
# Recent HEDP experiments at GSI-Darmstad

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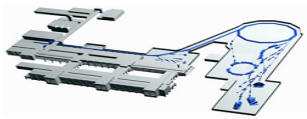
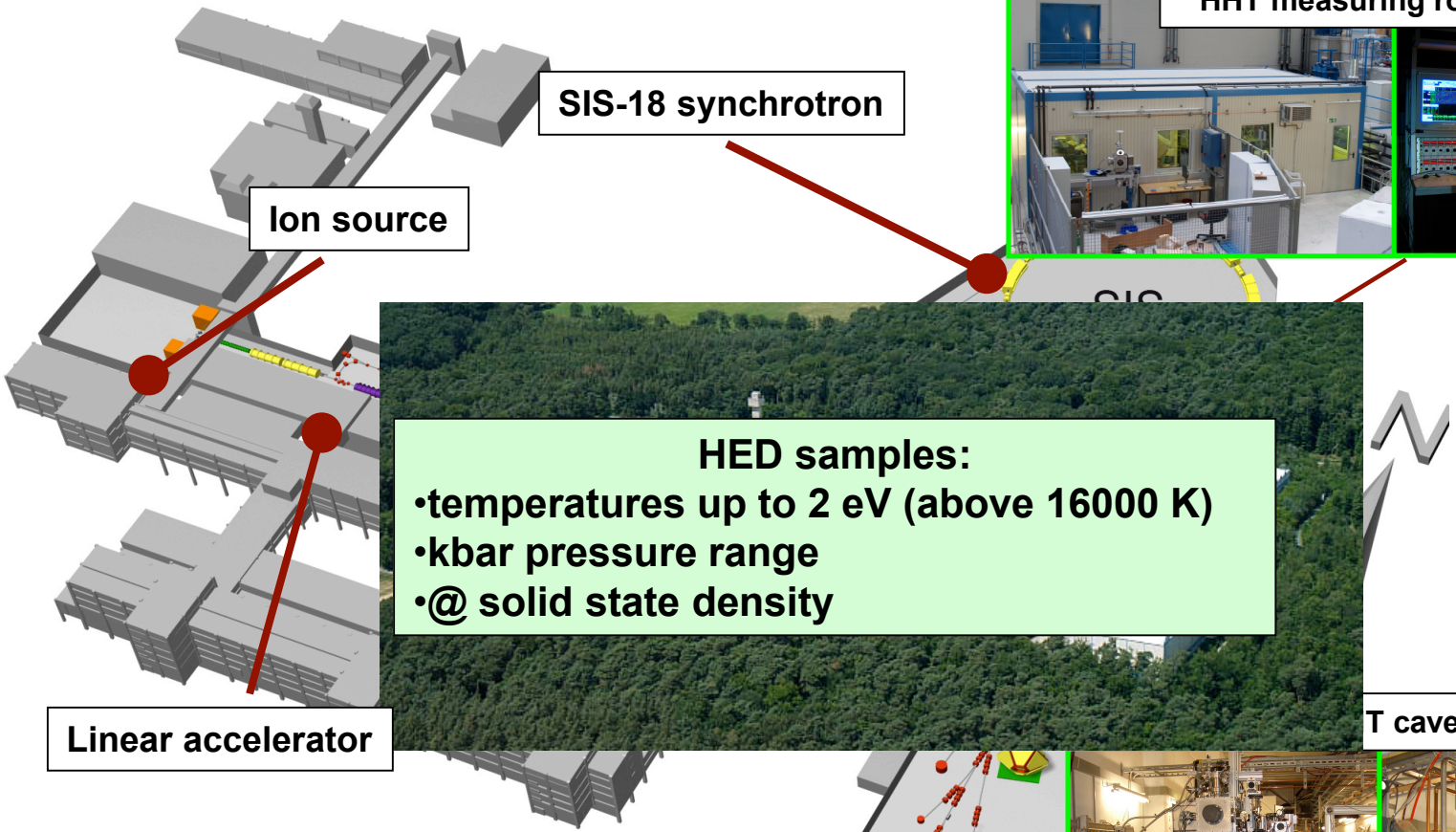
# Experimental area



HHT measuring room

SIS-18 synchrotron

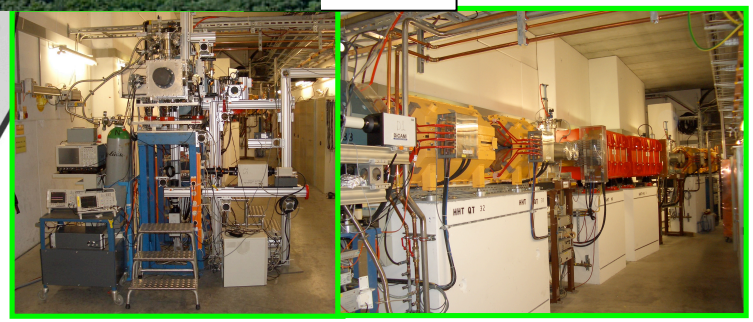
Ion source



HED samples:
- temperatures up to 2 eV (above 16000 K)
- kbar pressure range
- @ solid state density

