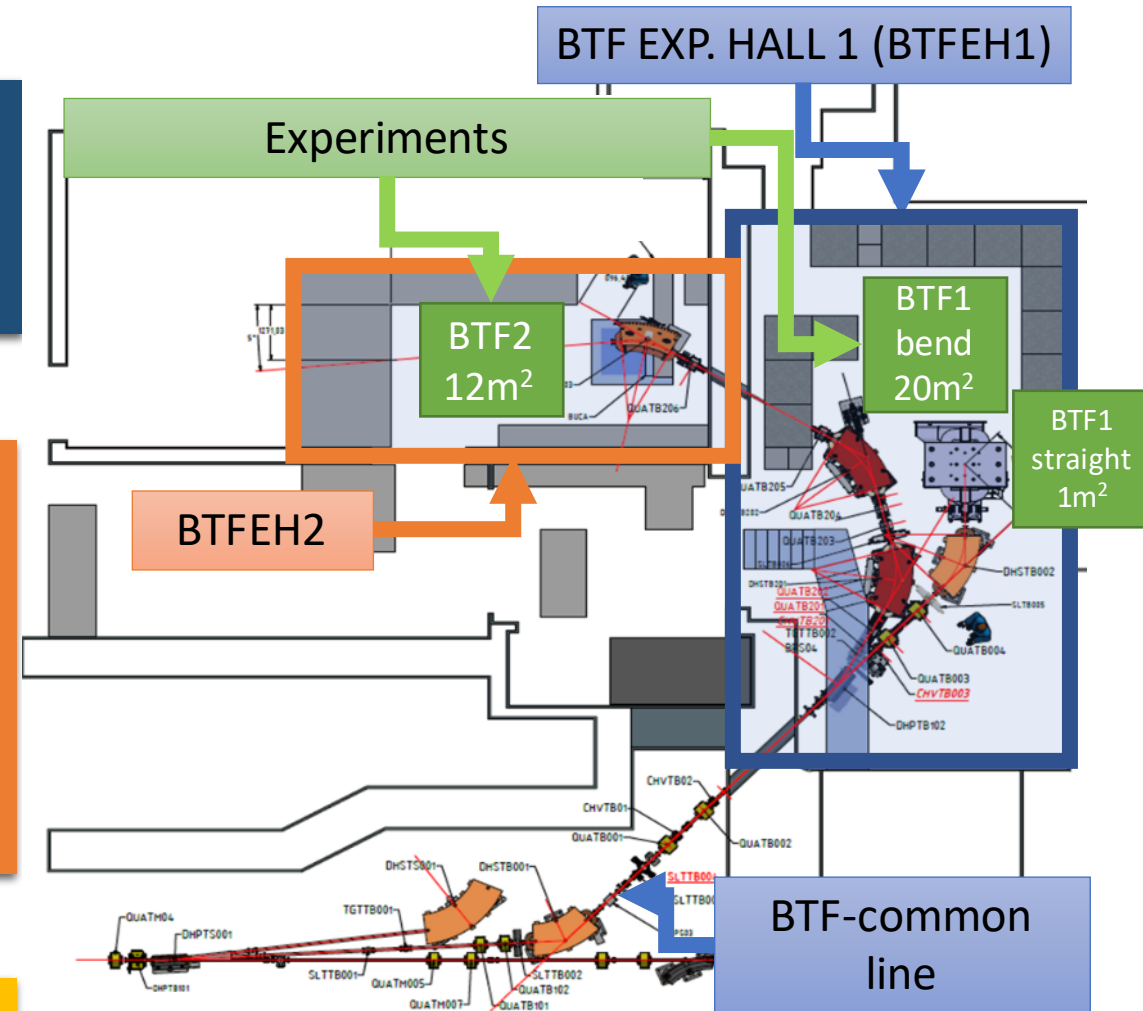
- Hall Operative
- Opportunistic INFN runs during maintenance period (FISMELE – SPARCULENS)
- Remarkable run FLASHMOB (99Tc production)

## BTFEH2 – BTF2 (1 line)

- Hall operative, BTF2 line to external users
  - external users run foreseen now up to October
  - Calls to be opened
    - June to July
    - Sept to Dec
- Only secondary beam
- Upgrade beam performances respect to first runs (transverse param.)
- Involved in EUROLABS Project, started on Autumn 2022

## BTFEHs

- **DHPTB101 PS is a TRUE pending problem, single point of failure**
- **Software for automated call and user management operative**



Parameters	BTF1 Time sharing		BTF1 Dedicated		BTF2 Time sharing	BTF2 Dedicated
	With Cu target	Without Cu target	With Cu target	Without Cu target	With Cu target	With Cu target
Particle	e <sup>+</sup> / e <sup>-</sup> (User)	e <sup>+</sup> / e <sup>-</sup> (DAΦNE status)	e <sup>+</sup> / e <sup>-</sup> (User)		e <sup>+</sup> / e <sup>-</sup> (User)	
Energy (MeV)	25–500	510	25–700 (e <sup>-</sup> /e <sup>+</sup> )	167–700 (e <sup>-</sup> ) 250–550 (e <sup>+</sup> )	25–500	25–700
Best Energy Resolution at the experiment	0.5% at 500 MeV	0.5%/1%	0.5%(Energy/mult dependent)		1% at 500 MeV(Energy/mult dependent)	
Repetition rate (Hz)	Variable from 1 to 49 (DAΦNE status)		1–49 (User)		Variable from 1 to 49 (DAΦNE status)	1–49 (User)
Pulse length (ns)	10		1.5–320 (User)		10	10
Intensity (particle/bunch)	1–10 <sup>5</sup> (Energy dependent)	10 <sup>3</sup> to 1.5x10 <sup>10</sup>	1–10 <sup>5</sup> (Energy dependent)	1 to 3x10 <sup>10</sup>	1–10 <sup>4</sup> (Energy dependent)	
Max int flux	3.125x10 <sup>10</sup> part./s				1x10 <sup>6</sup> part./s	
Exit Beam waist size (m1, mm)	0.5–55 X / 0.35–25 Y (vacuum window dependent)				0.6x0.6(Energy/mult dependent)	
Divergence (mrad)	Down to 0.5				Down to 0.5	

- Pulsed **electron** and **positron** beams (up to 49 pulses/second)
- Wide range: from 10<sup>10</sup> down to single particle per bunch, continuous energy selection
- Different ranges of parameters in the **two running modes**:
  - Dedicated: only when DAΦNE collider in shutdown, exclusive BTF users
  - Time sharing:
    - DAΦNE spare pulse injections mode via **DHPTB101** pulsed magnet
    - Beam top parameters defined by DAΦNE injections

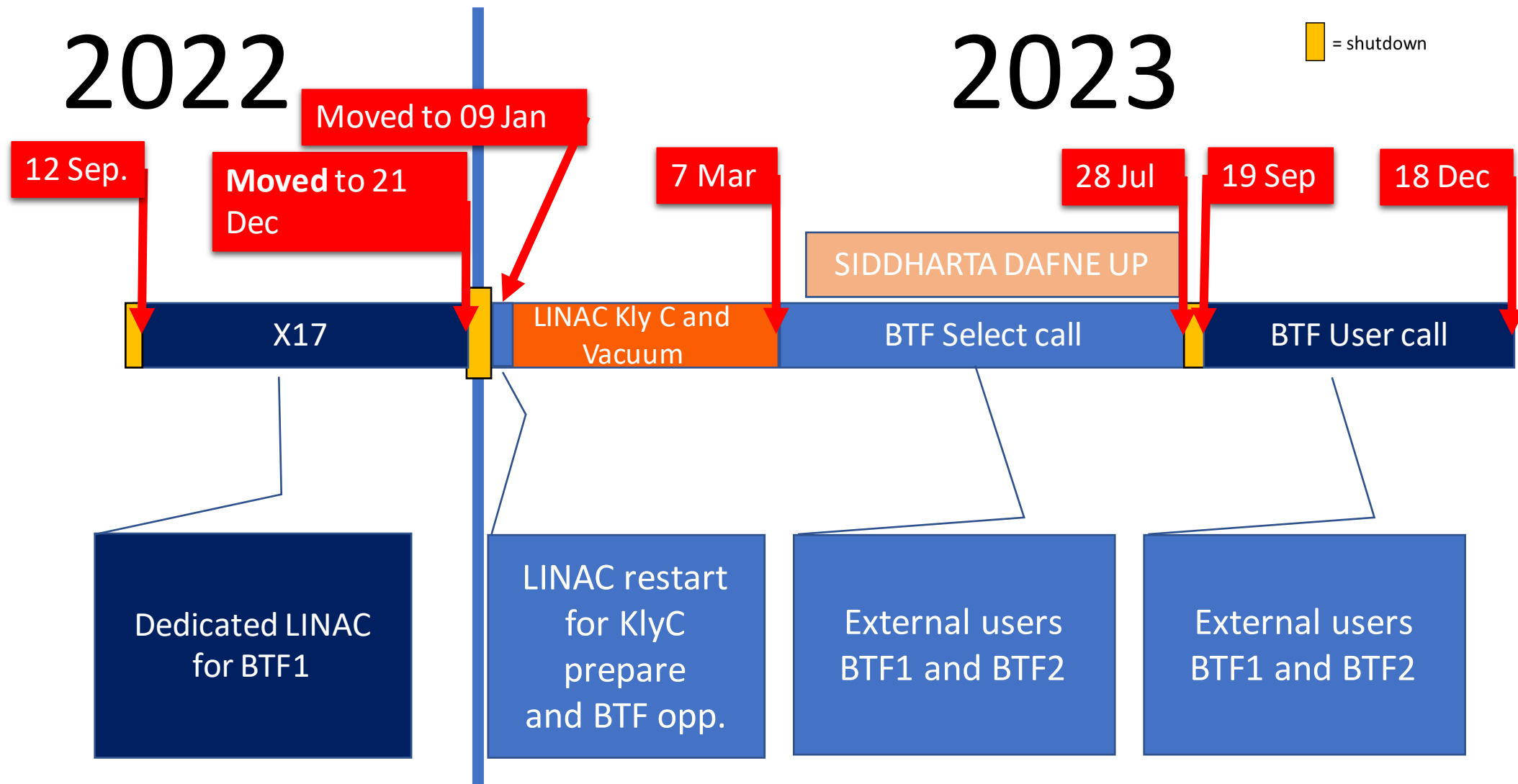
## Recommendations DAFNE-BTF SC63

*Operate the LINAC at 50 Hz, provided a repair of Klystron C is successful, to reduce injection time. Optimum “stable beam” duration should be adapted accordingly considering luminosity lifetime. Continue the analysis effort for the identification of the sources of LINAC down-time and of the elements that might require consolidation for long-term operation of the accelerator in view of maintaining and possibly increasing reliability.*

- 2022 user beam-days planning **totally acquired, X17 Run accomplished**
- 2023 beam-days planning expectations **ongoing smoothly**
- DAFNE on, **BTF run in spare pulse mode**
- Kly-C assessment **gained**, now 50 Hz but DAFNE inj remains 25 Hz since optimal inj has been implemented during March 2023.
- LINAC/BTF team mainly involved in 2023 for DAFNE and BTF operations, TEX, SPARCLAB
- EUROLABS (1w payed: one get?, one foreseen)

## *What we got from last SciCom (Fall 2022 – Spring 2023) – Internal activities*

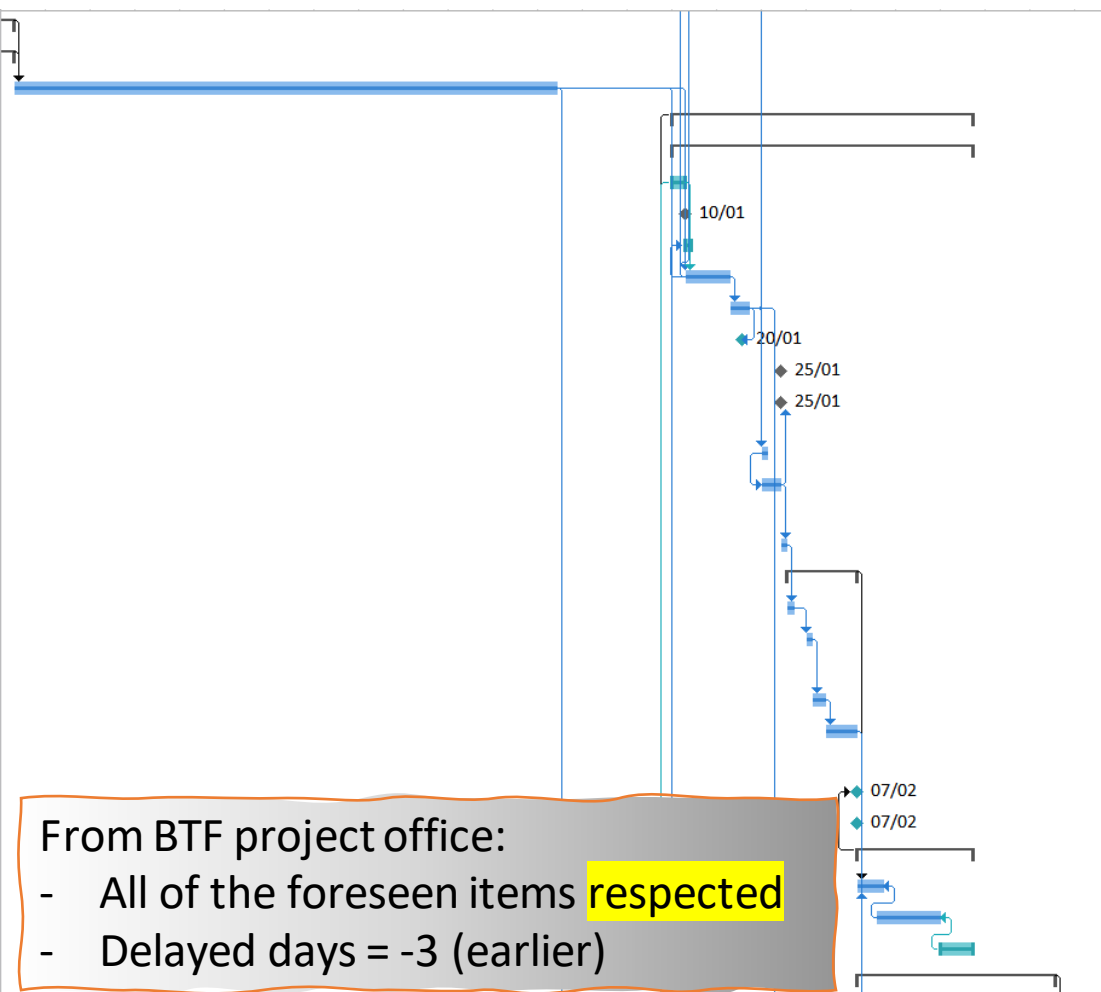
<b>BTF1 for X17 run</b>	<b>12 Sep. -&gt; extended up 21/12/2022</b>
<b>LINAC+BTF Shutdown for maintenance</b>	<b>21 Dec. 2022</b>
<b>LINAC restart for prepare KLYC replacement</b>	<b>09 Jan. 2023</b>
<b>BTF Restart for Opportunistic run</b>	<b>10-20 Jan.</b>
<b>LINAC Shutdown for overhauling KLYC and vacuum</b>	<b>20 Jan.</b>
<b>LINAC restart for KLYC and Vacuum conditioning</b>	<b>20 Feb.</b>
<b>LINAC e+/e- beam on</b>	<b>7 Mar.</b>
<b>LINAC for BTF User Activities Restart</b>	<b>10 Mar.</b>
<b>LINAC for DAFNE</b>	<b>16 Mar.</b>





## Items for KLYC overhauling

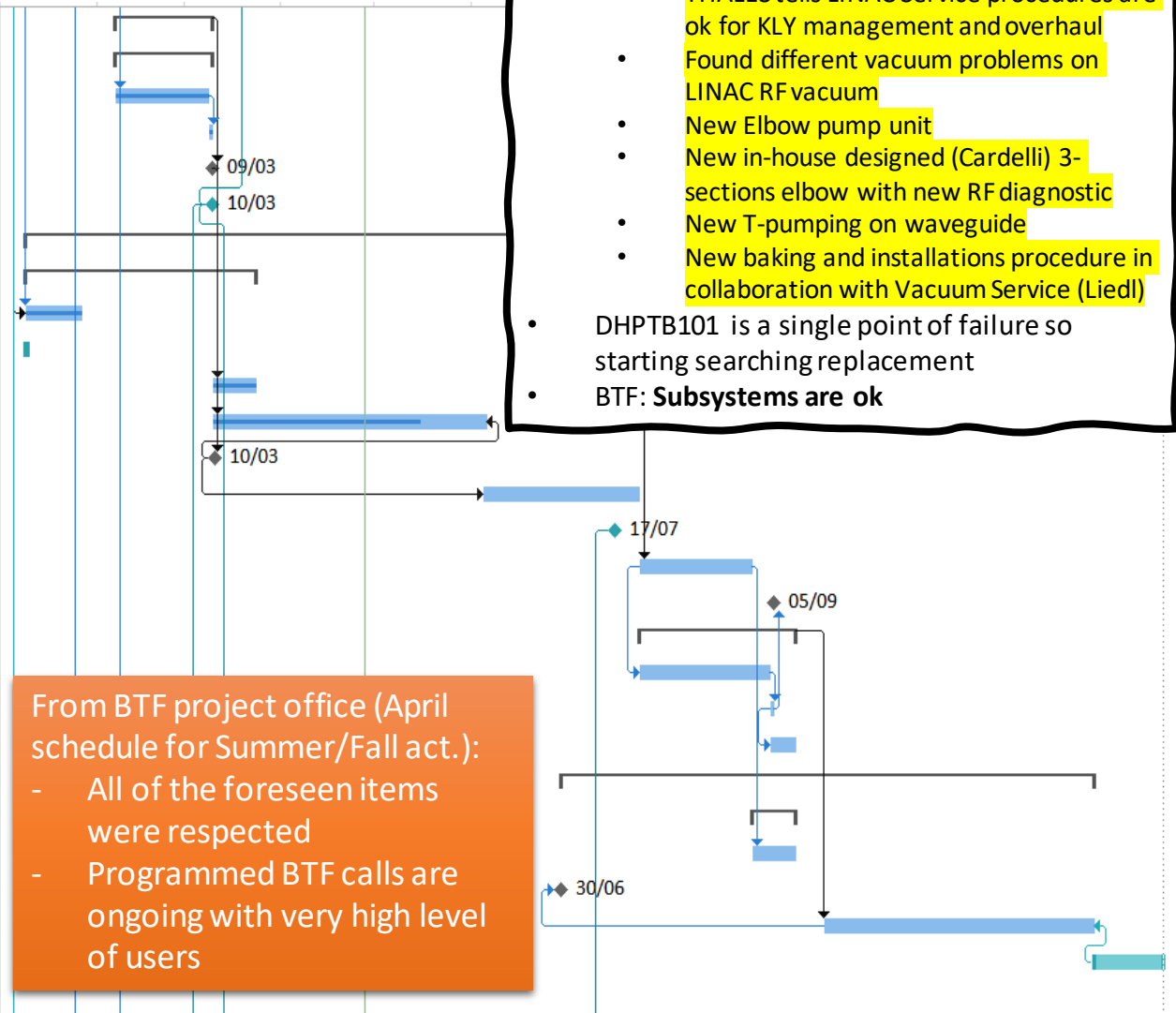
✓	▷ BTF on	12 g	lun 12/09/22	mar 27/09/22
✓	▷ LINAC on	7 g	lun 19/09/22	mar 27/09/22
✓	X17 Scient Run	61 g	mer 28/09/22	mer 21/12/22
✓	◁ Shutdown LINAC+BTF WINTER 2022	35 g?	lun 09/01/23	ven 24/02/23
✓	◁ <b>SHIFTED LINAC Kly C for THALES operation</b>	<b>35 g?</b>	<b>lun 09/01/23</b>	<b>ven 24/02/23</b>
✓	SHIFTED overhaul tank ModC	2 g	lun 09/01/23	mar 10/01/23
✓	▷ <b>DAFNE NEEDED Service</b>	<b>0 g</b>	<b>mar 10/01/23</b>	<b>mar 10/01/23</b>
✓	LINAC-BTF ON for maintenance	1 g	mer 11/01/23	mer 11/01/23
✓	RF test set ModC	5 g	mer 11/01/23	mar 17/01/23
✓	Test DHPTB101 for BTF inj	3 g	mer 18/01/23	ven 20/01/23
✓	LINAC-BTF OFF	0 g	ven 20/01/23	ven 20/01/23
✓	◁ <b>DAFNE NEEDED Service</b>	<b>0 g</b>	<b>mer 25/01/23</b>	<b>mer 25/01/23</b>
✓	LINAC Shift on for vacuum operation (TO BE DECIDED BY VACUUM SERVICE)	0 g	mer 25/01/23	mer 25/01/23
✓	Kly C dismounting	1 g	lun 23/01/23	lun 23/01/23
✓	Kly C vacuum port soldering, New SLED cer window installation	3 g	lun 23/01/23	mer 25/01/23
✓	Kly C elbow/SLED vacuum upgrade	1 g?	gio 26/01/23	gio 26/01/23
✓	◁ <b>New Kly C installation and pumping</b>	<b>7 g?</b>	<b>ven 27/01/23</b>	<b>lun 06/02/23</b>
✓	pre-vacuum pumping linac	1 g	ven 27/01/23	ven 27/01/23
✓	Ionic pumping on LINAC and elbow C installation	1 g?	lun 30/01/23	lun 30/01/23
✓	New Kly C installation	2 g	mar 31/01/23	mer 01/02/23
✓	Elbow Vacuum pumping, oil in tank and debubbling	3 g	gio 02/02/23	lun 06/02/23
✓	LINAC-BTF ON for maintenance	0 g	mar 07/02/23	mar 07/02/23
✓	▷ <b>DAFNE NEEDED Service</b>	<b>0 g?</b>	<b>mar 07/02/23</b>	<b>mar 07/02/23</b>
✓	◁ Kly C SAT	14 g	mar 07/02/23	ven 24/02/23
✓	Kly C preliminary test	4 g	mar 07/02/23	ven 10/02/23
✓	Mod C tuning and setup for new kly	6 g	ven 10/02/23	lun 20/02/23
✓	power ramp up with THALES	5 g	lun 20/02/23	ven 24/02/23
✓	◁ <b>LINAC CONDITIONING and START UP</b>	<b>23 g</b>	<b>mar 07/02/23</b>	<b>gio 09/03/23</b>



