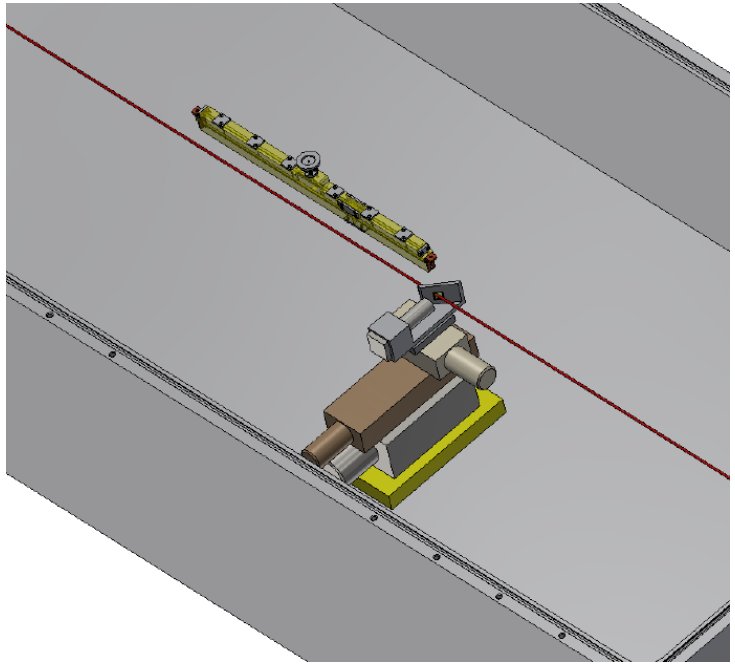
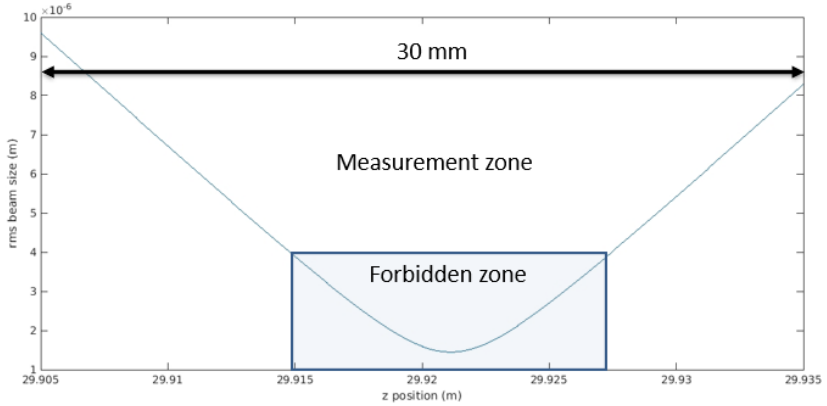
# WA 10
# Diagnostics

