Status of EAR-2 simulations

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n_TOF Collaboration Meeting

Bologna, 28th of November 2013

Outline and goals

- Influence of gap material
- Influence of 2nd collimator and block material
    - Lithium vs. Boron

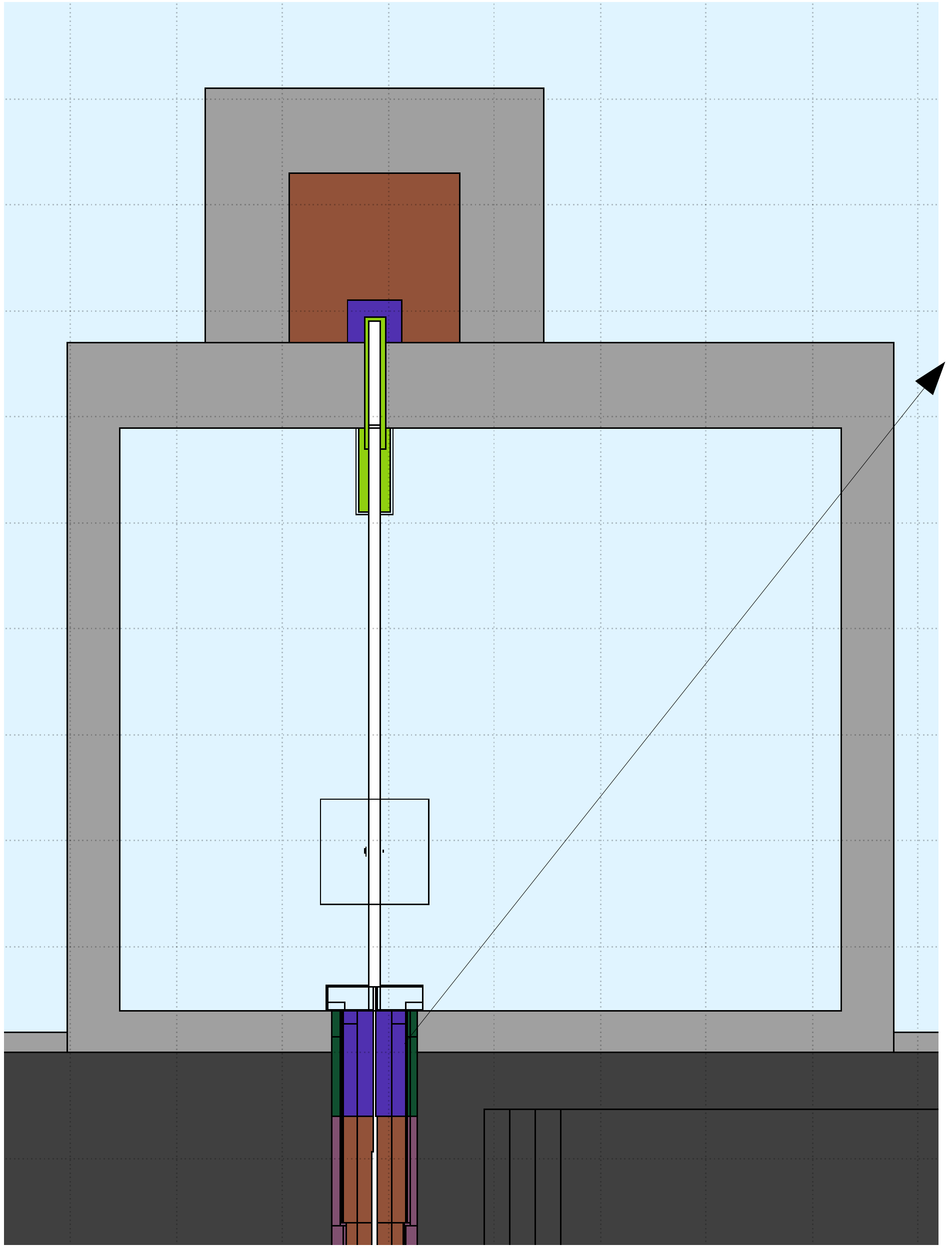
- C6D6 detector – Preliminary results
    - Lithium vs. Boron
    - Background

- Capture setup
  - Cylindrical sections with decreasing radius

- Fission setup

- Summary

Influence of gap material

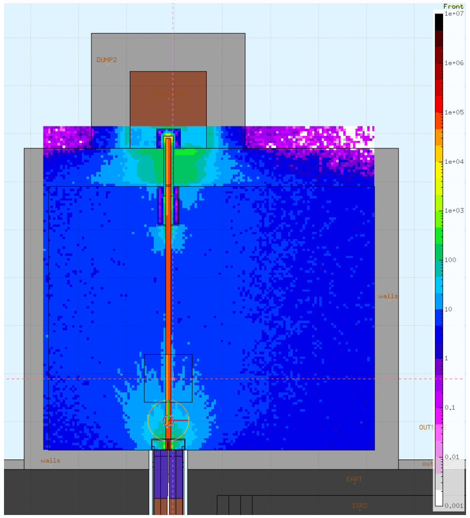


- Without block on top of 2nd collimator
- Gap materials
  - Only B4C
  - 0.5 m iron balls and B4C
  - 1 m iron balls and B4C
  - 1 m iron balls and Li instead of Boron
  - 1 m iron balls and 6Li instead of Boron

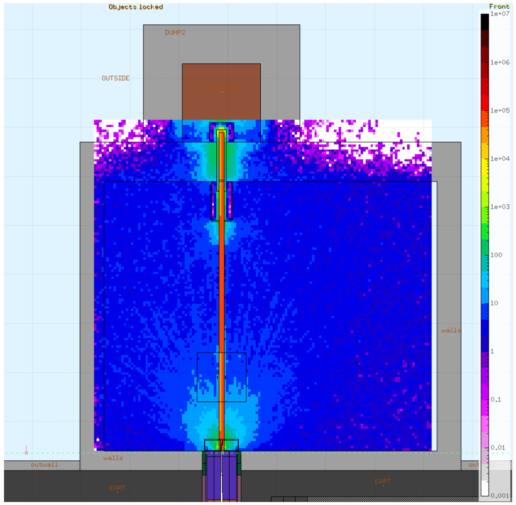
Influence of gap material

Neutron fluence (10 μs – 100 μs)

