EuPRAXIA@SPARC_LAB

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On behalf of the EuPRAXIA@SPARC_LAB team

INFN
Istituto Nazionale di Fisica Nucleare

LNF–18/03
May 7, 2018

EuPRAXIA@SPARC_LAB

Conceptual Design Report

LNF Scientific Committee – May 14, 2018

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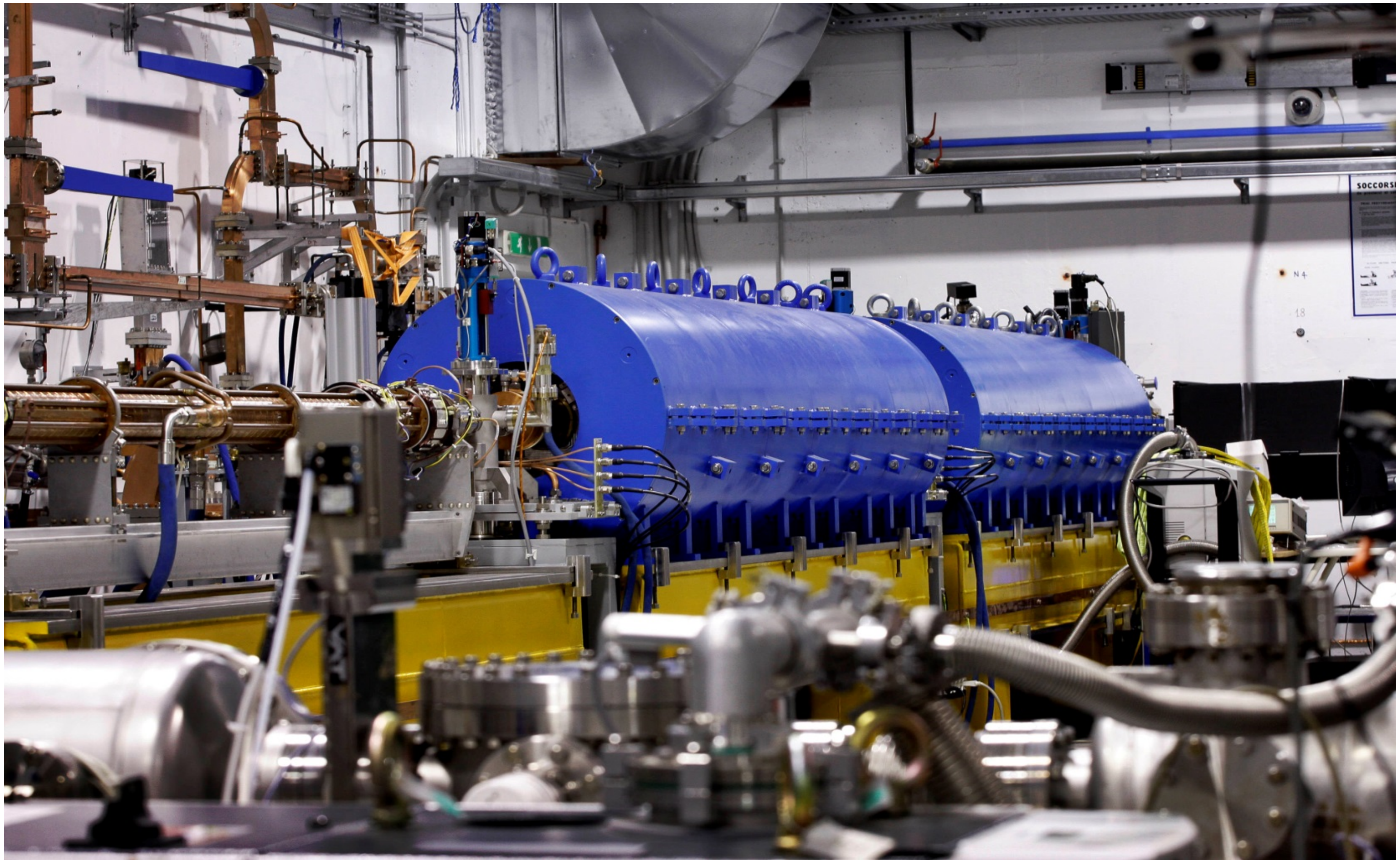
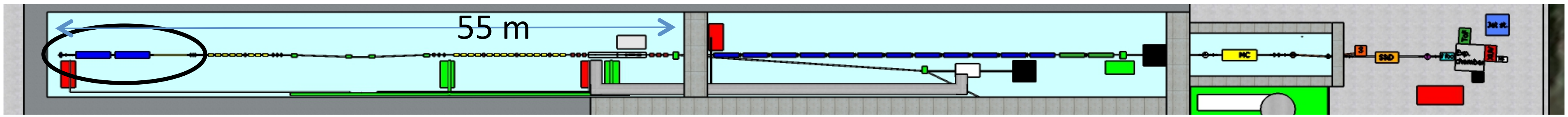
Conceptual Design Report

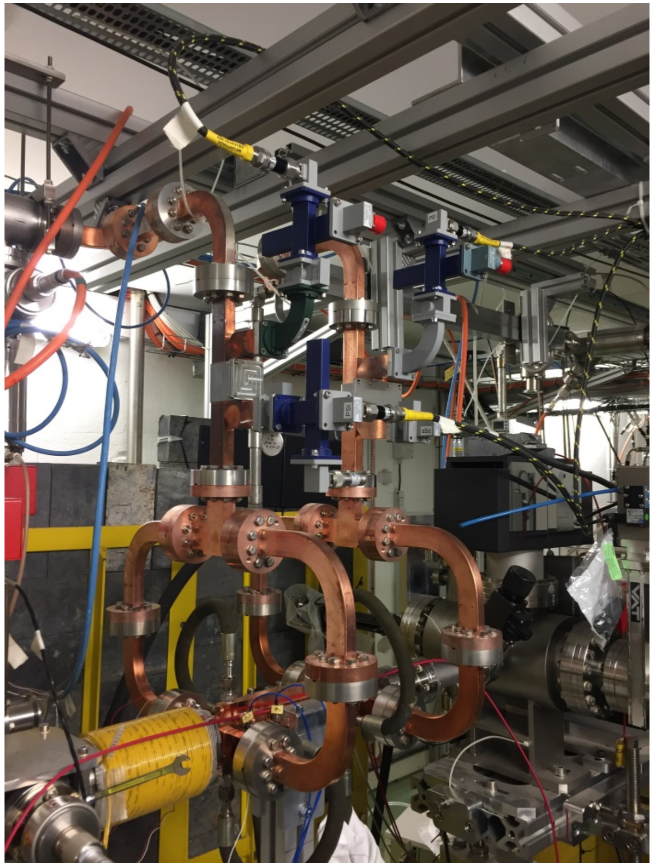
http://www.lnf.infn.it/sis/preprint/detail-new.php?id=5416

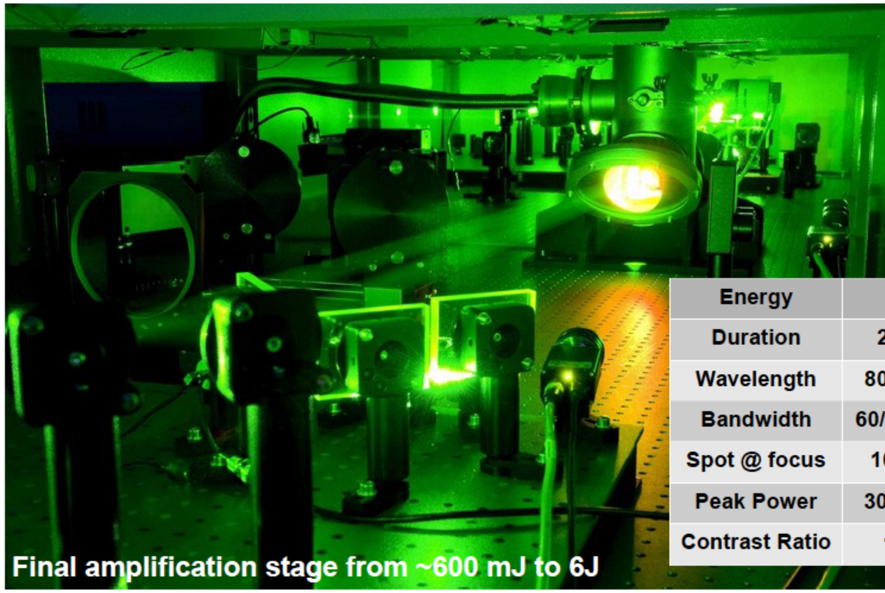
SPARC_LAB HB photo- injector



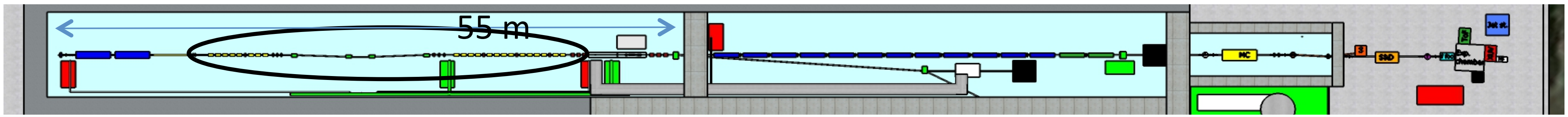


X-band Linac and High Power Laser

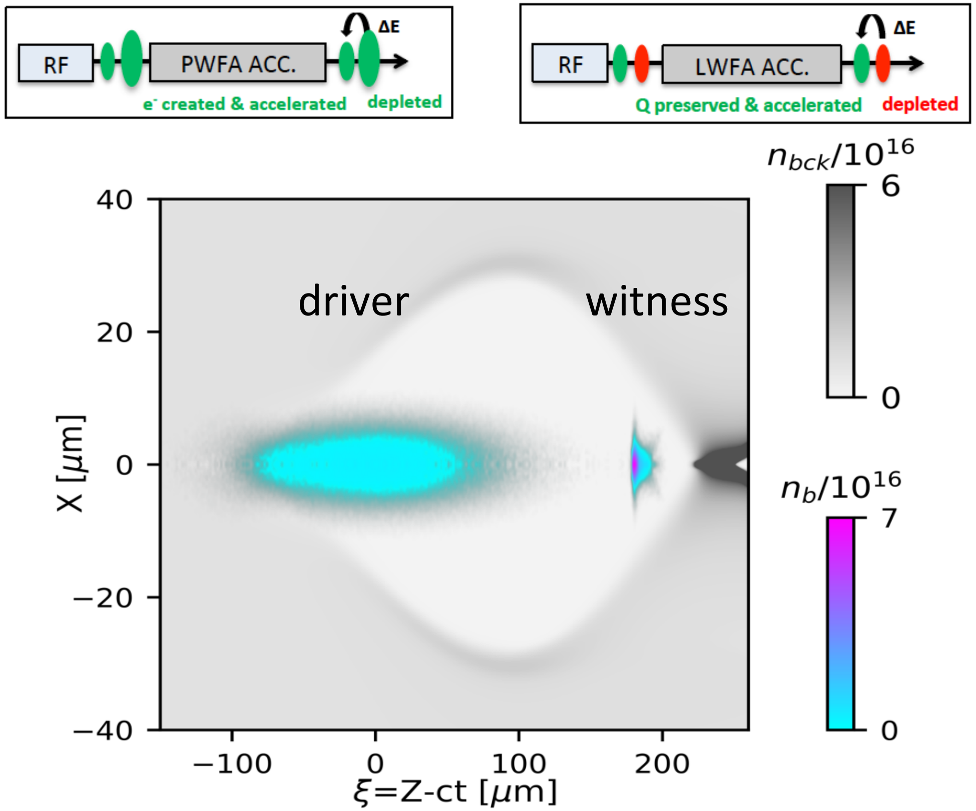


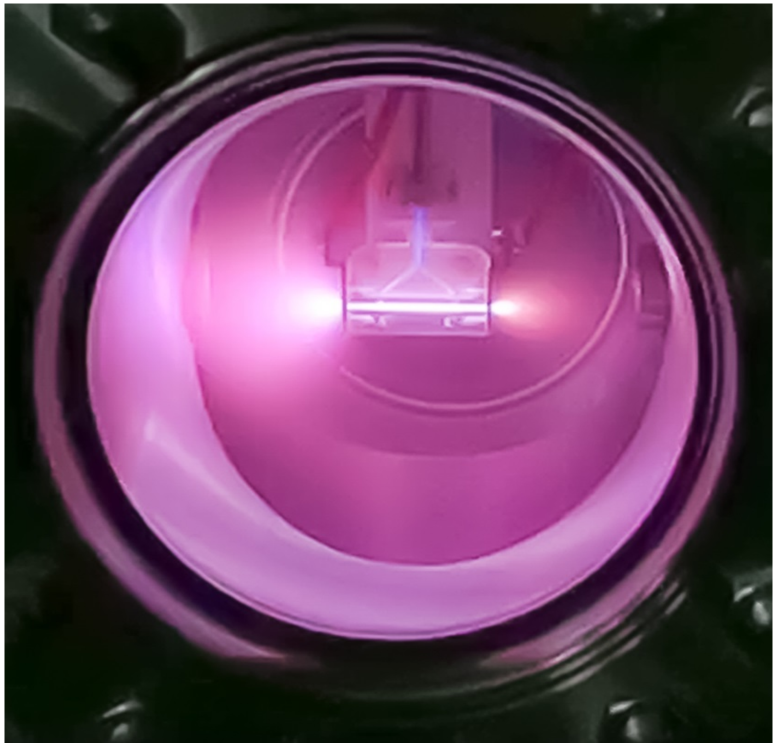


Energy	6 J
Duration	23 fs
Wavelength	800 nm
Bandwidth	60/80 nm
Spot @ focus	10 μm
Peak Power	300 TW
Contrast Ratio	10^{10}