# INFN 2022/2023 ACTIVITIES GANTT

Istituto Nazionale di Fisica Nucleare  
Laboratori Nazionali di Frascati

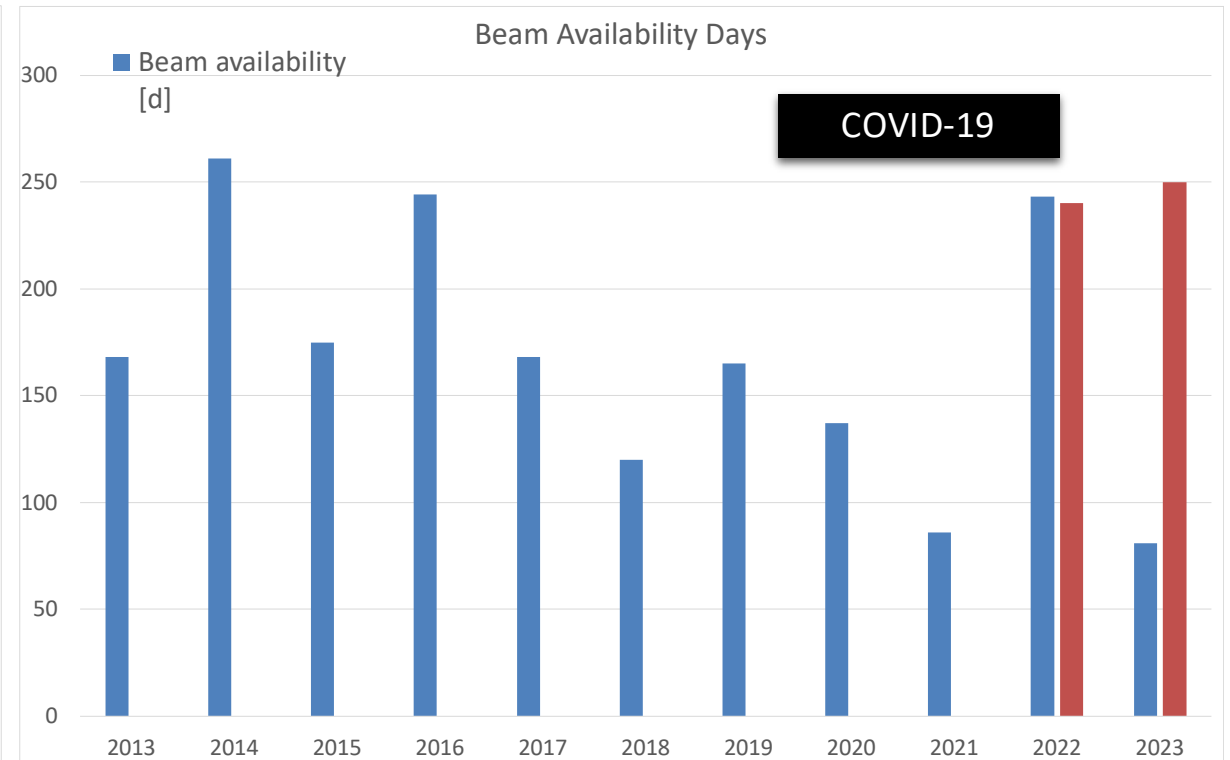
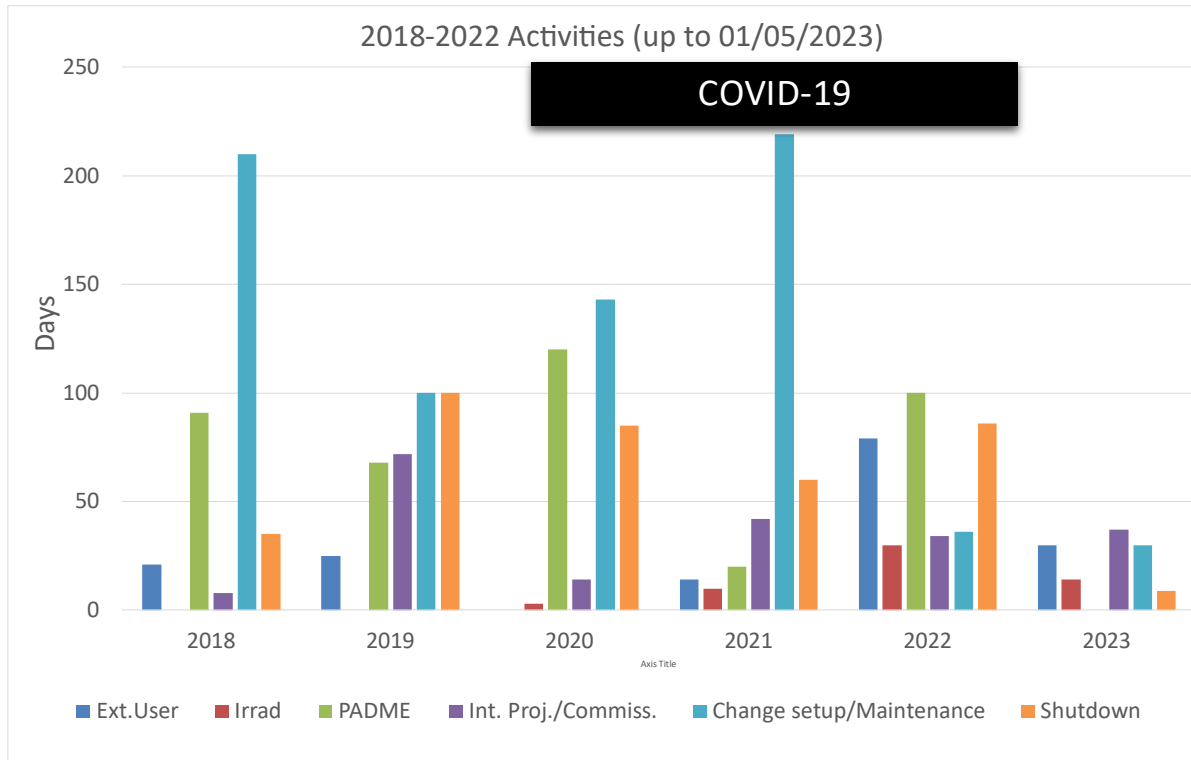
✓	◀ LINAC CONDITIONING and START UP	23 g	mar 07/02/23	gio 09/03/23
✓	◀ LINAC UP	23 g	mar 07/02/23	gio 09/03/23
✓	LINAC 4 mods conditioning	22 g	mar 07/02/23	mer 08/03/23
✓	LINAC beam on trials	1 g	gio 09/03/23	gio 09/03/23
✓	LINAC ready	0 g	gio 09/03/23	gio 09/03/23
✓	MAIN RING READY SPRING 2023	0 g	ven 10/03/23	ven 10/03/23
	◀ BTF ON SPRING	141 g	lun 09/01/23	lun 24/07/23
✓	◀ BTF1&BTF2 on	54 g	lun 09/01/23	gio 23/03/23
✓	PADME detaching vacuum and pumping	14 g	lun 09/01/23	gio 26/01/23
✓	DHPTB101 restore	1 g	lun 09/01/23	lun 09/01/23
✓	BTF start up	10 g	ven 10/03/23	gio 23/03/23
	beam time test call	62 g	ven 10/03/23	lun 05/06/23
✓	user call open	0 g	ven 10/03/23	ven 10/03/23
	beam time user call start	36 g	lun 05/06/23	lun 24/07/23
	MAIN RING Shutdown SUMMER 2023	0 g	lun 17/07/23	lun 17/07/23
	LINAC+BTF SHUTDOWN SUMMER 2023	26 g	mar 25/07/23	mar 29/08/23
	▶ DAFNE NEEDED Service	0 g	mar 05/09/23	mar 05/09/23
	◀ LINAC for FALL 2023	36 g	mar 25/07/23	mar 12/09/23
	Maintenance	30 g	mar 25/07/23	lun 04/09/23
	Operators shift start	1 g	mar 05/09/23	mar 05/09/23
	LINAC beam setup	6 g	mar 05/09/23	mar 12/09/23
	◀ BTF for FALL 2023	121 g	ven 30/06/23	lun 18/12/23
	◀ BTF1&BTF2 on	10 g	mer 30/08/23	mar 12/09/23
	BTF start up	10 g	mer 30/08/23	mar 12/09/23
	user call open	0 g	ven 30/06/23	ven 30/06/23
	beam time user start	61 g	ven 22/09/23	lun 18/12/23
	LINAC+BTF SHUTDOWN WINTER 2023	16 g	lun 18/12/23	lun 08/01/24



- GANTT in working days (add 40% for 24/7 ops)
- Big workout in winter for LINAC
  - Remaining LINAC correctors ready to be installed
  - THALES tells LINAC Service procedures are ok for KLY management and overhaul
  - Found different vacuum problems on LINAC RF vacuum
  - New Elbow pump unit
  - New in-house designed (Cardelli) 3-sections elbow with new RF diagnostic
  - New T-pumping on waveguide
  - New baking and installations procedure in collaboration with Vacuum Service (Liedl)
- DHPTB101 is a single point of failure so starting searching replacement
- BTF: **Subsystems are ok**

## 2018-2023 Activities

## Beam Availability Days



More than 40 paper citing BTF in 2022-> early 2023, some obviously from PADME collaboration.

- 6th International Conference Frontiers in Diagnostic Technologies (ICFDT6)
- 13th International Particle Accelerator Conference (IPAC'22)
- CLIC Workshop '22
- High Gradient Workshop '22
- Compact Light Follow up '23
- Next week on 14th International Particle Accelerator Conference (IPAC'23)

Ceravolo, Sergio, et al. "Crilin: A Semi-Homogeneous Calorimeter for a Future Muon Collider." *Instruments* 6.4 (2022): 62.

N. Atanov *et al.*, Towards the construction of the Mu2e electromagnetic calorimeter at Fermilab *J. Phys.: Conf. Ser.* **2374** 012021 (2022)

N. Atanov *et al.*, "The Mu2e crystal and SiPM calorimeter: construction status," in *IEEE Transactions on Nuclear Science*, (2023 )

Bartocci, S., et al. "Deep learning based event reconstruction for the Limadou High-Energy Particle Detector." *Physical Review D* 105.2 (2022): 022004.

Atanov, Nikolay, et al. "The Mu2e Crystal Calorimeter: An Overview." *Instruments* 6.4 (2022): 60.

S. Bartocci *et al.* (Limadou HEPD collaboration) *Phys. Rev. D* **105**, 022004  
Deep learning based event reconstruction for the Limadou High-Energy Particle Detector, *Phys. Rev. D* **105**, 022004 (2023)

Backe, H., et al. "Design study for a 500 MeV positron beam at the Mainz Microtron MAMI." *arXiv preprint arXiv:2205.12613* (2022).

Patrinos, Konstantinos. "On the Hypothesis of the Absolute Reference System: Theoretical and Experimental Confirmation." *New Trends in Physical Science Research Vol. 8* (2022): 13-36.

Amaro, Fernando, Domingues, et al. "The CYGNO Experiment." *Instruments* 6.1 (2022): 6.

Machine Learning Based Middle-Layer for Autonomous Accelerator Operation and Control  
Stefano Ploi, Bruno Buonomo, Fabio Cardelli, Paolo Ciuffetti, Domenico Di Giovenale et al.  
Published in: JA CoW ICALEPCS 2021 (2022), THAL03

The PADME beam line Monte Carlo simulation  
F. Bossi (Frascati), P. Branchini (INFN, Rome3), B. Buonomo (Frascati), V. Capirossi (Polytech. Turin), A.P. Caricato (INFN, Lecce and Salento U.) et al.

Search for a Dark Photon with the PADME experiment  
Stefania Spagnolo, A.P. Caricato, M. Martino, I. Oceano, F. Oliva et al.  
Published in: PoS EPS-HEP2021 (2022), 186

The physics program of the PADME experiment  
PADME Collaboration • A.P. Caricato (INFN, Lecce and Salento U.) et al.  
Published in: *Phys. Scripta* 97 (2022) 2, 024003

Simeonov, Radoslav. "PADME physics program." *Journal of Physics: Conference Series*. Vol. 2255. No. 1. IOP Publishing, 2022.

F. Bossi *et al.* "Cross-section measurement of two-photon in-flight annihilation of positrons at  $v_s=20$  MeV with the PADME detector". *Phys. Rev. D* **107**, 012008, (2023)

Dimitrova et al., Using Artificial Intelligence in the Reconstruction of Signals from the PADME Electromagnetic Calorimeter, *Instruments* 2022, 6(4), (2023)

Sytov, A., et al. "First design of a crystal-based extraction of 6 GeV electrons for the DESY II Booster Synchrotron." *The European Physical Journal C* 82.3 (2022): 1-17.

Balla, A., et al. "Performance of scintillating tiles with direct silicon-photomultiplier (SiPM) readout for application to large area detectors." *Journal of Instrumentation* 17.01 (2022): P01038.

Bandiera L. et al, "First design of a crystal-based extraction of 6 GeV electrons for the DESY II Booster Synchrotron", *The European Physical Journal C* volume 82(2022)

Bandiera L., "Crystal-based pair production for a lepton collider positron source", [The European Physical Journal C](#) volume 82 (2022)

M.Lamont et al., Accelerators for Rare Processes and Physics Beyond Colliders: Report of the AF5 Topical Group to Snow mass 2021, CERN internal (2022)

Alemi M. et al, Local a r&d project for the barrel electromagnetic calorimeter, DESY Internal (2022)

BTF Team in 2022/2023 has been involved as tutor, visit guide, and presenter for:

Event Type	Target	Year	Number of students/people involved
Accelerators PhD LABS	PhD Students	2023	7 students/ 3 sessions
BTF Tutoring	university student users	2023	10
LNf visit guide	university and high school	2022/2023	400
PCTO (work-school join)	high school students	2023	12 student for 9 days
<b>International Day of Women and Girls in Science</b>	high school students General communication	2022	+800 views up to April
LNf Lessons on Accelerators Researcher@School 2023	high school students General communication	2023	+800 views up to April
Childhood tutoring	Primary school	2023	35

Once the call for BTF is open, team leader can submit new booking request choosing the available dates on calendar.

## Dates

Select date of request booking

< >

### December 2022

today

Mon	Tue	Wed	Thu	Fri	Sat	Sun
28	29	30	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
1a UserBooking						
19	20	21	22	23	24	25
Temporary						
26	27	28	29	30	31	1
2	3	4	5	6	7	8

Bookable Not Bookable No configuration

From  To

✓ This period is bookable



**BTF**

EXPERIMENT Proposal name \*

Involved Institutions/Industries/Countries \*

Experiment motivation related to requested beam time, scientific discipline, research area and purposes \*

Proposal category (mark the right one): \*

New - If you are submitting this experiment plan for the first time

Team Leader Telephone Number \* \*

Device under test description (please describe possible hazards) \*

Owned setup to be put in experimental hall, brief description (please describe possible hazards related to)

Owned setup to be put in control room, brief description (please describe possible hazards) \*

BTF needed setup, hardware, software and LNF facilities (after handshake with BTF staff) \*

Time needed for experiment [contiguous days] \*

Time needed for experiment roll in [hour] \*

Time needed for experiment roll out [hour] \*

- Team leader must fill the BTF questionnaire in order to proceed with request.
- The facility management and facility user committee will approve or deny via tech. and scient. reasons the submitted questionnaire.

After facility management approval, the team leader can create the team by adding INFN identities hosted in INFN identity management system.

Period: 2023-02-13 / 2023-02-19 Info  
 Submitter: Giovanni Lorenzo Napoleoni  
 BTF ( Line2 )

**Selected State**

Cancel Save Draft Complete

Add new team member

**Selected user**

Luca Gennaro Foggetta ✕ Ramon Orrù ✕ Michele Antonio Tota ✕

**Create your team**

Q Tota +

Name	Surname	UUID
Leonardo	Mastrototaro	7b37f3c9-2af6-485b-bd5f-231e1ec48747
Michele Antonio	Tota	017579c1-6567-4dbb-a2fc-6ef092c48d1e
Michele	Tota	26c0c003-107f-4048-92c2-145aa397c405
Dante	Totani	0e3b888f-5a5c-4623-afa5-...

Period: 2023-02-13 / 2023-02-19 Info  
 Submitter: Giovanni Lorenzo Napoleoni  
 BTF ( Line2 )

**Selected State**

**List of selected identities**

Name	Submitted Questionnaire	Secretariat Approval	Personnel Approval
Luca Gennaro Foggetta	✕	✕	✕
Ramon Orrù	✕	✕	✕
Michele Antonio Tota	✓	⊖	⊖
Giovanni Lorenzo Napoleoni	✓	✓	✓

- Each team member must fill a web personal form.
- Workflow approval by secretariat and personnel.
- Team leader can view the approval team workflow in each moment.
- Once all approvals step the request is complete and team is authorized to enter the configured facility
- This software manage call period, documentation and the territorial QR-code access tool (to be yet implemented).

