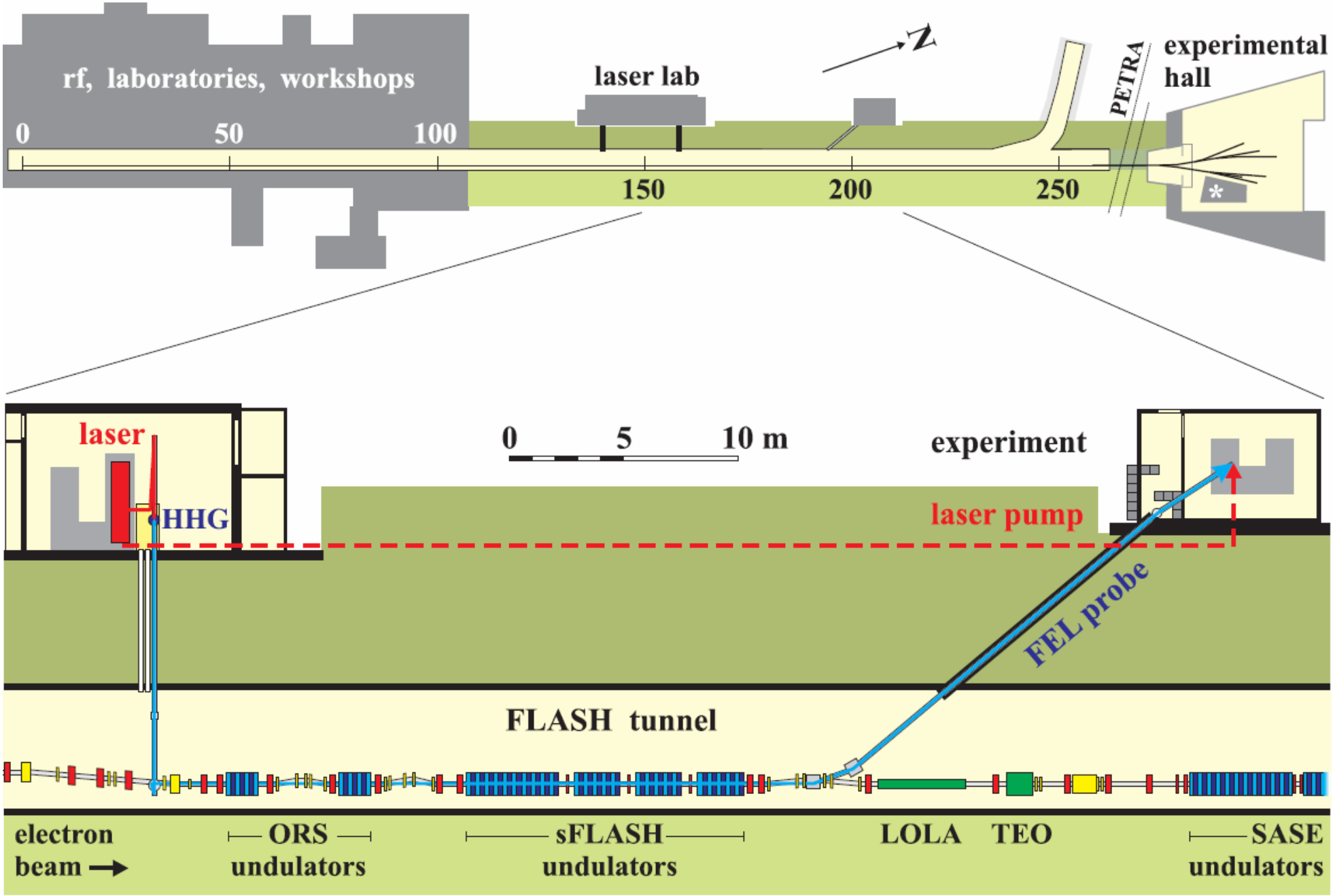
sFLASH status and commissioning plans

V. Miltchev on behalf of the sFLASH team

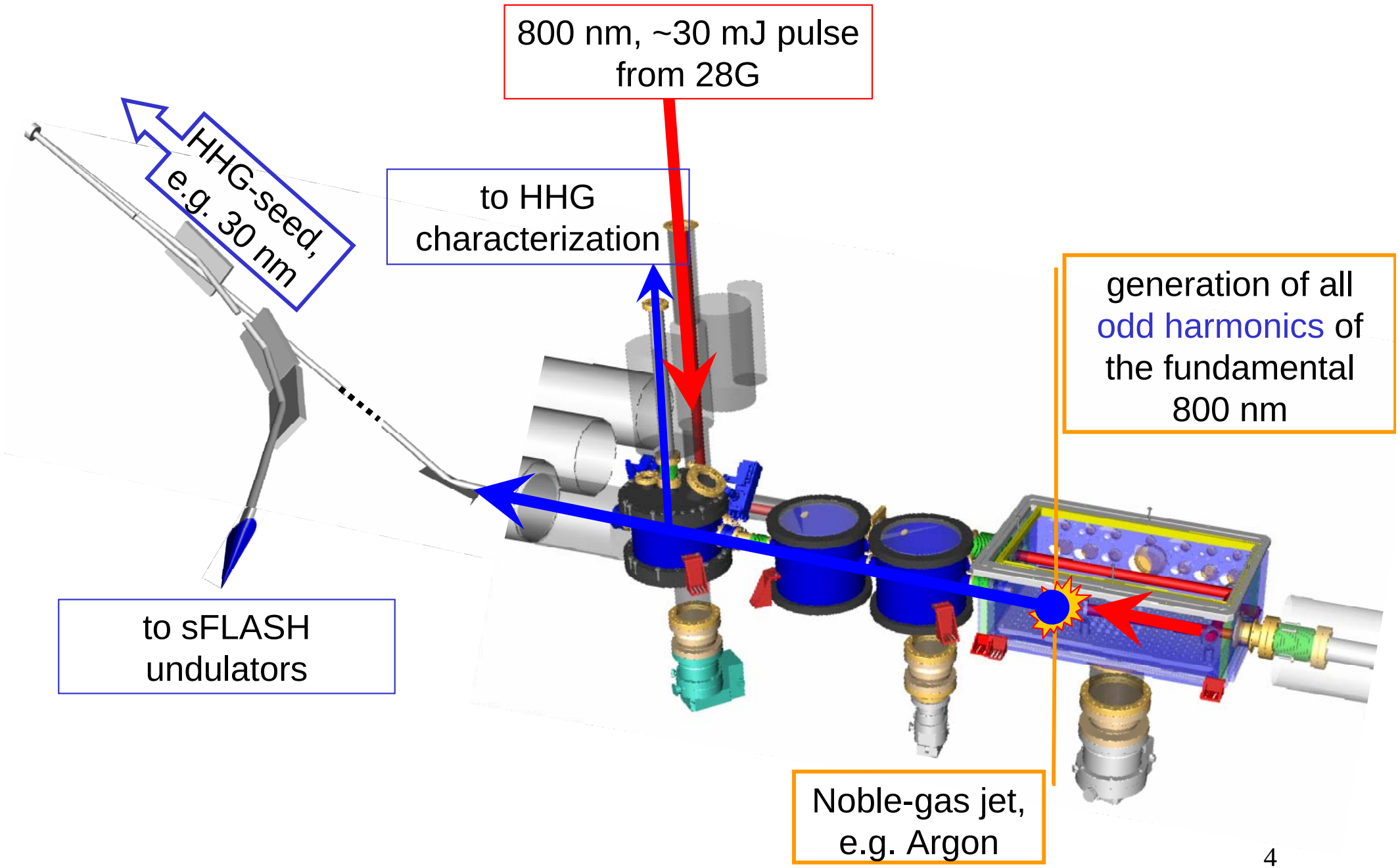
Outline

1. Overview
2. Installation status
3. Commissioning tasks
4. Beam parameter requirements
5. Outlook

sFLASH schematic set up