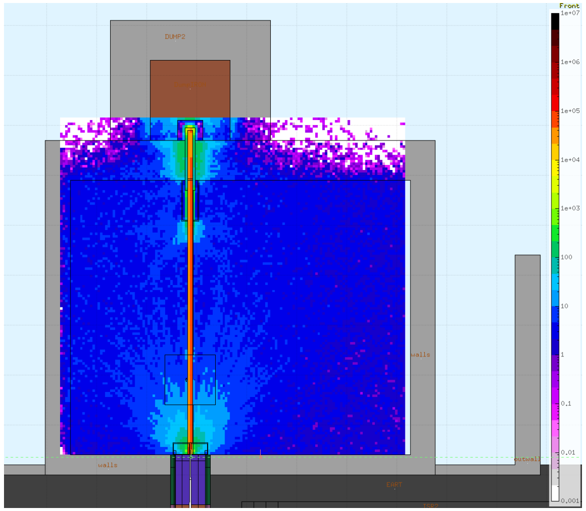
B4C in gap



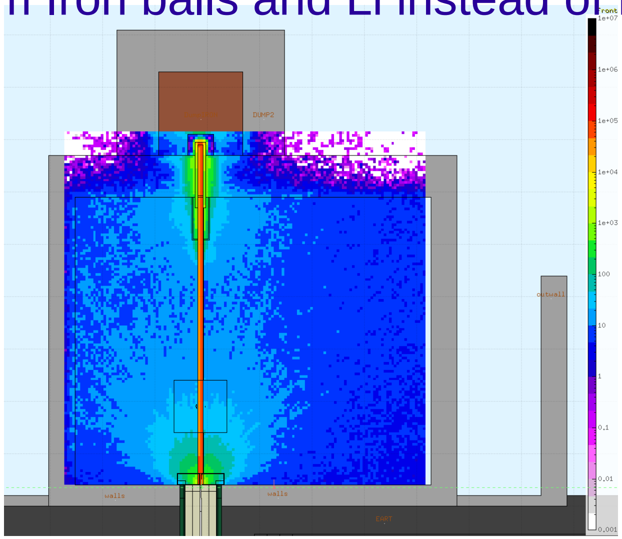
0.5 m Iron balls and B4C in gap



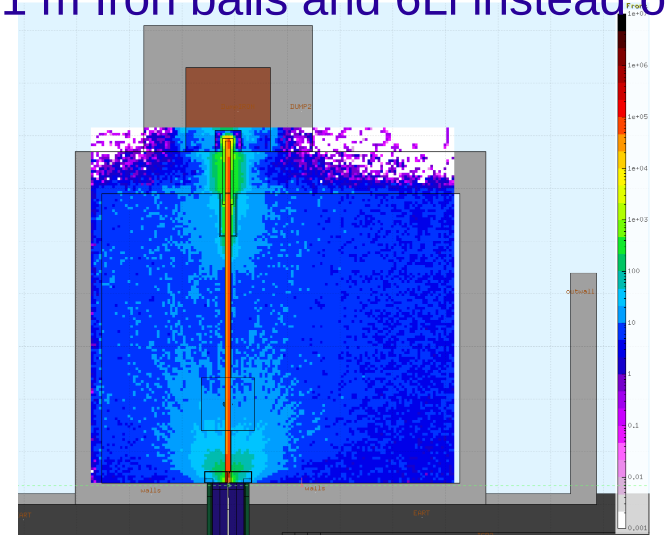
1 m Iron balls and B4C in gap



1 m Iron balls and Li instead of Boron

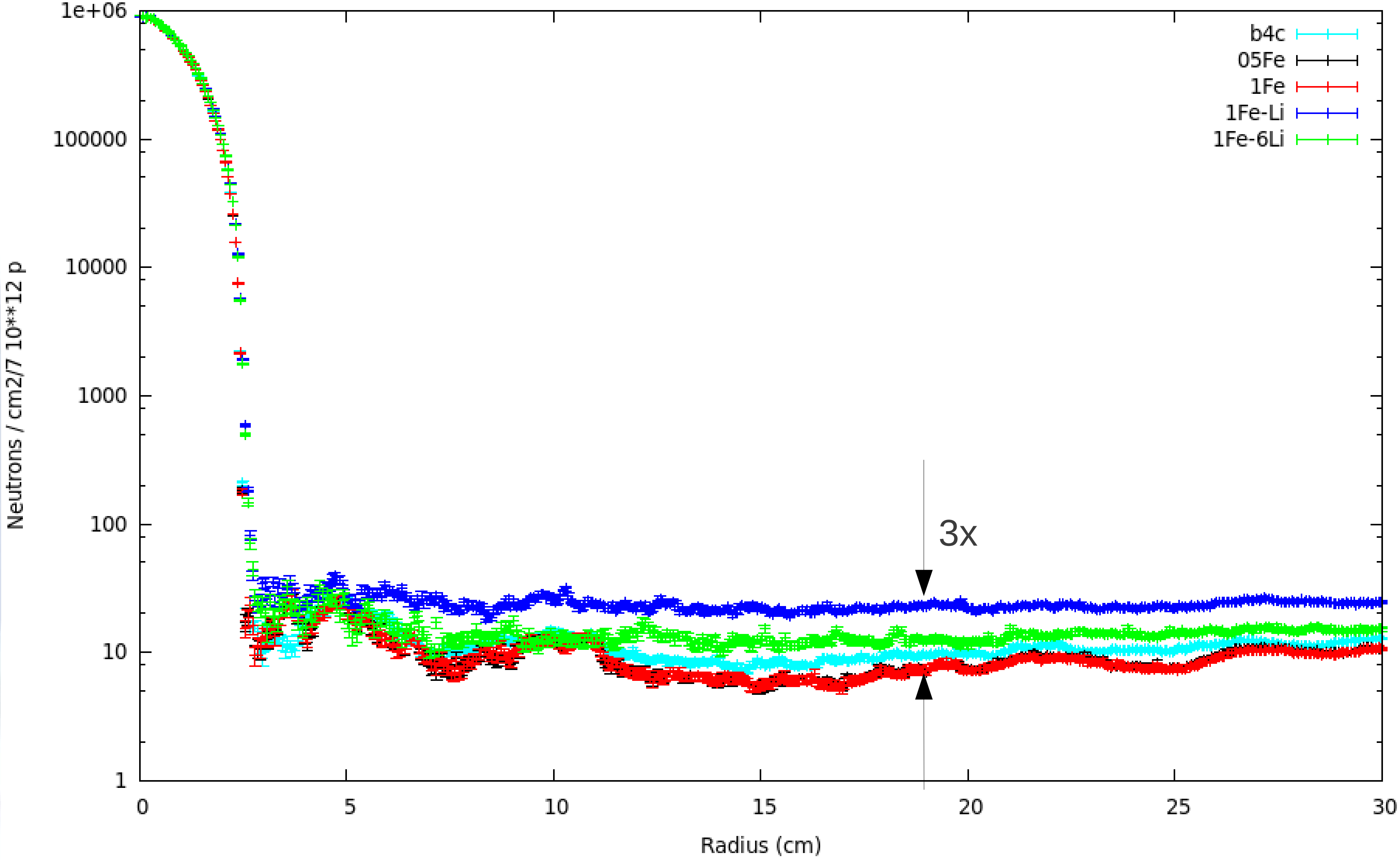


1 m Iron balls and 6Li instead of Boron



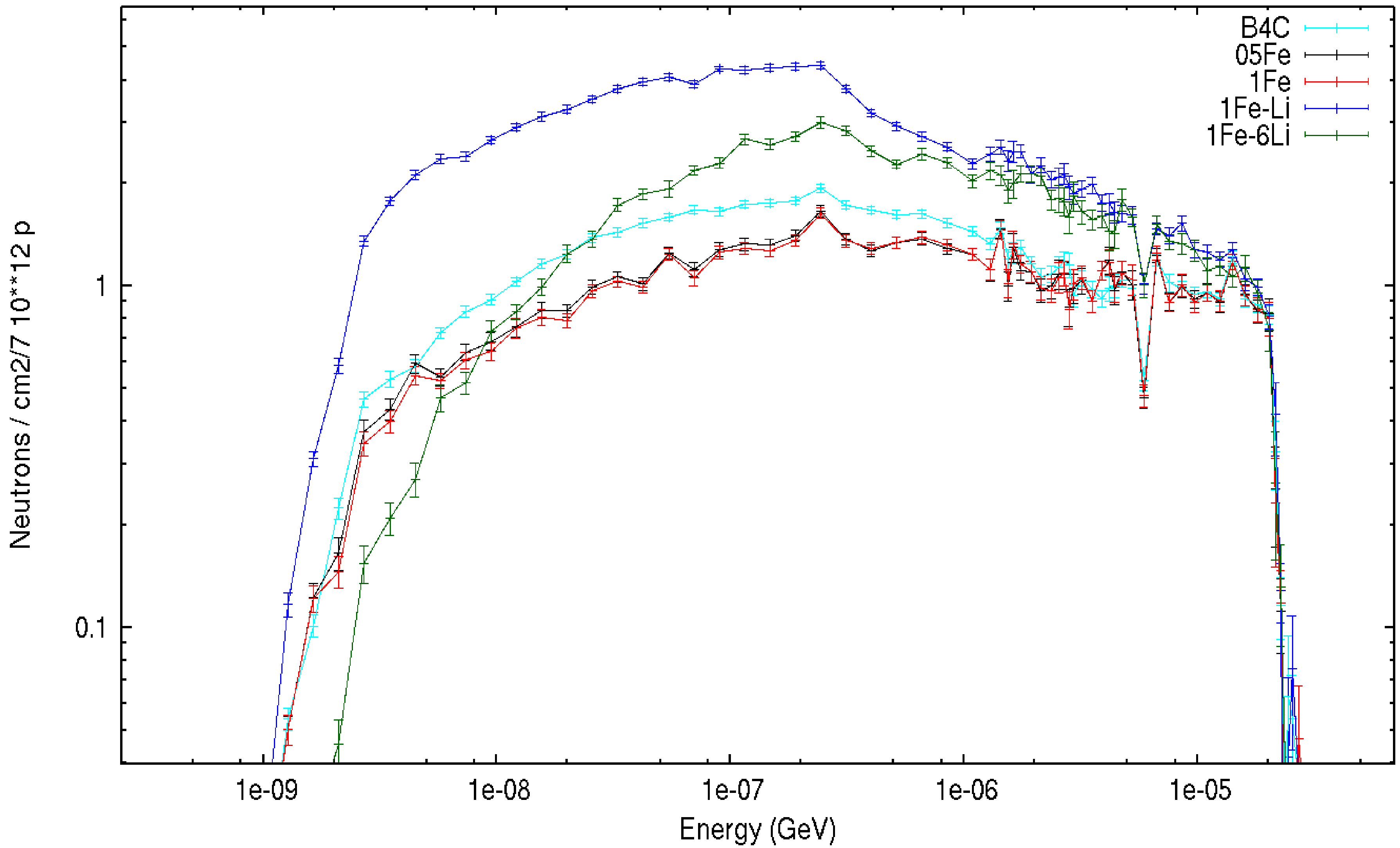
Influence of gap material

Neutron fluence vs. Radius (all time intervals)



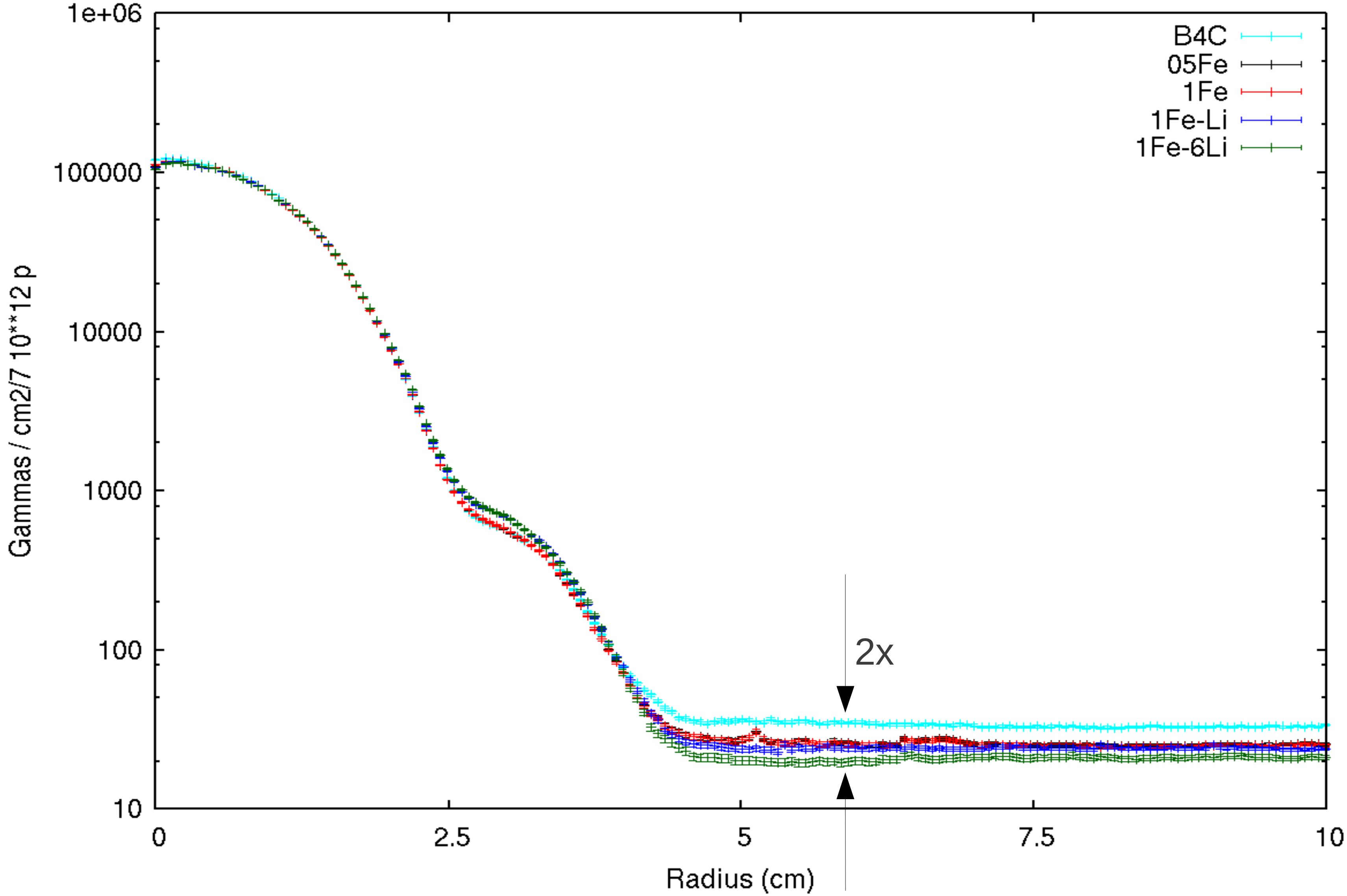
Influence of gap material

Neutron fluence outside beam (10 μs – 100 μs)



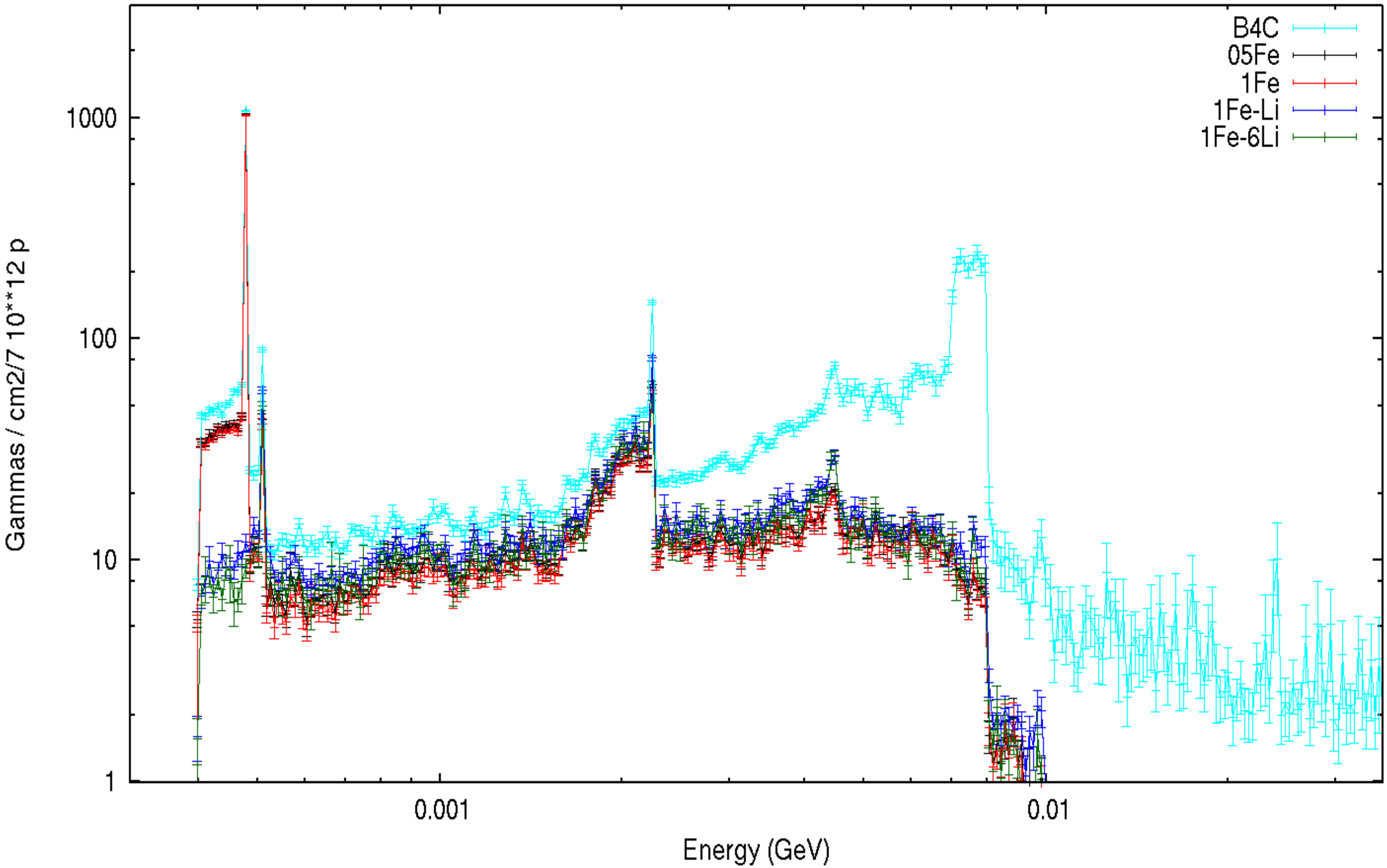
Influence of gap material

Gamma fluence vs. Radius (10 μs – 100 μs)



