PAUL SCHERRER INSTITUT

A. Trisorio (LNO) - on behalf of the Gun Laser Team

Overview and perspectives for the SwissFEL gun and seed lasers

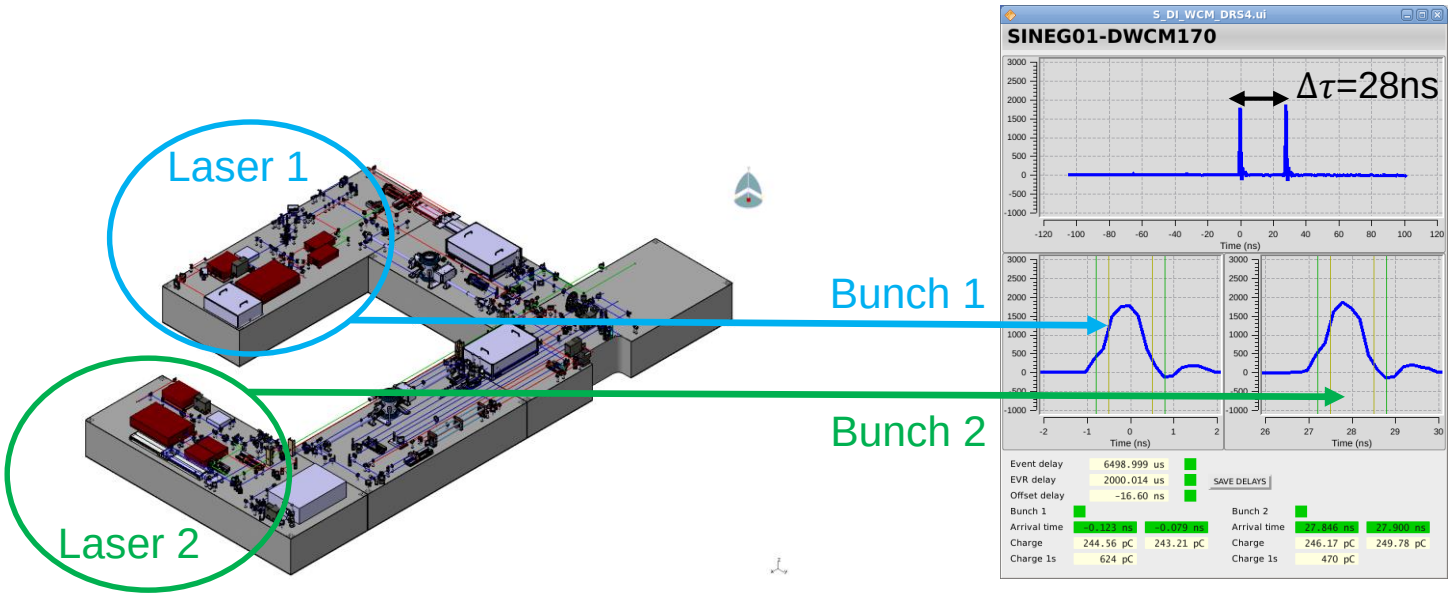
3rd SwissFEL Performance Workshop

January 27th - 2021

Outline

- Photocathode drive lasers
- Athos seed laser
- Upcoming challenges
- Conclusion

