EUROPEAN
PLASMA RESEARCH
ACCELERATOR WITH
EXCELLENCE IN
APPLICATIONS

EuPRAXIA

WP12
Acc. Prototyping & Exp. Test Facilities

Coordinators
Rajeev Pattathil - STFC Rutherford Appleton Laboratory
Andrea Mostacci - Sapienza Univ. within SPARC_LAB

3rd Collaboration Week, 4-6 July 2018

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653782.

Outline

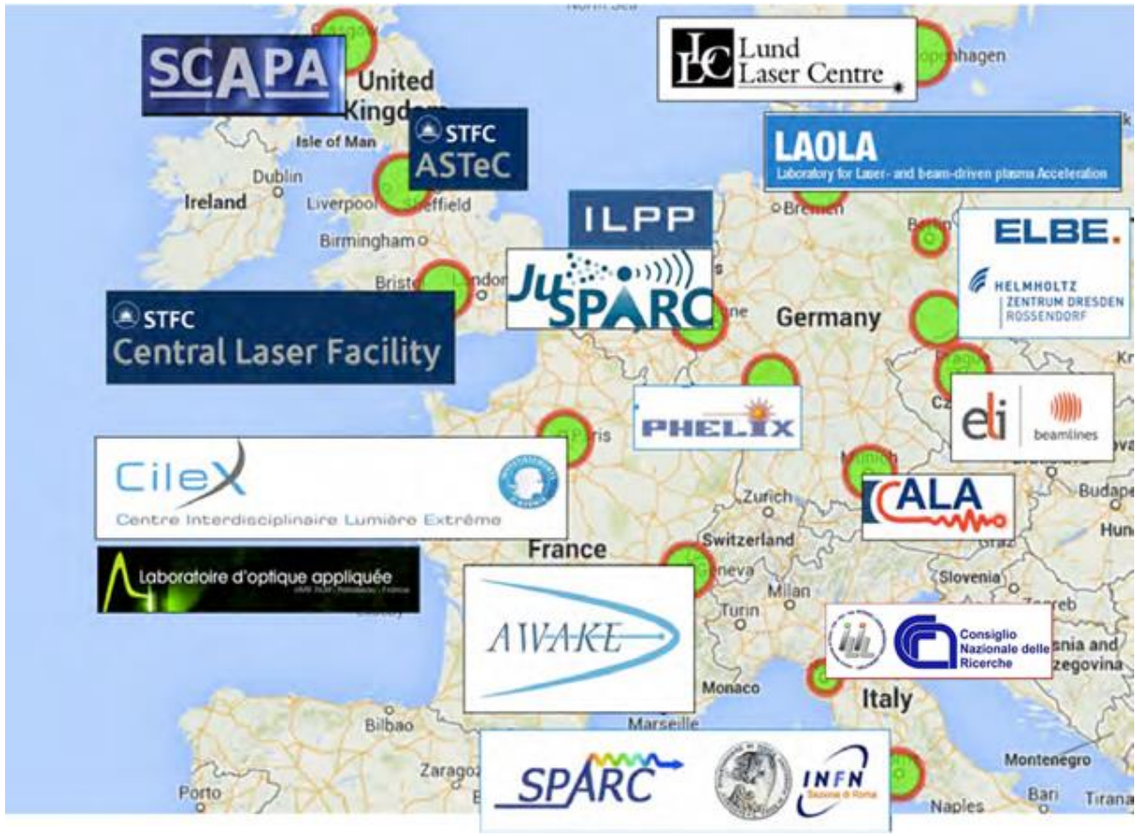
WP12:
Accelerator Prototyping and Experimental Test Facilities

Status @ Lisbon meeting

List of experiment useful to EuPRAXIA design study

Ongoing and proposed experimental activity

Interaction with Industries



Needed experiments

- Slice energy spread of plasma accelerated beam (~3fs slice for 1nm radiation)
- Schemes for selected issues (e.g. driver removal, resonant multiple laser pulses)
- Plasma based beam dump
- Switching options for driver and witness at low energy, preserving beam qualities.
- Compact advanced diagnostics and new ideas
- Stability of different schemes for plasma injectors (pointing stability of laser, plasma oscillations)
- High charge (higher than few tens of pC) in Plasma Injectors
- Synchronization for external injections
- Advanced devices (e.g. de-chirper for passive streaking)
- Feedback control (pointing, temporal, phase..)

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On going experiments

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- Schemes for selected issues (e.g. driver removal, resonant multiple laser pulses)
- Plasma based beam dump
- Switching options for driver and witness at low energy, preserving beam qualities.
- **Compact advanced diagnostics and new ideas**
- **Stability/Reliability of different schemes for plasma injectors** (pointing stability of laser, plasma oscillations)
- High charge (higher than few tens of pC) in Plasma Injectors
- Synchronization for external injections
- Advanced devices (e.g. de-chirper for passive streaking)
- **Feedback control** (pointing, temporal, phase..)

