

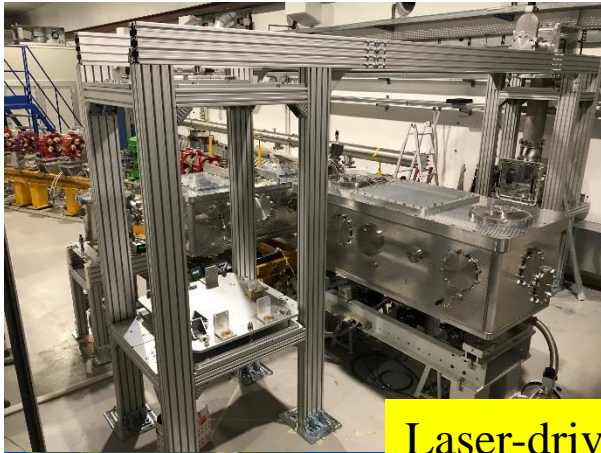


# SPARC\_LAB

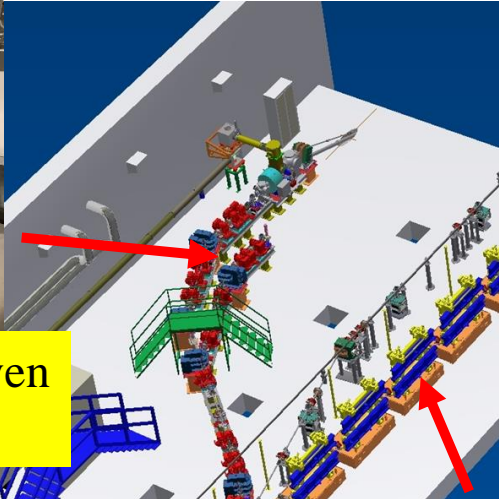
## recent results and activities

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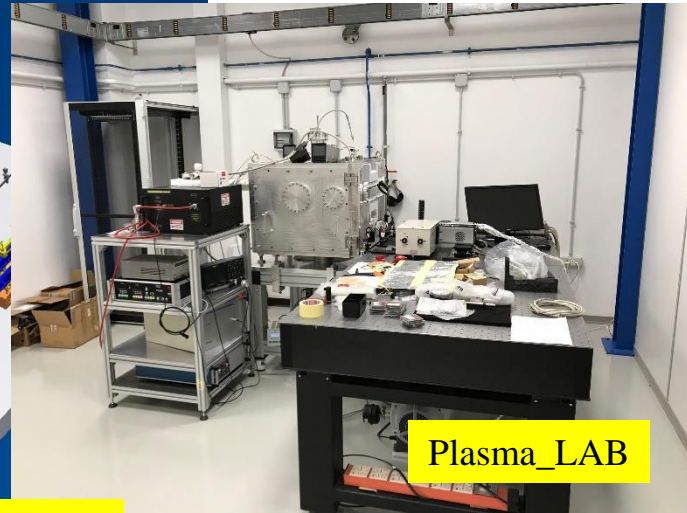
*on behalf of SPARC\_LAB collaboration*



Laser-driven  
(EXIN)

