



Laboratori Nazionali di Frascati: a status report

P. Campana – PECFA, CERN, 15.11.2018



Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Laboratory highlights since last PECFA

- **DAFNE & Beam Test Facility**

- Preparation of DAFNE for Siddharta2 data taking
- Completion of the preparation of BTF for PADME and for beam line #2
- Start of PADME (*Dark Photon Search*) data taking
- Steps done in proposing DAFNE as accelerator test facility

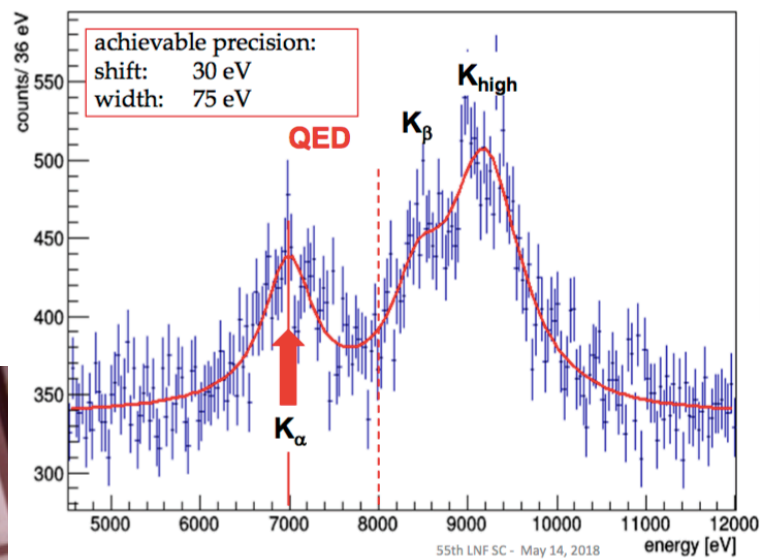
- **SPARC_LAB & EuPRAXIA**

- Results from experimentation on plasma cell and lenses
- Progress on EuPRAXIA project

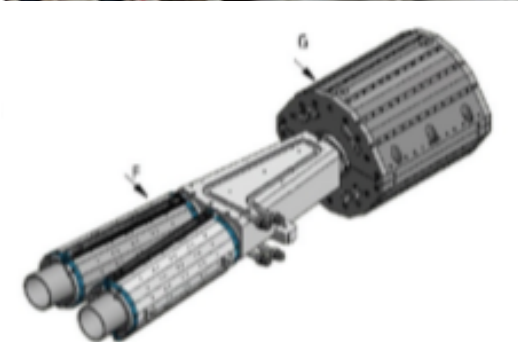
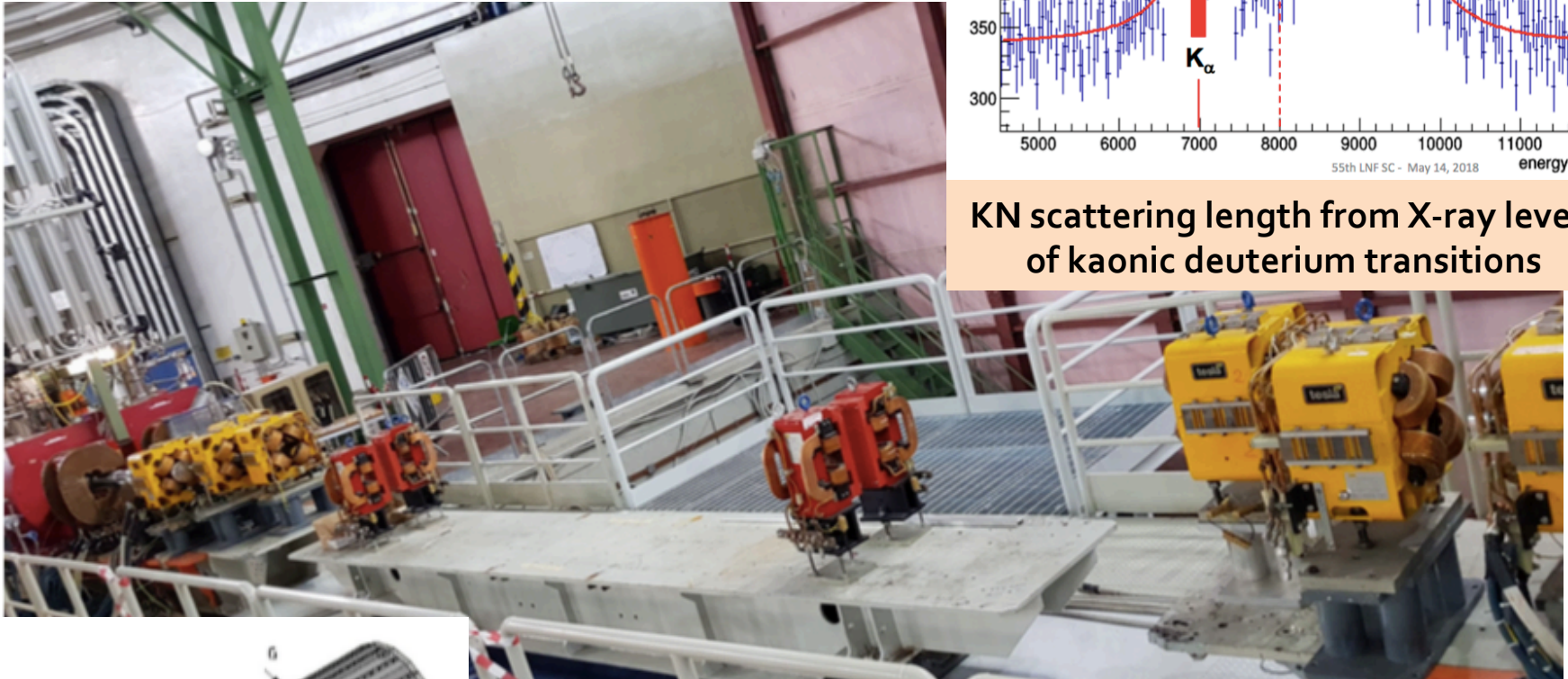
- **LHC Phase 1** detector construction continuing (ALICE & ATLAS)

- A (small) **Visitor Centre** opened to the public

DAFNE setting up for Siddhartaz



KN scattering length from X-ray levels of kaonic deuterium transitions



Preparation of focusing q-poles made with permanent magnets is on-going at ESRF

IP will be completed and Siddhartaz installed by the end of February 2019

DAFNE after 2020

At the end of its operation as collider, the Laboratory is planning to transform DAFNE into a test facility for accelerator physics and technologies and training site for young accelerator scientists. Proposal submitted to INFN. Moreover, 7 synchrotron beam lines in operation (from IR to soft X)

Few facilities available worldwide (ANKA, ATF₂, CLASSE, IOTA, ...)