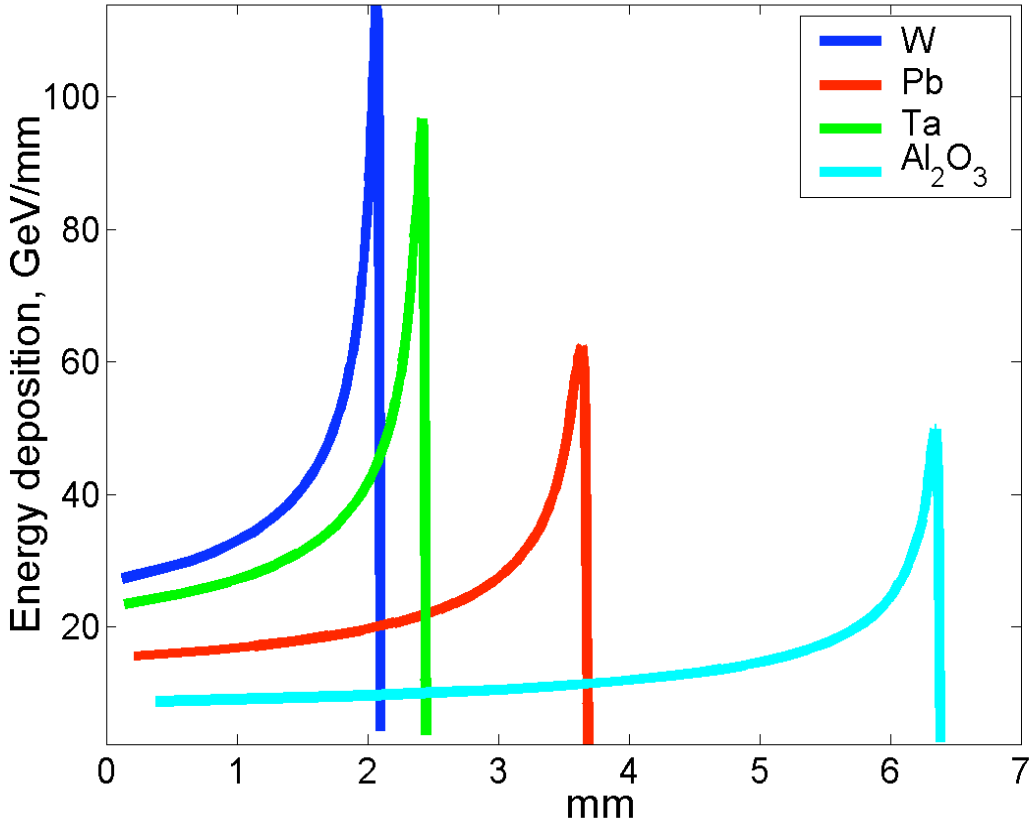
Linear accelerator

T cave

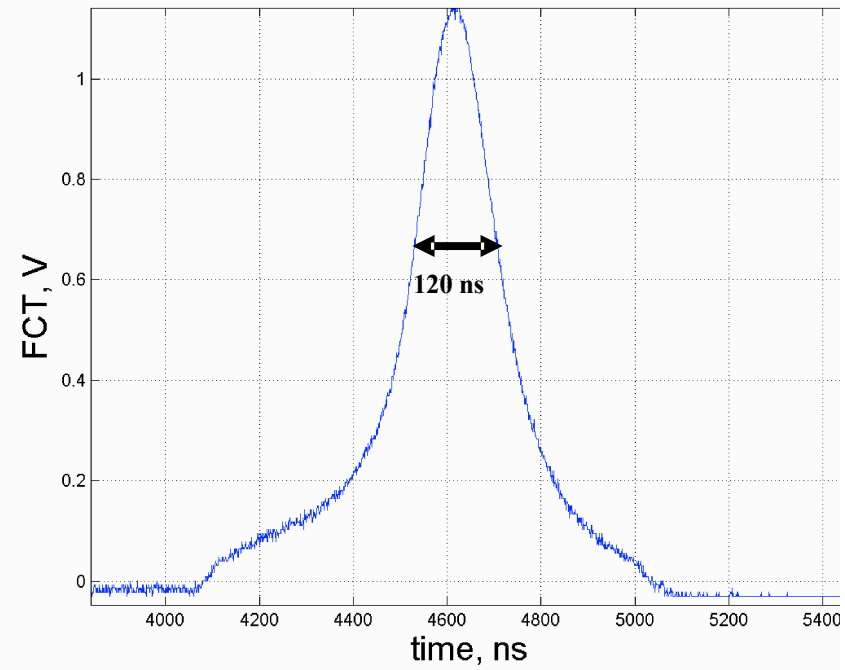


# Intense heavy ion beam is an excellent tool to generate large-volume HED samples

**Energy deposition by uranium ions available at GSI (E0=350 MeV/nukleon)**

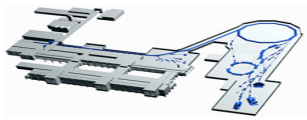



**Temporal beam profile taken by fast FCT**

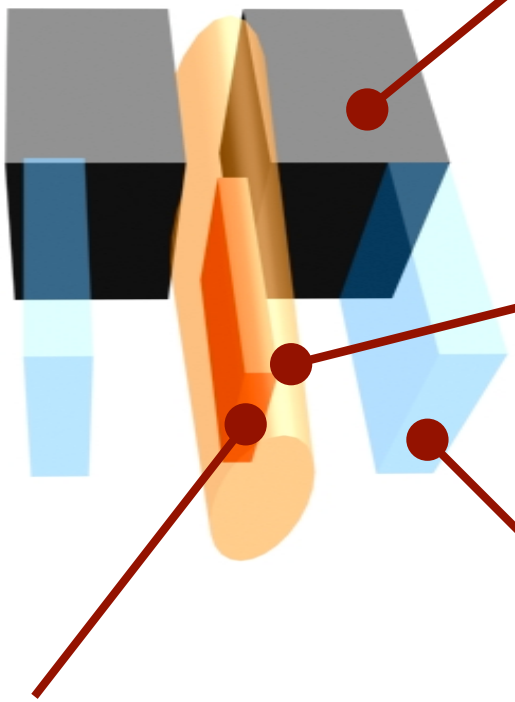



**Beam: Uranium (+74) e-cooled, compressed**
**Intensity: (1 - 4.2)x$10^9$**
**Energy: 350 MeV/nucleon**
**Focal spot: 0.150 mm - 1.5 mm**
**Duration (FWHM): 120 ns - 1000 ns**

# HED matter generated by intense heavy ion beam



**3D view**



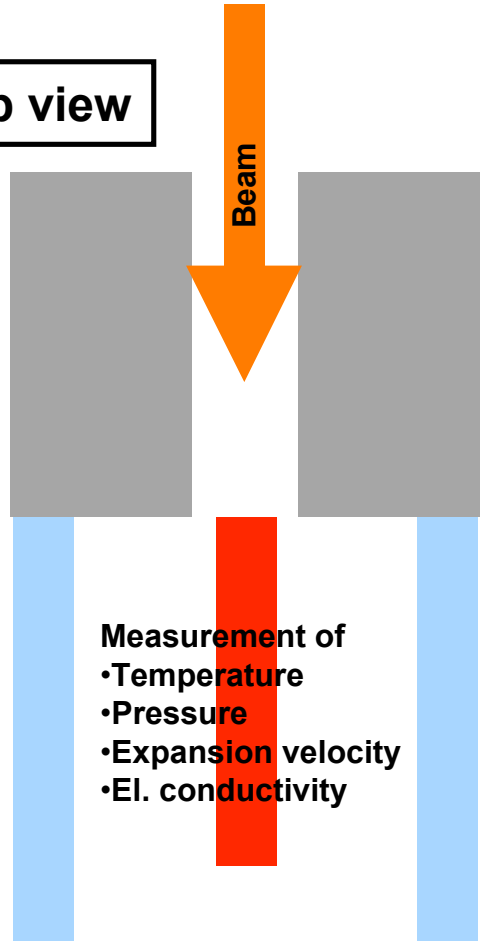
Tungsten diaphragm

Focused uranium beam (elliptical profile)

Sapphire

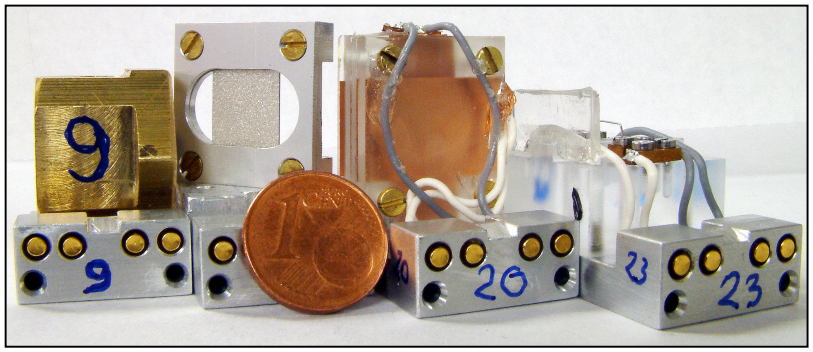
Sample foil
0.05 - 0.25 mm thick
Pb, Fe, Sn, W, Ta, Cu, UO2, Al, Al2O3

