A Portable Laser Heating System

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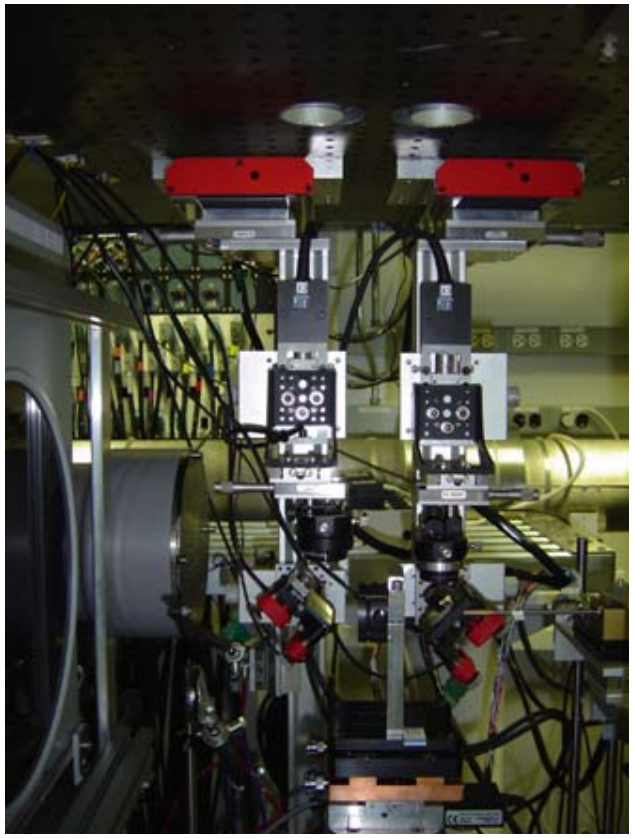
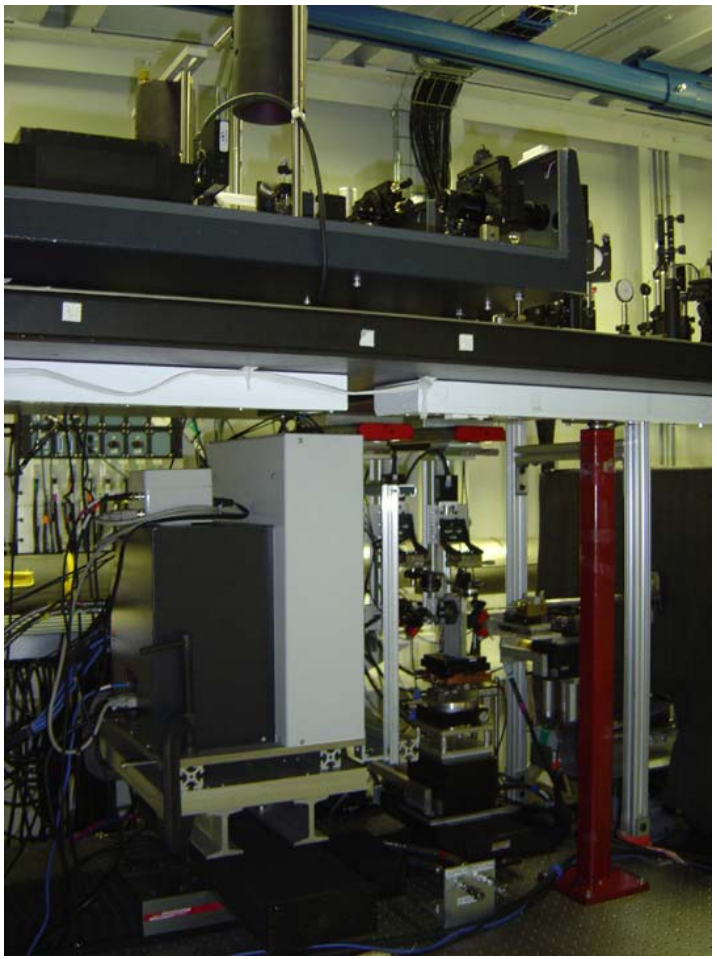
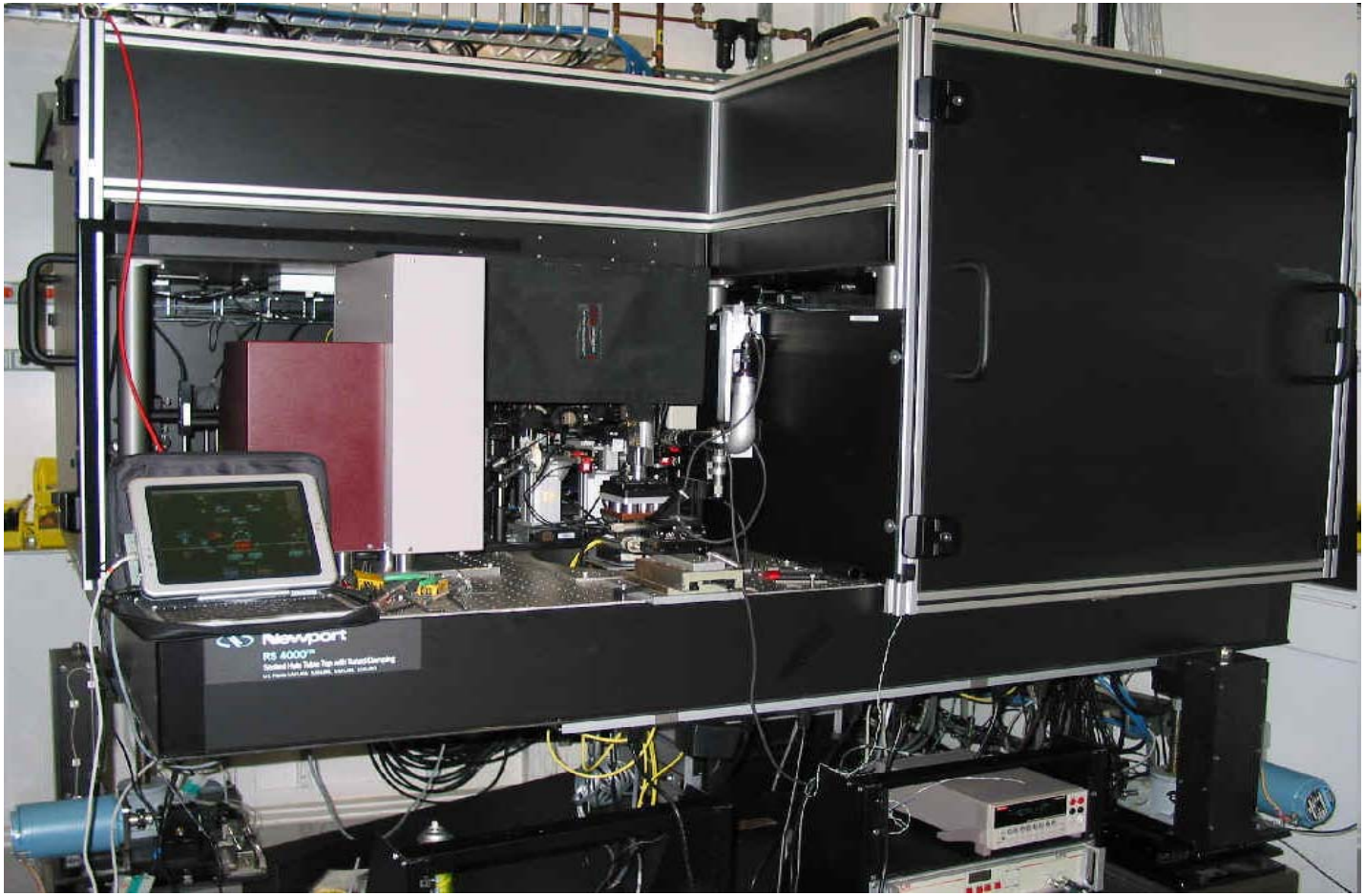
Carnegie Institution of Washington

Laser Heating System at HPCAT

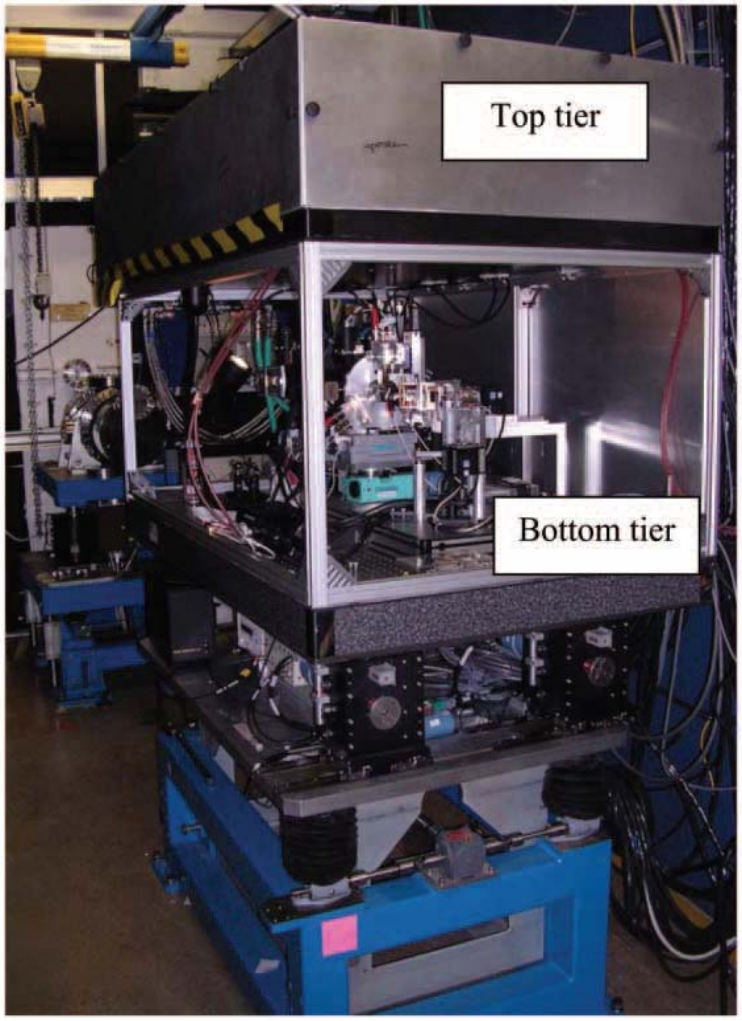


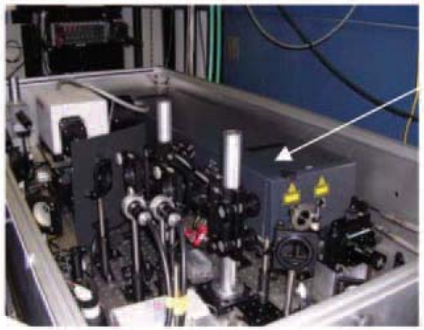


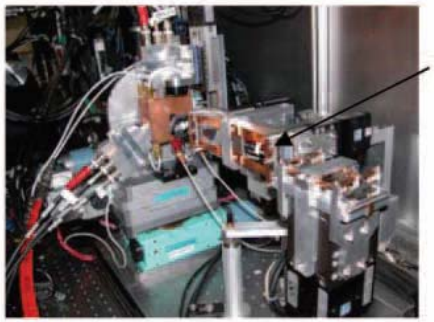
Laser Heating System at GSECARS

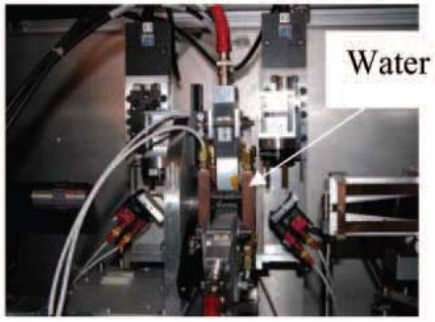


Laser Heating System at Sector 3





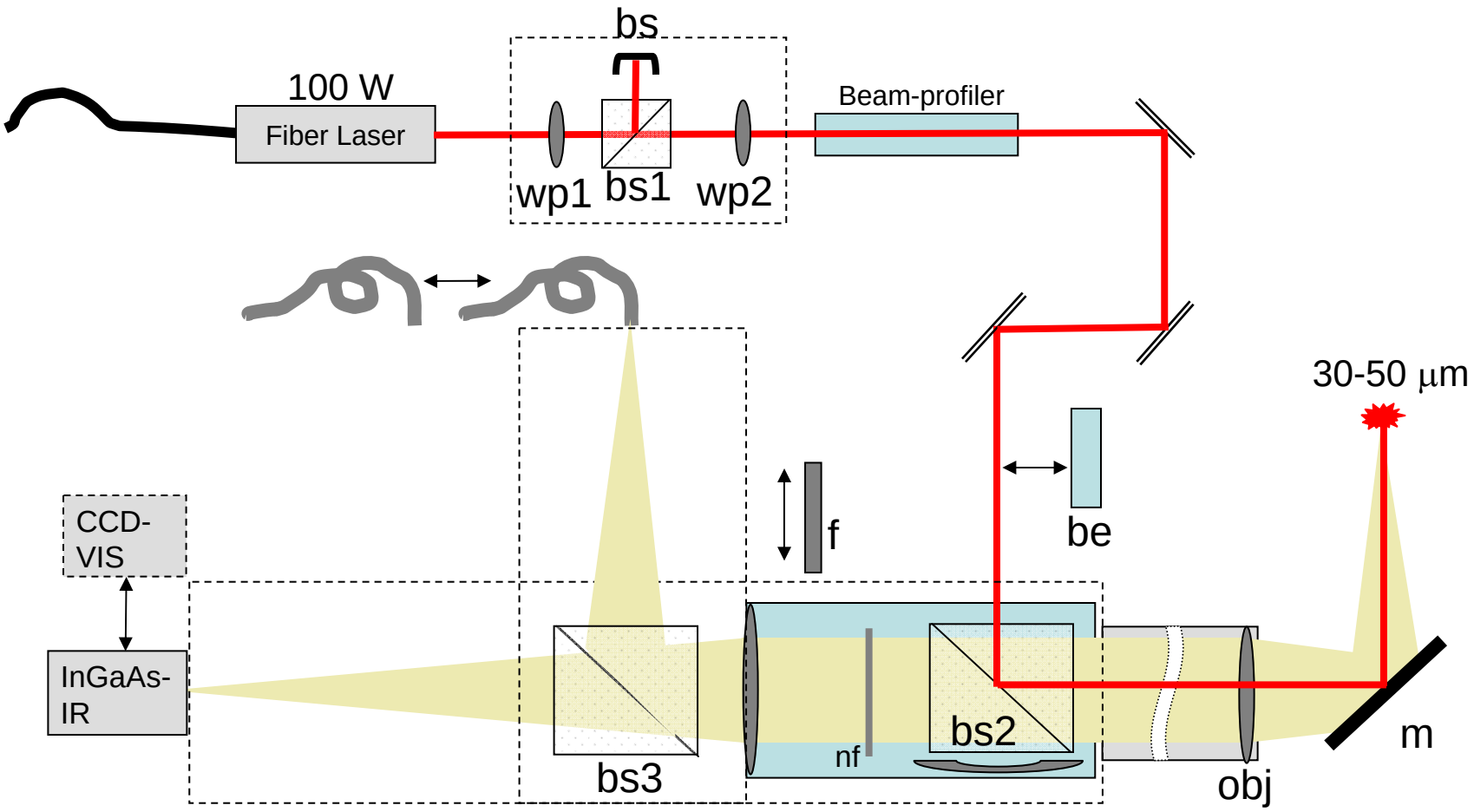




Features of the Portable System

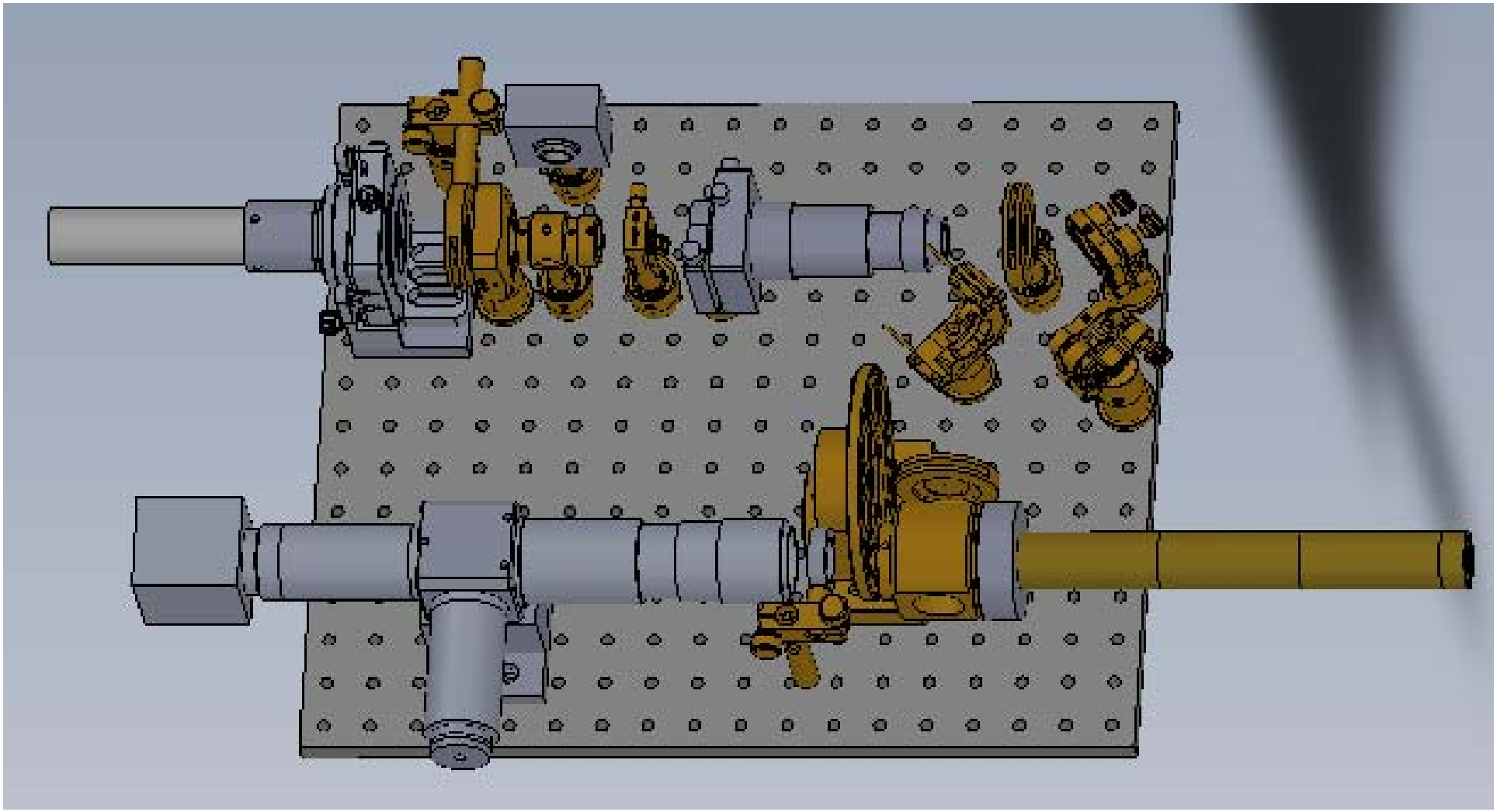
- Portability
- Modular design
- Extended medium temperature (down to 500 K) and high temperature (>5000K)
- In situ observation and measurement
- Safety (all enclosed except objective lens)

