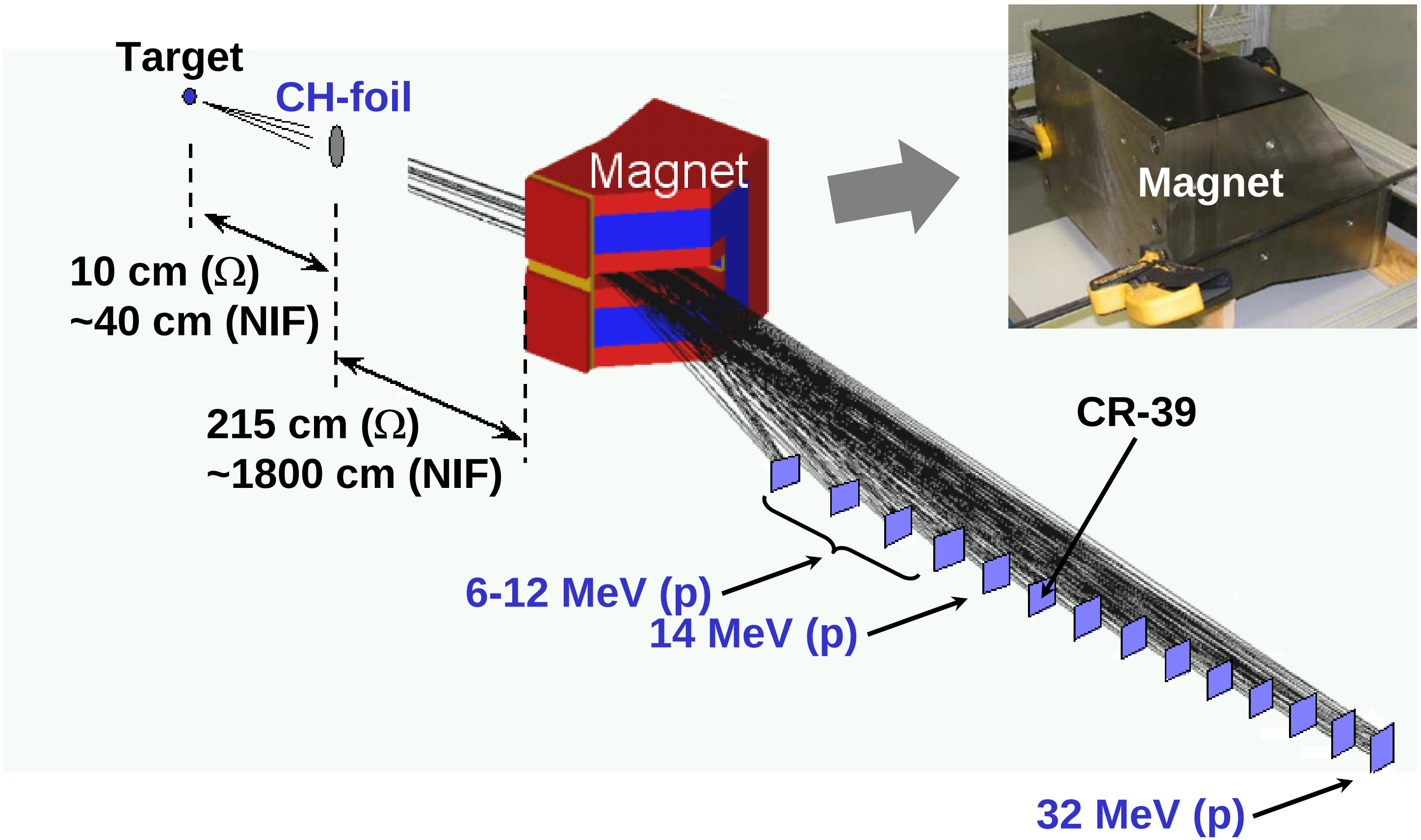
A Magnetic Recoil Spectrometer (MRS) for ρR, Y_{1n} and T_i measurements of implosions at OMEGA and the NIF



