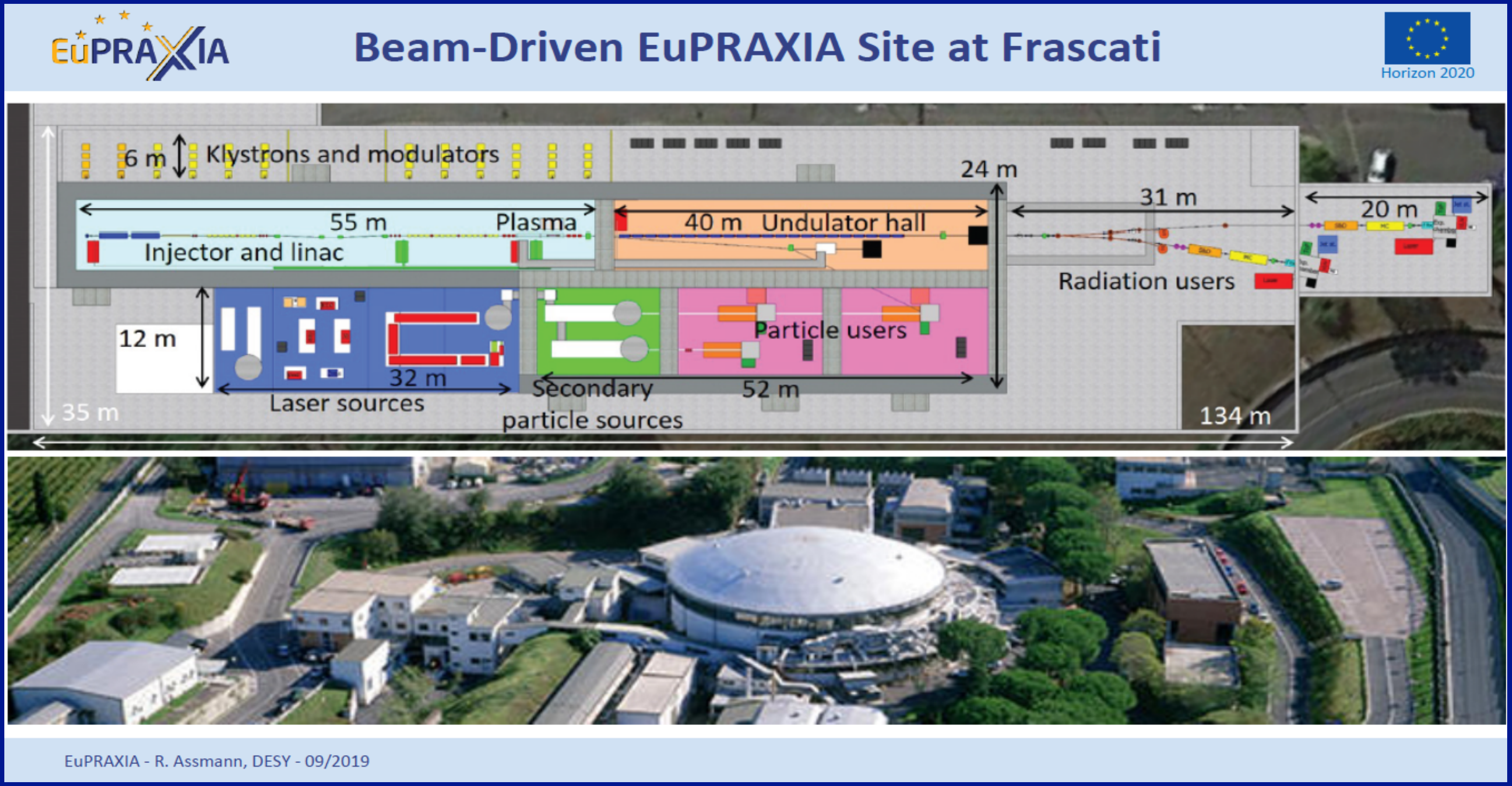
EuPRAXIA & SPARC_LAB

Massimo.Ferrario@lnf.infn.it
On behalf of the EuPRAXIA@SPARC_LAB team



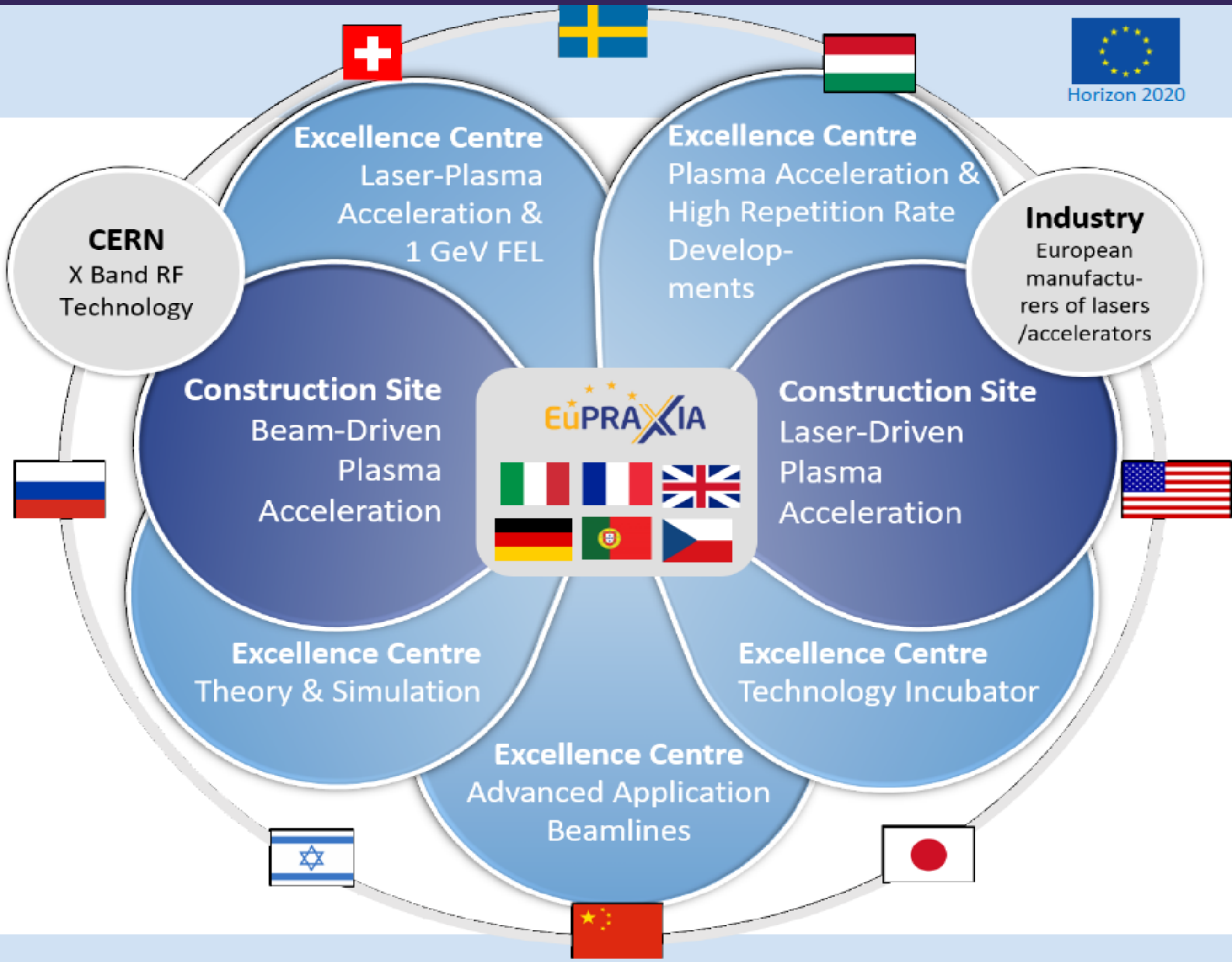
Deliverable: CDR (end of October)

- Work on **technical solutions**, but also on **facility concept**
- Present status:
  - **555 pages** strong draft
  - Some contributions still coming, changes to be included
- Cannot be reported completely here.
- Selection of results and concepts → apologies
- For more details: read the CDR once it is published...

Excellence Sites

Located at existing major facilities in Europe, profiting from ongoing investments

- demonstration of major **critical principles**
- construction of **prototypes**
- testing and qualification of prototypes
- construction/testing of **components for construction site(s)**



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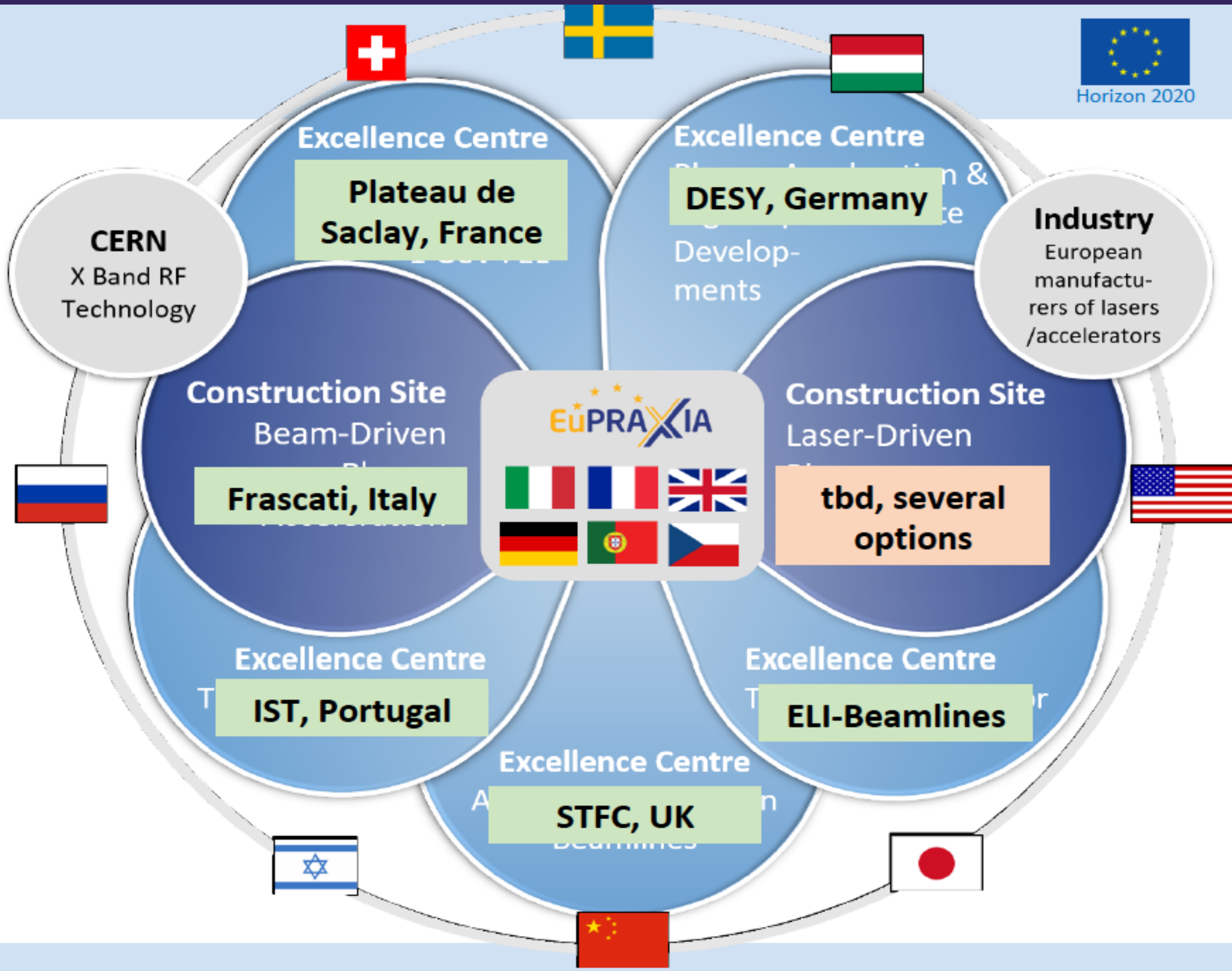
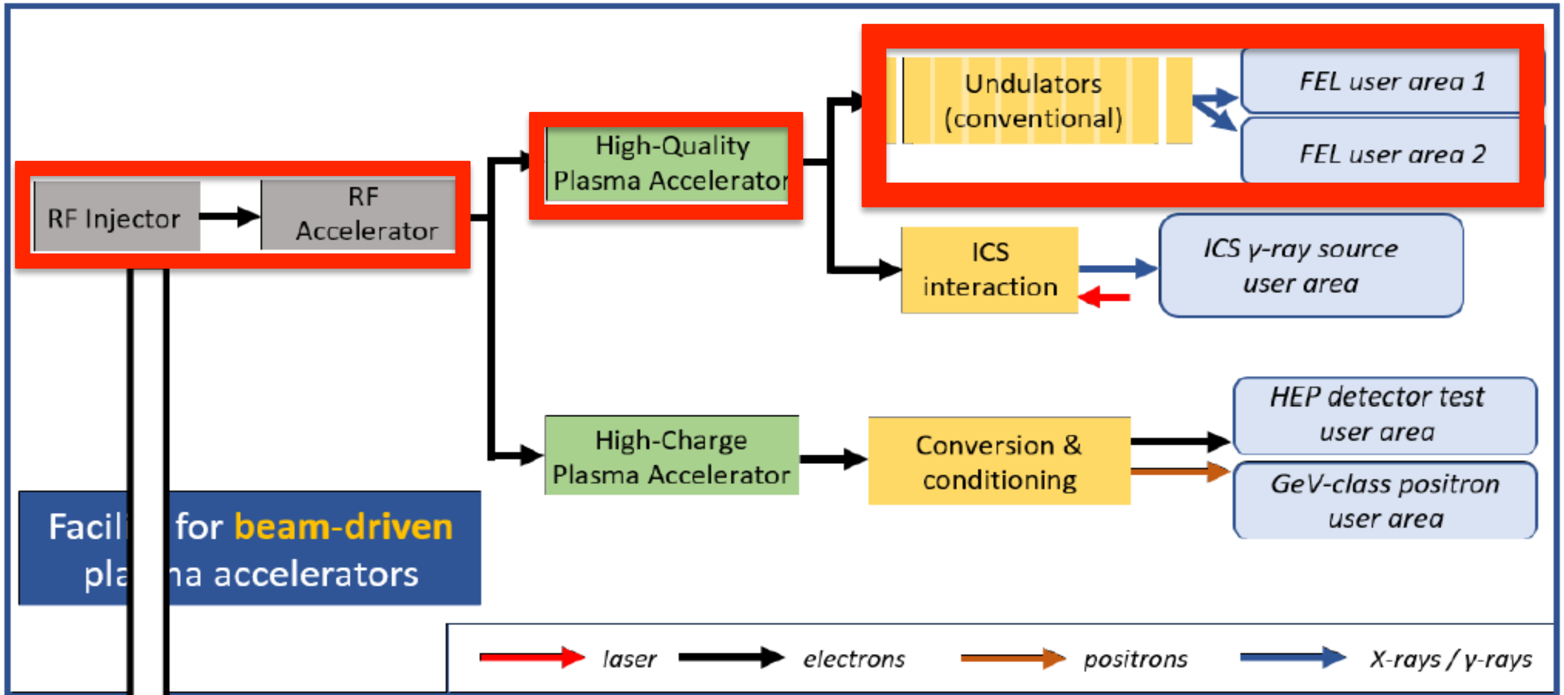


The Beam-Driven Construction Site



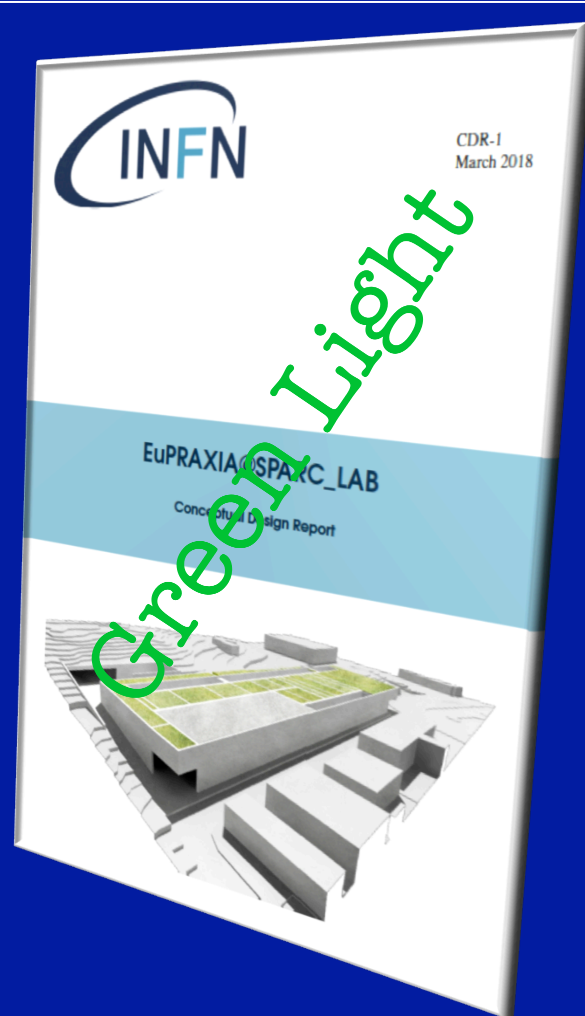
- Free-electron laser
- Gamma-ray source (inverse Compton scattering)
- GeV-class positron source
- High-energy physics detector testing stand

A STATE-OF-THE-ART X-BAND LINAC			
Operating frequency	Field strength	Length	Final beam energy
~12 Hz	≤ 80 MV/m	10 m	~500 MeV

EuPRAXIA@SPARC_LAB

CDR Review Committee Meeting June 20-21

- D. Angal-Kalinin (STFC)
- P. Muggli (MPI) – Chair
- M. Pedrozzi (PSI)
- L. Scibile (CERN)
- S. Schreiber (DESY)



http://www.lnf.infn.it/sis/preprint/pdf/getfile.php?filename=INFN-18-03-LNF.pdf

LNF SciCom Recommendations

- The committee strongly recommends that a clear organizational structure be put in place to further develop the EuPRAXIA@SPARC_LAB project. The project should be led by a scientist surrounded by a strong engineering and managerial team. In particular it is important that the project be fully integrated in the laboratory organization.

- The committee highlights the importance of properly sizing the new building to accommodate user areas and options for the linac/plasma and undulators and yet unexpected needed space.

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- Long term (24h) operation also needs to be demonstrated.

Project Office – (LNF Steering Board)

LNF Director - LNF Administration – Resp. Divisioni (R,A,T)

Edilizia – Impianti –Sicurezze – Radio Prot. - Project Leader & Technical Team

- A Project Office has been established aiming to bring together in a "control room" some of the key figures of the project and to be the indispensable managerial-organizational complement to the activities of the EuPRAXIA @ SPARC_LAB Collaboration, which remains responsible for the technical-scientific choices of the project, as well as its construction, installation and achievement of scientific goals.

- The mandate of the PO will include:

- deliver the Organisational Breakdown Structure (OBS) of the EuPRAXIA@SPARC_LAB project
- carry out all the steps necessary for the construction of the building intended to house EuPRAXIA@SPARC_LAB, monitor the project and its execution, the installation of technical services and the performance of all tender and administrative procedures, including the timing and financial resources;
- - carry out all the necessary steps for the preparation of the Technical Design Report for each subsystem of the EuPRAXIA @ SPARC_LAB machine, monitor the project, also in relation to the necessary R&D developments. Subsequently, coordinate their construction, installation and implementation, with particular regard to the timing and aspects relating to human and financial resources.

