EUROPEAN

PLASMA RESEARCH

ACCELERATOR WITH

EXCELLENCE IN

APPLICATIONS

EuPRAXIA

Preparatory Phase

WP13: Diagnostics

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on behalf of EuPRAXIA Diagnostic group

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WP13: Diagnostics

Funded by the European Union

- Tasks
  - Define a diagnostics suite for EuPRAXIA
  - Assess the suitability of existing designs for a plasma wakefield accelerator

Main Challenges

- A compact accelerator needs compact diagnostics
- Conventional solution can be used even if:
  - Small beam size at plasma entrance (µm scale) sets a problem for transverse diagnostics
  - Short bunch length (fs scale)
  - Since transporting the beam after the plasma cell is the first priority, the design of the diagnostics needs to accommodate the optics of the machine

Beam and photon diagnostics

Funded by the European Union

Beam diagnostics

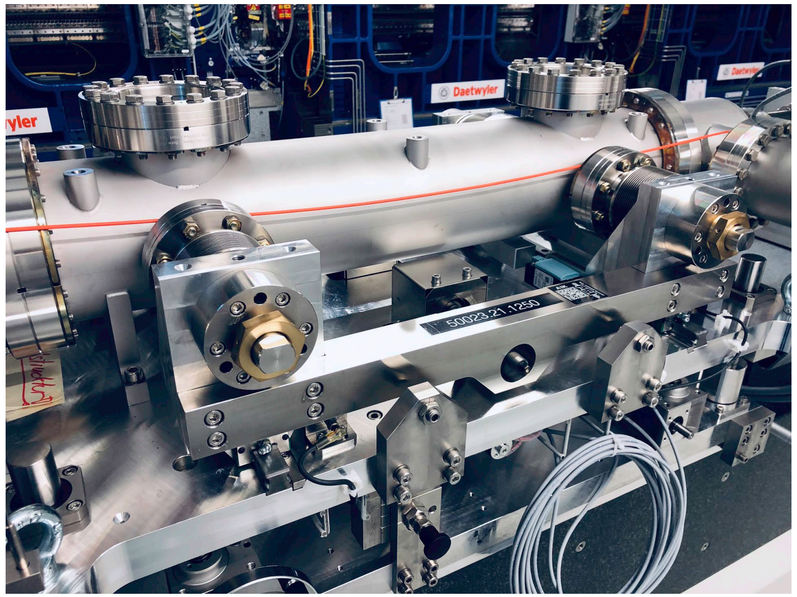
- PWFA & LWFA have similar problems:
  - Driver removal
  - Difficulties in capture optics
  - High divergence
  - Shot to shot instability

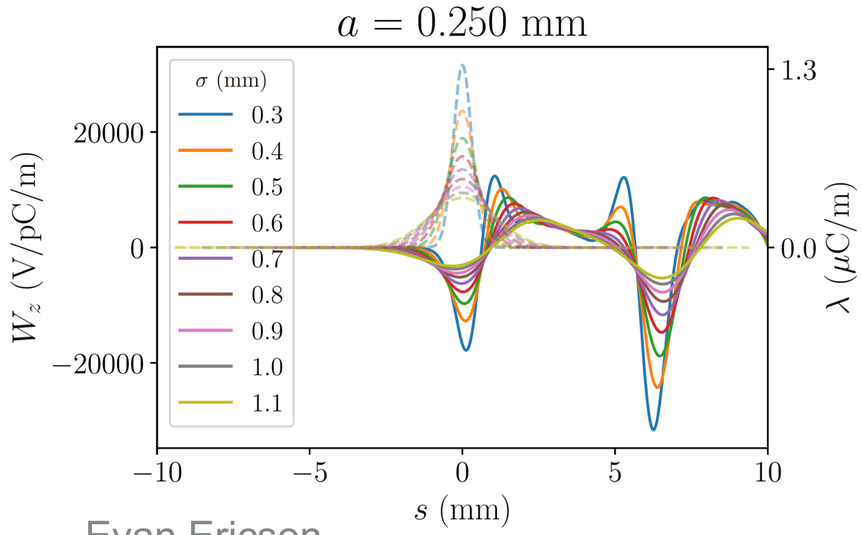
Photon diagnostics

- Less critical because we can use most of the usual FEL solution.
- Once the beam is lasing the tools for X rays diagnostics are state of the art....