Optics Layout

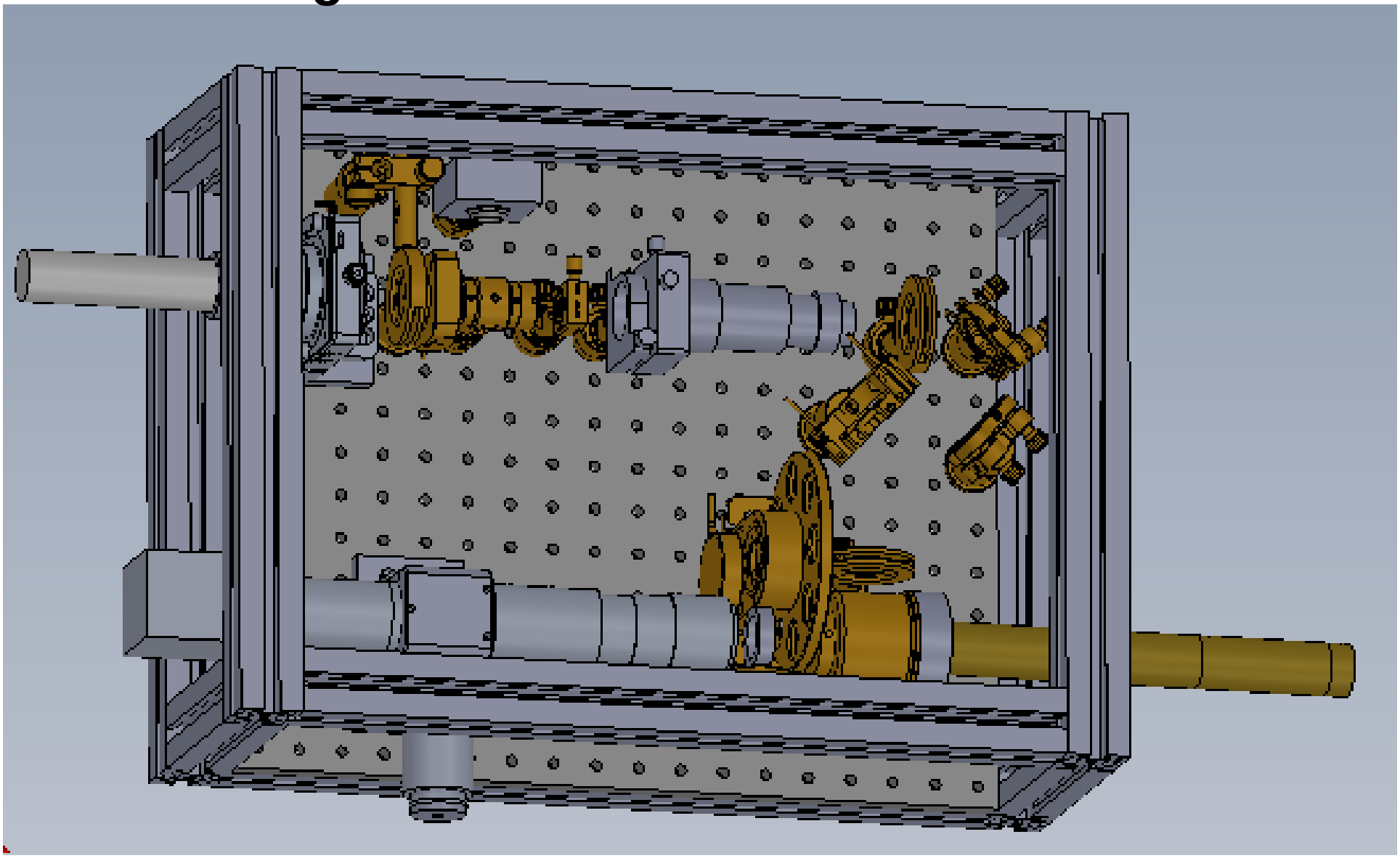


Magnification: 10-15x

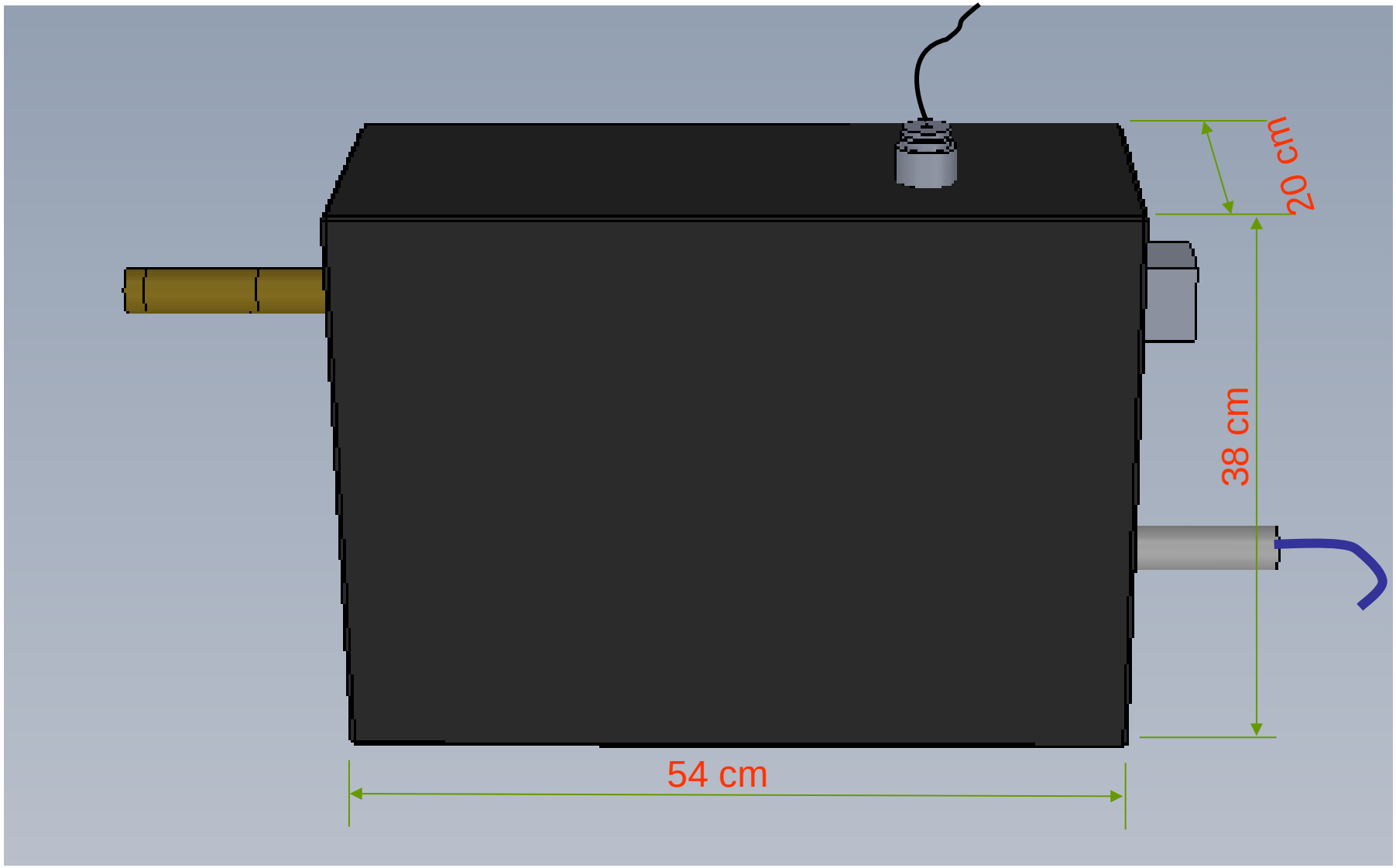
Layout …

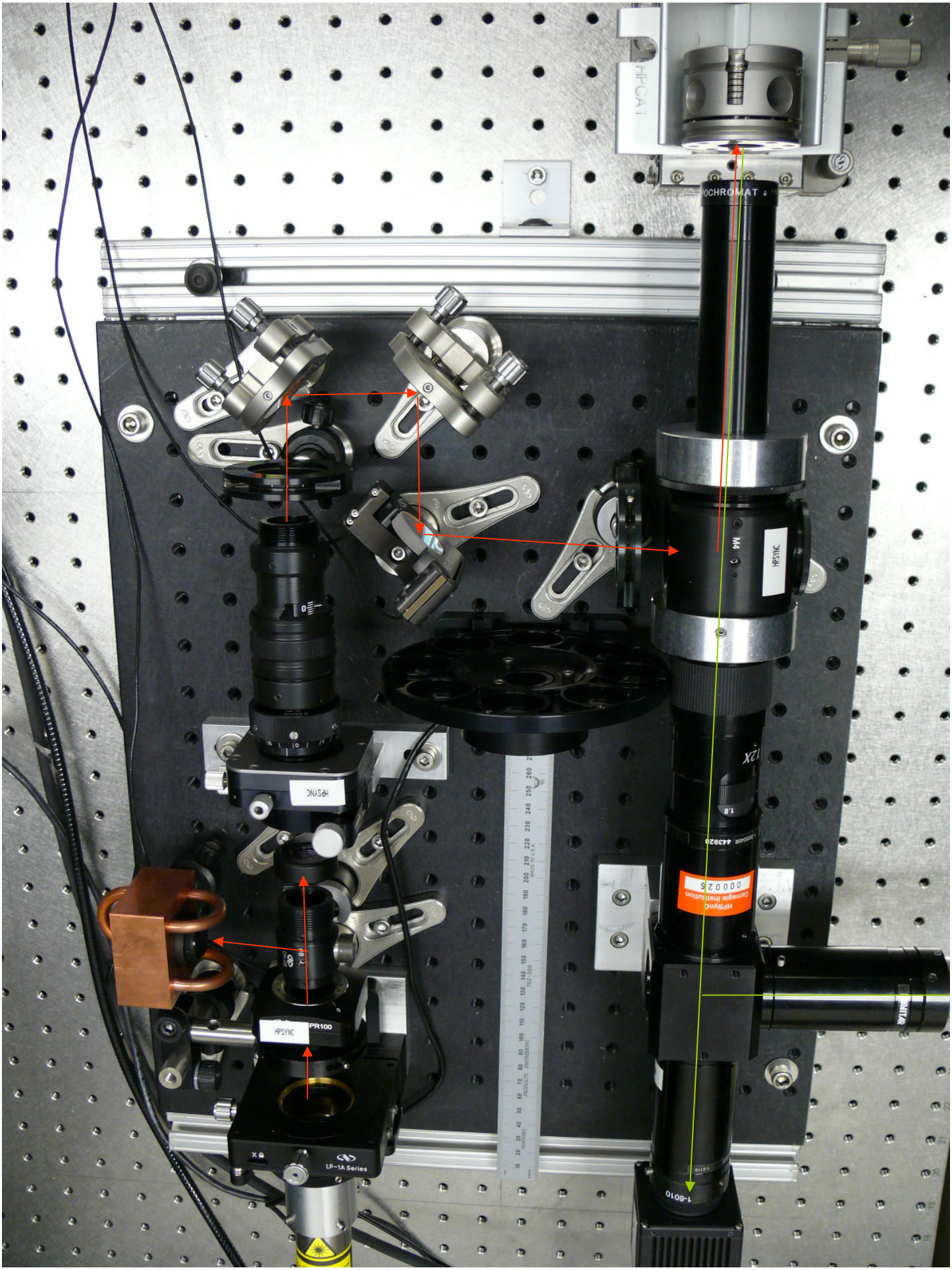


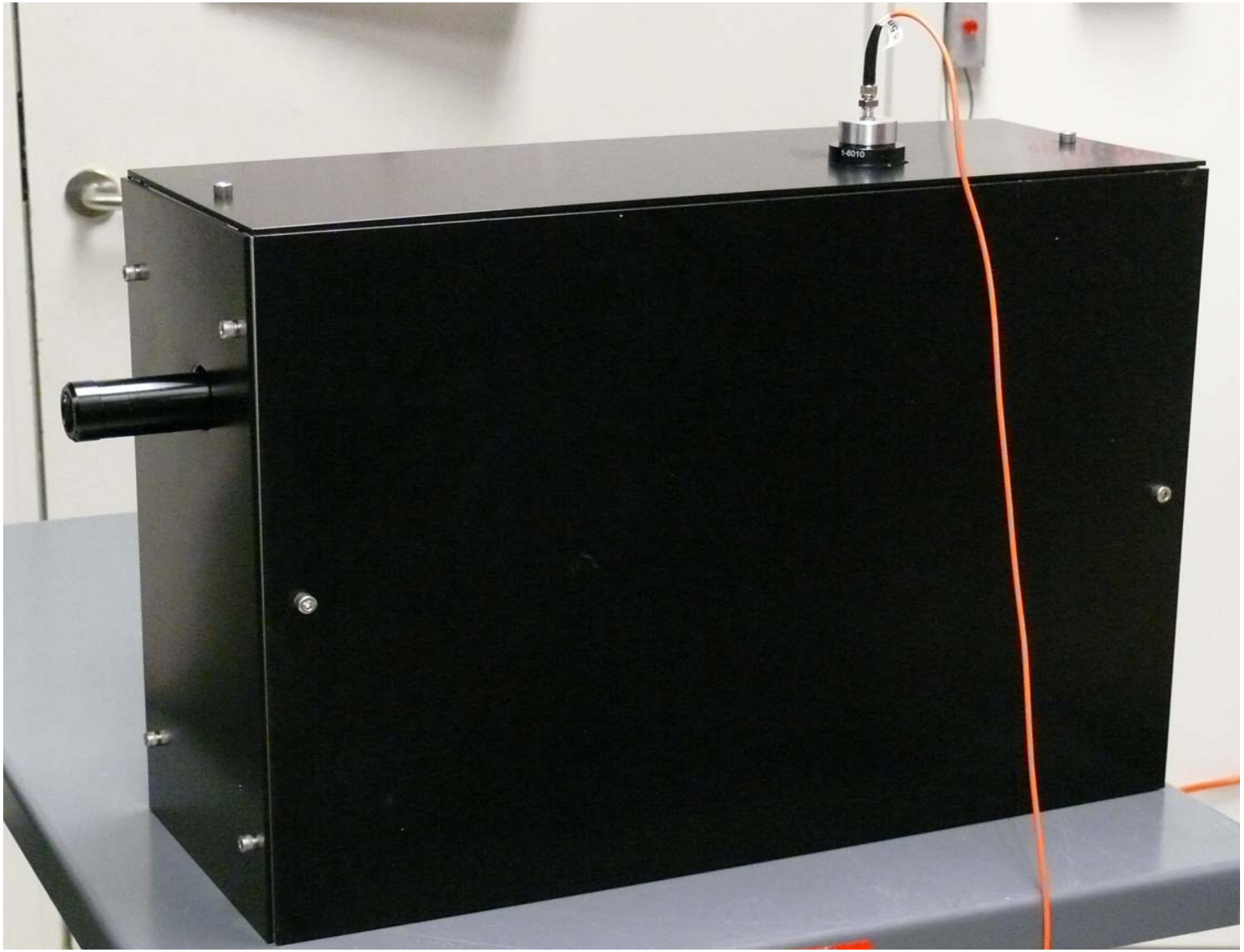
Framing …



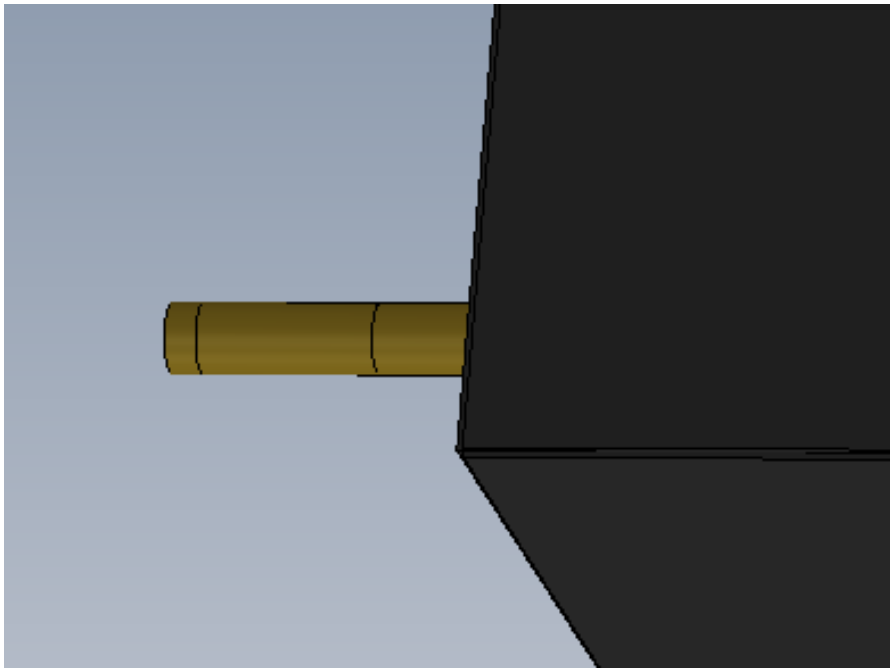
A Portable System: ~ 15 kg

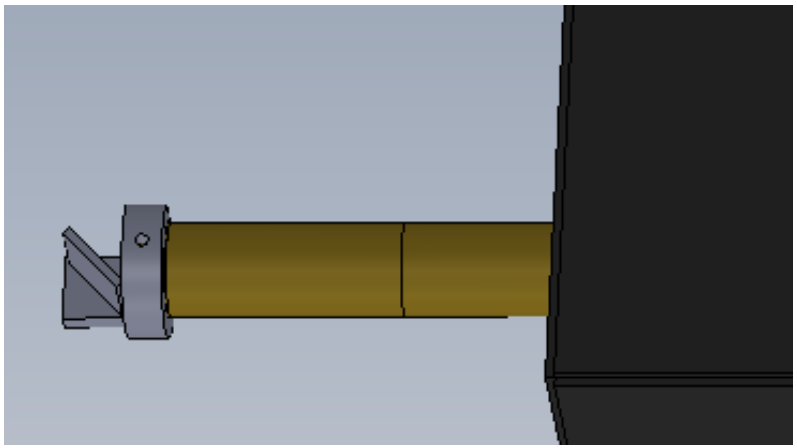


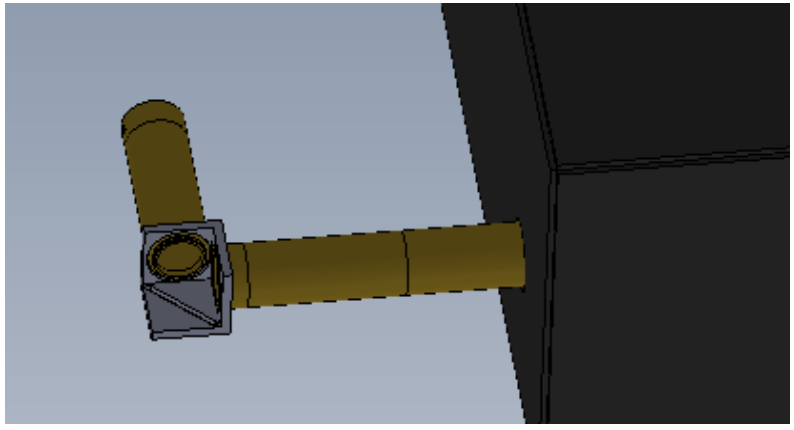

HPSYNC
HPSYNC
HPSYNC
LP-1A Series



