

Development of Energetic Probe Radiation with

Z ***Petawatt***

ICUIL 2008

Shanghai, China

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Aaron Edens, Guy Bennett, Dan Sinars, and Briggs Atherton

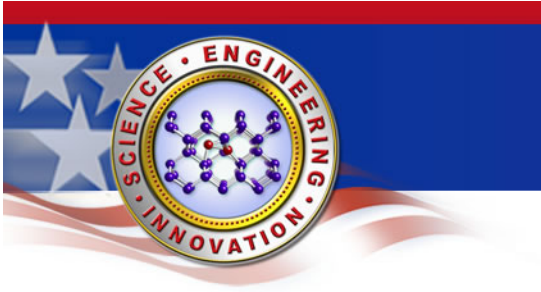
Sandia National Laboratories, USA



Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



 Sandia National Laboratories



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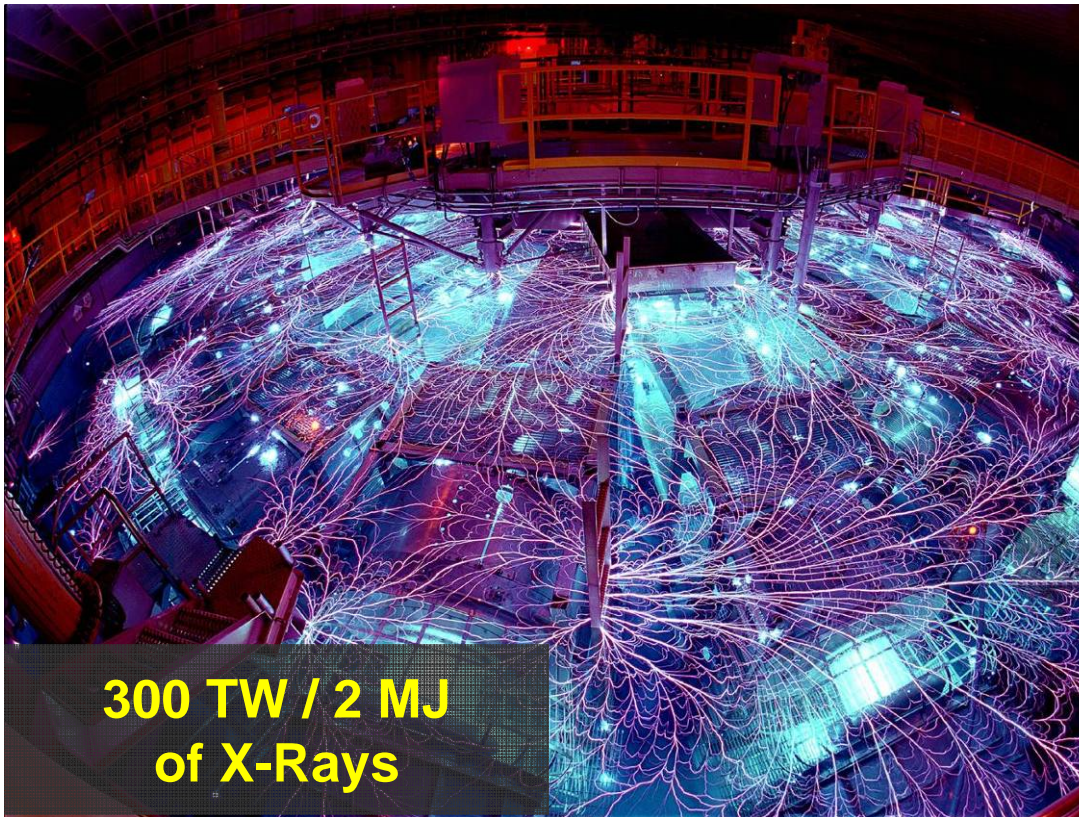
Multi-MeV Protons

Energetic X-Rays

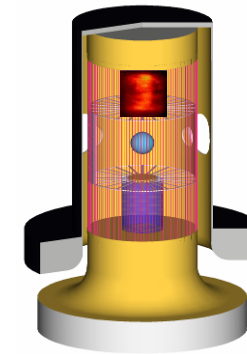


Primary Mission / Motivation

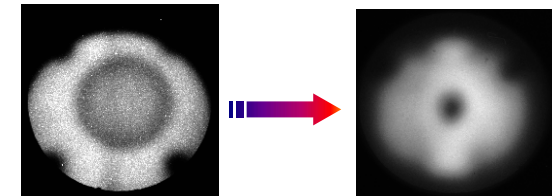
HEDP on



**300 TW / 2 MJ
of X-Rays**



X-ray driven deuterium capsule compression in a hohlraum.