Organization Breakdown Structure

INFN
Istituto Nazionale di Fisica Nucleare

DocID	Rev.	Validità
Eupraxia-PM-QA-0010	0.1	Bozza

Data 29/10/2019

Project Management - WBS, OBS

Organization Breakdown Structure,
Work Breakdown Structure e descrizione

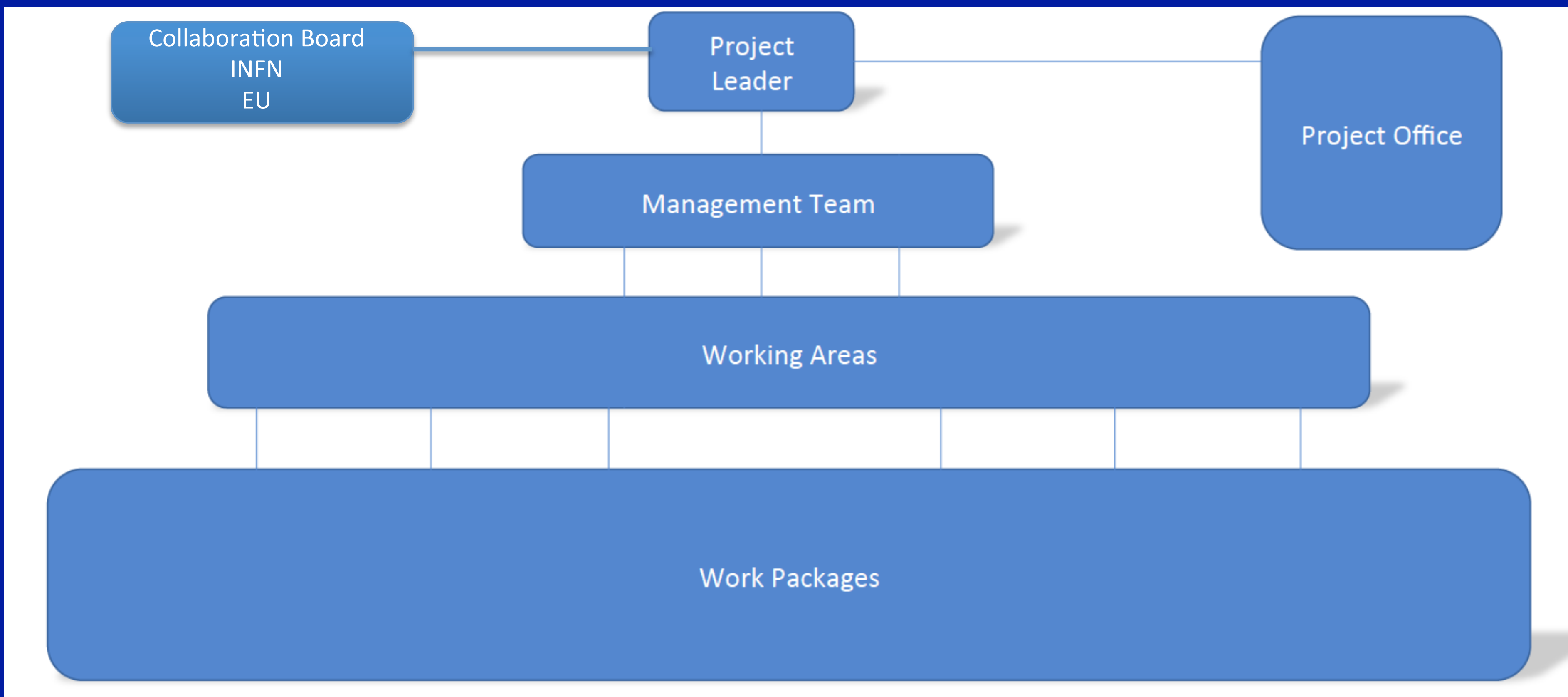
Descrizione dell'organigramma di progetto, della WBS, dei singoli WPs e relative attribuzioni

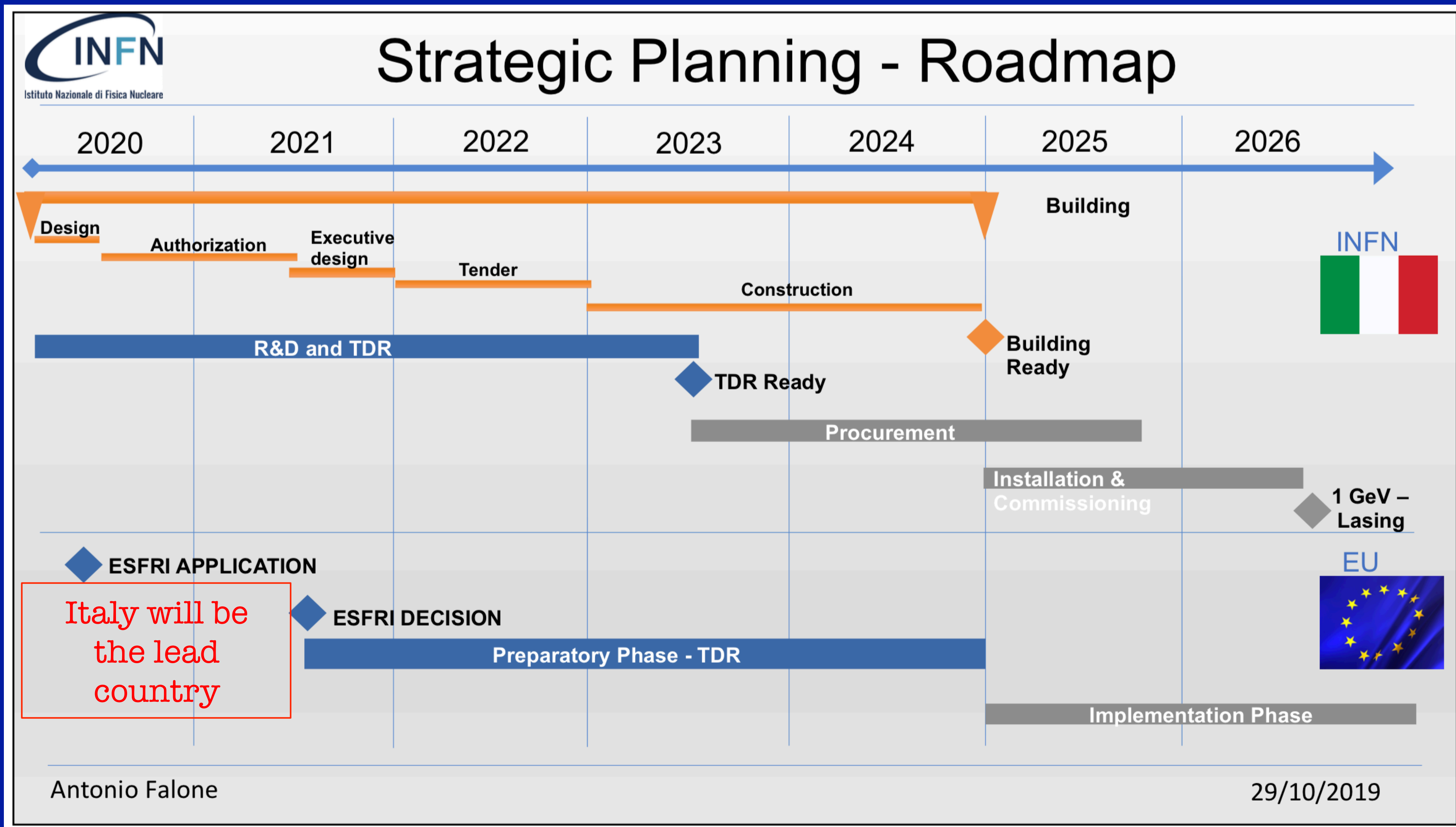
Autore	Verificato da	Approvato da
A.Falone	P.Campana A.Ghigo M.Ferrario	P.Campana A.Ghigo

Lista di distribuzione:

- Documento Pubblico

Organization Breakdown Structure




INFN
Istituto Nazionale di Fisica Nucleare
Strategic Planning - Roadmap
2020
2021
2022
2023
2024
2025
2026
Building
Design
Authorization
Executive design
Tender
Construction
INFN
R&D and TDR
Building Ready
TDR Ready
Procurement
Installation & Commissioning
1 GeV – Lasing
ESFRI APPLICATION
EU
Italy will be the lead country
ESFRI DECISION
Preparatory Phase - TDR
Implementation Phase
Antonio Falone
29/10/2019

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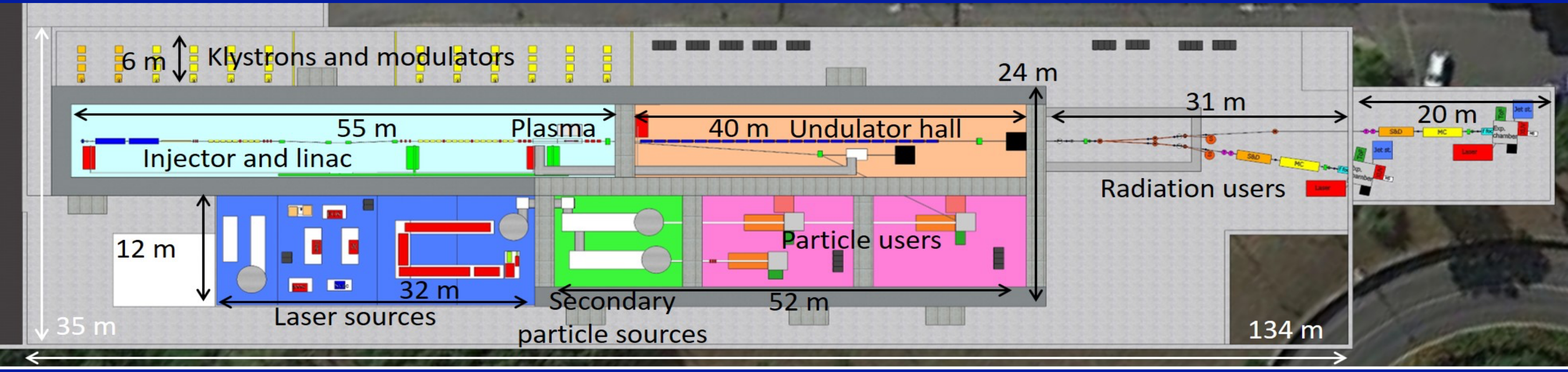
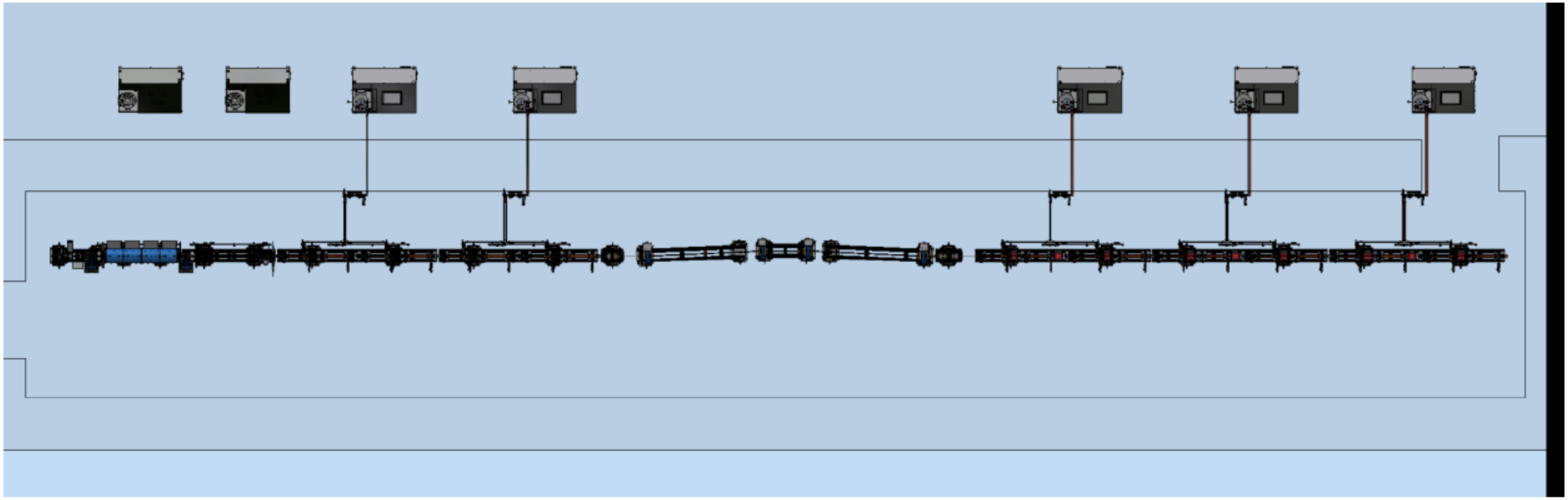
From the Preliminary Layout



To the CAD Layout

TO BE UPDATED.

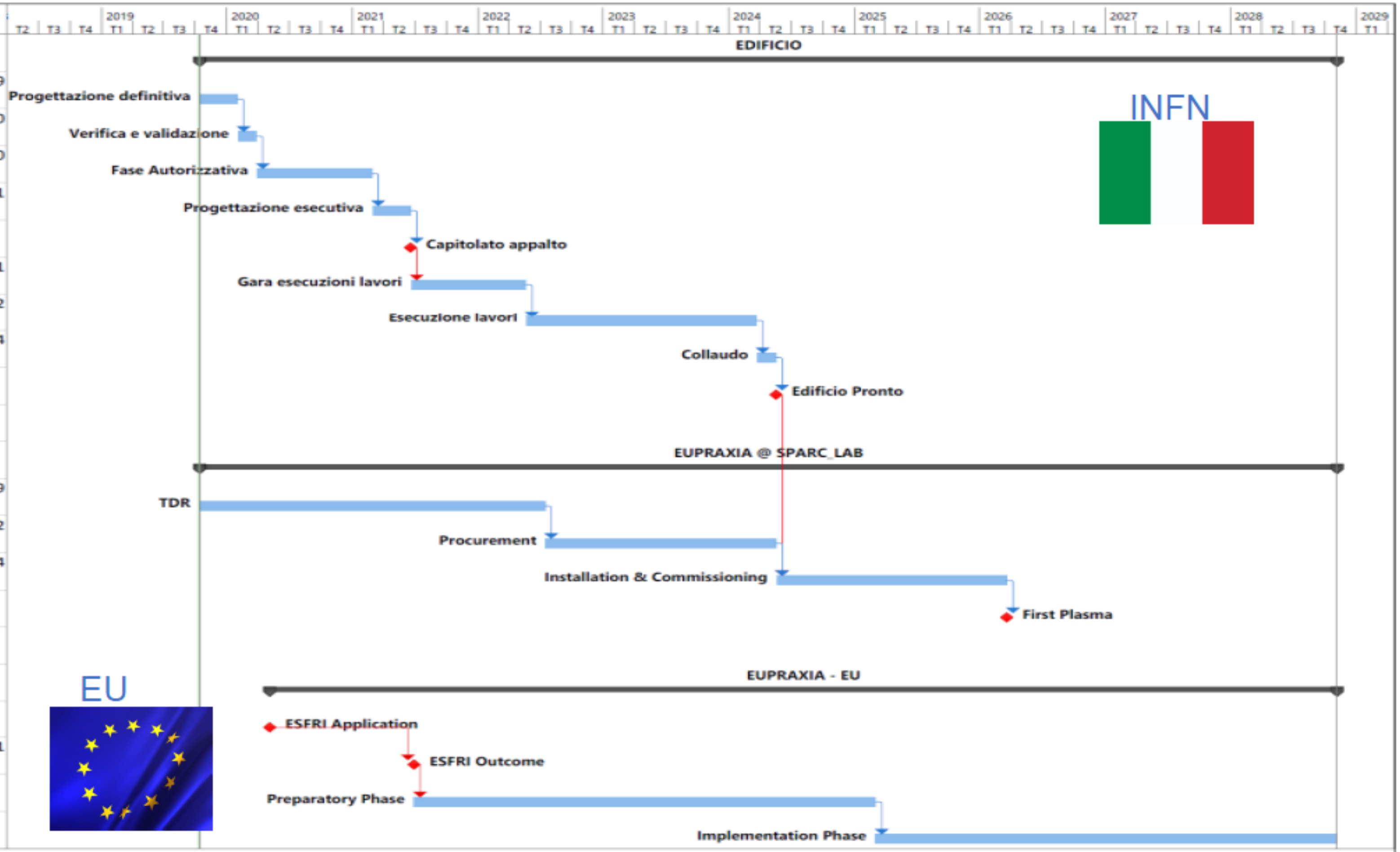


TO – DO – LIST:

- Numero e posizionamento dei racks.
- Valutazione di ingombri e sicurezze
- Ottimizzazione fill-factor
- Posizionamento beam dump

Detailed Building Construction Plan

ID	Nome attività	Durata	Inizio
1	**EDIFICIO**	**118,3 mes?**	**lun 14/10/19**
2	Progettazione definitiva	4 mes	lun 14/10/19
3	Verifica e validazione	2 mes	lun 03/02/20
4	Fase Autorizzativa	12 mes	lun 30/03/20
5	Progettazione esecutiva	4 mes	lun 01/03/21
6	Capitolato appalto	0 g	ven 18/06/21
7	Gara esecuzioni lavori	12 mes	lun 21/06/21
8	Esecuzione lavori	24 mes	lun 23/05/22
9	Collaudo	2 mes	lun 25/03/24
10	Edificio Pronto	0 g	ven 17/05/24
11			
12	**EUPRAXIA @ SPARC_LAB**	**118,3 mes?**	**lun 14/10/19**
13	TDR	36 mes	lun 14/10/19
14	Procurement	24 mes	lun 18/07/22
15	Installation & Commissioning	24 mes	lun 20/05/24
16	First Plasma	0 g	ven 20/03/26
17			
18	**EUPRAXIA - EU**	**111 mes**	**mar 05/05/20**
19	ESFRI Application	0 mes	mar 05/05/20
20	ESFRI Outcome	0 mes	lun 28/06/21
21	Preparatory Phase	48 mes	mar 29/06/21
22	Implementati Phase	48 mes	mar 04/03/25



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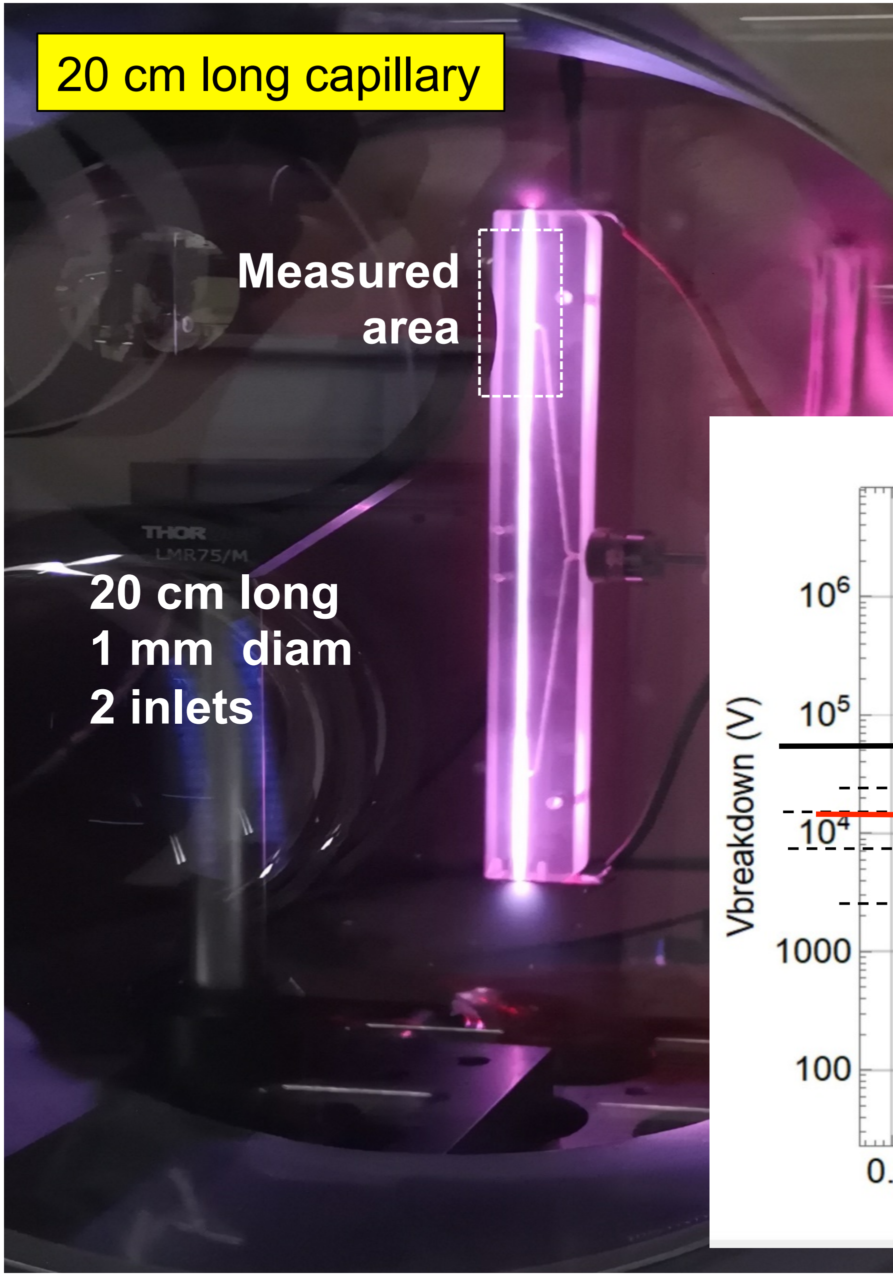
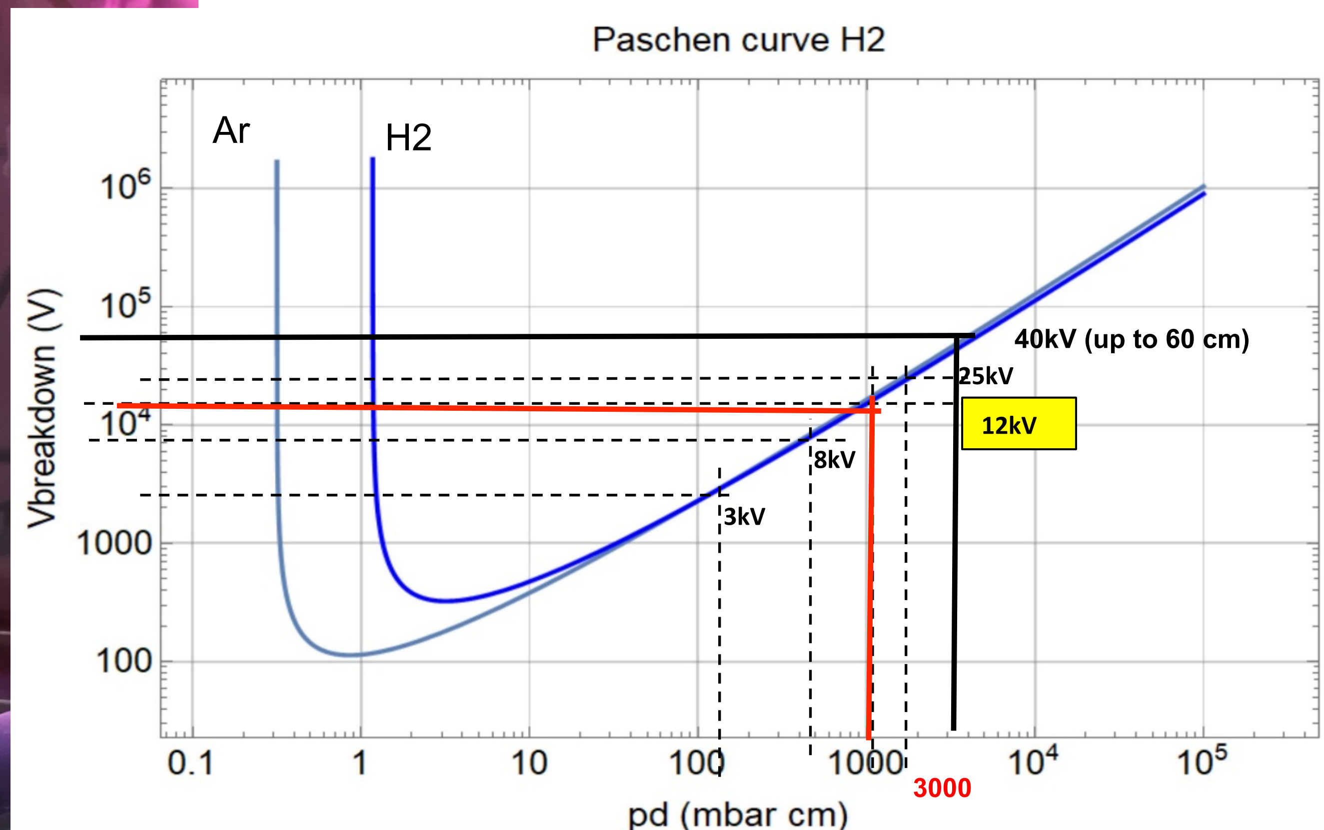
Plasma sources toward EuPraxia project: 40cm-long/10^{16} cm^{-3}

