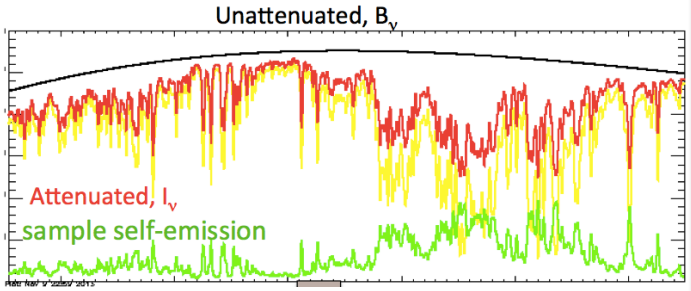
X-ray Spectroscopy 1, Tuesday Afternoon, 3:50 PM – 5:40 PM

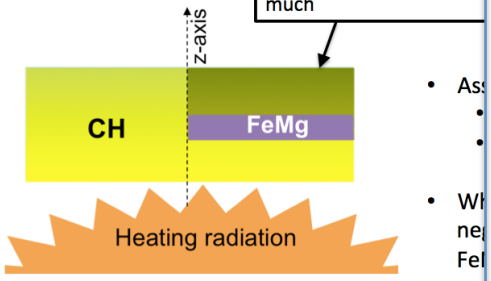
John Seely	ARTEP	High Res Hard Xray Spectroscopy at Titan
Jim Weaver (for Yefim Aglitsky)	NRL	High Resolution Spectra of He-like Fe for ICF
Patrick Ross	NSTec	Opacity Spectrometer
Ken Hill	PPPL	Stark broadening of Kr He-β lines for electron-density measurement on NIF
Taisuke Nagayama	SNL	Numerical scrutiny of SNL iron opacity experiments

Taisuke Nagayama (SNL) "Numerical scrutiny of SNL iron opacity experiments"