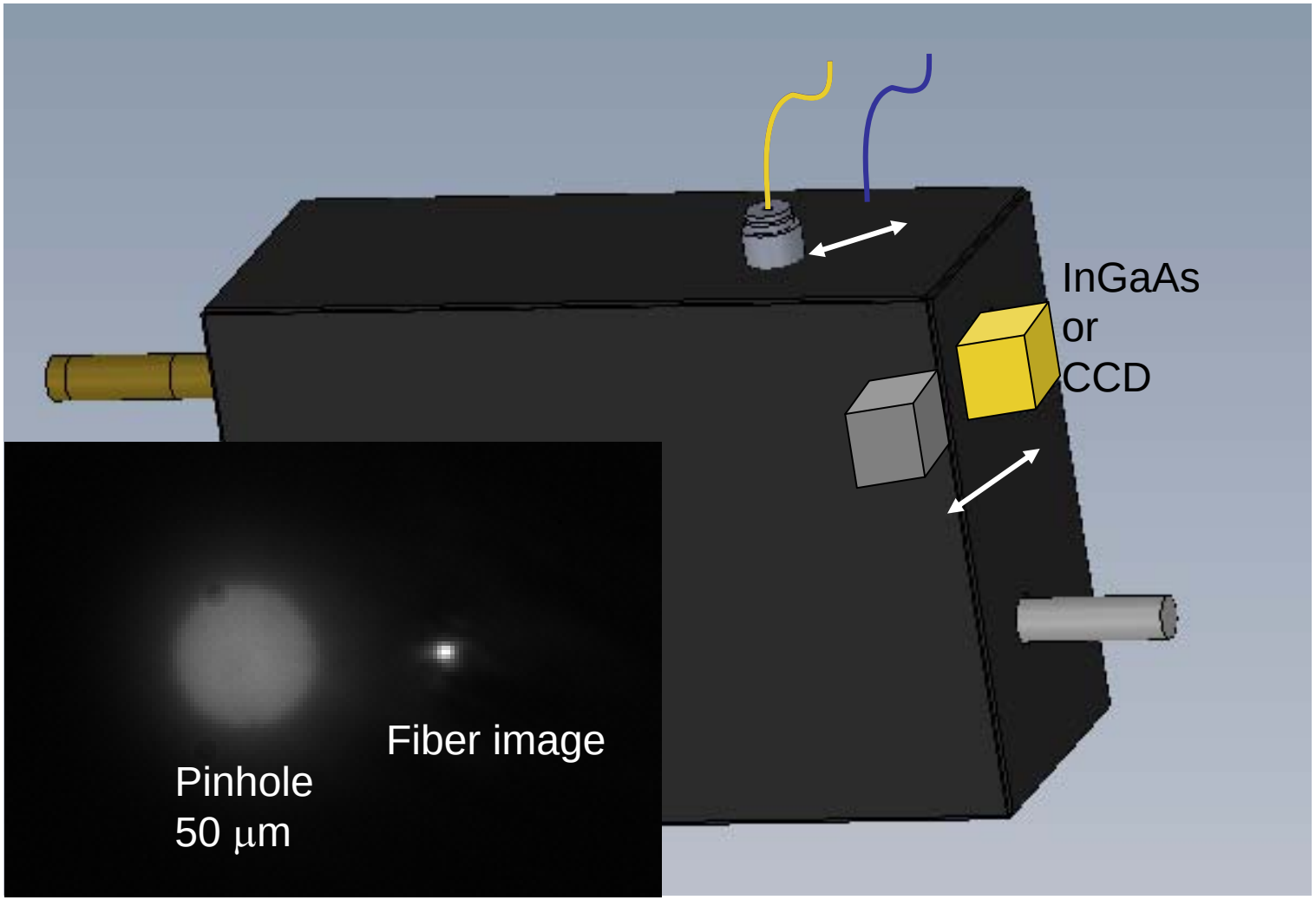
Modular design



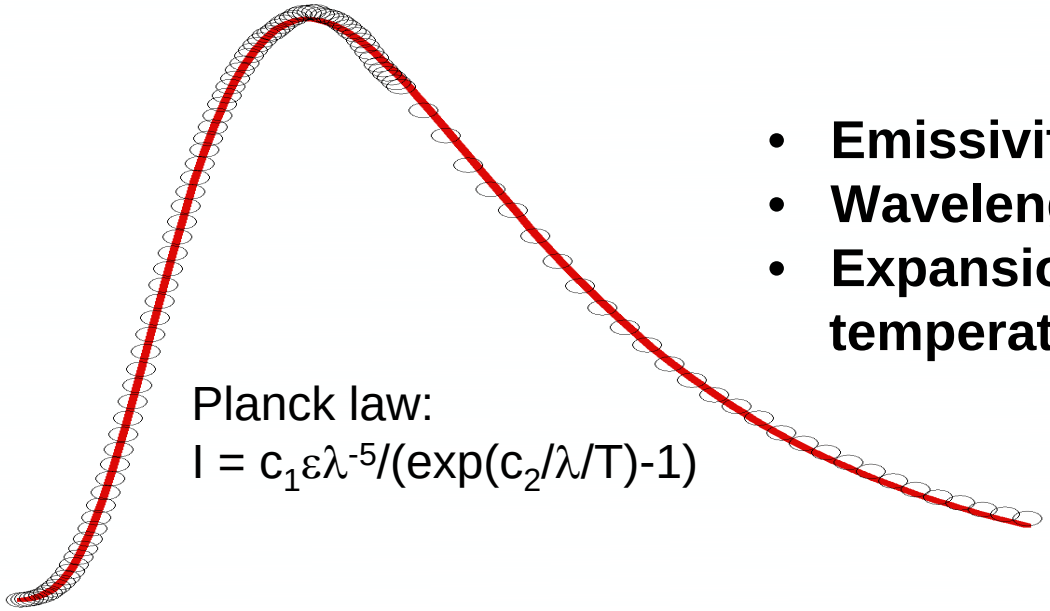




Modular design



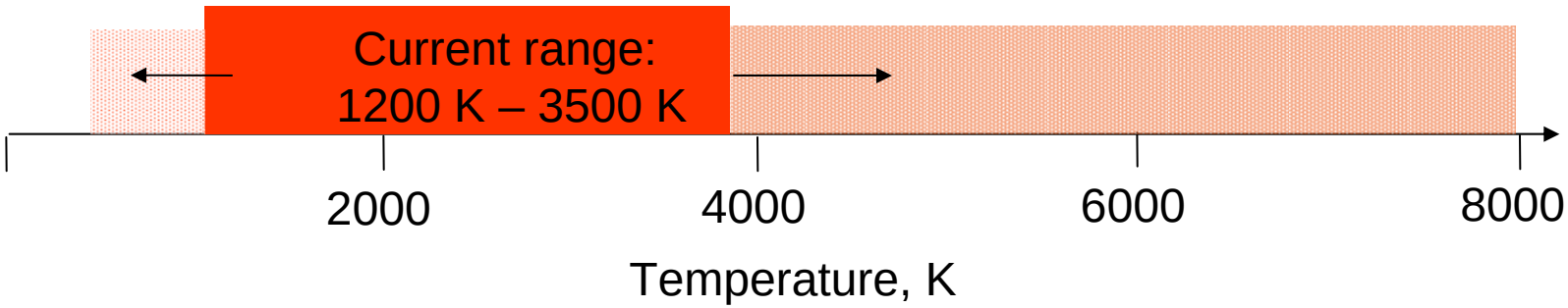
Temperature measurement

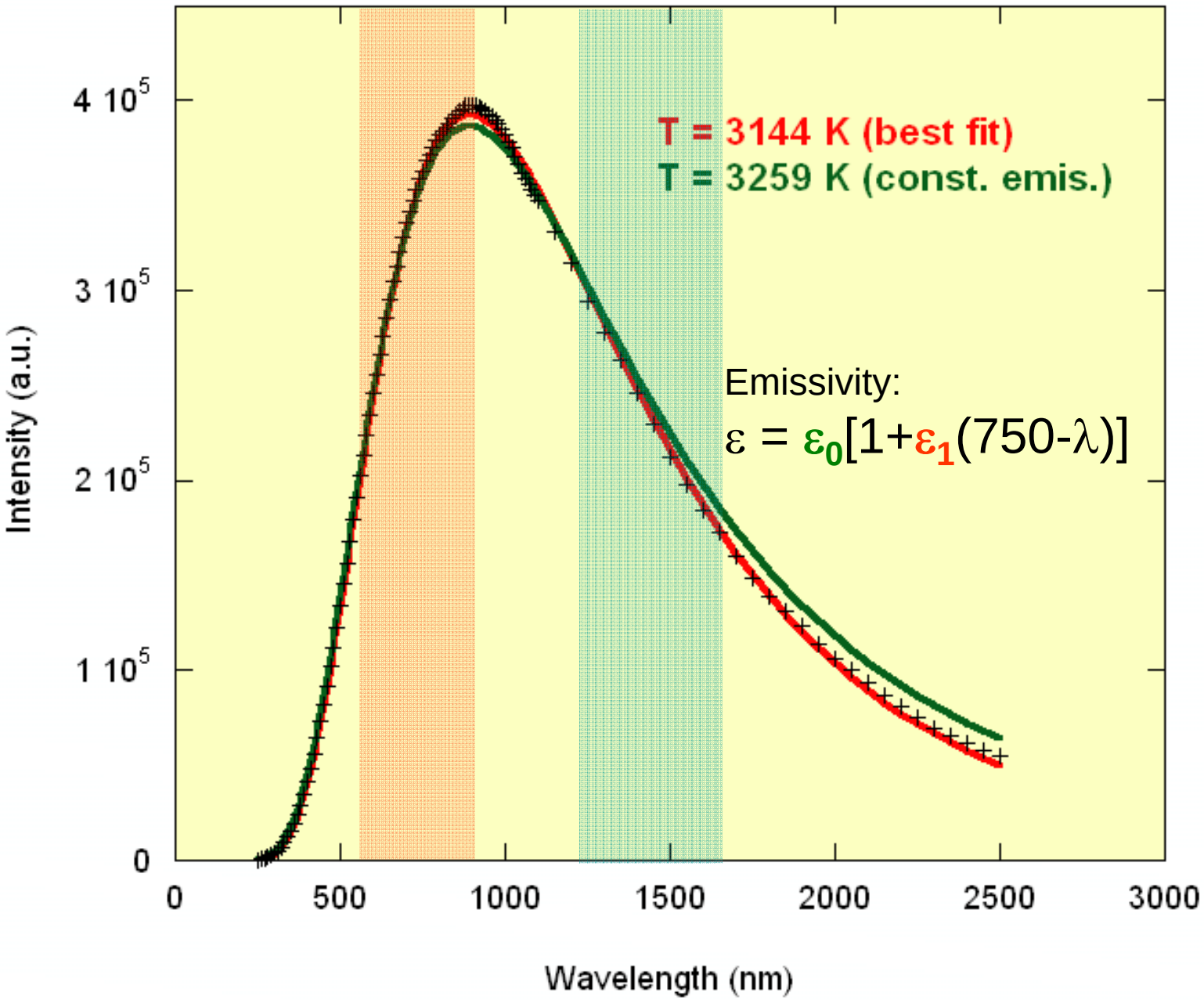


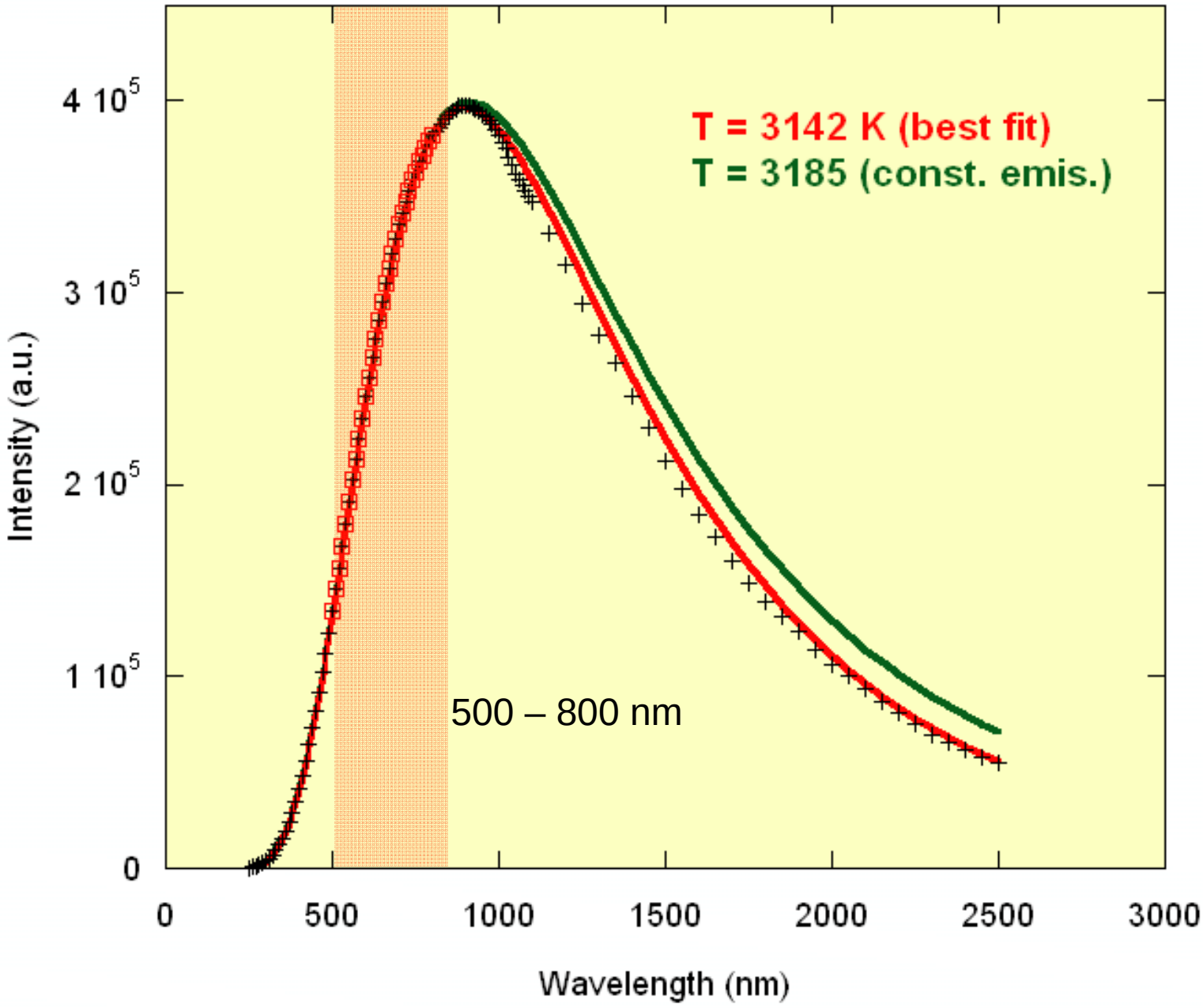
Planck law:

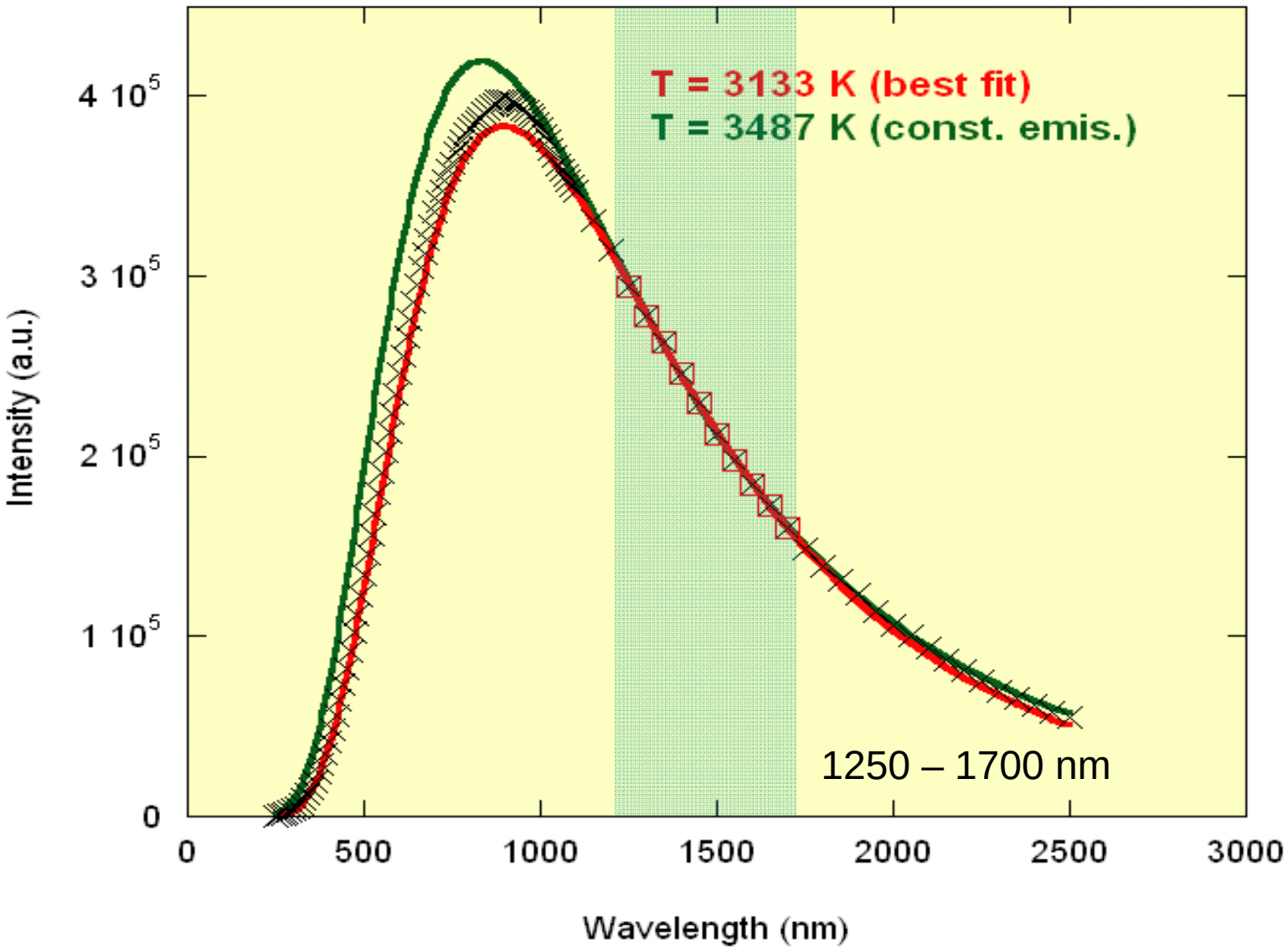
$I = c_1 \varepsilon \lambda^{-5} / (\exp(c_2/\lambda/T)-1)$

- **Emissivity**
- **Wavelength selection**
