Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

The current status of the Beam Test Facility (BTF) at LNF-INFN

L. G. Foggetta on behalf of INFN LNF-BTF Group

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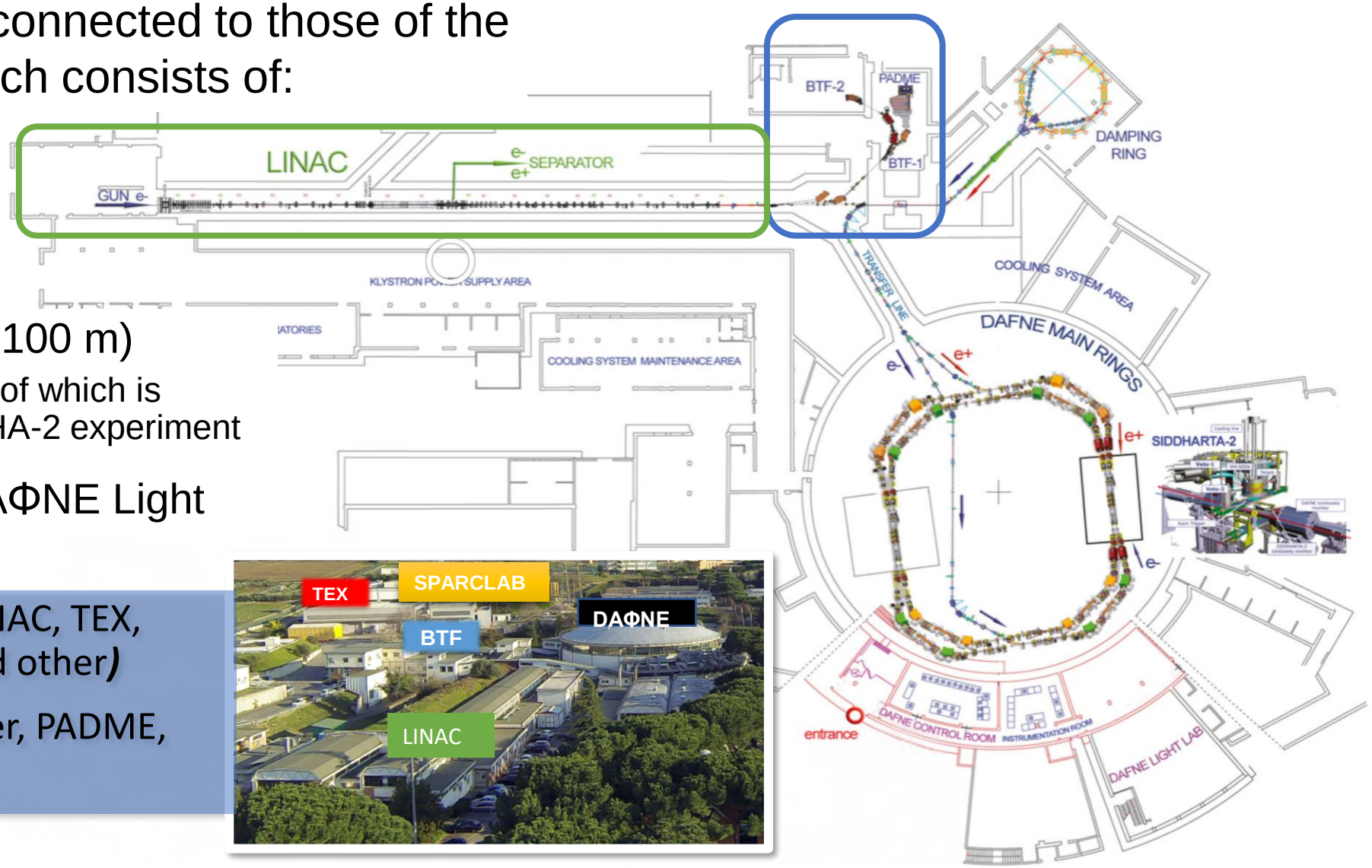
THE DAΦNE ACCELERATOR COMPLEX

The activities of BTF are connected to those of the e^+/e^- collider DAΦNE, which consists of:

- A SLAC- type ***LINAC*** (e+/e-)
- A damping ring
- Two accumulation rings (~100 m)
  - Two interaction points, one of which is occupied by the SIDDARTHA-2 experiment
- Two facilities: ***BTF*** and DAΦNE Light



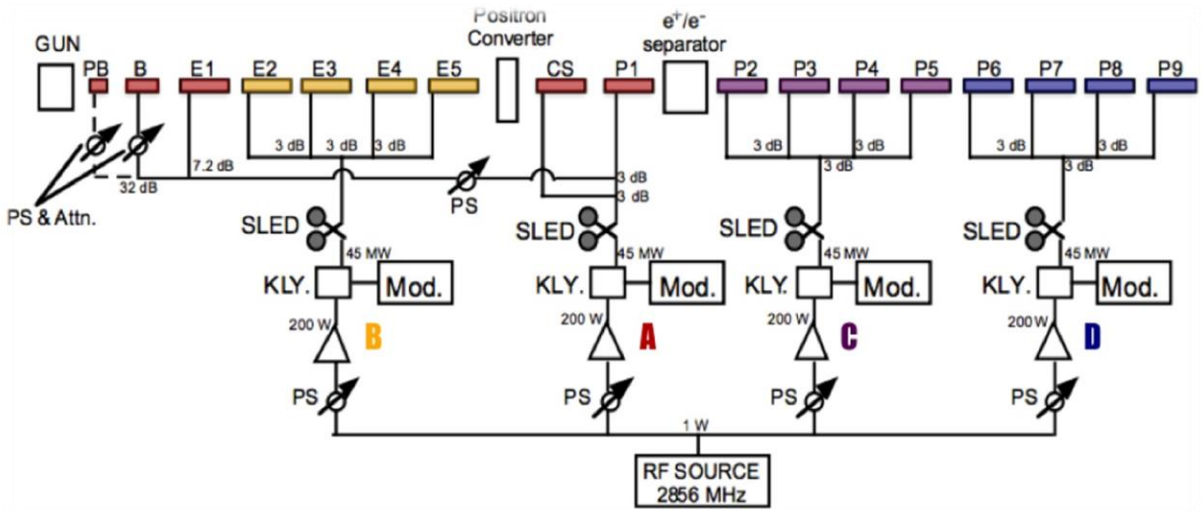
LINAC Group (10FTE: DAFNE LINAC, TEX, SPARC, ROME TECHNOPOLE and other***)***

BTF Group (3.8FTE: external user, PADME, ASIF2 & EUROLABS ***)***

THE DAΦNE LINAC

- Pulsed machine with **rep rate up to 50Hz**
  - **Highly charged electron and positron "primary" beams (nC range)**
  - Commissioning: 25 years ago
  - **Initially developed for a few hours of uptime per day with a 10 ns pulse length**.
- Current capabilities of the LINAC includes:
  - **Continuous operation - 24/7**,
  - Macrobunch length from 1.5 up to 320 ns (10ns typ.).
  - Primary electron beam energy spans from **150 MeV to 780 MeV.**

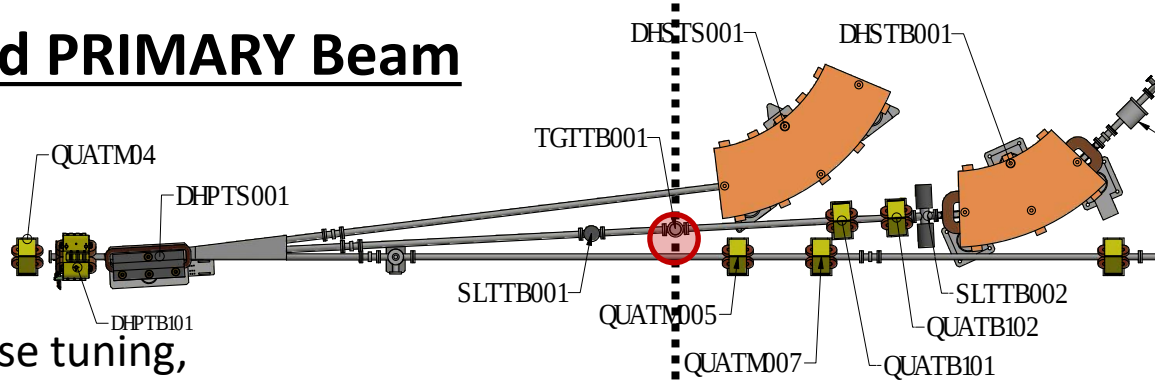
Following the shutdown of DAΦNE, the LINAC operates in **dedicated mode** for the BTF.



	Design	Operations (top)
Final energy e^-	800 MeV	510 MeV (780)
Conversion energy e^+	250 MeV	220 MeV
Final energy e^+	550 MeV	510 MeV (535)
Radiofrequency	2856 MHz	
Accelerating structure	SLAC-type, CG, $2\pi/3$	
RF amplifiers	4×45 MW klystron with TH2128C sleds	
Repetition frequency	1 Hz ÷ 50 Hz	1 Hz ÷ 50 Hz
Pulse duration	10 ns	1.4 ns ÷ 320 ns
Beam size on e+ converter	1 mm	1 mm
Normalized emittance (mm mrad)	1 (e^-) / 10 (e^+)	1 (e^-) / 10 (e^+)
Energy spread (RMS)	0.5% (e^-) / 1.0% (e^+)	0.5% (e^-) / 1.0% (e^+)
Output current e^- (510 MeV)	>150 mA	180 mA (>500)
Output current e^+ (510 MeV)	36 mA	50 mA (>85)

PRIMARY AND SECONDARY BEAM IN EH

LINAC Conditioned PRIMARY Beam

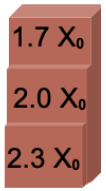


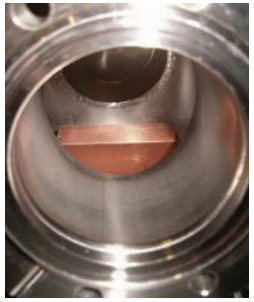
Fixed energy:

- Steering and transverse tuning,
- Longer implementation for energy setup (tuning LINAC and BTF)

High current up to ~10^{10} particle/shot:

- Scrapering injection current
- Tunable in **10 order of magnitude**





BTF SECONDARY beam

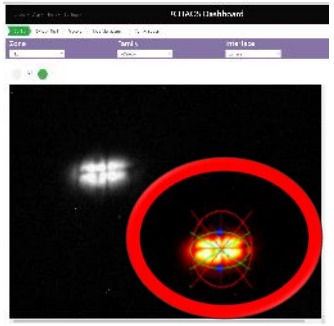
RUN time Tunable energy

- All energies from $E_{primary}$ to ≈25 MeV

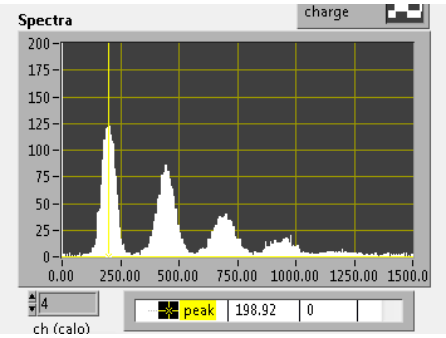
RUN time precise multiplicity

- From ~10^4 to single particle per shot
- More way to adapt multiplicity set

- Particle type **decoupled** from LINAC production
- Both energy and intensity setup with faster implementation (only BTF tuning)
- High quality single particle measurements



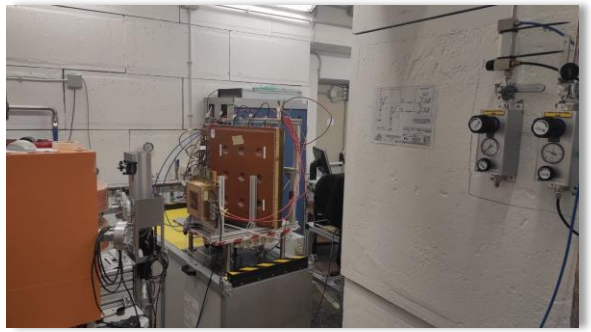
- Parameters setup via target/scrapers/magnets
- Final focus user dependent
- All parameters manageable during data taking



INFN LNF – BEAM TEST FACILITY

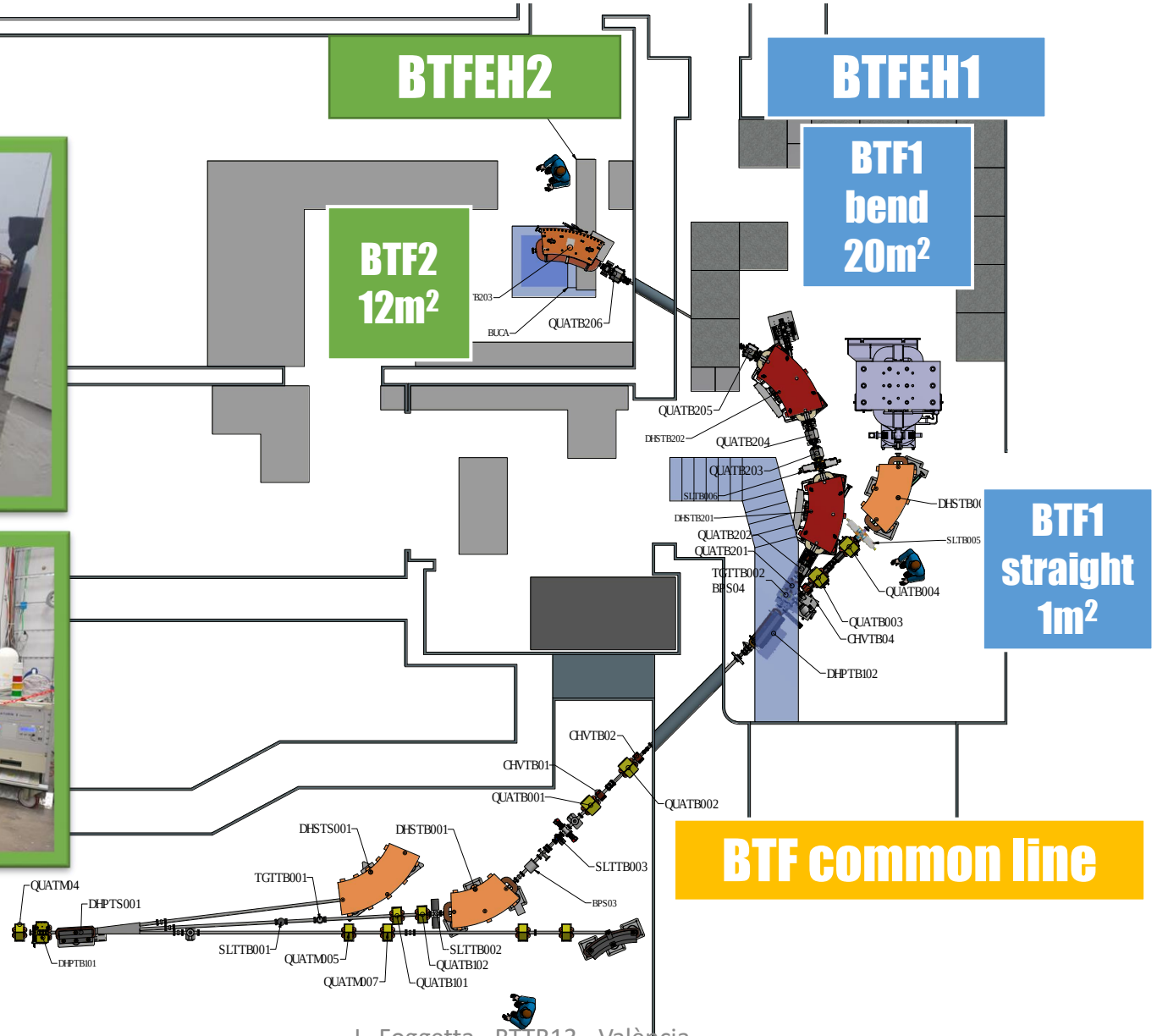
More at https://btf.lnf.infn.it

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^+ / e^- (User)	e^+ / e^- (DAΦNE status)	e^+ / e^- (User)		e^+ / e^- (User)	
Energy (MeV)	25–500	510	25–700 (e^-/e^+)	160–700 (e^-) 250–550 (e^+)	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)	1–10^5 (Energy dependent)	10^3 to 10^{10}	1–10^5 (Energy dependent)	1 to 10^{10}	1–10^4 (Energy dependent)	
Max int flux	$3x10^{10}$ part./s				$1x10^6$part./s	
Exit Beam waist size (m1, mm)	0.5–55 X / 0.35–25 Y (vacuum window dependent)				0.4x0.4(Energy/mult dependent)	
Divergence (mrad)	Down to 0.5				Down to 0.5	



- **Pulsed** (1.5 – 300 [ns]) **electron** and **positron** beams, both **primary** and **secondary** ones
- **Rep rate** up to 49 [pulses/second]
- Wide range: from **10^10 [p/s]** down to **single particle** per shot, continuous energy selection where in secondary beam delivery

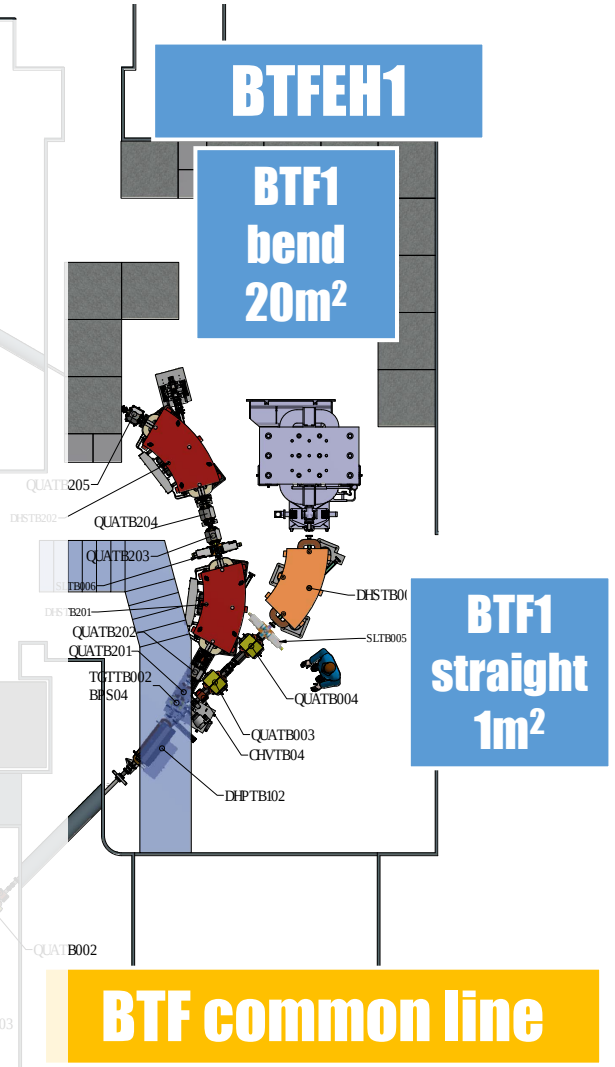
OVERVIEW OF THE EXPERIMENTAL HALL



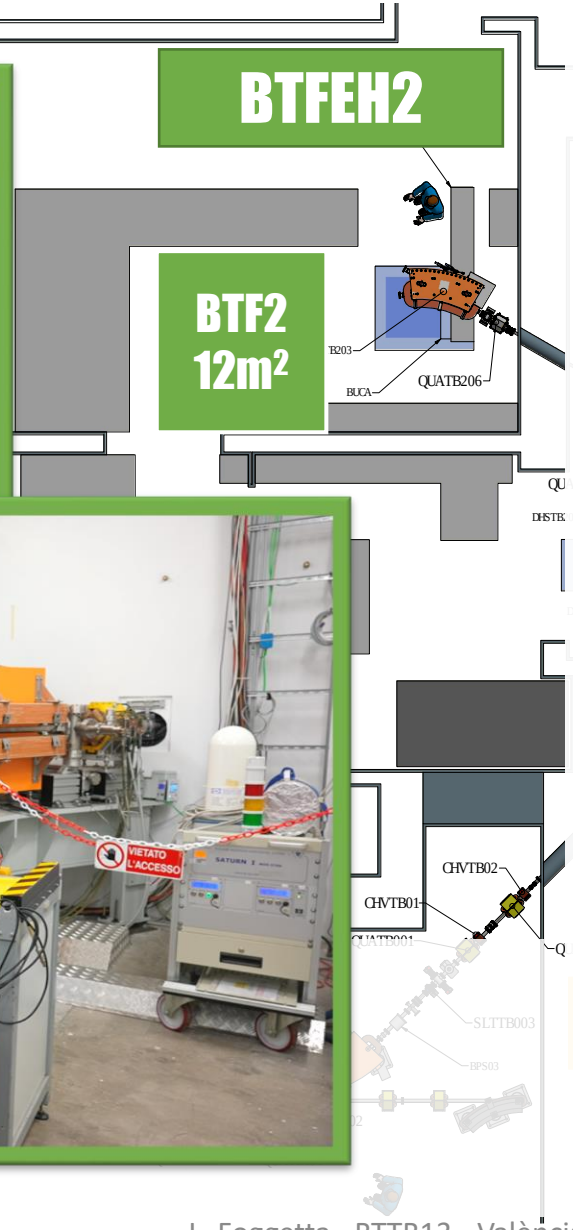
OVERVIEW OF THE EXPERIMENTAL HALL

BTFEH1 – BTF1 (2 lines)

