FLASHForward▸▸ Preparatory Experiments

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Project FLASHForward▸▸ | Research Group for Plasma Wakefield Accelerators FLA-PWA

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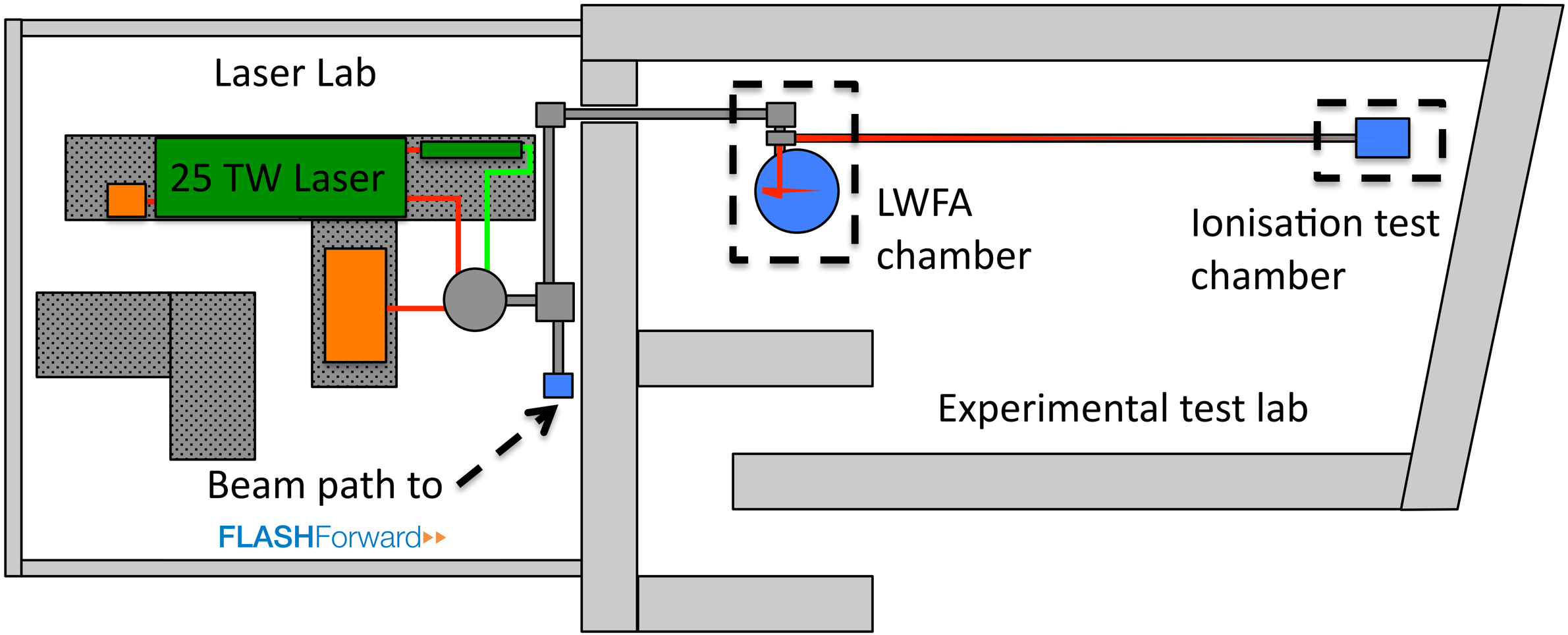
Alexander von Humboldt Stiftung/Foundation

HELMHOLTZ GEMEINSCHAFT

The laboratory facilities in 28M: Our laser and test lab



Laser performance characteristics

Property	Main beam	Probe beam	Hollow-core fibre compressor
Energy [mJ]	650	4	1
Pulse length [fs]	25	25	5
Spectrum [nm]	760 - 840	760 - 840	500 - 1100
Beam diameter [mm]	45	12	15
Repetition rate [Hz]	10	10	10
Contrast ratio	10^9	10^8	