- **Expansion of temperature range**




T = 3144 K (best fit)
T = 3259 K (const. emis.)
Emissivity:
ε = ε0[1+ε1(750-λ)]
Intensity (a.u.)
Wavelength (nm)
0
1 10^5
2 10^5
3 10^5
4 10^5
0
500
1000
1500
2000
2500
3000

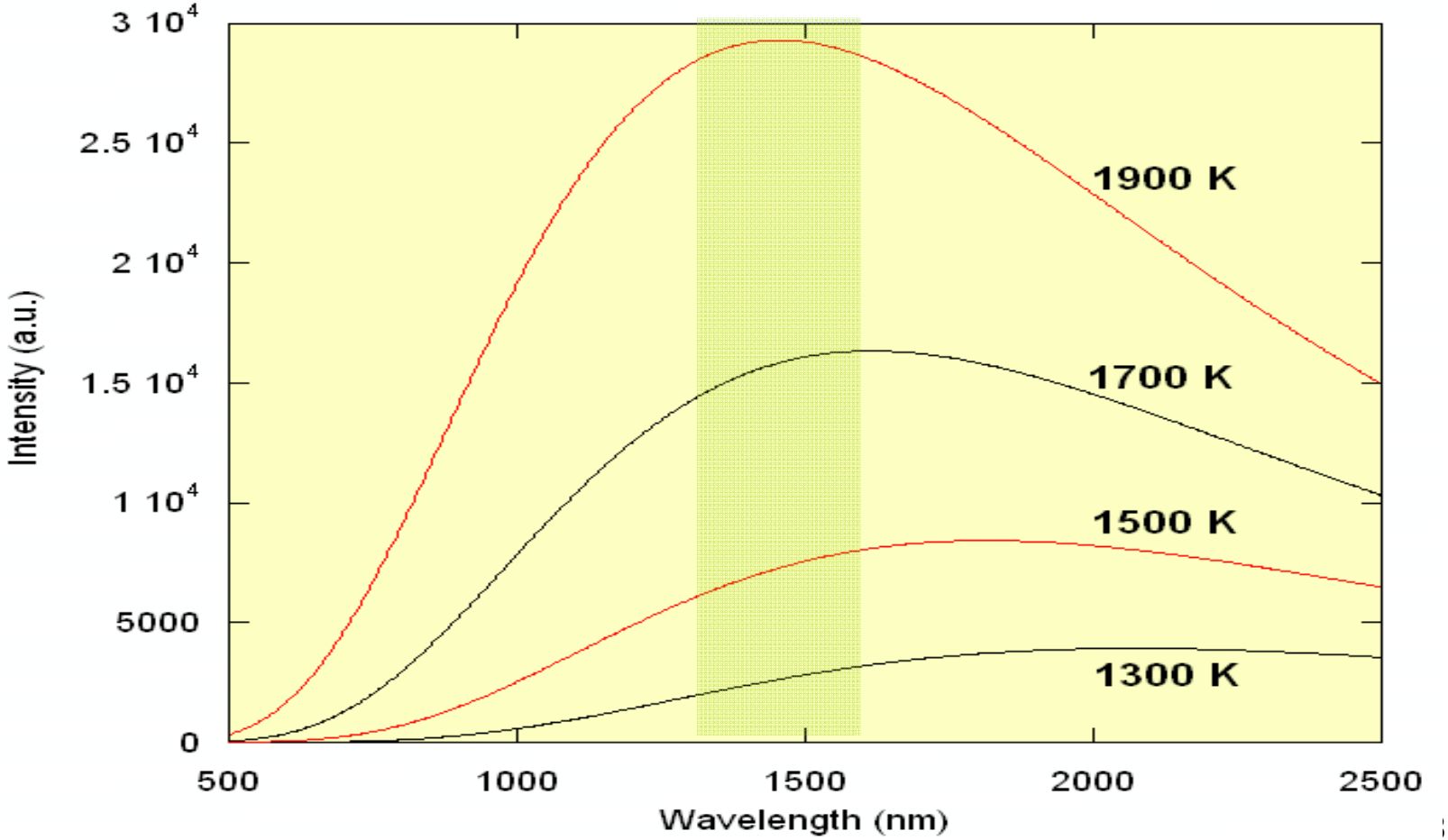

T = 3142 K (best fit)
T = 3185 (const. emis.)
500 – 800 nm
Intensity (a.u.)
Wavelength (nm)
0
1 10^5
2 10^5
3 10^5
4 10^5
0
500
1000
1500
2000
2500
3000