Longitudinal Phase Space

- Challenge: control the longitudinal phase space distribution
- Many FELs have adjustable wake field structures
- Modeling of these structures
  - Different length scales make modeling difficu
  - Exact material properties unknown
  - Cross-check with other systems
- Alternative to RF deflecting structures





Evan Ericson

Photolithographic Wire Scanners

← Spider web wire scanner, made from gold using electron beam lithography

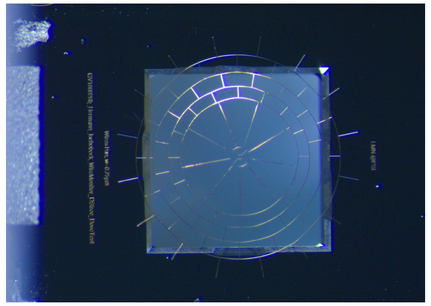
← Movement by in-vacuum piezo actuators

→ Manufacturing of silicon nitride structures

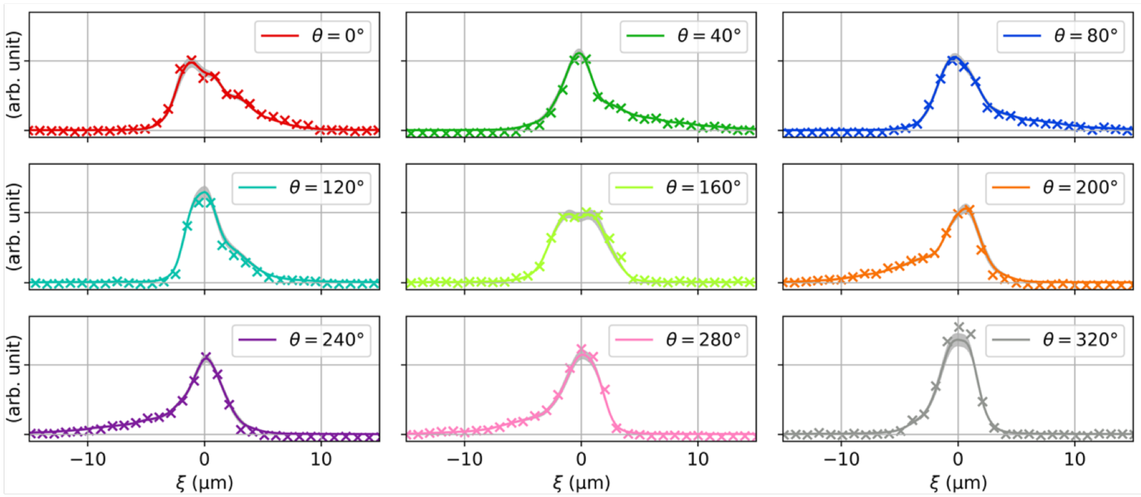
→ Made by low-pressure chemical vapor deposition, and photo-lithography, using direct laser writing of the photoresist

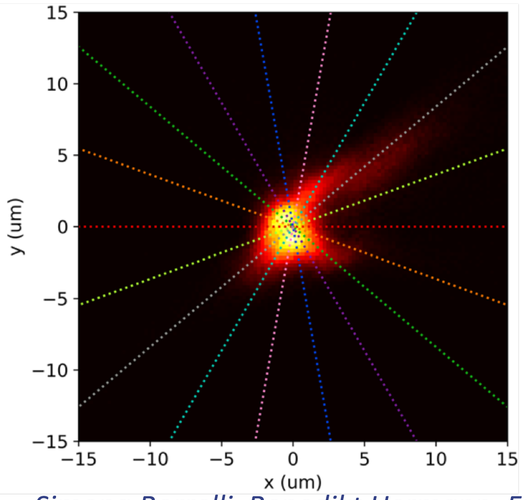
→ Melting point: 2170K

↓ Tomography is used to reconstruct the 2-dimensional image



- Challenge: integration into the plasma chamber
- Detection of scattered particles over the background
- Possible synergy with PACRI