Johan Frenje
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Summary

- **A Magnetic Recoil Spectrometer (MRS) is being built for measurements of the neutron spectrum (6-32 MeV) produced in cryogenic DT implosions at OMEGA and the NIF.**

- **The MRS will accurately and simultaneously provide information on:**
  - ρR **[from down-scattered neutron spectrum (6-10 MeV)]**
    [from tertiary neutron spectrum (20-32 MeV) (NIF)]
  - T_i **[from primary spectrum]**
  - Y_{1n}

- **The MRS will diagnose failure modes of NIF cryogenic DT implosions.**

Collaborators

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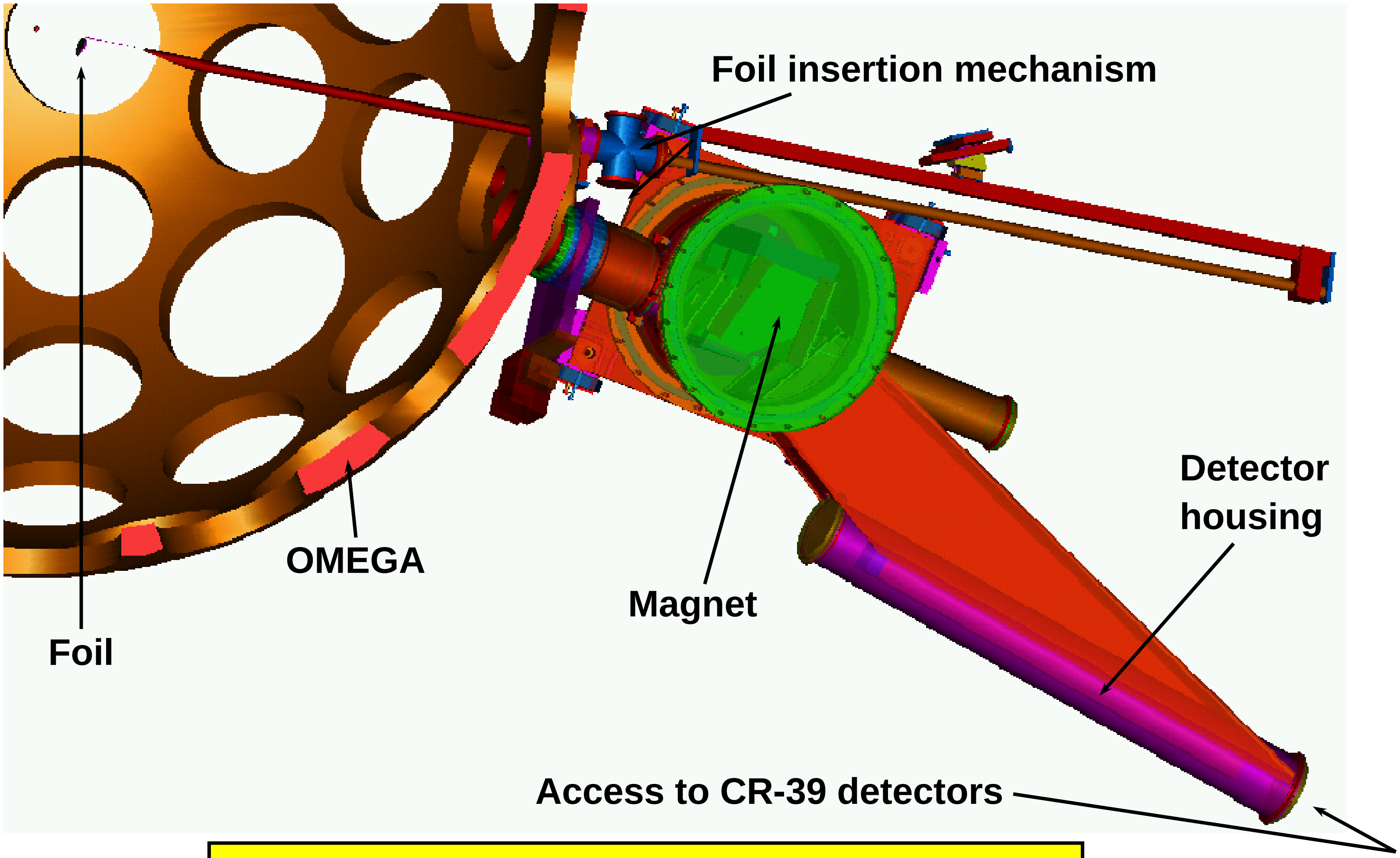
The MRS at OMEGA