Large uncertainties in temperature if only right side data are used

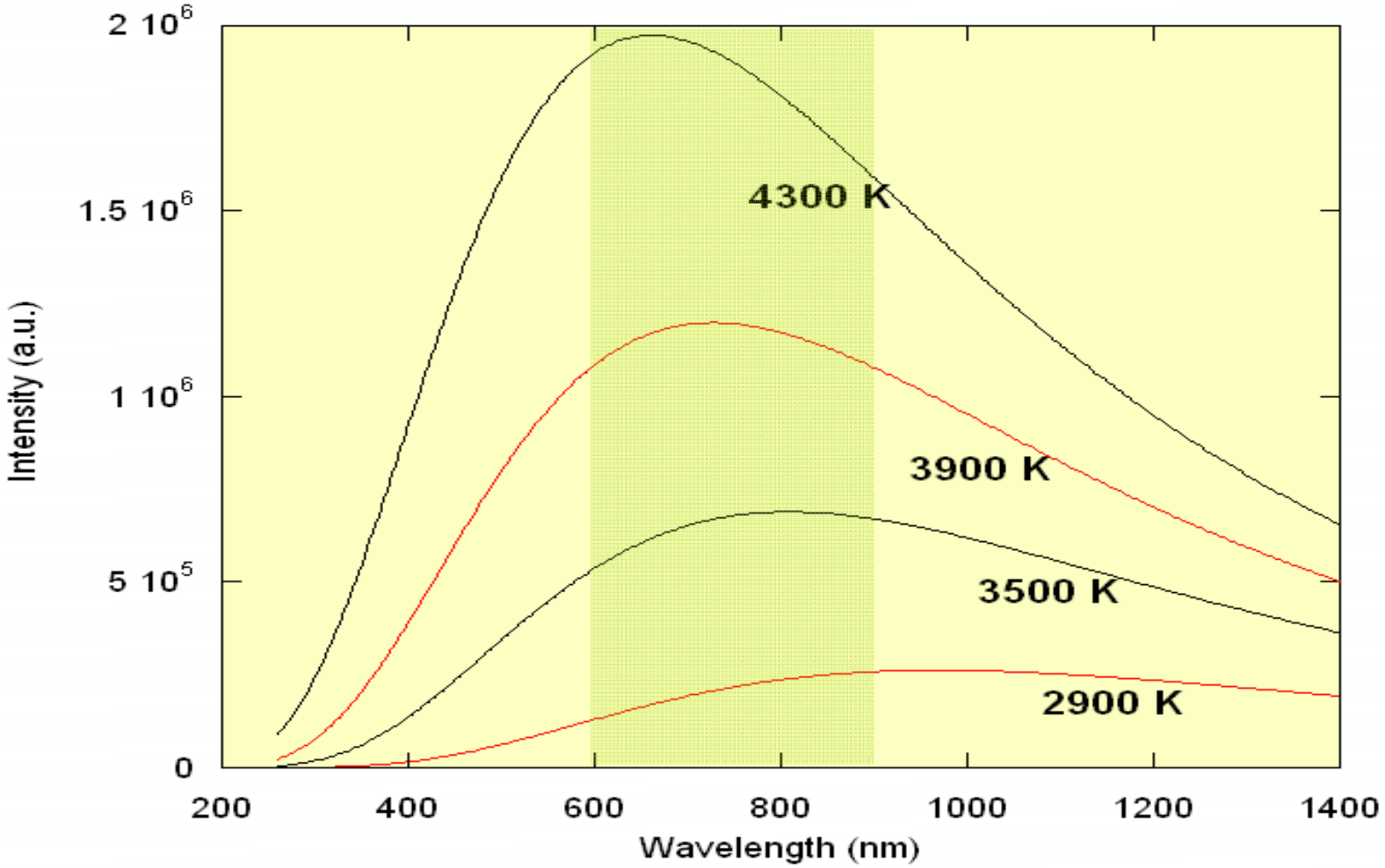
Wavelength selection

1300 – 1600 nm for <1700 K



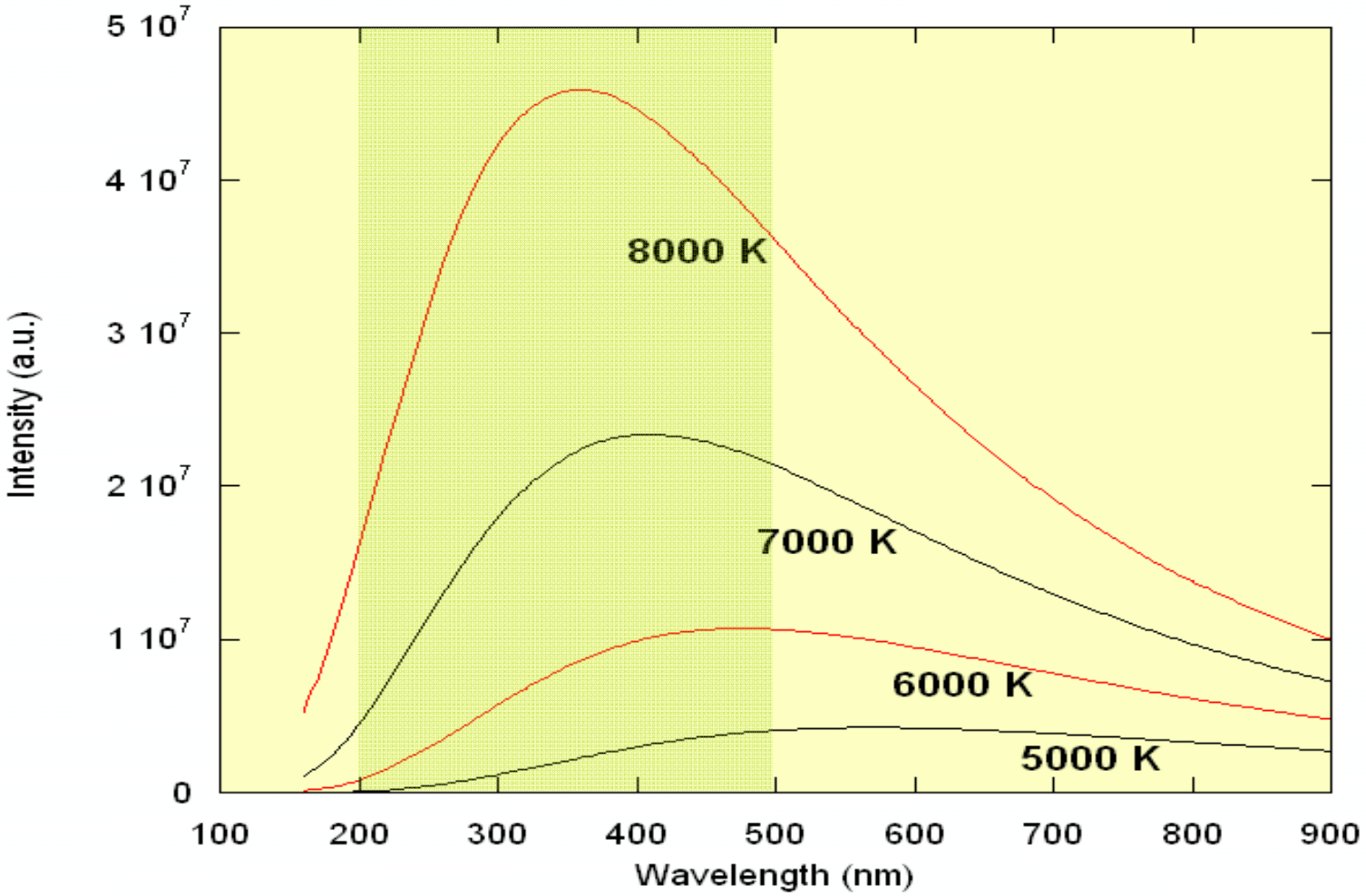
Wavelength selection

600 – 900 nm for 1200 - 3500 K



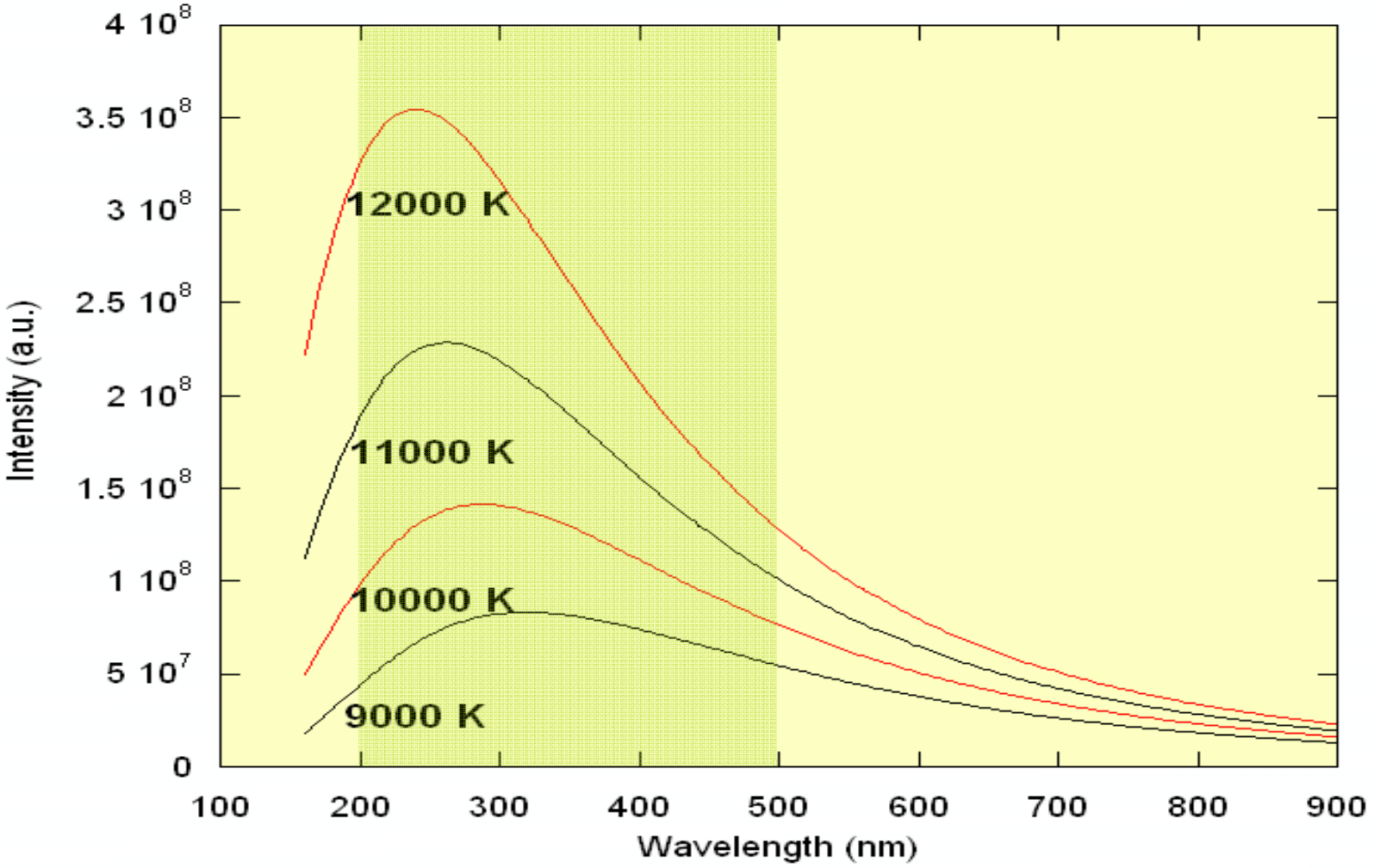
Wavelength selection

200 – 500 nm for >5000 K

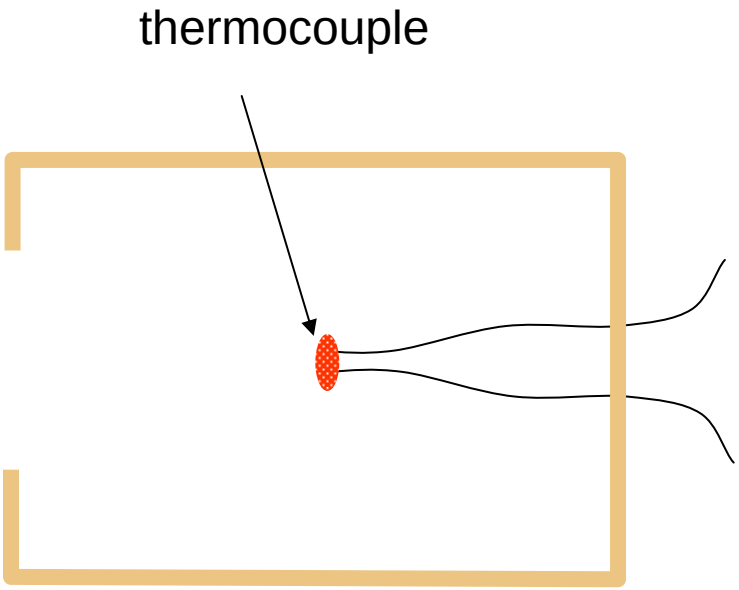


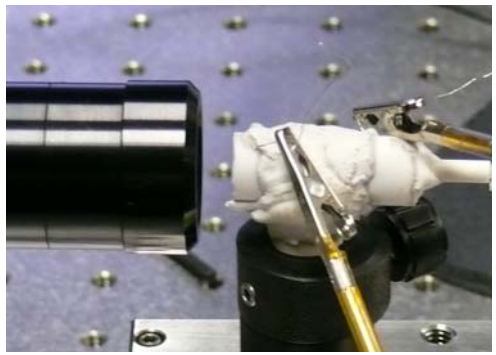
Wavelength selection

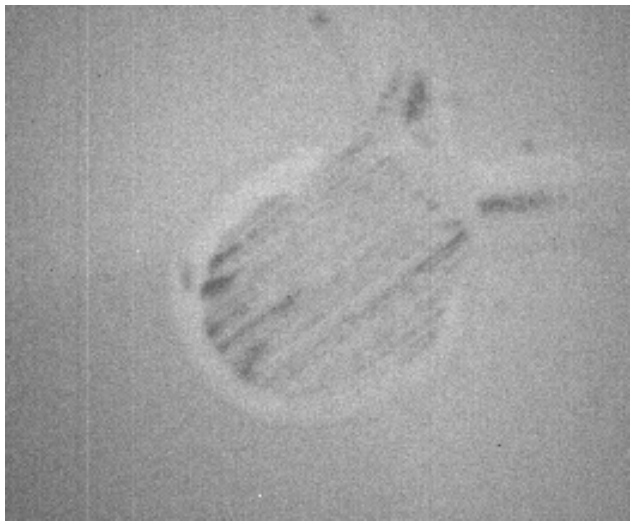
