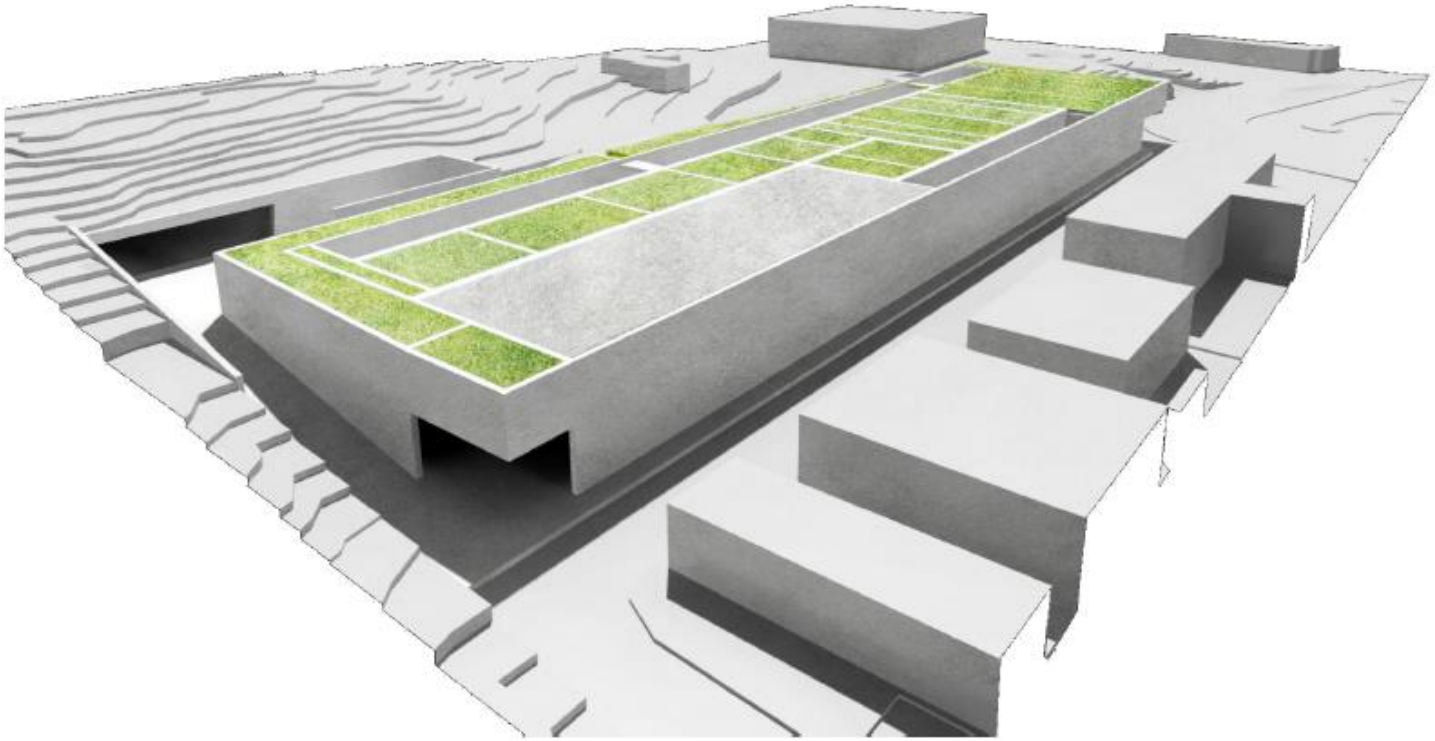


Laboratori Nazionali di Frascati: a status report

P. Campana – PECFA, ALBA – 19.07.2018

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

Laboratory highlights since last PECFA

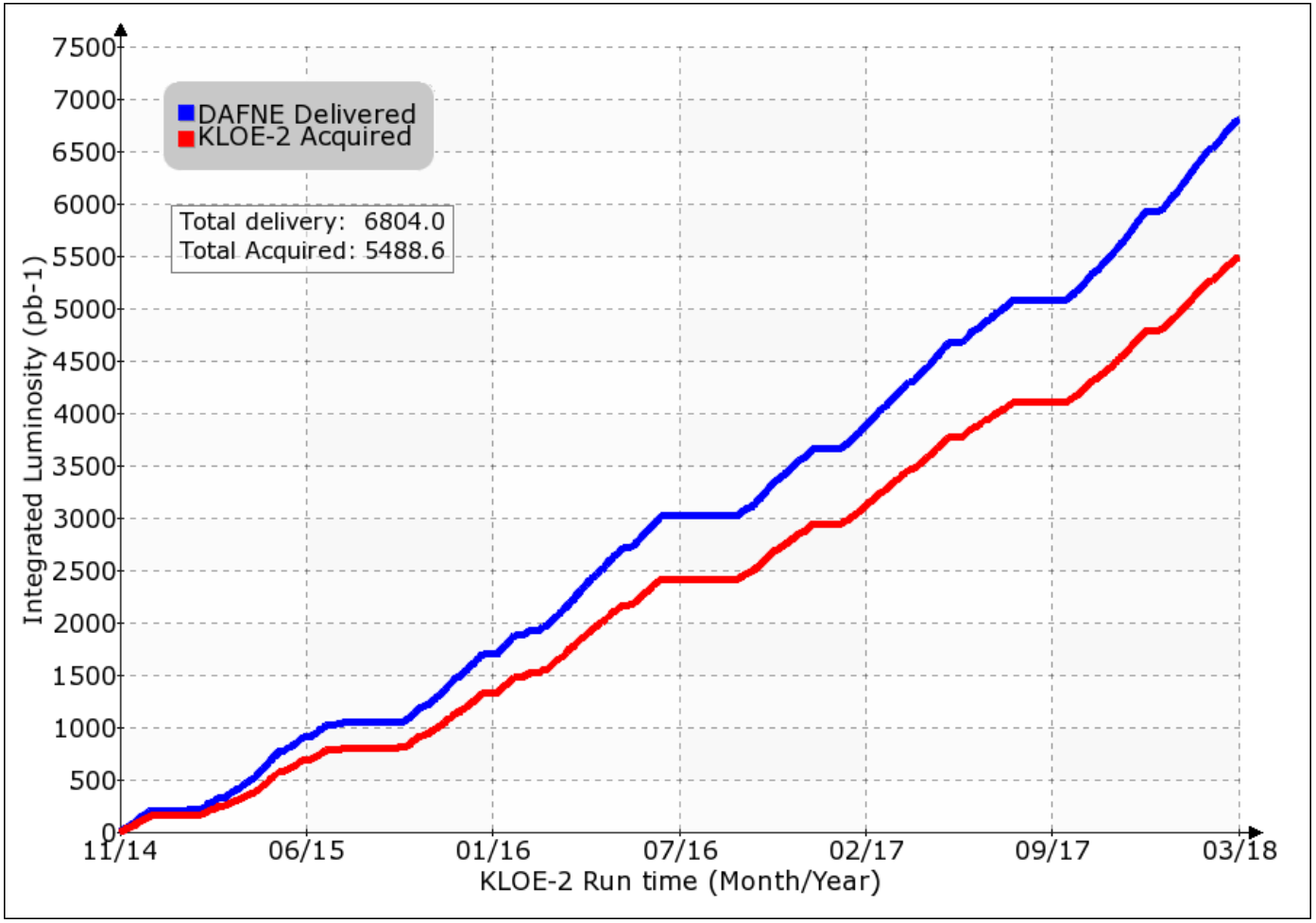
- **DAFNE & Beam Test Facility**

- Completion of KLOE2 data taking (March 31st, 2018)
