

X-ray and Proton Generation at the 40TW-Level with Z-Petawatt

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Matthias Geissel, B.W. Atherton, E. Brambrink,
A.D. Edens, P.K. Rambo, and J. Schwarz

Sandia National Laboratories

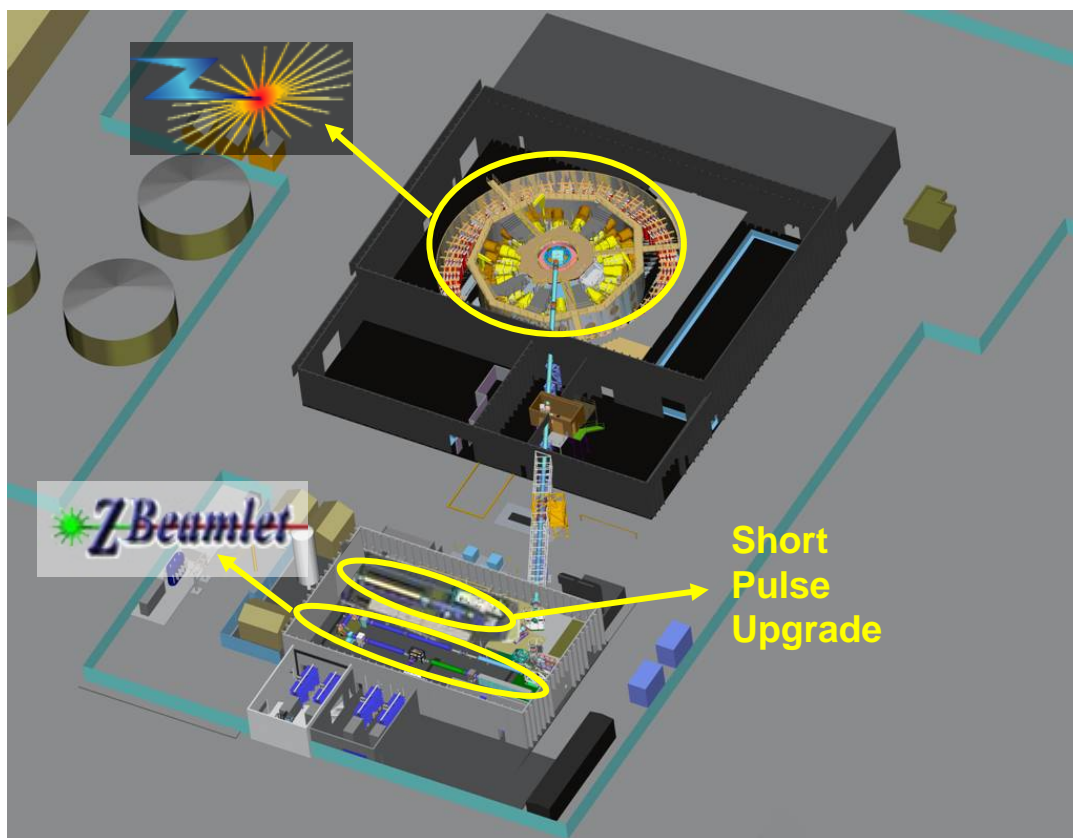
SNL Approval:
SAND 2006-6951C





Facility Overview

("Buildings 983/986")



Z-Petawatt

Front End

Front end:
OPCPA
(2+2+1 BBO)