- **Primary beam experiments, secondary ones too**
- Hosting big experiment layout
- Involved in internal/opportunistic INFN runs
- FLASH-VHEE community expressed high interests for beam quality and structure
- 2025 running for PADME/X17 experiment



OVERVIEW OF THE EXPERIMENTAL HALL



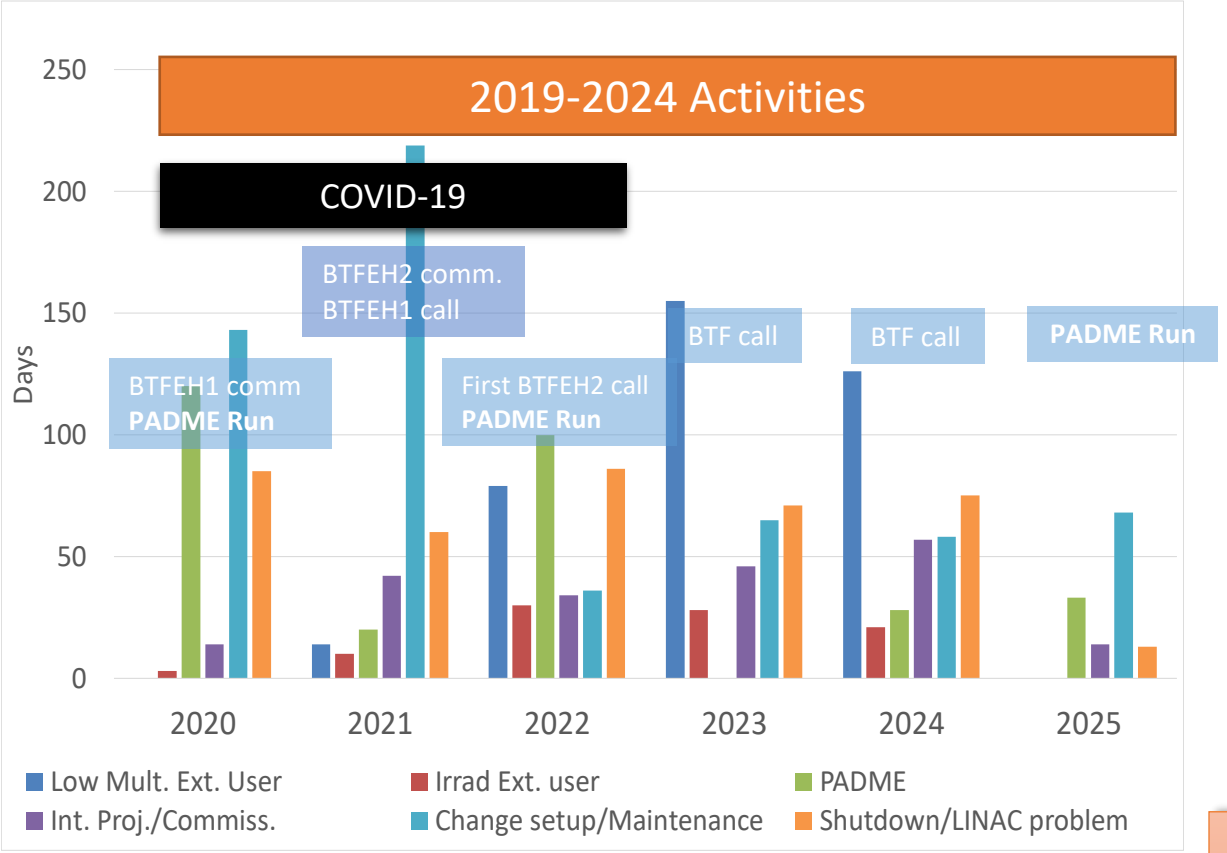
BTFEH2 – BTF2 (1 line)

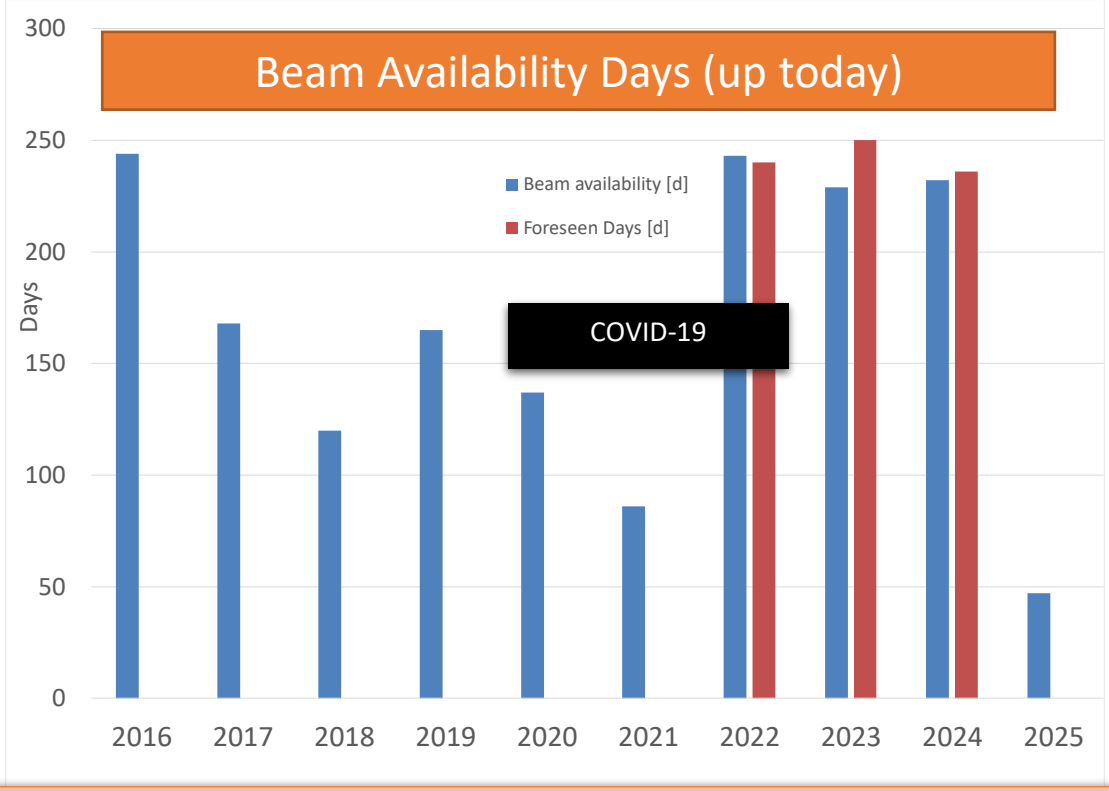
- **Only secondary beam**
- Hall operative from 2022
- Currently BTF2 line to external users
- Intended for weekly based users
- Upgraded performances – 0.4x0.4mm^2 at BTF2 Exit window
- 2024 around 90% beam time
- 2025 mostly in Standby

LNF – BTF NUMBERS

2024 BTF mostly used for:

- Space detectors test and calibration
- HEP detector developing
- FLASH-VHEE detector calibration

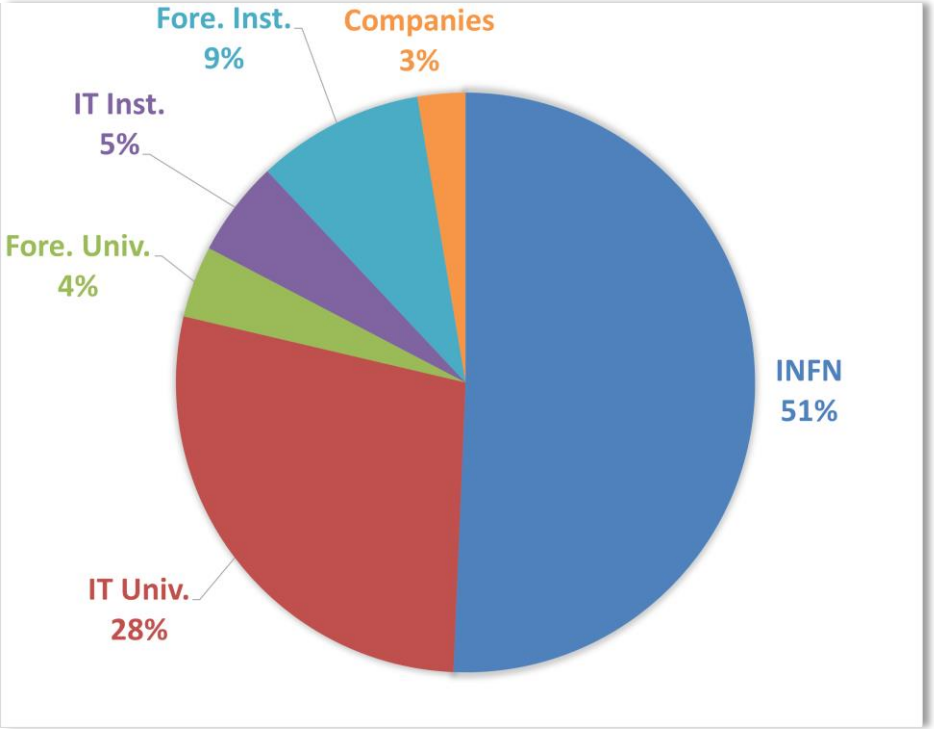


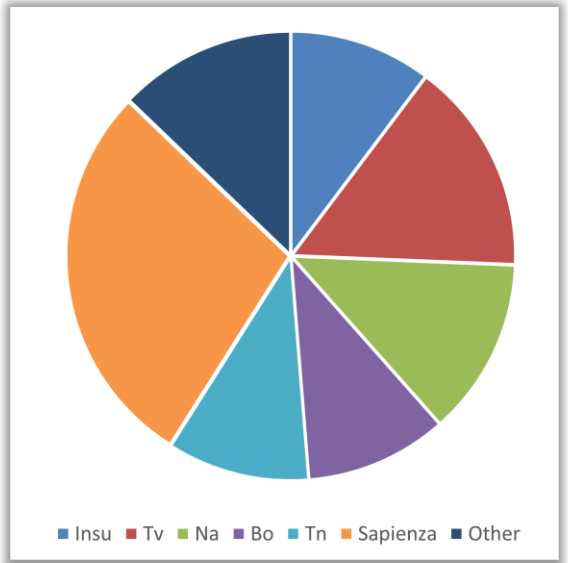


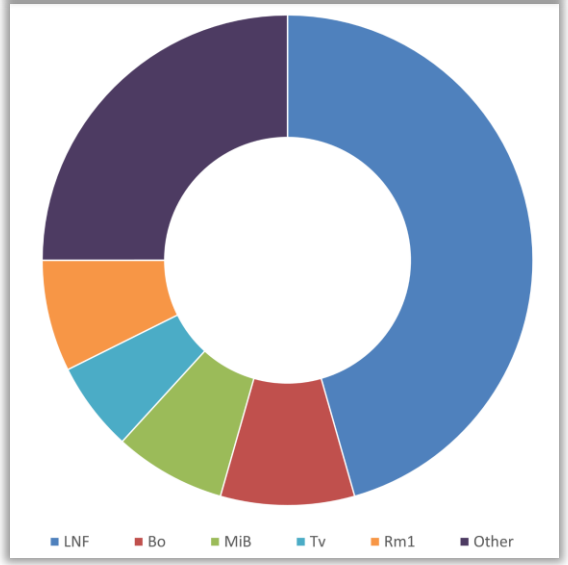
2024 Beam availability days = 232 (done)/236 (foreseen)
Shift average time = 6,5d, Converted withdrawal = 3
Average team member number = 7, Overbooking = 4

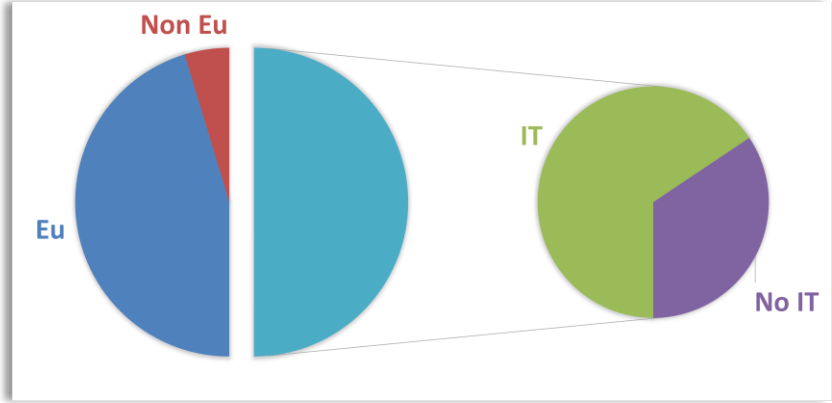
LNF – BTF NUMBERS

2022-2024 Involved Institutions



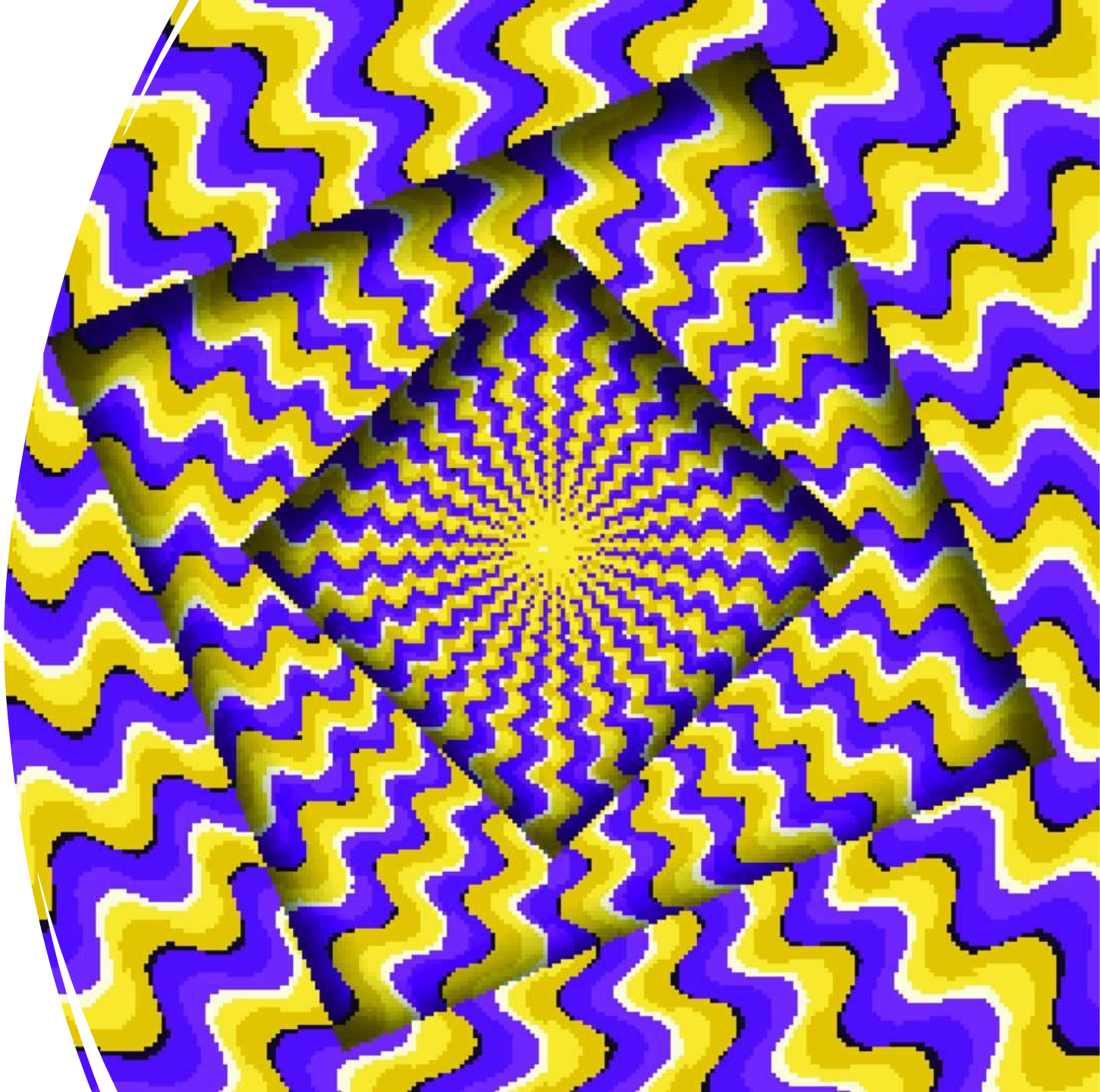






- **Large collaborations**
- 50% for INFN, 25% for LNF
- Good Regional Equalization Between IT Institutions
- Increased prevalence of non IT University and more INFN sites in the last years

BTF BEAMs



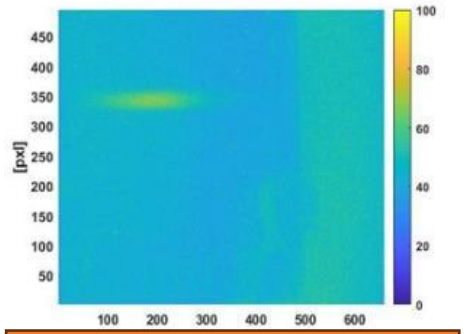
BTF PRIMARY AND SECONDARY BEAMS

LINAC Conditioned Primary Beam

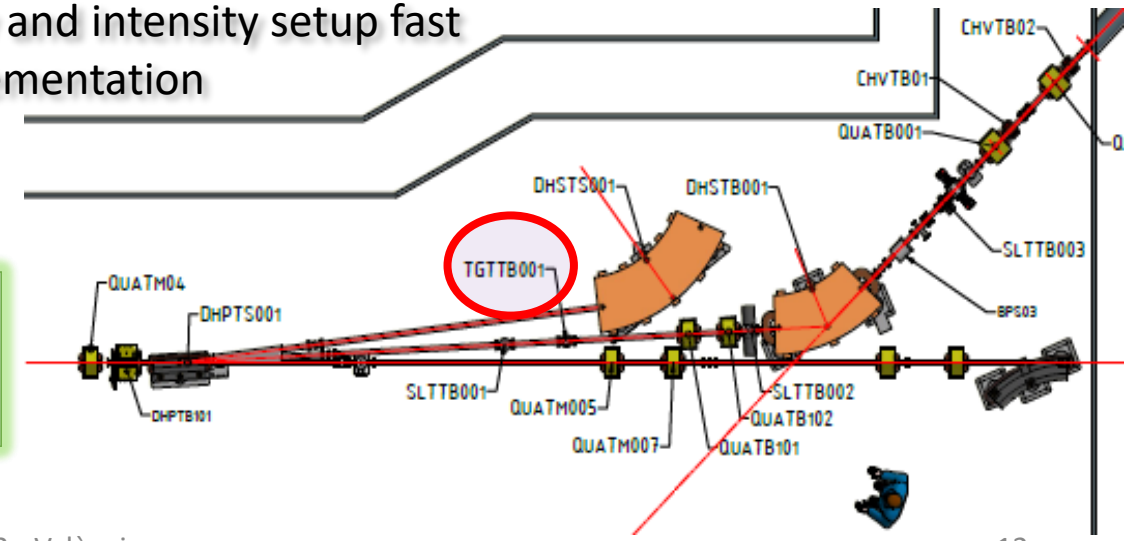
- Fixed energy
  - Steering and transverse tuning, energy setup longer implementation
- High current
  - from DAΦNE inj current
  - Tunable in 10 order of magnitude (dedicated mode)

Cu-Target in the middle

- RUN time Tunable energy
  - All energies from $E_{primary}$ to ≈25 MeV
- RUN time Tunable multiplicity
  - From max(E) to single particle per shot
- Particle type decoupled from LINAC production
- Both energy and intensity setup fast implementation



510MeV, prim. e+ beam, OTR, BTFEH1 - BTF triggered cam

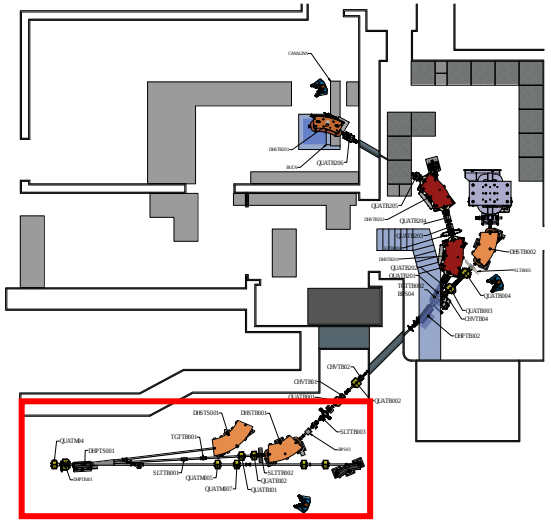


- Parameters setup **via LINAC and BTF scrapers/magnets**
- Final focus, multiplicity, energy (now, pulse length) **as user needs**
- **All parameters manageable during data taking**