Already achieved **Under construction**

S. Weichert, Master's thesis

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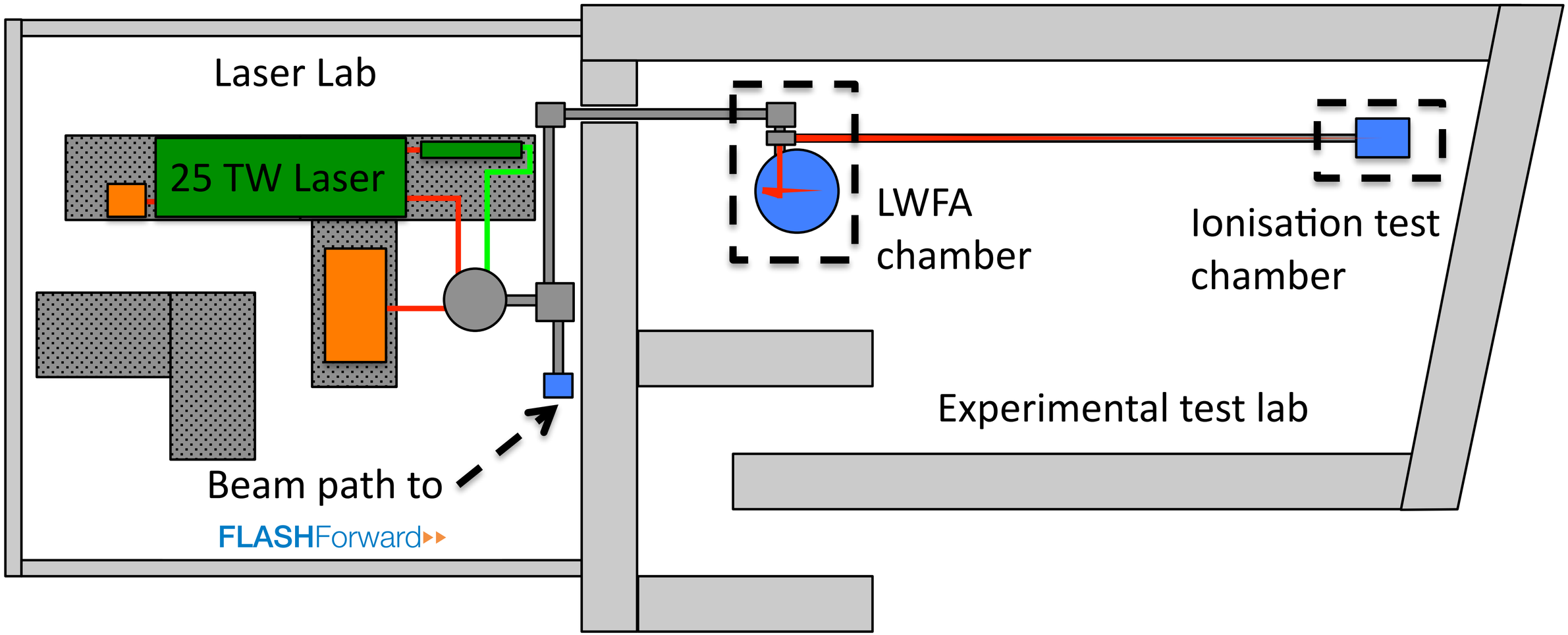
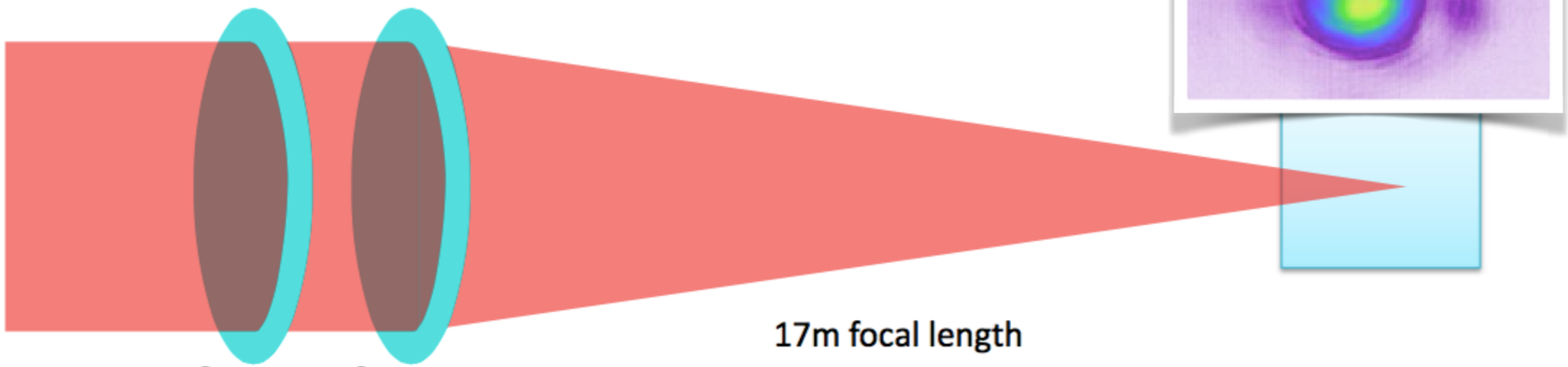