Assets: high currents (up to 2 A), positrons, space in 2 straight sections, cryogenics

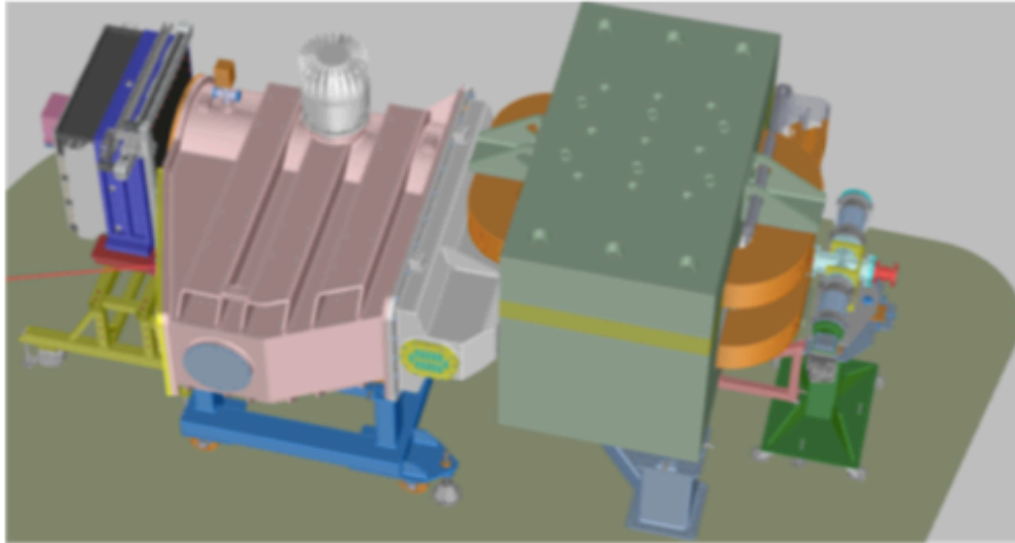
The initiative is willing to enhance and to foster the supporting role of *regional infrastructures*, also in view of ESPP 2020

Some refurbishment needed, mainly in diagnostics and in critical components

A sizeable list of interesting ideas has been already collected, including technological tests for muon colliders (LEMMA), e⁺ resonant extraction (POSEYDON), surface coatings to reduce e-cloud for future machines, beam dynamics, etc ...

Next **Dec. 17**, a workshop will be held at LNF to collect ideas, proposals, and collaborations (<https://agenda.infn.it/confRegistrantsDisplay.py/list?confId=16334>)

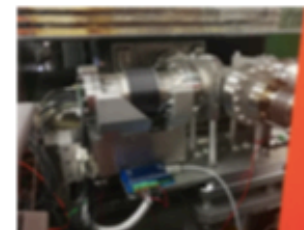
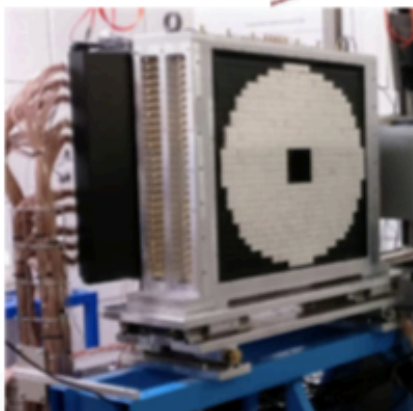
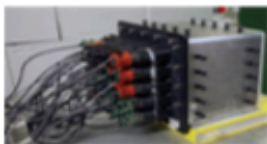
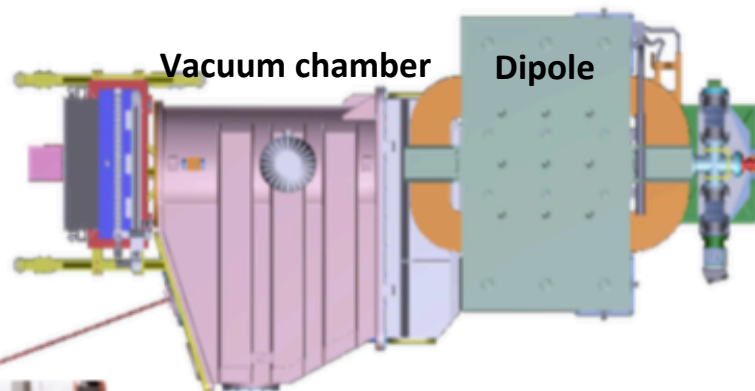
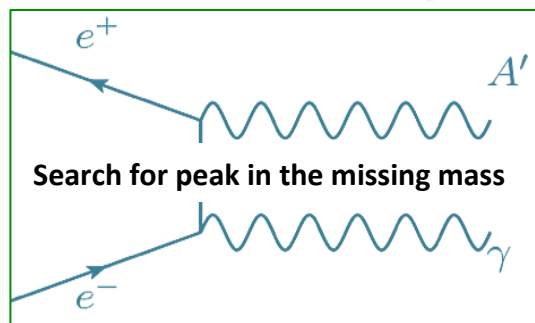
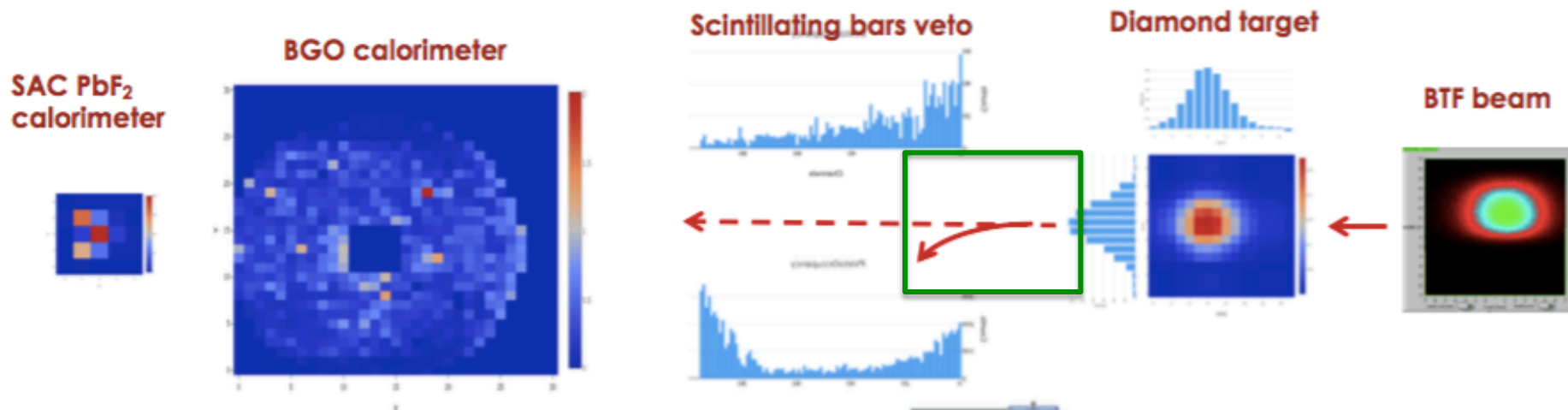
Beam Test Facility and PADME experiment set-up