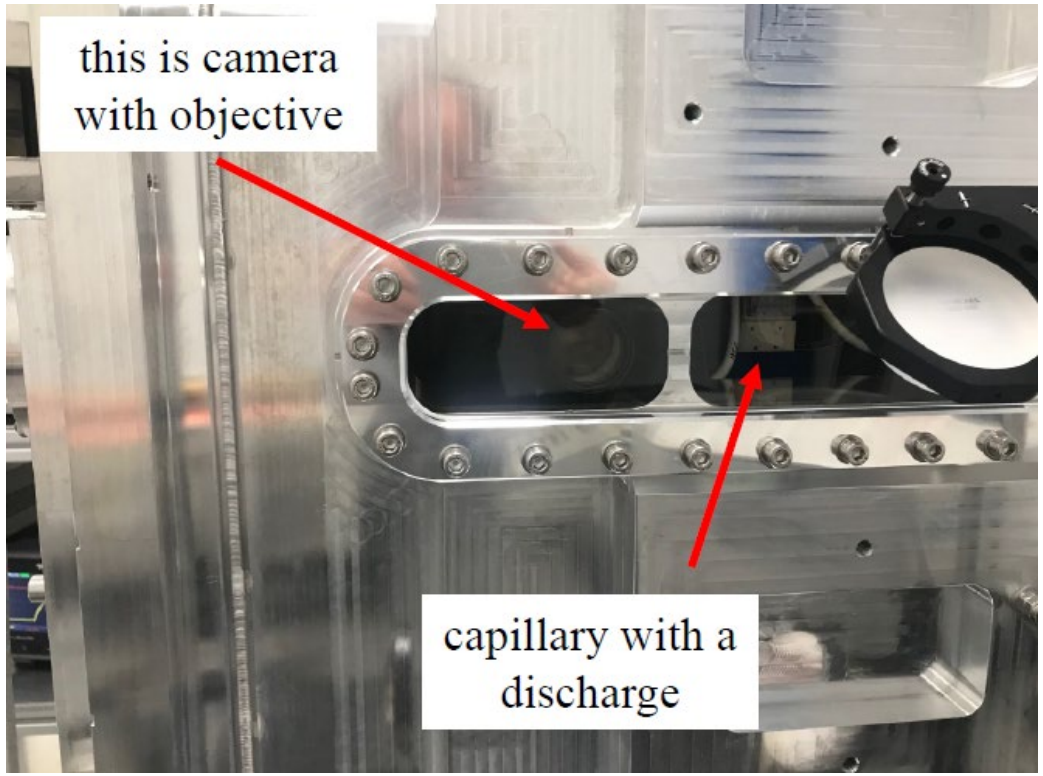
# RC step beam size @ plasma diagnostic

- The ”small size zone” emittance measurement technique still needs to be reviewed. The RC understands that due to delays in delivery of cameras, other options to measure small beam sizes are considered.





# Tests




- V. Shpakov, A. Biagioni

- Available camera Basler Scout which was used inside the bunker tested
- Camera was located inside the vacuum, level of ~$10^{-6}$ mbar
- Discharge was used in the direct vicinity from the camera
- Distance between the camera and the discharge capillary was 120-150 mm
- Camera was tested with and without external trigger

Conclusions:

- Camera can work inside the vacuum without problems with the temperature
- Discharge does not create problems with the camera or the trigger

# RC intraondulator

- Each intersection between the undulators is equipped with a high-resolution beam position monitor and a screen to measure the transverse beam size. The RC would like to hear about more studies on the radiation load of undulator magnets due to radiation produced by screens. Thickness and type of screens should also be discussed. The RC wants to point out that an alternative to screens should be considered for the intersections.

- We are not ready for this discussion.
- We need an expert of GEANT4 to make simulation of radiation produced by screens
- We are confident that in a few months we can solve this problem of recruitment
- About the screen type and thickness, we can consider to have Silicon Nitride Membrane (1 um thickness) with aluminum coating. We need some R&D.

# Intraondulator

- The design of the intersections has started. A more detailed study on how to efficiently integrate diagnostics into the present intersection length, including the space required for a movable quadrupole, a phase shifter, and a vacuum connection is expected.

- From diagnostics point of view, we have already the prototype of the view screen. The cavity BPM can be assumed similar to other already existing with overall length of 100 mm.
- The diagnostics space occupancy is well defined.
- The main issue in the intraondulator modules is the magnet design including the movable supports.
- Without this design is not possible to make a comprehensive layout of the region, including vacuum ports, bellows etc.

# Cavity BPM selection

cBPM requirements for EuPRAXIA:
Resolution: < 1 µm
Observable Range : ± 1 mm
Bunch Charge: > 10 pC
Repetition Rate: 100 Hz
Length: as short as possible
Number of Units: < 10

| | PSI CBPM5/8 | FMB Oxford |
|---|---|---|
| Material | Stainless Steel (outside) – Copper (inside) | Stainless Steel |
| Length [mm] | 100 mm | 100 mm |
| Inner Aperture [mm] | 5 / 8 mm | 20 mm (custom) |
| Res. frequency | 4.9266 GHz | 6.474 GHz |
| $Q_L$ | 1000 | 610 |
| Decay Constant | 64.6 ns | 30 ns |
| Charge Range | 10-200 pC | 10-100 pC |
| Typical Position Range | ±1 mm | |
| Position Sensitivity (CBPM5) | 4.5 V/mm/nC | 1 V/mm/nC |
| Charge Sensitivity (CBPM5) | 62.8 V/nC | |

- Already Installed and functioning at SWISSFEL.
- Measurements show results compatible with our requirements.
- Designer (Fabio marcellini) is willing to collaborate with us to adjust or create a new design.