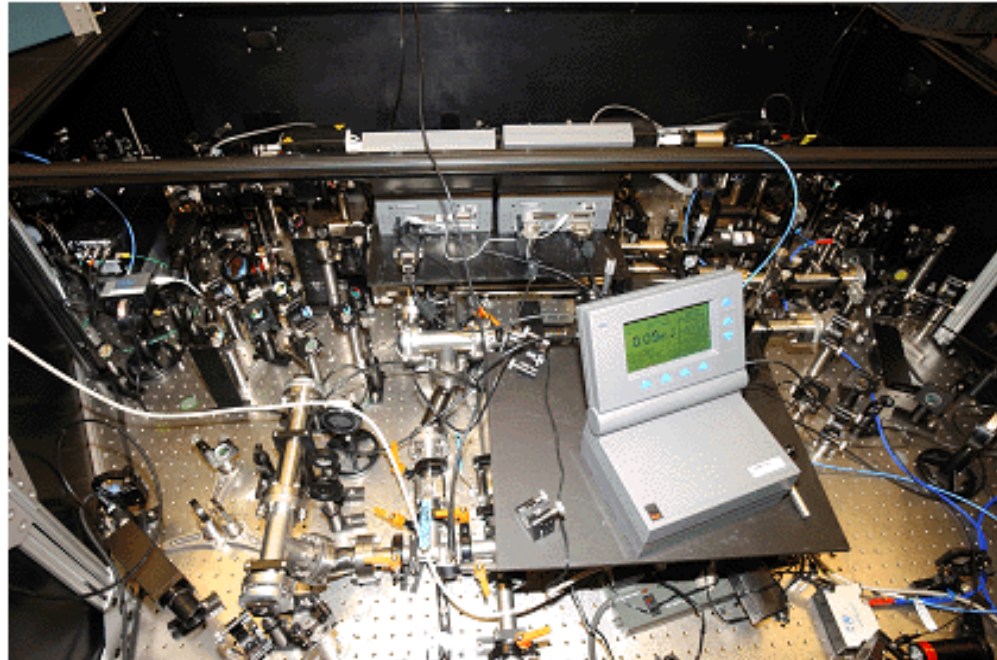
40mJ

$\lambda=1054\text{nm}$

$\delta\lambda=8\text{nm}$

$t_{\text{stretch}}=2.4\text{ns}$

rep=10Hz



Z-Petawatt

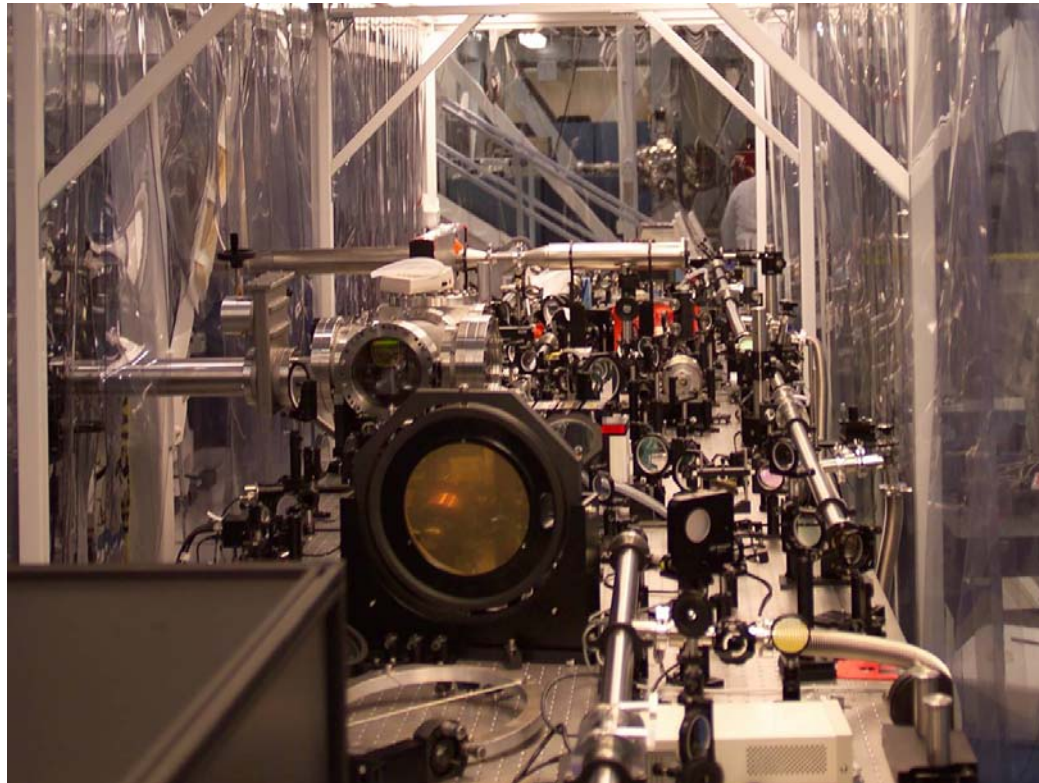
Front End

Rod Amps:

**16mm 2x-path
25mm 2x-path**

5J

20 min rep.