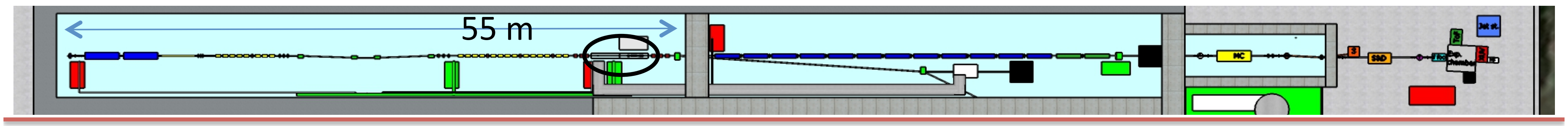


Plasma WakeField Acceleration – External Injection

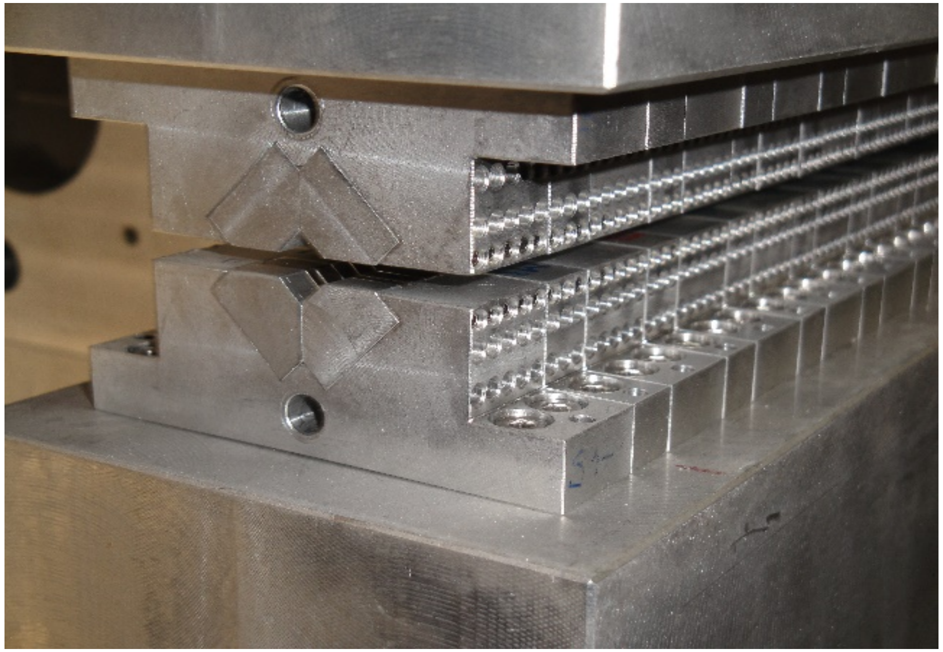




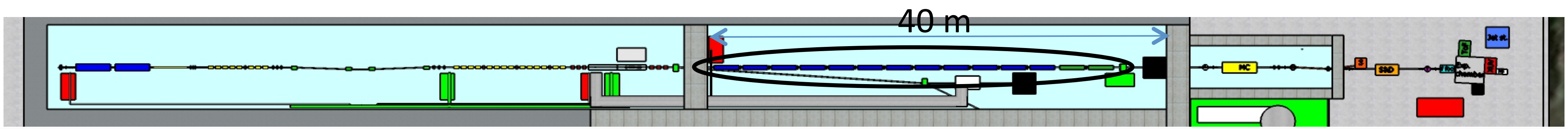
Capillary discharge at SPARC_LAB



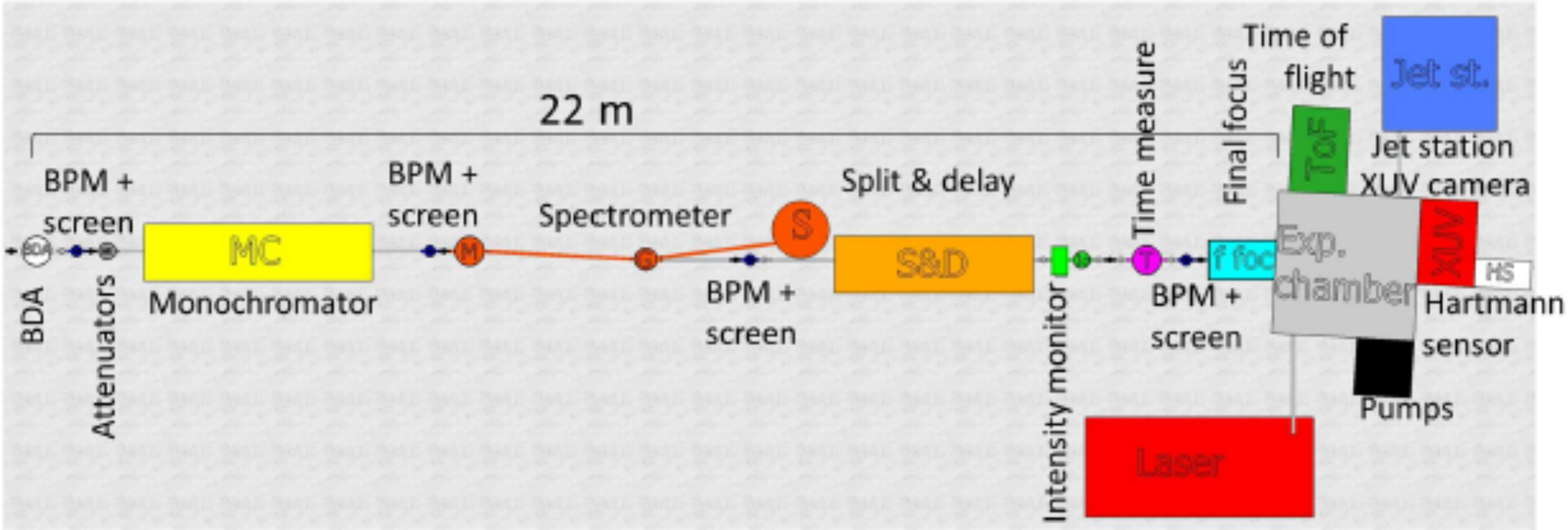
Undulators

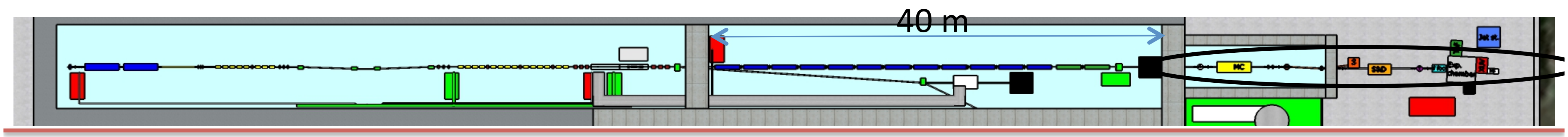


KYMA Δ udulator at SPARC_LAB: λ=1.4 cm, K1



Photon beam line



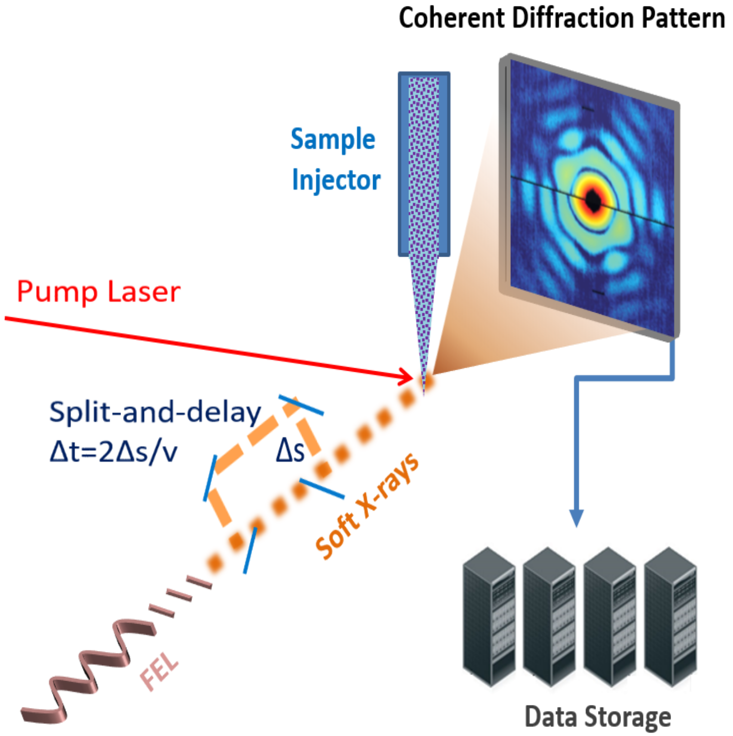


Coherent Imaging @ EuSPARC/EuPRAXA

2 key issues: brilliance and coherence of the FEL radiation

1 experimental station performing coherent imaging experiments

Many applications, ranging from biological systems to condensed matter physics

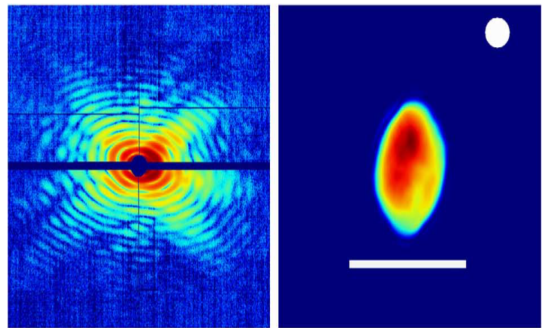


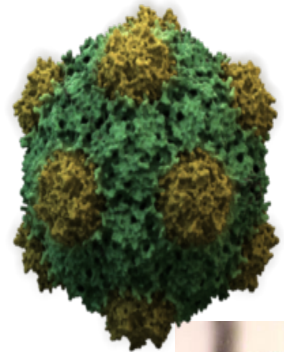
Water Window Coherent Imaging of biological systems

Energy region between oxygen and carbon K-edge

2D and 3D images of biological samples will be obtained

viruses, cells, organelles, protein fibrils…





Condensed-matter

High Temperature superconductors

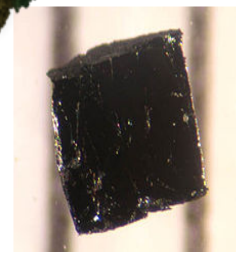
Metal-insulating transitions

Colossal magnetoresistance phenomena

Ferroelectrics & multiferroics materials

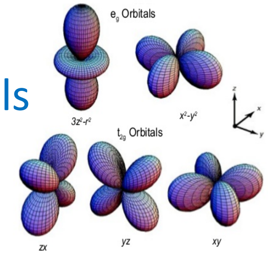
Skyrmions, spintronics

Nanoparticles and plasma

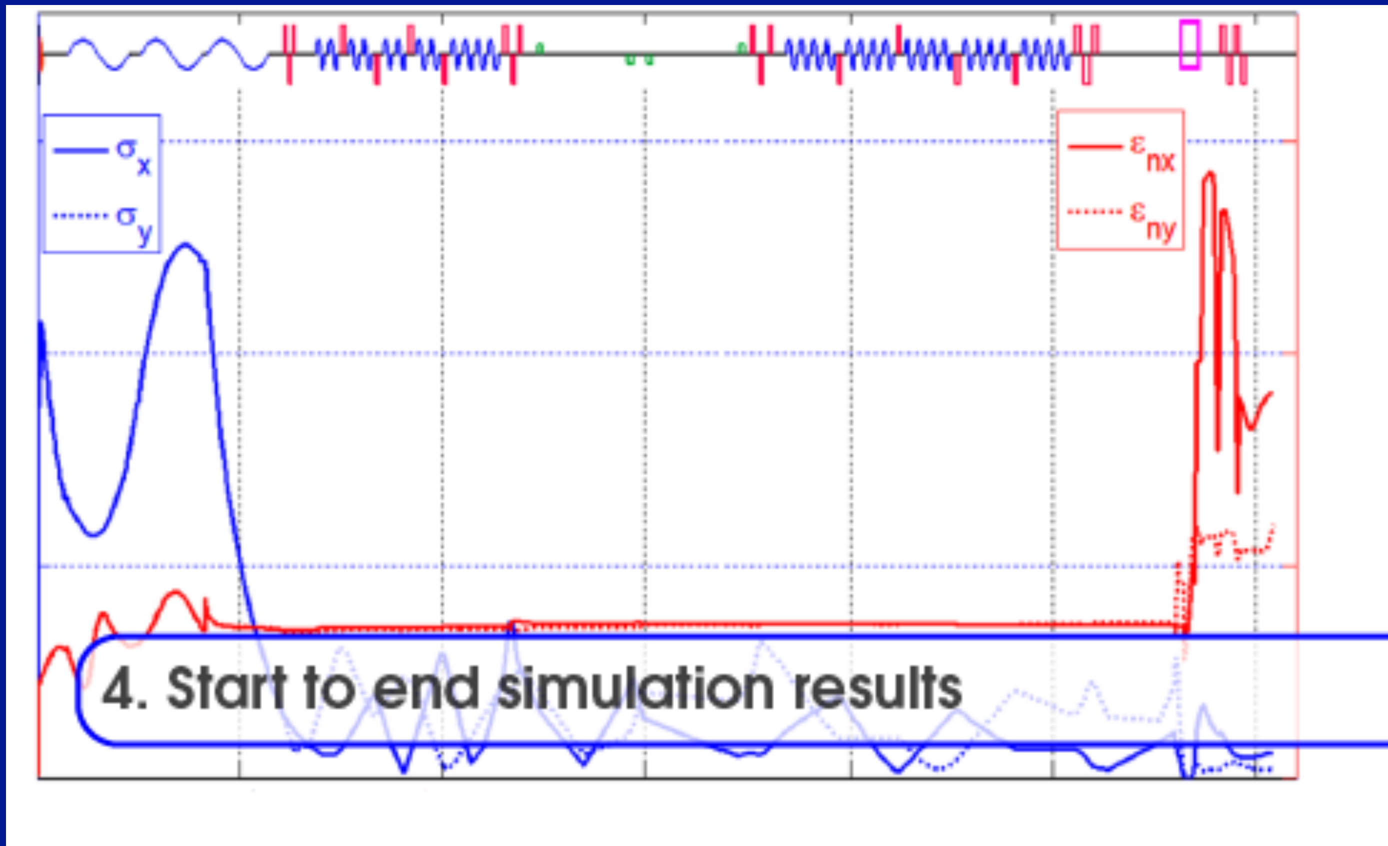


Colossal Magnetoresistance

3d Orbital Types



GPT => Elegant=> Architect => Elegant=> Genesis



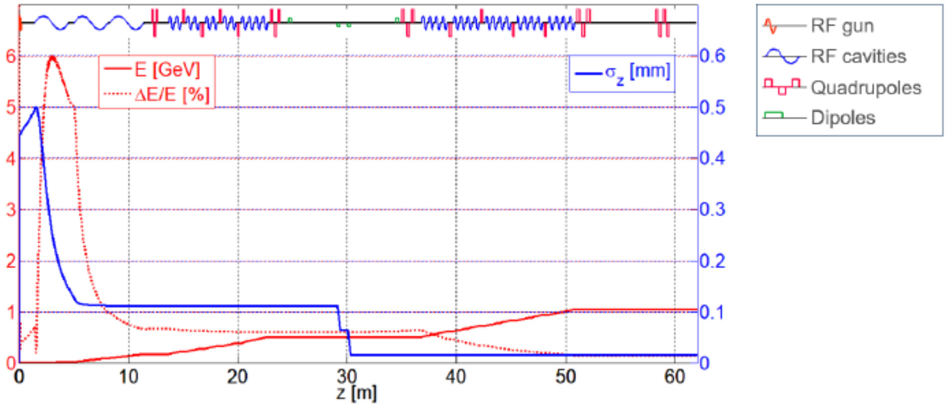


Figure 5.1: Start to end simulation results for the 200 pC bunch for the X-band case: evolution along the injector of the energy (E red line) and energy spread ($\Delta E/E$ red dotted-line) and longitudinal bunch length (σ_z blue line).

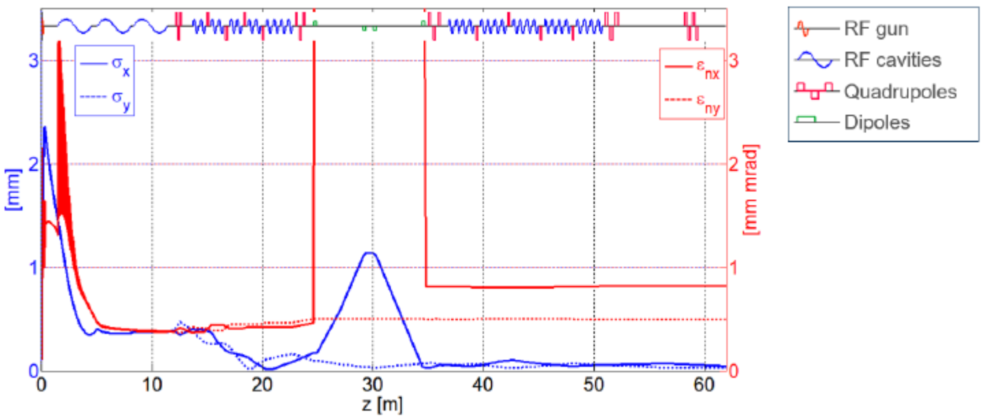


Figure 5.2: Start to end simulation results for the 200 pC bunch for the X-band case: evolution along the injector of the electron beam transverse normalised emittance (ε_{n_x} red line, ε_{n_y} red dotted-line) and spot sizes (σ_x blue line, σ_y blue dotted-line).

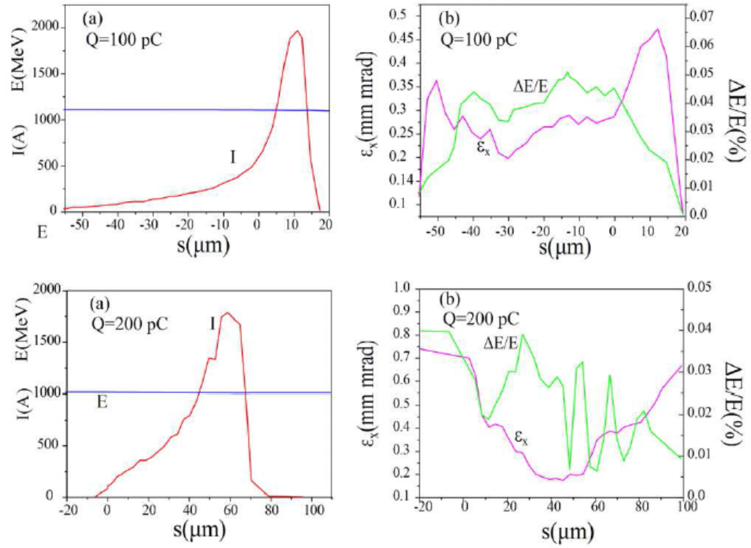


Figure 6.10: Upper windows $Q = 100$pC , lower windows $Q = 200$ pC . (a) in red I(A), in blue E(MeV), (b) emittance (mm mrad) and energy spread (%) vs the electron beam coordinate s (μm).

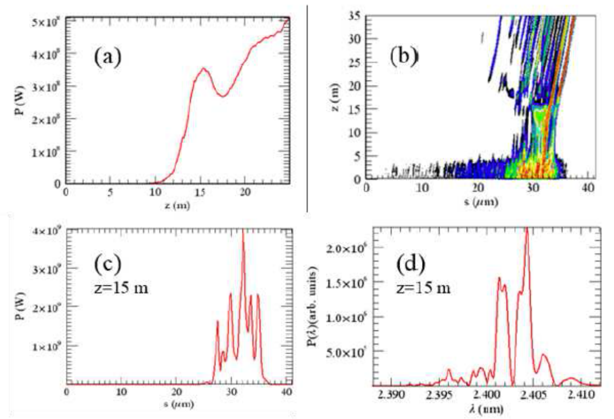


Figure 6.12: Case (a) at 100 pC : (a) power growth P(W) vs. the coordinate along the undulator z (m). (b) contour level of the radiated power in the (s, z) plane, with s (μm) coordinate along the electron beam. (c) Power and (d) spectral density at $z = 15$ m.