**Top view**

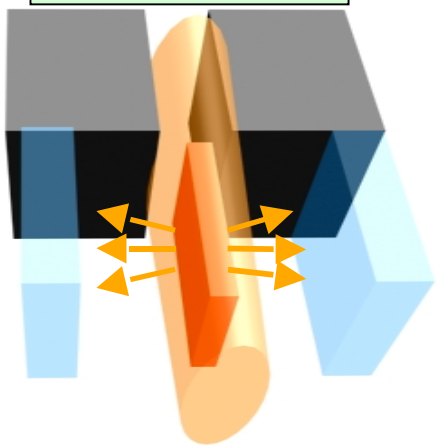



Measurement of
•Temperature
•Pressure
•Expansion velocity
•El. conductivity

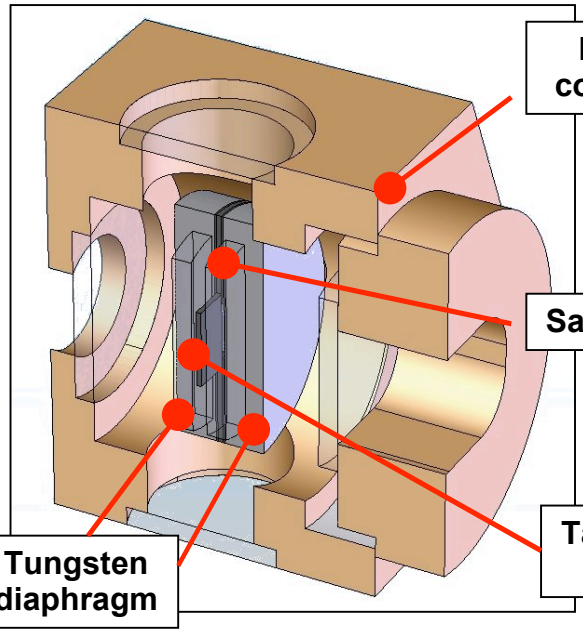
# Target design



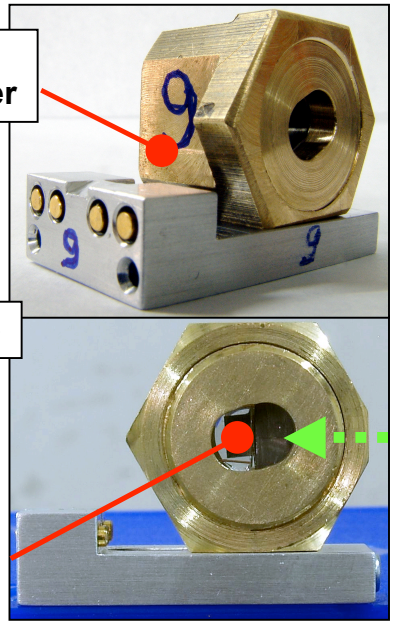

**Target concept**

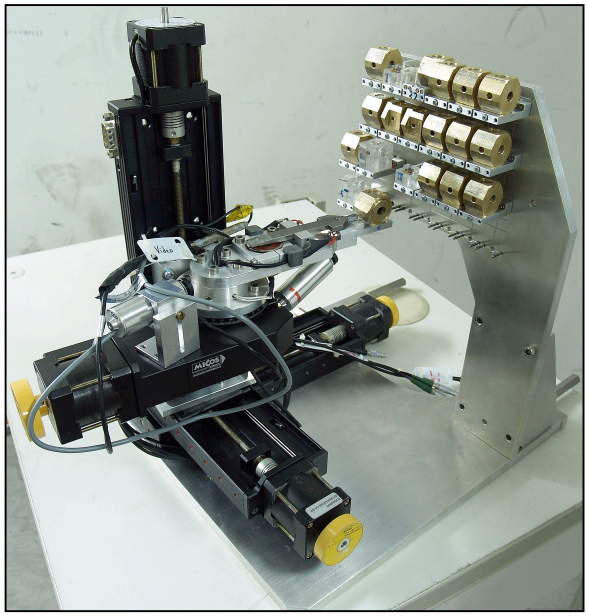


**Target design**



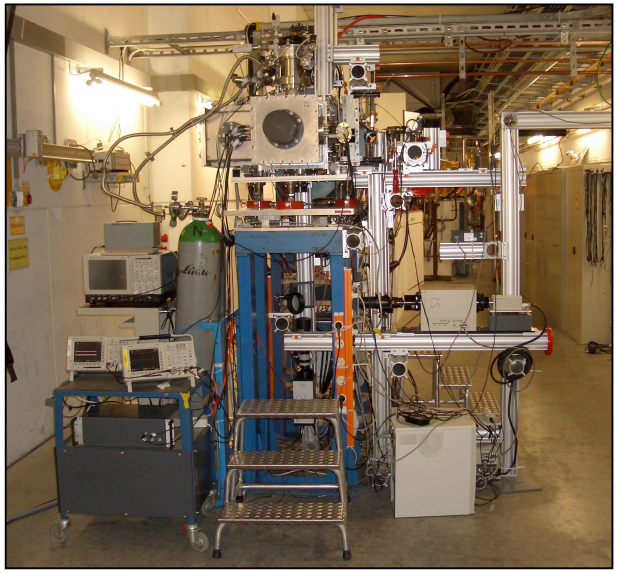

**Target Implementation**

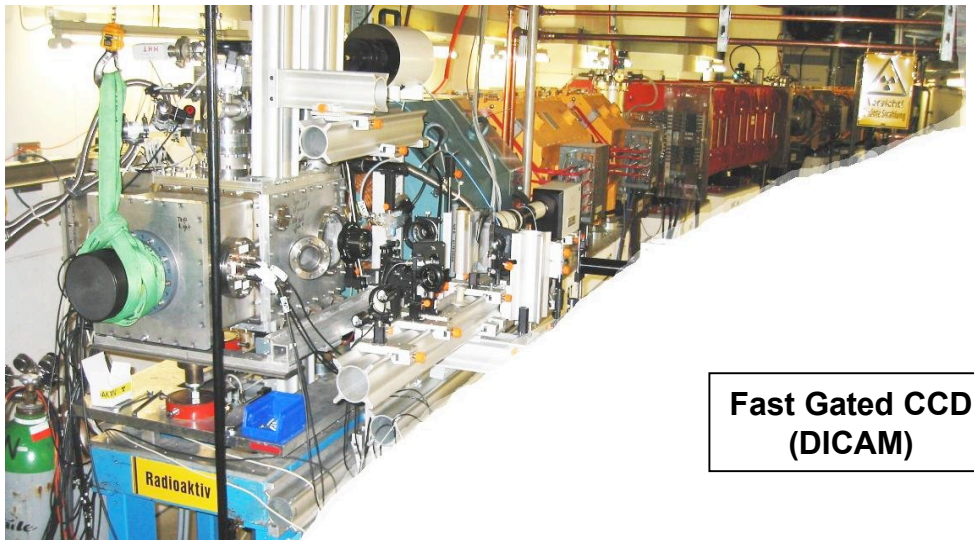


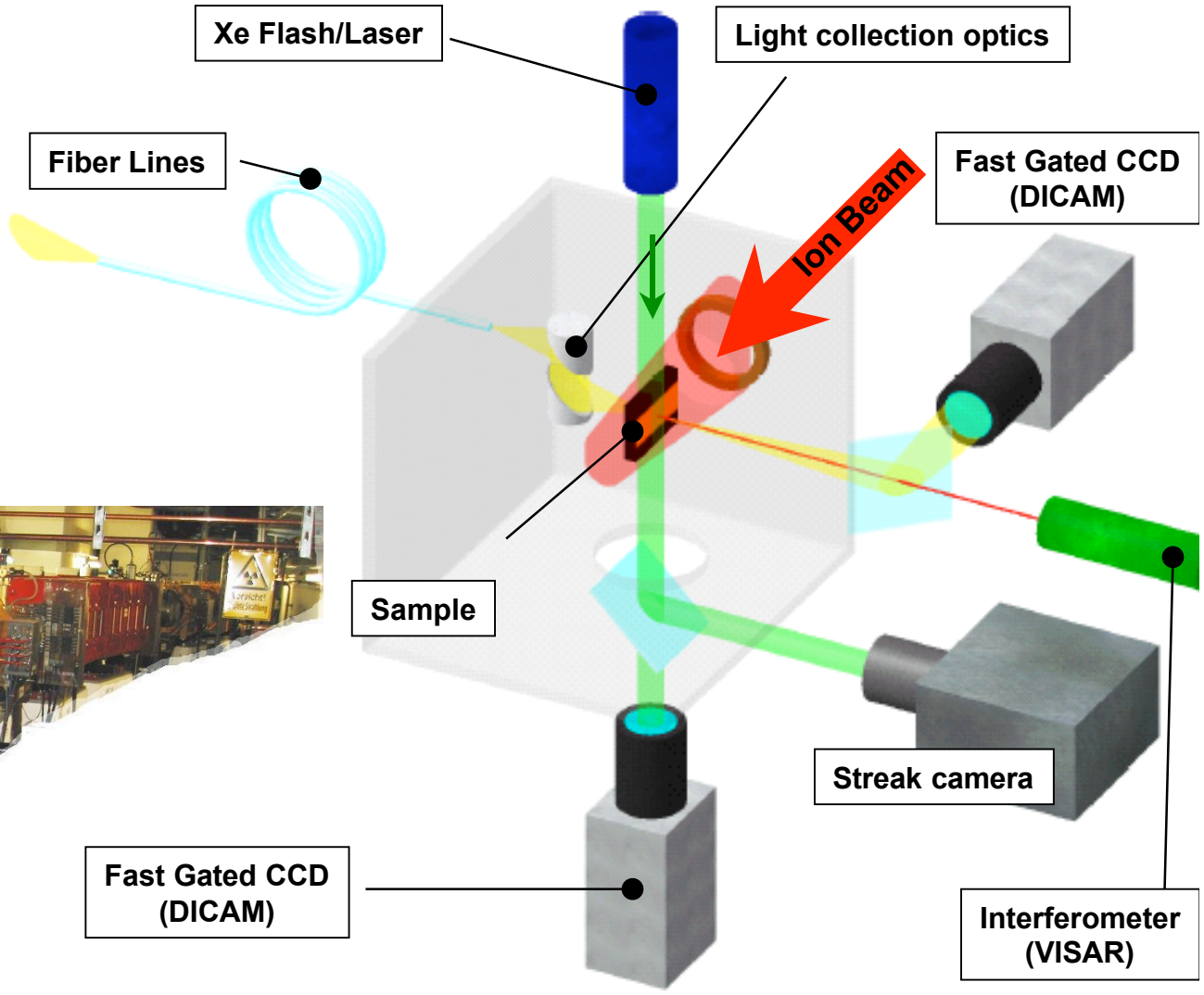



**4-axis target manipulator and target shelvs**

# Schematic layout of HEDP experiments at GSI

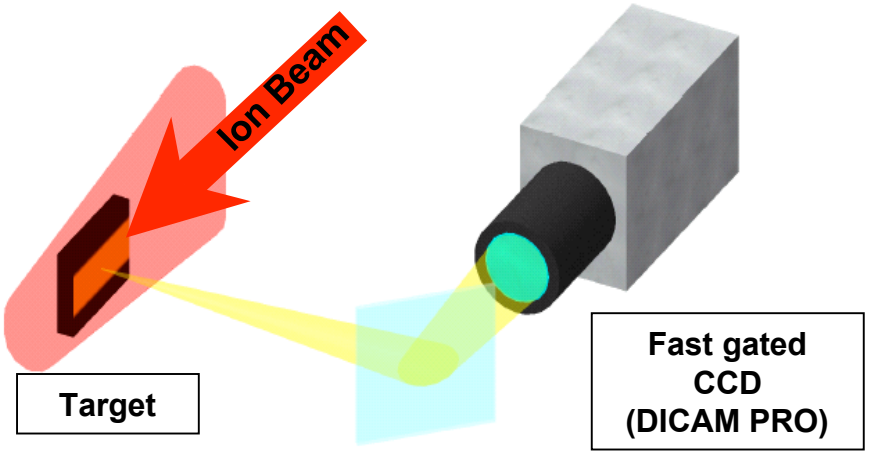




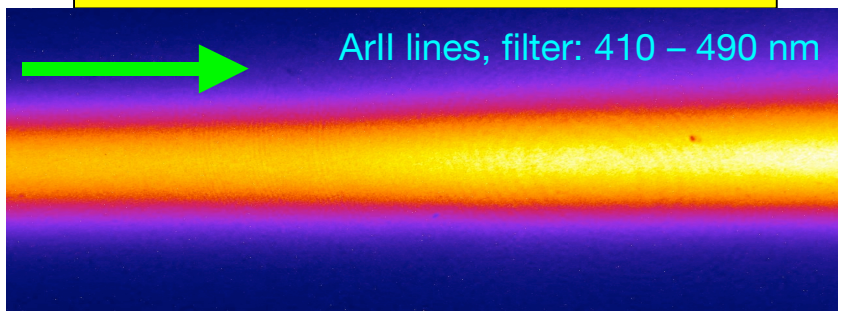



# Side camera diagnostics

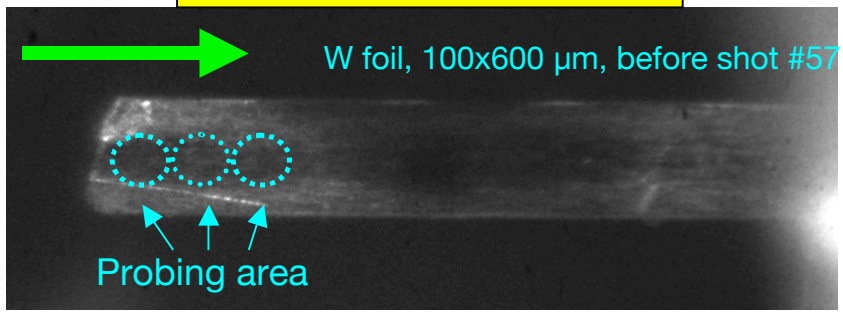
-Ion beam profile by gas scintillation
-Precise beam-target positioning
-Images of  self emission