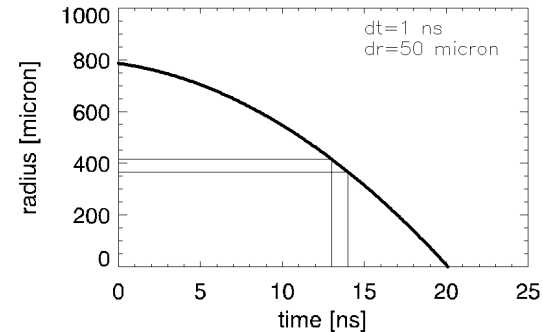
8×10^{10} neutrons
 $T_{\text{hohlr.}} = 220 \text{ eV}$
 $\text{CR} > 14 (40 \text{ g/cm}^3)$



Challenges for Improved Backlighting

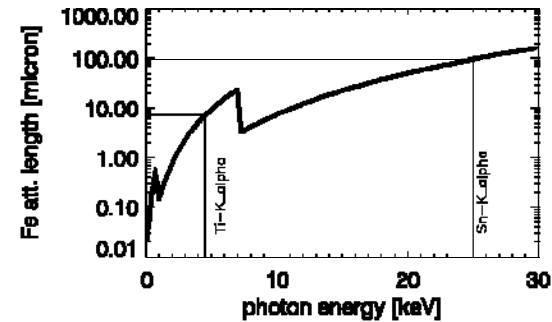
Motion Blur

- Shorter Pulses



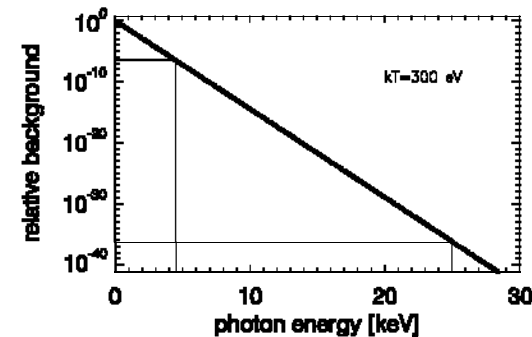
Higher Densities

- Higher Photon Energies
- Higher Laser Intensities



Higher Source Background

- Higher Photon Energies
- Higher Laser Intensities





More Motivations for Energetic Radiation

- **Isochoric Heating of Matter**
 - # Warm Dense Matter
 - # Equations of State
- **Solid Matter Probing**
 - # Shock Physics
 - # Material Sciences
- **Detector Development and Calibration**
 - # Neutron Radiography
 - # X-ray Imaging
- **Advanced Particle Beam Sources**
- **Astrophysics**