- Plasma (Fe/Mg) Self Emission



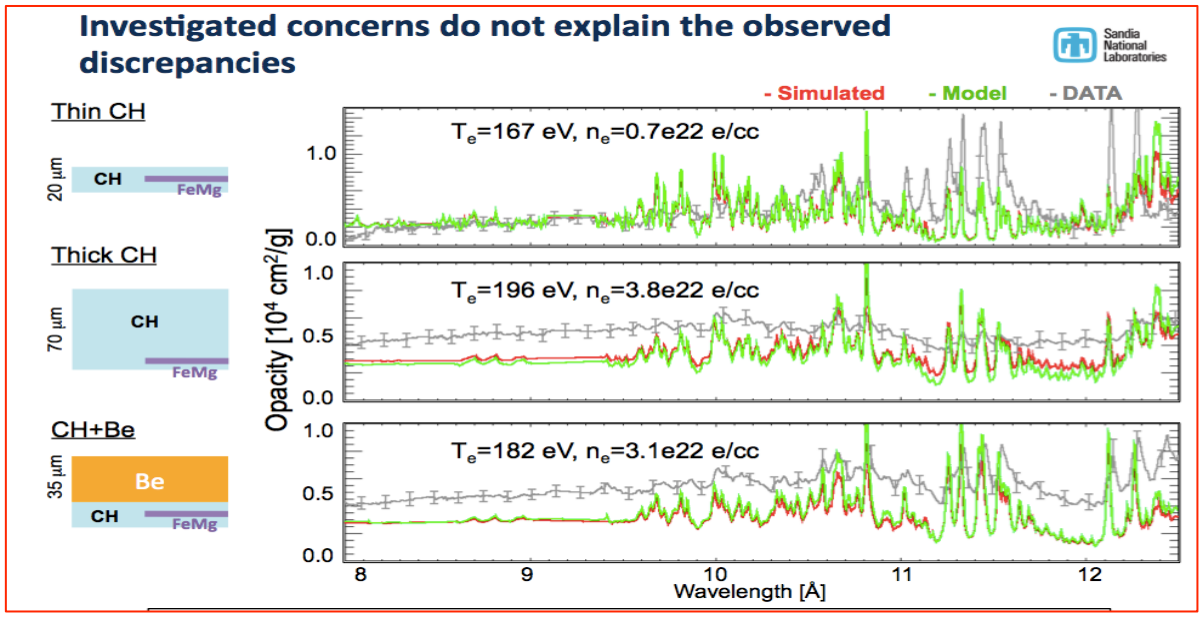
- Tamper Transmission Difference



- Time and space integration effects

Data analysis assumes static uniform plasma

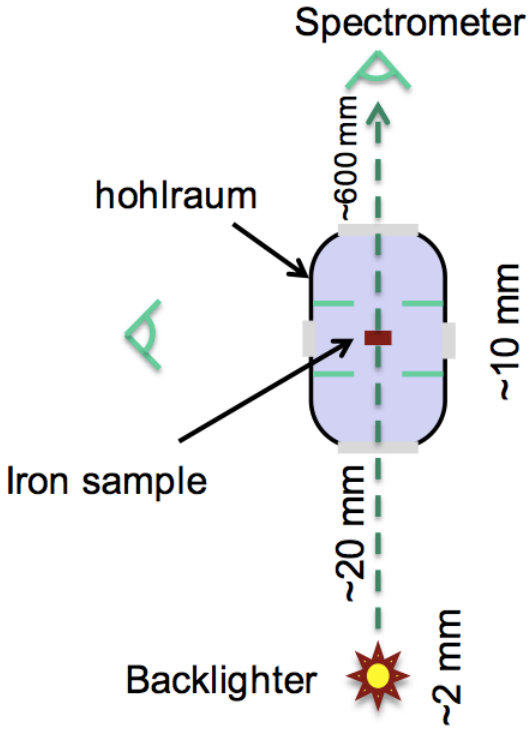
Systematic uncertainties associated with the concerns are numerically investigated



NEW

Patrick Ross (NSTec) Opacity Spectrometer (for NIF Opacity platform designed to replicate "Z" experiments)

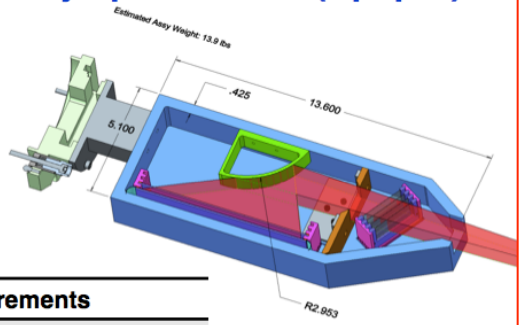
NIF Opacity Platform uses a capsule backlighter and a time-integrated spectrometer



Description of the NIF Opacity X-Ray Spectrometer (OpSpec)

The OpSpec is a crystal spectrometer snout designed to be fielded on a DIM in NIF. (Self-contained snout)

Time-integrated X-ray spectroscopy will be performed on NIF with OpSpec. (Time-resolved opacity measurements using a pulsed backlighter X-ray flash of ~500 ps)



Preliminary OpSpec Design

OpSpec requieres ~170 mm film

OpSpec Design Specifications/Requirements	
Dispersion Element	2 Curved Bragg Crystals
Spectral Coverage	0.54 – 2.1 keV photon energy (extendable using other dispersion elements e.g. PET vs. KAP crystal)
Resolving Power	E /ΔE > 500 (>700 from 0.8 to 1.5 keV)
Data Collection	Time-integrated X-ray film or Image Plate (Solid State detector in future)
NIF Usage	All DIMs (initially on Polar DIM). Weight <15lbs