Advanced Diagnostics

Constrains

- Resolution for emittance must better than 1 mm-mrad
- Time resolution must be in the fs scale
- The device must work even with some instabilities, as for instance pointing, energy, time jitter
- Compactness is a fundamental requirement

A. Cianchi,
Diagnostics for EuPraxia Accelerator
Lisbon 2017

EuPRAXIA Yearly Meeting Lisbon 2017

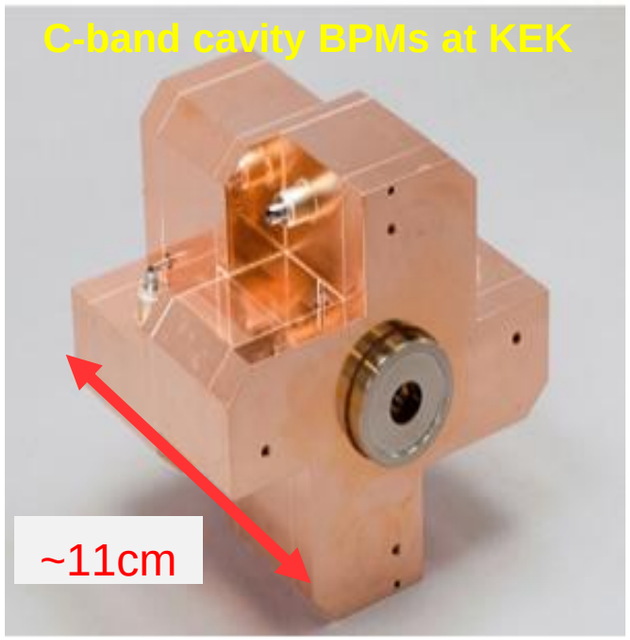
Compactness trough

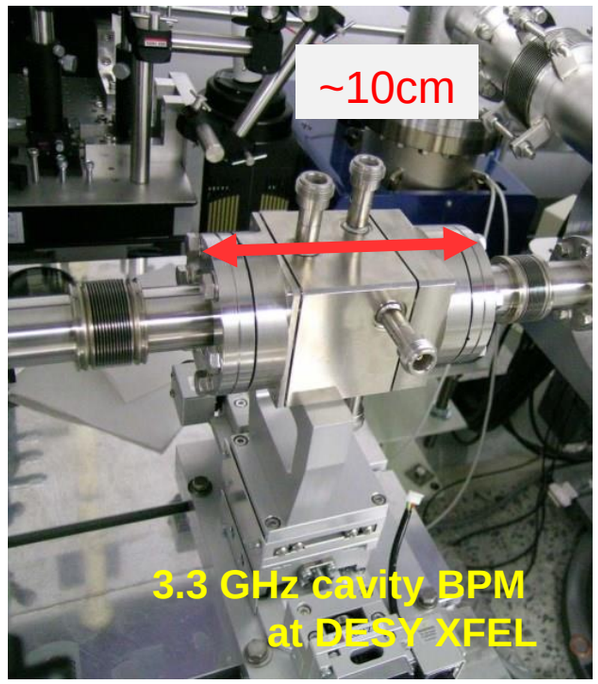
Sizing (e.g. reducing to 1 cavity)

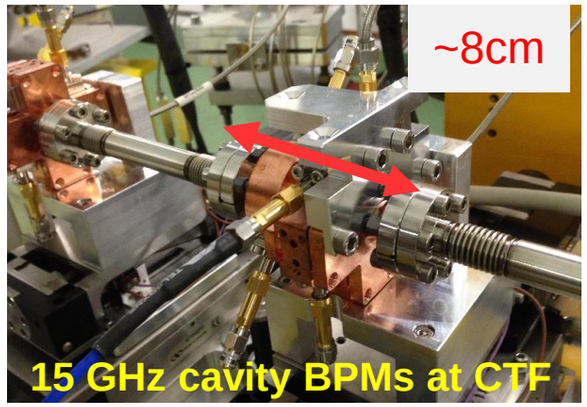
Combining measurements (e.g. position + charge)