X-rays/Protons

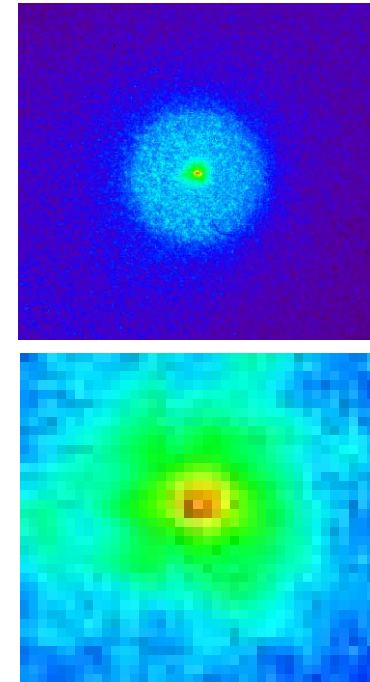
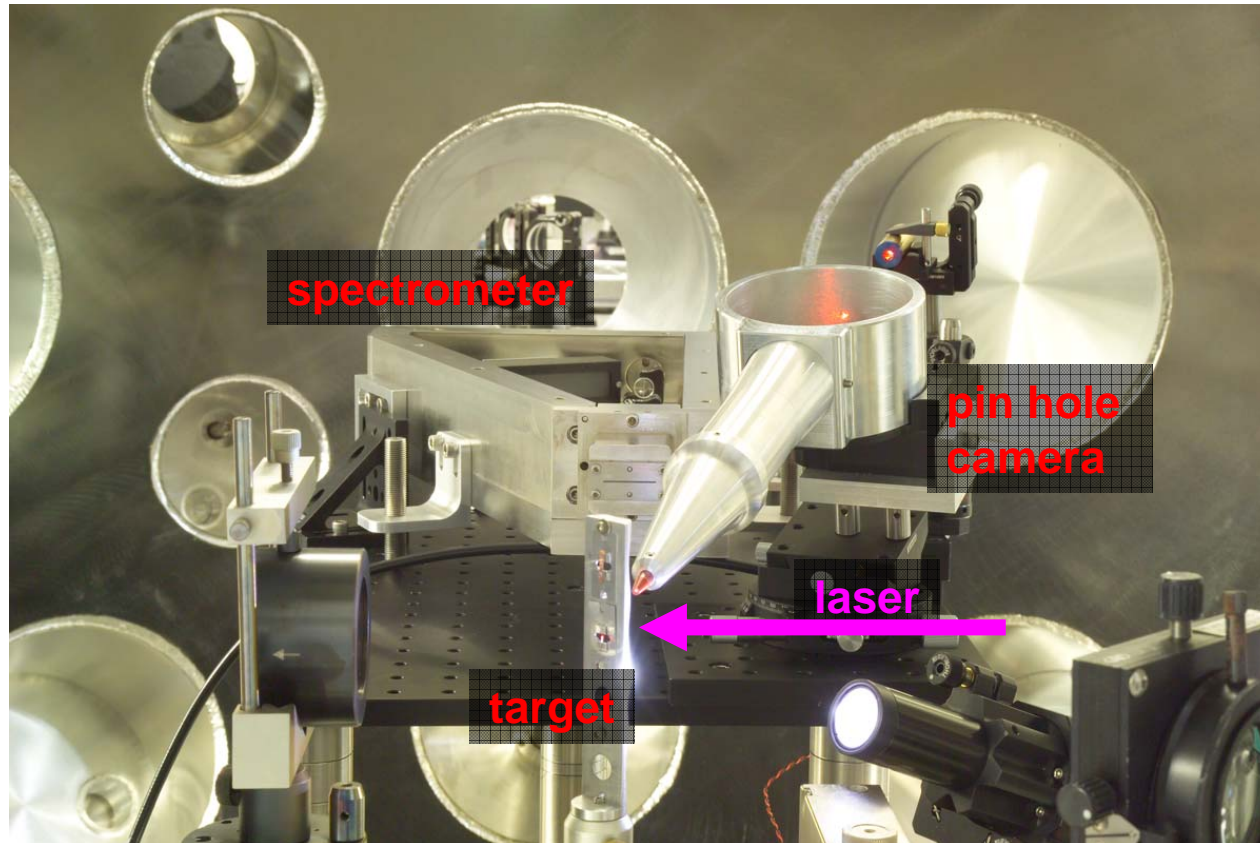
X-rays/Protons