## Multiple INFN National computing service tools working

- **BTF site** template in INFN national domain = btf.inf.infn.it (S. Reda)
- Call managed by INFN **mailing list** services with direct subscription
- **Booking software** (this one)
- **INFN DBs** and backups
- Development by applications abstraction layers
- Step by step guidance
- LNF Computing center In-house developing (except UI)
- Automated mailing for requesting authoritative action, releasing information and reminders to targets (users, management and secretariats)

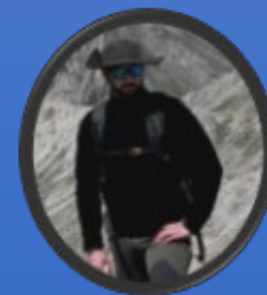
- Permits use by different beamline manager via little tuning (LNF and National)
- More robust structure and maintenance

## From this brief experience:

- **Huge reduction** factor of overall secretariat time – **GOAL acquired**
- Users report easier access from user side, with own survey by experiment Team Leader – **GOAL acquired**
- Easier manageability from Beamline management personnel – **GOAL acquired**
- Process traceability from submission, users needs up to site access in a single software – **GOAL acquired**

Developer G. L. Napoleoni (LNF Computing Center, main dev.), R. Orrú, M. Tota  
BTF group and LNF Secretariats (and bug-finder group):

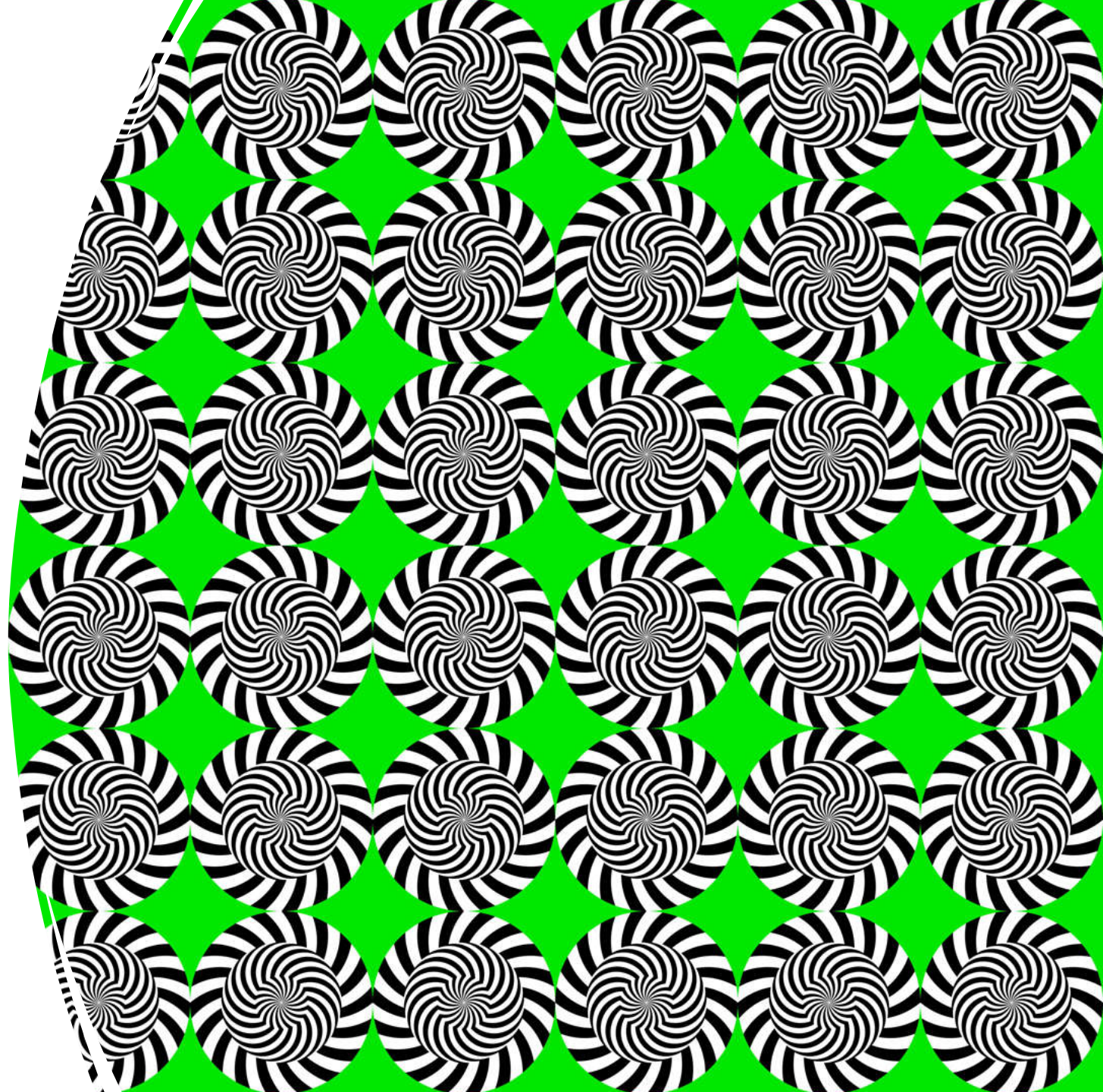
- AD-Secretariats (M.R. Ferrazza, G. Vinicola, V. Rosicarelli)
- Personnel-Secretariats (G. Dalla Vecchia, F. Triolo, L. Occidente, A. Mininni)





# BTF USERS

and few examples



## DONE (LATE 2022)

- FOOT-LNF
- PEROV
- FOOT-SCINTI
- SHERPA
- LIMADOU
- HERD
- ERAD
- FISMEL\_SIM&ACTLD
- SPARC-ULENS
- PADME e-tagger
- PADME trials with secondary beam
- X17 RUN

## 2023 Spring TO BE DONE

Type	Name	Gap before [gg]		Start date	Duration [g]
ALTRO	START	0	lun	16/01/2023	
Run approvati	SPARC-ULENS	0	lun	16/01/2023	2
Run approvati	FISMEL-TEST	0	mer	18/01/2023	2
Run da fissare/approvare	EPICI	0	lun	13/03/2023	7
Run approvati	LLMCP	0	lun	20/03/2023	7
Run approvati	FLASHMOB	0	lun	27/03/2023	7
Run approvati	LIMADOU	0	lun	03/04/2023	6
Festività	Pasqua	0	dom	09/04/2023	1
Manutenzioni	Cam test w GRAFANA reset	1	mar	11/04/2023	6
Run cancellati	LUXE		lun	17/04/2023	7
Run approvati	KLOE2-HET	0	lun	17/04/2023	7
Run approvati	INSULAB	0	lun	24/04/2023	7
Progetti interni	SCICOM	3	gio	04/05/2023	2
Festività	IPAC2023	0	dom	07/05/2023	7
Run approvati	CRILIN-RD_MUCOL	0	lun	15/05/2023	7
Run cancellati	SHADOWS	0	lun	22/05/2023	7
Run approvati	HERD	0	lun	29/05/2023	7
Manutenzioni	DAQ test with ETH arb. Fast	0	lun	05/06/2023	7

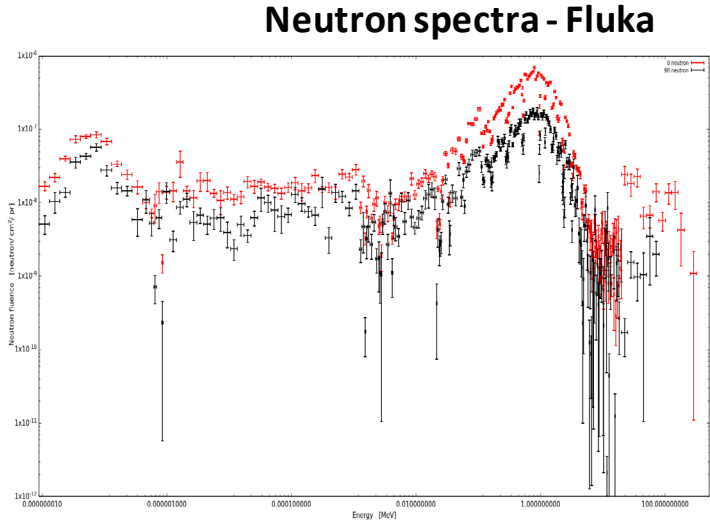
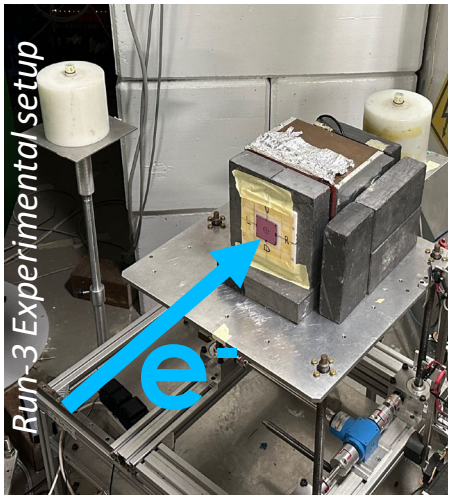
Dose evaluation from electrons impinging on a Pb target due to: i) Bremsstrahlung photon production; ii) photo-neutrons production.  
TLD passive dosimeters used to measure dose at several charge intervals.

BTF USER run: February 2<sup>nd</sup>, June 30<sup>th</sup> 2022 and January 2023

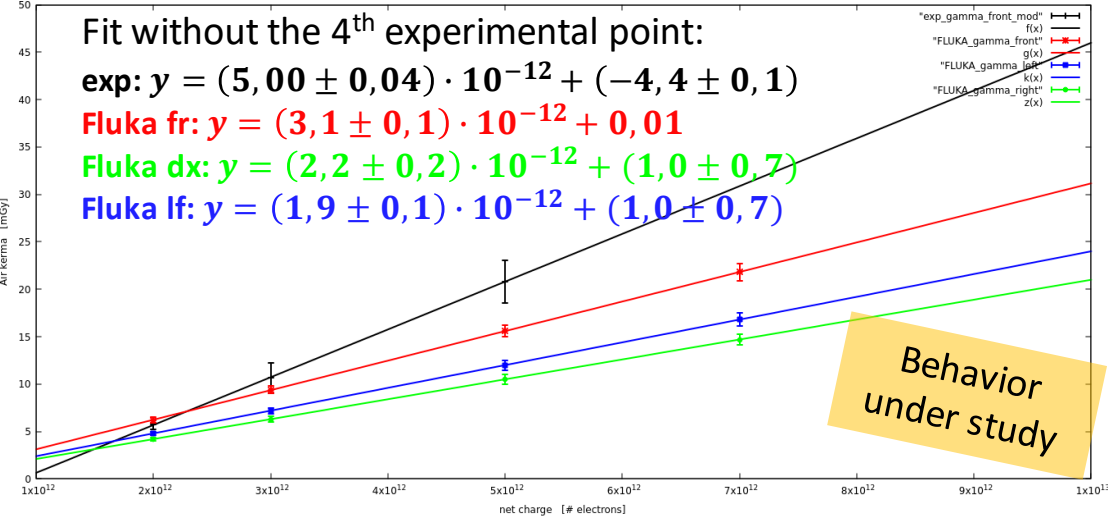
BTF beam 503 MeV, 1 Hz, 10<sup>9</sup> e-/s, spot diameter around 1 cm

Beam on a ~ 16 cm Pb target → mixed radiation field

1° run: photon Air KERMA evaluation at 0 ° (TLD700)  
2° and 3° run: photon Air KERMA and neutron ambient dose equivalent evaluation at 0 ° and 90 ° (TLD700 + TLD600)  
Calibration at Cs-137 and Am-Be → Data-MC comparison needed to validate the results at higher energies and benchmark the simulation (FLUKA) itself

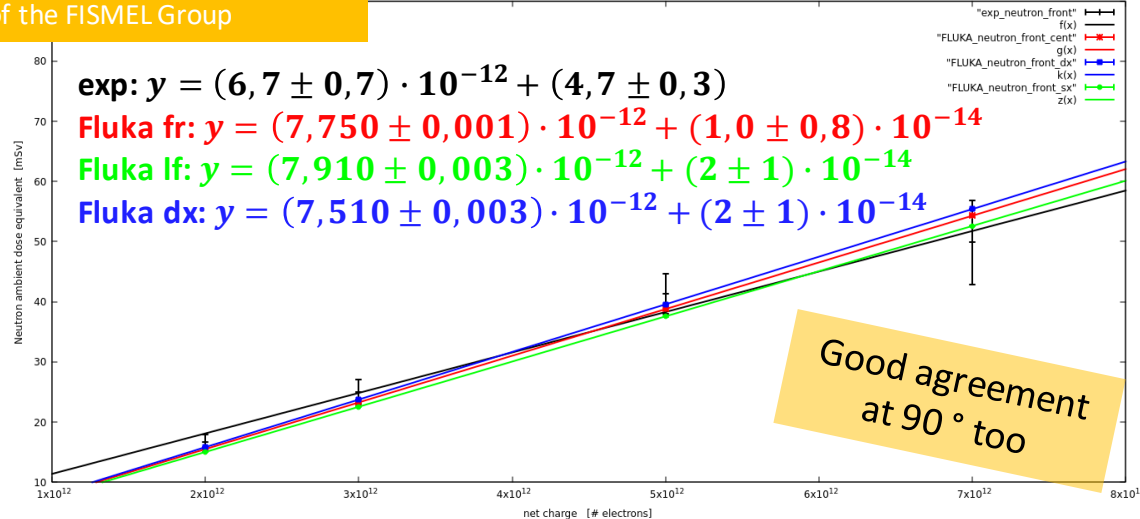


Photon air kerma at 0 °



Courtesy of F. Chiarelli and R. Donghia on behalf of the FISMEL Group

Neutron ambient dose equivalent at 0 °

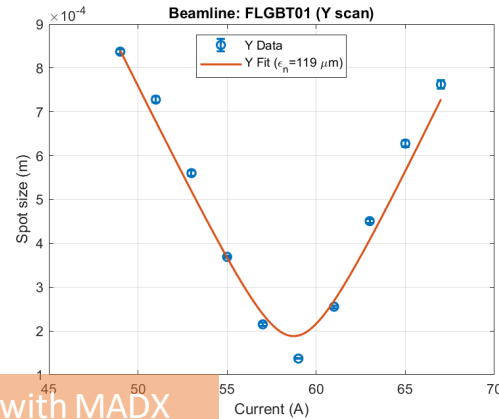
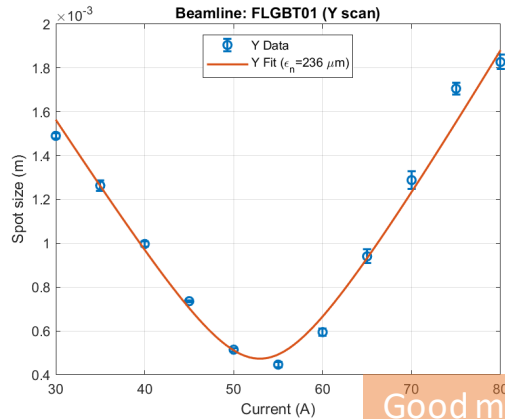
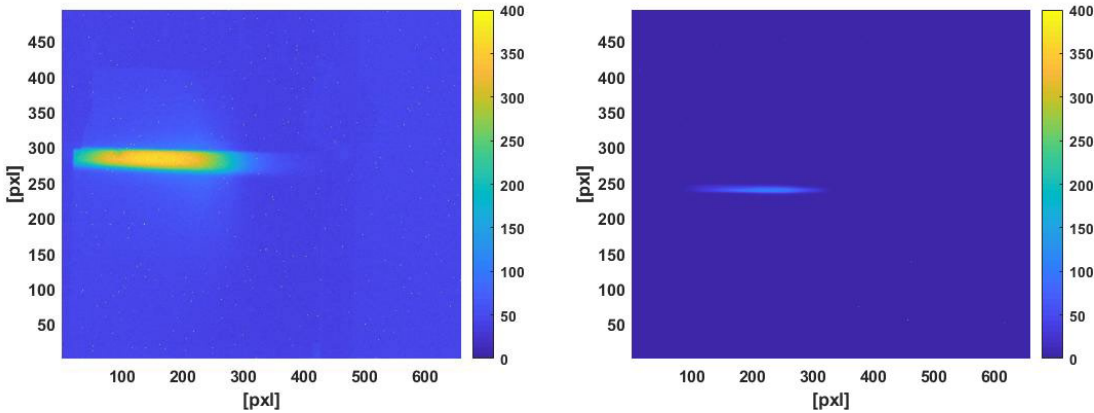


3° run provided updates useful to estimate the mixed radiation field doses in BTF produced by HE e-beam on target

**BTF USER run (New Diagn.): Jan 2023 – NEW SETUP**

BTF beam 503 MeV, 1 Hz,  $\sim 10^7$  e+/s,  $\sim 10^9$  e-/s, optimized spot diameter for vertical measurement

**ELECTRON** Beam = 503 MeV/10ns/300pC  
Vertical emittance (rms)  $0,2 \pm 0,05$  mm x mrad



Good match with MADX sims (C. Di Giulio)

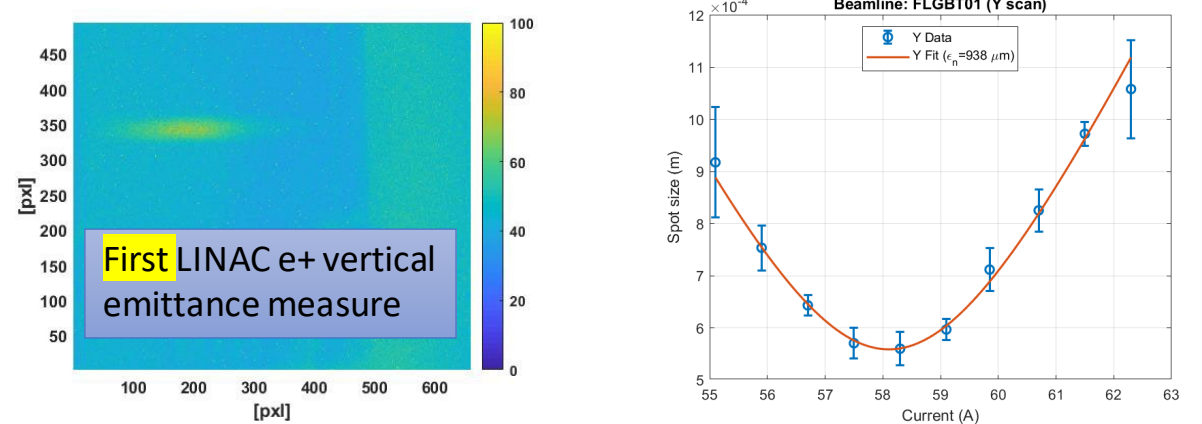
04/05/2022

Synergistic emittance measurement system both for SPARC **Vladimir Shpakov** (leave) and BTF team.

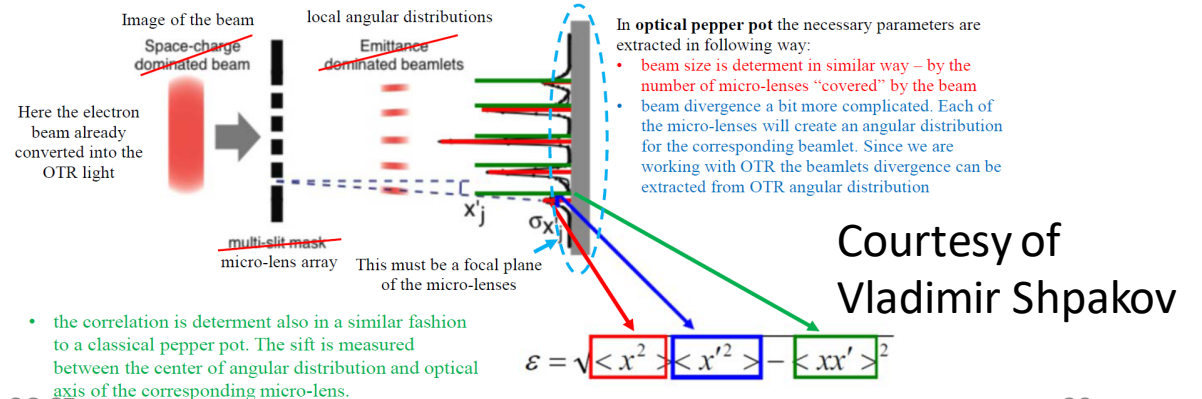
Single-shot beam emittance via a pepper-pot-like method:

-> microlens array beamlets from the beam OTR radiation produced by the OTR radiator. Single shot measurement of **beam size (OTR beam image)**, **beam divergence (from OTR ang. distr. image)**, **beam correlation (from microlens)**