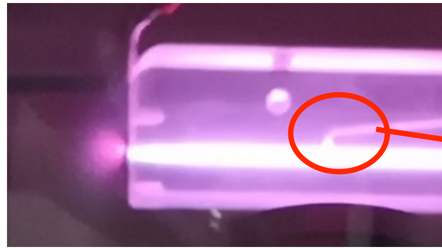


We are going to reach the EuPraxia goal by using the plasma module at Sparc_lab: here 20 cm-long capillary with two inlets can be ionized:

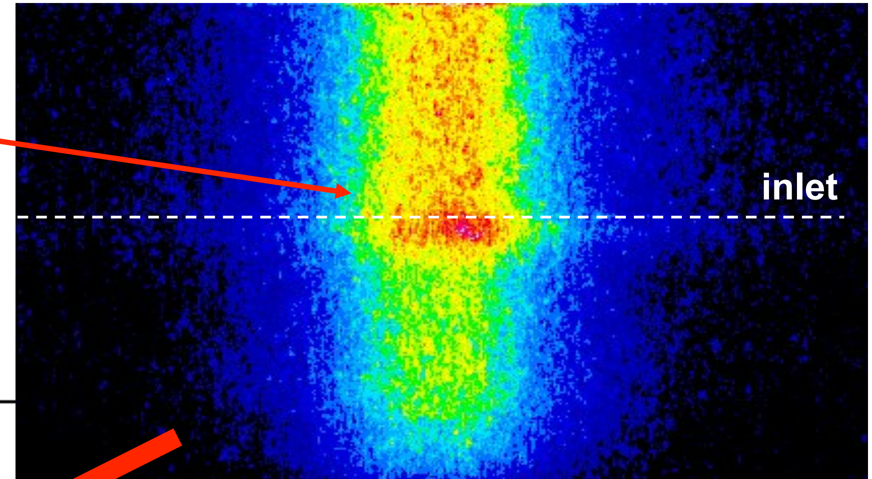
- Minimum voltage (Vb) 12 kV
- Plasma current 250 A
- Plasma density $3x10^{17}$ cm^{-3}

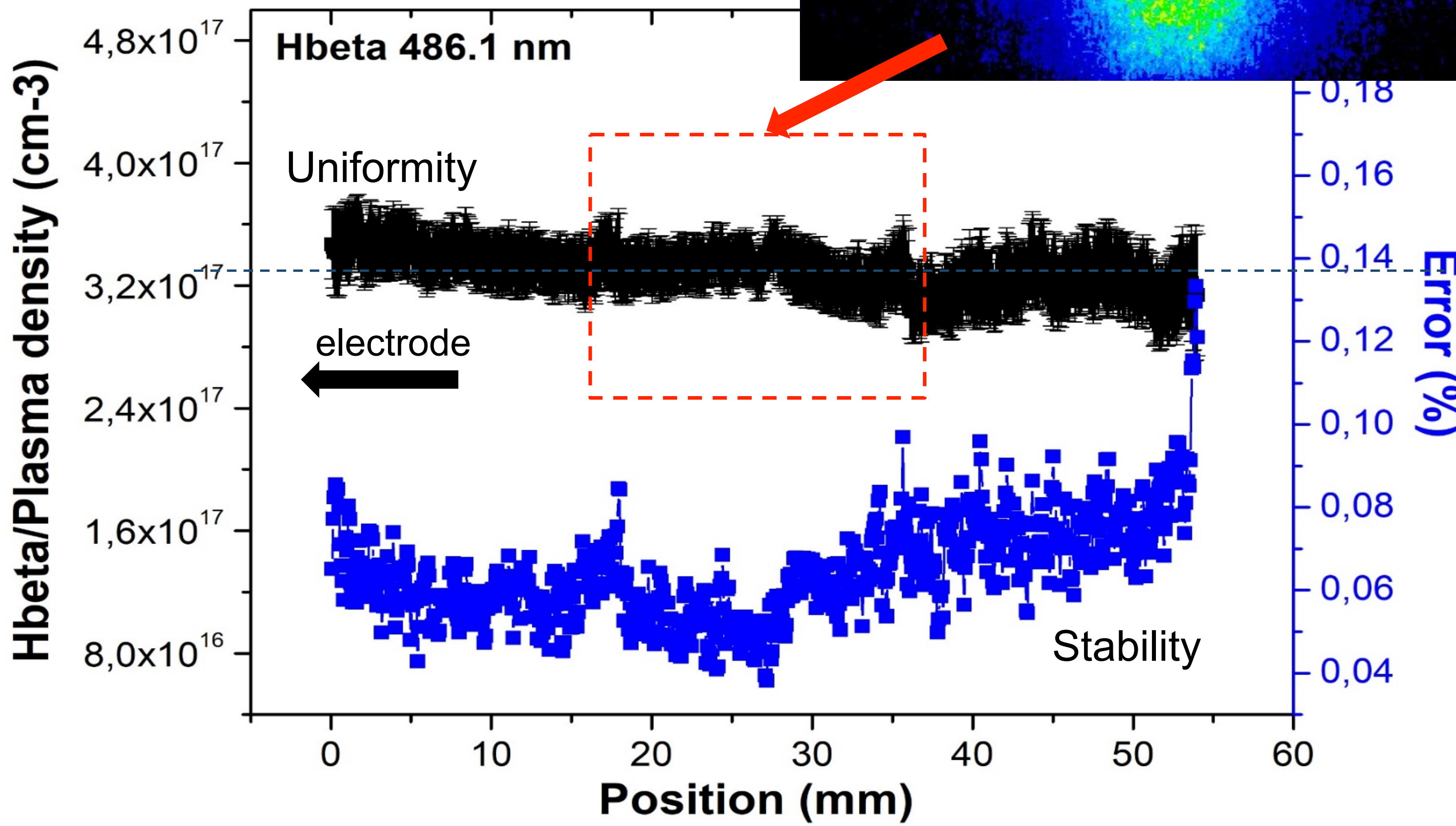


- Stability shot-to-shot around 5-8% that has to be improved
- Uniformity inside capillary is good because there is no strong changing along longitudinal dimension



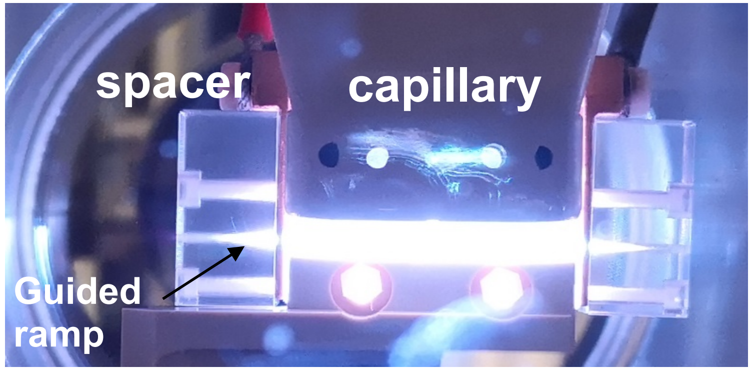
Spectral line at 486.1

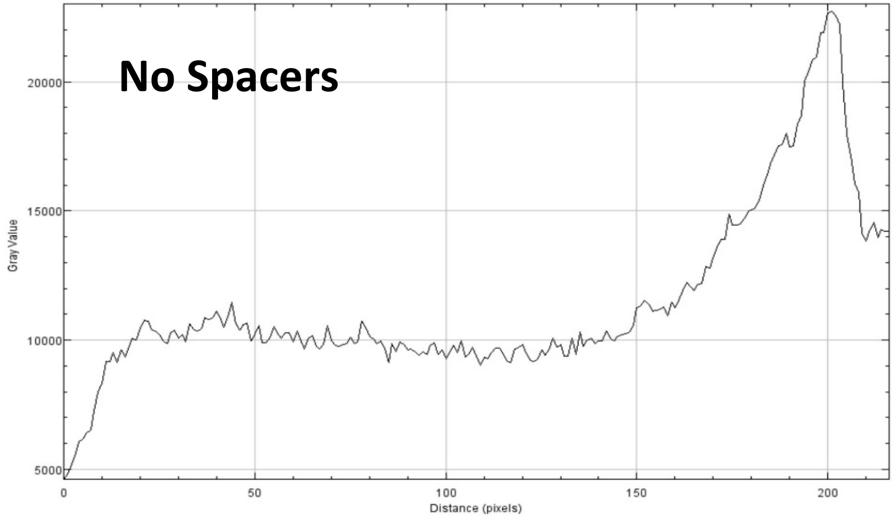


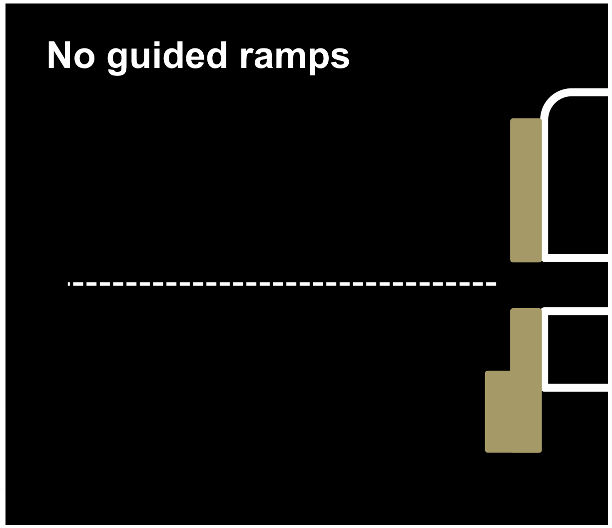


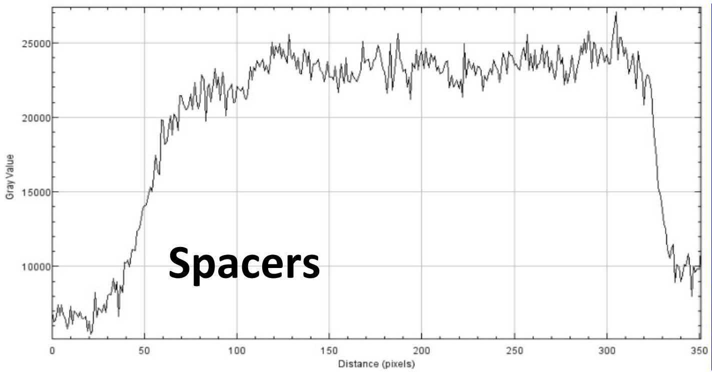
Plasma ramps characterization

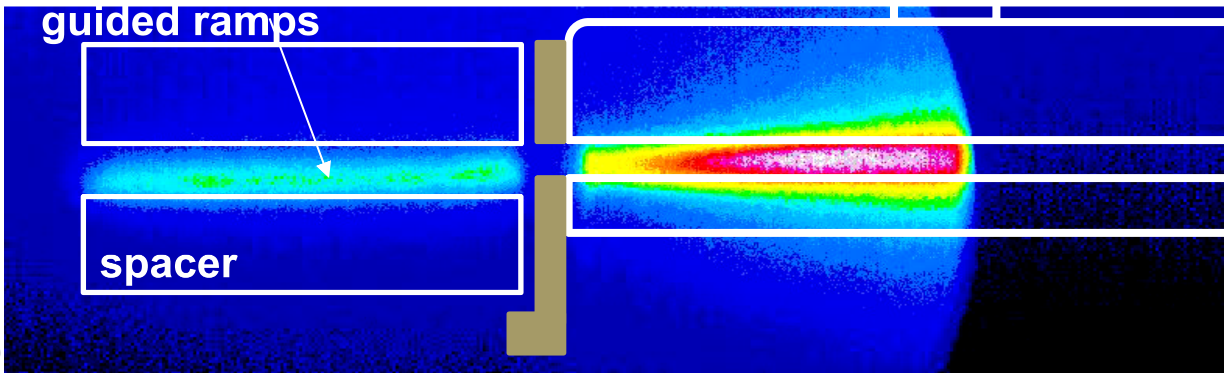
Elongations (spacers) can be attached to the ends of the capillary (after the electrodes) to control the plasma ramps produced during the discharge both the positioning and the density of the ramps.



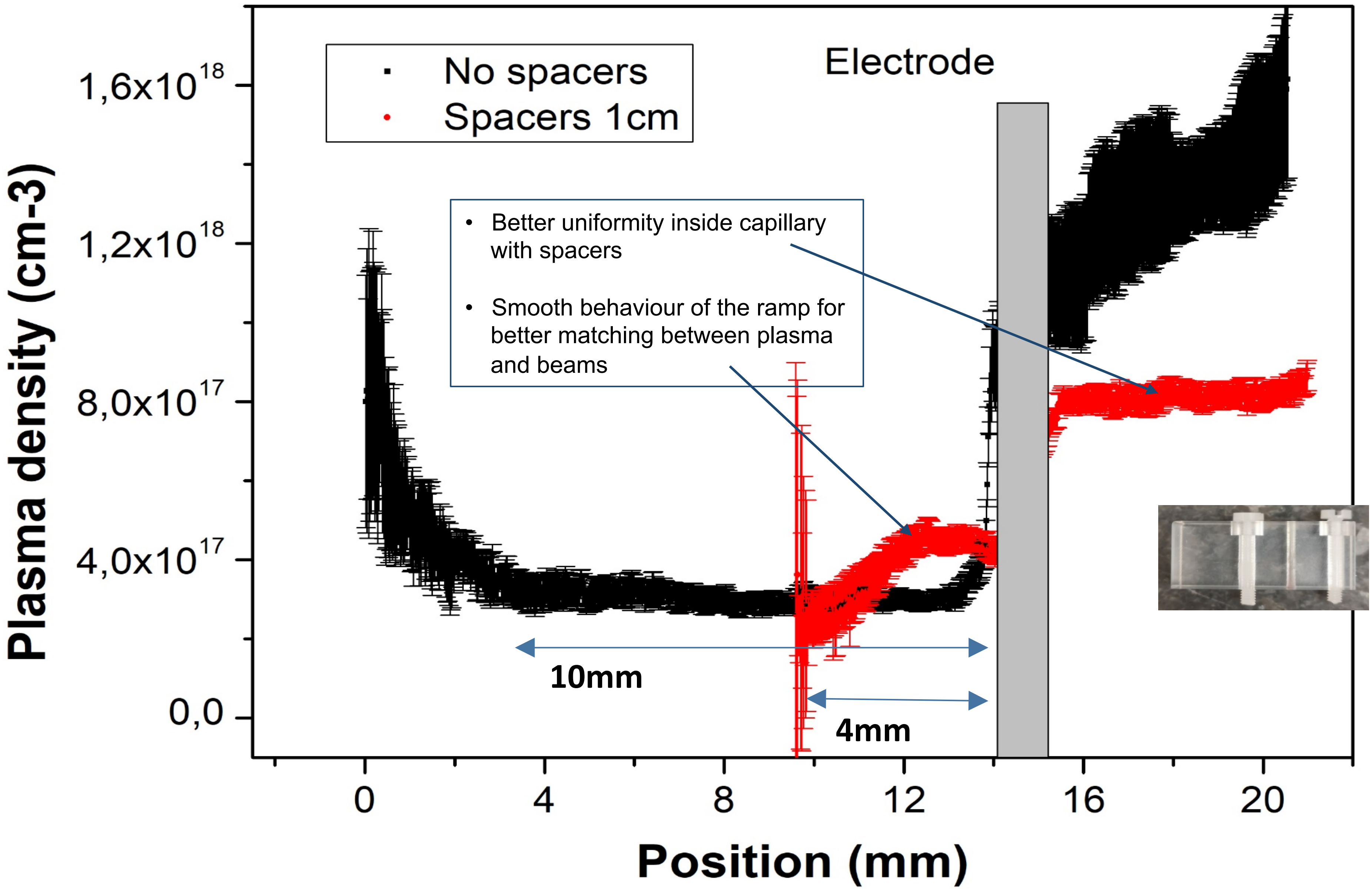








Spacers characterization by mean of density measurements



Plasma Lab: future planning

- Other experiments about spacers to optimize the density and the stability
    - Changing of the plasma ramp profiles by using different diameter/tapering…

- Transverse profile

- Simulations of the neutral gas and plasma expansion

- Test about longer capillaries starting from 20 cm in order to reach 40cm (Eupraxia), but:
    - 20-25 cm represents a limit for our chamber and for 3D printing (segmentation)

    - Segmented capillary

- Starting to design a new chamber

- Closing widows to cut the plasma ramps and so redesign the gas injection system (continuously flow)

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Beam Dynamics Group

SPARC S2E:e^-→ph	A. Giribono	Tstep-Architect-Genesis (Astra,GPT,Elegant,IMPACT-Z,CST,PoissonSF)	SPARC-EuPRAXIA
XLS- C-band Photoinjecto r S2E	M. Croia	GPT-ASTRA (CST, Poisson SF)	XLS-Tuareg
SABINA S2E:e^-→ph	F. Di Pace	Tstep-Genesis (Astra,GPT,Elegant,IMPACT-Z,CST,PoissonSF)	SABINA
Plasma Module Simulations	Del Dotto S. Romeo A. Rossi	Osiris Architect Qfluid	Comb-Exin-EuPRAXIA
Photocathod e R&D+Sim &Theory	J. Scifo	Tstep, Astra, GPT + Spec. Codes	Tuareg, High Gradient Cathodes @FERMI
Plasma_Lab Simulations	A. Biagioni	Openfoam, Flash	Comb-Exin
Laser beam Simulations	F. Bisesto G. Costa F. Villa	Zemax, Pluto	Exin- One shot Diag.
EM Simulations	M. Bethoui M.Diomede A. Vannozzi	CST,ABCI Poisson,OPERA,Tosca	SPARC New Gun EuPRAXIA Sabina

Beam Dynamics Group

- A new dedicated CPU/GPU farm for SPARC_LAB/FLAME activities

IBM® Power System™ AC922

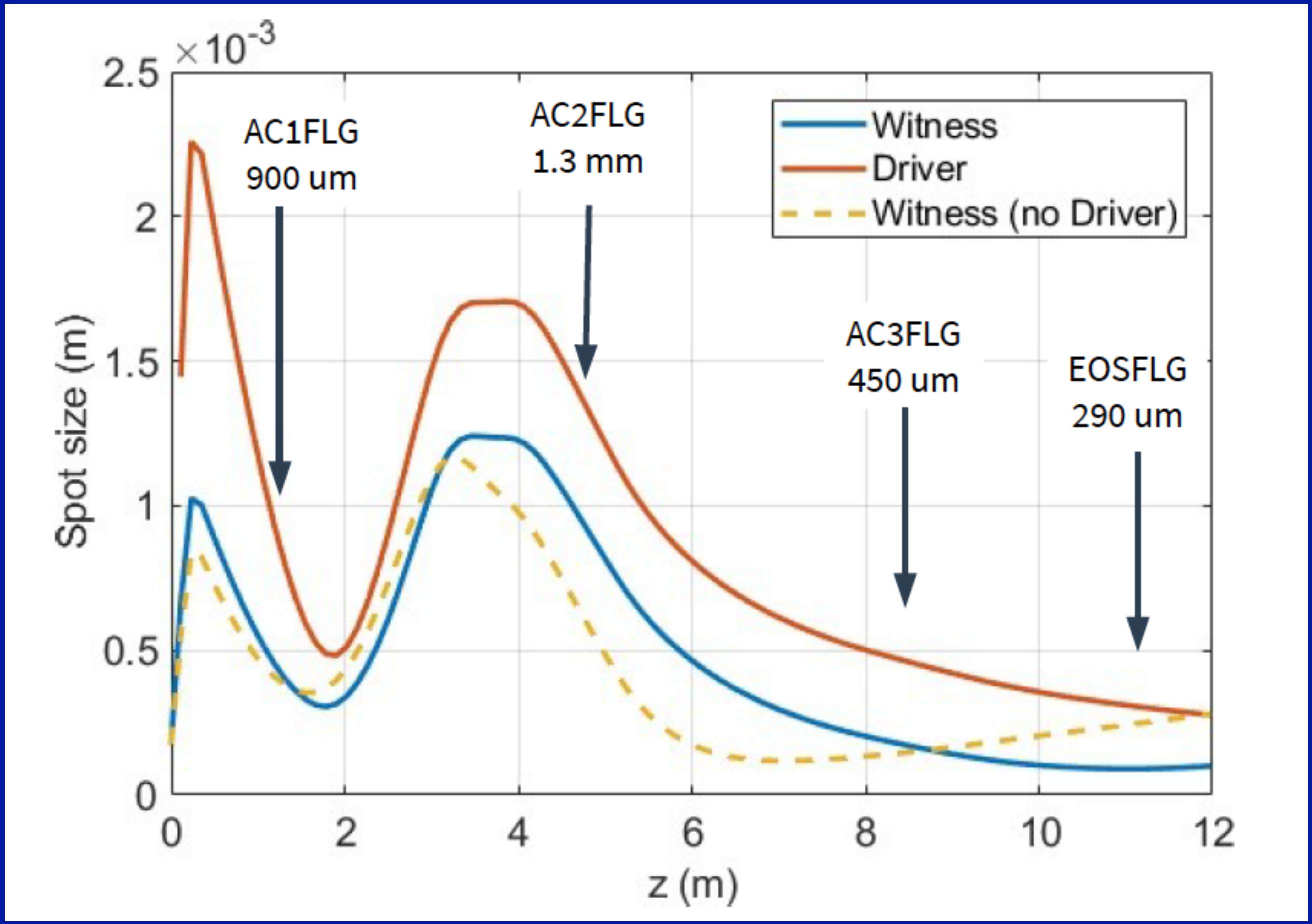
- Two IBM Power9 processors (2 CPUs x 8 core x 8 threads = 128 computational units)
- Two NVIDIA Volta 100 GPUs

This is a first test machine: it can be upgraded (up to 6 GPUs) and used in a cluster with other AC922

- Main PIC codes on the "market" can be run on that machine, at least for small/medium size simulations for supporting SPARC_LAB/FLAME experiments