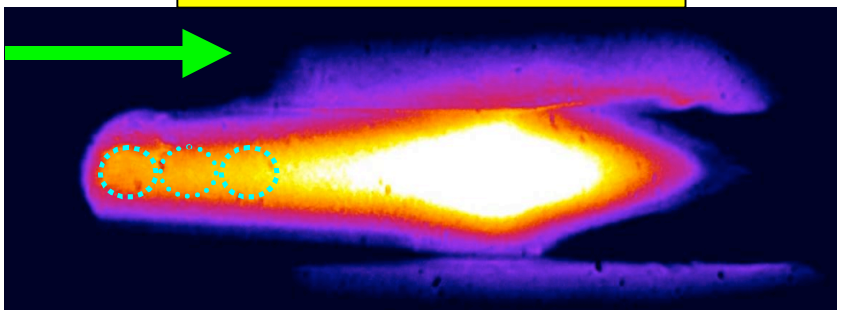

**Beam-induced light emission from Ar**



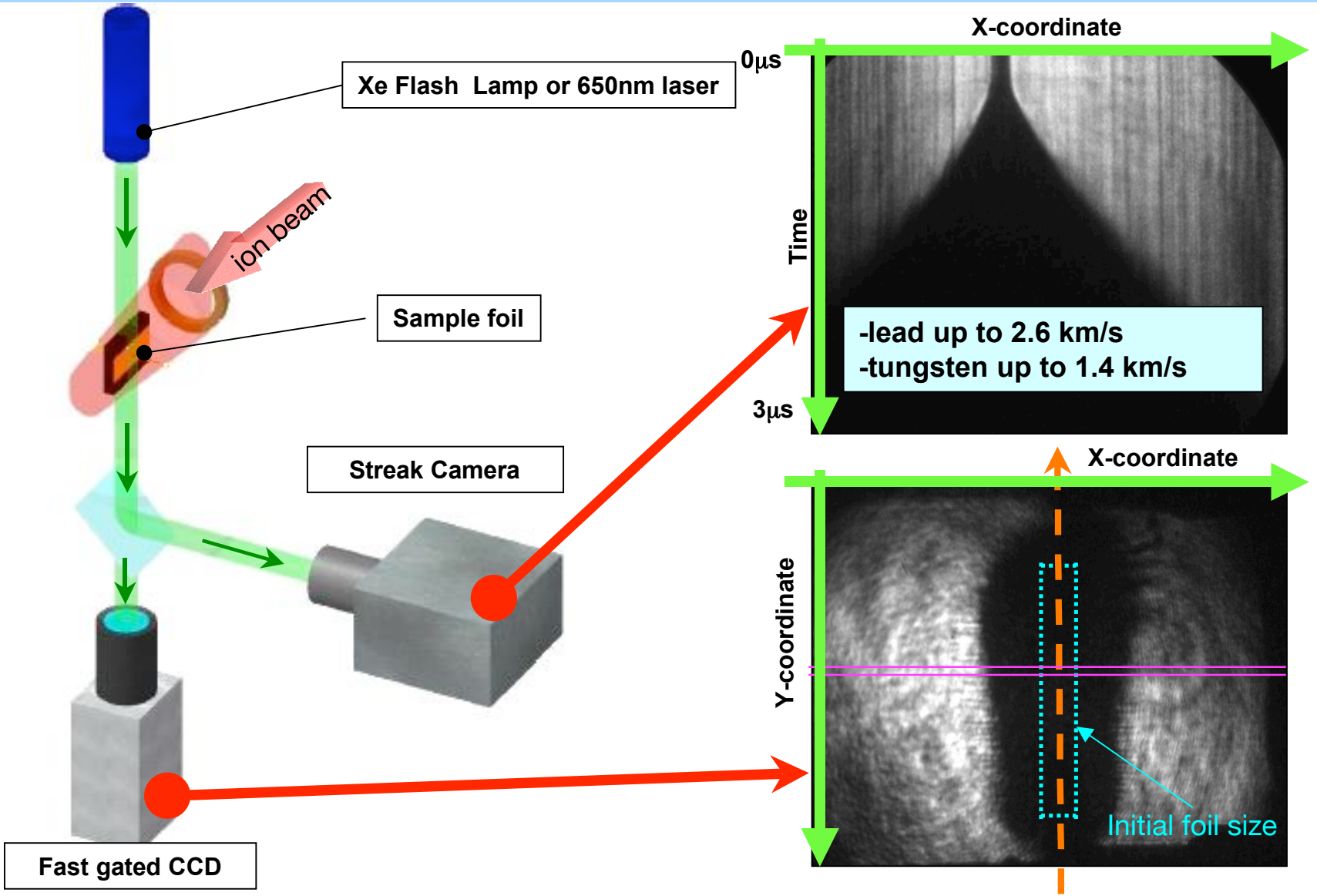

**W target before irradiation**



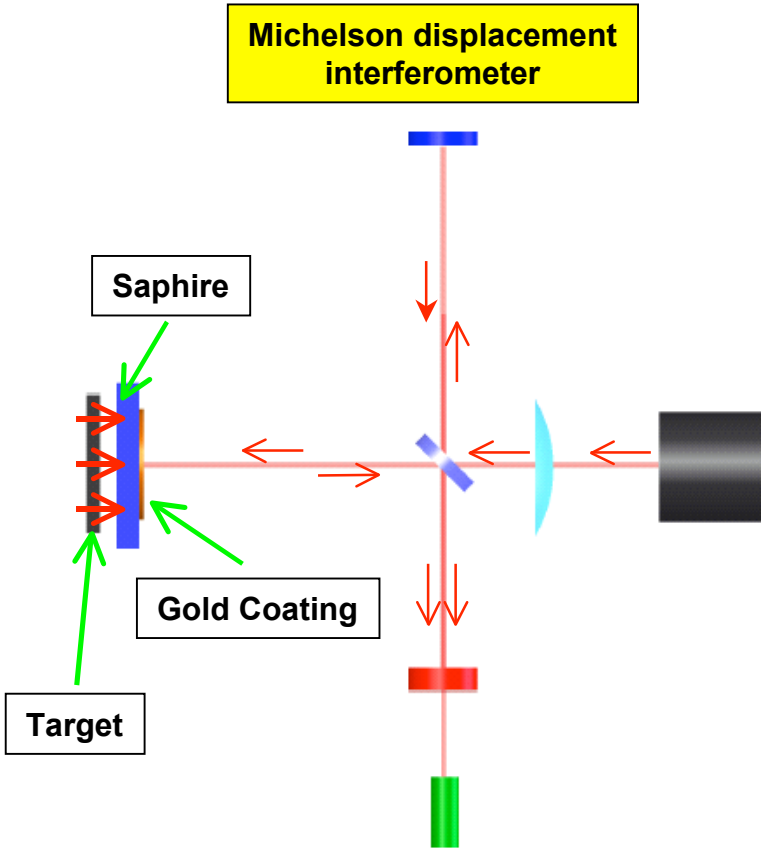

**W target during irradiation**

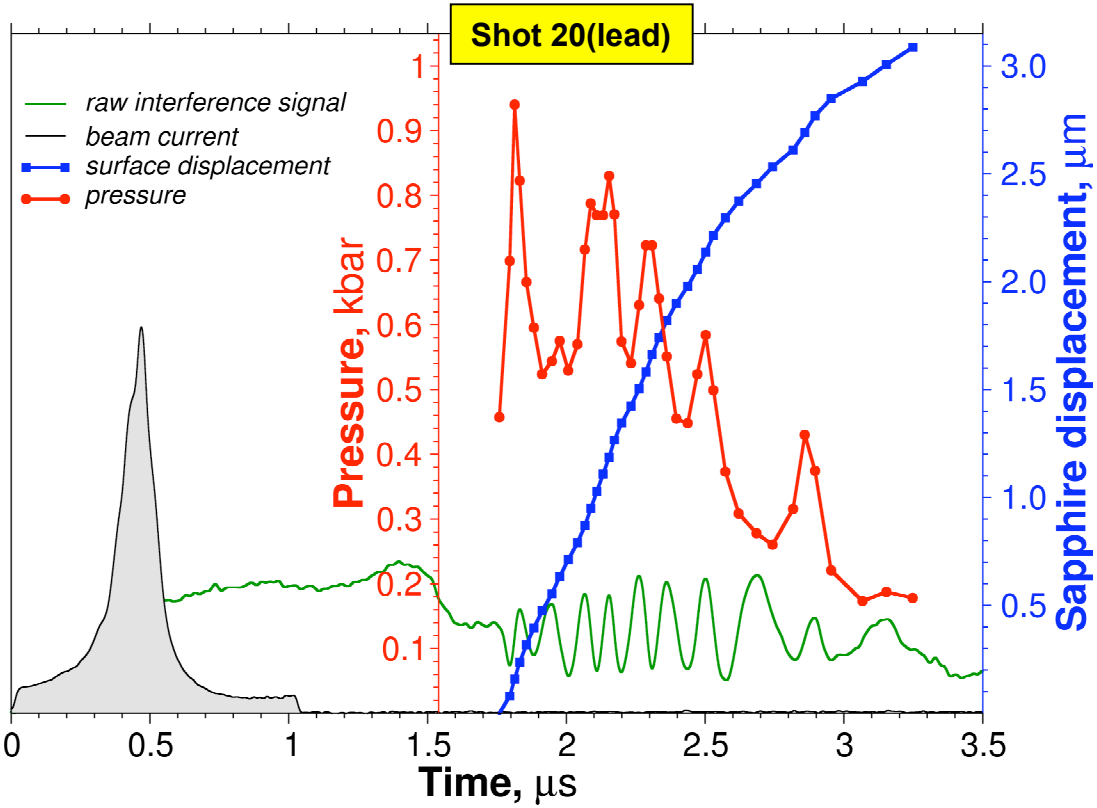


# Visible shadowgraphy



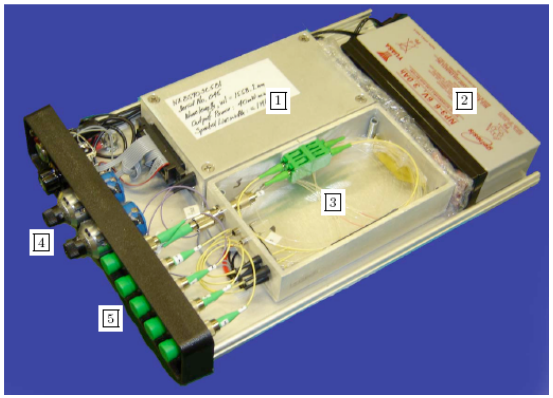
# Pressure measurement with laser interferometry (1)