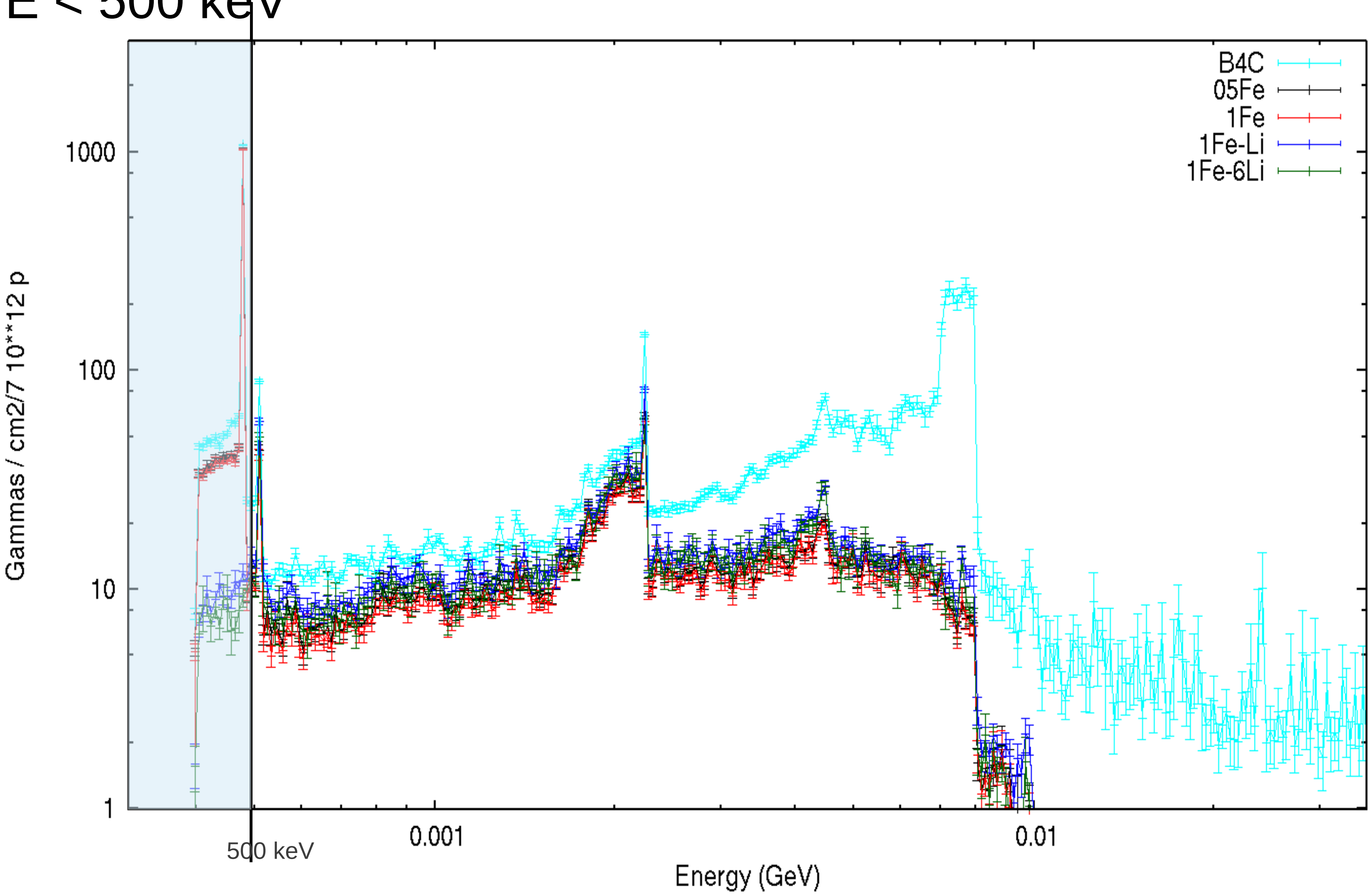
Influence of gap material

Gamma fluence outside beam (all time cuts)



Influence of gap material

Gamma fluence outside beam (all time cuts) – integral for E < 500 keV



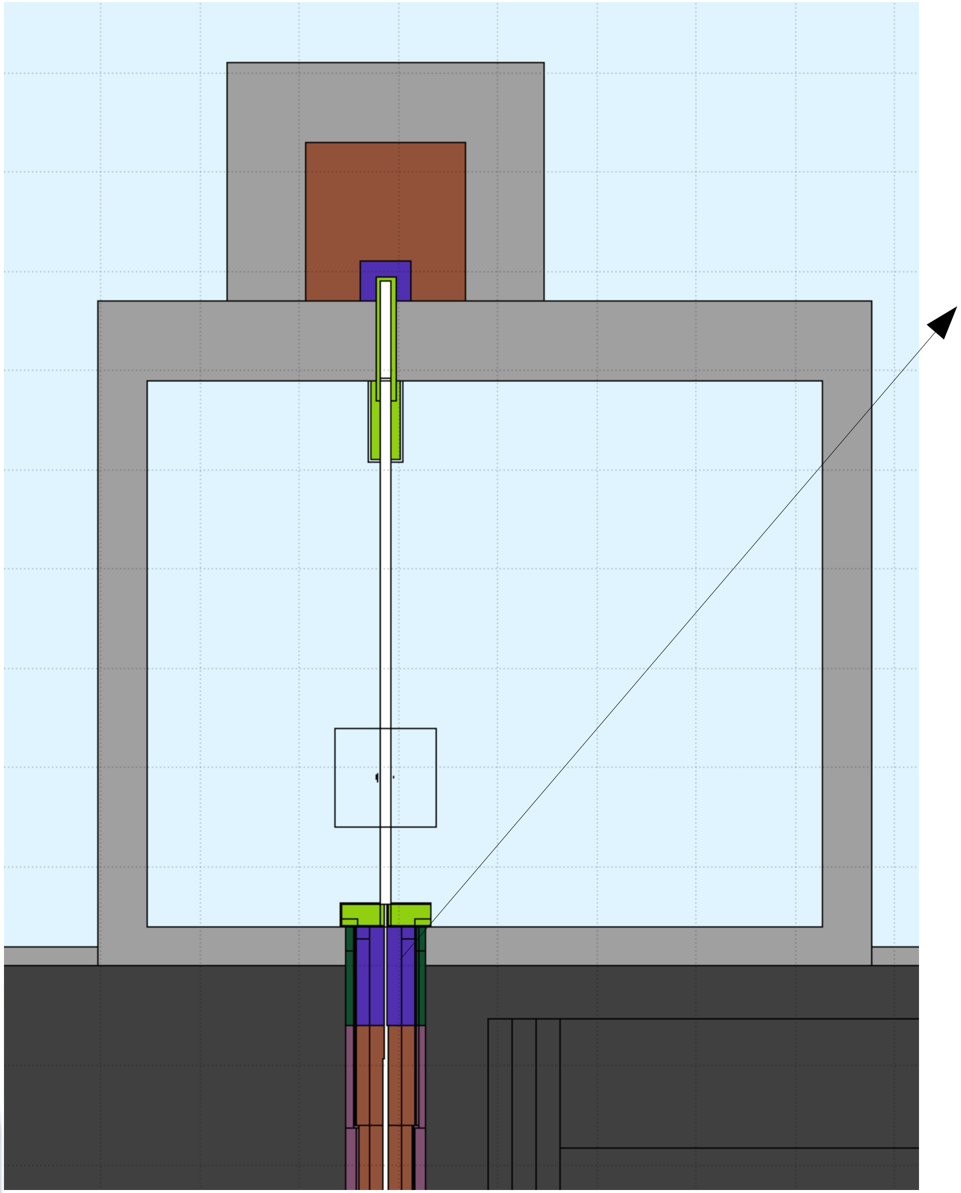
Influence of gap material

Gamma fluence outside beam (all time cuts)

- Integral values for energies < 500 keV and total response (part/cm^2)

	< 500 keV	unc (%)	total	unc (%)
b4c	26.1	3	147.2	2
05Fe	23.0	2	58.1	1
1Fe	22.6	2	56.2	1
1Fe-Li	2.2	1	44.7	1
1Fe-6Li	1.8	2	40.4	2

Influence of block and 2nd collimator material

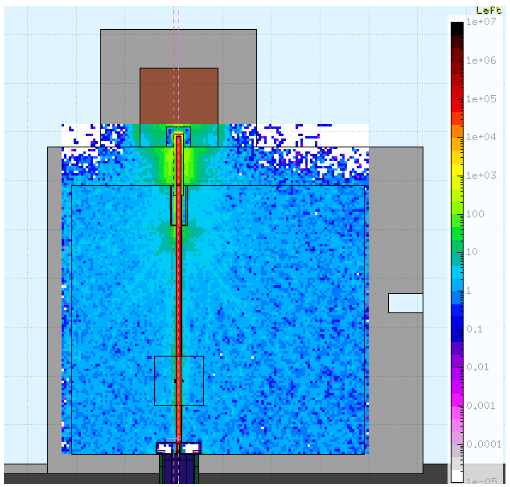


- All B
- Li-poly block & 2nd coll B-poly
- B4C block & 2nd coll 6Li-poly
- All Li-poly
- All 6Li-poly

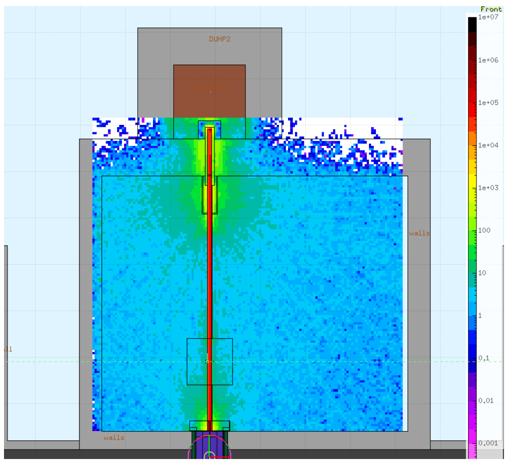
Influence of block & 2nd collimator material

Neutron fluence (10 μs – 100 μs)