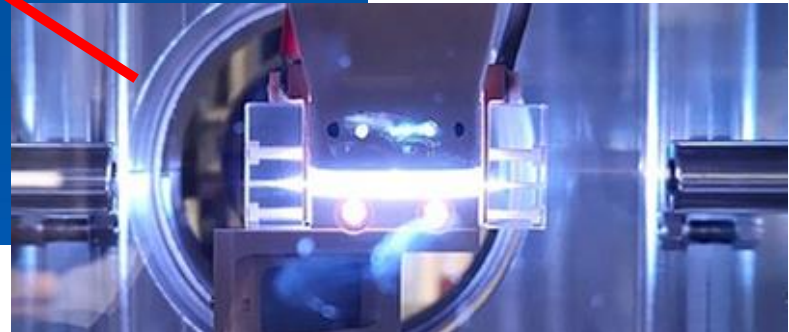
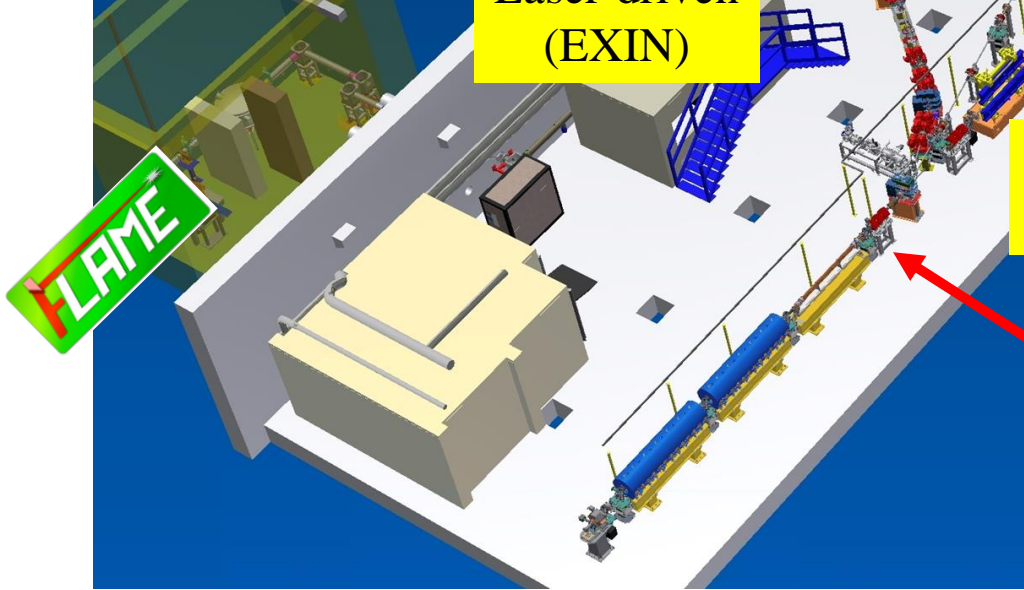


Free-electron  
laser



Plasma\_LAB

Beam-driven  
experiments



## Gun commissioning



- gun commissioning
- UV vs “blue” experiments
- external users
- C-band modulator installations
- EXIN beam line installations
- plasma laboratory relocation
- new focusing system
- recent publications:
  - *M.Galetti et.al., Advanced Stabilization Methods of Plasma Devices for Plasma-Based Acceleration, Symmetry* **2022**, 14(3), 450;
  - *R. Pompili et al., "Free-electron lasing with compact beam-driven plasma wakefield accelerator." Nature, Accepted.*