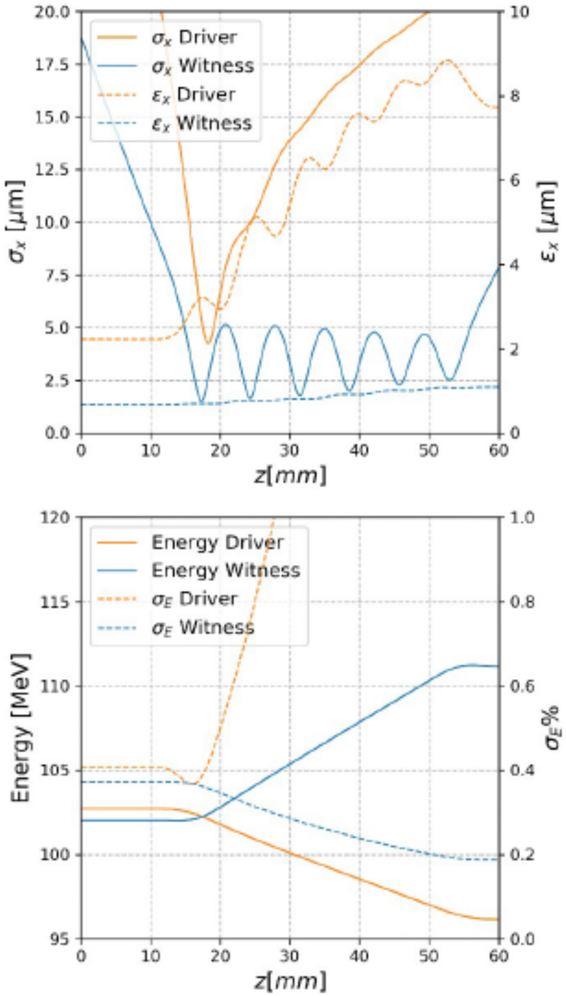
We are taking profit of the technical support on the farm by
G. Fortugno and P. Santangelo

New working point



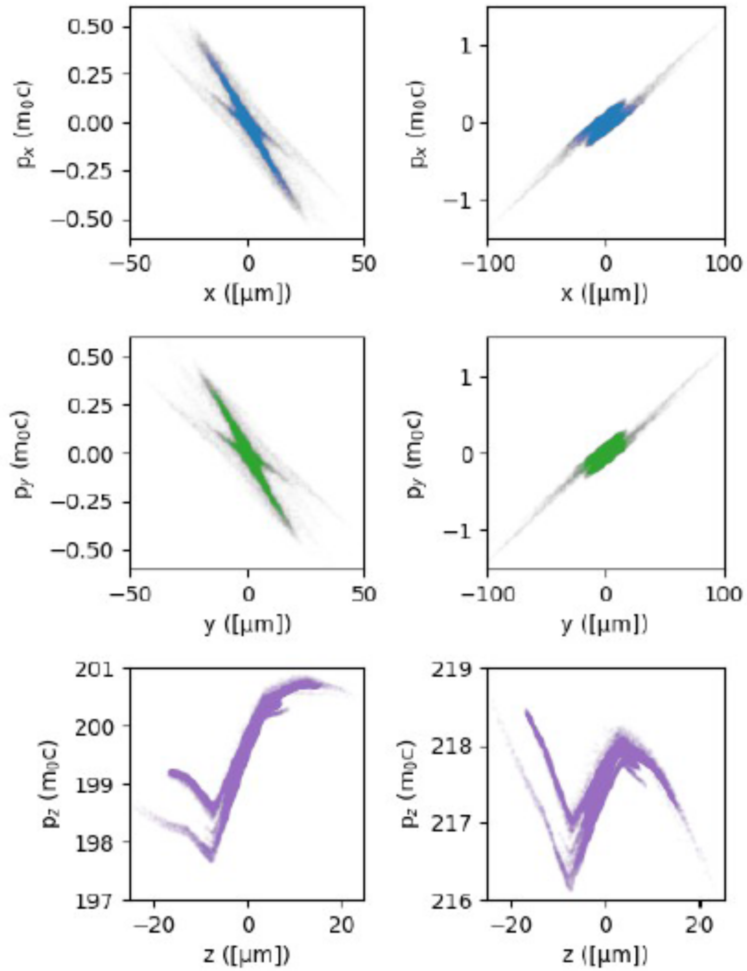
Plasma simulations

Driver/Witness evolution

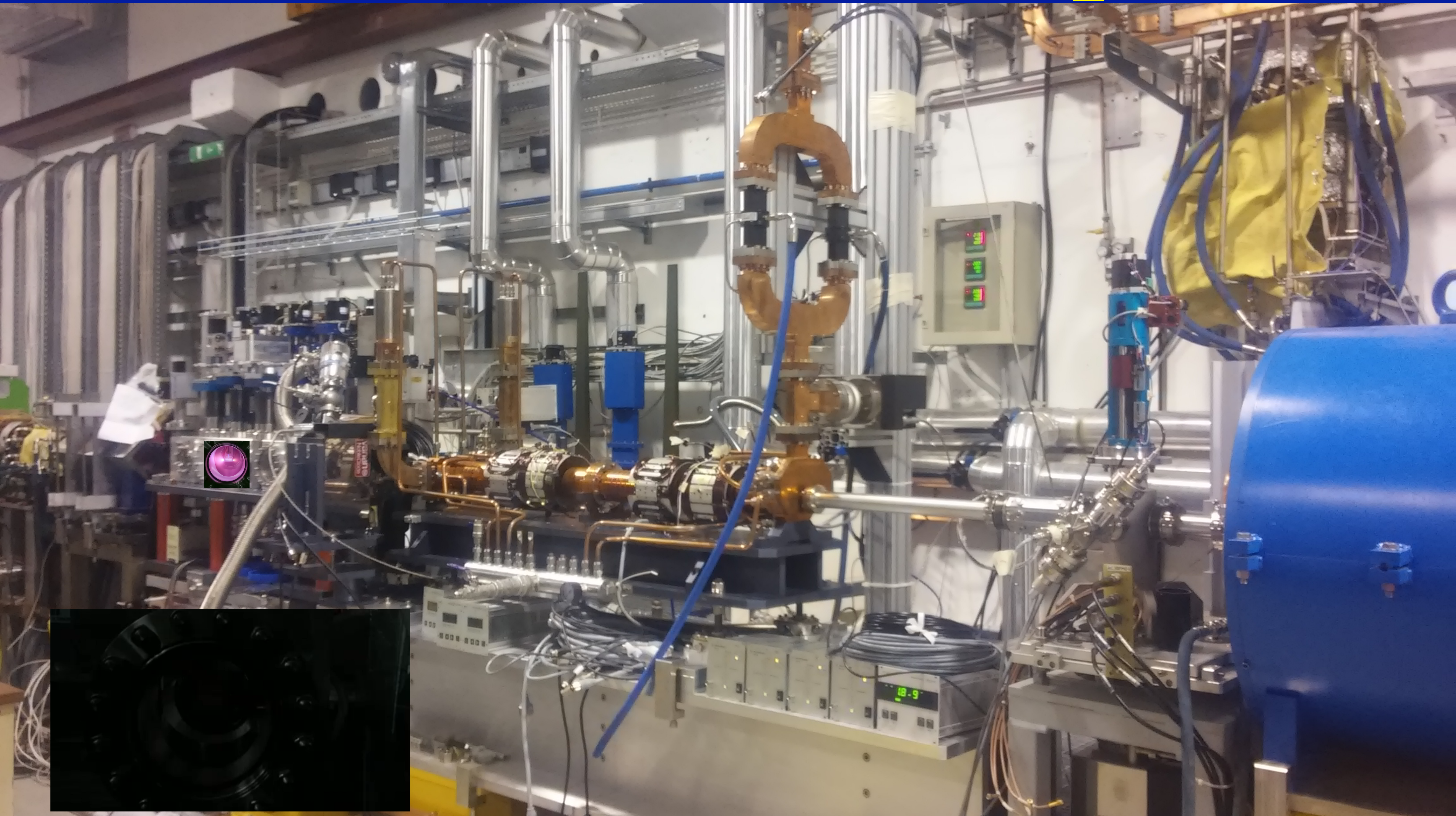


9 MeV witness energy gain

Witness phase space



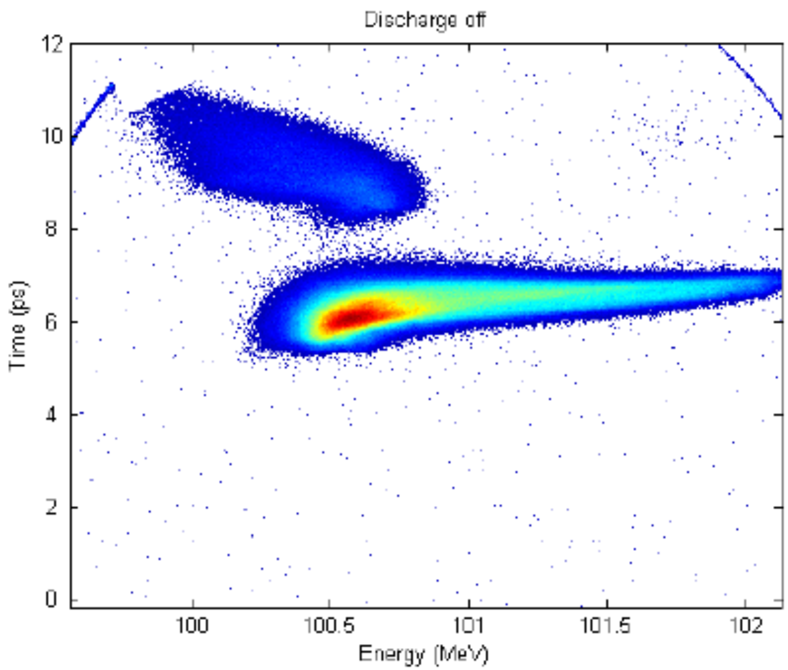
PWFA vacuum chamber at SPARC_LAB

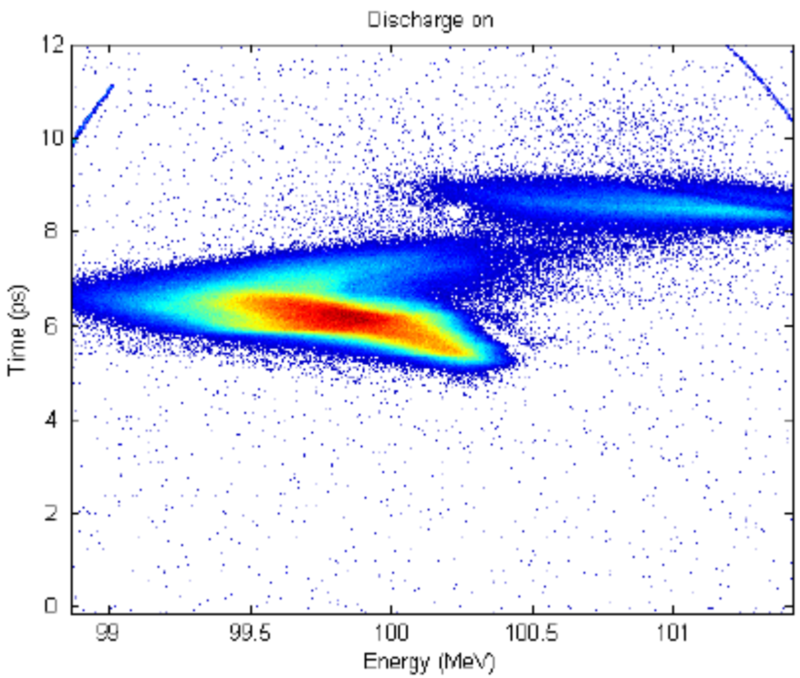


Latest acceleration results

Single bunch with 200 pC and 300 fs duration.
By optimizing the discharge delay (→ plasma density) we found 30-100 MV/m
Spread <0.5%

Main problem seems to be related to transverse/longitudinal matching





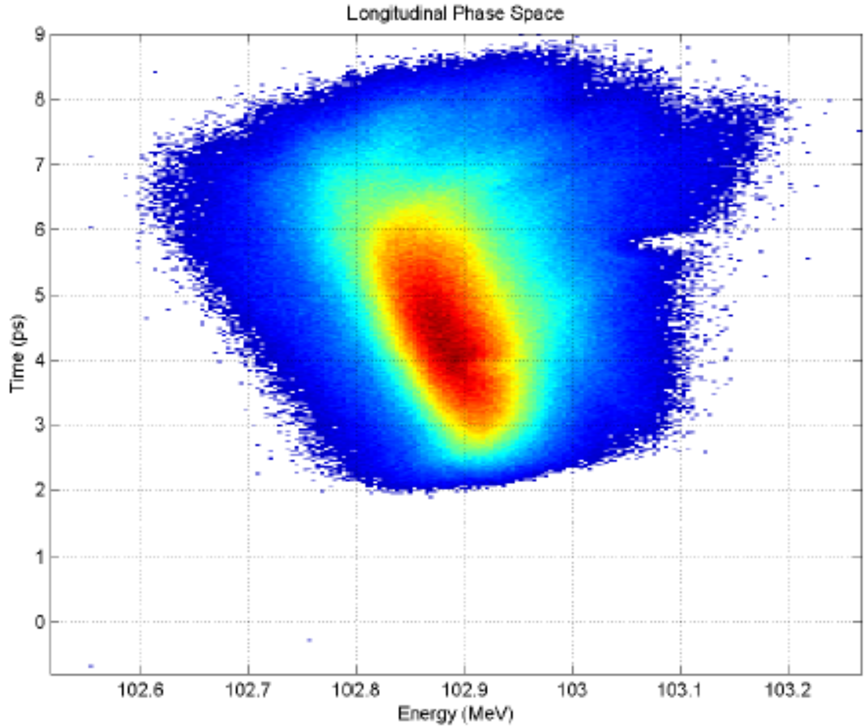
Measurements with single long bunch

Charge: 200 pC

Duration: 1.5 ps (rms)

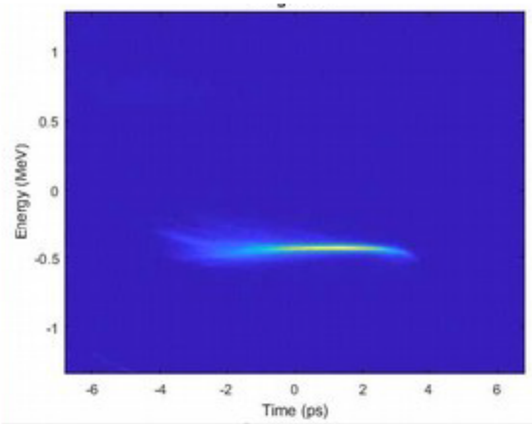
Emittance: 2,7 um (rms)

Energy: 100 MeV

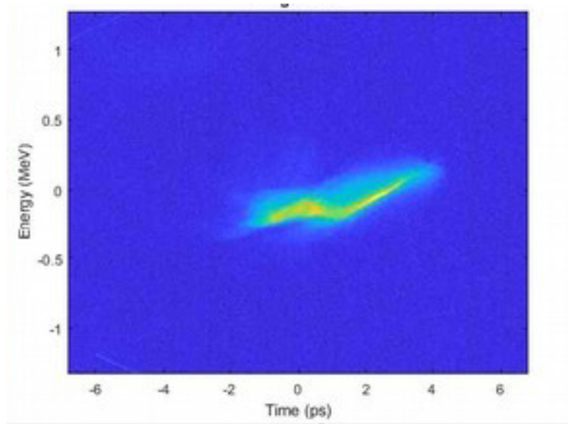


Modulations with plasma (9 July 19)