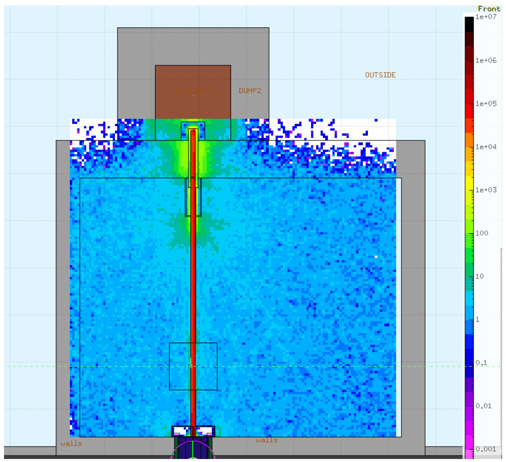
All B



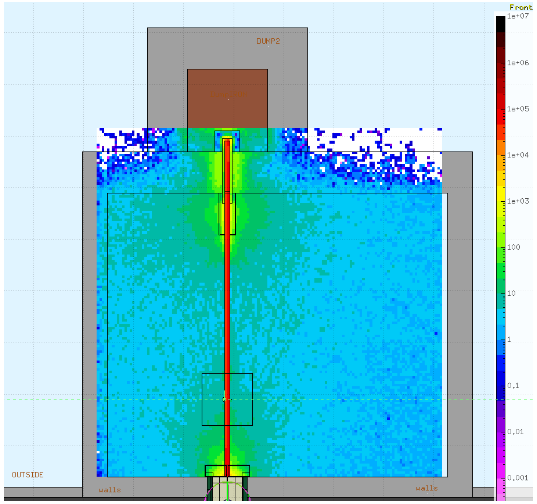
Li block and B coll



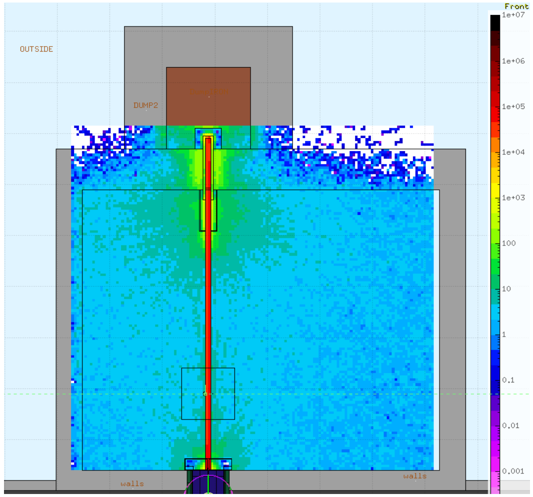
B block and 6Li coll



All Li

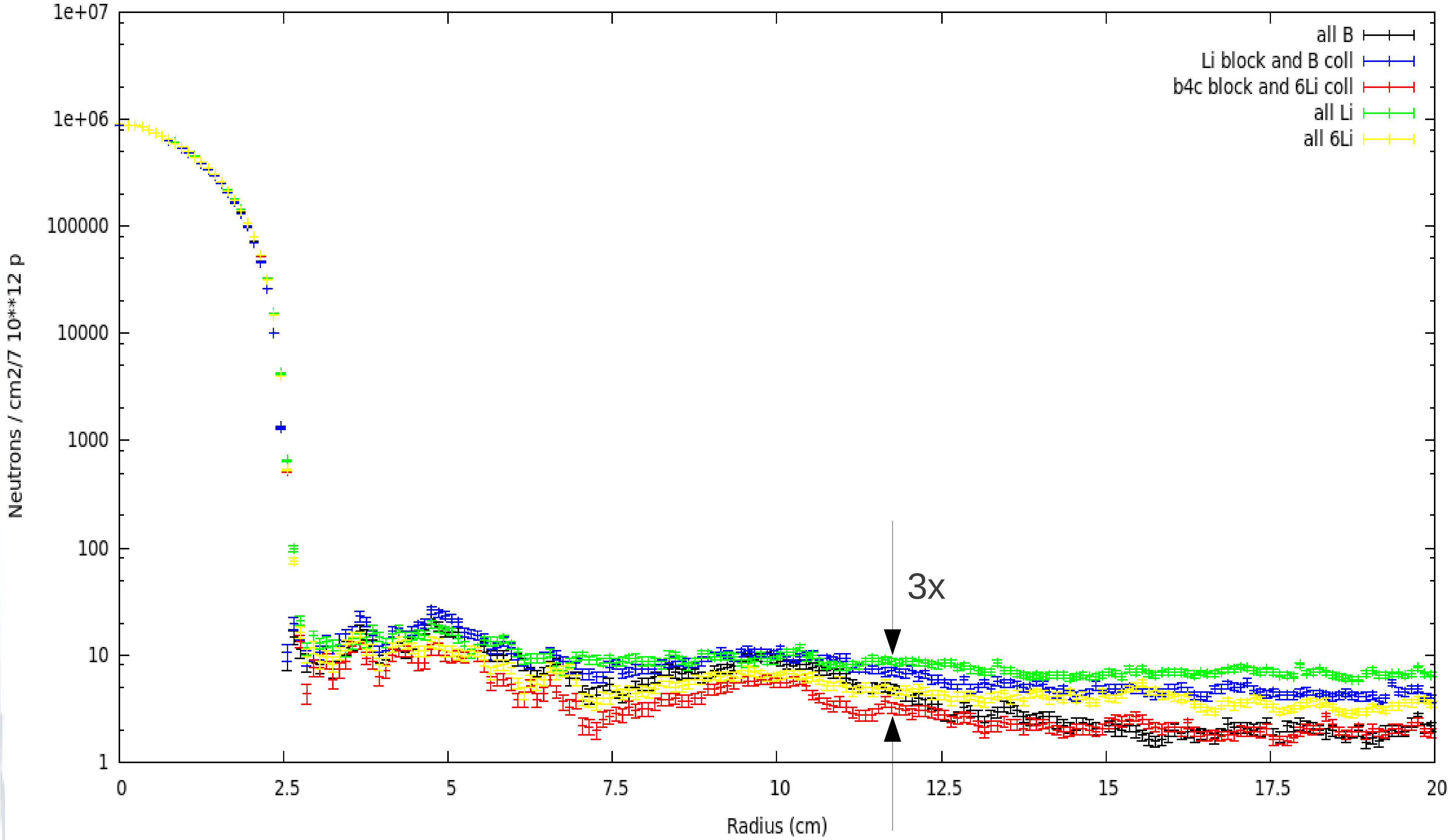


All 6Li



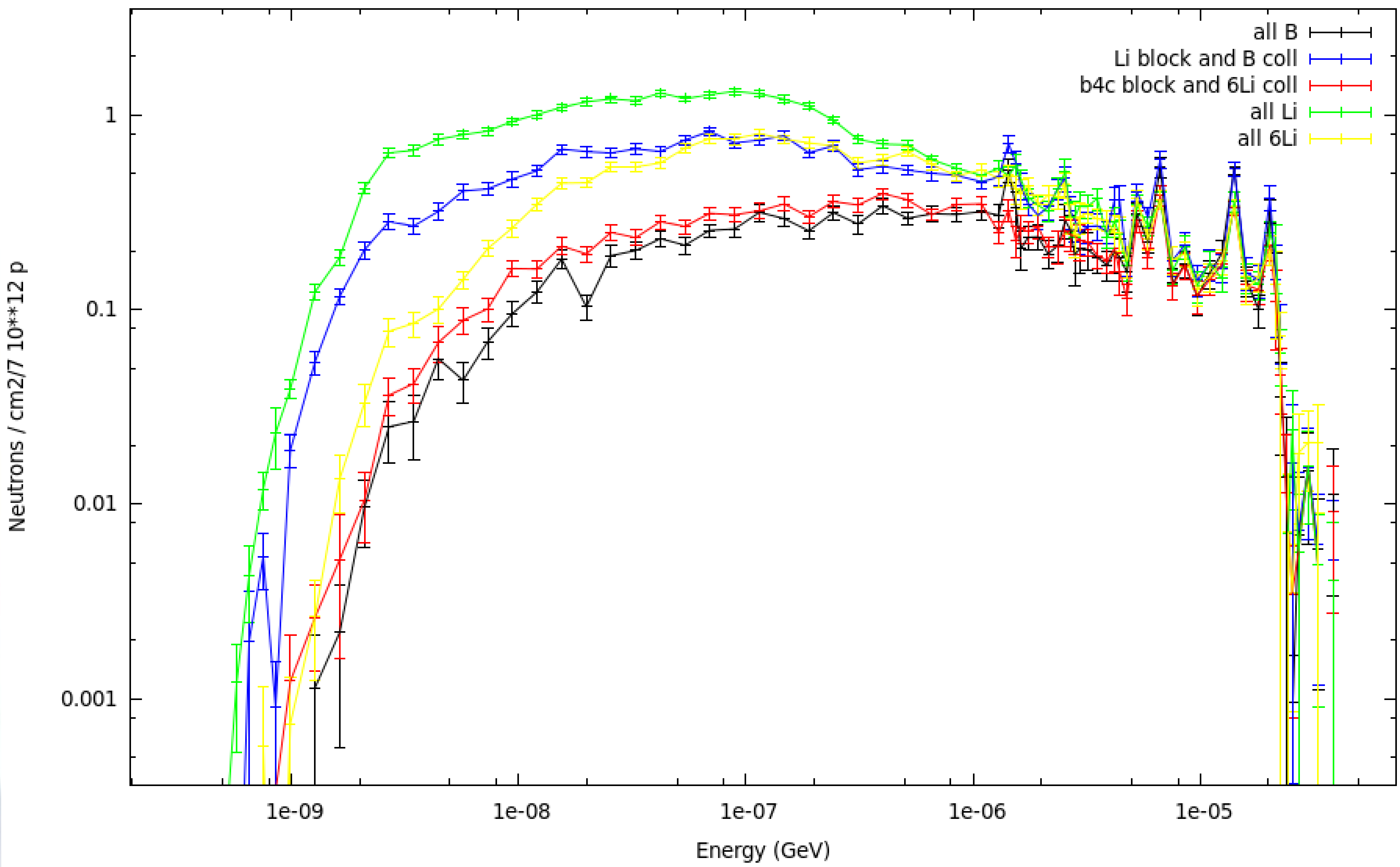
Influence of block & 2nd collimator material

Neutron fluence vs. Radius (10 μs – 100 μs)



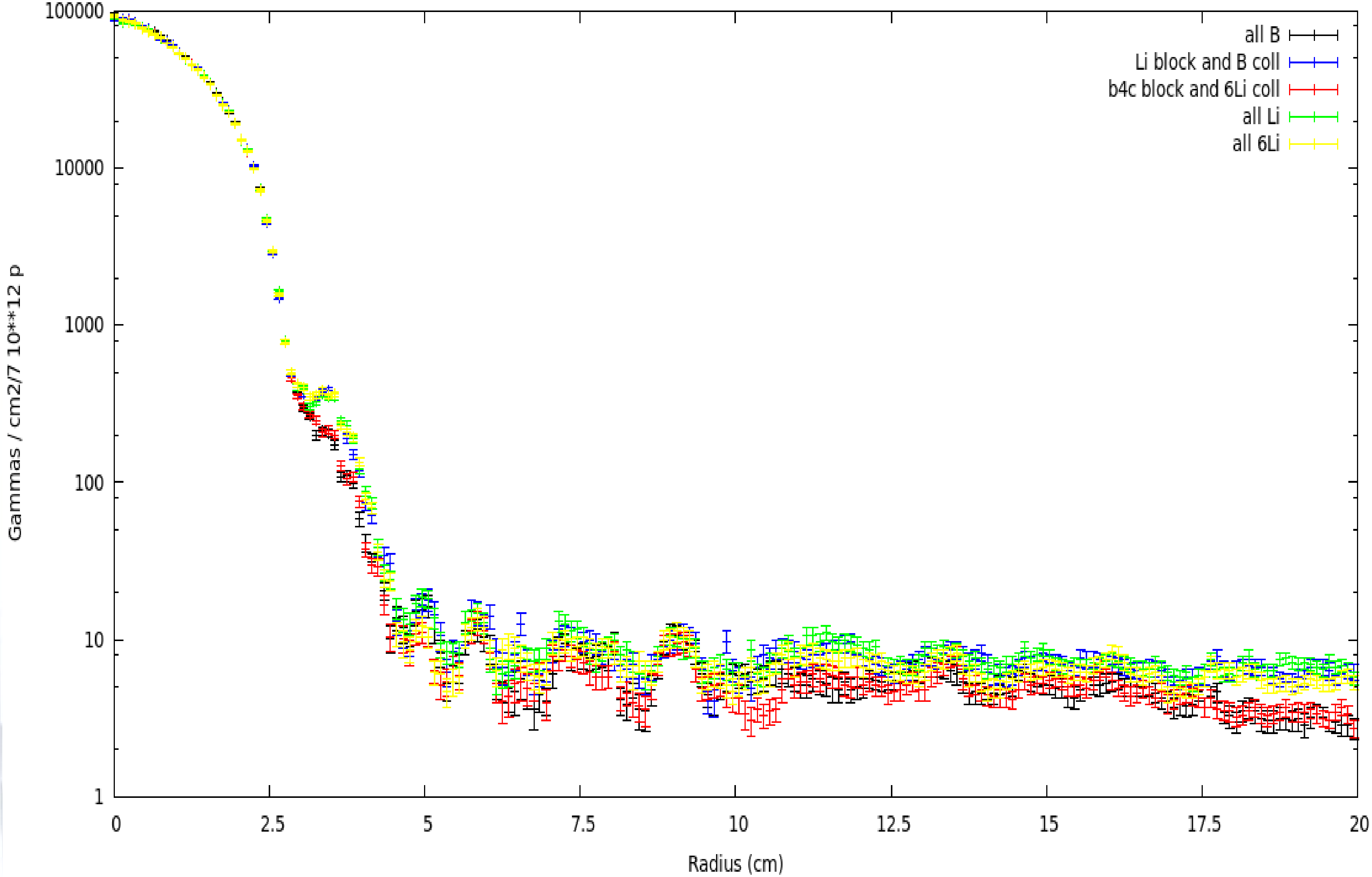
Influence of block & 2nd collimator material