## EXIN line



15 May 2022

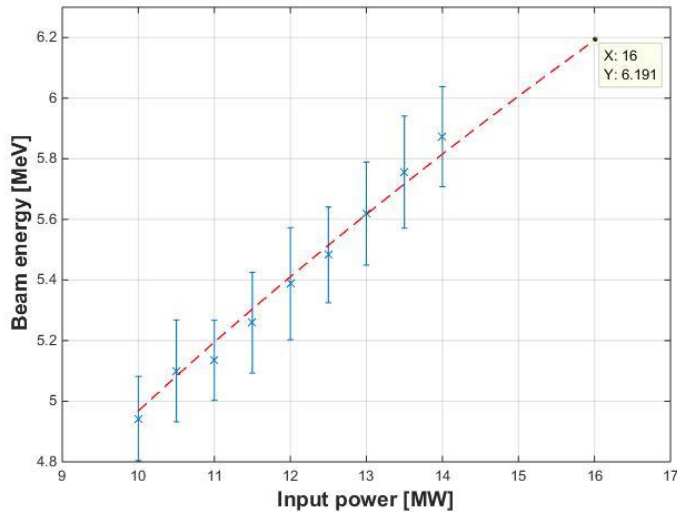
## New C-band modulator



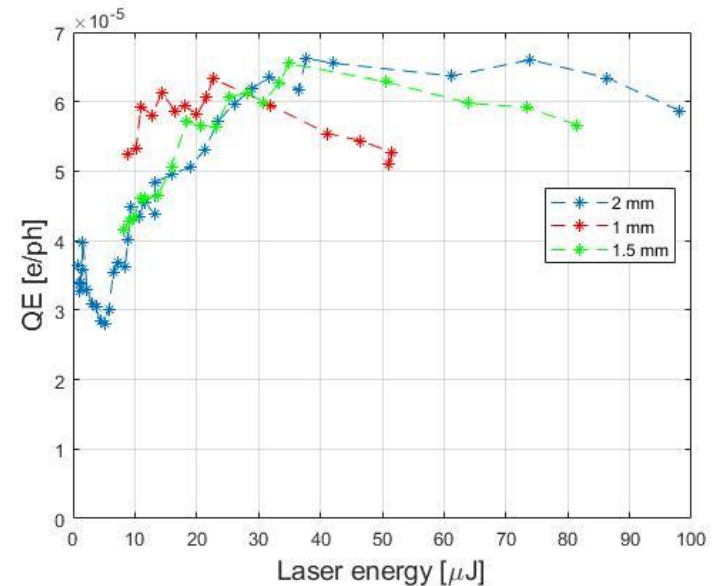
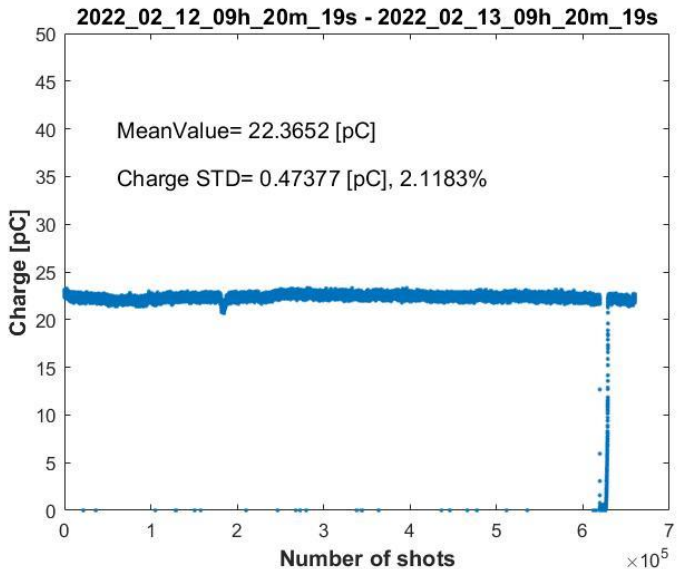
63<sup>rd</sup> LNF Scientific Committee, Frascati,  
May 2022

## new plasma laboratory



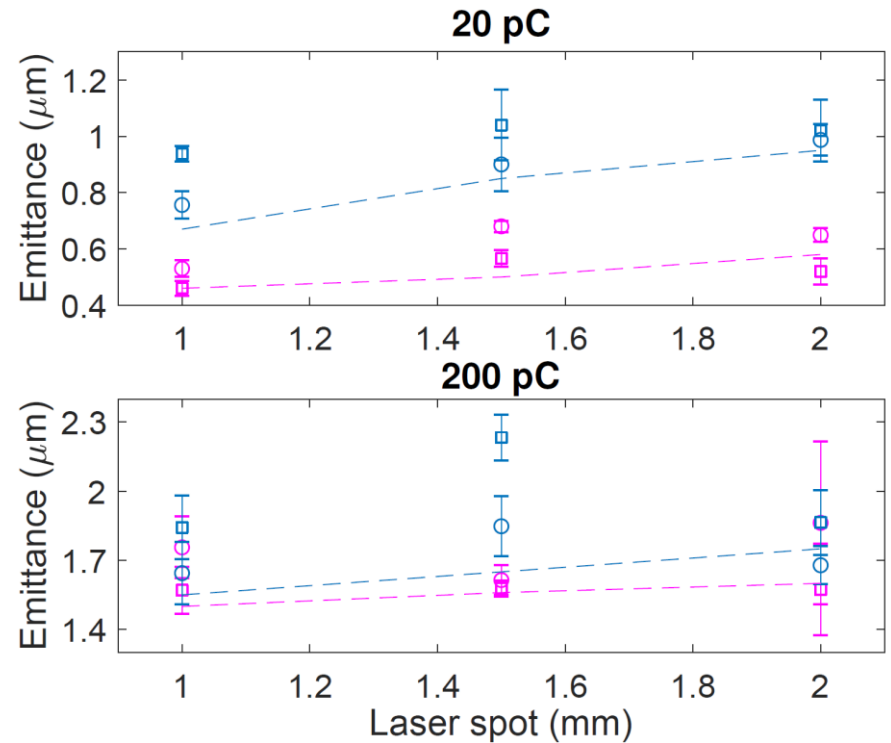
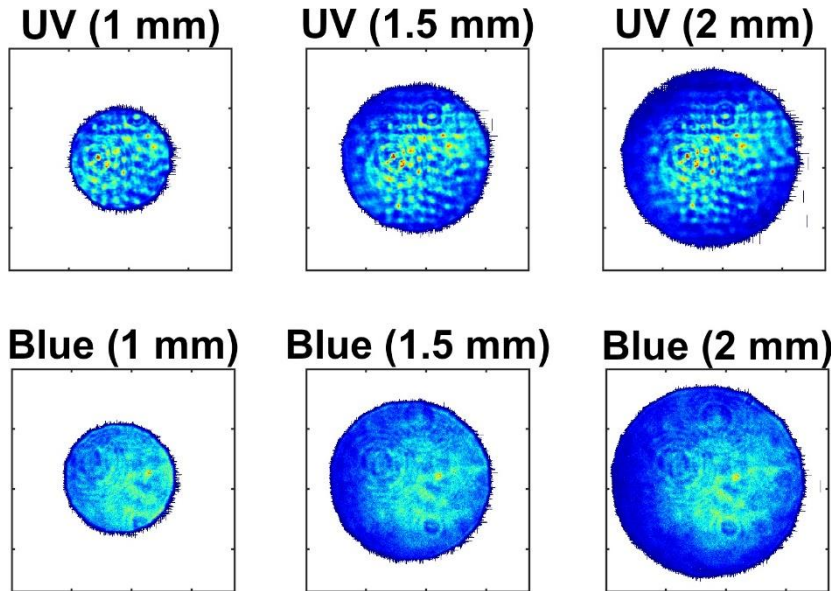