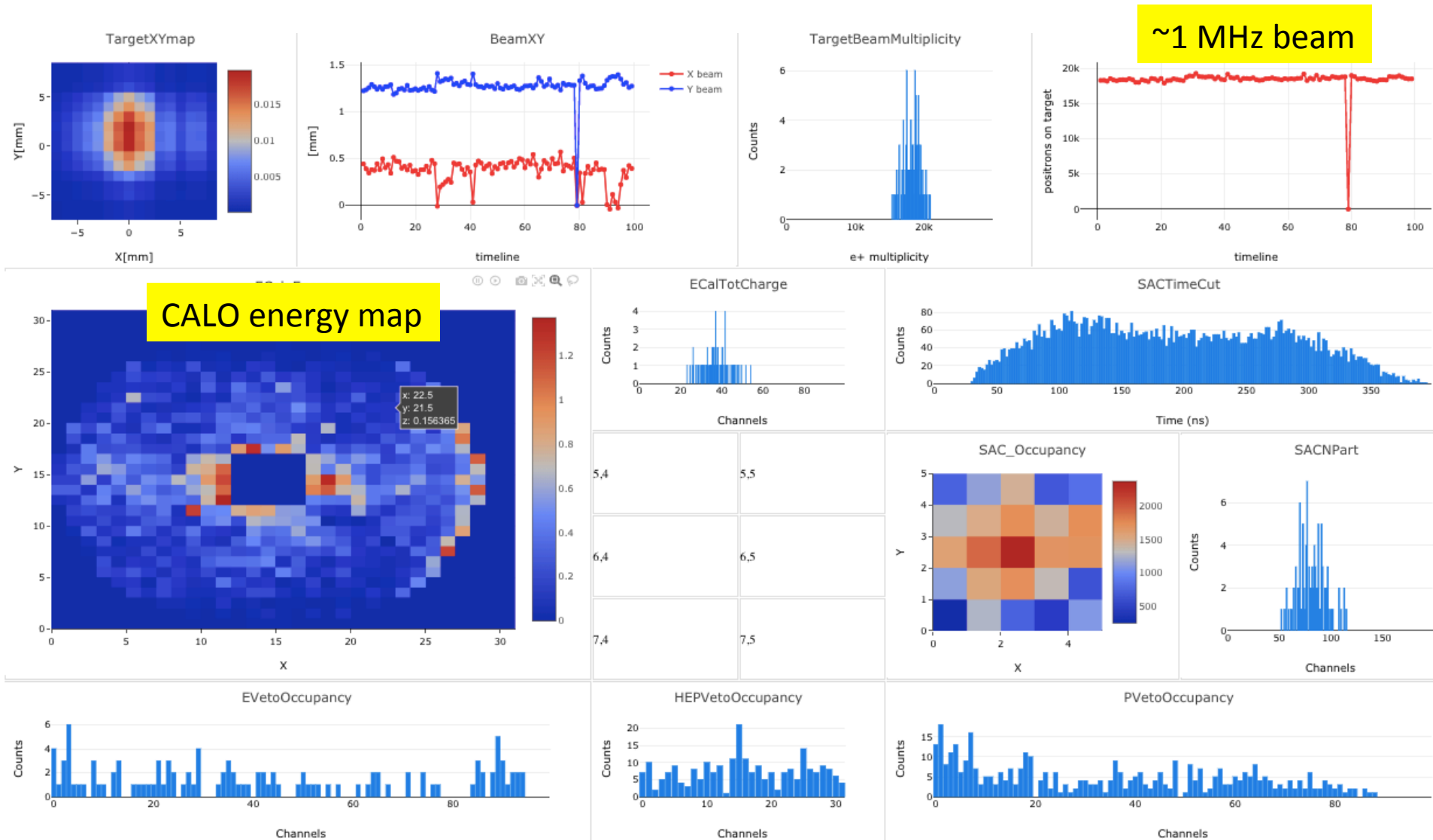


- ▣ LINAC commissioning after consolidation **OK**
- ▣ **BTF-1 beam-line** (where PADME is installed) has been **completed**
- ▣ **BTF-2 beam-line first components installed**
 - ◆ Line splitting for BTF-2 mounted, including new fast dipole
- Activity performed in the framework and with the support of AIDA 2020
- Further consolidations of Linac is on-going adiabatically
- Planning to open the call for users at beam line #2 by Spring 2019
- Beam time for BL4S outreach program available in 2020

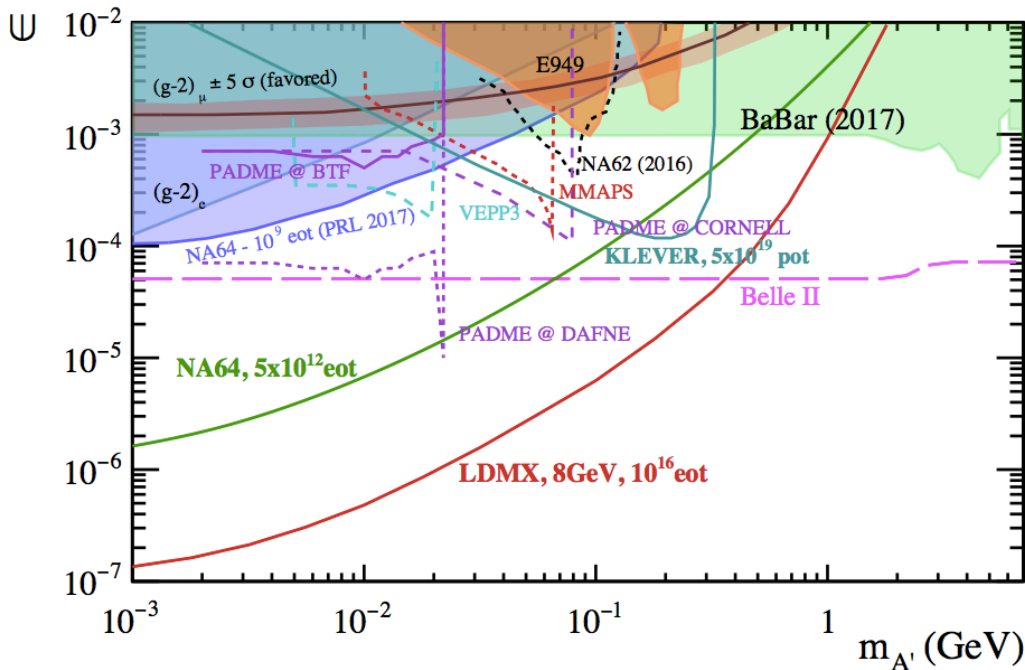
PADME in 1 slide



Experiment On-Line Monitoring



PADME experiment perspectives



*A dark sector dedicated experiment
(a lot to learn !)*

Installation completed in **Sep. 2018**

Run 1 up to the end of **Feb. 2019**

Goal: collect 10^{13} pot with **550 MeV**
200 ns e+ beam ($\sim 10^6$ Hz)