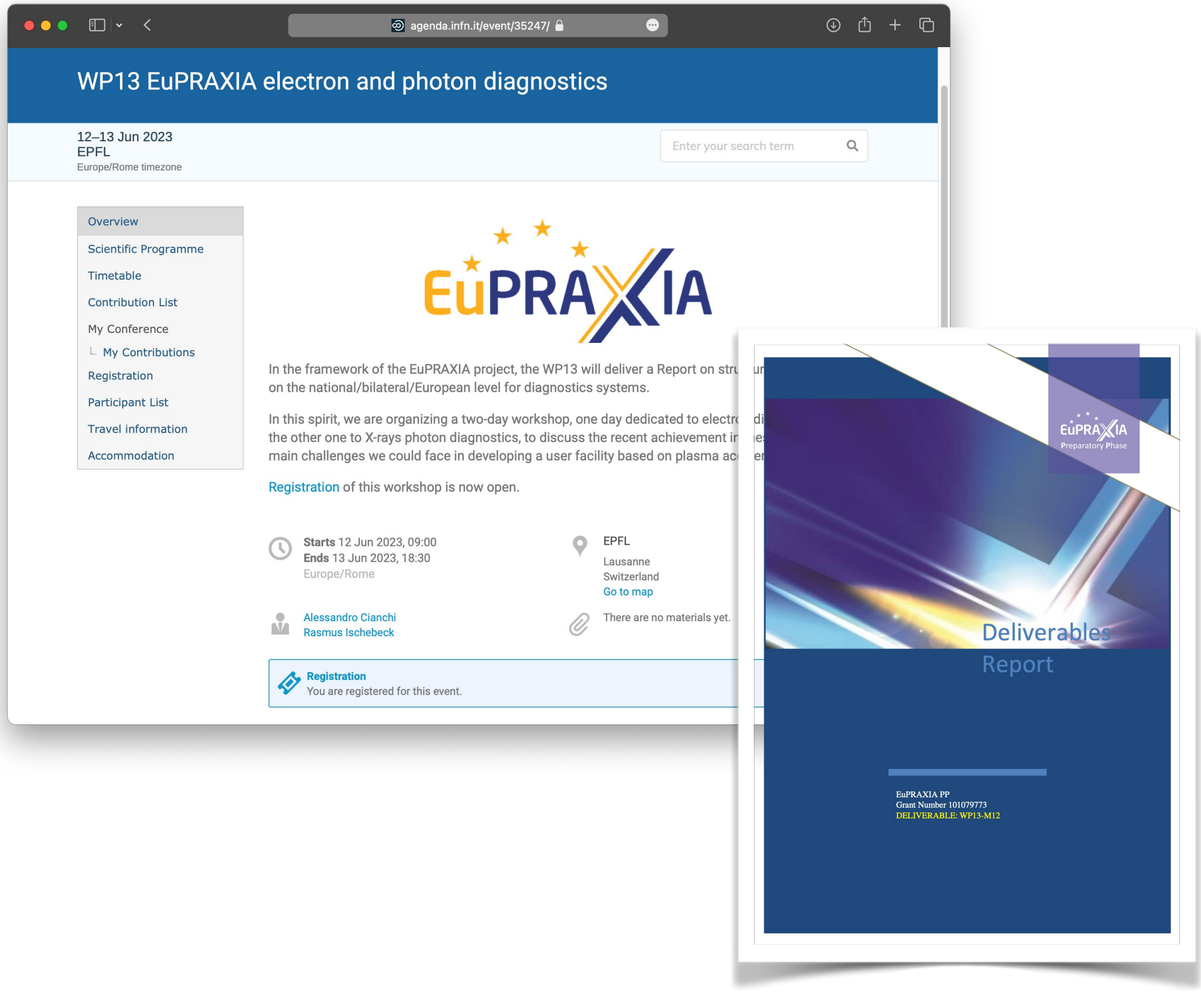




Simona Borrelli, Benedikt Hermann, Francesca Addesa, Alessandro Cianchi, Rasmus Ischebeck