BTF PRIMARY BEAMS

- Fixed Energy (Straigth forward from the LINAC)
- Multiplicity (current) selection (Scrapers)
- Spot transverse dimensions (Scrapers, Quad for final focus)
- Matching angle and position in the DUT (Dipoles and Correctors)
- Maximum allowed intensity ≈ 10^10 prim/sec, only in BTFEH1

Normal way of thinking

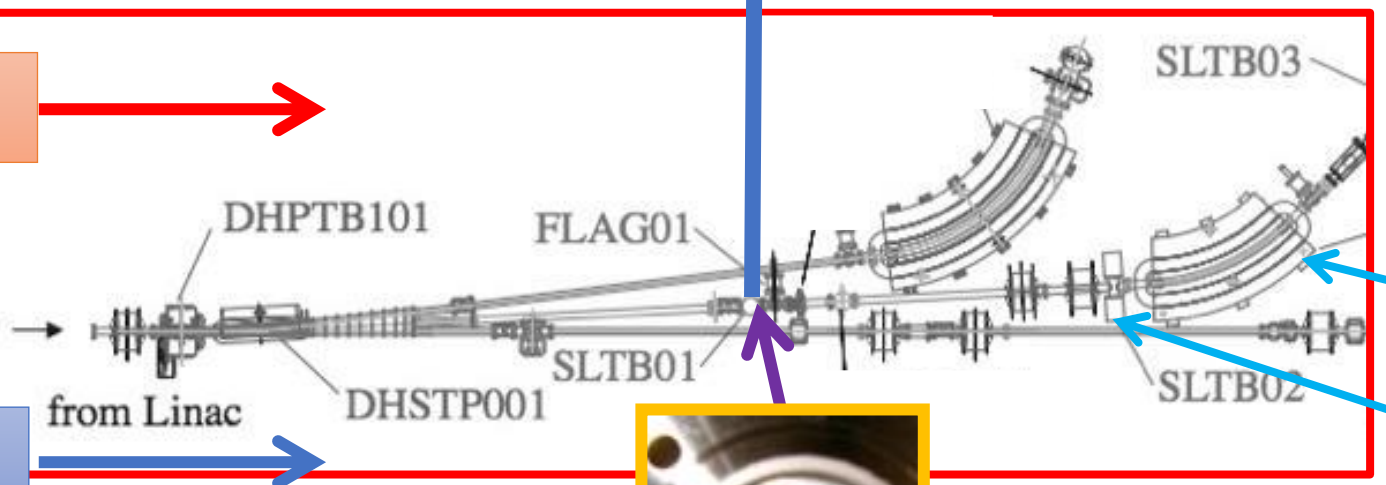


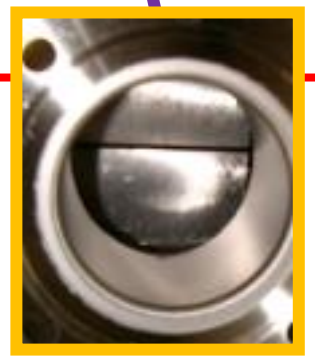
PRIMARY

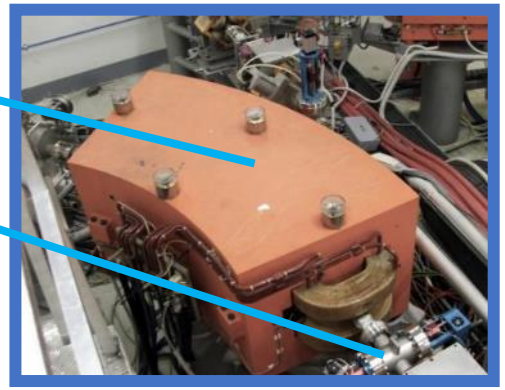
PRIM conditioned

Positron Beam
6×10^{9} e^{+}/bunch

Electron Beam
1×10^{10} e^{-}/bunch



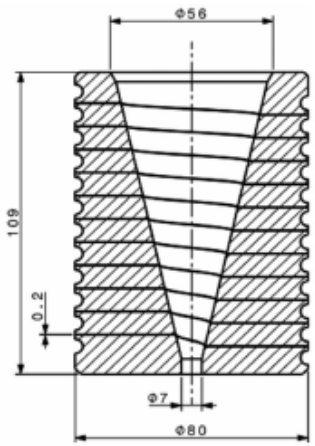


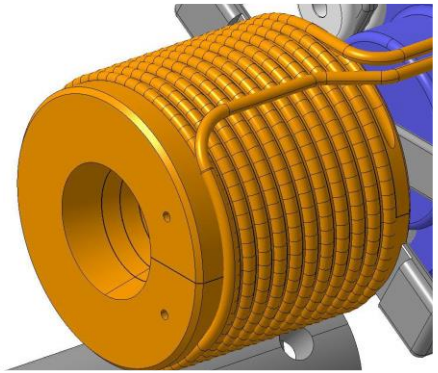


BTF TARGETS: SECONDARY BEAMS

LINAC positron converter

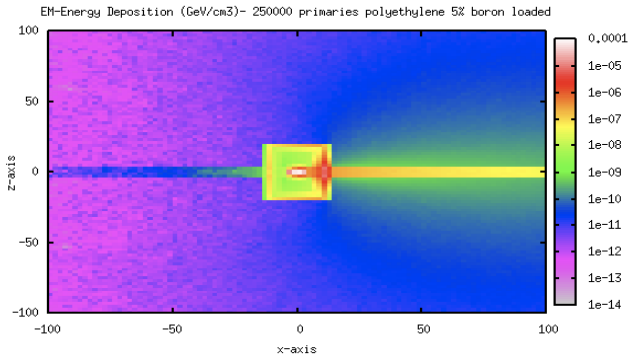
- Target: tungsten (Z=74)-rhenium(Z=75), L=2 x_0
- **Positrons by pairs production**
- **Active capture** via Flux Concentrator (5 T peak), jointly with DC solenoid magnets.

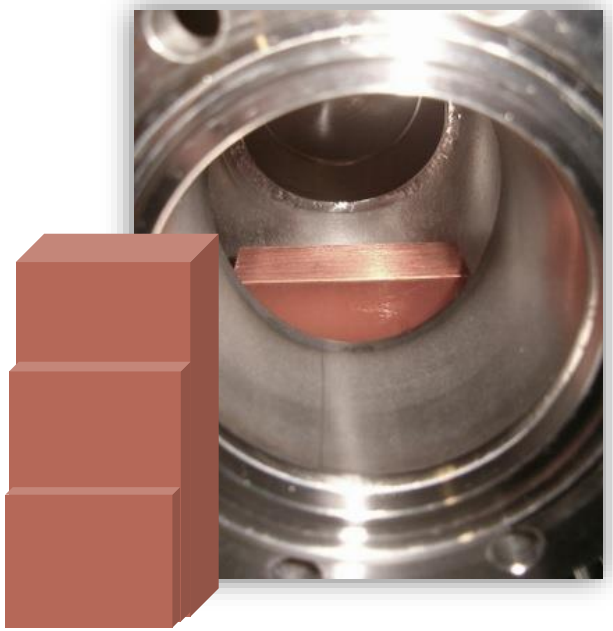


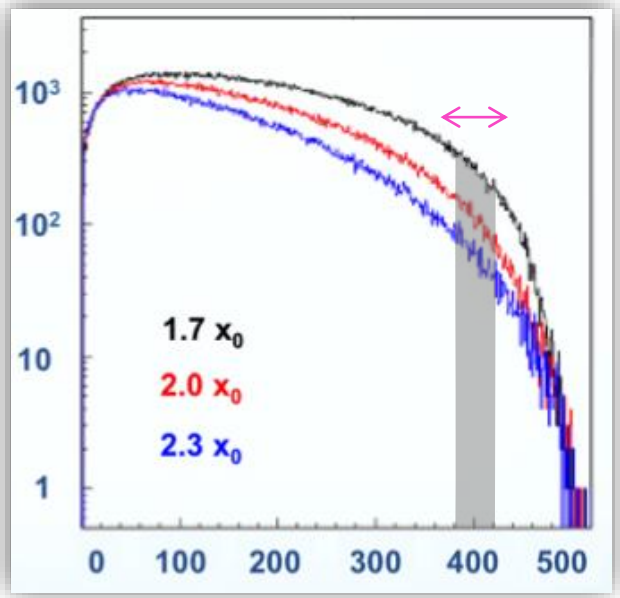


BTF target

- Copper (Z=29) variable depth (1.7, 2 or 2.3 radiation lengths)
- **Positrons selection by pairs production and de/dx**
- **Passive Capture** (scrapers and quads)
- Selection in energy with (DHSTB001) and scrapers
- Copper critical energy ≈ **19 MeV**
- Not so far from the less energetic BTF tuned beam (25MeV)







BTF SECONDARY BEAMS

- 8x single-axes SCRAPERS
- LINAC Energy is different to BTF energy
- TARGET!!!!

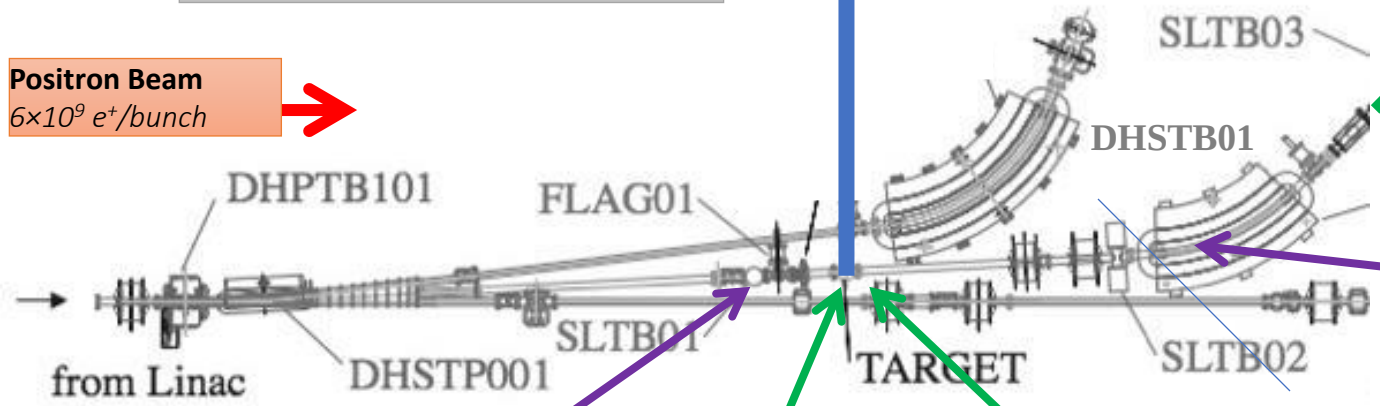
PRIMARY

SECONDARY

BTFEH1
BTFEH2

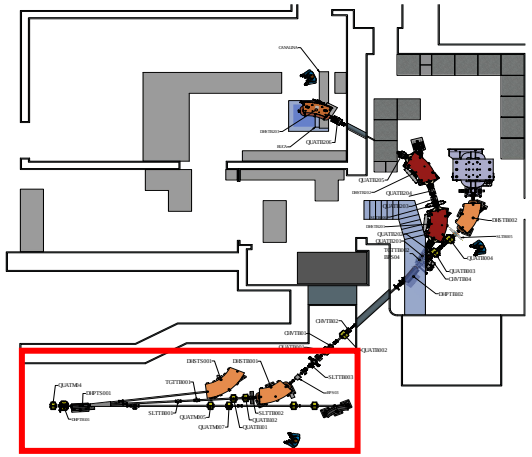
Positron Beam
6×10^9 e^+/bunch

Electron Beam
3×10^{10} e^-/bunch



DHSTB001
- Selects energy
- Steers

Is a spectrometer!



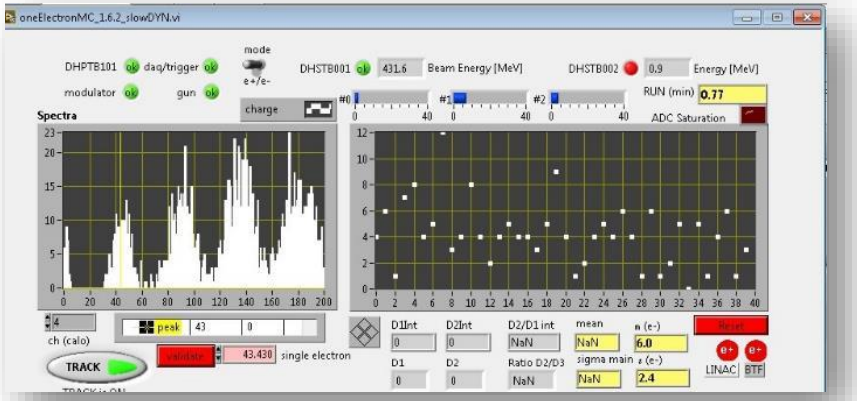
Relation:
- **Copper target** in the middle
- **Energy and related spread** selection (Scrapers,Dipoles)
- **Multiplicity selection** (Scrapers,Dipoles)
- **Transverse** (Scrapers, Quad, Dipoles)

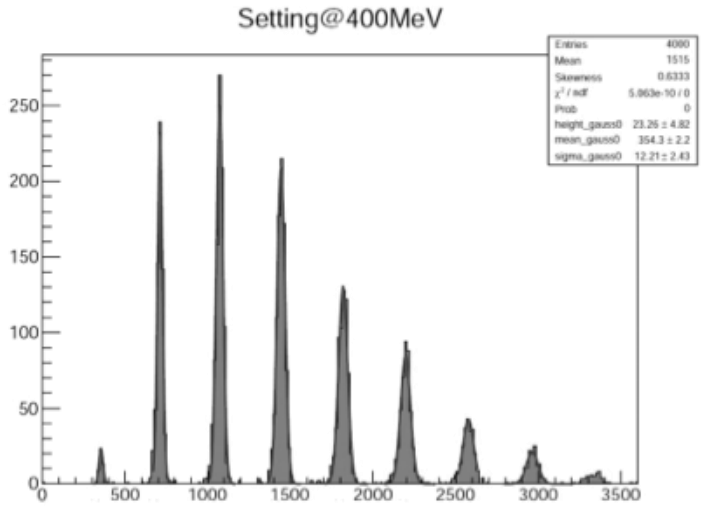
Dipoles and Steering to match angle and position in the DUT

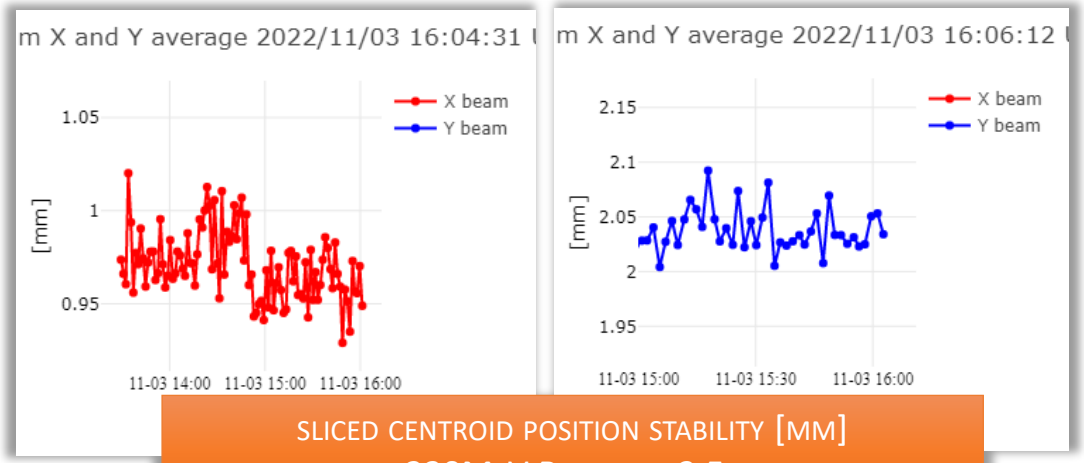
INTENSITY TUNING: BTF SECONDARY BEAMS

Secondary beam, single particle to 10^4 per shot, energy dependent

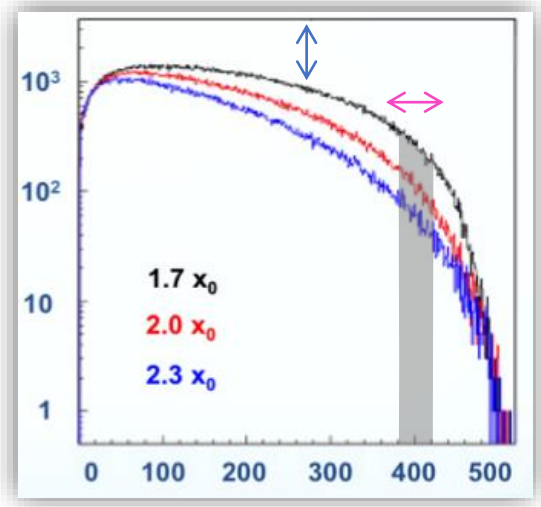
- Primary beam is attenuated by the copper target
- Secondary (even tertiary) is also generated
- Starting from primary beam energy down to 25 MeV
- **Multiplicity as Poissonian distribution with average multiplicity, selectable up to *the secondary energy spectrum accepted by the line (scrapers)***
- **Selectable** positrons or electrons , **independently from LINAC**







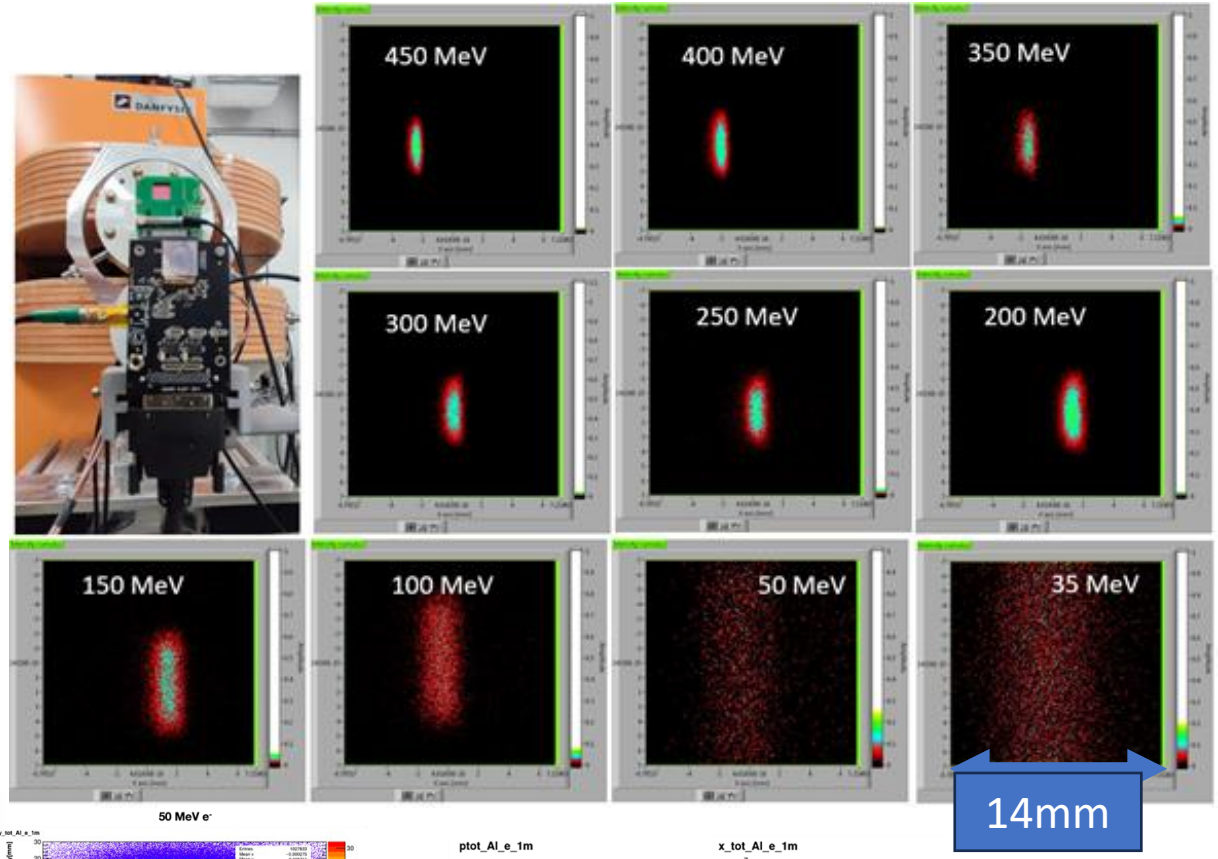
SLICED CENTROID POSITION STABILITY [MM]
230MEV BEAM, M=2.5K

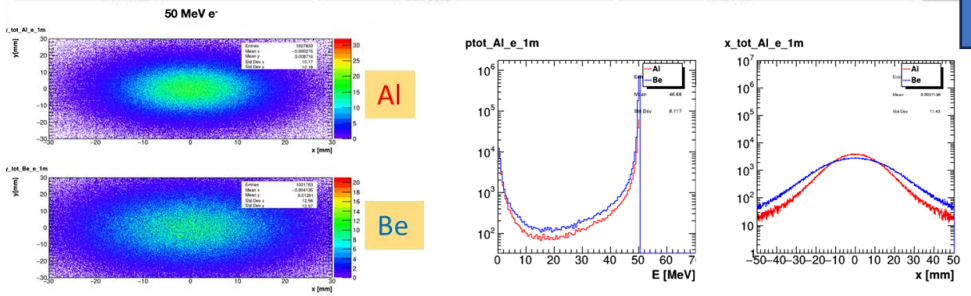


→ thus allowing a **very fine tuning of the beam** intensity and energy in a matter of **seconds, runtime, by users**

