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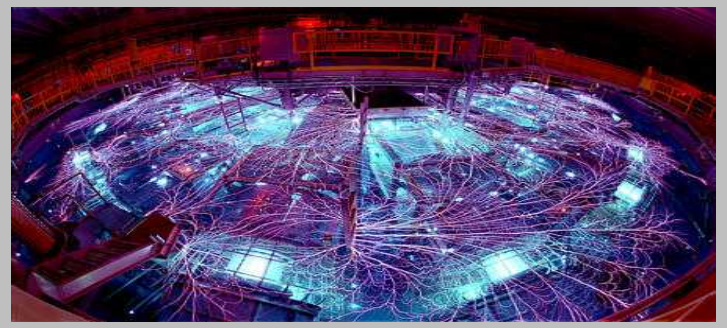
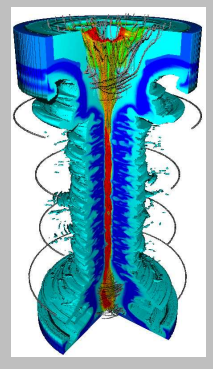


ZBeamlet



Self-emission spherical crystal imaging at Z and plans for 3D imaging.

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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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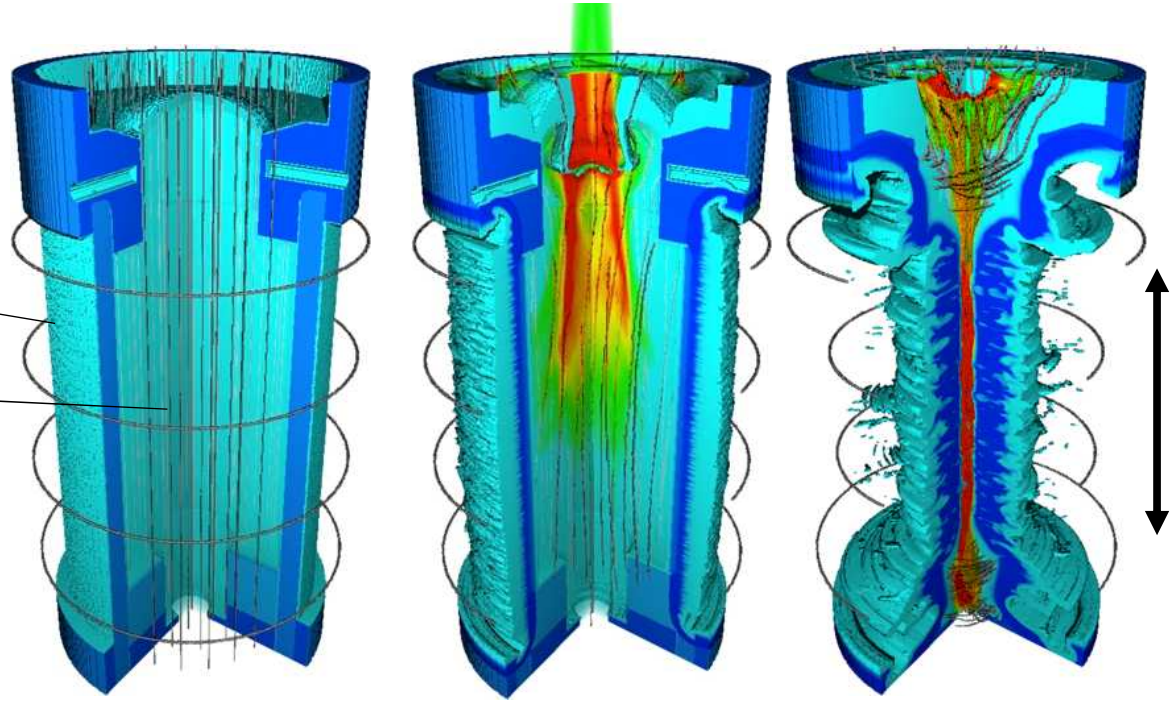
New diagnostics are now needed to diagnose the self-emission from the stagnation of a Magnetized Liner Inertial Fusion (MagLIF) implosion.*

MagLIF Implosion Sequence

Imploding Be tube
- **inner diameter = 4.65 mm**
- **thickness = 0.47 mm**
- **10 mm tall**