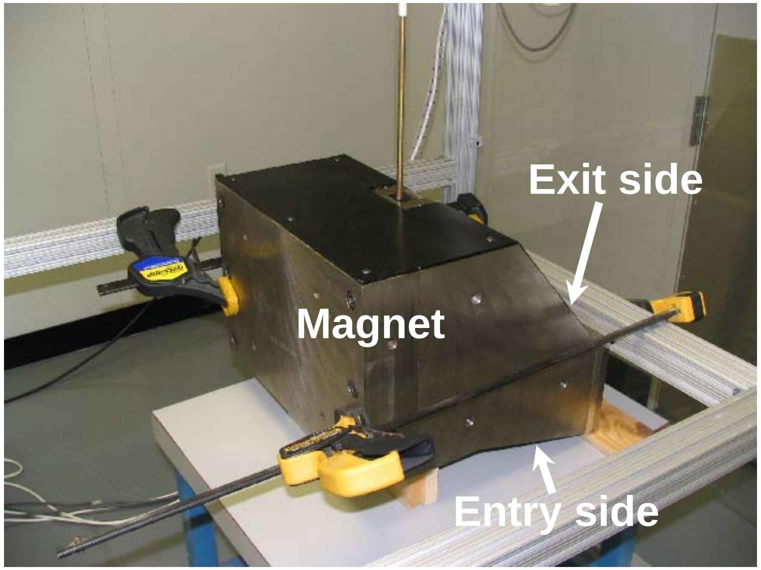
Much of the R&D and instrument optimization of the OMEGA MRS will be applicable to the NIF MRS

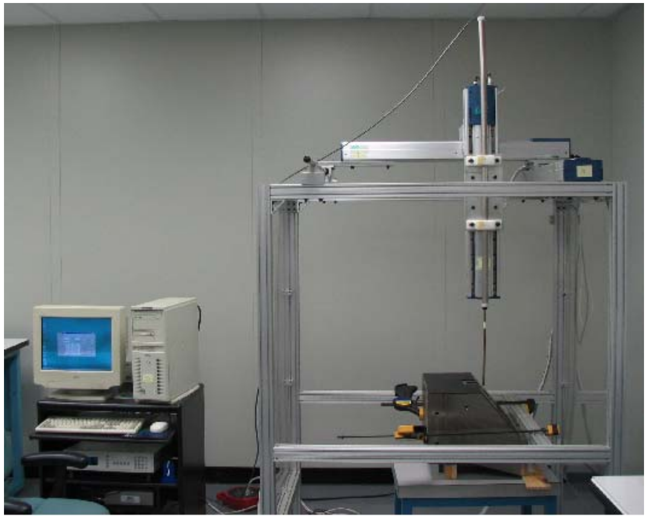
Important differences and similarities between the OMEGA MRS and the NIF MRS