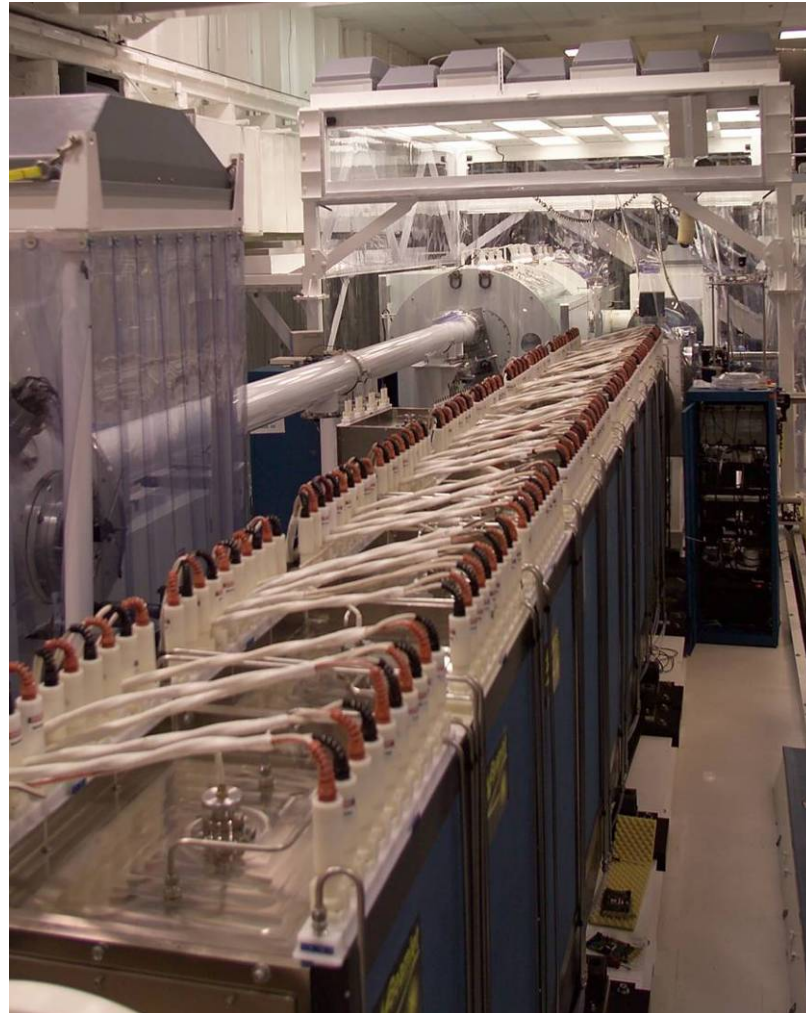
Z-Petawatt

Front End

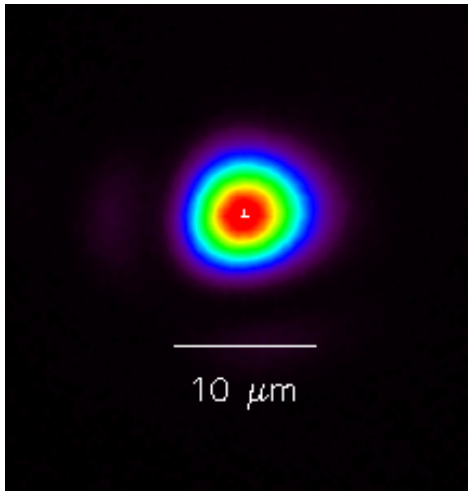
**Main Amps:
10x ZBL-slabs**

**10-100J
(sub-aperture)**

150 min rep.



Laser Performance



10 Hz OPCPA signal on target

FWHM x: 6.3 μm

FWHM y: 6.4 μm

Radius of disc which includes...

65.7% of total energy: 4.71 μm

81.1% of total energy: 7.55 μm

90.8% of total energy: 10.86 μm

Strehl ratio: 0.58

Amplified energy: typ. 25 J, max. 33 J

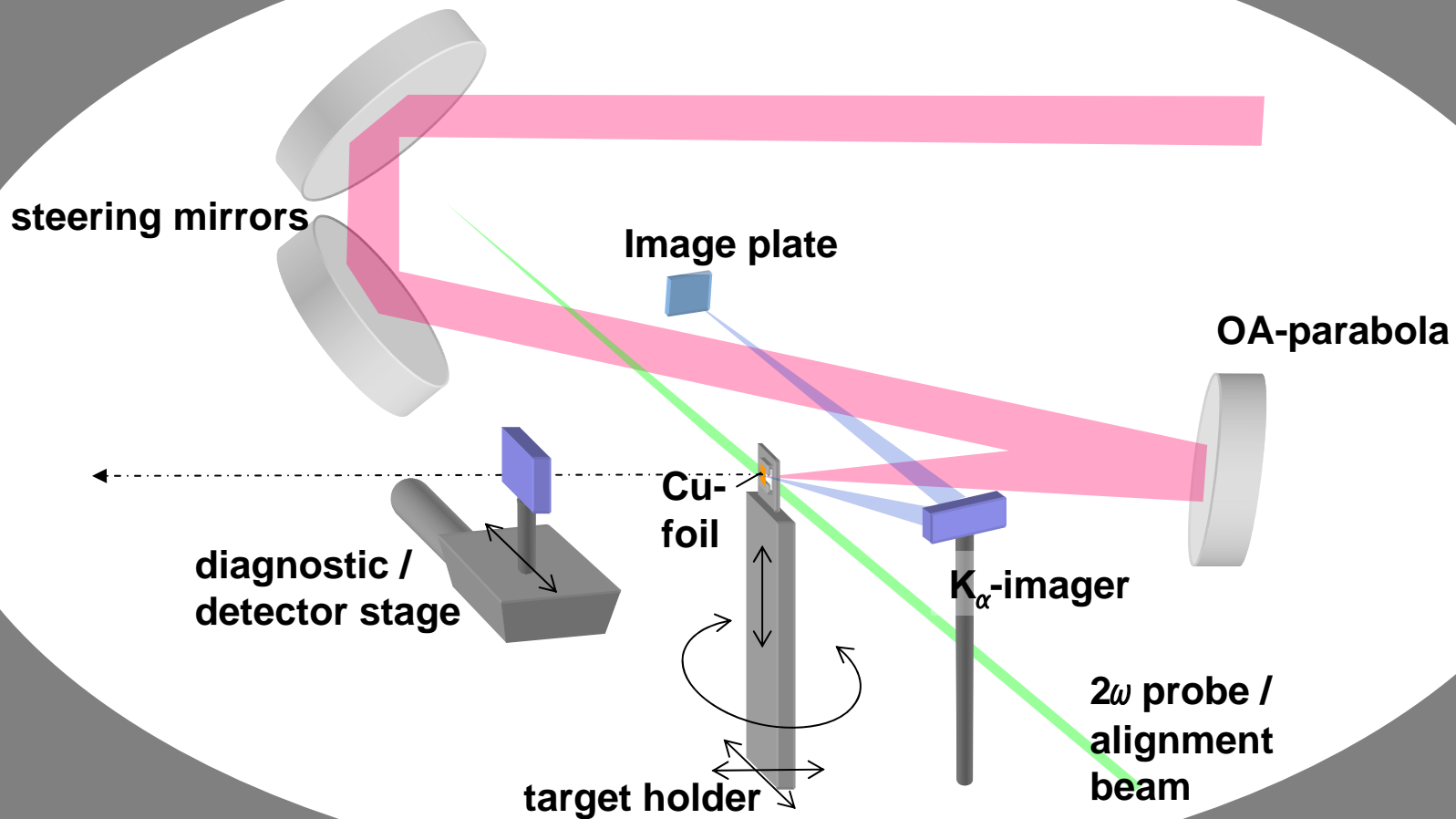
Full pulse width: < 3 ps (BW limit ~450fs)