Gaseous D_2 fuel 0.7 mg/cc



Magnetization B = 10 T

Laser Heating

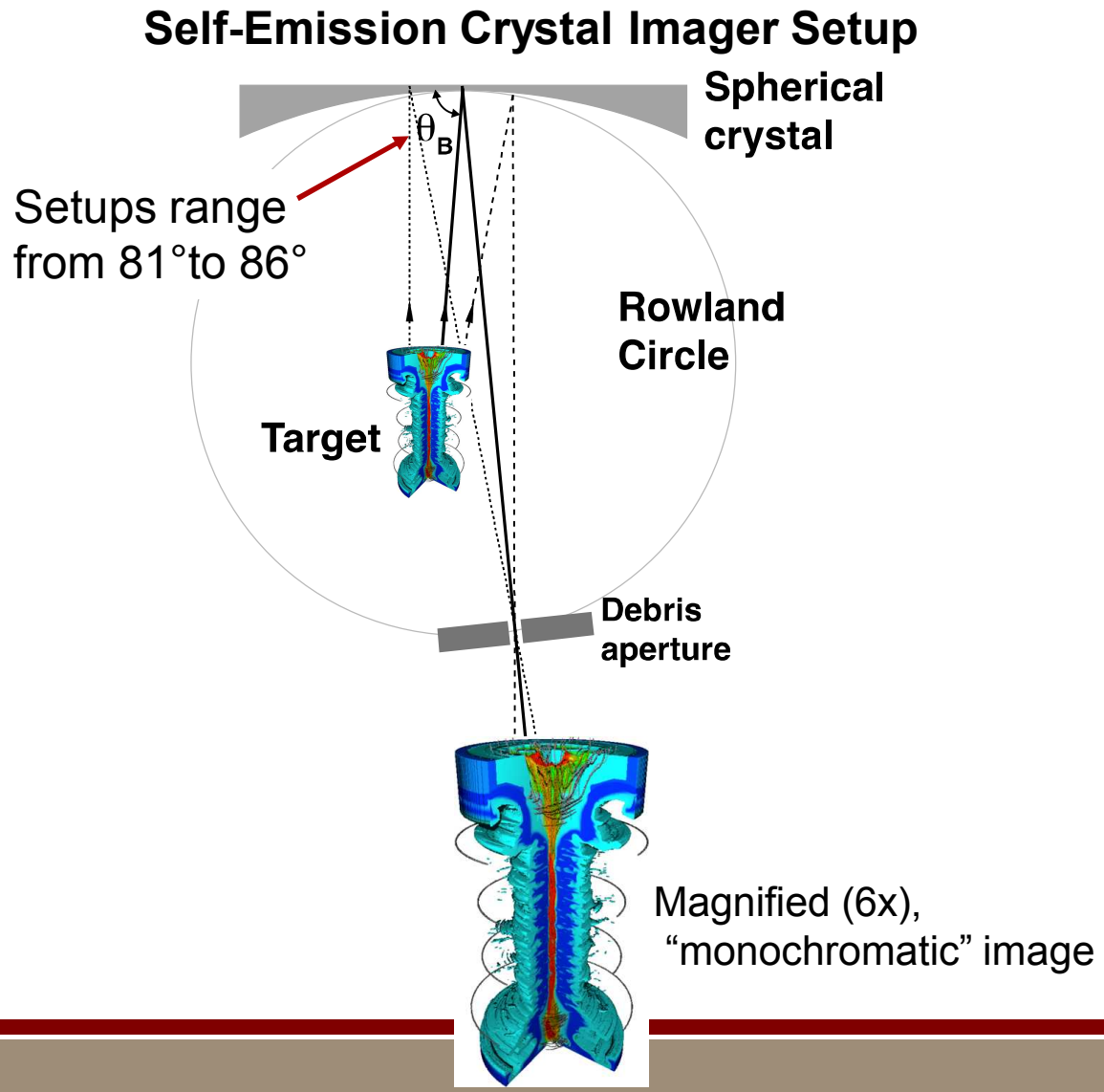
Compression

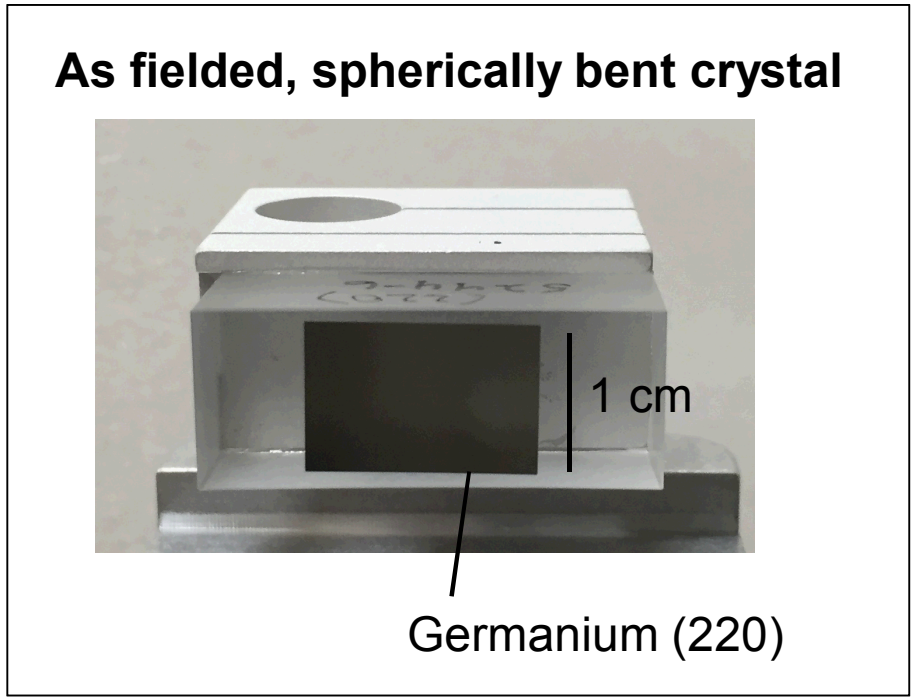
Stagnation column 6-8 mm

*S.A. Slutz *et. al.*, PoP (2010)
S.A. Slutz and R. A. Vesey, PRL (2012)
M.R. Gomez *et. al.*, PRL (2014)
P.F. Schmit *et. al.*, PRL (2014)
