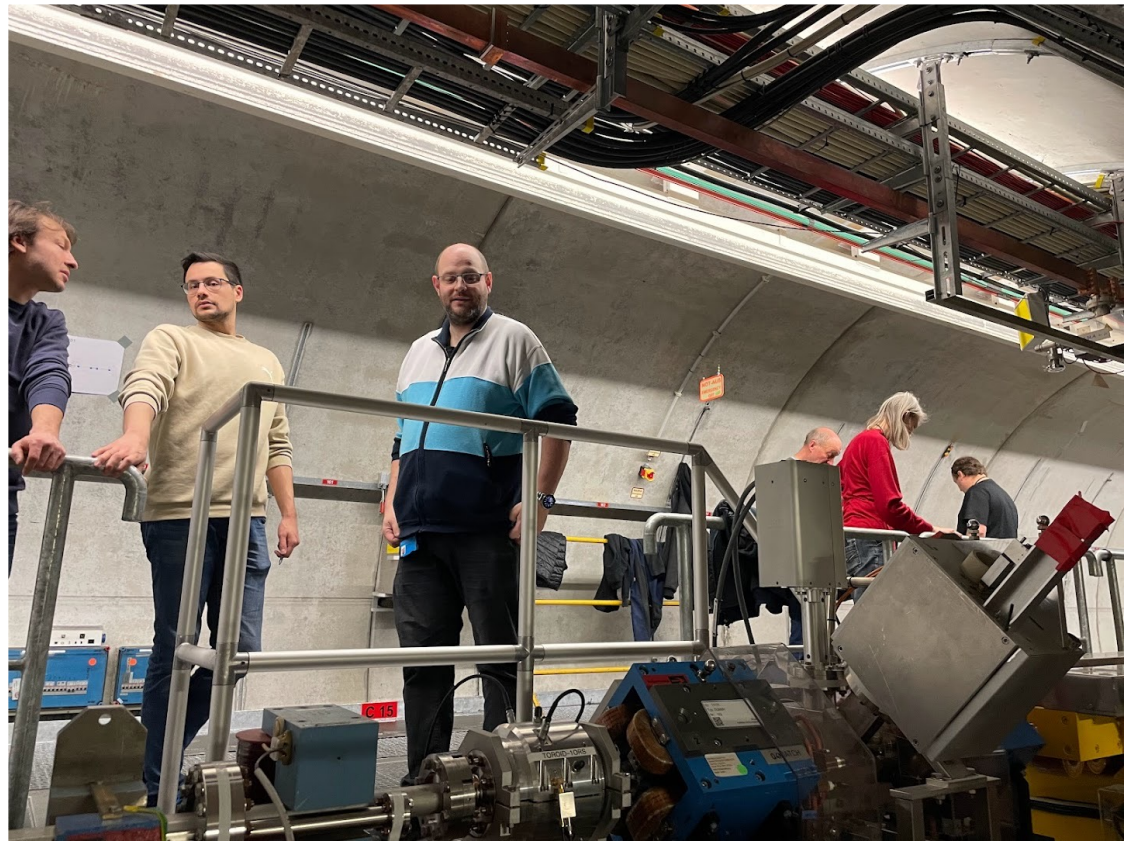
# Seed Laser And Transport.

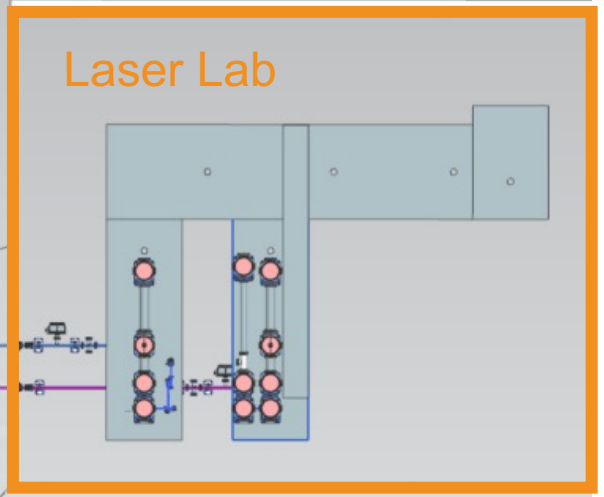



FS-LA
Laser Science and Technology

DESY.

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

# Seed Laser And Transport.



# Seed Laser And Transport.

# Seed Laser And Transport.

Extraction

Laser Lab

Tunnel

# Seed Laser And Transport.

Extraction

Seed 1

Laser Lab

Tunnel

# Seed Laser And Transport.

Laser Lab

Extraction

Seed 1

Seed 2

Tunnel

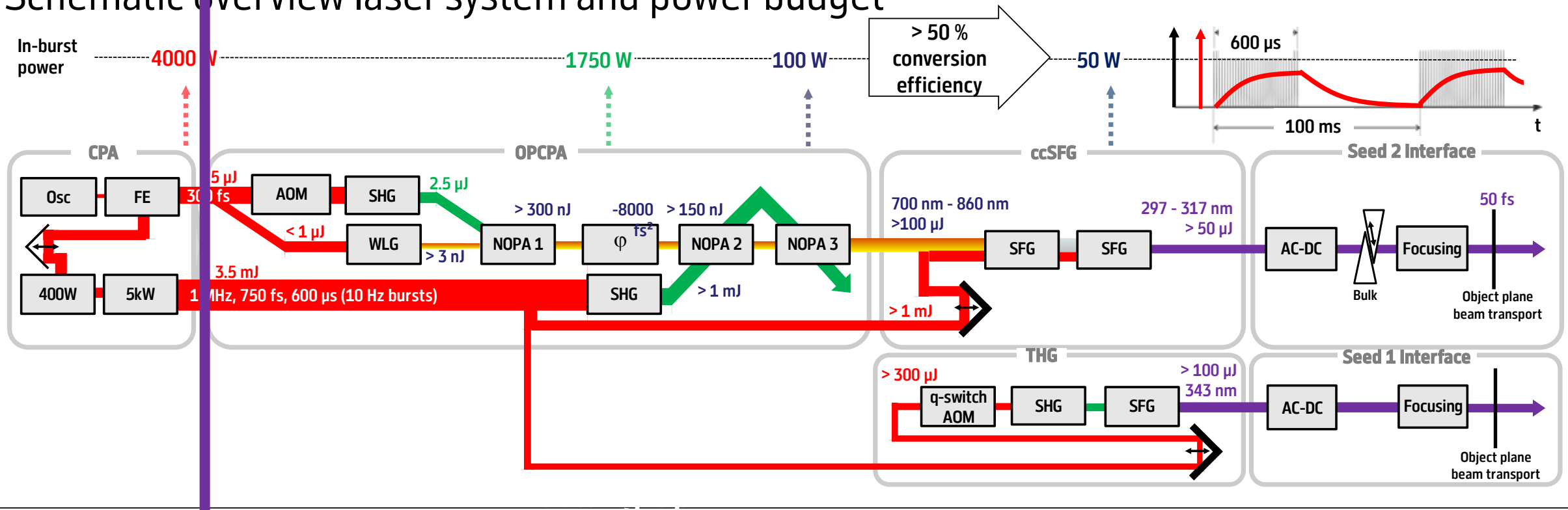
# Laser Requirements.

