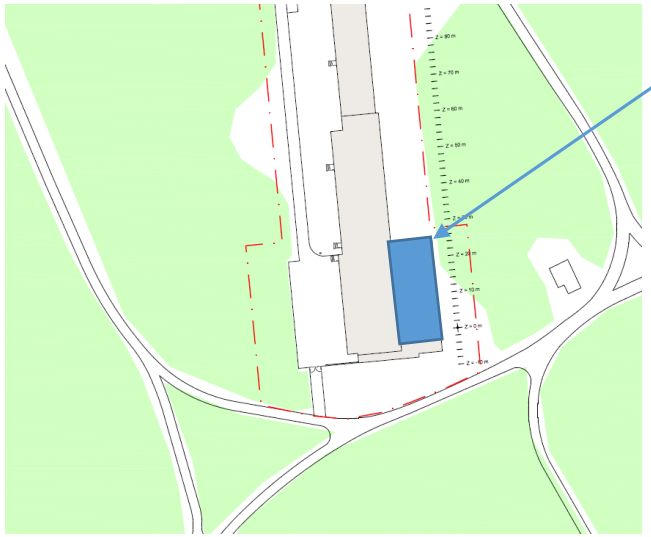
Concepts for Porthos & D'Artagnan gun lasers

Porthos machine working group - 22/09/2020

A. Trisorio, on behalf of the gun laser group

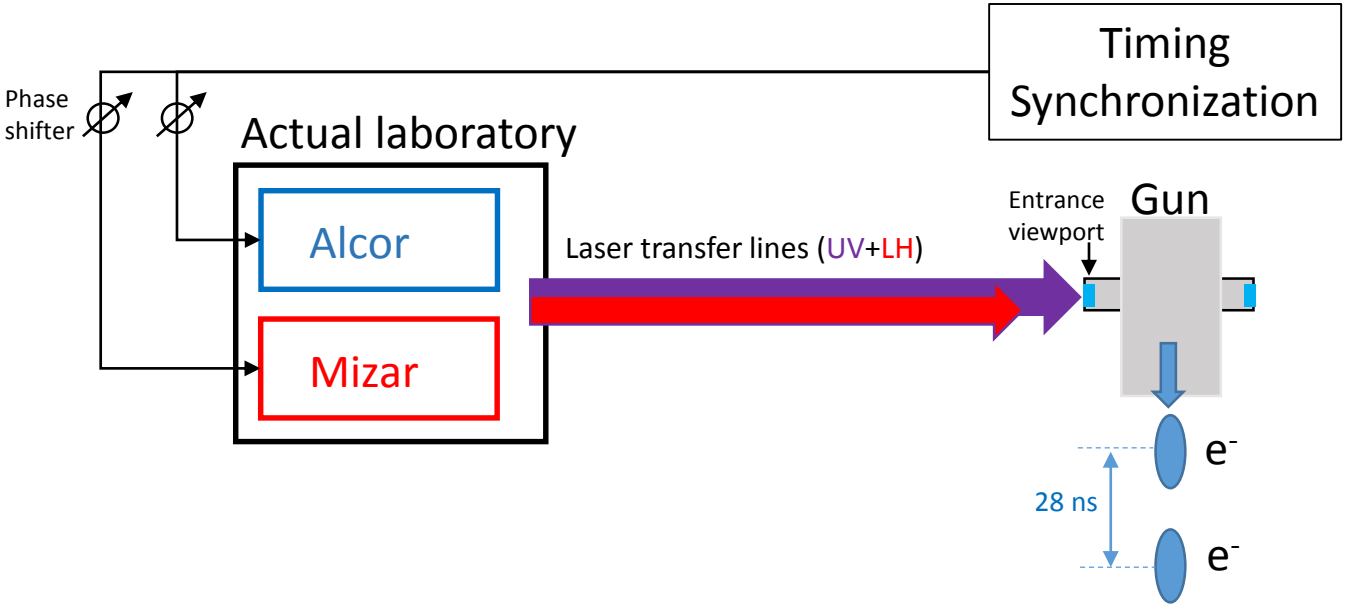
Concept 1: baseline solution

SwissFEL overview



Actual gun laser lab. + T&S + technical gallery and A/C

Concept 1: baseline solution



- We use the actual gun lasers and optical setup
- Gun laser 1 seeds 1 FEL line (Aramis) / 1-100Hz RR
- Gun laser 2 seeds 2 FEL lines (Athos/Porthos) / RR must be defined