ENERGY/SHAPE TUNING: BTF SECONDARY BEAMS

BTF-2 Vert. Beam example

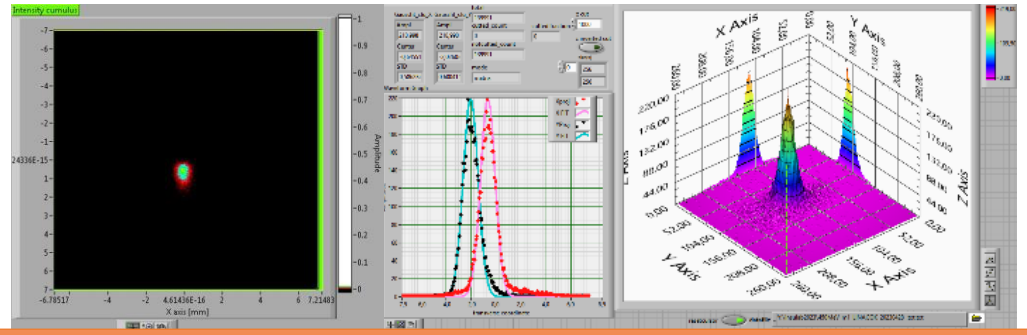




Low Energy Secondary (<50MeV) beams experiences:

- **DAC limits on magnets PS** (on energy selection O(100KeV))
- **Exit windows** for multiple scattering and photons generation:
  - BTFEH1-S 50um, Ti
  - BTFEH2 120um, Al
- Energy specific emittance from BTF target (secondary beam from positron primary ones affected too)
- Beam Profile Sigma => shot by shot precision

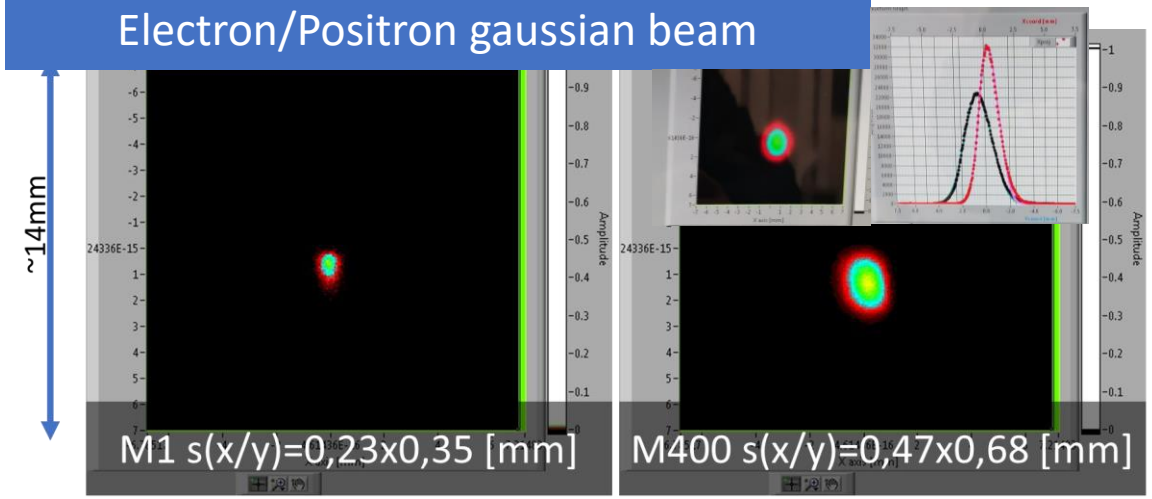
=> BTF minimum energy set around 25MeV, on lower no reasonable energy spread, multiplicity…



450MeV, 0.2x0.35mm^2, SINGLE PARTICLE ELECTRON (LEFT)
CUMULATIVE PLOT, REP RATE 20HZ, ~2H EXPOSURE

BTF2 NOT/GAUSSIAN BEAM

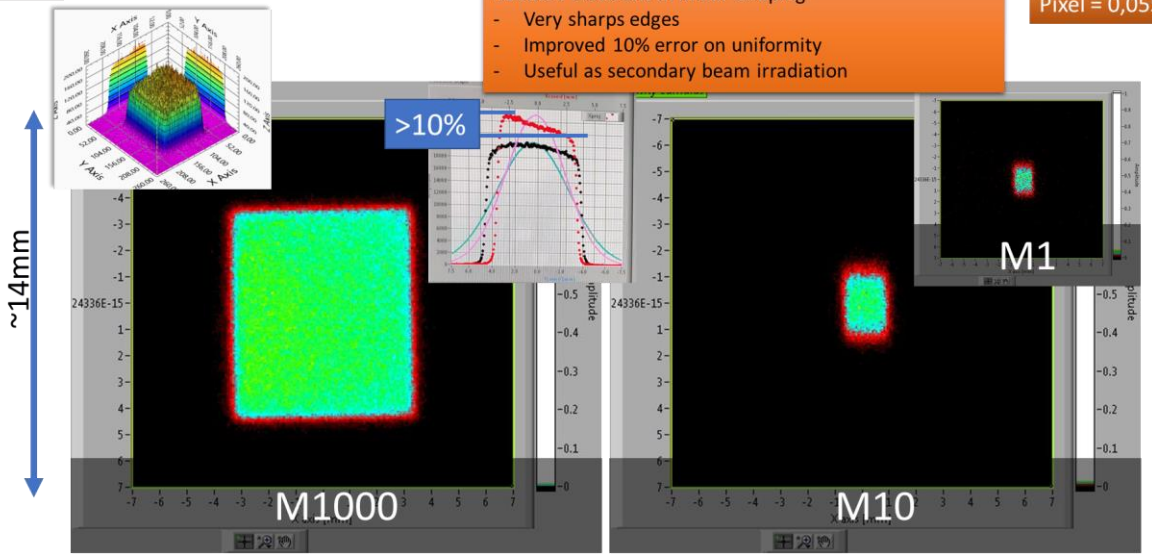
Electron/Positron gaussian beam



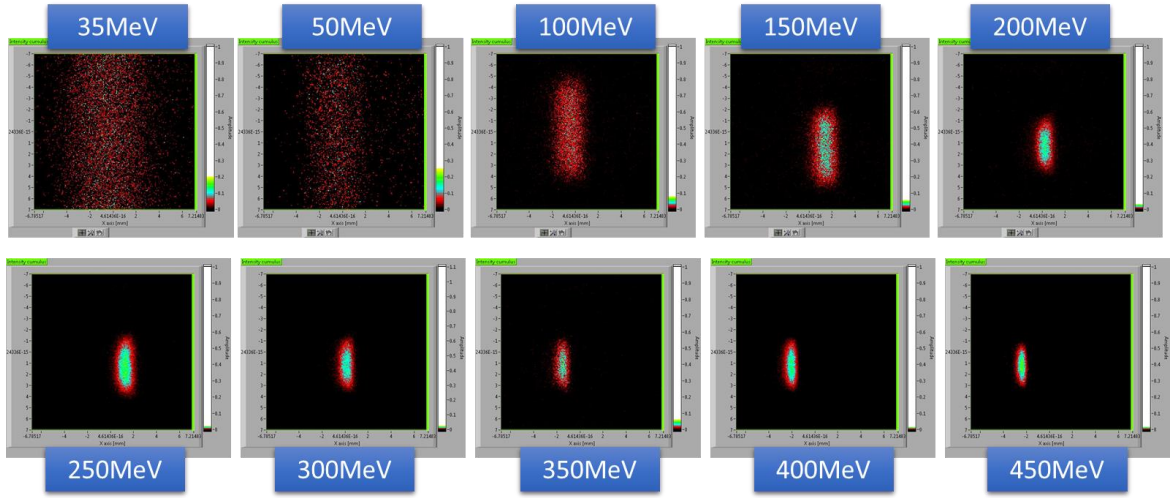
BTF1S – BTF2

450MeV electrons in linear scraping
- Very sharps edges
- Improved 10% error on uniformity
- Useful as secondary beam irradiation

Timepix Detector
Pixels = 256x256
Pixel = 0,055um

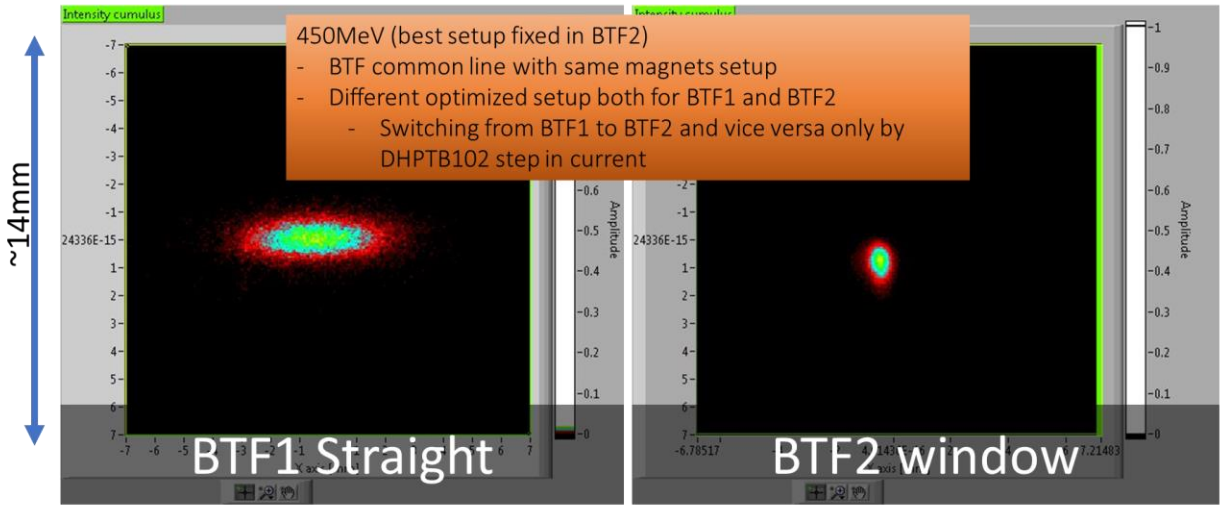


Beam BTF2 – Electron Beam energy set



Best Beam Common transport BTF1/BTF2

450MeV (best setup fixed in BTF2)
- BTF common line with same magnets setup
- Different optimized setup both for BTF1 and BTF2
  - Switching from BTF1 to BTF2 and vice versa only by DHPTB102 step in current

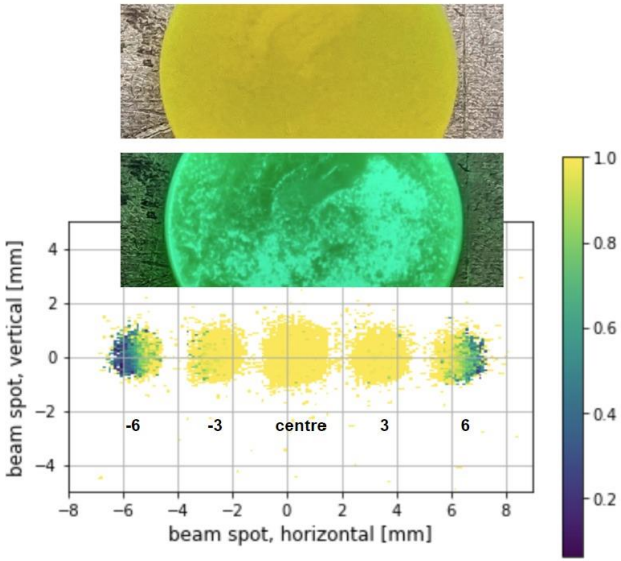


BTF2 SP BEAM STABILITY

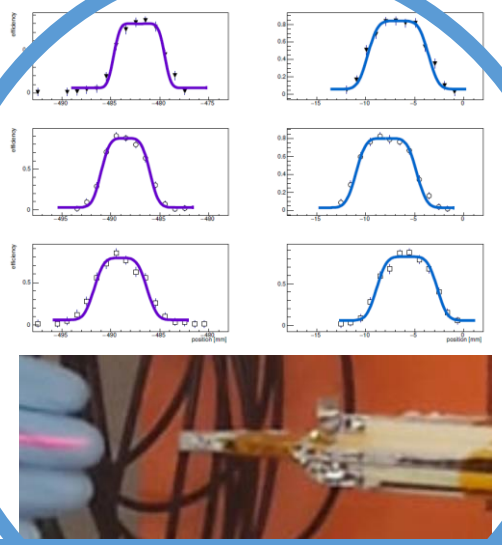
NANOCAL – Nano Crist Scintillator developing

(M. Soldani (LNF-INFN) et al.)

NanoCal aims to develop fine-sampling, large-volume calorimeters for next-generation experiments using innovative scintillating materials made from perovskite or chalcogenide nanocrystals in a plastic matrix to create a nanocomposite scintillator



- Study charges collected by SiPM coupled with samples



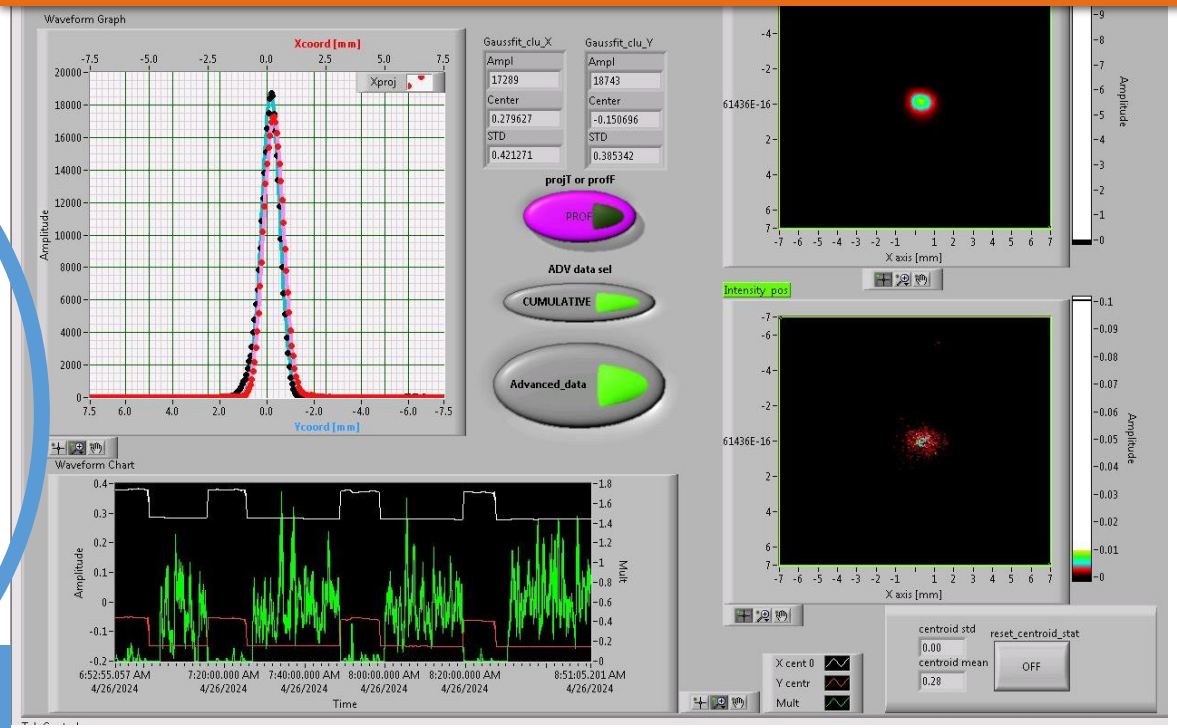
2023 KLOE2-HET (C. Bloise et al.) 100um sensitivity sampling

BTF beam for **sub mm detector spatial sensitivity reconstruction**

BTF BEAM single particle STABILITY

5 days long measure

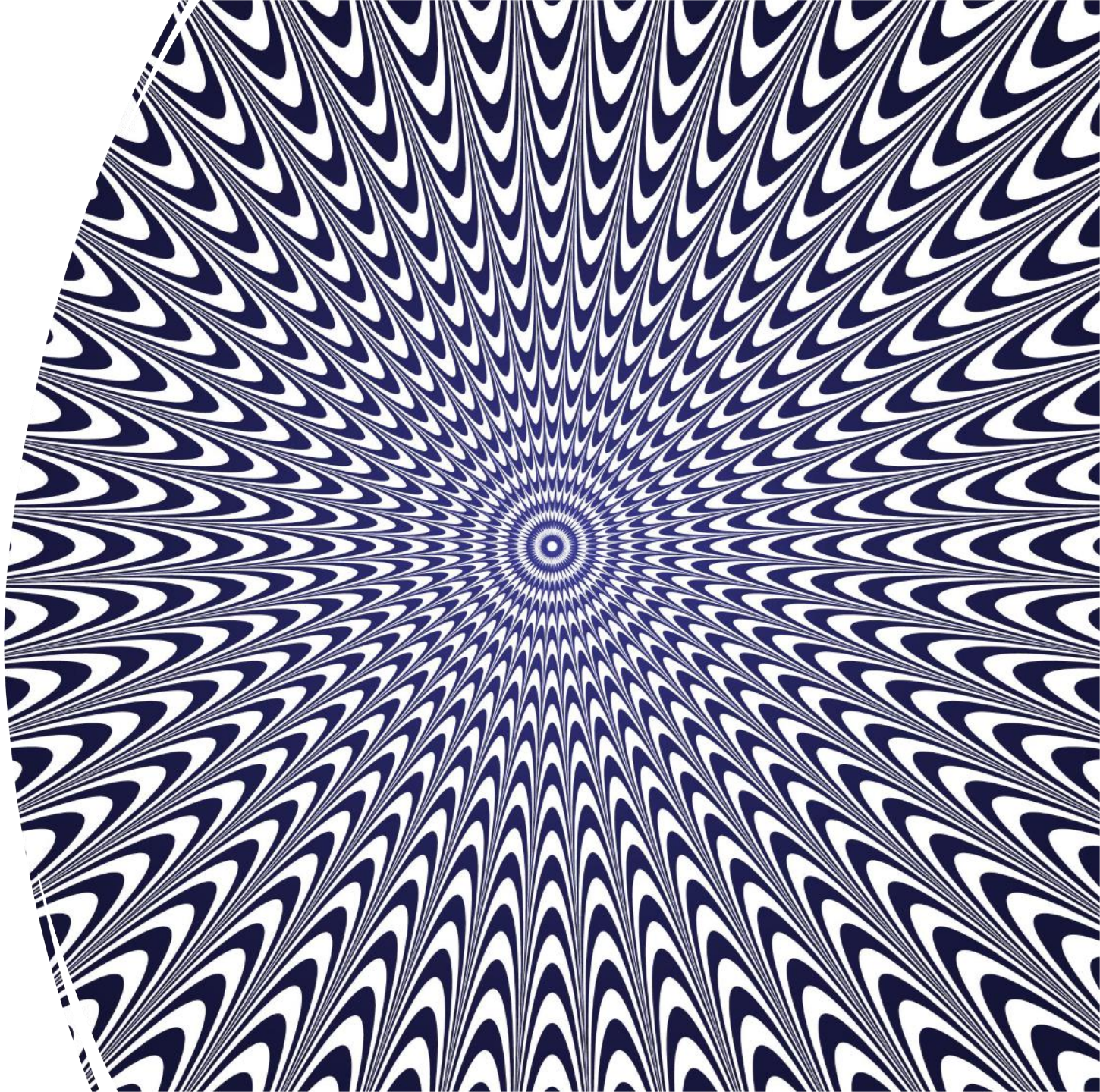
- >600k events single particle (l poiss=0.8) for single run
- $3x10^6$ SINGLE PARTICLE EVENTS – 15 hall entrances with full dipoles cycling