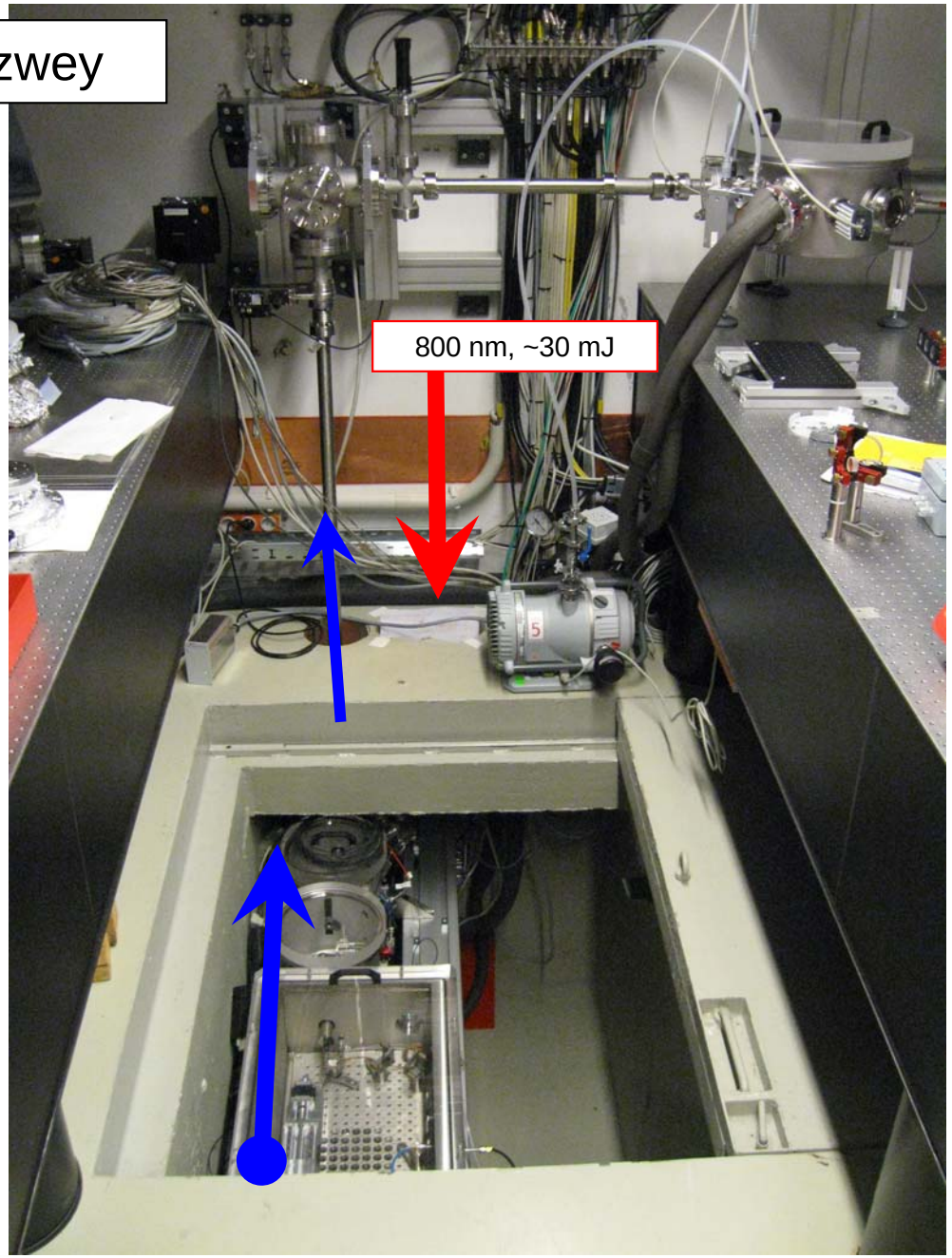


HHG source

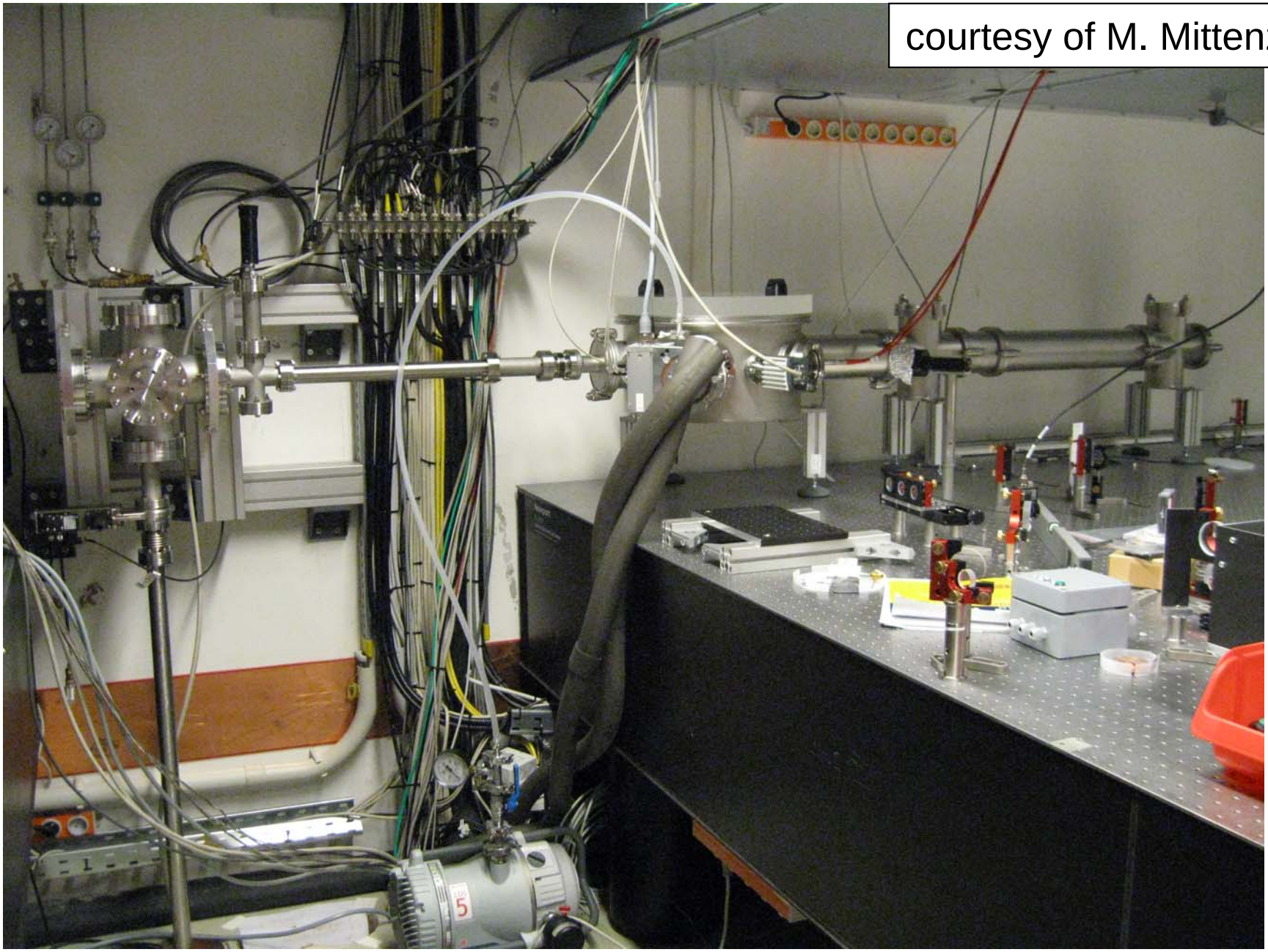

800 nm, ~30 mJ pulse from 28G
HHG-seed, e.g. 30 nm
to HHG characterization
generation of all odd harmonics of the fundamental 800 nm
to sFLASH undulators
Noble-gas jet, e.g. Argon