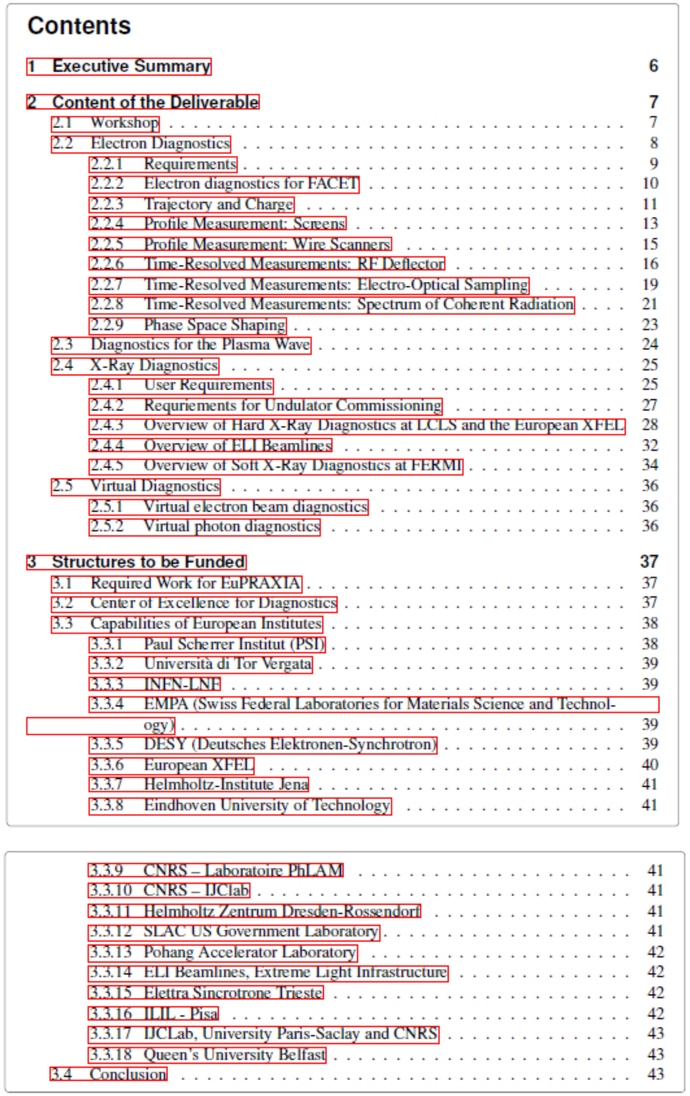
Workshop

- Workshop on EuPRAXIA Electron and Photon Diagnostics
- June 12–13, 2023
- https://agenda.infn.it/event/35247/



Deliverables WP13

- Report on state of the art and structures to be funded
  - Delivered: October 2023
- Report on technical results achieved
  - To be delivered: October 2024
- Report on the technical readiness level and maturity of diagnostics
  - To be delivered: April 2026