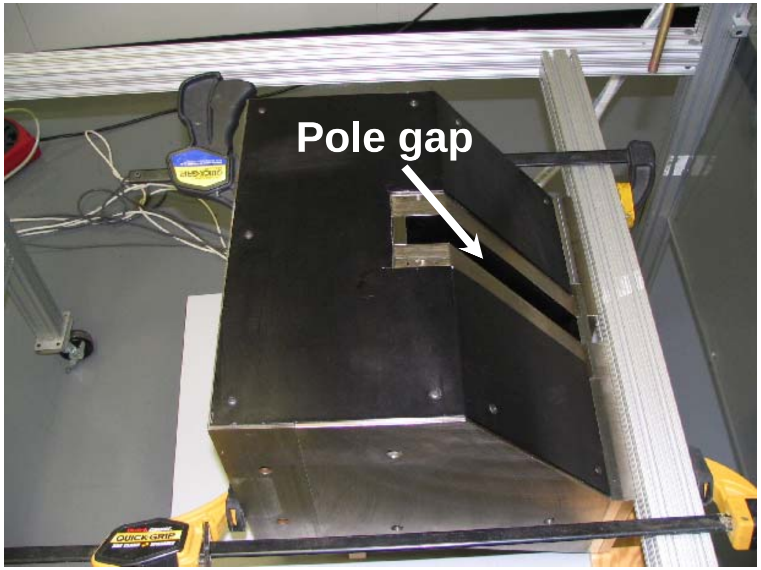
	OMEGA MRS	NIF MRS
Shielding**	~0.2 m polyethylene	~2 m of concrete (NIF target bay wall)
Coincidence counting*** of down-scattered signal	Necessary	Not needed
Magnet	Use current design	Use current design

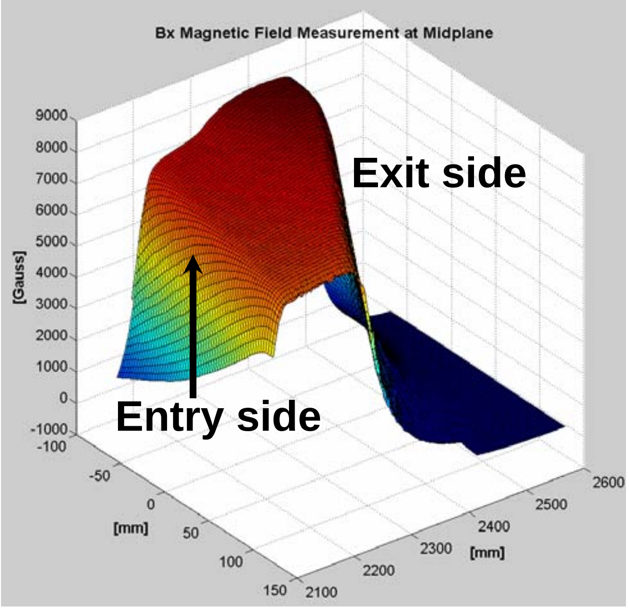
** D.T. Casey et al., FP1.00009
*** S. Volkmer et al., FP1.00007

The MRS magnet has been built and characterized









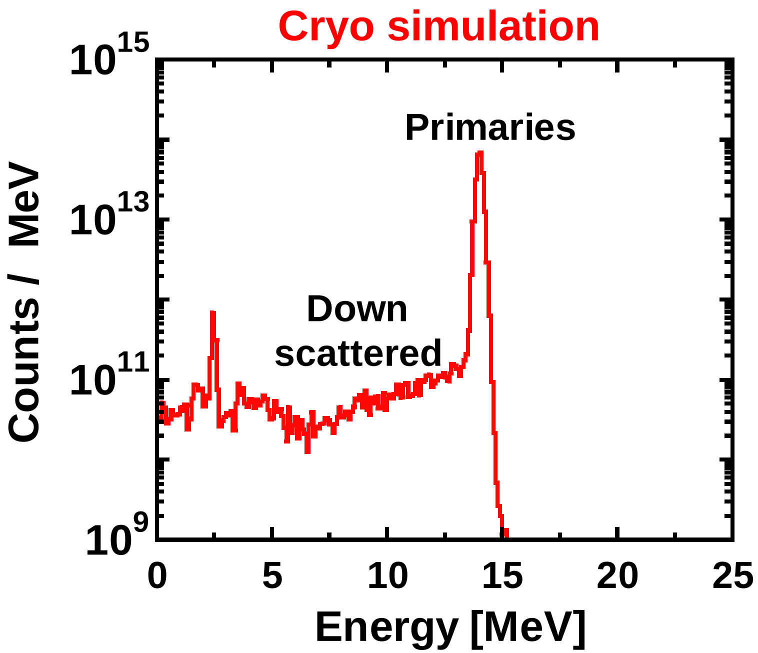
Parameters for the OMEGA MRS point design*:
(~10% ρR measurement for ρR=100 mg/cm^2 and $Y_{1n}=10^{13}$)