	Old gun	New gun
Peak field, [MV/m]	~102	~112
Beam energy [MeV]	5.2	5.8
QE, [e/ph]	~10 <sup>-6</sup>	~6.0×10 <sup>-5</sup>
Dark Current, [pC]	~1.5-2.0×10 <sup>3</sup>	~22.3
Discharge rate	1/5min (??)	1/day



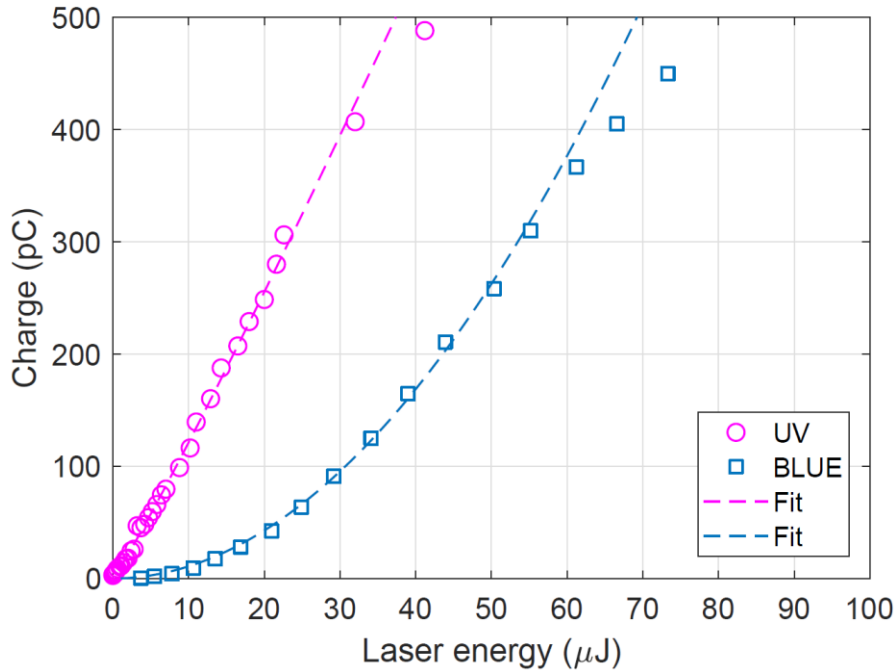
- *The SC recommends doing a full comparative study between beam performance at blue and UV emission from the cathode. This new operation mode is of potential interest for many photo-injectors worldwide.*
- *The SC recommends realizing the upgrade of the K2 modulator to a solid-state version with high priority.*