Price to pay: more challenging **electronics** and measurements **resolution**

Cavity Beam Position Monitors

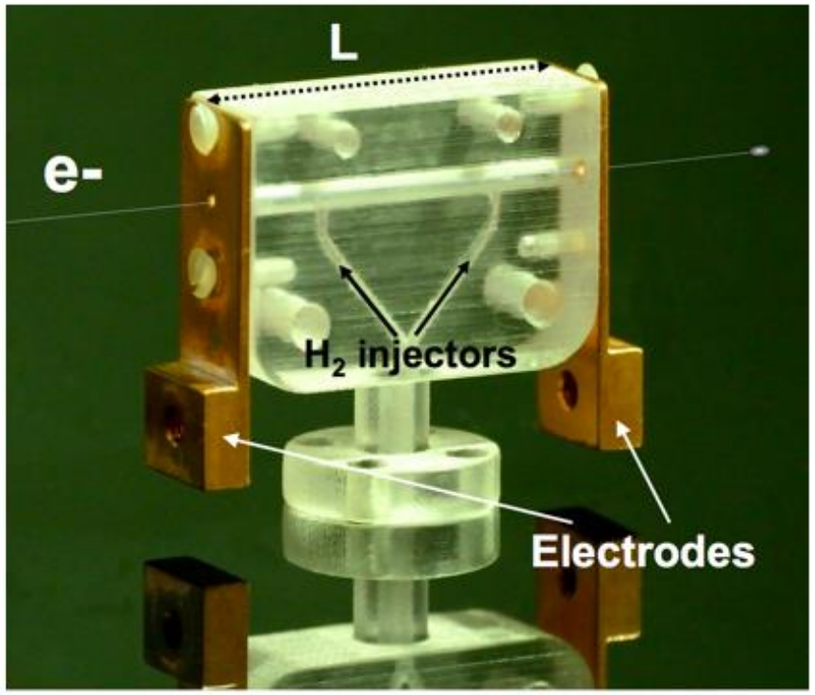


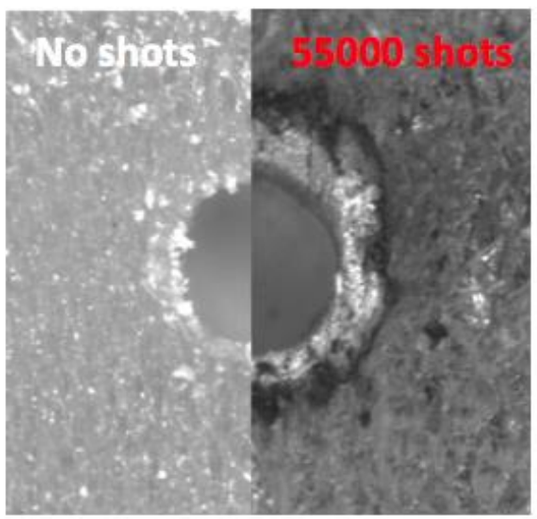


