LA-UR-16-24088
Approved for public release; distribution is unlimited.

Title:	Design of the Next Generation Spallation Target
Author(s):	Ferres, Laurent
Intended for:	Sharing presentation with external visitor coming to LANSCE Lujan Center. Report
Issued:	2016-06-13

Design of the Next Generation Spallation Target

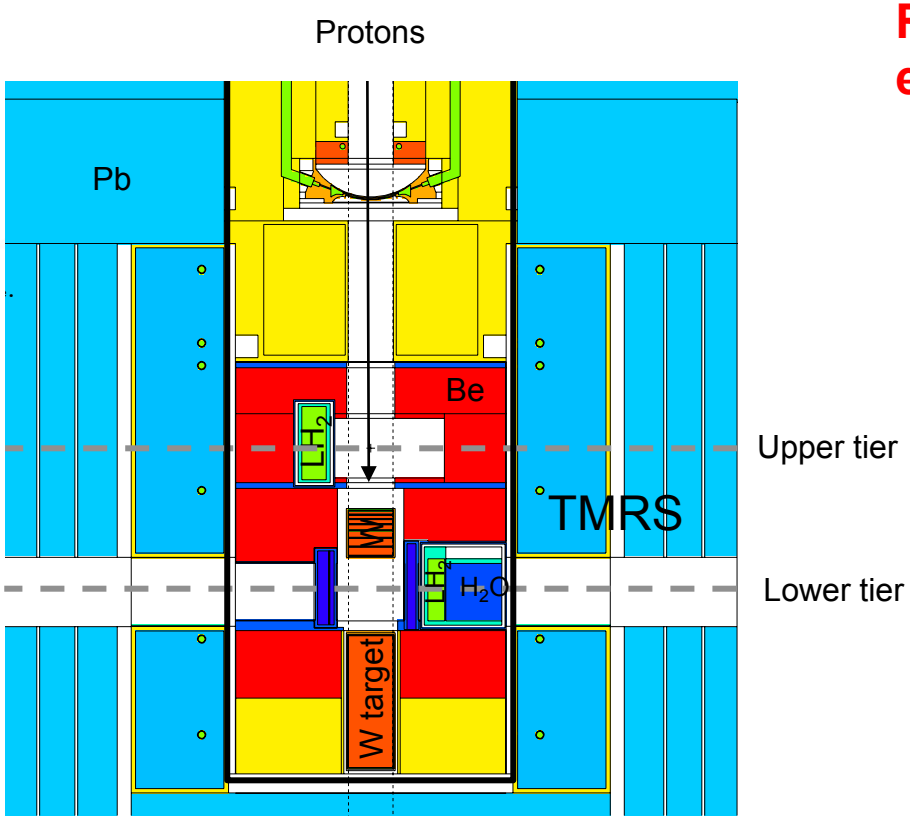
Student : Laurent Ferres
Mentor : Suzanne Nowicki
Supervisor : Mickael Mocko

Motivation

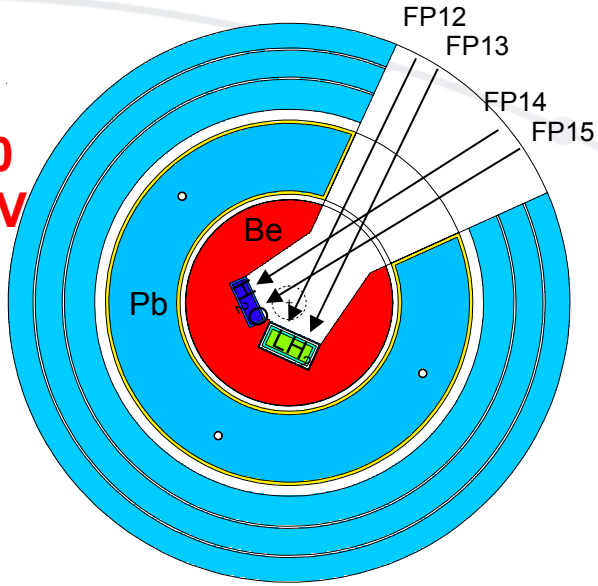
- Enable new nuclear physics experiments (defense program applications (DANCE)) that are currently limited by neutron intensity or energy resolution available at LANSCE.
- The target is being redesigned so that the Flight Paths (FP) in the upper tier provide a higher intensity in the epithermal and medium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