Protons
X-rays

Protons
X-rays/Protons



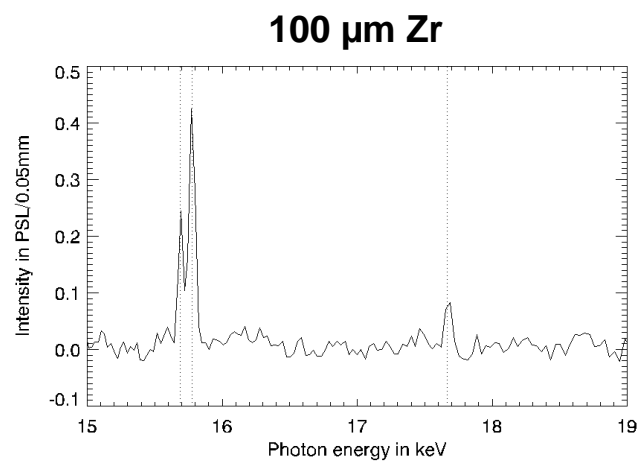
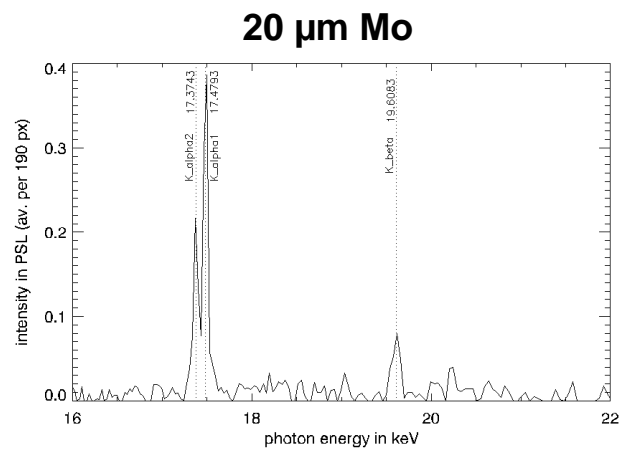
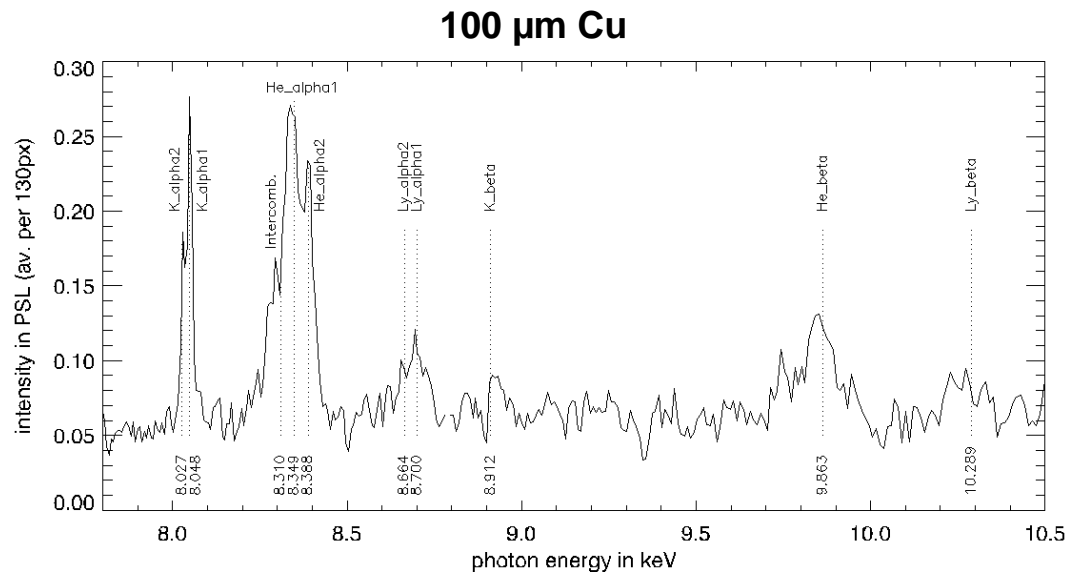
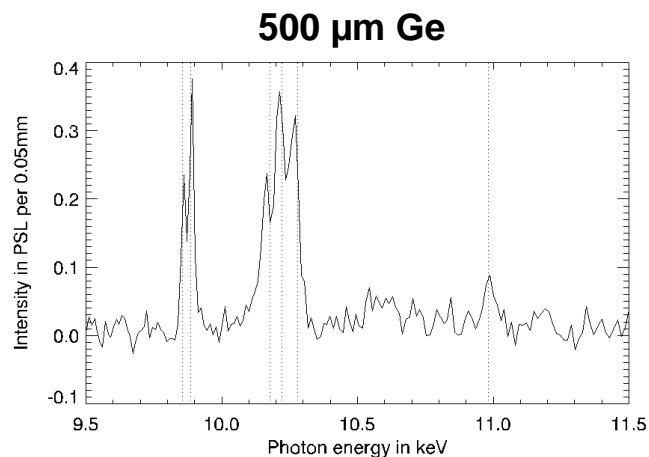
Characterization of X-Ray Sources



