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Title: Design of the next generation target at Lujan center, LANSCE.

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Design of the next generation target at Lujan center, LANSCE.

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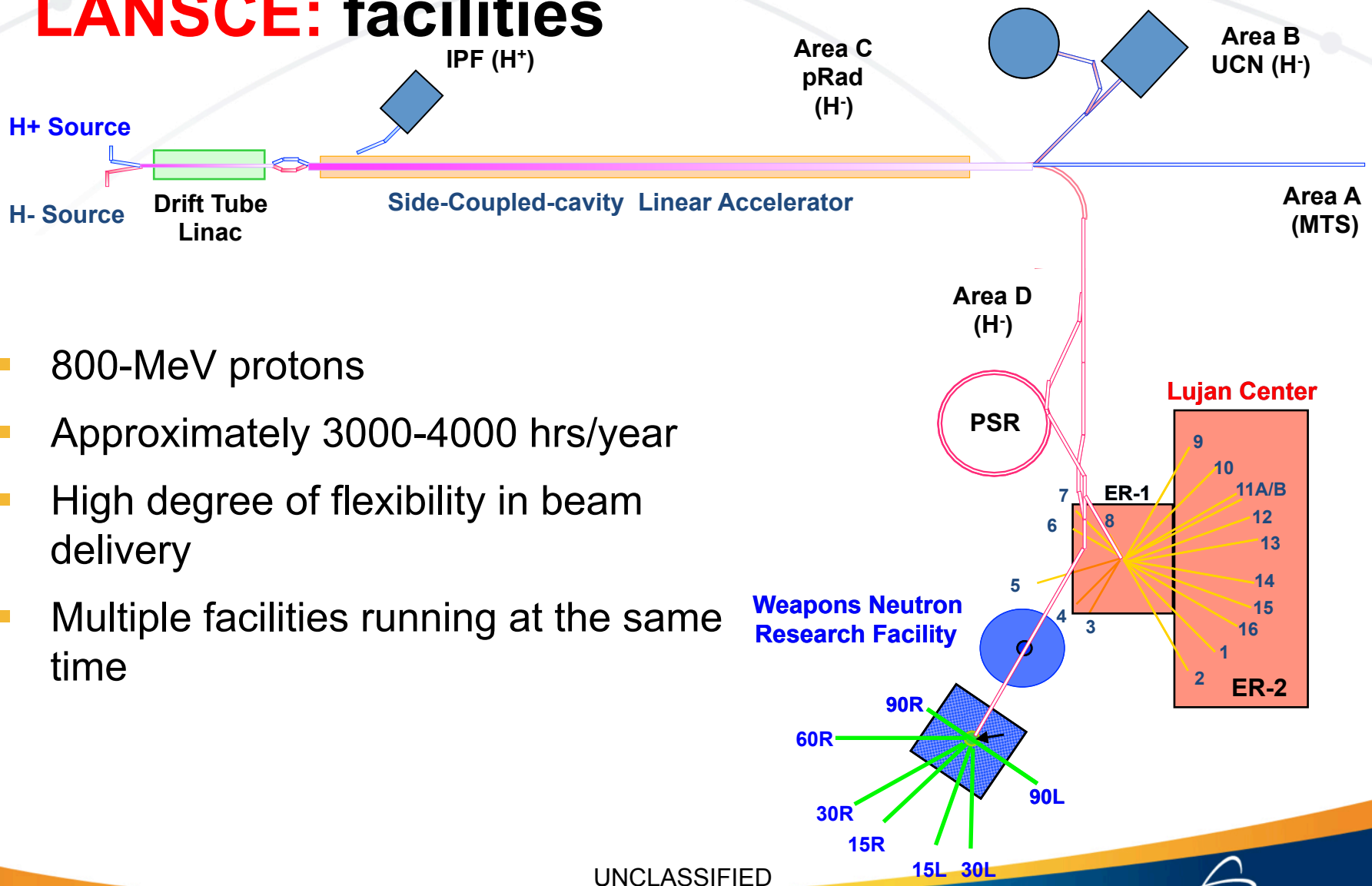
Supervisors : Mickael Mocko, Steve Wender

July 27, 2016

LANSCE: facilities



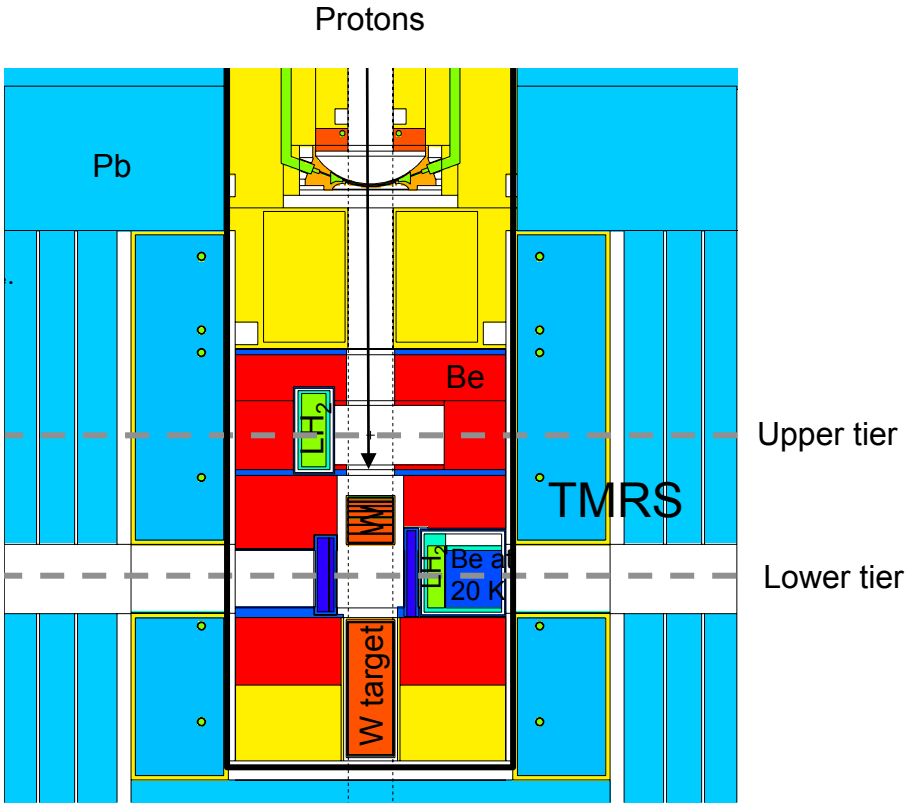
- 800-MeV protons
- Approximately 3000-4000 hrs/year
- High degree of flexibility in beam delivery
- Multiple facilities running at the same time

Motivation

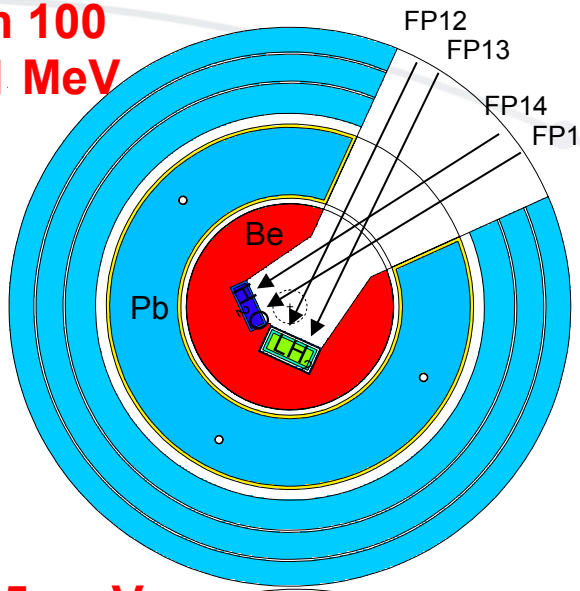
- Enable new nuclear physics experiments (defense program applications (DANCE)) that are currently limited by neutron intensity or energy resolution available at LANSCE.
- The target is being redesigned so that the Flight Paths in the upper tier provide a higher intensity in the epithermal and medium energy ranges.

	Energy ranges
Cold neutrons	< 5 meV
Thermal neutrons	5 meV - 0.4 eV
Low energy range	0.4 eV - 100 eV
Epithermal energy range	100 eV -10 keV
Medium energy range	10 keV - 1 MeV
Fast energy range	1 - 100 MeV

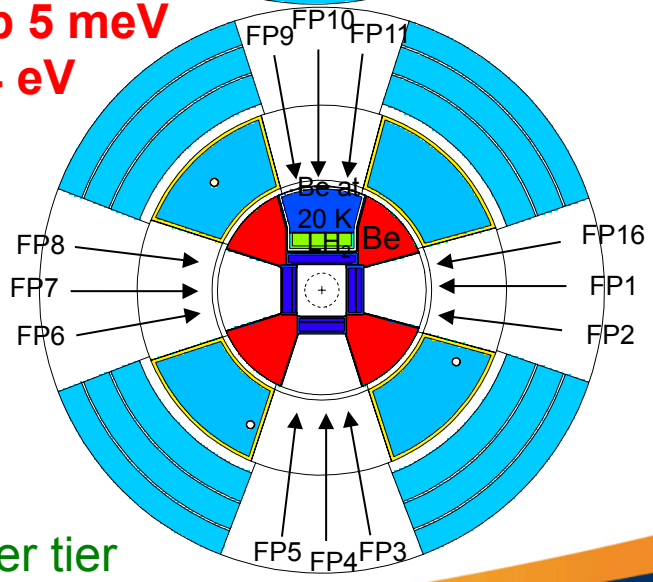
Current design: Mark III



Reach 100 eV – 1 MeV



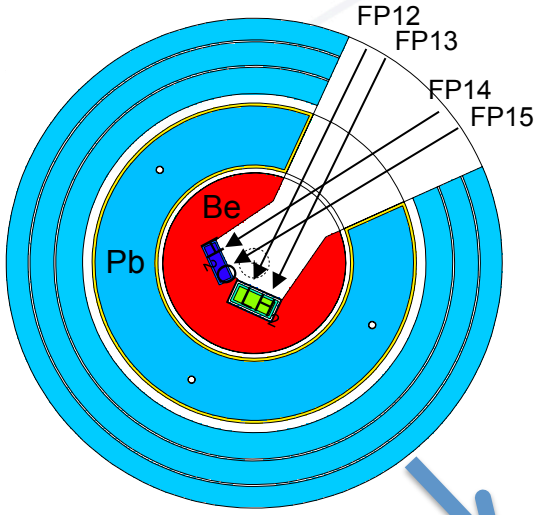
Keep 5 meV – 0.4 eV

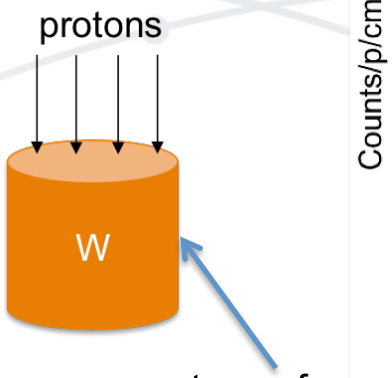


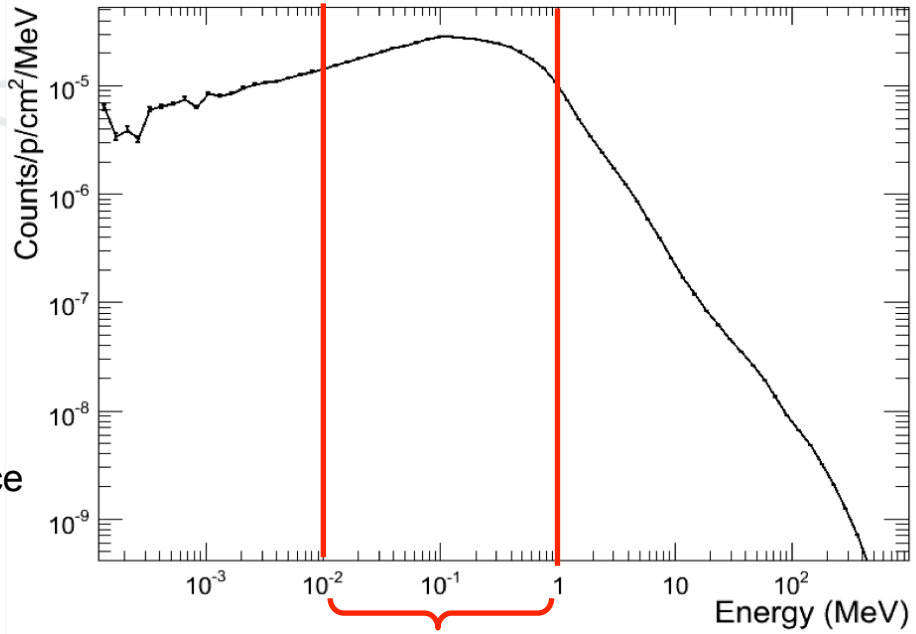
Use of MCNPX to model various arrangements of moderator/reflector/filter materials

Issue: impact on the thermal flux in the lower tier

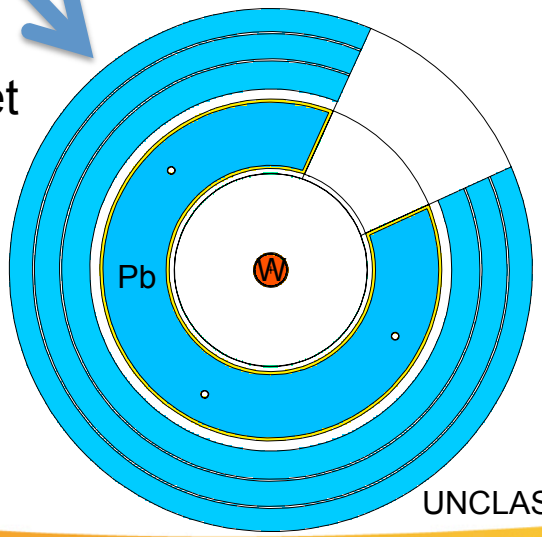
Neutron Spectrum : Outer Surface

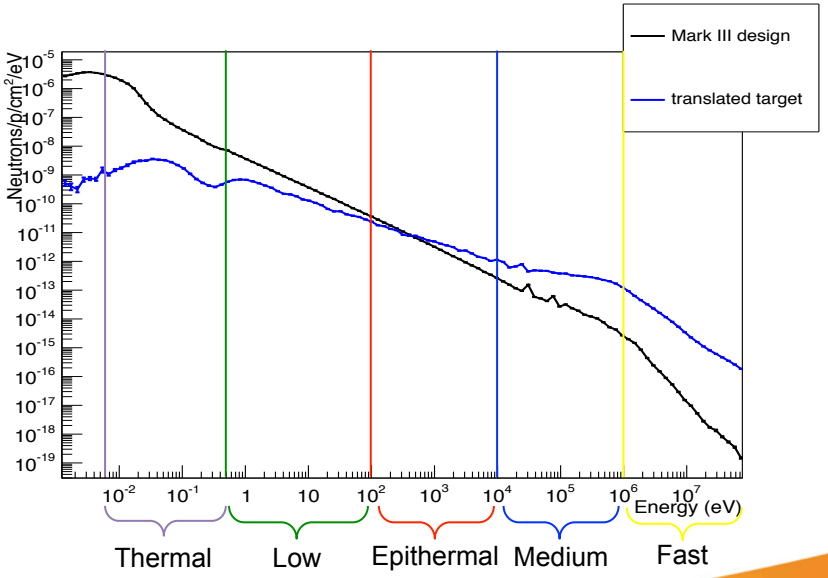






Translated target





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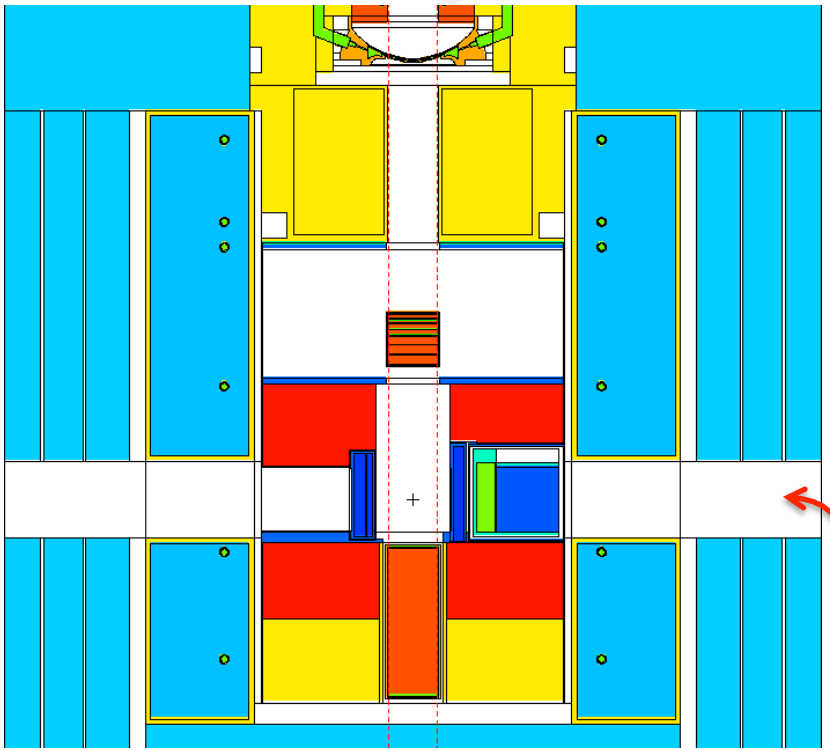
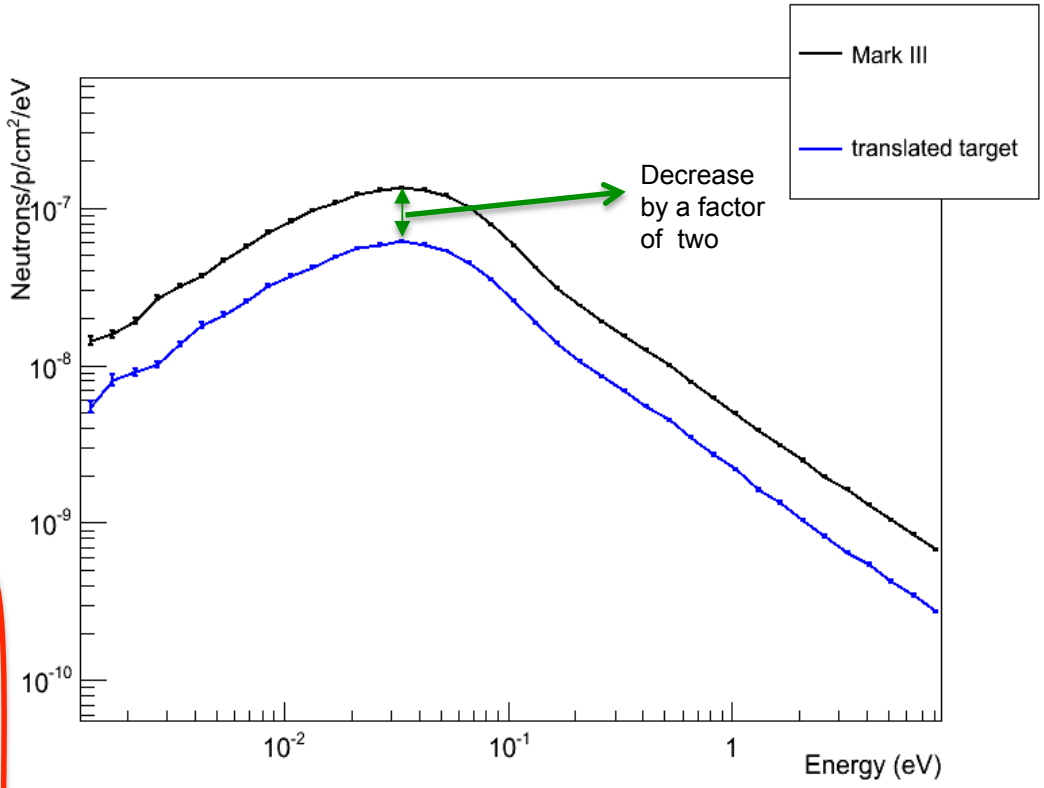
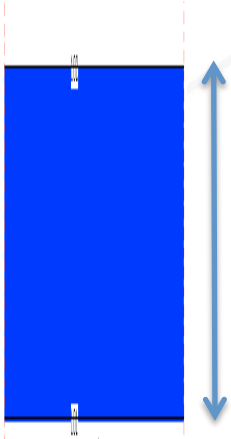
Translated Target Design



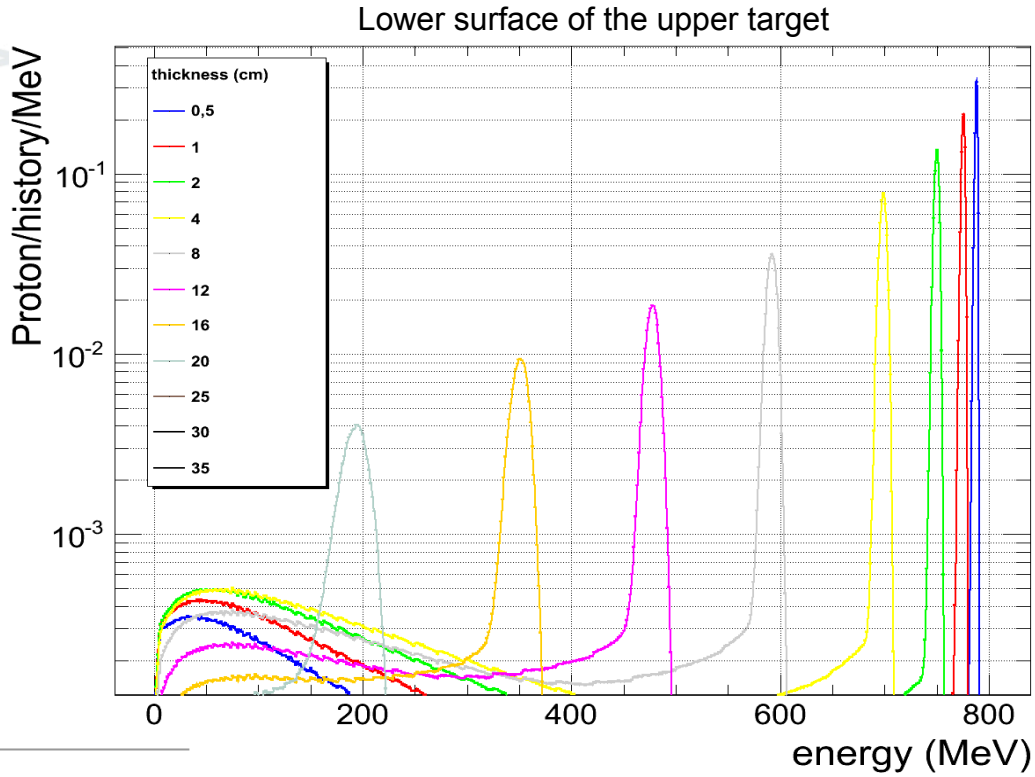


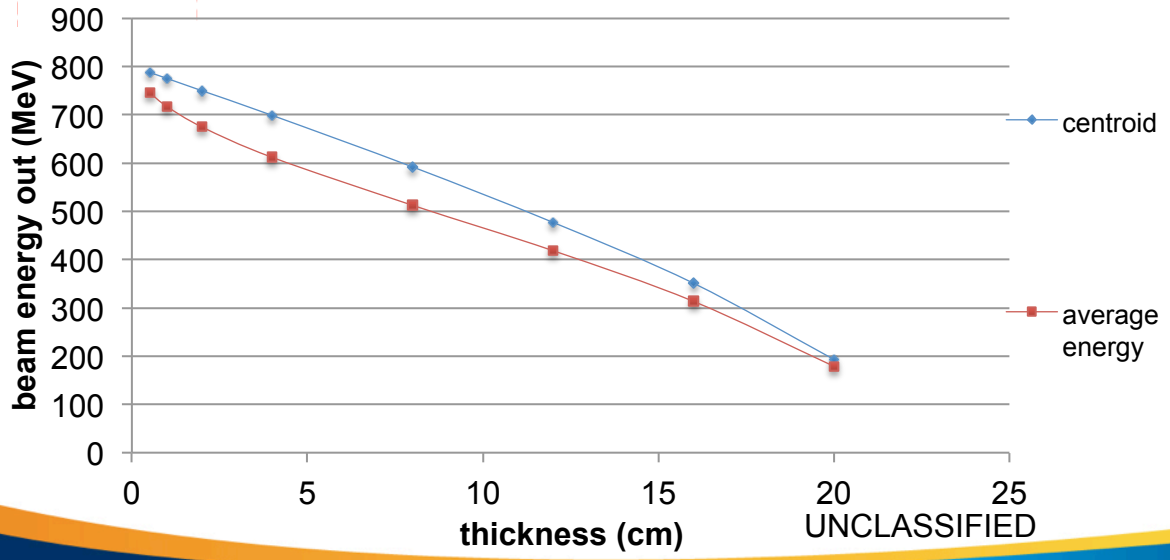
Consequences : thermal neutron intensity is divided by a factor of two in the lower tier

Simple Model : Thickness Study



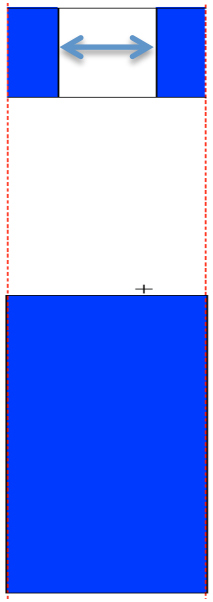
Thickness of upper target varies from 0.5 to 35 cm.