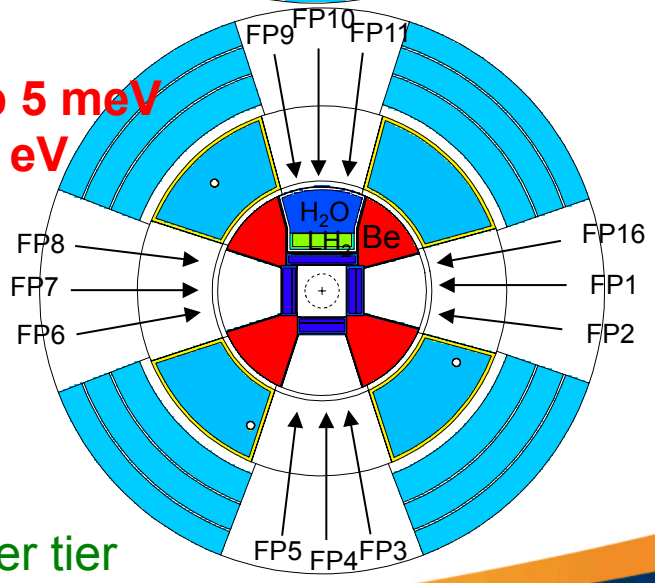
Current design: Mark III



Reach 100 eV – 1 MeV



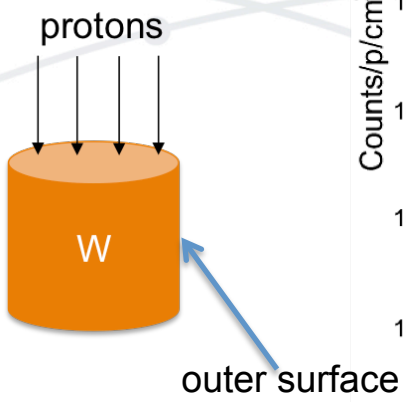
Keep 5 meV – 0.4 eV

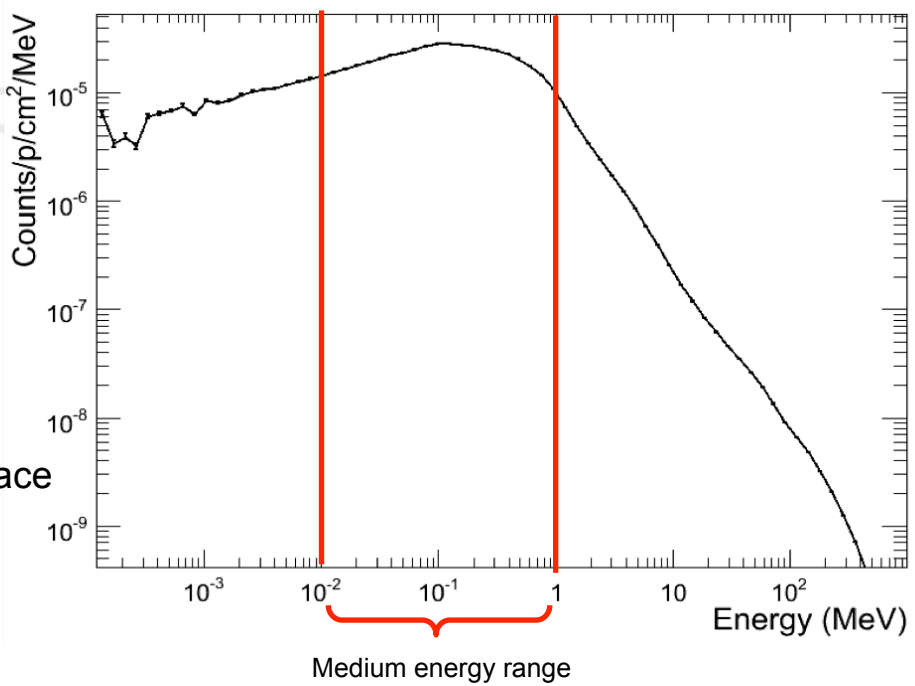


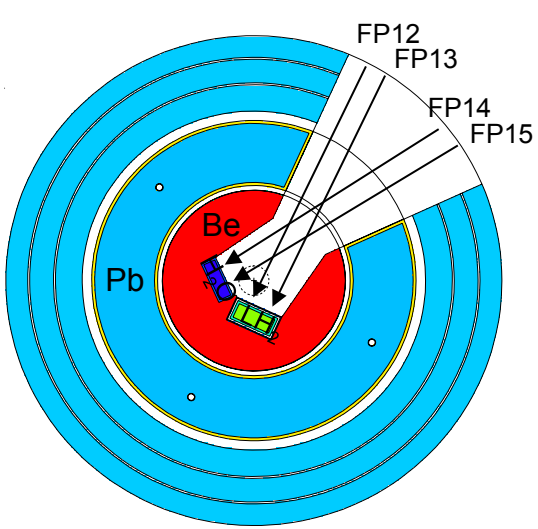
Use of MCNPX to model various arrangements of moderator/reflector/filter materials