BEAM sigma is actually shot precision

450MeV , m1, electrons

BTF FOR USERS



BTF CALL FOR PROPOSAL

Quarter of the year	Opening Proposal submission	Last day for proposal submission	PAC decision and Final Calendar settling	Beam time 1st slot	Beam time last slot
Q1->3	Beam time 1st slot – 5M	Beam time 1st slot – 1,5M	Beam time 1st slot – 1M	Half of January	Half of July
Summer maintenance, SHUTDOWN, Restart and calibrations					
Q4	Beam time 1st slot – 5M	Beam time 1st slot – 1,5M	Beam time 1st slot – 1M	Half of September	Christmas-1W
Winter maintenance, SHUTDOWN, Restart and calibrations					

Step of decision for proposal selection

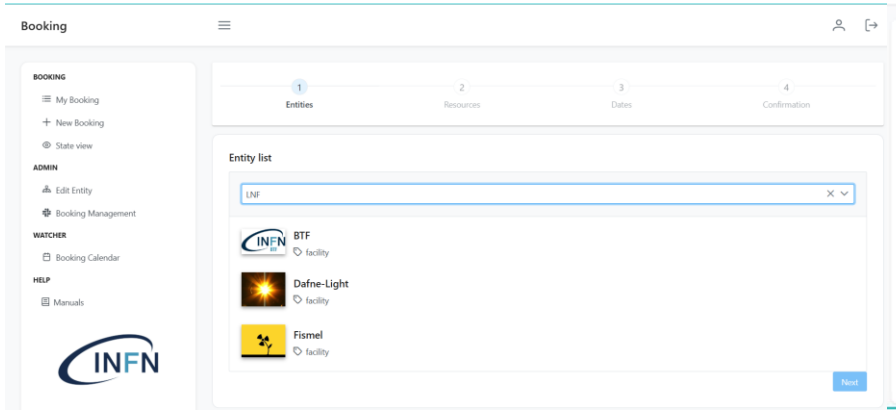
- Technical evaluation (by BTF management)
- PAC evaluation (https://btf.lnf.infn.it/dafne-btf-committee/)

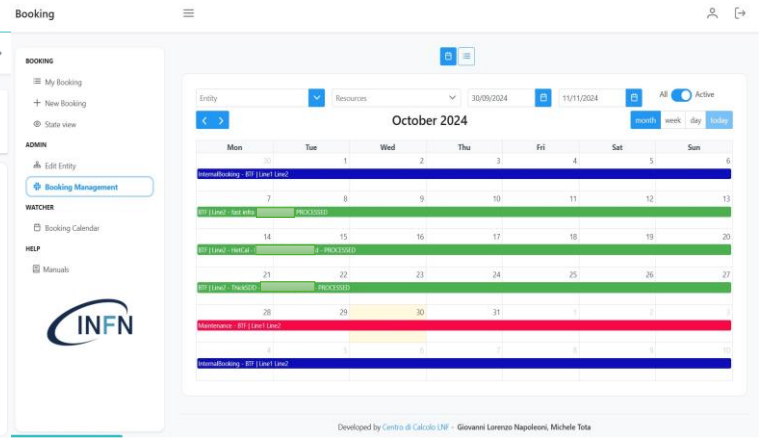
Operational Schedule

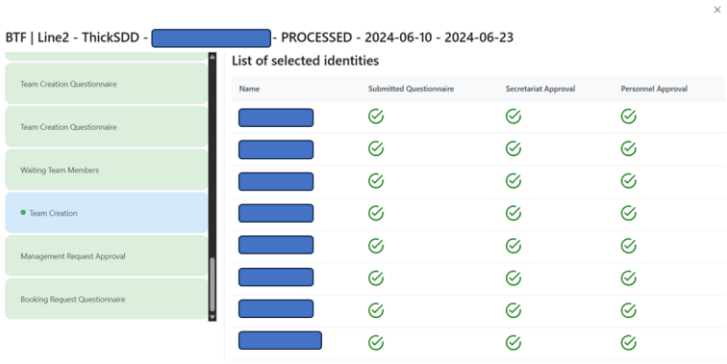
- From Monday at 12:00 PM to the following Monday at 12:00 PM, the facility operates in 24/7 mode for one full week per experiment

BOOKING SW

Booking BTF: BTF booking management software based on an automated approval workflow software. Call management.







- **User Guidance** for open view calendar selection (as the same-name one) via GUI
- **Proposal submission** and related necessary information/document upload
- **User oriented workflow** -> every team member as specifc area, team leader know real-time status of their approval
- <u>**Workflow steps and email dispatching** (reminders too) and due dates clearly showed, traced and logged</u>
- **Advance management** via role attributes -> approval actions
  - Beam Line Scientist
  - PAC
  - BeamLine Manager
  - Infrastructure Manager
  - Secretariat
  - Team Leader

BTF SERVICES TO USERS

BTF Services at user disposable (following an handshake) in Experimental Halls/Control Room

Networking
- BTF dedicated VLAN at 10Gb-1Gb single endpoint
- DHCP Server (on DHCP auto endpoint)
- Proxy for web access
- LNF INFN VPN External connection (for registered users)
- BTF Live Diagnostics on:
  - MemCached (key-value)
  - EPIK8S (PV)

GAS feeding pipelines and related safety system
- BTFEH1, standby, 4 lines (2x inflamm, 2x inert)
- BTFEH2, 2 lines (2x inert)

Power supply, crates, boards
- CAEN5527 crates and multiple HV boards type
- VME/NIM crates and commonly used boards on pool

Logistics
- Trolley tables (100um rep., 200kg max load)
- Sliders, mounting kits

Detectors, DAQ, Data delivery
- TPX, ICT, Calorimeter, Flags and Triggered Cameras
- VME based (QDC, TDC, Scalers…)
- LC8108 scope (8Ch's,5Gsam/s, 1GHz BP)
- EPIK8S triggered cams online data analysis
- EPIK8S Grafana online data monitoring
- C/C++/Python BTF API for users DAQ integration

Triggering
- Digital delay, particle type latching, finger triggering

Related Lab Services
Electrical, Fluids, Compressed Air, Safety, Logistics, Engineering

BTF SERVICES TO USERS

BTF Services at user disposable (following an handshake) in Experimental Halls/Control Room

Networking
- BTF dedicated VLAN at 10Gb-1Gb single endpoint
- DHC
- Pro
- LNF
- BTF
  -
  -

GAS fe
- BTF
- BTFEH2, 2 lines (2x inert)

Power supply, crates, boards
- CAEN5527 crates and multiple HV boards type
- VME/NIM crates and commonly used boards on pool

Logistics
- Trolley tables (100um rep., 200kg max load)

Triggering
- Digital delay, particle type latching, finger triggering

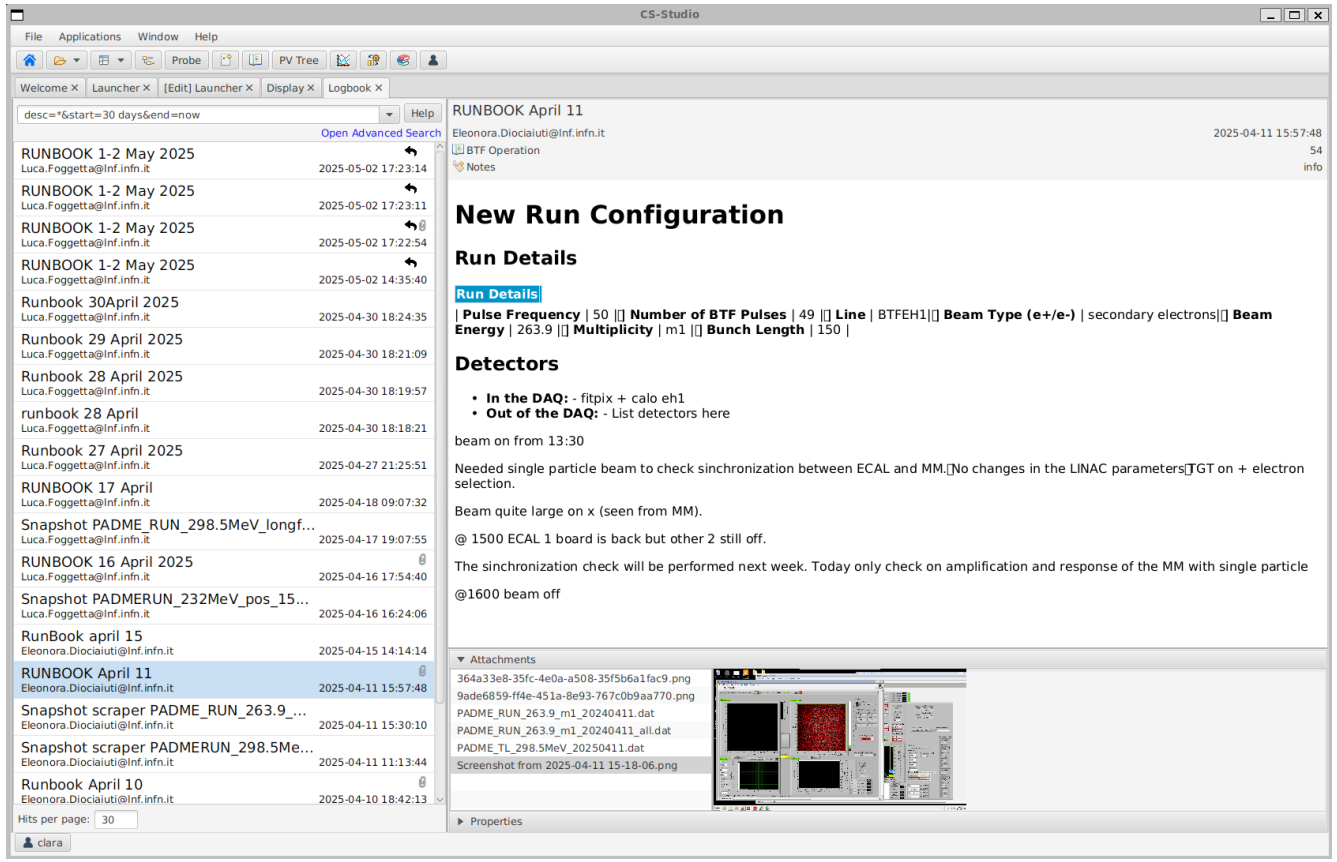
Related Lab Services
Electrical, Fluids, Compressed Air, Safety, Logistics, Engineering

Most important: keep in touch with users
- Pre-run experiment developing
- Run-time 24/7 beam line scientist
- Post-run assistance

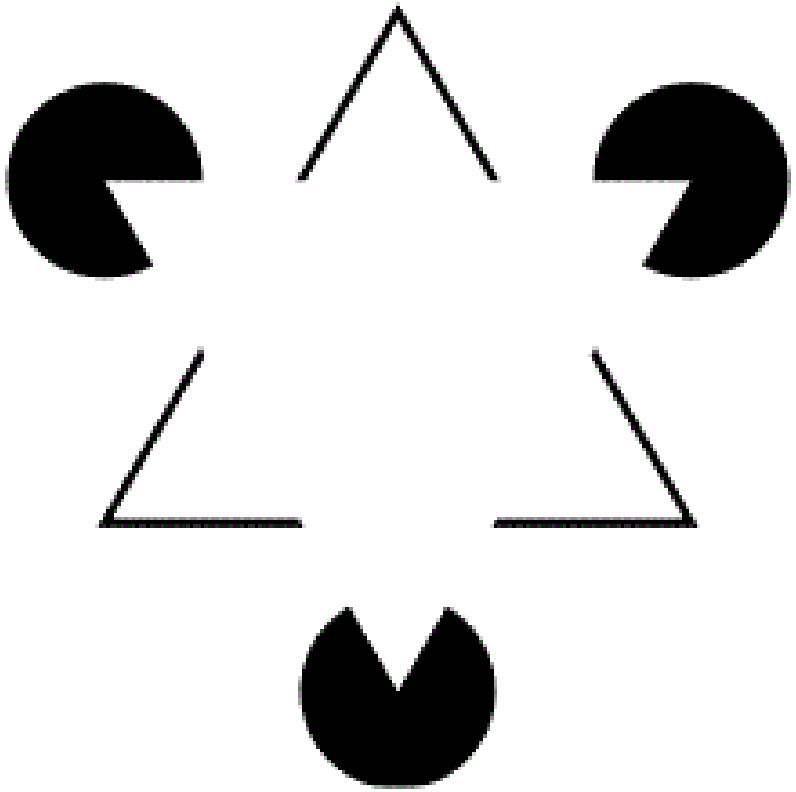
OLOG LOGGING

* Work presented @ 2025 **EPICS collaboration Meeting**

- OLOG (Online LOGbook) is a web-accessible electronic logbook, based on the EPICS controls system.
- It supports image attachments, time-stamped entries, and metadata tags.
- These tools enhance the reproducibility and efficiency of experimental operations, offering an essential resource for both users and facility staff.
- Based on feedback from the BTF team, the system has been **gradually adapted by the Control Service (A. Michelotti) and the SICR (G. L. Napoleoni),** to meet the facility's specific operational needs.
- **Released for also for users**: user operation tracking and data retrieving offline (for post run consulting)
- OAuth2 login (INFN AAI)



BTF Projects



Project lasting 2025-2027

ASIF – an ASI, ENEA, INFN, UniMiB project with INFN TT

Goal

- Create a national network to support customers and scientific research on radiation hardness assessment for space projects

Exploits

- Top-notch research labs and irradiation facilities
- Shared strategic vision from ASI, ENEA, INFN, UniMiB
- Dedicated professionals

Commitments on WP1500

Calibration activities of space detectors with electron beams, exploiting the specific temporal and energetic properties of the BTF.

Feasibility study of irradiation campaigns and radiation damage measurement with electron beams on space components (electronics and sensors).

Maintenance and updating of the test facility and systems for measuring the intensity and fluence of test beam particles

This work was supported by the ASI-INFN Cooperative Agreement 2024-21-HH.0: "ASIF – ASI Supported Irradiation Facilities, Sviluppo Operativo."
L. Latronico

ASIF NETWORK

Facility / Service	Managing Institute	Product	Application / Rad Test	Status in ASIF
BTF - LNF	INFN	e (25-700 MeV), up to high intensity	TID, TNID	joining
TIFPA	INFN	p (70-235) MeV, high intensity	TID, SEE	joining
LNS	INFN	p, ions (up to 60 MeV*cm2/mg)	TID, SEE	joining
LNL	INFN	Light ions, large area and current, heavy ions (up to 180 MeV*cm2/mg)	TID, TNID, SEE	joining
LABEC	INFN	Mass spectroscopy, 14C, ion beam analysis	Chemical composition	TBC
Calliope	ENEA	Gamma (60Co)	TID	joined
FNG	ENEA	n (14MeV, 2.5MeV)	DD	joined
TAPIRO	ENEA	Fast n	DD	joined
TRIGA	ENEA	Thermal n	DD	joined
TOP-IMPLRT	ENEA	p (7-55 MeV)	TID	joined
REX	ENEA	e (up to 5 MeV)	TID, TNID	joined
TECHEA	ENEA	e (up to 3 MeV)	TID, TNID	joined
Gateway	UniMiB	Web portal, dose simulators	Entry point, support	joined

All research infrastructures largely used for detector calibrations and particle / nuclear physics dedicated experiments

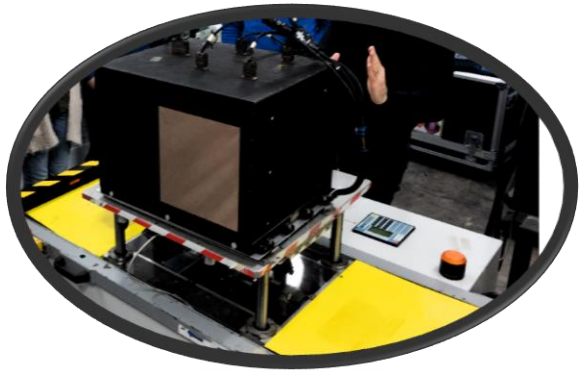
SPACE MISSIONS

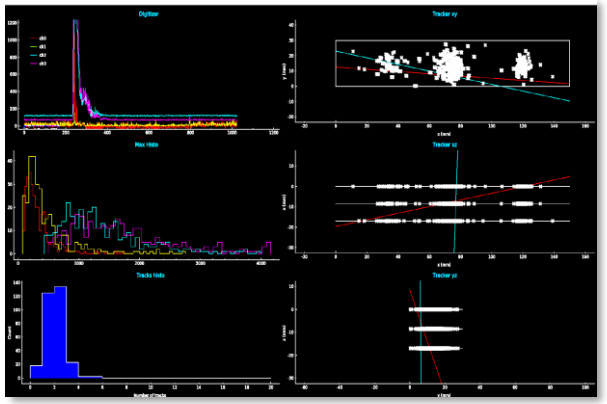
HEPD CSES LIMADOU – (SPACE Appl)

Prototype: LIMADOU is part of a scientific program that studies natural and anthropogenic electromagnetic fields, their emissions and possible correlations with seismic events.
https://w3.lnf.infn.it/experiments-in-btf-orbit/?lang=en

Run with dedicated 30MeV- single particle beam

The main purpose of the test: check tracker efficiency in track reconstruction with single-particle electron beams at different energies (from 30 to 120MeV) were produced to characterize the response of the apparatus to natural events, similar events that will occur along the satellite's orbit



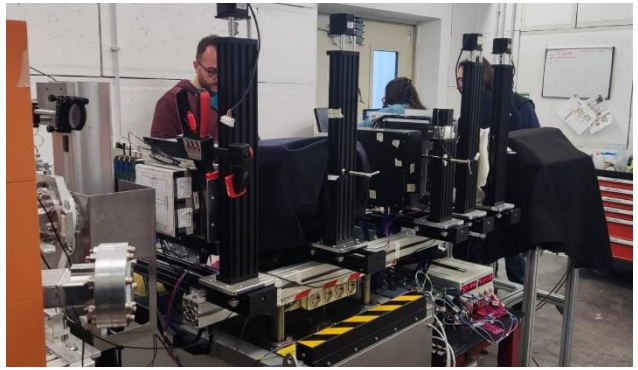


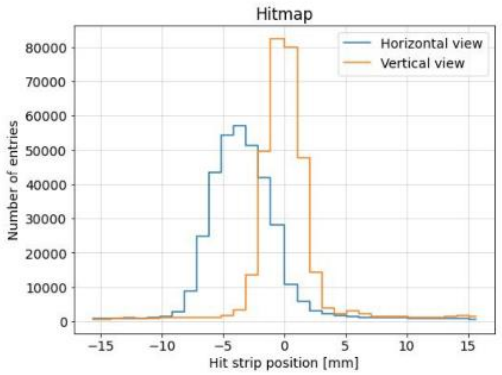
ZIRETTINO – (Space Appl)

Zirettino is a prototype of Ziré which is parte of the NUSES space mission and will detect Cosmic Rays with energies from few up to hundreds of MeV

BTF Beam from 450 to 50 MeV few particles regime in a impressively dense setup

Firsts operative test with FTK+LYSO cubic crystals @ lower energies (different energies, m1, electrons), multiple apparatus test, developed directly in the BTF EH, fiber tracking calibration and test.