| Source | WL, Pulse duration, Energy | calculated values | Beam waist in modulator ($1/e^2$,radius) and beam quality | Beam waist z-tuning | Rayleigh length | Pointing stability | Pointing stability | position control | Polarization |
|---|---|---|---|---|---|---|---|---|---|
| **Seed1** | **wavelength: 343nm**<br>**pulse duration: 500 fs FWHM**<br>**pulse energy: 50µJ**<br>**rep-rate: 1 MHz**<br>**burst rep rate: 10 Hz**<br>**burst length: 0.6 ms** | **bandwidth: 0.35nm**<br>**peak power: 100MW**<br>**in-burst power: 50W**<br>**avg. power: 300mW** | **600 µm, $M^2 < 1.5$**<br>**An asymmetry of 10% is tolerated** | In the center of the first modulator (no tuning) | 3,297 m @ $M^2 = 1.0$<br>2,198 m @ $M^2 = 1.5$ | **40 µrad** | **50 µm transverse (rms)** | Remotely controlled with 20 µm over a range of 500 µm and 20 µrad accuracy, both at interaction region. | **Horizontal** |
| **Seed2** | **wavelength: 297nm – 317nm**<br>**pulse duration: 50 fs FWHM**<br>**pulse energy: 16µJ**<br>**rep-rate: 1 MHz**<br>**burst rep rate: 10 Hz**<br>**burst length: 0.6 ms** | **bandwidth: 2.8nm**<br>**peak power: 300 MW**<br>**in-burst power: 16W**<br>**avg. power: 100mW** | **600 µm, $M^2 < 1.5$** | Optimization of the waist position might be required with changes of +/- 2 m with 20 cm steps. | 3.81 ...<br>3.57 m @ $M^2 = 1.0$<br>2.54 ...<br>2.98 m @ $M^2 = 1.5$ | **40 µrad** | **50 µm transverse (rms)** | Remotely controlled with 20 µm over a range of 500 µm and 20 µrad accuracy at the point of interaction | **Horizontal** |

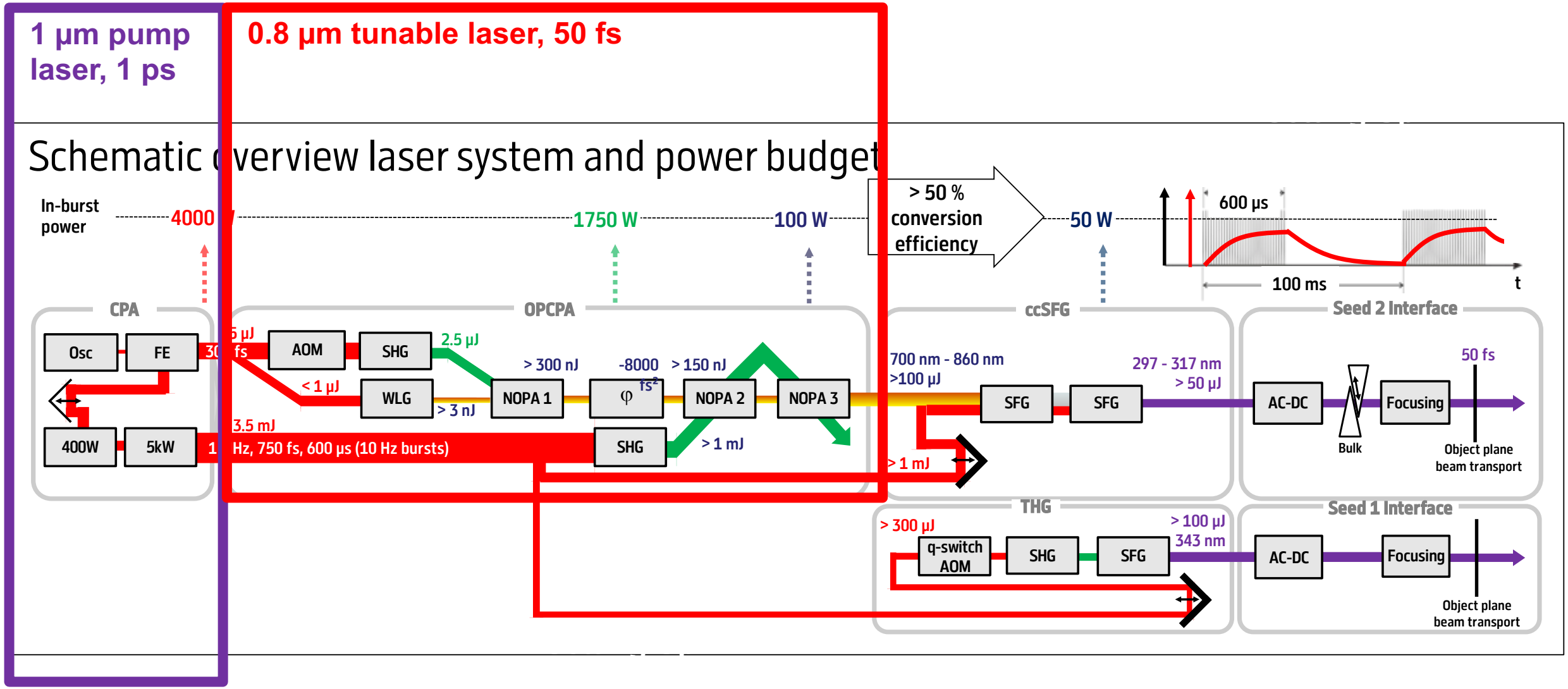
# Laser System.