HHG source

courtesy of M. Mittenzwey

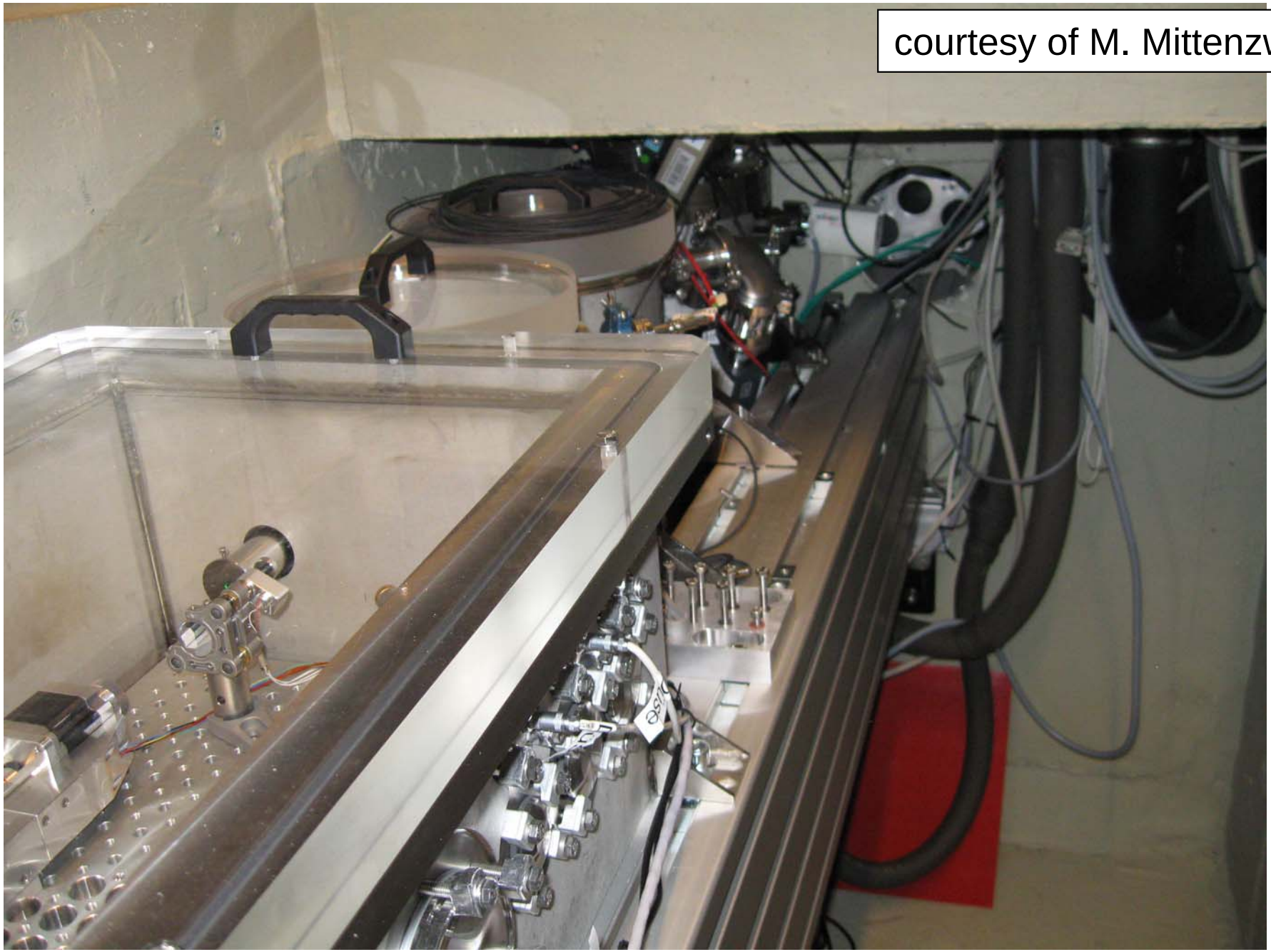


HHG source



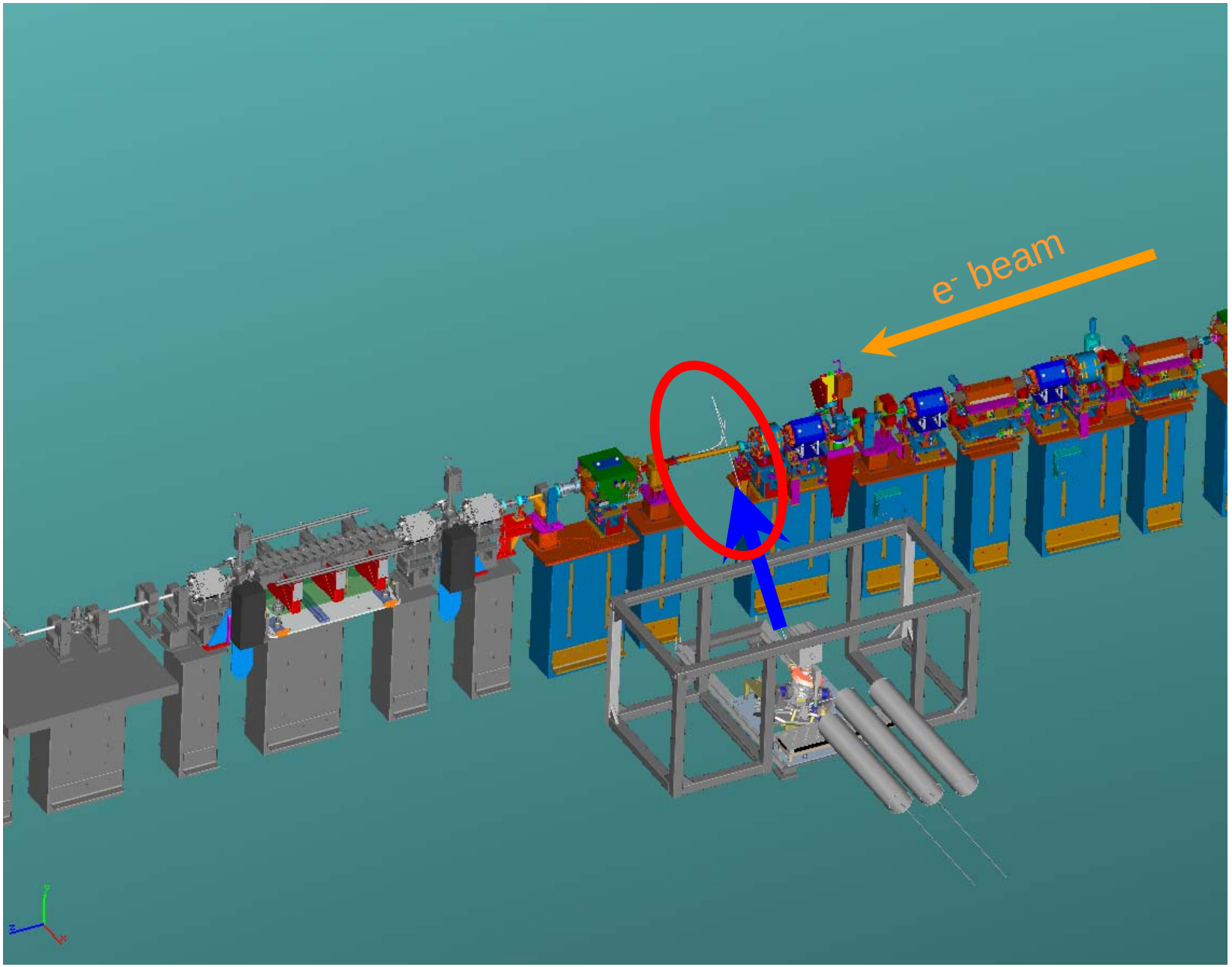
courtesy of M. Mittenzwey

HHG source

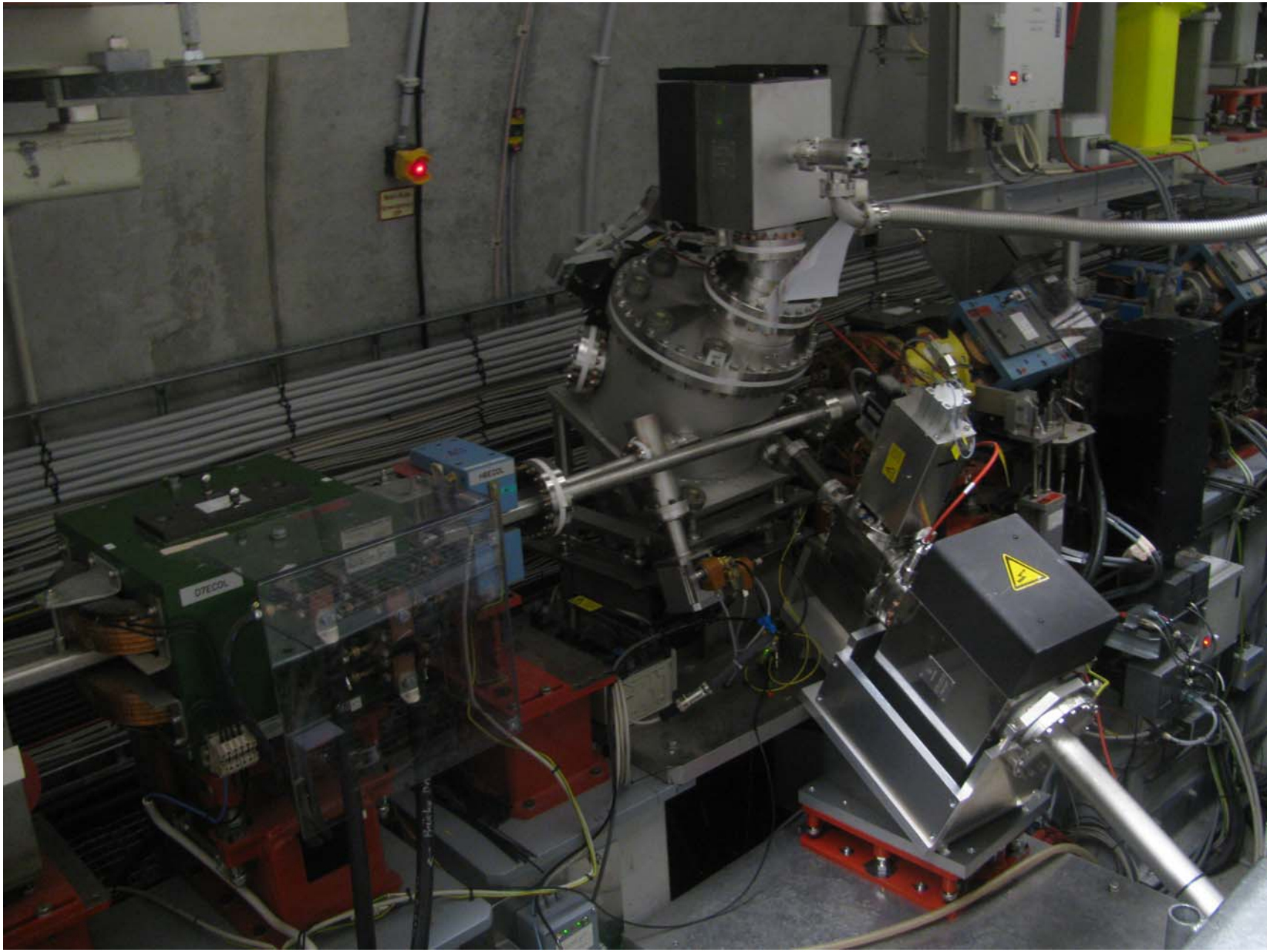