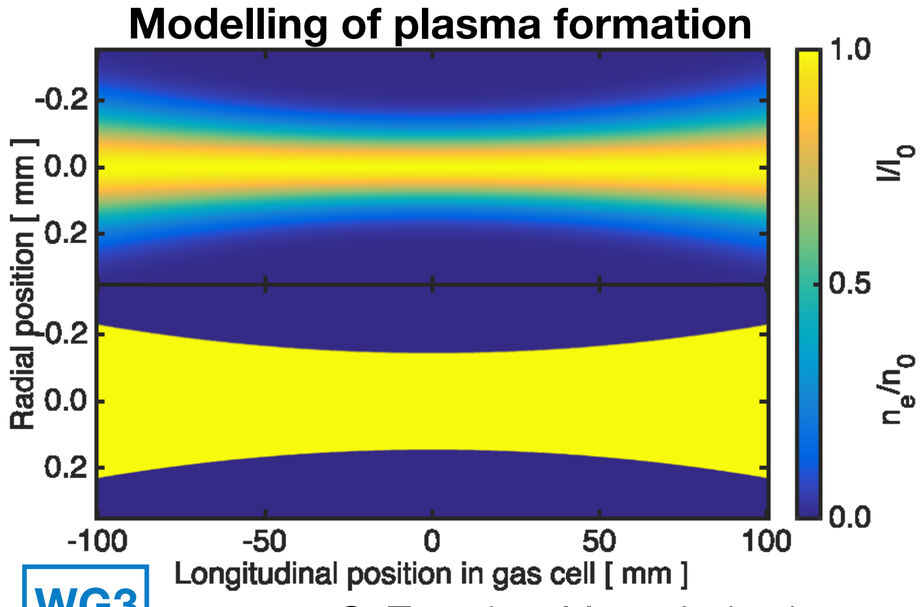
FLASHForward▸▸ ionisation testing line

M. Quast, Master's thesis



Focusing setup identical to FLASHForward▸▸ ionisation line and allows for testing of:

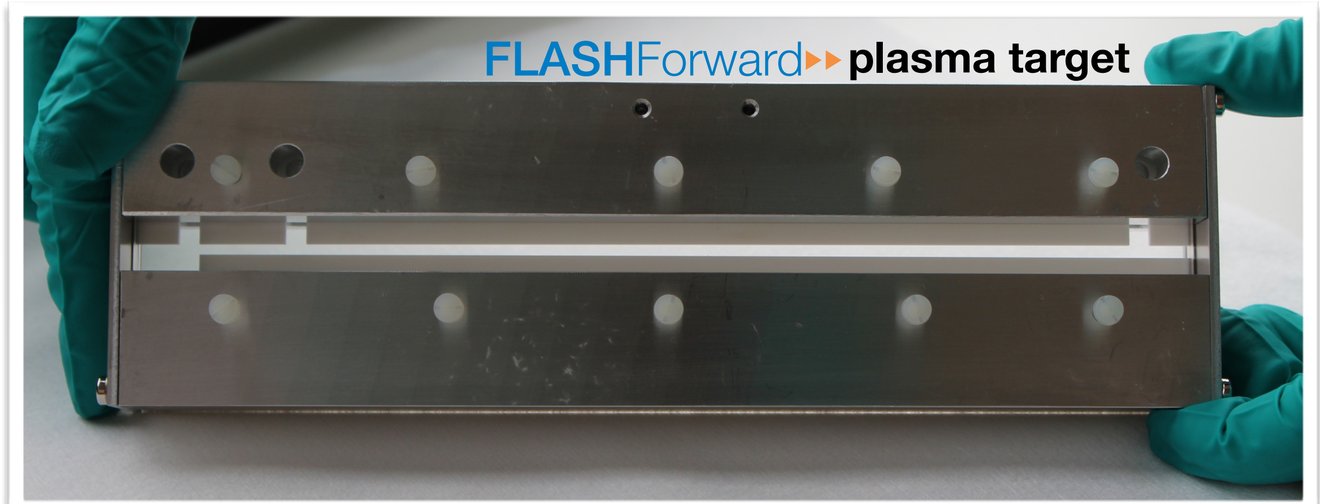
- plasma channel formation ⟶ required pulse power and duration
- plasma based laser defocusing



WG3

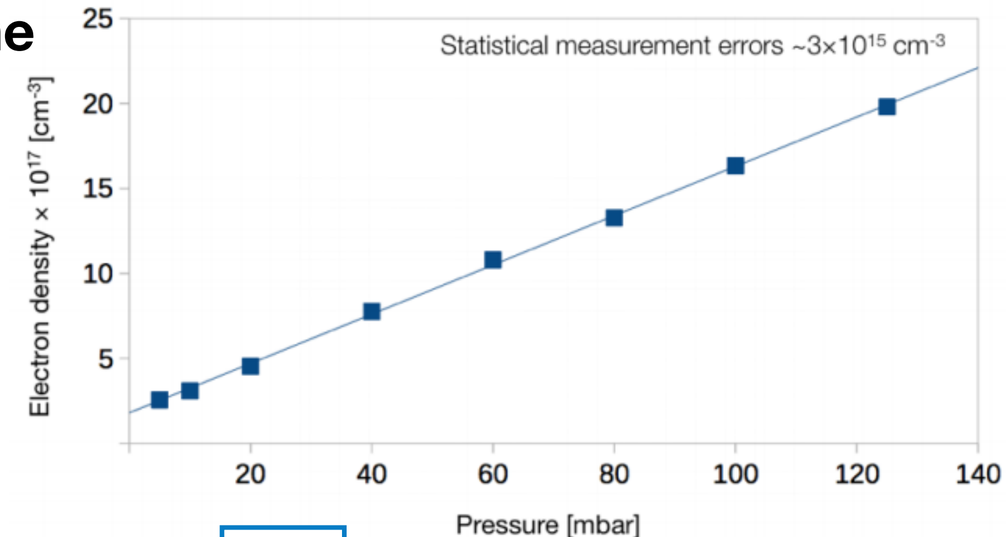
G. Tauscher, Master's thesis

FLASHForward▸▸ ionisation testing line



Focusing setup identical to FLASHForward▸▸ ionisation line and allows for testing of:

- plasma channel formation ⟶ required pulse power and duration
- plasma based laser defocusing
- targetry, including novel plasma density and species profiles
- plasma density and species diagnostics
  - including calibration of plasma diagnostics based on stark broadening