Neutron fluence outside beam (10 µs – 100 µs)



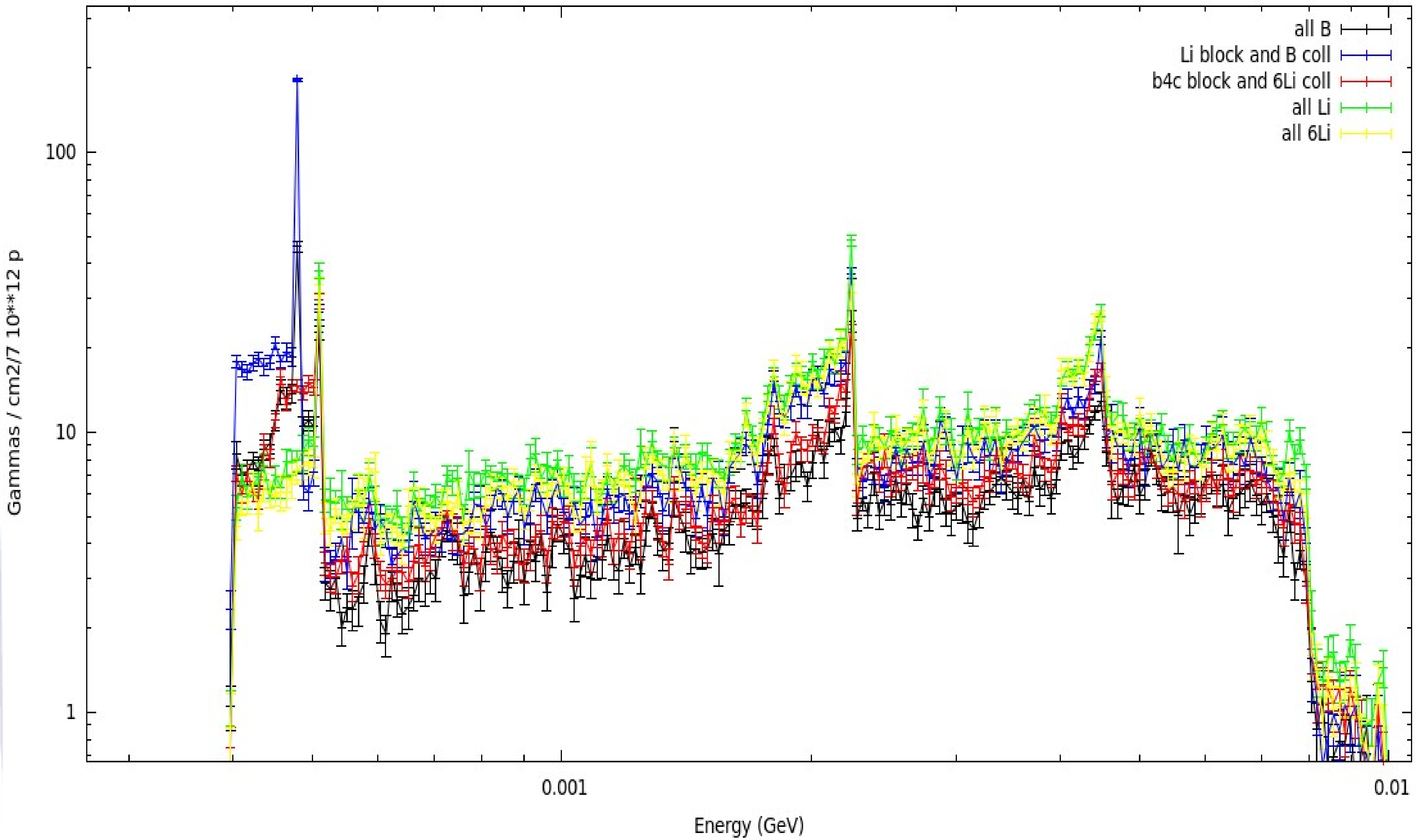
Influence of block & 2nd collimator material

Gamma fluence vs. Radius (10 μs – 100 μs)



Influence of block & 2nd collimator material

Gamma fluence outside beam (all time cuts)



Influence of block & 2nd collimator material

Gamma fluence outside beam (all time cuts)

- Integral values for energies < 500 keV and total response (part/cm^2)

	< 500 keV	unc (%)	total	unc (%)
All-B	2.7	2	18.3	2
Li block and B coll	6.1	3	28.7	2
B4C block and 6Li coll	2.3	2	20.6	2
All Li	1.6	2	29.4	1
All 6Li	1.4	2	27.1	2

C6D6 simulations

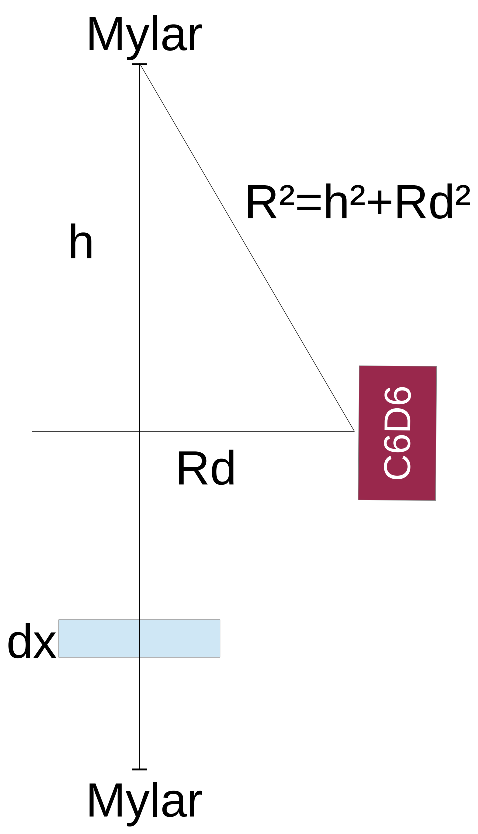
- Routine to scatter homogeneously the particles
    - Mylar windows
    - Sample

- Distance between windows
  - FOM

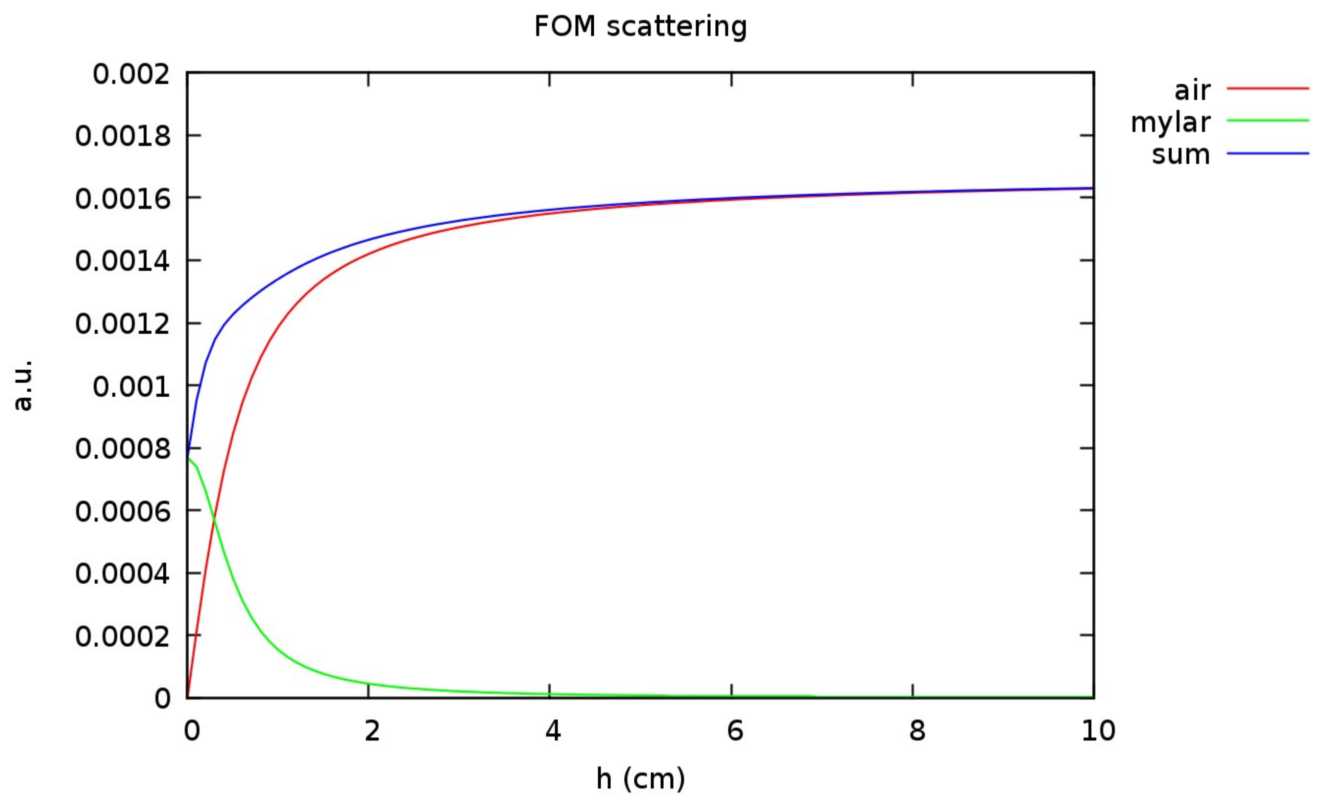
- Block, 2nd collimator and dump materials
  - Li - polyethylene
  - B   - polyethylene

C6D6 simulations

- Distance between mylar windows
  - Contribution from mylar windows (100 μm thickness) and air vs. distance between windows

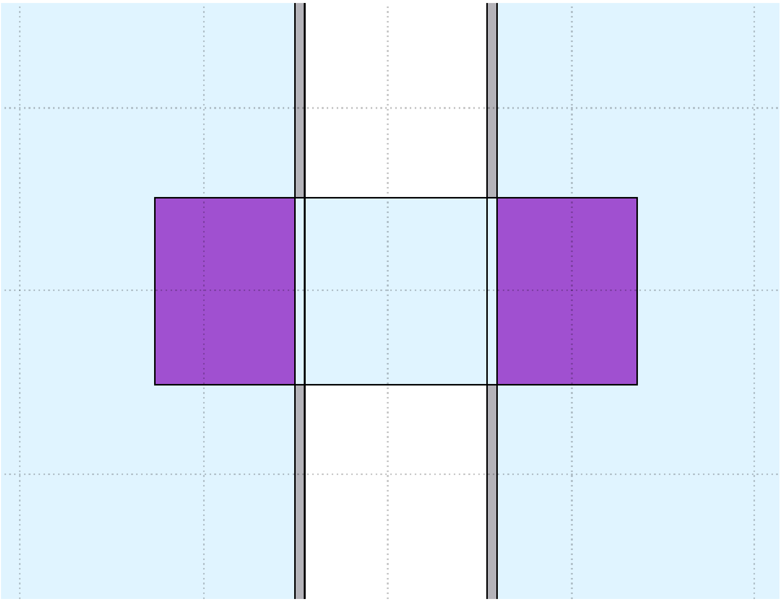


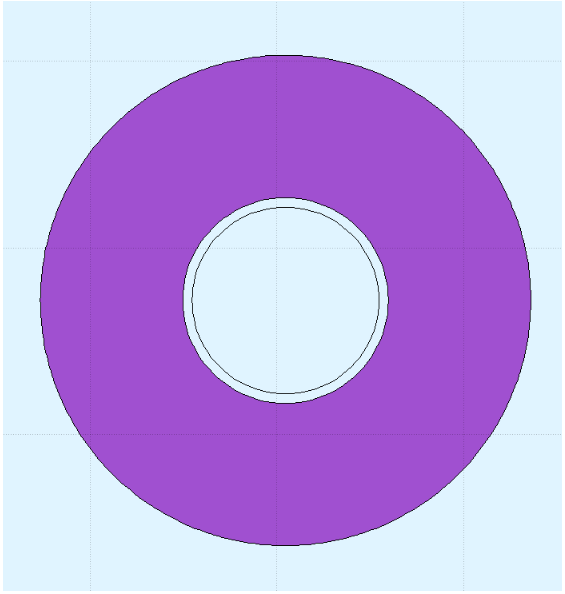
$$FOM = \int_0^h \frac{Prob_{air} * dx}{R^2 + x^2} + \frac{2 * Prob_{mylar}}{h^2 + Rd^2}$$