**POSITRON** Beam = 497 MeV/10ns/4,7pC  
Vertical emittance (rms)  $0,93 \pm 0,32$  mm x mrad

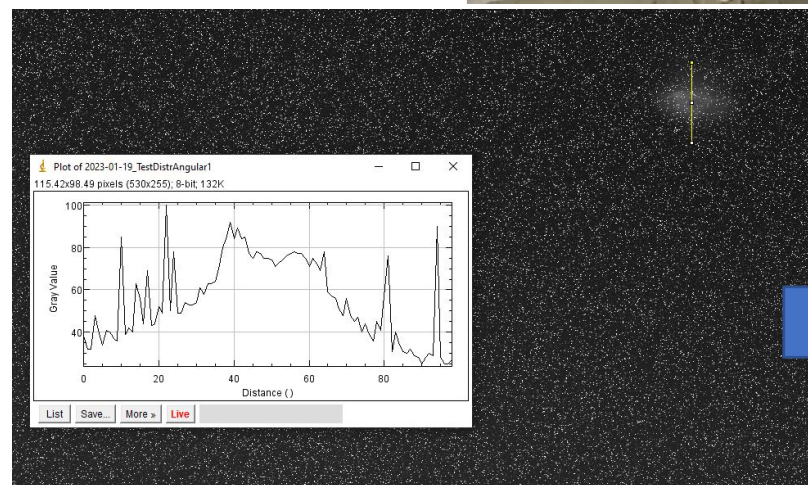
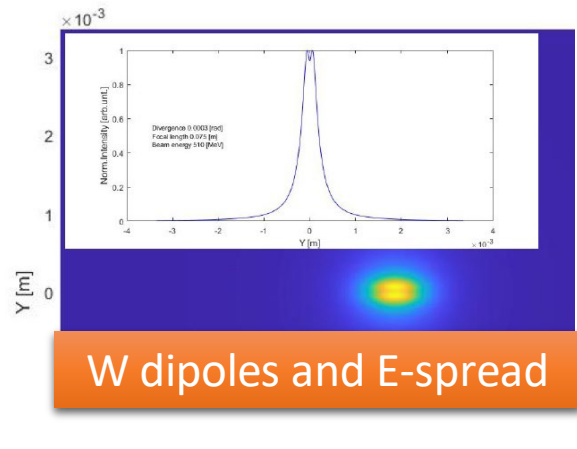
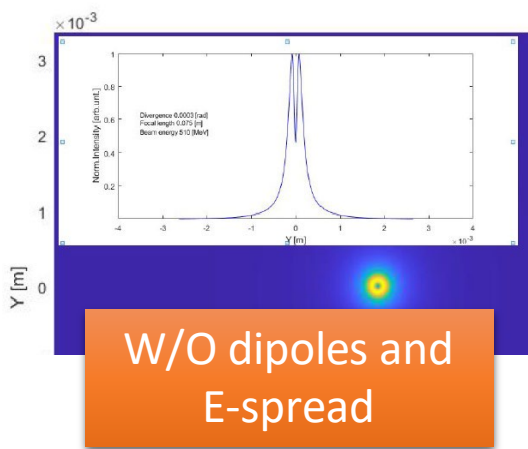
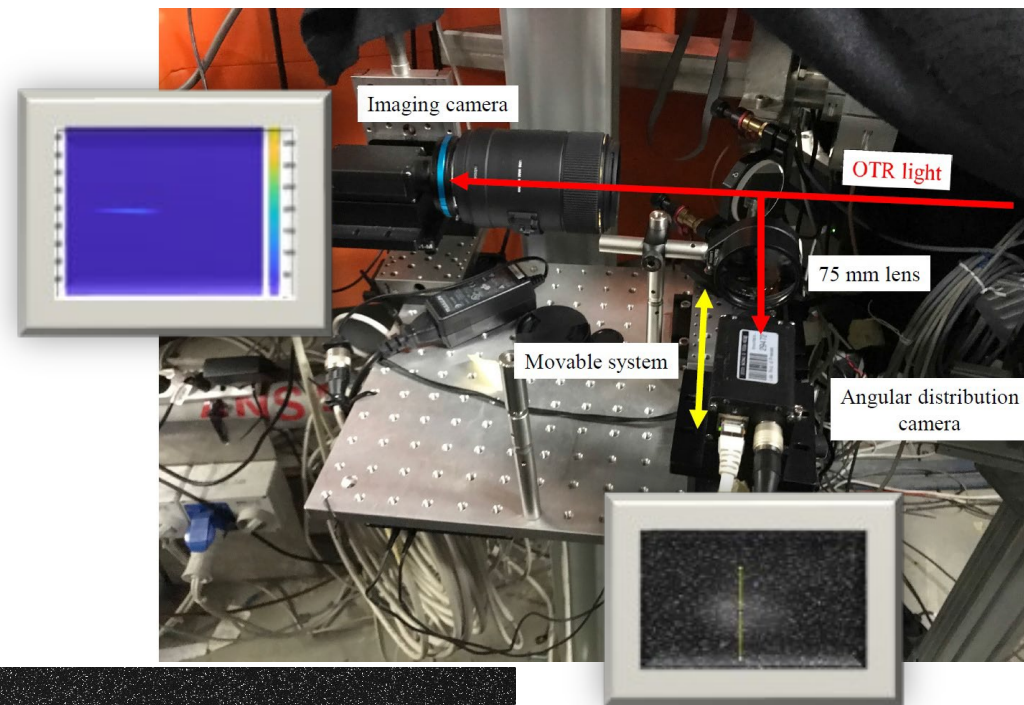


First LINAC e+ vertical emittance measure



Courtesy of Vladimir Shpakov

- First run: we explore the possibility to make emittance measurements at FLGQUATB003,
- Got good experience via fixing problem for divergence measure using OTR to image the beam (software, motors, optical set and alignment procedure...)
- The few hour beam time give us the first hints for a good angular distribution measurements, but results were poor
- The beam with fully symmetric divergence actually can give us a daunt-like shape of the distribution, BTF is after Dipoles and energy spread => different shape
- Setup ready, we could continue in opportunistic time



CSES - LIMADOU is part of a scientific program that studies natural and anthropogenic electromagnetic fields, their emissions and possible correlations with seismic events.

<https://w3.inf.infn.it/una-pioggia-di-elettroni-per-lhigh-energy-particle-detector-di-cses-limadou/>

## BTF USER run (SPACE Appl) : 11 Jun -> 20 Jun

The main purpose of the test:

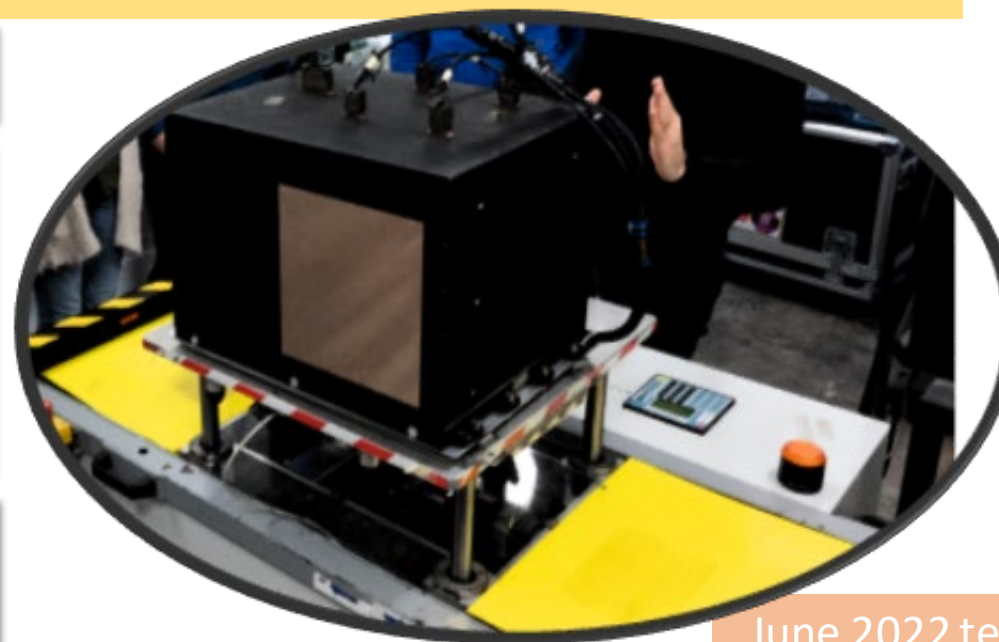
Check before flight HEPD with different BTF configuration set:

- from 30MeV to 120MeV in 15MeV steps,
- different multiplicity (mostly single particle for all energy sets)
- Large spot area up to 30 cm<sup>2</sup>
- Collision angle

### Flight model High-Energy Particle Detector (HEPD-02)

HEPD-02 comprises a tracker made of CMOS Monolithic Active Pixel Sensors (MAPS), a double layer of crossed plastic scintillators for trigger and a calorimeter, made of a tower of plastic scintillators and a matrix of inorganic crystals, surrounded by plastic scintillator planes for containment tagging.

All the HEPD subsystem was tested as programmed



June 2022 test



## • BTF SCI Coll run: (New Mat. Prod. and Dosy.) Mar 2023

BTF beam 504 MeV, 1 Hz,  $10^9$  e-/s, spot diameter around 2mm  
Beam on a  $\sim$  thin foil Mo target

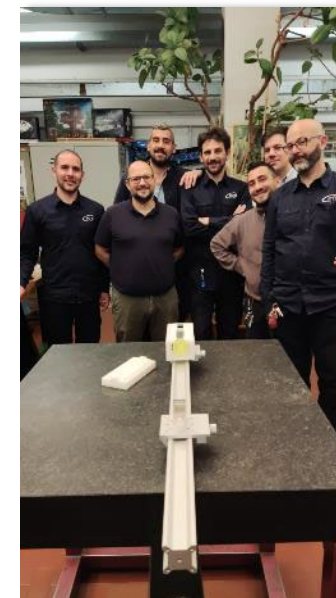
Explored an alternative approach to produce Tc-99m radiopharmaceutical, a crucial diagnostic tool in medical imaging, without relying on nuclear reactors.

Scientific collaboration with:

- Researchers from Rutherford Appleton Laboratory and (RAL, UK) and ENEA (target, idea)
- INFN-LNF (BTF, FISMEL, and SPCM teams) (target setup, testbeam and measure)
- Based on [Nature | Vol 603 | 17 March 2022 | 393](#)
- **Two months from measure idea to install the 3D printed setup**

Run Aims:

- **$^{99}\text{Tc}$  Production**
- **Tc buffer (based Mo precursor)**
- **assessment of the physical model used in the Monte Carlo code (cross section measurement). First measure at these energy**



Currently compared to the updated MC predictions, using the real exposure data acquired during the beamtime.

**The preliminary results confirm the success of the feasibility study, paper ongoing**

# LINAC&BTF for DAFNE and X17

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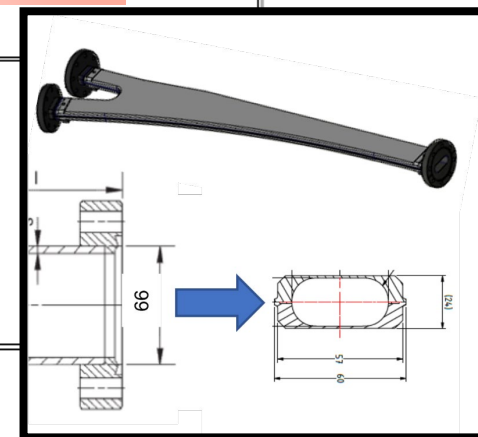
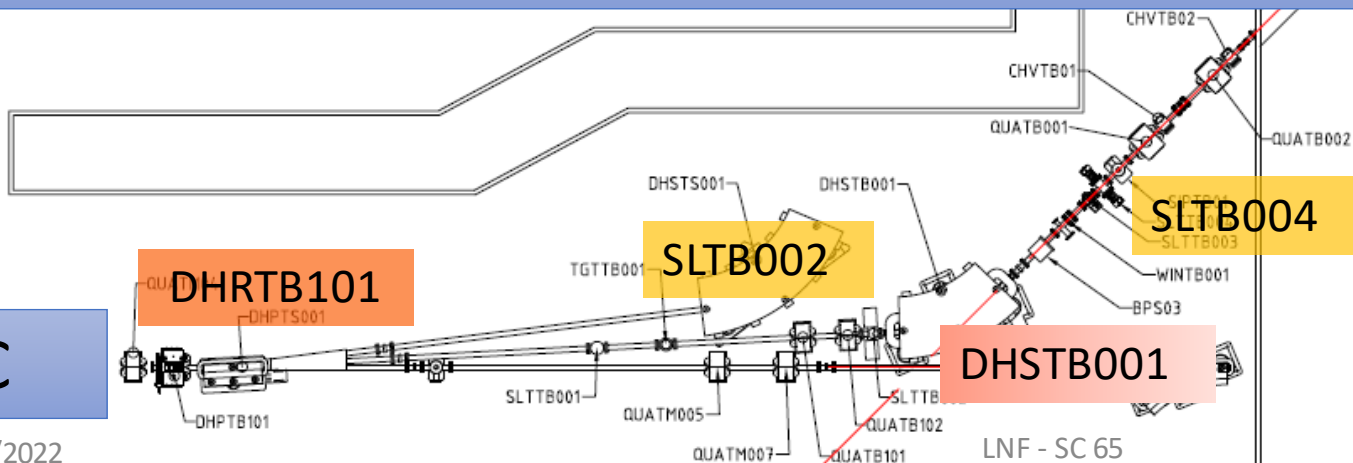
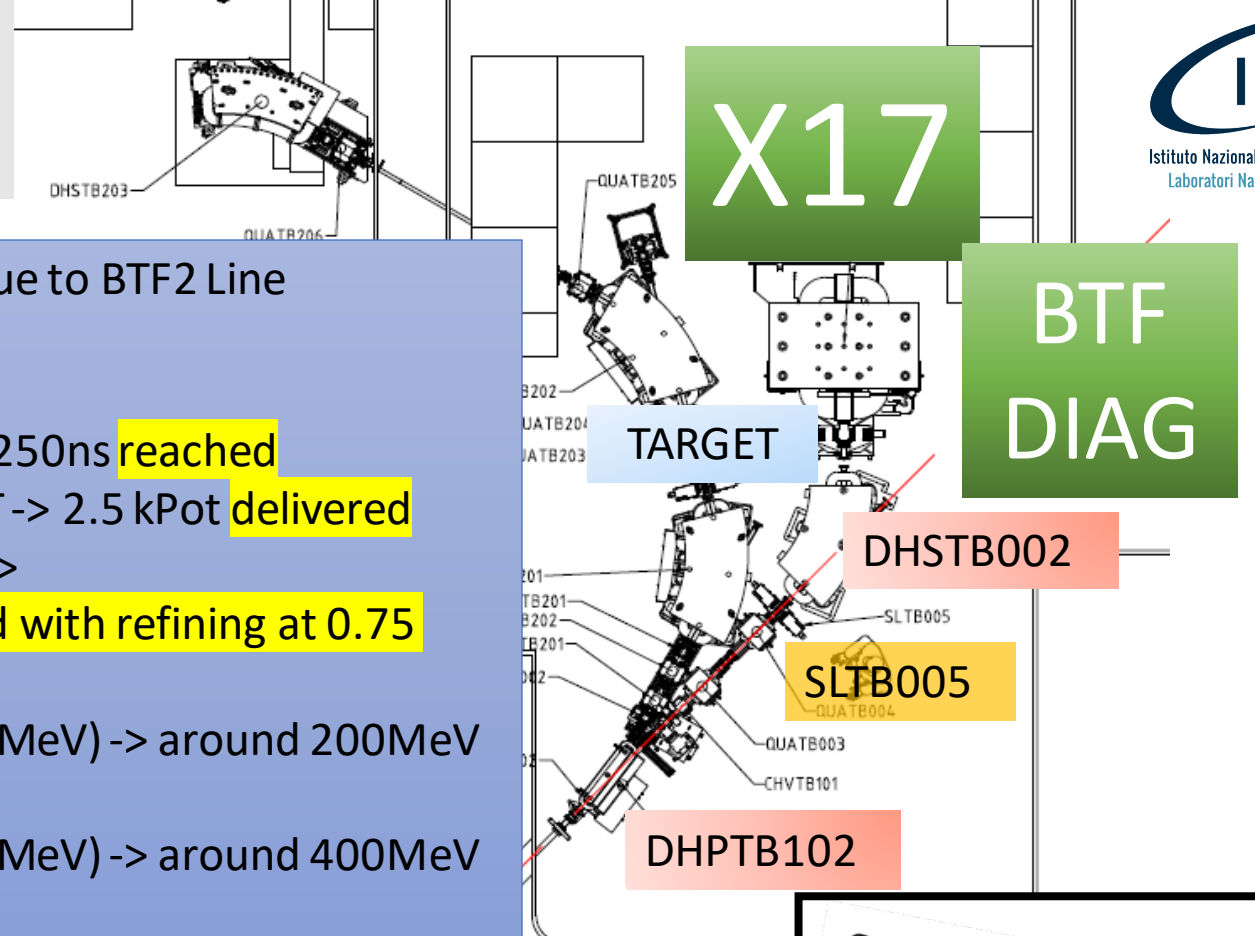




# X17 VS PADME RUN

**Main differences from PADME RUN2/FORMER X17 due to BTF2 Line implemented in BTFEH1:**

- Positrons beam request:
  - Lower Pulse Length 320ns -> at least 100ns -> 250ns **reached**
  - Lower Pulse Charge 30kPoT -> less than 5kPoT -> 2.5 kPot **delivered**
  - Pulse selection: from fixed energy (430MeV) ->
    - Energy scan from [295-260] MeV **reached with refining at 0.75 MeV**
    - Energy scan out of resonances in U(<220MeV) -> around 200MeV **reached**
    - Energy scan out of resonances in U(>320MeV) -> around 400MeV **feasible only trials reached**



LINAC

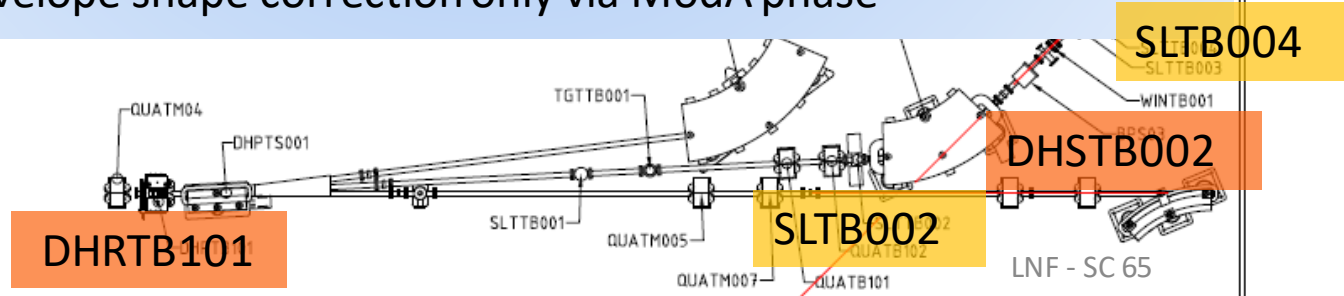
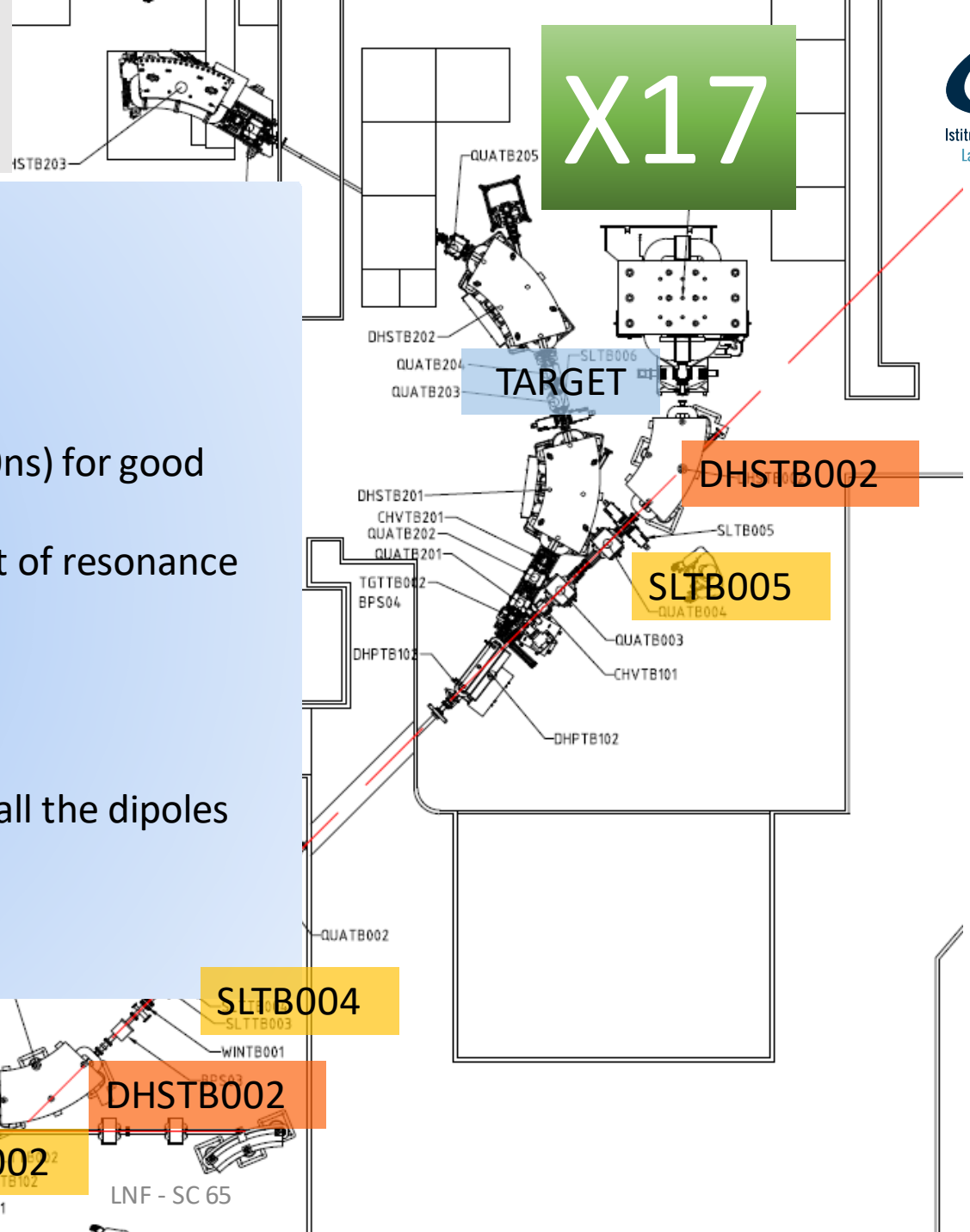
# BTF ENERGY SCAN