WG3 L. Goldberg and L. Schaper

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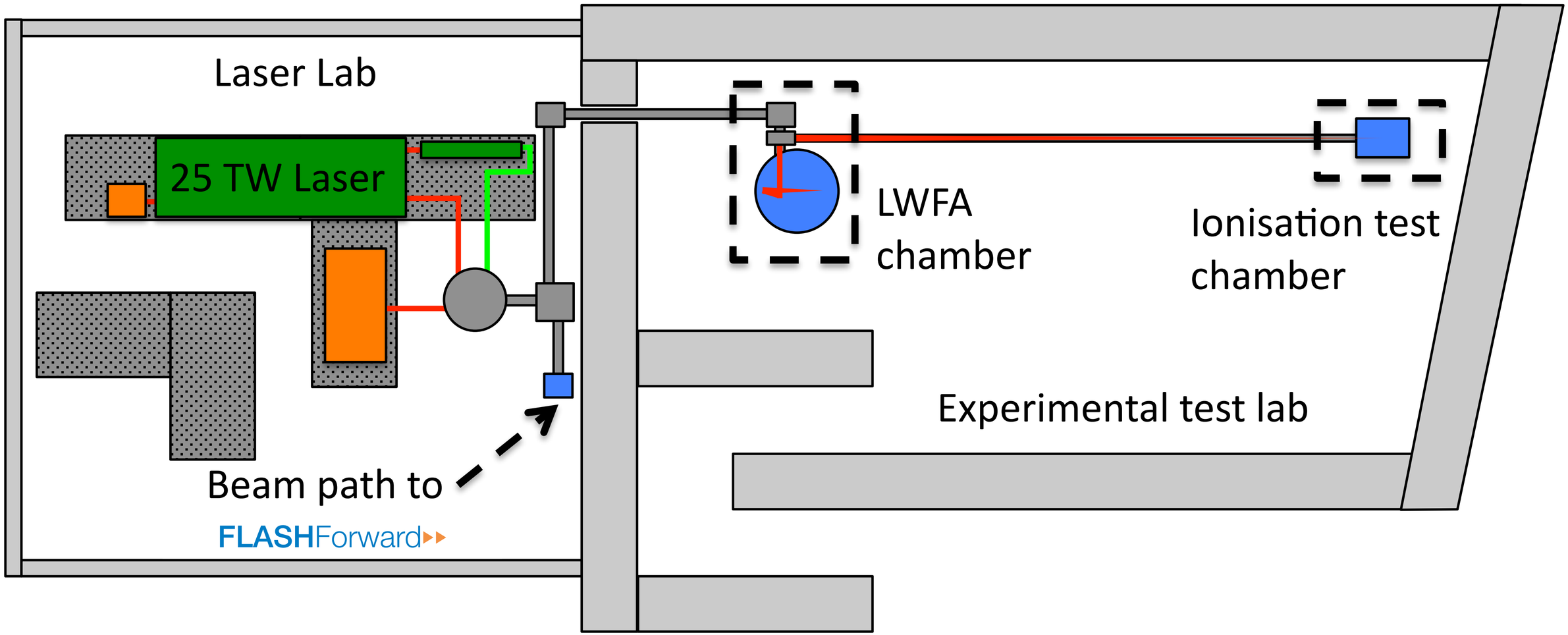