Issue: impact on the thermal flux in the lower tier

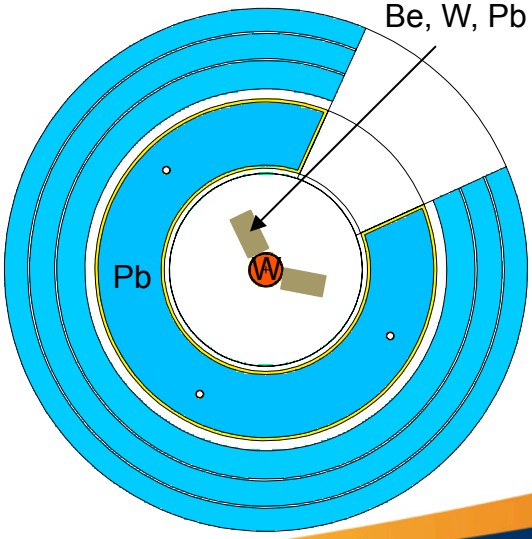
Neutron spectrum : outer surface





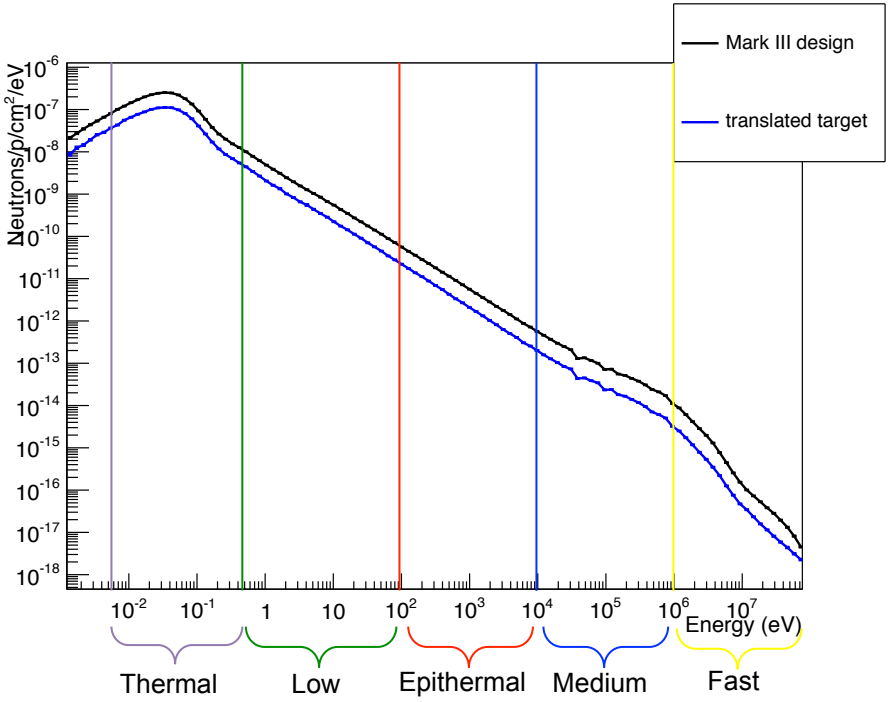


Translated target

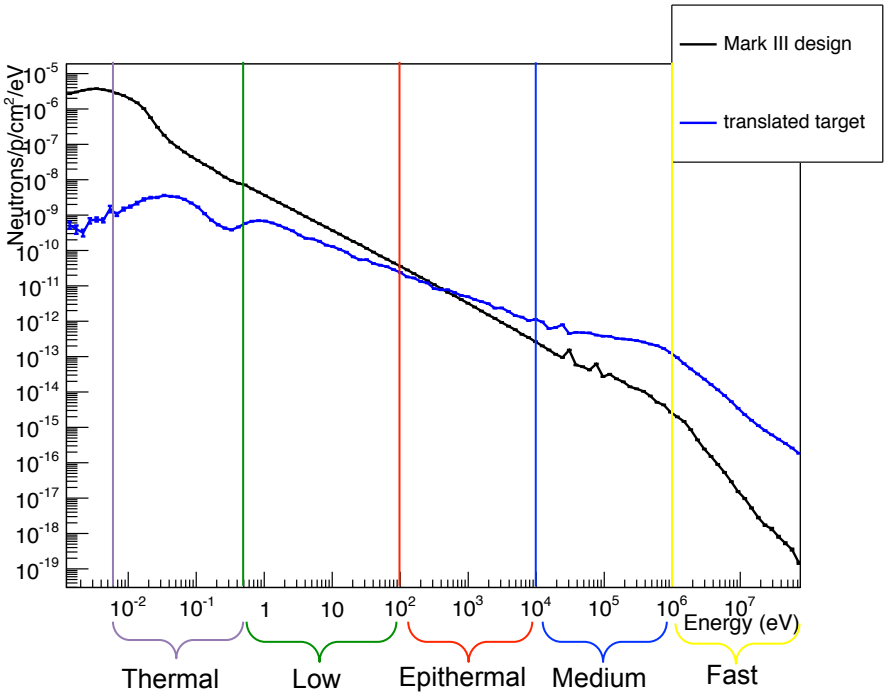


Neutron intensity results

