STATUS OF BEAM IMAGING DEVELOPMENTS FOR THE SNS TARGET

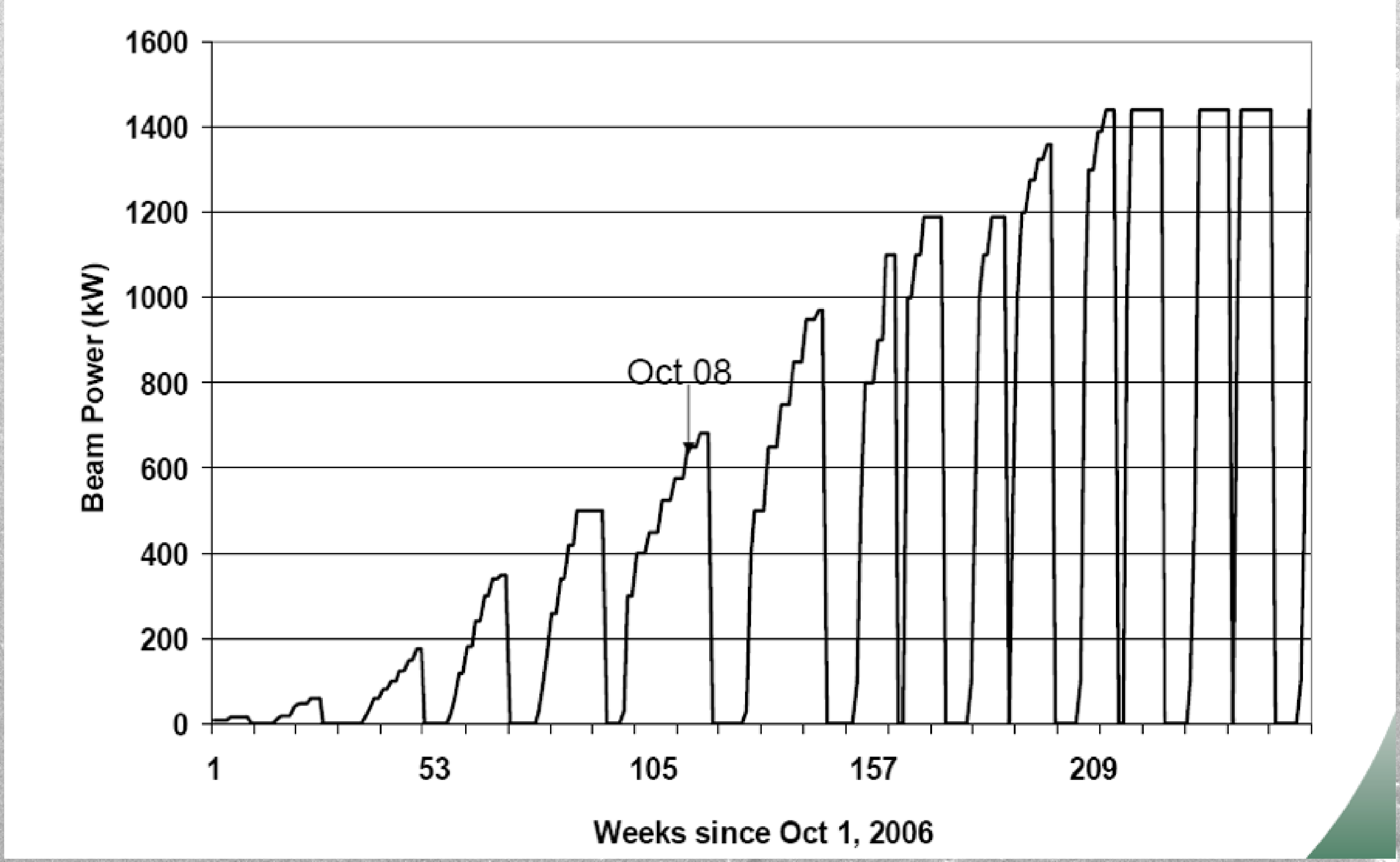
Tom Shea, Curt Maxey, Tom McManamy
ORNL

Donald Feldman, Ralph Fiorito,
Anatoly Shkvarunets
University of Maryland

DIPAC 2009