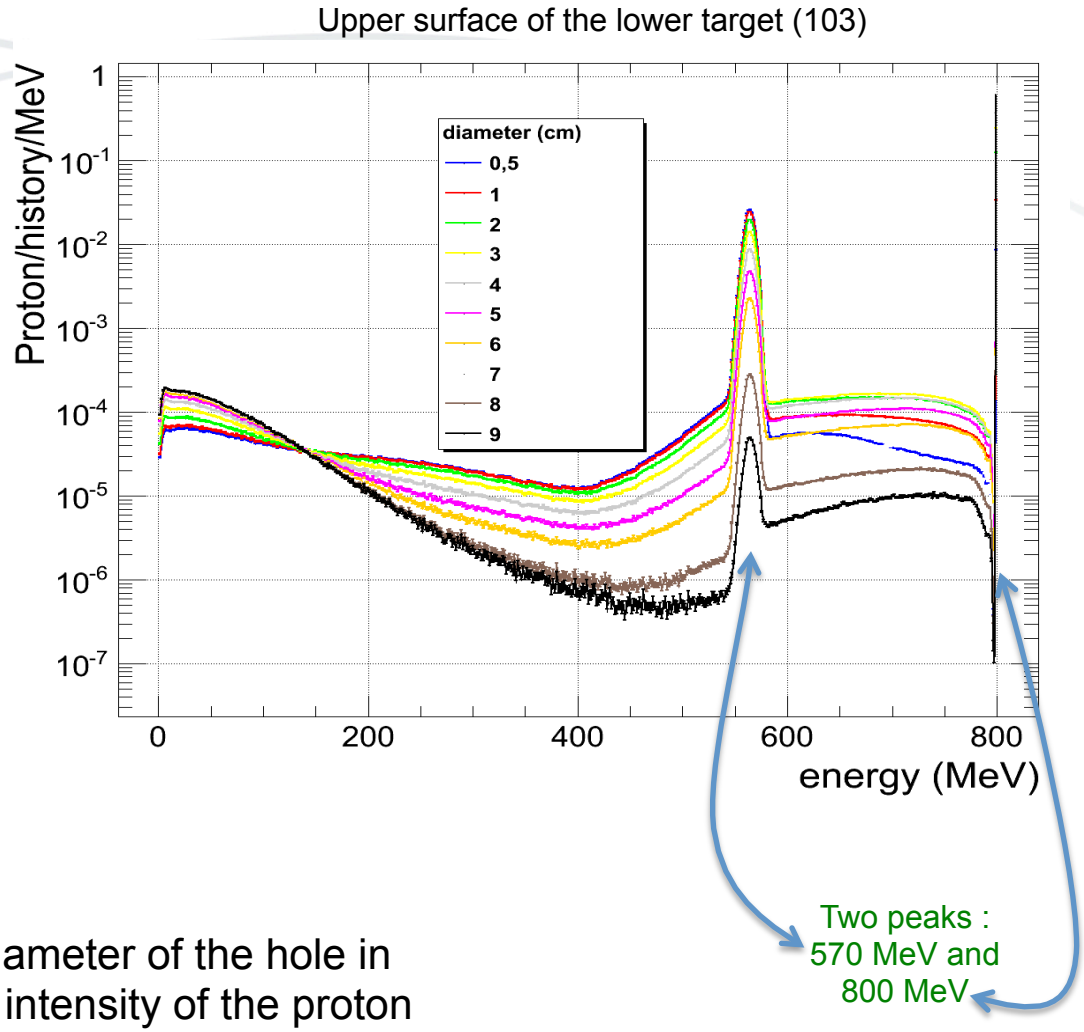


By increasing the thickness of the target, the energy and the intensity of the proton flux that reaches the lower surface of the target decreases.

Simple Model : Hole Study

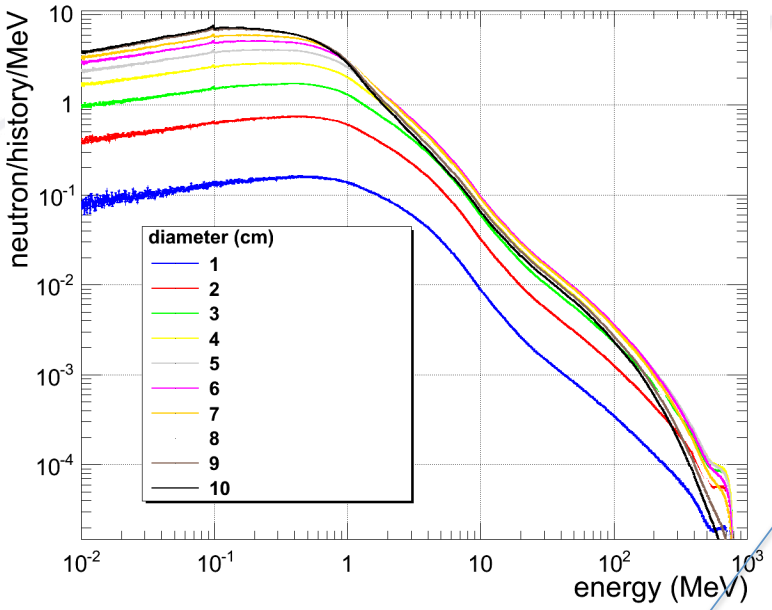


Hole diameter in the upper target varies from 0.5 to 9 cm



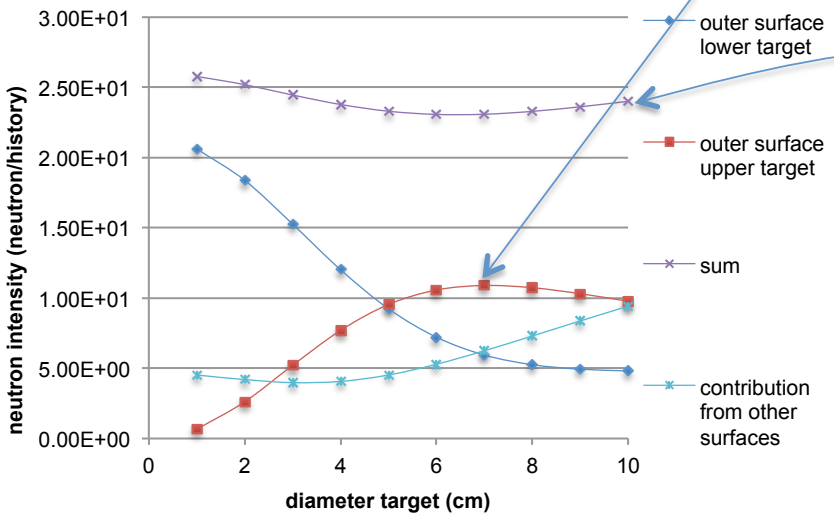
By increasing the diameter of the hole in the upper target, the intensity of the proton flux that reaches the upper surface of the lower target increases.

Neutron Spectrum on Outer Surface of the Upper Target

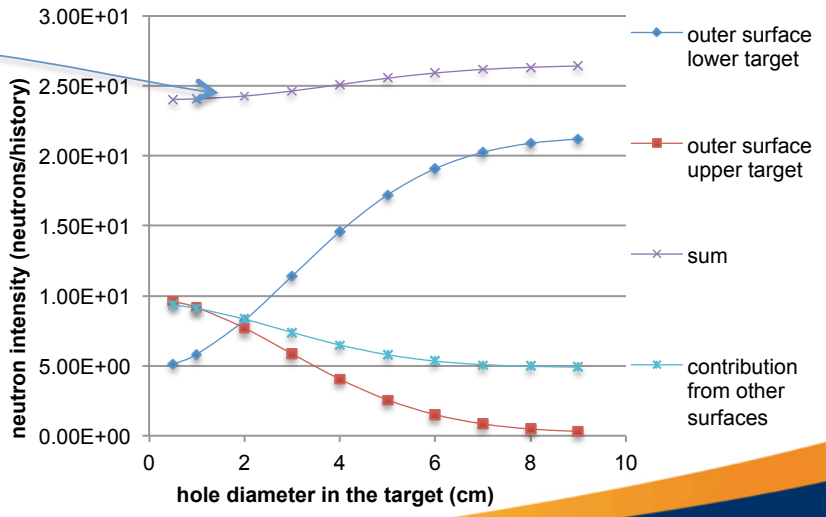


beyond a diameter of about 7 cm, neutron production starts to decrease : neutrons are absorbed in the tungsten before they can get out

Neutron production starts to vary less above roughly a diameter of 5 cm : Gaussian function, 70% of protons are contained in the inner 5 cm diameter of the beam



Sum constant : neutron production remains the same



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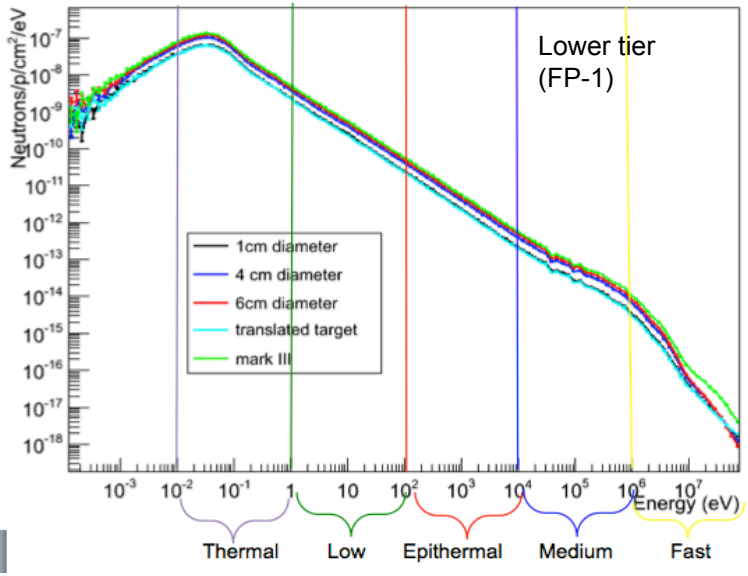
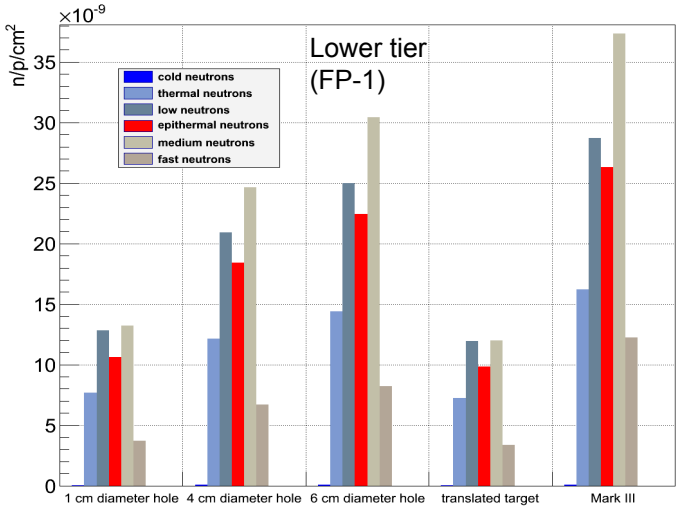
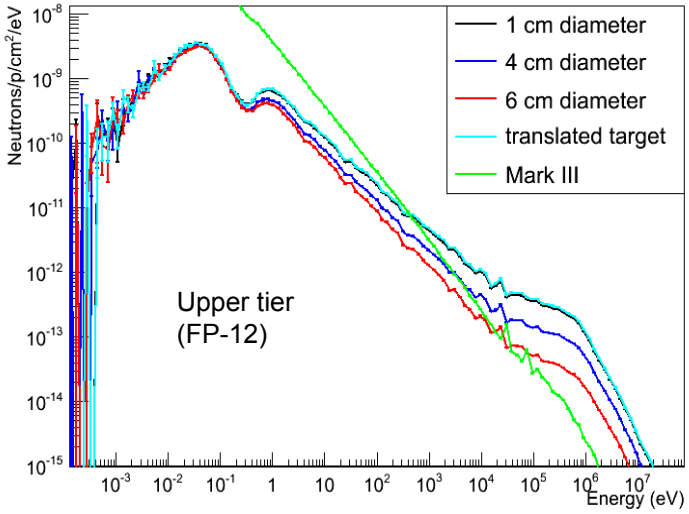
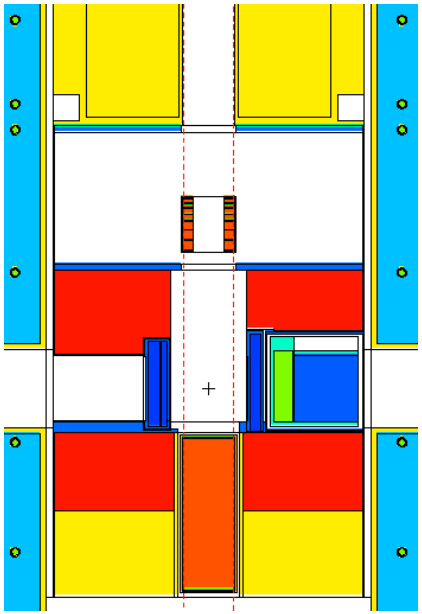
Hole Study

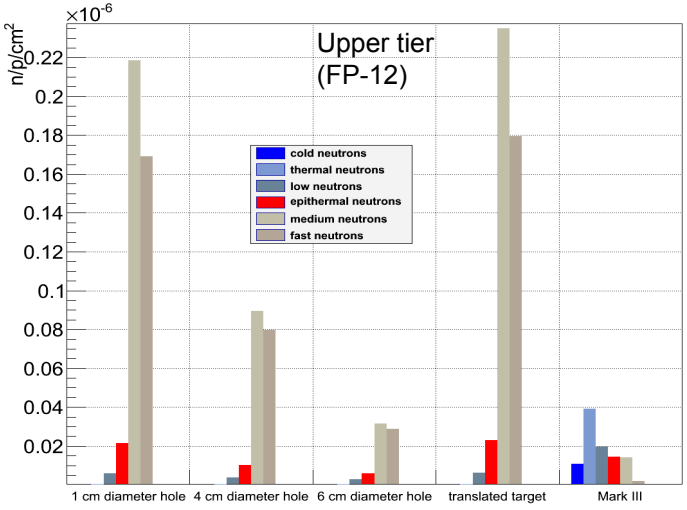


The integral below the curves



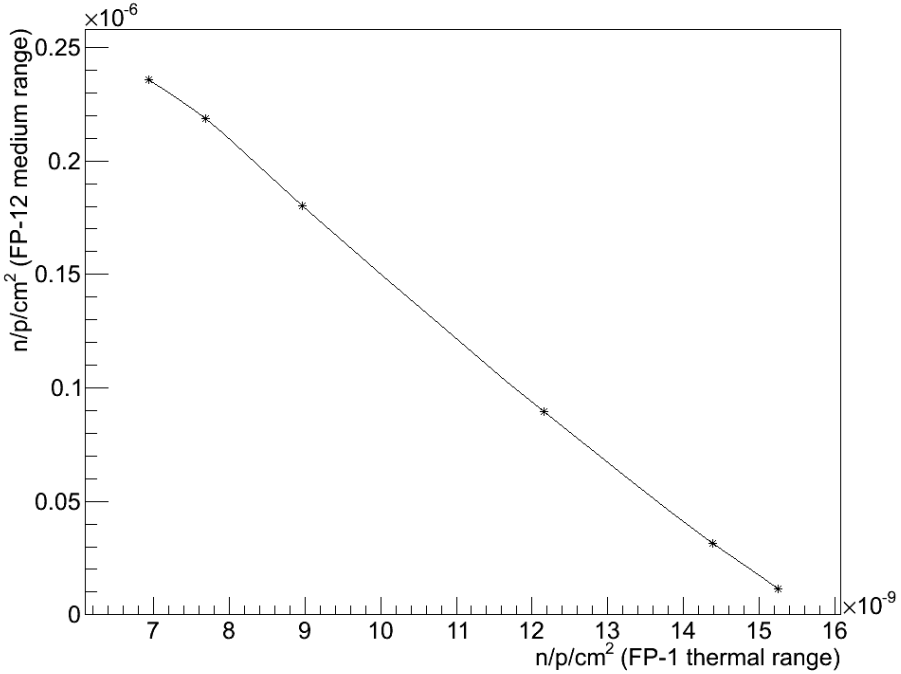






Hole in the upper target => 800 MeV proton beam directly hits the lower target : neutron production in the lower tier increases

Figure of Merit : Hole Study



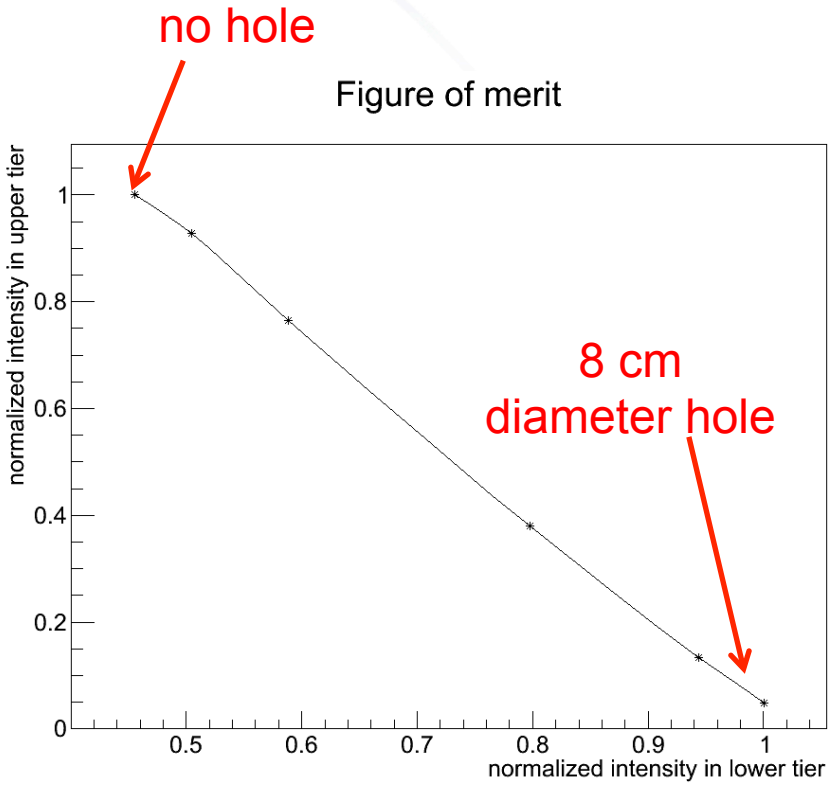
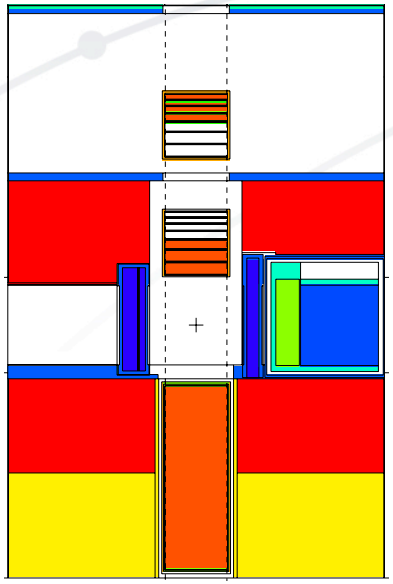
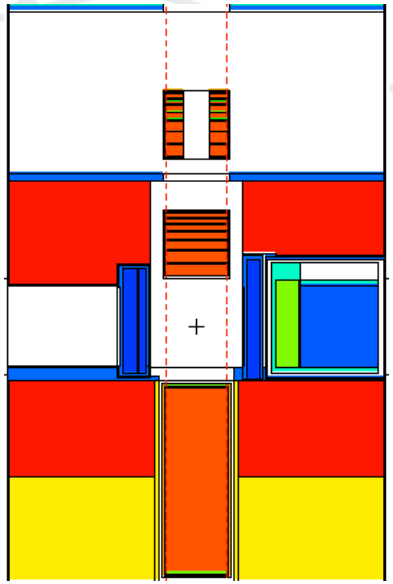


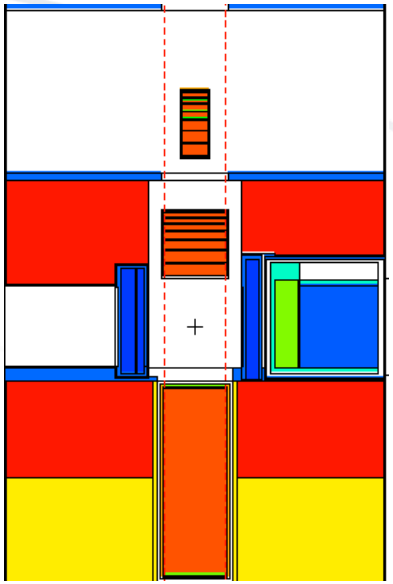
Plate study



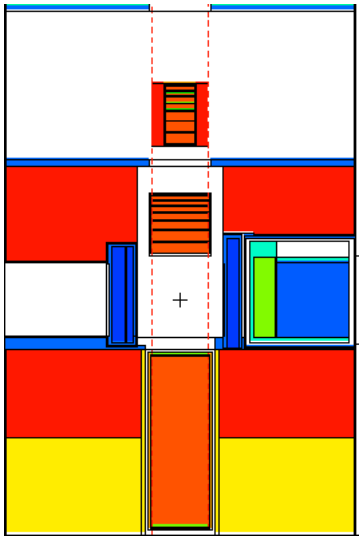
Hole in the upper target with a middle target study