Measure setup (X17 decisions) and its progression:  
 Rules for reproducible measurements and simulations:

- **Maximum current limit** due to experiment constraint
- Minimum current obvious (Data taking)
- **Hit point stability** on diamond target
- Flat Pulse shape (ideal double step pulse in time, >100ns) for good current inj
- **Fixed quadrupoles** current (different setup only for out of resonance trials)
- Energy spread containment

DHSTB001 as energy selector

- Energy scan on hysteresis loop descending branch for all the dipoles
- Multiplicity correction only via scrapers
- Scrapers maximum gap in tuning (+-0.1 $\mu$ m)
- Pulse envelope shape correction only via ModA phase

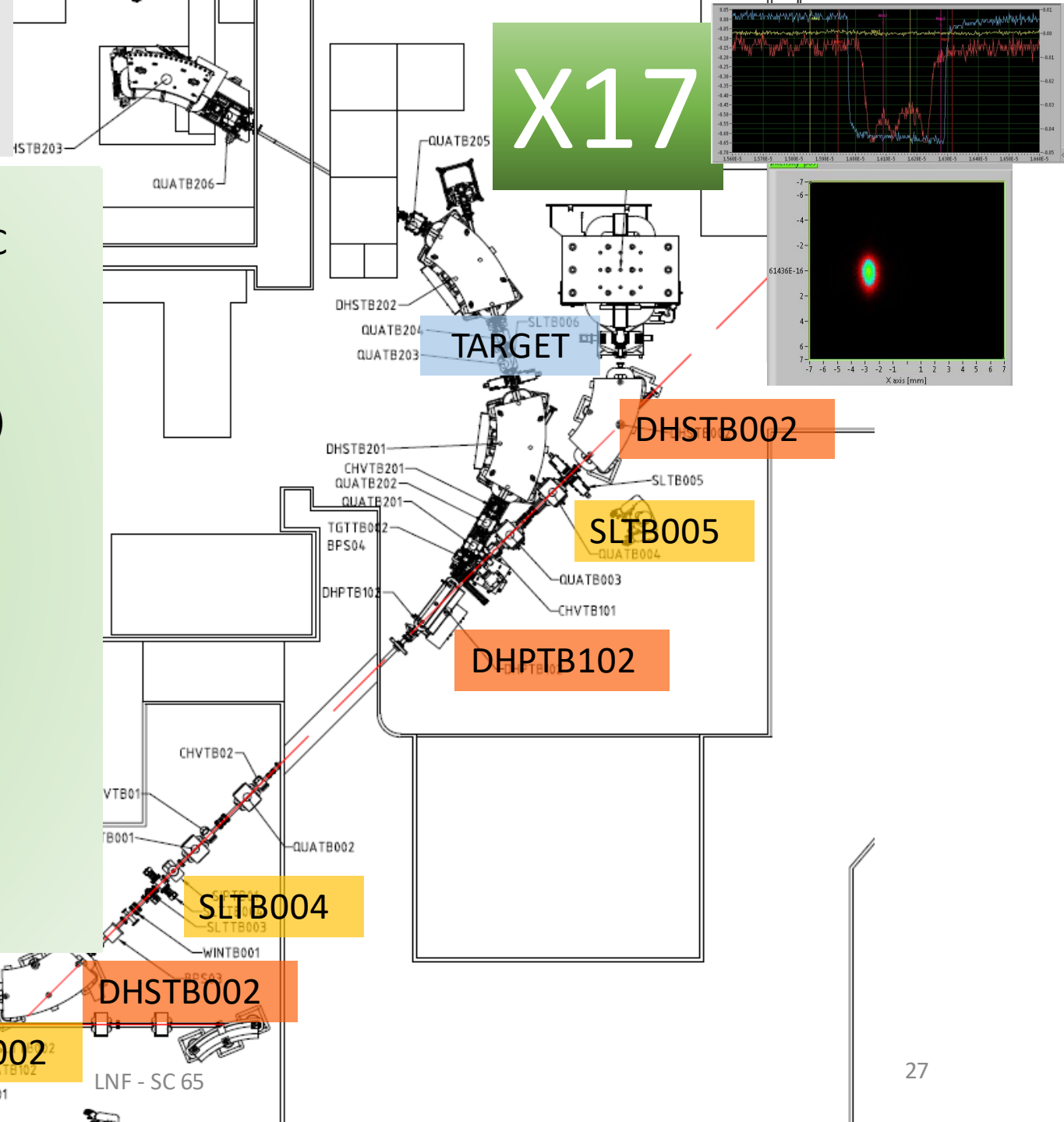


# BTF ENERGY SCAN

## Measure type:

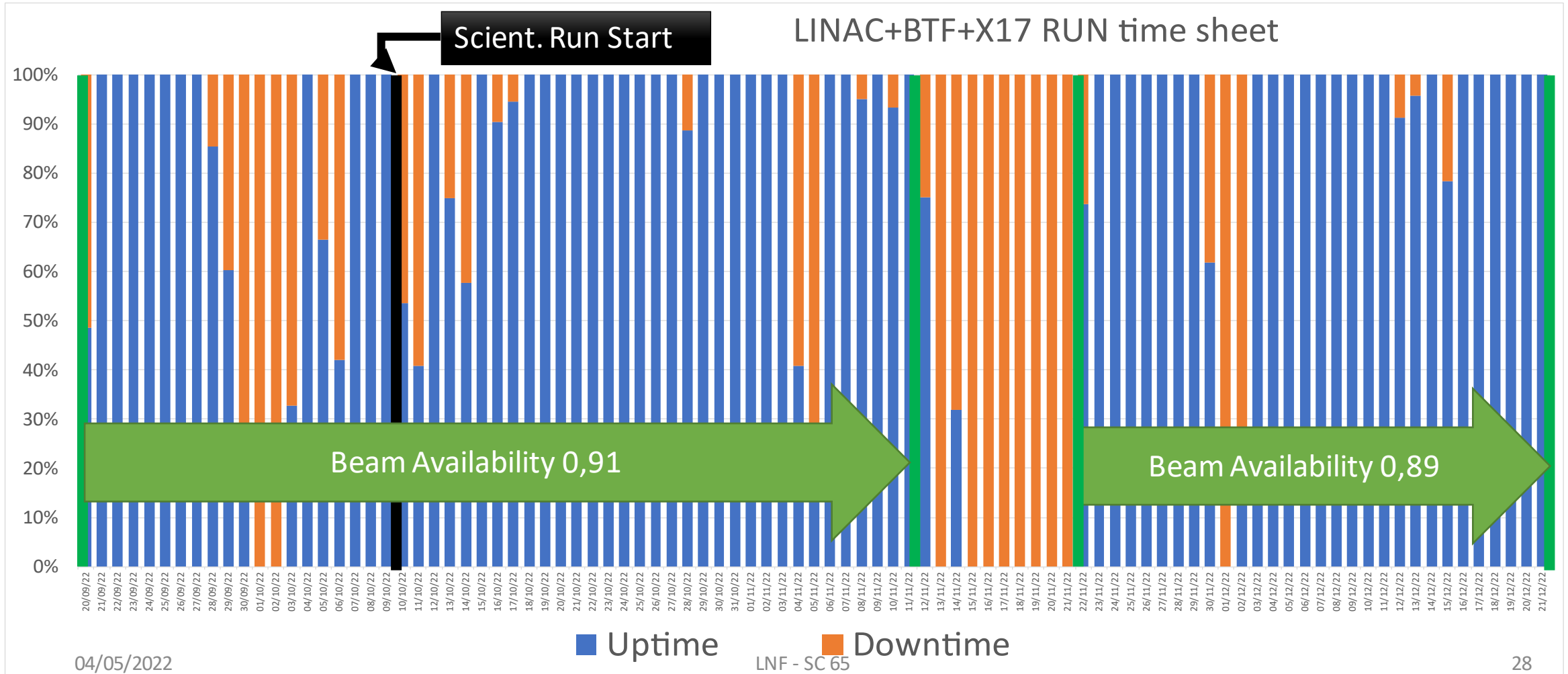
- Improved energy scan of  $\sim 0,75$  MeV (around 10 PS DAC digits  $\rightarrow$  150KeV)
- Descending branch of the DHSTB001 hysteresis loop
- DHSTB001  $\rightarrow -0,5A$
- DHSTB002  $\rightarrow -0,5A \pm$  DAC digit (beam based alignment)
- DHRTB001  $\rightarrow -1A$  in the tails of energy scan
- SLTB002 Scrapers  $\pm 0,1mm$  ( $\pm 500PoT$ )
- REMAINING SCRAPERS
  - Halo removal
  - Beam transverse reference point
  - Untouched for overall data taking

Stay clear checks via steering magnets (CHHVVTBXXX and DHPTB102)

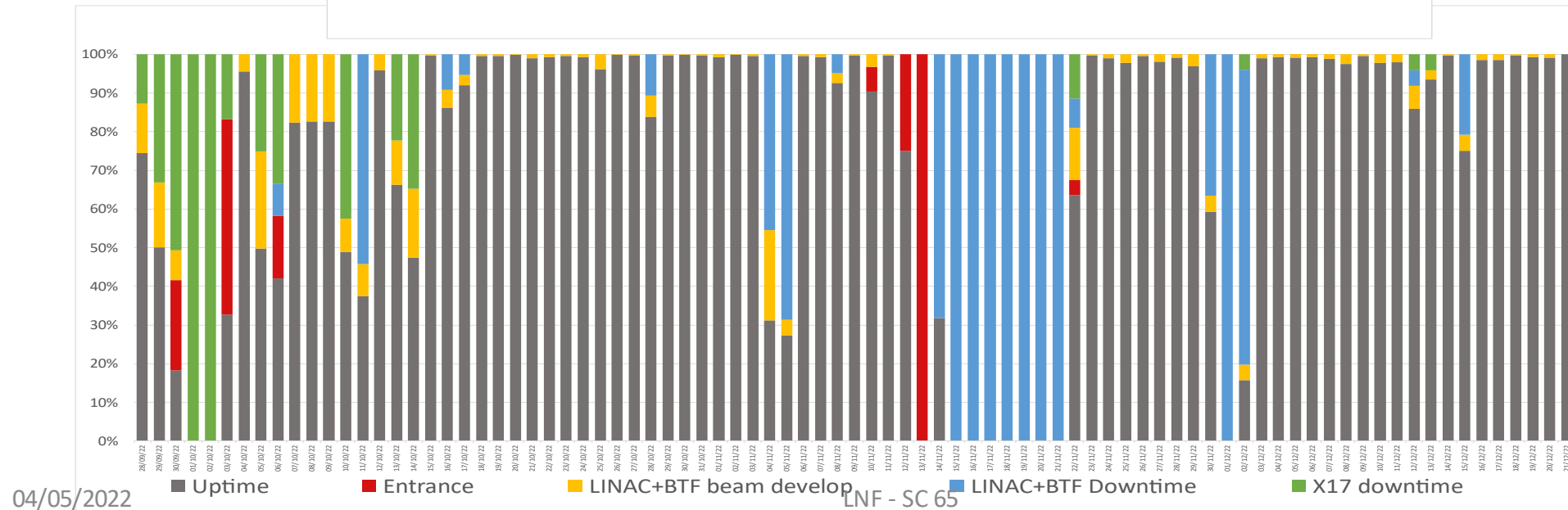
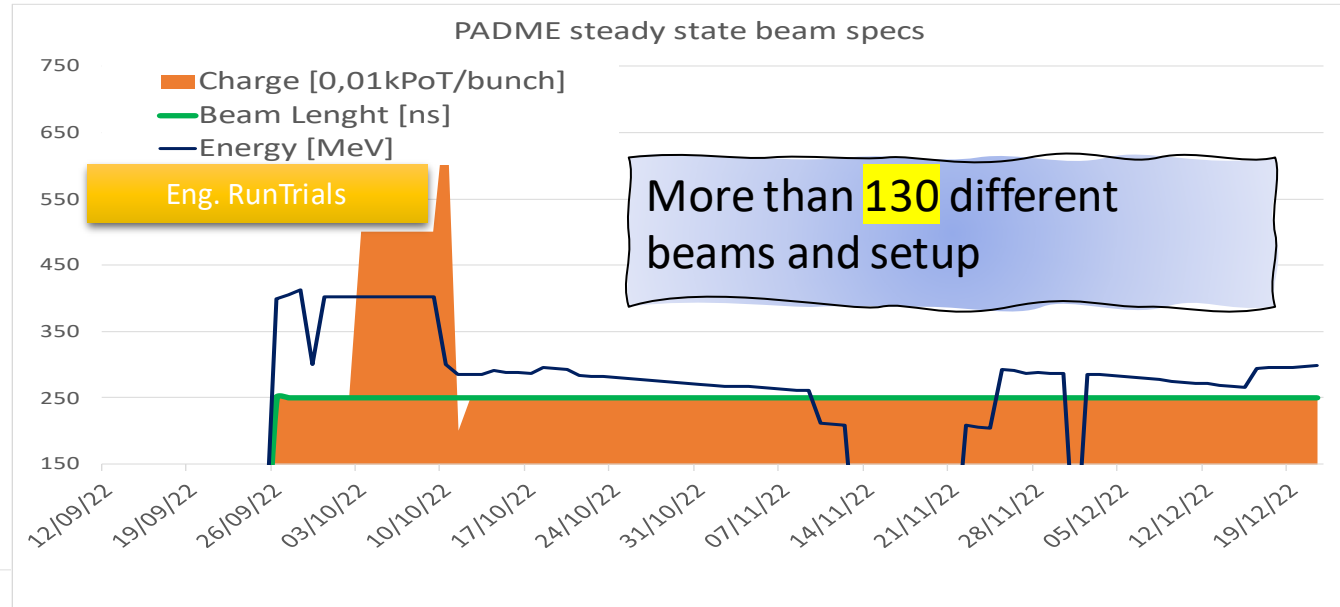


# BTF X17 RUN STATISTICS

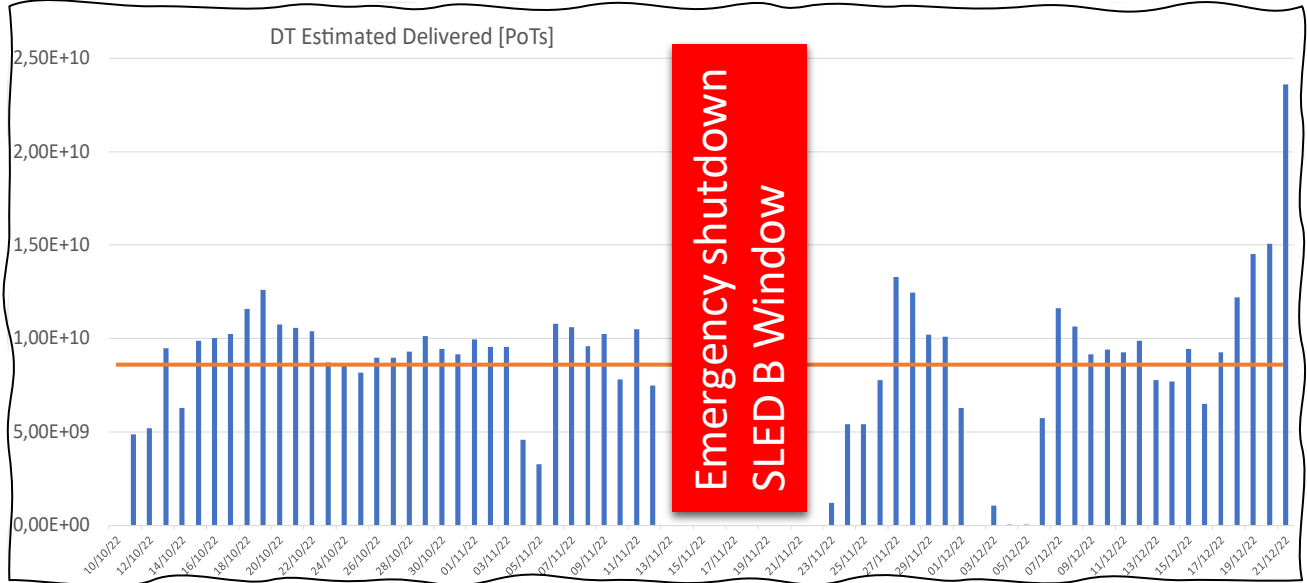
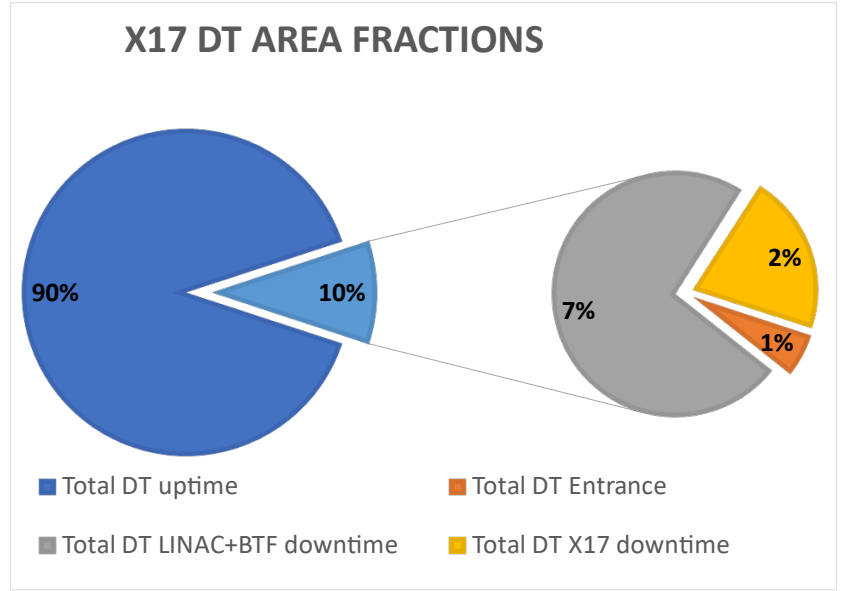
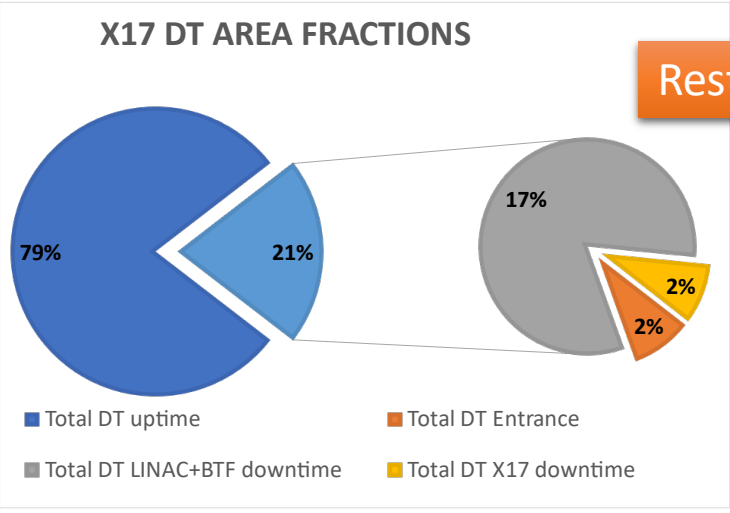
- In respect to PADME RUN2, the injection efficiency moves from 0.77 to 0.9 average (counting restored days at December)
- Main stop due to maintenance on this National Main Power Line branch and a fault on SLED B Vacuum Windows