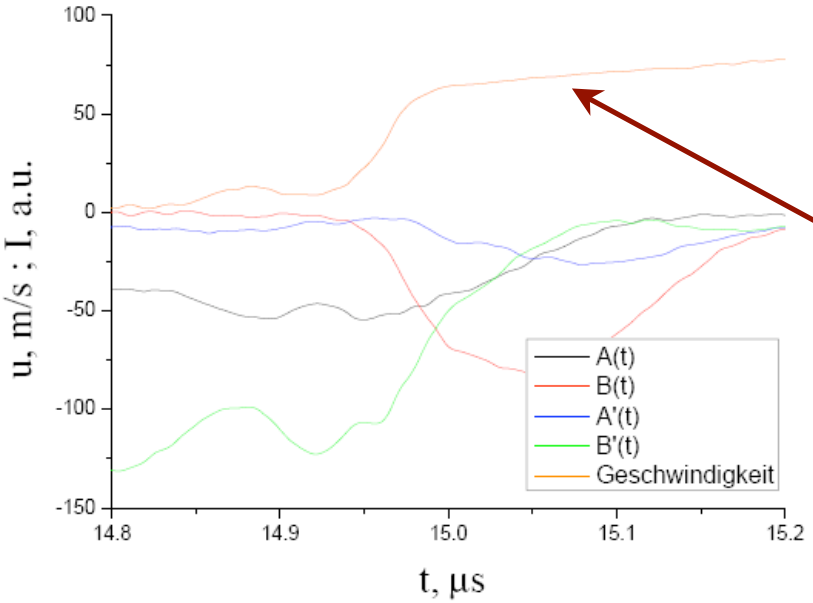


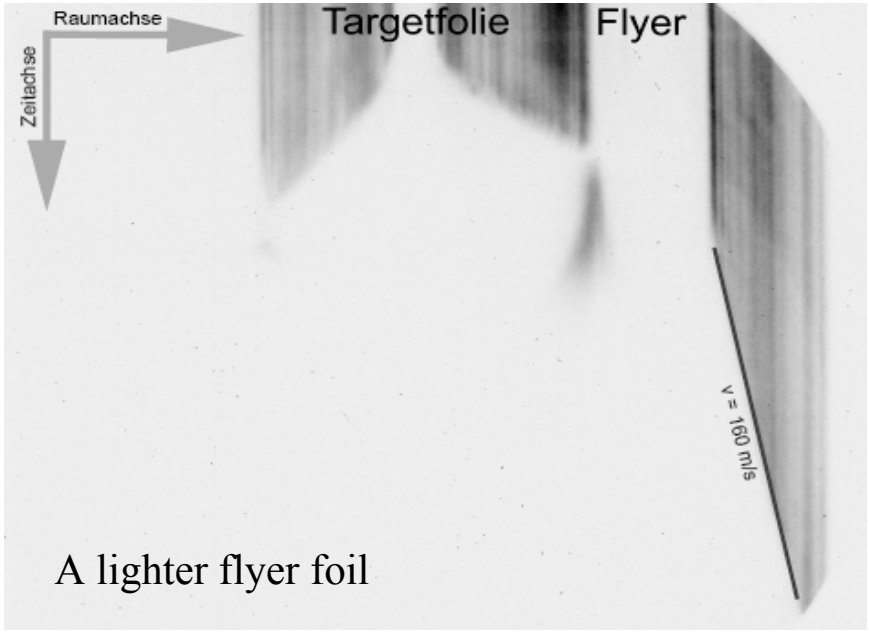



# Pressure measurement with laser interferometry (2)

**All-fiber laser-Doppler interferometer (VISAR)**



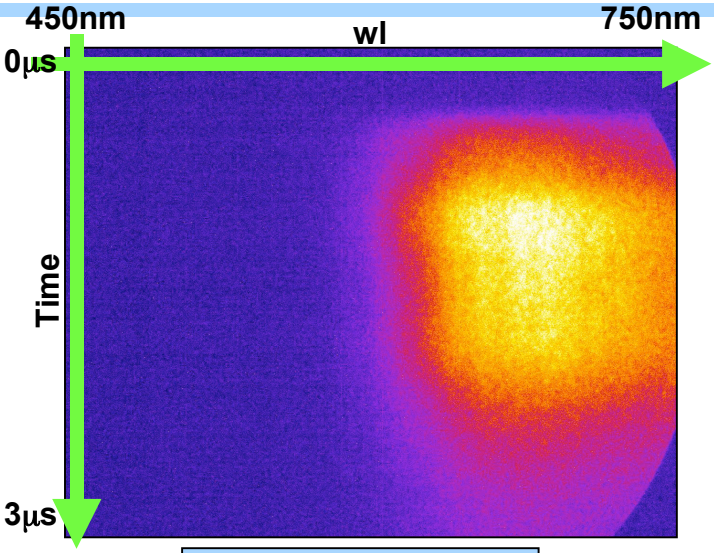



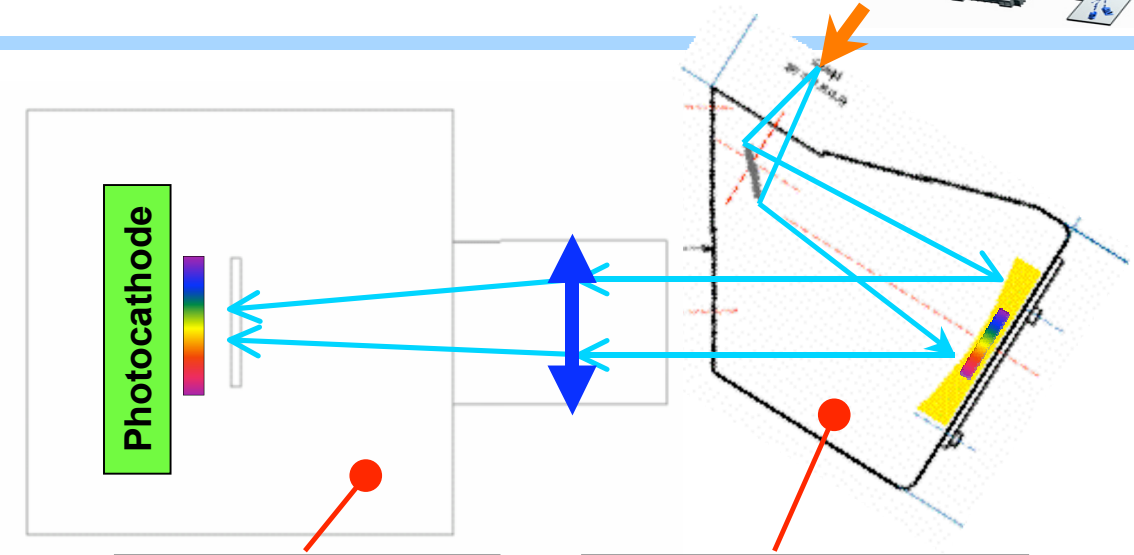

A lighter flyer foil

Speed measured by VISAR

# Streak Spectrograph

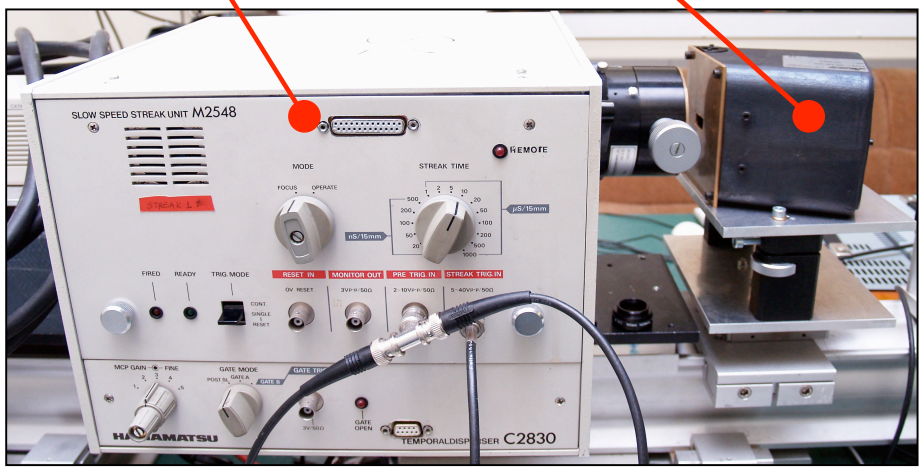



Shot 57(tungsten)