- Preparation of BTF for PADME data taking
- Preparation of DAFNE for Siddharta2 data taking
- Thinking to reuse DAFNE as accelerator test facility

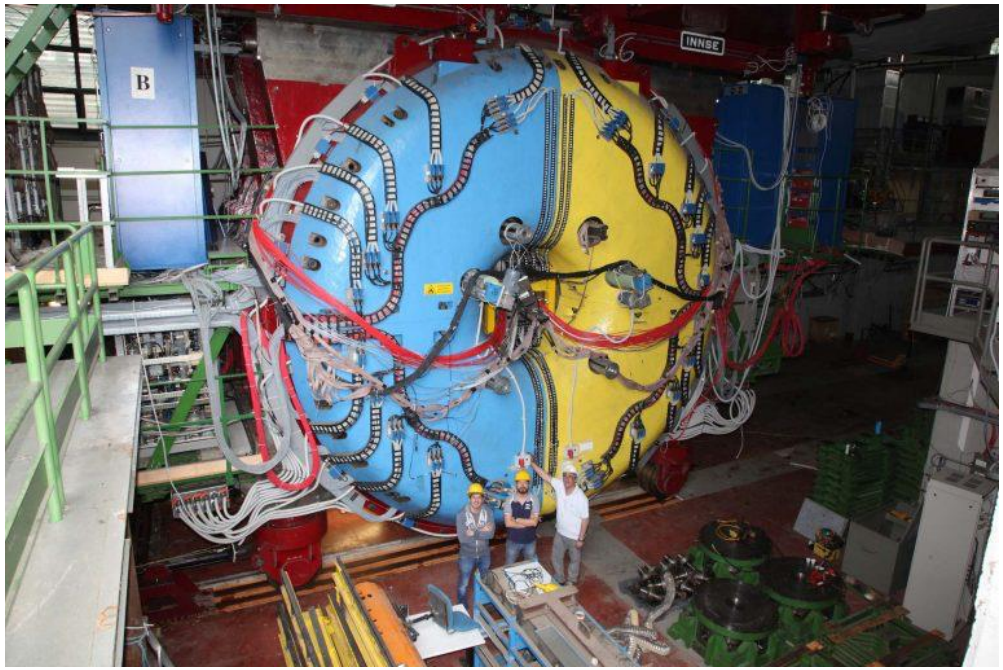
- **SPARC_LAB & EuPRAXIA**

- Experimentation on plasma cell started with the final setup
- X-band facility under preparation
- A Conceptual Design Report for EuPRAXIA European Design Study