ASE prepulse better 10^{-6} @ < 1ns

Focus shape is approximately maintained for rod-shots.

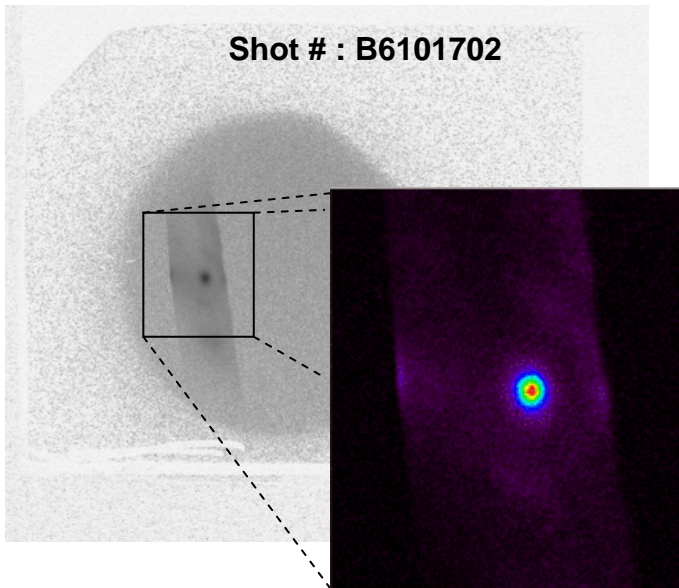
Full system shot foci have not been measured yet.

Target Chamber

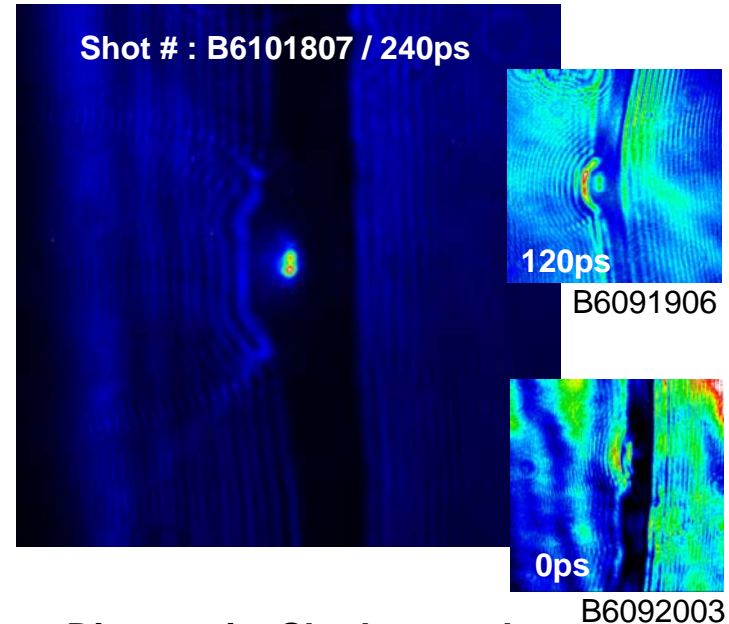


Target Diagnostic

(in collaboration with UCSD: Farhat Beg / Jim King)