Streak Camera Unit

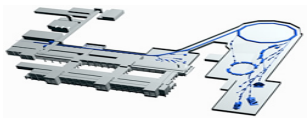
Imaging Spectrograph



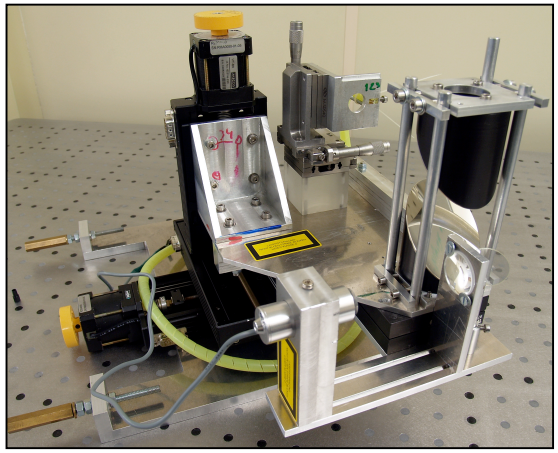

Streak Spectrometer

- Ion-etched and holographic grating
- Continous spectra from 250 -950 nm
- Numerical apperture f/2
- High temporal resolution
- Fiber input

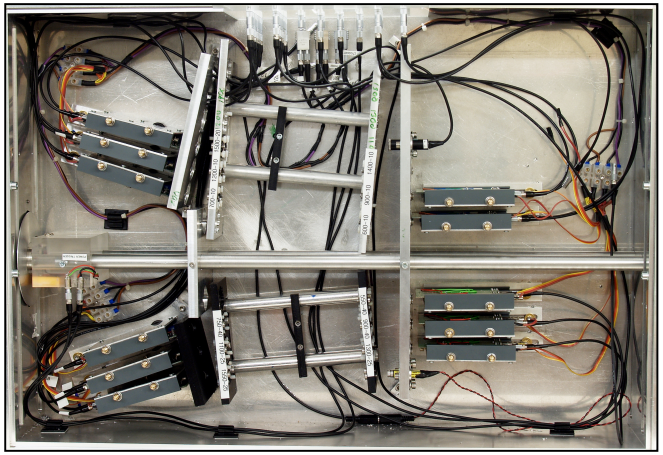
# Fast multi-channel optical pyrometer



- high efficiency: f/2
- 1:1 imaging
- no chromatic aberrations
- high resolution (20-400 μm)
- motorized 0.01 mm



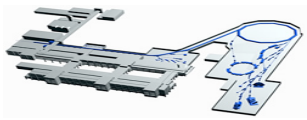
Flexible/ modular design
Interference filters as filters and mirrors

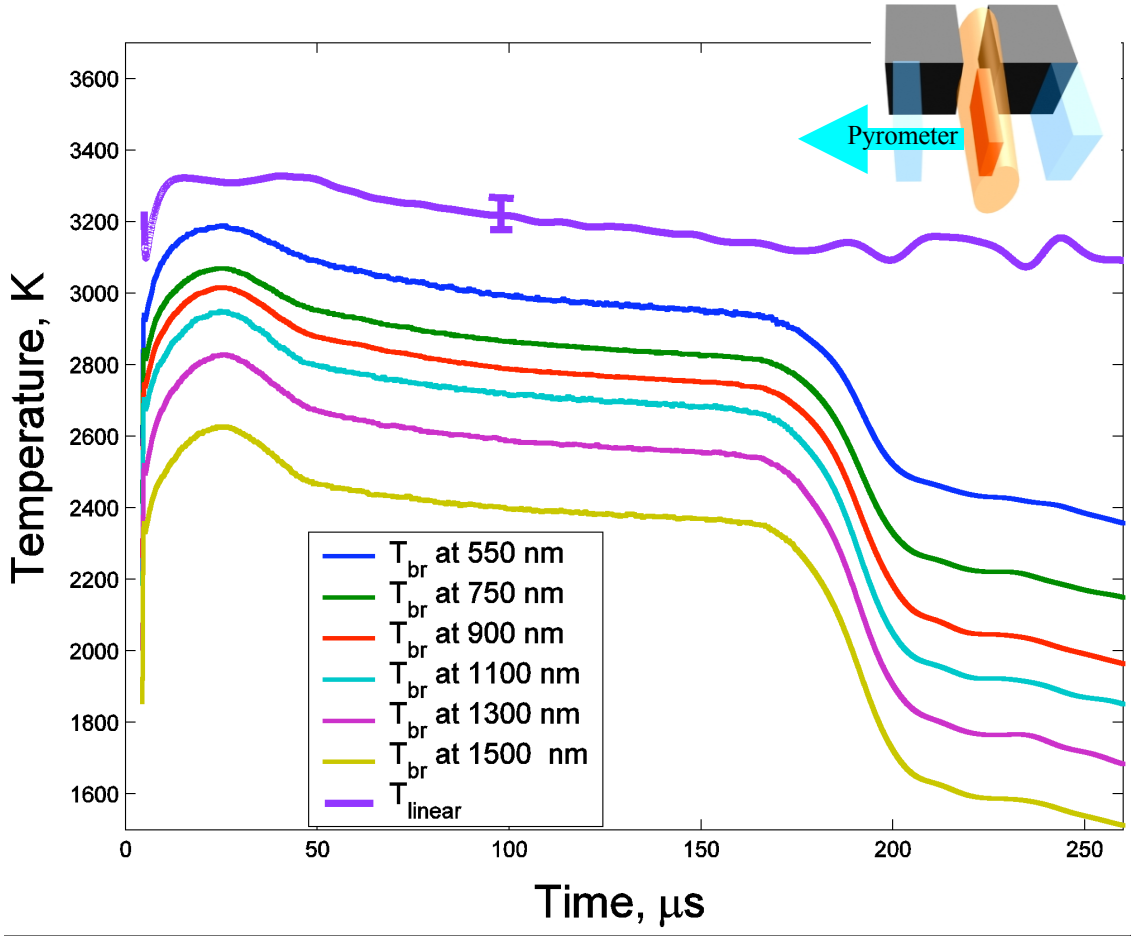


- 24 channels, 8 bit, 1 GHz bandwidth
- Controlled by LabView


- 12 channels (550- 1550 nm)
- 5 ns temporal resolution
- Absolutely calibrated
- High efficiency, T ≤ 1000 K is detectable
- High dynamic range (from 1000 K up 6000 K)
- Grey and liner models of emissivity