lower tier

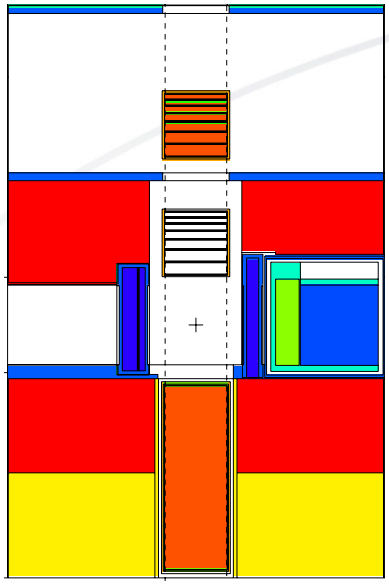


upper tier

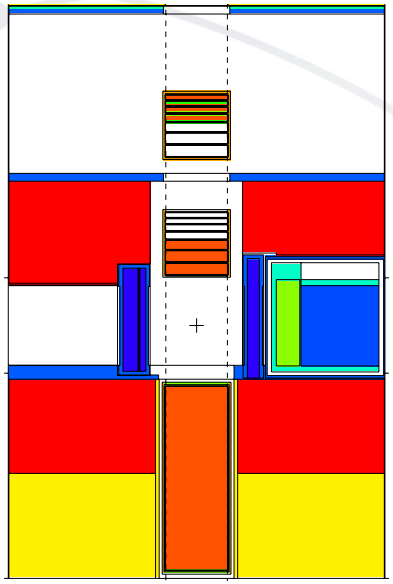


Consequences : thermal neutron intensity is divided by two in the lower tier

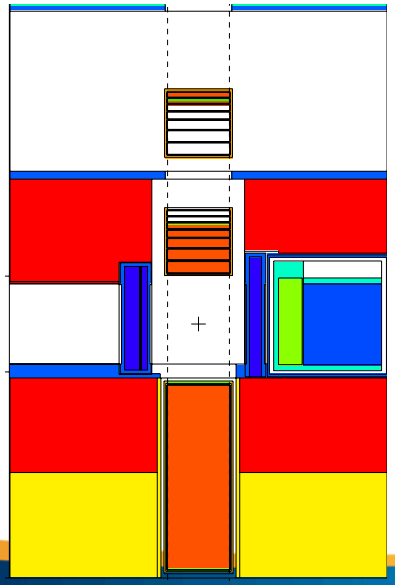
0 plate (translated target)