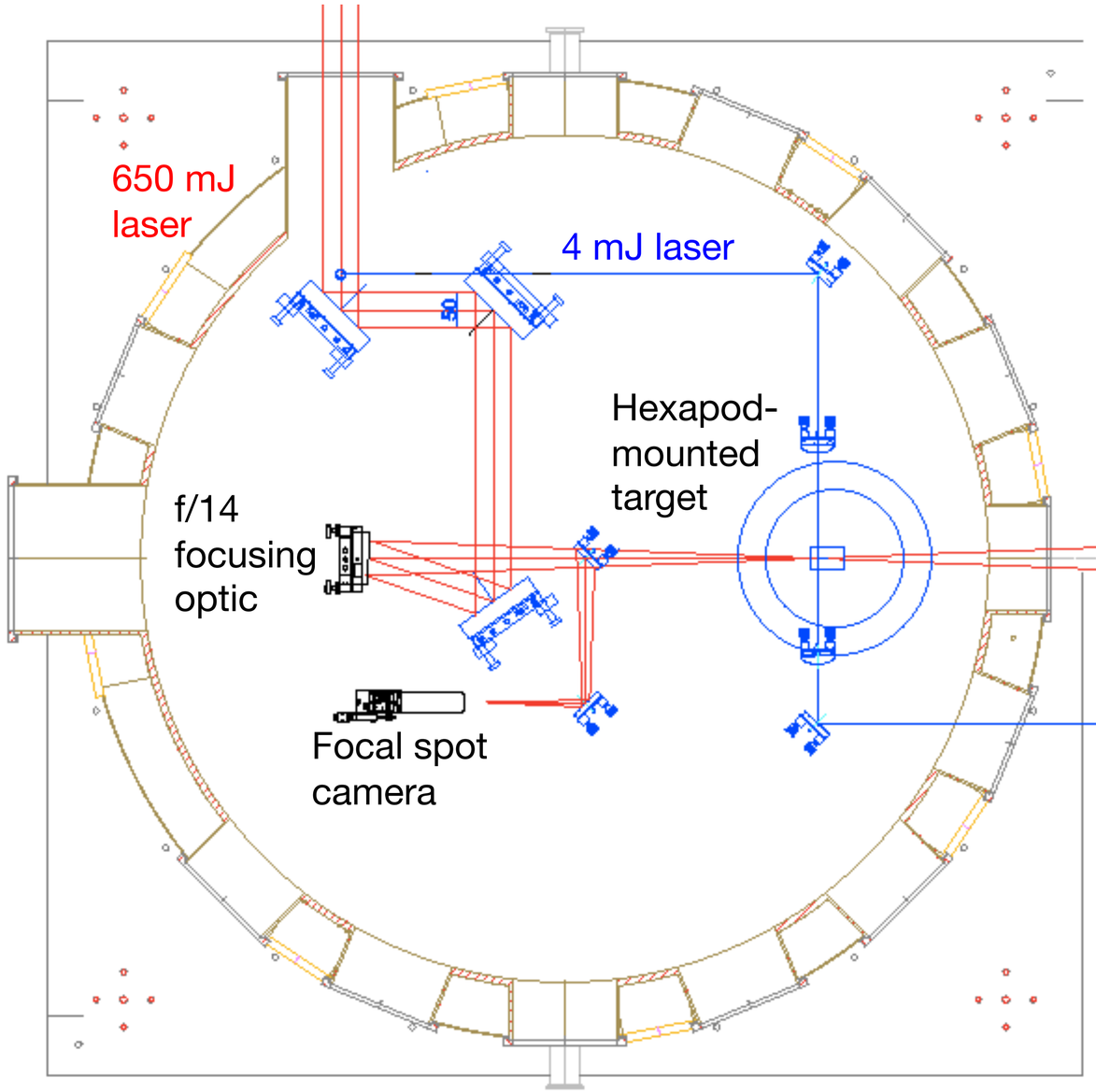
LWFA experimental setup

Setup usable to generate electron beams via LWFA.

- Used for testing of diagnostic concepts for **FLASH**Forward▸▸:
  - X-ray filters and camera
  - Transition Radiation pick-up optics and spectrometers
  - Laser-electron interactions (Thomson scattering)
  - Additional plasma diagnostics

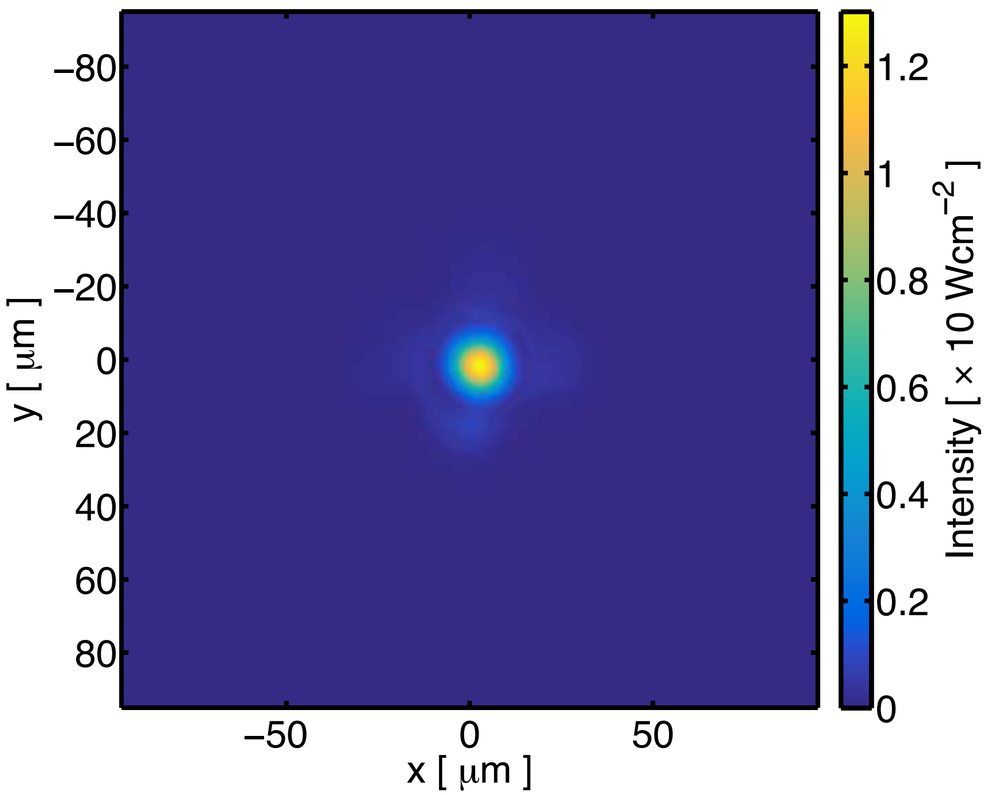
WG2 and WG3

- Additional investigation of relevant areas, such as laser generated plasma down ramp targets and damage testing.