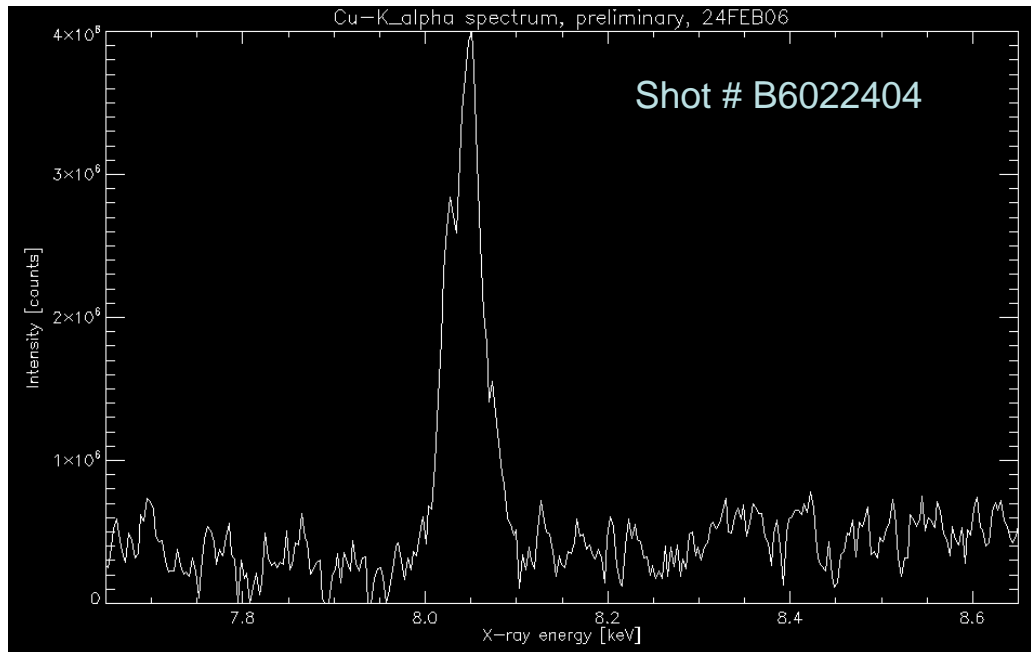
- Diagnostic: Spherically curved crystal; K_{α} X-ray imager
- Target: 25 μm Cu foil
- Detector: Fujifilm BAS-SR image plate
- Laser energy: 20 J
- Spot diameter: FWHM~60 μm
- Magnification : 7.1x



- Diagnostic: Shadowgraphy image / probe beam
- Target: 25 μm Cu foil
- Detector: Roper internally cooled CCD
- Exposure time: ~300 fs
- Magnification: ~9

X-ray Spectra

K_α- Spectroscopy



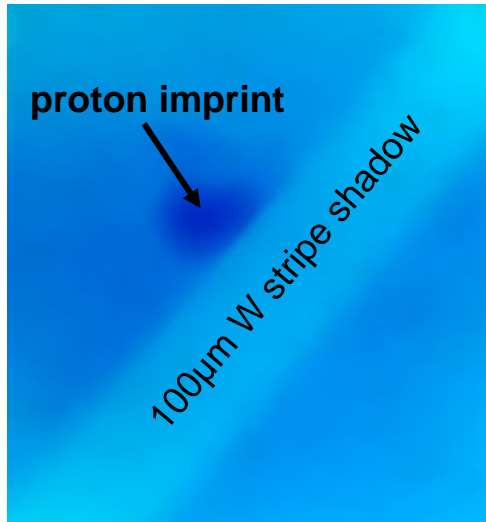
Shot # B6083003 (Cu)



Shot # B6091101 (Ge / 10keV)