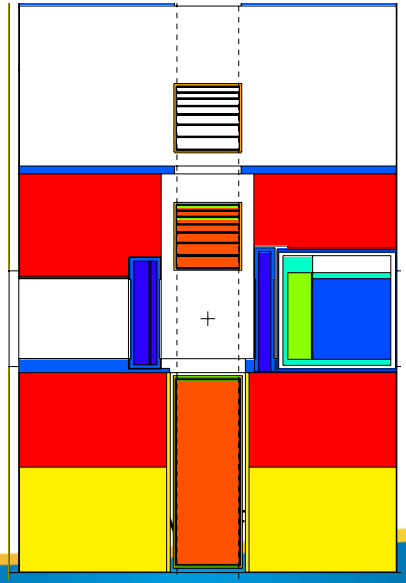
3 plates



5 plates



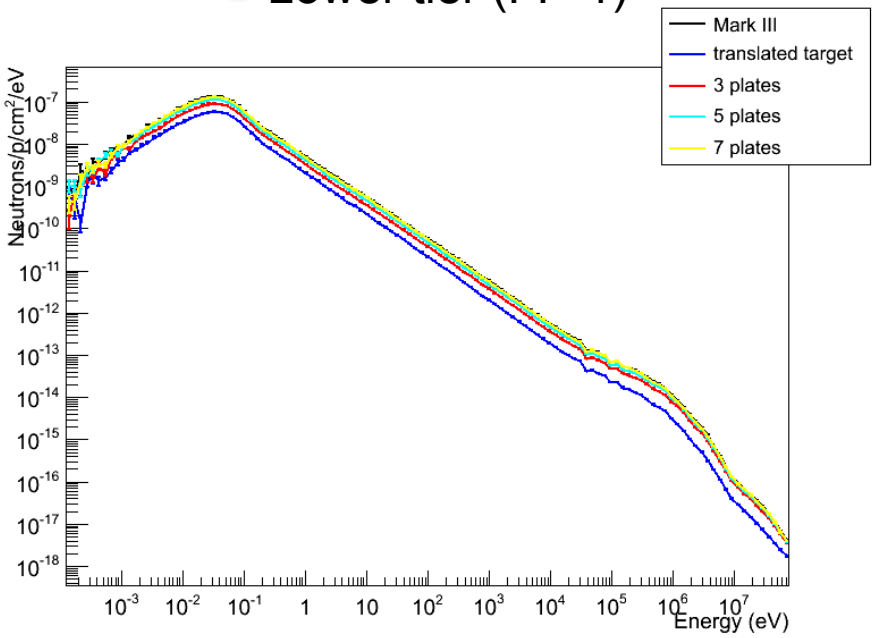
7 plates



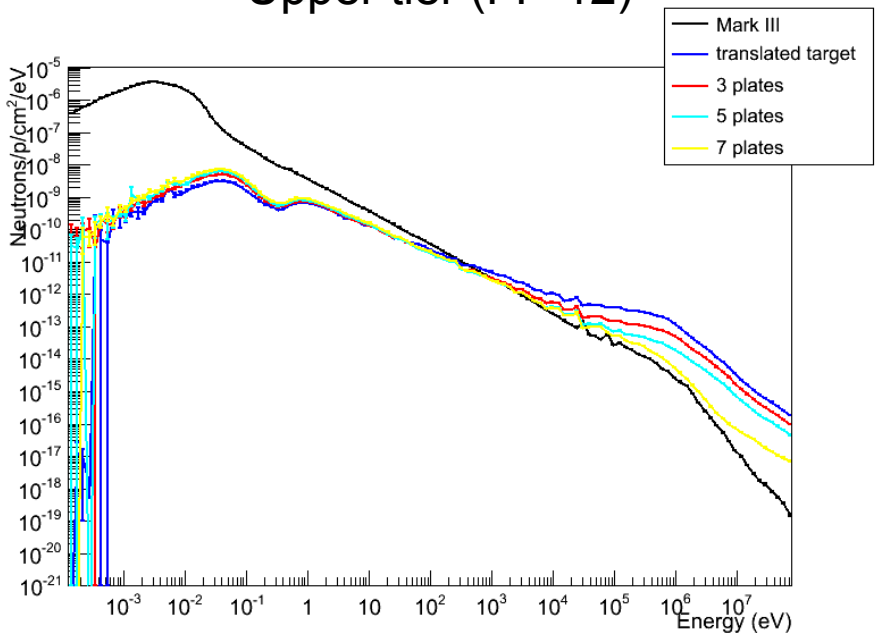
The thickness of the plates varies

Neutron spectrum : plate study

Lower tier (FP-1)