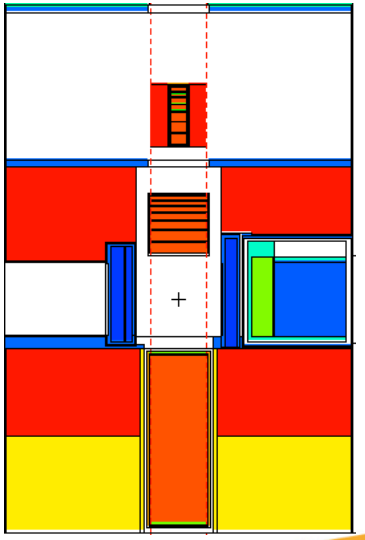


Anti-hole and middle target study



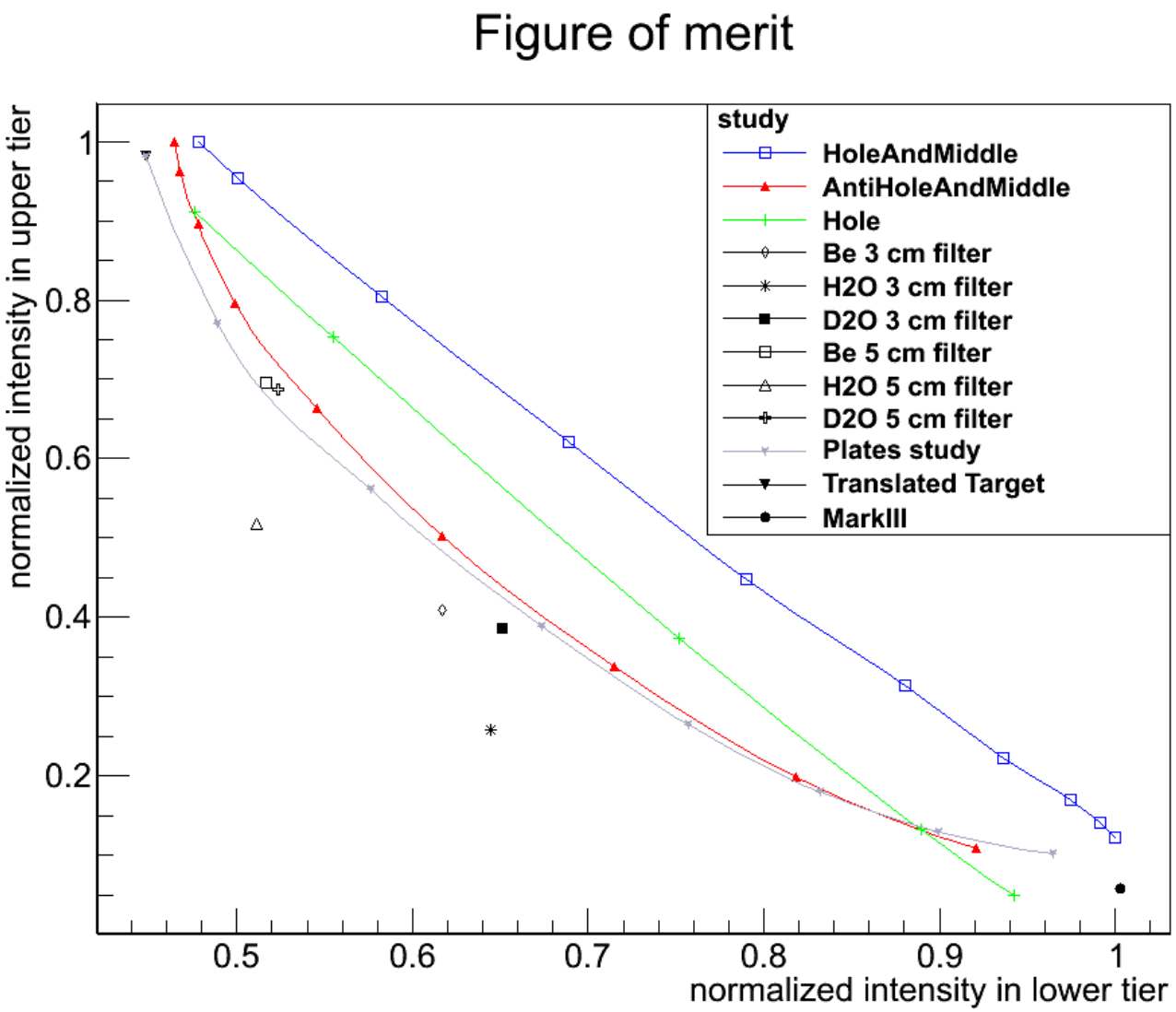
Filter with 5 cm diameter of tungsten study





Filter with 3 cm diameter of tungsten study

Figure of Merit with All Studies



Comparison between the intensity of medium range neutrons produced in the upper tier and the thermal neutrons produced in the lower tier

Conclusion

- Be aware that some parameters in reality are very instable.
- Next idea : change the field of view

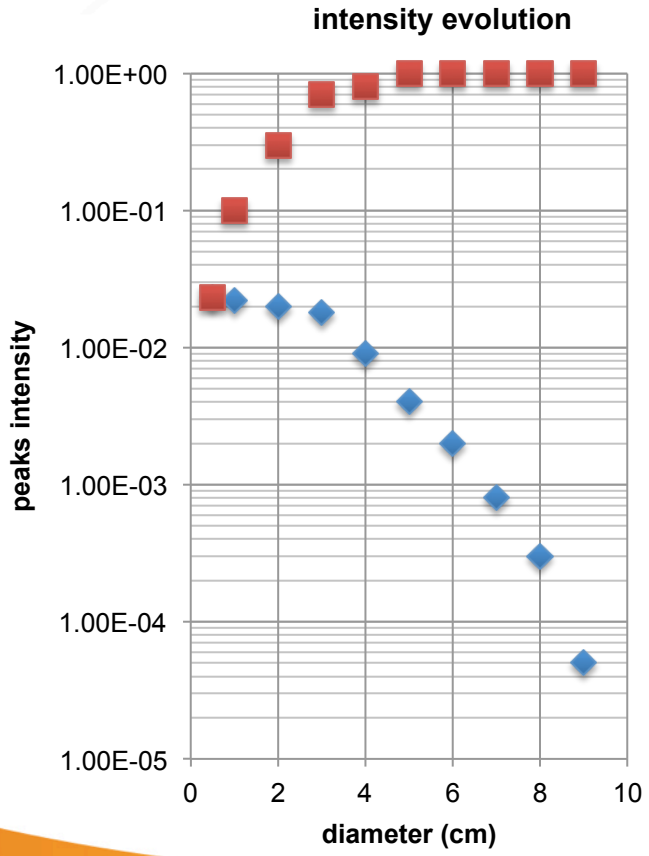
Thank you !

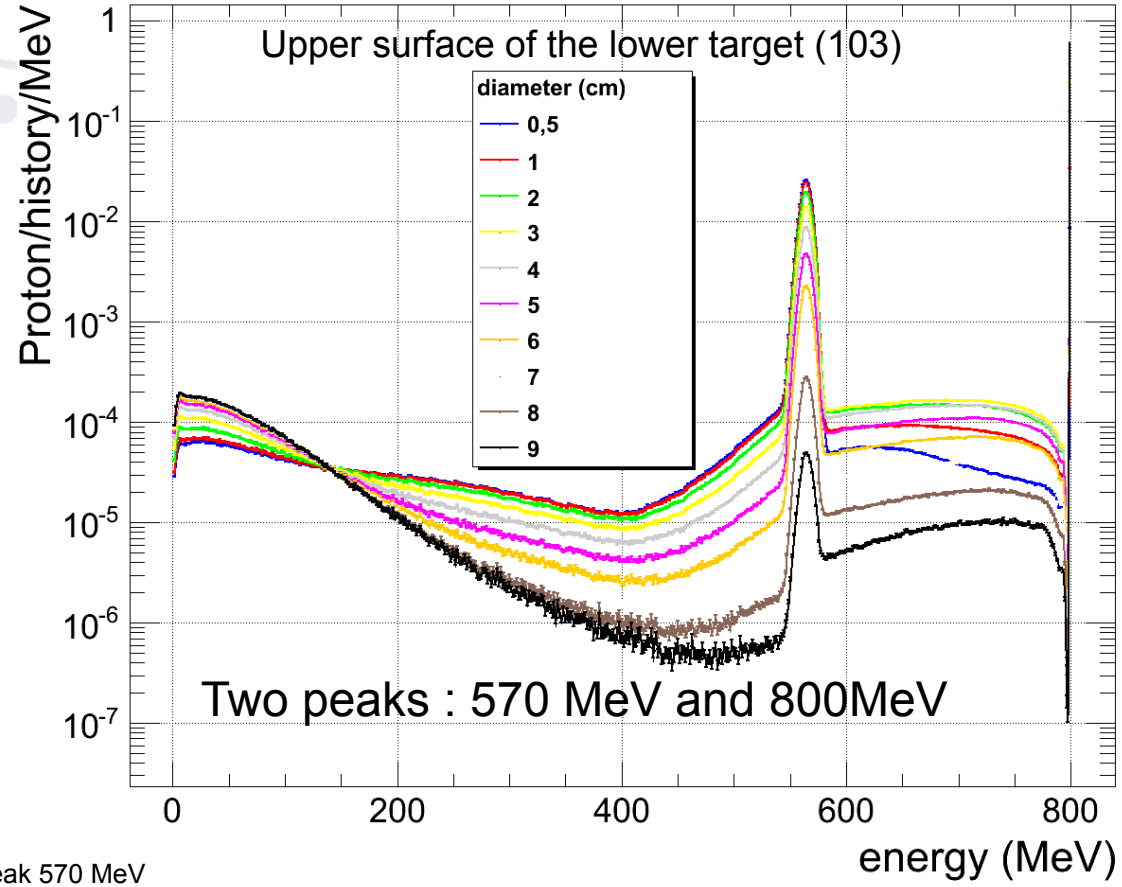
Questions ?

Contact information :
laurent.ferres@ecole.ensicaen

Annexes

Hole Studies on upper target





peak 570 MeV

Peak 800 MeV

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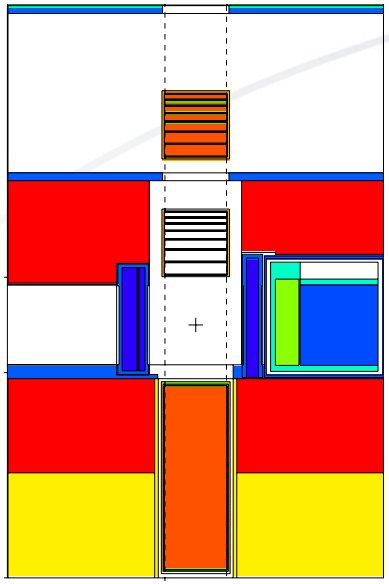
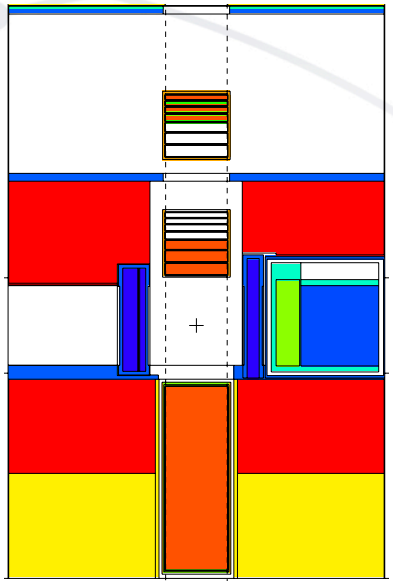
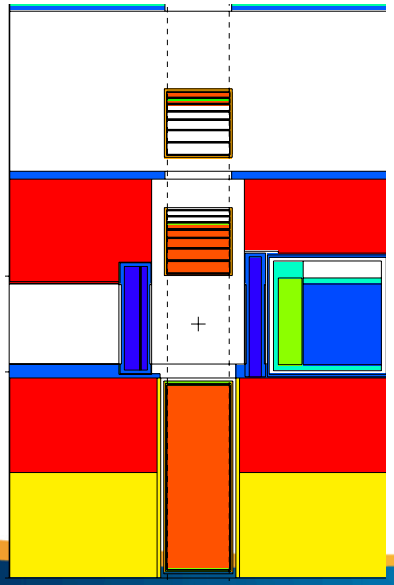
0 plate (translated target)



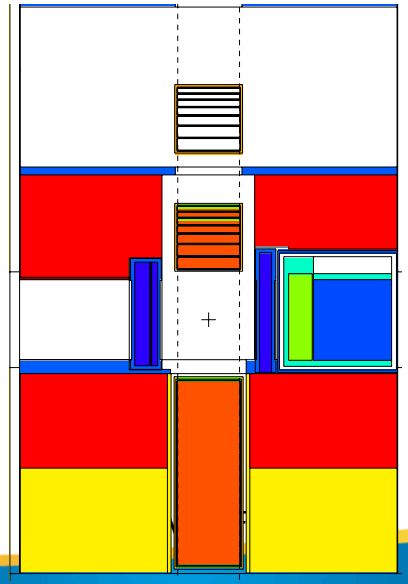
3 plates



5 plates



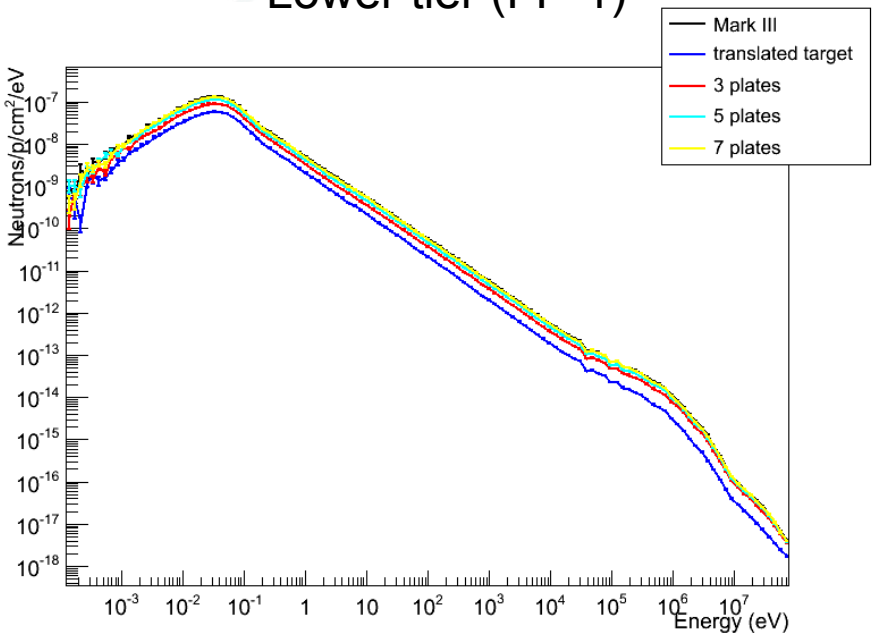
7 plates



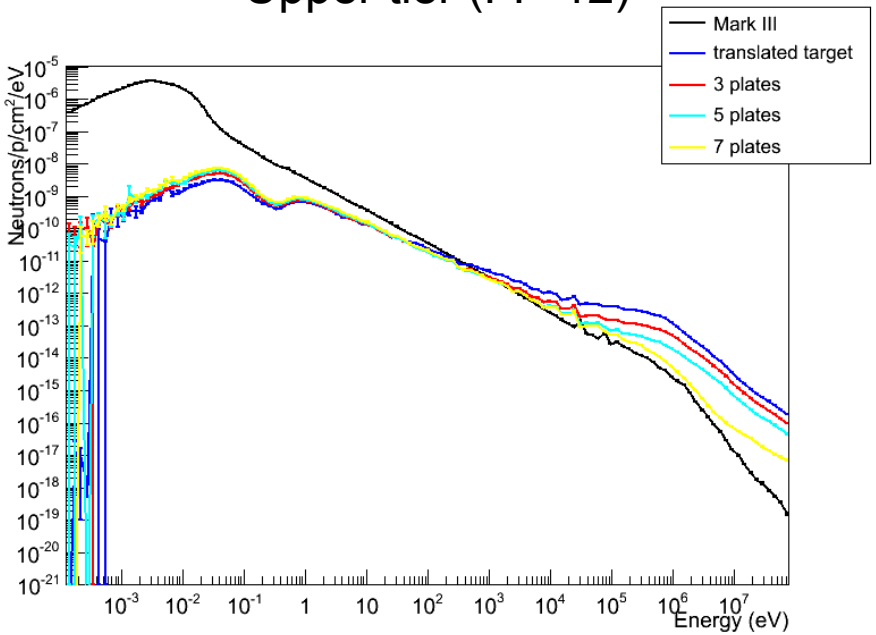
The thickness of the plates varies

Neutron spectrum : plate study

Lower tier (FP-1)



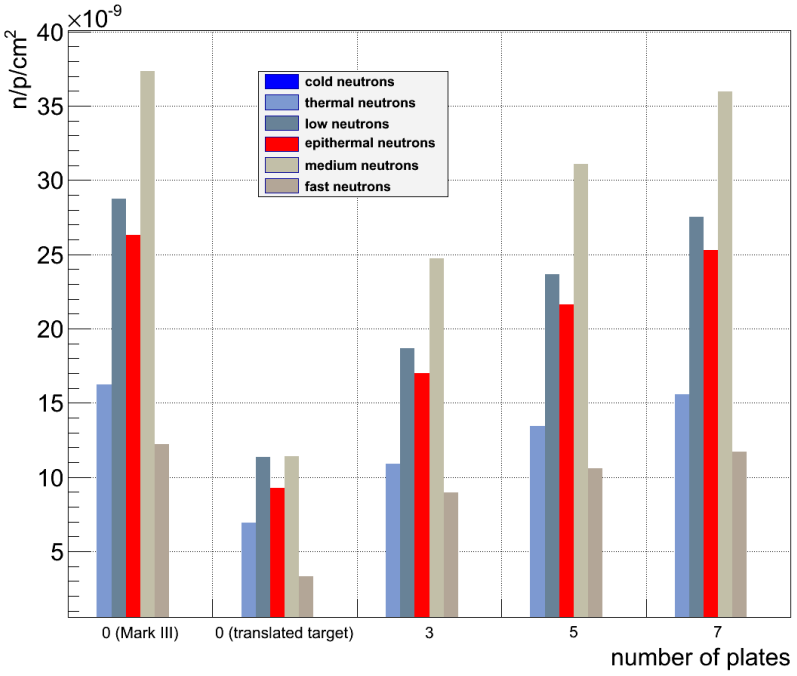
Upper tier (FP-12)



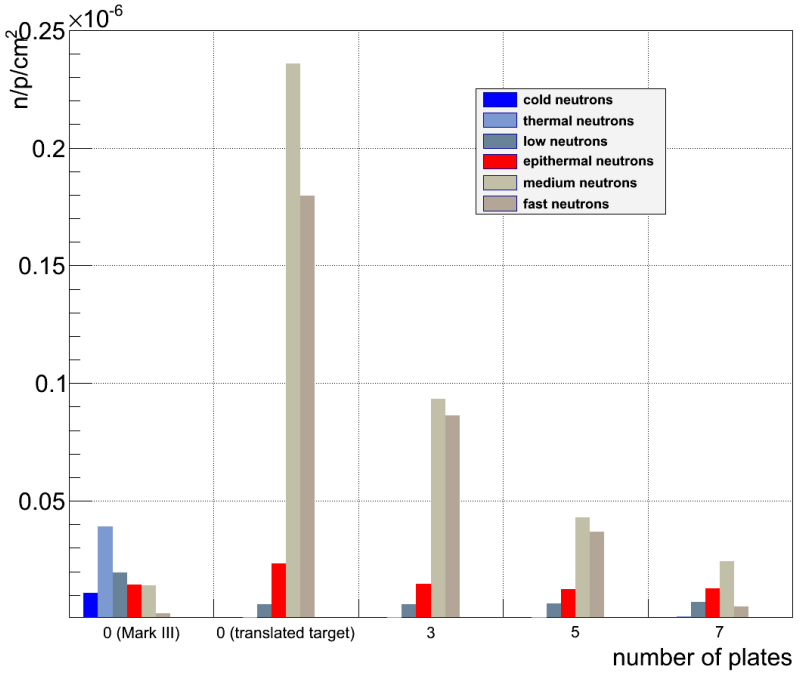
The addition of plates from top to bottom brings the intensity of the thermal range in the lower tier higher but brings it down for the medium range in the upper tier (as expected)

Neutron intensity : plate study

Lower tier (FP-1)

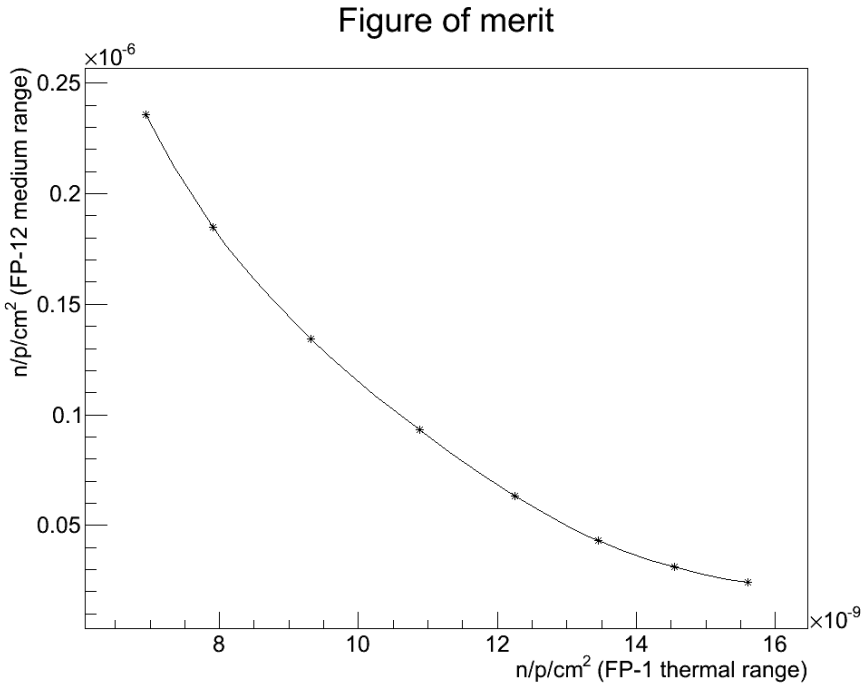


Upper tier (FP-12)

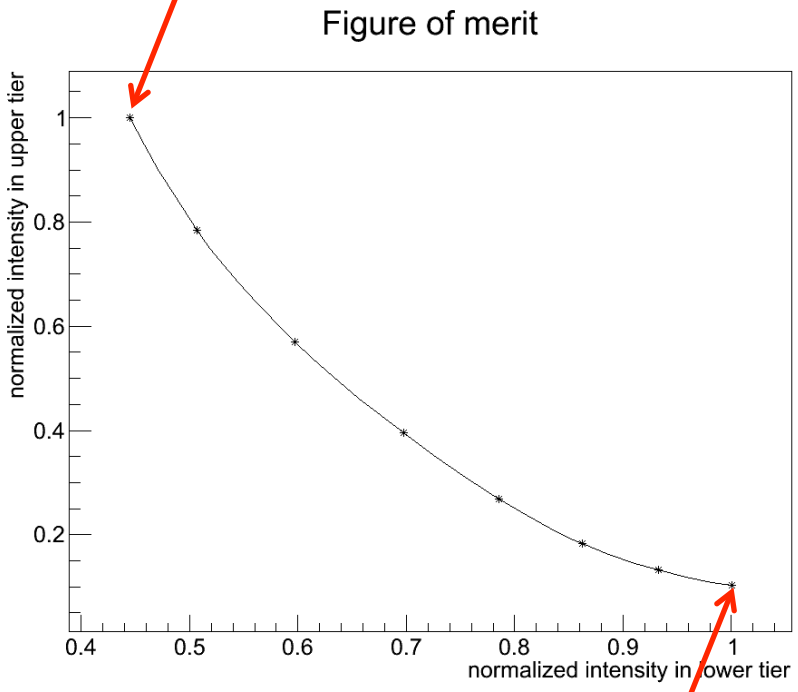


The addition of plates from top to bottom brings the intensity of the thermal range in the lower tier higher but brings it down for the medium range in the upper tier (as expected)