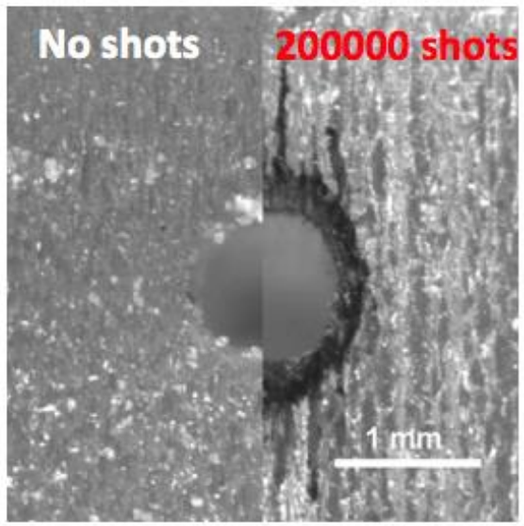


Reliability experiments

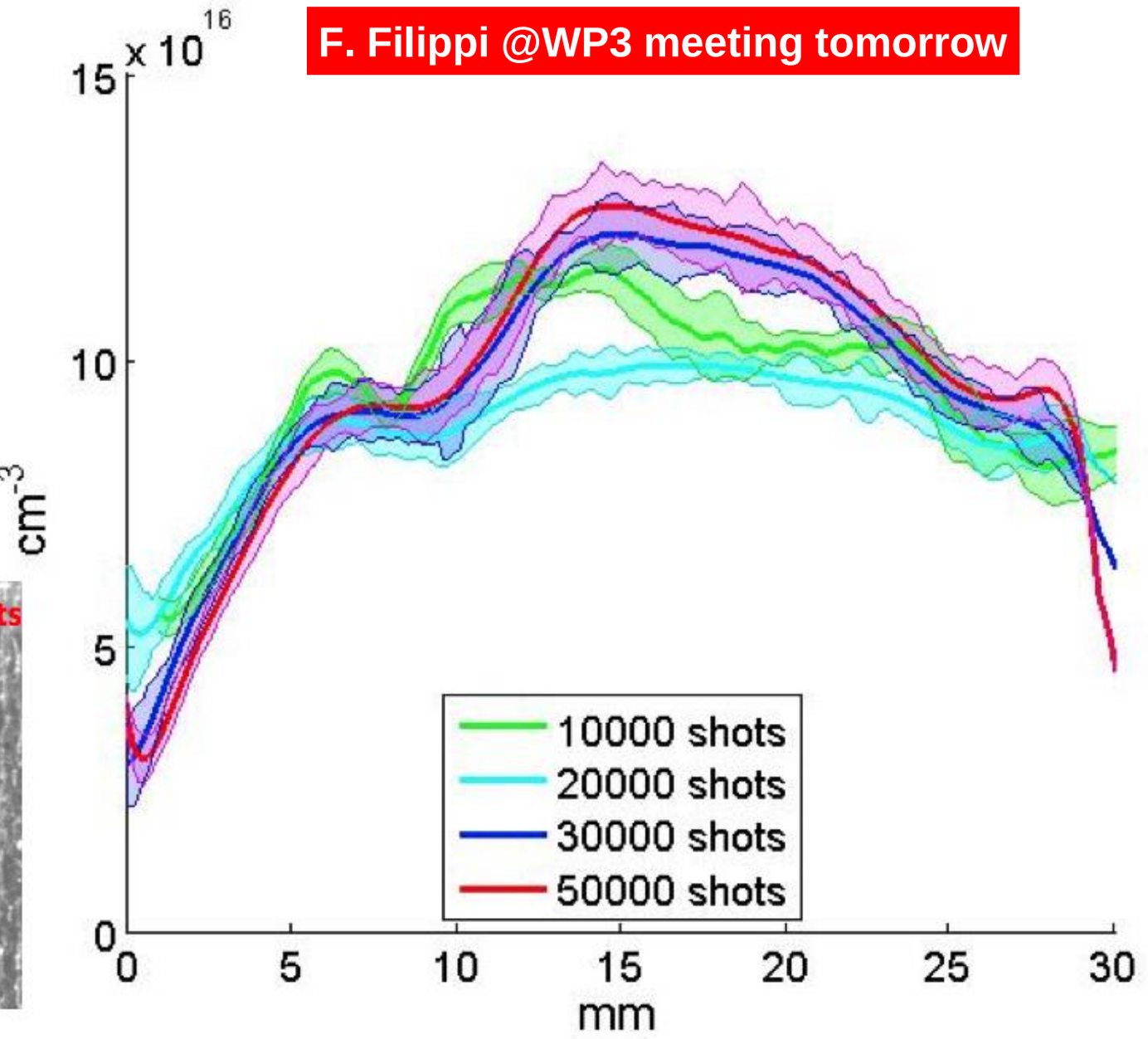
Design and characterization of 3D printed capillaries