C6D6 simulations

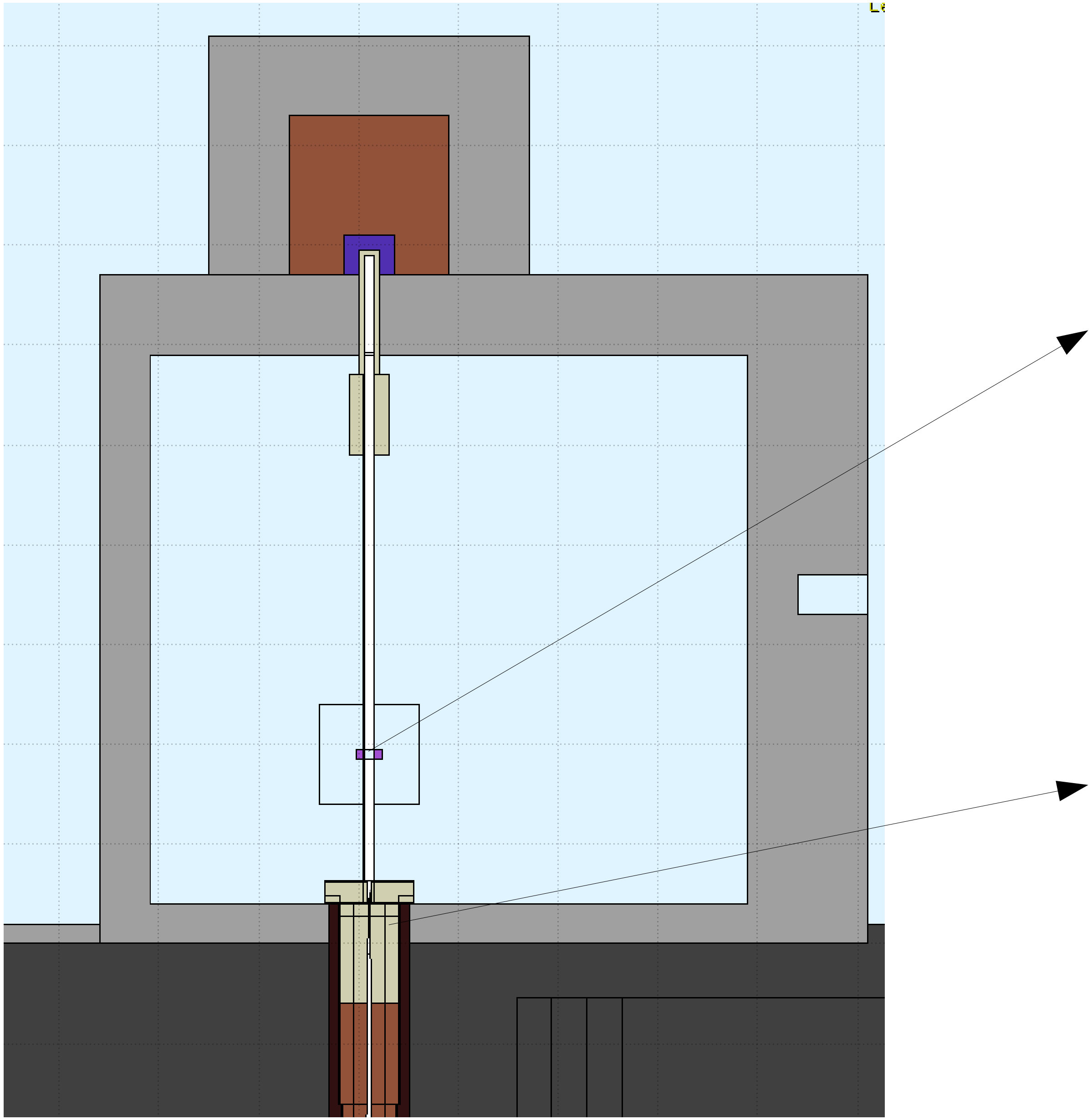
- C6D6 geometry
  - Ring R_{int}= 5.5 cm; R_{ext}=13.12 cm; h= 10.16 cm
  - Volume 7x bigger compared to K6D6





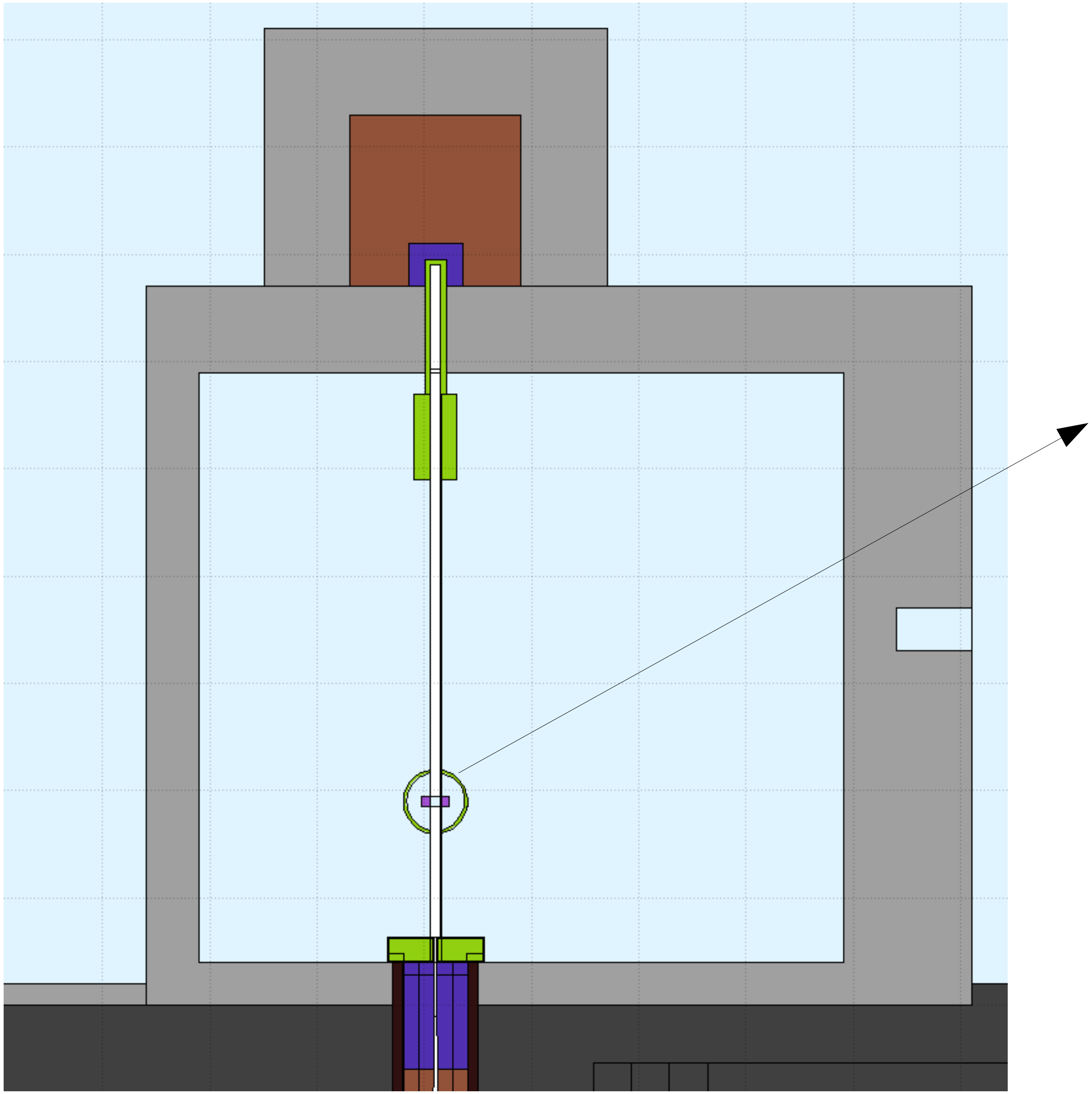
- Distance between windows (100 µm Mylar)
  - 10.16 cm