Figure of merit : plate study



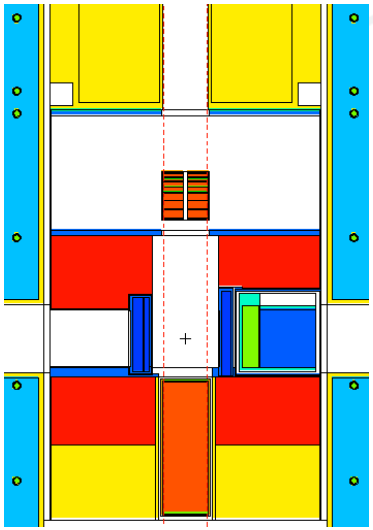
0 plate (translated target)



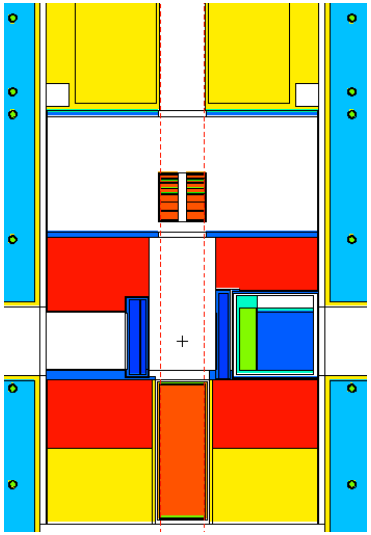
7 plates

Hole study

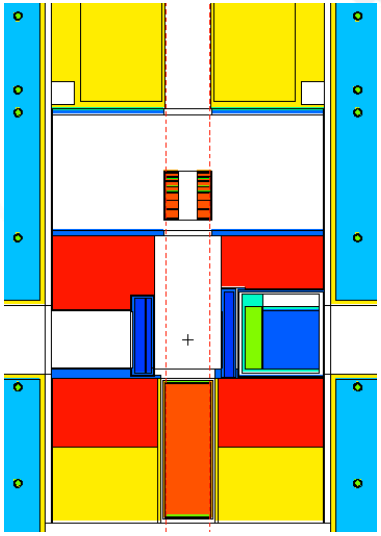
1 cm diameter hole



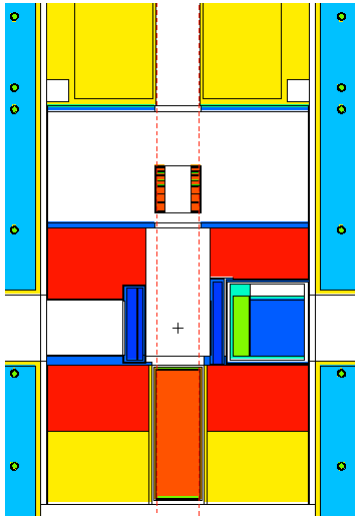
2 cm diameter hole



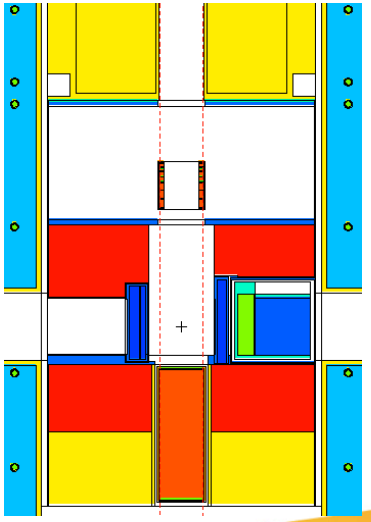
4 cm diameter hole



6 cm diameter hole

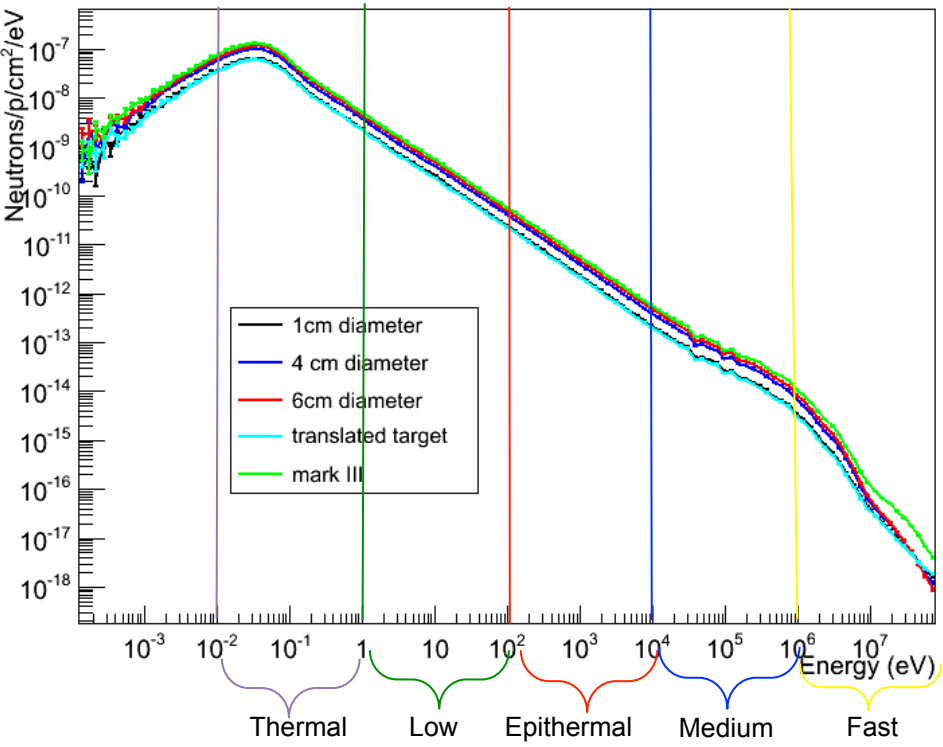


8 cm diameter hole

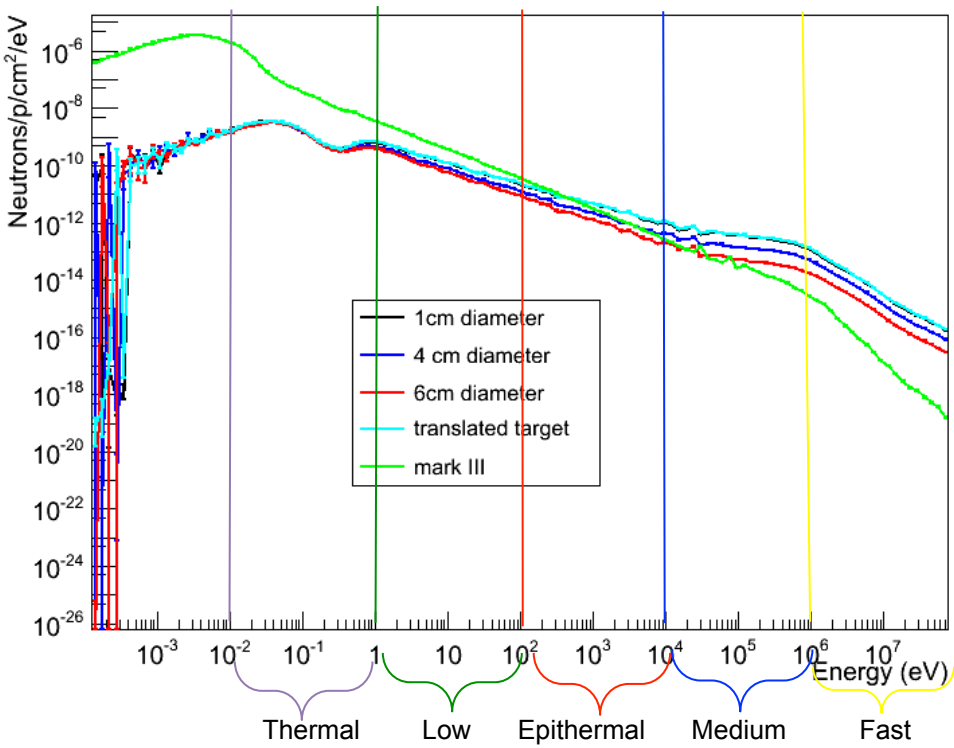


Neutron spectrum : hole study

Lower tier (FP-1)



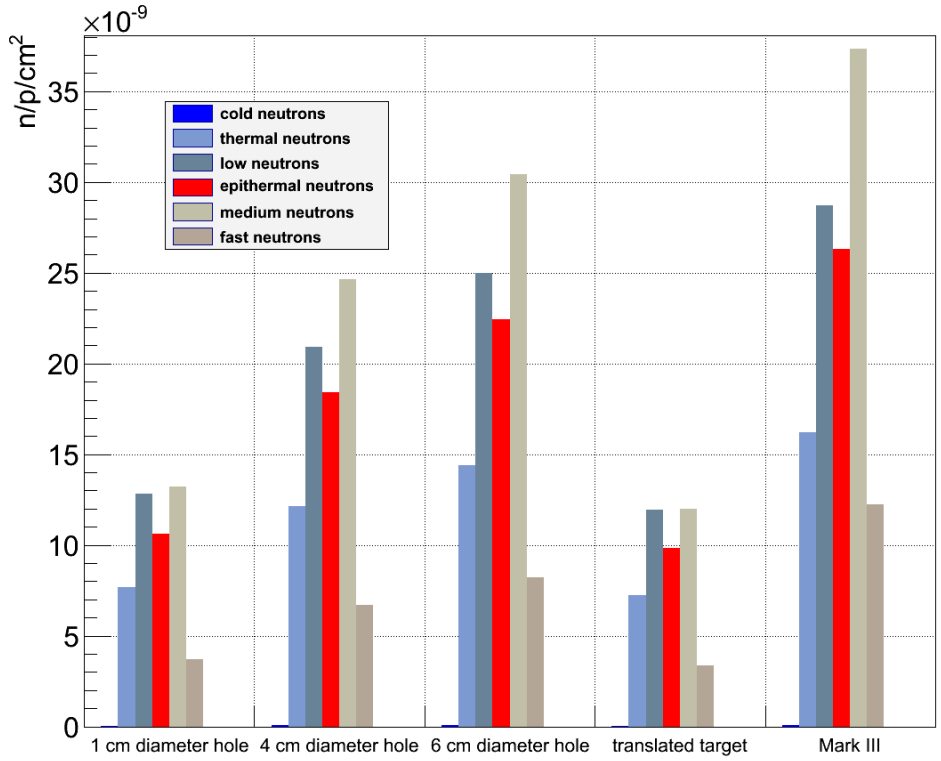
Upper tier (FP-12)



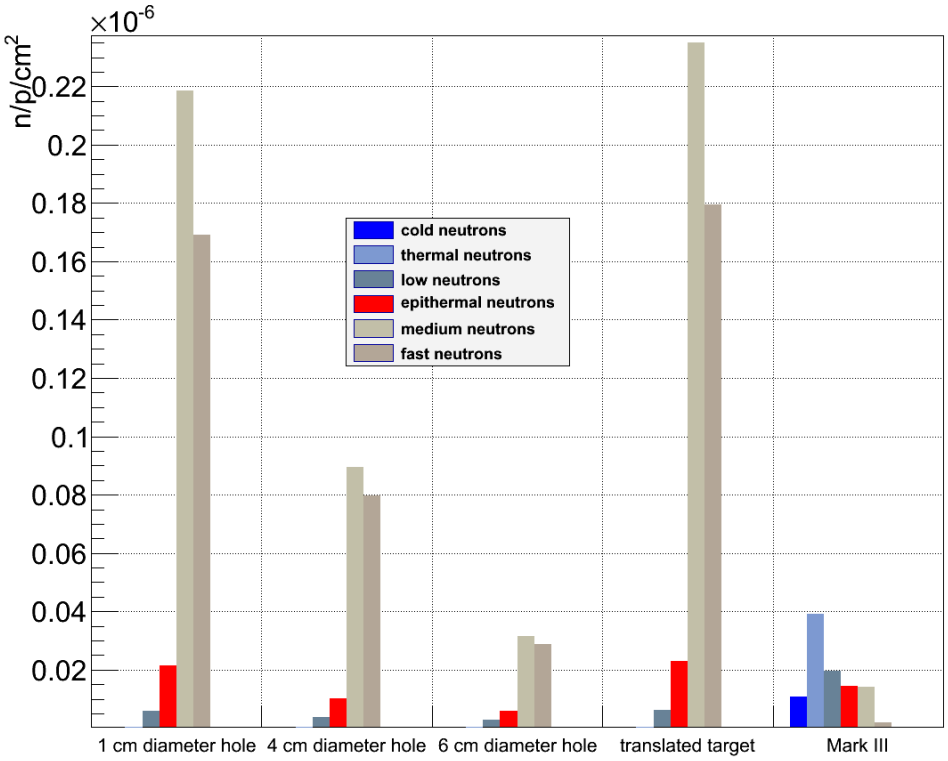
The enlargement of the hole brings the intensity of the thermal range in the lower tier higher but brings it down for the medium range in the upper tier (as expected)

Neutron intensity : hole study

Lower tier (FP-1)



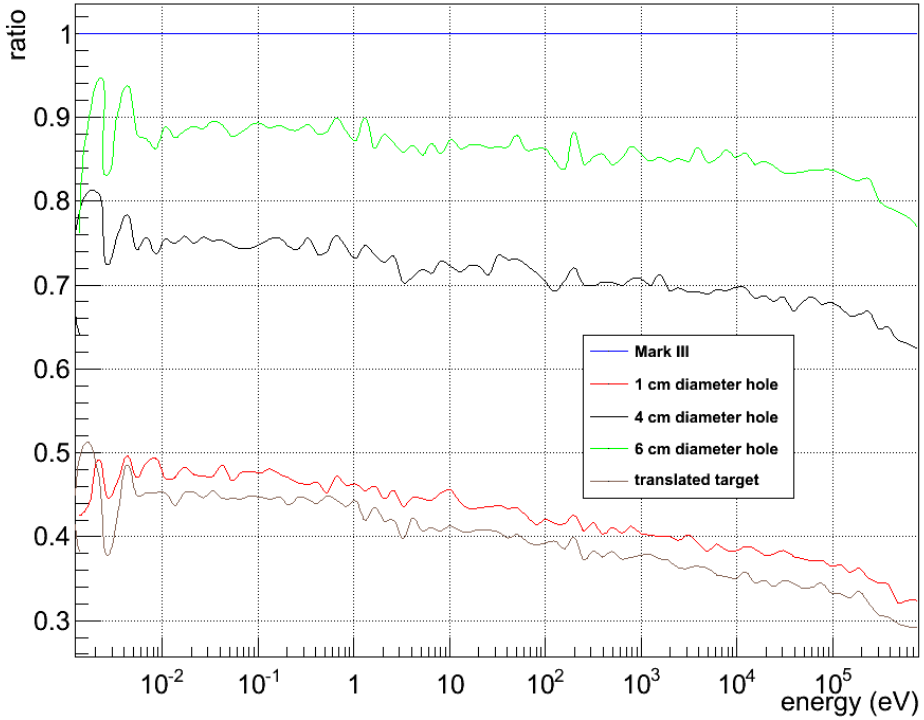
Upper tier (FP-12)



Ratio to mark III : hole study

Lower tier

hole in upper target without middle target



Upper tier

hole in upper target without middle target

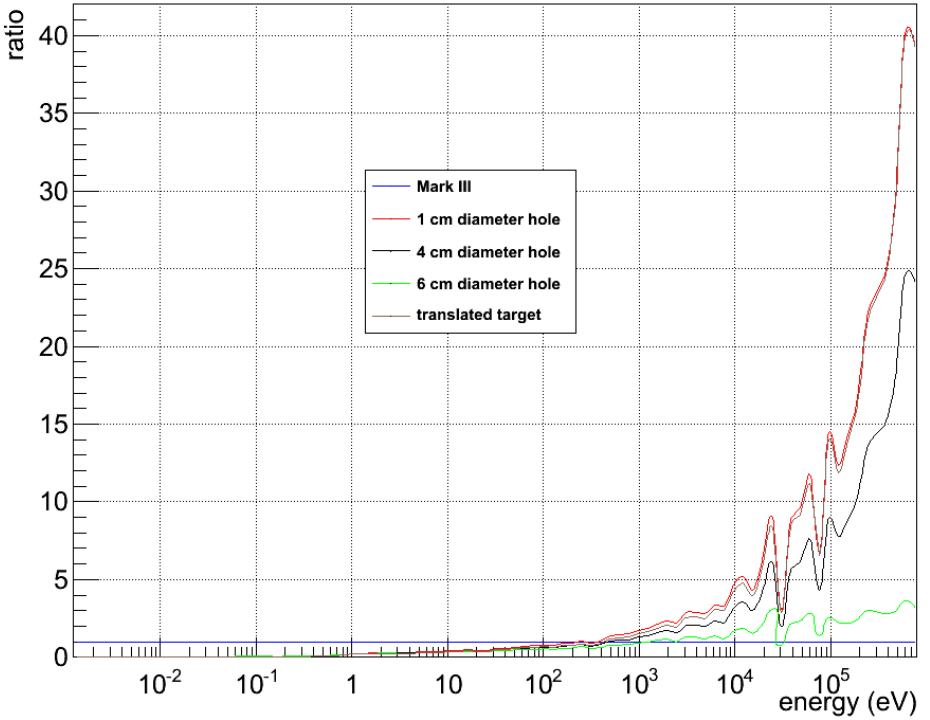
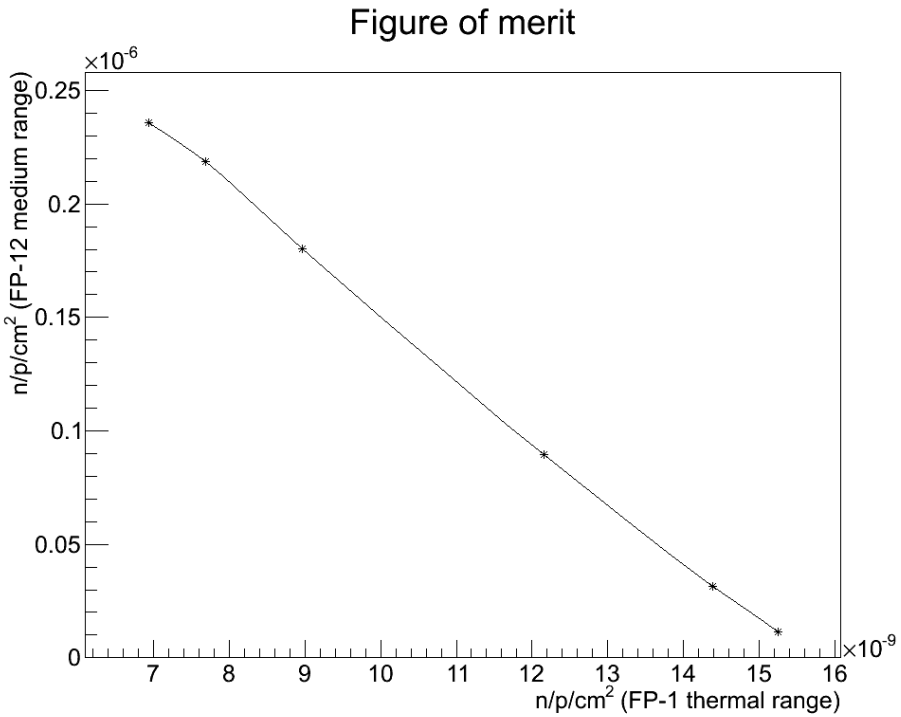
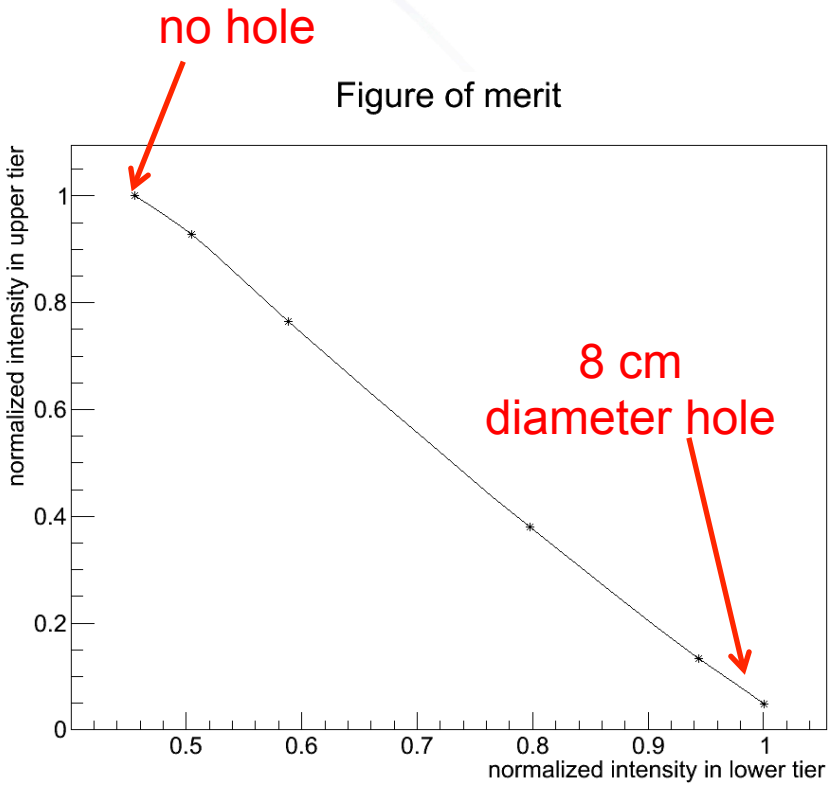