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



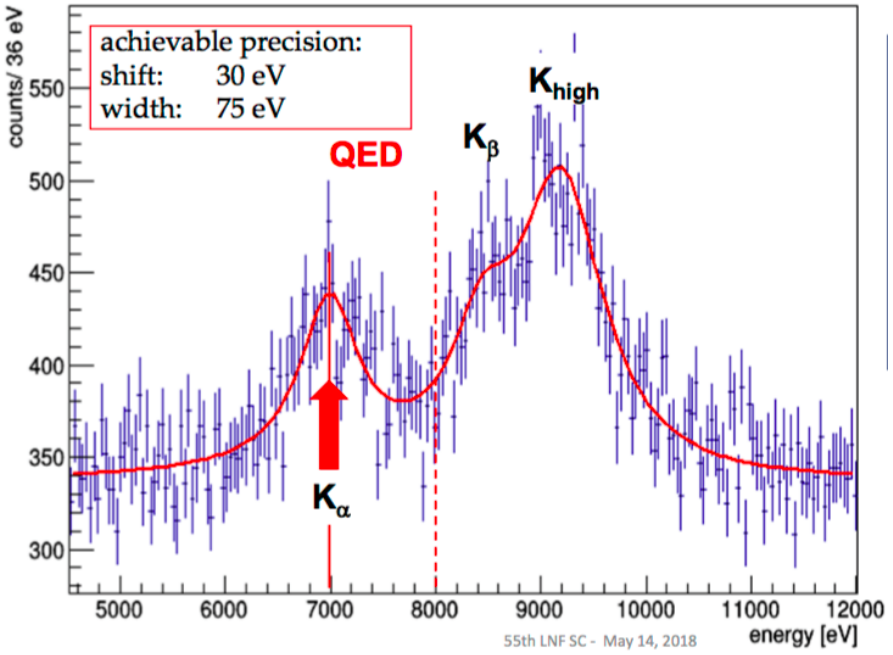
- **DAFNE** honoured the commitment of delivering > 5/fb on tape
- **KLOE2** removed from interaction point and now in garage position
- Setting up the IP to host **Siddharta2** (new focusing IP quadrupoles, new beam pipe, mechanical infrastructure)



KLOE2: a very large data set (8/fb) on hadron physics (η, η□, ϕ and low mass scalars), CP & CPT tests, K rare decays.
A sample of 2 x 10^{10} ϕ decays.
Plans to made it available to the experimental & theory community (working with CERN Open Data people)

Siddharta2: measuring for the 1st time shift and width of X ray transition in
exotic kaonic deuterium,
(strong interactions in atoms), to obtain the KN scattering length (Meissner, 2004):
state equation of neutron stars, chiral symmetries, etc…
1/fb is needed (~ 1 year data taking in 2019-20)

Geant4 simulated K^-d X-ray spectrum



DAFNE after 2020

At the end of its operation as collider, the Laboratory is thinking to transform the machine into a test facility for accelerator physics and technologies.
Moreover, 7 synchrotron beam lines are operating (from IR to soft X)

Very few facilities available worldwide (ANKA, ATF2, CLASSE, …)
The Laboratory has submitted a feasibility study to INFN management, including a plan for a minimal refurbishment, mainly on diagnostics and critical components

A list of realistic possibilities:

- Test of structures with low SEY
- Test of 3D-printed components
- Solid state amplifiers
- Tests of targets at high fluxes
- Emittance exchangers
- Components for SLED
- Beam dynamics study with crystals
- Positron sources within DAFNE

A sizeable list of interesting ideas has been already collected, including technological tests for muon colliders (LEMMA), e+ resonant extraction (POSEYDON), study of electron cloud for HL-LHC, FCC, etc …

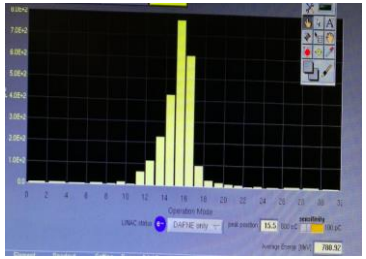
A dedicated, international workshop, will be held at LNF at the end of 2018, to collect ideas, proposals, and collaborations, in the frame of supporting ***regional infrastructures*** in the European Strategy

Beam-Test Facility upgrade

LINAC consolidation

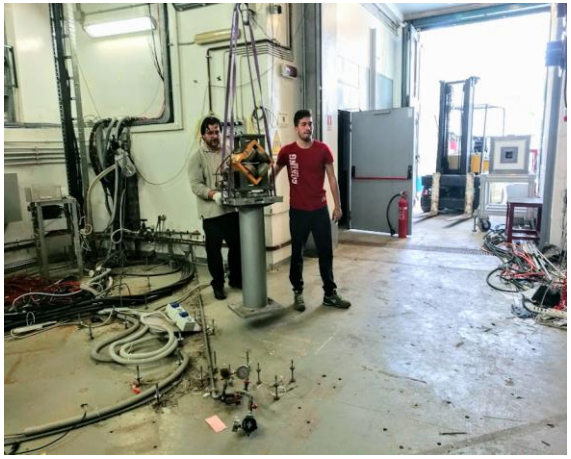
- New PFN charging power supplies, new pulse transformer, new interlocks and control system
- **Done on 1 modulator out of 4: commissioning OK**