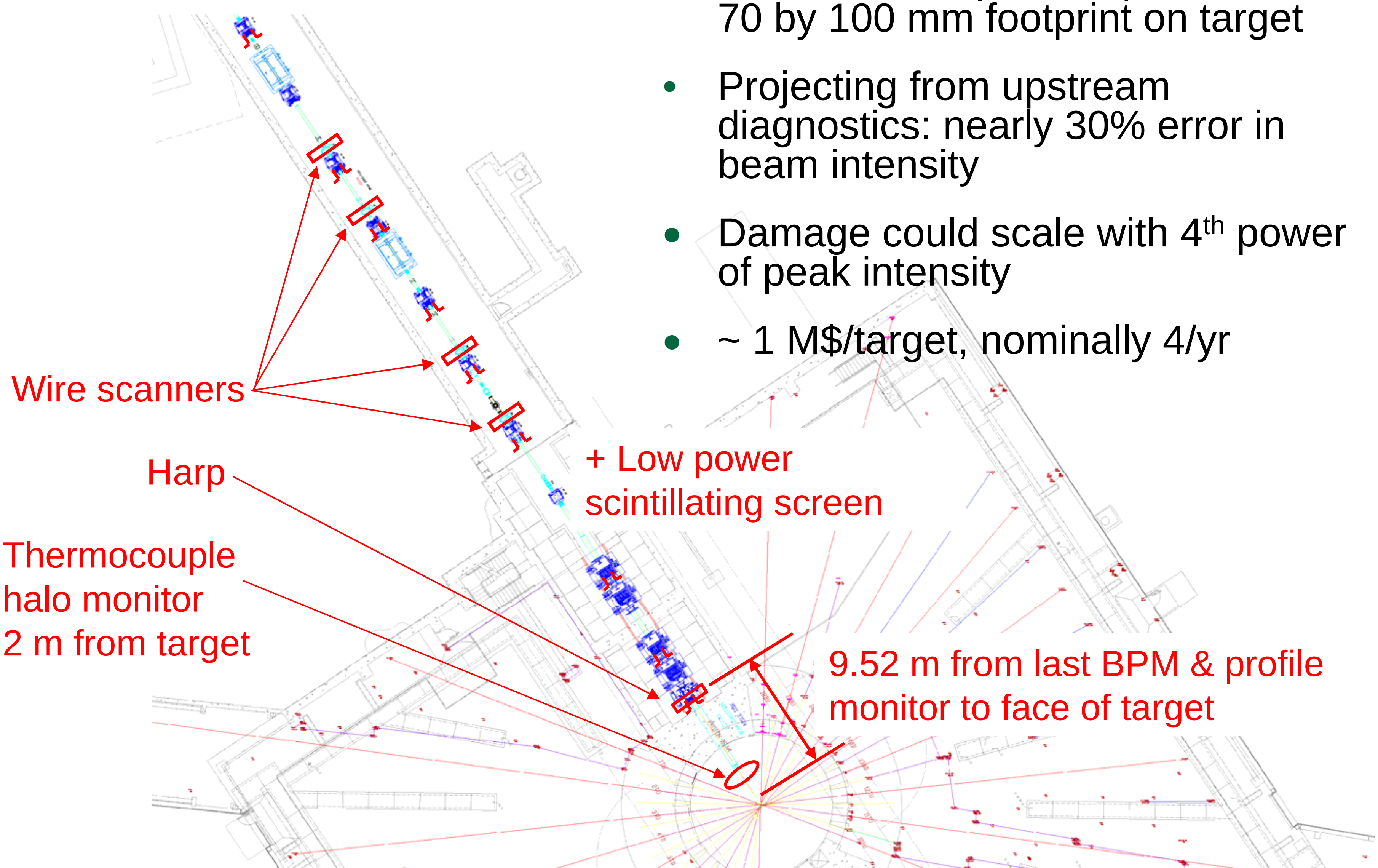
SNS Power Ramp up Plan

- **This year, >MW proton beam on Mercury target**
- **One of ~dozen high power hadron facilities, operating or planned**
- **All approach limits of solid and liquid target technology**