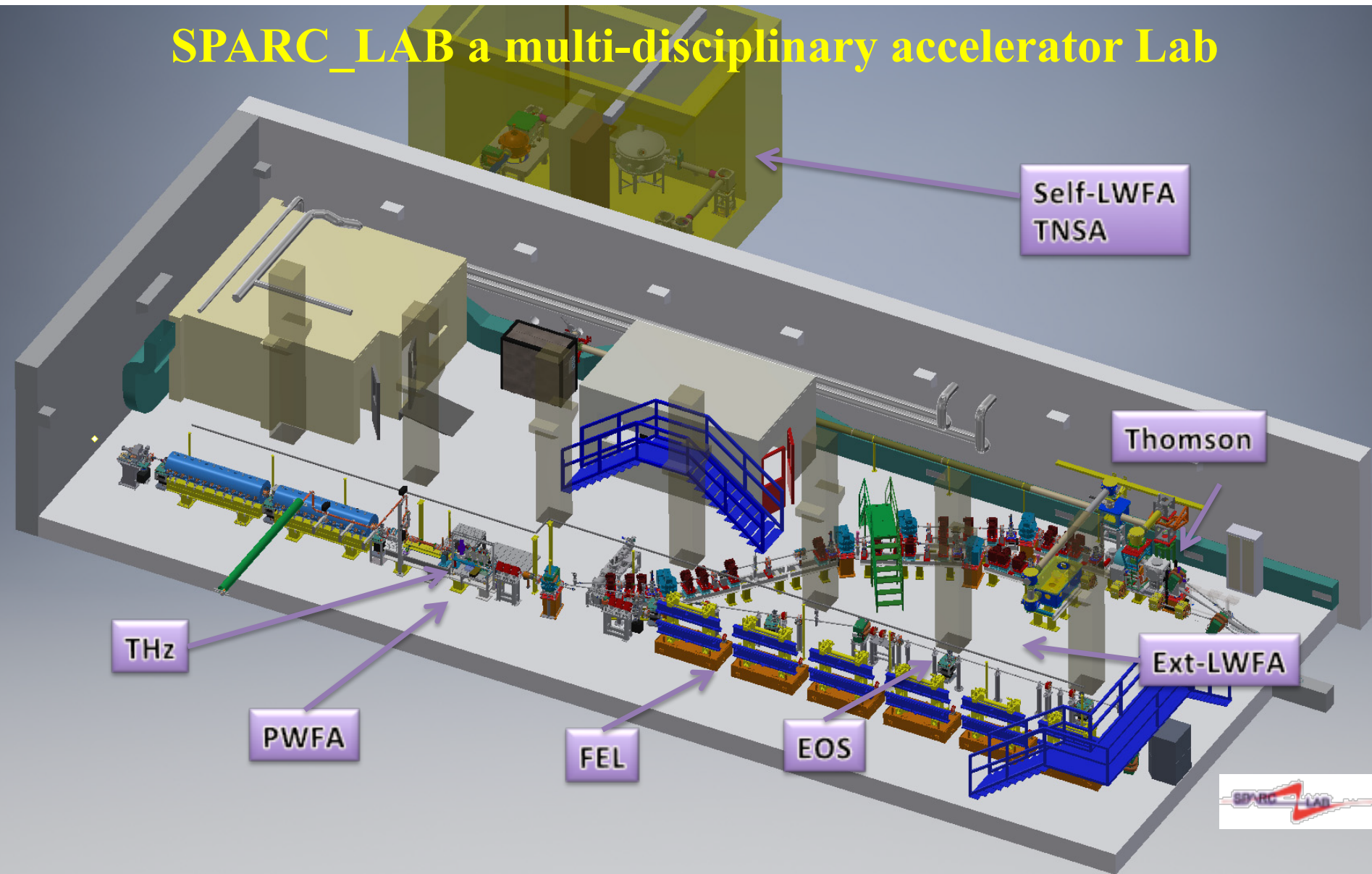
Possible extension of physics program

- Test of ^8Be anomaly: resonant production of X(17 MeV) proto-phobic boson
- Search for axion-like particles
- Searches for visible dark photons with thick targets exploring resonant production

Programs for boosting the sensitivity (not at BTF)

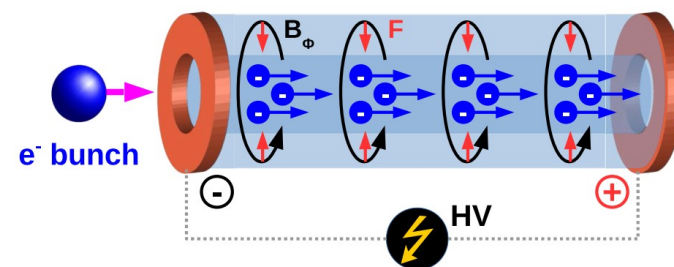
- High intensity at DAFNE (setting-up e+ slow extraction)
- e+ at VEPP (510 MeV)
- 6 GeV/11 GeV at Cornell/JLAB or/and Electron Beam Facility at CERN (Akesson et al.)

SPARC_LAB a multi-disciplinary accelerator Lab



Discharge-current flowing in a gas-filled capillary

- The gas acts like a conductor between the two electrodes
- By the Ampere law, an azimuthal magnetic field is induced
 - It radially grows across the current and decreases outside of it
- The capillary radially confine the gas and, thus, the current



$$B_{\phi}(r) = \frac{\mu_0}{r} \int_0^r J(r') r' dr'$$

Benefits

- Cylindrical symmetry in focusing (like solenoids)
- Favorable focusing strength $K \sim 1/\gamma$ (like quadrupoles)
- Large focusing gradients (\sim kT/m) \rightarrow short focal length
- Tunability by adjusting the current amplitude