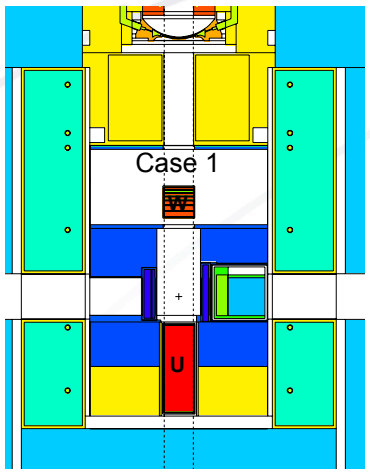
Figure of merit : hole study

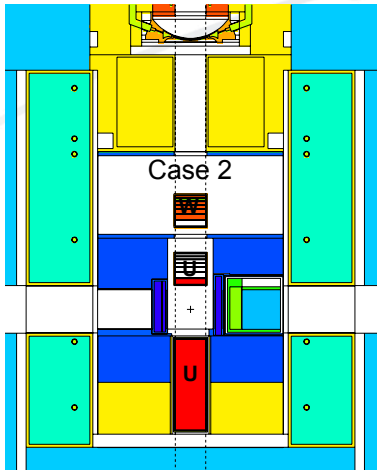


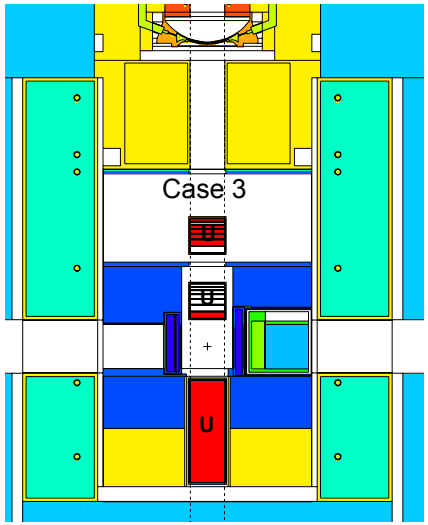


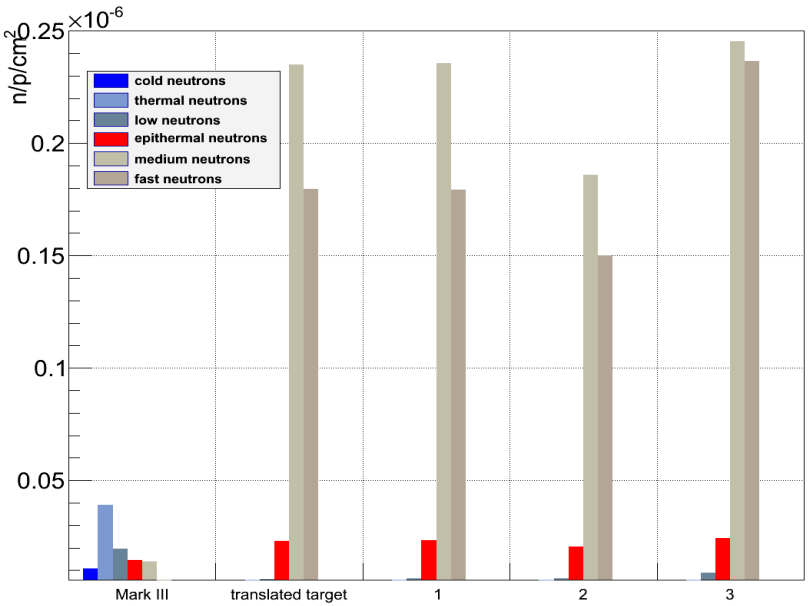
Uranium studies

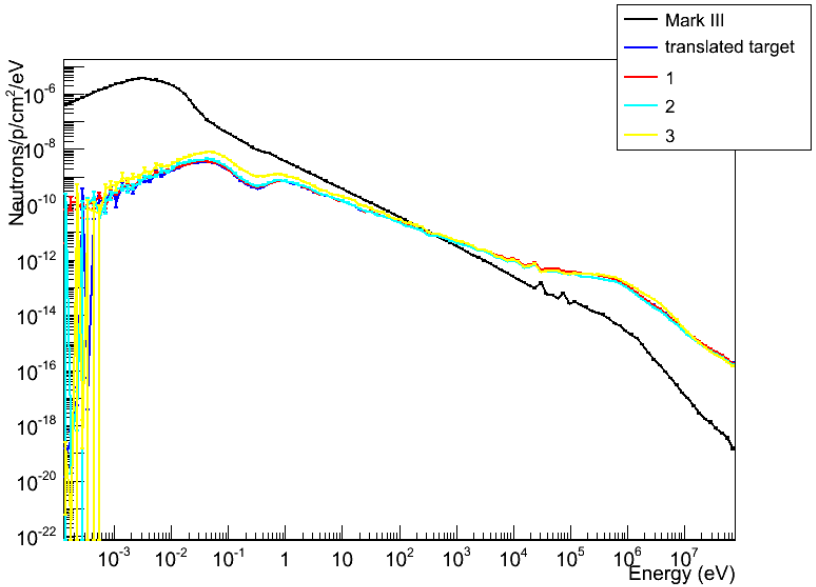
upper Tier







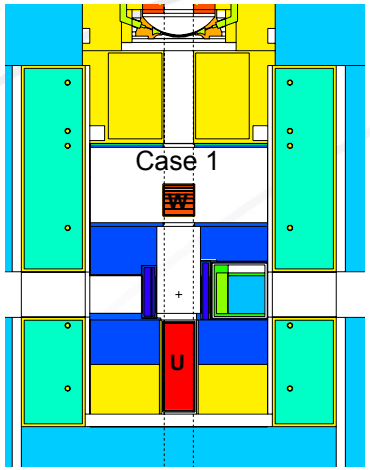


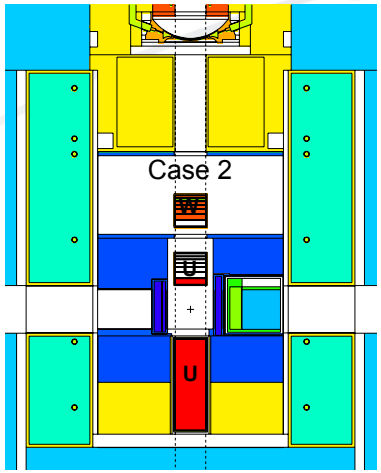


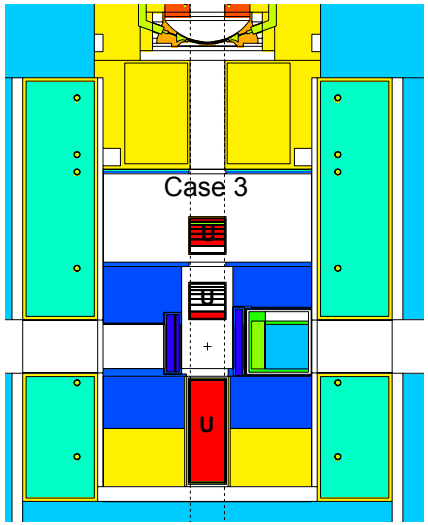
Results :

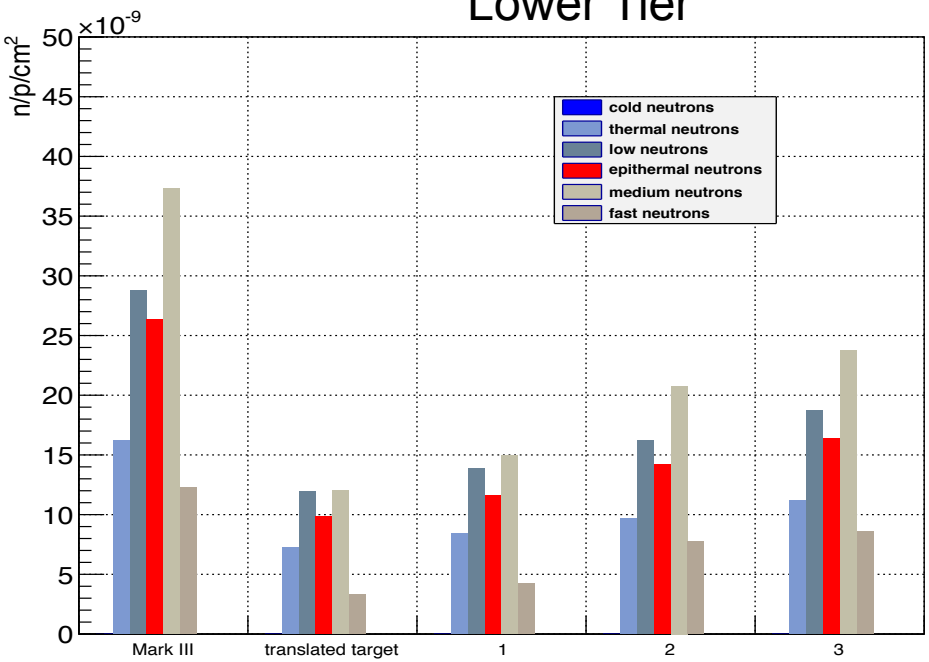
- Thermal neutrons decrease a lot : who cares because only medium and fast neutrons are interesting
- Medium and fast neutrons increase a lot : good but delayed neutron have to be considered

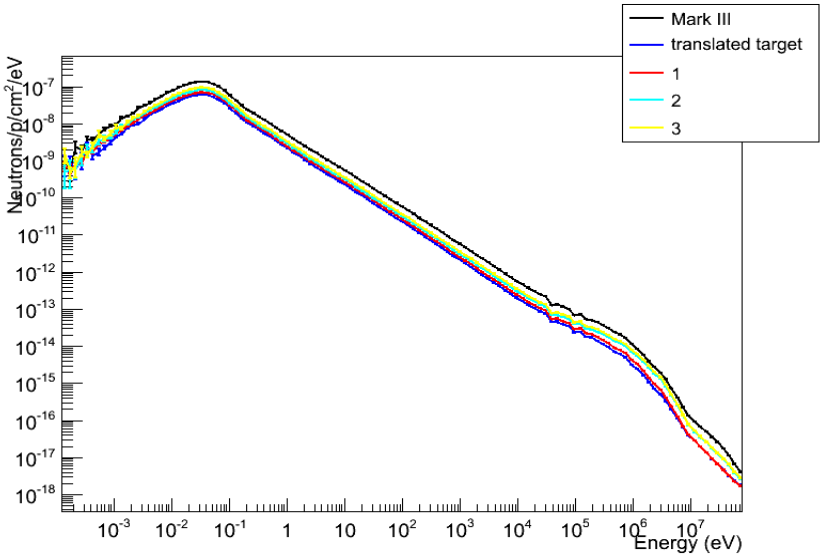
Uranium studies











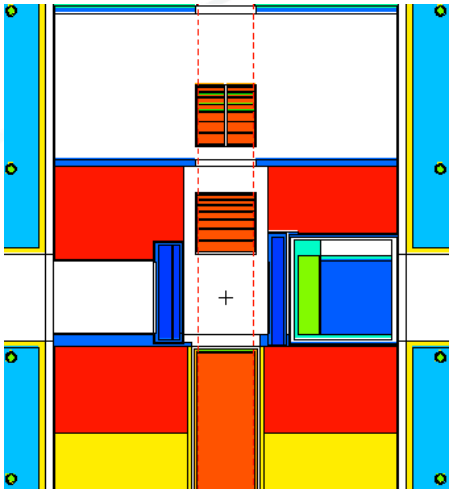
Thermal neutron beam intensity divided by 2 with translated target

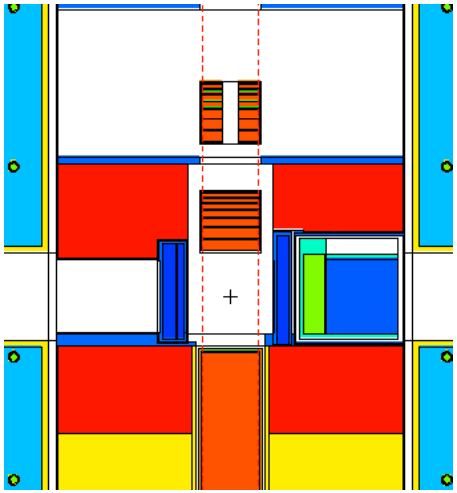
Solutions : Uranium instead tungsten

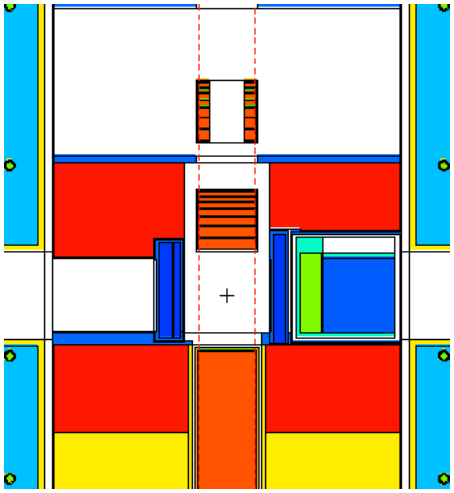
Results :

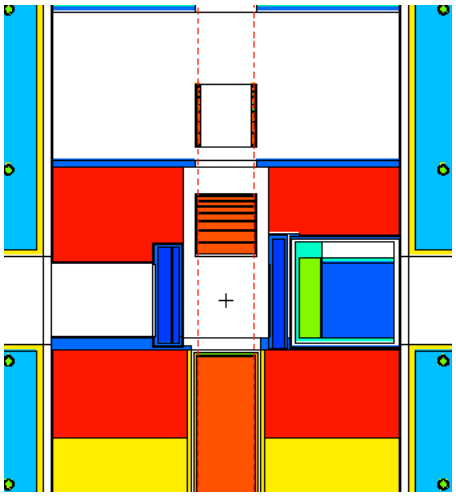
- Thermal neutron beam increase by 60% in the case 3
- Good but uranium target : waste and delayed neutron

Hole in the upper target with a middle target study



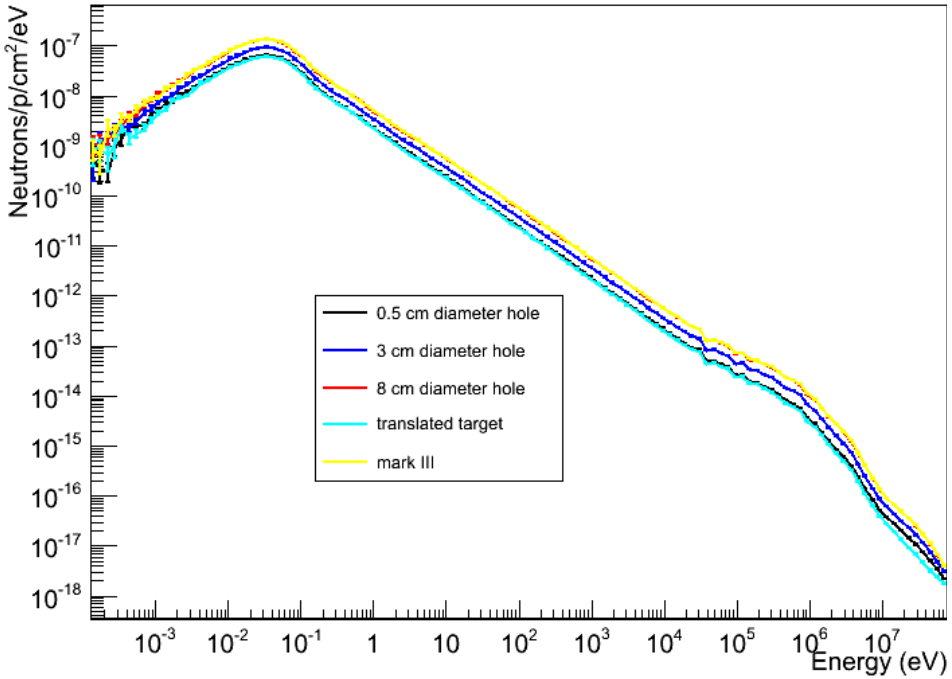




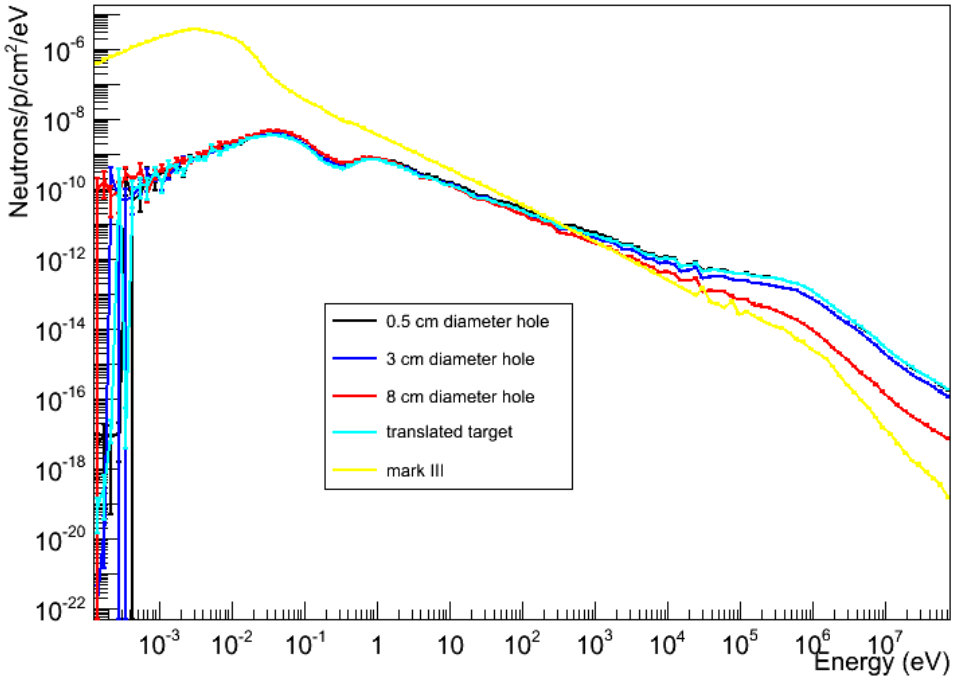


Neutron spectrum : hole and middle study

Lower tier (FP-1)



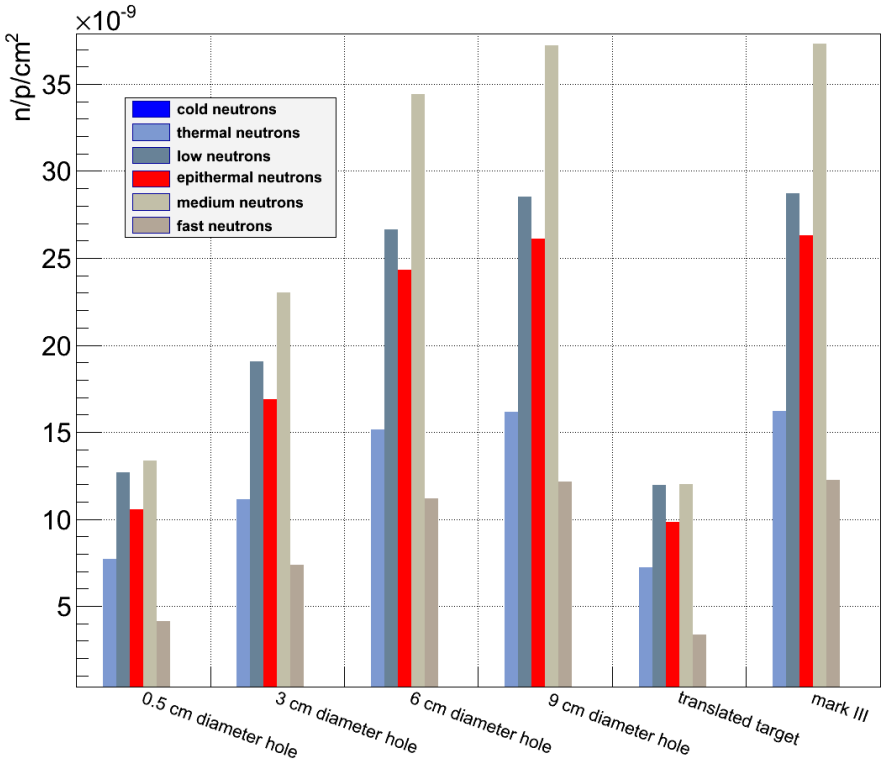
Upper tier (FP-12)



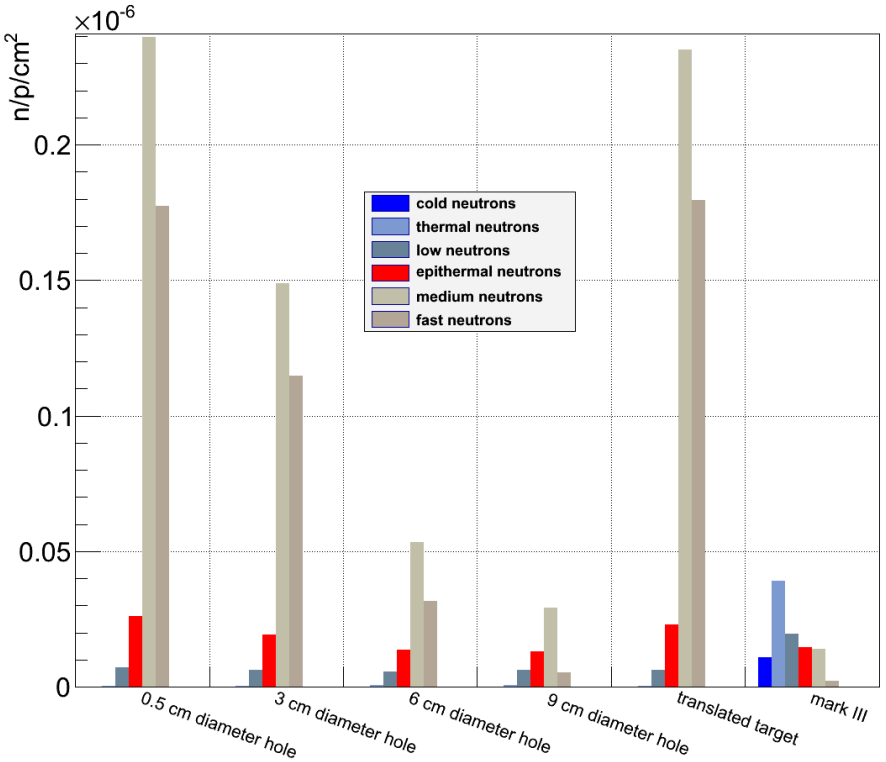
/*The enlargement of the hole brings the intensity of the thermal range in the lower tier higher but brings it down for the medium range in the upper tier (as expected) */

Neutron intensity : hole and middle study

Lower tier (FP-1)



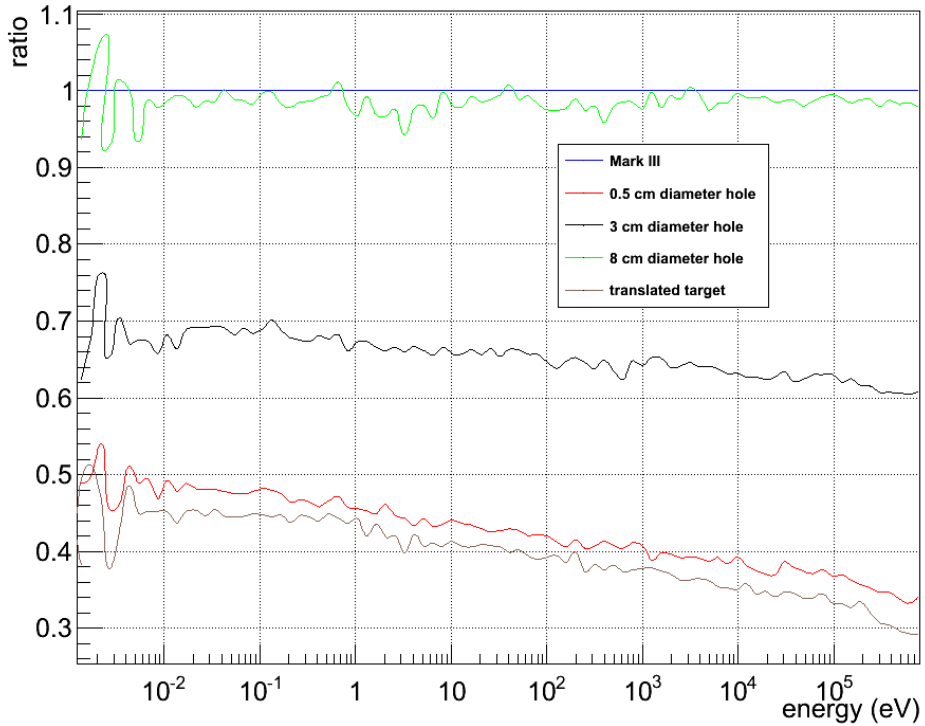
Upper tier (FP-12)