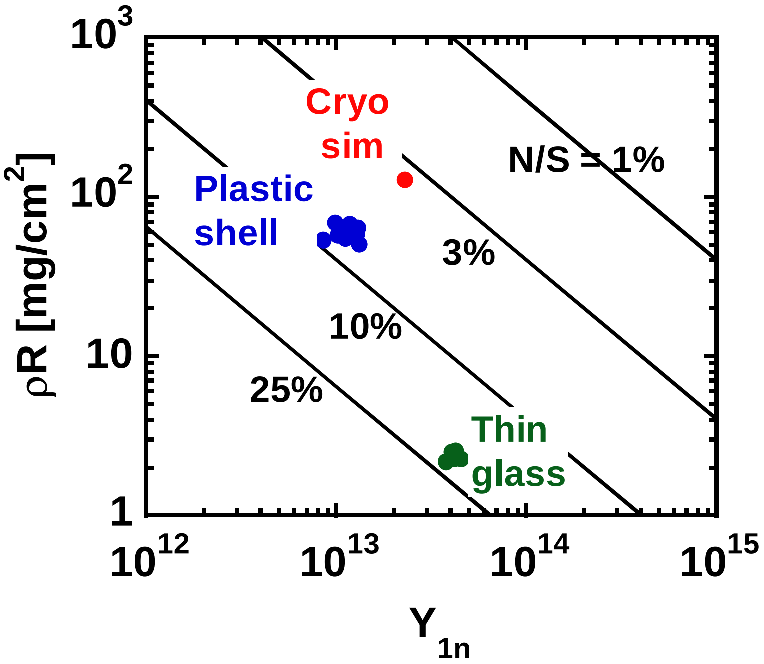
- Magnet aperture distance to TCC:	215 cm
- Magnet aperture area:	22 cm^2
- Foil distance to TCC:	10 cm
- Foil area:	15 cm^2
- Foil thickness:	600 μm (CH)

	Detection efficiency (ε_{MRS})	Resolution (ΔE_l)
Down-scattered neutrons	~10^{-8}	~3000 keV

* The MRS setup can be changed for high-resolution measurements

The OMEGA MRS Point Design
was driven by simulations and prior experiments





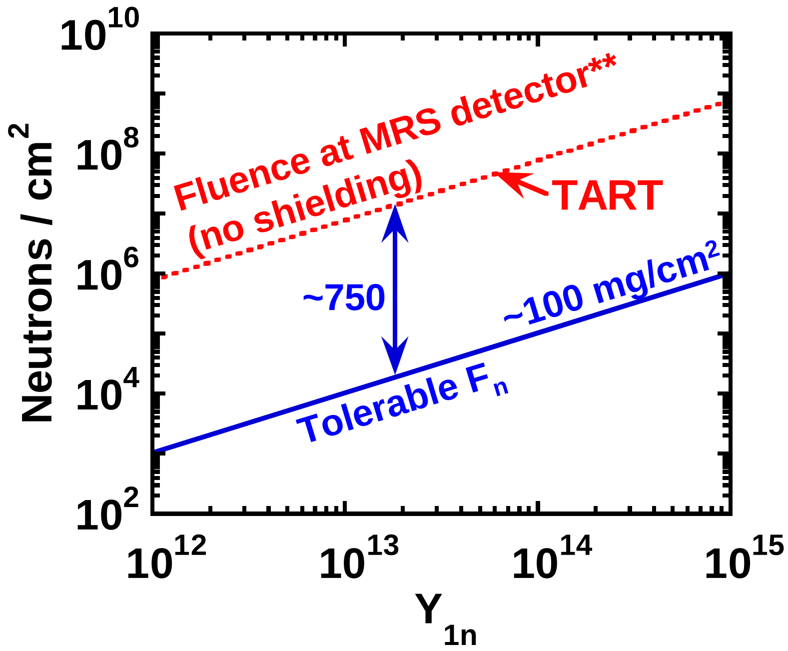
Simulated by Steve Hatchett

Minimizing neutron background is necessary for the implementation of the OMEGA MRS