**1 µm pump laser, 1 ps**

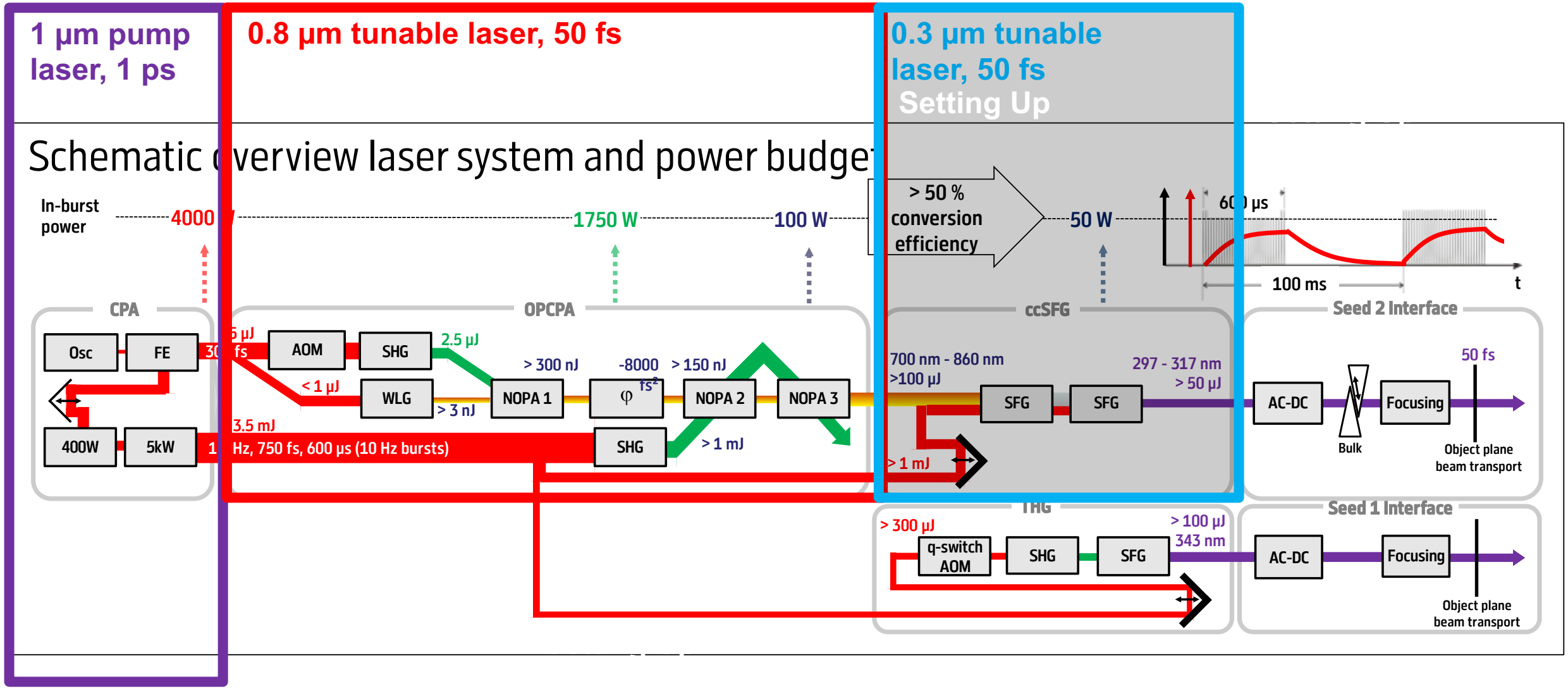
## Schematic overview laser system and power budget



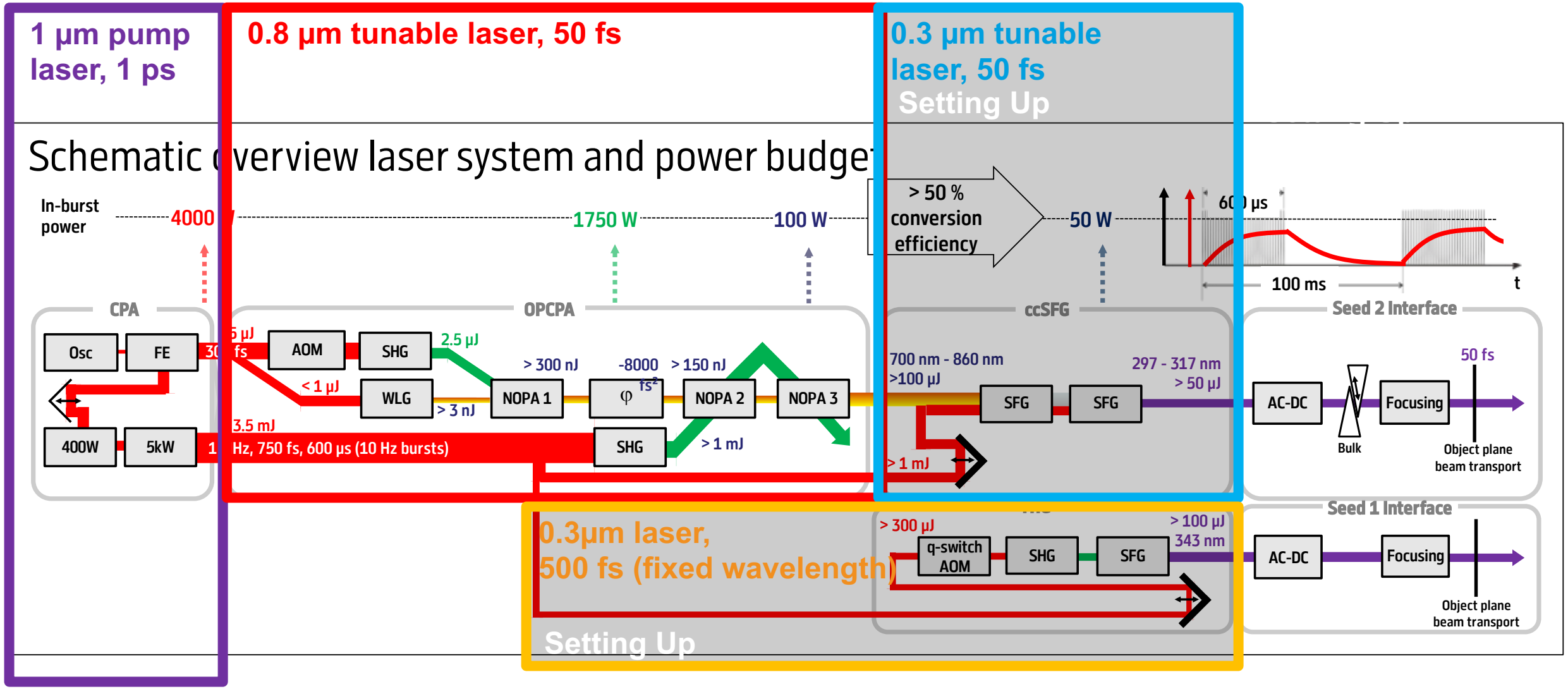
# Laser System.