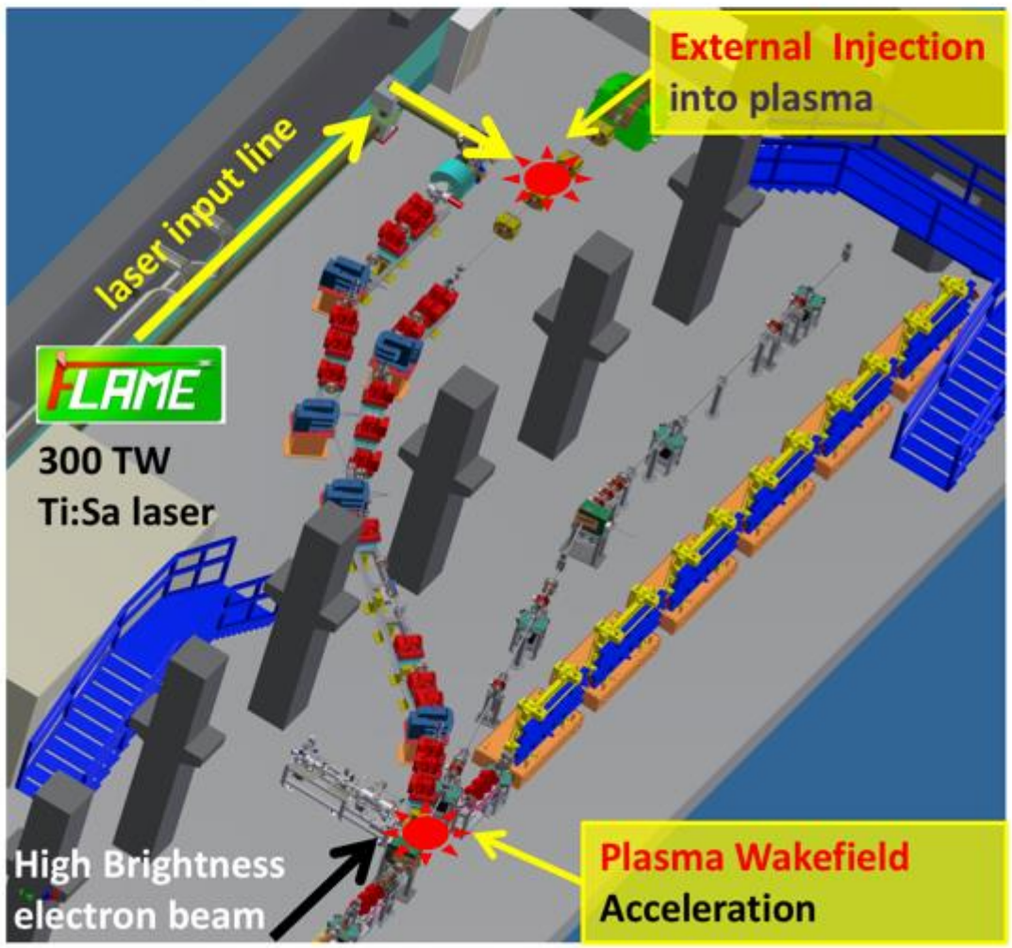
F. Filippi @WP3 meeting tomorrow

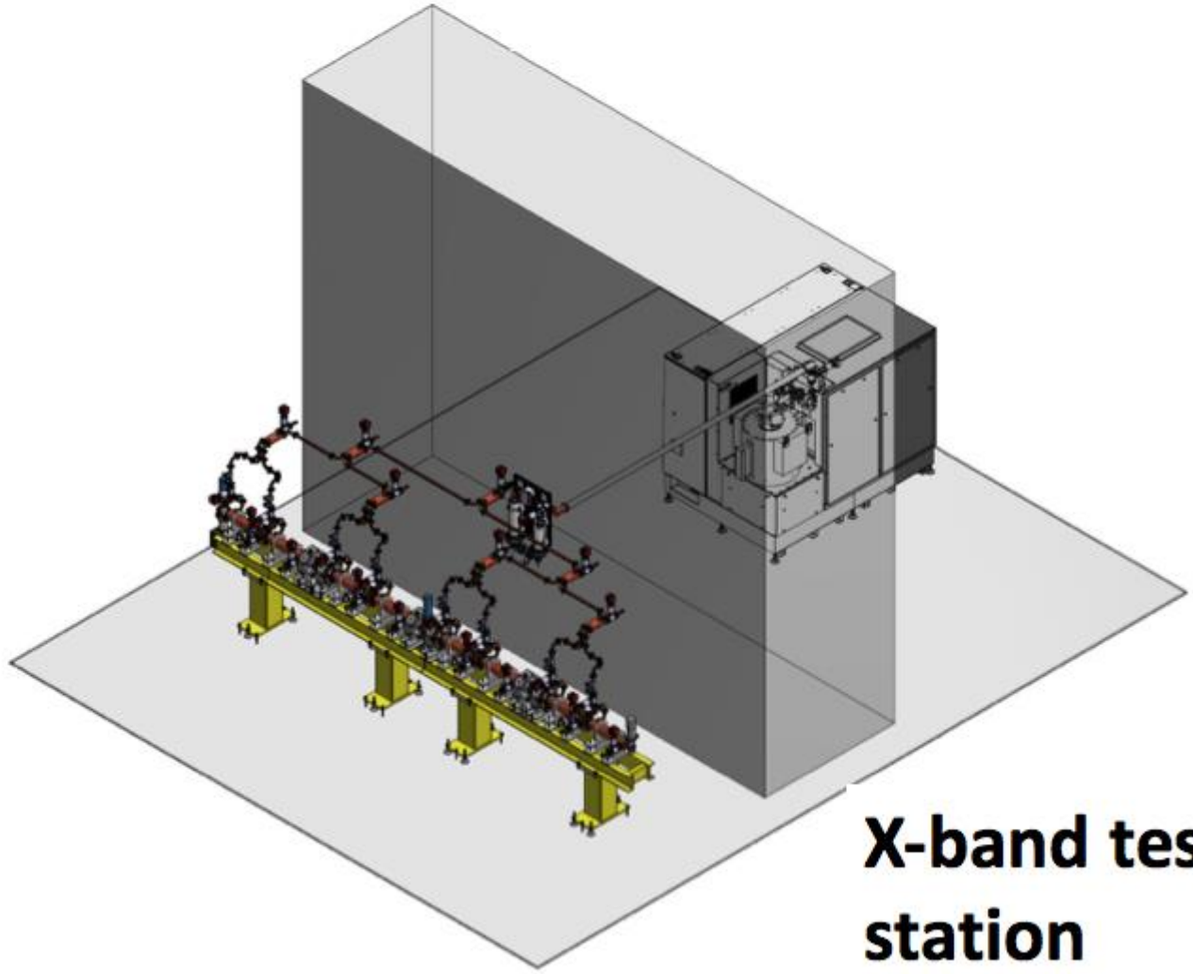


F. Flilppi et al, **3D-printed capillary for hydrogen filled discharge for plasma based experiments in RF-based electron linac accelerator**, submitted to RSI (2018)