courtesy of M. Mittenzwey

XUV-seed in-coupling



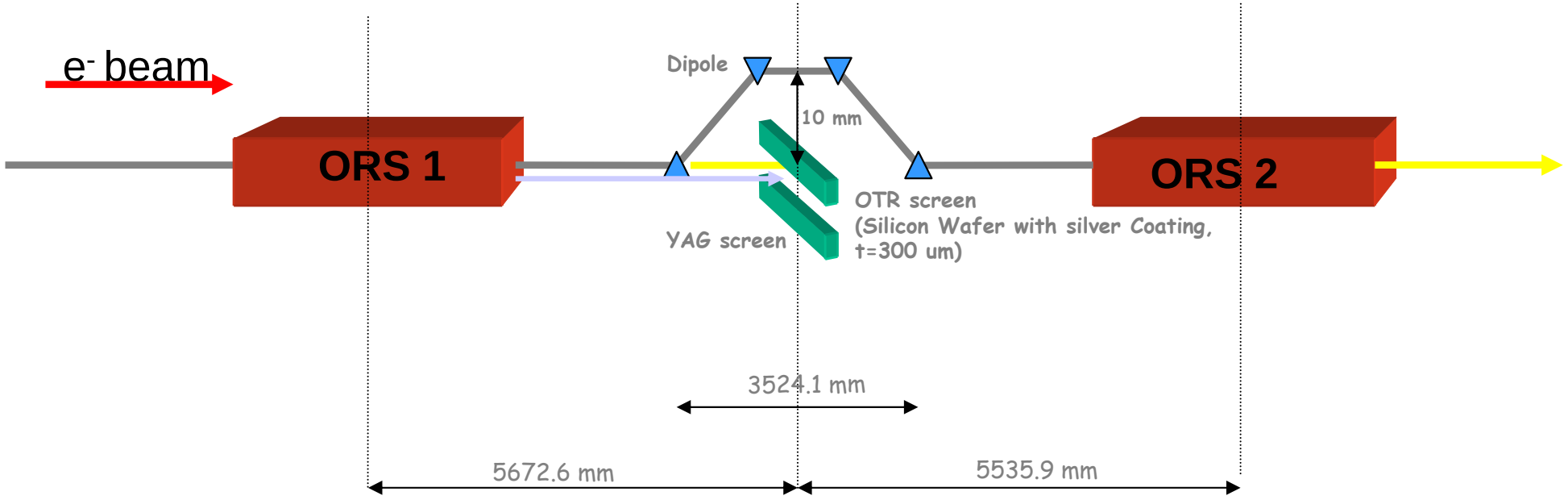
XUV-seed in-coupling



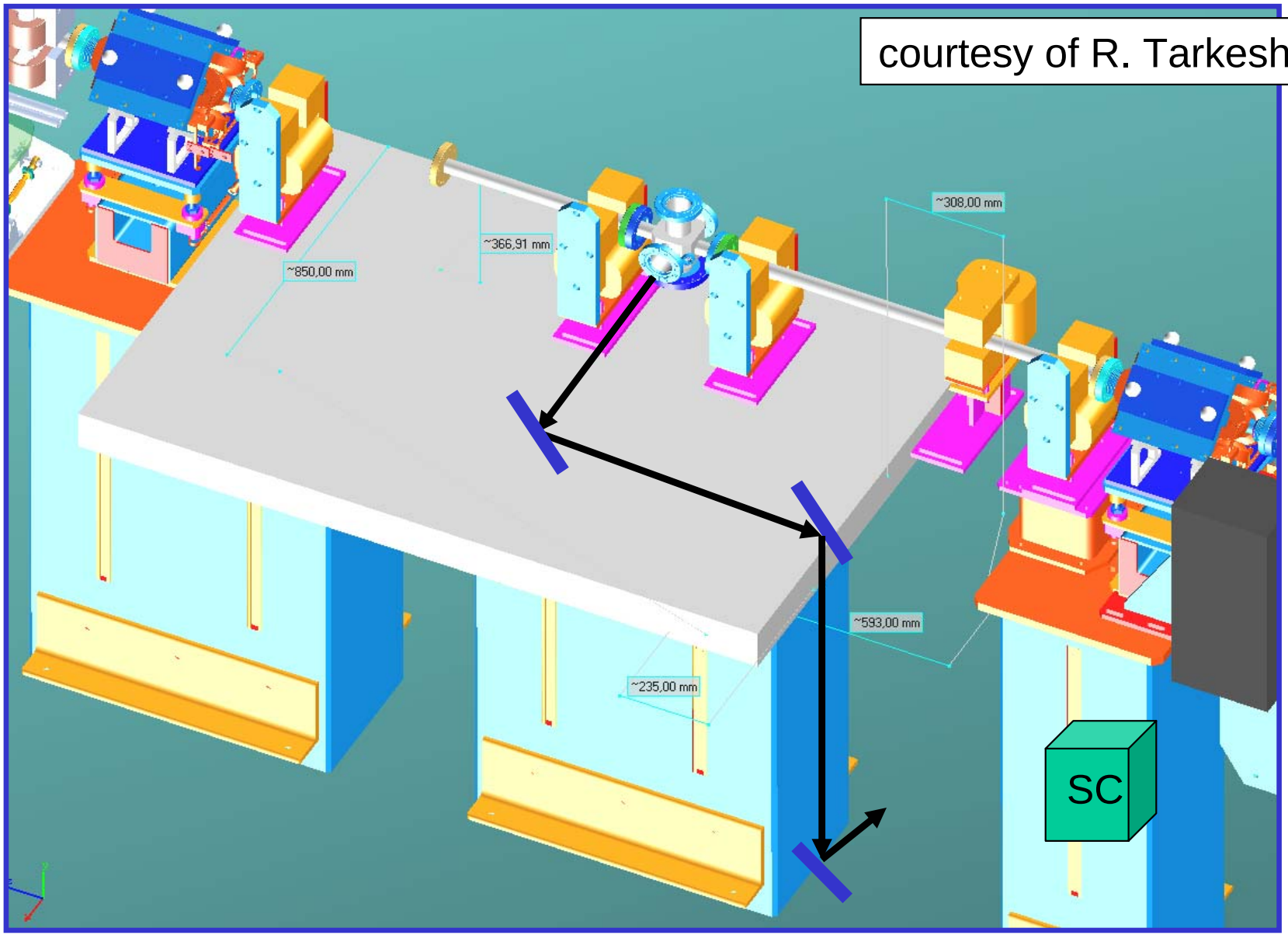
Concept for finding the temporal overlap