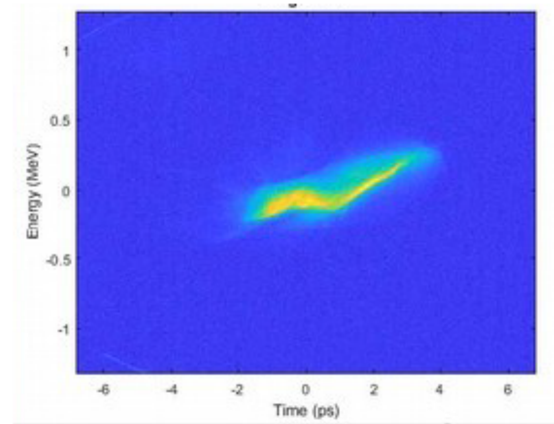
No plasma



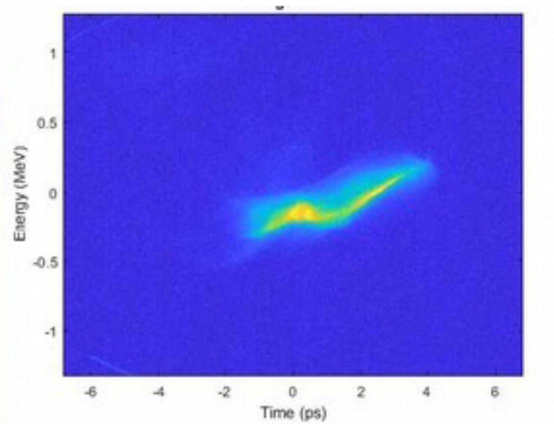
4000 ns



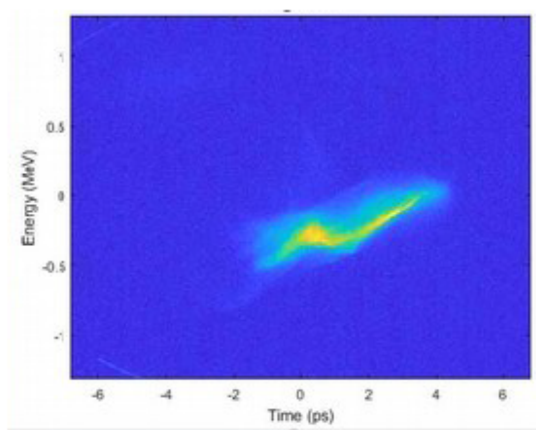
3800 ns



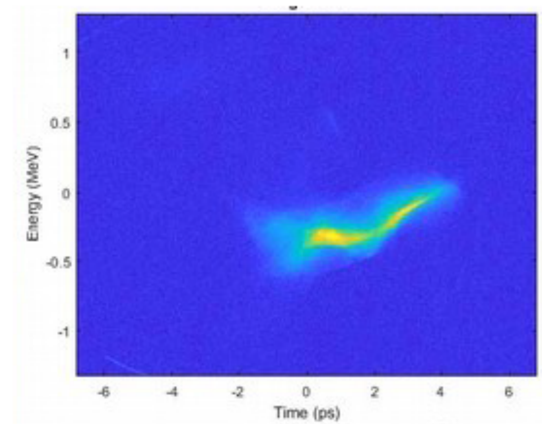
3600 ns



3400 ns

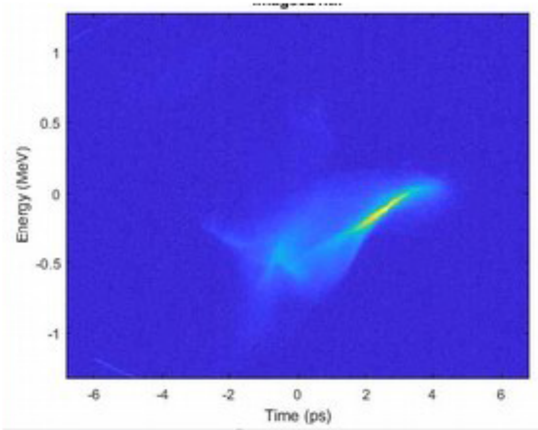


3200 ns

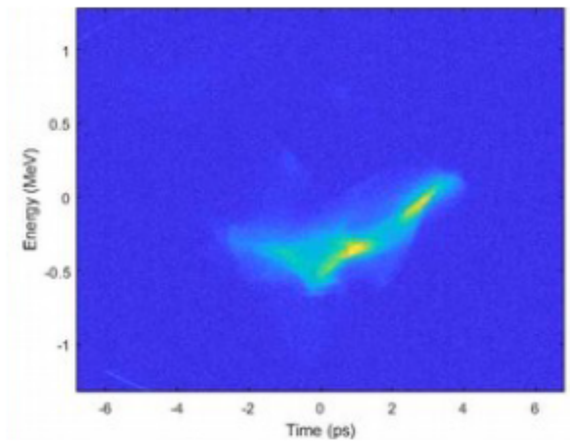


Modulations with plasma interactions

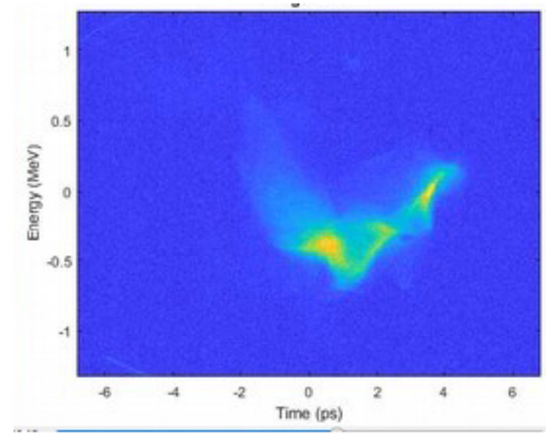
3000 ns



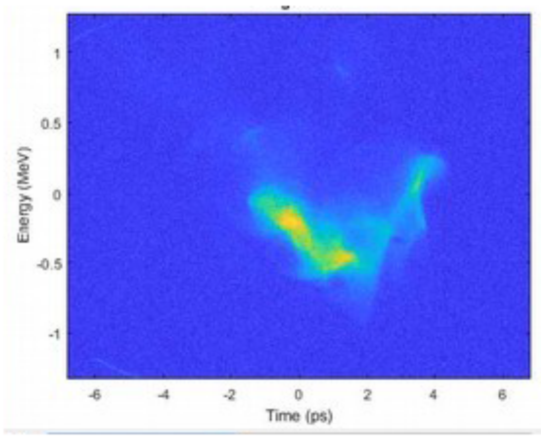
2800 ns



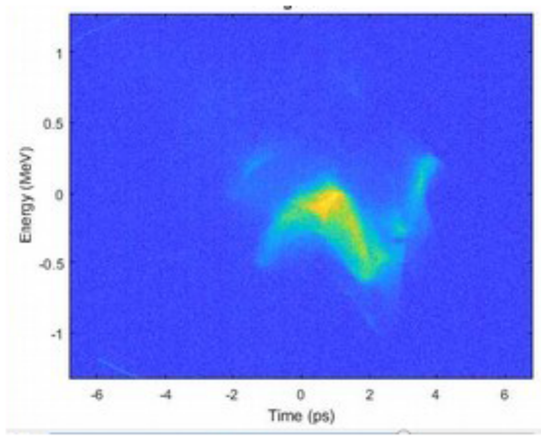
2600 ns



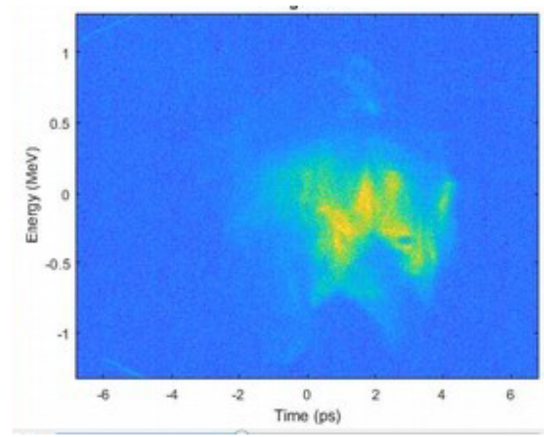
2400 ns



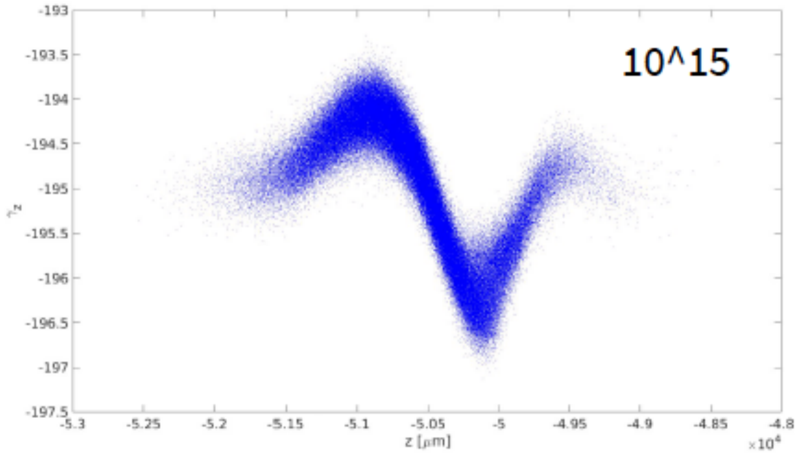
2200 ns

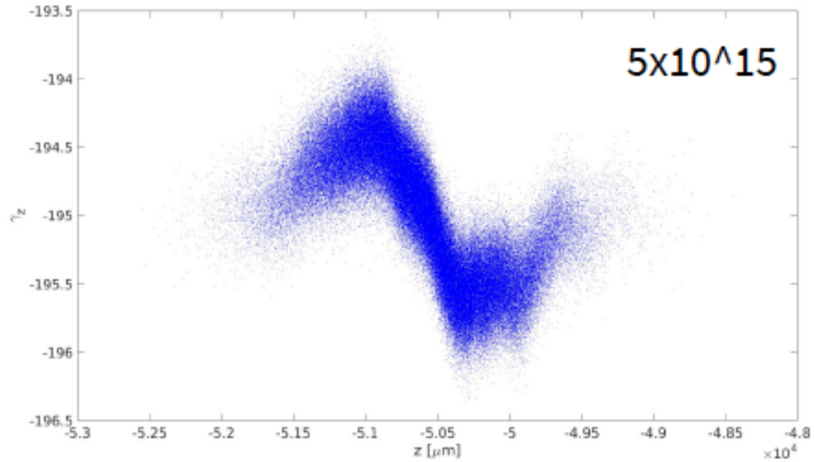


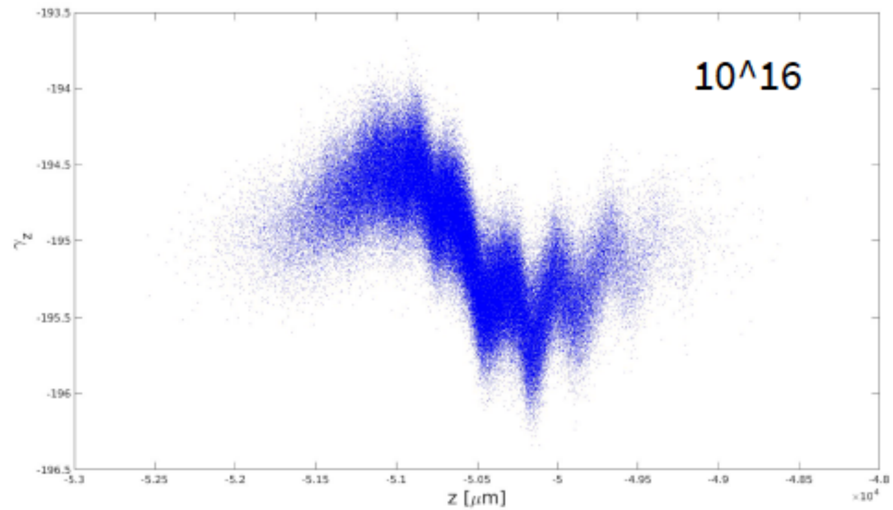
2000 ns



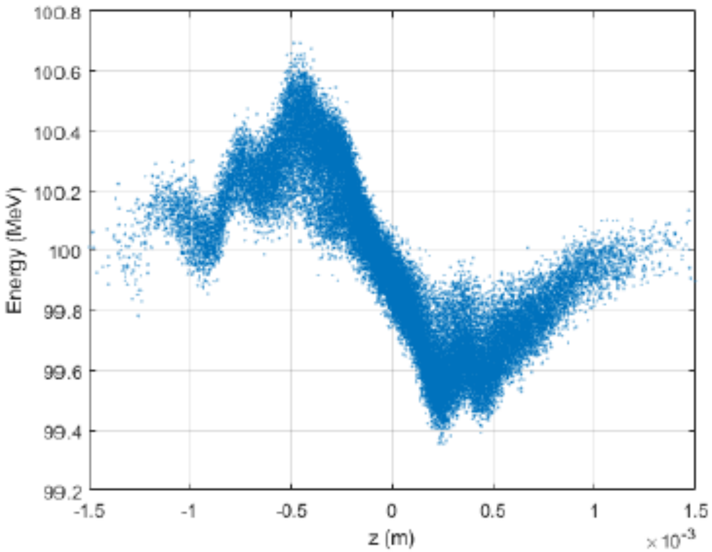
Architect simulations of LPS

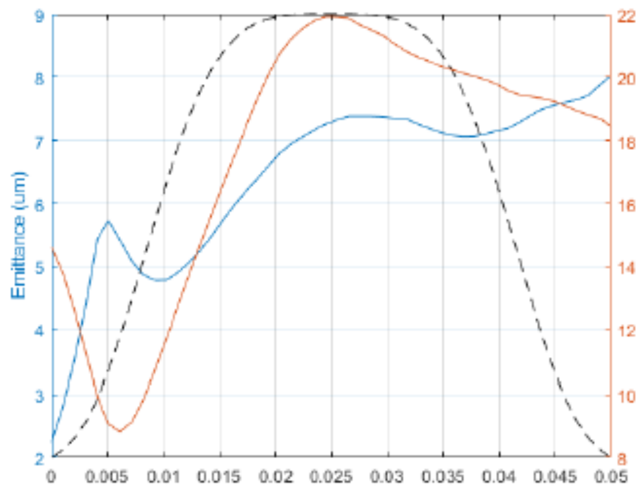


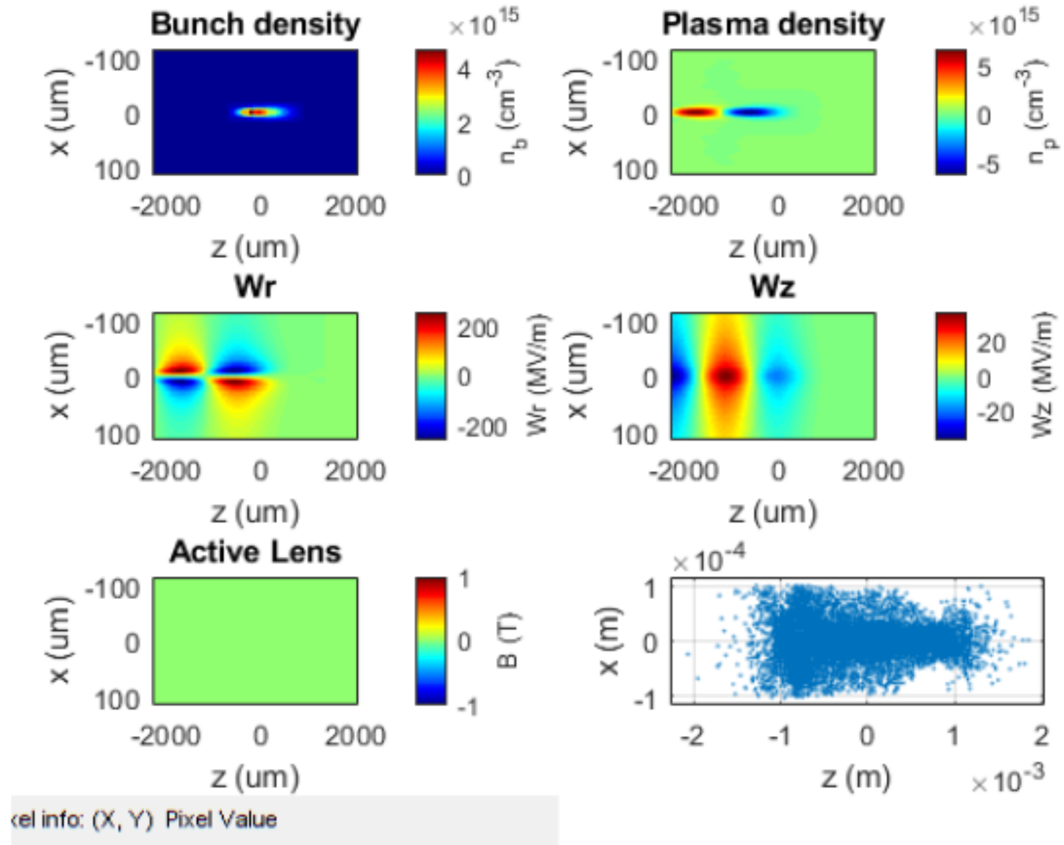




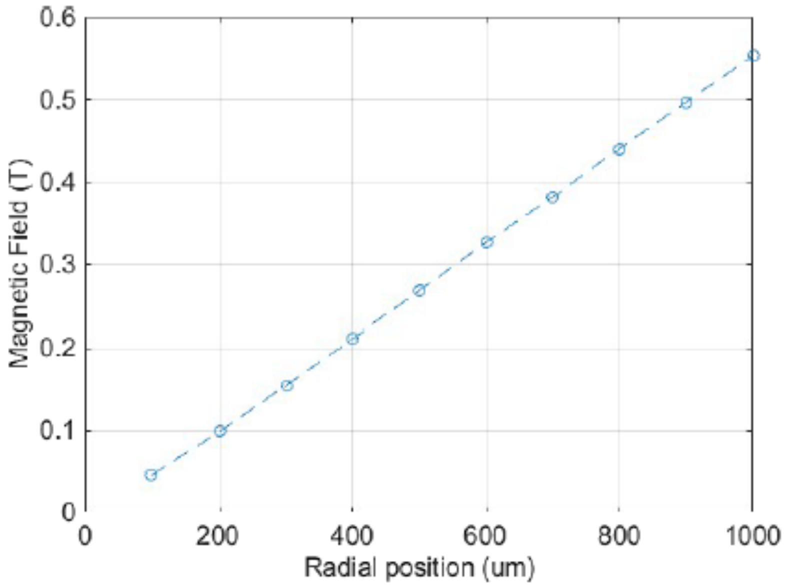
Preliminary simulations (@10^{16})

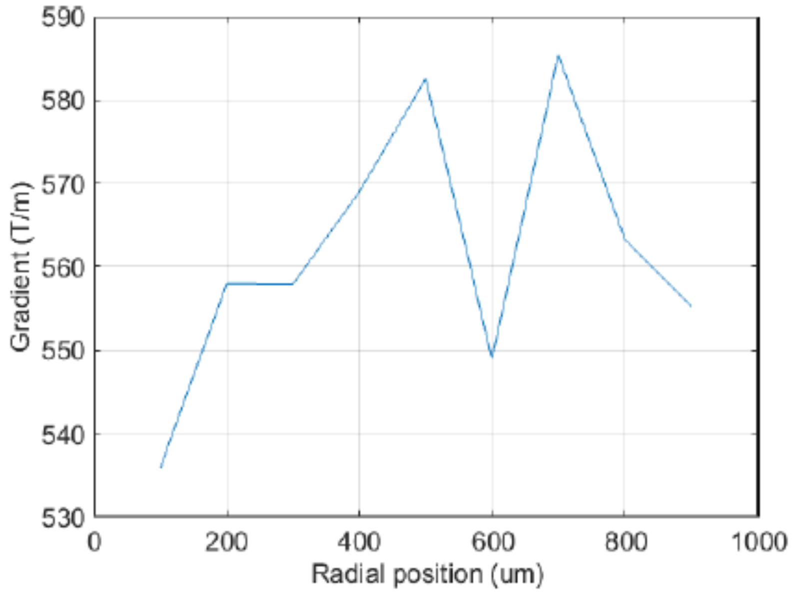






PMQ radial characterization





Looking at the magnetic field of the PMQ it seems linear…

Looking at the corresponding gradient (G=B/r) it is not constant!

From RADIA simulations, G should vary only by 4 T/m in the range r=0-1 mm

SciCom Recommendations

- The committee strongly recommends that a clear organizational structure be put in place to further develop the EuPRAXIA@SPARC_LAB project. The project should be led by a scientist surrounded by a strong engineering and managerial team. In particular it is important that the project be fully integrated in the laboratory organization.

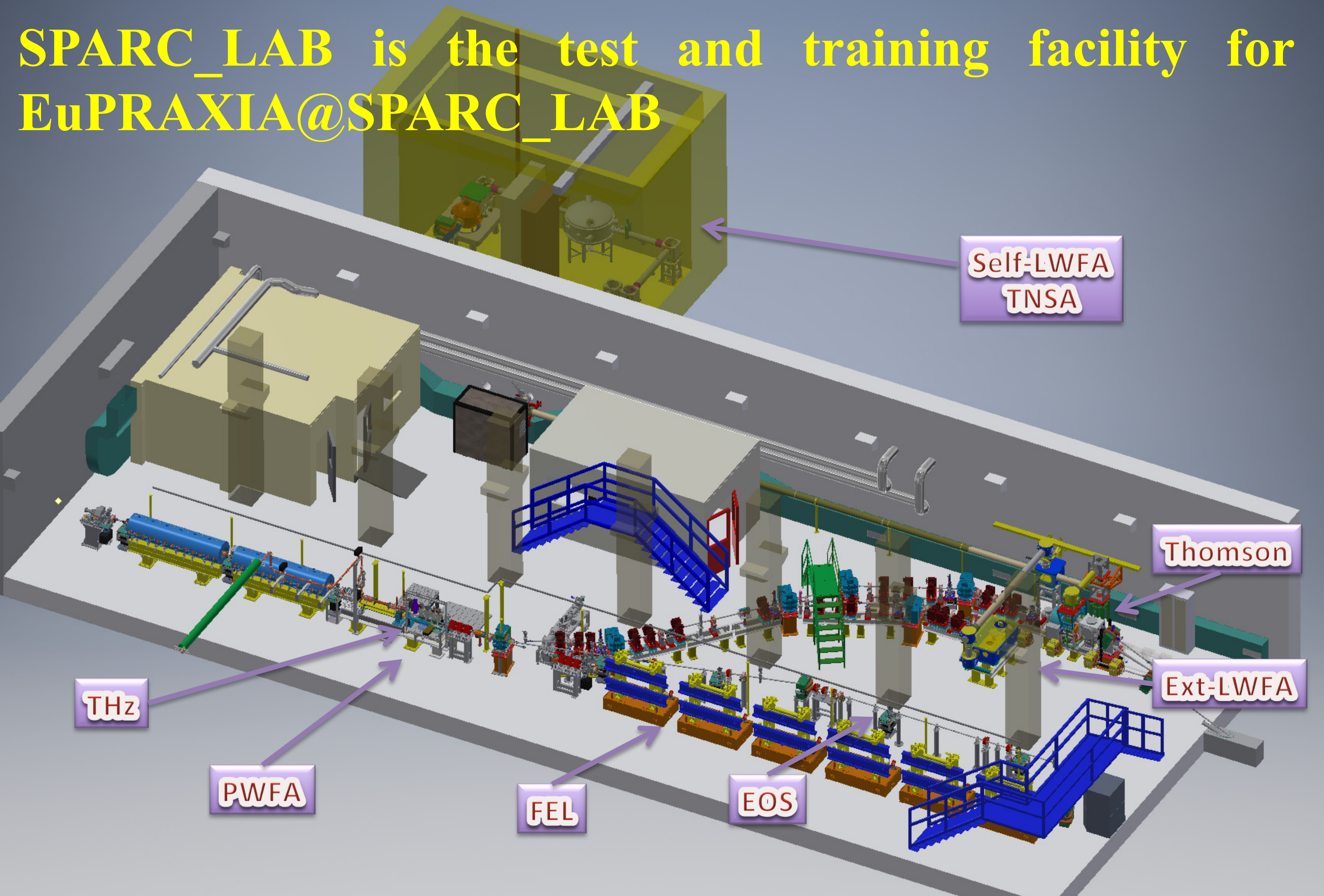
- The committee highlights the importance of properly sizing the new building to accommodate user areas and options for the linac/plasma and undulators and yet unexpected needed space.

- The committee notices that the length of the plasma source envisaged for EuPRAXIA@SPARC_LAB is significant (~2m) and encourages strong effort in developing this key element of the project.

- The committee also strongly advices further development of the beam electron optimization, through simulations and comparison with experimental results, especially regarding the phase-space characterization of the witness bunch.

- Long term (24h) operation also needs to be demonstrated.

SPARC_LAB is the test and training facility for EuPRAXIA@SPARC_LAB



Summary of June-july activities

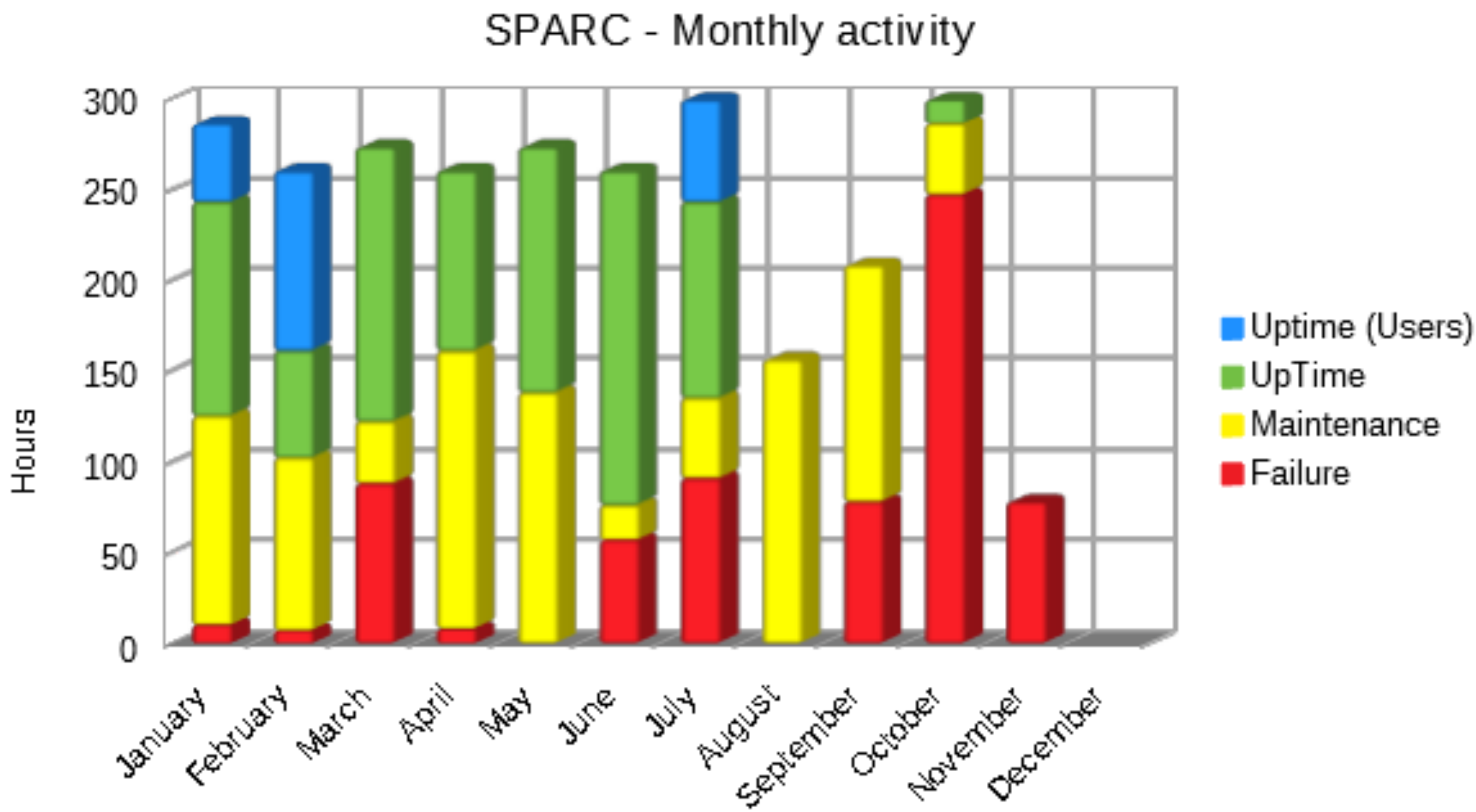
June: first tests with the new COMB working point

- Beam dynamics measurements with 1 driver (200 pC) + witness (20-50 pC)
- Tests with plasma acceleration. Cannot see any energy gain for the witness (energy spread?)
- Tests with PMQ. Some time spent to investigate the focusing for several configurations
- Check of alignment of S2 and C3 sections. Also COMB chamber measured
- Issues with the dry-cooler and water temperature in modulators

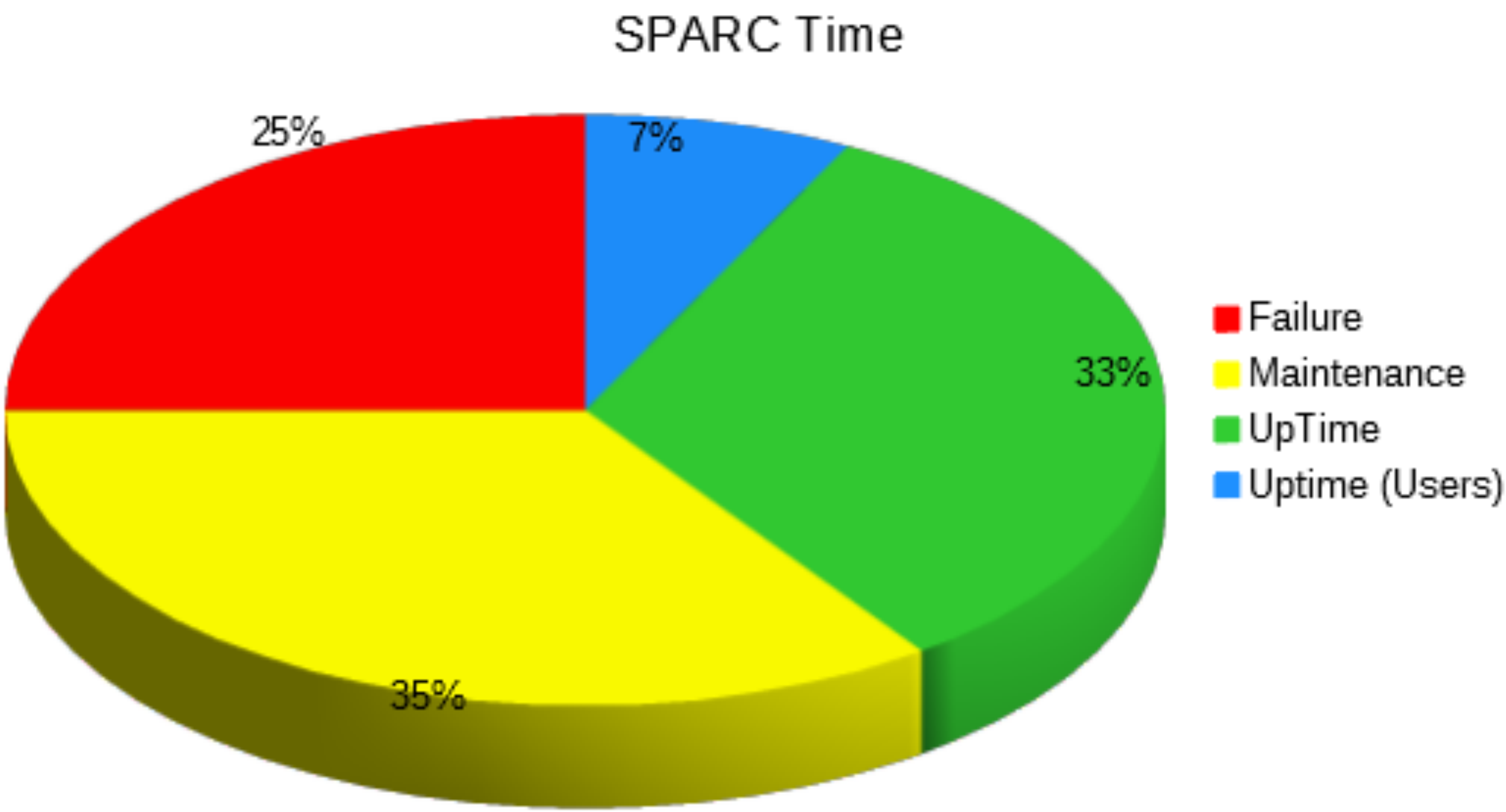
July: tests with plasma acceleration

- Best results found at low density (~10^{14} cm^{-3}). Witness accelerated by ~2-3 MeV (~100 MV/m) but energy spread increased.
- Done many scans by varying the plasma density and witness distance.