	Units	Full RF case	LWFA case	PWFA case
Electron Energy	GeV	1	1	1
RMS Energy Spread	%	0.05	2.3	1.1
Peak Current	kA	1.79	2.26	2.0
Bunch Charge	pC	200	30	30
RMS Bunch Length	µm (fs)	16.7 (55.6)	2.14 (7.1)	3.82 (12.7)
RMS normalized Emittance	mm mrad	0.5	0.47	1.1
Slice Length	µm	1.66	0.5	1.2
Slice Charge	pC	6.67	18.7	8
Slice Energy Spread	%	0.02	0.03	0.034
Slice normalized Emittance (x/y)	mm mrad	0.35/0.24	0.45/0.465	0.57/0.615
Undulator Period	mm	15	15	15
Undulator Strength $K(a_w)$		0.978 (0.7)	1.13 (0.8)	1.13 (0.8)
Undulator Length	m	30	30	30
Pierce parameter ρ (1D/3D)	$\times 10^{-3}$	1.55/1.38	2/1.68	2.5/1.8
Radiation Wavelength	nm (keV)	2.87 (0.43)	2.8 (0.44)	2.98 (0.42)
Photon Energy	µJ	177	40	6.5
Photon per pulse	$\times 10^{10}$	255	43	10
Photon Bandwidth	%	0.46	0.4	0.9
Photon RMS Transverse Size	µm	200	145	10
Photon Brilliance per shot	$(\mathrm{s\ mm^2\ mrad^2\ bw}(0.1\%))^{-1}$	1.4×10^{27}	1.7×10^{27}	0.8×10^{27}

Table 4.1: Beam parameters from start-to-end simulations for full RF and for plasma wakefield acceleration cases with electron (PWFA) or laser (LWFA) driver beam

Procedure for purchasing neighboring land started

Announcement of tender for the building design

Indizione gara di progettazione edificio

DELIBERA GE n. 11652 del 28.03.2018

Indizione di gara comunitaria a procedura ristretta per l'affidamento dell'incarico di progettazione definitiva ed esecutiva, CSFP per la realizzazione di un nuovo complesso edilizio EuSPARC presso i LNF-INFN, con riserva di affidamento di DL e del CSFE.

Importo a base di gara:

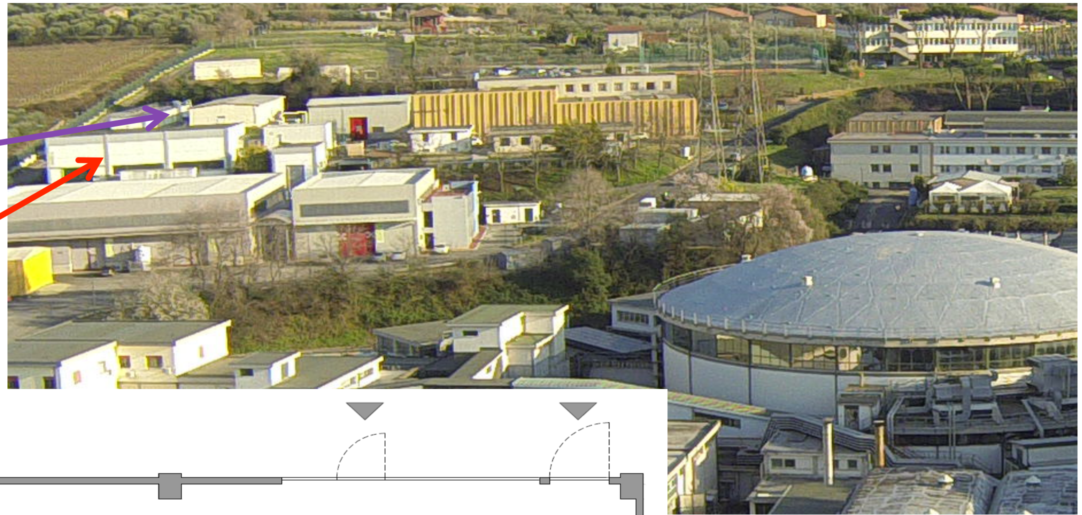
Progettazione definitiva	€ 724.489,30
Progettazione esecutiva e CSFP	€ 537.977,17
TOTALE INCARICO	**€ 1.262.466,47**
Con riserva: Direzione Lavori e CSFE	€ 1.213.256,10

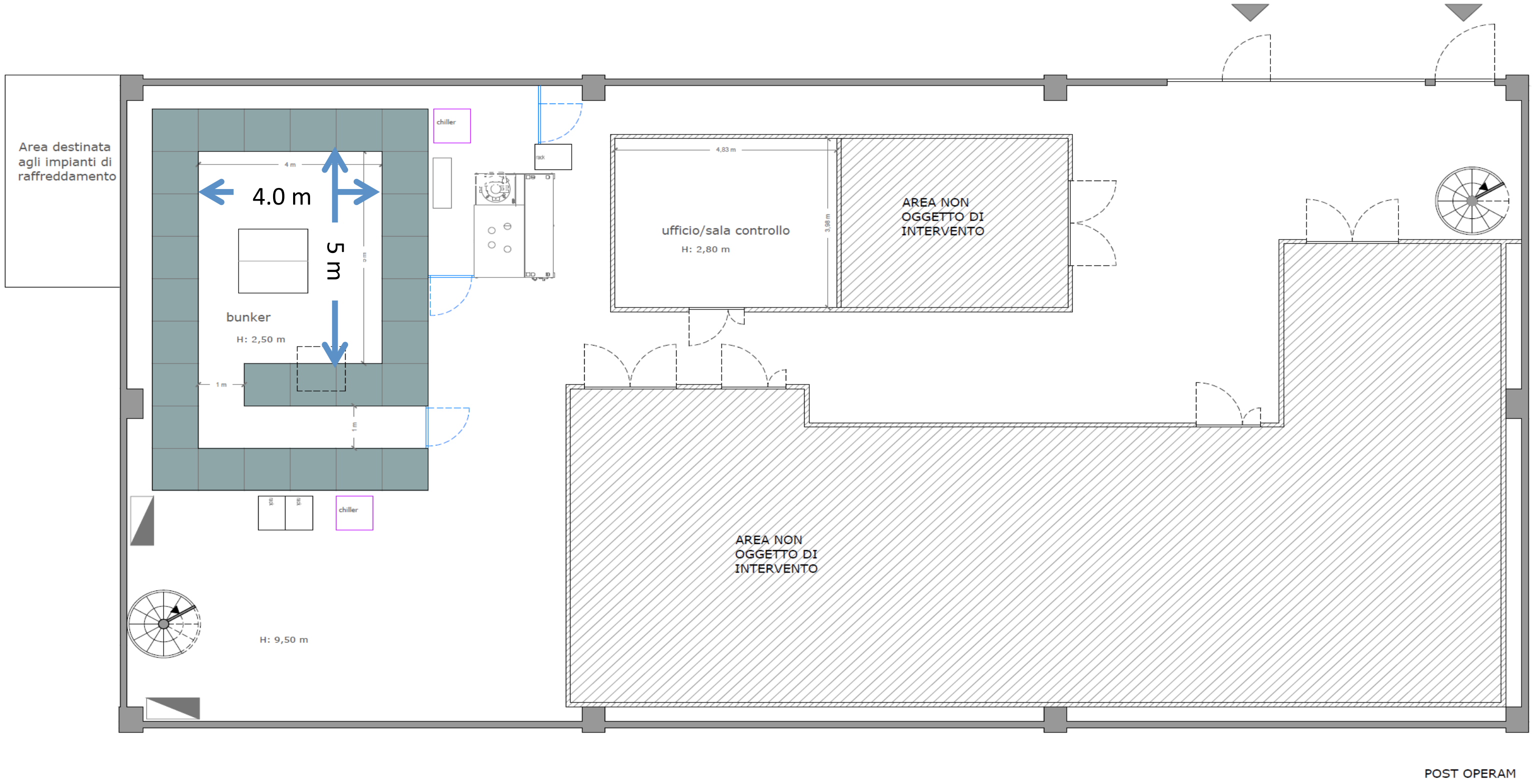
INFN – CERN official partnership on X-band RF development

The INFN Frascati X-box

SPARC_LAB

Building #7





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

LNF building #7: the old bunker

LNF building #7: inside view

The INFN Frascati X-box

Pulsed Modulator: to be procured by INFN

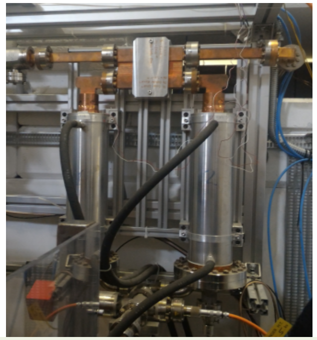
OPERATIONAL PARAMETERS

		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
	Kly. 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	48	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;
- …

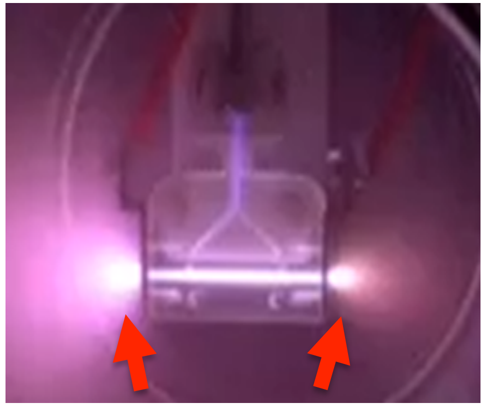
All components will be either provided by CERN or procured by INFN in full conformity with the original CERN X-box parts.

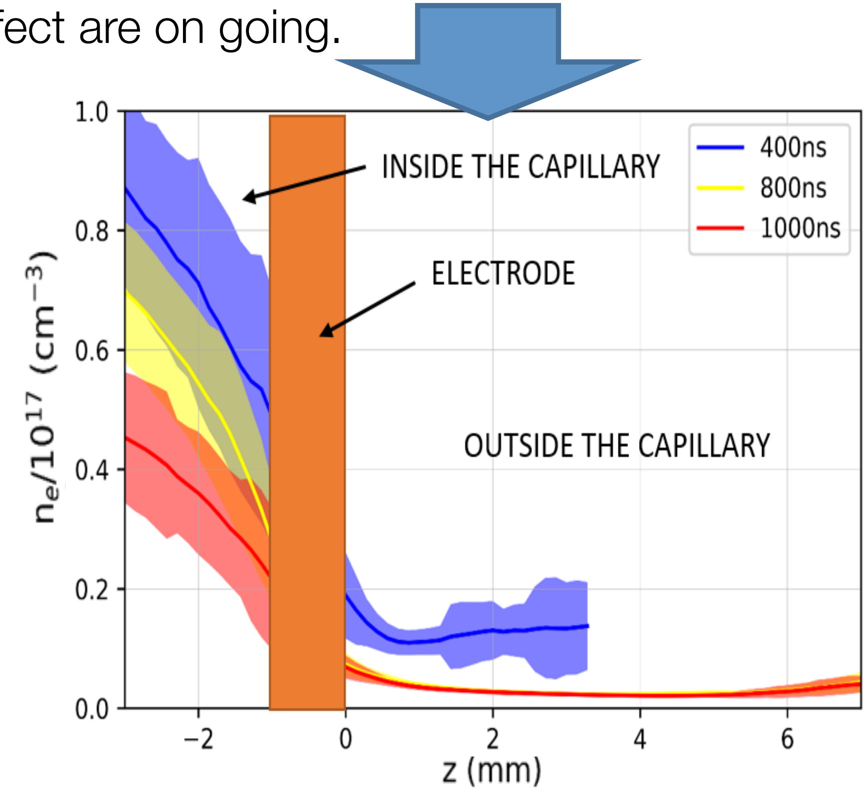
With the contribution of the **LATINO** project: a "Laboratory in Advanced Technologies for INnOvation" funded by Regione Lazio

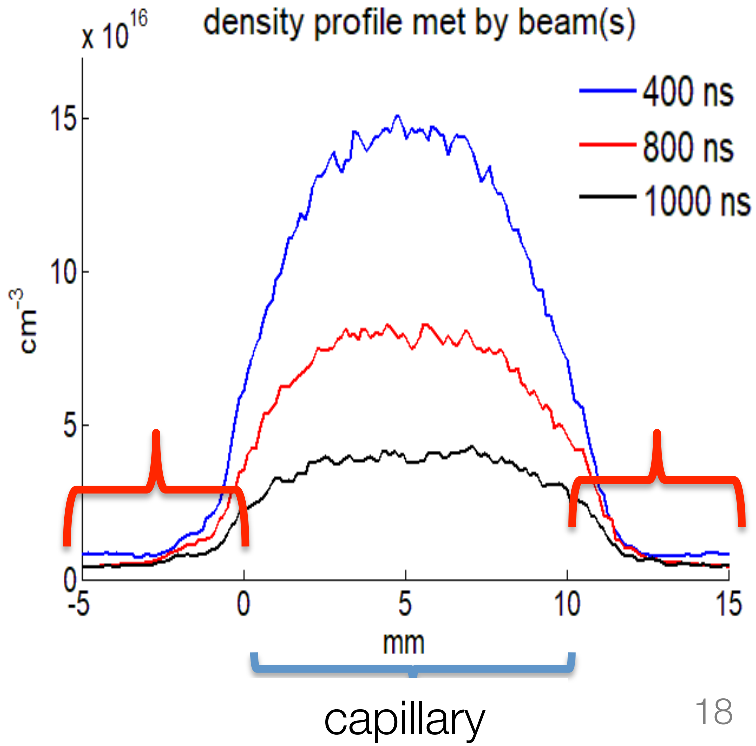
Plasma source characterisation

Spectroscopic measurements of plasma density

- Measurements and experimental results obtained at SPARC_LAB have shown that the externally injected beam interacts with the plasma outflown (plasma ramps)
- This effect has been investigated and studies to mitigate this effect are on going.





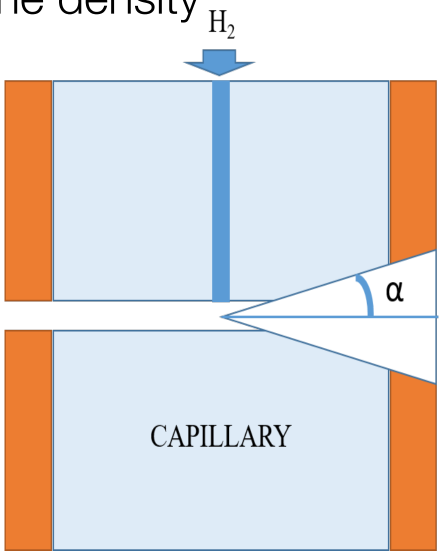


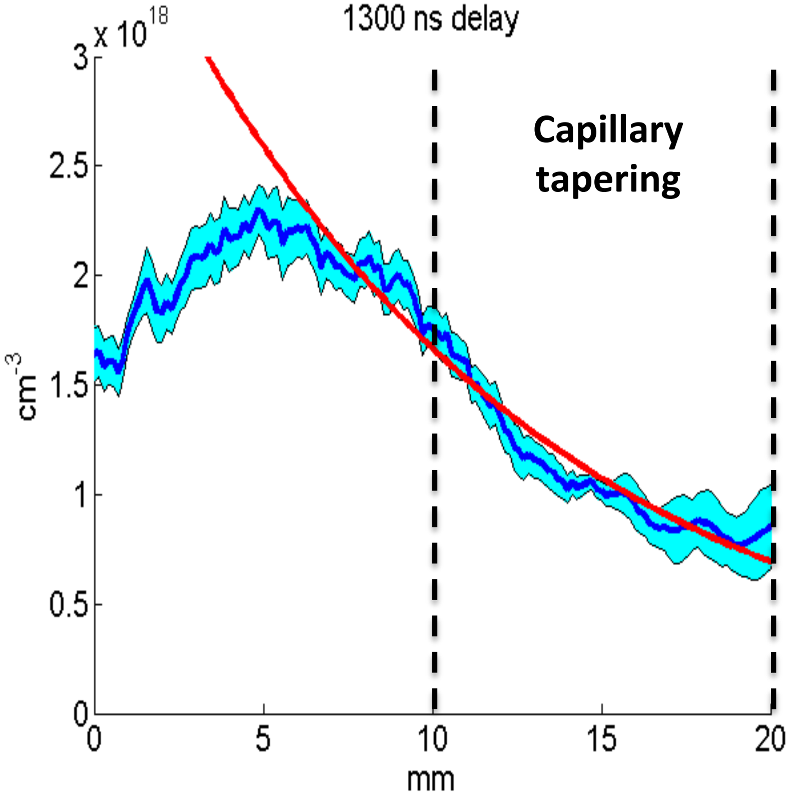
Filippi et al. NIMA(2018), DOI: 10.1016/j.nima.
Marocchino et al. Applied Physics Letters (2017),

Tapered capillaries for LWFA and PWFA experiments

Local control of the plasma density is required to match the laser/electron beam into the plasma. Tapering the capillary diameter is the easiest way to change locally the density.

By monotonically varying the radius of the capillary it is possible to change the density





Kaganovich et al., Appl. Phys. Lett. 75, 772–774 (1999).

Filippi et al. NIMA(2018), DOI: 10.1016/j.nima.2018.04.037

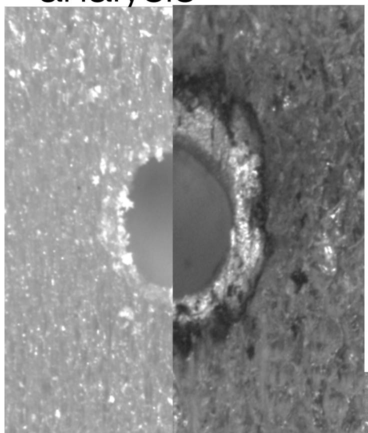
Studies on plasma tapering are currently ongoing

Design and characterisation of 3D printed capillary capillaries

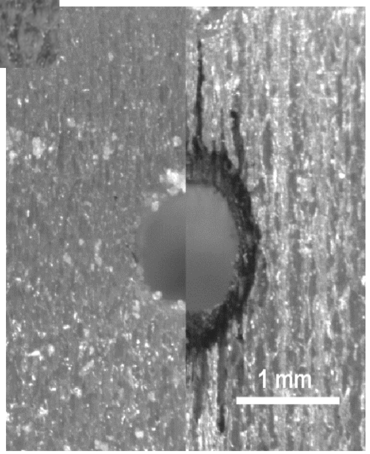
We studied the duration of the **3D printed capillaries**, fundamental for plasma based experiments.