- Use fraction of the light emitted by ORS 1 and the 800nm drive laser
- Measure the time difference using a streak camera located in the tunnel

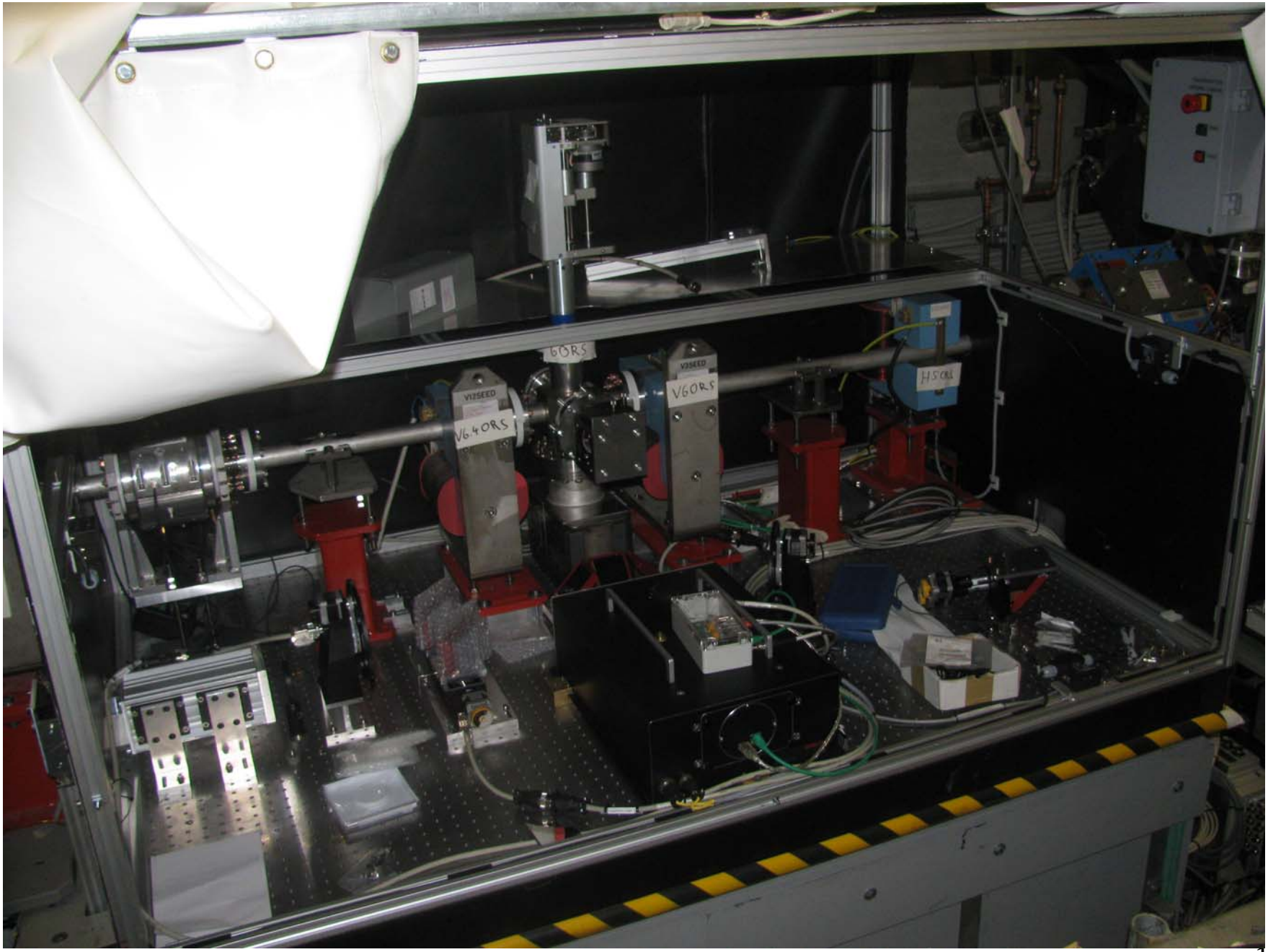
courtesy of R. Tarkeshian



Concept for finding the temporal overlap

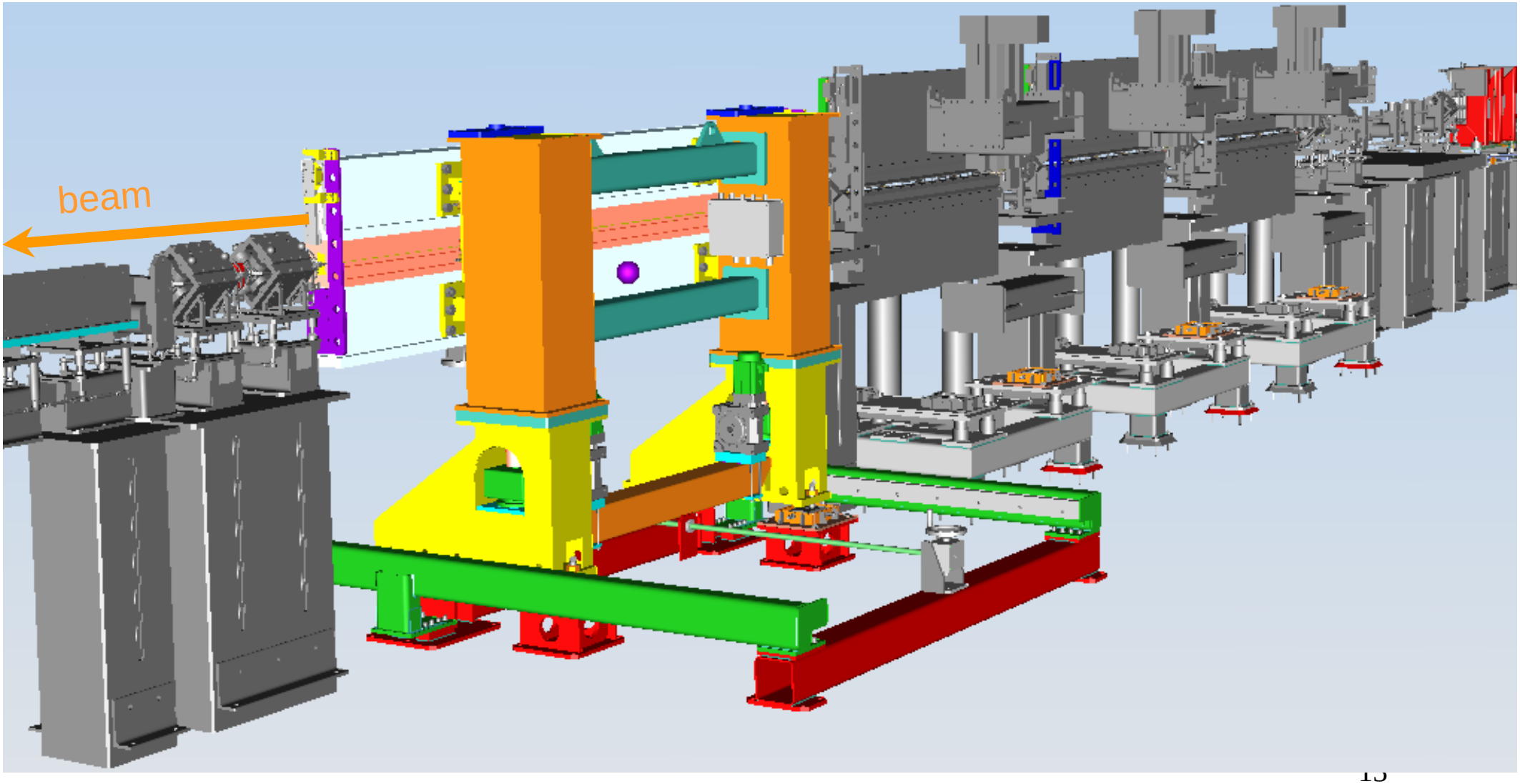


Concept for finding the temporal overlap



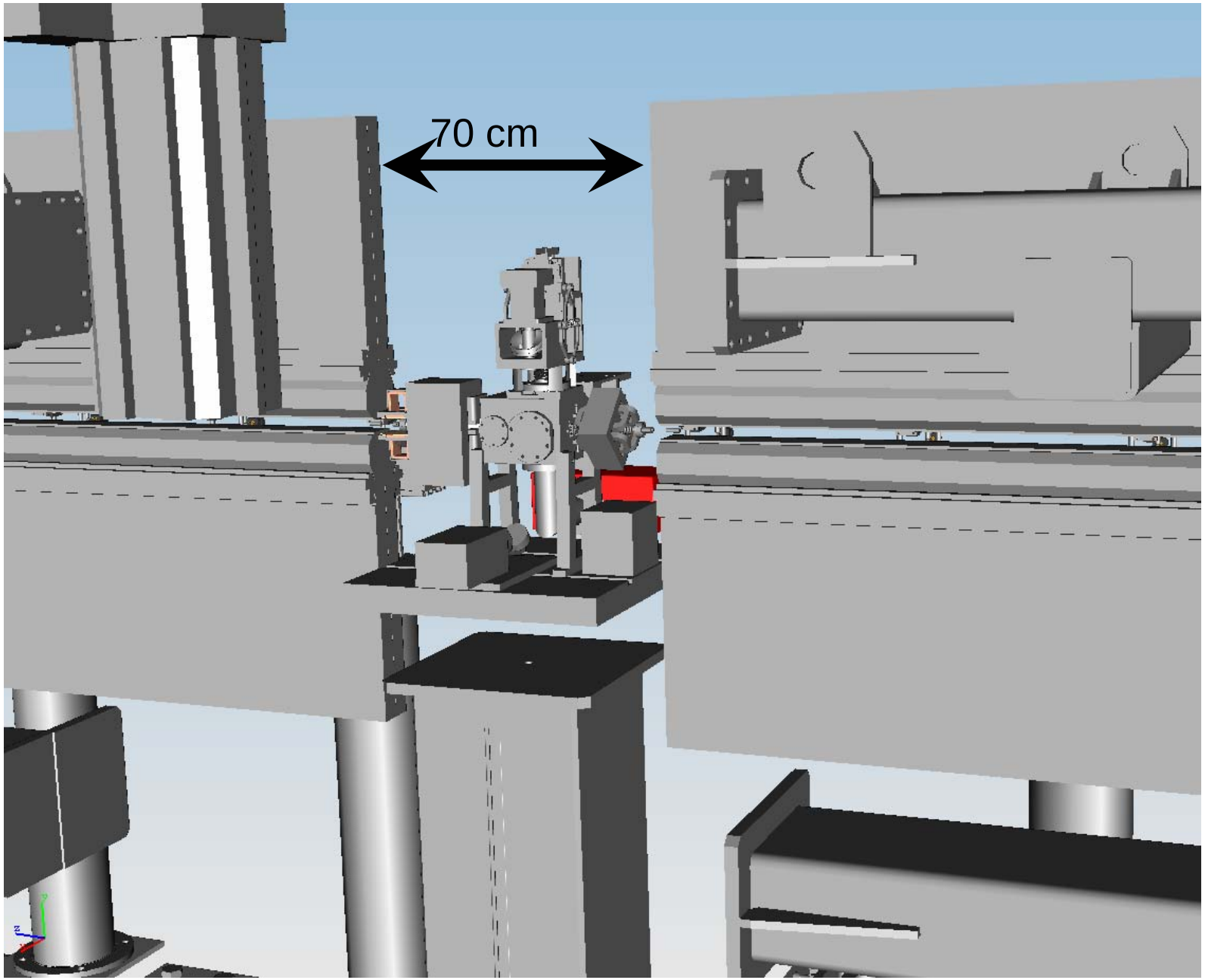
Seeding section

- Four planar variable-gap undulators of 10m total length with period of 31.4mm and 33mm.
- Transverse focussing, accomplished by quadrupoles placed in undulator intersections
- Diagnostics using wire scanners, OTR stations and Ce:YAG screens and BPMs assembled in a common diagnostic block, usable for both electron beam and HHG radiation