**THIS SEEMS THE BEST CHOICE**

There are three possible solutions for the readout electronics:

1. To buy (or to develop together) read-out electronics from Instrumentation Technologies.
2. To buy and to test PSI readout Electronics.
3. To internally develop readout electronics

G. Franzini

# Striplines BPM

**STATUS: Strip-Lines BPM**

**10cm between flanges and 25mm aperture**

- BPM prototype (delivered Feb2022) ✓
- RF Bench tests (march 2022) ✓

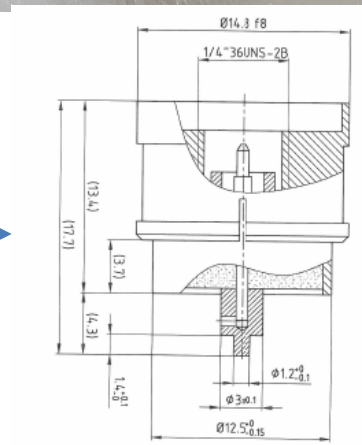
- **BPM realization for beam tests including minor modification to design**

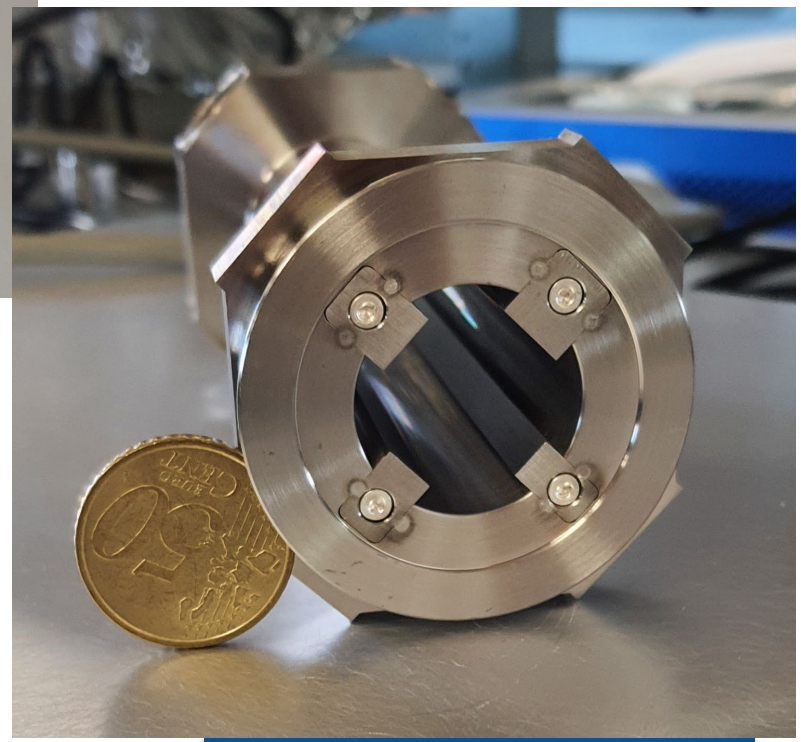
  **Vacuum feedthroughs procurement (qty:16)**
  **Purchase order (PMB, May2022)** ✓
  **Delivery: 4 weeks (estimated)**

  **Tender for mechanical realization (with vacuum group) before 12/2022**

  **Installation @ SPARC (before 03/23)**

  **Beam Tests@ Sparc (before 09/23)**



# Beam loss monitor

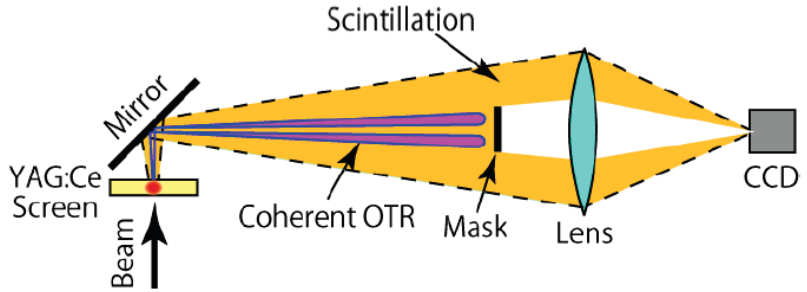
- Radiation monitors based on fibers and RADFETs installed along the beamline and the undulators have been chosen. They will be tested at TEX and SPARC LAB. The integration of the loss monitors into the protection system should be addressed at the next meeting.