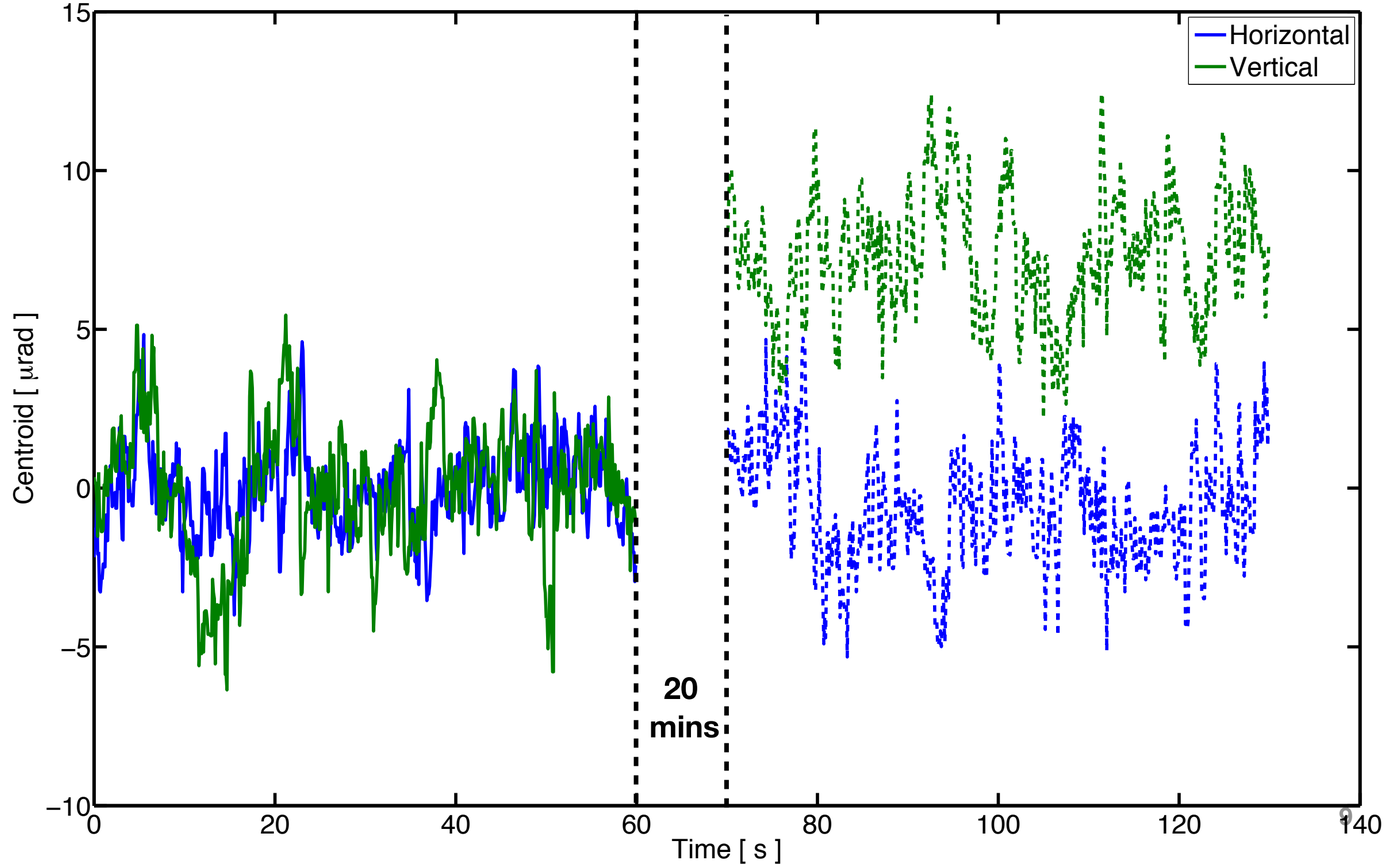
Focus quality and stability

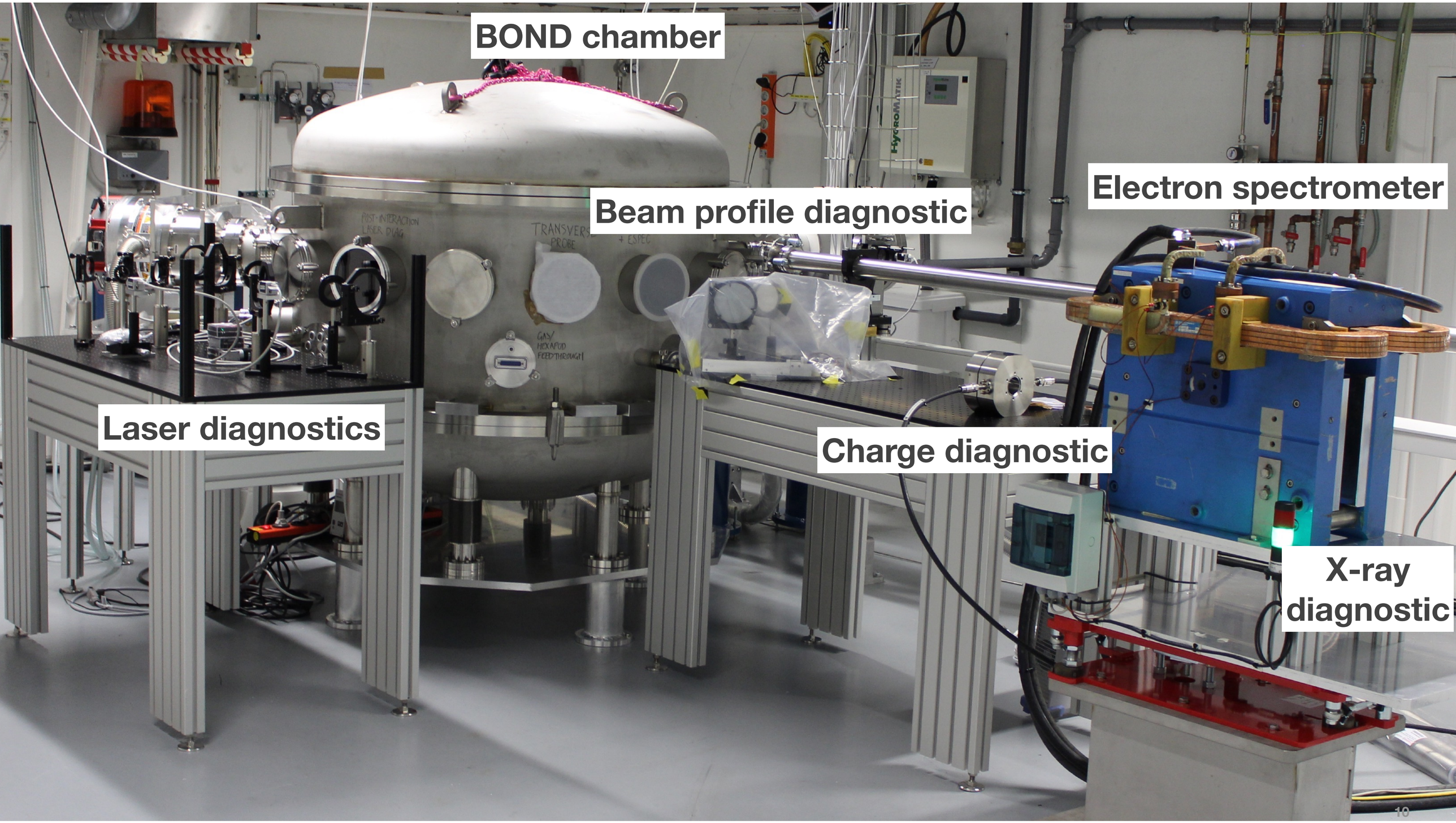
- After focusing with f/14 off-axis-parabolic mirror



- Peak intensity : 1.25×10^{19} W/cm^2
- Spot radius, I/e^2 : 9.4 μm
- Peak normalised vector potential, a_0 : 2.42
- Strehl ratio : 0.84

- Pointing stability :< 2 μrad
- Drift over hours : 5 μrad




BOND chamber
Beam profile diagnostic
Electron spectrometer
Laser diagnostics
Charge diagnostic
X-ray diagnostic
POST-INTERACTION LASER PLUG
TRANSVERSE PROBE
+ ESPEC
GAS/ HEXAPOD FEEDTHROUGH
HYGROMATIK

Current experimental schedule and priorities

1. **Testing of FLASHForward▸▸ ionisation**
   - A. Characterise laser focus ← **Experiments underway**
   - B. Demonstrate reliable density diagnostics ← **Diagnostics under construction**
   - C. Benchmark modelling of plasma generation
   - D. Prove usable PWFA target
   - E. Explore tailored targets for DDR, etc