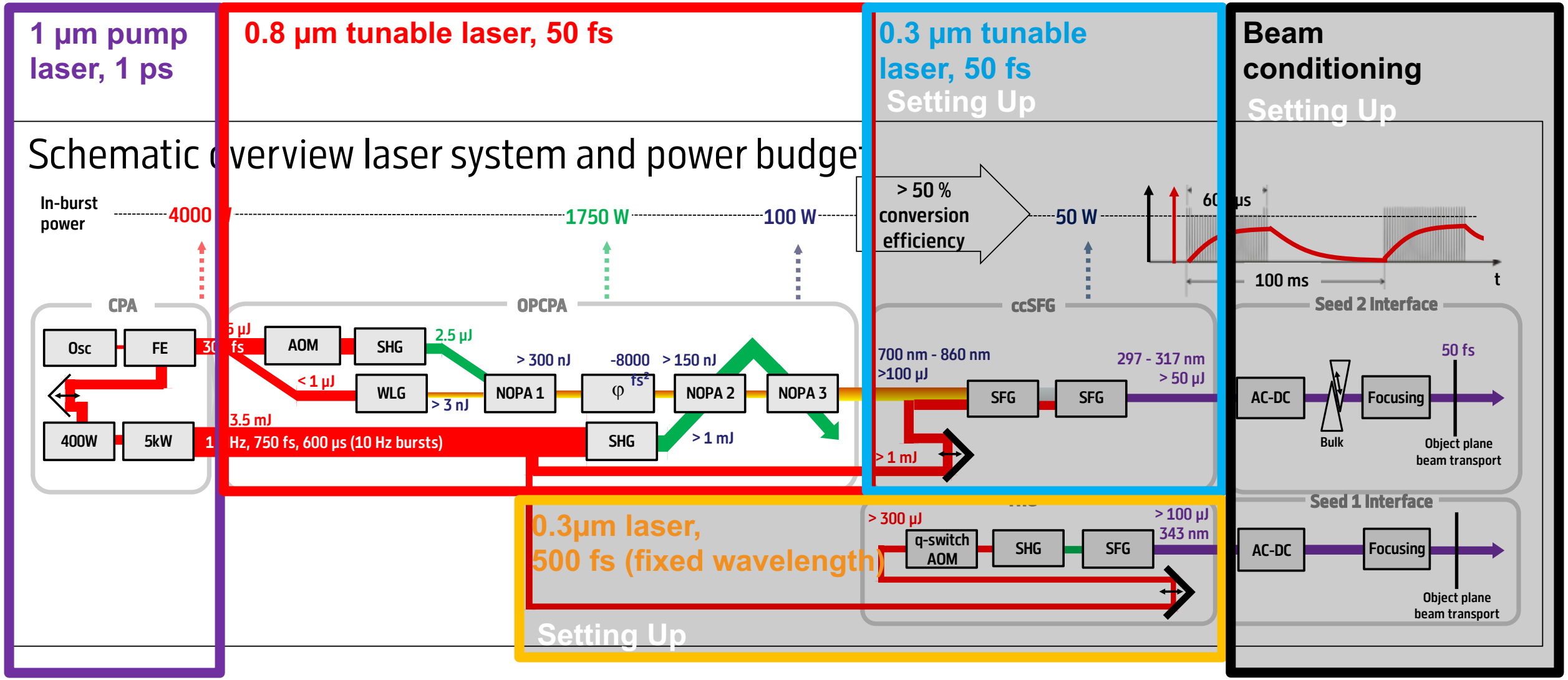
# Laser System.



# Laser System.



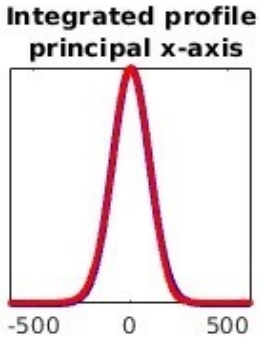
# Laser System.

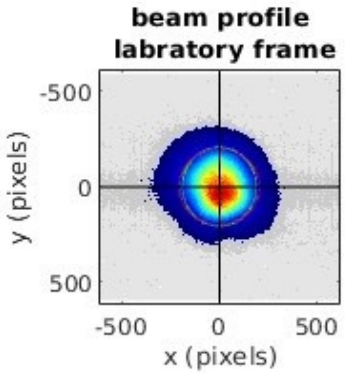


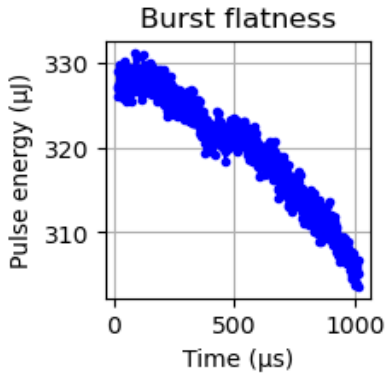
# Laser System – Results at 0.8 µm, 50 fs, 1 MHz, 600 pulses.

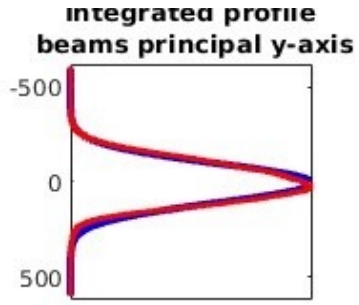
## First OPCPA results

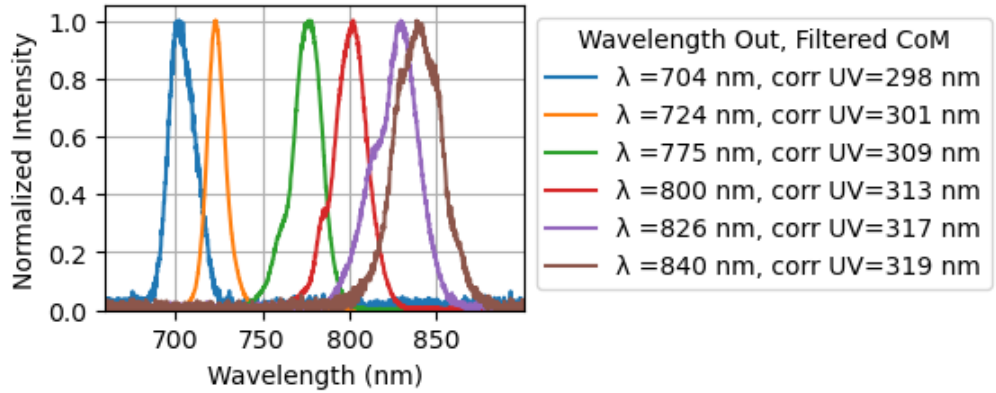
- **Pulse energy:**
  **>> 100 µJ**
  **~ 1% rms**
- **Beam profile:**
  **very good**
- **TL pulse duration:**
  **40 fs – 50 fs**
- **Tuning rang:**
  **705 nm – 850 nm**