780 MeV electron beam



Existing BTF line **completely dismantled**

BTF building modified and refurbished for accommodating a **second experimental area** and bunker

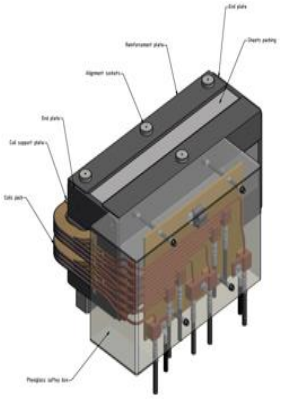


Experimental hall

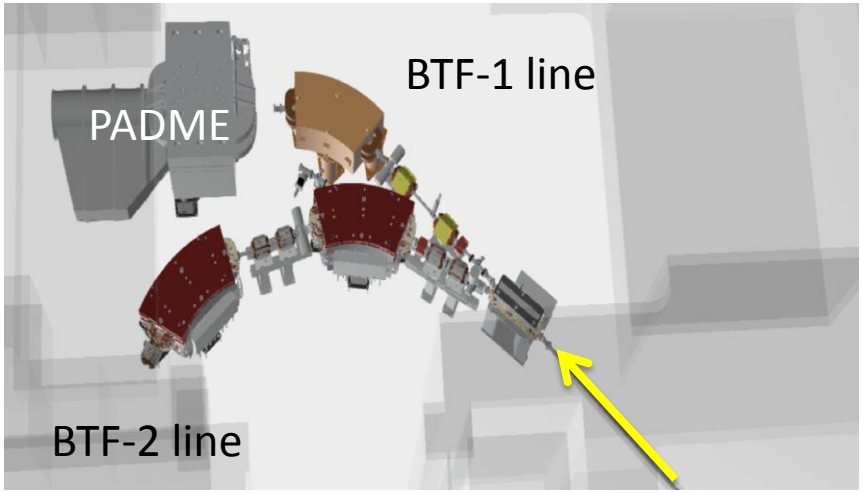
New entrance

Old control room

Doubling the BTF line



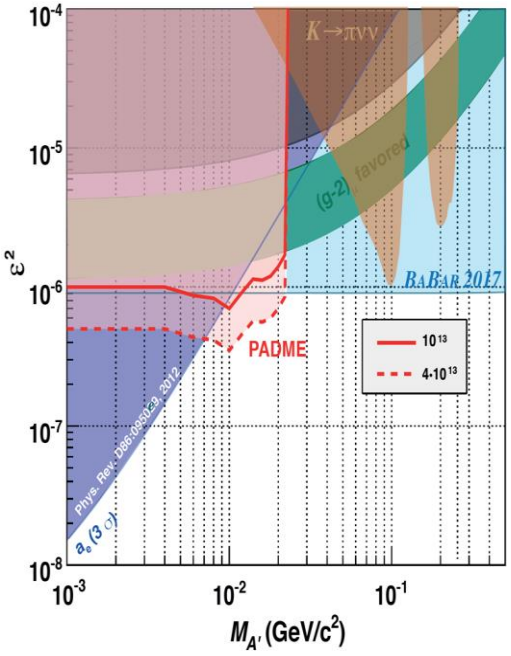
New fast dipole



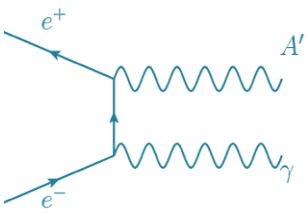
from LINAC

- **BTF-1 beam-line** (where PADME experiment is being installed) has been **completed**
- **BTF-2 beam-line** first components installed
- **Electron beam delivered to BTF-1**
- **Completion of BTF-2 beam-line by spring ‘19**

PADME: exploring dark sector in positron annihilations



550 MeV positron beam from BTF, known momentum, low divergence

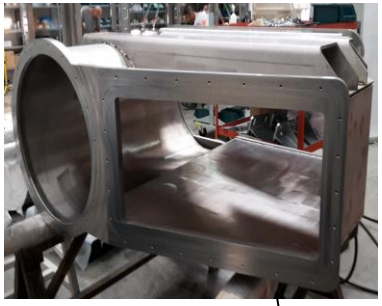


Looking for a peak in the missing mass

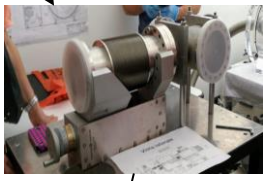
Measure position and energy of recoiling photon with a crystal (BGO) calorimeter

Thin (100 , low-Z (Carbon), active (graphitized strips diamond) target

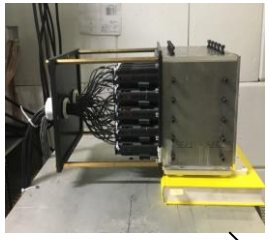
Main vacuum + scintillating veto detector