Sources for Plasma Accelerators and Radiation Compton with Lasers And Beam

SPARC LAB





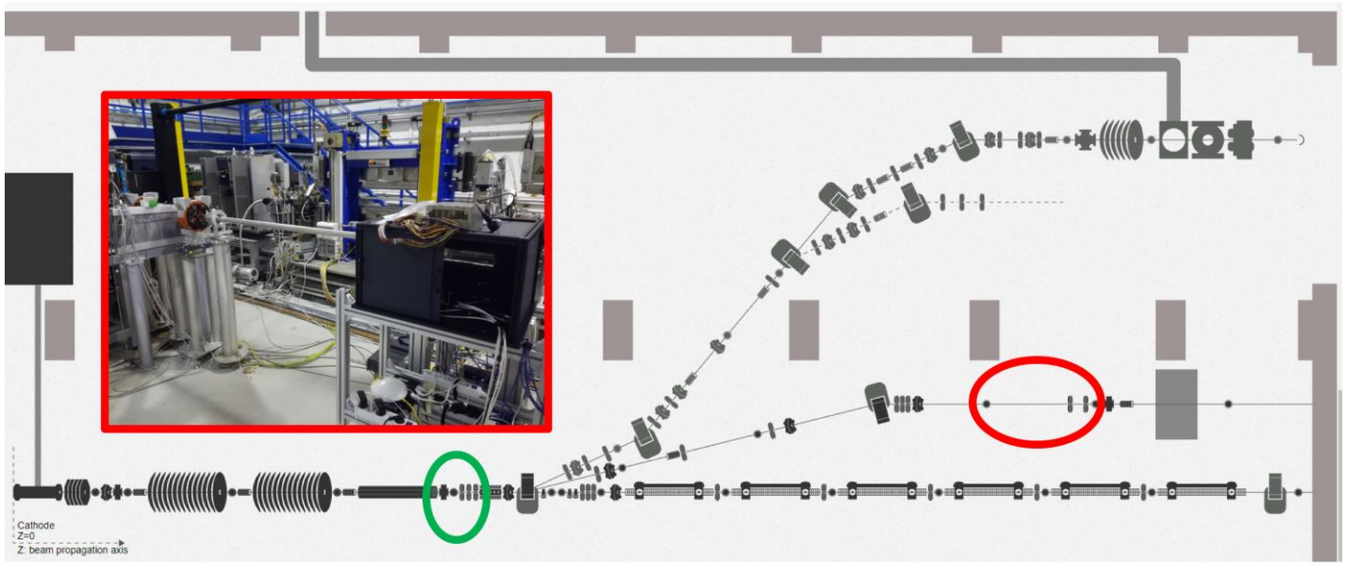
X-band test station

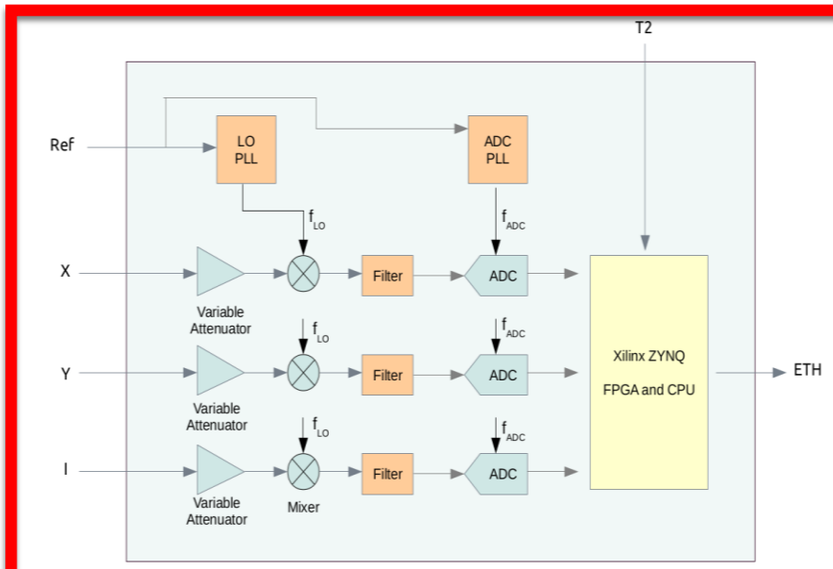
Test bench @ SPARC_LAB

Sources for Plasma Accelerators and Radiation Compton with Lasers And Beam

SPARC LAB

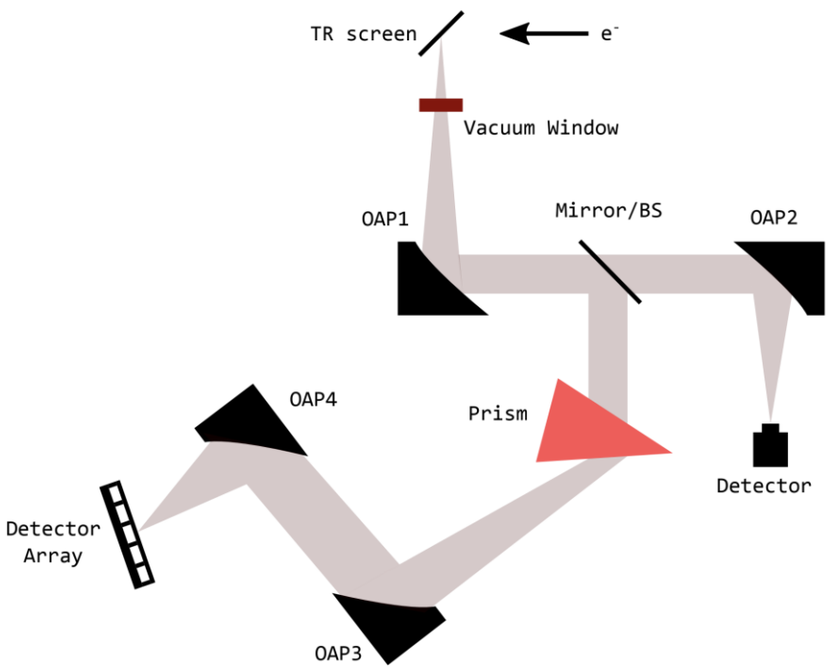
Next Experiments @ SPARC_LAB



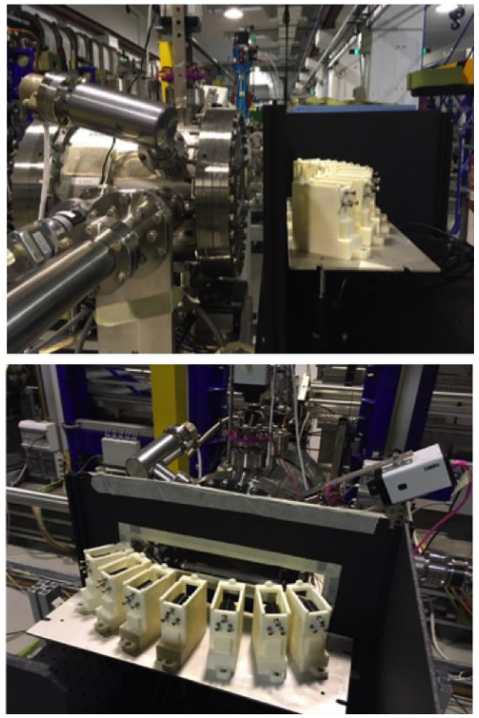