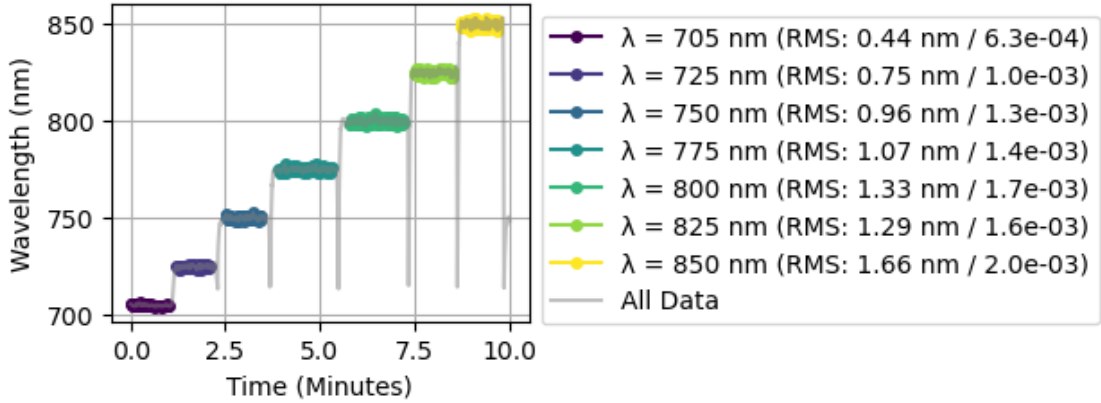


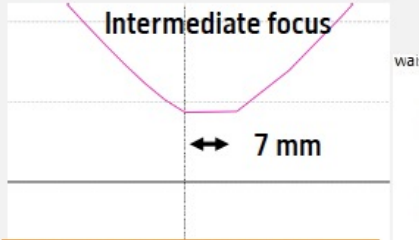



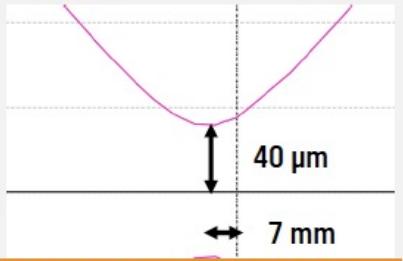



# Optics Design Seed 2

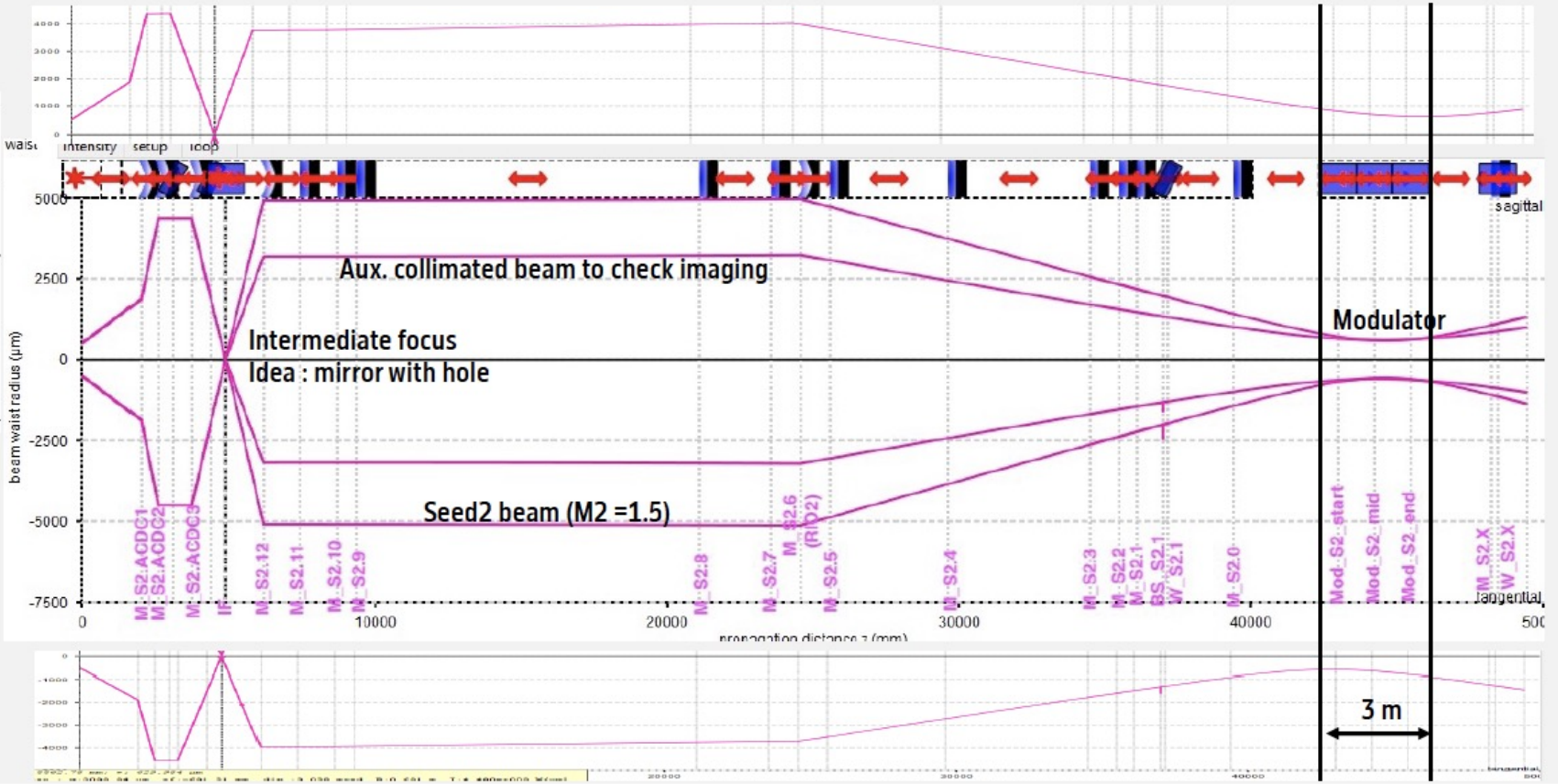
- Waist position can be tuned – as required
- Waist diameter is fixed (by design, we order a range of telescope mirror curvatures to be able to adapt to the measured UV beam divergence)
  → **we might need to implement an additional telescope to be able to dynamically adapt, if we do see drifts in divergence**

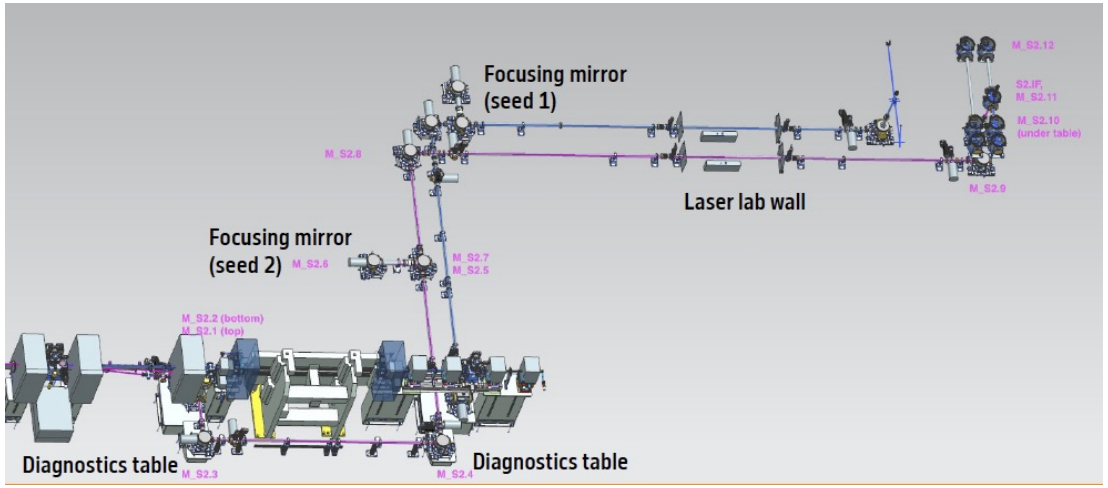



Waist at end of modulator
(- 3mm telescope mirror in laser lab displacement)