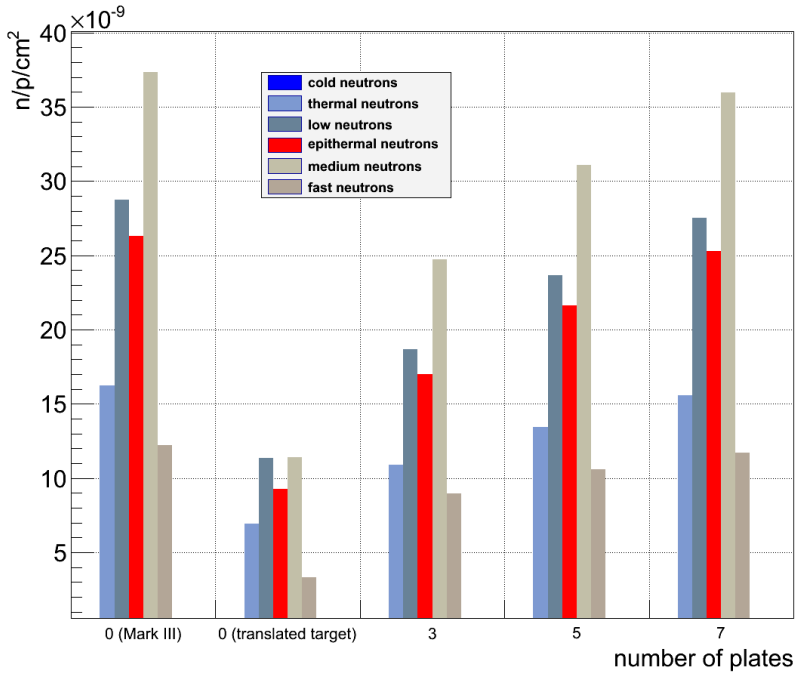
Upper tier (FP-12)



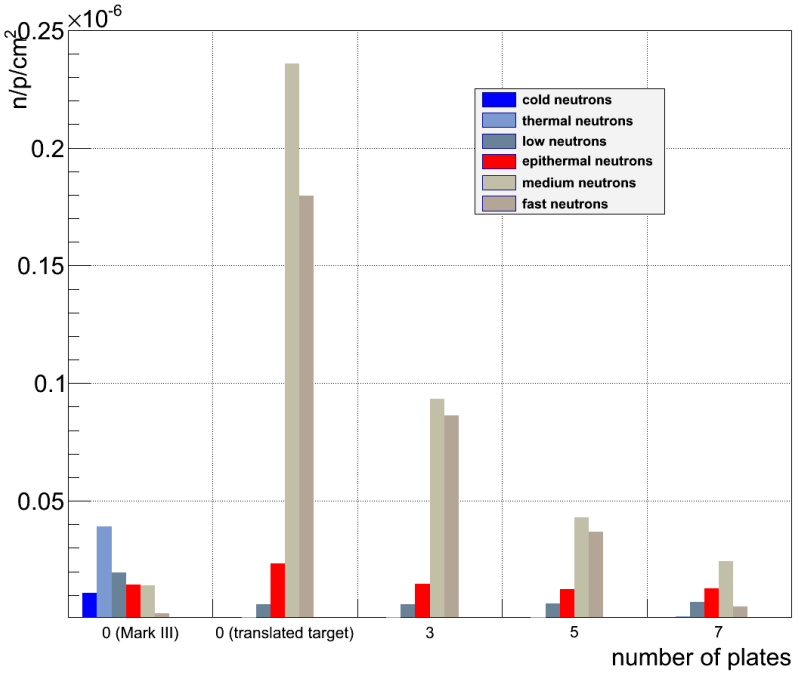
The addition of plates from top to bottom brings the intensity of the thermal range in the lower tier higher but brings it down for the medium range in the upper tier (as expected)