45 J shot on 100 μm Cu,
FWHM = 11 μm ,
-> $8\text{E}19 \text{ W}/\text{cm}^2$



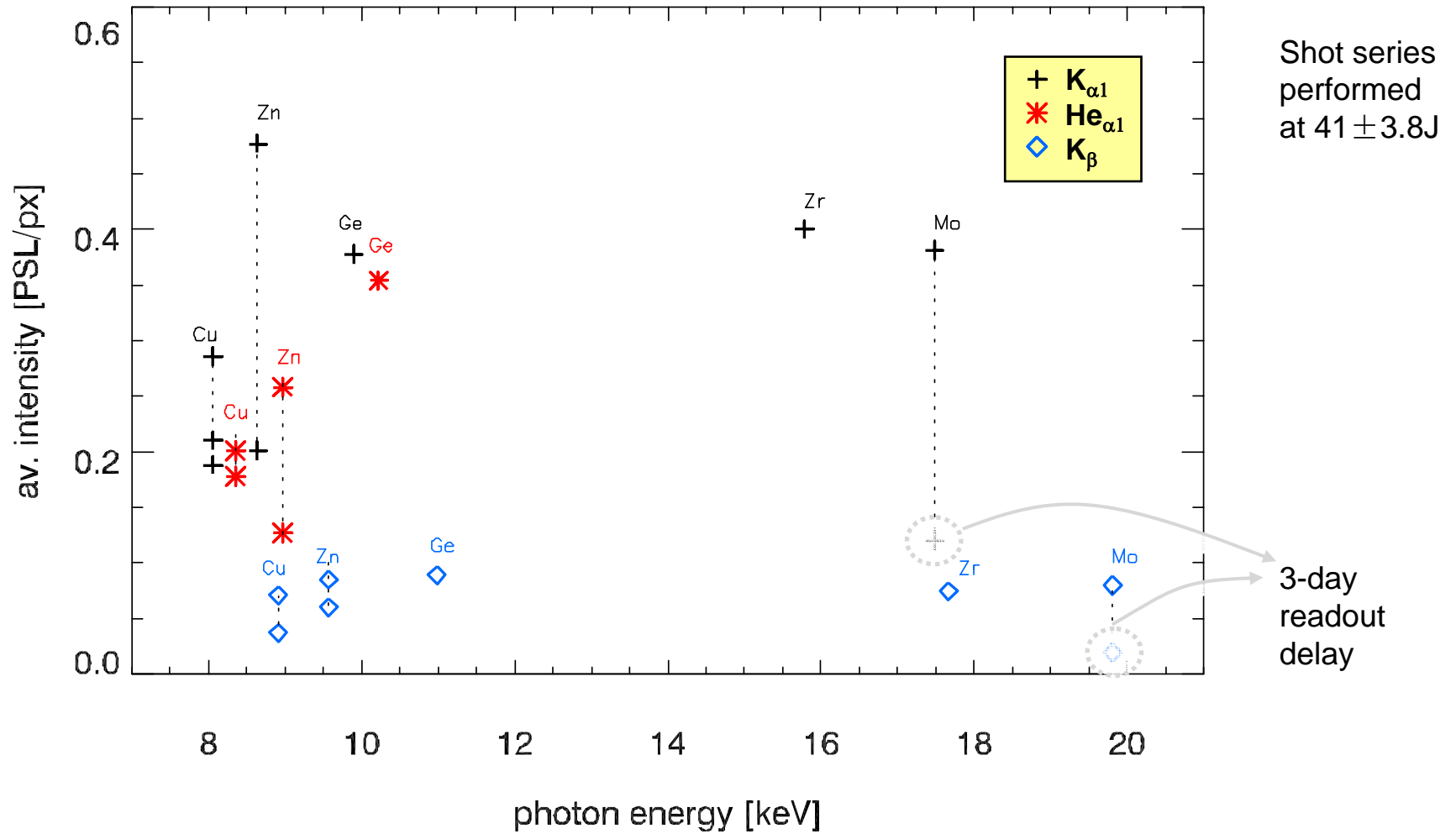
Characterization of X-Ray Sources