Existing Instrumentation Near Target

- 1 GeV, 10^14 protons/pulse, 60 Hz, 70 by 100 mm footprint on target
- Projecting from upstream diagnostics: nearly 30% error in beam intensity
- Damage could scale with 4th power of peak intensity
- ~ 1 M$/target, nominally 4/yr



Candidate Photon Sources

Source	Photon yield (photons/proton/stera
Screen* (Cr:Al2O3)	$2*10^{+2}$
Coating (Cr:Al2O3)	$2*10^{+1}$
Optical Transition Radiation	$3*10^{-4}$
Helium scintillation (10 mm)	$3*10^{-3}$
Thermal Incandescence	(nonlinear)

* Ruby screen used during low power commissioning

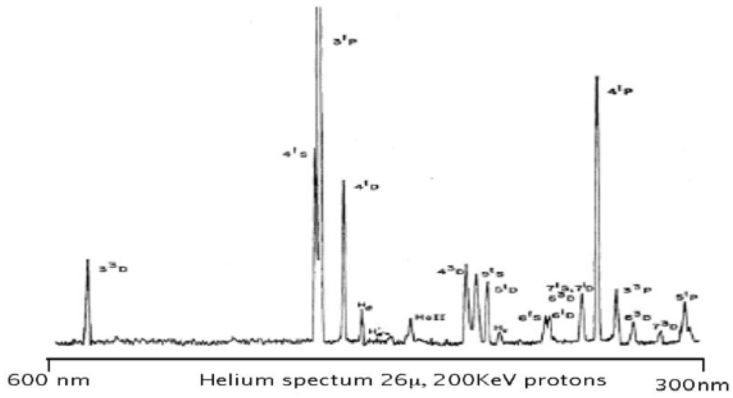
Fiorito et al, UMD

OTR and He Scintillation Studies

- ~GeV proton beams: low photon yield

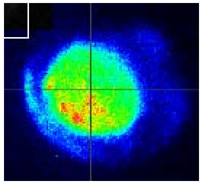
Initial test at LANL:

- with $\gamma = 1.8$ and $3 \cdot 10^{13}$ protons, expected to collect $3 \cdot 10^{8}$ visible photons
- Similar photon yield from 10 mm of He
- However, no discernable beam image