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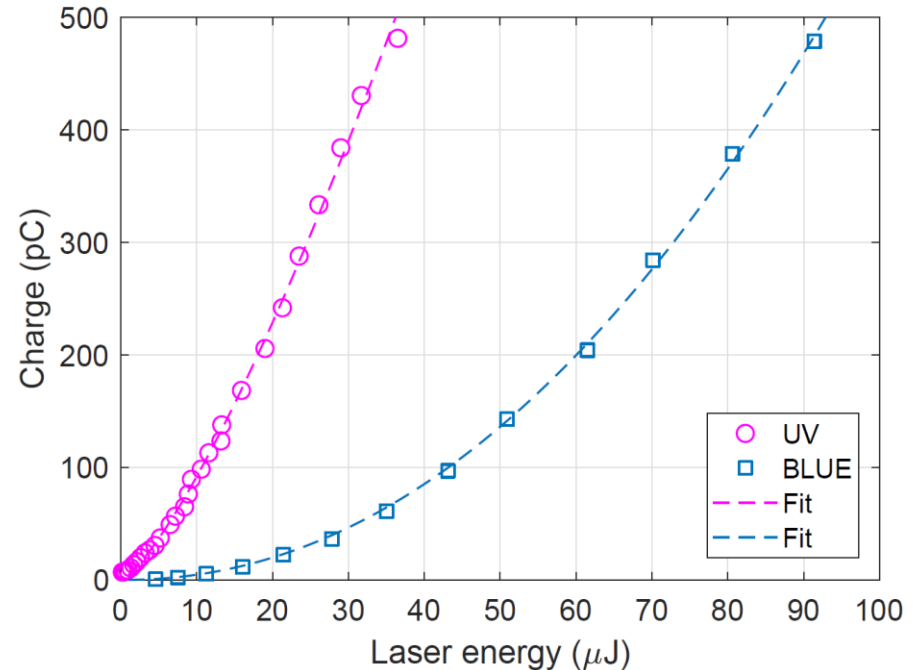


- The SC recommends doing a full comparative study between beam performance at blue and UV emission from the cathode. This new operation mode is of potential interest for many photo-injectors worldwide.

laser spot, 1mm



laser spot, 2mm



QE within our charge range

UV  $\sim 6 \times 10^{-5}$  [e/ph]

“blue”  $\sim 2 \times 10^{-5}$  [e/ph]

- *The SC recommends doing a full comparative study between beam performance at blue and UV emission from the cathode. This new operation mode is of potential interest for many photo-injectors worldwide.*

### Reply

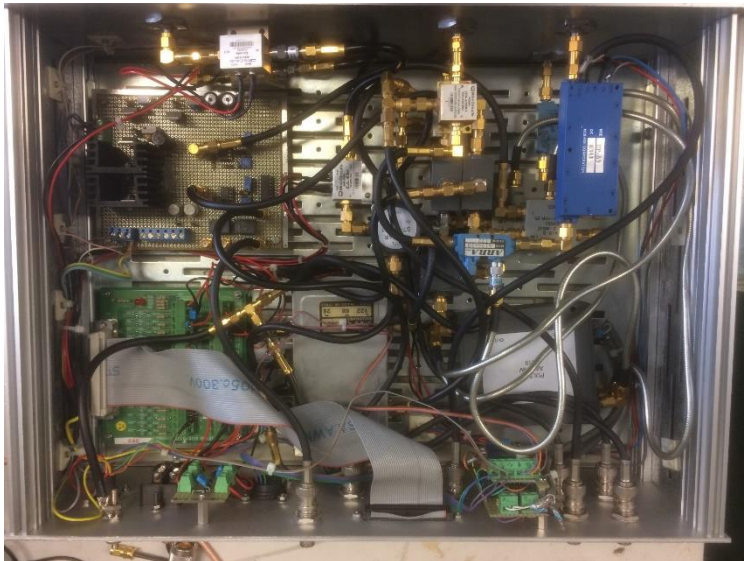
- a full characterization of the linac operation for both UV and “blue” emission was done in January 2022
- the lasers have demonstrated rather similar performance
- in absolute numbers, the “blue” laser increases the beam emittance for  $\sim 0.2 \mu\text{m}$ . Such difference is most noticeable for low charge beams ( $\sim 20 \text{ pC}$ ).
- at the end there was made a decision to stay on UV laser, due to the simple fact that the new gun capable to provide up to 1.2 nC beams even with UV laser, which solves our problem of the high charge driver.