# Temperature measurement of tantalum foil

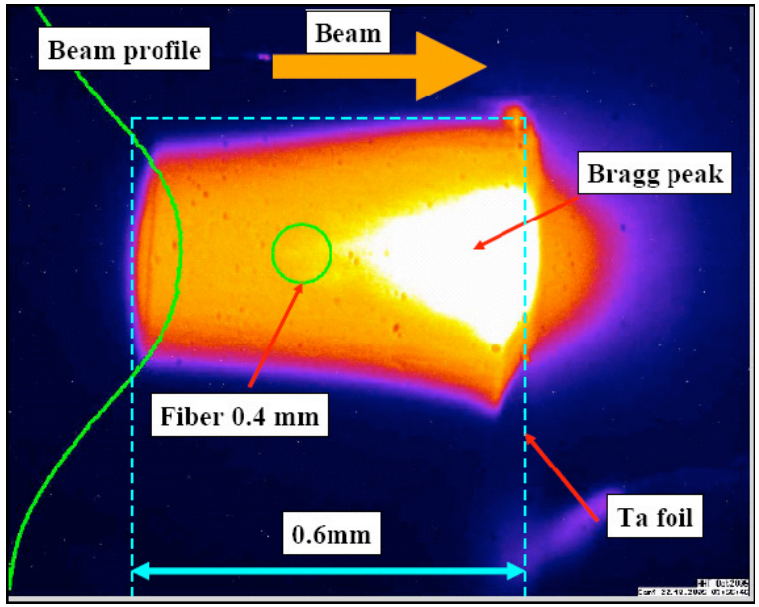




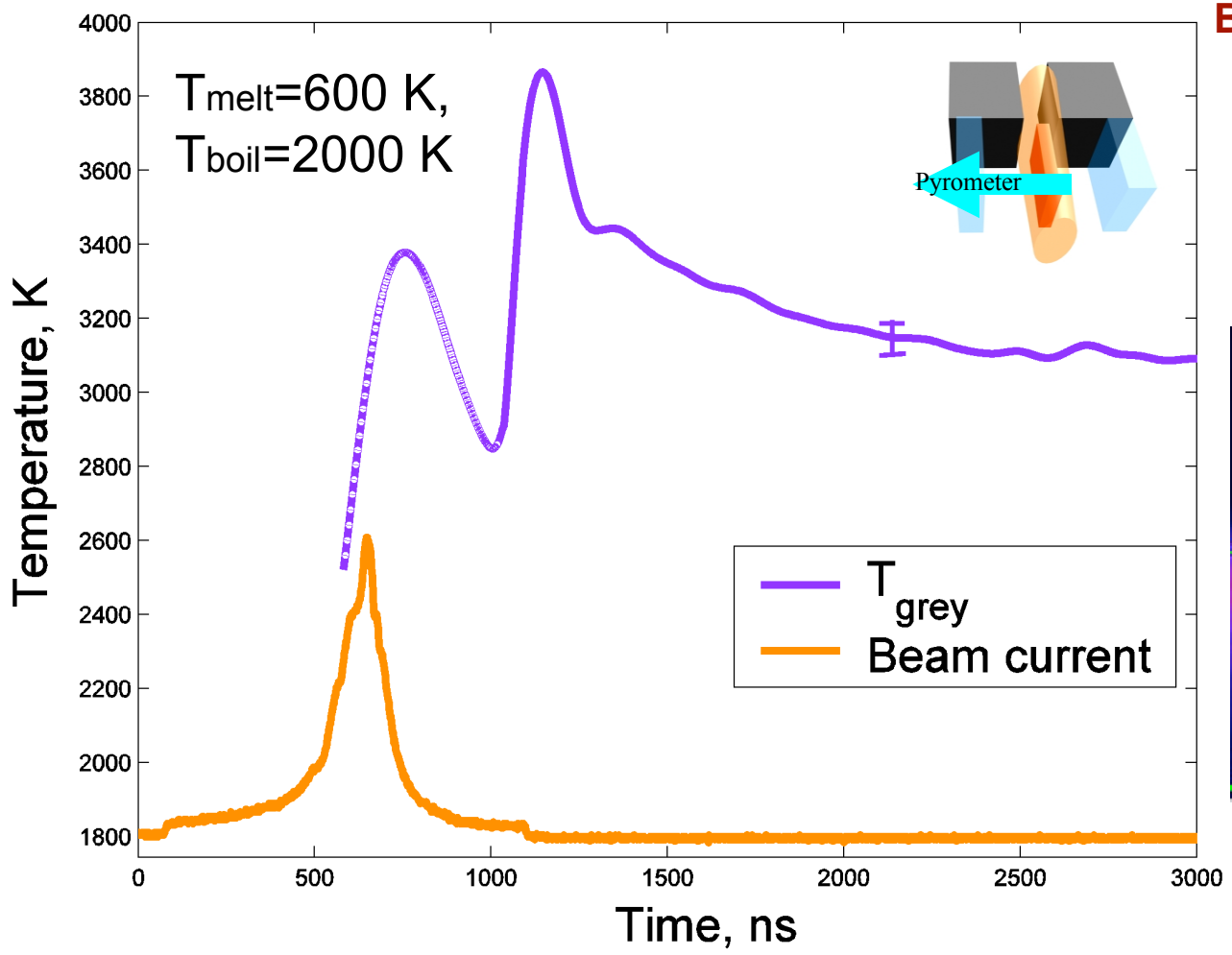

**Beam: $^{238}$U, 350 AMeV, 120 ns, 1.63·10**

**Target: Ta foil, 200 μm thickness,**

Tmelt=3200 K

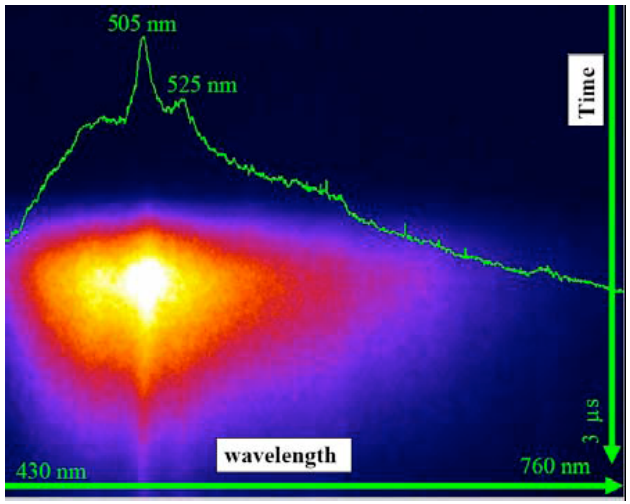


# Temperature measurement of lead foil (1)




**Beam: $^{238}$U, 350 AMeV, 120 ns, $1.28 \cdot 10^9$**

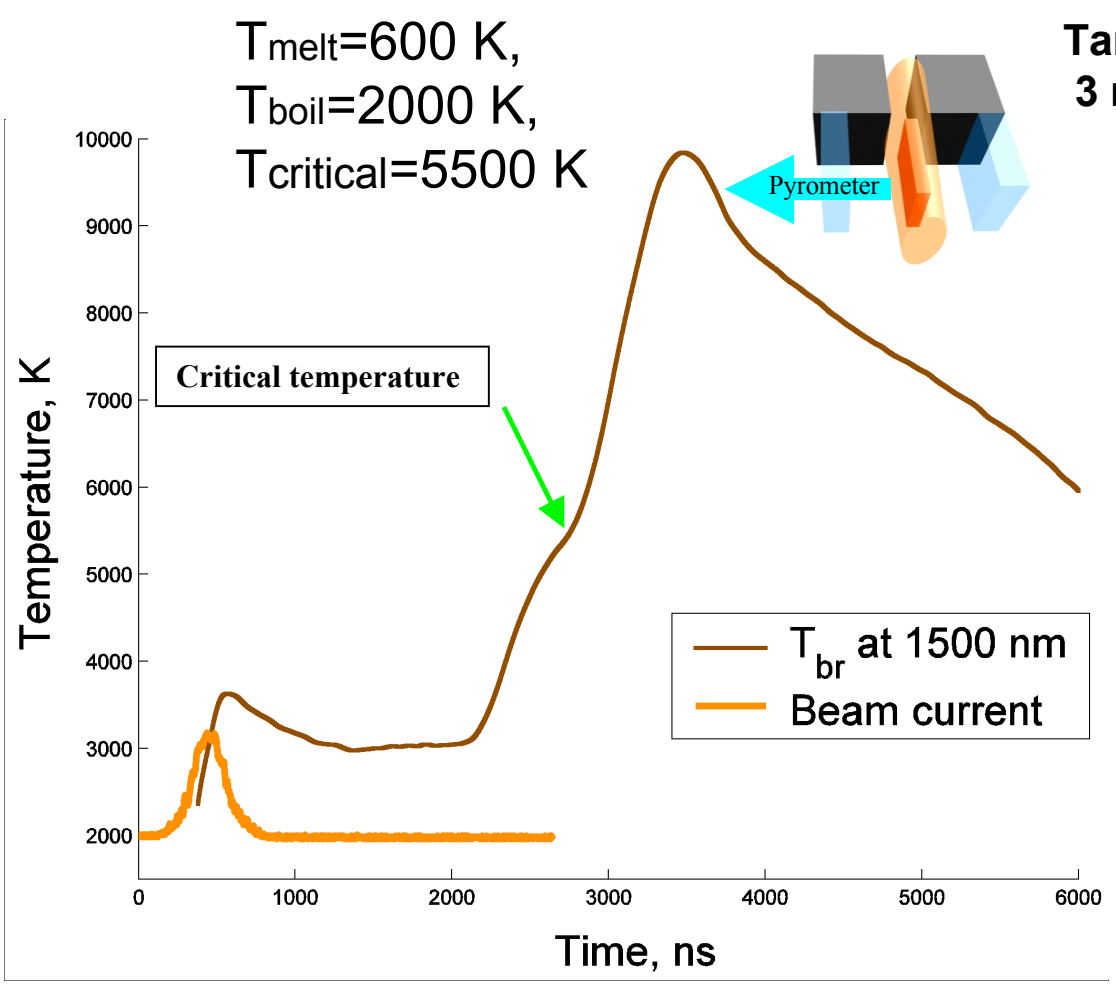
**Target: Pb foil, 240 µm thickness, 0.2 mm gap**