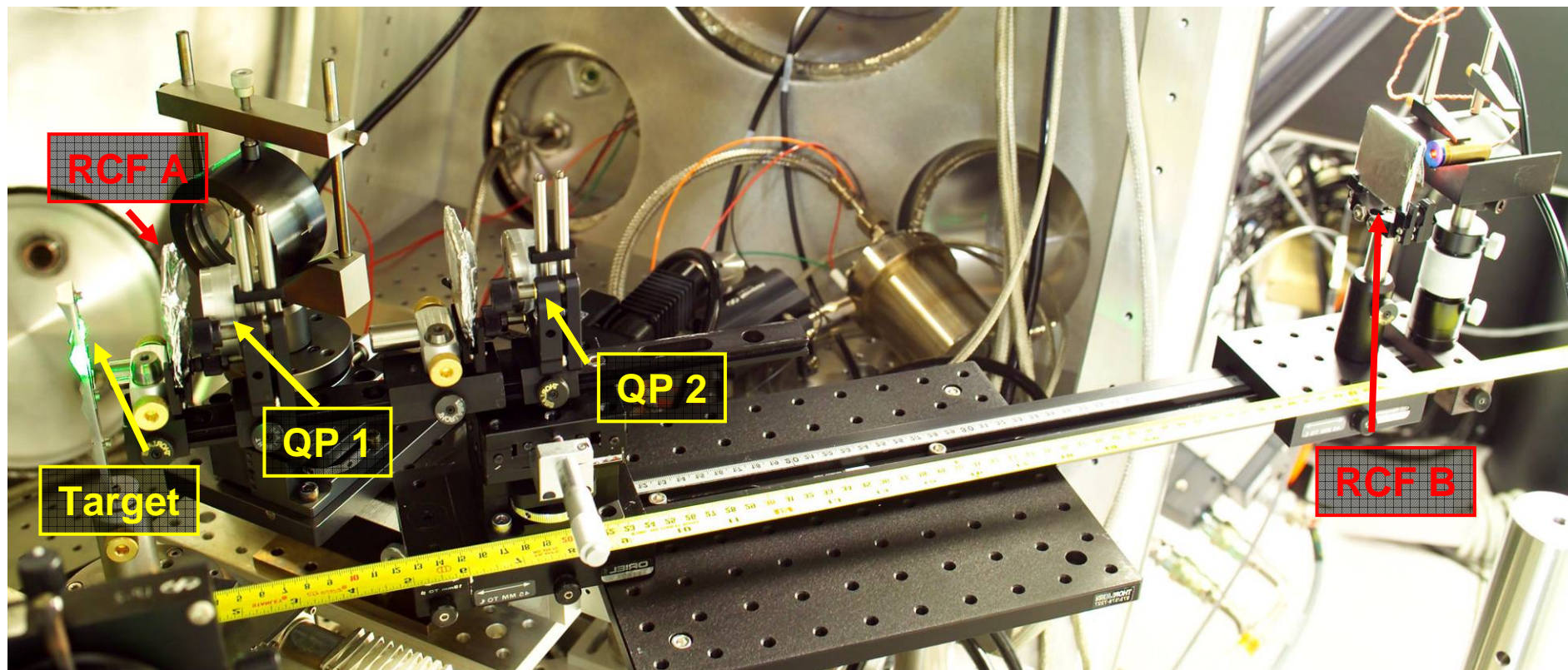
Characterization of X-Ray Sources

Maximum Line Intensities (normalized to 41J Laser Energy*)