2. **Generation of electrons and x-rays via LWFA** ← **LWFA experiments to begin May/June**
   - A. Achieve `stable' beams suitable for testing
   - B. Test/Develop diagnostics
3. **Additional studies**
   - C. Further investigate novel targetry with flexible driver-probe geometry
   - D. Laser damage testing of FLASHForward▸▸ components

FLASHForward▸▸ Preparatory Experiments: Backup slides

WG2

Backup slide: X-ray diagnostics

Vacuum closed using micron-thick polymer window with good transmission to < 2keV

LUXEL

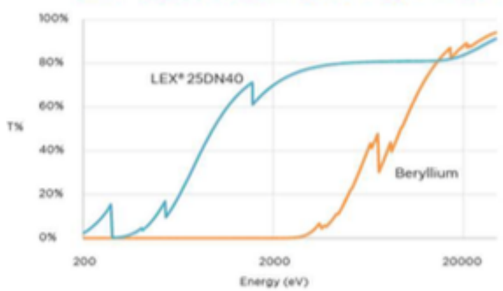
Delivery in April

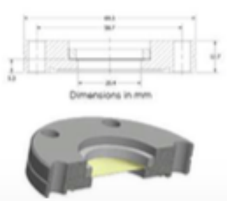
The supporting grid structure for both is stainless steel.

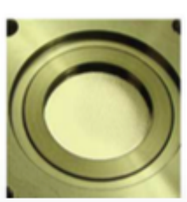
For the LEX25-HT, the grid bar width is 30 microns, the pitch is 390μ and the grid is 84% open. The membrane is 60nm total of aluminum and 600nm of polymer. The visible light transmittance is a few percent.