$$\frac{\mathbf{S}}{\mathbf{B}} > 10 \Rightarrow \frac{S}{F_n \cdot A_{CR39} \cdot \varepsilon_{CR39}} > 10$$

$$S \approx 2.75 \times 10^{-5} \cdot \rho R \cdot Y_{1n} \cdot \varepsilon_{MRS}$$

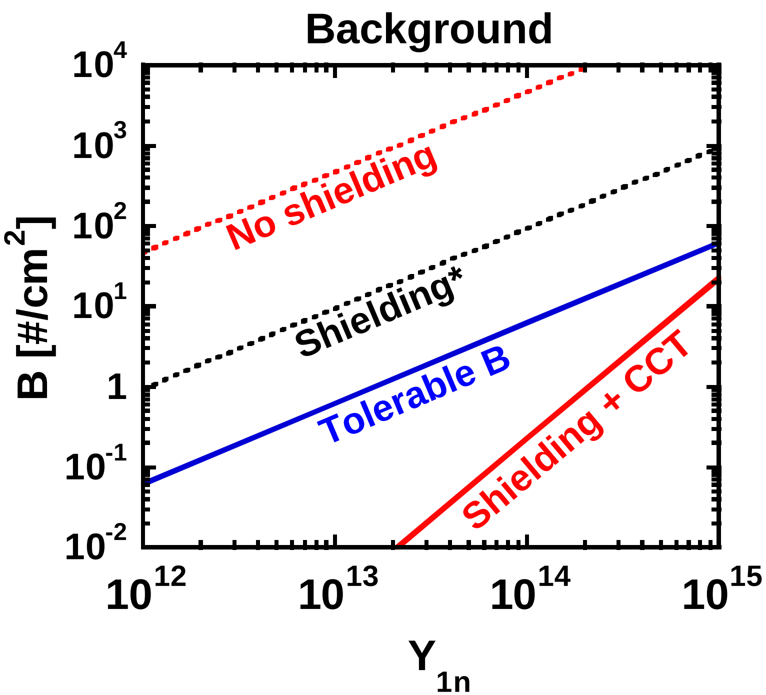
$$F_n < 1.03 \times 10^{-9} \cdot \rho R \cdot Y_{1n}$$