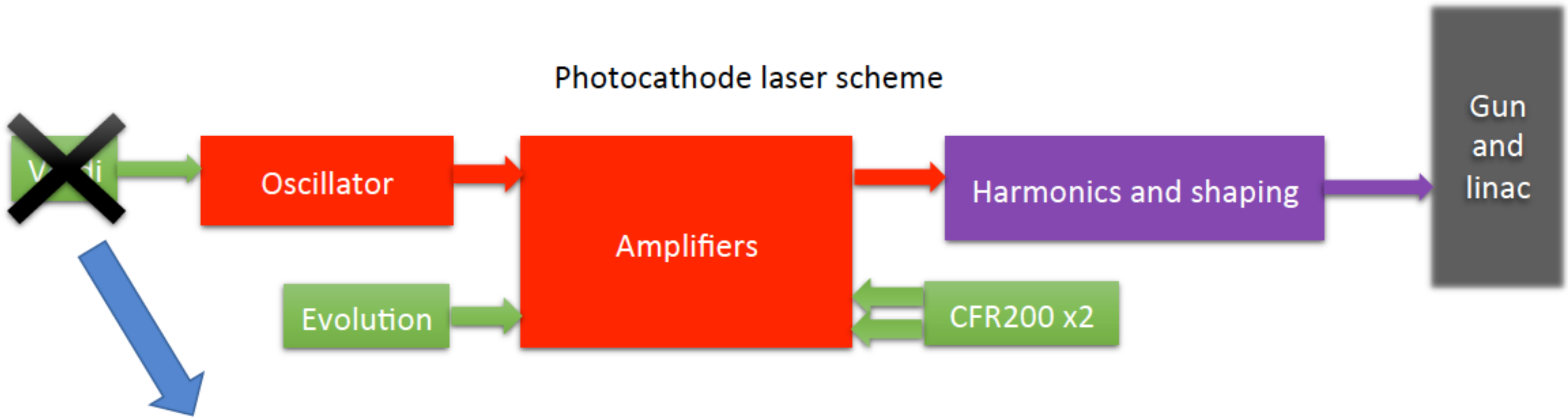
Detailed view



SPARC time (January-July 2019)



Photocatode laser system problem:



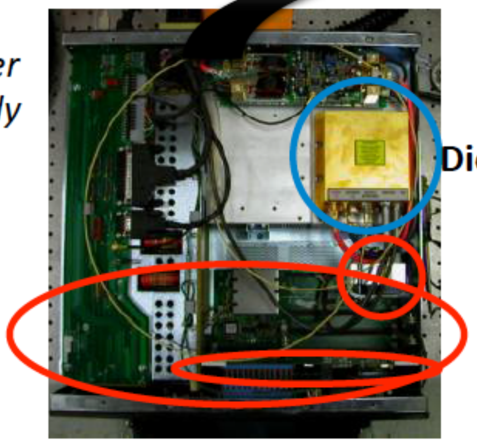
5W @532 nm in CW to pump the oscillator, without that no laser (at all) => no electrons
Coherent Verdi V5 pump: very stable, little maintenance required and many internal diagnostics
Long working operation life (45kh), without faults or problems (before July)

SPARC LAB

Verdi fault:

Verdi Laser components

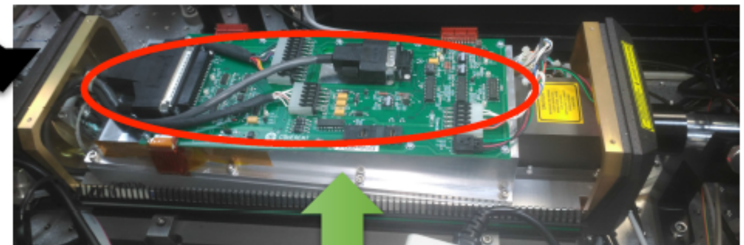
Power supply



Cables, fiber

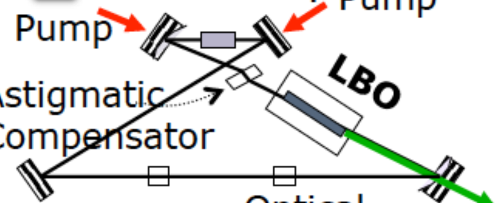
Diode pump

Laser head



Oscillator

Sealed cavity: (in the metallic box)



Controlled values:
Temperature of bold elements, V and I of diode, P of 532nm

Problem: all diagnostics on set points but only 20 mW of green output (instead of 5W)

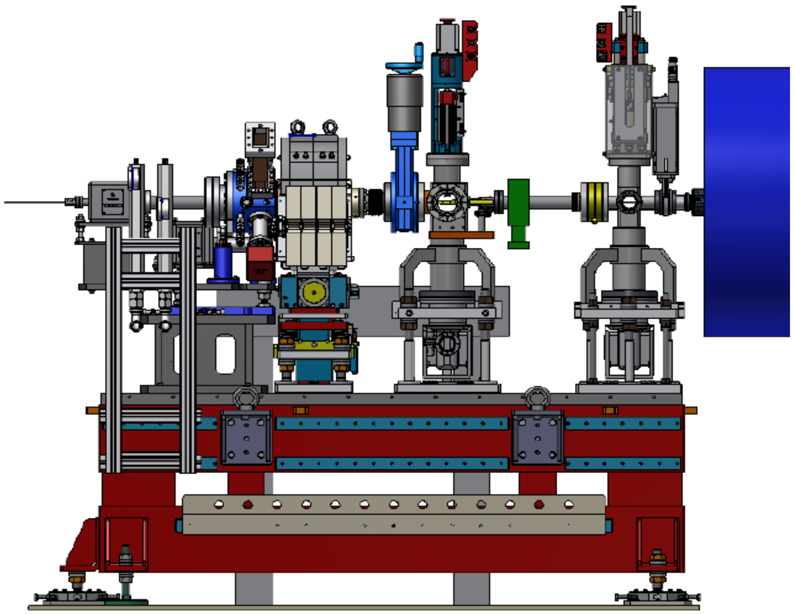
Verdi V5 model: not in production anymore => longer wait for the spare parts (ordered a new model, delivery in December)

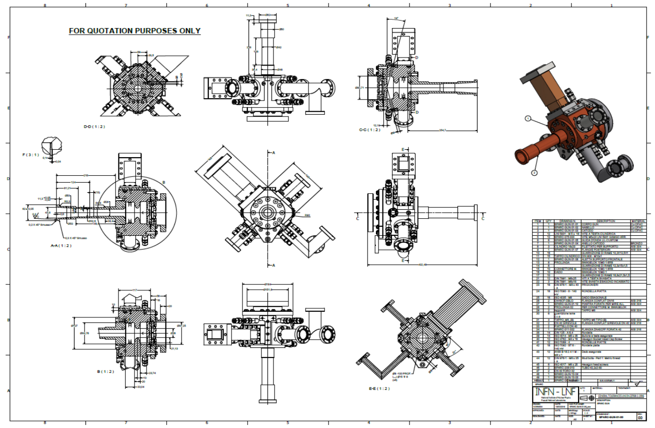
- Electronic control elements: changed and verified with Coherent service
- Diode pump: long working life, but in good condition (170% of the minimum power required is available) when tested
- Sealed cavity: pumped by the diode battery (via optical fiber), not accessible, will be changed (scheduled on 11/11 week)

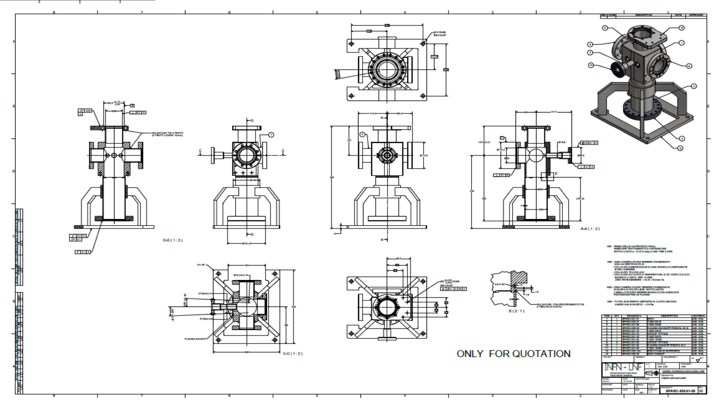
Faults timeline

24/07/19	**Verdi stopped** working after an electrical problem; all internal diagnostics ok, turned off during summer break
26/08/19	**Restart** the system with the Coherent technical **visit**: all working properly without any problem, checked the system and all in the working parameters
23/09/19	After near a month of properly work the laser has the same **fault** as July (all diagnostics ok, but no lasing). Checked again but without having the laser working properly (~20 mW output instead of 5W).
16/10/19	2^{nd} Coherent technical **visit**: new electronics, diode complete checkup, each checked element was working fine but the problem was not solved. Laser head wasn't shipped from company yet.
23/10/19	Short attempt to **restart** the system after a week of shutdown: good working condition for 30 hours, then a fault on LBO temperature and it **stopped** again (at low power)
13/11/19	3^{rd} scheduled Coherent technical **visit** (changing laser head, reconditioned, had a problem with the manufacturer tests and the delivery was delayed until 11/11)
06/12/19	Expected delivery of the **new Verdi** laser (as a spare/substitution), 15 weeks of delivery time from order

NEW SPARC_LAB INJECTOR







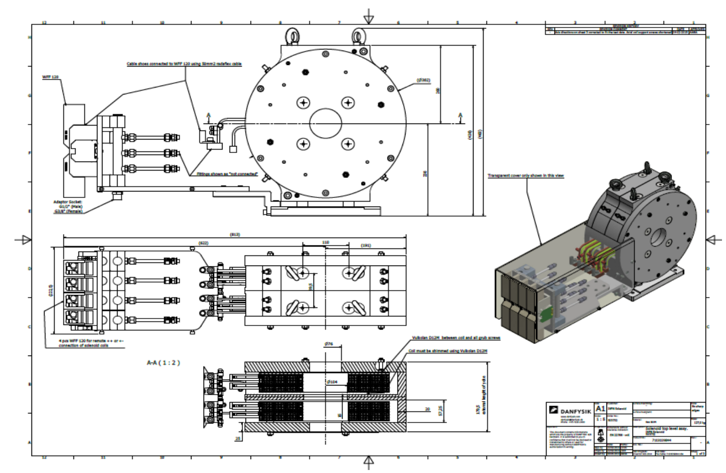
⇒ All components of the new injector **have been designed and 90% ordered**

⇒ Deliveries of components expected from **Nov 2019-March 2019**

⇒ **Assembly from Jan 2019-March 2019**

⇒ **Strategy for the installation** to be decided. We have several possibilities:

- ⇒ Install in April and do the conditioning
- ⇒ Install in a parallel line at SPARC_LAB for the conditioning
- ⇒ Install with the other components of the SABINA project



Publications 2019

1. EuPRAXIA-a compact, cost-efficient particle and radiation source, MK Weikum, T Akhter, PD Alesini, AS Alexandrova, MP Anania,AIP Conference Proceedings 2160 (1), 040012 2019

2. From SPARC_LAB to EuPRAXIA@ SPARC_LAB, R Pompili, E Chiadroni, A Cianchi, M Ferrario, A Gallo, V Shpakov, F Villa, Instruments 3 (3), 45 1 2019

3. Longitudinal phase-space manipulation with beam-driven plasma wakefields, V Shpakov, MP Anania, M Bellaveglia, A Biagioni, F Bisesto, F Cardelli, Physical review letters 122 (11), 114801 11 2019

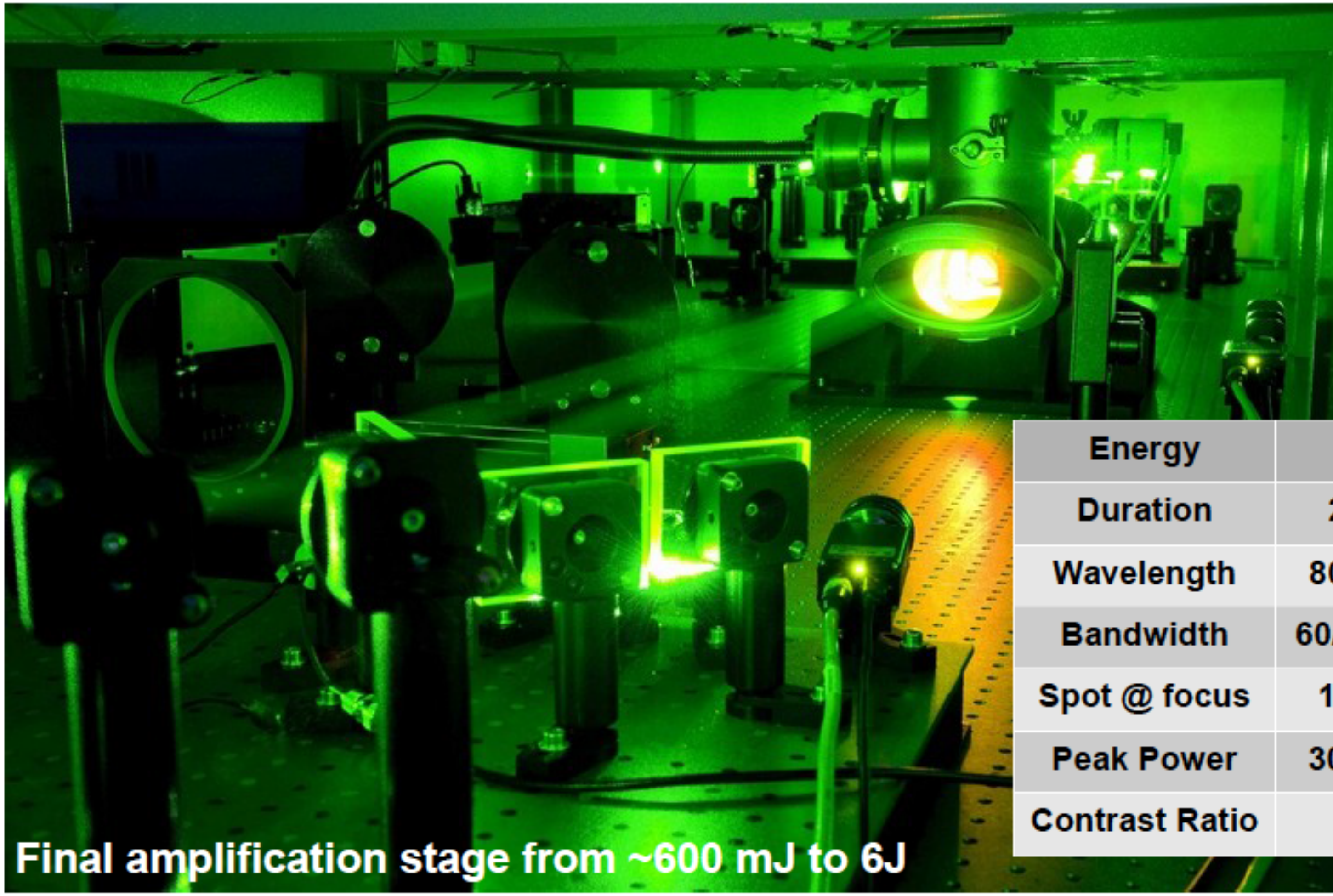
4. Temperature analysis in the shock waves regime for gas-filled plasma capillaries in plasma-based accelerators,A Biagioni, D Alesini, MP Anania, M Bellaveglia, S Bini, F Bisesto,Journal of Instrumentation 14 (03), C03002 2019

5. The Potential of EuPRAXIA@ SPARC_LAB for Radiation Based Techniques,A Balerna, S Bartocci, G Batignani, A Cianchi, E Chiadroni, M Coreno ,Condensed Matter 4 (1), 30 2 2019

6. Review on TNSA diagnostics and recent developments at SPARC_LAB,F Bisesto, M Galletti, MP Anania, M Ferrario, R Pompili, M Botton, High Power Laser Science and Engineering 7 2019

7. Single-shot electrons and protons time-resolved detection from high-intensity laser–solid matter interactions at SPARC_LAB,F Bisesto, M Galletti, MP Anania, M Ferrario, R Pompili, M Botton, A Zigler, High Power Laser Science and Engineering 7 1 2019