They allows for:

- capillary shape with high spatial resolution (not easy to obtain with other technique)
- they are particularly suitable for plasma diagnostics like spectroscopic or interferometric analysis

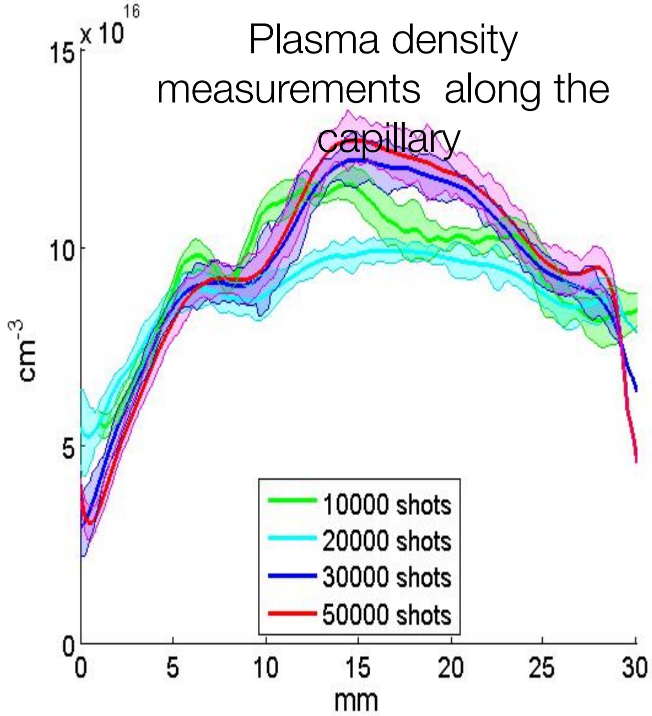


After 55000 shots
(16 h of working time)
capillary radius is larger
by 79 um



After 200000 shots
(55 h of working time)
radius was larger
by 102 um

Plasma density measurements along the capillary



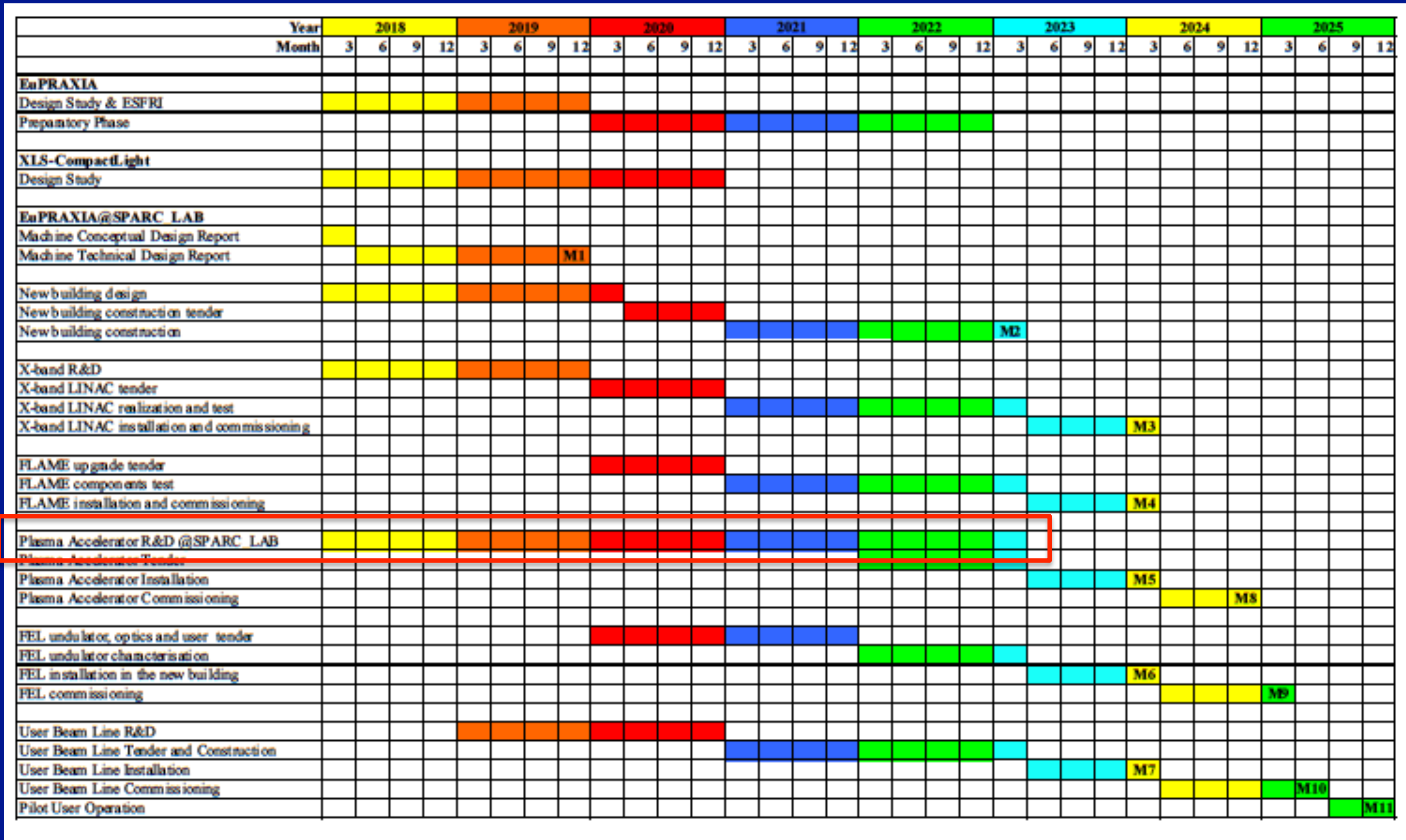
Uniform plasma density for long plasma acceleration experiments can be obtained.

Filippi et al., “3D-printed capillary for hydrogen filled discharge for plasma based experiments in RF-based electron linac accelerator”

Other work in progress

- Detailed tolerance studies by S2E
- Driver / Witness separation at the plasma exit
- Options for 5 GeV electron beams
- Multi-bunch RF linac operation?

- Secondary particle Sources
- Compton Source
- Update cost analysis
- Managerial structure


Year
2018
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2020
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Month
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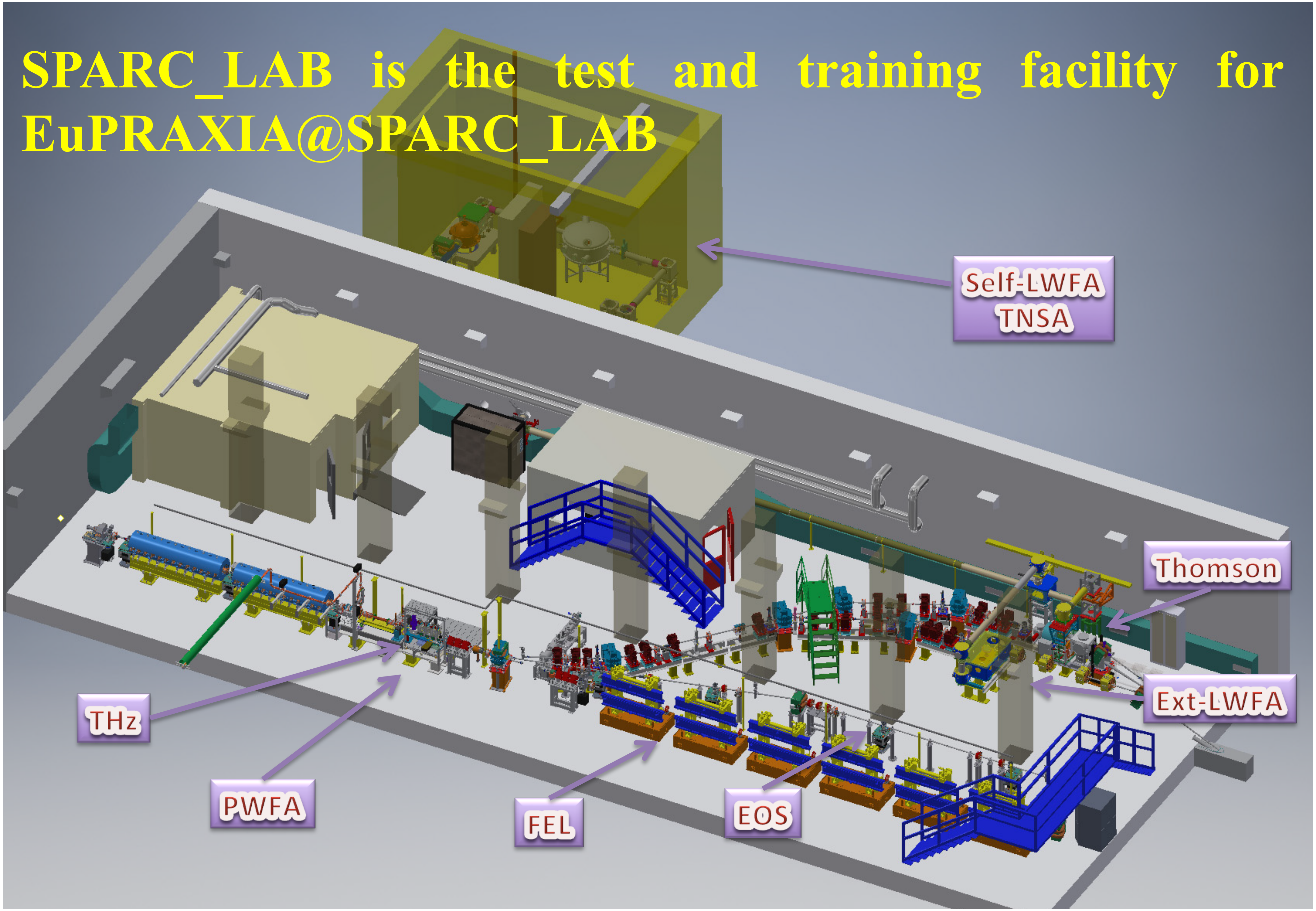
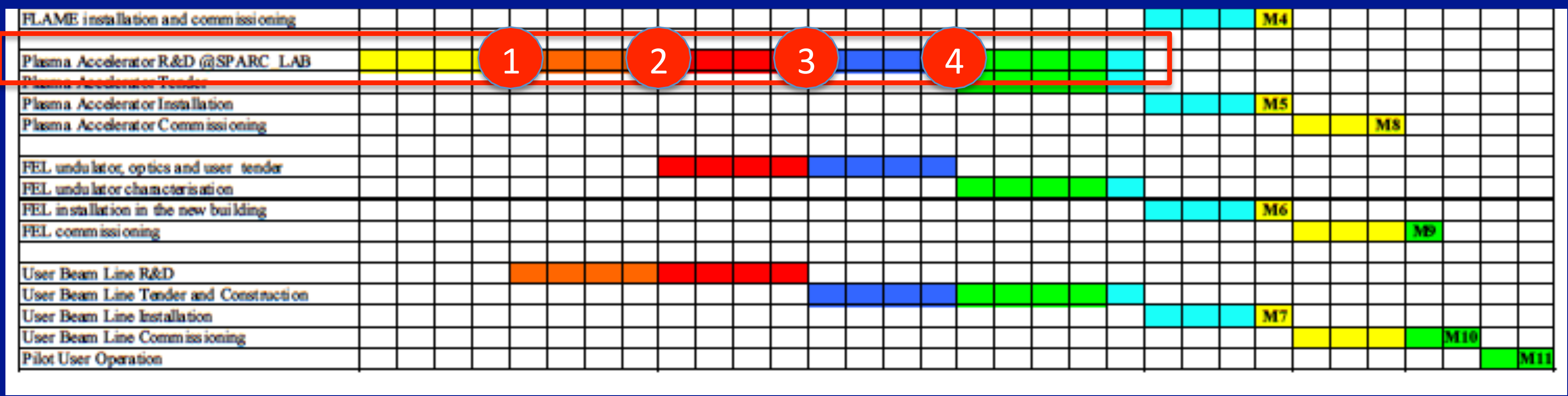
EuPRAXIA@SPARC_LAB
Machine Conceptual Design Report
Machine Technical Design Report
M1
New building design
New building construction tender
New building construction
M2
X-band R&D
X-band LINAC tender
X-band LINAC realization and test
X-band LINAC installation and commissioning
M3
FLAME upgrade tender
FLAME components test
FLAME installation and commissioning
M4
Plasma Accelerator R&D @SPARC_LAB
Plasma Accelerator Tender
Plasma Accelerator Installation
M5
Plasma Accelerator Commissioning
M8
FEL undulator, optics and user tender
FEL undulator characterisation
FEL installation in the new building
M6
FEL commissioning
M9
User Beam Line R&D
User Beam Line Tender and Construction
User Beam Line Installation
M7
User Beam Line Commissioning
M10
Pilot User Operation
M11

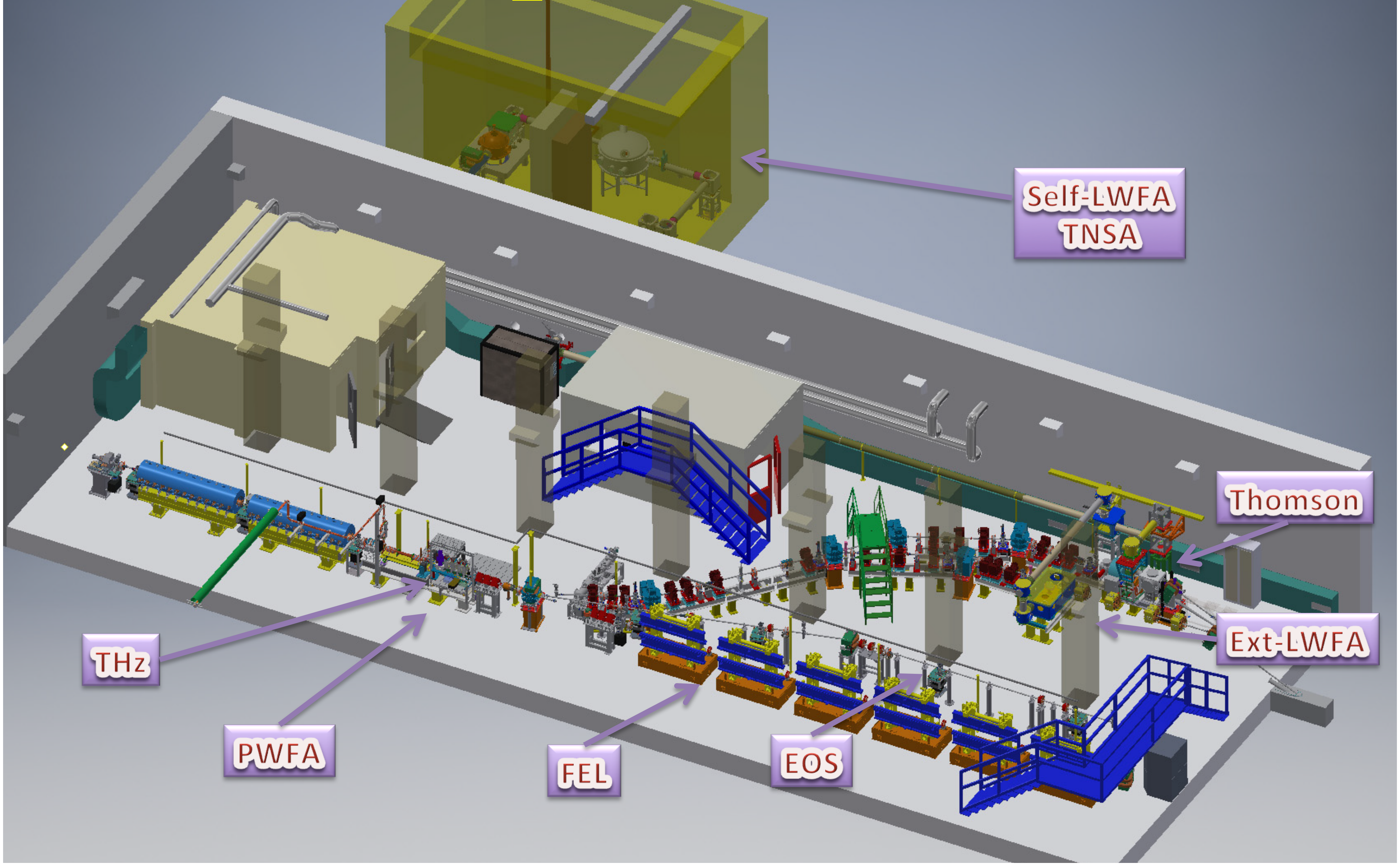
SPARC_LAB is the test and training facility for EuPRAXIA@SPARC_LAB



1. 2018 - PWFA – Beam/Plasma matching studies
2. 2019 - PWFA – Acceleration and FEL injection
3. 2020 – LWFA - Beam/Plasma matching studies
4. 2021 – LWFA – Acceleration and Diagnostics