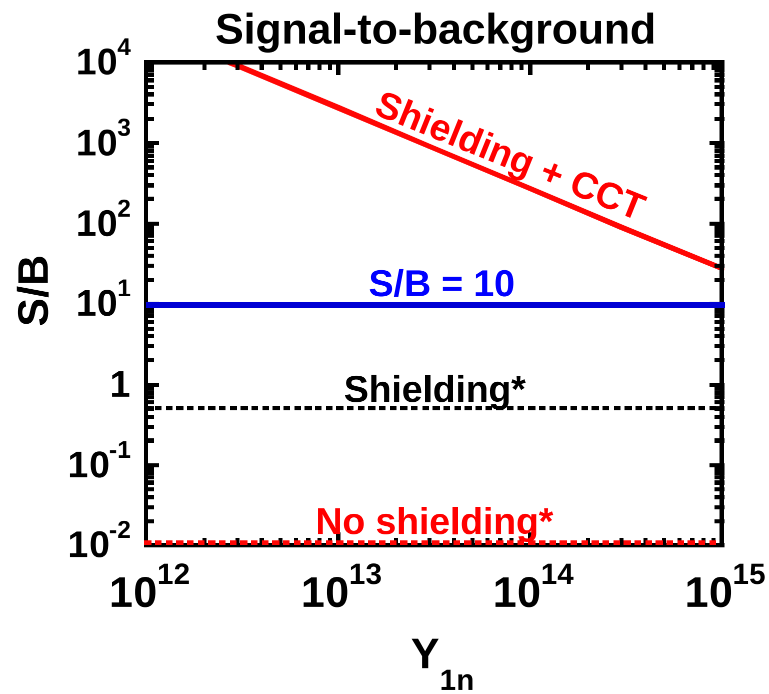


For a ρR~100 mg/cm^2, neutron fluence needs to be reduced ~750 times

** D.T. Casey et al., FP1.00009

For OMEGA, the coincidence counting technique (CCT)** combined with the shielding point design* increases S/B>>10





These results clearly indicate that:

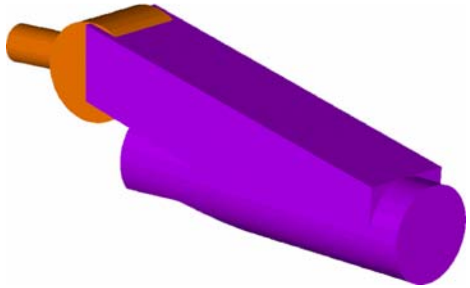
- **Shielding point design can be reduced**
- **S/B can be relaxed**