Proton Radiography

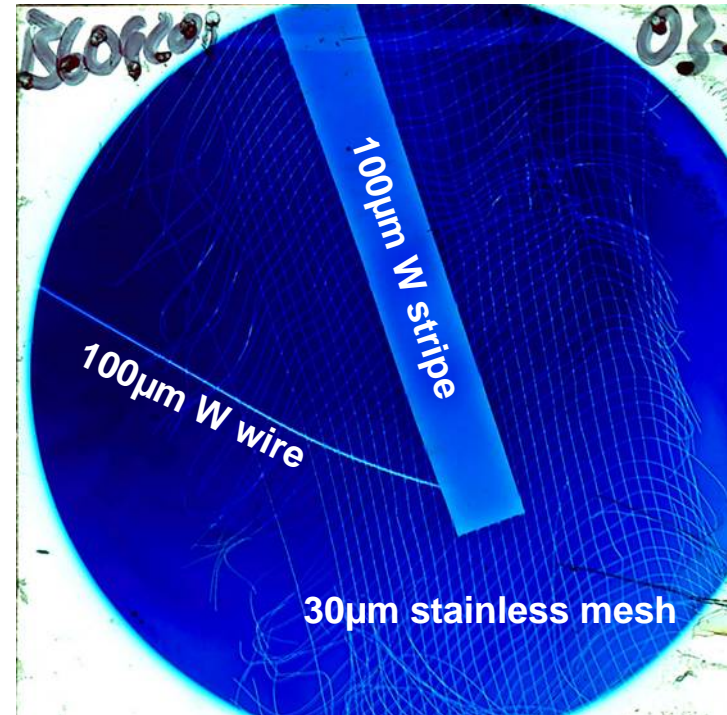
First Results



SHOT # B6090104:
Layer #18: $E_{\text{proton}} \sim 20 \text{ MeV}$

Stack: 8x GAFchromic HD-type
+ 12x GAFchromic MD-type

Laser energy: 24.5 J
Target: 8 µm Cu

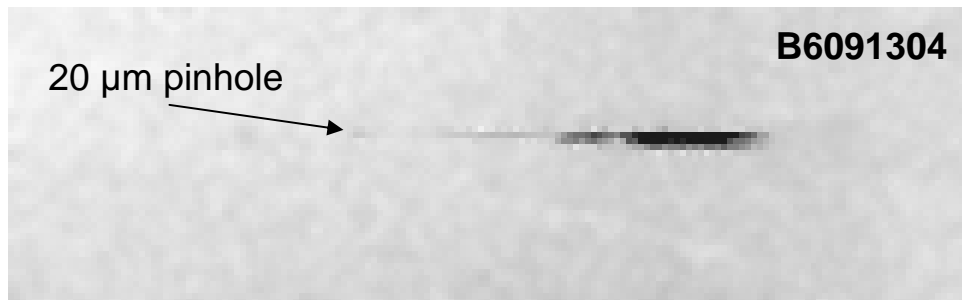
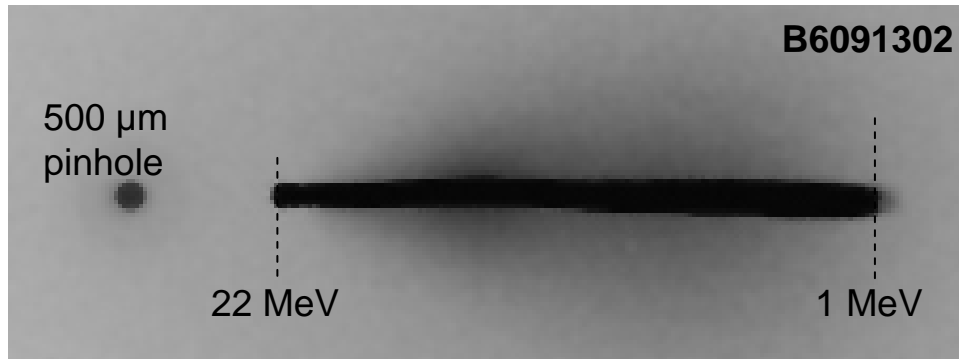