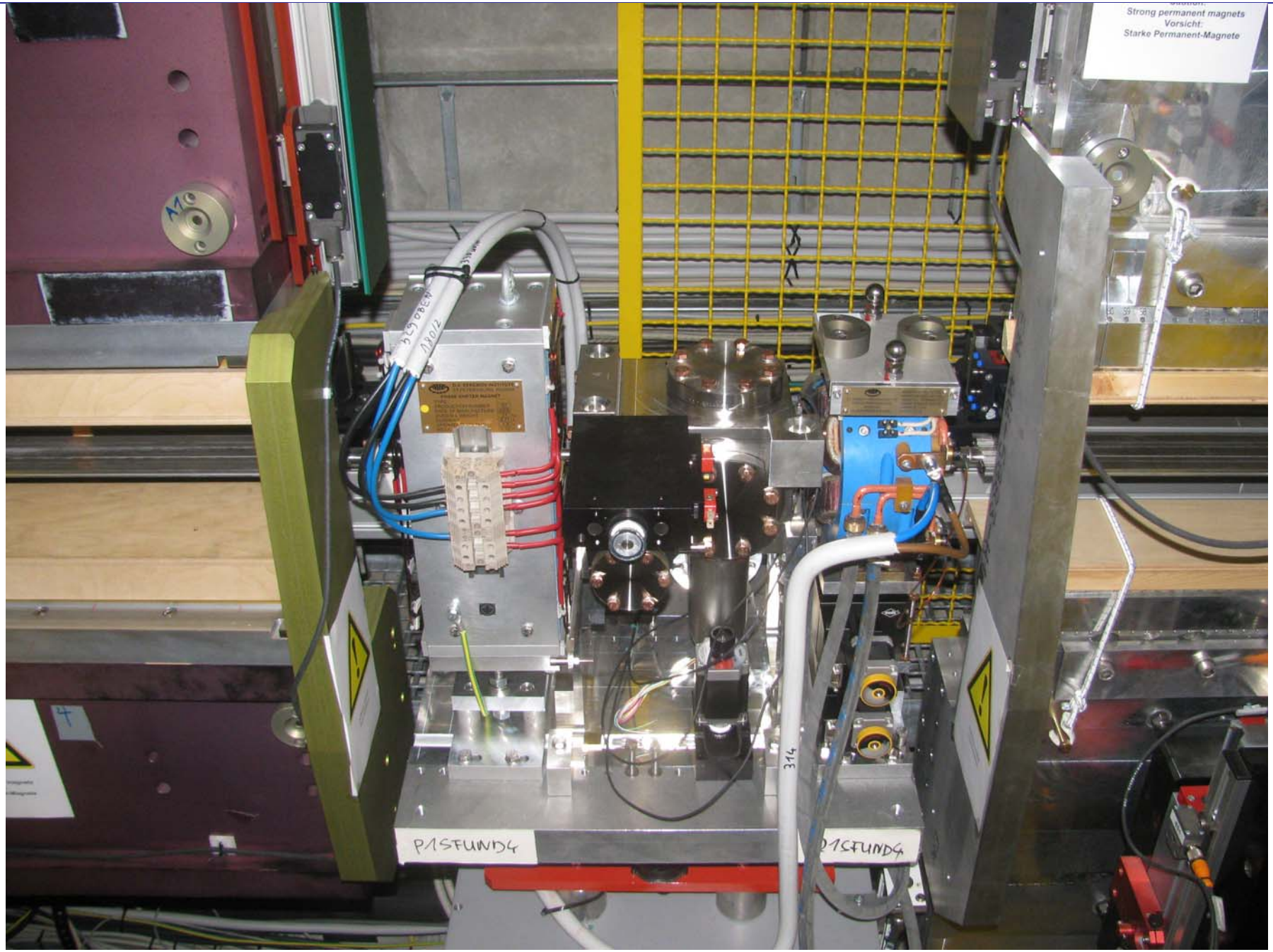


Seeding section

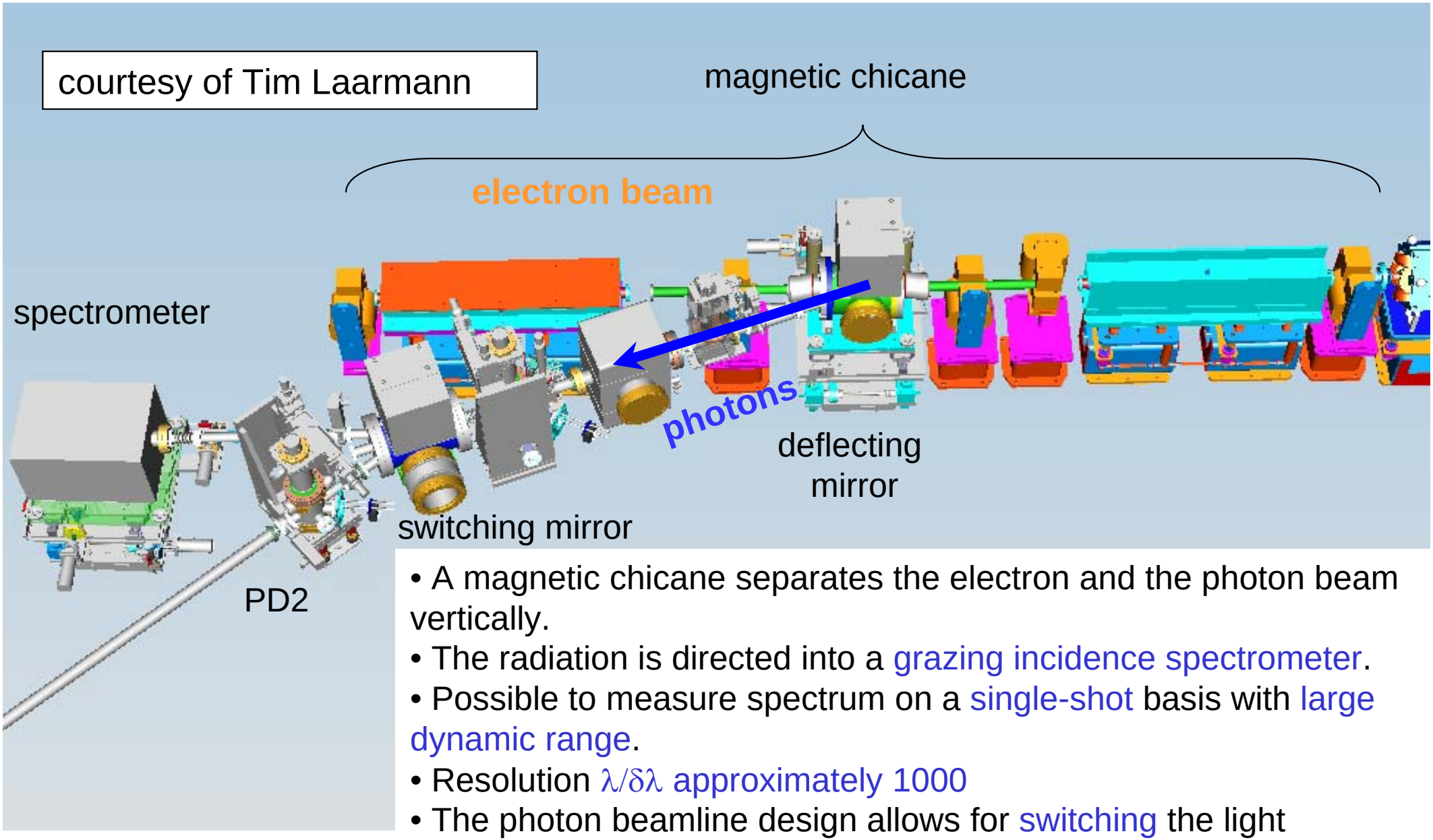
Undulator intersection



Undulator intersection

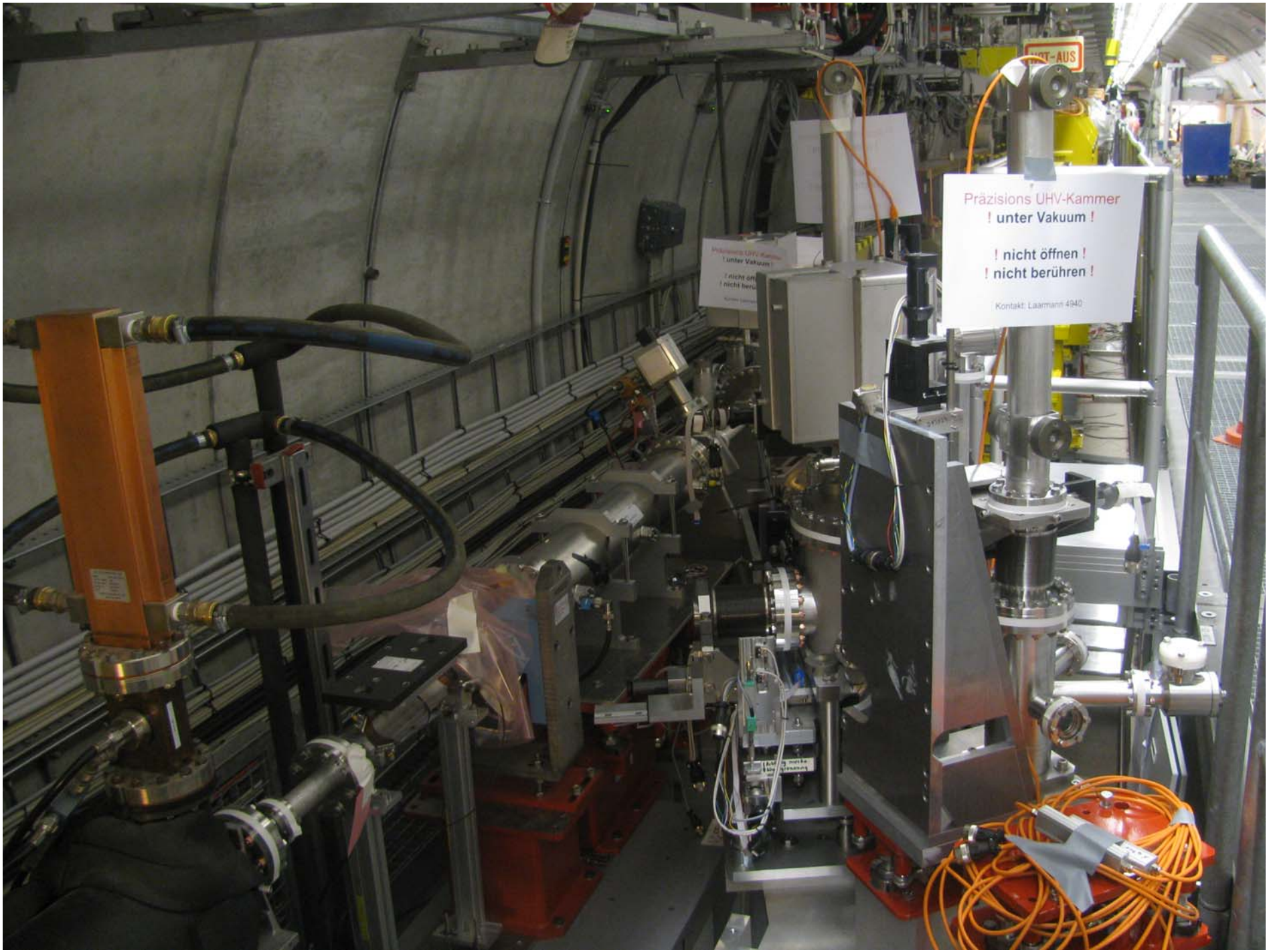


Layout of the sFLASH photon beamline



- A magnetic chicane separates the electron and the photon beam vertically.
- The radiation is directed into a grazing incidence spectrometer.
- Possible to measure spectrum on a single-shot basis with large dynamic range.
- Resolution $\lambda/\delta\lambda$ approximately 1000
- The photon beamline design allows for switching the light between the spectrometer branch and the experimental hutch

Layout of the sFLASH photon beamline



Commissioning tasks

HHG transport and overlap with HHG seed

Goal: Transport the XUV seed laser from 28g to the sFLASH FEL diagnostics. Controlling the beam orbit and writing FF tables for the steering mirror for a given initial state (J. Boedewadt).