OpSpec Design Parameters

Film Length	173 mm
Resolving Power	>800
Crystal	KAP
Crystal Radius	75 mm

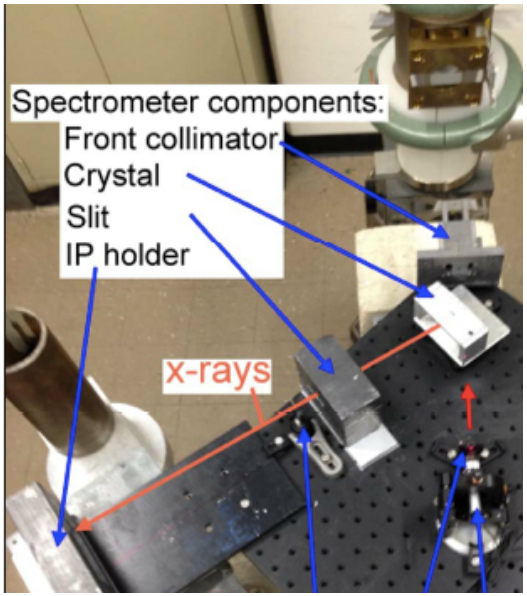
NEW

John Seely (ARTEP) High Res Hard Xray Spectroscopy at Titan

- New type of high-resolution transmission crystal spectrometer

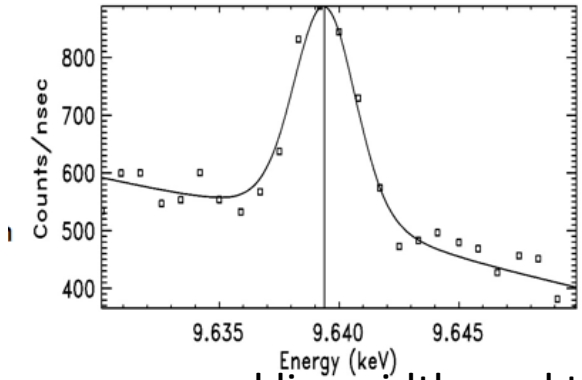
- Diffraction from quartz (301) planes
  - Crystal cut so (101) planes are perpendicular to crystal surface
  - The (301) plans are 23.51° to the (101) planes
  - Diffracted x-rays emerge almost perpendicular to back surface of crystal
    - excellent focusing
    - minimal aberrations from bending crystal

Spectrometer lay out at TItan



Compact: 0.5 m Crystal to Detector

Ga He "w" line:

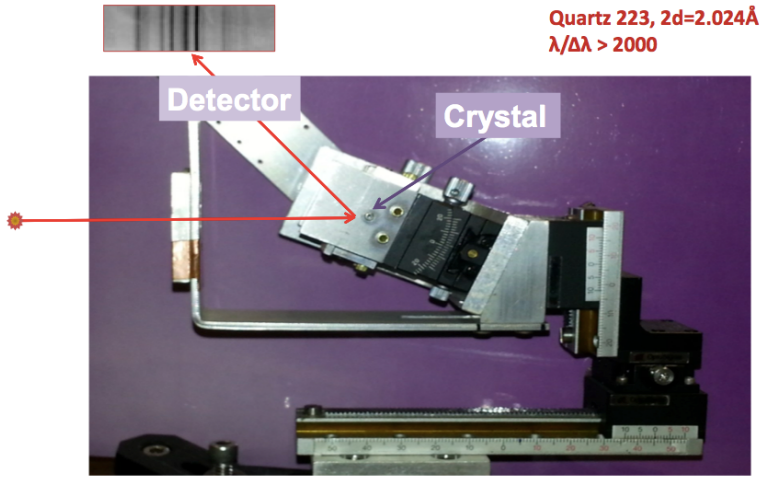


From measured linewidth, and taking all contributors into account, deduce that ***The intrinsic Lorentzian broadening of the (301) planes is 0.4 eV FWHM.***

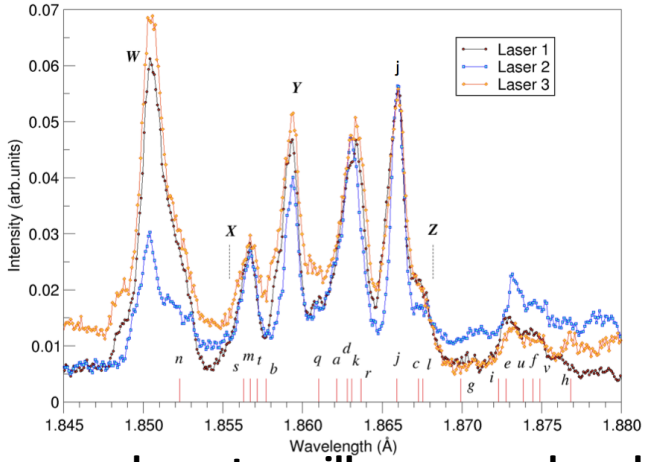
2014– concept presented

Jim Weaver for Yefim Aglitsky (NRL) "High Resolution Spectra of He-like Fe for ICF"

Spherical crystal spectrometer



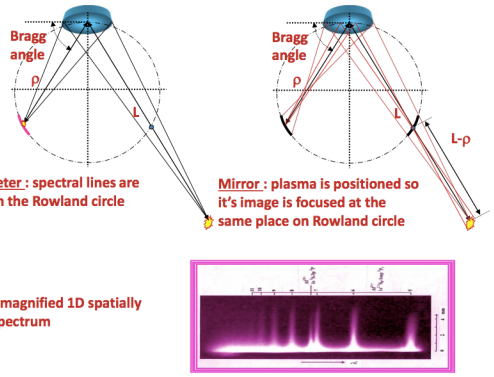
Nike spectra: normalized to j [Li] satellite