A.B. Sefkow, *et. al.* ,PoP (2014)
M.R. Gomez, *et. al.*, PoP (2015)
S.B. Hansen, *et. al.* , PoP (2015)
R.D. McBride, *et. al.*, PoP (2016)

Graphic by C.A. Jennings

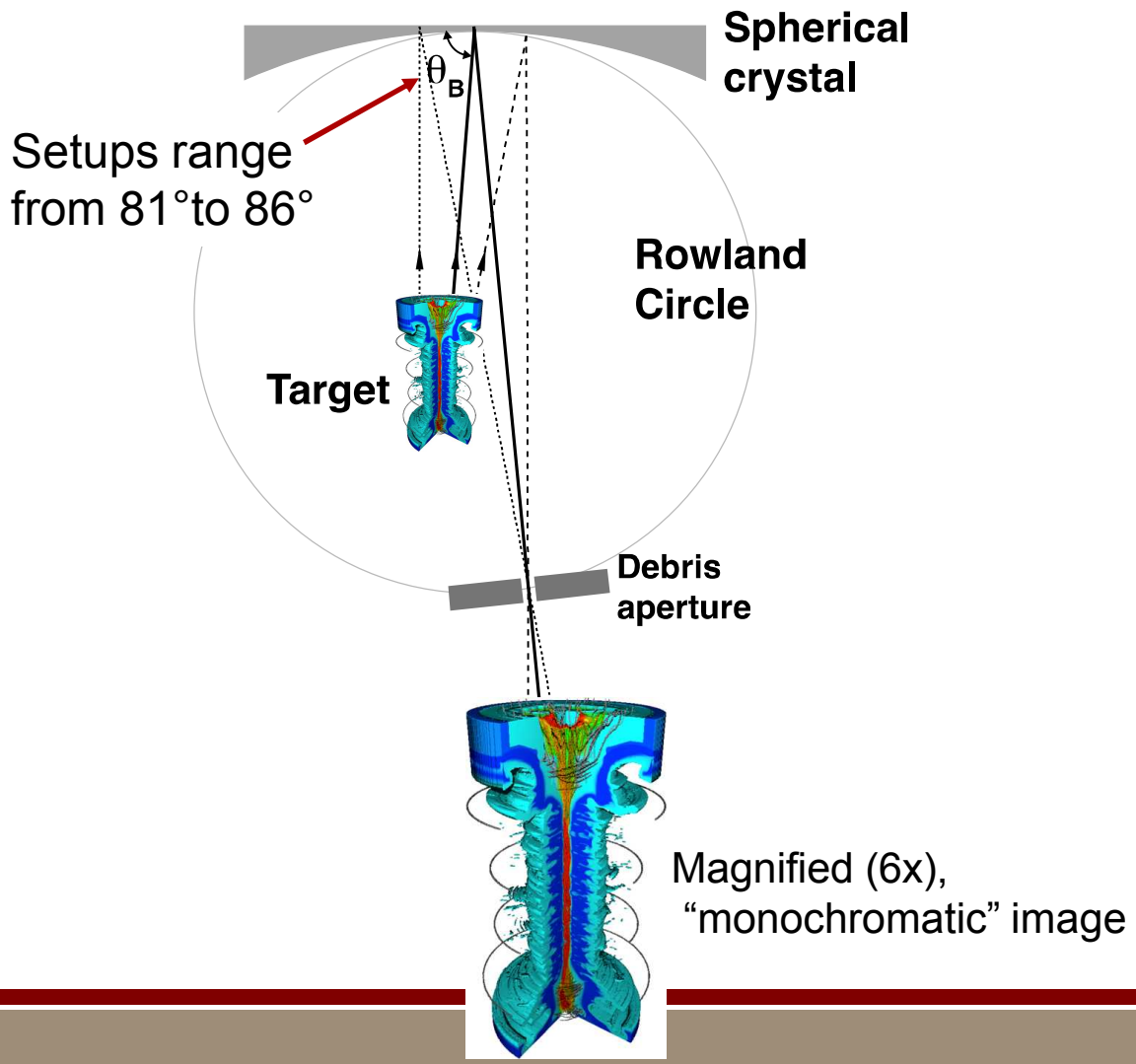
Spherical crystal imaging is the workhorse imaging diagnostic to for MagLIF implosions.