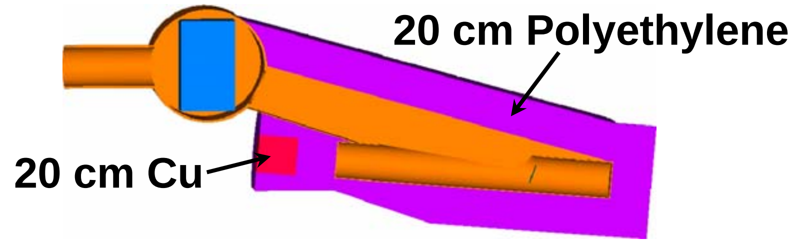
* D.T. Casey et al., FP1.00009

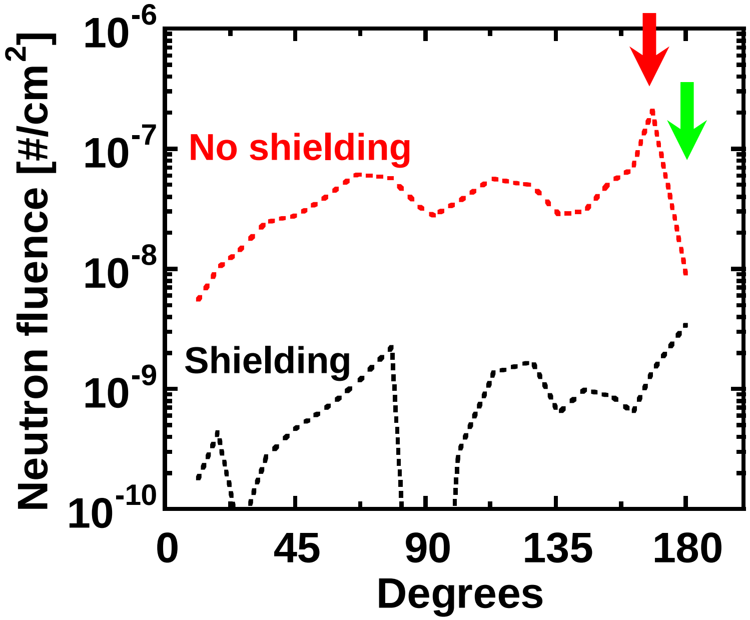
** S. Volkmer et al., FP1.00007

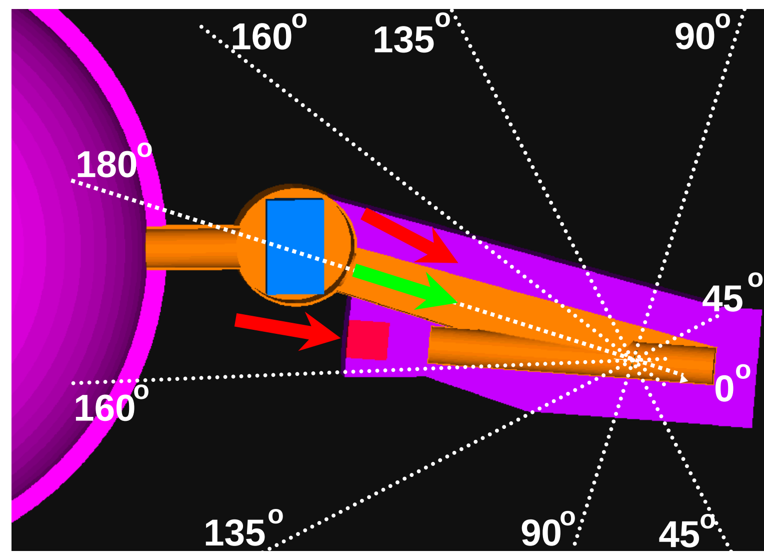
The MRS shielding point design reduces neutron fluence ~50 times at the detector**

MRS shielding point design



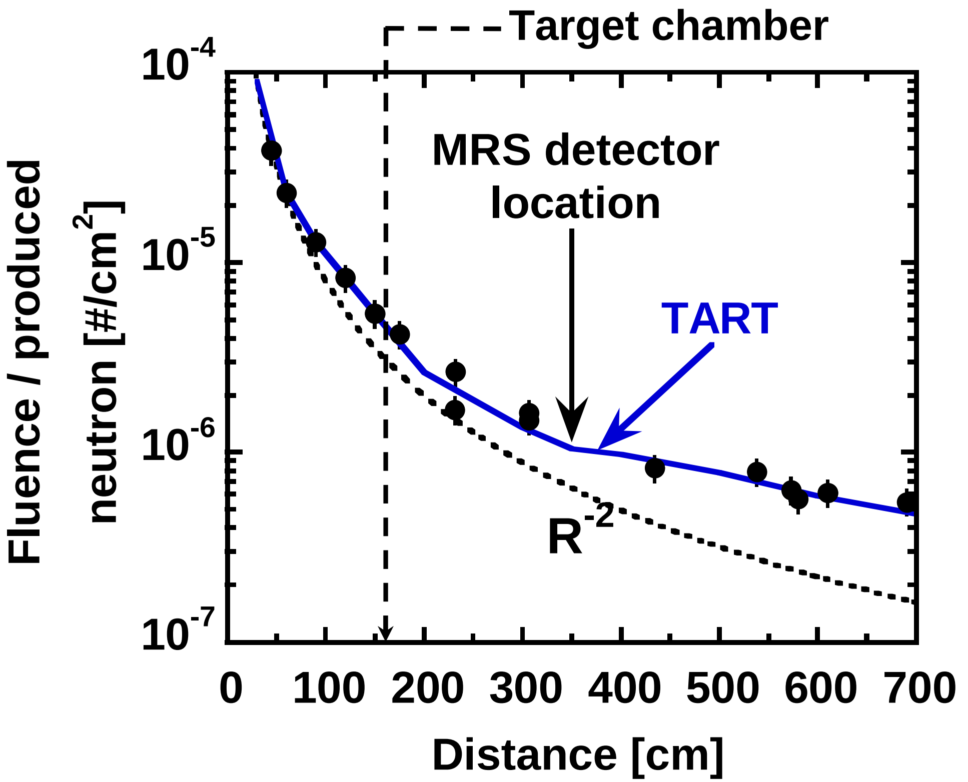






** D.T. Casey et al., FP1.00009

The TART calculations were benchmarked by neutron fluence measurements performed at OMEGA



- These results indicate that the MRS shielding calculations are accurate.
- Similar calculations will be performed for the NIF MRS.

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