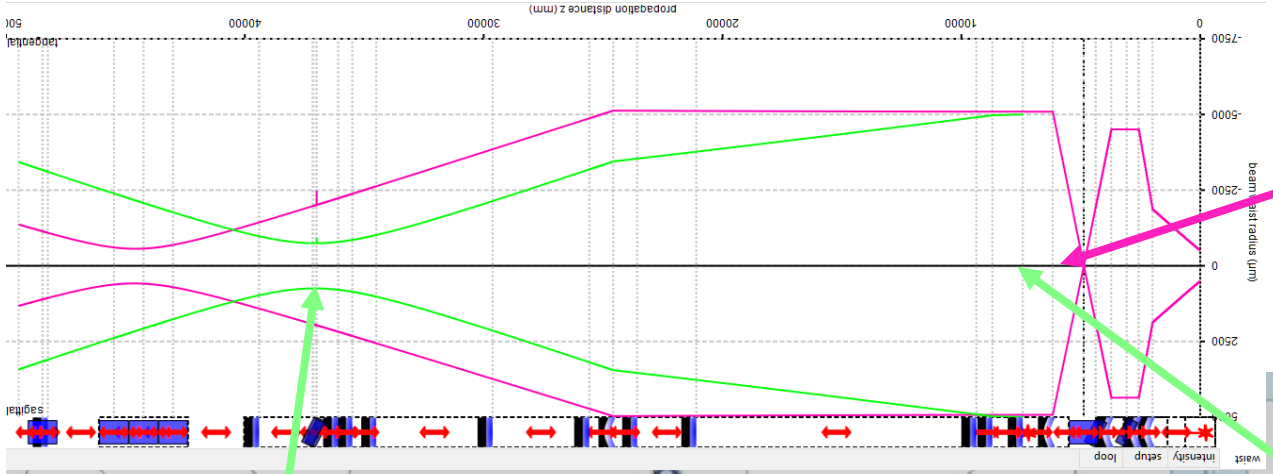



Waist at begin of modulator
(+ 3mm telescope mirror in laser lab displacement)



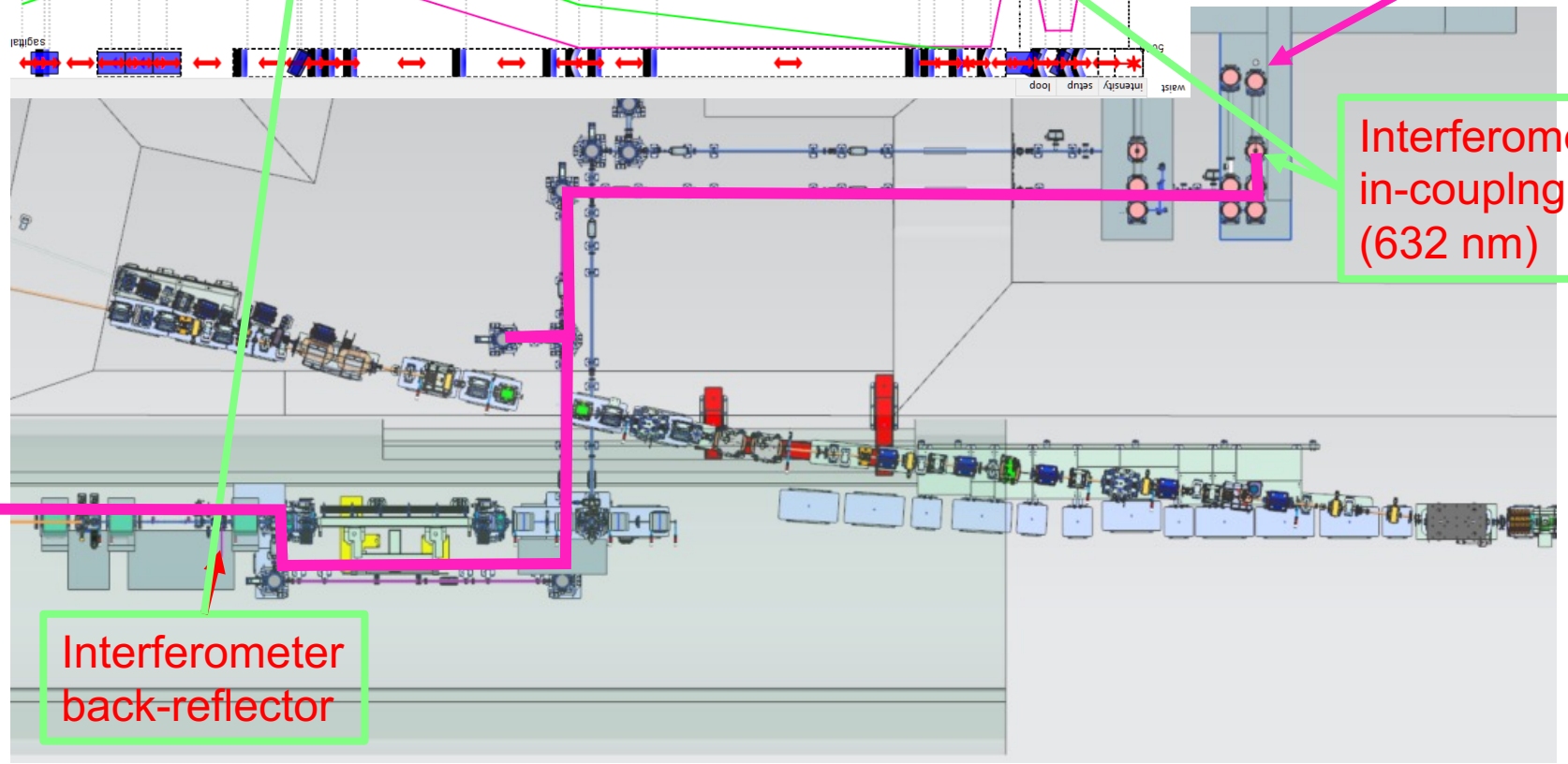



# Laser Beam Transport – Length / Group Delay Measurement.

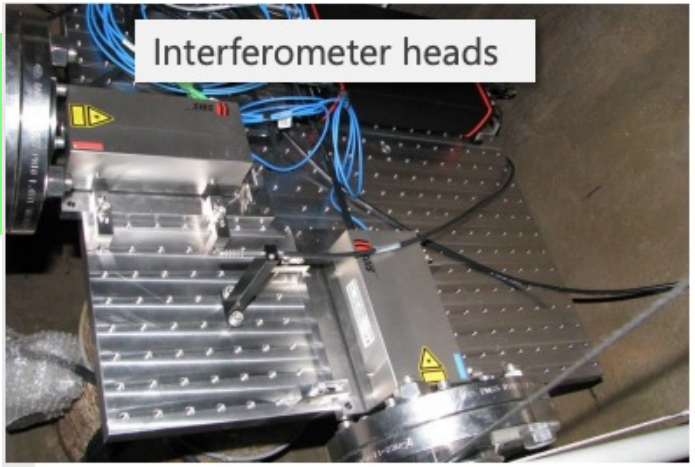



Seed2 – UV beam (300 nm)
UV – NIR cross correlator
(LbSync / FS-LA – TBD)