Target vacuum



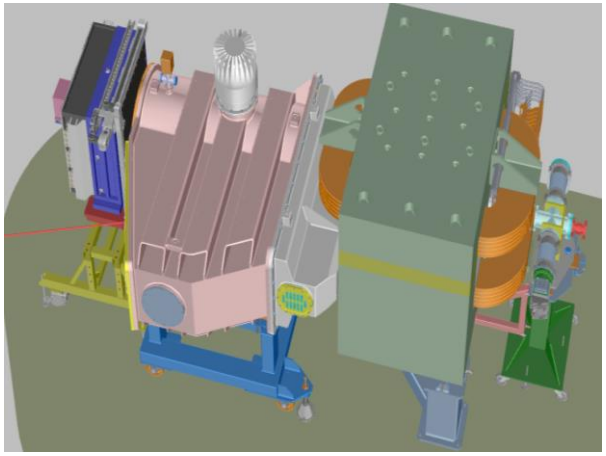
Fast veto calorimeter (PbF_2 crystals)



Beam-sweeping/analysing dipole

Timepix tracker

PADME experiment perspectives



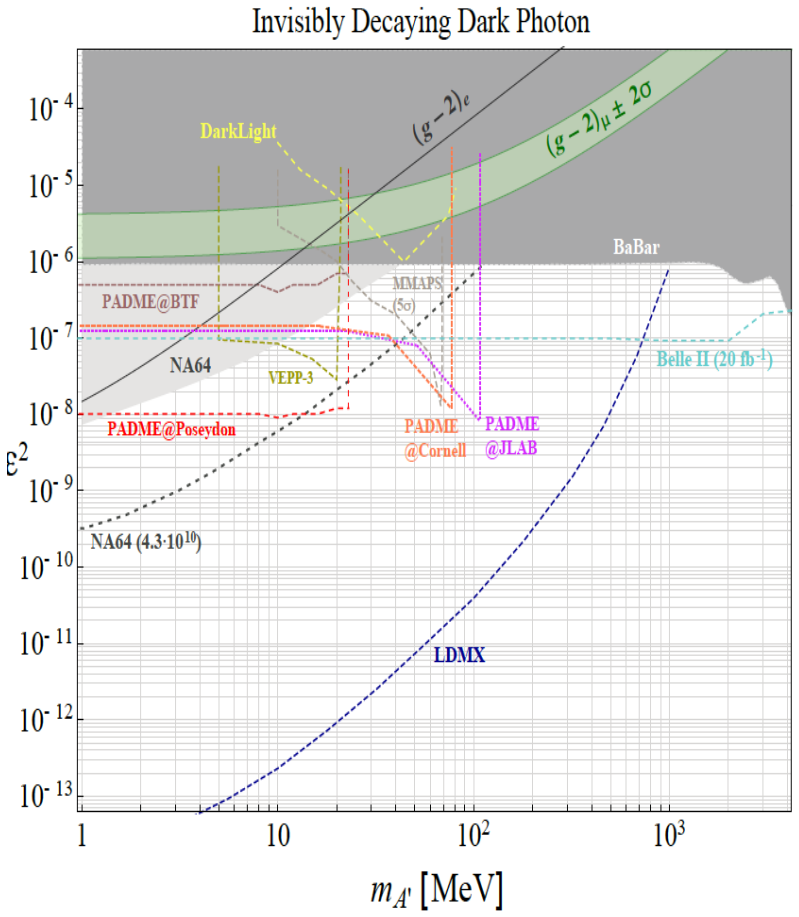
- PADME installation completed by **July 2018**
- First data in **September 2018** for 4-5 months
- Goal 10^{13} pot with **550 MeV – 200 ns** e+ beam

Possible extension of physics program (in 2019)