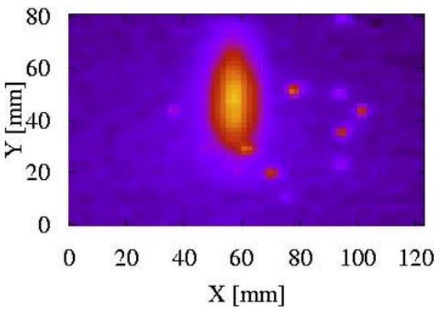


Visible He spectrum

OTR from 5keV electrons @ UMER



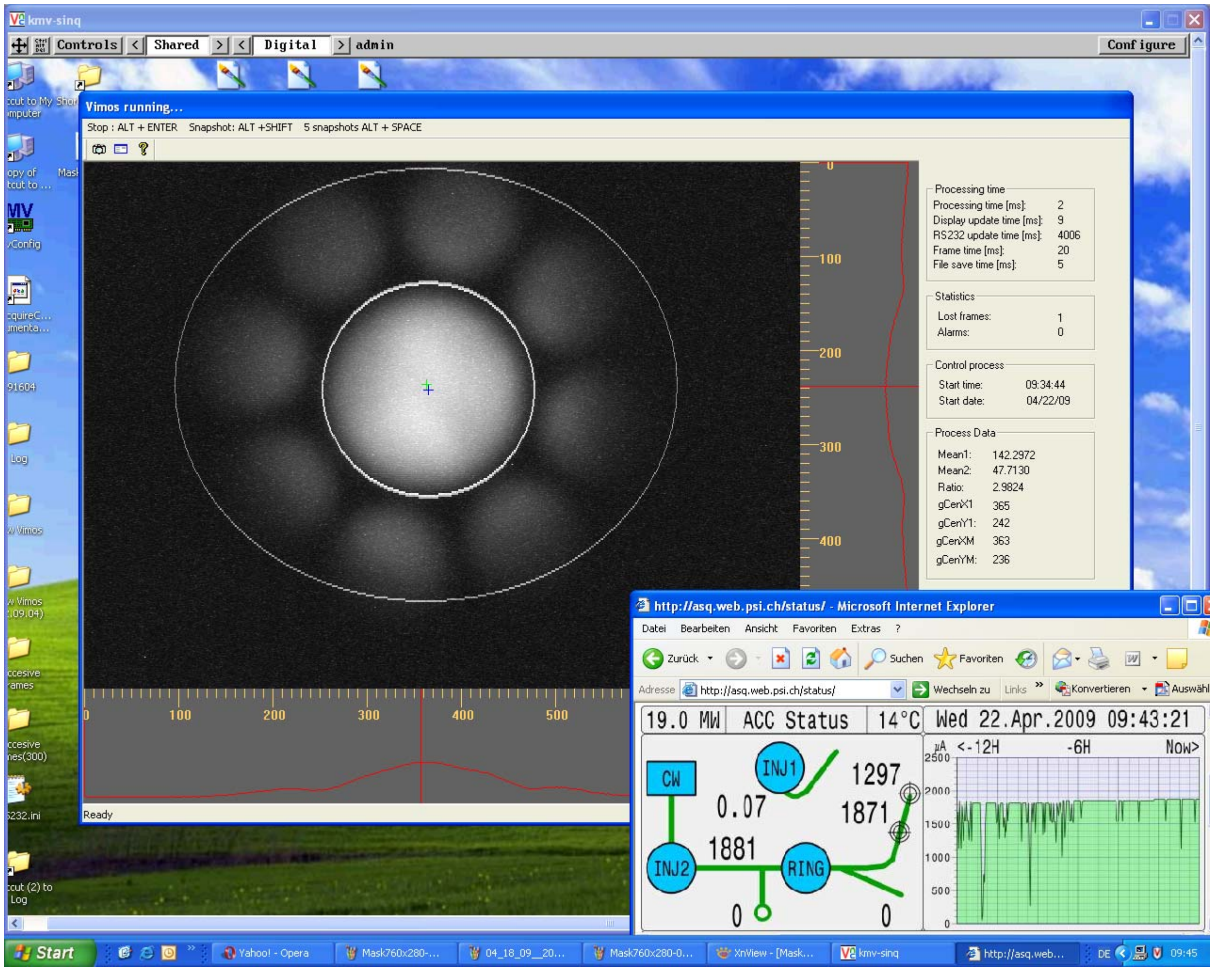
OTR from 4 x 10^11 protons per pulse, 12 GeV at KEK Toyoda, et al



Fiorito, Shkvarunets

Thermal Incandescence at SINQ

Looking at glowing wire mesh near target

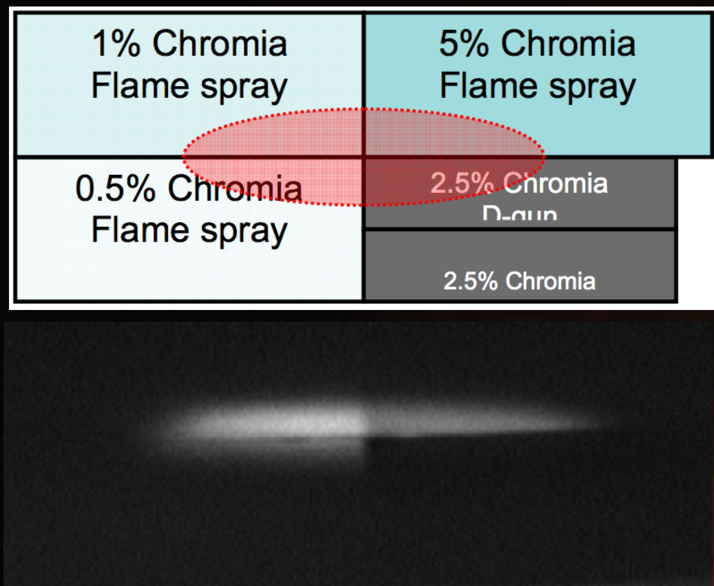


- 2 mA, 590 MeV protons
- Aluminum mirror, Fujikura fiber bundles
- Nonlinear: Excellent sensitivity to off-normal conditions, but challenging to calibrate