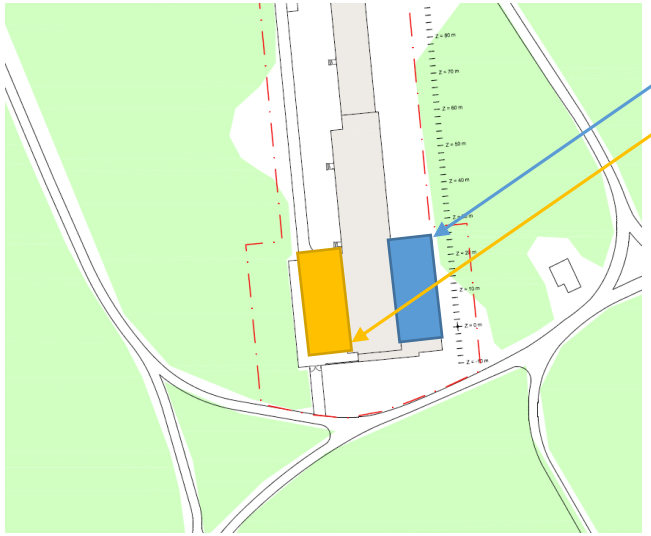
- We do not modify the optical setup / purchase HW
- No impact on RF / T&S
- No machine downtime
- Very limited additional costs

On the FEL lines seeded by gun laser 2:

- The laser parameters (duration, size…) must be identical
- The e- kicker must allow the RR chosen machine
- DRPS / MPS / DosFET / charge integral alarms will lower the RR of FEL lines simultaneously
- Maximum machine rate of 50Hz

Concept 2: advanced solution

SwissFEL overview

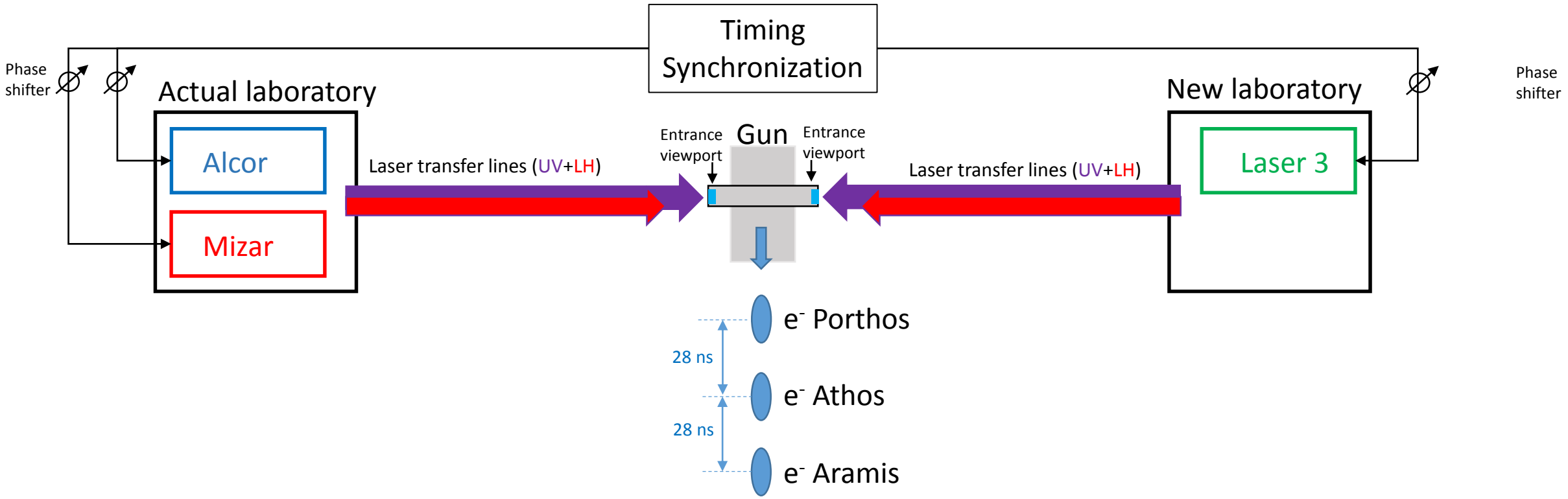


Actual gun laser lab. + Laser transfer lines (UV +LH) + T&S + technical gallery and A/C

Build a new gun laser lab. + Laser transfer lines (UV +LH) + technical gallery and A/C

<u>This concept allows to fulfill the gun laser requirements for Porthos and D'Artagnan</u>