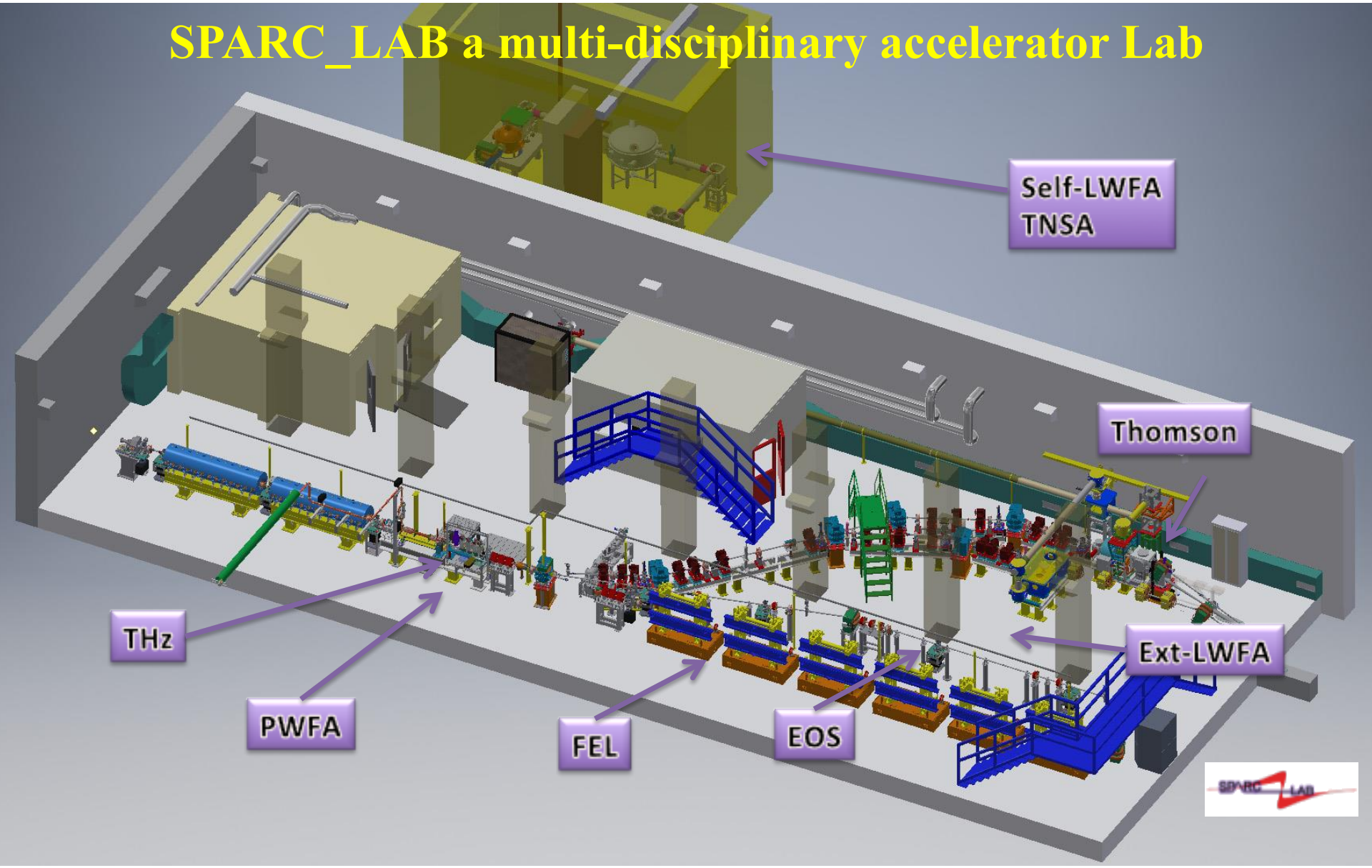
- Resonant production of X(17 MeV) protophobic boson (^{8}Be anomaly)
- Search for axion-like particles
- Searches for visible dark photons with thick targets exploring resonant production

Boosted sensitivity (not at BTF)

- High intensity at DAFNE (e+ slow extraction)
- e+ at VEPP (510 MeV)
- 6 GeV/11 GeV at Cornell/JLAB