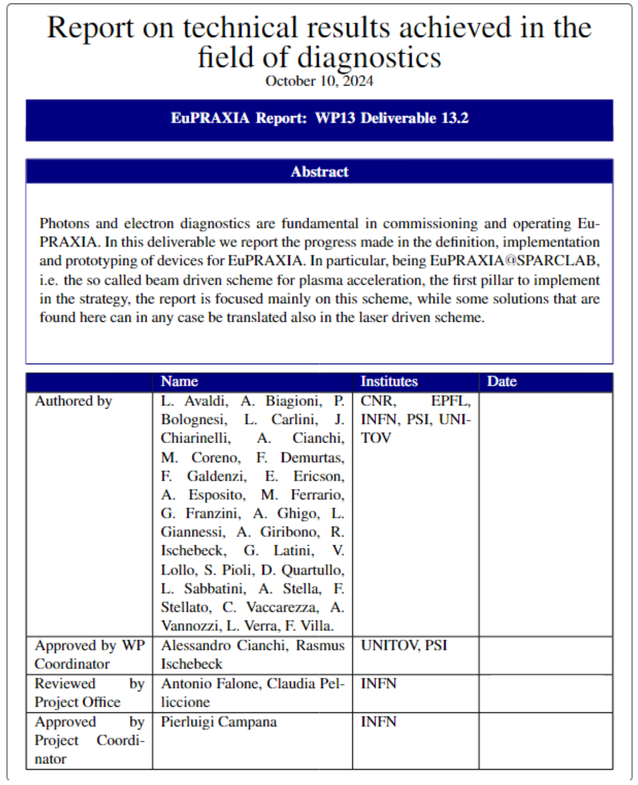
Contents

Synergy with EuPRAXIA@SparcLab

- EuPRAXIA@SPARC_LAB will be the first FEL for users driven by plasma acceleration
- All the EuPRAXIA developments can be tested and used at EuPRAXIA@SPARC_LAB.
- Diagnostics integration in the machine layout, especially in the plasma chamber will be the most difficult challenges

Second deliverable WP13

- This second deliverable is mainly the status of the diagnostics in EuPRAXIA@SPARC_LAB TDR
- We did not address all the problems, but we wrote the solutions for the ones we solved.



Report on technical results achieved in the field of diagnostics

October 10, 2024

EuPRAXIA Report: WP13 Deliverable 13.2

Abstract

Photons and electron diagnostics are fundamental in commissioning and operating EuPRAXIA. In this deliverable we report the progress made in the definition, implementation and prototyping of devices for EuPRAXIA. In particular, being EuPRAXIA@SPARCLAB, i.e. the so called beam driven scheme for plasma acceleration, the first pillar to implement in the strategy, the report is focused mainly on this scheme, while some solutions that are found here can in any case be translated also in the laser driven scheme.

	Name	Institutes	Date
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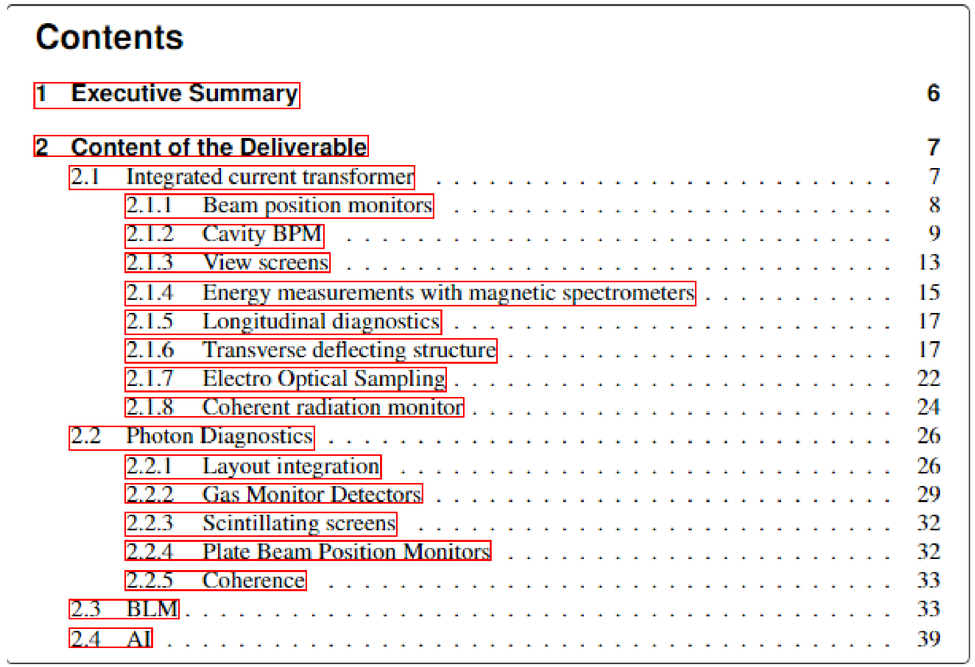