Neutron intensity : plate study

Lower tier (FP-1)

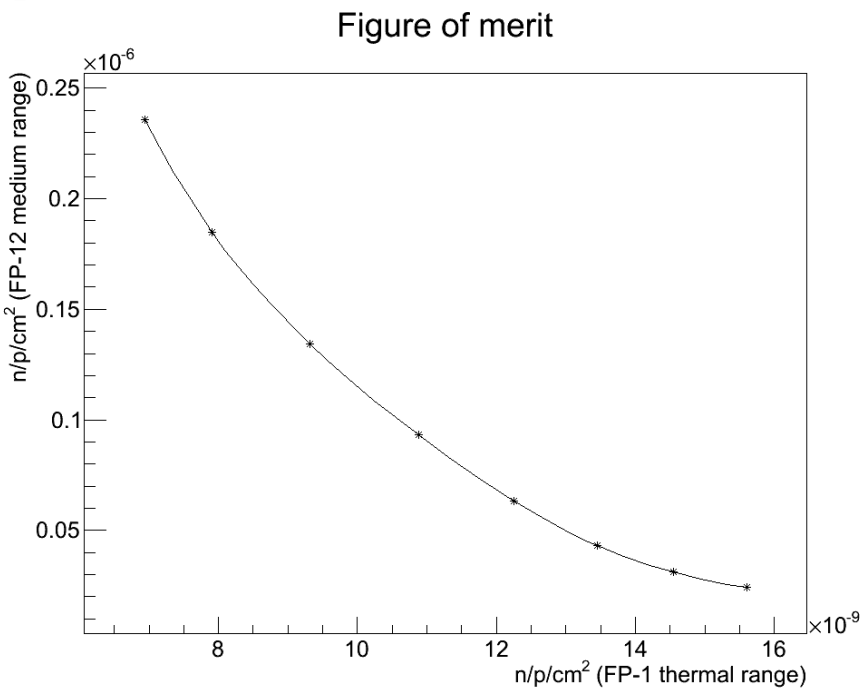


Upper tier (FP-12)

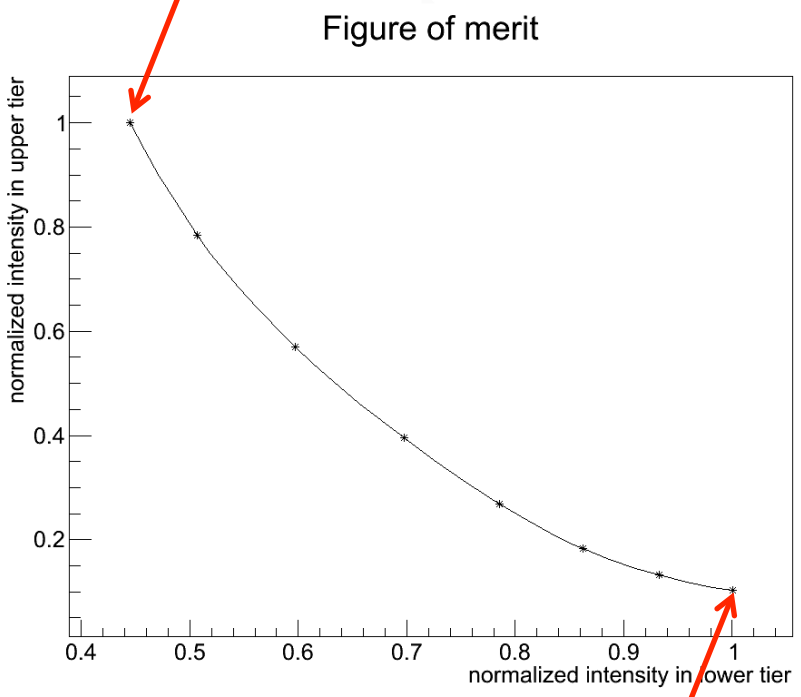


The addition of plates from top to bottom brings the intensity of the thermal range in the lower tier higher but brings it down for the medium range in the upper tier (as expected)