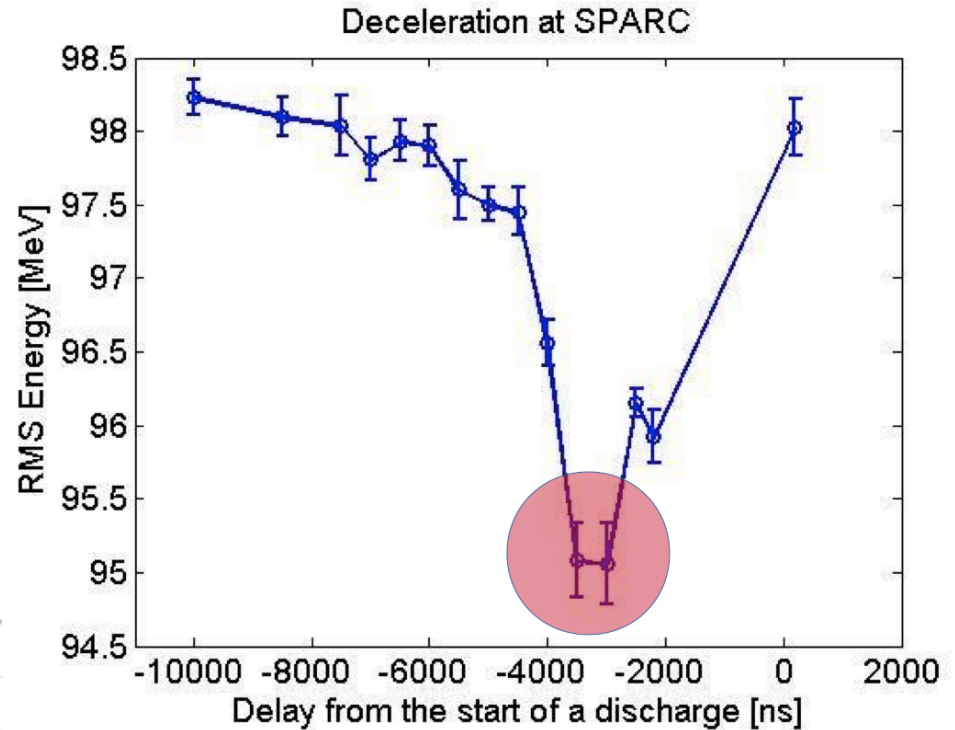
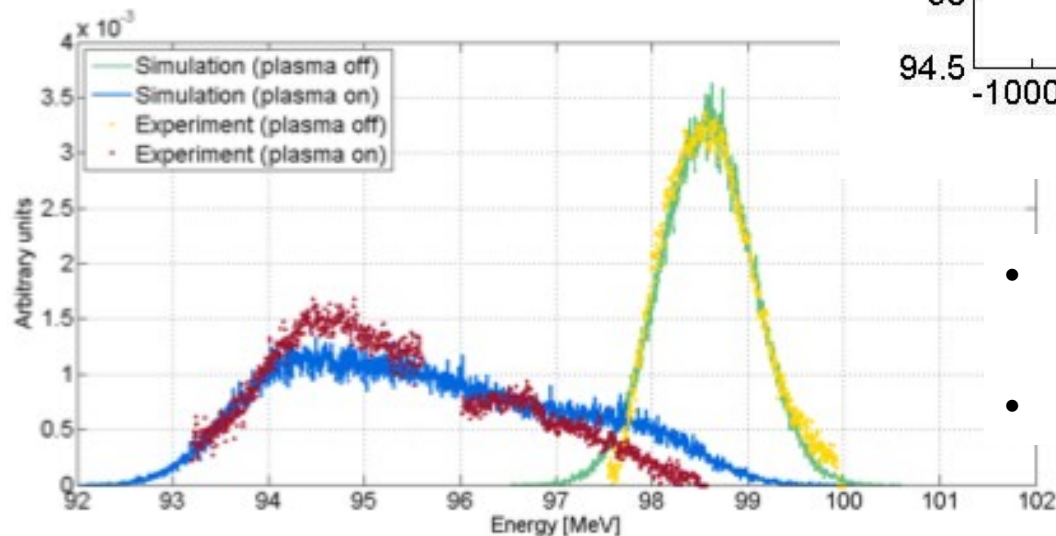
Similar to “passive” lenses

This is the real added value!

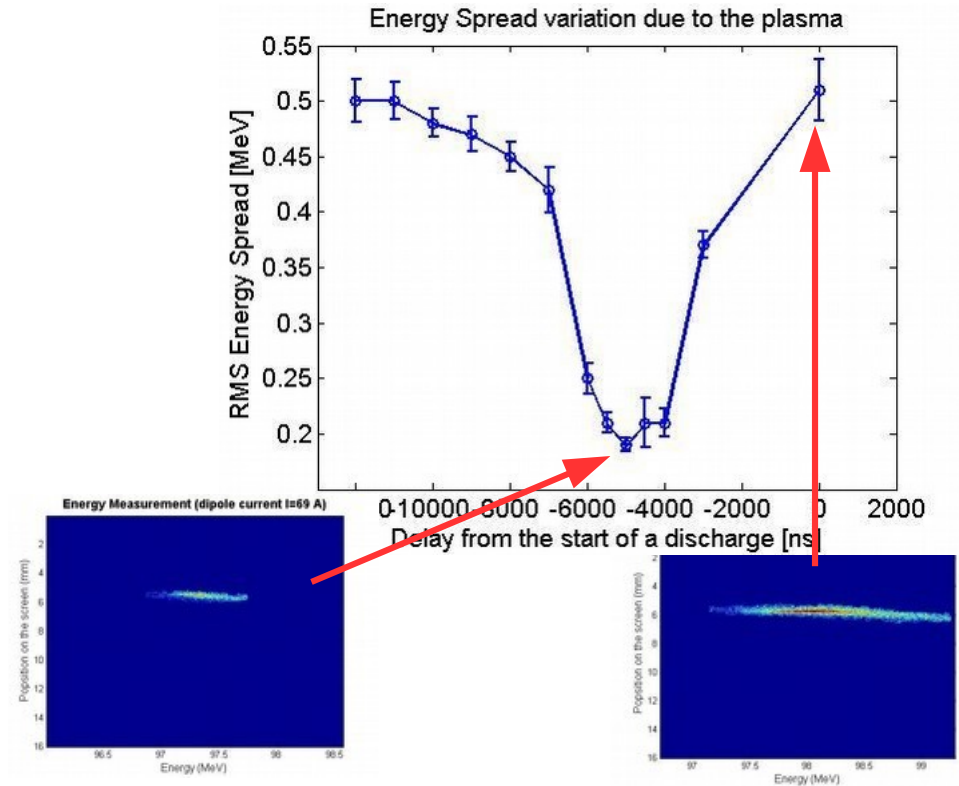
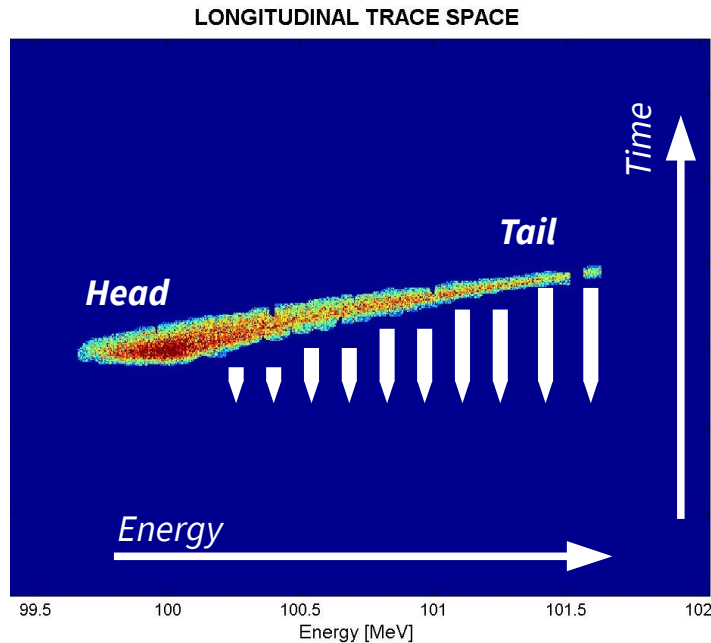
First results published in Phys. Rev. Lett. 121 174801