- *The SC recommends realizing the upgrade of the K2 modulator to a solid-state version with high priority.*

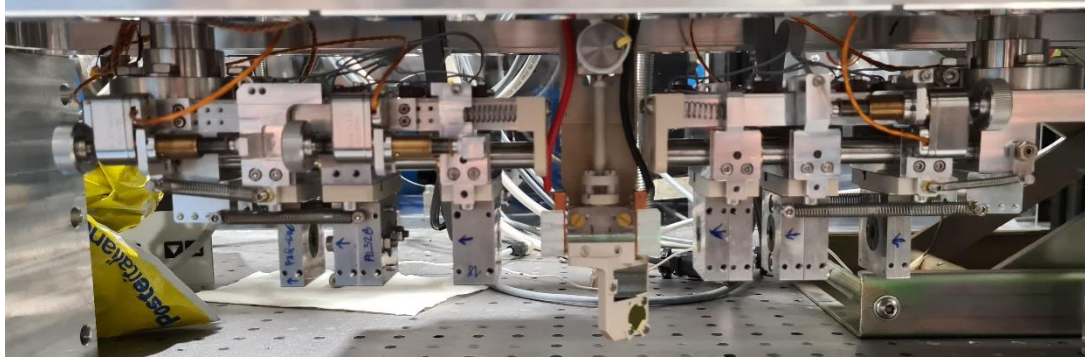


- Phase jitter of the K2 is the primary source of the bunch separation instability. PFN + klystron loop ( $\sim 50$  fs)
- A solid state modulator capable to stabilize the phase down to  $\sim 30$  fs.
- A solid state modulator + klystron loop system is under investigation
- Short term alternative: an additional *feed forward* system



Courtesy: Giacomo Giannetti,  
Marco Bellaveglia, Luca Piersanti

## New focusing system under construction

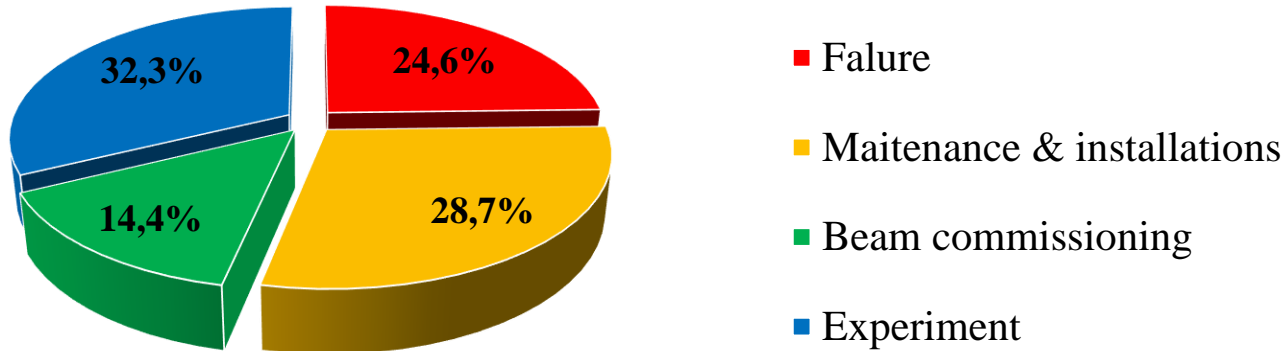


- C-band modulator installation
- new focusing system for plasma injection
- overhaul of the cathode laser control system
- EXIN line installation
- number of minor changes/updates inside the SPARC bunker