Spherical crystal imaging is the workhorse imaging diagnostic to for MagLIF implosions.

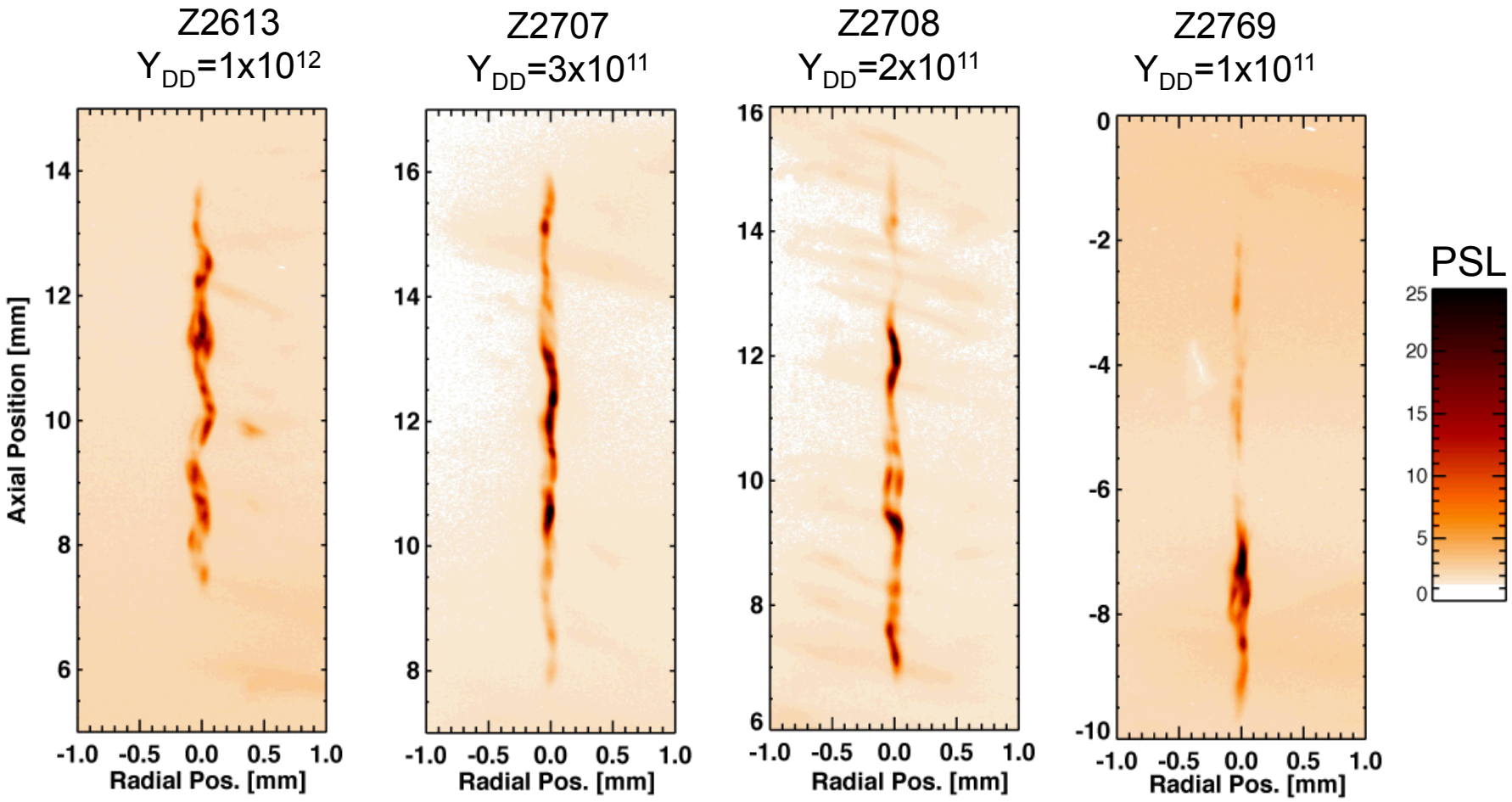
Self-Emission Crystal Imager Setup



Spherical crystal imaging offers critical advantages for imaging on Z:

1. **High resolution**
   - Up to 17 μm. No comparable PH camera currently available on Z.
2. **Large FOV**
   - We need 10 mm V x 2 mm H
3. **High brightness**
   - Crystal provides large throughput, ~10^{-5} ster currently achieved.
4. **Low background signals**
   - 1" W shielding inserted between target and detector
5. **Minimizes shot debris on detector.**
   - Detector sees the crystal and not the target.

The continuum emission generated during the liner stagnation shows complex structure and non-uniformity in the vertical direction.



The average, radial width is around 100 μm, which is approaching the diagnostic limit of 60 μm.

The radial emission profile of the stagnation plasma from a MagLIF implosion is now measured with greater accuracy using an improved x-ray crystal imager.

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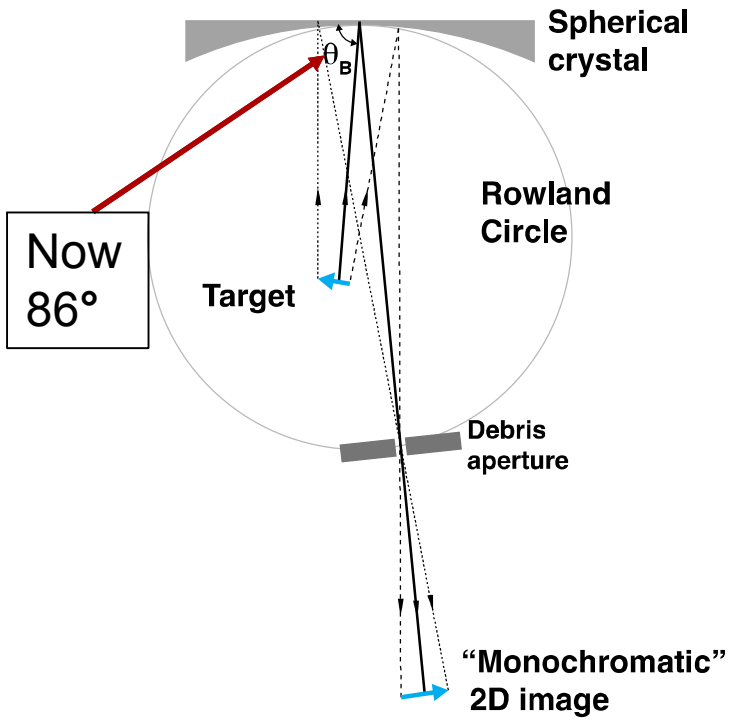
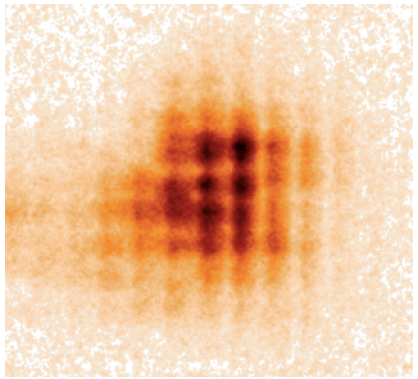
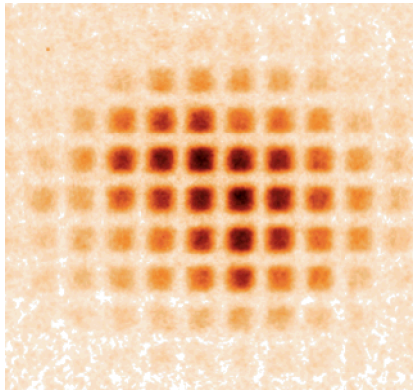
To reduce astigmatism and improve resolution we increased the reflection angle from 82.9° to 86°.



Resolution tests were performed using an Au grid and a laser (ZBL) heated foil.