Beam parameters

- 200 pC, 97 MeV, 50 μm (rms), 0.5 MeV spread
- Emittance: 1.7 μm (X), 1.8 μm (Y)
- Spot size: 24 μm (X), 33 μm (Y)



- $E(\text{acc}) \sim 300 \text{ MV/m}$ evaluated (still not optimized – target is few GV/m)
- Plasma density $\sim 1.5 \cdot 10^{15} / \text{cm}^3$



Beam-driven plasma wakefields can be used to tune/reduce the beam energy-chirp

The tail of the beam is decelerated with respect to the head

Several knobs allow to adjust the energy-time correlation

Plasma density, bunch charge/density, bunch length, capillary length

Future steps of EuPRAXIA project

Next week – Collaboration Meeting in Frascati to decide the configuration of chosen site/sites to host the infrastructure(s) and the ancillary centres

2019 / Preparation of a CDR containing the plans for the machine(s), the proposal for the site(s), the costs and the governance of the Consortium (one possibility under evaluation: HEP-style collaboration)

November 2019 / End of 4 year H2020 Design Study

April 2020 (?) / CDR submission to ESFRI roadmap

~1 y delay with respect to what planned, due to recent change of ESFRI schedule
*Critical assets for positive evaluation from ESFRI: **Open Innovation and Sustainability***

May 2021 (?) / Outcome of ESFRI roadmap

If positive, start of Preparatory Phase towards a full TDR

News on EuPRAXIA@SPARC_LAB

Basic ingredients of EuPRAXIA@SPARC_LAB : **X-band Linac driver+plasma+FEL@3nm**

CDR submitted to INFN management (May 2018)

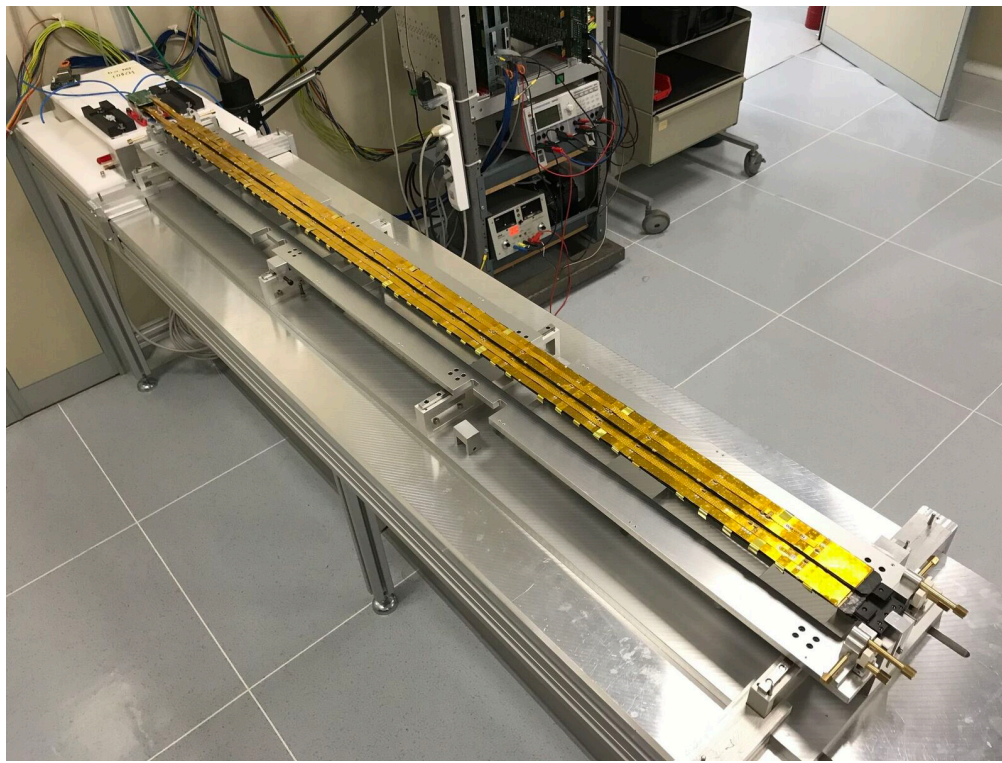
Nomination of an International Review Committee (*P. Muggli chair*)

Bid for preliminary design of infrastructure out: to be assigned by the end of 2018

Preparation work of technical infrastructure on-going (a Project Office for the infrastructure has been setup)