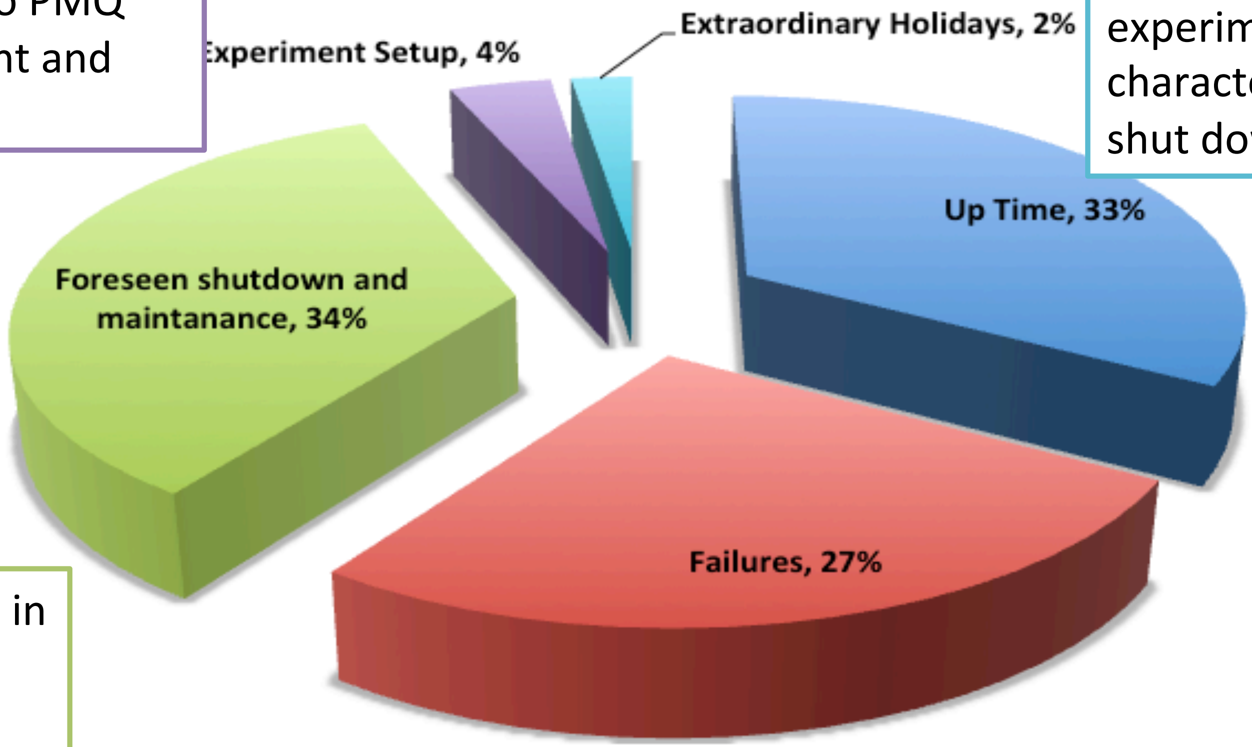
Activities at SPARC_LAB since November 2017



Up Time/Down Time in the last 6 months

Experiment set up time was dedicated to PMQ triplets alignment and characterization

Up Time was dedicated to plasma lens experiments and BPM characterization after shut down



Foreseen shutdown in January and April mainly for plasma interaction chamber and laser upgrade

Failures were due mainly to laser bad operation, chillers and water plant leakage, klystron ceramic window damage

Activity at SPARC

- NOV 2017
  - **Active plasma lens measurements** (plastic capillary 1 cm length, 1 mm diameter) with different applied voltages, different transverse beam sizes at the plasma surface, with the aim to preserve the emittance
- DEC 2017
  - **C-band structure in operation**, providing a **gain of energy of about 32 MeV** with SLED (corresponding to ~27 MW in the section)
  - Gas velocity and gas density measurements to **characterize the plumes out of the capillary**
  - **Active plasma lens experiments** (sapphire capillary 3 cm length, 1 mm diameter) with different beam current (both on crest and velocity bunching operation)
    - Passive plasma lens studies to understand the effect of the plasma plumes on the emittance
  - Experimental studies on the effects of **wakefields from dielectric capillary** on the beam
- JAN – FEB 2018
  - **Machine shut-down**
    - Replacement of the **plasma interaction chamber** with a new one
      - Better alignment between input PMQs, capillary and output PMQs
      - Greater flexibility of input PMQs longitudinal position with respect to the capillary, allowing operation within a larger range of beam energy
    - Replacement of **the YAG pump laser** with a new one
    - **Removal of the 3 dB coupler** on the Line 1 to allow for more power on the Gun
    - Replacement of the in-vacuum, single mirror holder for the photo-cathode laser injection with a **two-mirror holder to ease UV alignment on the cathode**
    - Test on electric plants => critical issues
  - **Damage of the output ceramic of the Klystron 1**=> replacement and conditioning
  - Conditioning of Kly1 and waveguides
  - Conditioning of C-band SLED
  - **Weather issues**
  - Water plants issues: leakege from S-band SLED circuit and **damage of S-band SLED chiller**
    - **No spare parts at the moment**

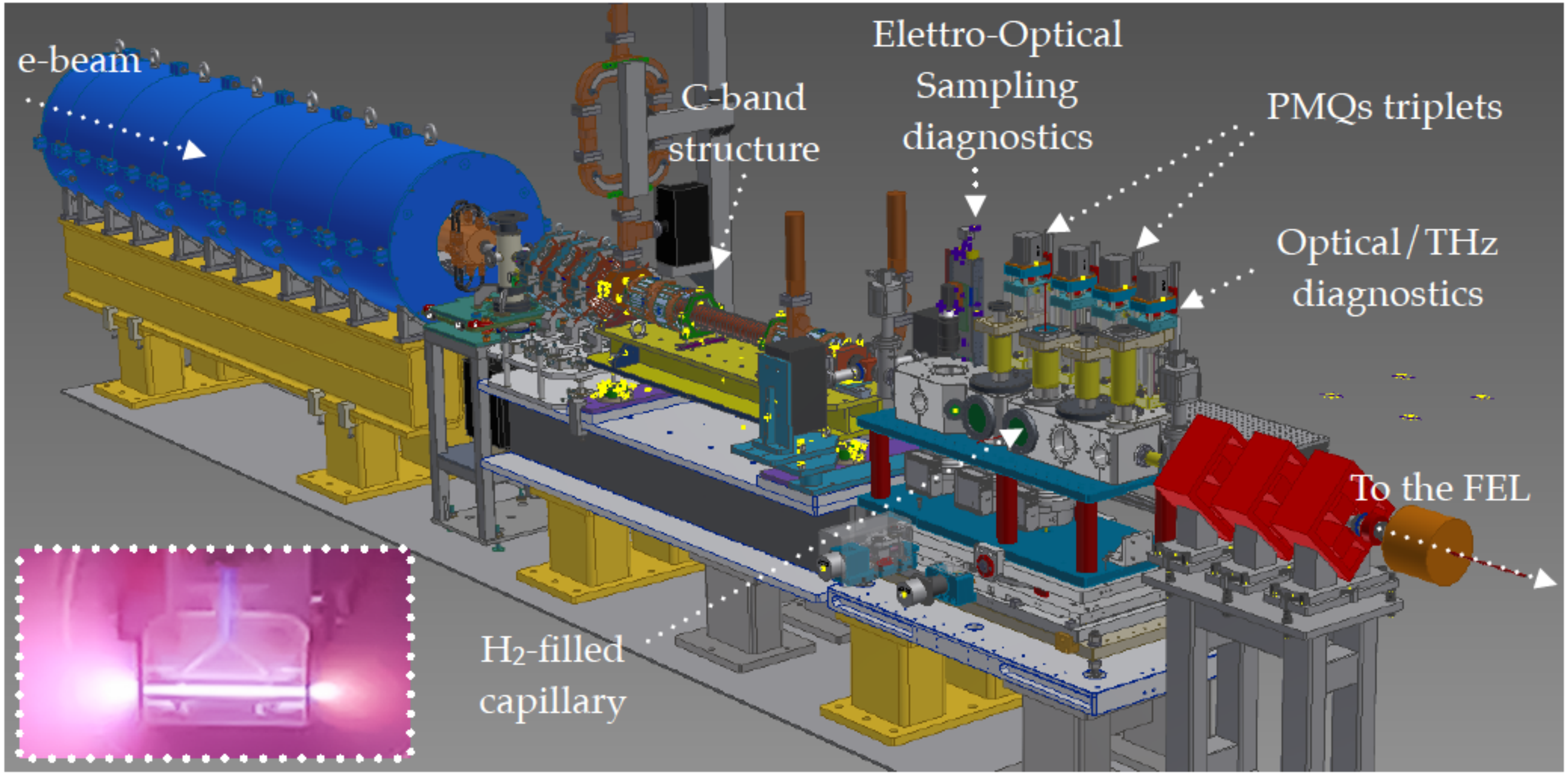
Activity at SPARC

- MAR 2018
  - **Issues with Laser alignment on cathode**
  - **Issues with YAG pump laser (on stability and transverse uniformity)**
  - **Issues with magnets power supplies**
- APR 2018
  - Mini-shutdown
    - Amplitude visit
      - **Still issues with YAG pump laser => waiting for short-term solution (to allow stable operation) and long term solution for real experiments**
    - Preliminary installations of Smith-Purcell experiments (CalipsoPlus)
    - Security tests
  - Alignment studies with PMQs triplets and capillary to obtain the micron scale spot size at the capillary
  - **Still issues with YAG pump laser: several optics damaged because of too high energy and too small spot size; decreasing the number of passes in the multi-pass produce a dramatic increment of instability (~30%)**
  - **Still issues with the chiller of the S-band SLED**
  - **Thermal reservoir for magnet, RF, …, cooling below the safety level => low flux in the pipes caused a critical increment of temperature in the cooling system of solenoid => there is no floating probe (galleggiante) in the reservoir to check the level**
- MAY 2018 (1st-12th)
  - Mini-shutdown
    - Amplitude visit
      - **Still issues with YAG pump laser => Old YAG laser back into operation**

Plasma Interaction Chamber

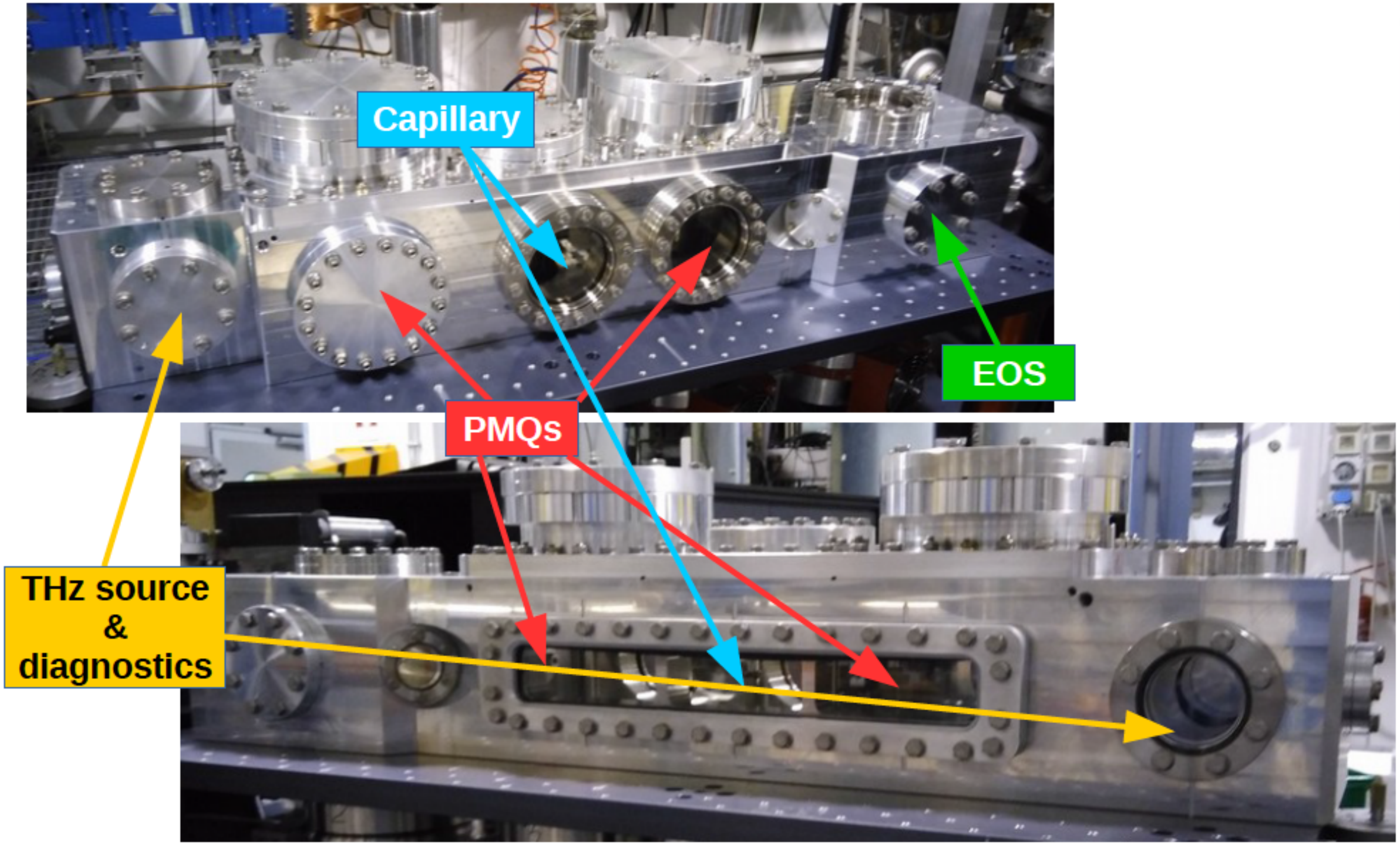
H_2 generation and injection system

- Electrolytic generator (1 l of water → 1.4 m³ 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)



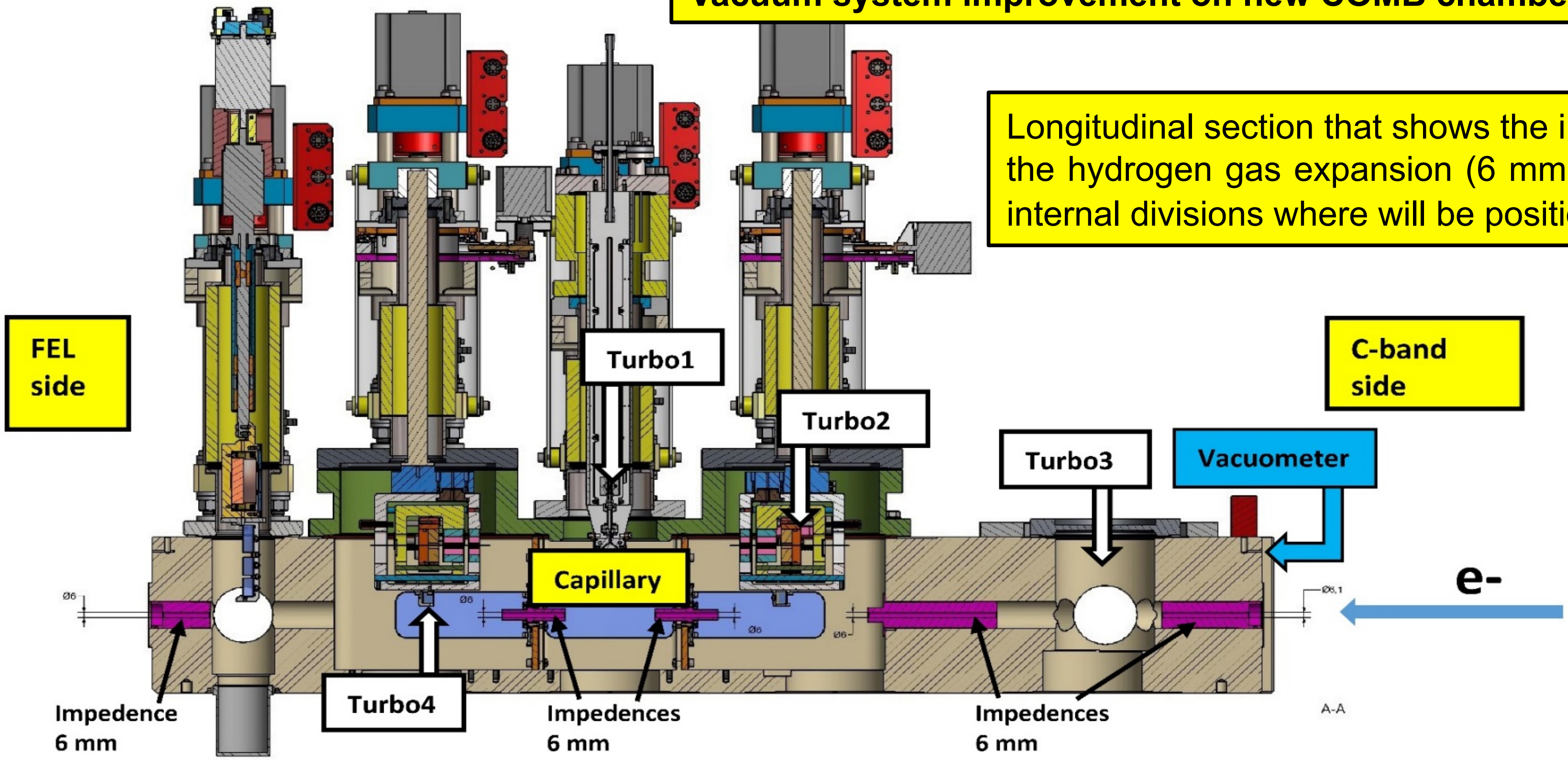
enrica.chiadroni@lnf.infn.it

New vacuum chamber



Vacuum system improvement on new COMB chamber

Longitudinal section that shows the impedances to the hydrogen gas expansion (6 mm diameter) and the internal divisions where will be positioned capillary.