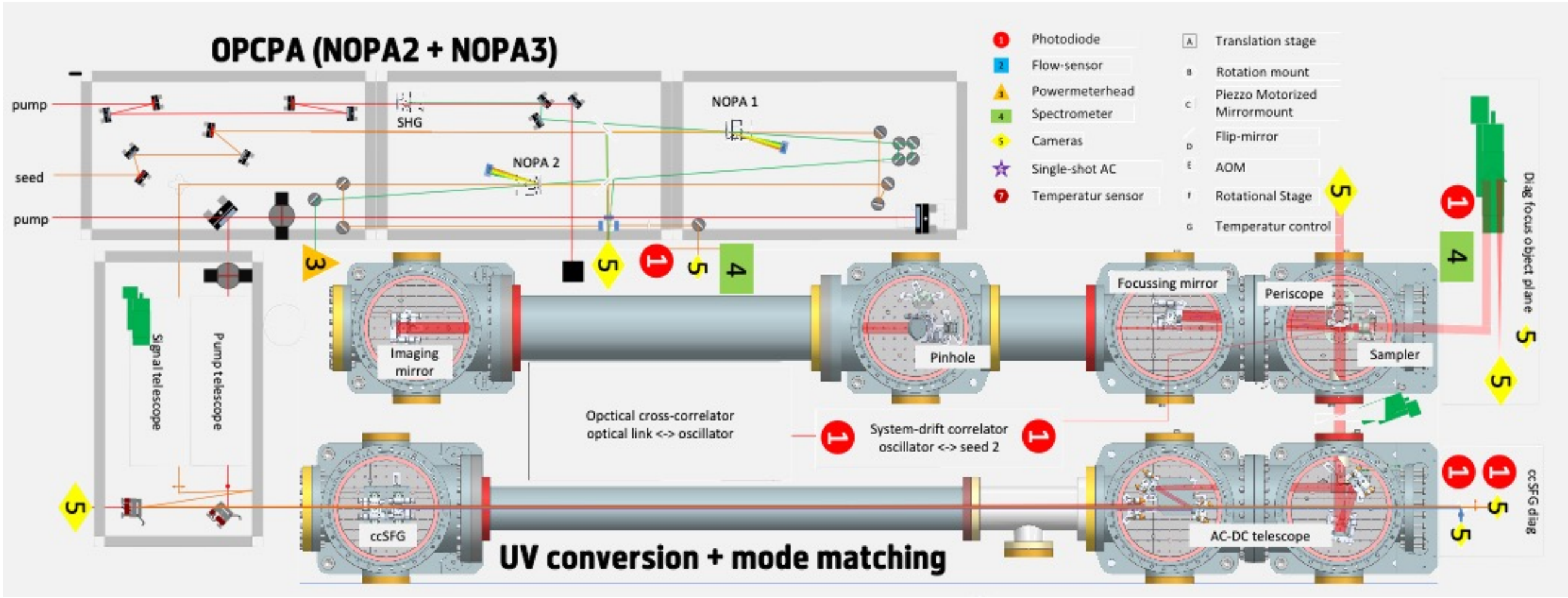
Interferometer
in-couplng
(632 nm)