Knud Thomsen

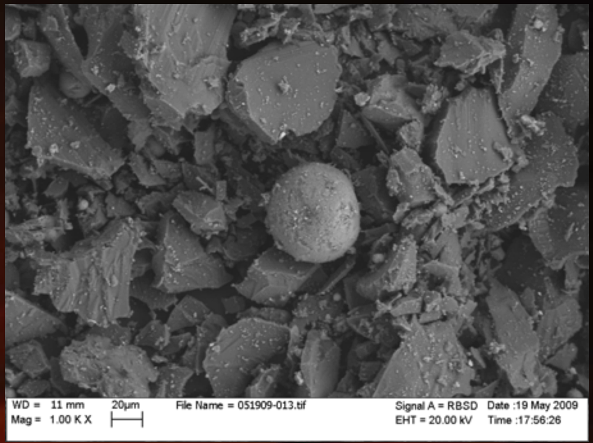
Scintillator Coating Development for SNS

800 MeV beam test at LANL

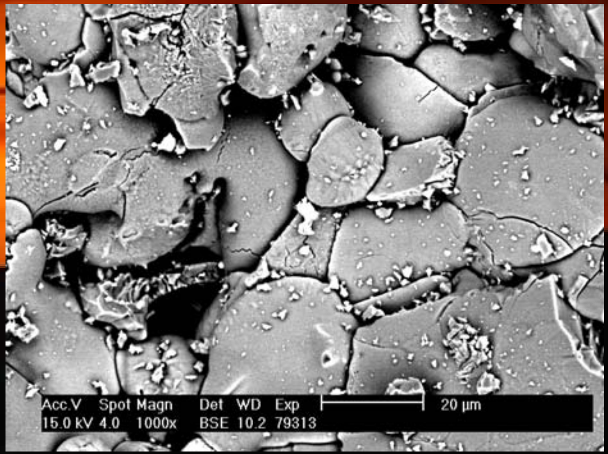


1 GeV test at SNS linac: 0.25 mm coating produced 1/17 intensity of 1 mm Ruby plate

Structure of powder before spraying