200 – 500 nm for > 5000 K



Medium Temperature 500-1200K

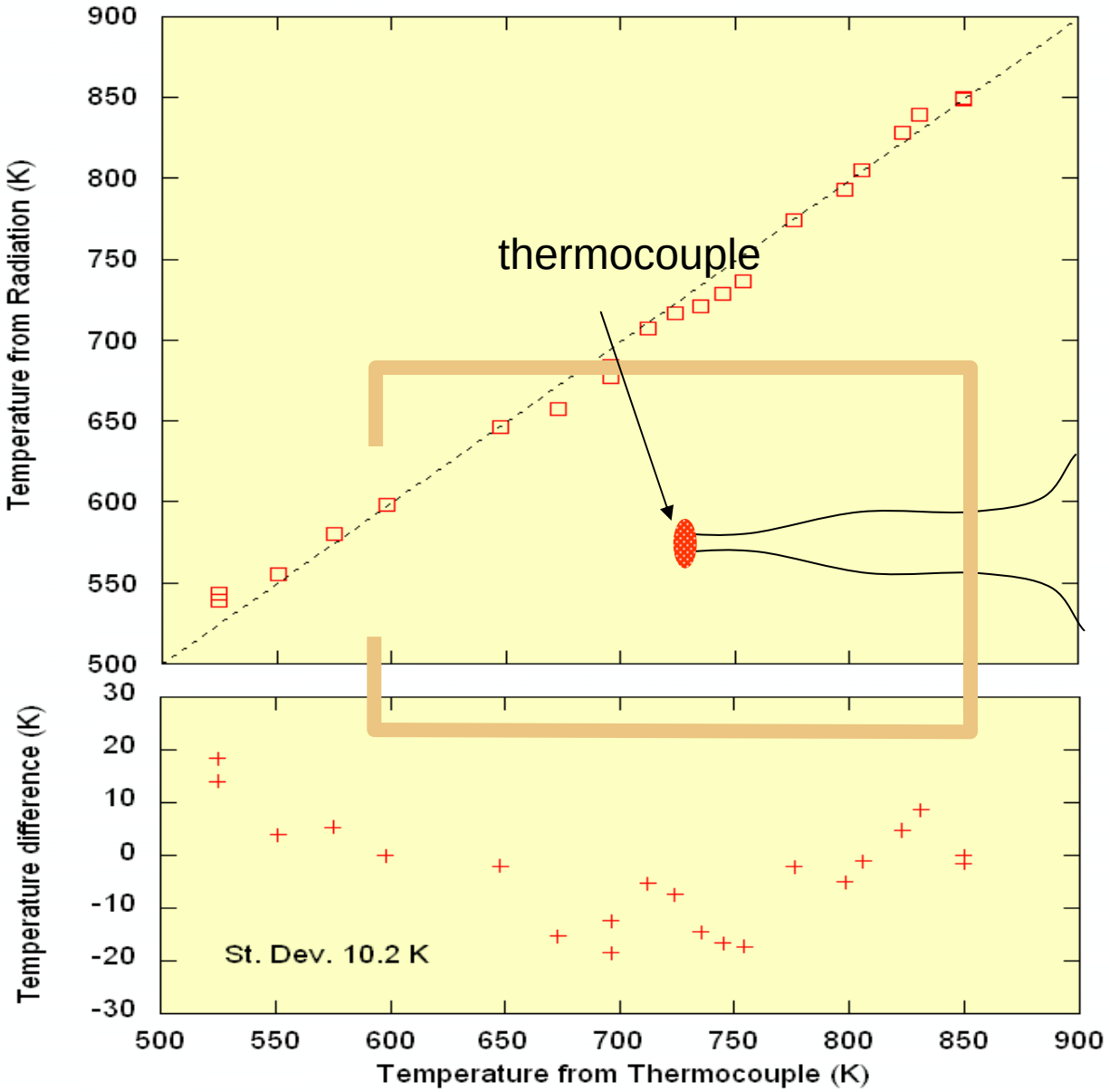


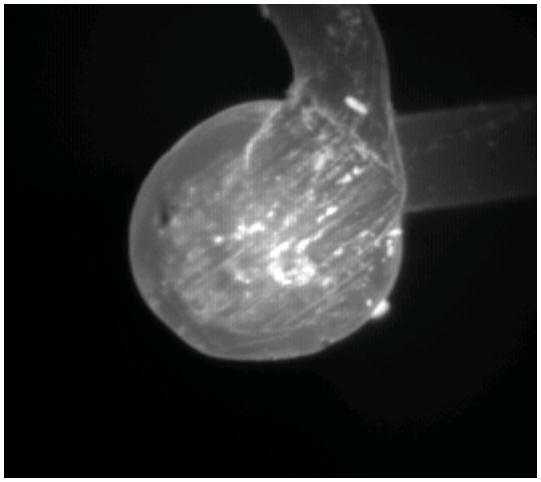




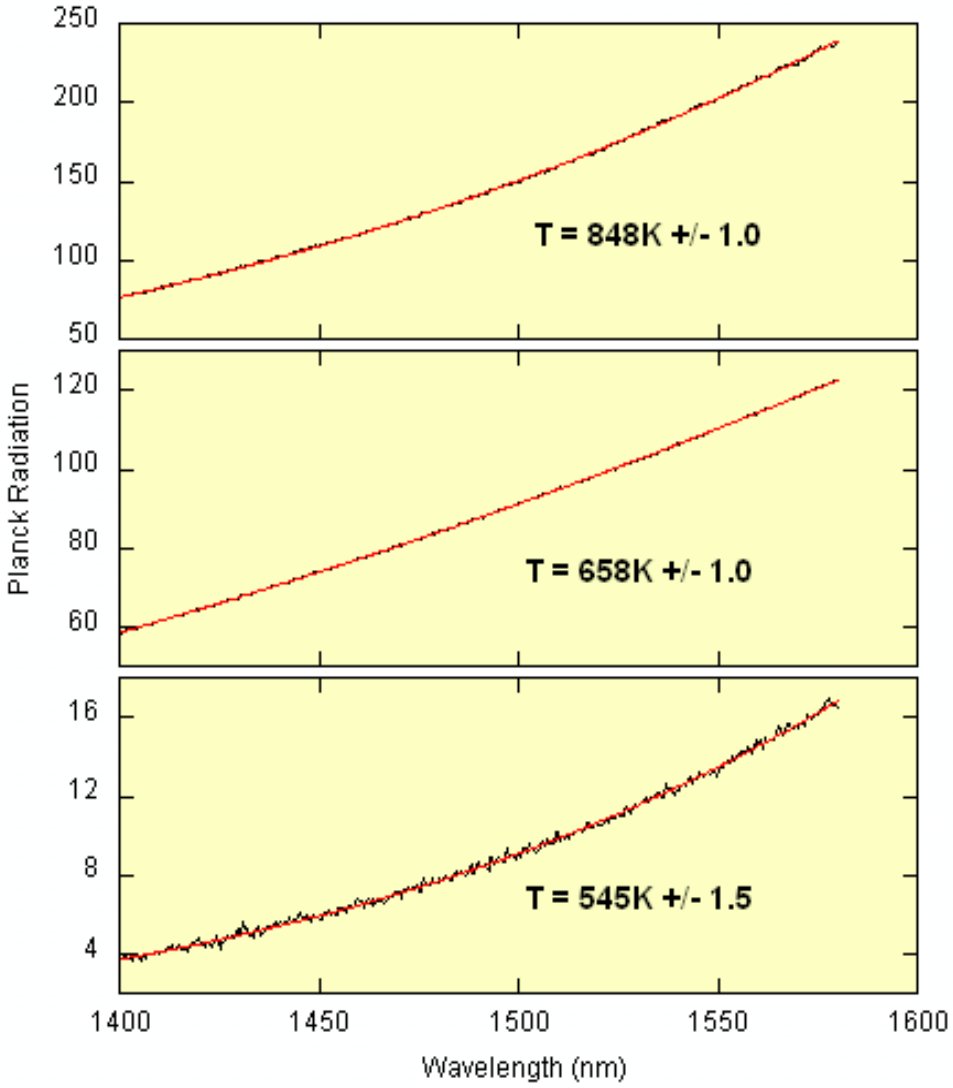
A thermal couple image at 473 K

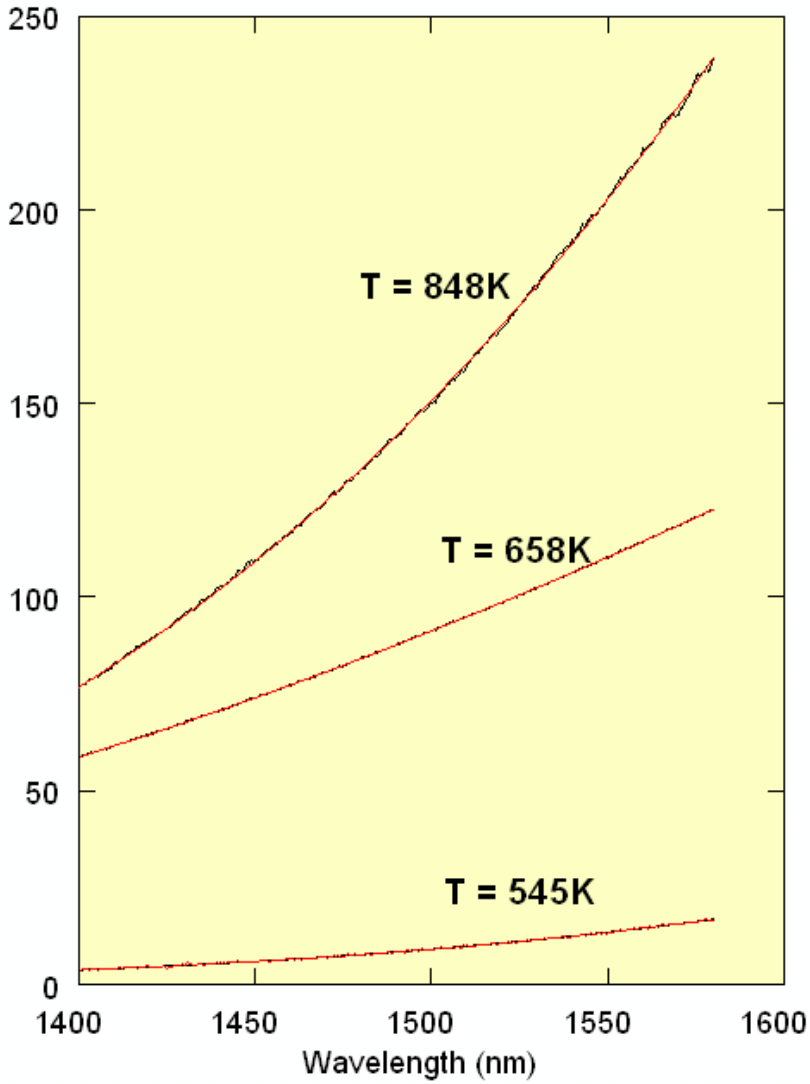
Medium Temperature 500-1200K



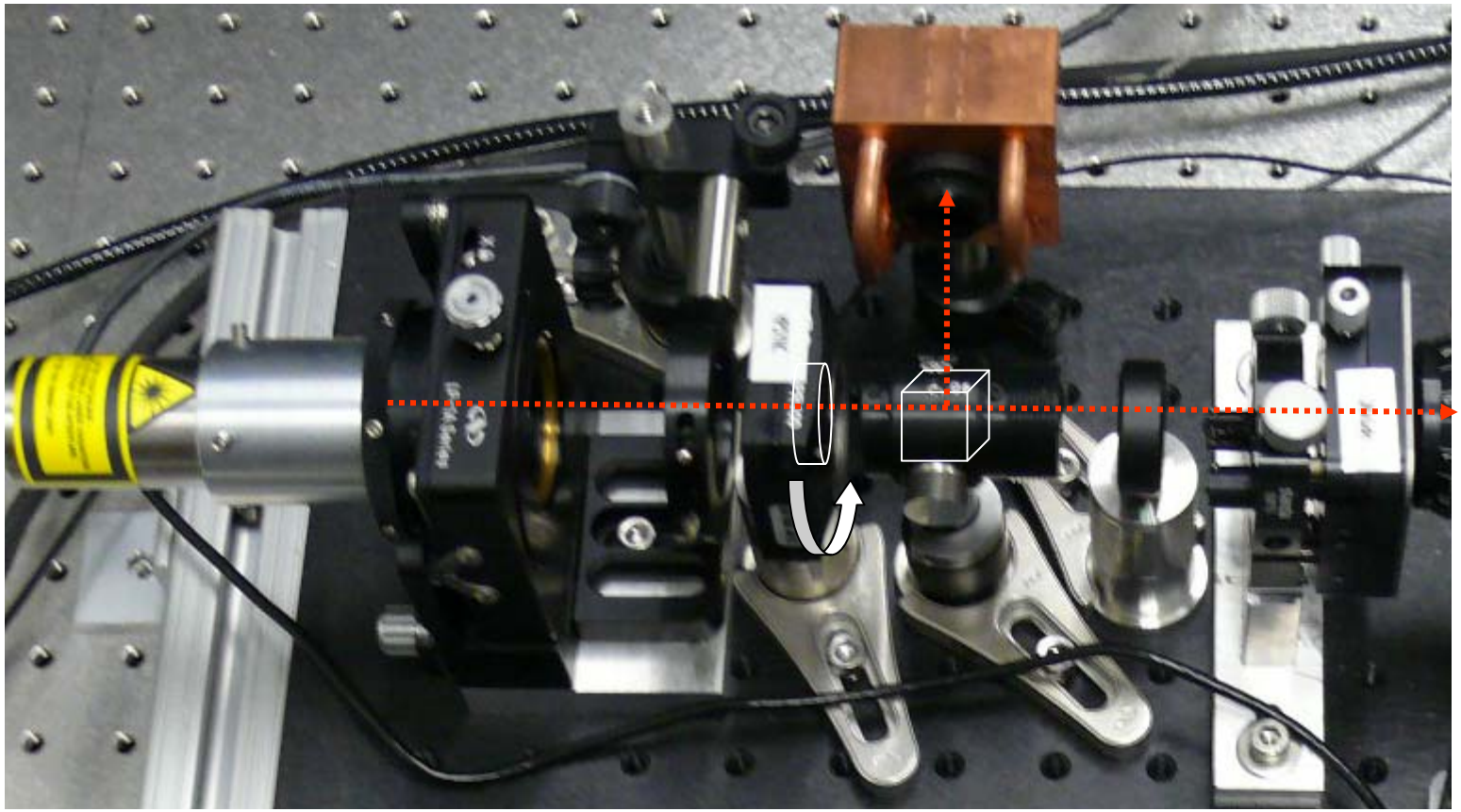


Medium Temperature

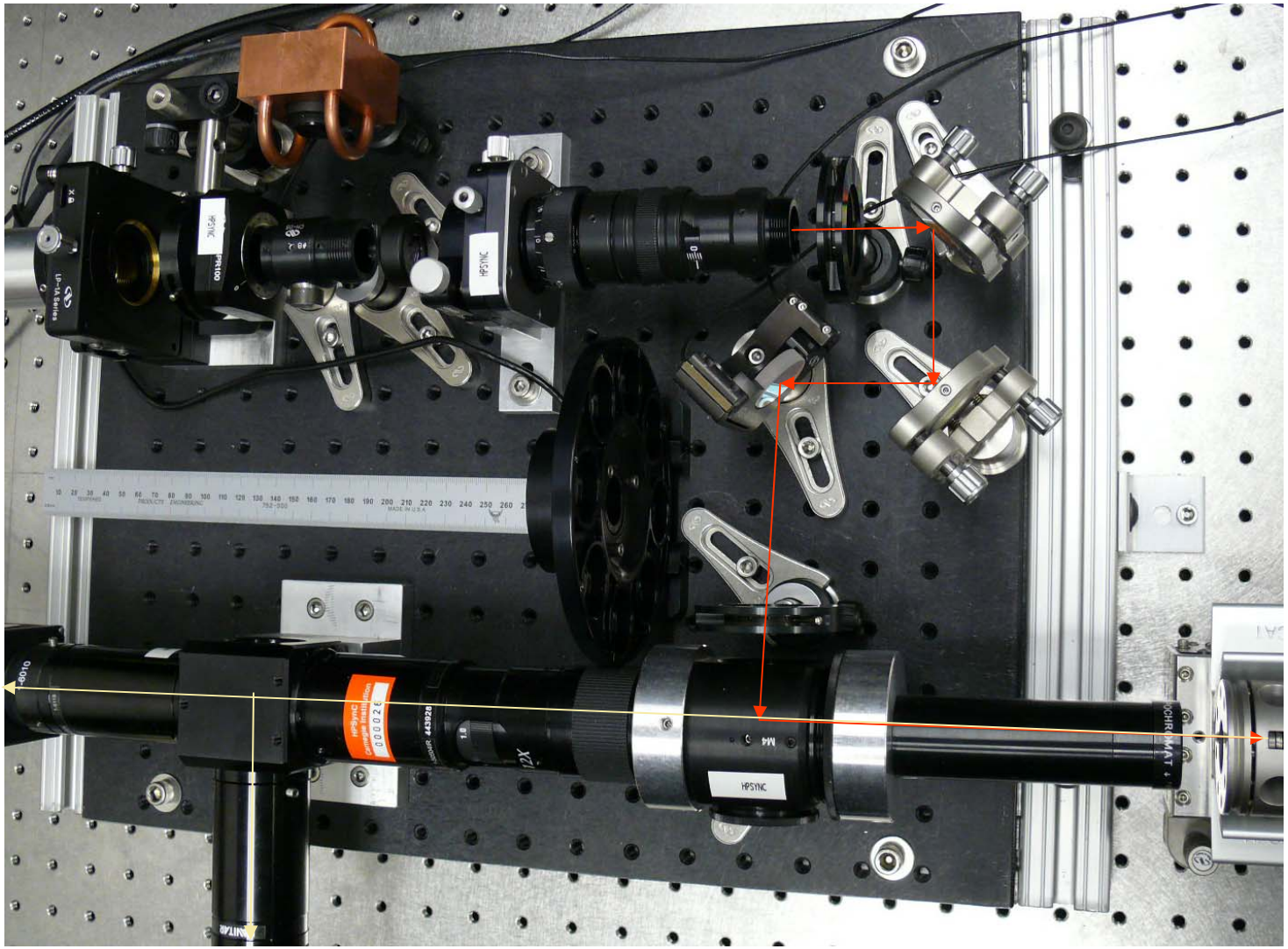




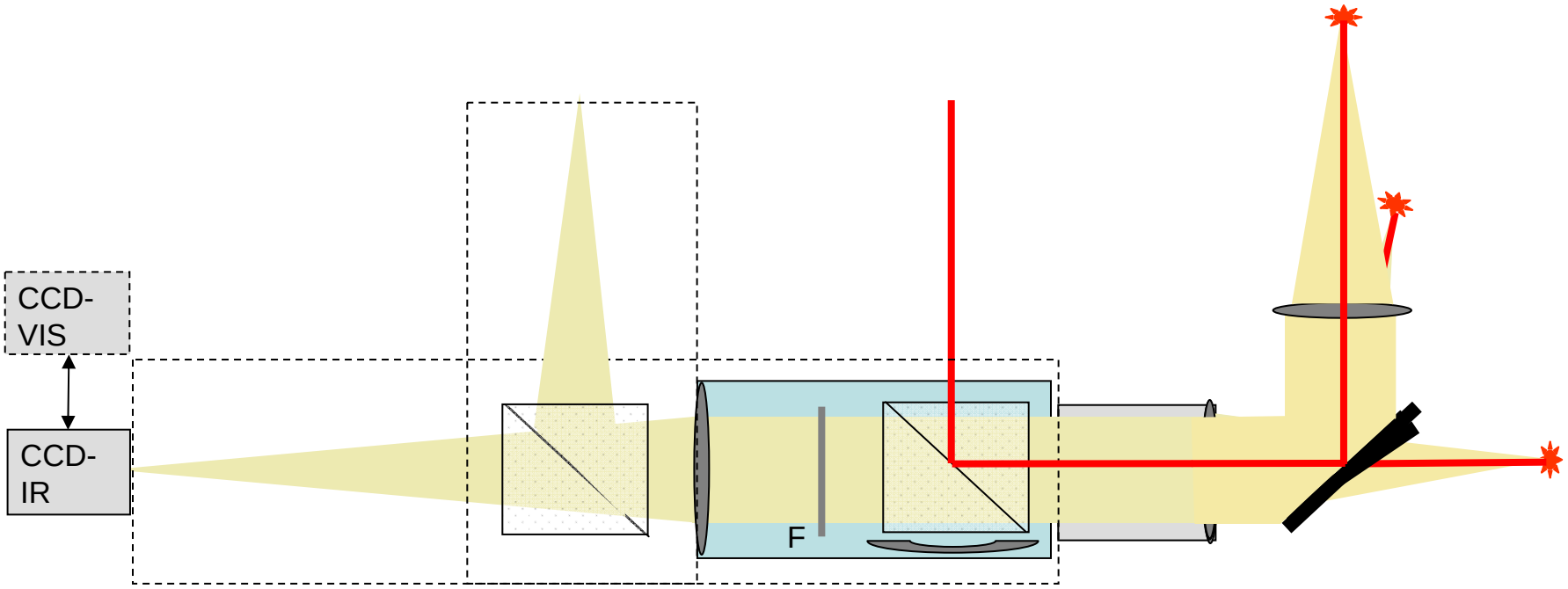
Laser power control



Co-axial arrangement