# BTF X17 RUN STATISTICS



# X17 RUN STATISTICS



- Delivered suffers huge variance due to very low current (and related photons from Mylar window, see previous slides)
- Delivered PoTs
  - Average  $(0,9 \pm 0,2) \times 10^{10}$  [PoTs/day]
  - Gross total  $6,51 \times 10^{11}$  [PoTs]
- We were out of total 3+2+8 overall day in data taking
- Restored 8 days
- **72 days on Scientific Run, 100 Tech+Scient**

# BTF Projects

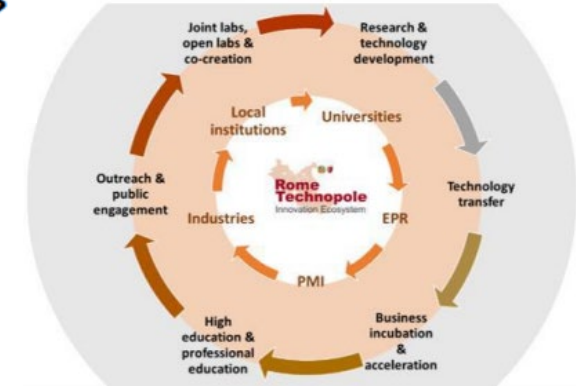
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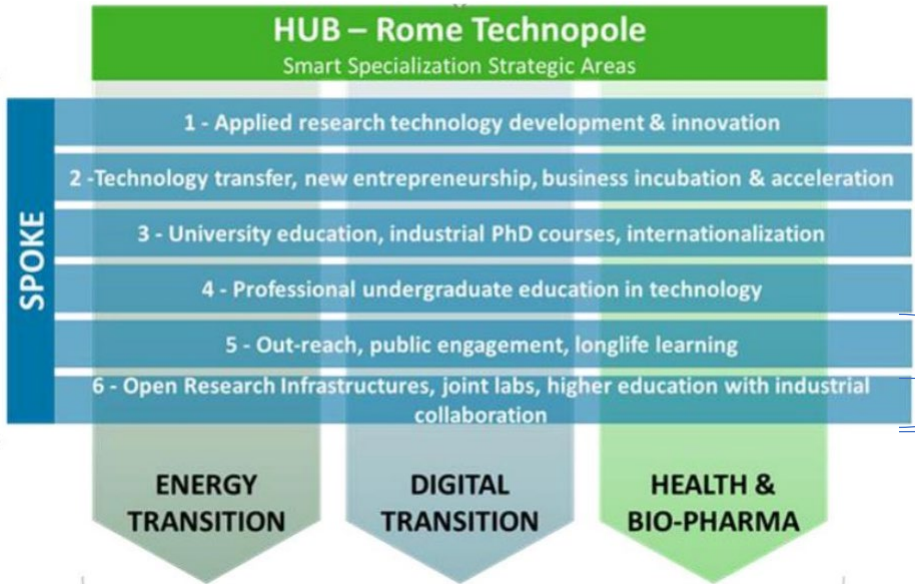
**Avviso pubblico: Proposte per la creazione e il rafforzamento di "Ecosistemi dell'Innovazione»  
PNRR, Missione 4 Istruzione e ricerca  
Componente 2 Dalla ricerca all'impresa, Investimento 1.5**



**AIM:**  
Equip the region with an open research infrastructure to provide support for competitive innovation and growth for companies and stakeholders.



**Flagship projects**



LNF

**LINAC SERVICE  
involved with total  
1.2 FTE/YEAR**

(B. Buonomo, F. Cardelli, C. Di Giulio)

- Joint Open Labs:
- o FP4 (Health & Bio-Pharma) – **F. Cardelli** (Resp. BvTech) – Measurements and RF conditioning of acc. structures for medical application
  - o FP6 (Digital Transition) – **C. Di Giulio** (Resp. Thales) – Development of algorithms based on Machine learning for big-data analytics, Virtual and augmented reality and Digital Twin.



## ERAD funding

Started selection for BTF – fixed-term contract 2-years (**adding 1 FTE in BTF**)

- Expected at Sept 2023

## PNRR - Rome Technopole funding

Expected Two young researcher – (**adding 2 FTE in LINAC SERVICE for PNRR**)

- Expected in July 2023
- **BUT in the next years other retirements will occur** and needs overlapping actions
  - At least other 4 technicians

- **BTF is the right place for young people and ideas**
- **We have to balance working hours with LINAC/BTF group personnel**

## Recommendations DAFNE-BTF SC63

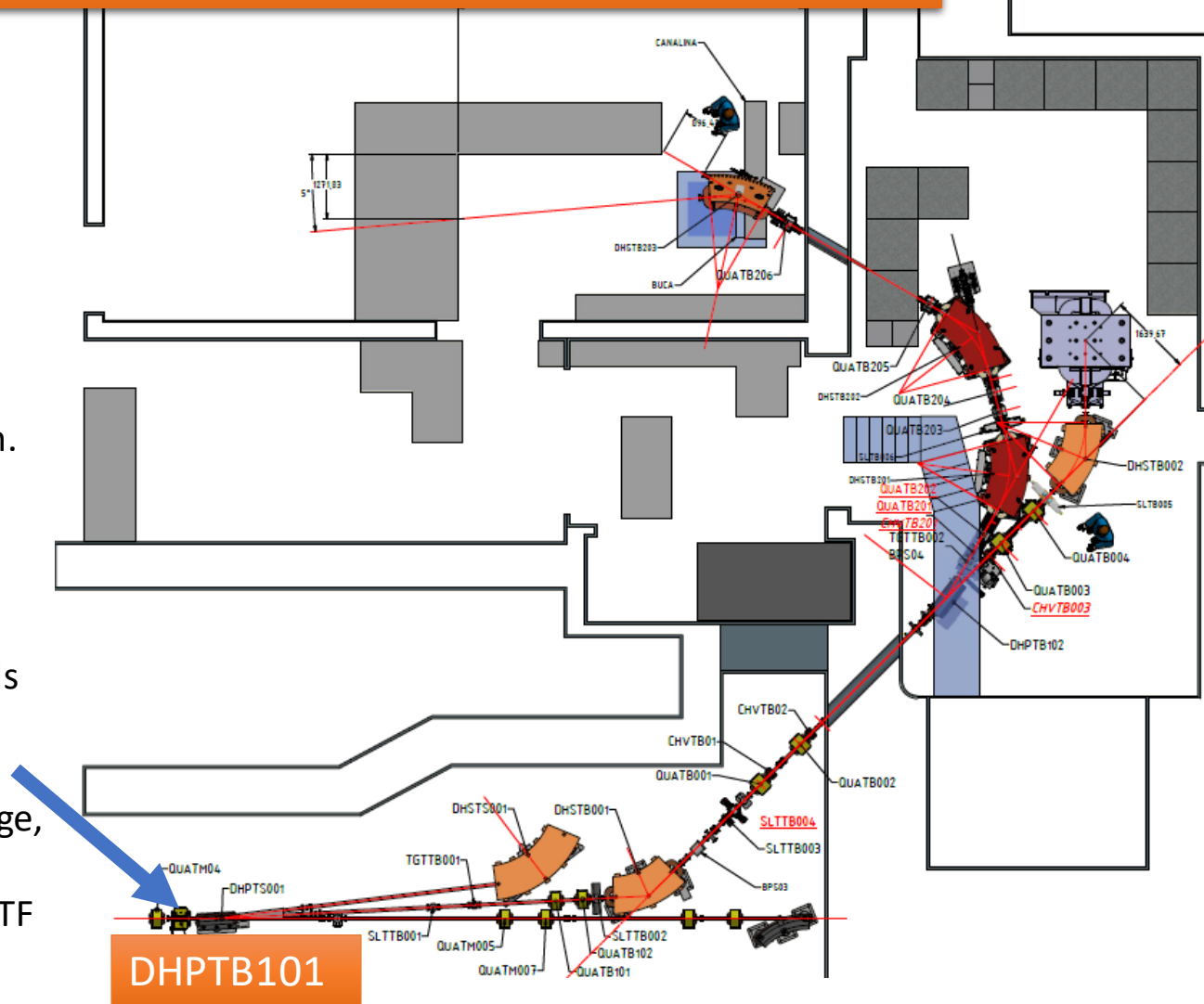
*Continue the analysis effort for the identification of the sources of LINAC down-time and of the elements that might require consolidation for long-term operation of the accelerator in view of maintaining and possibly increasing reliability.*

**DHPTB101** is a pulsed magnet:

- ~**20 years old**, LNF-CERN collaboration
- ~5ms/300A/510MeV ramp for 3deg steering, magnet not optimized
- **Crucial** for DAFNE+BTF LINAC pulse sharing
- **DOWN** for all X17 run
  - Replaced with a not pulsed PS (since DAFNE off)
  - Revamped by huge effort of the MAGNET group in Jan. 2023
- **NOW** some problems in comm with DCS
  - It has to switch automatically polarity as the LINAC switches particle type, ~2 times for half of an hour
  - Currently reset and ramped up by operators when fails autoproc.

Trials to understand the use of DHPTS001 as double B-field stage, seems not so feasible

- In case of fail, needs procedure to handshaking DAFNE vs BTF duty cycle



## Recommendations DAFNE-BTF SC63

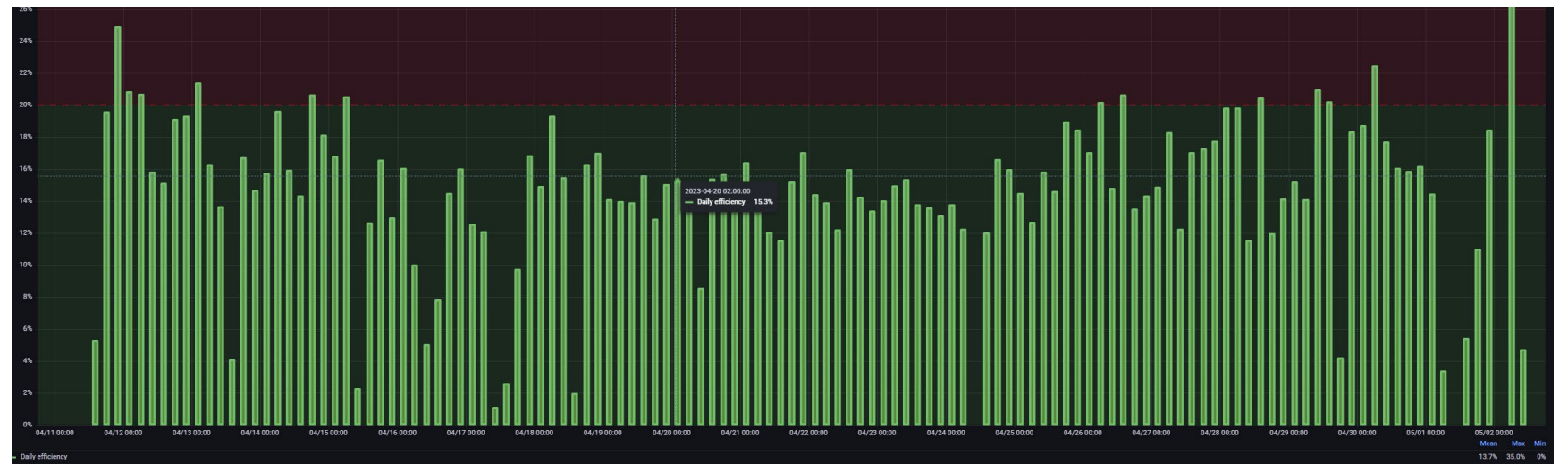
Operate the LINAC at 50 Hz, provided a repair of Klystron C is successful, to reduce injection time. Optimum "stable beam" duration should be adapted accordingly considering luminosity lifetime.

25Hz BEST ops (current ops)	e- inj	e+ inj	switch phase	coasting
Time [min]	3,5	4,3	5	12
BTF [pulse/s]	20	5	0	25
Pulses/sect	70	21,5	0	300
BTF D/sect	0,11	0,03	0,00	0,48
BTF D				0,63
BTF Average rate				15,79
Time between cycle	24,8			

50Hz BEST ops (my opinion)	e- inj	e+ inj	switch phase	coasting
Time [m]	2	3	5	12
BTF pulse/s	40	10	0	50
Pulses/sect	80	30	0	600
BTF D/sect	0,07	0,03	0,00	0,55
BTF D				0,65
BTF Average rate				32,27
Time between cycle	22			

Injection efficiency = time spent during injection  
 Last 20days = average 13% (little bit more)  
 LINAC switch time = ~2min  
 TL switch time = ~2min  
 50Hz ops -> take in account:

- Double rate of faults
- Less efficient for TL, DR inj (stability)
- Duty cycle for BTF now is around 50% (this month)
- Not even in BEST ops

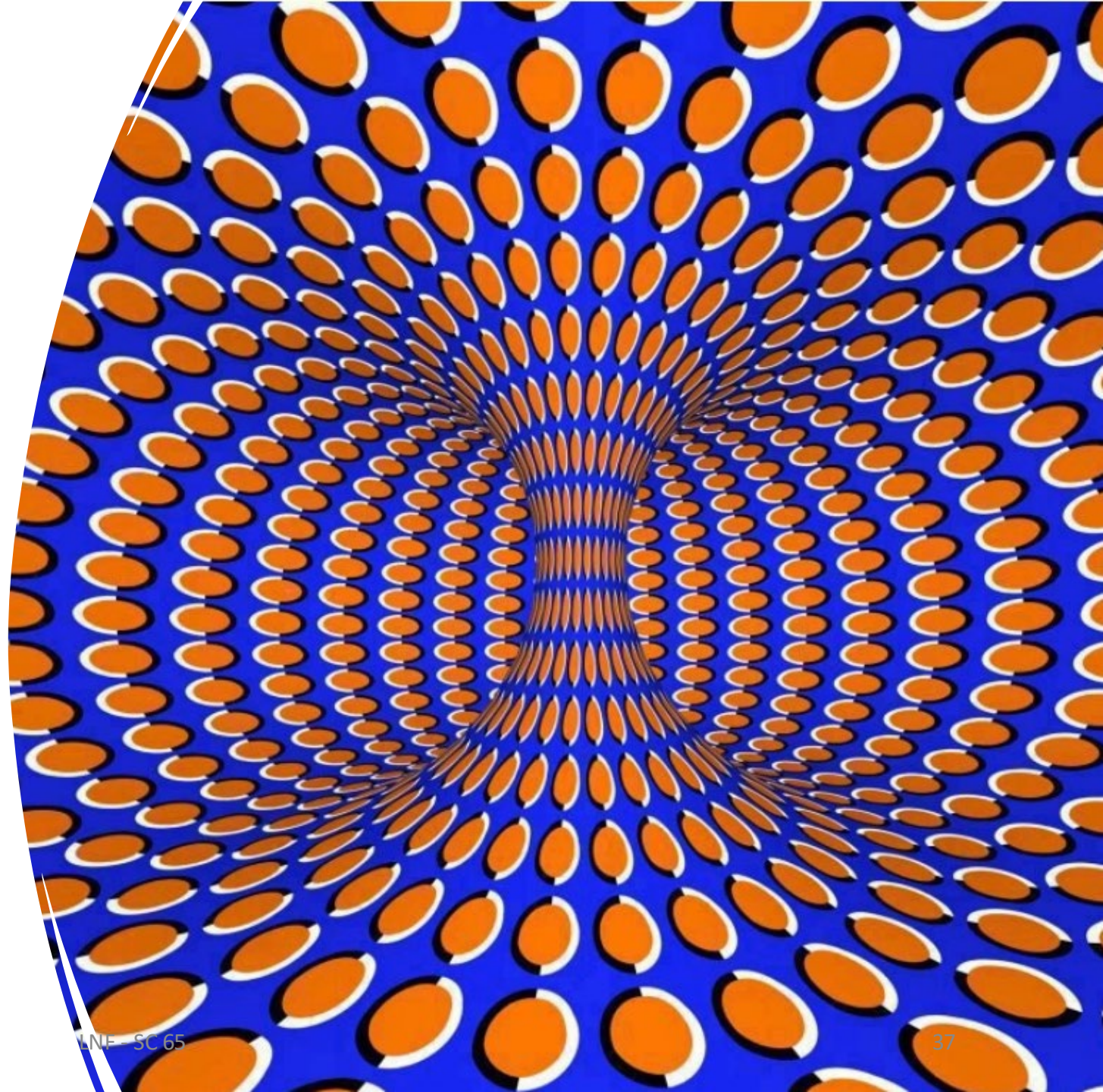


<https://dashboard.lnf.infn.it/prod/grafana/d/WeAkaME4k/long-term-trends?orgId=1&refresh=1h>

- X17 **run closed successfully**
- Ext. User call **on going, very high level of users**
  - Reducing old queue of users, Sept. open call
  - BTF People too old, looking forward also for student
  - EUROLABS
- **DHPTB101 is a serious problem**
  - Currently investigating a solution
- New stable collaboration on the horizon
  - FLASHMOB, some discussion with **HRMT62**
- BTF results have to be shared with **all the LNF people involved**
  - DT and DA services, secretariats and administrations
  - Especially the DAFNE operators

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# SPARE SLIDE



Very low charged primary positron beam  
X17 received different beams type

- Bunch length up to 250ns
- Lower beam charge 2.5kPoTs
- Improvements in beam stability and background

## AGAIN HUGE improvements in respect PADME RUN2 2020 primary

- **Lower GUN emitted current**
  - Under the dynamic range for the most LINAC diagnostic, after positron converter (BCM, BPM, ICT)
  - Setup done at lower current without attenuator since shorter pulse requested from experiment
- **Very good** background in BTF1 experimental hall and X17 (now less than 180nS/h)
  - **Even with a reduced** stay-clear factor in BTFE1 pipes, due to BTF2 (DHPTB102) installation
    - By beam steering defined gap (2mm/3A on vertical correctors)
    - But **harder constraint** on beam passage and stability
    - X17 staff happy for this
- **Low beam loading** => Final beam energy spread around 0,5% (before BTF line selection) at 400MeV trails
  - Different energy populations with different bunch length and charge
- Beam pulse length and charge at Diamond Target with harder constraint in respect of initially asked by experiment:
  - **LINAC pulse extended from 100->200ns** => improved in respect of what experiment requested

# EURO LABS

- <https://web.infn.it/EURO-LABS/>

## Access

To provide efficient access to the available resources at a major fraction of **EUROpean Laboratories for Accelerator Based Sciences (EURO-LABS)**.

## RIs

Provide broad and focused joint training activities with hands-on experience at the RIs to develop diverse skills of the next generation researchers, for the optimal use of the large number of RIs potential for scientific and technological discoveries.

## Infrastructure

Large and diverse community of users to choose the most appropriate state-of-the-art Research Infrastructures RI(s).  
For conducting high impact research, fostering the sharing of knowledge and technologies across scientific fields.

## Community

Build a super community of sub-atomic researchers and the associated technical staff.

## Data Management & Service Improvements

Implementation of good practices for data management and activities relating to targeted service improvement to enhance capabilities and performance of the RIs.

## Physics

This proposal brings together for the first time in Europe the three communities engaged in Nuclear Physics and Accelerator/ Detector technology for High Energy Physics.