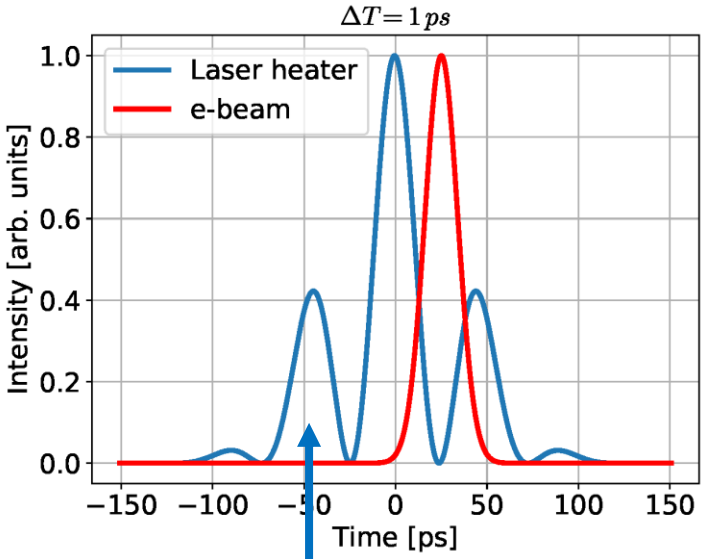
Photocathode drive lasers status

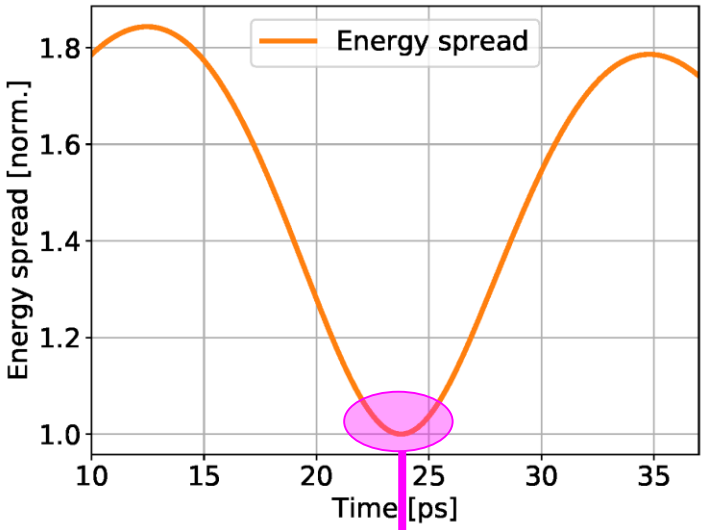


- Laser 2 commissioned for UV – 200pC
- Procedure to setup the 2 bunches at the gun – Collab. RF, Operation and Laser Groups
- Overall, 19h of down time due to laser-related components failure in 2020
- To be finished in 2021:
  - UV stretcher
  - LH
  - High resolution, time resolved energy diagnostic
- Multiple diagnostics and feedbacks are in place: charge, pointing, transverse profile and precise timing….and we work on improving them !