BTF TRANSNATIONAL USER ACCESS

To get informed about BTF experimental call opening, please check:

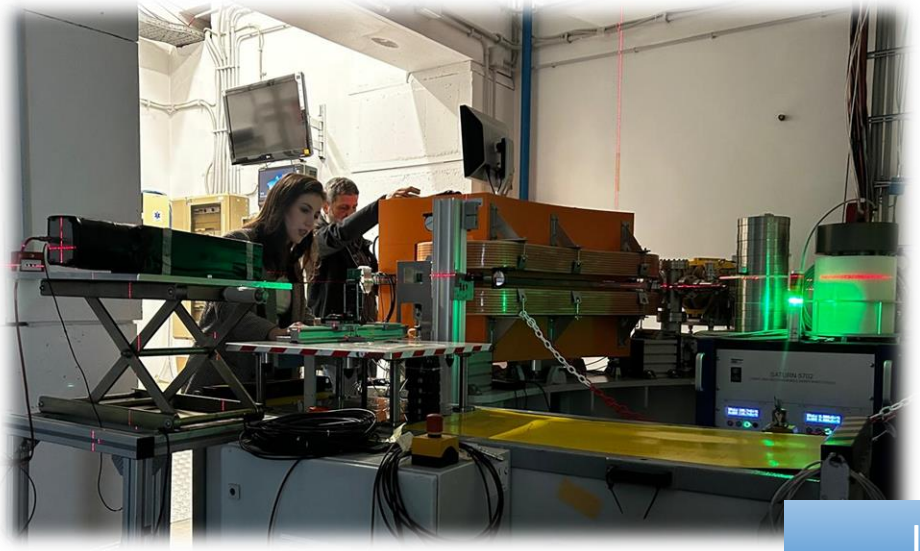
- BTF site
- Subscribe to BTF Newsletter
- If you need more information or help, please contact btf@lists.lnf.infn.it

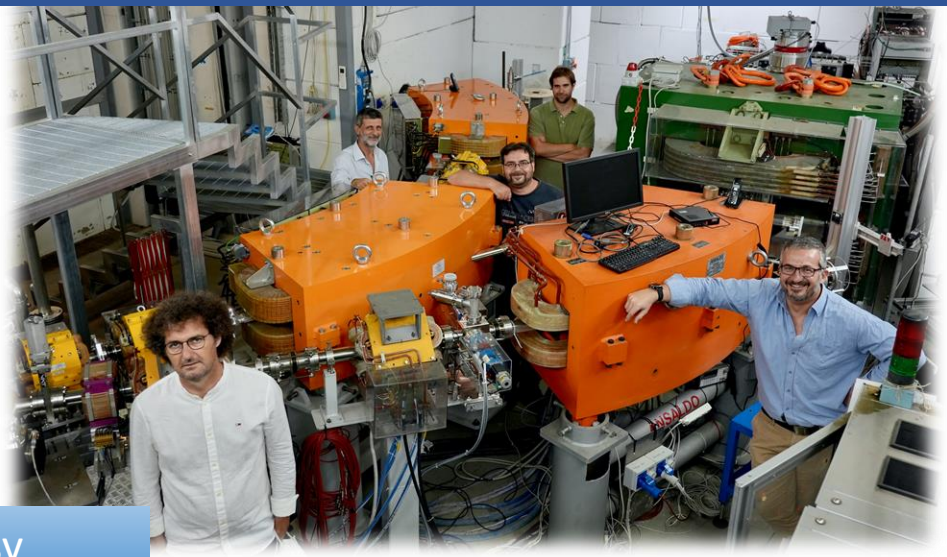
BTF - Transnational Access

BTF is part of the EURO-LABS (EUROpean Laboratories for Accelerator Based Science) project that has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement no. 101057511.

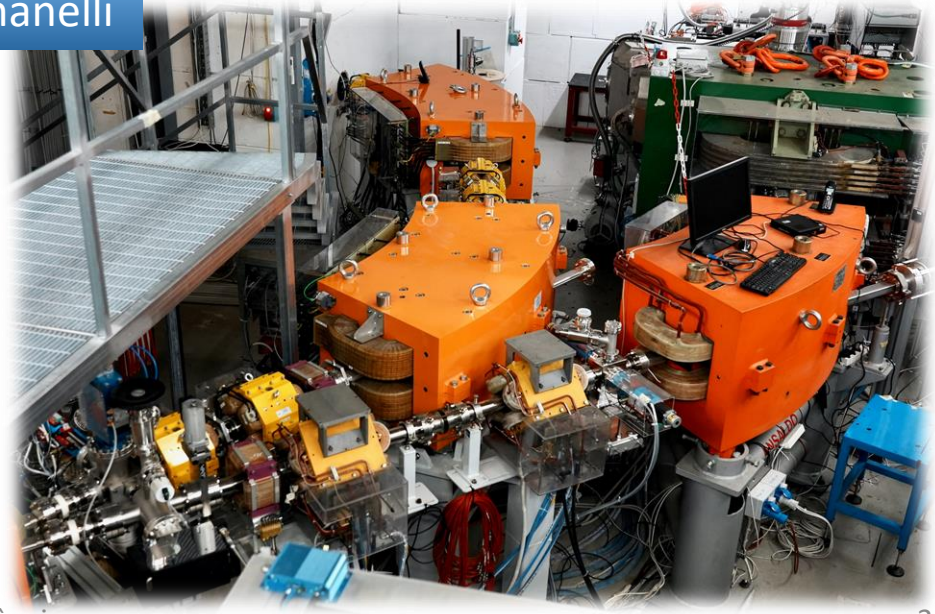
https://web.infn.it/EURO-LABS/

SEE YOU AT BTF!

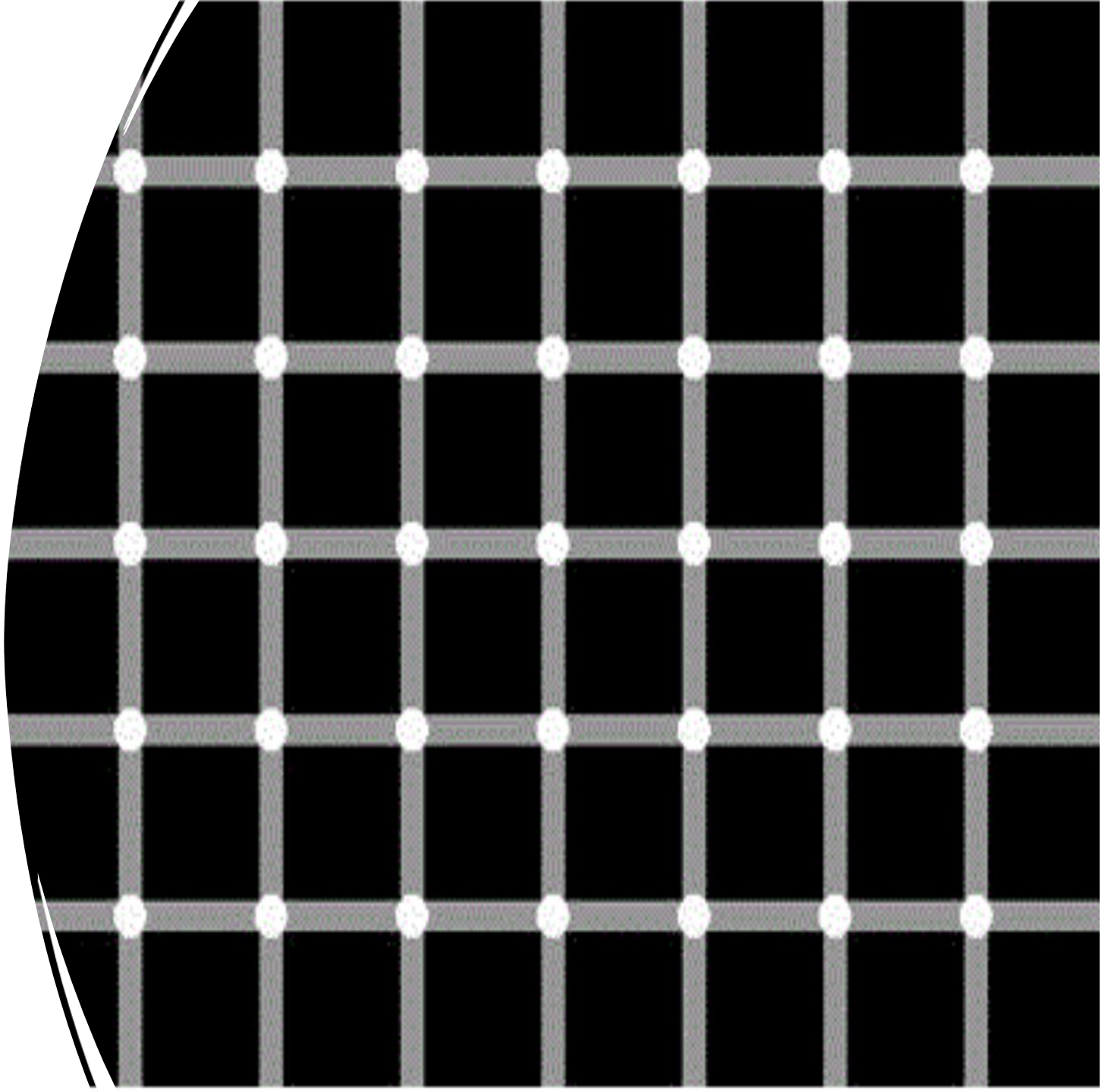




LNF SIDS Courtesy
Photo by Elena Patrignanelli



2024 BTF USERS HIGHLIGHTS

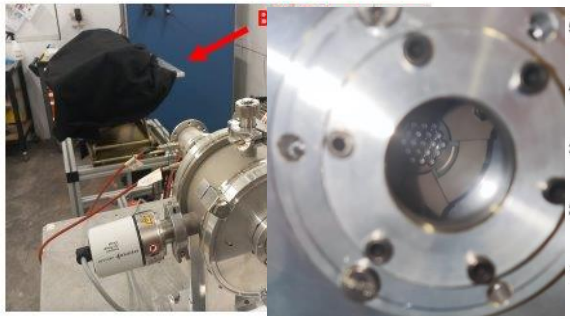


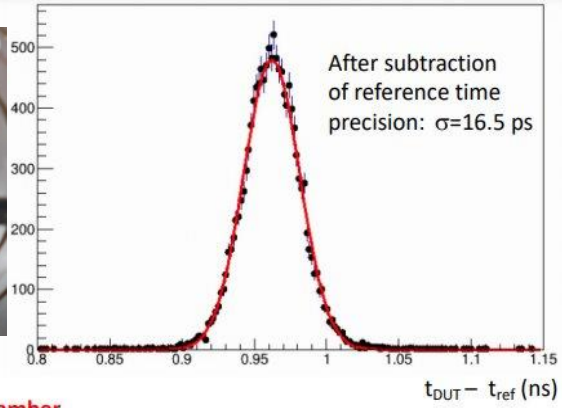
BTF2 SINGLE PARTICLE MEASUREMENTS

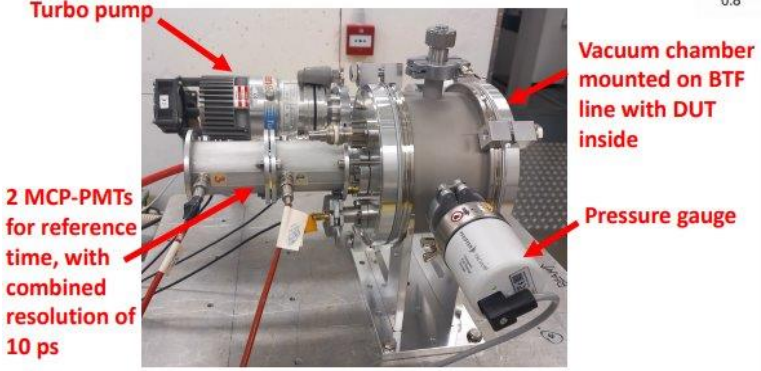
NOVA – MPC Devel - HEP Physics

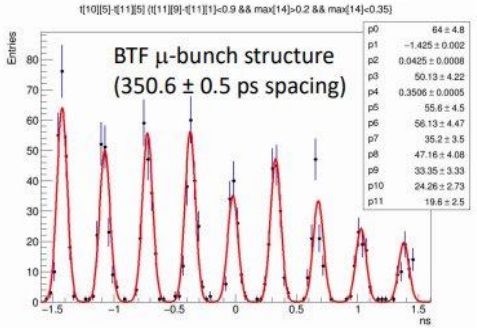
T. Spadaro (LNF-INFN), V. Vagnoni (INFN-Bo) et al.

- New generation MCP detector with new anode design,
- impressive prompt σ_t ~ **16ps**







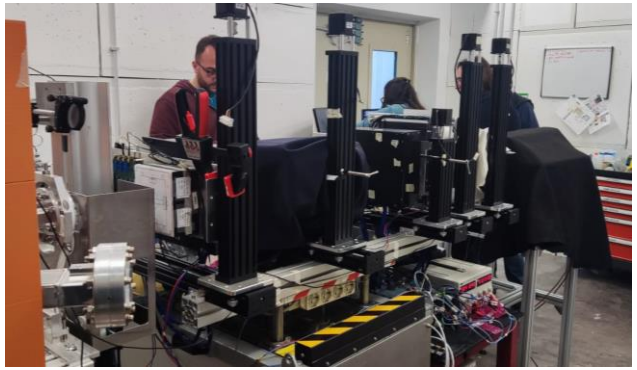


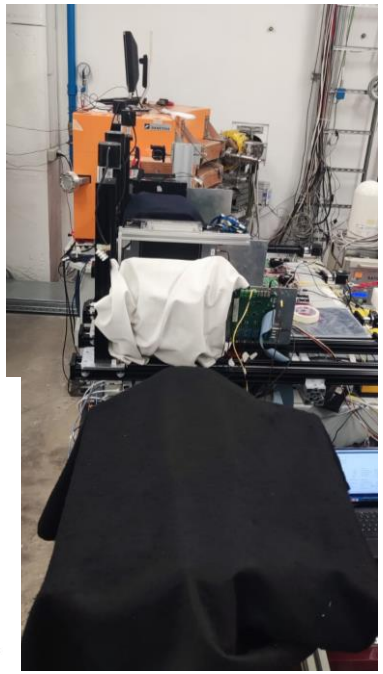
Machine measurement of LINAC bunched structure with a single particle, off energy, secondary beam (450MeV, m1, electrons)

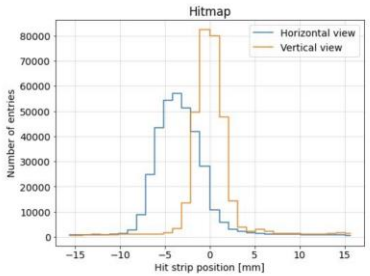
ZIRETTINO – Fiber Tracking detect – Space and Earth Physics

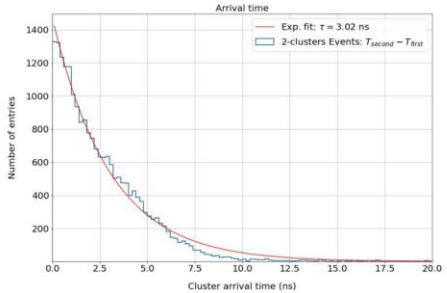
N.M. Mazziotta (INFN-Ba) et al., Nuclear Instrument corp.

- Zirettino is a prototype of Ziré which is parte of **the NUSES space mission** and will detect Cosmic Rays with energies from few up to hundreds of MeVs
  - Beam from 450 to 50 MeV few particles regime in a impressively dense setup









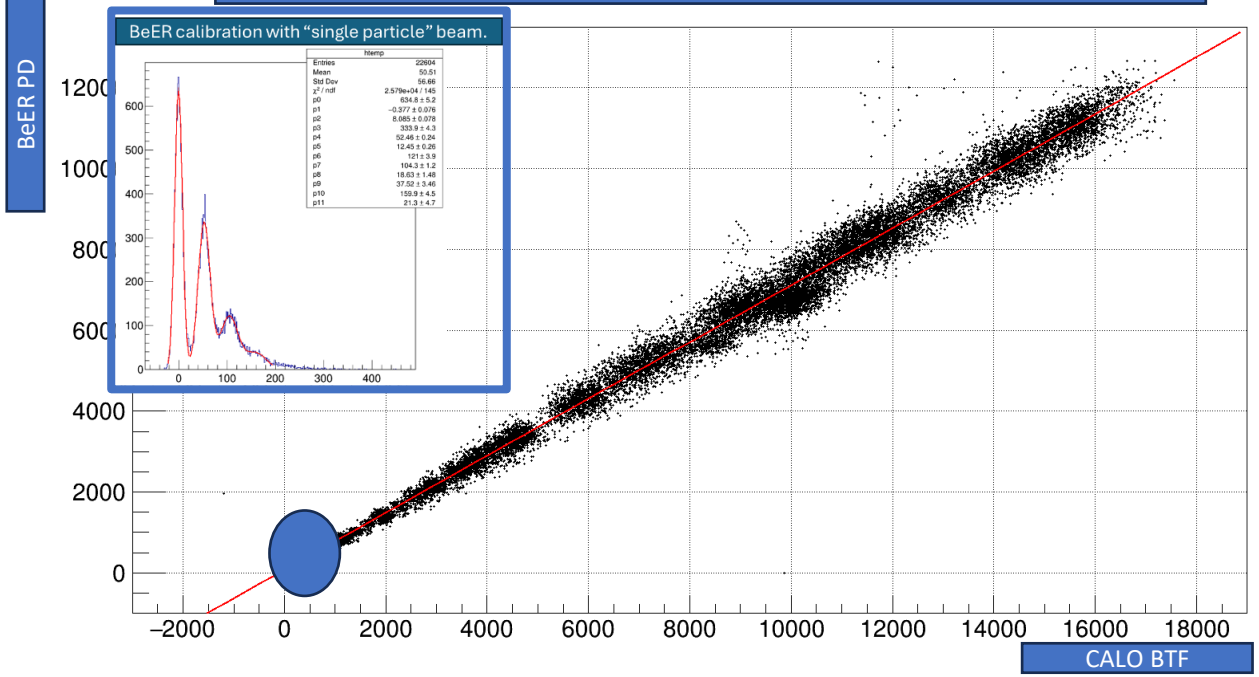
Firsts operative test with FTK+LYSO cubic crystals @ lower energies (different energies, m1, electrons)

BTF2 HI RANGE SCANS W SEC. BEAM

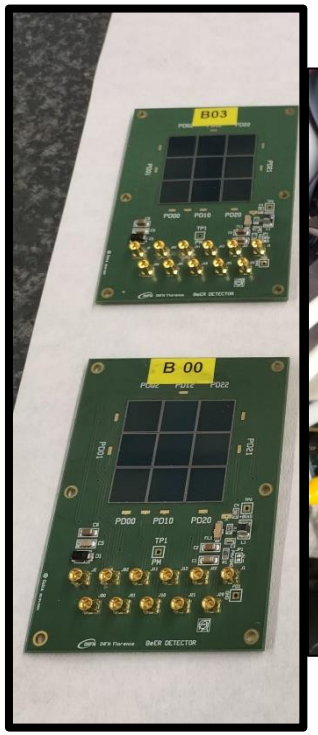
BeER (Beam-monitor with Extreme Range)
Photo Diodes (Pr. L. Pacini (FI-INFN) et al.)

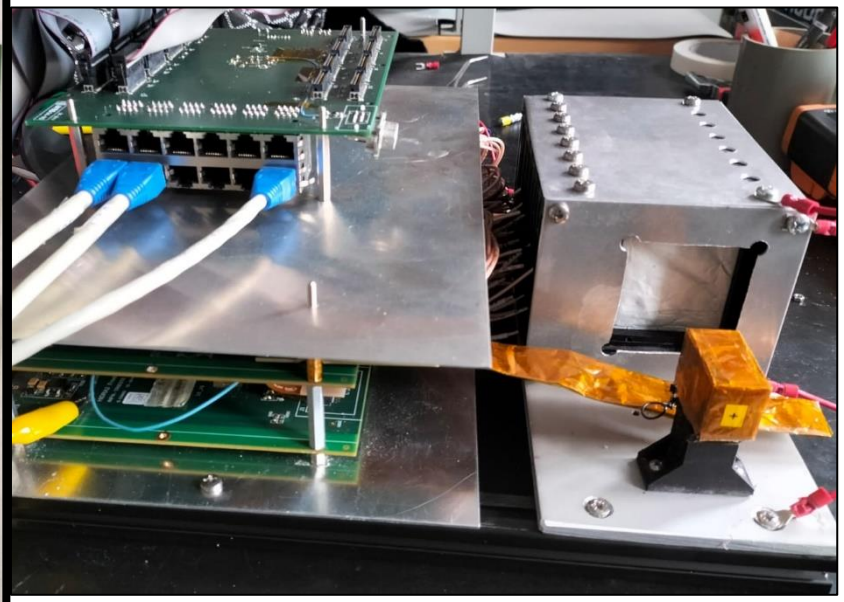
BeER consists of 6 layers made of 3x3 blind PDs (active area of each PD = 1 cm2): Excelitas VTH2110 PDs are silicon PIN diode which are used as ionization detector.
BeER main goals: **easy to use online monitor of high energy nuclei (e.g. SPS ion) and high multiplicity (BTF electron) beams, easy to integrate in users DAQ** to provide event per event information of charge (or number of particles.)

BeER single sensor vs BTF Calo



BTF BEAM FROM SINGLE PARTICLE TO 20k Multi days scan
Large dynamic range confirmed with high multiplicity runs by using BTF CALO information: the detector is capable to count more than 10k electrons. Non-linearity estimation is ongoing.