Ratio to mark III : hole and middle study

Lower tier

hole in upper target with middle target



Upper tier

hole in upper target with middle target

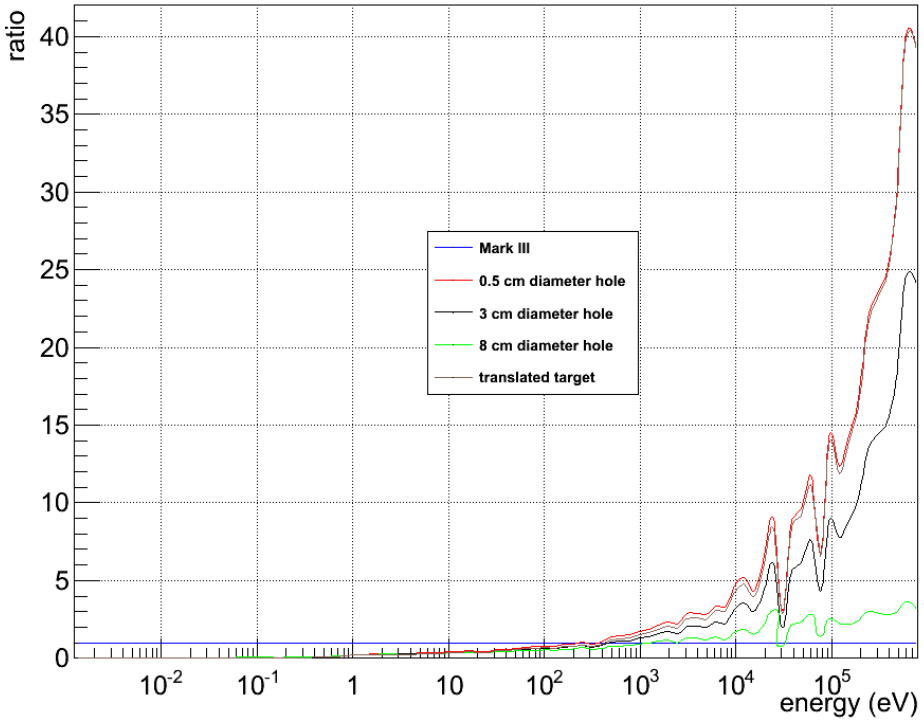
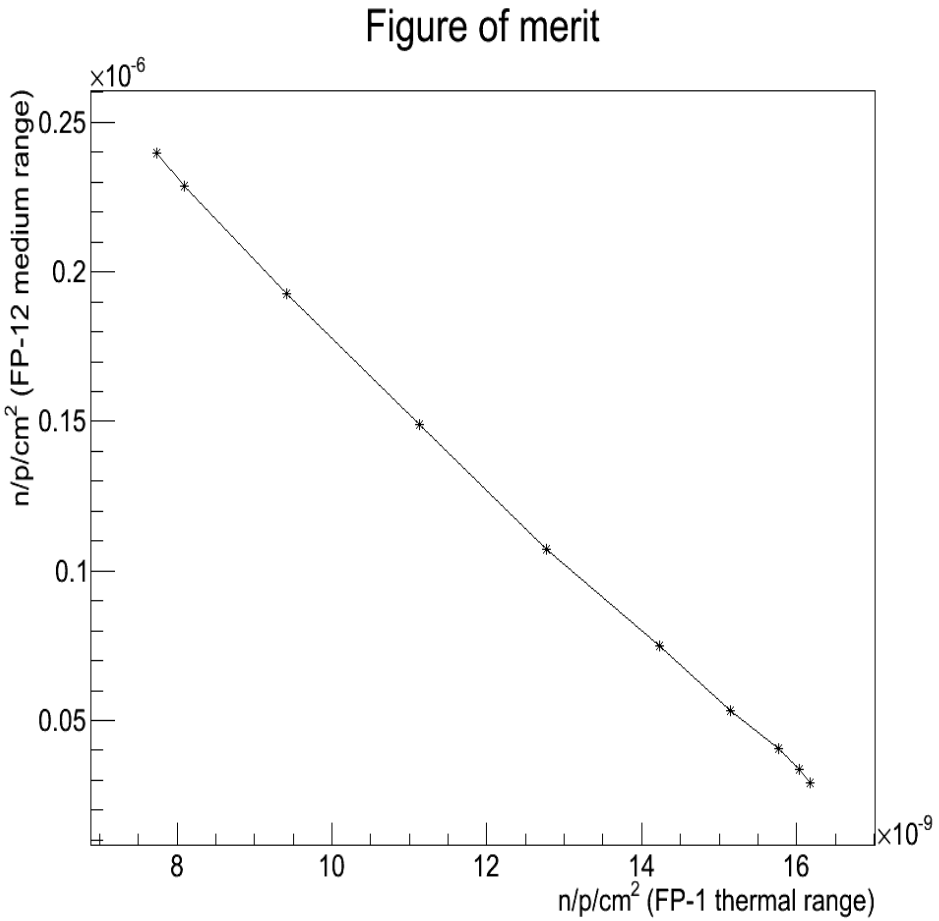
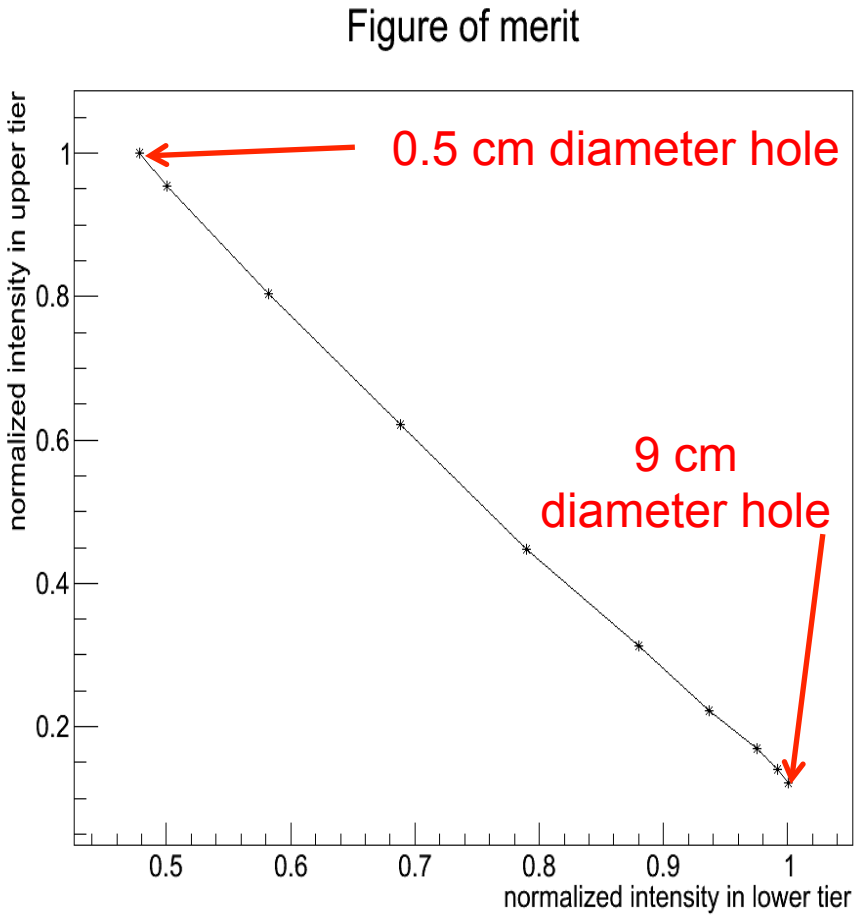
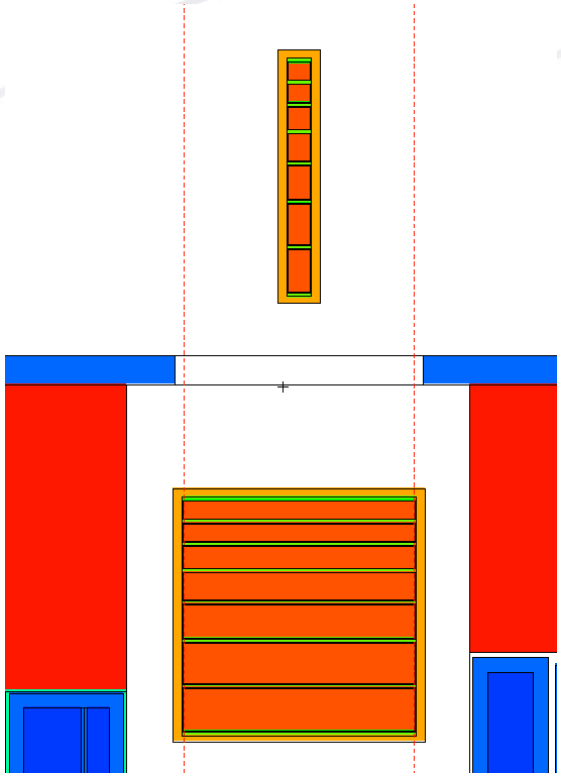


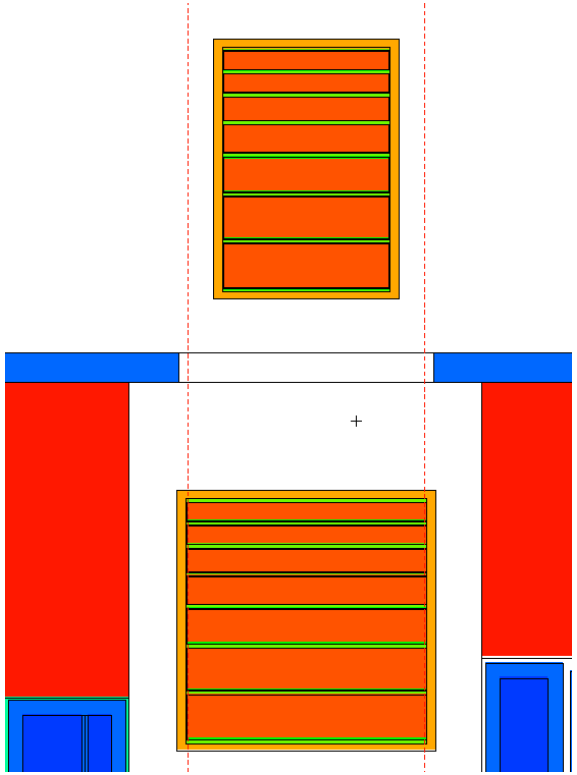
Figure of merit : hole and middle study

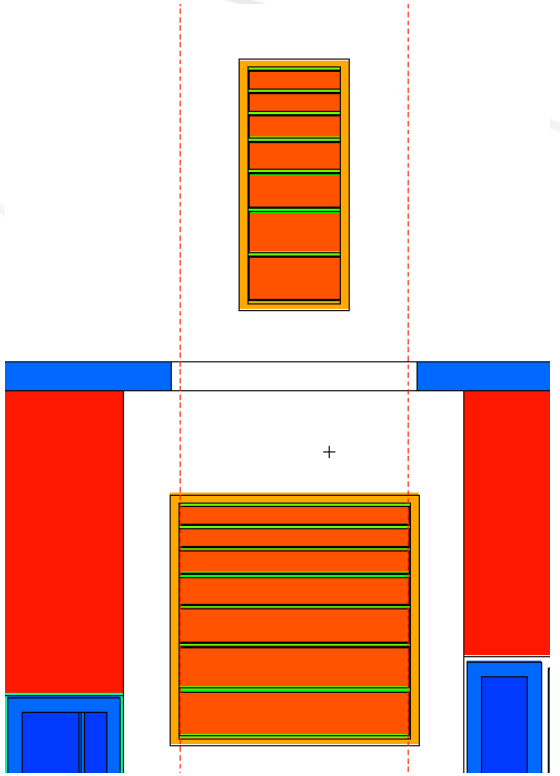




Anti hole study

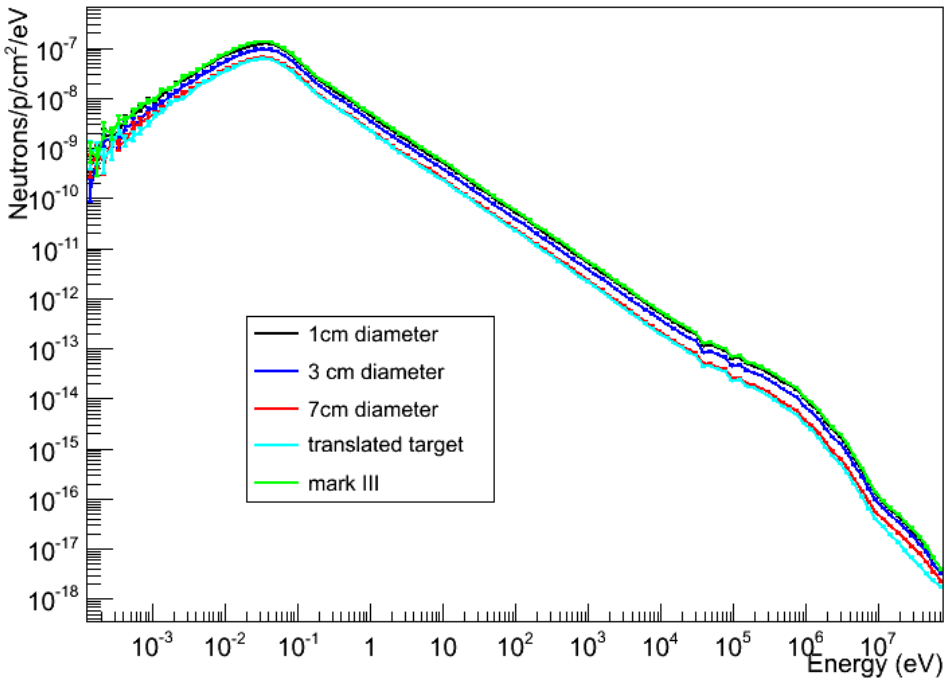




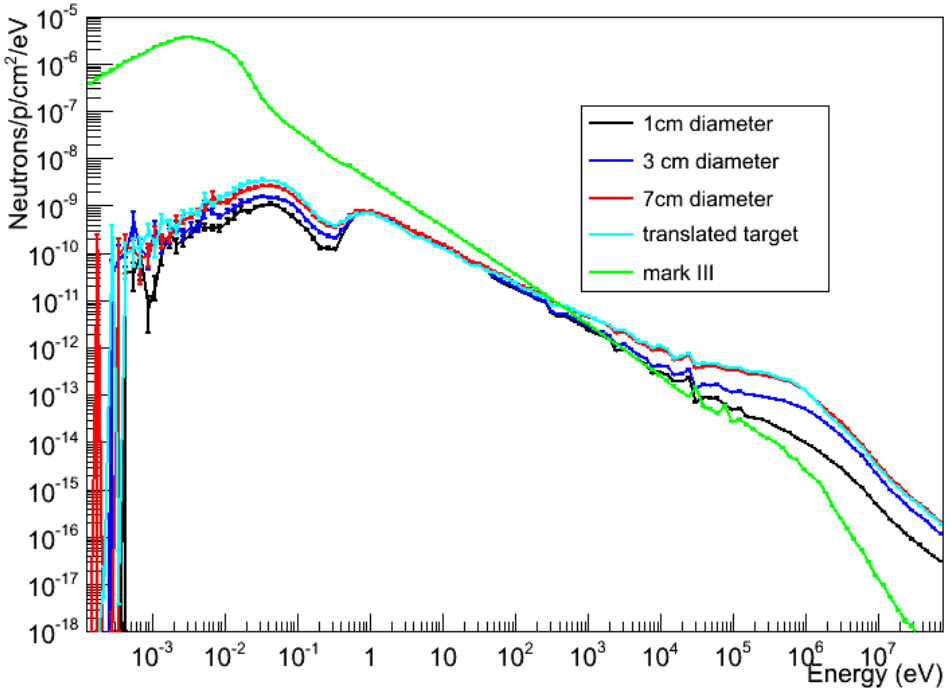


Neutron spectrum : anti hole study

Lower tier (FP-1)

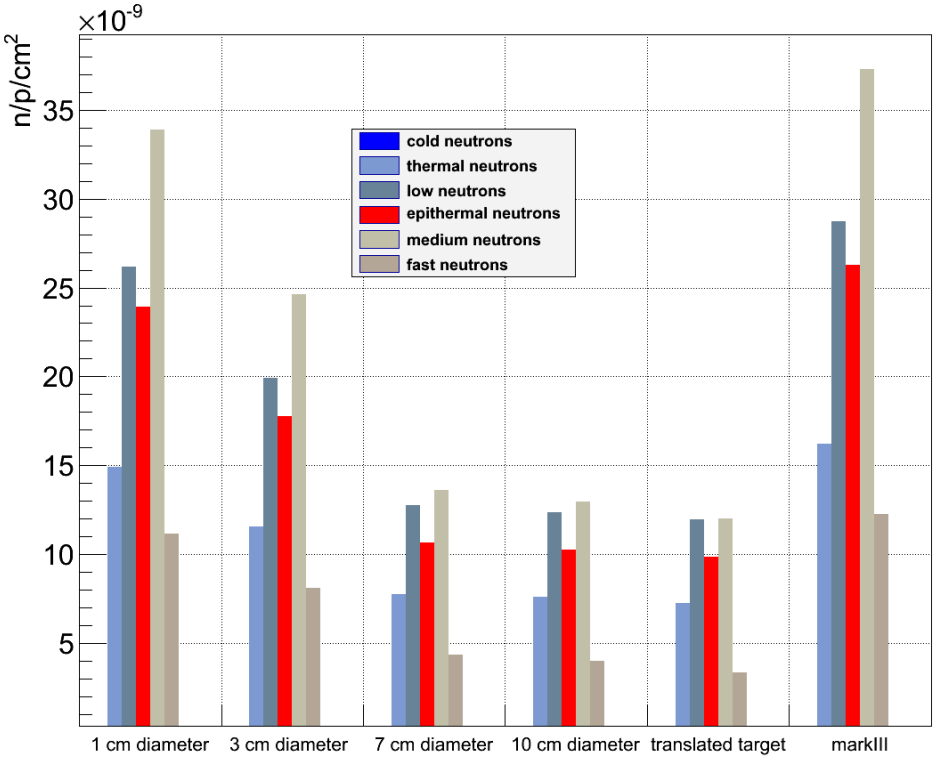


Upper tier (FP-12)

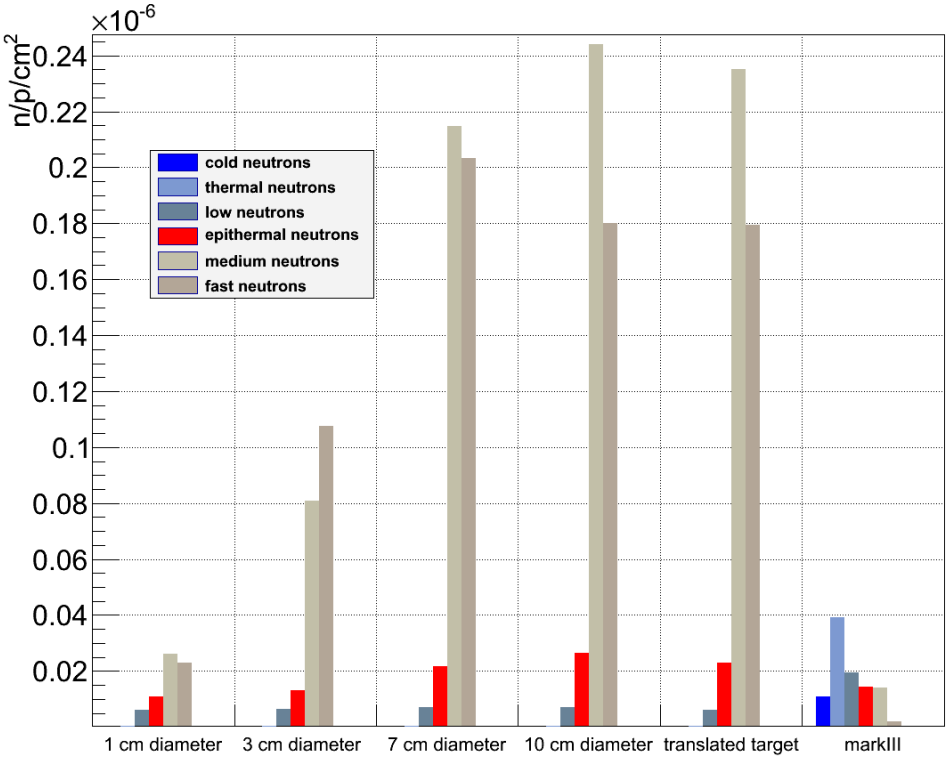


Neutron intensity : anti hole study

Lower tier (FP-1)



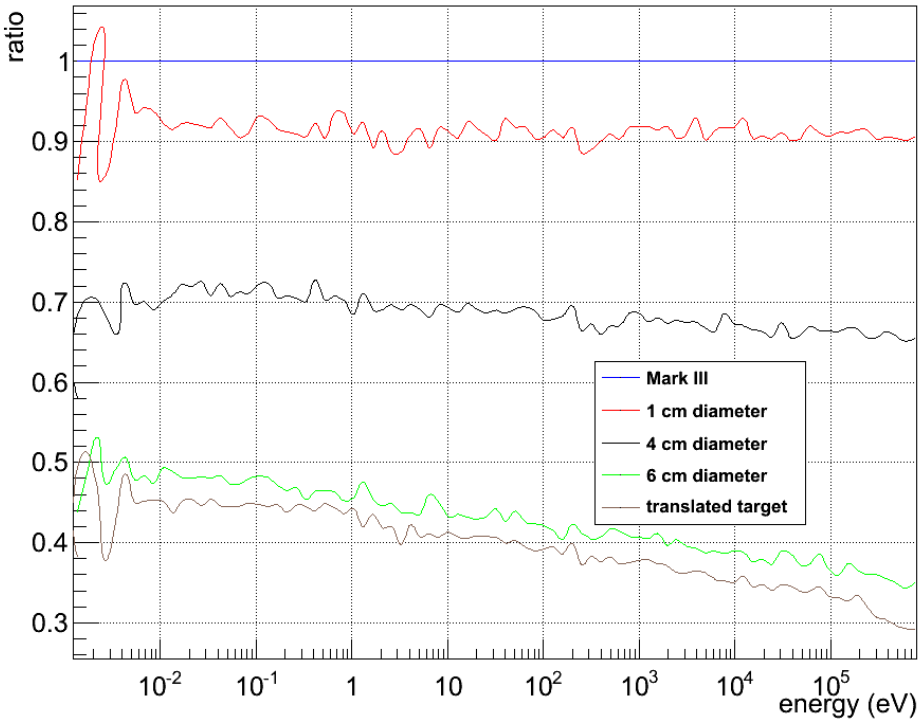
Upper tier (FP-12)