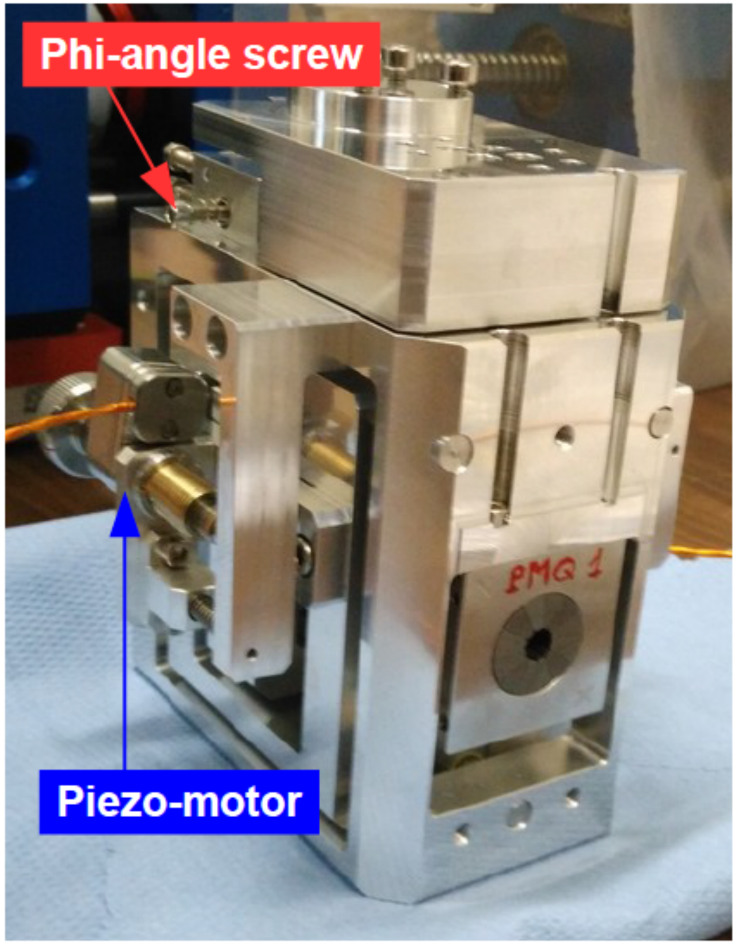


Gas injection frequency: 10 Hz					
Measurement duration	**C-band (mbar)**	**Current Turbo1 (A)**	**Current Turbo2 (A)**	**Current Turbo3 (A)**	**Current Turbo 4 (A)**
Starting values	**$2.7x10^{-9}$**	0.53	0.53	0.53	0.53
t_0 (gas opening)	**$6x10^{-9}$**	1.81	0.56	0.68	0.62
20 min	**$1x10^{-8}$**	1.84	0.59	0.68	0.62
50 min	**$1.2x10^{-8}$**	1.87	0.56	0.68	0.81
70 min	**$1.1x10^{-8}$**	1.87	0.59	0.68	0.62
90 min	**$1x10^{-8}$**	1.87	0.56	0.68	0.93

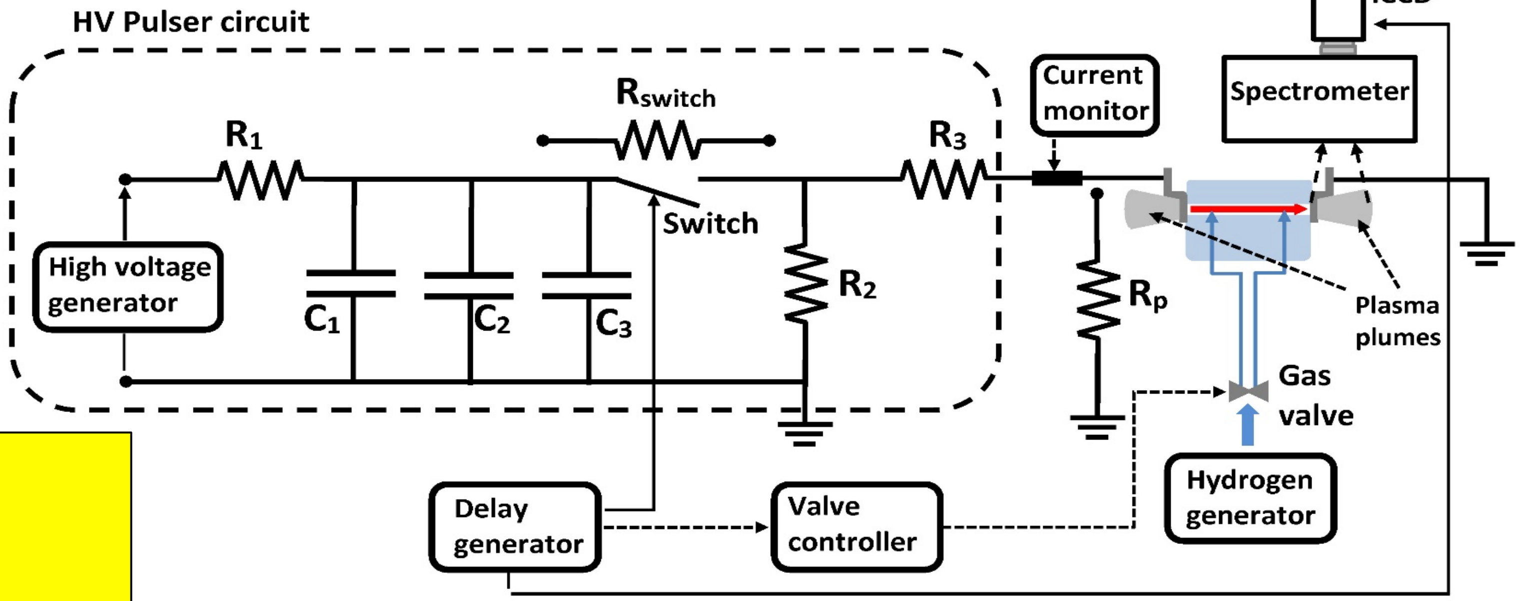
C-band pressure is around $1x10^{-8}$ mbar (lower than the safety value for acc. sections)
Current of turbo pumps ranging from 0.5 to 2 A (limit value is 8 A)

PMQ triplet mechanics

- Three PMQs installed, movable in z
- 2 movable channels (2 piezo motors)
- PMQ1 (close to capillary) is fixed
- 1st actuator moves PMQ2 and PMQ3 wrt PMQ1
- 2nd actuator moves PMQ3 wrt PMQ2 and PMQ1
- Minimum distance between quads is 3-4mm
- Maximum distance is >10mm
- A system consisting of several springs helps against magnetic attraction
- The phi-angle of the whole system can be manually adjusted
- Realized by TecnoAlarm



Improvement of the High-voltage Pulser to reach higher currents (up to 620 A)



Circuit parameters

HV gen: 0-40 kV
R1=10 kΩ
R2=400 kΩ
C1=C2=C3=3.6 nF (10.8 nF)
Rswitch≈45 Ω
R3=10 Ω

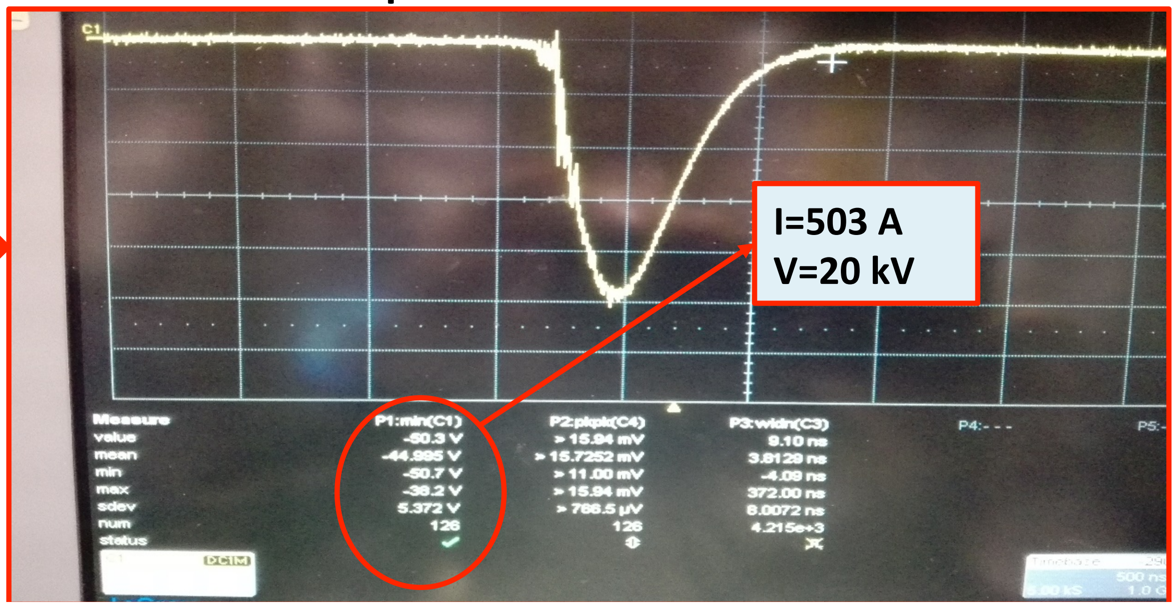
New Pulser

Imax=620 A (25 kV)
τ=RC≈600 ns

Old Pulser

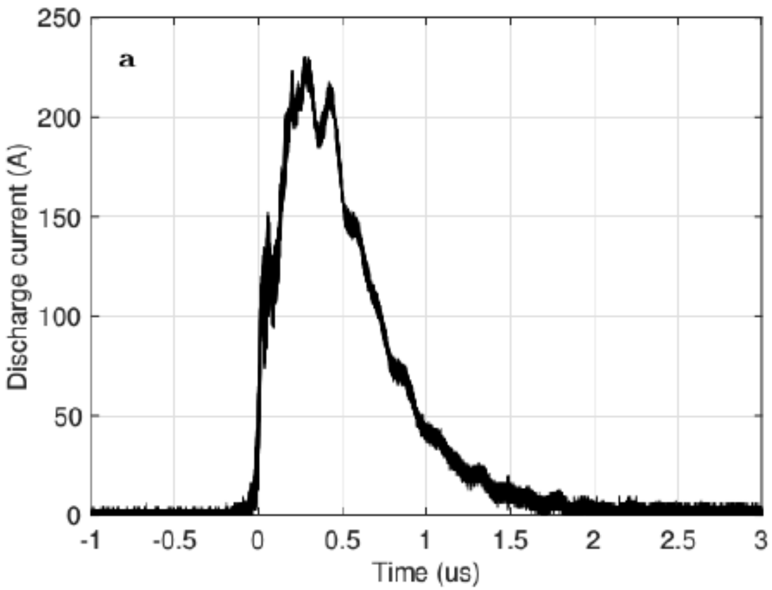
Imax=300 A (25 kV)
τ=RC≈600 ns

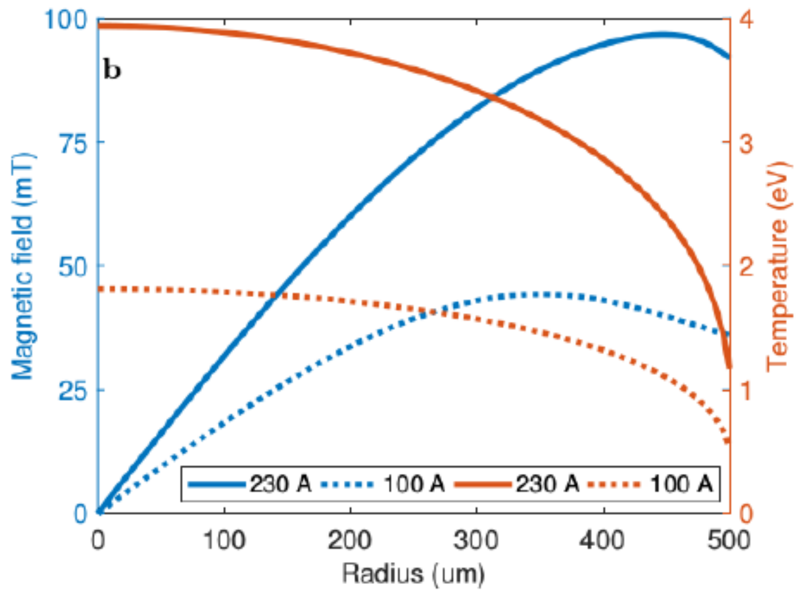
Measured current pulse



The role of temperature in Active Plasma Lens experiments

- Considering the average ionization of a H_2 gas @ 1.5×10^{18} cm^{-3}
  - *100 A current → 30% (corresponds to $n_p=4\times10^{17}$ cm^{-3})*
  - *200 A current → 44% (corresponds to $n_p=7\times10^{17}$ cm^{-3})*
  - *500 A current → 75% (corresponds to $n_p=1.9\times10^{18}$ cm^{-3})*
- About 7 eV max temperature @ CLEAR (500 A current)

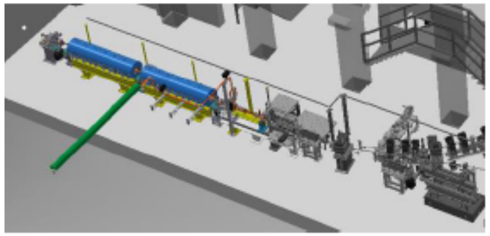




2018 - Planned experimental activities

- May => PM Quads matching studies
- June => Driver interaction with the Plasma
- June => Witness interaction with the Plasma
- July => Driver +Witness interaction with the Plasma
- August => Shut down, maintenance, start up
- September => Calipso$^+$ Smith Purcell experiment
- October-December => PWFA experimets

First start to end: 200 pC driving bunch on crest



Plasma injection LPS

$\sigma_x = 6.21\ \mu\text{m}$

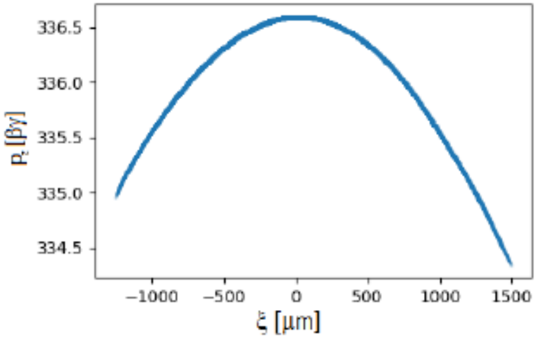
$\sigma_y = 6.11\ \mu\text{m}$

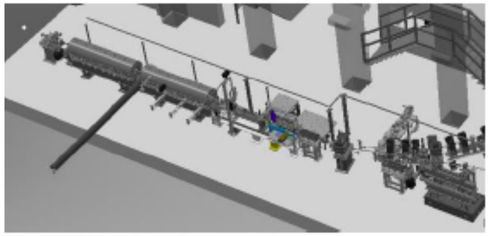
$\sigma_x = 600\ \mu\text{m}$

$\varepsilon_{n,x} = 1.35\ \text{mm mrad}$

$\varepsilon_{n,x} = 1.62\ \text{mm mrad}$

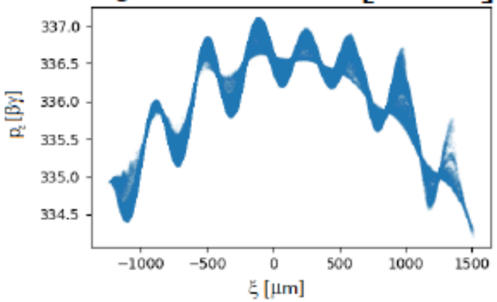
$\sigma_E = 0.12\%$

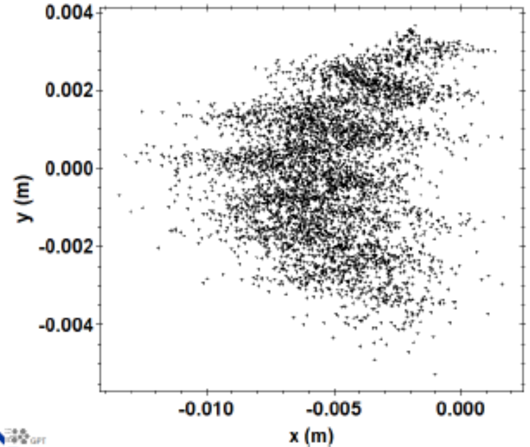




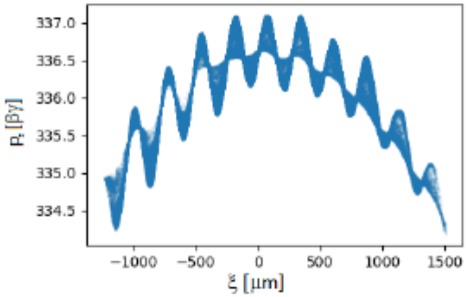
Plasma extraction LPS

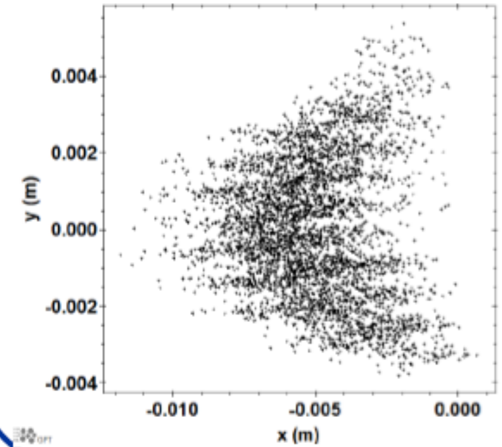
$n_0 = 5 \cdot 10^{15}\ [\text{cm}^{-3}]$