It is too early to talk about integration.
There is not yet a design of the machine protection system.
Maybe in one year…

# Diagnostic into plasma chamber

- Diagnostics around the plasma source still need to be studied in more details. Layout, functionality, and requirements are certainly different than those in more standard diagnostics in the electron beamline. An example would be that coherent OTR (COTR) is hard or impossible to suppress close to the plasma chamber – when standard OTR screens are used.

We can talk about diagnostics integration once that the plasma chamber has been defined.
Yes there is no way to suppress COTR in case of using OTR screen. With other screen we can use SACLA-type optics.
the best thing is not to produce COTR.




We have plan to study Mylar with aluminum coating to shield the plasma light, if it is needed.

# Photon diagnostics in the beamlines

- The RC suggests that in a next step, all diagnostic items be addressed in more detail: from design, construction and prototyping, to realization. One should start with the key components and with those requiring a long development time. Measurements of the number of photons per pulse, of spectrum, of transverse pulse shape, including the wavefront are essential for start-up FEL operation. A specific effort needs to go into the design and production of all mirrors and focussing elements (especially the KB-optics).
- Another important point is to understand how all the diagnostics components presented could fit into the short beamline space available.
- The RC wants to point out that some important parameters, such as the monochromator transmission efficiency and general stability issues, have not yet been specified. The RC would like to hear about detailed specifications of key diagnostic elements in the next meetings.

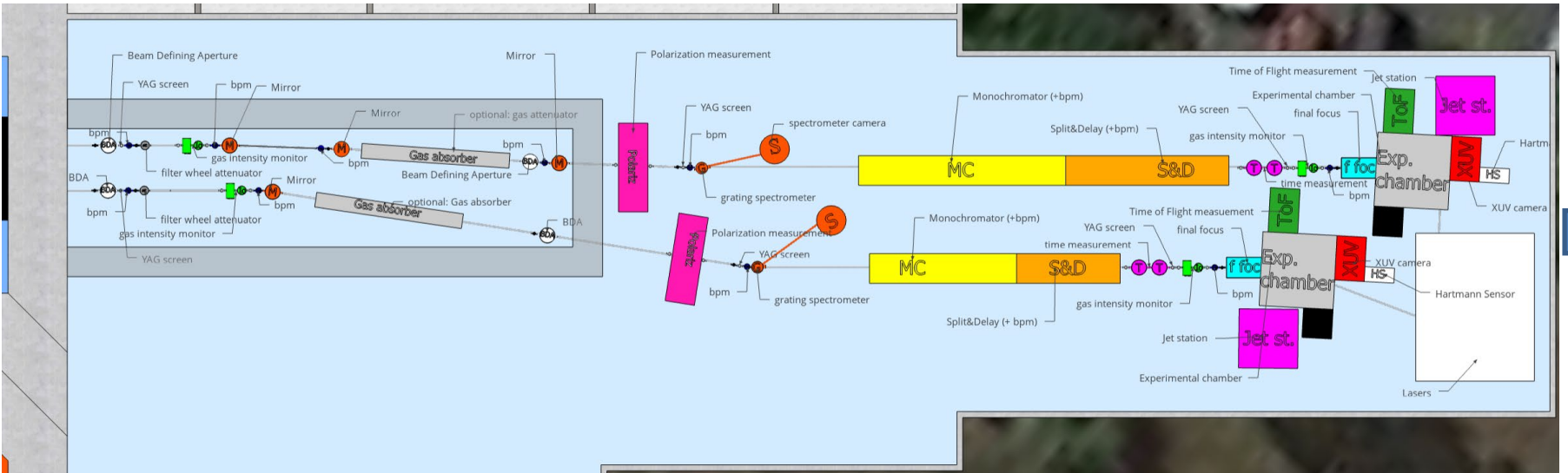
- Absolutely unfeasible and impossible with the actual manpower.
- Situation in the next slide.