Ratio to mark III : anti hole study

Lower tier

antihole upper target with middle target



Upper tier

antihole upper target with middle target

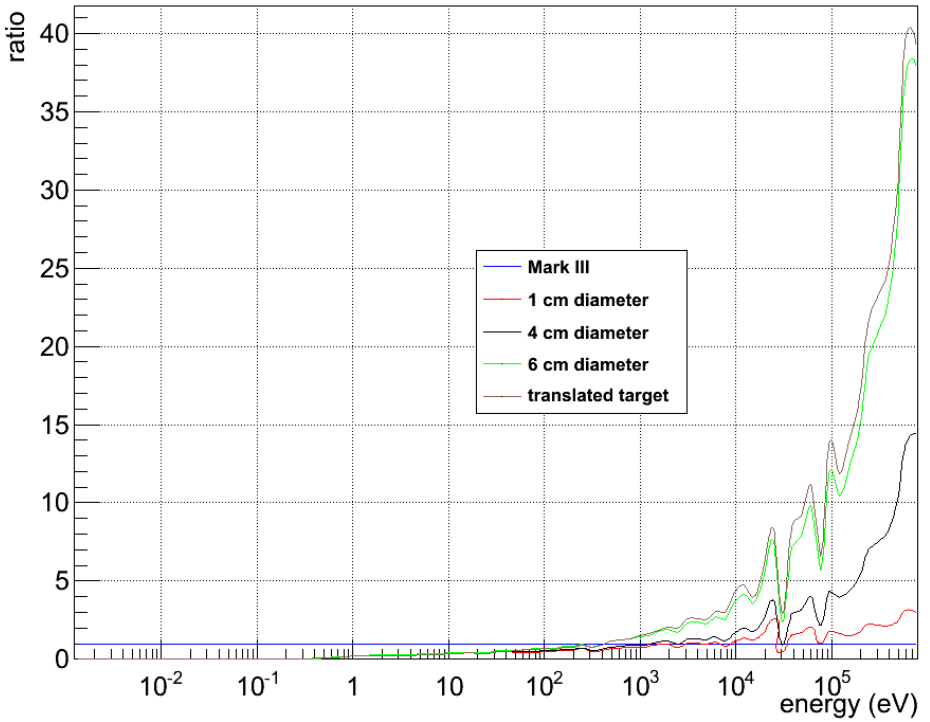
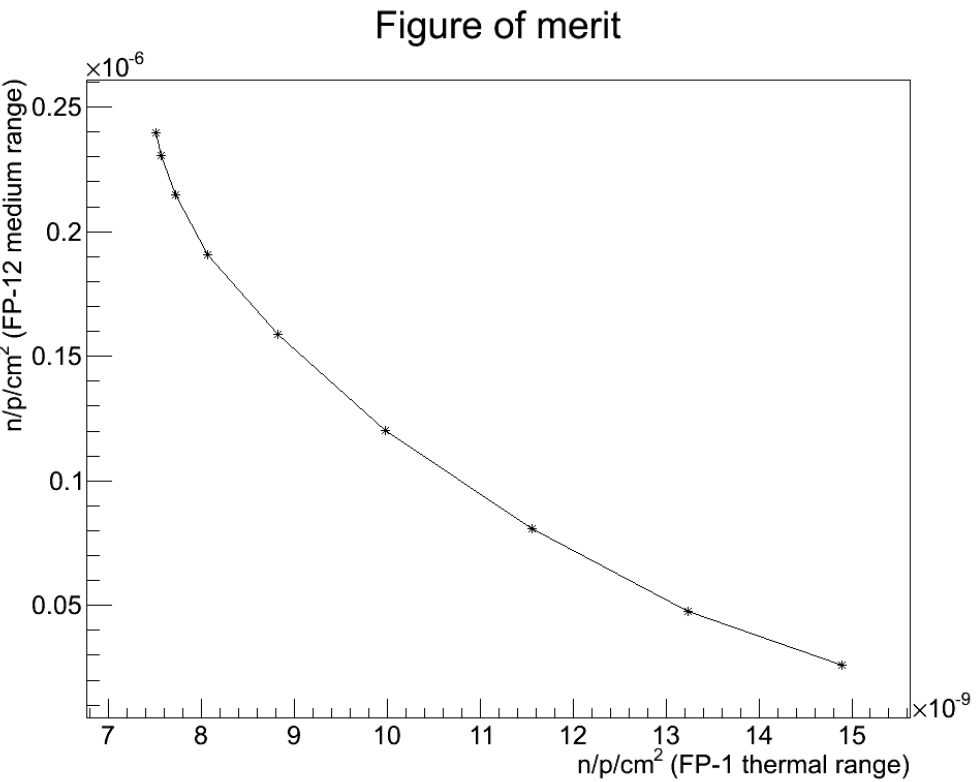
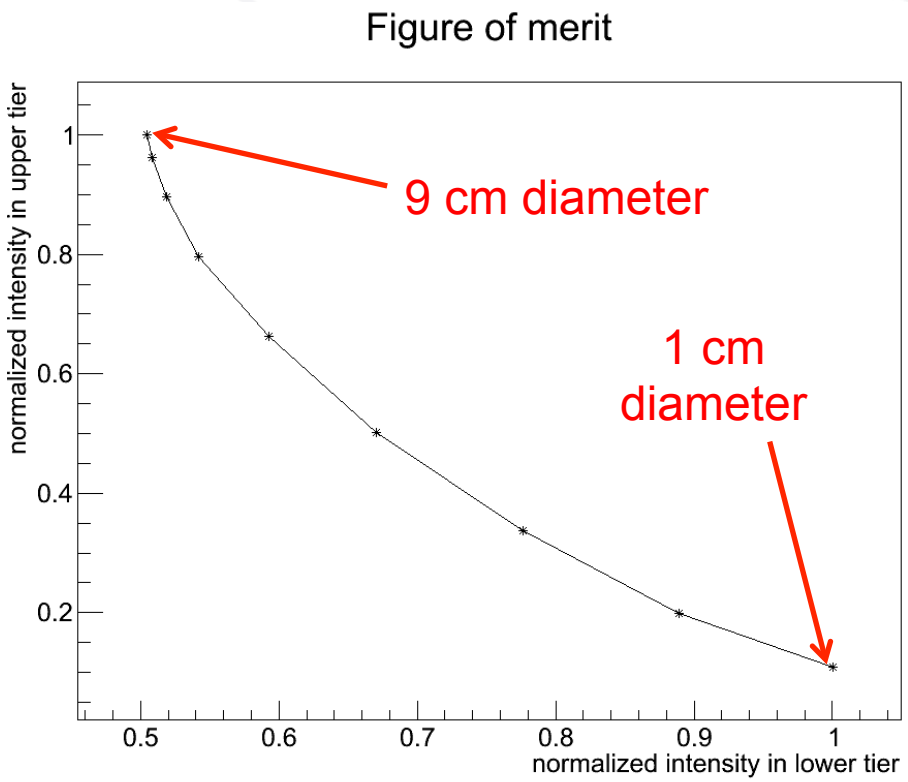


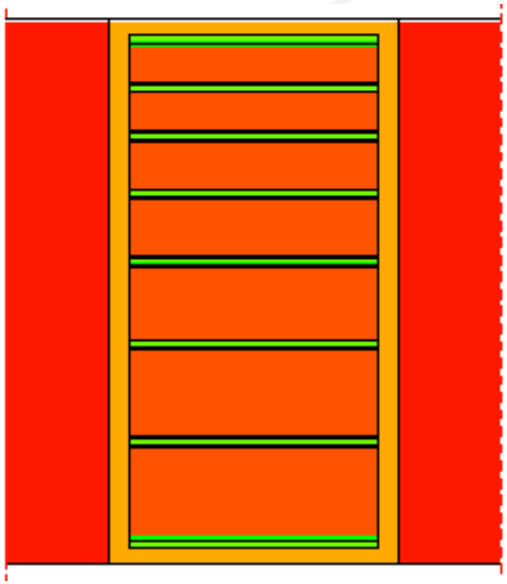
Figure of merit : anti hole study



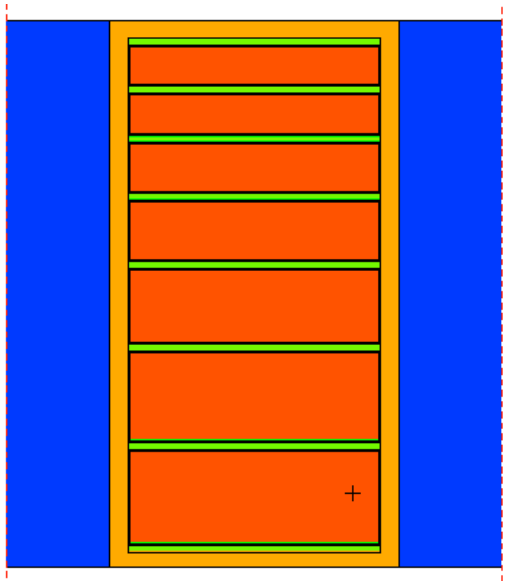


Shield study with 5 cm diameter of tungsten

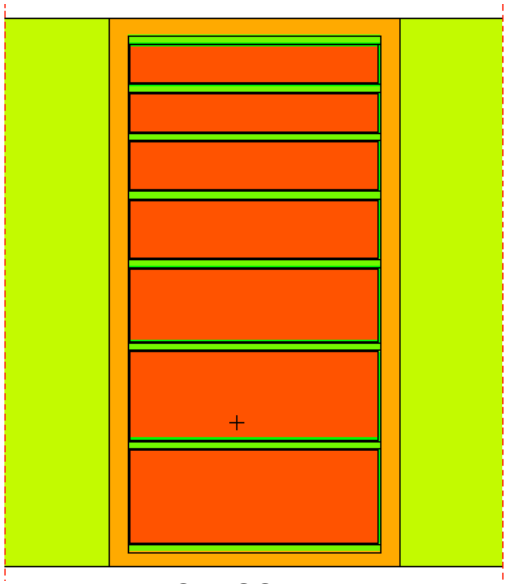
Beryllium shield



H2O shield

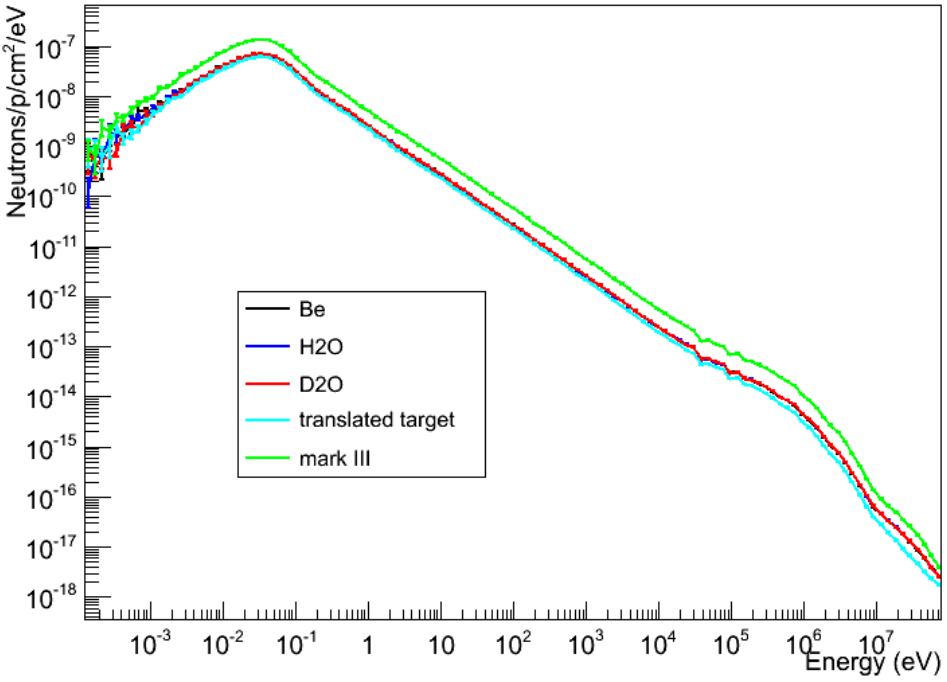


D2O shield

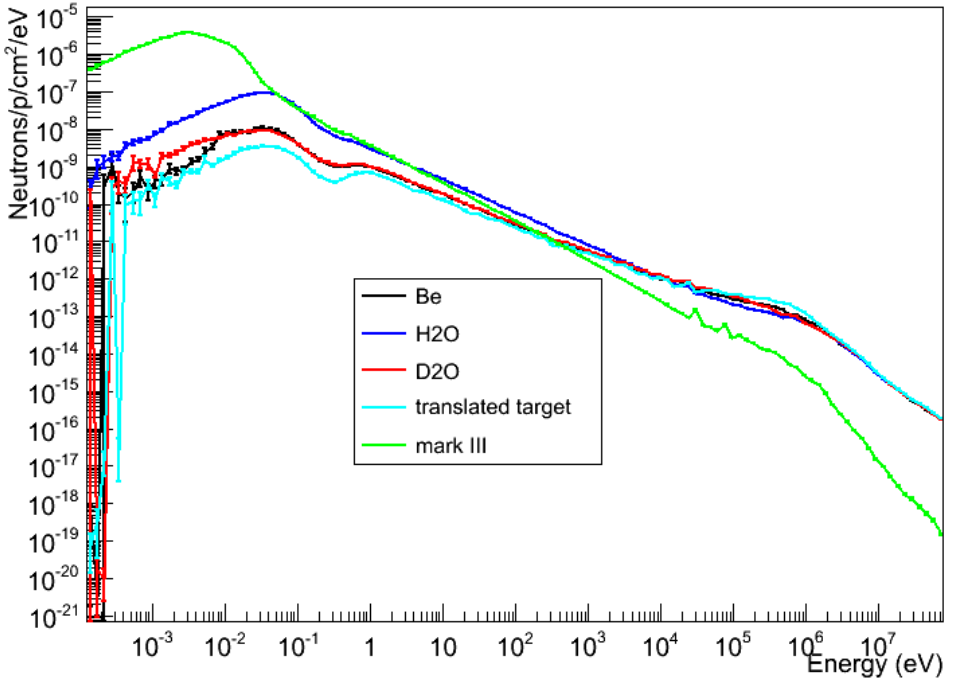


Neutron spectrum : 5 cm shield study

Lower tier (FP-1)

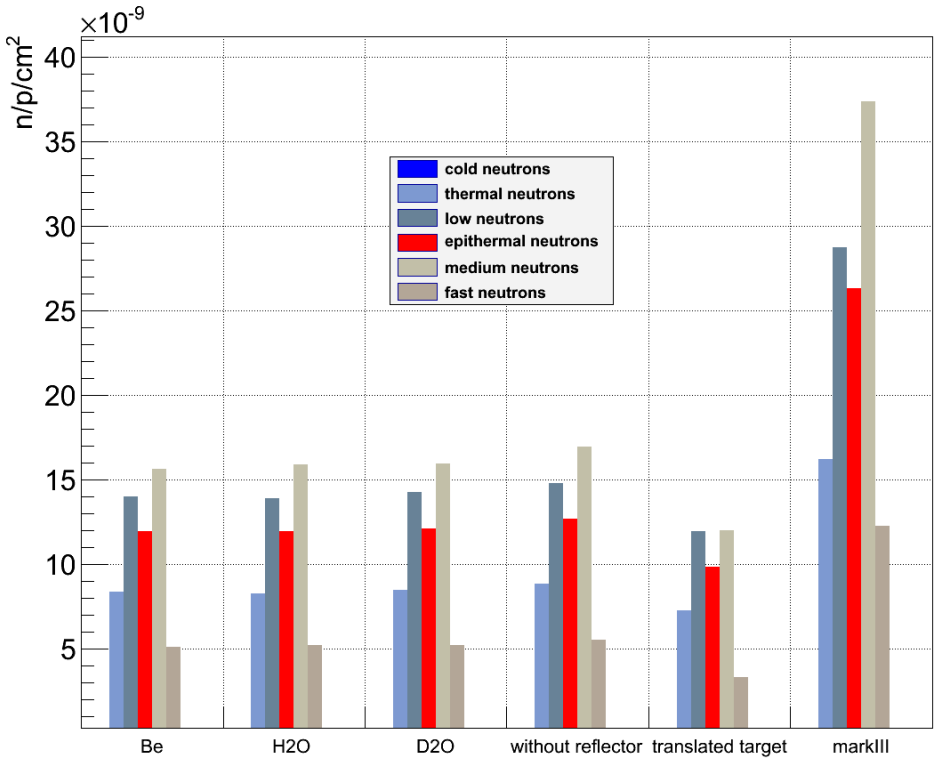


Upper tier (FP-12)

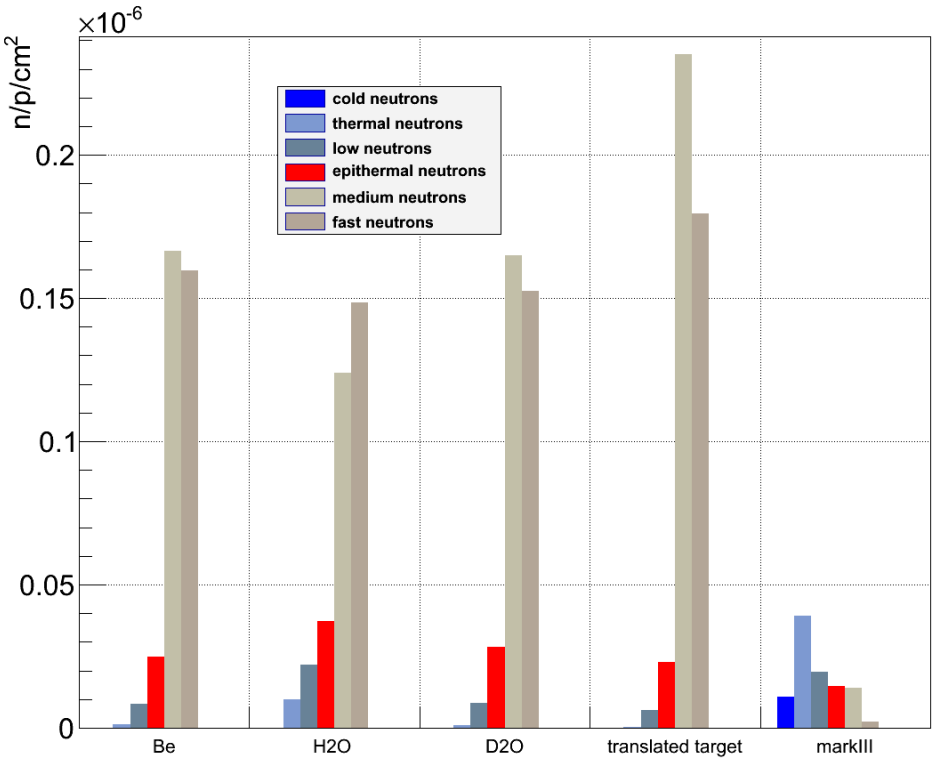


Neutron intensity : 5 cm shield study

Lower tier (FP-1)

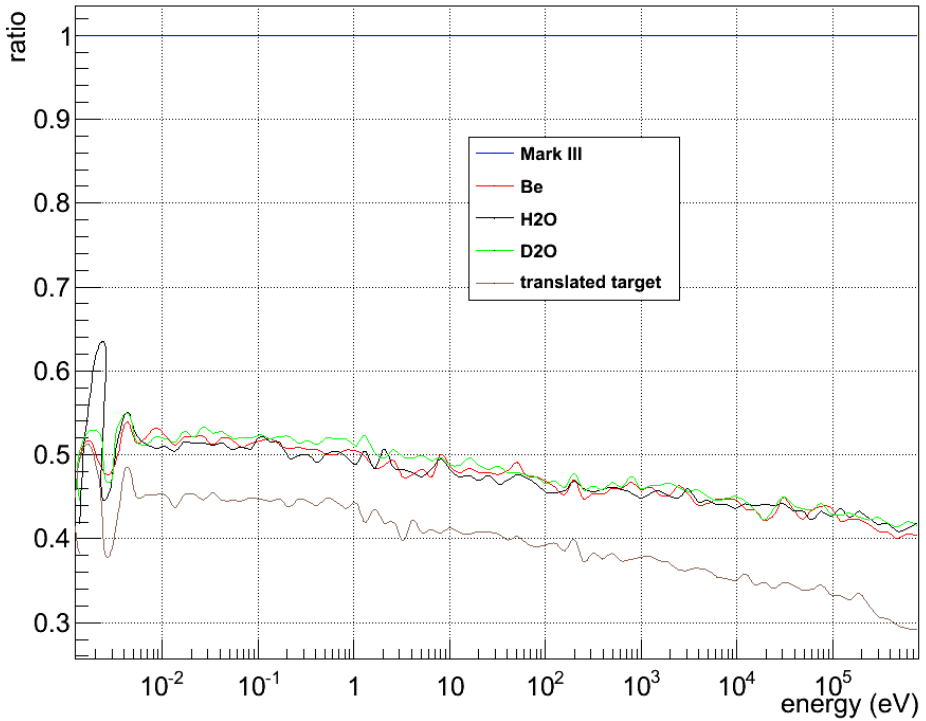


Upper tier (FP-12)