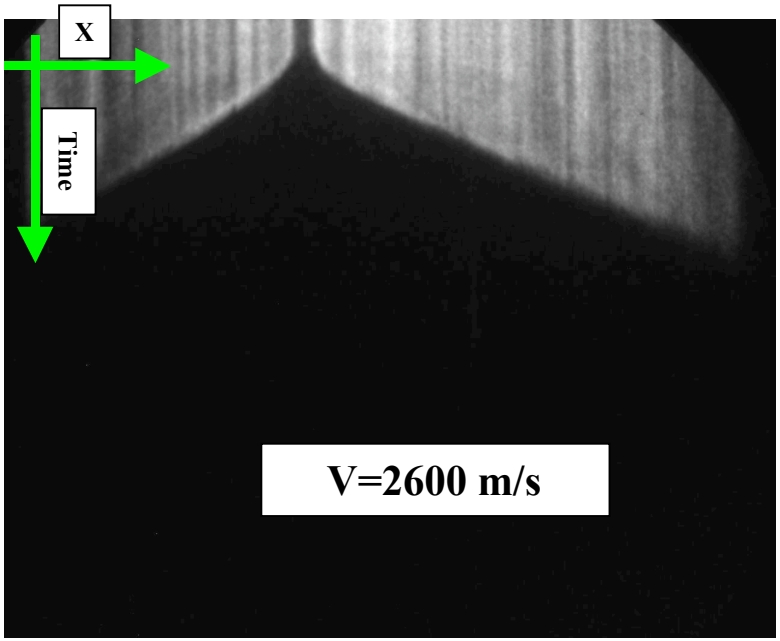


# Temperature measurement of lead foil (2)

**Beam: $^{238}$U, 350 AMeV, 120 ns, 1.61·10$^{9}$**

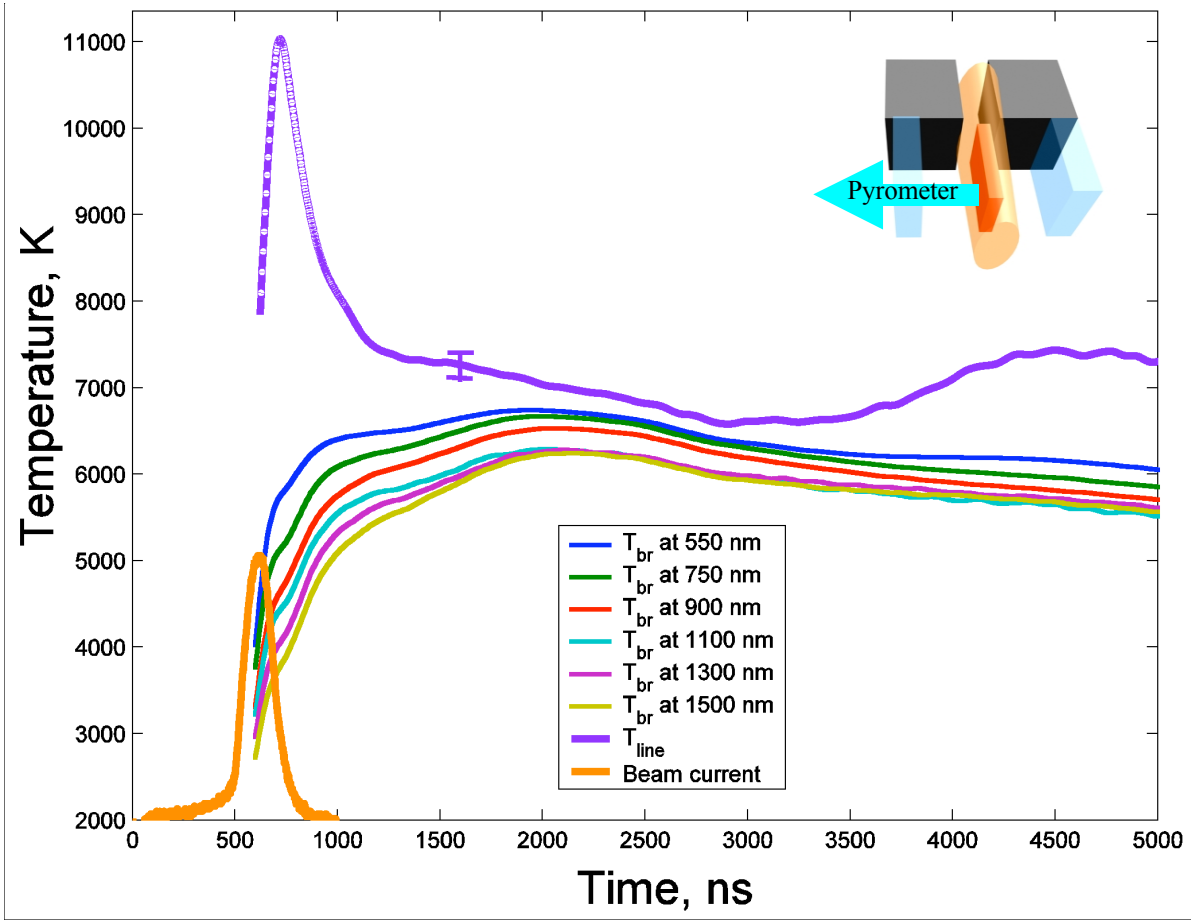
**Target: Pb foil, 100 μm thickness, 3 mm gap**



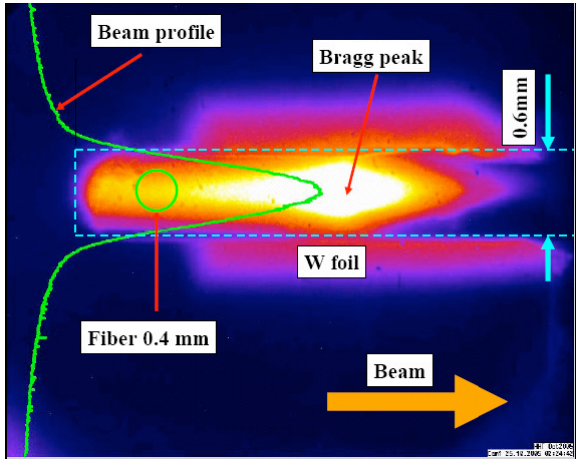
# Temperature measurement of tungsten foil

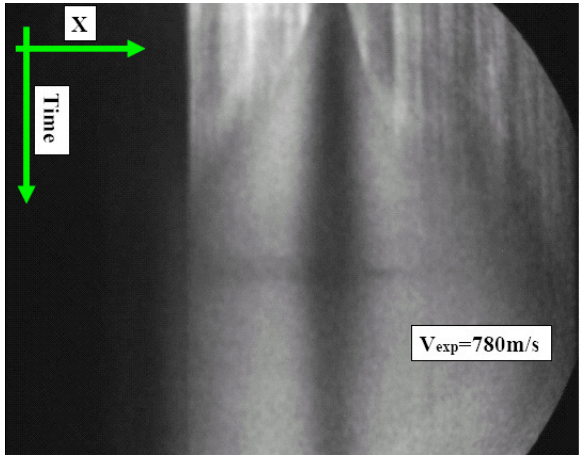
$T_{melt}$=3700 K,
$T_{boil}$=5800 K




**Beam: $^{238}$U, 350 AMeV, 120 ns, 2·10$^9$**

**Target: W foil, 100 μm thickness, 3 mm gap**

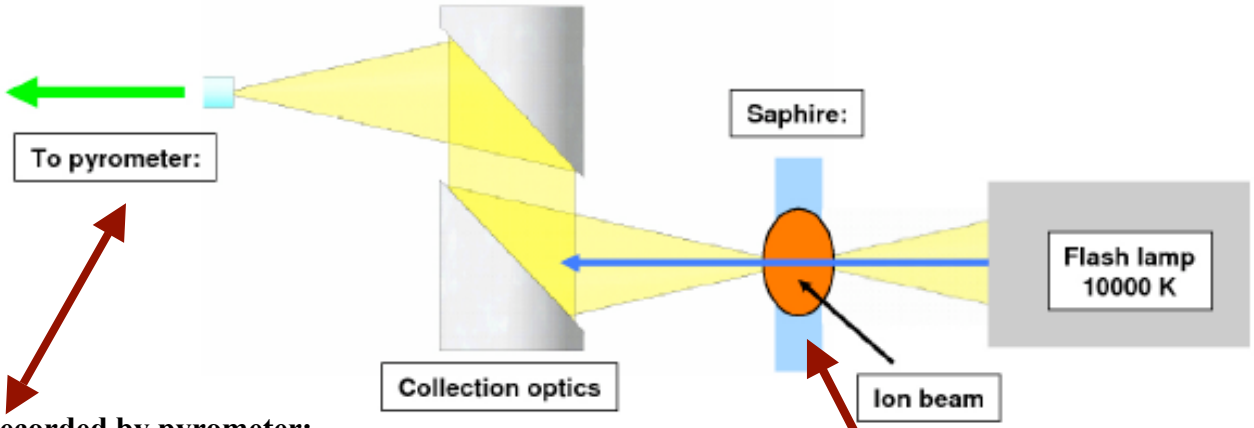


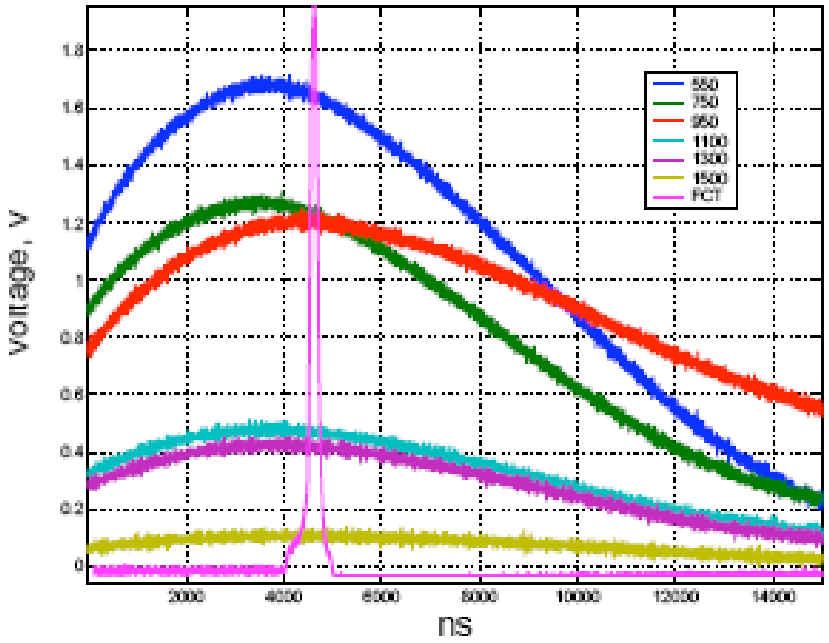
# Experiments with sapphire (1)

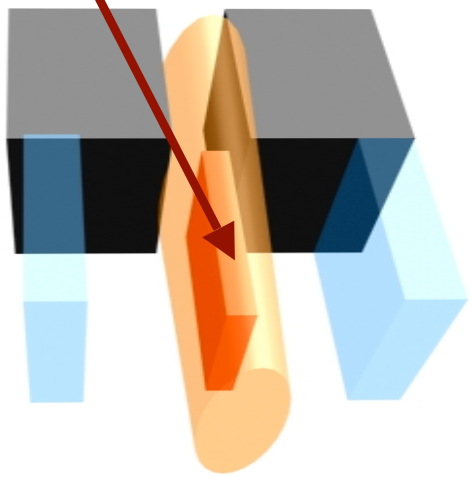
- Al2O3
- SiO2
- LiF2

**Setup for optical transmission study:**




**Reference signal recorded by pyrometer:**



# Experiments with sapphire (2)