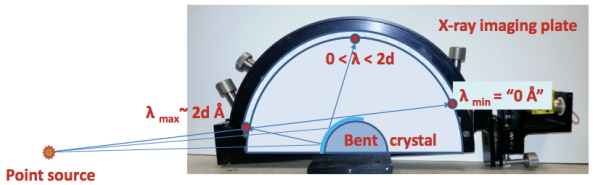
This work is new

The measured spectra will serve as a benchmark to the 9th Non-LTE Code Comparison Workshop, Dec 2015, Paris, France

1D-imaging spectroscopy with spherically bent crystal



Nike survey "half-moon" convex crystal spectrometer



Crystal : mica, 2d = 20 Å
Working orders of reflection:
n= 1,2,3,5,7.....
λ/Δλ > 1000

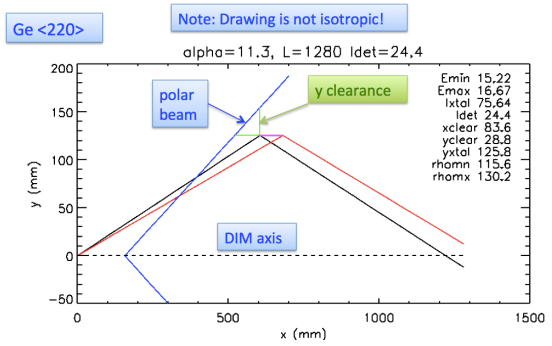
0.6 keV to 24.8 keV

Ken Hill (PPPL) High Resolution spectrometer to measure Stark broadening of Kr He-β lines for electron-density measurement on NIF

Optical lay out:

- Fit in Stay out zone of DIM
- Do not block 7o ports

Graphing the x-ray paths in our IDL program allows study of the crystal clearance for different values of L



- Examine different crystals
  ex: Ge (220), Ge <111>
- Examine different bending
  cylindrical (von Hamos)
  conical

THIS is new

2014

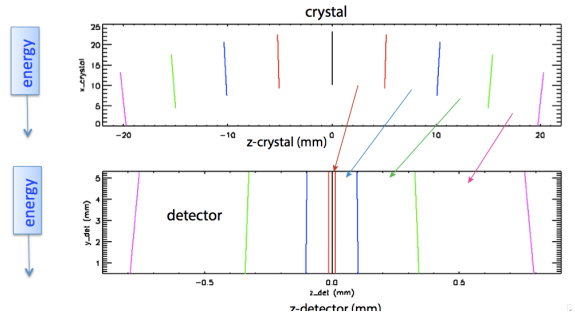
K Hill presented Hi Res (but not in DIM)

J Koch presented Johann design

Determine pattern of rays hitting photocathode as function of where they hit crystal

X-ray intensities from equal areas of crystal are concentrated toward center of detector in the conical crystal geometry

All x rays from a 20-mm high crystal are concentrated inside a 200 μm detector slit



- Match crystal height to photocathode
- affects thru put

- Kr Heβ, 15.43 keV, ΔE=400 eV or 1.4 keV, Ge (220), θ_B=11.6°, $\Delta\theta_{RC}$ ~ 41 μrad, ΔE_{RC}=3 eV
- Cylindrical
  - Rays from 2-cm high crystal (Ω ~ 1.3 x 10^{-6} sr) fit within a 400-μm slit
  - Energy spread over 100-μm detector "pixel": 5.5 eV (-> 6.25 eV total)
  - High quality concave cylindrical lenses are available as substrates
- Conical
  - Rays from 2-cm high crystal fit within a 200-μm slit
  - Narrow spatial peak will provide better time resolution with DISC
  - Energy spread over 100-μm detector "pixel": 7.5-9 eV for 100-μm or 500-μm slit
  - Substrate requires special fabrication
- Cone length 23.5 mm, angle: 23.545°, r_{min}: 95.447 mm, r_{max}:100.14 mm
- We plan to obtain both a cylindrical and a conical crystal for evaluation

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-Identify areas of potential deeper collaboration. What and What impact?

- NIF Opacity is already a collaboration of 5 labs (LANL, LLNL, SNL, LLE, NSTec)
- NIF Stagnation (Kr He beta) collaboration needs atomic modelers (U Nevada, Reno?)

Existing collaboration: • NRL built VIRGIL • ARTEP built NSS

? Work together on calibrations ???

-identify areas where an effort could use help from the national community. What are the questions? What impact?

-identify efforts that should be classified as either Transformational or Broad and would benefit from specific attention from the National Diagnostic Plan

For high resolution:

- Rectangular, time integrated detector with high dynamic range and good spatial resolution that can take place of film
- Rectangular, gated detector with high dynamic range and good spatial resolution that can take place of film