SPARC_LAB a multi-disciplinary accelerator Lab

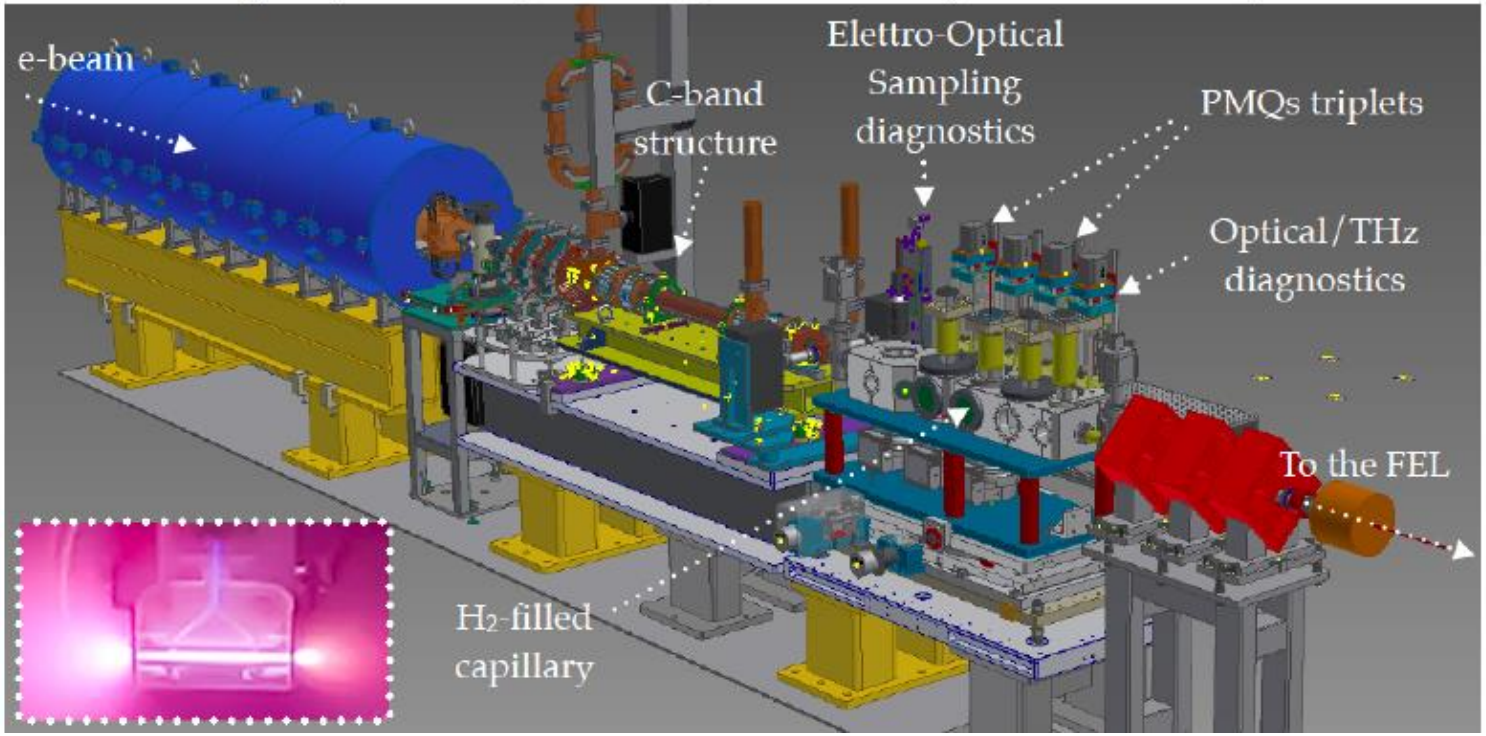


Plasma Interaction Chamber

SPARC LAB

H_2 generation and injection system

- Electrolytic generator (1 l of water → 1.4 m^3 Hydrogen)
- Pressure reduction system (300 mbar → 10 mbar in capillary)
- Electro-valve triggered by the HV discharge with tunable aperture (3 ms) and delay time (10 μs before discharge)



A new Interaction Chamber installed since April 2018: better functionalities and more diagnostics. Planned experiments (PWFA technique) in this year:

- Driver/Witness interaction with plasma in the capillary
- Driver+Witness interaction with plasma in the capillary

A full Conceptual Design Report (EuPRAXIA@SPARC_LAB, 280 pages) has been prepared to propose Frascati as host site for the future European FEL operated by a plasma driven accelerator (a Design Study in H2020).
PDF available at: http://www.lnf.infn.it/sis/preprint/pdf/getfile.php?filename=INFN-18-03-LNF.pdf

The first start-to-end full simulation (from **injector to FEL exit**) of such a facility !
A very important result for the whole EuPRAXIA collaboration

Basic assets of EuPRAXIA@SPARC_LAB:

- a 12 GHz ***X-band*** state-of-the-art 1 GeV Linac, able to inject high quality beam into a plasma cell, and capable to run alone a FEL;
- ***plasma cells*** operated in PWFA or in LWFA mode to accelerate e^- up to 1-2 GeV;
- an undulator ***lasering with 1 GeV beam*** at **3 nm** (UV photons of 420 eV), centered at the "***water window***", of extreme interest for biological samples

INFN – CERN official partnership on X-band RF development

The INFN Frascati X-box

it will be located in LNF building #7, very close to the SPARC_LAB area, formerly used for testing and conditioning of the DAFNE RF power plants and cavities

Now refurbishing an area at LNF to host the X-band test stand

The INFN Frascati X-box

Pulsed Modulator: to be procured by INFN

OPERATIONAL PARAMETERS

		Unit	K2-3X	Notes
Pulse Output				
	Peak power to Klystron	MW	150.7	Peak power from Modulator
	Average power to Klystron	kW	17.3	Average power from Modulator
	Klystron Voltage range	kV	450	Nominal 410kV, see fig above
	Klystron Current range	A	335	Nominal 305A, see fig above
	Inverse Klystron Voltage	kV	<30	Reduced by the Solid State technology
	Pulse length	µs	1.5	Top of Klystron Voltage pulse
	Pulse length at 50%	µs	3.4	Of the Voltage Pulse
	RF duty cycle	%	0.0075	
	PRF range	Hz	1 - 50	
	Top flatness (dV)	%	<±0.25	Deviation from nominal voltage within the top of the pulse length
	Amplitude stability	%	<±0.1	
	Trig delay	µs	~1.2	See fig above
	Pulse to pulse jitter	ns	<6	
	Pulse length jitter	ns	<±10	
Filament Output				
	Klystron Max voltage DC	V	30	Nominal 10-30V
	Klystron Max current DC	A	30	Nominal 18-30A
	Ky. Fil. Current stability	%	<±1	
	Pre-heating period	min	60	Filament current is softly ramped to max value during pre-set time

VKX-8311A

X-band klystron: provided by CERN

Typical Operating Parameters		
Item	Value	Units
Beam Voltage	410	kV
Beam Current	310	A
Frequency	11.994	GHz
Peak Power	50	MW
Ave. Power	5	kW
Sat. Gain	46	dB
Efficiency	40	%
Duty	0.009	%

Pulse compressor: provided by CERN

Other components:

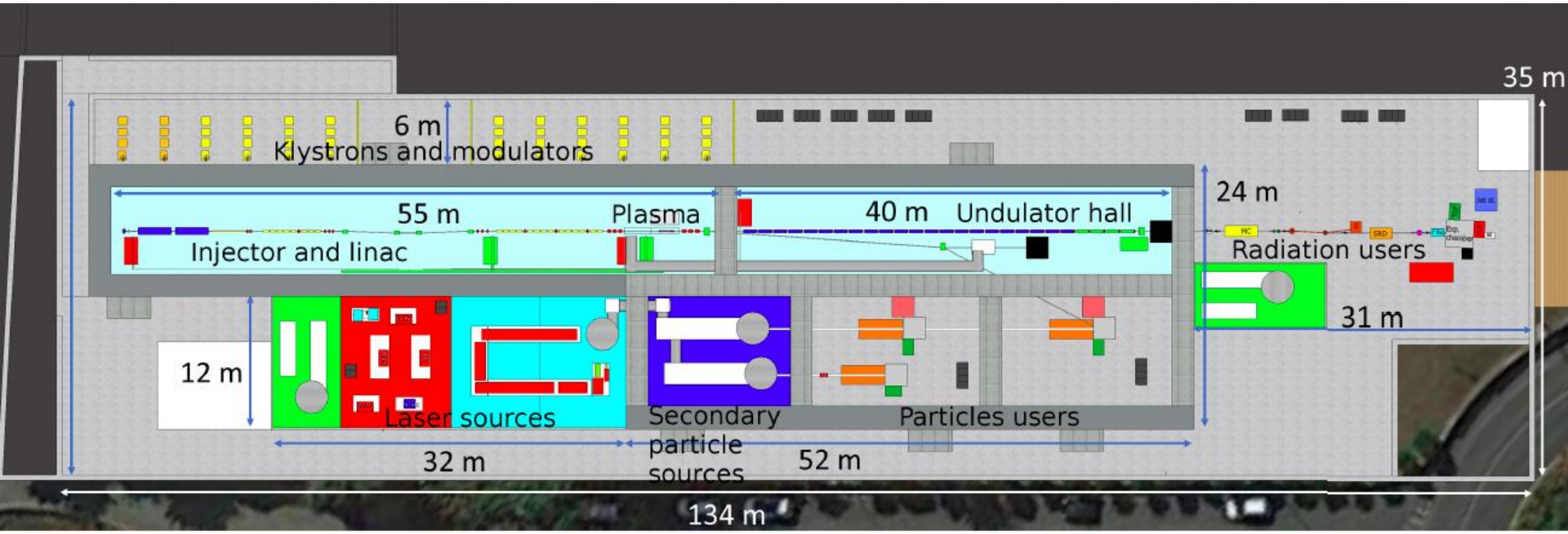
- Low level RF and controls;
- RF driver amplifier;
- Rectangular waveguides;
- Ceramic windows;
- Vacuum pumps and power supplies;
- ...

All components will be either provided by CERN or procured by INFN in full conformity with the original CERN X-box parts.

With the contribution of the **LATINO** project: a "Laboratory in Advanced Technologies for INnOvation" funded by Regione Lazio

An OPEN Infrastructure for Technological Transfer (2.7 ME investment)

- 130 x 30 m^2
- 58,000 m^3



A preliminary evaluation of project costs

Buildings: design, construction and technical infrastructures **~ 25 ME**

Phase 1: X-band Linac up to 0.9 GeV, plasma cell, undulator, diagnostics, reuse parts of SPARC_LAB (injector and 0.2 PW laser)
Phase 2: Upgraded Linac, new injector, upgraded laser (0.5 PW), FEL user station

Phase1+2 **~50 ME**

TOTAL (only hardware) **~ 75 ME**

>> Bid for the executive design of the building went out last week !

HELMHOLTZ ASSOCIATION SUPPORTS ATHENA WITH 29.99M EURO GRANT

2018 - 06 - 29

DESY news 29.06.18

A preliminary evaluation of project timeline

At least 5-6 years are needed for the construction (site ready in ~ 2023-24).
About 1 year needed for Phase 1 installation, to be followed by beam commissioning

Next steps for EuPRAXIA

The next relevant milestones for the EuPRAXIA project are represented by:

- the conclusion of the Design Study (**November 2019**);
- the submission to the ESFRI roadmap (**August 2019**) of a CDR which will define the choice of the site (single, distributed ?) and the governance of the infrastructure

ERIC ? Consortium ? HEP style-collaboration (very interesting option …) ?
To be decided at the next EuPRAXIA meeting (in November 2018)
Interested countries: Germany, France, Portugal, UK and Italy

ESFRI decision in Autumn 2020. If positive it will lead to a Preparatory Phase (TDR) and to possible EU co-funding (to be explored)

Conclusion

- DAFNE has nearly come to an end in operating in collider mode. A plan to transform it in a accelerator test facility is under evaluation, pointing to a regional supporting infrastructure for large future accelerator projects

- KLOE2 data set will represent a legacy on precision physics for future analyses also in "open access"

- PADME and Siddharta2 are ready to take data in 2018 and 2019

- There is a *window of opportunity* to host in Frascati a future European facility for new advanced technologies in particle acceleration. A flexible project has been finalized in the form of a CDR, to build an "EuPRAXIA compliant" infrastructure, including a X-band Linac. A project in phases, based on SPARC_LAB experience

- X-band R&D has started in collaboration with CERN-CLIC group