Layout flexible enough to host EuPRAXIA requirements

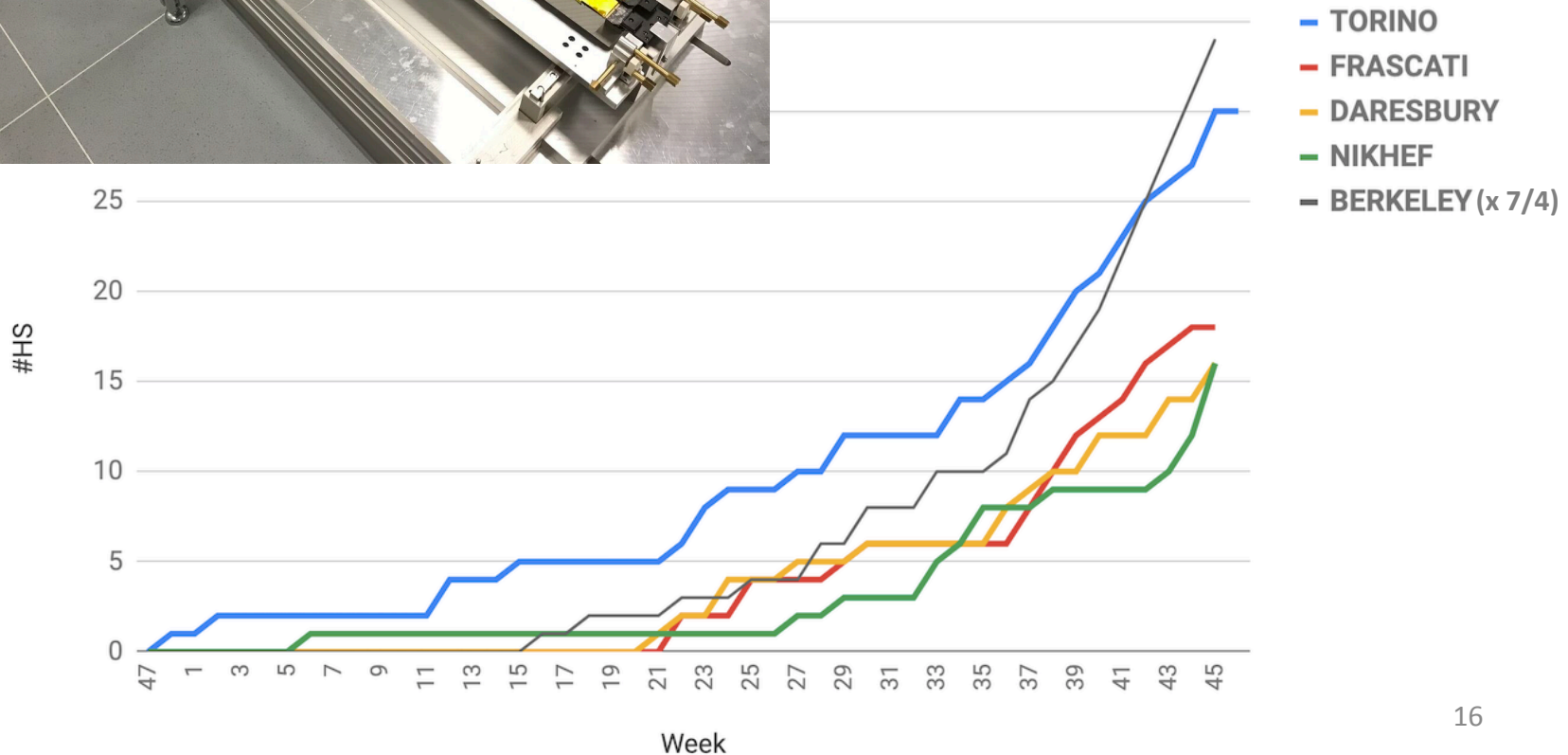


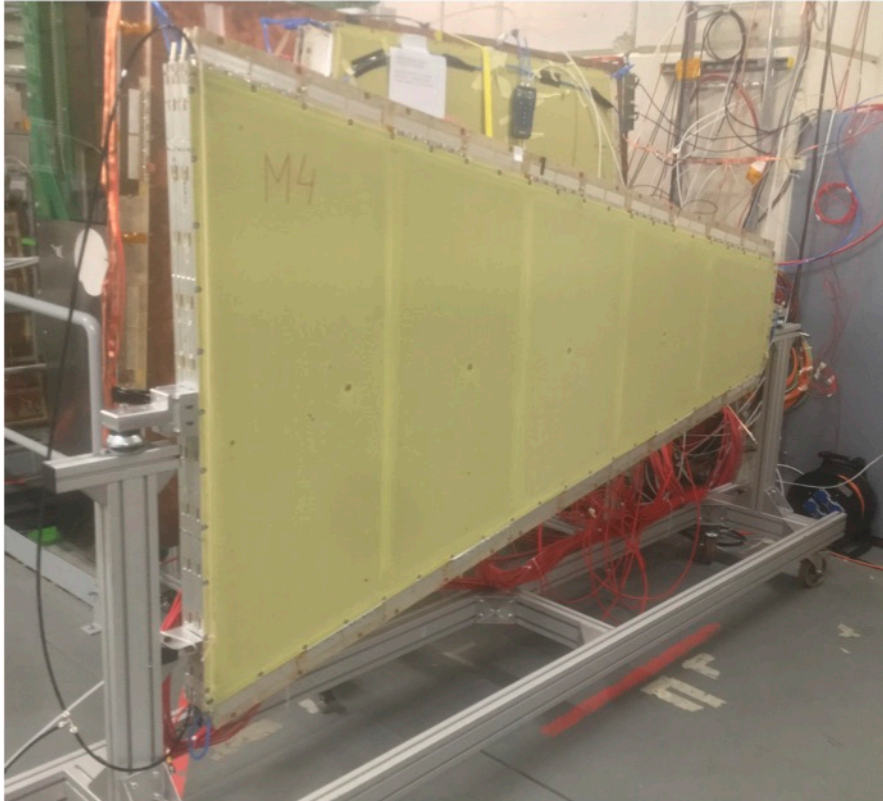


ALICE Phase 1 ITK @ LNF

10/27 staves produced
smoothly on-going
7h-22h shifts to speed up production

Expected to end in September 2019





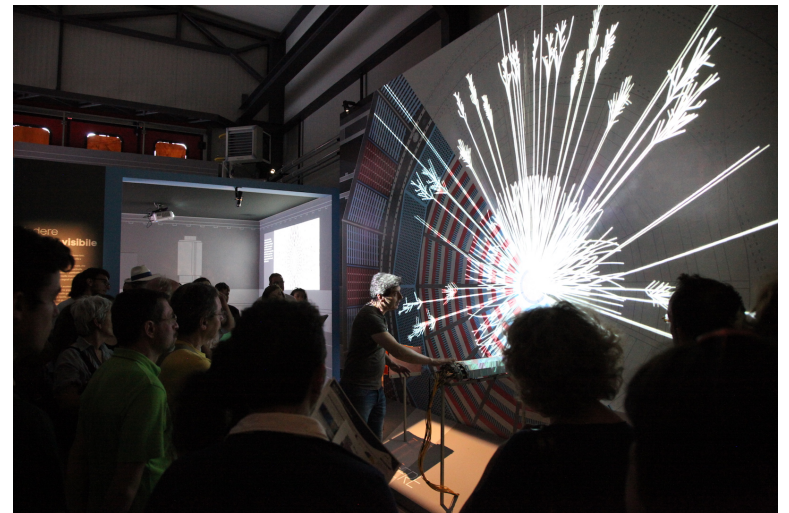
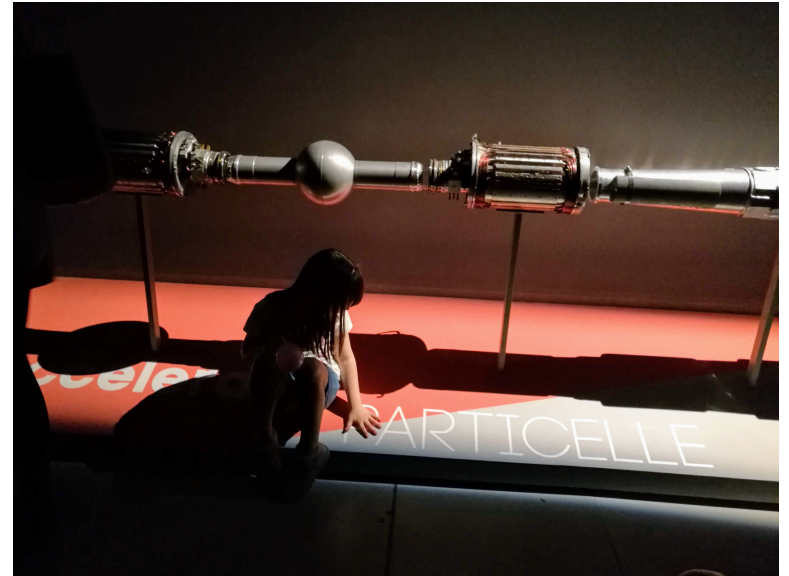
ATLAS Phase 1 Muon NSW @ LNF