Read out Electronics for cavity BPMs (EuPraxia@Sparc_LAB)

- Noise treatment
- Linearity
- Variable attenuators calibration
- Signal Phase recognition
- Digital Signal treatment



Bunch length measurement from coherent transition radiation (K. Kruchinin, ELI-Beamlines)

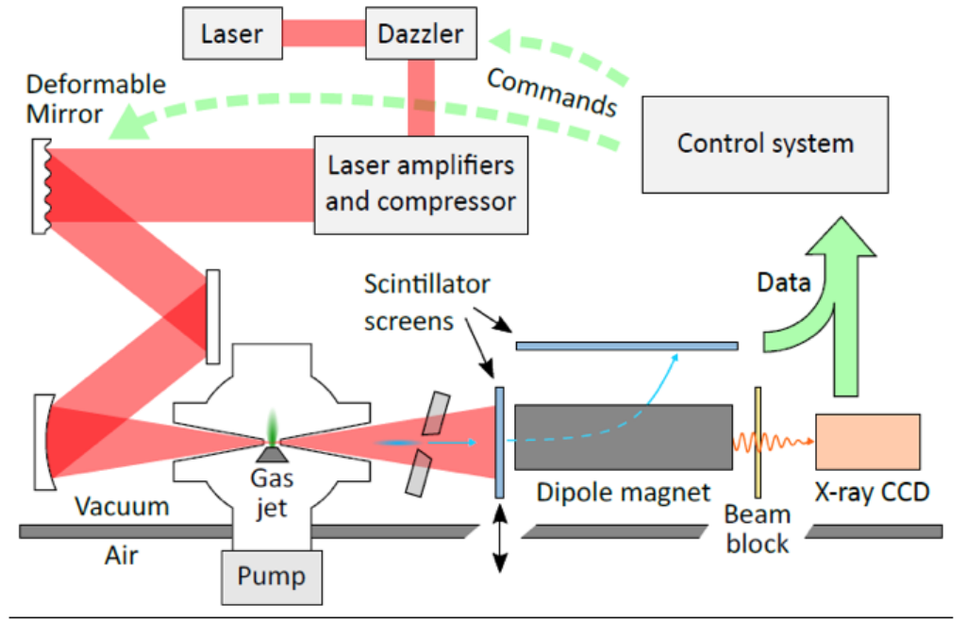


Bunch length measurement with Smith-Purcell radiation (N. Delleroux, CEA)