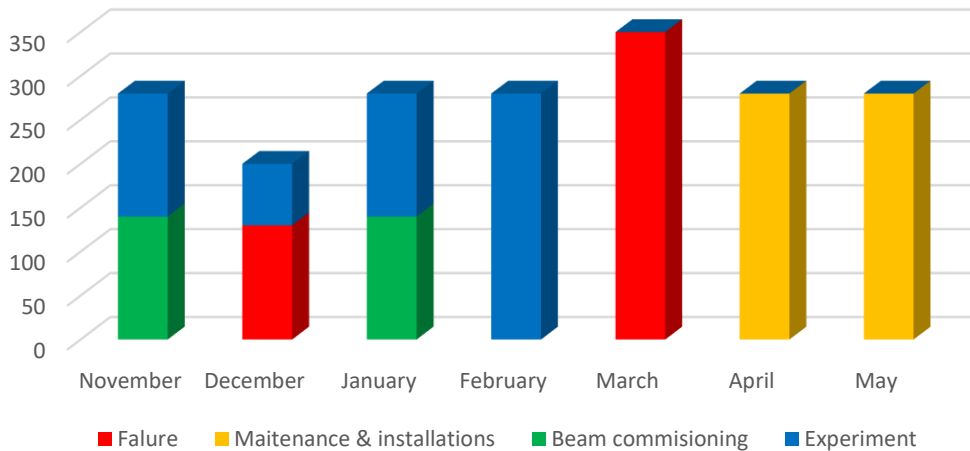


**SPARC operation restart June 6<sup>th</sup>**

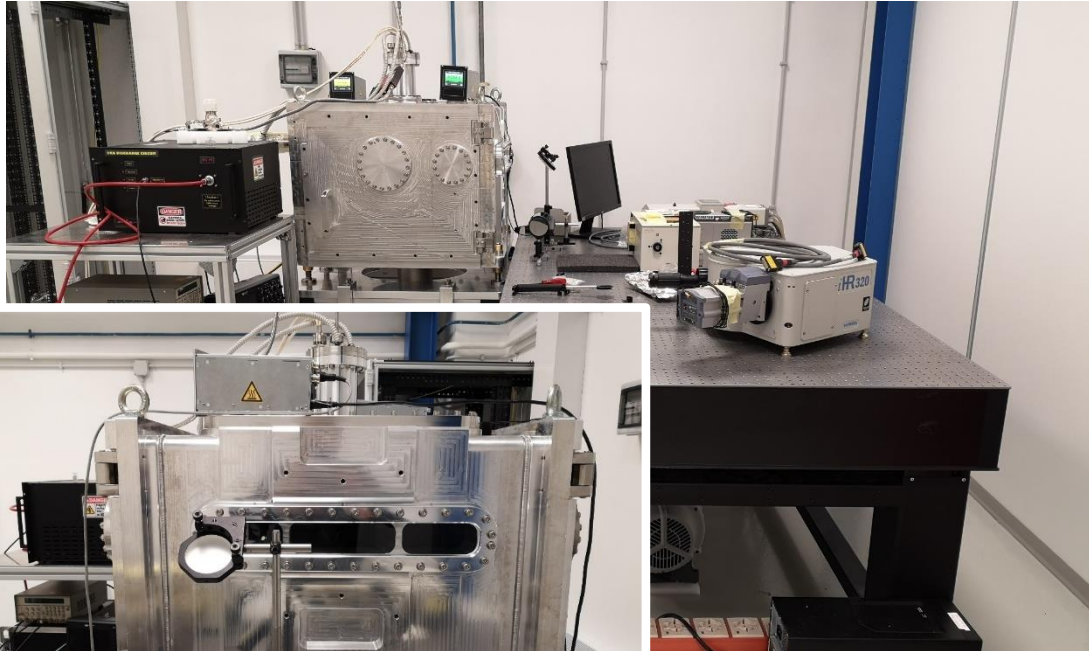
SPARC Time



SPARC - Montly activities 2022

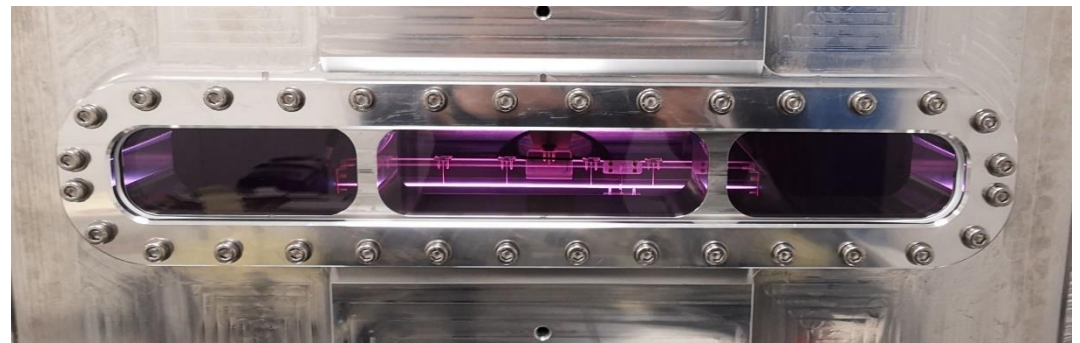


The experimental activities were stopped in March. The installation program includes: new focusing system for plasma experiments, new C-band modulator, EXIN line