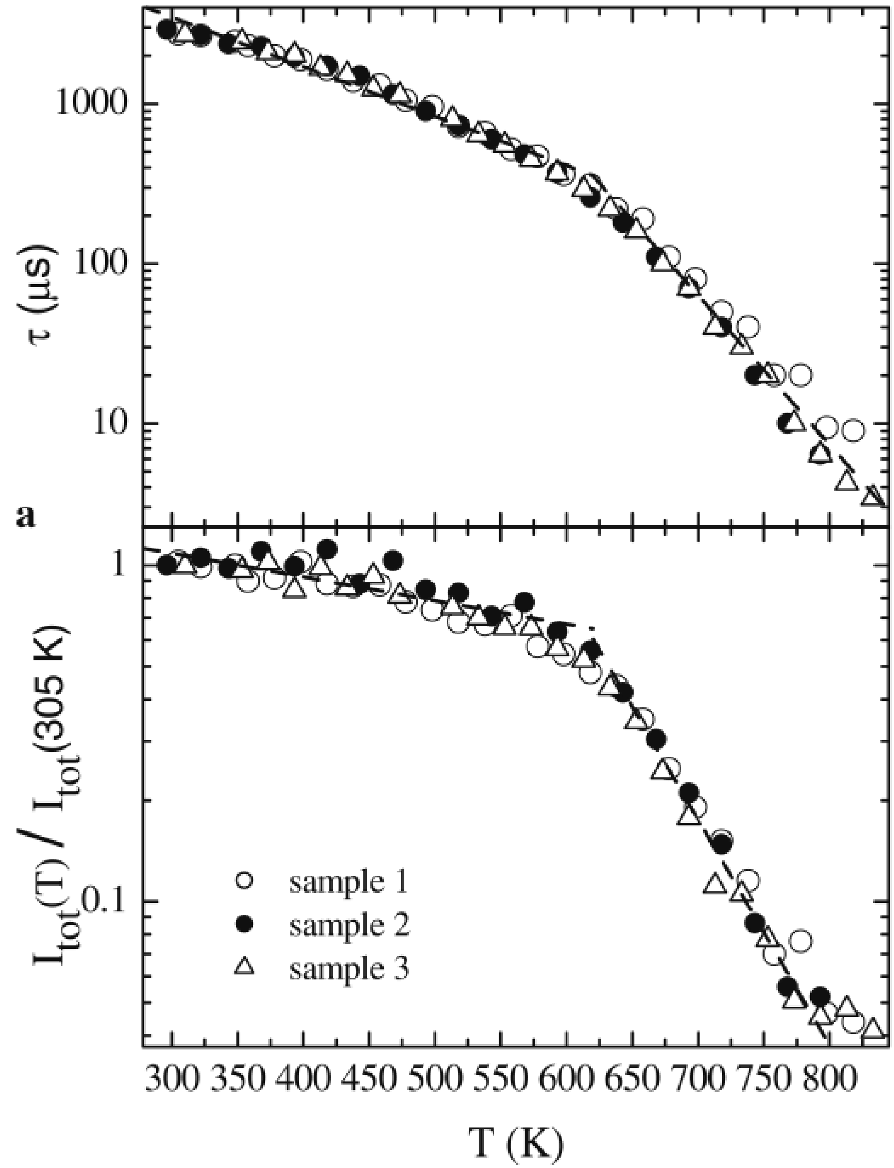
Electron backscatter image of coating



Kenik, Sampath, Blokland

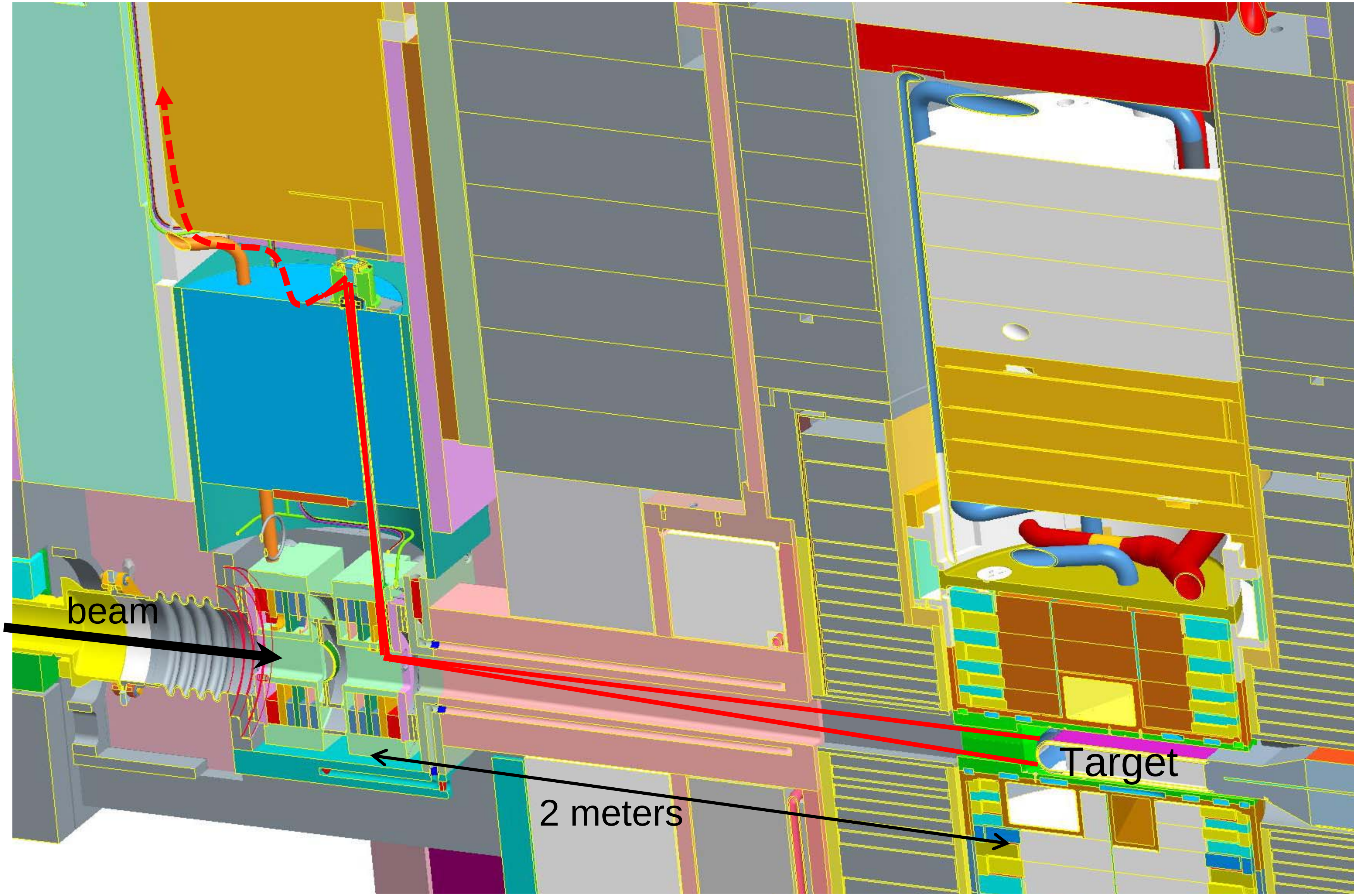
Scintillator Performance at High Power

- **SUNY collaboration:** spray the cooled target nose without overheating – retain alpha phase alumina