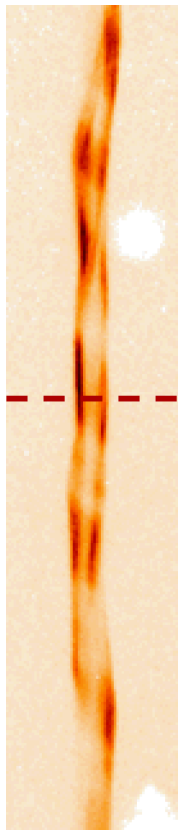
Old imager
Resolution
~ 60 μm



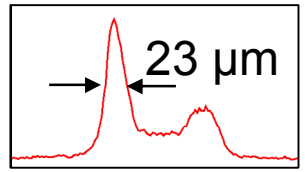
New imager
Resolution
~ 17 μm

Assuming bar width = 25 μm

Recent MagLIF experimental data (PI: Matt Gomez, z3120)



Radial emission profile



A new differential crystal imaging technique is being to developed to identify line emission from dopants or impurities.

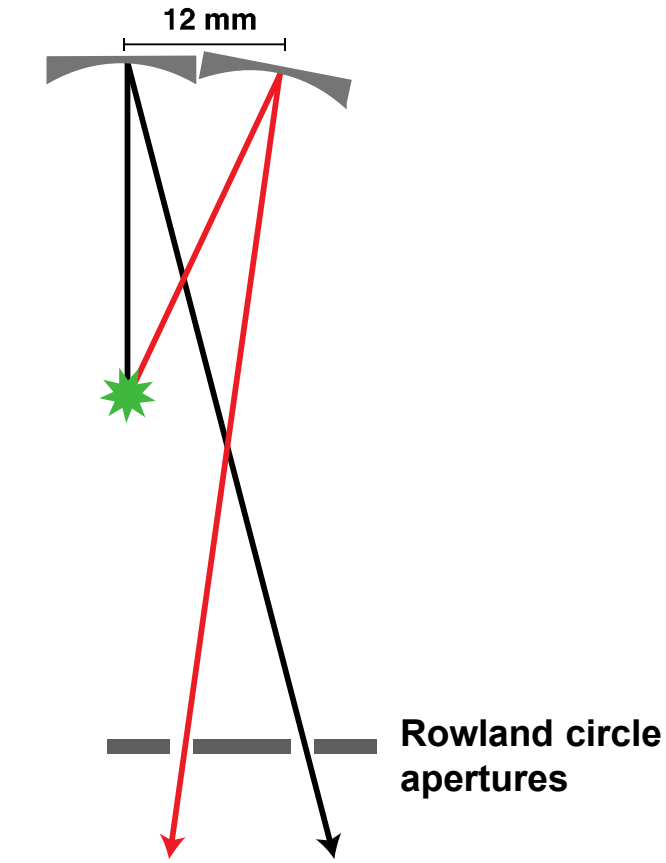


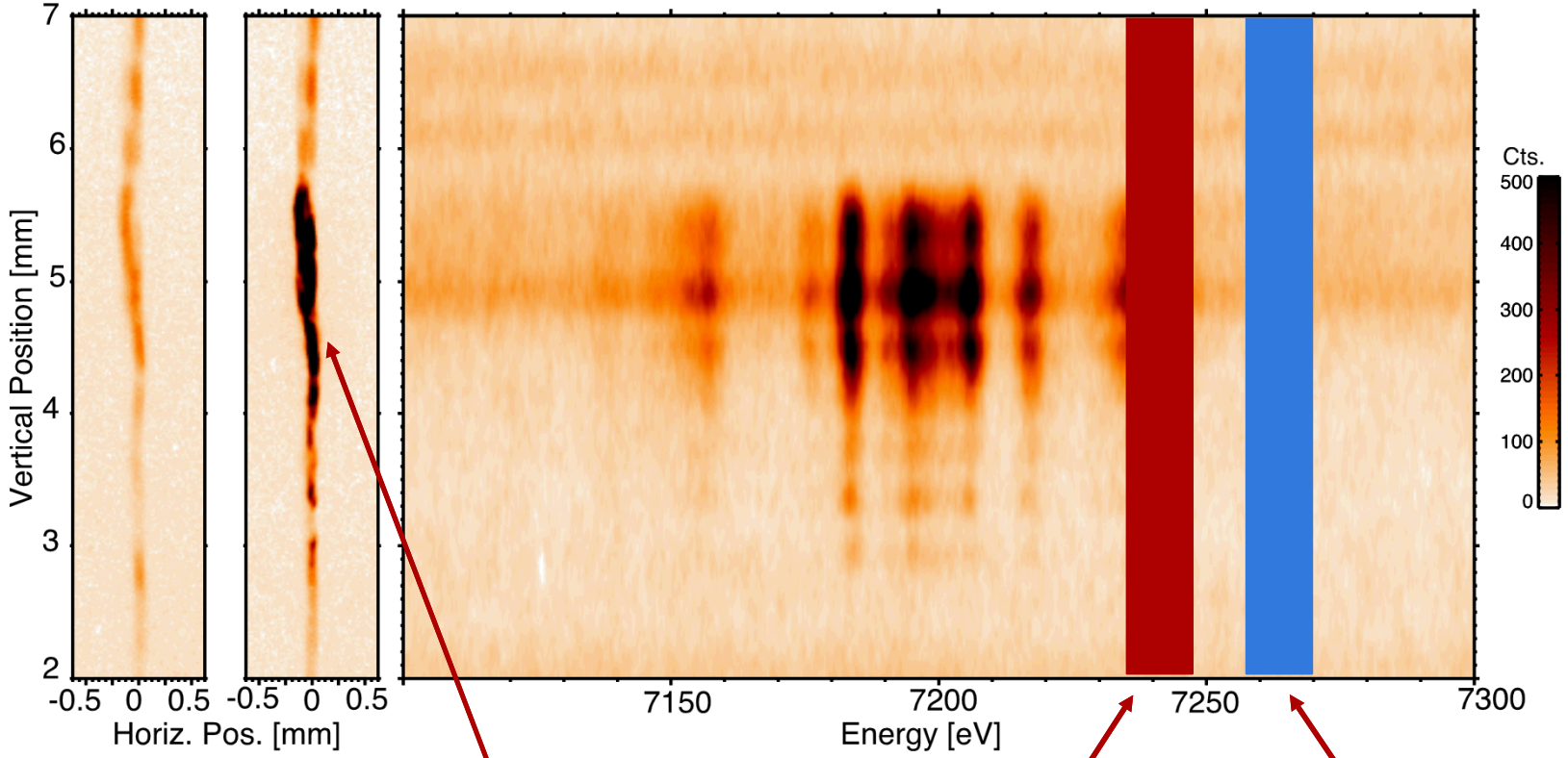
Image 1: Continuum

Image 2: Continuum + line

Image 1: Contin.

Image 2: Contin. + Co He-w line

Space-resolved spectrum: z3078



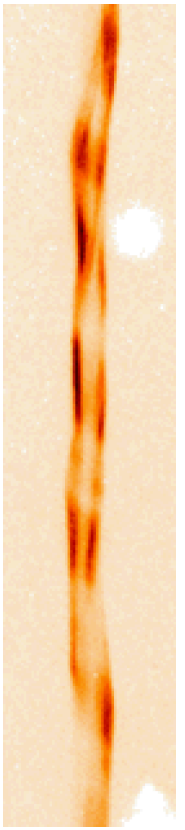
Co emission