C6D6 simulations



- Au sample
  - 100 µm
  - 25 µm kapton backing
- Li-Poly
- B-Poly/Poly-bor

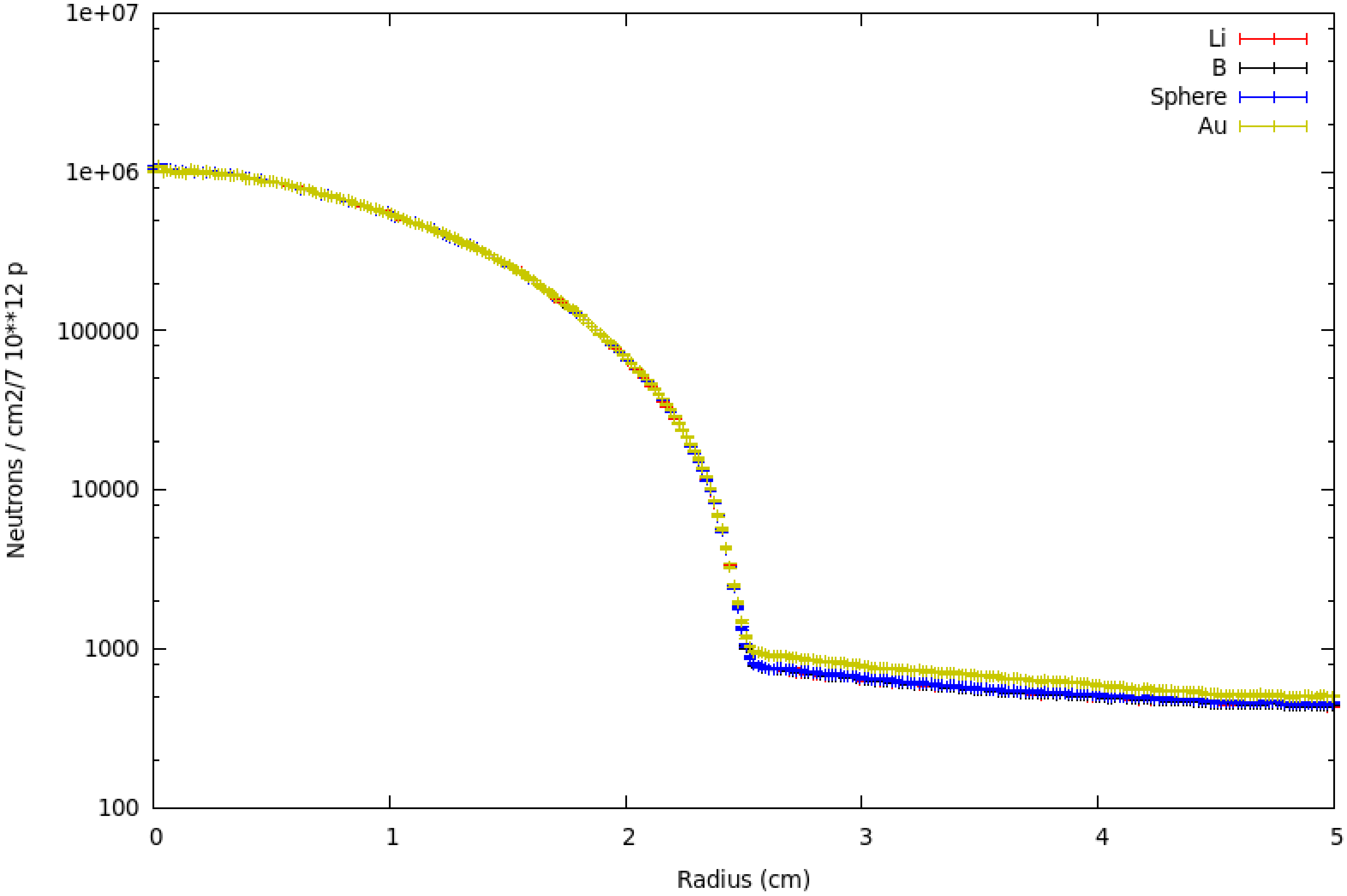
C6D6 simulations



- Boron sphere to reduce background

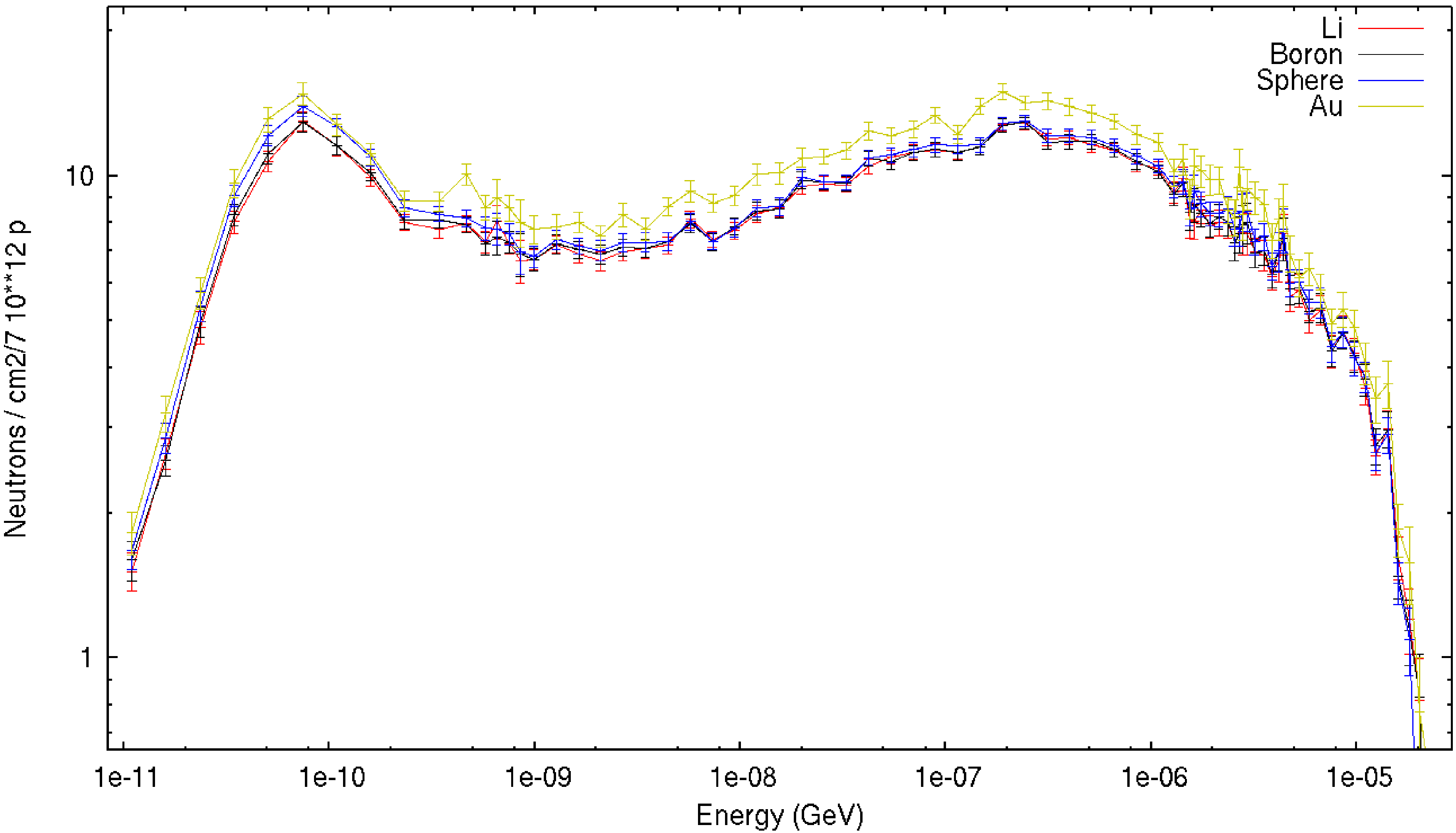
C6D6 simulations – Preliminary results

- Inbeam neutron fluence vs. Radius (10 µs – 100 µs)



C6D6 simulations – Preliminary results

- Neutron fluence in C6D6 (10 μs – 100 μs)



C6D6 simulations – Preliminary results

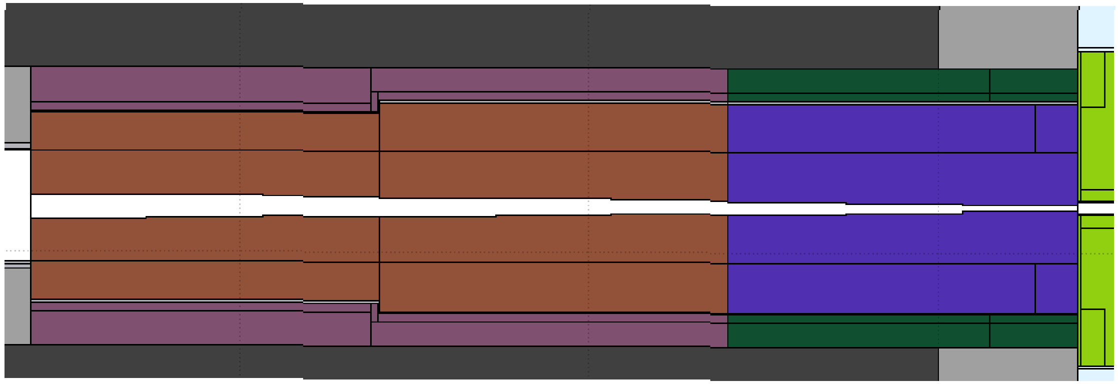
- Energy deposition in C6D6 (keV)

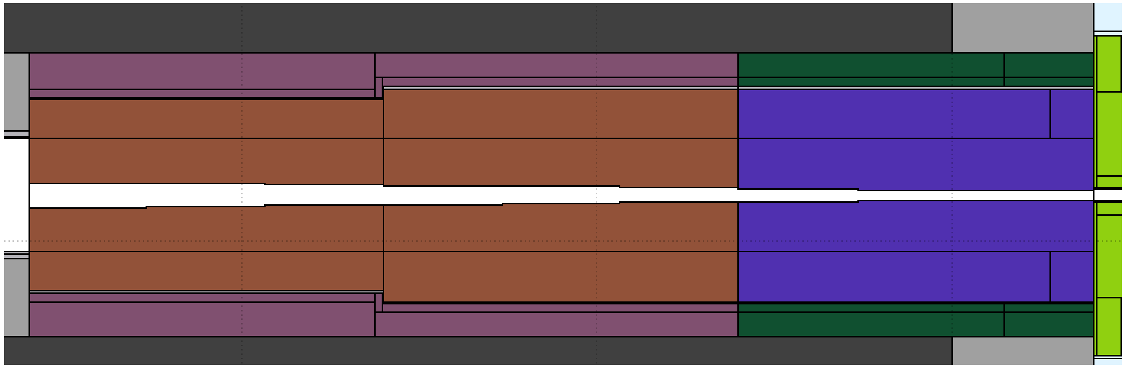
	< 1us				< 10us				< 100us			
	all parts	unc (%)	neutrons	unc (%)	all parts	unc (%)	neutrons	unc (%)	all parts	unc (%)	neutrons	unc (%)
Li	60548	3	6322	4	3190	2	3048	2	171	18	23	2
Boron	57085	3	6573	4	3232	2	3106	2	163	19	23	2
Boron sph	60701	3	8465	3	3444	2	3253	2	378	11	23	2
Boron Au	56907	4	6792	5	3841	2	3696	2	404	13	26	3

	< 1m				> 1m			
	all parts	unc (%)	neutrons	unc (%)	all parts	unc (%)	neutrons	unc (%)
Li	339	16	0.2	2	283	18	0.4	8
Boron	290	17	0.2	3	275	18	0.4	8
Boron sph	420	11	0.2	2	759	7	0.4	8
Boron Au	3241	5	0.3	3	3405	7	0.4	9

Capture setup

- Conical aperture with apex radius = 1.0 cm for a Rh=2.5 cm
  - Only possible to produce with cylindrical sections
    - Rh remains 2.5 cm?