SHOT # B6092003



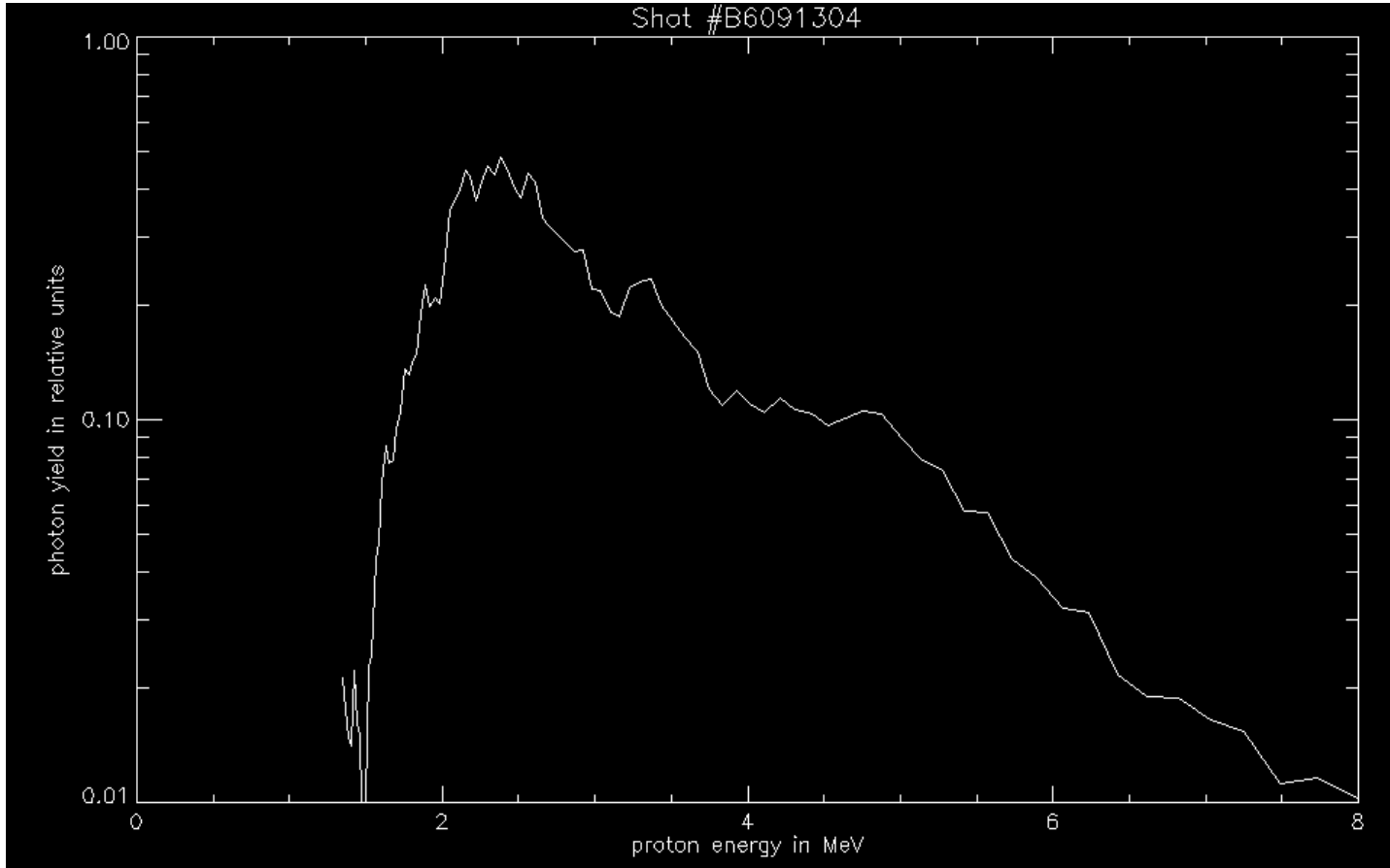
Proton Spectra

First Results



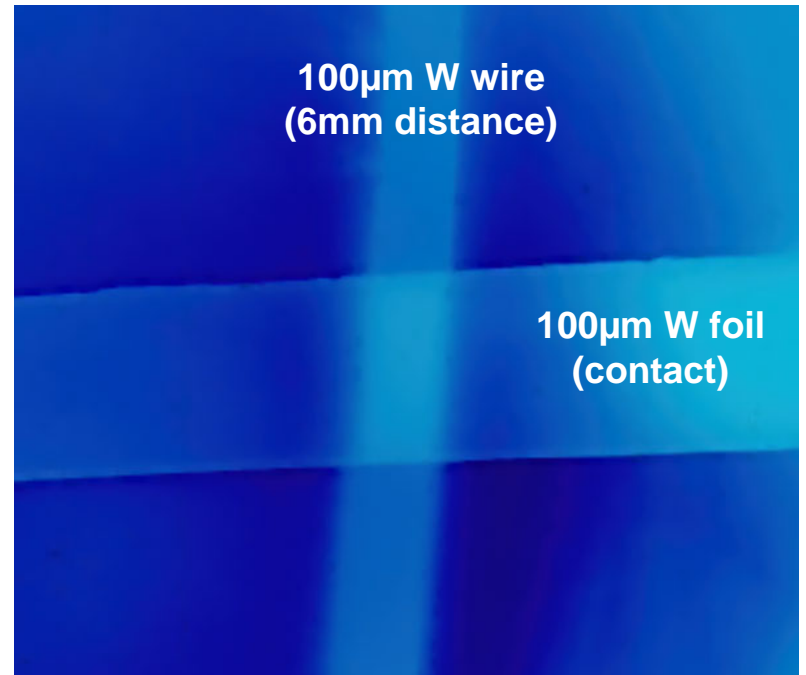
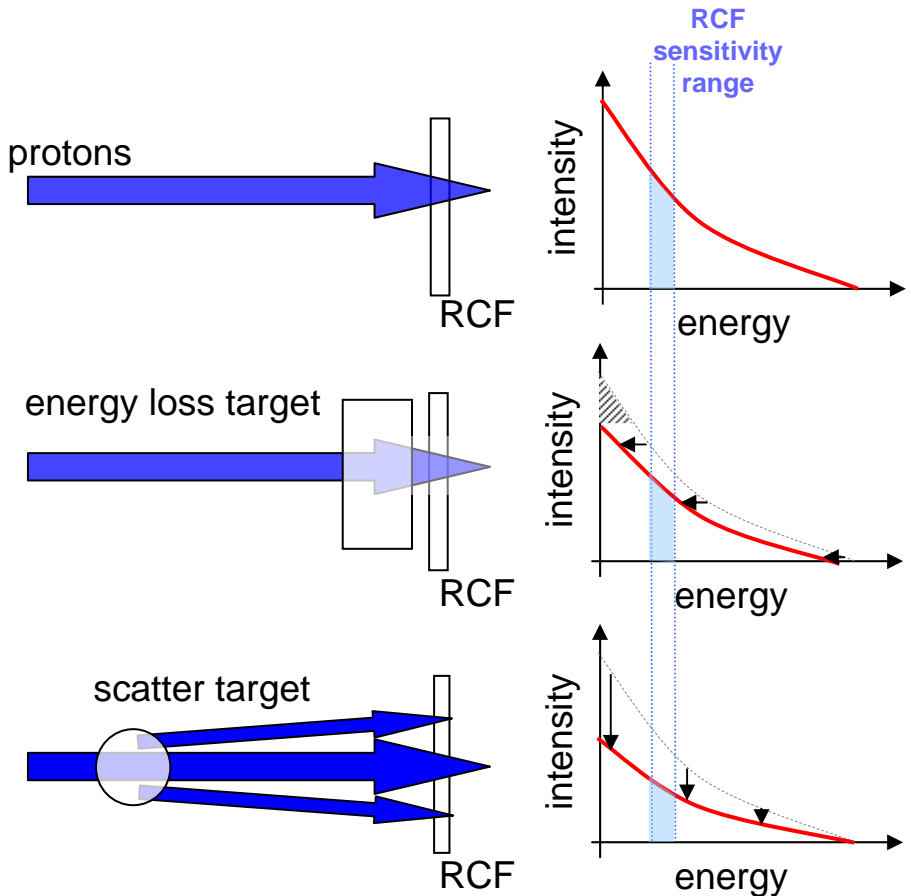
Proton Spectra