- At high power, peak target surface temperature is ~150 deg C
- Gated imaging or spectral analysis to measure beam and temperature distribution



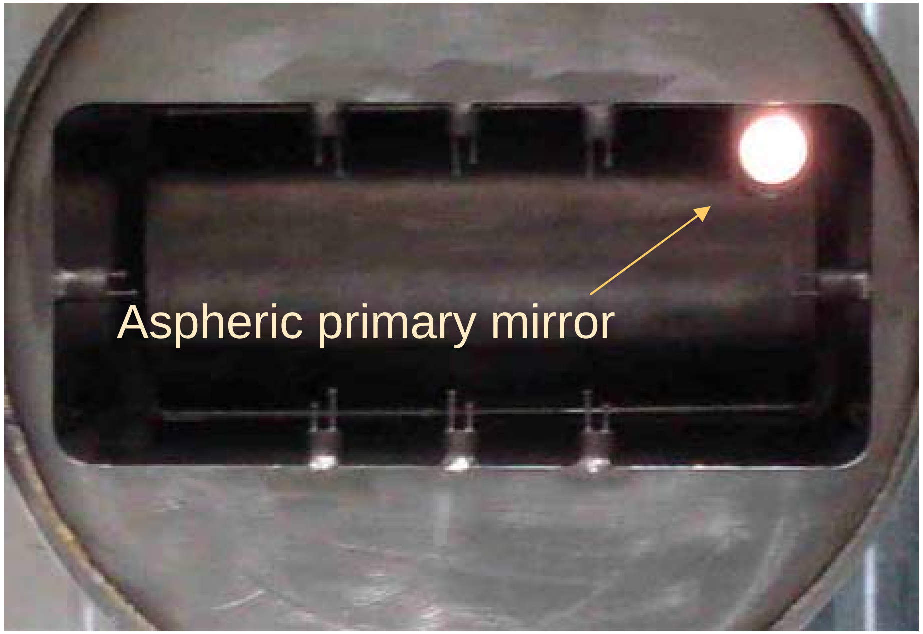
Montgomery, Lance (ORNL), Sampath (SUNY)