Contact persons:
E. Chiadroni, A. Cianchi

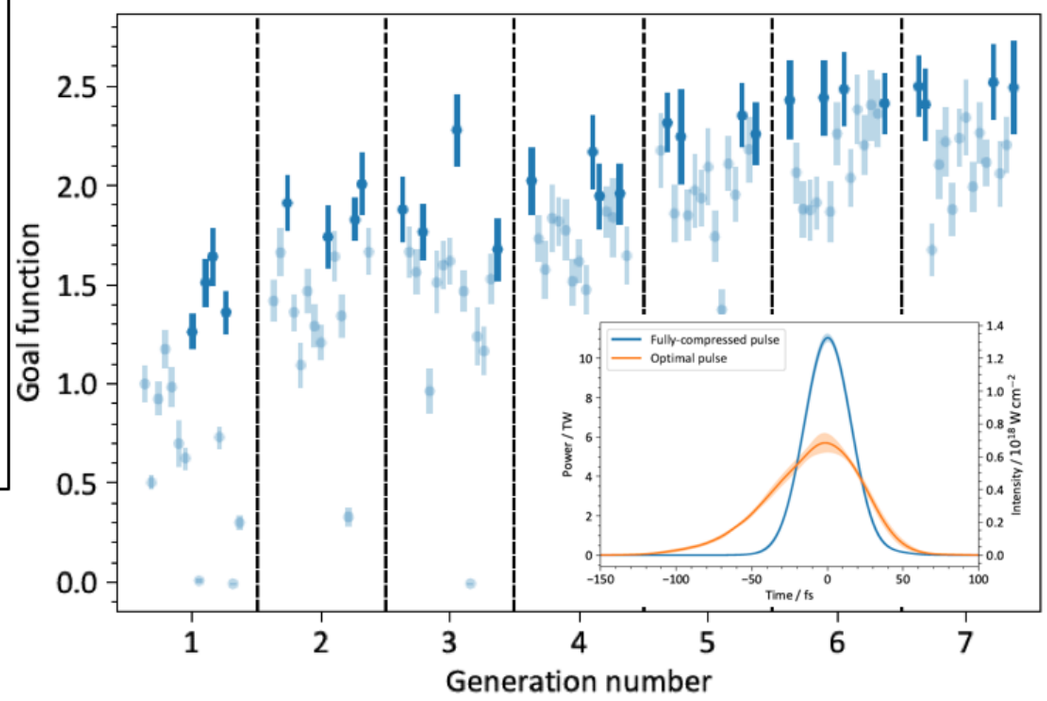
Optimization Experiments

Optimization of laser wakefield accelerator using active feedback loops



- Diagnostic data from the experiment is fed back to a control computer that can control the properties of the laser pulse
- Over multiple generations the pulse structure evolves to the shape that produces the best result
- The charge in the electron beam was more than doubled with a slowly rising temporal beam profile.

Optimisation of electron beam charge from a laser-driven accelerator



Experimental Access

WP3

Testing the high gradient plasma structure: **gas cell designed as part of WP3 (Brigitte Cross)**

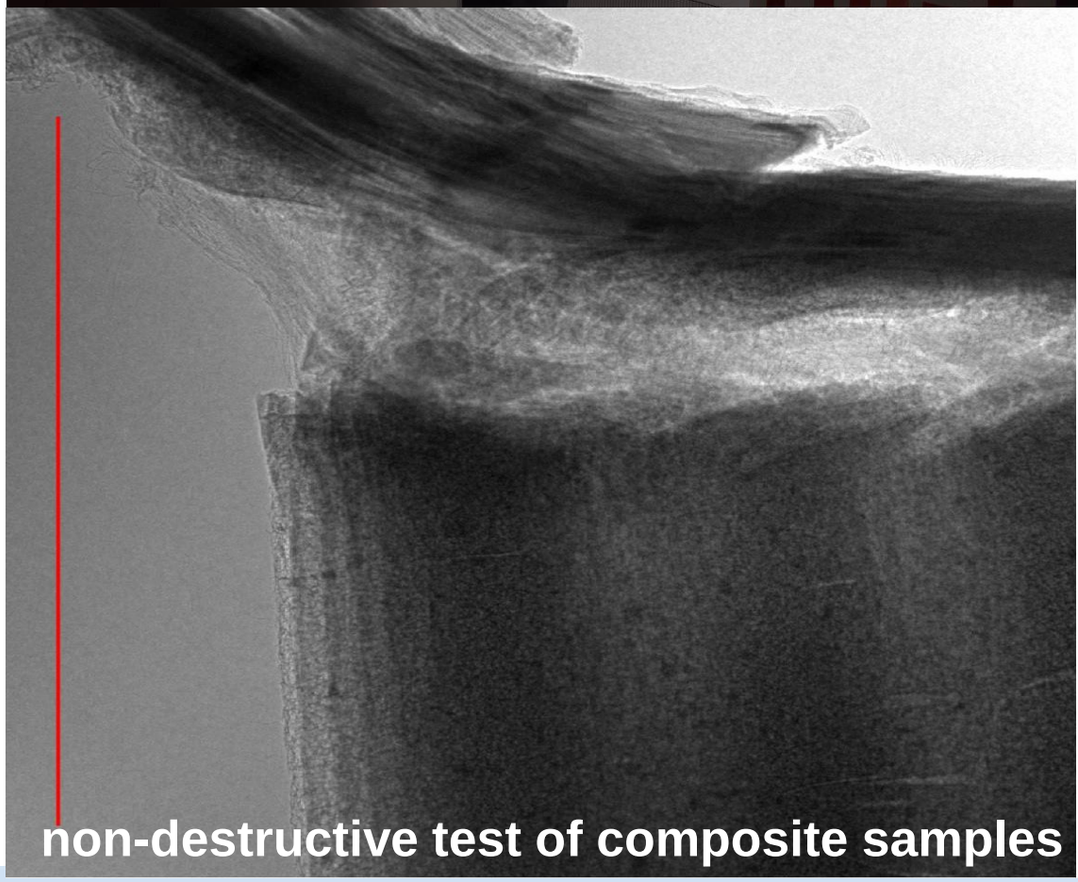
Require **full characterization of the laser along the focal volume**

Discussed with Lund Laser Centre

Aries Access proposal to be submitted

Workshops with industries

- Industrial workshop at **ELI beamlines** (25-28 May 2018)
- Industrial workshop at **CLF** on potential applications of **laser-driven sources** (2017)
- Strong industrial engagement and interest in sources (**electron and x-ray beams**); proof of principle experiments done in CLF show potential
- Propose to organize an industrial workshop for Eupraxia (**end-users industries**)



Conclusions

- **Experimental activity** supporting EuPRAXIA design study is progressing, both because of single laboratory initiatives or joined ones through European networks.

- Sparc_Lab is planning **beam test** of innovative devices (capillaries, X-band devices, diagnostics …)

- **Experimental proposal** to be submitted to Lund Laser Center for testing a high gradient plasma structure

- Proposed workshop with **end-users industries**

Thank you for your attention