# Operational Budget

	Number of hours over the 4 years	Actual cost (*)	Total value	INFN in kind contribution	Project contribution
<b>BTF</b>	1176 (7 weeks)	180.75 €/h	≈ 213 k€	60 %	≈ 86 k€
<b>SPARC</b>	1680 (10 weeks)	126.75 €/h	≈ 213 k€	60 %	≈ 86 k€
















*(\*) includes:*










*electric power, personnel (2 technicians h 24, 1 staff researcher h 8), user initial training*

*Other budget items:*

*user travel support, INFN staff travels, TA management*



		Modal attività ▾	Nome attività ▾	Durata ▾	Inizio ▾	Fine ▾	Prede
1			▷ FISMEL_calendar_2023	320 g	lun 19/09/22	ven 08/12/23	
2			▷ BTF_calendar_2023	380,13 g	ven 08/07/22	lun 08/01/24	
3			▷ DA_calendar_2023	0 g?	gio 15/09/22	gio 15/09/22	
4			▷ SPP_calendar_2023	0 g?	lun 19/09/22	lun 19/09/22	
5			▷ DT0_calendar_2023	302 g?	lun 24/10/22	mar 19/12/23	
6			▷ Fest_calendar_2023	262 g	mer 28/09/22	gio 28/09/23	
7			▷ DR_calendar_2023	0 g?	mar 04/10/22	mar 04/10/22	

5			◀ DT0_calendar_2023	302 g?	lun 24/10/22	mar 19/12/23	
1			▷ Crane Maintenances	299 g?	gio 27/10/22	mar 19/12/23	
8			▷ Shilding Doors Maintenance	264 g	lun 24/10/22	gio 26/10/23	
12			▷ LINAC mowing	196 g	lun 31/10/22	lun 31/07/23	
18			▷ CR Deep cleanings	261 g	lun 19/12/22	lun 18/12/23	
24			▷ FLUIDS Maintenance	20 g	lun 23/01/23	ven 17/02/23	
29			▷ Pest control	101 g	ven 28/04/23	ven 15/09/23	
34			▷ Special DAFNE Building Maintenance	43 g	gio 01/06/23	lun 31/07/23	

		Modal attività	Nome attività	Durata	Inizio	Fine	Predecessori	N
1			<b>▲ FISMEL_calendar_2023</b>	<b>320 g</b>	<b>lun 19/09/22</b>	<b>ven 08/12/23</b>		
1			▲ <b>Controllo periodico Sicurezze Radioprotezione</b>	<b>152 g</b>	<b>ven 02/12/22</b>	<b>lun 03/07/23</b>		
2			Check FISMEL LINAC+BTF	3 g	lun 09/01/23	mer 11/01/23		
3			Check Globale+DAFNE-L	3 g	ven 02/12/22	<u>mar 06/12/22</u>	2	
4			Check FISMEL LINAC+BTF	3 g	gio 29/06/23	lun 03/07/23	2FI+6 mes	
5			Check Globale+DAFNE-L	3 g	ven 02/12/22	<u>mar 06/12/22</u>	4	
6			▲ <b>Controllo Buon Funzionamento Sistema radiometrico</b>	<b>320 g</b>	<b>lun 19/09/22</b>	<b>ven 08/12/23</b>		
7			Controllo Buon Funzionamento Sistema radiometrico	2 g	lun 19/09/22	mar 20/09/22		
8			Controllo Buon Funzionamento Sistema radiometrico	2 g	mar 20/06/23	mer 21/06/23	7FI+6 mes;11FI+6 mes	
9			Controllo Buon Funzionamento Sistema radiometrico	2 g	gio 07/12/23	ven 08/12/23	8FI+6 mes	
10			▲ <b>Manutenzione Sistema radiometrico</b>	<b>1 g</b>	<b>lun 02/01/23</b>	<b>lun 02/01/23</b>		
11			Manutenzione Sistema radiometrico	1 g	lun 02/01/23	lun 02/01/23		
12			▲ <b>Monitoraggio attivazione residua aree</b>	<b>153 g</b>	<b>lun 02/01/23</b>	<b>mer 02/08/23</b>		
13			Monitoraggio attivazione residua aree	2 g	lun 02/01/23	mar 03/01/23		
14			Monitoraggio attivazione residua aree	2 g	mar 01/08/23	mer 02/08/23		

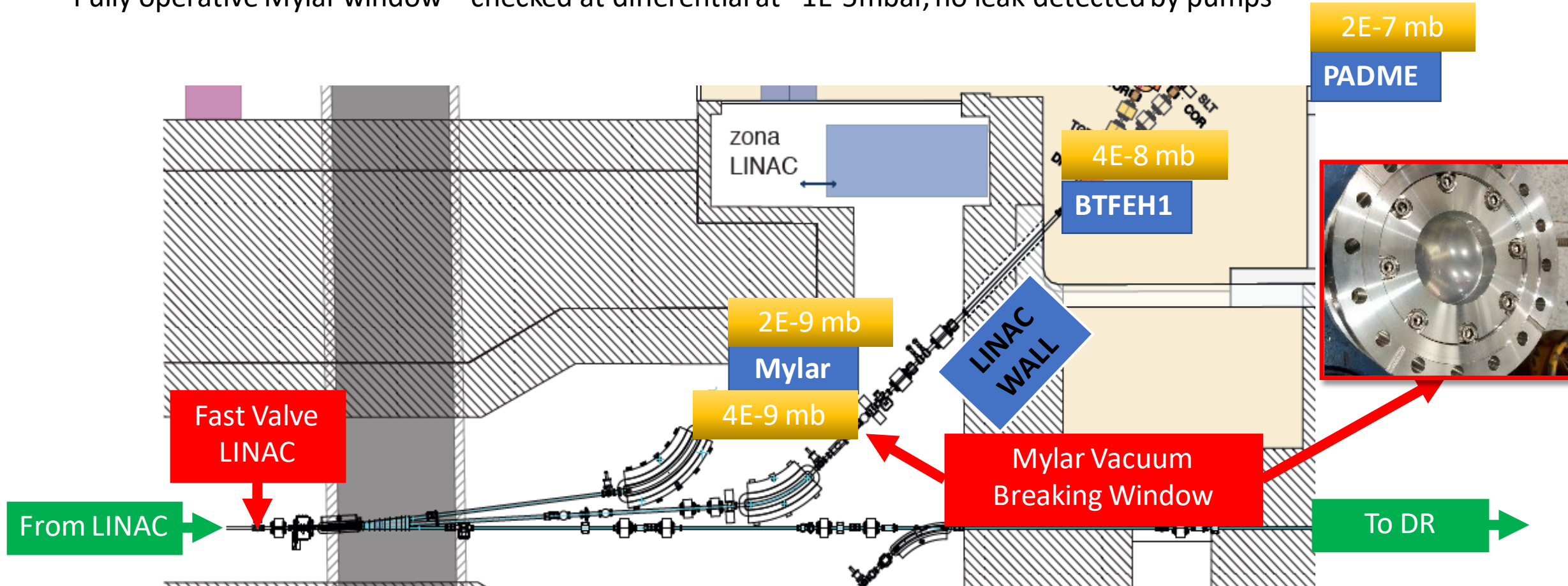
Minimize impact on inline check and maintenance operations

Repetitive scheduled events

# BTF VACUUM – SAFETY SYSTEM

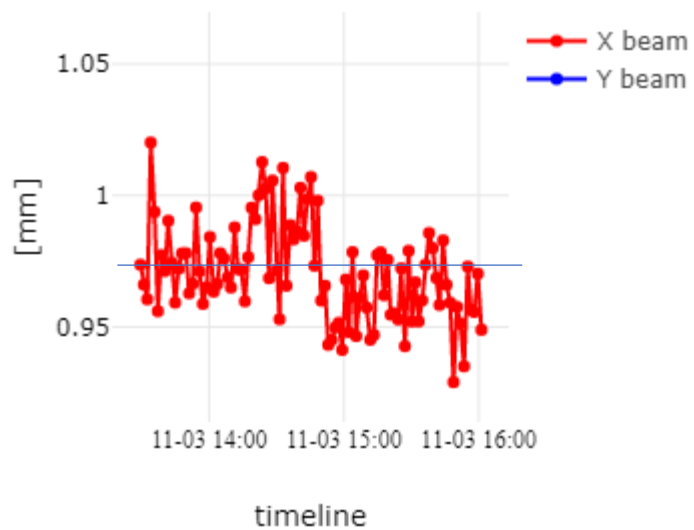
Both checked at the end of Tech-RUN2 and at the RUN2 start

- Fully operative Fast Valve safety system – at the vacuum vents
- Fully operative Mylar window – checked at differential at  $\sim 1\text{E-5mbar}$ , no leak detected by pumps

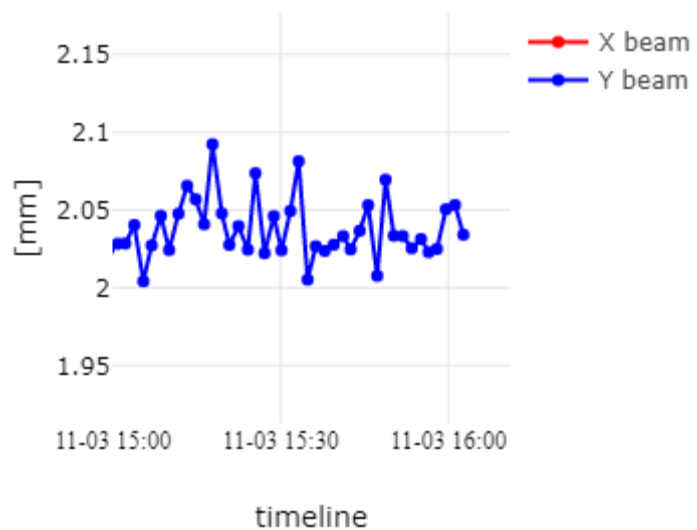


# BEAM PERFORMANCES

m X and Y average 2022/11/03 16:04:31 I



m X and Y average 2022/11/03 16:06:12 I



**Setup O (low stat in restart):**

DHSTB001: 175.925 A (276.3MeV) (5061,20g)  
DHSTB002: 186.300 A (275.4MeV)  
DHRTB101: 165.3 A

**Setup A**

**Line PLC fault, Magnet switch off**

**Magnets involved: QUATMXXX, QUATB10X, QUATB001, QUATB002, DHSTB001**

DHSTB001: 175.925 A (276.3MeV) (5061,20g)  
DHSTB002: 186.240 A (275.3MeV)  
DHRTB101: 165.3 A

**Setup B (tune DH)**

DHSTB001: 176.225 A (276.8MeV) (5070.4g)  
DHSTB002: 186.240 A (274.3MeV)  
DHRTB101: 165.300 A

**Setup C (tune DH)**

DHSTB001: 175.925 A (276.3MeV) (5061,20g)  
DHSTB002: 186.240 A (274.3MeV)  
DHRTB101: 166.900 A

**Setup D (tune DH)**

DHSTB001: 175.925 A (276.3MeV) (5061,20g)  
DHSTB002: 186.240 A (274.3MeV)  
DHRTB101: 165.300 A

**Setup E (tune DH)**

DHSTB001: 176.225 A (276.8MeV) (5070.4g)  
DHSTB002: 186.240 A (274.3MeV)  
DHRTB101: 165.300 A

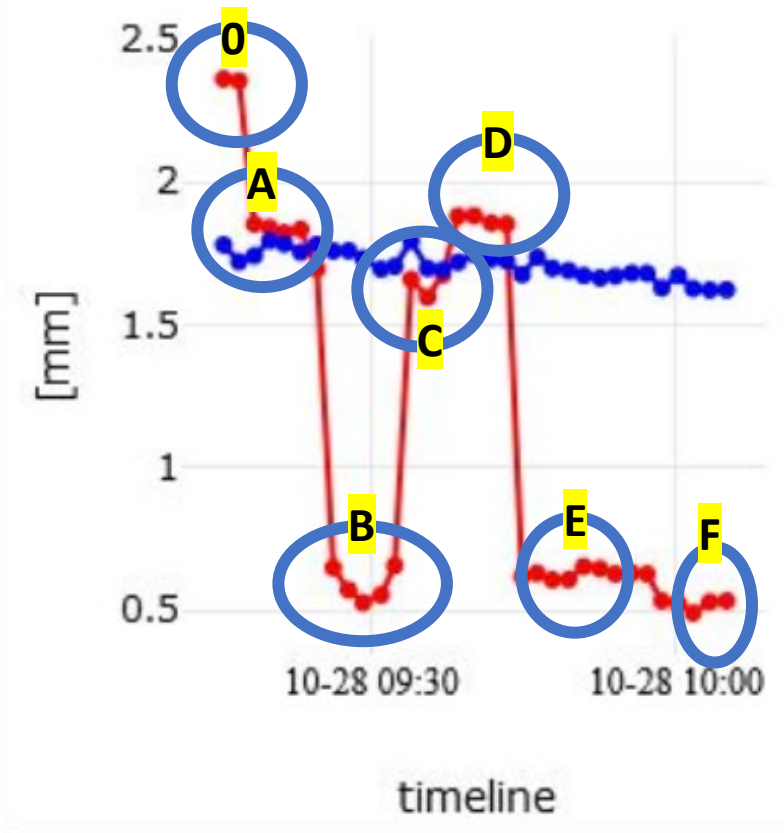
**Setup F (tune DH)**

DHSTB001: 176.225 A (276.8MeV) (5070.4g)  
DHSTB002: 186.240 A (274.3MeV)  
DHRTB101: 166.300 A

04/05/2022

**Original setup:**

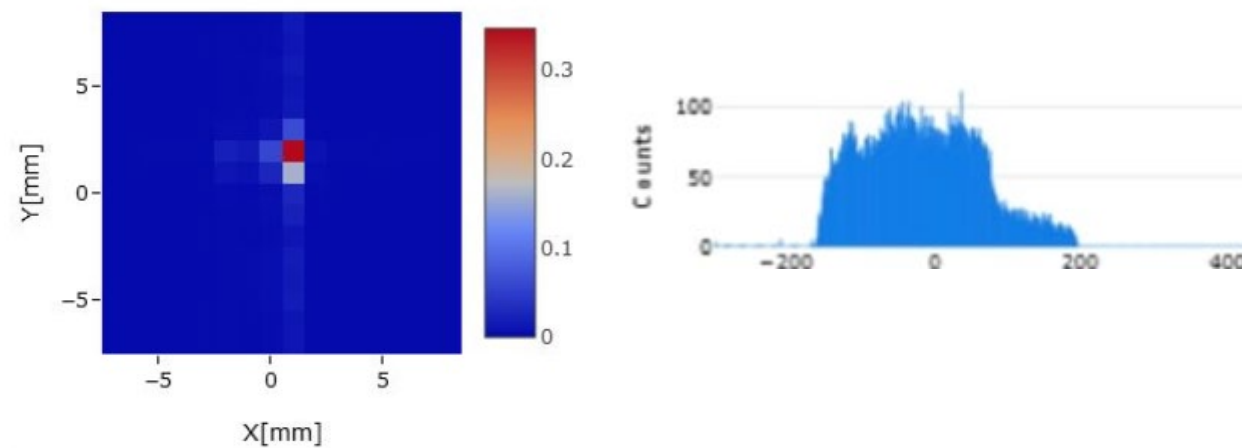
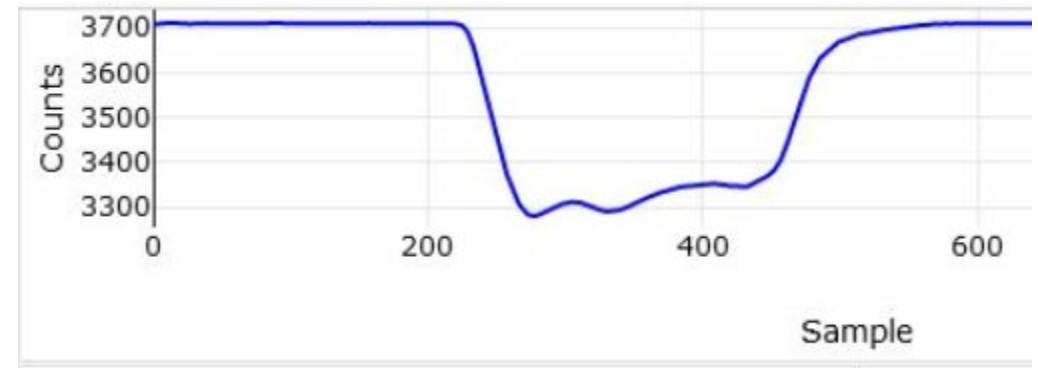
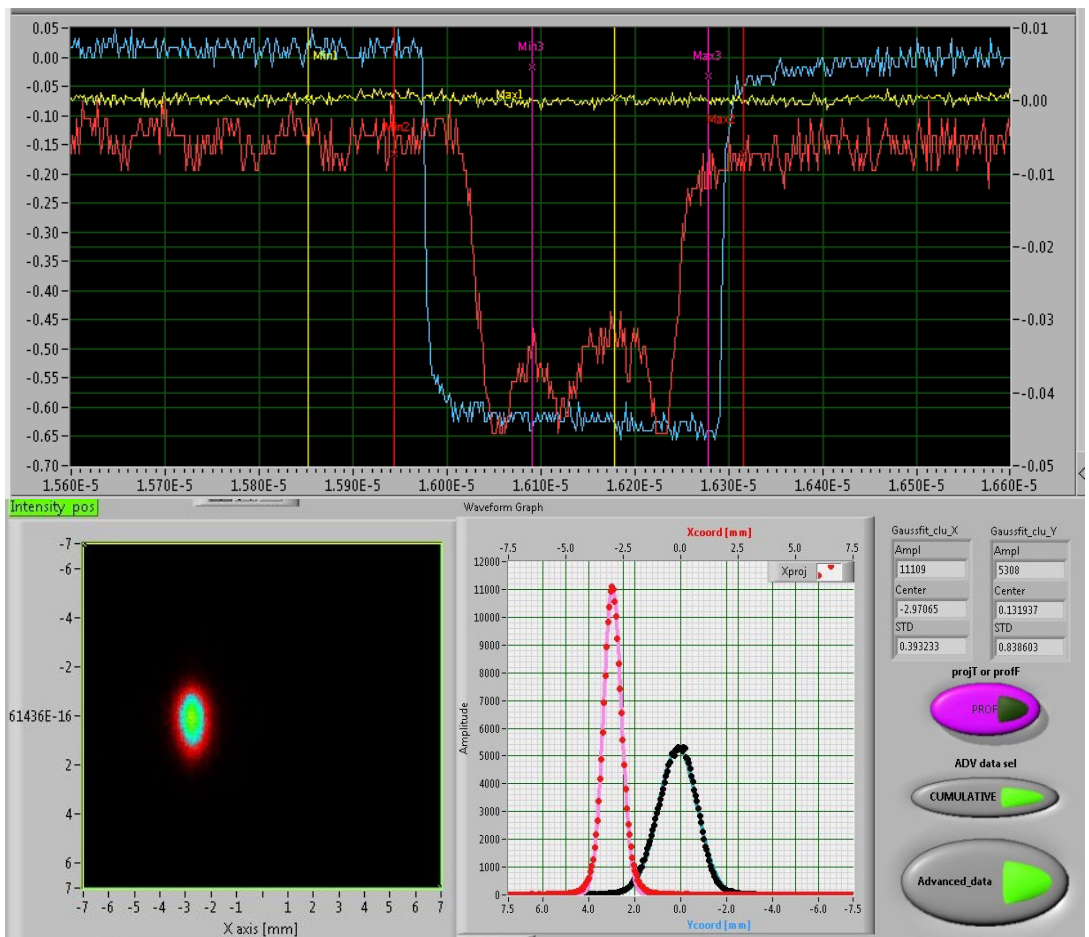
DHSTB001: 175.925 A (276.3MeV) 5071,20 G  
DHSTB002: 186.240 A (275.3MeV)  
DHRTB101 166.9 A