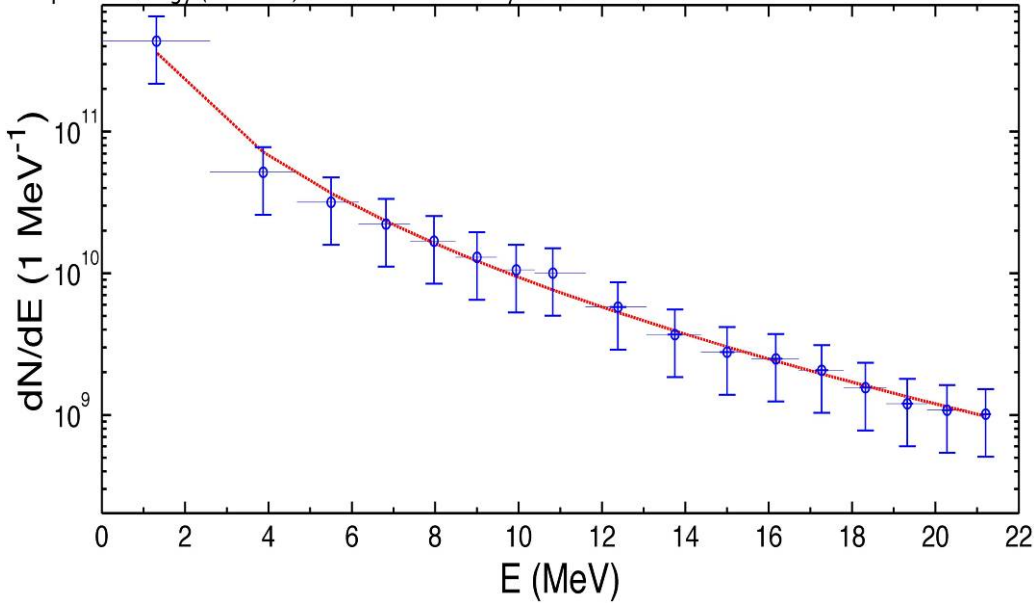
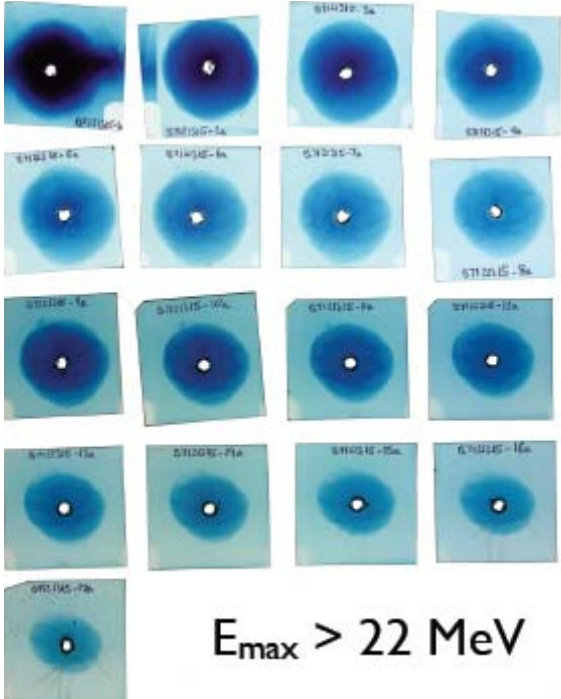
Proton Focusing





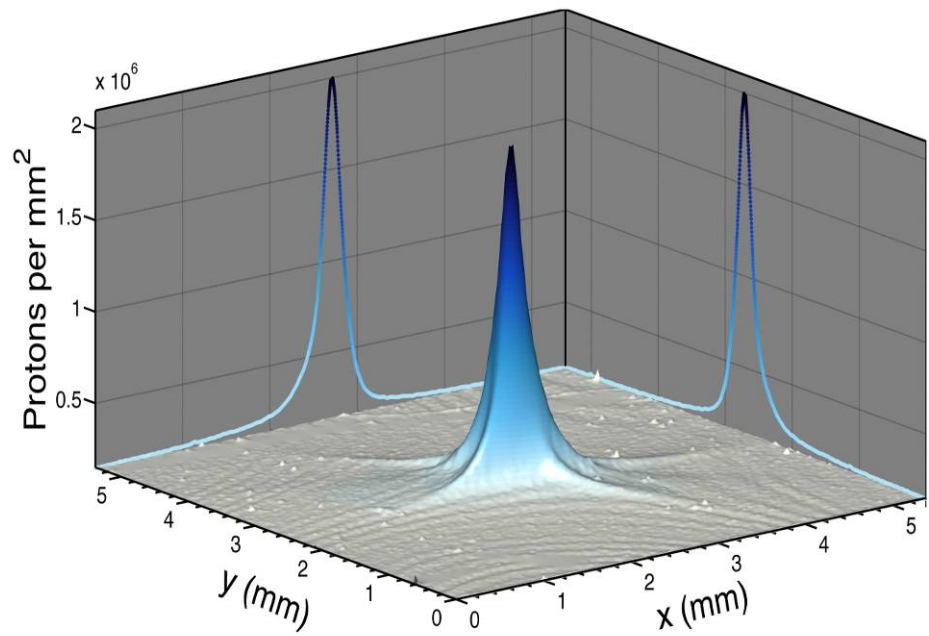
Proton Focusing

RCF A



$E_{\text{las}} = 39 \text{ J}$
 $kT_{\text{fit}} = 1.24 \text{ MeV}$
 $\eta(\text{las} \rightarrow \text{prot} > 4 \text{ MeV}) \sim 1\%$

RCF B



~200 μ m x 300 μ m FWHM @ 14 MeV





Moving ahead....

➤ Continuous work on proton/ion acceleration



1st half '09
1st quarter '09
January '09
2009
2009 / 10