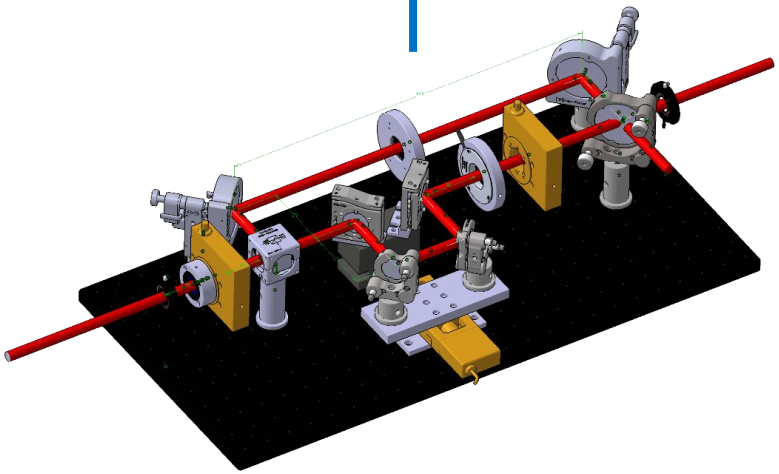
Laser Heater Shaping

Ready for commissioning with e- beam in 2021





Unspoiled beam

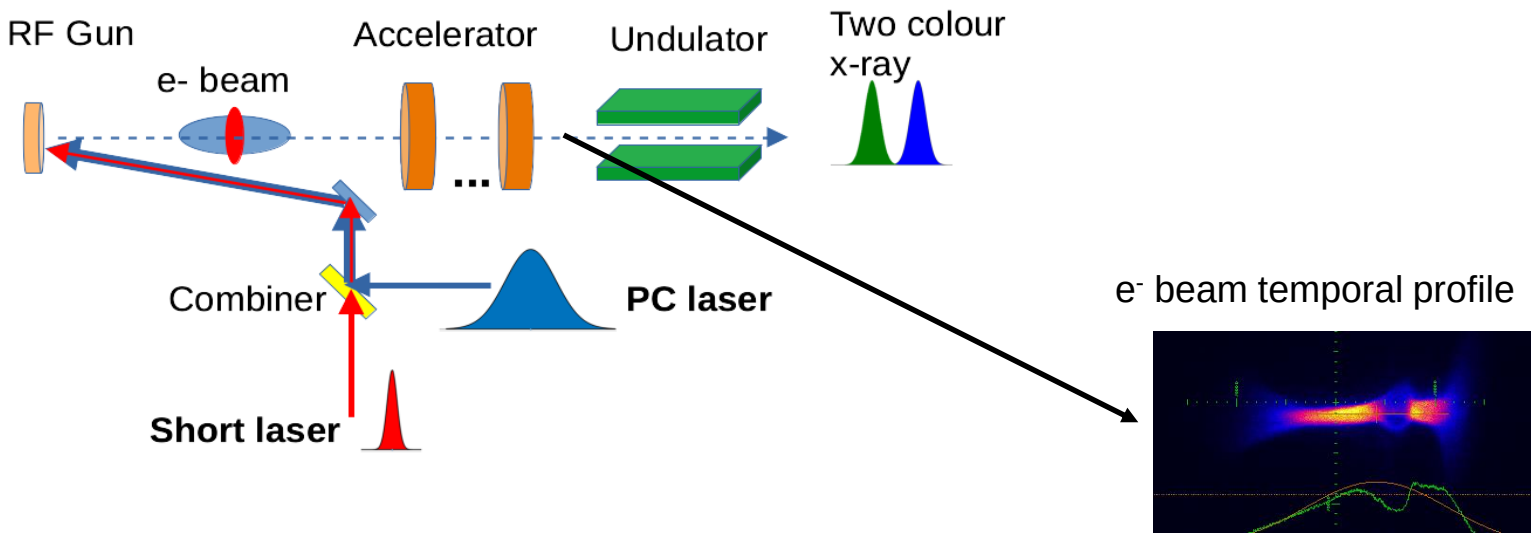


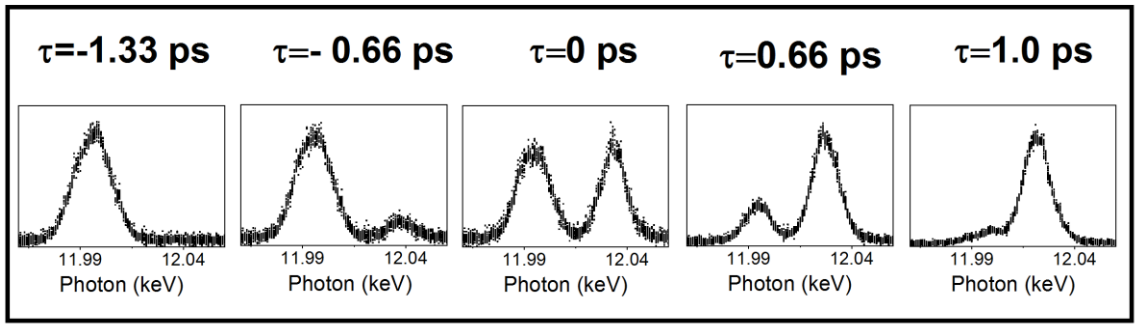
Two color FEL using 2 gun lasers

Overlapping temporally two laser pulses on the cathode

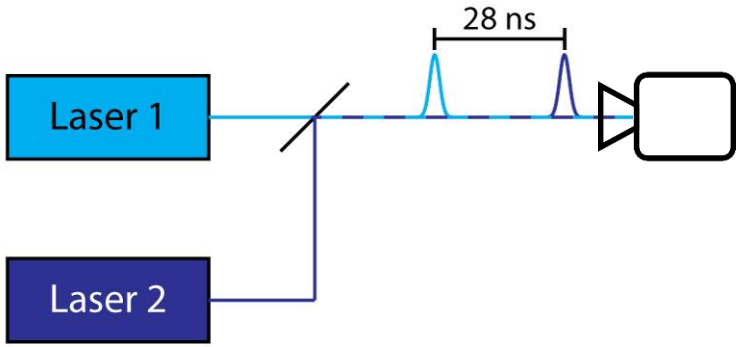
Part of the e^- emittance is spoiled at the gun due to space charge: only part with low emittance will lase