Pulse sharing beam time in June 2024
302MeV, m1->16k, electrons

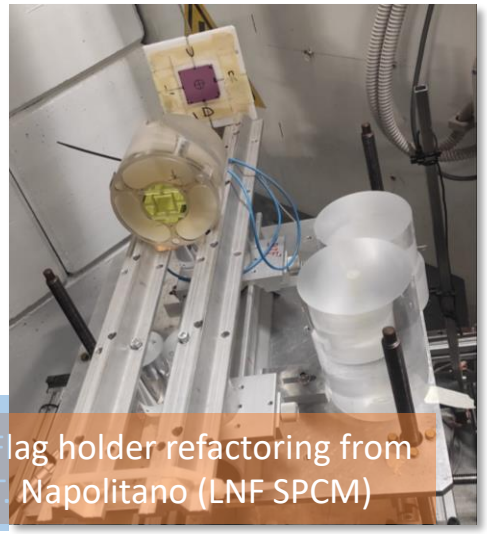
BTF RUNS FLASH VHEE

DIAMONDS for VHEE – new dosimetry - Medical Physics

M. Marinelli, **G. Rinati(Uni Roma TV) courtesy**

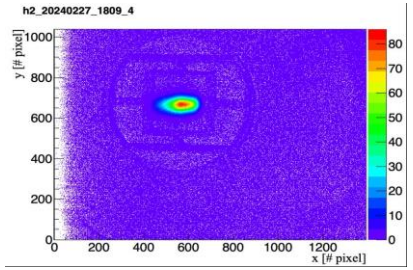
Dose measurement at high energy in FLASH regime, measure with Synthetic diamond based Schottky diodes operated at zero bias voltage

Shower n.1
510MeV, m1E9



Flag holder refactoring from T. Napolitano (LNF SPCM)

BTF triggered cams on Nd:YAG flags, in optical lock in regime

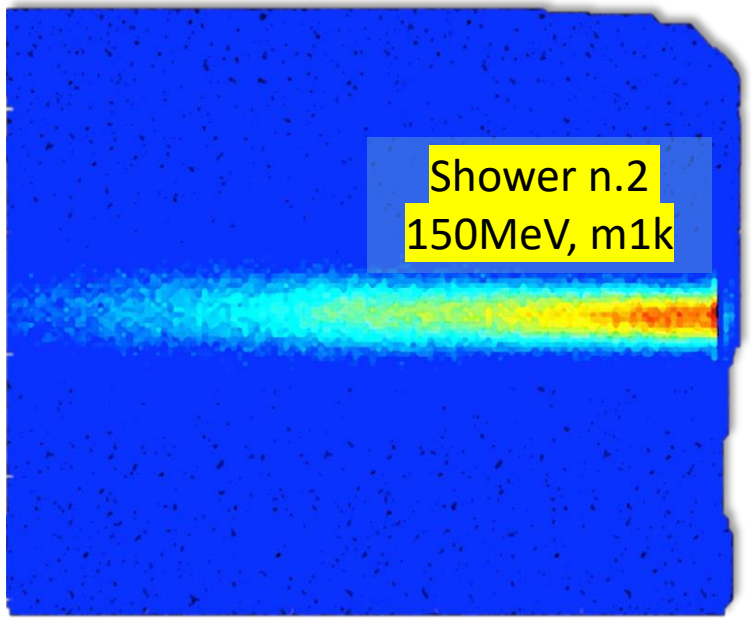


510MeV electrons primary beam, shot by shot dose measurement
Reproducing ELMA shower dose release in PMMA in different depths
Diamond active dose comparison with EBT3 GAFCHROMIC film
FIRST TRIAL ever MADE!!!

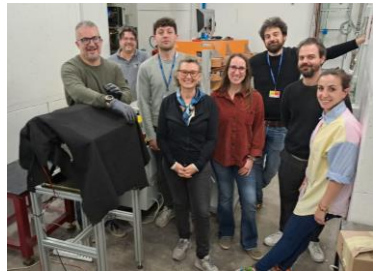
MORSEPET – Dose monitorng in real time - Medical Physics

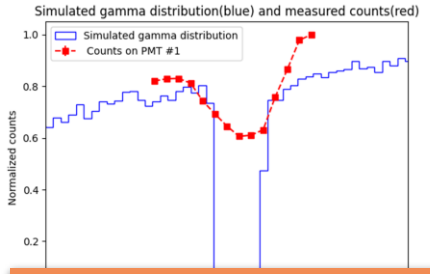
(M.G Bisogni et al. – Univ. Pisa courtesy)

a novel method to verify the dose delivered to a tissue or a phantom by a VHEE beam based on the detection of the Bremsstrahlung radiation emitted by the beam while crossing the tissue/phantom



Shower n.2
150MeV, m1k



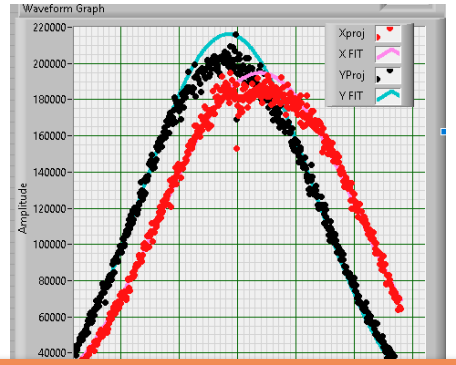


150MeV electrons secondary m=1k, single shot, PMMA hollow

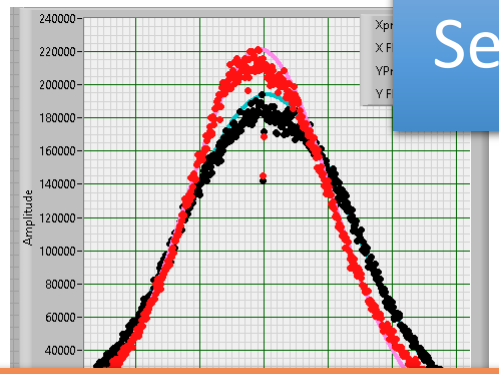
150MeV electrons secondary beam, m=1k, single shot
EJ212 plastic scintillator foil parallel to the beam direction
Cooled CCD camera to collect emitted peaked blue light

BTF HI FLUX LOW ENERGY SECONDARY BEAMS

Trial study for FCC – PCUBE injector and N – TOF



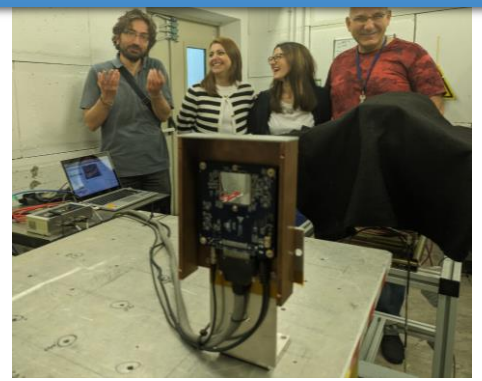
25MeV – m=2,5K
σx/σy=8,4/7,3[mm]

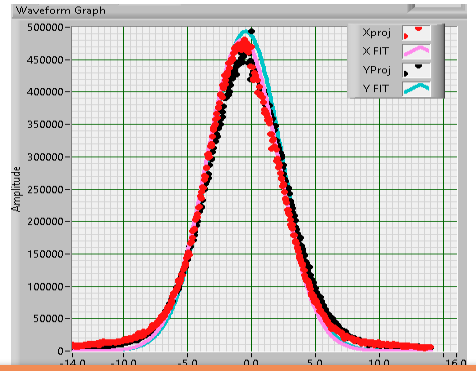


50MeV – m=5K
σx/σy=5,5/6,5[mm]

Secondary e- Long focus

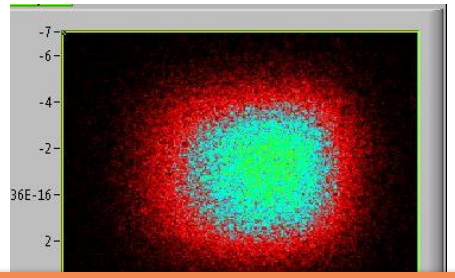
thanks to new vacuum window



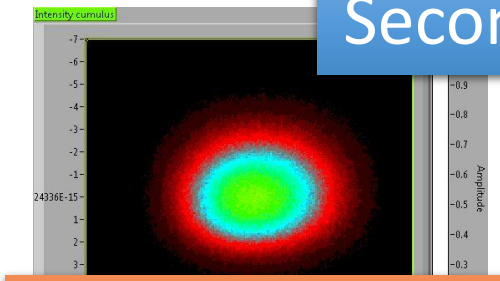


100MeV – m=6K
σx/σy=2,8/2,8[mm]

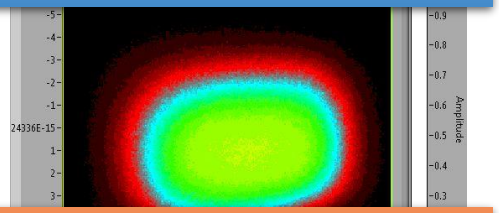
Secondary e- Short focus



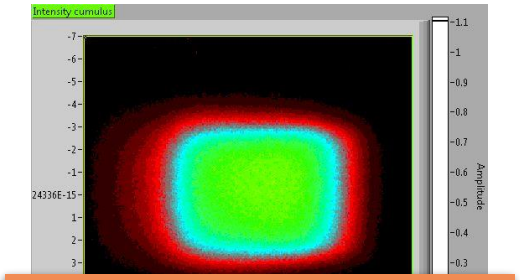
25MeV – m=1K
σx/σy=2,5/2,4[mm]



50MeV – m=5K
σx/σy=2,3/1,7[mm]



75MeV – m=18K
σx/σy=3,2/2,3[mm]



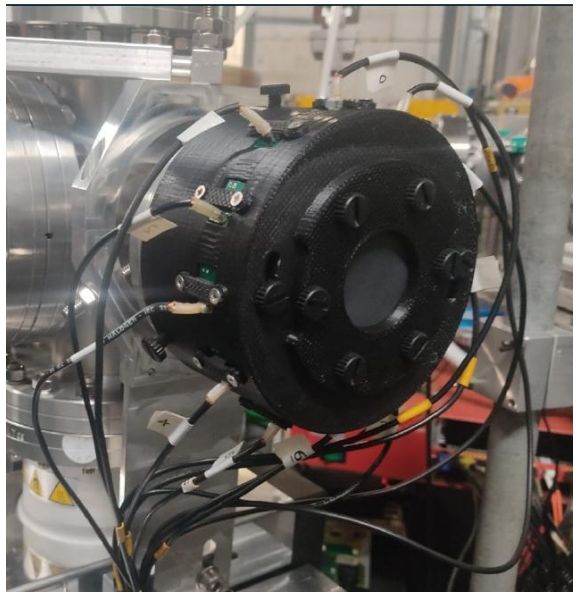
100MeV – m=30K
σx/σy=3,2/2,3[mm]

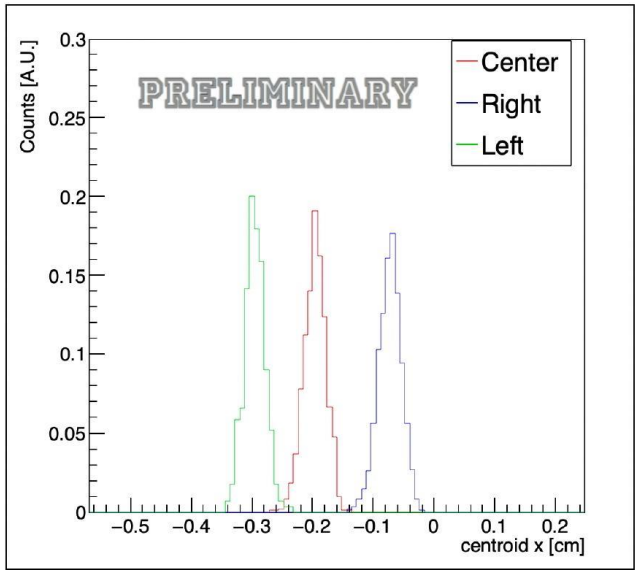
BTF1S HI RANGE SCANS W PRIM. BEAM

FLASHDC (Beam characterization via Air Fluorescence)

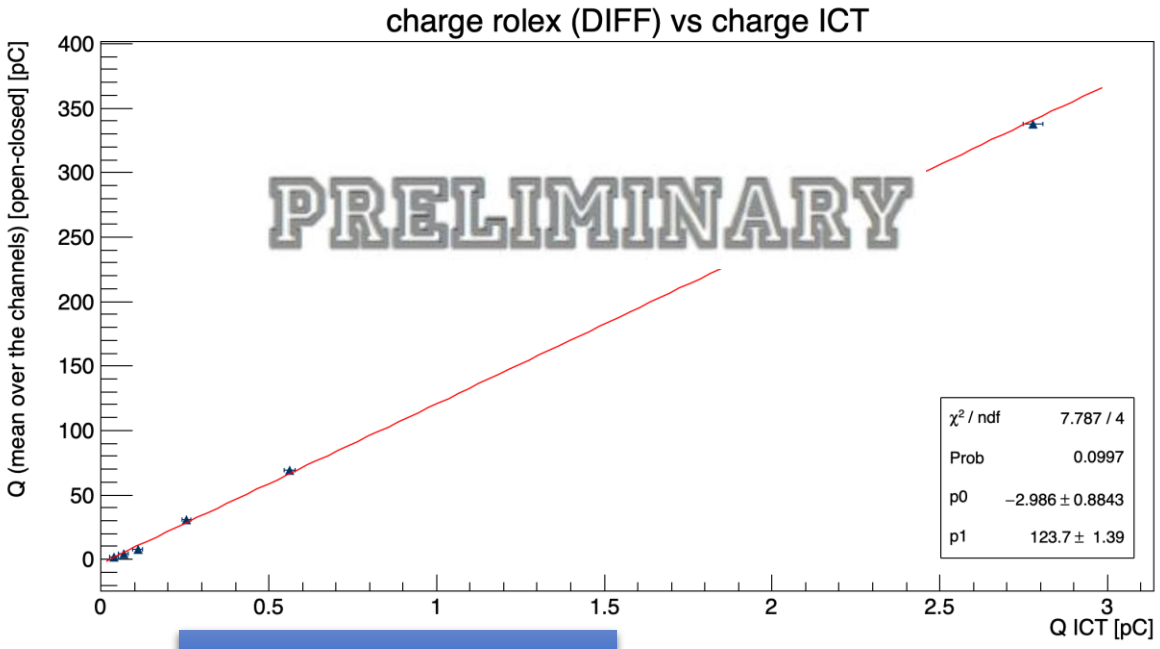
SiPM (A. Trigilio et al.)

This experiment aims to measure pulsed beam charge and centroid position by means of SiPM array in a cylindrical darkroom. This setup is calibrated to read-out part of the fluorescence spectrum emission in air induced by the passage of 510 MeV primary electron beam. The charge measurements have been compared with those of the BTF ICT's, with single pulse charge tuning from 10 pC (lower ICT sensitivity range) up to around 1 nC range.
The experiment demonstrated the detector's performances in terms of linearity, centroid sensitivity and the understanding of the detector's capabilities.





BTFEH1 EXPERIMENT
The centroid measurements was performed by steering the single set beam inside the detector itself, multiplicity scan with ICT

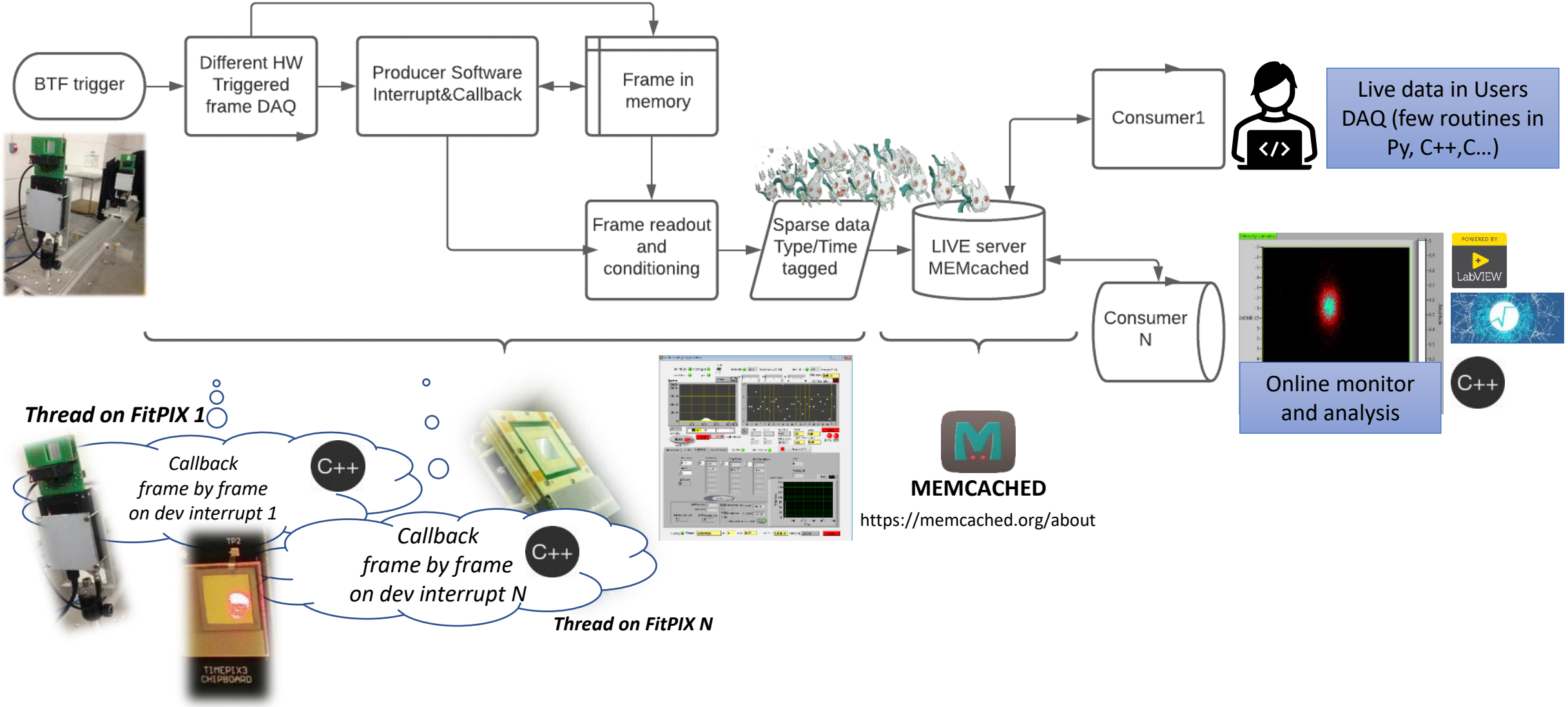


Courtesy of M.Marafini

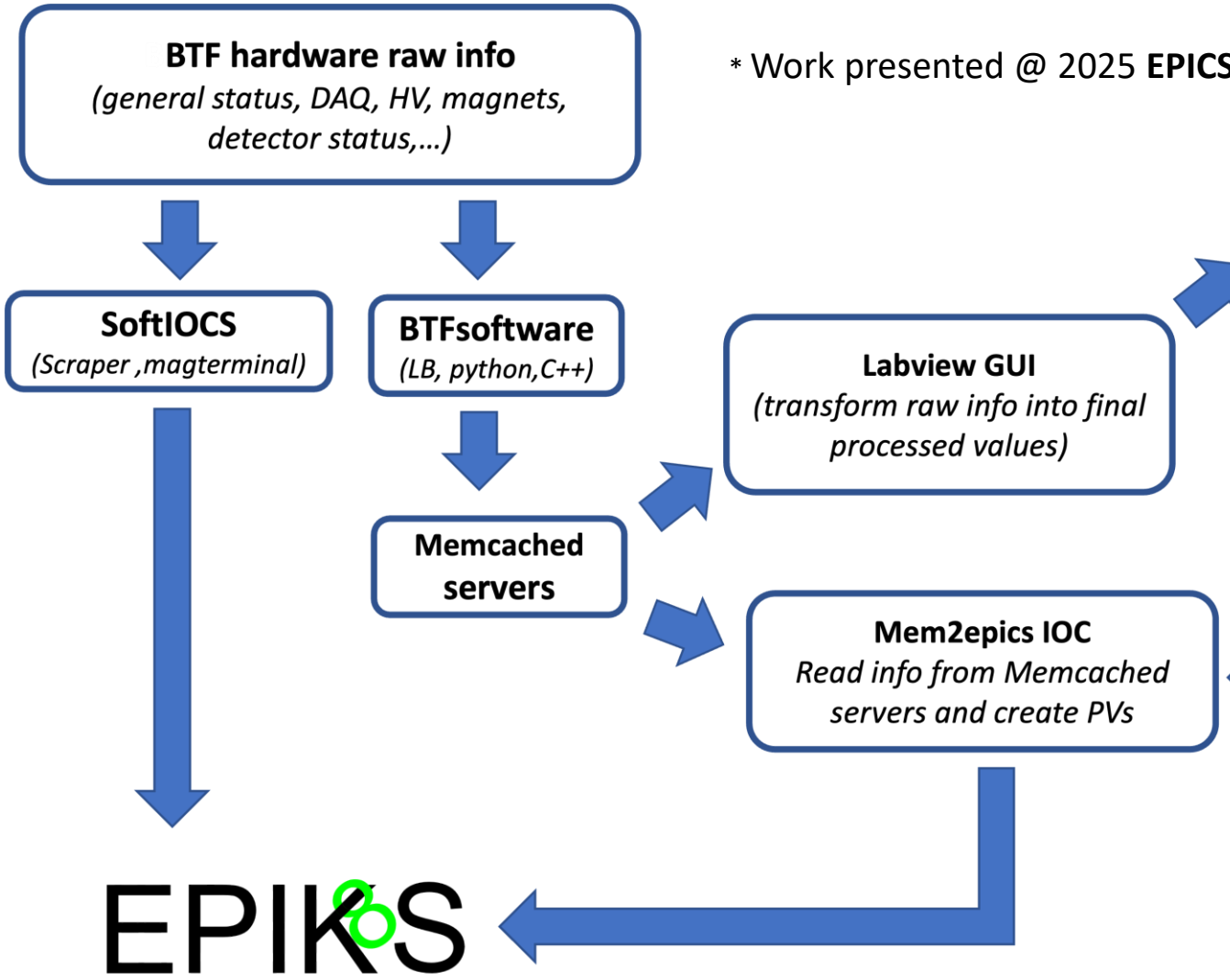
High intensity beam multiplicity scan and steering
510MeV, 10^10 down to 10^7 e/pulse