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Announcements

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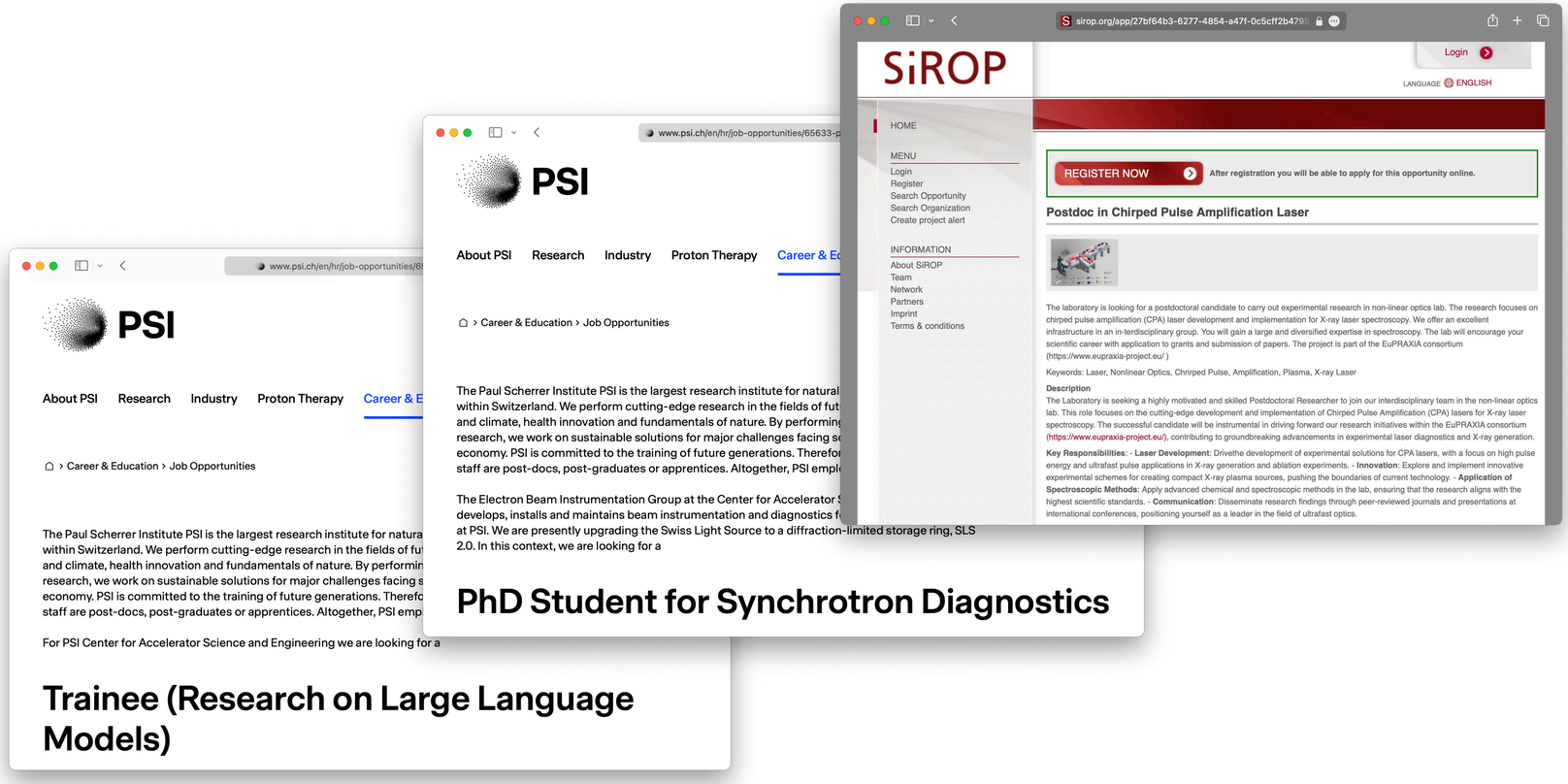
Workshop

Open Positions



Center of Excellence for Diagnostics

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- Scope:
  - Electron beam instrumentation
  - X-ray instrumentation
  - Controls, data acquisition
  - Virtual diagnostics

- Proposal: locate at PSI

Develop

Funded by the European Union

Rasmus + Midjourney

Design

Funded by the European Union

Deliver

Funded by the European Union

Center of Excellence for Diagnostics

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