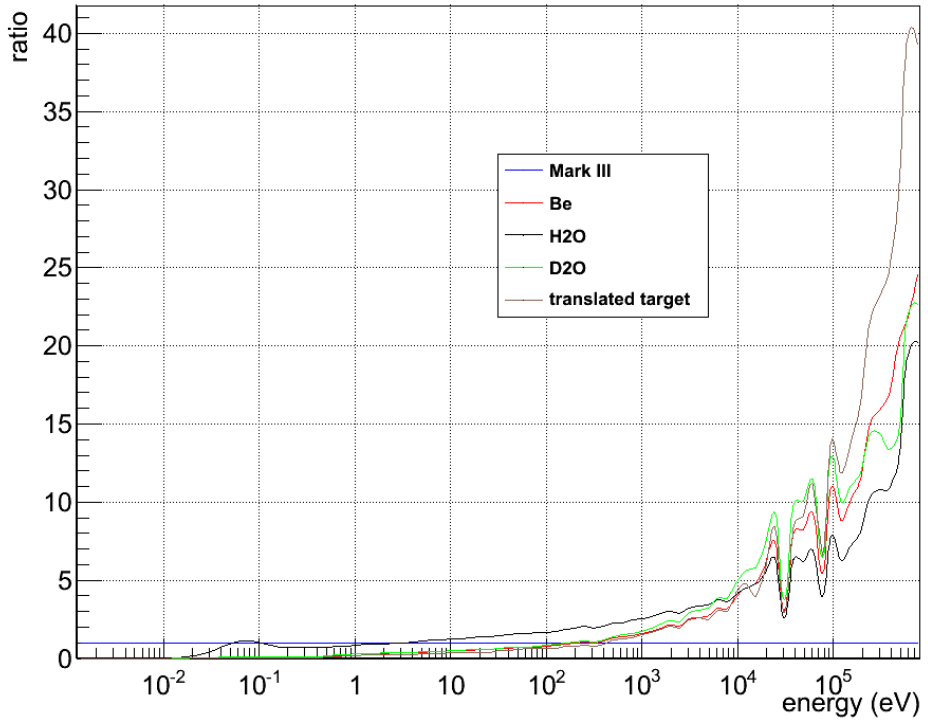


Ratio to mark III : 5 cm shield study

Lower tier

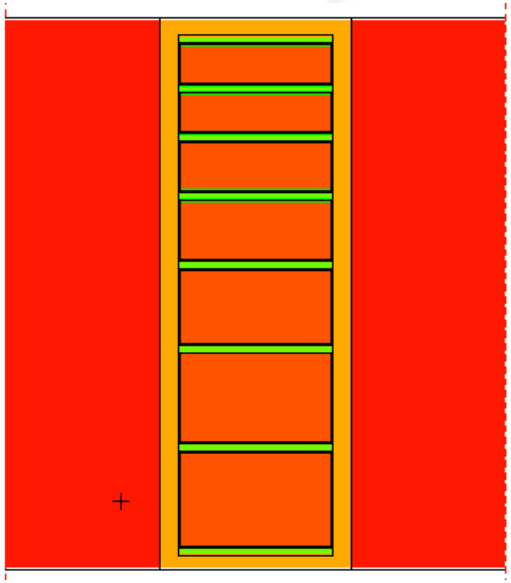


Upper tier

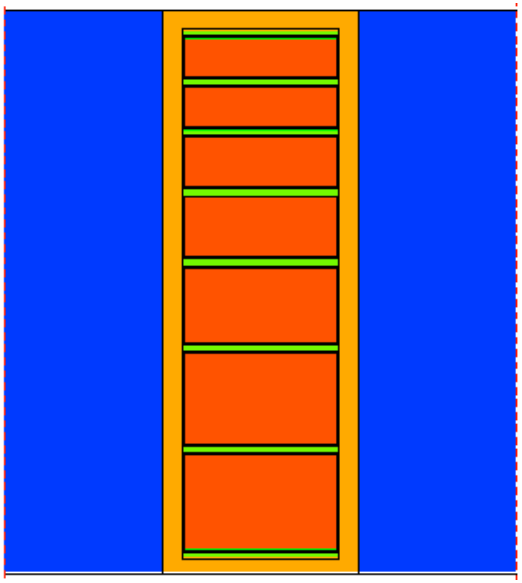


Shield study with 3 cm diameter of tungsten

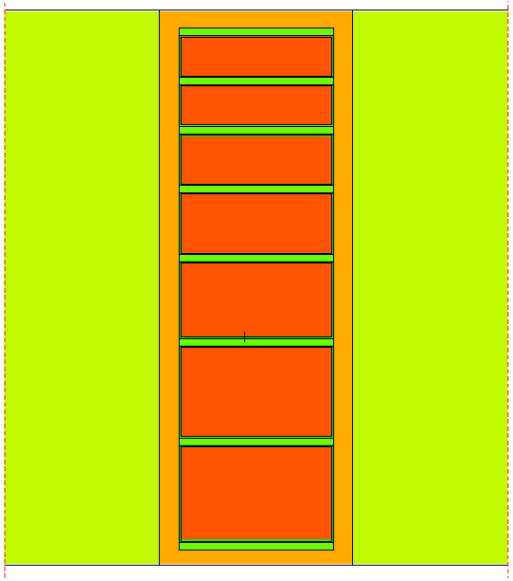
Beryllium shield



H2O shield

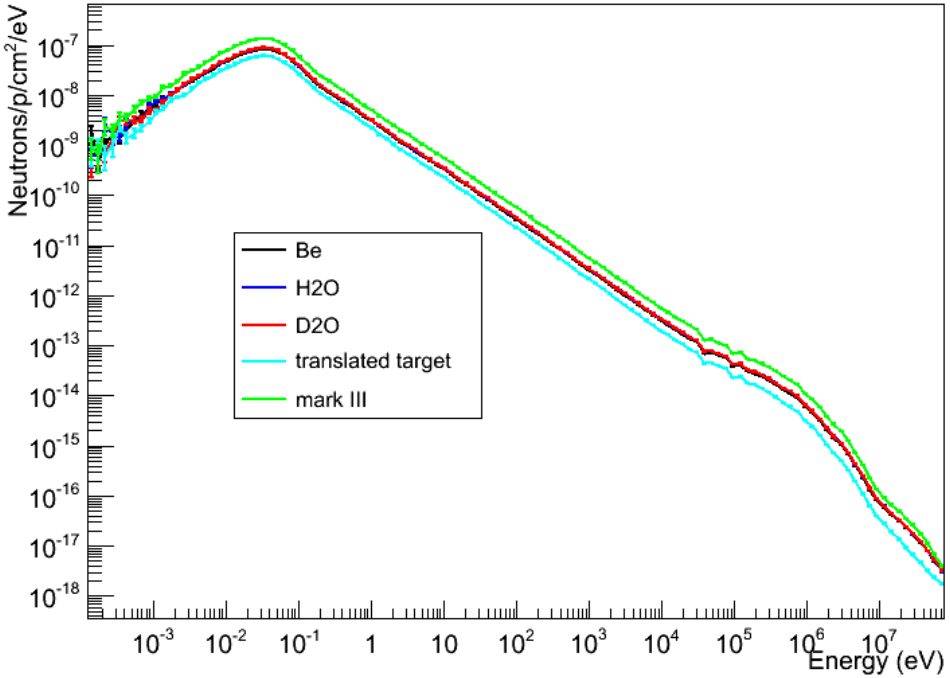


D2O shield

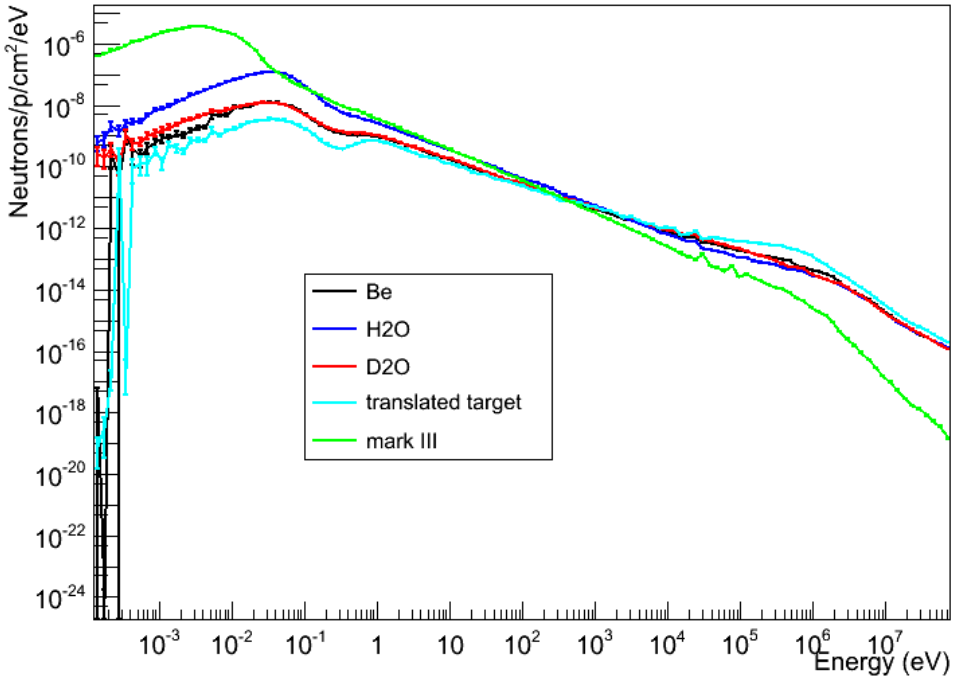


Neutron spectrum : 3 cm shield study

Lower target

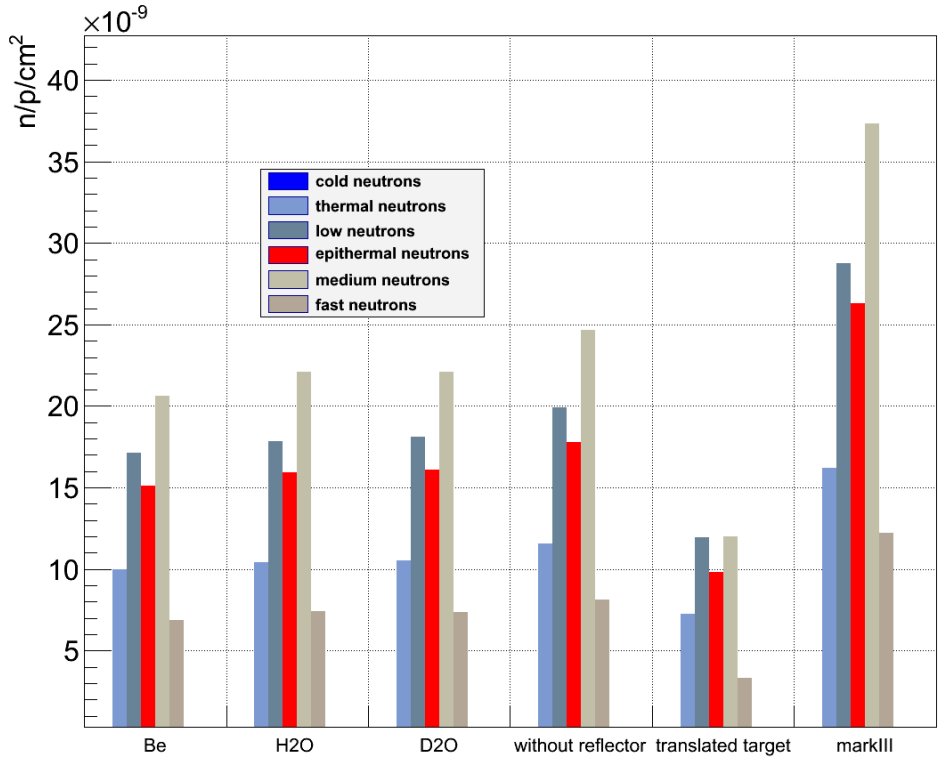


Upper target

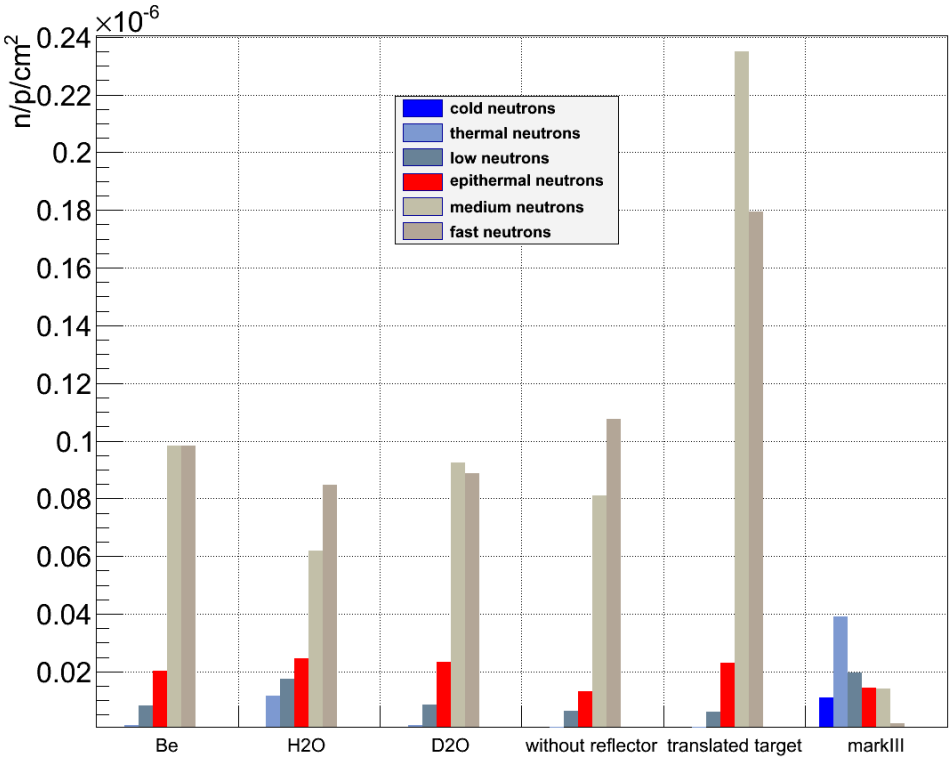


Neutron intensity : 3 cm shield study

Lower tier (FP-1)

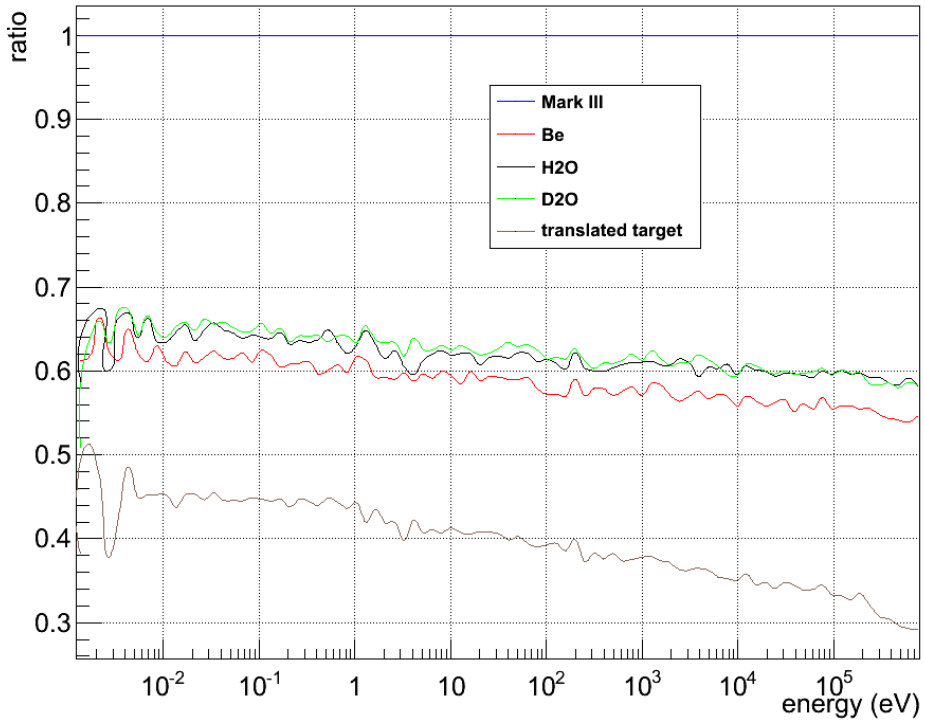


Upper tier (FP-12)

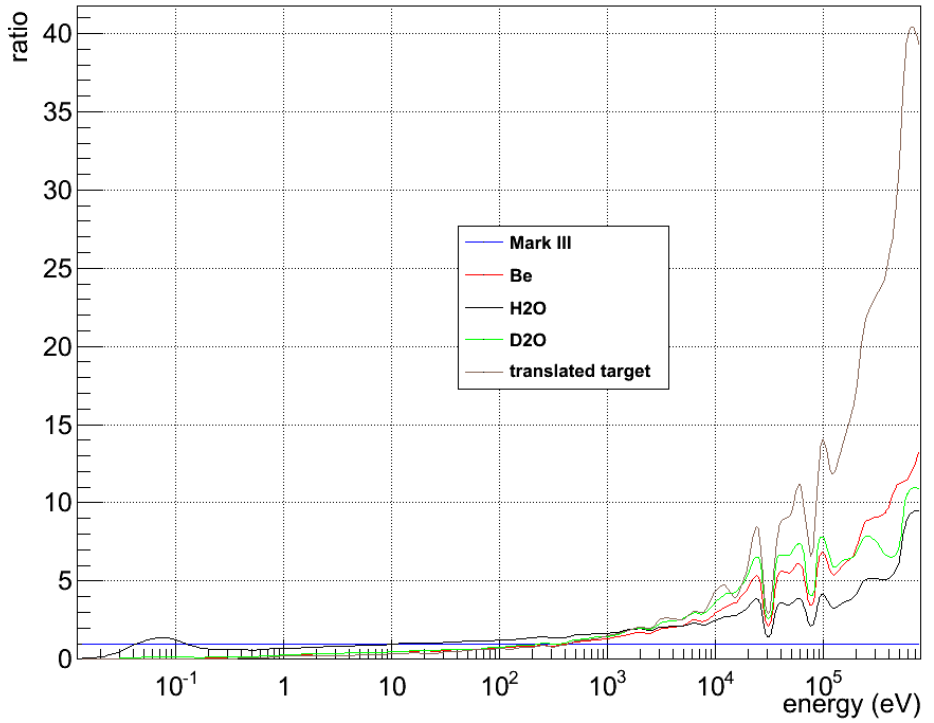


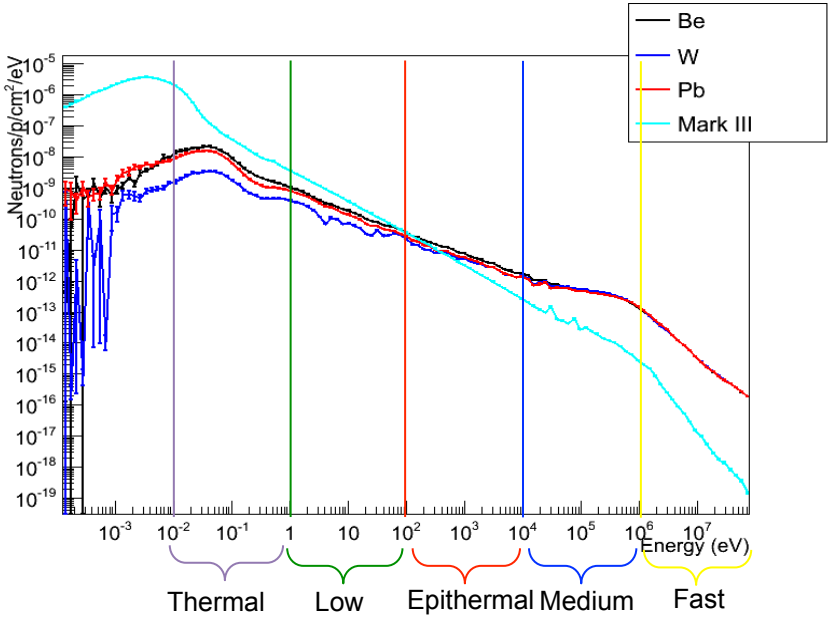
Ratio to mark III : 3 cm shield study

Lower tier



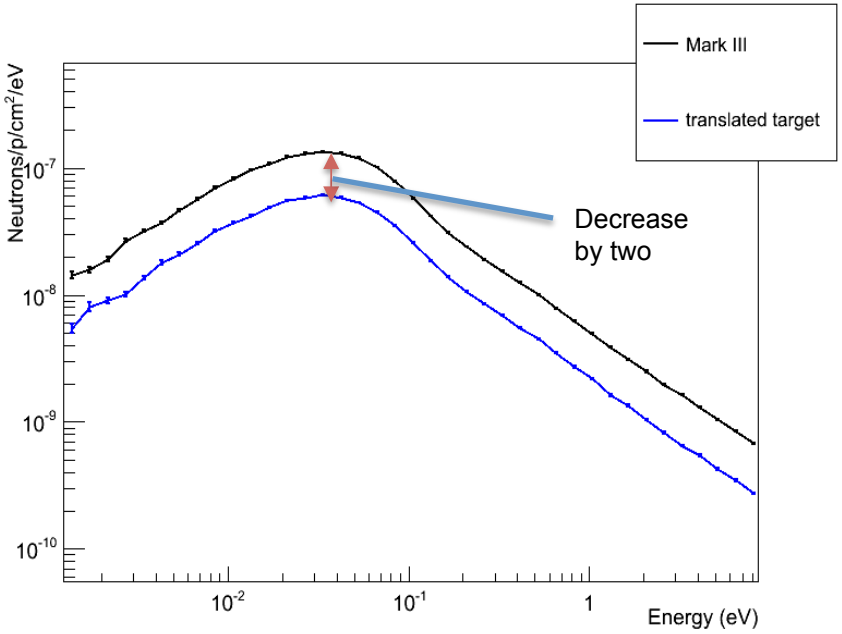
Upper tier





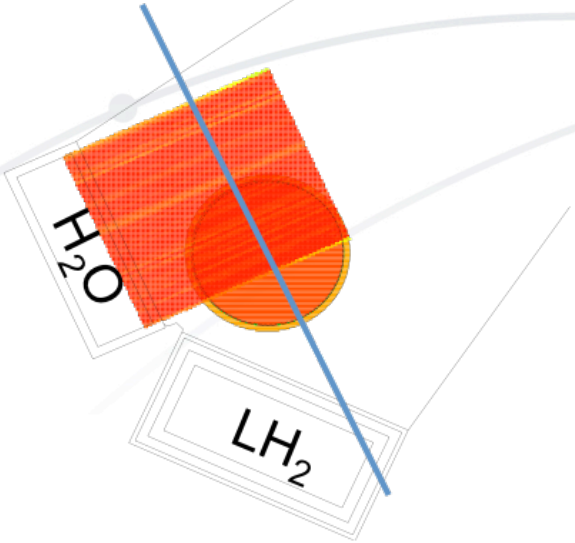
Improvement of one to two orders of magnitude in epithermal and medium energy range

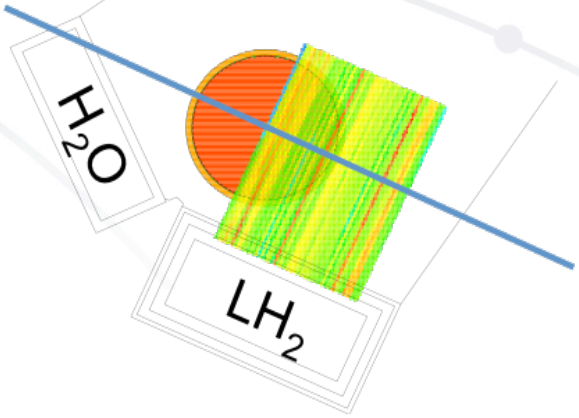
Use of “wings” reflectors to focus the beam of neutrons in the flight path : The beryllium increases the intensity of epithermal and medium neutrons and reduces the amount of backscattered neutrons from the lead outer shield

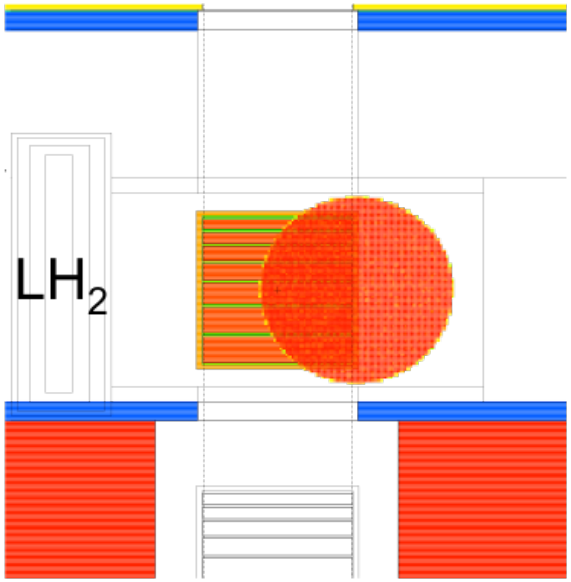


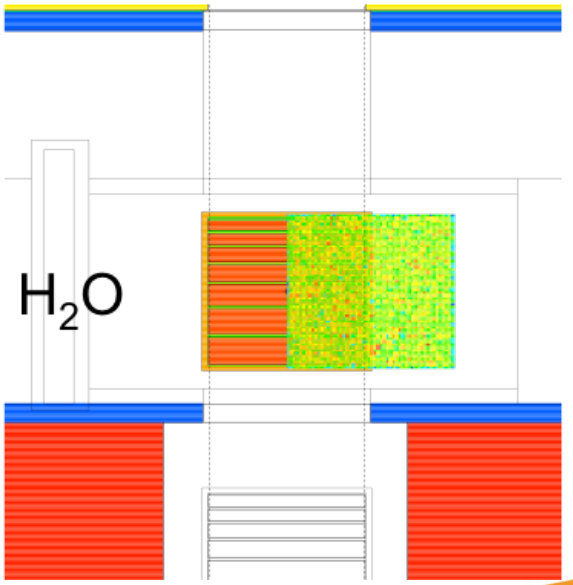
Consequences : thermal neutron intensity is divided by two in the lower tier

Field of view









Neutron spectrum : wing study