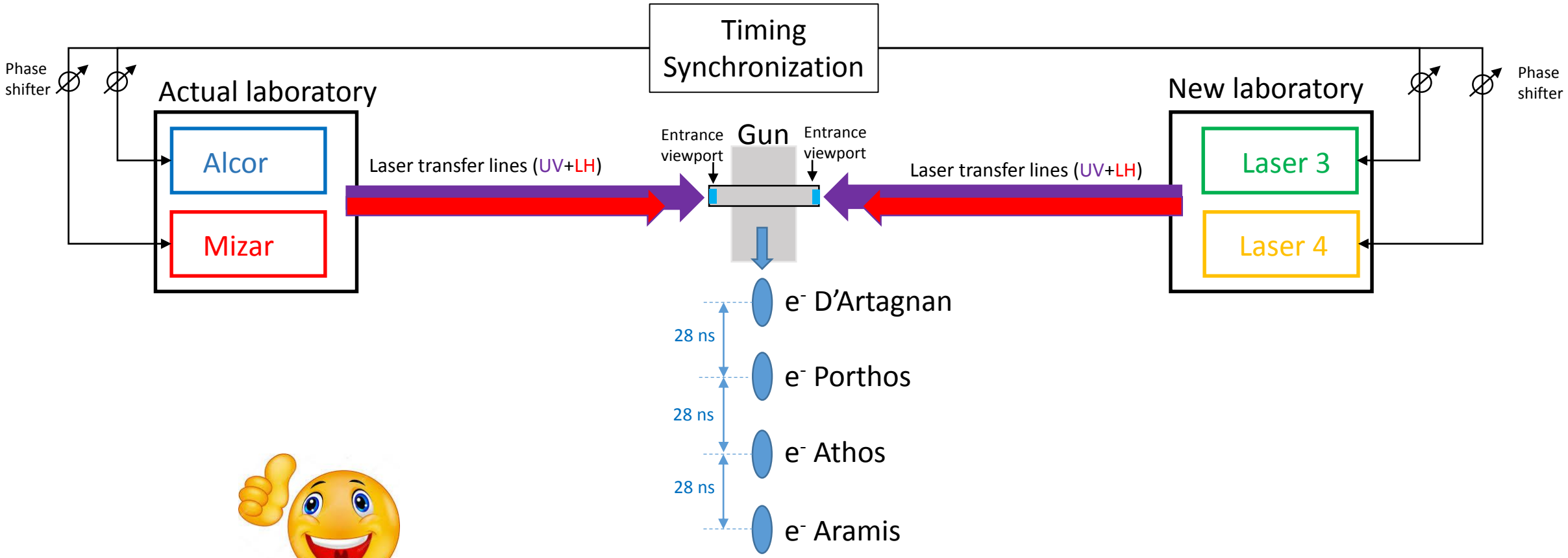
Concept 2: advanced solution



- Independent lasers systems and feedbacks scheme for each FEL line
- Duplication and upgrade of our actual proven concept
- We are sure we can reach the required level of laser stability for a stable operation of the machine
- Compatible with existing T&S scheme

- Build a new laboratory and infrastructure:
  - Total Costs ≈ 5 M CHF
  - Good planning of the work to minimize machine downtime
- Sub-ps, UV laser arrival time monitor is a challenging project: not sur it's achievable

Concept 2 expended to D'Artagnan



Technical reasons why we need independent lasers

- Performance:
  - Fine tuning of the FEL lines requires independent fine tuning of laser size and temporal pulse duration
  - Using a single amplifier to deliver 2 laser pulses is not an option: mode competition btw the pulses-> energy instability + not possible to switch OFF the 2nd pulse
  - Premature aging of some of critical UV components
  - Behavior of common feedbacks with >2 laser pulses: how to discriminate?
  - Efficiency of the laser transport in the UV will be strongly decreased->issue with extracting the charge

  Will lead to unstable injector operation and drastically lower the available UV energy on cathode: stable FEL operation won't be achieved !

- Space: no space available to install more laser amplifiers on the optical tables of the existing gun laser lab.

Global comparison

Concept	Independent Laser parameters[1]	Precise delay of 28ns[2] btw pulses	FEL line rate[3]	Downtime for installation	Upgradable for D'Artagnan	Behavior with respect to machine alarms	Cost CHF approx.
Baseline	partial	yes	Aramis: 1-100Hz Athos and Porthos: x-50Hz	no	no	correlated	<100 k.
Advanced	yes	yes	Aramis: 1-100Hz Athos and Porthos: 1-100Hz	yes	yes[4]	independent	5 M.

1: pulse energy, duration, temporal shape and size on the cathode
2: with sub-300 ps accuracy based on fast PD + scope
3: Depends on kicker capabilities
4: depends on RF + kicker capabilities