Interferometer
back-reflector

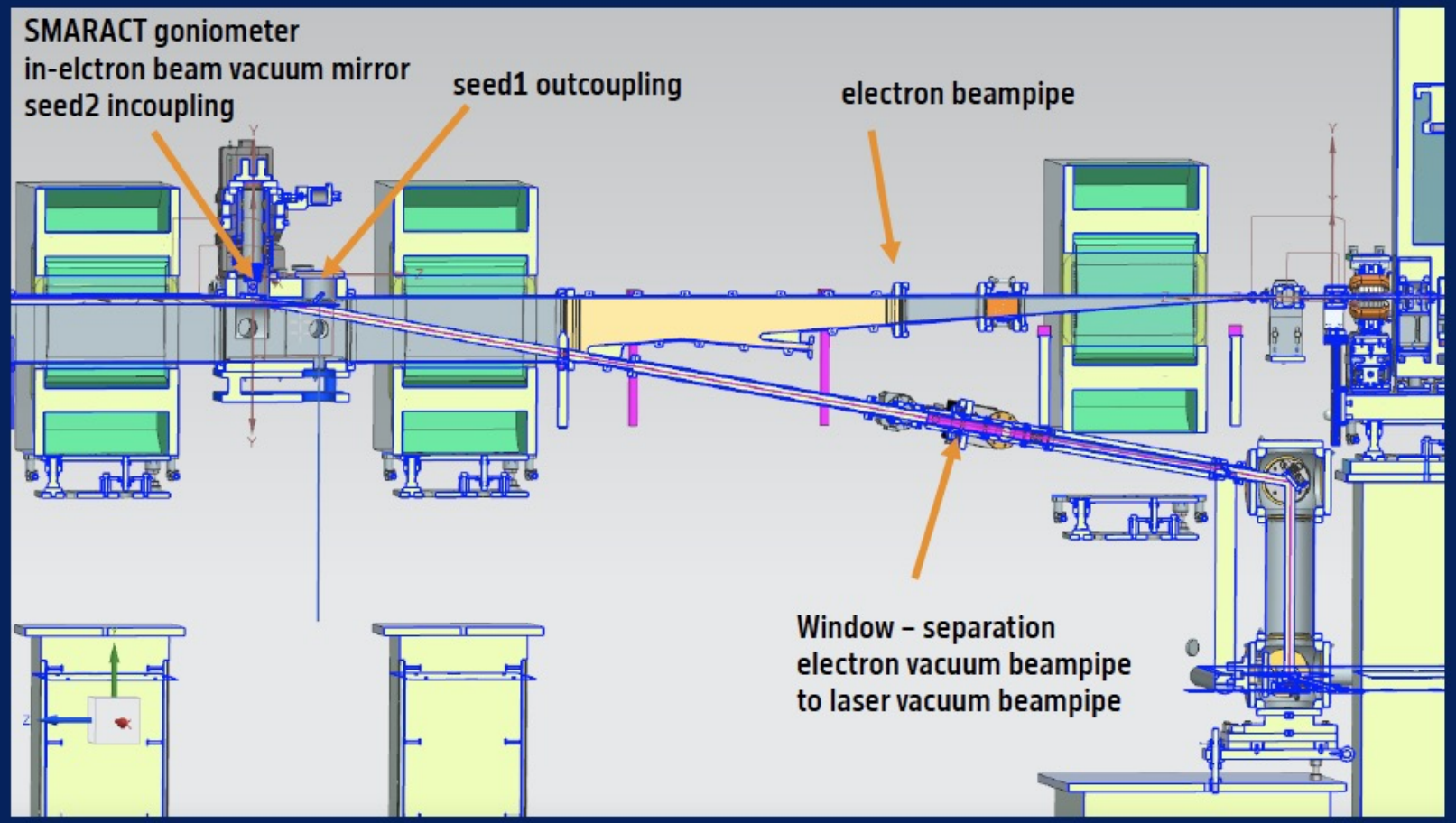


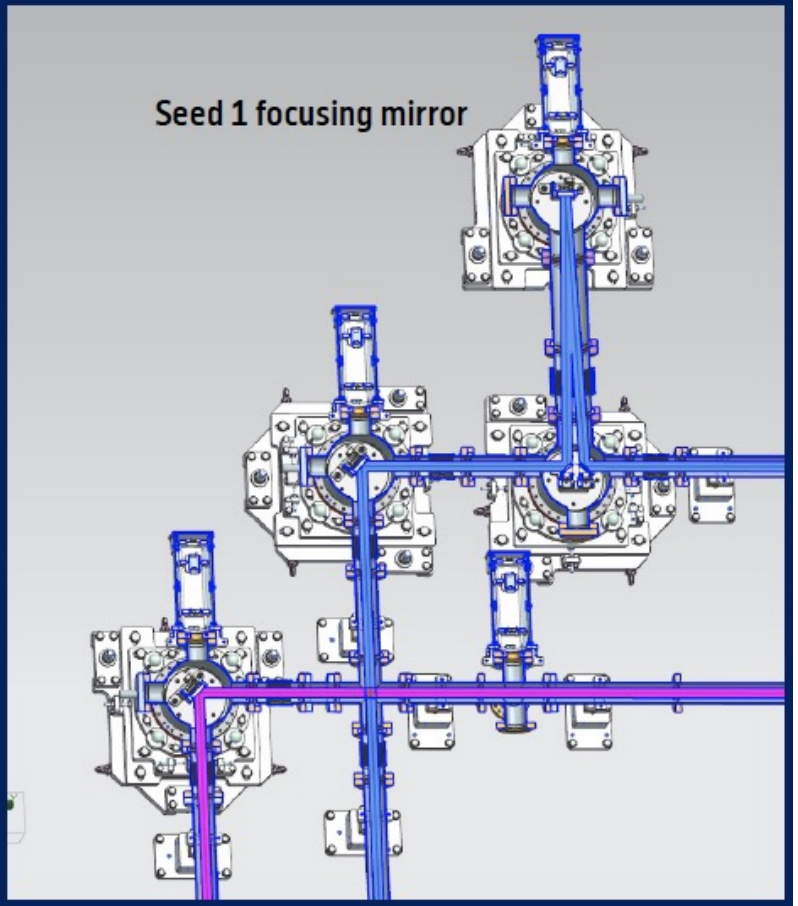
# UV Generation (Seed 2).



# Seeding Beam Transport.

## Some Details – Mirror Chambers



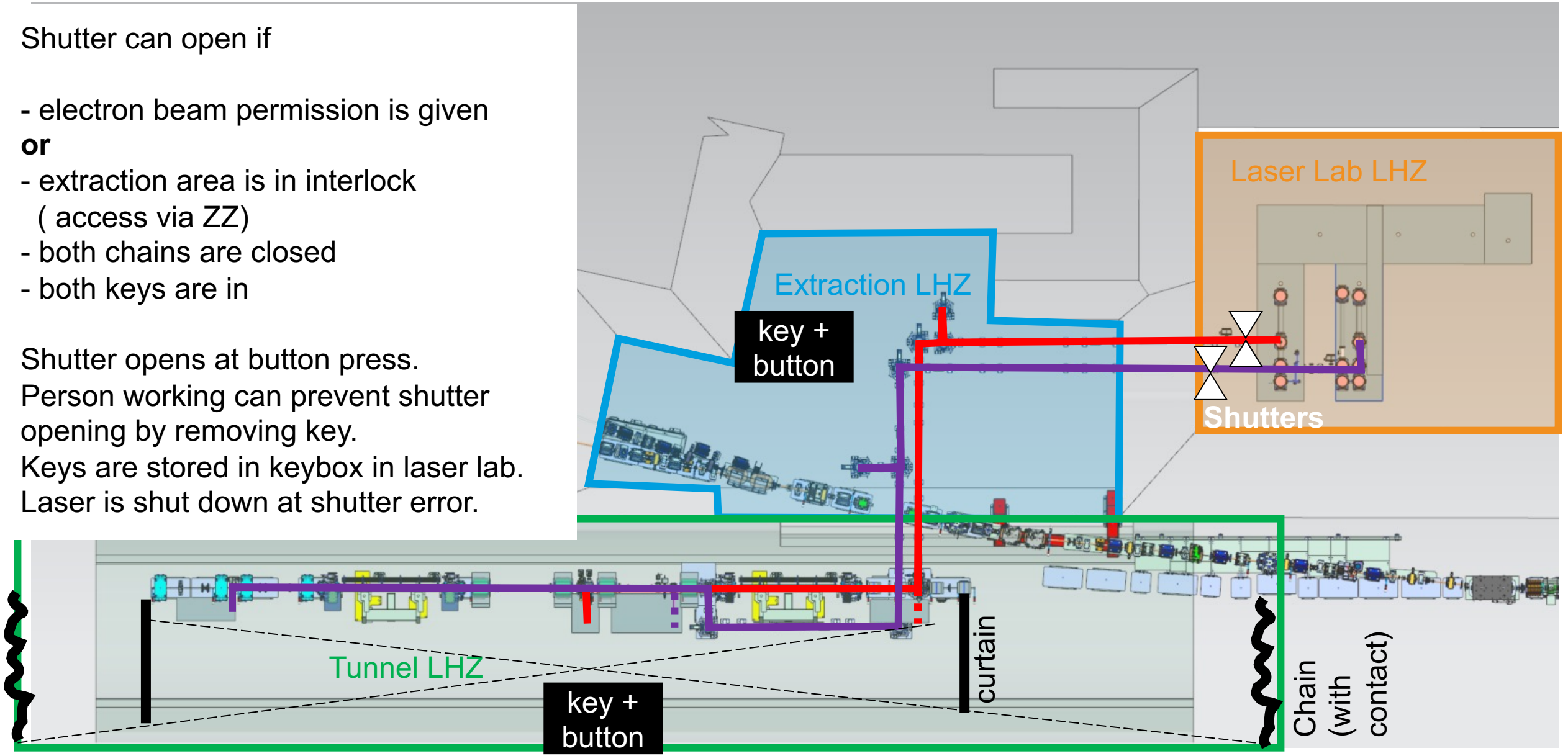



# Laser Safety Concept Extraction + Tunnel.

Shutter can open if

- electron beam permission is given
**or**
- extraction area is in interlock
  ( access via ZZ)
- both chains are closed
- both keys are in

Shutter opens at button press.
Person working can prevent shutter opening by removing key.
Keys are stored in keybox in laser lab.
Laser is shut down at shutter error.



# Status and Summary

- **Overall:**
  - Staff: critical until shutdown – then FS-LA pump-probe laser staff can support
  - Budget: critical but sufficient.

- **Laser System (WP S2)**
  - Project is on track,
  - no technical showstoppers,
  - results so far match excellently simulations

- **Laser Beam Transport (WP S3)**
  - Project delayed ( but catching up). Reason: Loss of staff
  - Catching up – Dirk (ZM) and Hamid (FS-LA) are driving the project
  - Currently finalizing optics specifications and mechanical design.
  - Ordering of components on-going, ordering as soon specifications are finalized