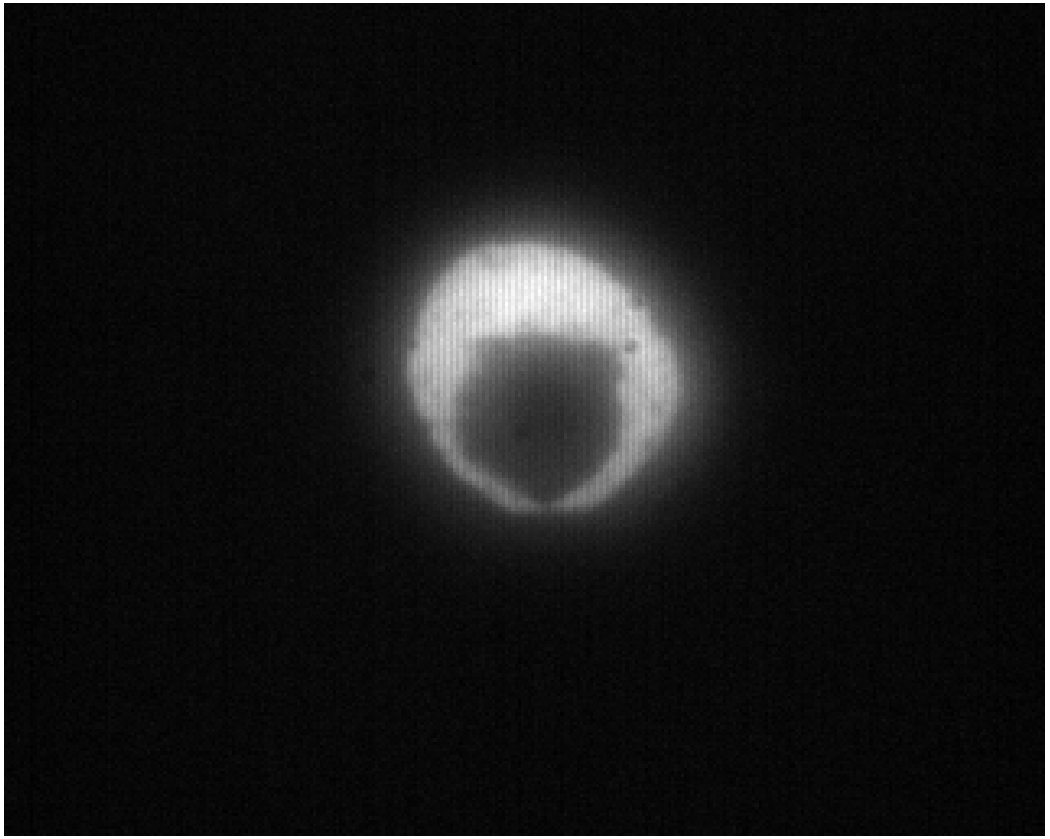


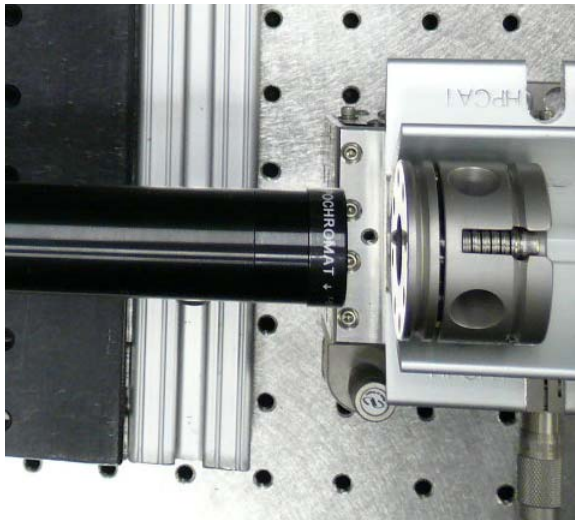
Co-axial arrangement



Magnification: 10-15x

Heating spot: ~30-50 μm in diameter



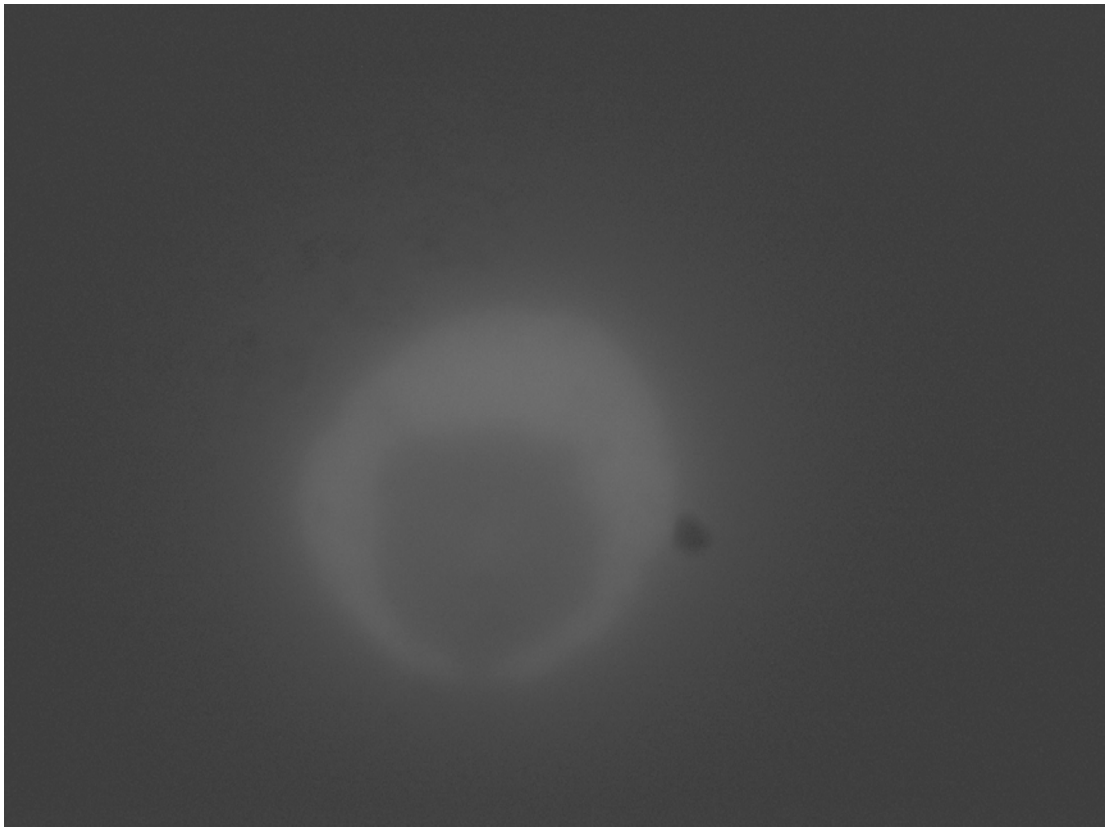


150 μm chamber size

By InGaAs Camera

T: 500 – 2000 K

Heating spot: ~30-50 μm in diameter



150 μm chamber size

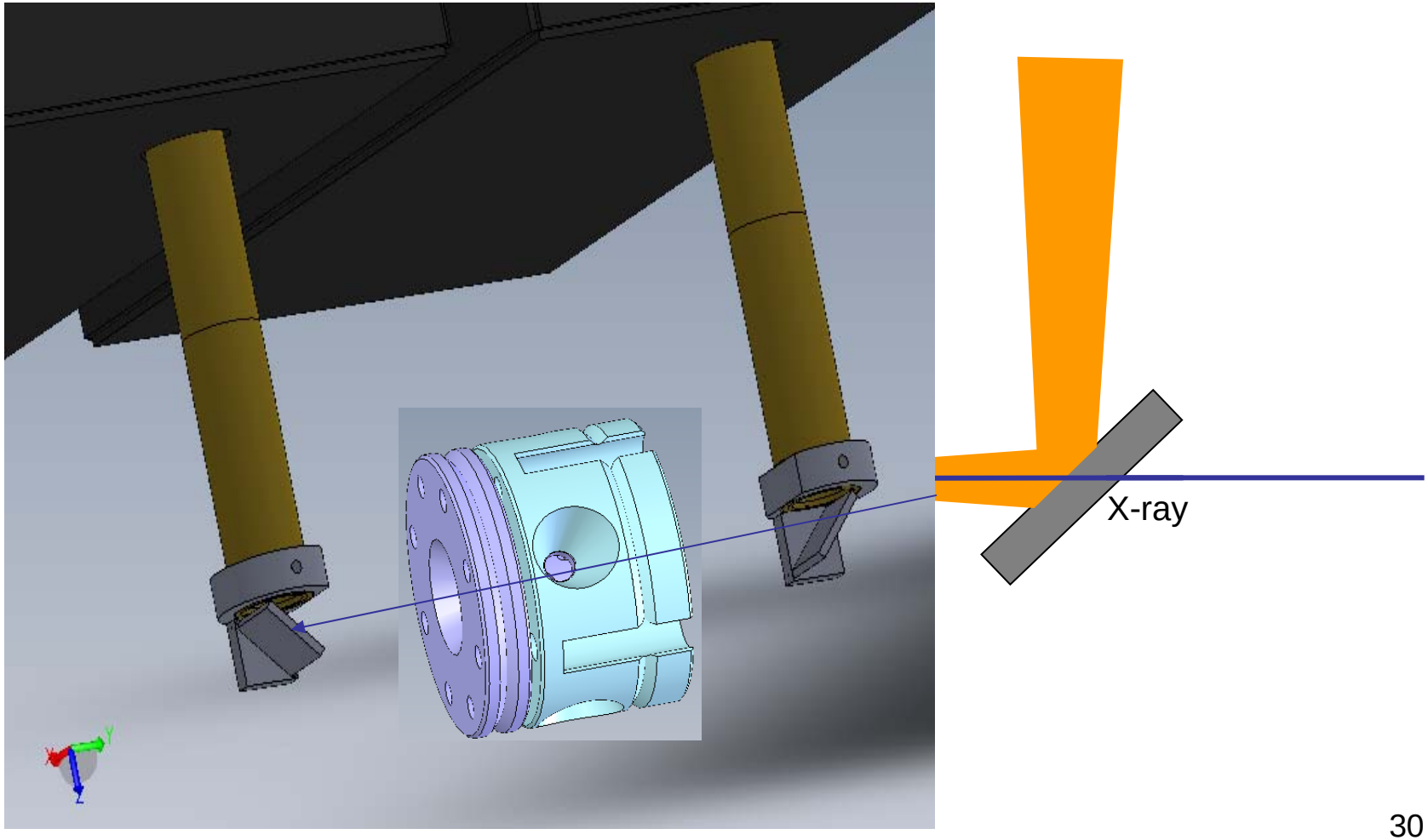
By CCD Camera

T: >1500 K

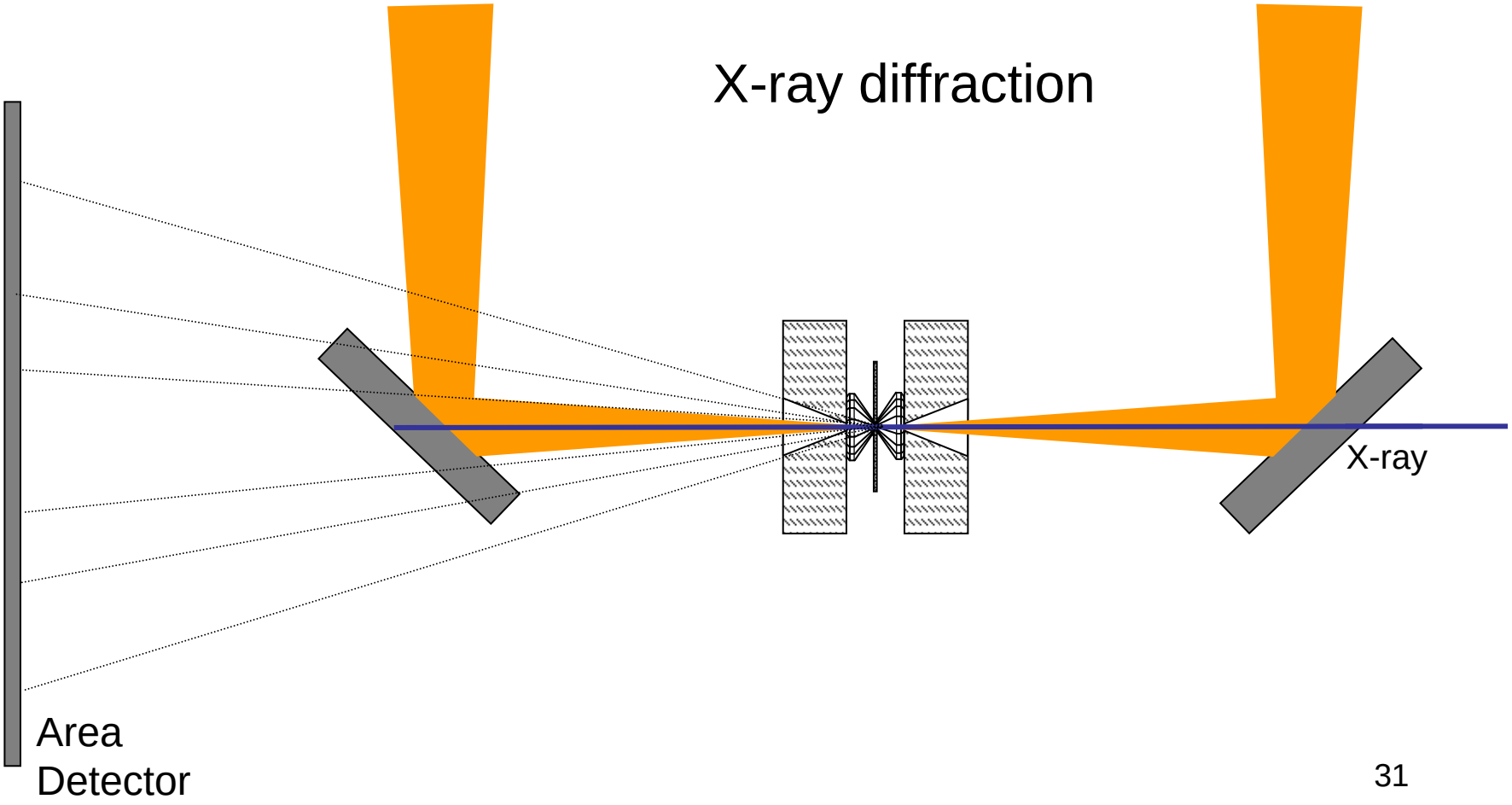
For very high T (>3500K), filters are used