For the LEX25, the grid bar width is 50 microns, the pitch is 500 μm , and the grid is 81% open.The membrane is 150nm total of Al and 1000nm of polymer. The visible light transmittance is <1E-6.

LEX® 25DN40 25mm Soft X-ray Window







Transmittance

Element Ka	LEX® 25	130 micron Be*
C: 282 eV	12%	0%
O: 526 eV	15%	0%
F: 677 eV	23%	0%
Mg: 1250eV	64%	0%
Al: 1490 eV	70%	0%
Cl: 2620 eV	75%	2%

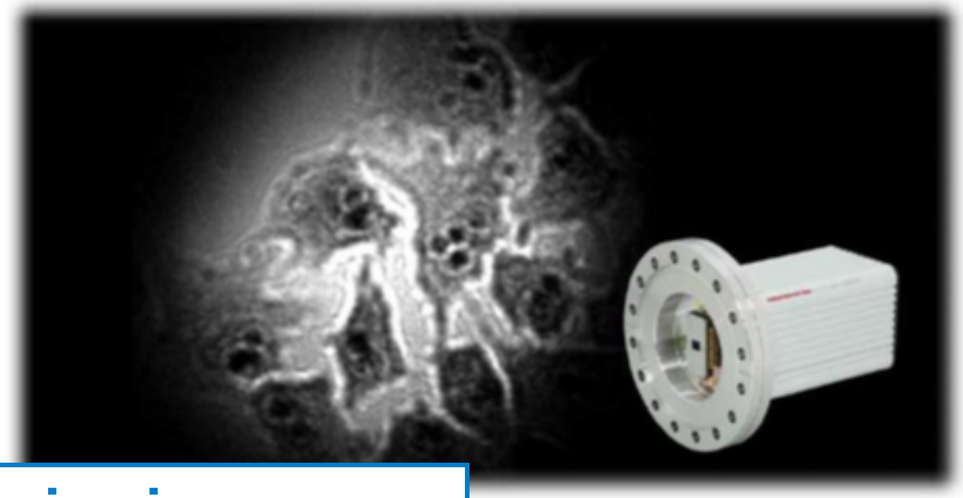
*98.5% pure Be

Specifications

Mounting Flange	DN40/CF275
Mesh Open Area	81%
Max. Pressurized Temp.	100°C
He Leak Rate	<1E-9 mbar-L/sec
Pressure Limit	+/-1 atm
Aperture	25mm

Beryllium-free, ROHS compliant, nontoxic construction

X-ray Direct CCD Camera



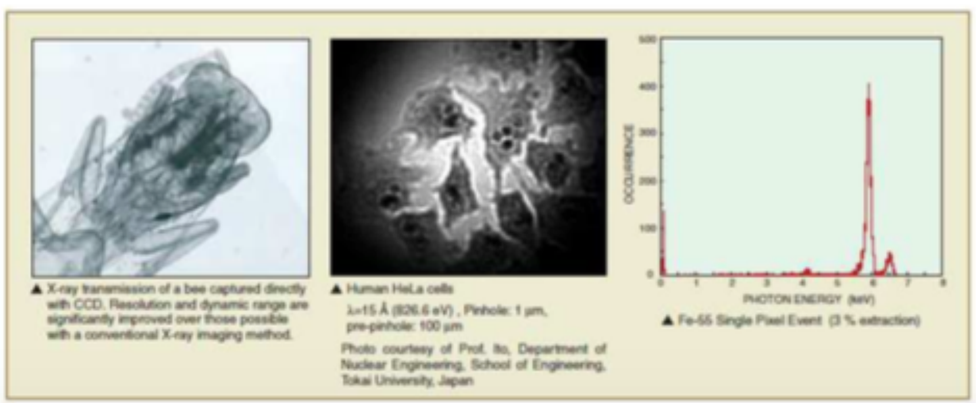
Ordering in progress

...diated EUV and soft X-ray ...ectrons are generated into CCD by irradiating high energy photons, so high sensitive detection is realized.
The energy range of 20 eV to 10 keV is covered by back illuminated CCD.
Beryllium window type and vacuum chamber type can be selected for camera front structure.

X-ray has high energy, so it can easily damage the sensors forming the CCD, causing a drop in sensitivity and rise dark current according to the total incident light energy.
When using in the X-ray, take steps not to apply excessive X-ray light. In addition, extended exposure causes a drop in sensitivity, even if the intensity is not excessive. When not shot, take care to protect the CCD from X-ray.

APPLICATIONS

- X-ray microscope
- X-ray spectroscopy
- Micro-CT
- EUV lithography
- X-ray energy analysis



▲ X-ray transmission of a bee captured directly with CCD. Resolution and dynamic range are significantly improved over those possible with a conventional X-ray imaging method.

▲ Human HeLa cells
λ=15 Å (826.6 eV) , Pinhole: 1 μm, pre-pinhole: 100 μm
Photo courtesy of Prof. Ito, Department of Nuclear Engineering, School of Engineering, Tokai University, Japan

▲ Fe-55 Single Pixel Event (3 % extraction)

Charlotte F