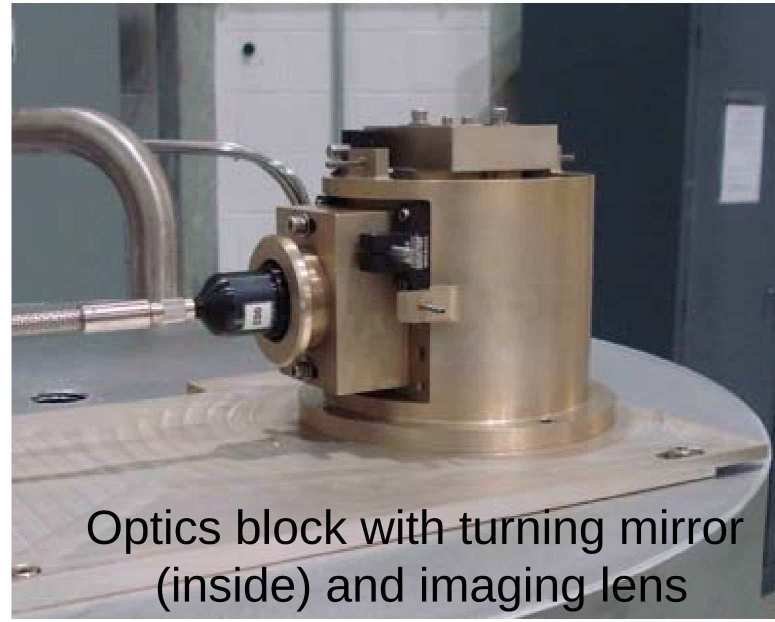
Proposed Optical Path



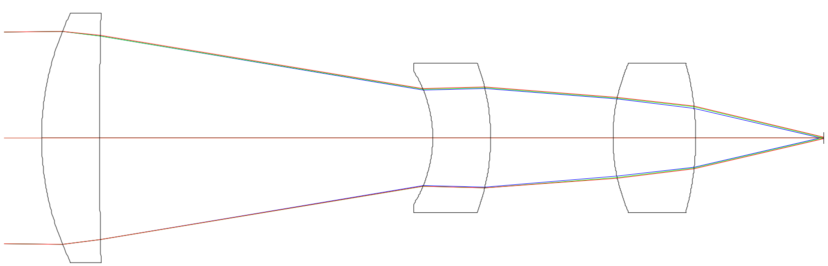
Optical Components

~100 MegaRad lifetime dose

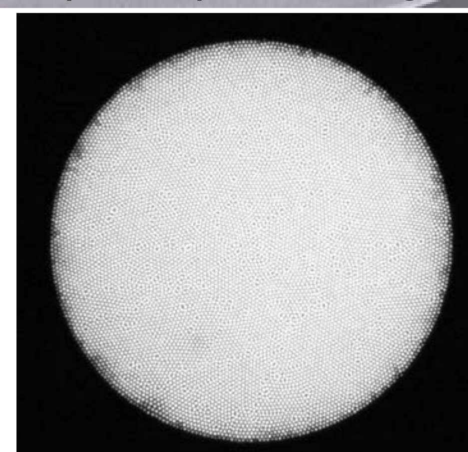




Optics block with turning mirror (inside) and imaging lens



Imaging lens diagram

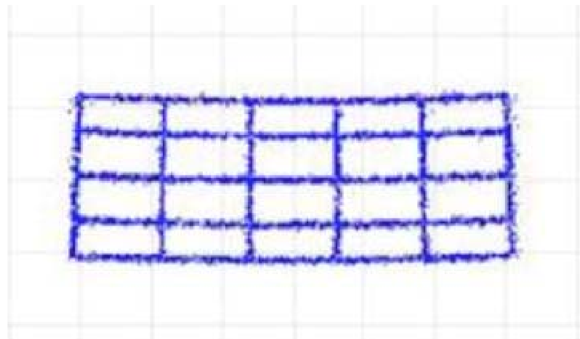


Imaging fiber bundle

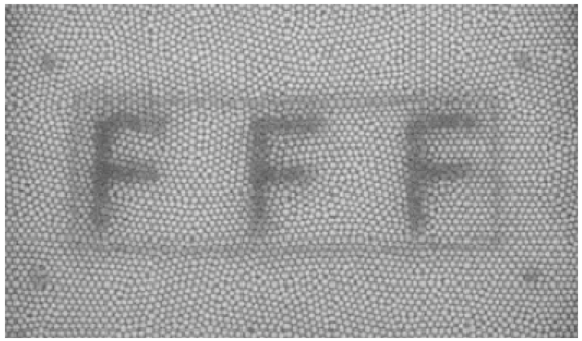
Optical performance

70 by 200 mm region of interest

Image Data



Raytrace model



End-to-end test

Transmission Data

Calculated power loss		
Geometric (r^2) loss	-47.50	dB
Imaging system loss	-18.70	dB
Reflective losses		
Aluminum mirrors	-0.92	dB
Silica lenses	-0.93	dB
Imaging fiber losses		
Packing fraction	-1.37	dB
Attenuation	-0.35	dB
P_{loss}	**-69.8**	dB

Measured loss in end-to-end tests

65 dB

Outlook

- **Summer 2009:** coat target, install optics
- Significant risk remains
- R&D program will continue