Applications

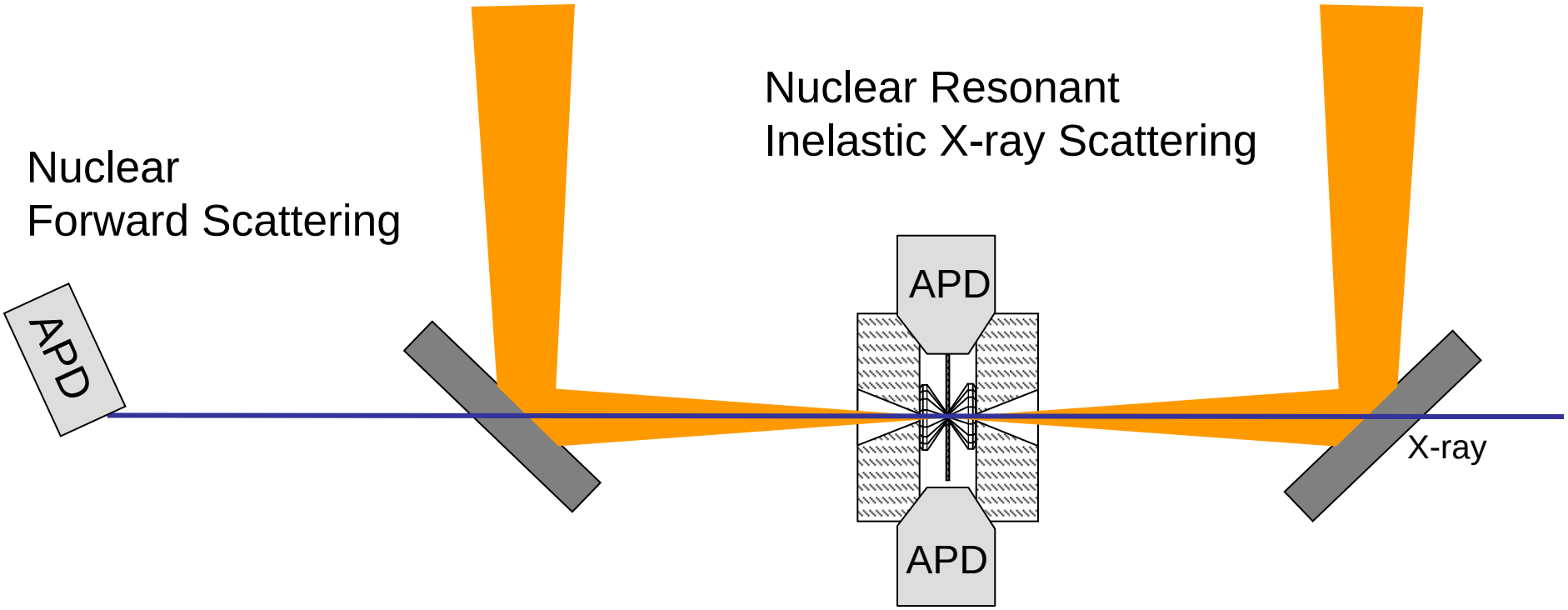
Axial Geometry



Applications

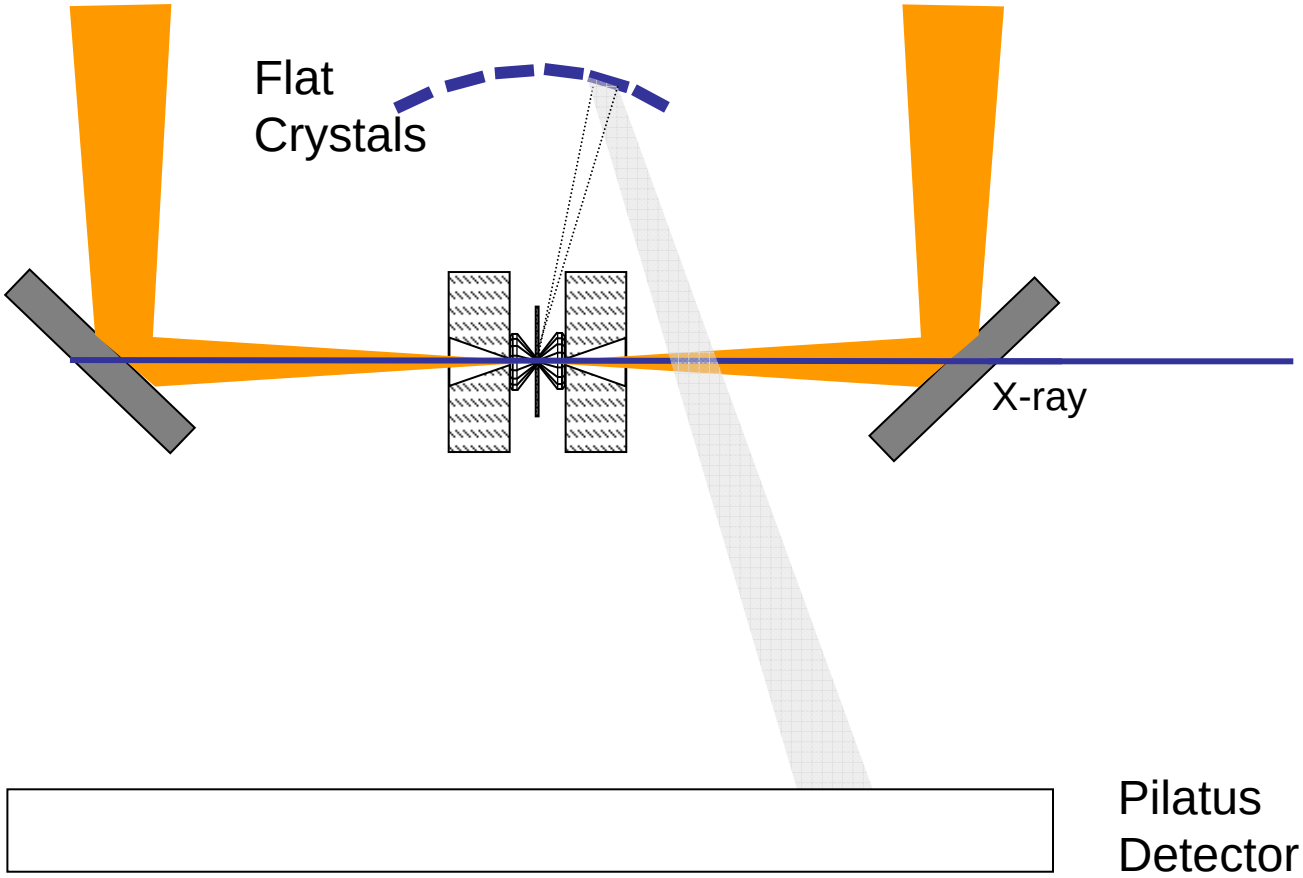


Applications

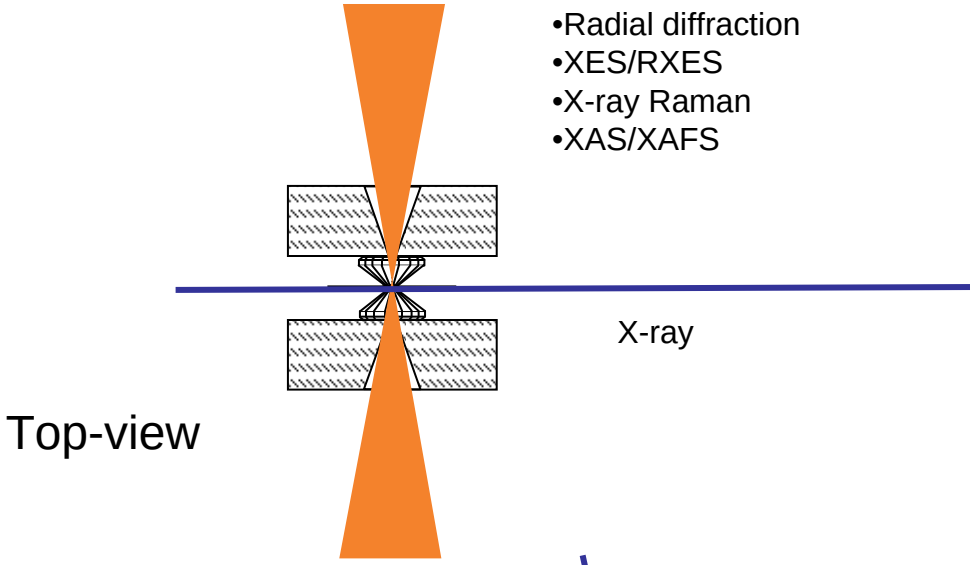


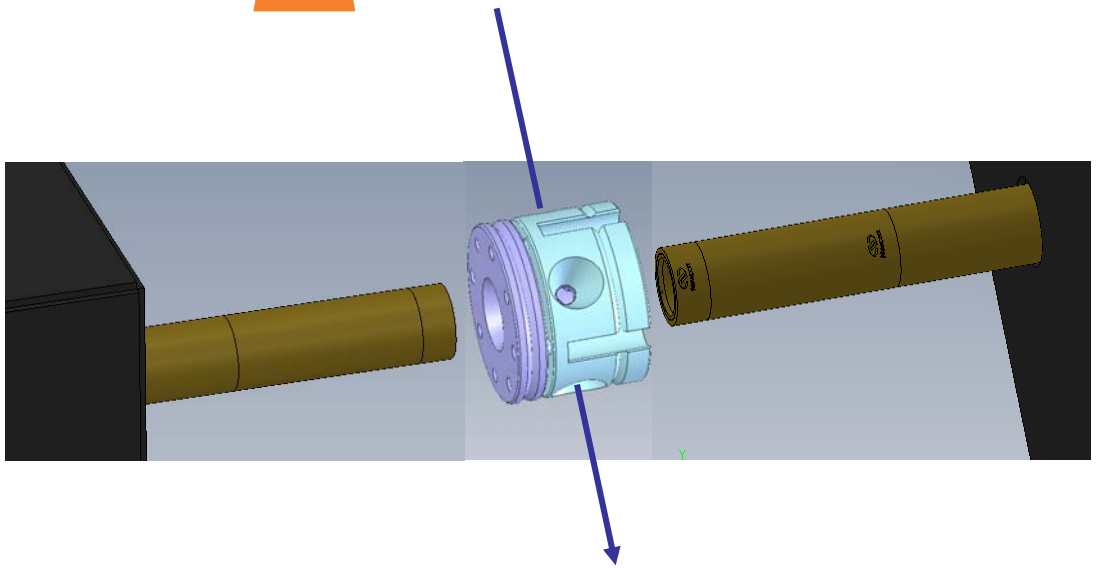
Applications

X-ray Emission spectroscopy

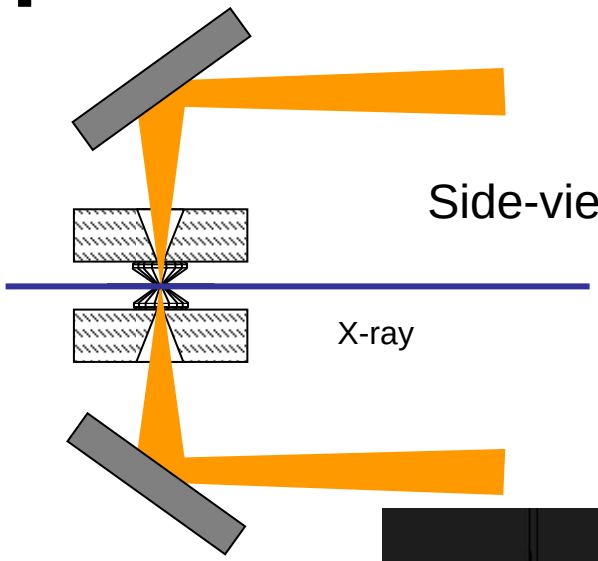


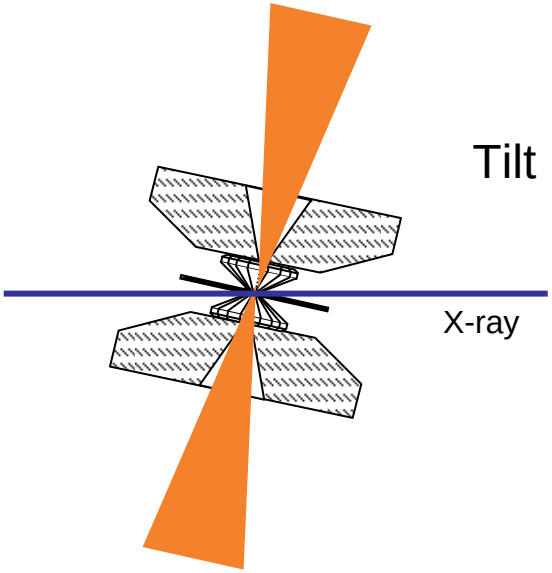
Application – Radial Geometry

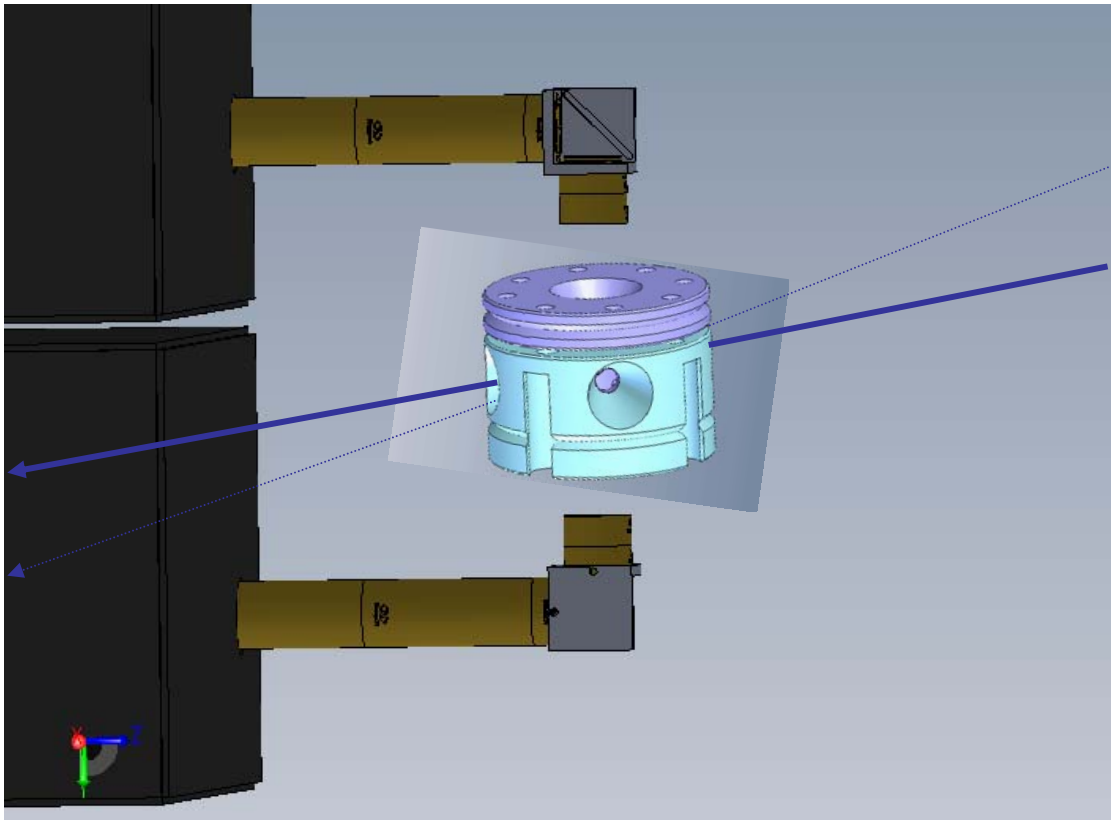




Application – Radial Geometry

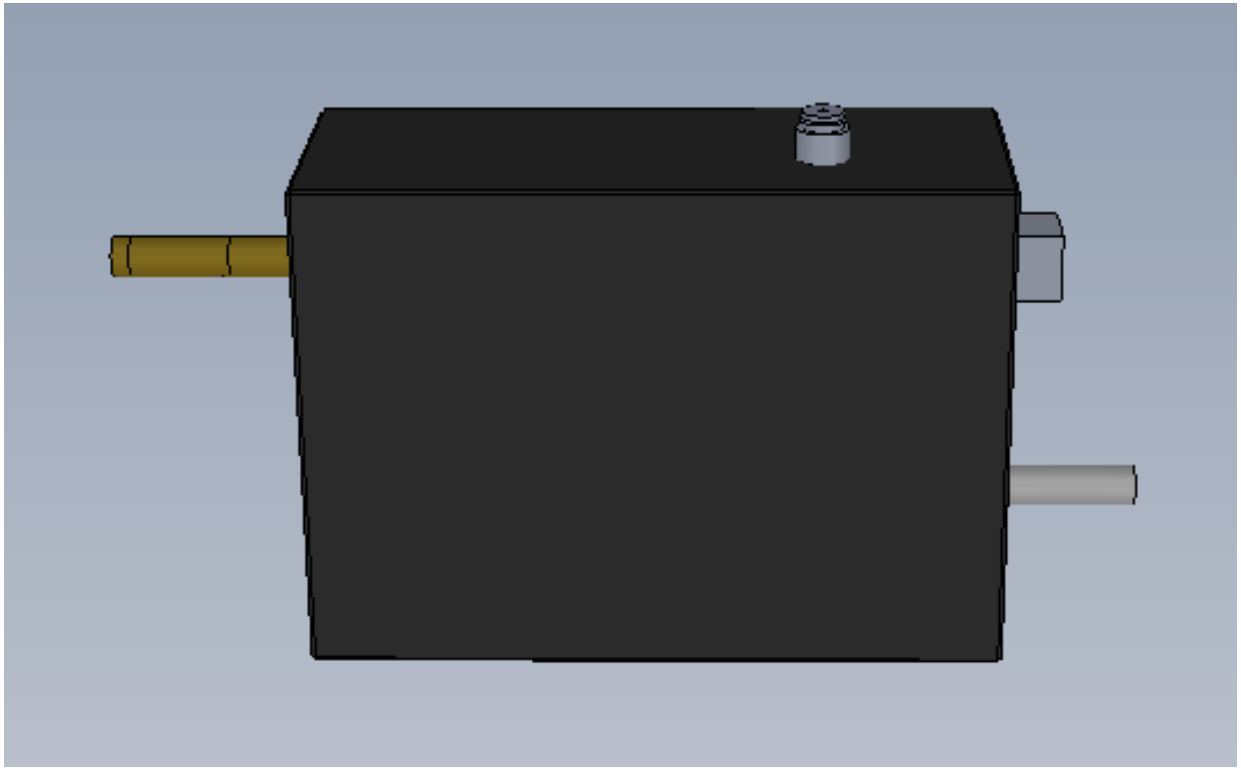




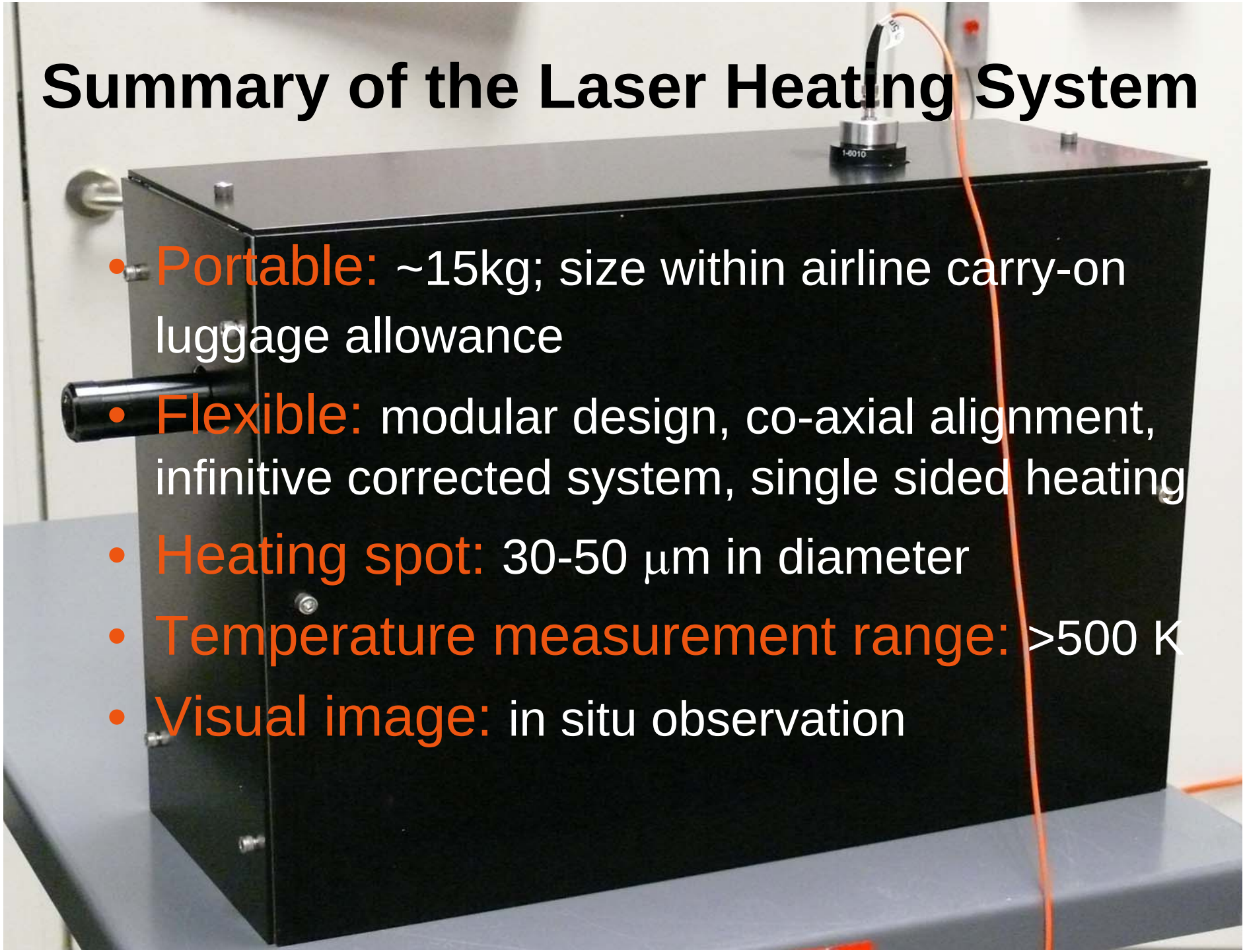


Other applications

- **A thermometer for resistively heated DAC**
- **Optical Raman spectroscopy**
- **Conventional and synchrotron IR spectroscopy**
- **Brillouin scattering**
- **Neutron diffraction**



Summary of the Laser Heating System



- Portable: ~15kg; size within airline carry-on luggage allowance
- Flexible: modular design, co-axial alignment, infinitive corrected system, single sided heating
- Heating spot: 30-50 μm in diameter
- Temperature measurement range: >500 K
- Visual image: in situ observation