SPARE SLIDES

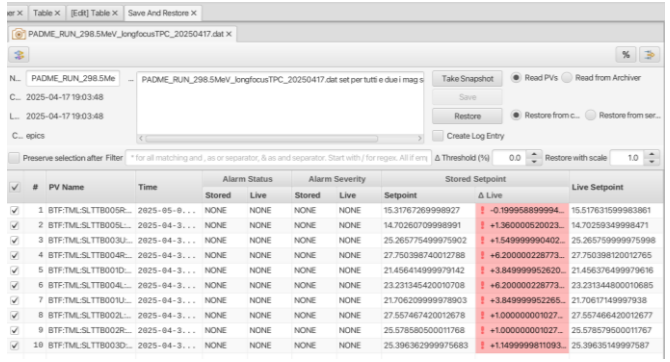
DIAGNOSTICS SOFTWARE LAYOUT



NEW BTF DCS– AN OVERVIEW



* Work presented @ 2025 **EPICS collaboration Meeting**



ITEM	TEST PHASE	PROD PHASE	Note
Magnets	√	80%	Not possible to complete the migration now for BTF activities
Motors – Scraper	√	In use	
Triggered Cams	√	In use	
HV crate control	√	30%	Final design not ready
PTH sensors in EH1-2	√	In use	
Vacuum monitor	√	In use	
Dipoles hall probes	√	In use	
DAQ data	√	In use	
OLOG	√	In use, 70%	AAI authentication under development

SHARED INFO

https://mediawall.infn.it/v/1030

BTF site

https://btf.lnf.infn.it/

https://btf.lnf.infn.it/schedule-beam-request/

BTF wiki

https://wiki.infn.it/strutture/lnf/da/btf/home/

Technical, Call for submission information and documentation

INFN User Portal guide

http://btf.lnf.infn.it/wp-content/uploads/sites/75/2023/03/Instruction_INFN_USER_Portal.pdf

INFN Identity management guide (for getting BTF beamtime and access)

Booking Call for beam time guide

https://btf.lnf.infn.it/wp-content/uploads/sites/75/2023/03/Booking_BTF_Call_Guide.pdf

Booking guide for Team Leader

http://btf.lnf.infn.it/wp-content/uploads/sites/75/2023/03/Booking_guide_team_LEADER.pdf

Booking guide for Team Members

http://btf.lnf.infn.it/wp-content/uploads/sites/75/2023/03/Booking_guide_team_MEMBER.pdf

Call for proposal submission guide

BTF submit proposal software

https://booking.dsi.infn.it/

INFN Identity management guide (for getting BTF beamtime and access)

2024 SOME CONTRIBUTION CITING BTF

Cantone, C., Ceravolo, S., Colao, F., Di Meco, E., Diociaiuti, E., Frank, I., ... & Tagnani, D. (2024). R&D status for an innovative crystal calorimeter for the future Muon Collider. *IEEE Transactions on Nuclear Science*.	MUON COLLIDER
Chiti, M., Chiti, D., Chiarelli, F., Donghia, R., & Esposito, A. (2024). Photon and neutron dose evaluation at the Beam Test Facility of the INFN-National Laboratory of Frascati. *Radiation Measurements*, *176*, 107216.	NEUTRON DOSE MEASUREMENT
Antonelli, A., Auffray, E., Brovelli, S., Bruni, F., Campajola, M., Carsi, S., ... & Vallazza, E. (2024). Development of nanocomposite scintillators for use in high-energy physics. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 1069, 169877.	NANOCOMPOSITE Scintillator, MUON COLLIDER, CRILIN
Avoni, G., Benettoni, M., Bruschi, M., Cian, A., Dal Corso, F., Dosselli, U., ... & Zuffa, M. (2024). Development of a sapphire microstrip detector for gamma beam monitoring. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 1068, 169752.	LUXE, NEW DETECTOR
Testa, M., De Santis, A., Tinti, G., Paoloni, A., Papalino, G., Felici, G., ... & Rovelli, C. (2024). Direct detection of minimum ionizing charged particles in a perovskite single crystal detector with single particle sensitivity. Nanoscale, 16(27), 12918-12922.	PEROSKIVITE
der Maur, M. A. PEROV: R&D for photodetectors based on Organo-Metal Halide Perovskite materia. LNF NOTE	PEROSKIVITE
Borra, F. Study of the PMTs signals during the first underground run of the LIME prototype for the CYGNO experiment (No. CERN-THESIS-2023-323).	DM SEARCHES, CYGNO, THESIS
Bertelli, S., Bossi, F., Ceravolo, S., Corradi, G., Di Giulio, C., Di Meco, E., ... & Padme Collaboration. (2024). Design and performance of the front-end electronics of the charged particle detectors of PADME experiment. Journal of Instrumentation, 19(01), C01051.	PADME
Cantone, C., Cemmi, A., Ceravolo, S., Ciccarella, V., Colao, F., Di Meco, E., ... & Zuliani, D. (2024). Developing an alternative calorimeter solution for the future Muon Collider: The Crilin design. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 169973.	CRILIN, MUON COLLIDER
Bertelli, S., Bossi, F., Di Giulio, C., Di Meco, E., Dimitrova, K., De Sangro, R., ... & Variola, A. (2024). Beam diagnostics with silicon pixel detector array at PADME experiment. Journal of Instrumentation, 19(01), C01016.	PADME
Mancini, M. (2024). Searching for X17 using resonant production at PADME. IL NUOVO CIMENTO, 100(254), 47.	PADME
Bertelli, S., Bossi, F., Buonomo, B., De Sangro, R., Di Giulio, C., Di Meco, E., ... & Vilucchi, E. (2024). Characterization of the PADME positron beam for the X17 measurement. arXiv preprint arXiv:2405.07203.	PADME
Carsi, S. (2024). Advanced Tracking System for Crystal Physics (No. CERN-THESIS-2024-017).	BENT CRYSTAL, THESIS
Garattini, M., et al. "Steering of sub-GeV positrons by ultrathin bent silicon crystal for ultraslow extraction applications." Physical Review Accelerators and Beams 28.2 (2025): 023501.	BENT CRYSTAL
Cantone, C., et al. "Advancements in Muon Collider Calorimetry: Design, Testing, and Radiation Resistance of the Crilin Calorimeter Prototype." EPJ Web of Conferences. Vol. 320. EDP Sciences, 2025.	MUON COLLIDER
Cemmi, Alessia, et al. "Radiation resistance of the Muon Collider CRILIN calorimeter prototype equipped with Cherenkov lead fluoride crystals." IEEE Transactions on Nuclear Science (2025).	MUON COLLIDER, NEW DETECTOR
Soldani, M., et al. "Innovative nanocrystal-based scintillators for next-generation sampling calorimeters." EPJ Web of Conferences. Vol. 320. EDP Sciences, 2025.	NANO CRYSTAL, NEW DETECTOR
Adriani, O., et al. "Development of a high-resolution, high-dynamic-range charge detector for ion beam monitoring." Journal of Instrumentation 20.01 (2025): P01019.	HEP, NEW DETECTOR

Around 20 paper citing BTF (Jan. 2024, Now)

- Others in the ARXIV or different channels
- **Positive feedback to users via sharing BTF live data**
- Some detectors are **directly developed** at BTF in different runs
- **BTF beamline scientists provide significant support** during the experiment project phase and in understanding data

DIAGNOSTICS: PRIMARY BEAMS

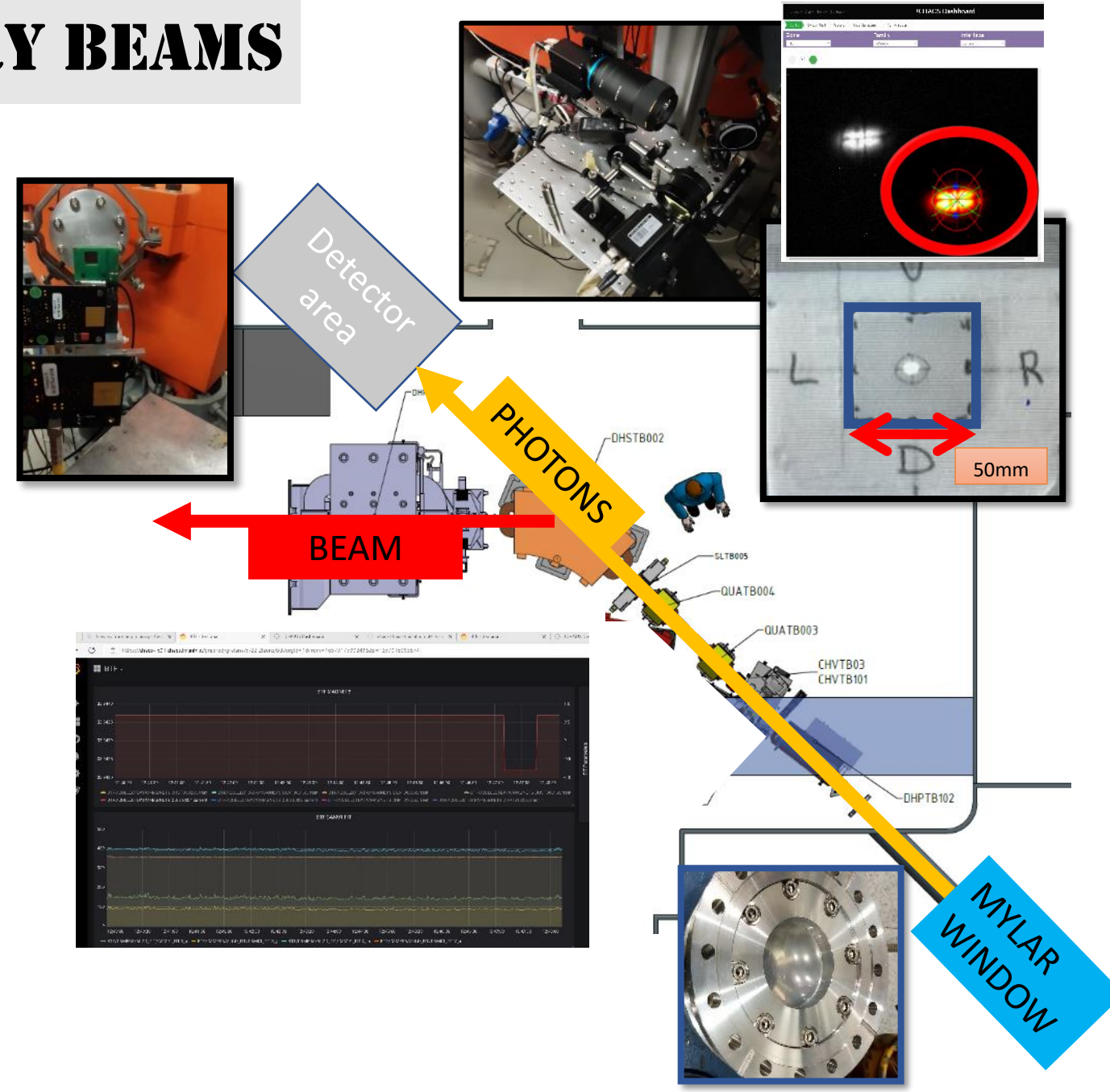
Primary beam diagnostics (some of)

Direct measurement
(test beam particles, partially destructive)

- Bergoz Integrating Current Transformer
- Flags and triggered fast cam,
- Faraday Cup, PIC
- DAQ measures shot by shot

Indirect measurement
(secondary photons, run quality monitor)

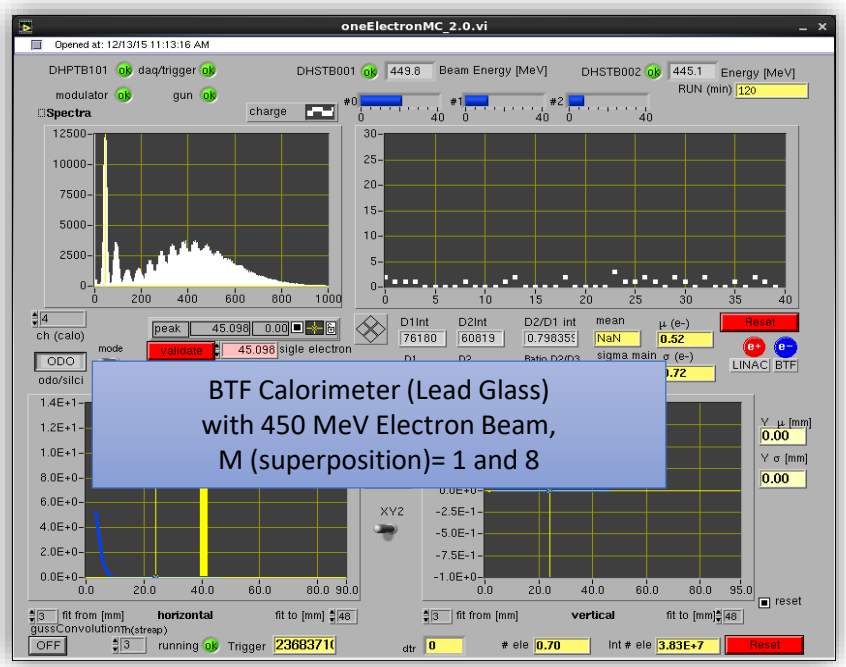
- Beam steered to experiment, detectors get secondaries
- Lead Glass Calo gets Bremsstrahlung photon from mylar window (vacuum decoupler for static-ionic to dyn-TMP vacuum types)
- Energy collected is less a factor of 0,001 of the total steered charge (12m away)
- Used to calculate approx. delivered charge, beam length, uptime
- Higher measurement errors (~10%)

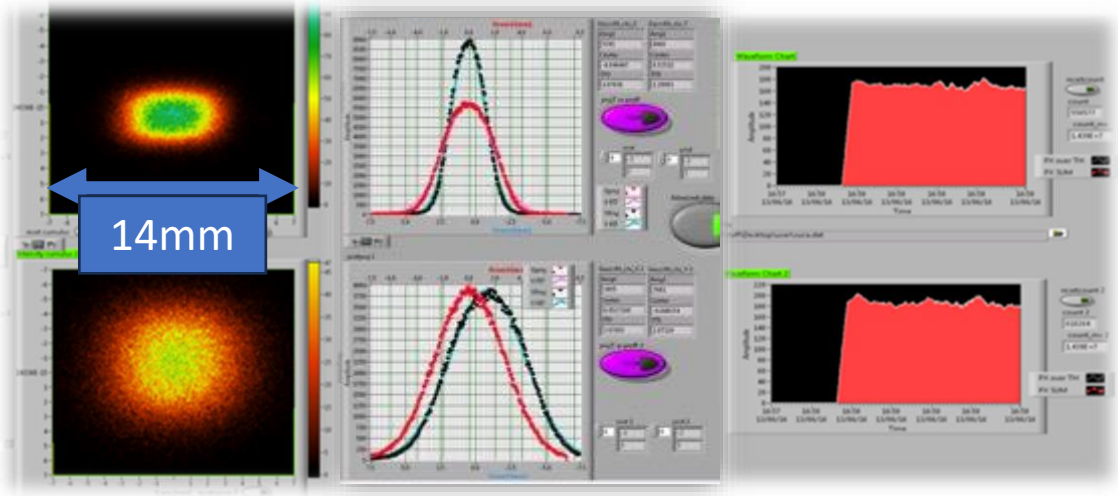


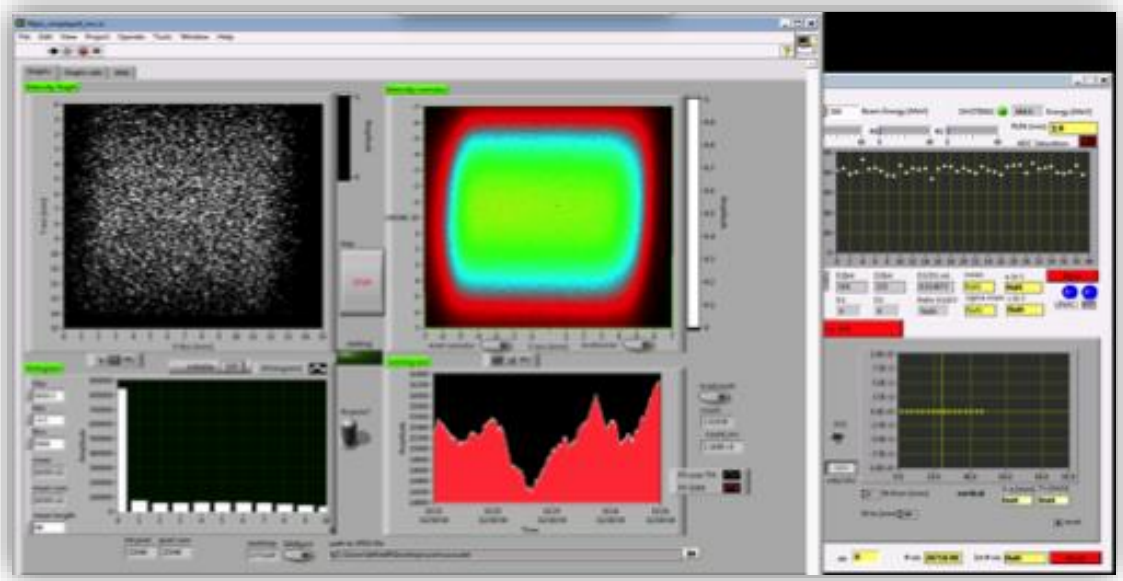
DIAGNOSTICS: SECONDARY BEAMS

Typical secondary beam diagnostics (some of)

- **ADVACAM FITPIX/TIMEPIX detectors**
  - 256×256 pixels, 55 μm pitch, 14×14 mm^2 active area
  - 300 μm thickness sensor
  - Three FitPIX devices **operational**
- **LEAD GLASS Calorimeter: higher beam (charge*energy)**
- **BGO segmented Calorimeter**
- **TPX3 Katherine**







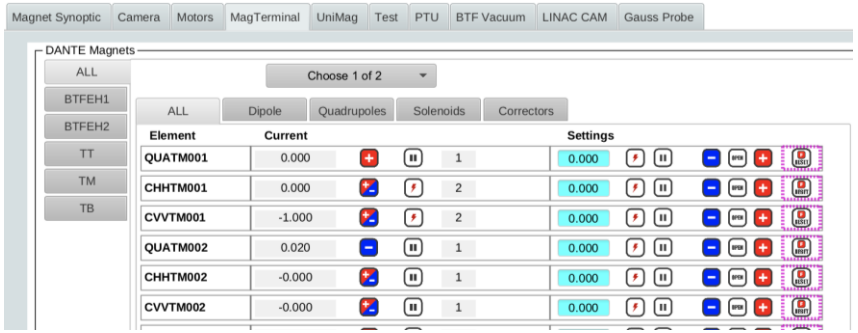
BTF EPIK8S GUI – CONTINUOUS DEV

Phoebus GUI interface organized in different tabs : one synoptic + N specific tab for the implemented subsystem

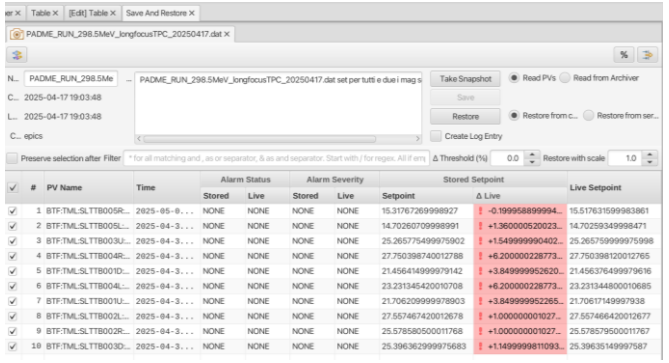
Magnets

2 different possibilities of operation:

- **MagTerminal:**
  - exact copy of LV magterminal.
  - All the commands are sent through the devil
  - S&R not implemented
- **Unimag**:
  - Communication directly through the magnet drivers
  - To ensure the continuity with the current operation
  - still using devil communication
  - Pretune implemented
  - Possibility to S&R tested



Scrapers

Completely migrated to Scraper control in EPIK8s

- Possibility to S&R from OLOG particular and interesting configuration
- Different control for TGTs (password required)