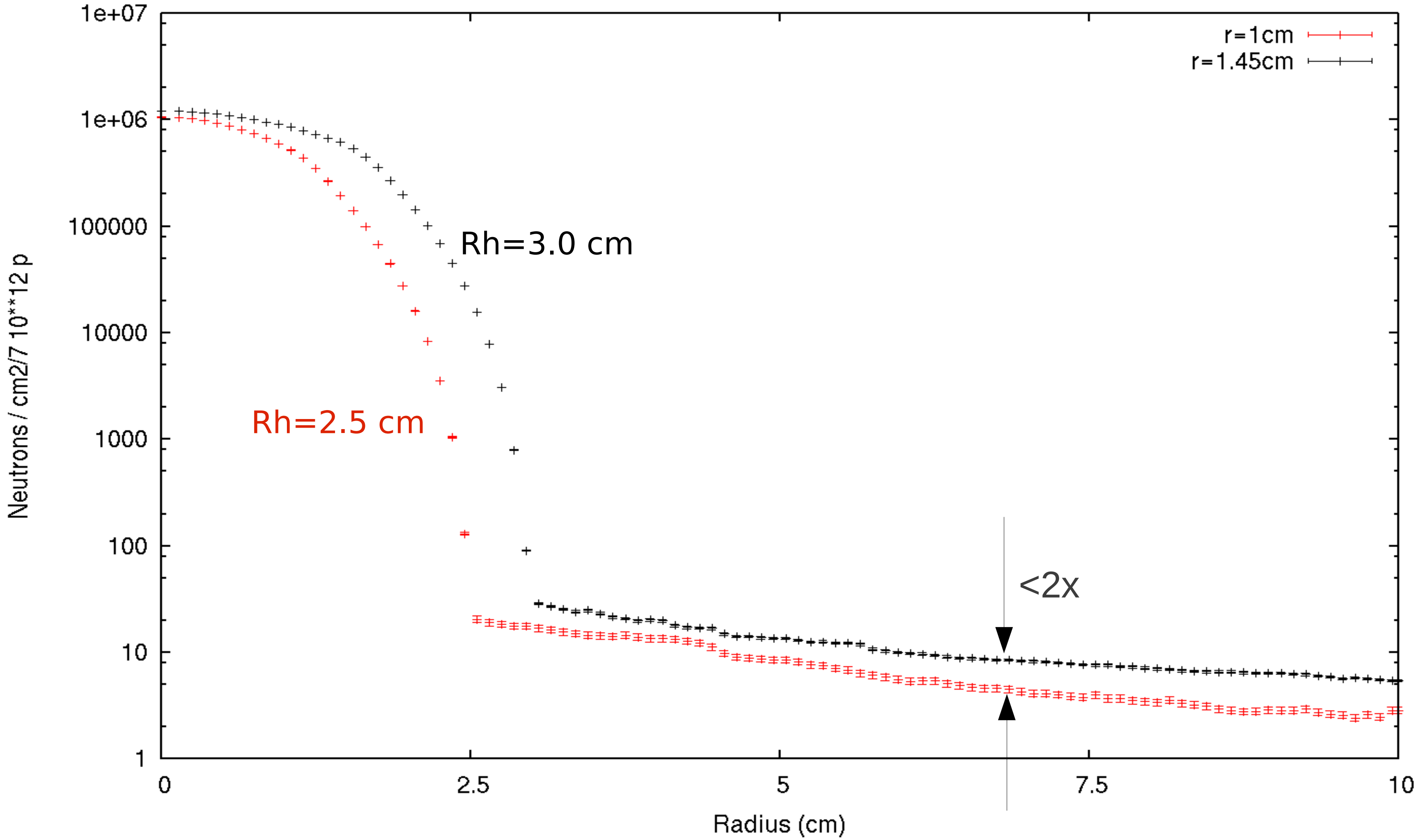




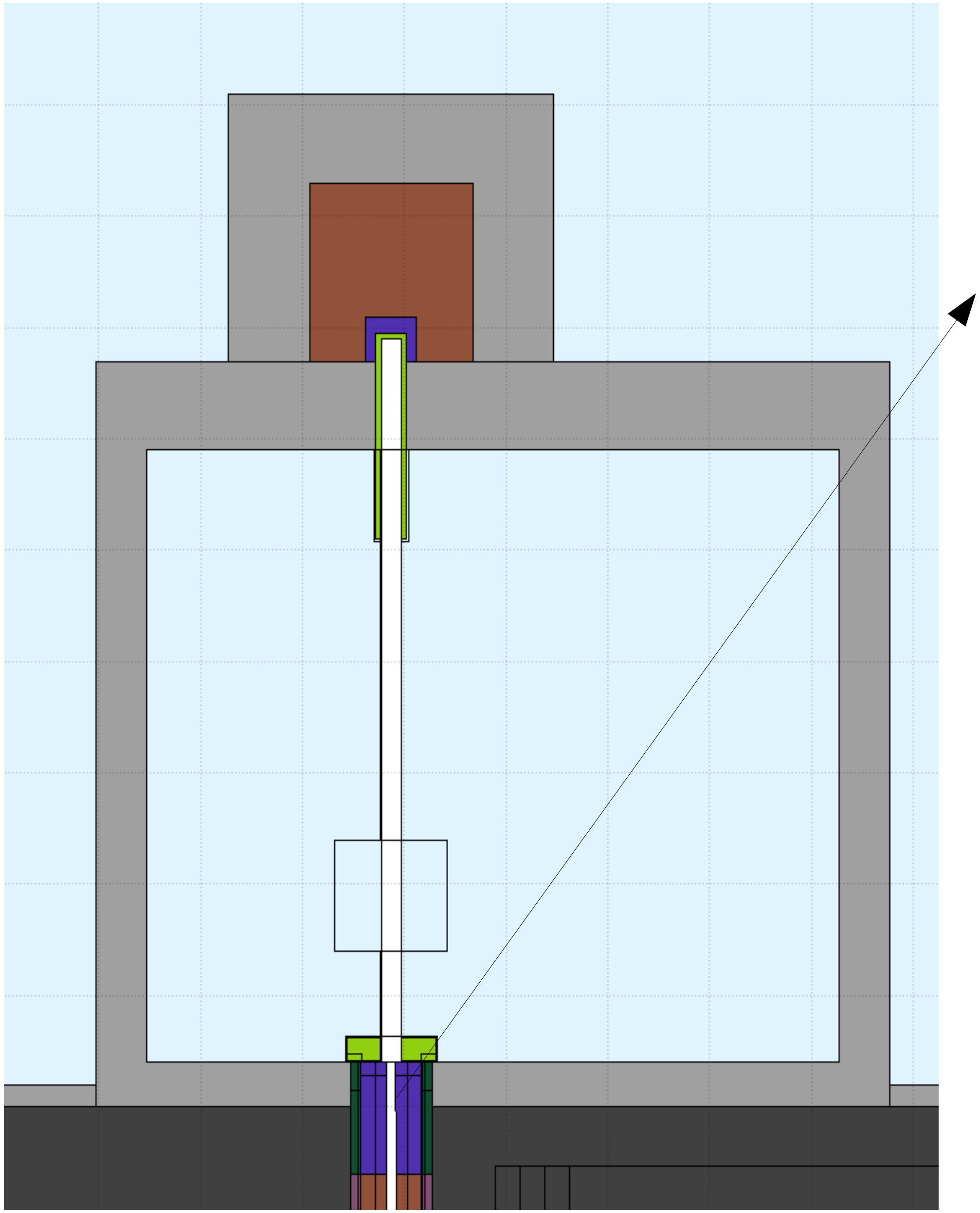
- 2 cases:
- Final radius
  - 1.00 cm
  - 1.45 cm
  - Effect on the final Rh and fluence

Capture setup

- Neutron fluence vs. Radius (10 μs – 100 μs)



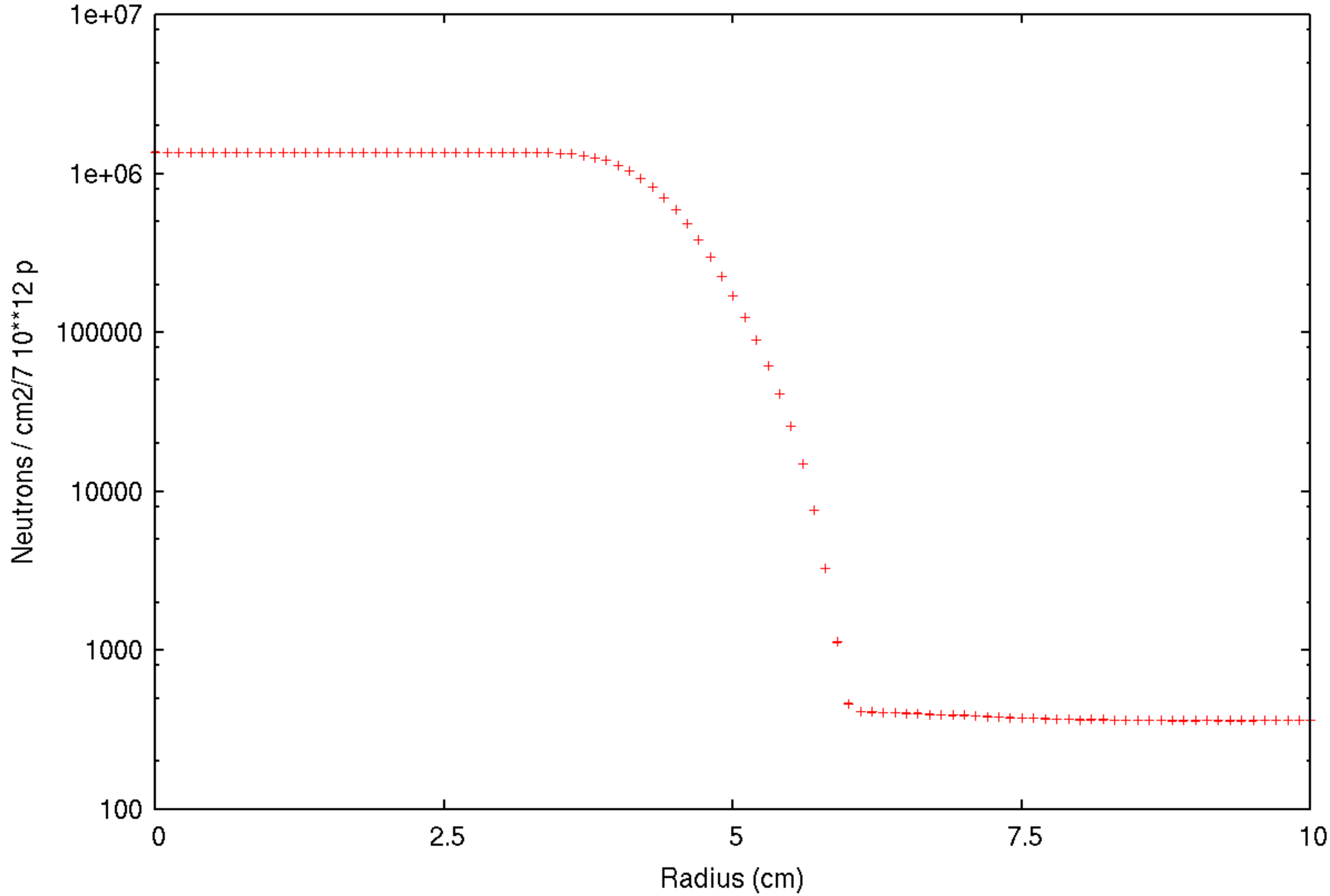
Fission setup



- Without 1st collimator
- Conical closing aperture
- Rhalo = 6 cm
- Rflat = 3.3 cm

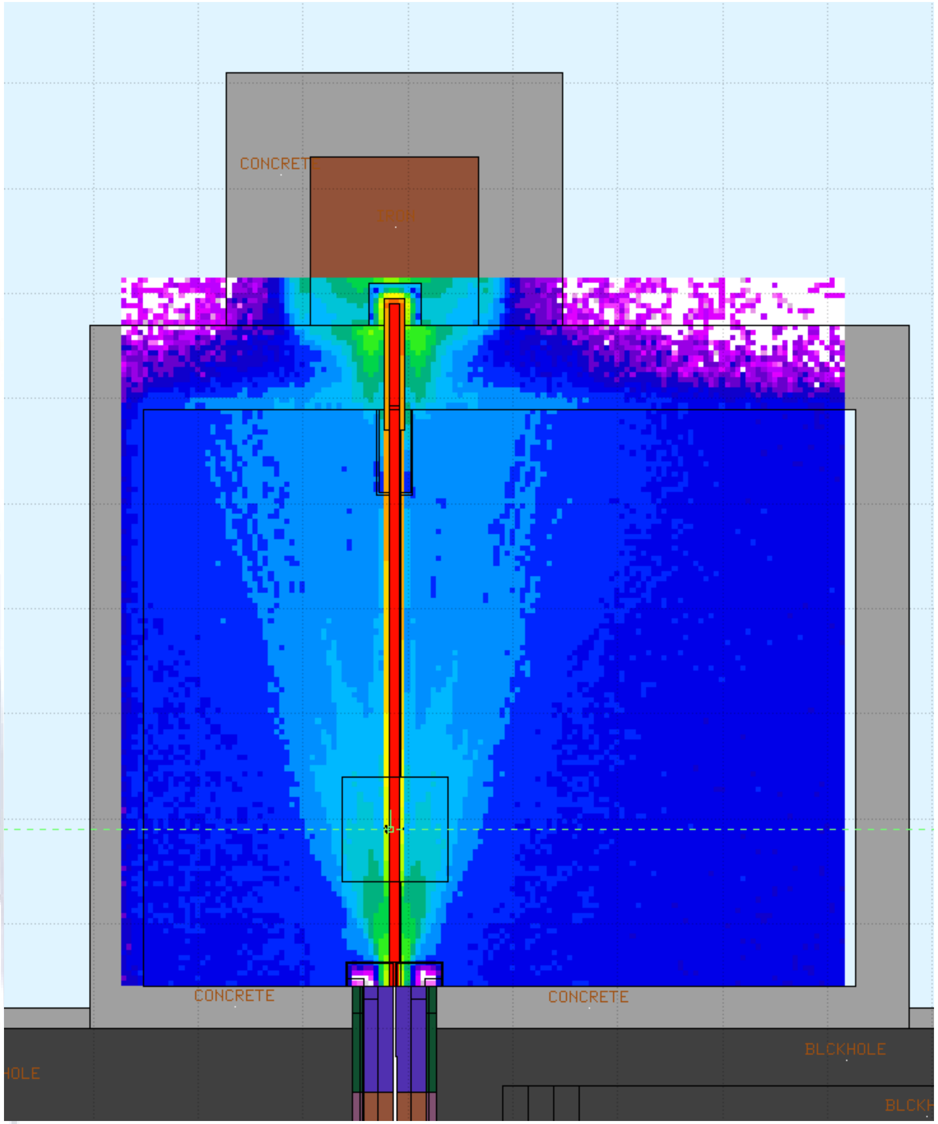
Fission setup

Neutron fluence vs. Radius (10 μs – 100 μs)



Fission setup

Neutron fluence (10 μs – 100 μs)



- Necessary to optimize block aperture to reduce background

Conclusions

- **Influence of gap material**
  - 3x increase of neutron background when using Li instead of B4C
  - Iron balls: low neutron and gamma background

- **Influence of block material**
  - 480 keV peak killed when using Li instead of B
    - reduced when using a B4C block and 6Li collimator, low neutron background
  - 3x increase of neutron background (for r>5cm) when using all as Li instead of using all as B

- **C6D6 simulations – PRELIMINARY RESULTS**
  - distance between windows should be as small as possible
  - small differences in energy deposited by neutrons in C6D6 when using Li instead of B

- **Fission setup**
  - 3.3 cm plateau and Rh=6 cm achieved without 1st collimator
  - necessary to optimize block dimensions

Thank you for your attention!