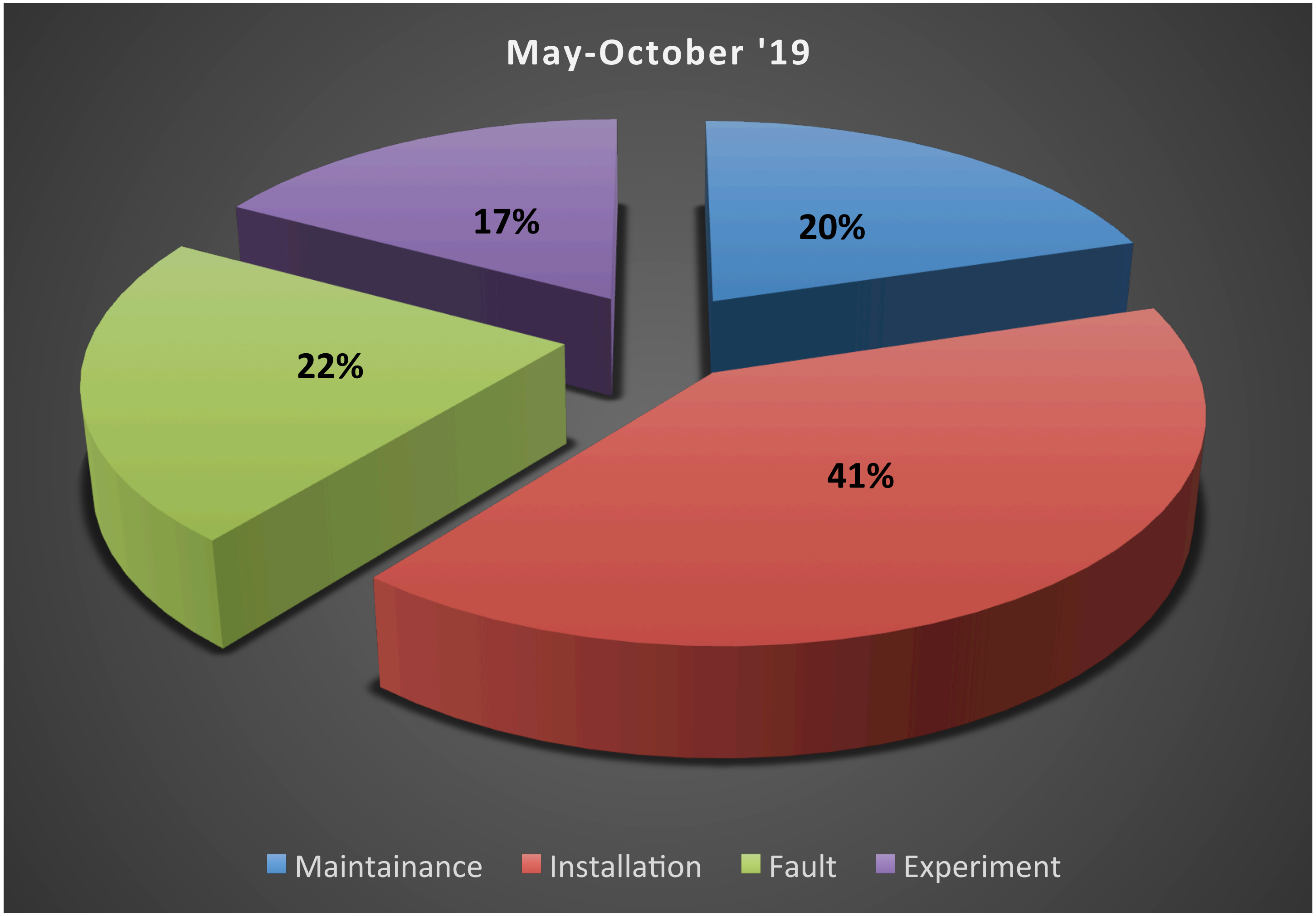
FLAME activities



Final amplification stage from ~600 mJ to 6J

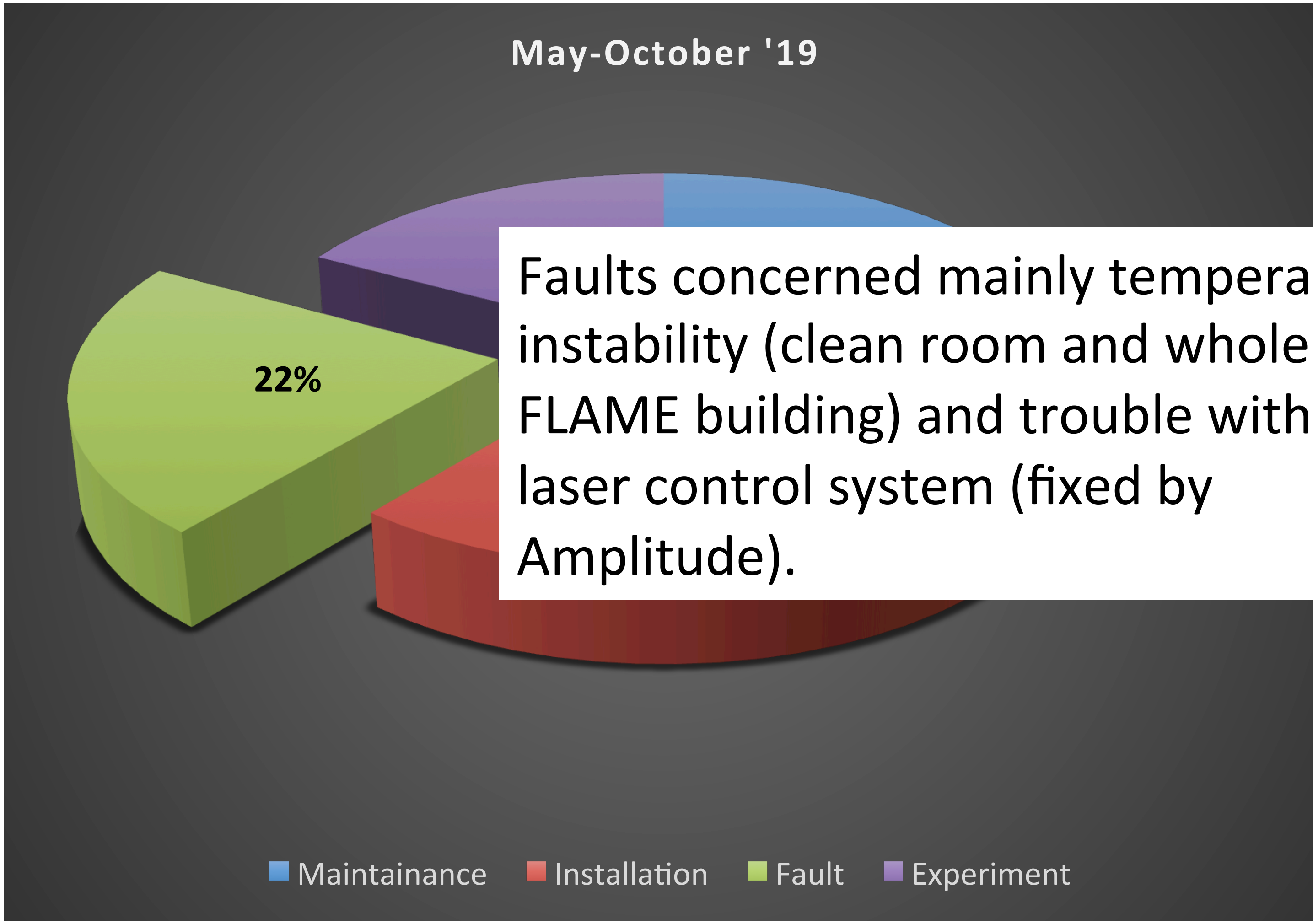
Energy	6 J
Duration	23 fs
Wavelength	800 nm
Bandwidth	60/80 nm
Spot @ focus	10 µm
Peak Power	300 TW
Contrast Ratio	10^{10}

FLAME time



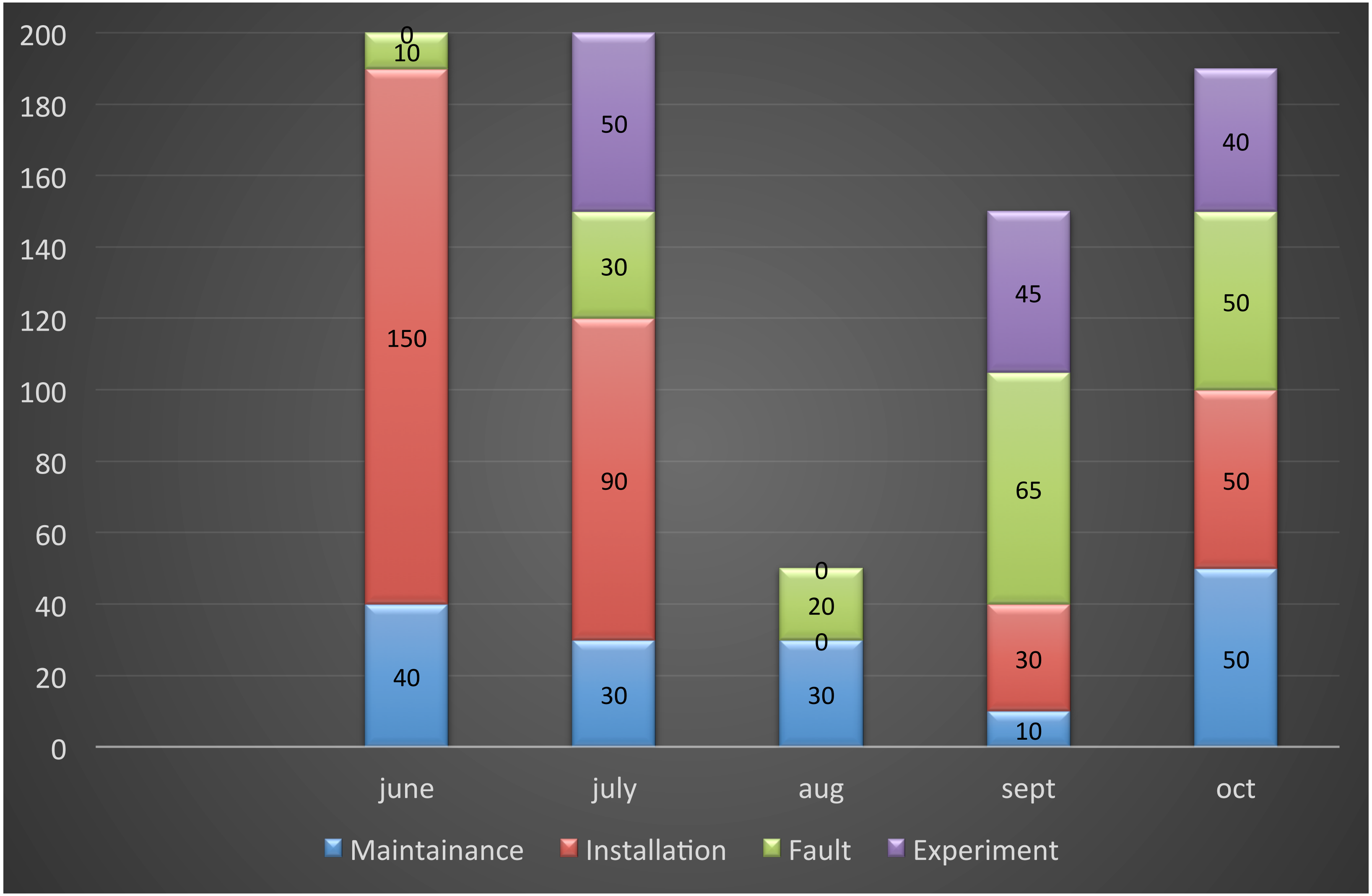
May-October '19
17%
20%
22%
41%
Maintainance
Installation
Fault
Experiment

FLAME time



Faults concerned mainly temperature instability (clean room and whole FLAME building) and trouble with laser control system (fixed by Amplitude).

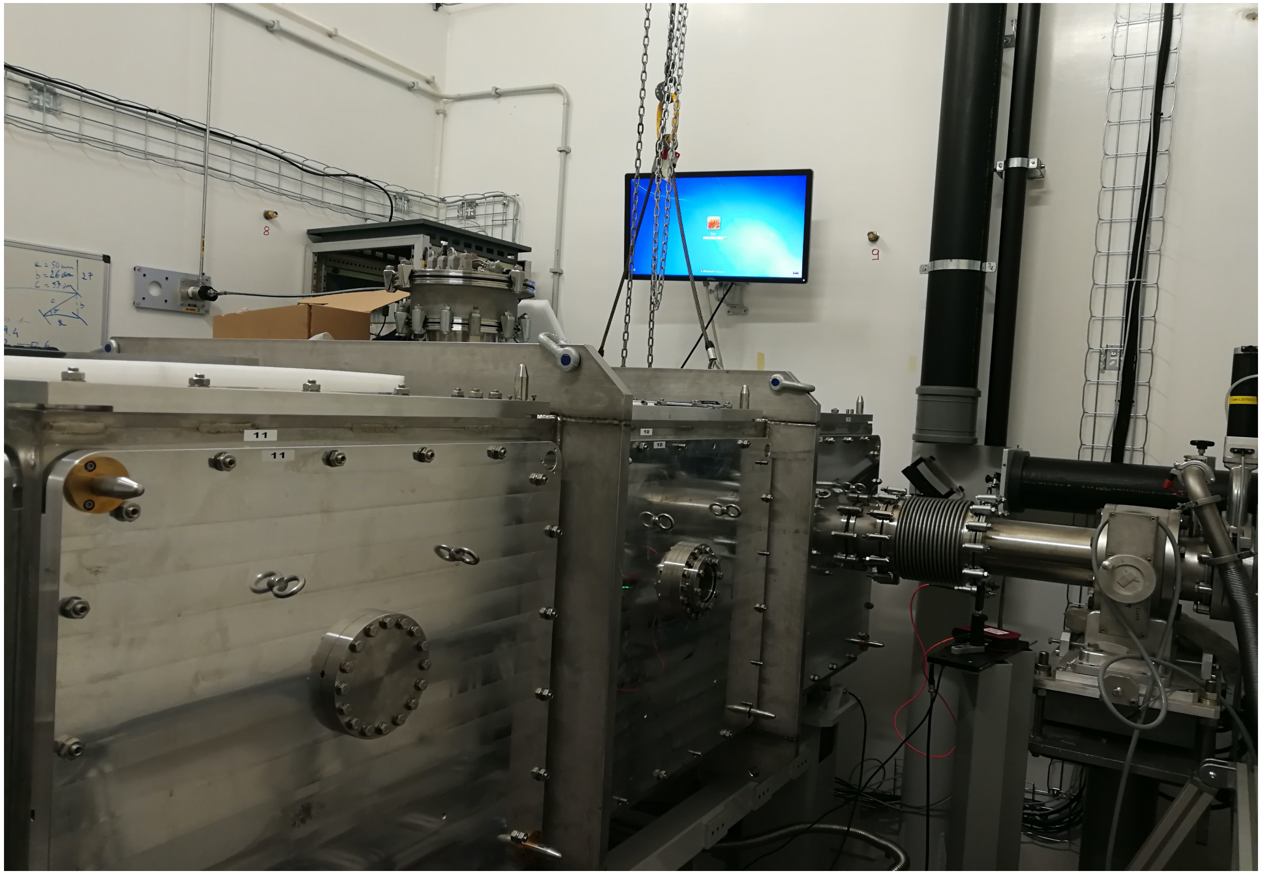
FLAME monthly time



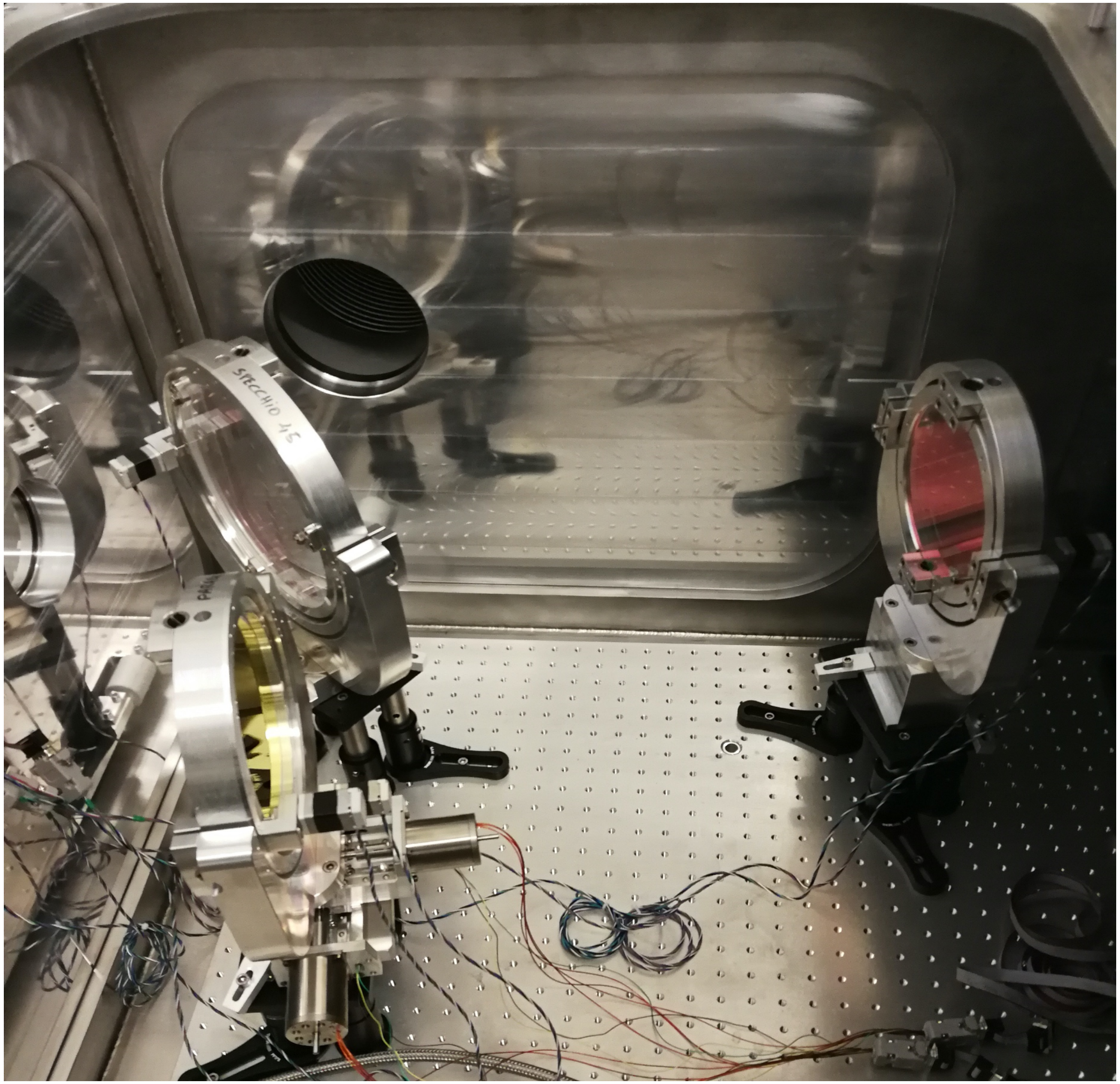
FLAME activities in May-October 2019

1. New experimental chamber installed and vacuum tests performed.
2. Re-installation of optical setup for final focus and beam optimization.
3. Several beam position diagnostics installed along the laser transport line.

New experimental chamber installed



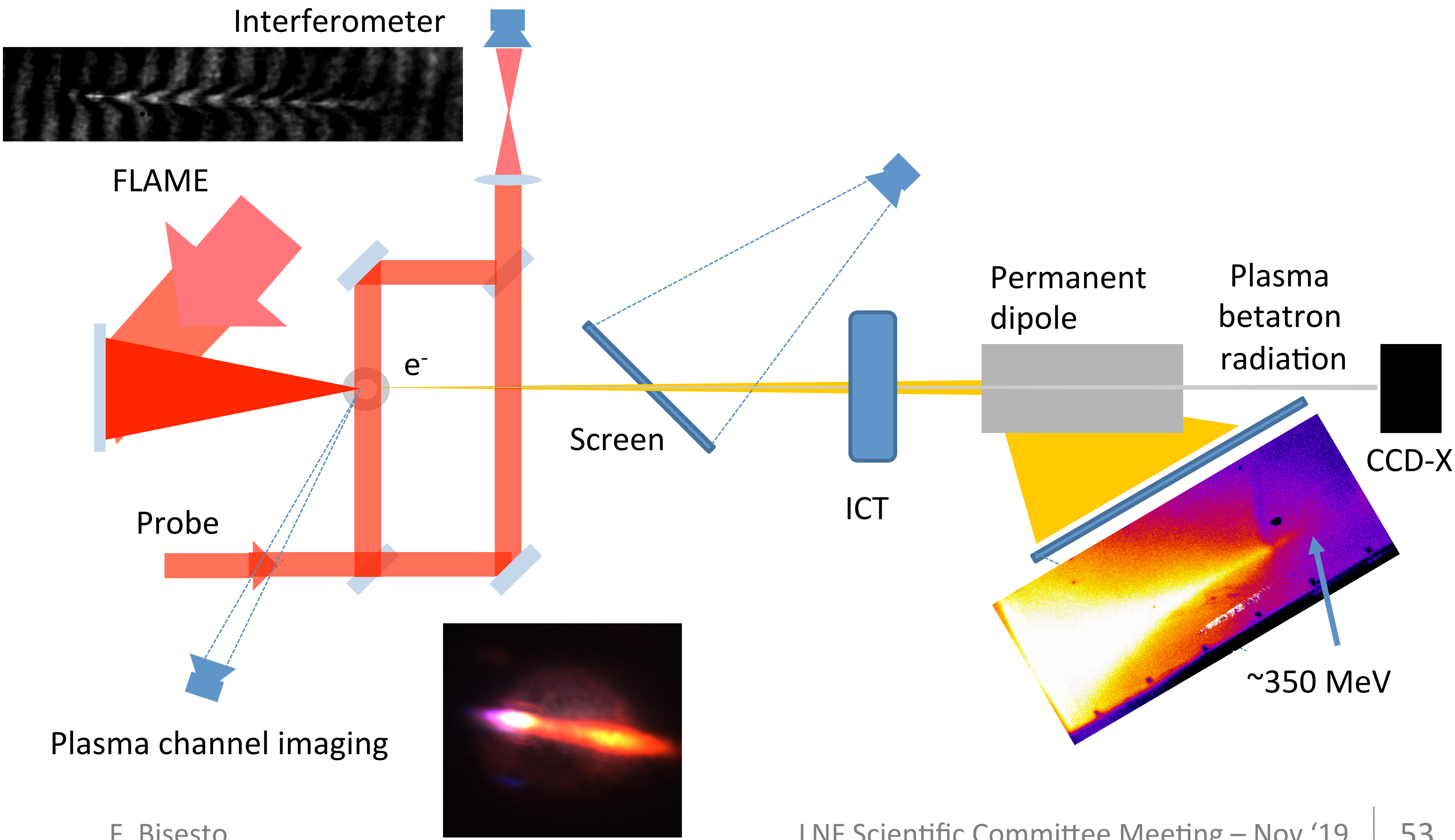
Optical Layout for final focus



FLAME activities in May-October 2019

- New experimental setup for LWFA mounted.
- First tests with He gas performed and e^- beams accelerated with 3mm gas-jet.
- Measured maximum electron energy around 350 MeV, not optimized yet.
- Detection of X-Ray from betatron radiation in the plasma channel: coming soon.

LWFA experimental setup



Beam Dynamics Group

Collaboration with *A. Berceanu* (spokesperson of the application) in the context of **HPC-Europe3**

- FLAME is the hosting experimental facility
- SPARC_LAB/FLAME group is collaborating on the simulation activity and performing the experimental measurements
- 10 GPUs K80@CINECA

HPC Europa3 — Pan-European Research Infrastructure on High Performance Computing

Network Compute Learn Travel

: a program offering

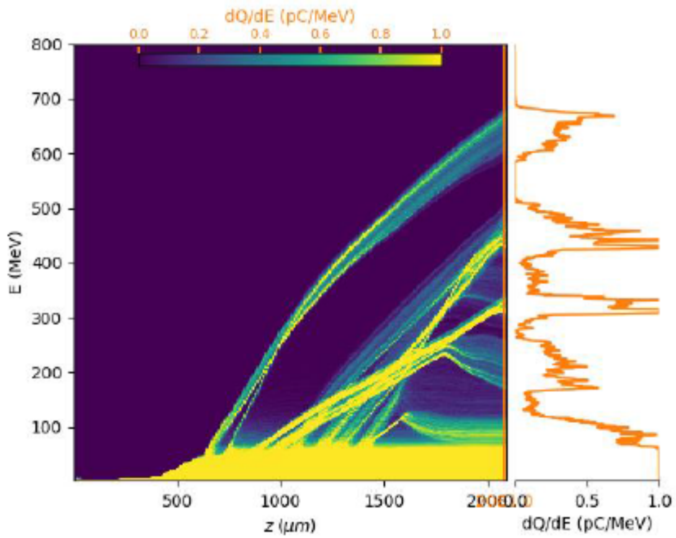
- access to world-class HPC systems to academic and industrial researchers
- scientific collaboration with host researchers in any field
- technical support by the HPC centers
- travel and living expenses reimbursed

Title of the project: **Laser-wakefield radiation sources as diagnostic tools**

The main project objective is using the emitted betatron radiation as a non-intercepting, single-shot diagnostic tool for the properties of the accelerated electron bunch. The basic algorithm is described in a recent publication of the Frascati group [A. Curcio et. al, Appl. Phys. Lett. 111, 133105 (2017)], and, in a nutshell, it amounts to measuring both the electron, as well as betatron energy spectra and obtaining the (radial) beam profile from the system's S-matrix. In a related paper [A. Curcio et. al, Phys. Rev. Accel. Beams 20, 012801 (2017)], the same group reconstructed both the beam profile, as well as the radial emittance of the electron beam, finally obtaining the trace-space density of the beam.