Image 2 bandwidth centered on Co He – Res. line

Image 1 bandwidth

Key questions for MagLIF imaging:

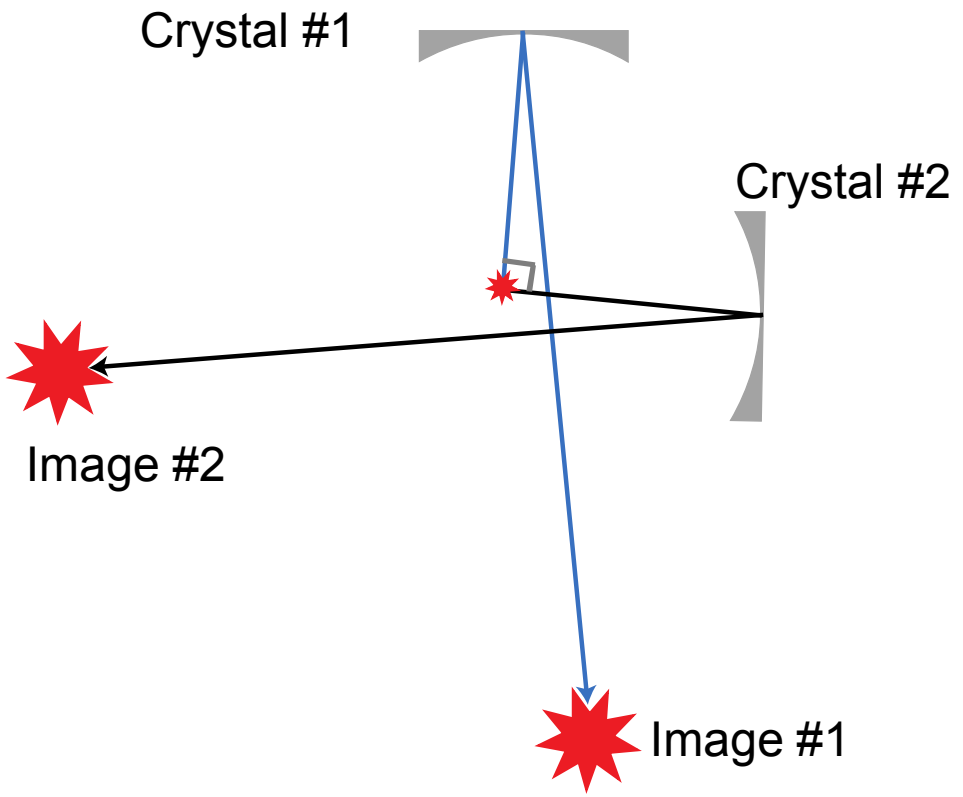
- **How does the column evolve in time?**
  - Currently commissioning a time-gated PH camera at M = 3x.
  - hCMOS for backlighting commissioned this year; extend to self-emission next year.
- **Does the liner opacity modulate the self-emission from the column?**
  - Need to operate above 13 keV, where >80% transmission through Be
- **What is the shape of the cross-section?**
  - This will allow an accurate volume calculation.
- **Is the column really helical?**
- **What does a bifurcation look like from an orthogonal view?**