Requirements:

- Tunnel closed, IL set
- electron beam not needed

Maybe end of March or beginning of April.

Spectral diagnostics in tunnel with HHG seed

Goal: Measurement of the HHG source with the spectrometer installed in the diagnostic branch. Cross-check with 28g spectrometer (F. Curbis)

Requirements:

- Tunnel closed, IL set
- electron beam not needed

Maybe end of March or beginning of April.

Longitudinal overlap set up

Goal: Measure, control longitudinal offset between HHG seed and el. beam (R. Tarkeshian)

Requirements:

- need el. beam, compression not relevant, any energy
- eventually up to 30 bunches
- Need to switch ON Veronica + ORS-chicane
- quazi-Parasitic
- Streak camera, IR laser

Electron optics set-up

Goal: Preparation of a procedure to compensate the gap-dependent change in the focusing of sFLASH undulators. Prepare SR files compatible with both SASE and sFLASH operation (V. Miltchev)

Requirements:

- 1 x 1 nC, ACC39 ON
- Not Parasitic
- need all OTR + BPM down to SASE UND

Extraction of FF table for undulator air coils

Goal: Make sFLASH undulators as parasitic IDs to the FLASH operation. For this purpose feed-forward tables for the setting of undulator air-coils have to be extracted with electron beam (Hossein Hashemi)

Requirements:

- sFLASH optics set, 0.2-0.5 nC, 700 MeV & 800 MeV
- Not Parasitic
- need all OTR + BPM down to SASE UND

Spectral diagnostics in tunnel with spontaneous undulator radiation

Goal:

Characterization of the spontaneous radiation from sFLASH undulators with the spectrometer and the intensity monitor.

Measurement of the K-value of each undulator (F. Curbis)

Requirements:

- on-crest operation
- different energies

Overlap of seed with beam

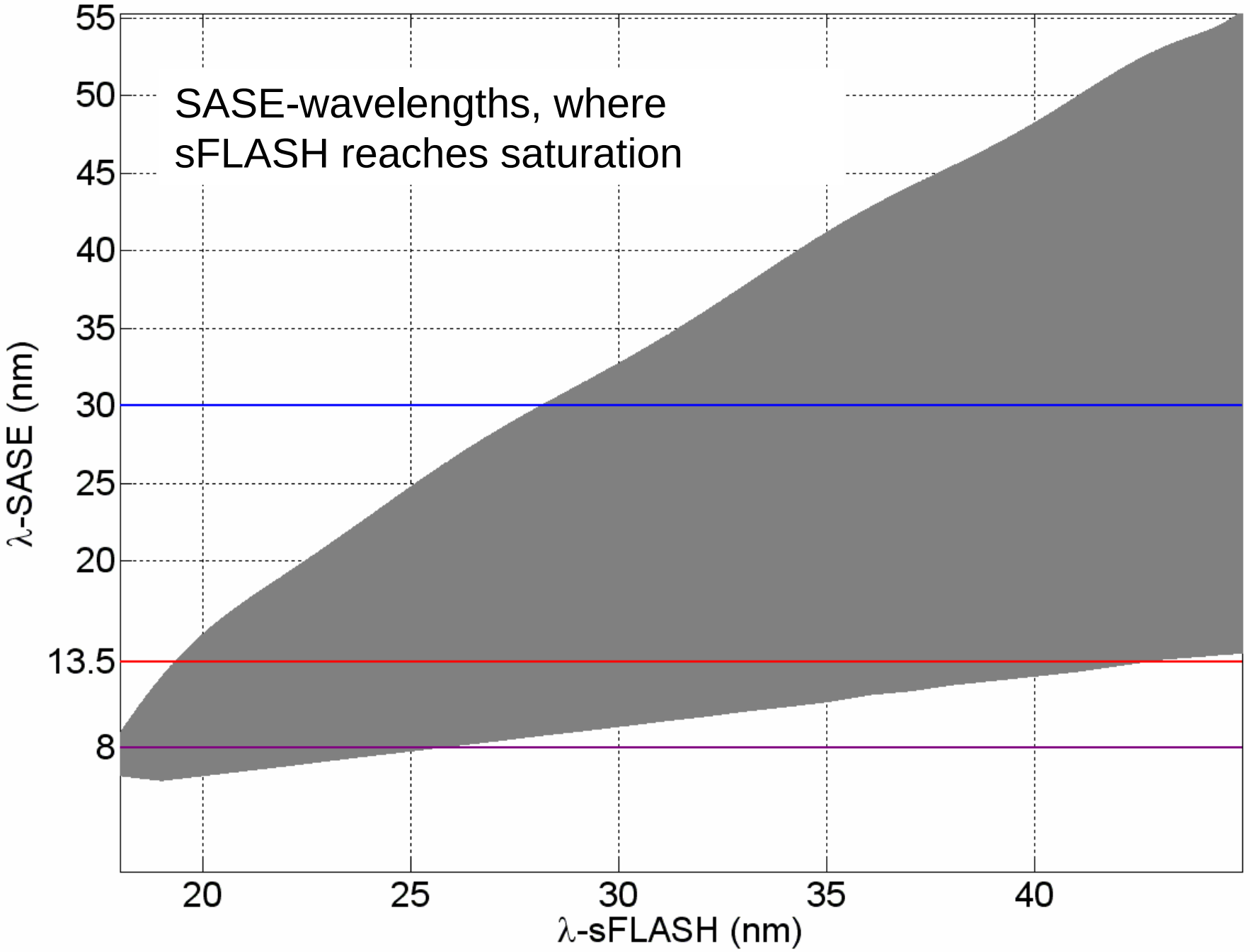
Goal:

Demonstrate stable transverse and temporal overlap of HHG seed with electron beam. Test of complete HHG-seed transport system and electron beam orbit control

Requirements:

- 1x1 nC @ 850 MeV
- Not parasitic
- bunch length ~500 fs FWHM, availability of transverse diagnostics along sFLASH beamline, availability of HHG-seed, LOLA
- sFLASH electron optics

Beam requirements



General requirements

- Transverse emittance <= 3 μm, uniform along the bunch
- Peak current >= 1kA, bunch length ~600 fs FWHM
- Slice energy spread <= 0.4 MeV
- Energy chirp <= 0.1MeV/μm
- Nominal conditions: I=1.5 kA, ε=2μm, ΔE=0.2 MeV
- Possible difficulties due to:
  - small emittance in the unseeded part => worse contrast
  - energy chirp => output energy fluctuations
  - nonuniform current profile

Summary and outlook

- sFLASH XUV-seed source: installation in the pit under 28G complete.
- Seed in-coupling beamline installed. Preliminary adjustment done.
- Longitudinal overlap measurement system installed and aligned.
- Undulators installed, aligned and commissioned.
- Electron beam diagnostics* and magnets installed.
- Both mirror chambers in the XUV-out coupling beamline installed.

Summary and outlook

Work to be done in the next shutdown-weeks

- Installation of sFLASH-spectrometer in tunnel.
- Installation of IR-drive laser beamline in 28G.
- Mounting of the XUV-focusing mirror in the in-coupling beamline.
- Mounting of MCPs in undulator intersections.
- Commissioning of motors.
- sFLASH vacuum, laser IL tests -> required for HHG in tunnel
- (s)FLASH magnets commissioning.
- First HHG-photons in tunnel (~ beginning of April)