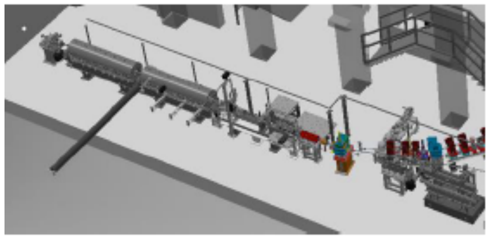




$n_0 = 10^{16}[\text{cm}^{-3}]$







Screen downstream Bending+RFD

Detailed planned activities (Enrica Chiadroni)

May 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5
		Holiday	Issues with photo-cathode laser	Holiday	Issues with photo-cathode laser	
6	7	8	9	10	11	12
	Amplitude visit	Amplitude visit	Amplitude visit	Amplitude visit	Amplitude visit	
13	14	15	16	17	18	19
	Contingency week	Contingency week	Contingency week	Contingency week	Contingency week	
20	21	22	23	24	25	26
	Injection and extraction PMQ studies	Injection and extraction PMQ studies	Injection and extraction PMQ studies	Injection and extraction PMQ studies	Injection and extraction PMQ studies	
27	28	29	30	31		
	Injection and extraction PMQ studies	Injection and extraction PMQ studies	Injection and extraction PMQ studies	Injection and extraction PMQ studies		

Notes:

Experimental activities: Amplitude visit to recover old YAG laser. Injection and extraction PMQs studies

June 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
					Single bunch (driver-like) interaction w plasma	
3	4	5	6	7	8	9
	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	
10	11	12	13	14	15	16
	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	
17	18	19	20	21	22	23
	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	Single bunch (driver-like) interaction w plasma	
24	25	26	27	28	29	30
	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	

Notes:

Experimental activities: Characterization of the interaction with a driver like beam (200 pC) with the plasma for different bunch length (with respect to the plasma wavelength; beam dynamics studies w C-band). Beam dynamics studies for a witness like beam (20 pC) compressed through velocity bunching (VB) in the first two structures (=> demonstration of EuPRAXIA working point for laser driven external injection)

July 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	Single bunch (witness-like) beam dynamics studies without plasma: Experimental demonstration of EuPRAXIA working point with VB in the first two S-band sections	
8	9	10	11	12	13	14
	Driver and witness beam dynamics studies without plasma	Driver and witness beam dynamics studies without plasma	Driver and witness beam dynamics studies without plasma	Driver and witness beam dynamics studies without plasma	Driver and witness beam dynamics studies without plasma	
15	16	17	18	19	20	21
	Driver+witness interaction with capillary without plasma to study the wakefields	Driver+witness interaction with capillary without plasma to study the wakefields	Driver+witness interaction with capillary without plasma to study the wakefields	Driver+witness interaction with capillary without plasma to study the wakefields	Driver+witness interaction with capillary without plasma to study the wakefields	
22	23	24	25	26	27	28
	Driver+witness interaction w plasma	Driver+witness interaction w plasma	Driver+witness interaction w plasma	Driver+witness interaction w plasma	Driver+witness interaction w plasma	
29	30	31				
	Driver+witness interaction w plasma	Driver+witness interaction w plasma				

Notes:

Experimental activities: Characterization of driver and witness beam without plasma (beam dynamics studies w C-band); Wakefield studies with driver and witness self-interaction with capillary without plasma; characterization of driver and witness beam interaction with plasma => acceleration studies

August 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
			Driver+witness interaction w plasma	Driver+witness interaction w plasma	Driver+witness interaction w plasma	
5	6	7	8	9	10	11
	Labs closed	Labs closed	Labs closed	Labs closed	Labs closed	
12	13	14	15	16	17	18
	Labs closed	Labs closed	Labs closed	Labs closed	Labs closed	
19	20	21	22	23	24	25
	Sub-systems start up	Sub-systems start up	Sub-systems start up	Sub-systems start up	Sub-systems start up	
26	27	28	29	30	31	
	Sub-systems start up	Sub-systems start up	Sub-systems start up	Sub-systems start up	Sub-systems start up	
		Notes:				
		The experimental activities are dependent on the presence of available personnel (also technical)				

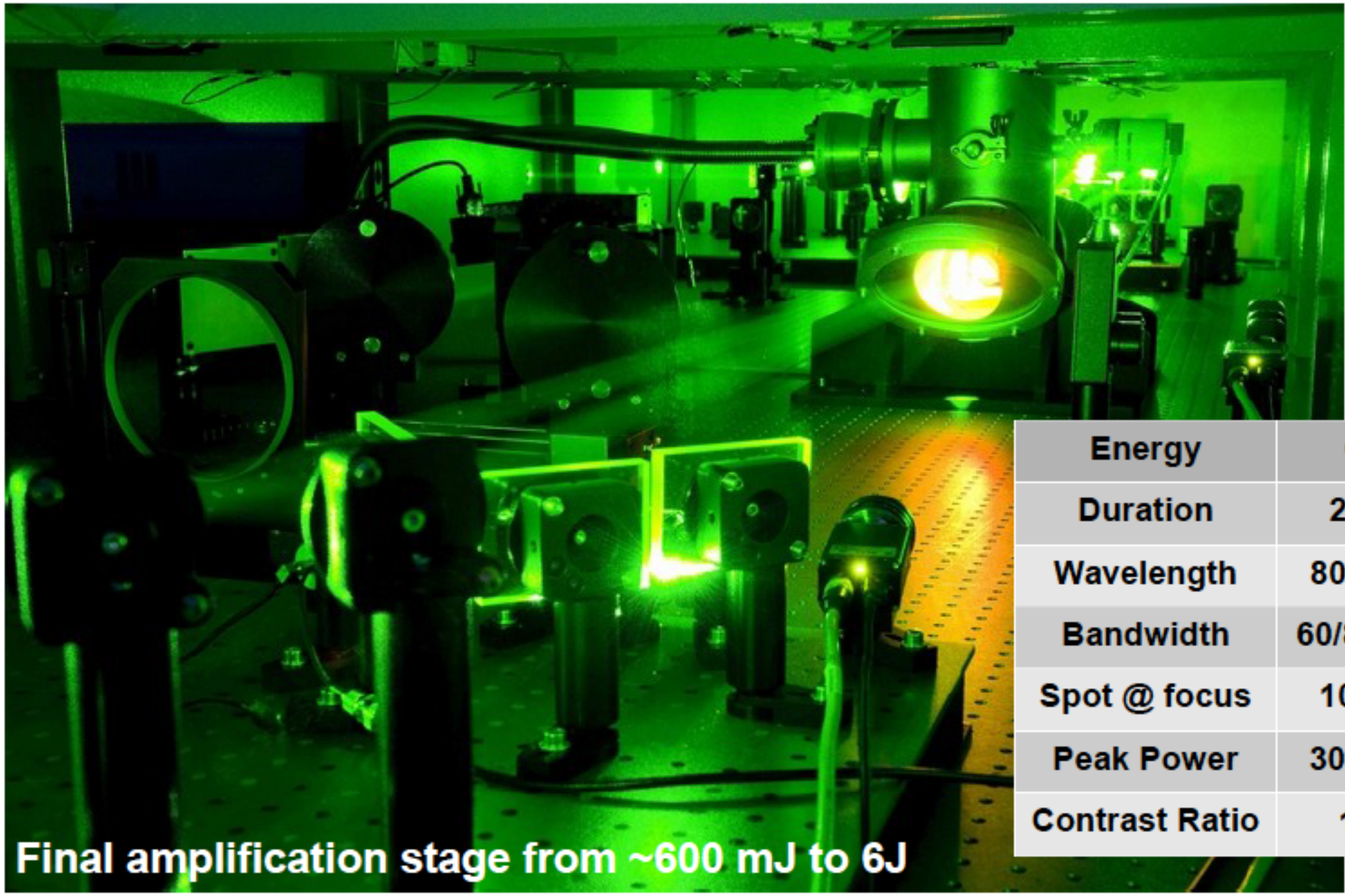
September 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
	Machine start-up	Machine start-up	Machine start-up	Machine start-up	Machine start-up	
9	10	11	12	13	14	15
	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	
16	17	18	19	20	21	22
	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	Commissioning of the dogleg beamline for Smith-Purcell experiment (CalipsoPlus)/CavBPM experiment	
23	24	25	26	27	28	29
	Smith-Purcell experiment	Smith-Purcell experiment	Smith-Purcell experiment	Smith-Purcell experiment	Smith-Purcell experiment	
30	**Notes:**					
	Experimental activities: The autumn start up will be dedicated to the commissioning of the dogleg beamline to satisfy the beam time request from CEA group within the CalipsoPlus framework to study a device based on Smith-Purcell radiation for measuring the bunch length (proposal submitted at the CalipsoPlus Committee). The same beamline will be optimized to host other two experiments, one to characterize a new design for the cavity BPM, and the second one to calibrate dosimetry films at different energies.					

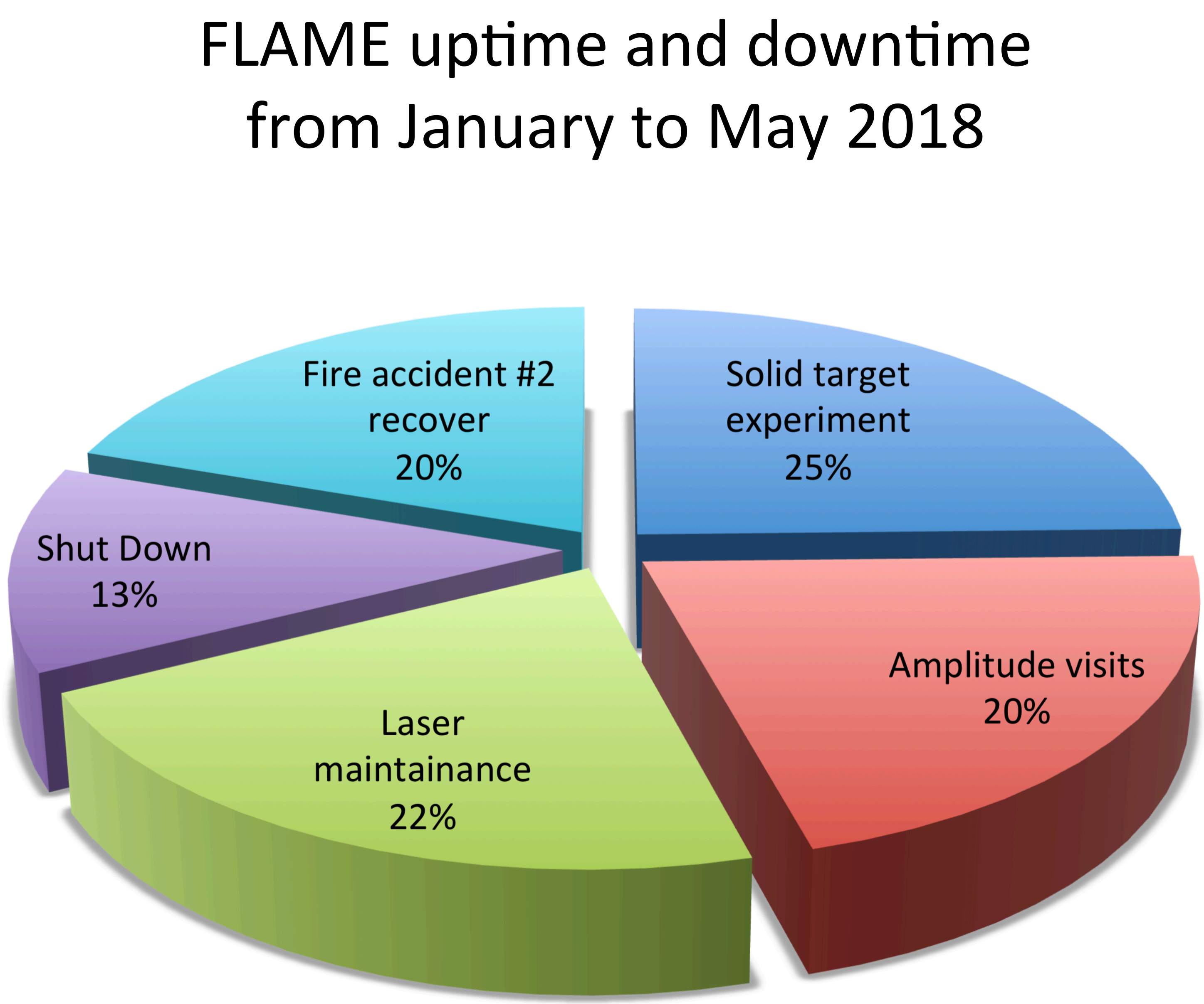
October 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
	Cavity BPM experiments	Cavity BPM experiments	Cavity BPM experiments	Cavity BPM experiments	Cavity BPM experiments	
7	8	9	10	11	12	13
	Smith-Purcell experiment	Smith-Purcell experiment	Smith-Purcell experiment	Smith-Purcell experiment	Smith-Purcell experiment	
14	15	16	17	18	19	20
	Plasma-based experiments	Plasma-based experiments	Plasma-based experiments	Plasma-based experiments	Plasma-based experiments	
21	22	23	24	25	26	27
	Plasma-based experiments	Plasma-based experiments	Plasma-based experiments	Plasma-based experiments	Plasma-based experiments	
28	29	30	31			
	Plasma-based experiments	Plasma-based experiments		Till the end of 2018		
		Notes:				

FLAME activity



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 uptime and downtime
from January to May 2018
Fire accident #2
recover
20%
Solid target
experiment
25%
Shut Down
13%
Amplitude visits
20%
Laser
maintainance
22%

Activity at FLAME

- NOV 2017
  - **EOS experiment – phase 2,** measurement of electrons accelerated by using EOS and electron spectrometer
  - **Amlitude visit,** installation of new mazzler and a few more YAGs.
- DEC 2017
  - **EOS experiment**, measurement of the first electron spectra. No signs of EOS signal.
- JAN – FEB 2018
  - **Machine shut-down**
    - AT visit for YAG installation
    - **FIRE ACCIDENT n.2** => laser shout down
  - Installation of the new fire alarm
  - Upgrade of interlock system of the YAGs
  - Installation of a new vacuum chamber for EXIN capillary guiding on the sealing of the FLAME bunker
- MAR 2018
  - Alignment of the capillaries and installation of the diagnostics
  - **AT visit for the interlock system finalization and laser restart**
- APR 2018
  - Cleaning of water filters
    - Replacement of water tubes is needed
  - Replacement of electrical cables
  - **5.7 J energy achieved**

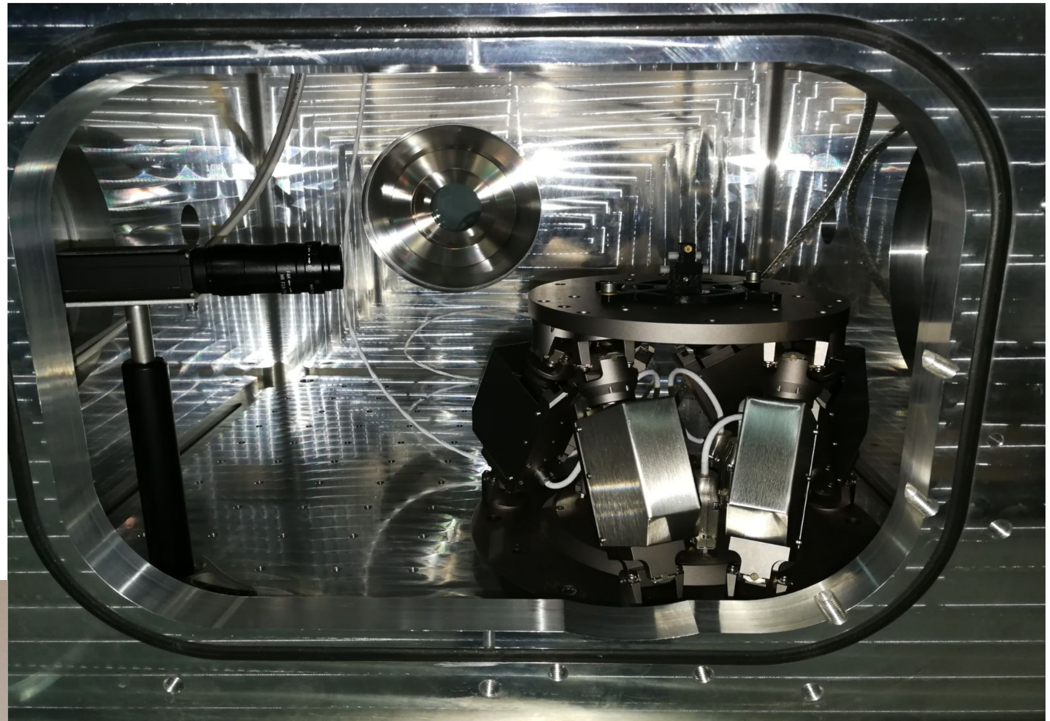
FLAME status

After fire accident #2 (Feb. 2018) FLAME has been recovered and now is back in operation.