A problematic start-up,
common to all production sites.
Now solved with better cleaning of
components

4/ 32 certified modules
2 module/month achieved
smoothly on-going
7h-22h shifts to speed up production

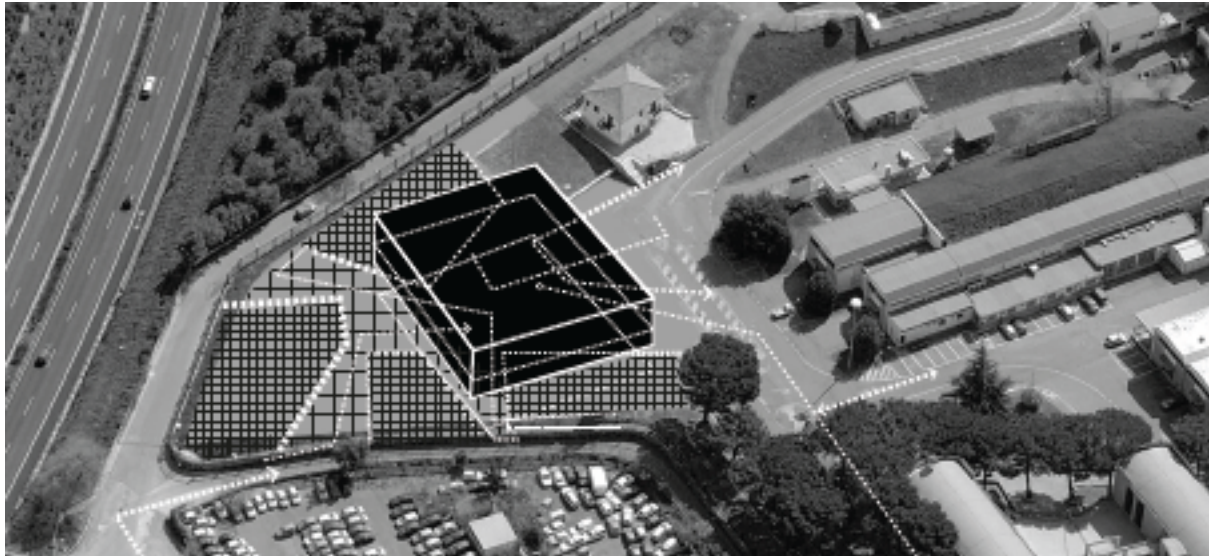
The new Visitor Centre just opened

Completed and in use !



~ 150 m² of exhibition and interactive media

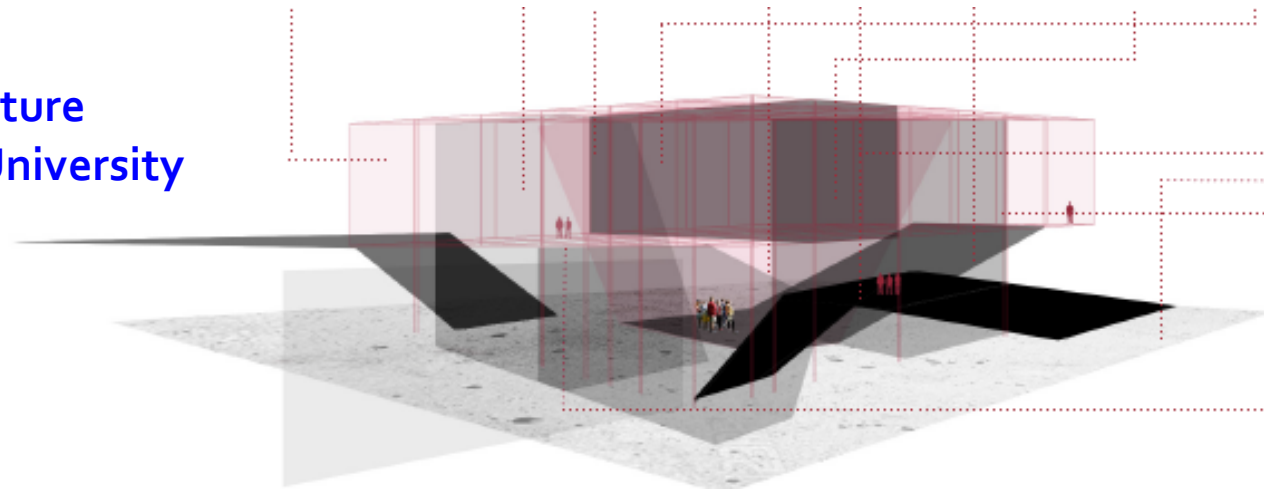
... and a more ambitious plan presented to local government (Lazio Region) ...



A thread of spaces devoted to outreach (exhibitions, hands-on, multimedia, ...) and to research (laboratories, clean rooms, ...)

Volume ~ 10,000 m³

Very preliminary ideas in collaboration with **Architecture Dept. of Sassari-Alghero University**



Conclusions

- DAFNE is preparing to host Siddhartaz experiment to start data taking before summer 2019
- Discussion on-going in the community to transform it in a accelerator test facility (DAFNE-TF), providing a further infrastructure to support large future accelerator projects, KT and young accelerator scientists training
- BTF line #2 is approaching its completion
- PADME has successfully entered data taking mode
- Plans for EuPRAXIA (and EuPRAXIA@SPARC_LAB) progressing well, in the spirit of proposing a future pilot European FEL infrastructure operated by good quality electron beams accelerated in plasma cells (by PWFA or LWFA mode)
- Boosting the Laboratory capabilities in outreach