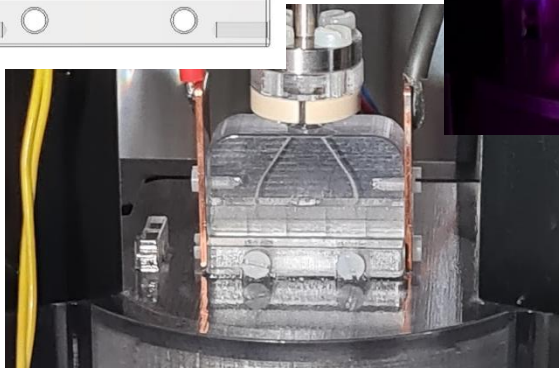
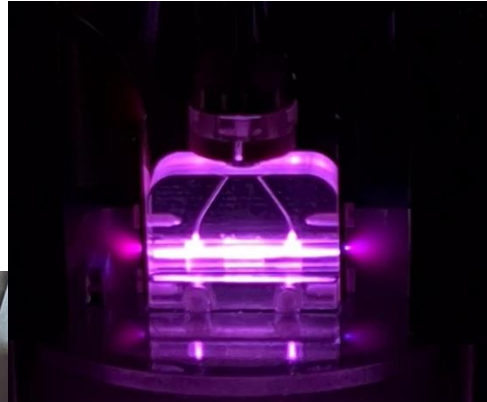
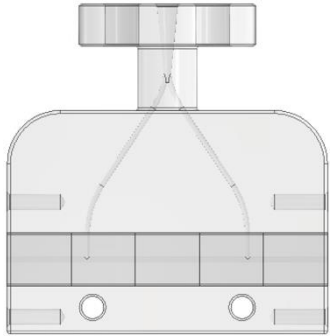


- laboratory was moved to a new location:
  - larger plasma chamber
  - updated pumping system
  - new high voltage source
- experiments with the long EuPRAXIA style capillary

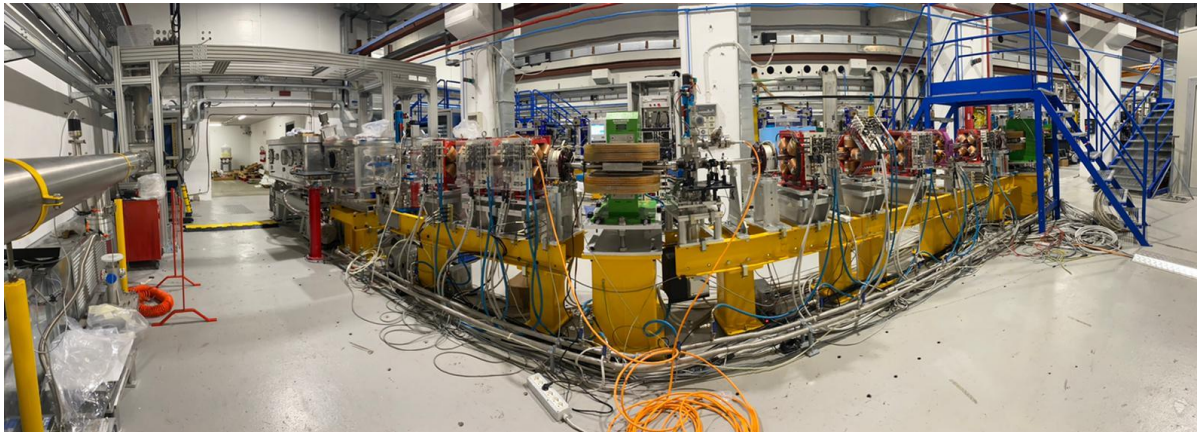
Last result in the Plasma\_Lab: First EuPRAXIA plasma source to reach 1.1 GeV (1.5 GV/m) - **40 cm long**



Courtesy: Angelo Biagioni



- First test at FLAME with a more robust material (sapphire). All previous test done with 3D printed capillary (aging issue).
- To get the 3cm total length for a inner diameter of 500um, we had to split the sapphire in 5 pieces.
- Good discharge with 10 kV, 500 A.



- Mounted and cabled all the mirrors of the EXIN beamline and EOS diagnostic is also in place.
- Vacuum tests of the optical beamline done.

Courtesy: Maria-Pia Anania

1. **March – May 2022. All sorts of installations.** New C-band modulator, new focusing system for plasma experiments, EXIN line, additional diagnostics.
2. **June – July 2022. PWFA experiments.** New focusing system and higher charge for the driver should provide us with desirable 1 GeV/m.
3. **September – November 2022. PWFA experiments or/and EXIN synchronization test.** Depending on the summer results and readiness of the FLAME and EXIN line
4. **November – December 2022. Major SPARC overhaul, SABINA project installations.** New section solenoids, THz undulators (DGL line), excavation to make room for SABINA users, water and air systems at SPARC, number of smaller works/improvements/updates.



Thank You!