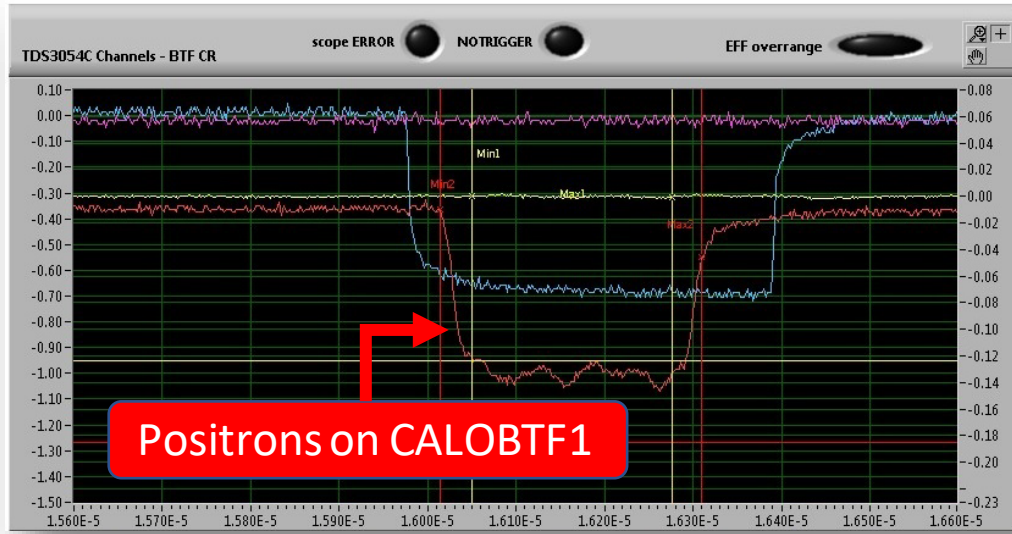
Energia e <sup>+</sup>		DHSTB001				DHSTB002			DHRTB101		DATE	Hour	NOTE
E(MeV)	dE	Corrente (A)	dA	Campo (G)	dG	E(MeV)	Corrente (A)	dA	Corrente (A)	dA			
211,5	-50,30	134,66	-31,67	3894	-898,6	210,3	142,806	-33,26	125	-30,900	10/11/2022	12:51	
261,8	-1,00	166,325	-1,00	4792,6	-27,6	259,3	176,07	-1,00	155,900	-1,000	08/11/2022	22:00	
262,8	-1,60	167,325	-1,00	4820,2	-27,8	260,8	177,07	-1,13	156,900	-1,000	07/11/2022	18:30	
264,4	-1,60	168,325	-1,00	4848	-27,5	262,5	178,2	-1,17	157,900	-1,000	06/11/2022	18:03	
266	-1,50	169,325	-1,00	4875,5	-27,5		179,37	-0,63	158,900	-1,000	05/11/2022	18:45	
267,5	0,10	170,325	0,10	4903	-1,2		180	0,00	159,900	0,000	04/11/2022		restore di 267.4
267,4	-1,50	170,225	-1,00	4904,2	-27,4		180	-1,00	159,900	-1,000	02/11/2022	18:30	
268,9	-1,60	171,225	-1,00	4931,6	-27,8		181	-1,07	160,900	-1,000	01/11/2022	19:00	
270,5	-1,60	172,225	-1,00	4959,4	-27,8		182,07	-1,03	161,900	-1,000	31/10/2022	19:00	
272,1	-1,40	173,225	-1,00	4987,2	-27,6		183,1	-1,14	162,900	-1,000	30/10/2022	18:00	
273,5	-1,70	174,225	-1,00	5014,8	-55,6		184,24	-1,00	163,900	-1,400	29/10/2022	19:48	
275,2	-1,60	175,225	-1,00	5070,4	0	272,8	185,24	-1,00	165,300	-1,000	28/10/2022	19:31	
276,8	-1,10	176,225	-0,70	5070,4	-29	274,3	186,24	-1,06	166,300	-0,600	27/10/2022	16:20	276.3MeV
277,9	-1,60	176,925	-1,00	5099,4	-28	275,3	187,3	-1,00	166,900	0,000	26/10/2022	14:40	
279,5	-1,50	177,925	-1,00	5127,4	-24,2	277,3	188,3	-1,42	166,900	-2,300	25/10/2022	10:30	
281	-1,60	178,925	-1,00	5151,6	-27,6	279,5	189,722	-0,99	169,200	169,200	24/10/2022		
282,6	-1,60	179,925	-1,00	5179,2	-28	281	190,715	-1,09		-169,400	22/10/2022		20/10/2022
284,2	-1,50	180,925	-1,00	5207,2	-27	282,5	191,8	-1,00	169,400	169,400	21/10/2022	17:00	
285,7	-1,70	181,925	-1,00	5234,2	-25,8	284	192,8	-0,90		-169,400	11/10/2022		RUN11/10-13/10
287,4	-1,50	182,925	-1,00	5260	-28,4	285,4	193,7	-1,10	169,400	0,000	17/10/2022		RUN 17/10-18/10
288,9	-1,60	183,925	-1,00	5288,4	-28,4	286,9	194,8	-1,00	169,400	0,000	15/10/2022		RUN 15/10-17/10
290,5	-1,50	184,925	-1,00	5316,8	-27,2	288,4	195,8	-0,20	169,400	-6,100	14/10/2022		RUN 14/10-15/10
292	-1,60	185,925	-1,00	5344	-28,2	289,8	196	-1,80	175,500	0,000	20/10/2022		
293,6	-1,60	186,925	16,60	5372,2	-28,8	291,3	197,8	-1,00	175,500	0,000	19/10/2022		
295,2	0,00	170,325	0,00	5401	0	292,8	198,8	0,00	175,500	175,500	18/10/2022		

# INFN BTF BEAM ON X17 DIAG

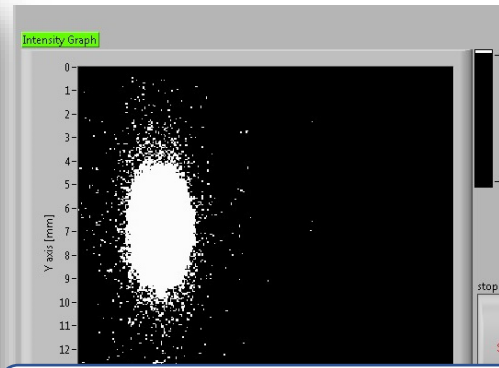
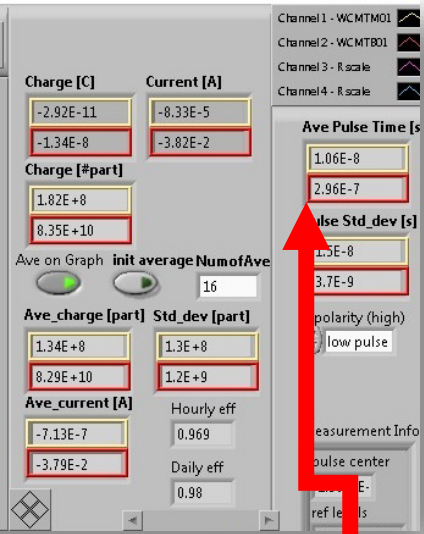
Istituto Nazionale di Fisica Nucleare  
Laboratori Nazionali di Frascati



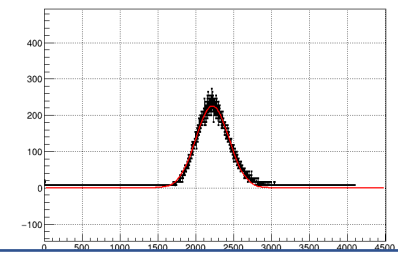
# BTF BEAM – STANDARD PADME PULSE



Positrons on CALOBTF1

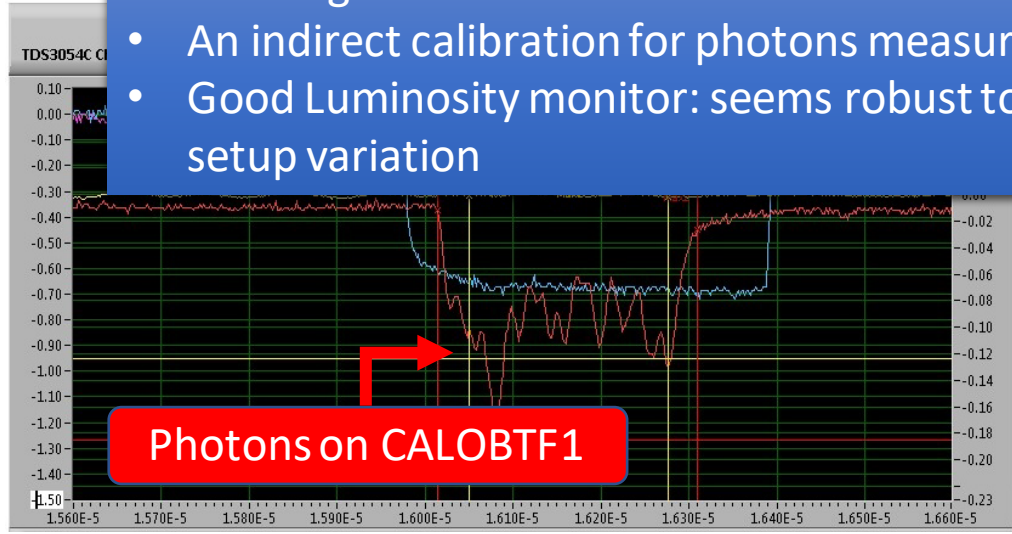


Direct positrons in FitPIX

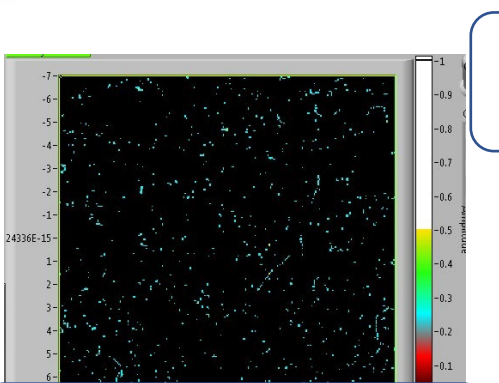
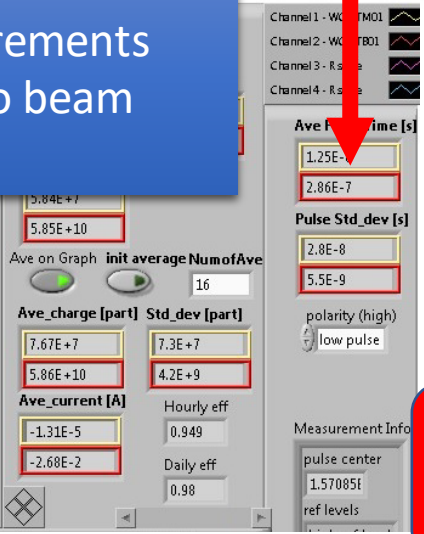


1000 bunched 30kPoT photons charge distribution  
10% resolution

- Good agreement in time evaluation
- An indirect calibration for photons measurements
- Good Luminosity monitor: seems robust to beam setup variation



Photons on CALOBTF1



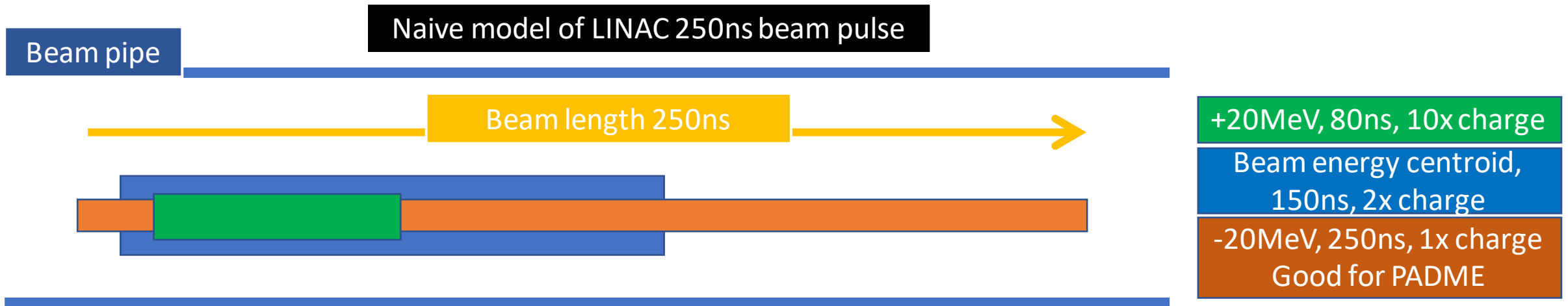
Photons conversion on adsorber, deltas... in FitPIX



After July trials with secondary positron beam, X17 team preferred to move vs primary positron beam, enhancing final beam spread and top current (max multiplicity was up to 3000 secondary PoT at 400MeV).

For X17 run:

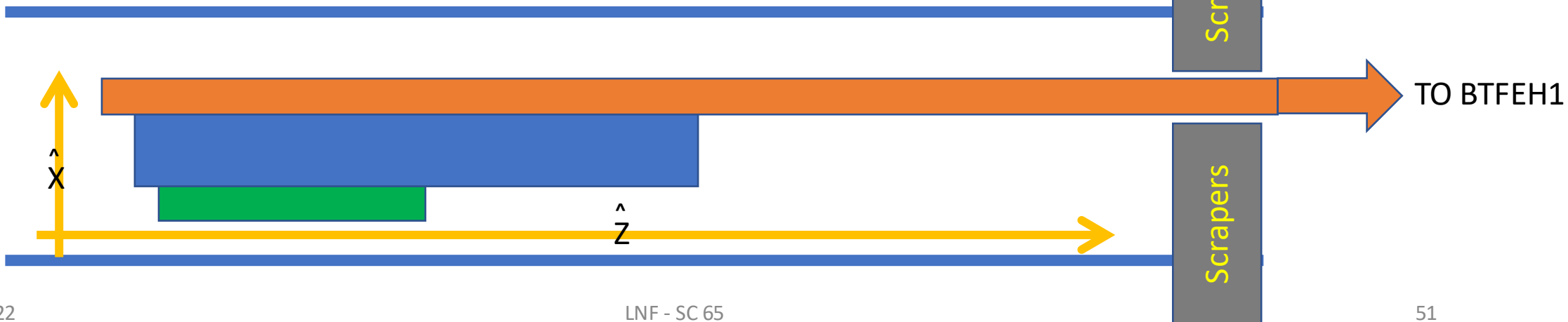
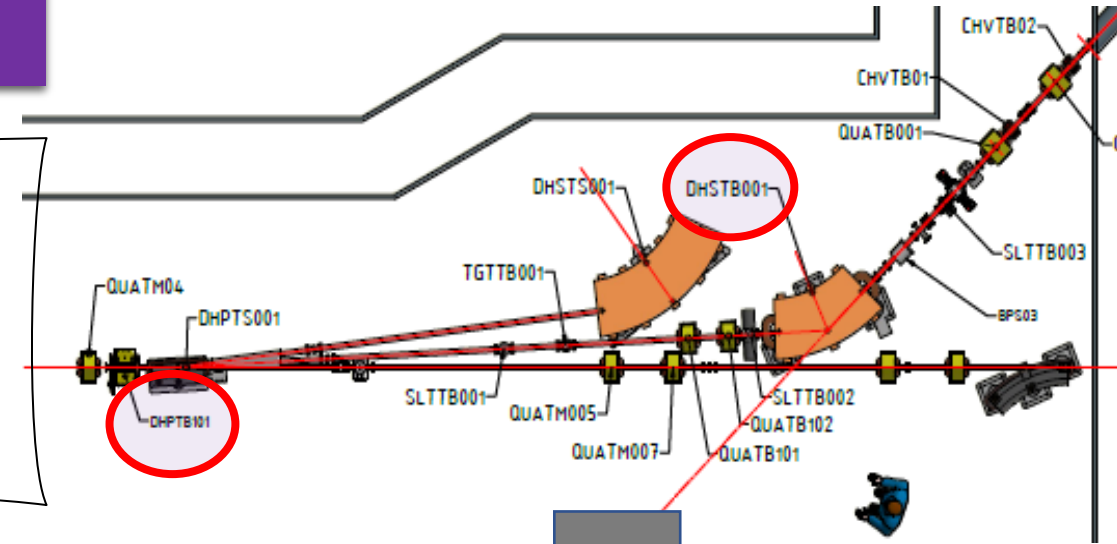
- LINAC pulses 50 shots/s
- Primary positrons
- 250ns pulse for all the energy involved (400MeV and continuously 300MeV down to 200MeV)
- Lower current on target



## After DHSTB001 e DHRTB101, TB2 scraping

The structured beam spread is used for time/charge selection via:

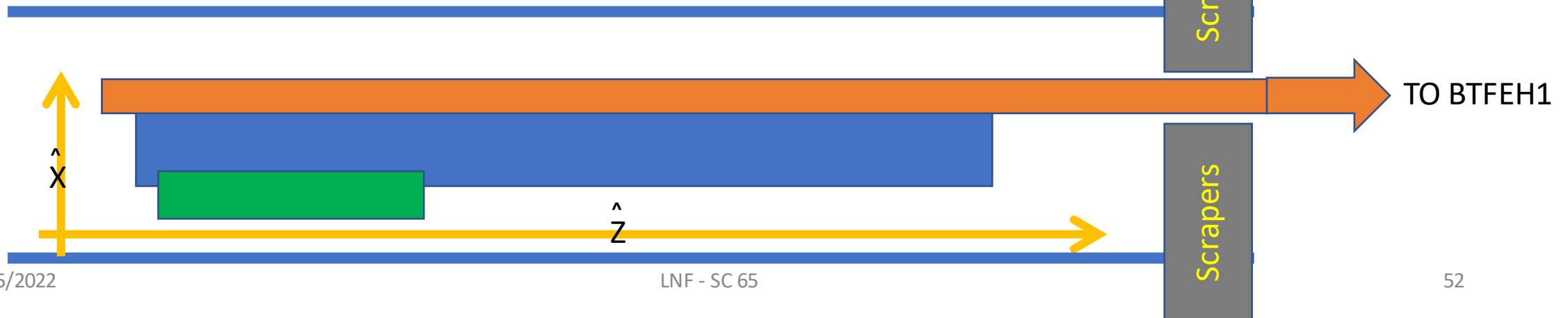
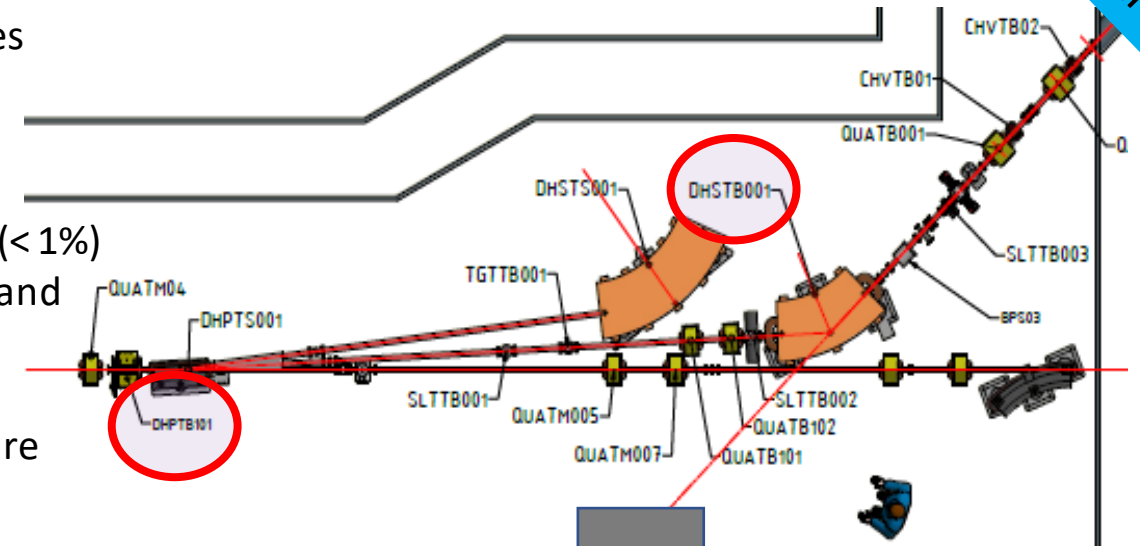
- Injection angle in BTF channel
- **Horizontal scraping**, get final energy spread at SLTB002 level
- Refining as secondary beam the SLTB004
- **Charge control via LINAC current is great (down to single particle multiplicity !!!!) -> no needs of target**



TO  
BTFEH1

## These way of beam structure leads to:

- DHRTB101 - DHSTB001 act as second beam pulse flattening tool (removes head-tail peaks)
- DHSTB001 sector magnet => -X sees more focusing, higher energy
  - Treat this beam as secondary beam (as BTF usually do)
- SLTB004 – SLTB005 scraping downstream enhances final beam spread (< 1%)
  - Limited use of downstream scrapers => lower BTFEH1 background and beam side effects
- More degree of freedom to get desired beam parameters
- **Reduced coupling of final focus from injected beam** (transverse shape are huge compared to SLTB003-004 scraper pin hole)
- Mylar window is a good Bremsstrahlung radiator for an online monitor



## Fast BTF beam diagnostics

- CALOBTF1 (PbWO – NA62 like)
- Timepix detectors (65k Pixel TPX, TPX3 detector,  $\sim 2\text{cm}^2$ )
- Located downstream the straight pipe in the DHSTB002 dipole
- Adsorber in the middle (0.05mm Ti window, 0.7 Si detectors)

## Direct measurement (positrons, X17 delivered beam):

- Stop injections to X17
- DHSTB002 switch off
- Injection in the straight DHSTB002 channel

## Undirect measurement (secondary photons, run quality monitor)

- Beam steered to X17
- CALOBTF1 and FITPix get Bremsstrahlung photon from mylar window
- Energy collected is less 0,001 of the total steered charge (12m away)
- Used to monitor delivered PoT and beam length runtime
- Higher measurement errors in respect to PADME RUN(20%)