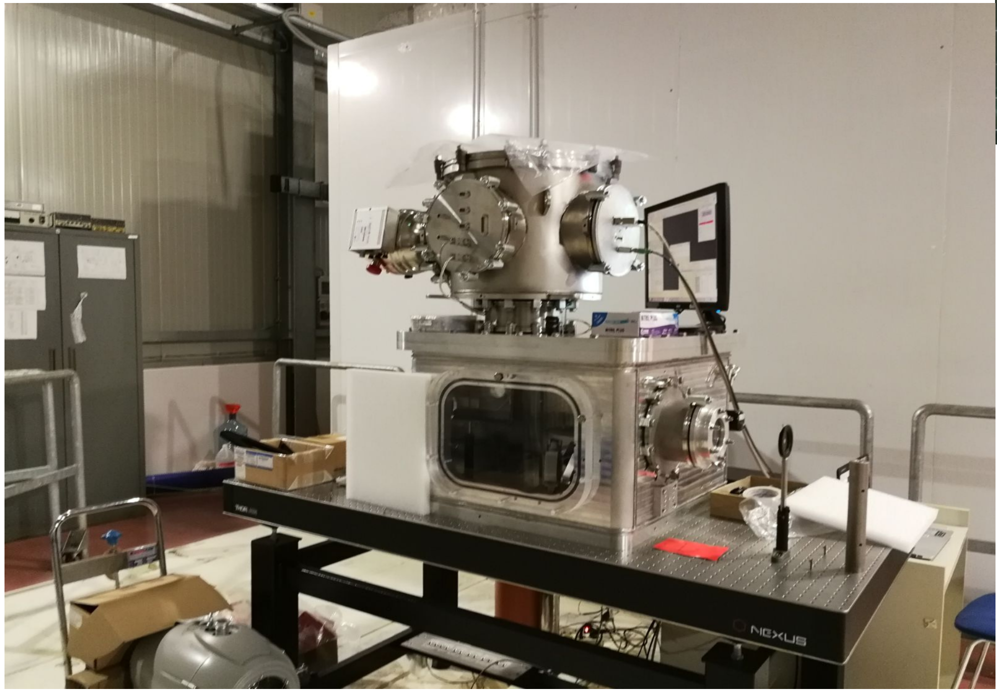
We are still running experiments with EOS to finalize the intensity scaling. We have got correlated electron spectrum with EOS signal! There are still many aspects to investigate and delay is mainly due to fire accident (1 month of shout down) and photocathode laser issues (which has required all laser team efforts).

The new interaction chamber to be installed in the FLAME bunker has experienced lot of delays due to administration issues. It's overseen to be order this month and be deliver in Frascati before summer. Hopefully will be installed in the FLAME bunker (after vacuum tests) after summer holidays.

FLAME status: EXIN tests at FLAME



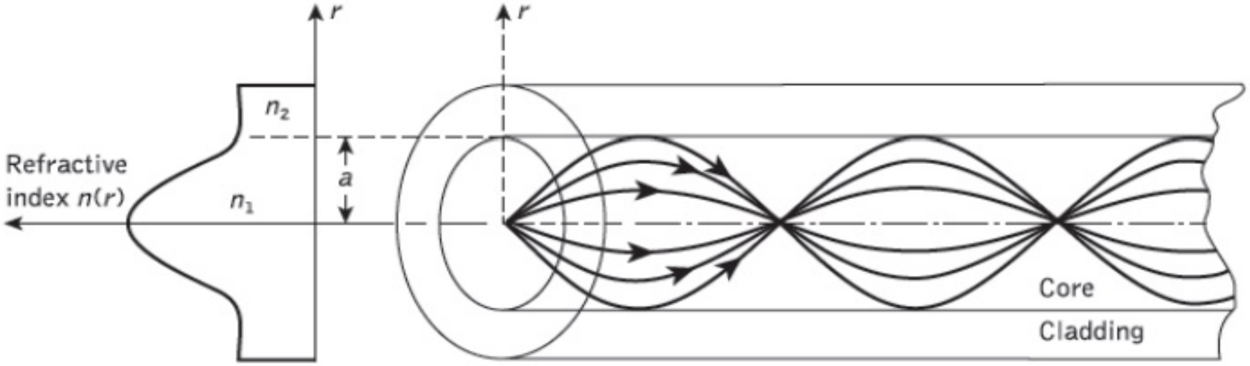
Part of the EXIN beam-line has been mounted at the exit of the laser clean room. The whole system (gas, high voltage, capillary, movements, diagnostics and so on) have been mounted in the chamber. A small part of the **probe beam will be used to start the guiding experiments.**



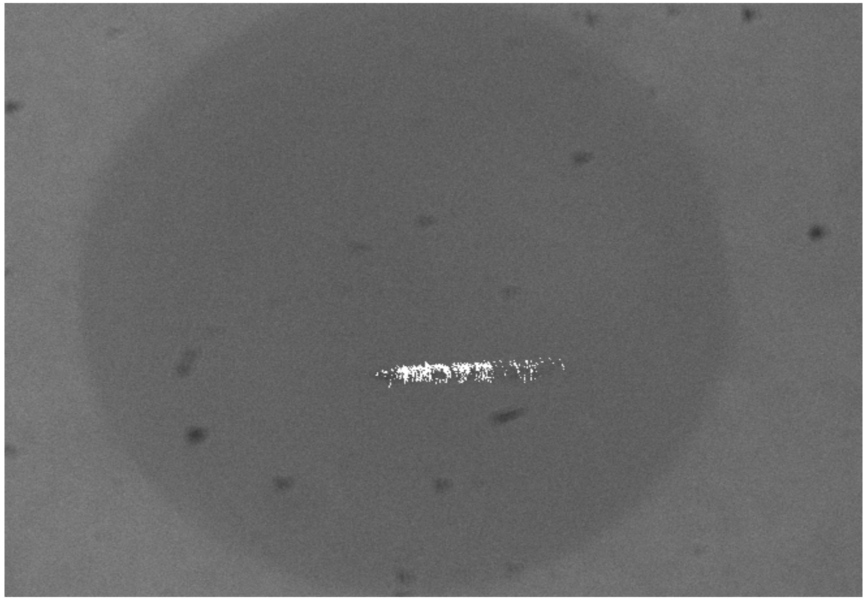
In this way experiments in the main chamber downstairs can go in parallel.

The goal of the experiment is to implement diagnostic, to learn guiding, see lifetime of capillaries, implement the right plasma profile for guiding, test diagnostics and ideas and so on.

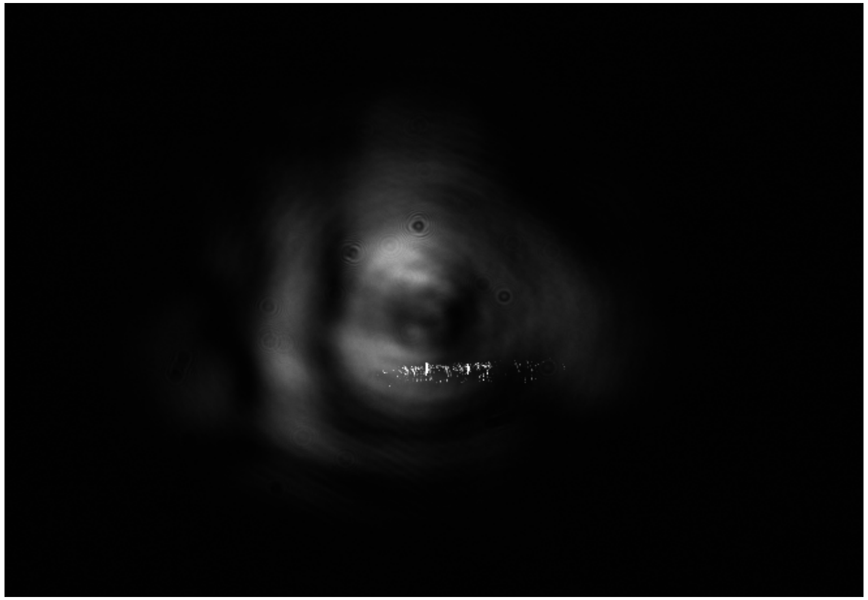
Laser guiding test alignment



w/o capillary

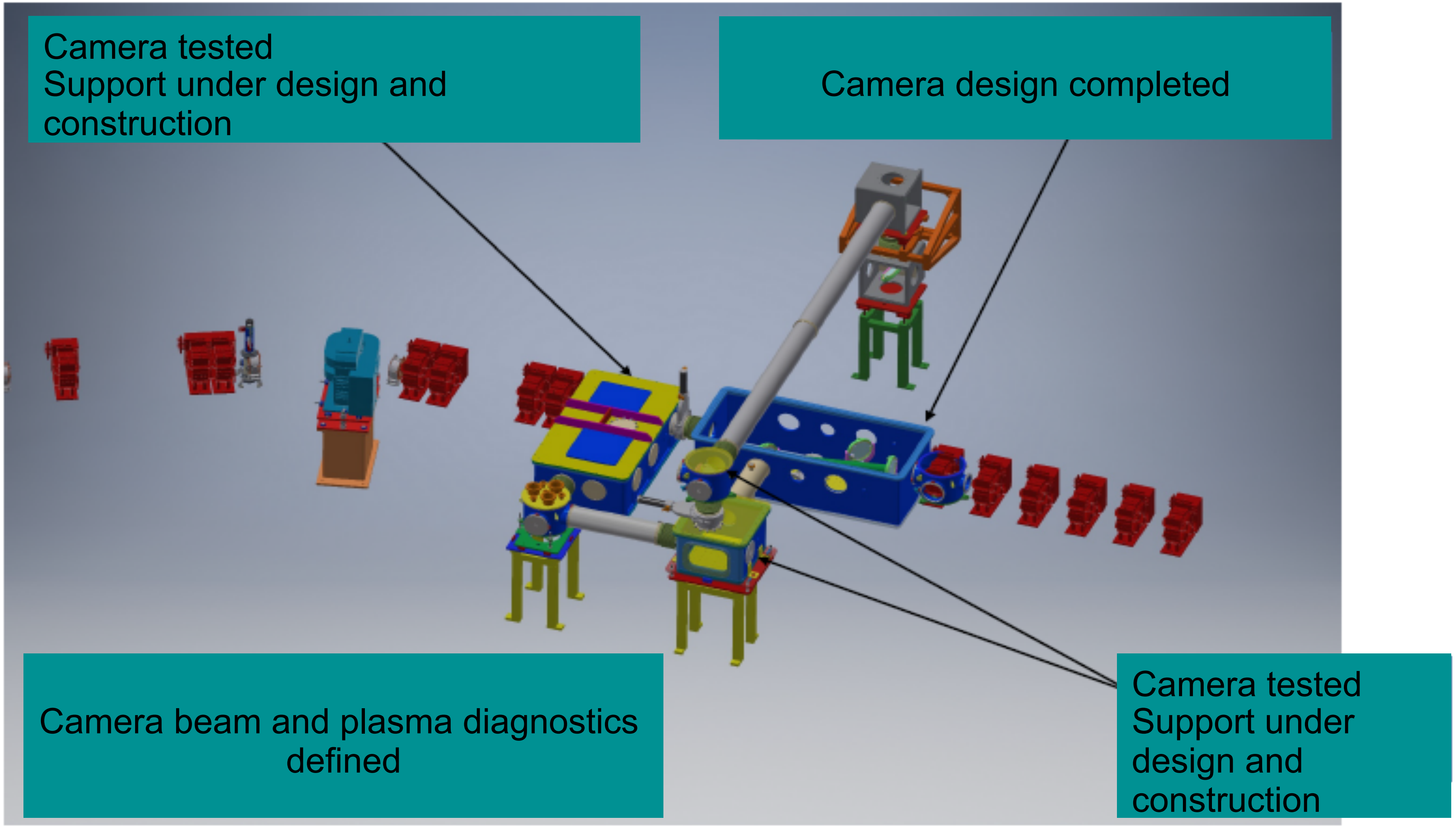


With capillary



SL_EXIN experiment preparation

The LWFA & the Thomson experiments have been joined in the same beamline provided a tunable mirrors set able to propagate and counter-propagate the FLAME laser pulse in the modified interaction chamber



FLAME status: program

From now on.

Activity	Start date	End date
EOS experiment – phase 2	14/05/2018	15/06/2018
Gas plant − preparation and installation	25/06/2018	06/07/2018
EOS experiment – phase 2	09/07/2018	27/07/2018
New interaction chamber deliver and vacuum tests	01/06/2018	27/07/2018
Installation of the new interaction chamber	03/09/2018	28/09/2018
Capillary guiding for EXIN @ FLAME − bunker	22/10/2018	21/12/2018

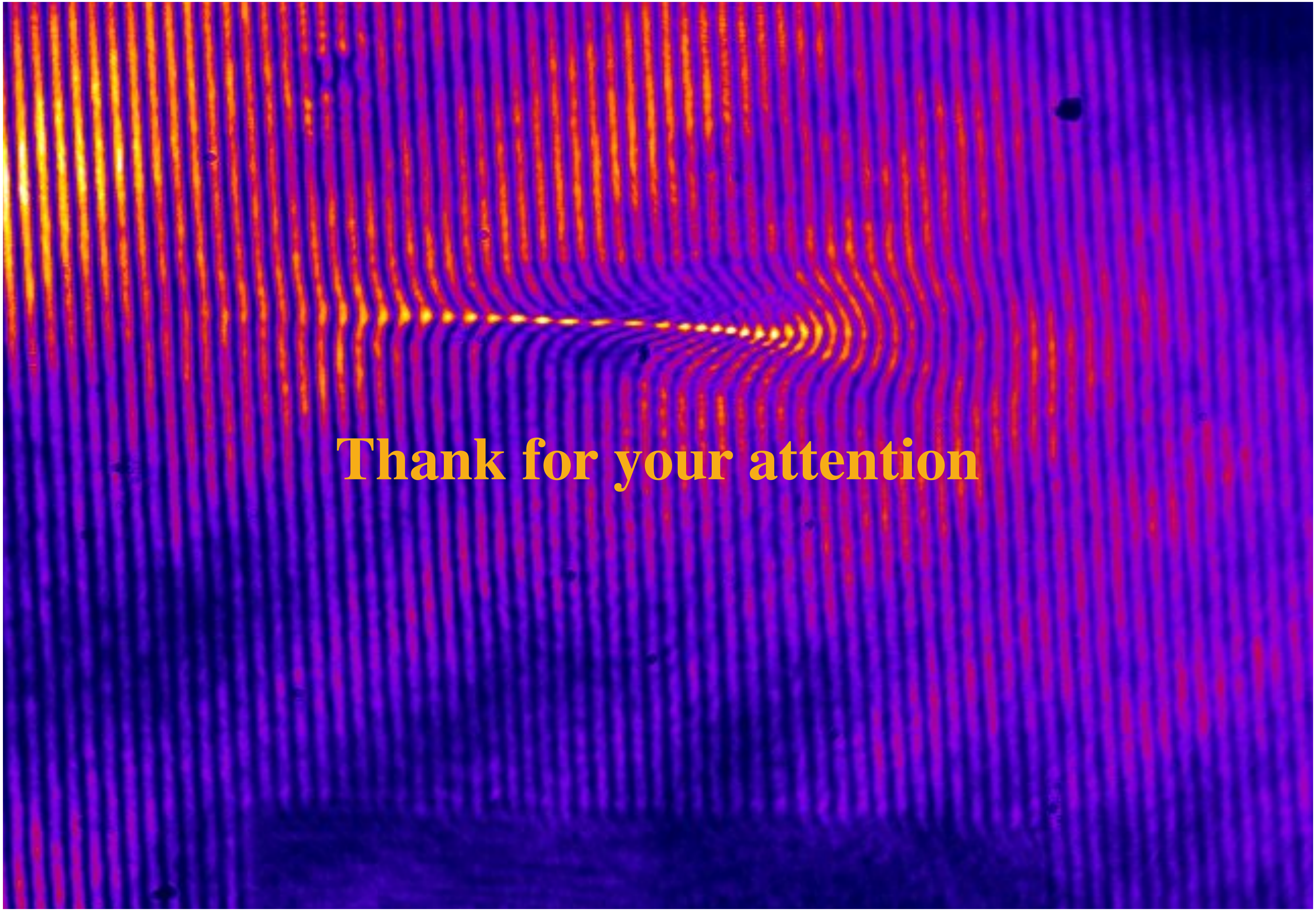
In parallel to EOS experiment and until the new interaction chamber installation in the FLAME bunker there are EXIN tests that will be done just out of the laser clean room (from now until the beginning of summer holidays).

Conclusions

- EuPRAXIA@SPARC_LAB CDR delivered
- Procedure for purchasing neighboring land started
- Announcement of tender for the building design ready
- X-box design and components purchase started
- New Capillary design and test in progress

- New plasma interaction chambers installed at SPARC and FLAME
- FLAME in operation with 5 J
- SPARC still suffering for laser, cooling et al.

- **SPARC_LAB is a unique test & training opportunity for LNF towards the realization of the EuPRAXIA@SPARC_LAB user facility.**


Thank for your attention