Beam Dynamics Group

Preliminary results (activity ongoing) obtained using Fourier-Bessel Particle-In-Cell code (FBPIC) (runnable on CPU/GPUs)
Online documentation: http://fbpic.github.io



Energy spectrum simulated using FLAME's experimental setup (self-injection) with 2mm He gas-jet

Here the a video

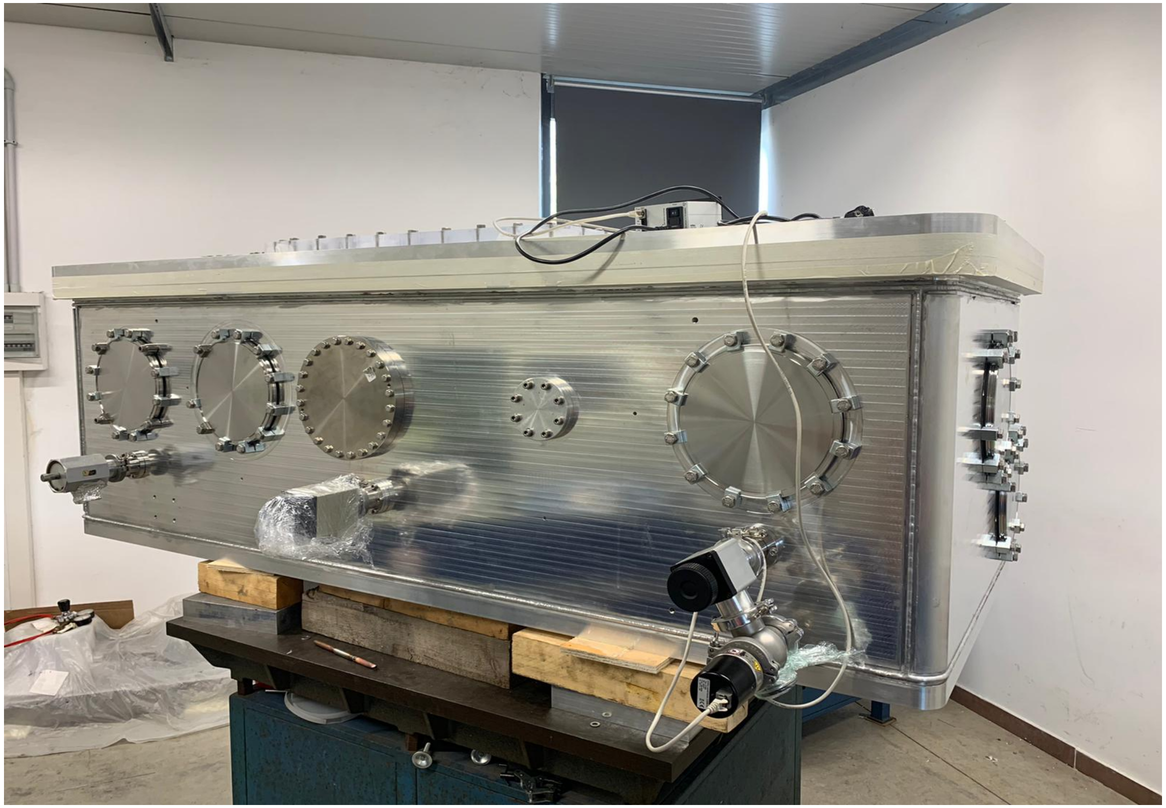
Program for the next 6 months

- Optimize the current set-up and start X-Ray measurements.
- Extend the accelerator length to increase beam energy by using longer gas-jet and/or other gas target (capillary, gas-cell etc.).
- Try different injection scheme to improve beam quality and tune energy, charge and emitted radiation.

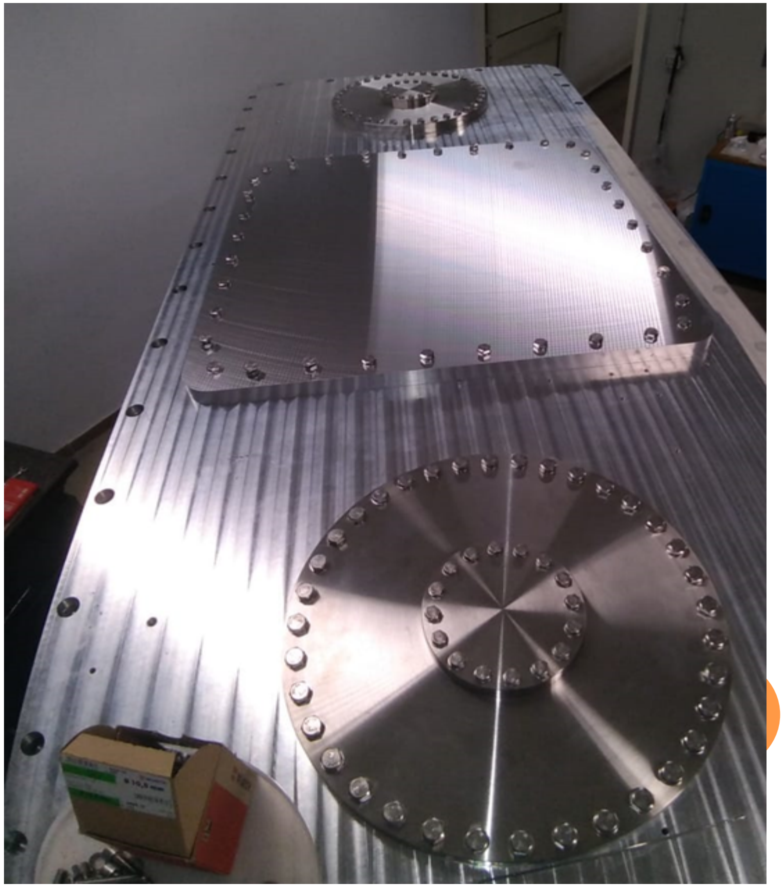
Publications

1. M Galletti, et al., «Vulcan and flame ultra-short pulses characterization by grog algorithm.» **Journal of Instrumentation**, 14(02):C02005, 2019.
2. A Curcio, et al., «Towards the detection of nanometric emittances in plasma accelerators.» **Journal of Instrumentation**, 14(02):C02004, 2019.
3. F Bisesto, et al., «Single-shot electrons and protons time-resolved detection from high-intensity laser–solid matter interactions at SPARC_LAB.» **High Power Laser Science and Engineering**, 7, 2019.
4. F Bisesto, et al., «Review on tnsa diagnostics and recent developments at SPARC_LAB.» **High Power Laser Science and Engineering**, 7, 2019.
5. A Curcio, et al., «Modeling and diagnostics for plasma discharge capillaries.» Accepted for publication on **Physical Review E.**

Camera EXIN



The manufacturing of ExIn Interaction Chamber has been conclused and passed the first vacuum test on welds.



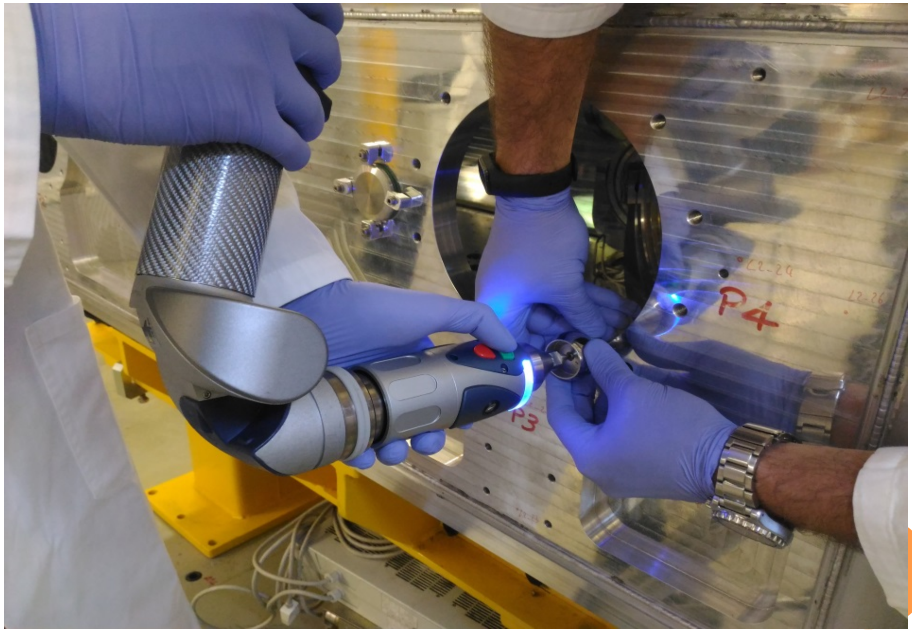
ExIn Interaction Chamber Delivery : **15th December, 2019**

F.Cioeta, R. Sorchetti

GREY ROOM

- The Grey Room has been staged in order to install the components of the ExIn Interaction Zone to test the chambers on vacuum limit.

- The injection chamber was dimensionally characterized



Commissioning of the SPARC_LAB optical synchronization system in view of EXIN experiment

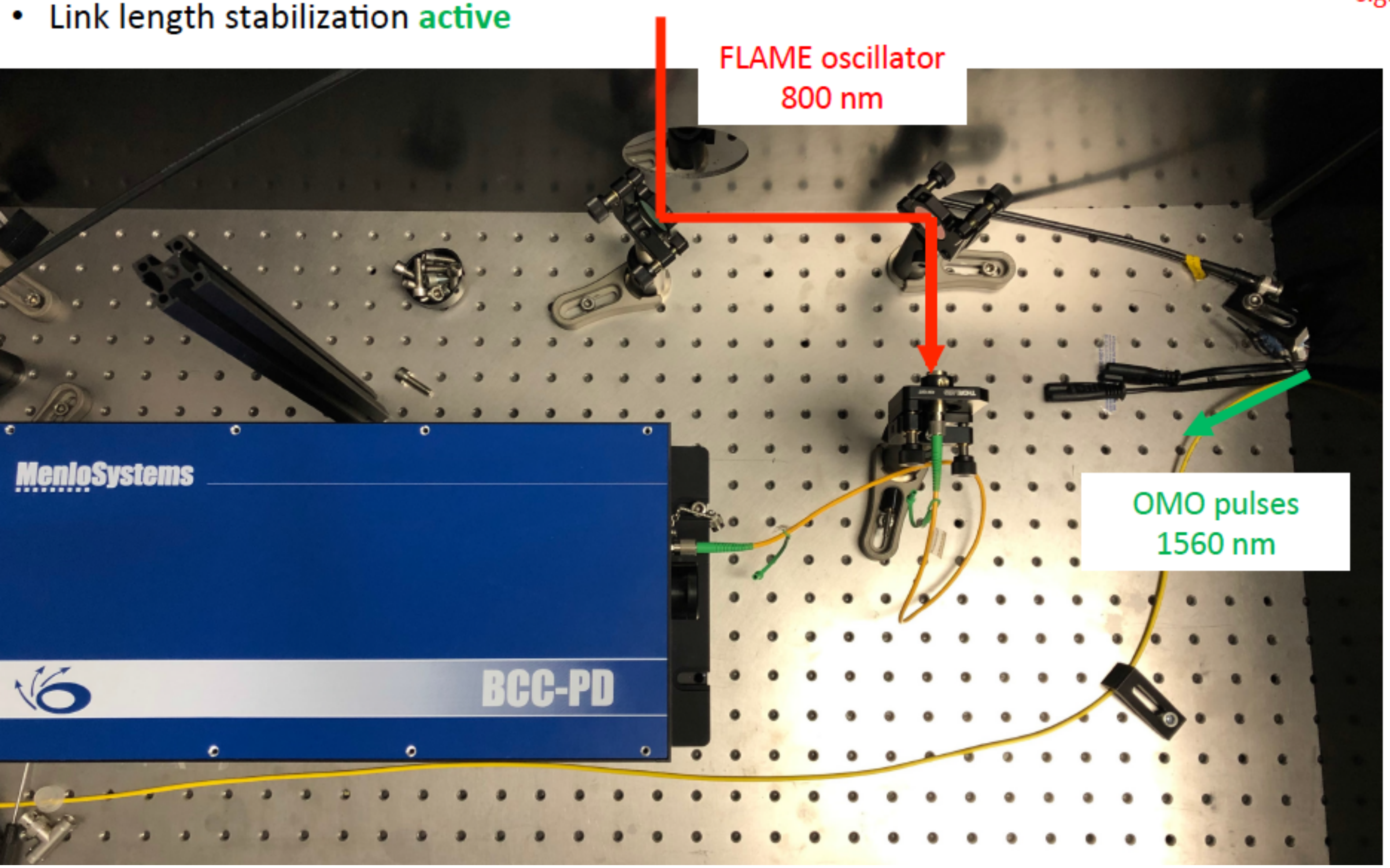
- At present SPARC_LAB synchronization system is based on a microwave oscillator and a coaxial distribution of the reference with RF mixers used as phase detectors
- In view of EXIN experiment, the synchronization system is being upgraded. It will employ an Optical Master Oscillator (OMO) locked to the microwave reference, one stabilized fiber link to distribute the reference to FLAME lab and one link to the Photo-Cathode (PC) laser. The phase detectors used are optical cross correlators ($10^2 \div 10^3$ times more sensitive than RF mixers)

RECENT ACTIVITY

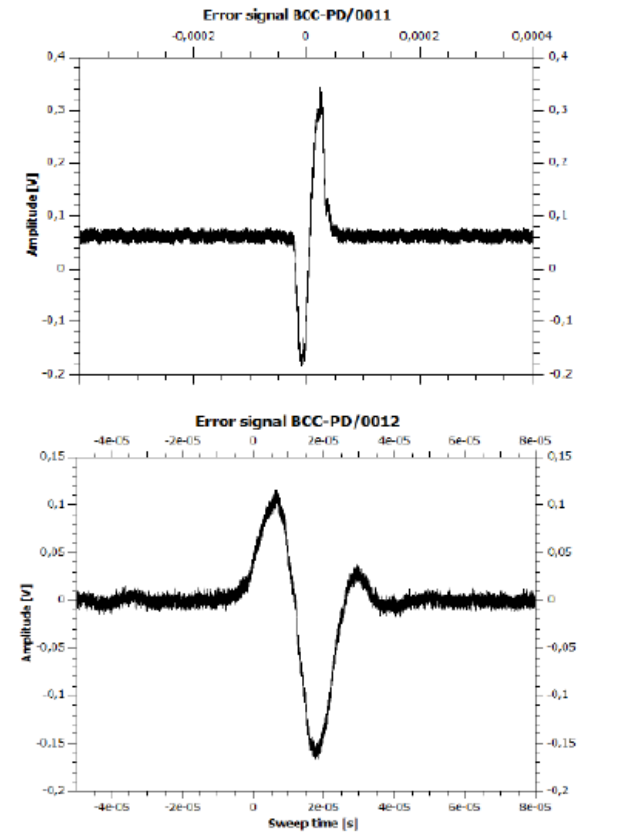
- Optimization of the stabilized fiber link between OMO and FLAME oscillator. The length of the link has been modified to achieve a better overlap of the signals in the cross correlator (higher sensitivity)
- The OMO pulse length at the end of the link has been measured using a fiber coupled autocorrelator to be < 250 fs
- An upgraded version of the two Balanced Cross-Correlators (800/1560 nm) has been installed to measure the phase difference between:
  - FLAME laser oscillator and OMO
  - PC_laser oscillator and OMO
- Both Cross correlators have been **tested successfully** with FLAME oscillator
- Only **FLAME cross correlator** has been **commissioned**, due to the temporary unavailability of PC laser
- The measured sensitivity of 30 µV/fs is lower than expected. This can be explained since FLAME short pulses (few tens of fs) suffer remarkable elongation due to dispersion in several cm of uncompensated optical fiber (**to be improved**)
- A dedicated locking electronics for both FLAME and PC_laser oscillators is **currently being designed** by synchronization group

Commissioning of the SPARC_LAB optical synchronization system in view of EXIN experiment: cross-correlator commissioning

- OMO **locked** to microwave reference
- Link length stabilization **active**



Cross correlator n.1 (top) and n.2 (bottom) error signal. The fiber coupled power at 800 nm was 20 mW



AVVISO PUBBLICO

POTENZIAMENTO DELLE INFRASTRUTTURE DELLA RICERCA PNIR PER ELEVARE IL TASSO DI INNOVAZIONE DEL TESSUTO PRODUTTIVO REGIONALE

SABINA

SOURCE of ADVANCED BEAM IMAGING for NOVEL APPLICATIONS

FELs OF EUROPE

INFN LNF

Istituto Nazionale di Fisica Nucleare

SABINA

SOURCE OF ADVANCED BEAM IMAGING FOR NOVEL APPLICATIONS

Strengthening of SPARC (as member of FELs OF EUROPE)

Goals:

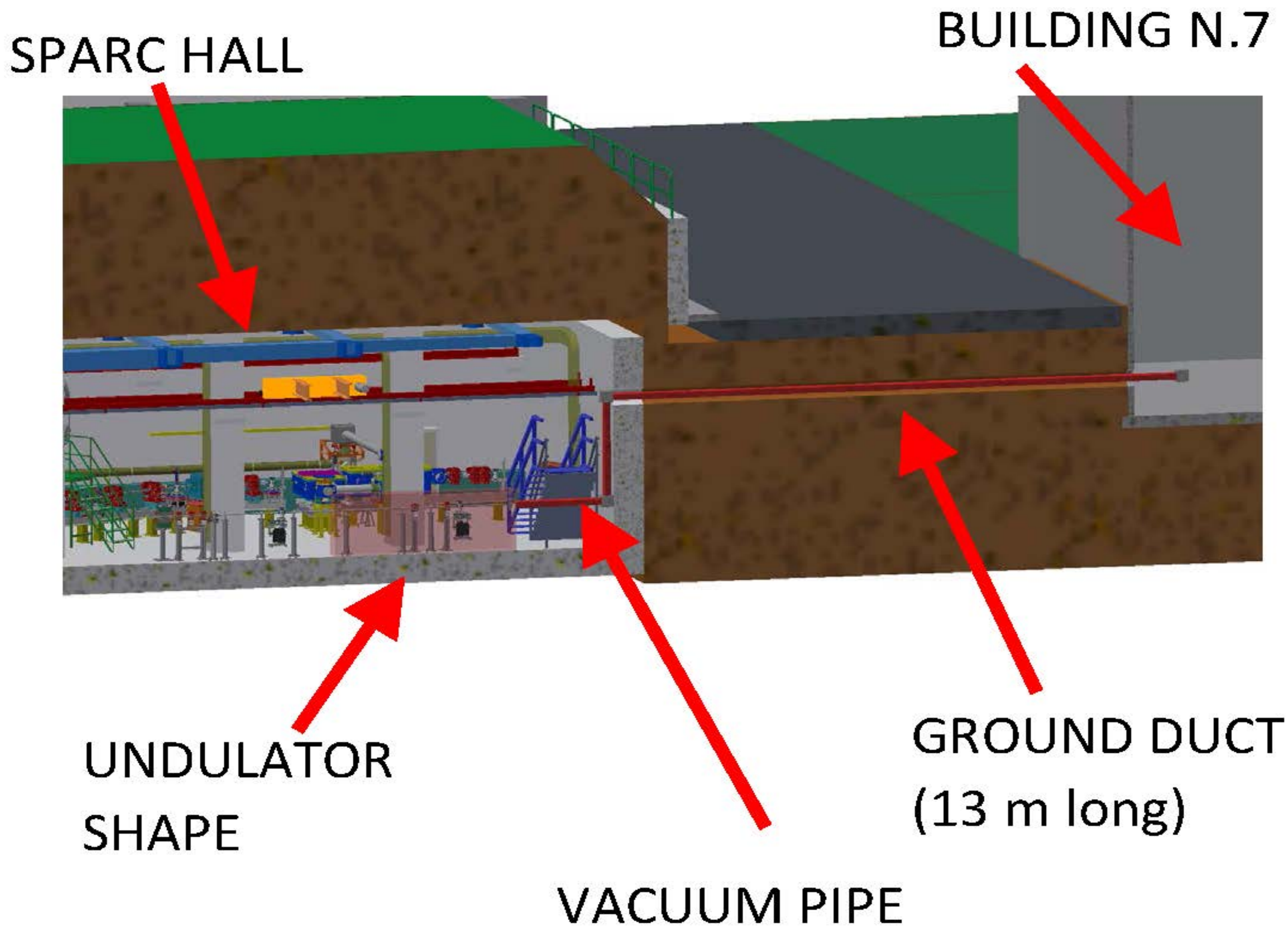
- Technological plants renewal (increase of the uptime)
- Update of equipment (photoinjector, beam manipulation, diagnostics)
- Creation of two user facilities: THz and FLAME

User Facilities:

- THz: spectroscopic analysis (single point or imaging), also at cryogenic T
- FLAME: surface coating tests (green, infrared), vacuum tests

Budget: about 6.1 M€ (4.5M€ Regional funds POR-FESR, 1.6M€ INFN)

Ed. 7
Ed. 6
Bunker Sparc
Ed. 56
Flame


SPARC HALL
BUILDING N.7
UNDULATOR
SHAPE
VACUUM PIPE
GROUND DUCT
(13 m long)

Next SPARC_LAB Milestones

1. 2020 - PWFA – Acceleration and transport
2. 2021 – LWFA - Beam/Plasma matching studies
3. 2022 – LWFA – Acceleration and Diagnostics
4. 2023 –COMB2FEL - PWFA SASE demonstration


Thank for your attention

SPARC_LAB activities related to the EuPRAXIA R&D

- Laser Comb technique
- S/C RF gun design and fabrication
- X-band test facility
- Velocity Bunching
- fs Synchronization
- Single shot diagnostics

- **Capillary characterization**
- Laser guiding
- Active Plasma Lens
- Plasma Dechirper
- PWFA acceleration experiments
- High transformer ratio studies

- LWFA with external injection
- Plasma driven FEL test