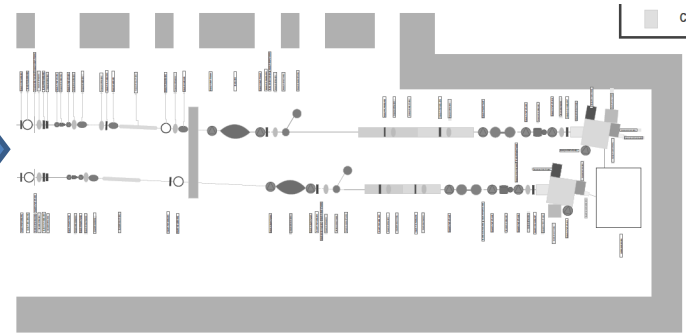
# Beamlines diagnostics (report from WP4)

- F. Villa

- Diagnostic:
  - Beam position monitors → In use @dafneluce => included the dafneluce group inside WP4
  - **Intensity monitors** → Standard instrument –> no progress
  - **Spectrometer** → Standard instrument –> no progress
  - **Transverse dimension** → Same geometry as electron screens –> no progress
  - Longitudinal dimension & time arrival → Non-standard instrument –> no progress
  - **Wavefront measurement** → Commercial instrument –> no progress
  - Polarization measurement → Non-standard instrument –> no progress
  - Coherence measurement → Standard instrument –> no progress

Most of the WA4 efforts in the last months were in team building (new members from dafne) and beamlines layout (mirrors)



# WA 10

Alessandro Cianchi
06/10/2022

## On going actions

Realization of the compact BPM stripline

Definition of photon diagnostics for the photon beamlines

## Outcome closed actions & Decisions

Test of CCD under vacuum and discharge for microemittance meter

Decision to adopt PSI-like CBPM

## To Do

Realization, test and installation of compact stripline

Design of the plasma chamber with the microemittancemeter

Discuss with PSI about cavity BPMs and related electronics

Start the test of beam loss monitor in TEX

Start to define at least 1-2 diagnostics devices for photons beamlines

# WA 10 –Diagnostics

Alessandro Cianchi
05/04/2022

## Upcoming milestones

1. 30/01/2023 BLM prototyping

2. 31/05/2023 Design of micrometer resolution diagnostics

2. 30/06/24 Preliminary Technical Design of the photon diagnostics

## Potential risks

1. Manpower overlap with other projects
2. Availability of CAD designer, implementation with plasma chamber
3. Manpower

## General Status

# Timeline

| WA.10 | DIAGNOSTICS | 106,8 w | 01/06/21 | 19/06/23 |
|---|---|---|---|---|
| WA10.0100 | e-beam diagnostics design | 10 mons | 03/12/21 | 09/09/22 |
| WA10.0101 | High precision charge measurements | 6 mons | 03/12/21 | 20/05/22 |
| WA10.0200 | Compact diag. chamber design | 12 mons | 01/06/21 | 03/05/22 |
| WA10.0201 | Compact diag.chamber prototyping | 10 mons | 03/05/22 | 07/02/23 |
| WA10.0300 | BPM design | 8 mons | 01/09/21 | 13/04/22 |
| WA10.0301 | BPM prototyping | 6 mons | 13/04/22 | 28/09/22 |
| WA10.0400 | BLM design | 8 mons | 03/01/22 | 15/08/22 |
| WA10.0401 | BLM prototyping | 6 mons | 15/08/22 | 30/01/23 |
| WA10.0501 | ML data taking test | 6 mons | 02/01/23 | 19/06/23 |
| WA10.0601 | CCD Test in vacuum & under discharge | 3 mons | 10/10/22 | 30/12/22 |
| WA10.0701 | Design of micrometer resolution diagnostics | 5 mons | 12/01/23 | 31/05/23 |
| M10.1 | Diagnostic prototyping validation | 0 w | 24/04/23 | 24/04/23 |
| M10.2 | Final e-beam diagnostic design | 0 w | 09/10/23 | 09/10/23 |
| M10.3 | ML data taking final design | 0 w | 06/11/23 | 06/11/23 |

- It is worth mentioning that there are many other WAs that can impact on diagnostics, for instance machine layout, quadrupole development, plasma chamber and so on...
- From the point of view of diagnostics right now we are on schedule, but at some point we need to have integration and sooner is better.