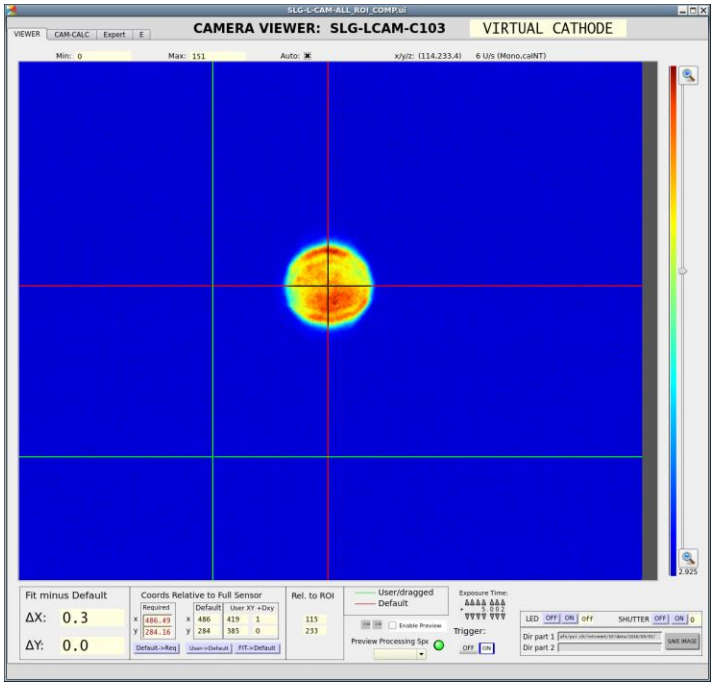
Energy chirp of the e^- beam leads to two colors





Gated-UV beam profile diagnostic
Motivation

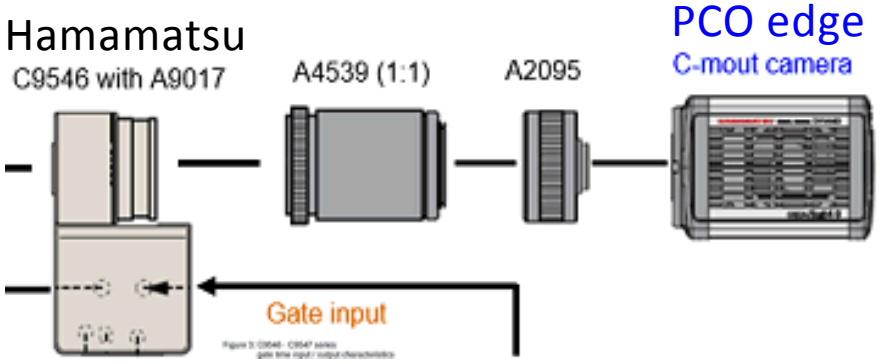


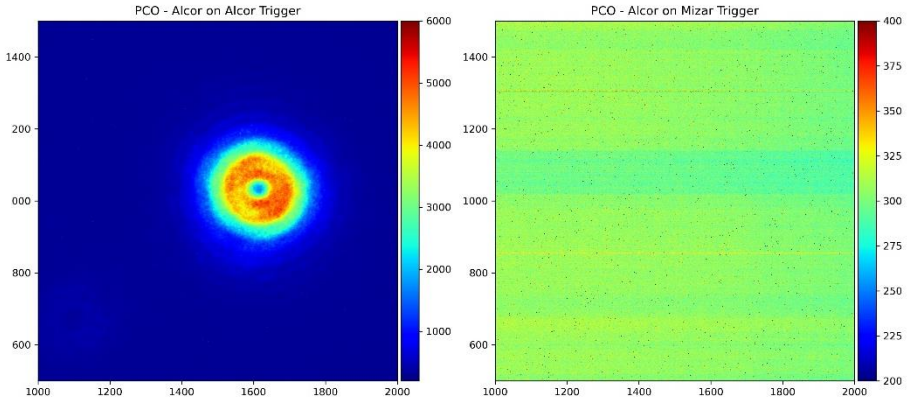


Requirements:

- Laser parameters:
  260 nm, 3 - 7 ps FWHM, 100 Hz, >30 nJ
- <u>Polarization independent (stacking)</u>
- Spatially and spectrally identical
- Temporal separation of 28 ns

Gated-UV beam profile diagnostic
Performance & Cost





Device feature:

- Online UV beam profile for both lasers at the photocathode <u>for arbitrary polarization states of the lasers (pulse stacking)</u>
- BS data acquisition up to 50 Hz possible
- No background from the other pulse

TOTAL cost estimated ≈ 73 kCHF (incl. cam server)

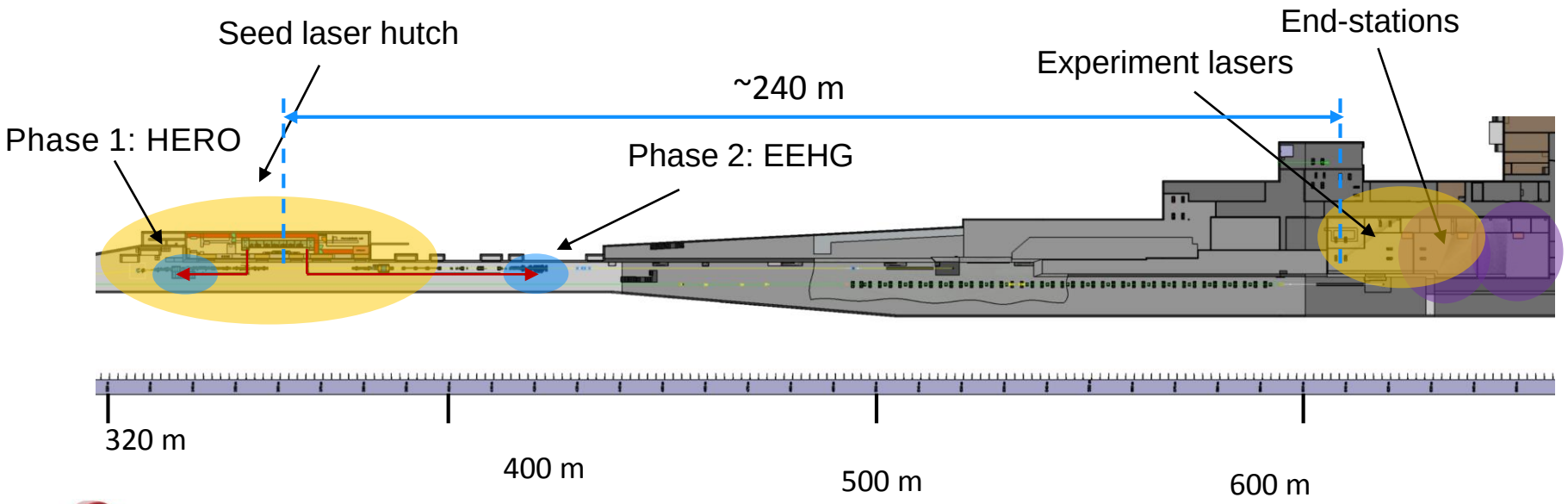
Alternative possible solution (not compatible with stacking)≈ 65kCHF (incl. cam server)

Open questions:

- Does the SwissFEL operation benefits justify the cost?
- How do we finance that investment?

Soft X-ray seeding at ATHOS

Laser based seeding of the Athos soft X-ray line is envisioned-> coherent soft X-ray



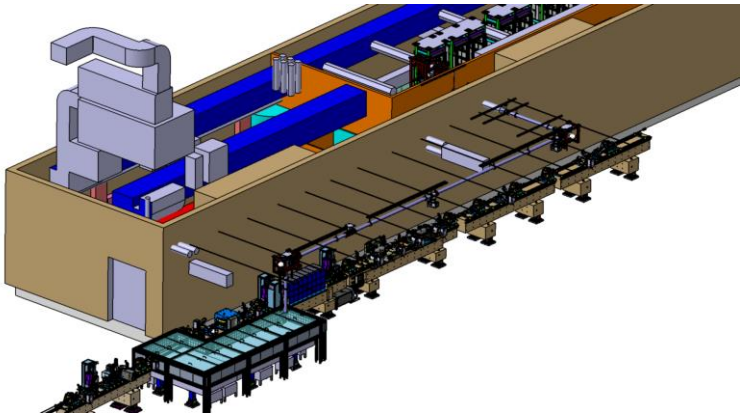
Milestones Phase 1-HERO:

- **Laser Laboratory ready for installation of the laser: end of August 2021**
- **Laser setup commissioned for 1st test of slicing by end of June 2022**

Milestones Phase2-EEHG:

- **Laser setup commissioned for 1st test of EEHG by end of April 2023**

Soft X-ray seeding at ATHOS: Installation status



A/C and optical tables installed

New laser oscillator in house

Upcoming challenges
Gun Lasers

- In principle Aramis and Athos can run in parallel from the laser point of view
- Limitation: Mizar only available with 200pC Gaussian pulse

- Maintenance of the laser systems onsite by PSI personnel: transfer of knowledge necessary from the company
- Necessity to purchase a third laser system as complete spare

- Minimum frequency of service days: once every 2 months to guarantee operation
- Organization of the shutdown may be reviewed as:
  - Part1: Maintenance/Upgrade infrastructure systems, facility tests, PSYS, MPS
  - Part2: Maintenance main operative systems (T&S,RF, lasers…)
  - Part3: Machine startup

- For the gun lasers, we will commit to be able to deliver beam up to 72h after having an up and running infrastructure (A/C, IT, Controls, Camera systems, Timing System…)

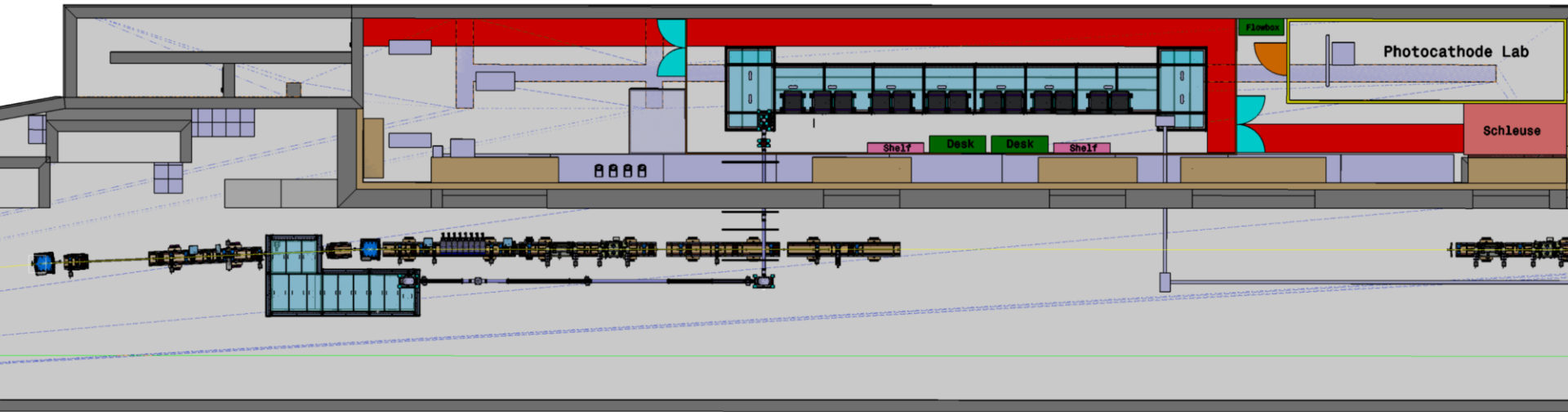
Upcoming challenges
Gun Lasers Operation - Seed laser installation - R&D

- The gun laser upgrades will be restricted to absolutely necessary ones
- Manpower limited during shutdowns: priorities must be assigned to the gun
- Athos seeding is an experiment by itself, also the laser is an experimental laser: may require more frequent adjustment than the photocathode lasers
- A realistic planning of the seed laser installation, commissioning and R&D is necessary if we do not risk the gun lasers maintenance and be compatible with SwissFEL operation
- Agile due to Covid

Conclusion

- Most of the 2020 goals have been achieved: Mizar commissioning, LH shaping Alcor, improvement in laser amplitude and arrival time stability…
- Active contribution in future exotic SwissFEL operation modes and advanced diagnostics
- Athos seeding will be the main challenge for 2021 on…

- Agile project management: installation/operation/R&D:
  - Deal with limited installation time
  - Efficient use of available manpower / manpower limitations
  - Covid limitations
- Rethink shutdown plan/structure



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Thanks for your attention