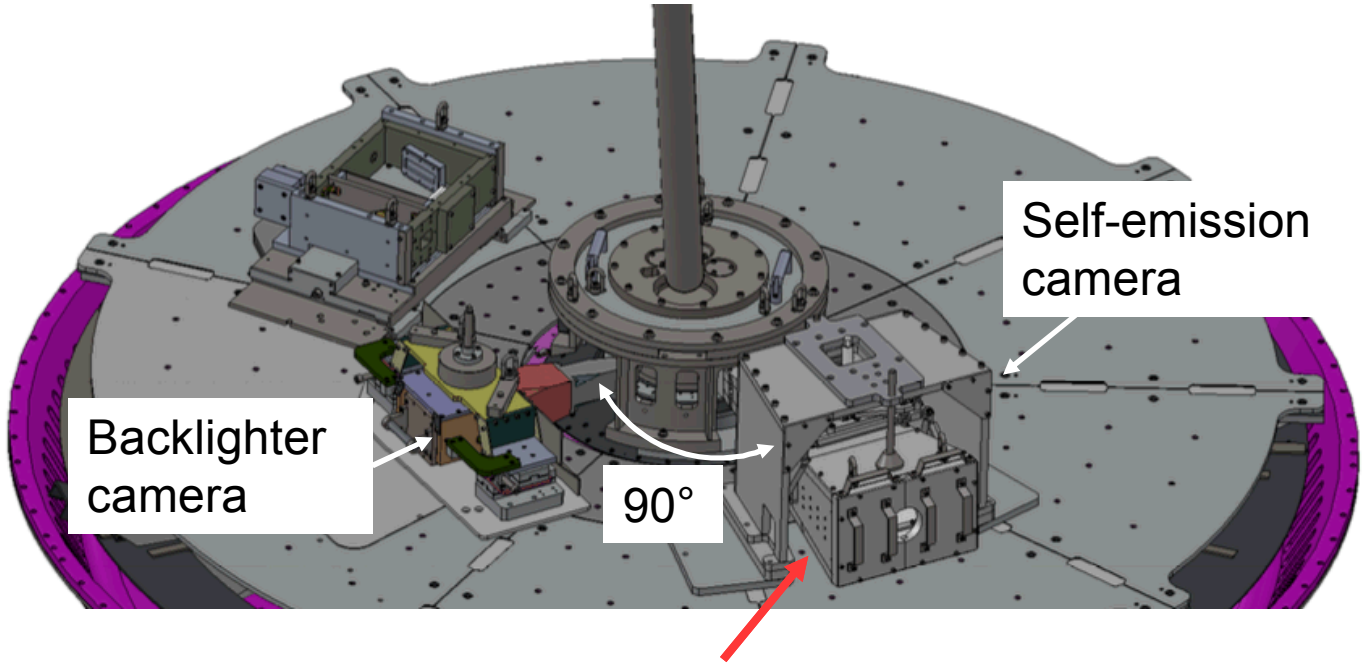
3D imaging will answer these questions

To allow 3D reconstruction of the column we would two field crystal imagers with orthogonal views. Both would be time-integrating.

Orthogonal Crystal Imaging



Z setup showing orthogonal *backlighting* and self-emission imaging.



Another camera body is needed to capture an additional self-emission crystal image.

We expect 2nd camera to be ready in Spring 2018.