First Results



Proton Radiography

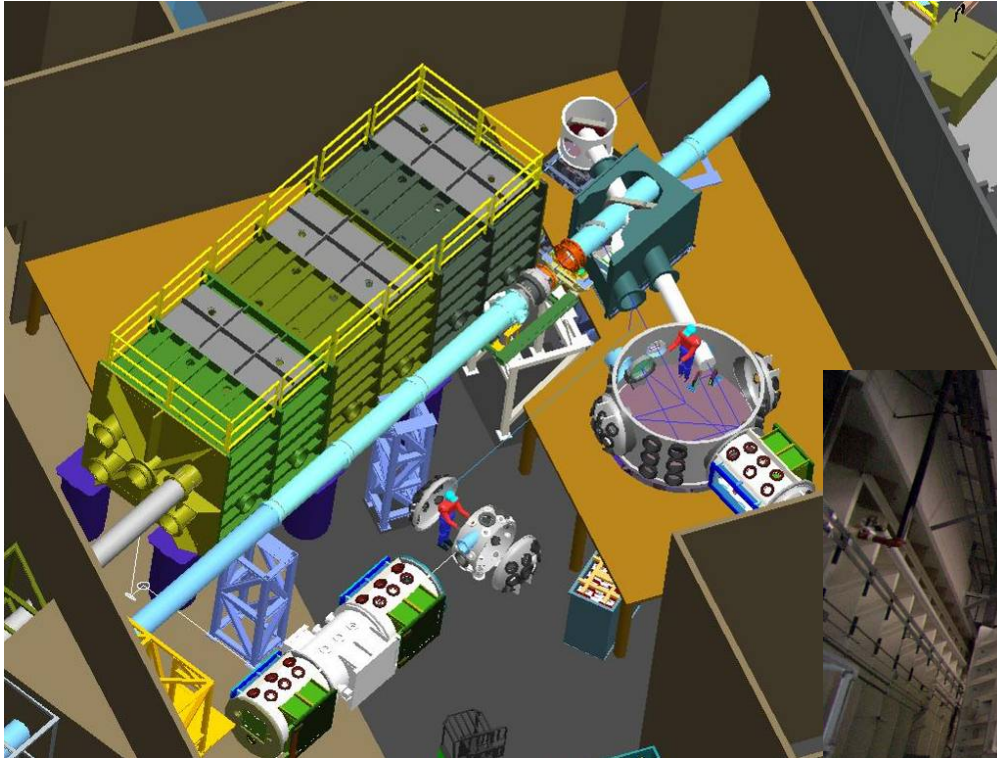
Scattering vs. Energy Loss



SHOT # B6090701 (5th layer)

Z-Petawatt

Outlook



Main Beam:

E: 400 – 1000 J

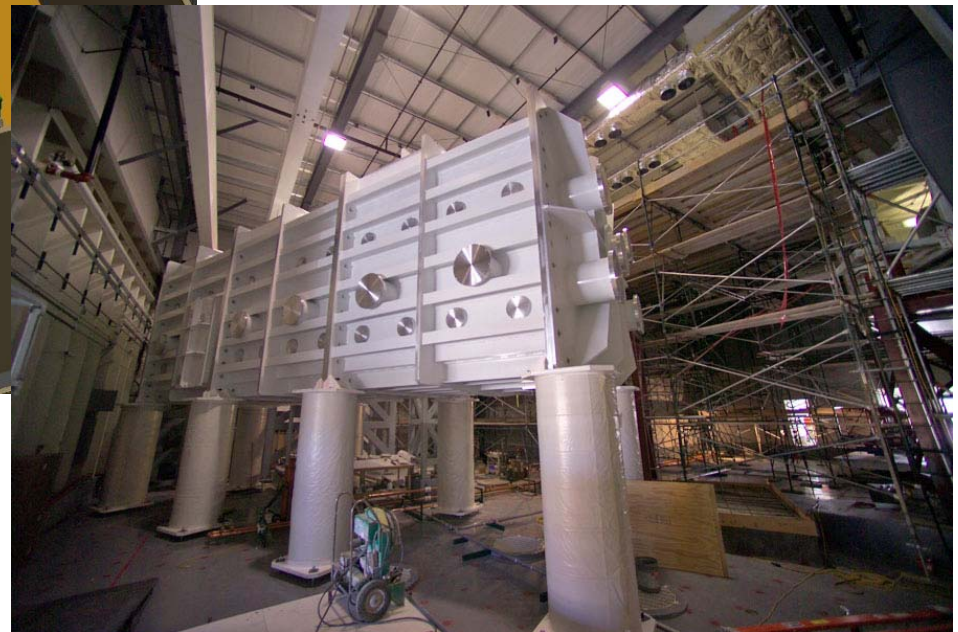
t: 500 fs

λ : 1054 nm

$I\lambda^2$: 10^{21} W/cm²

800 nm Probe:

3 J @ 30 fs



Commissioning

For ZR: Summer 2007

Stand alone: TBD