Figure of merit : plate study

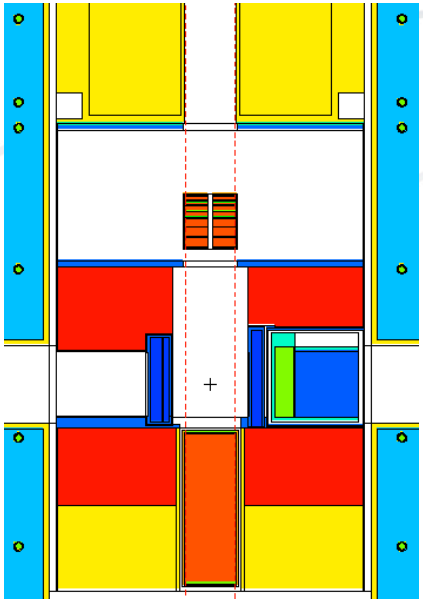


0 plate (translated target)

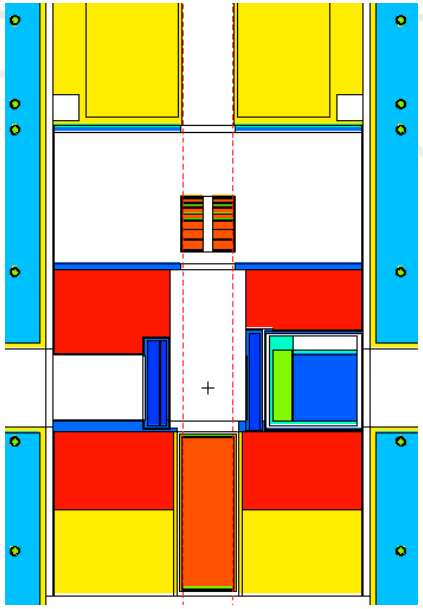


7 plates

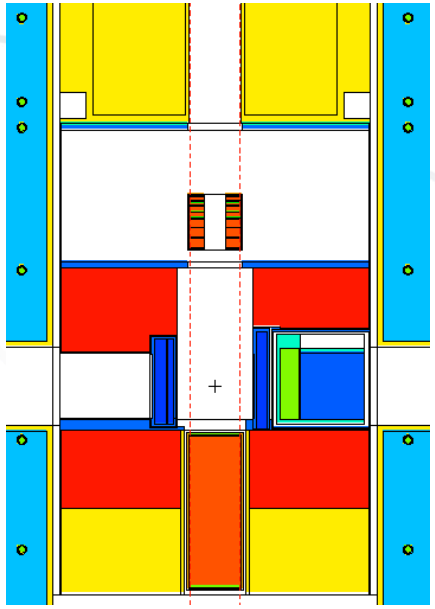
1 cm diameter hole



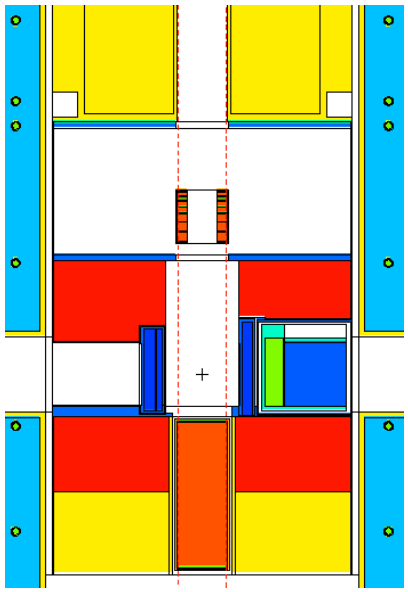
2 cm diameter hole

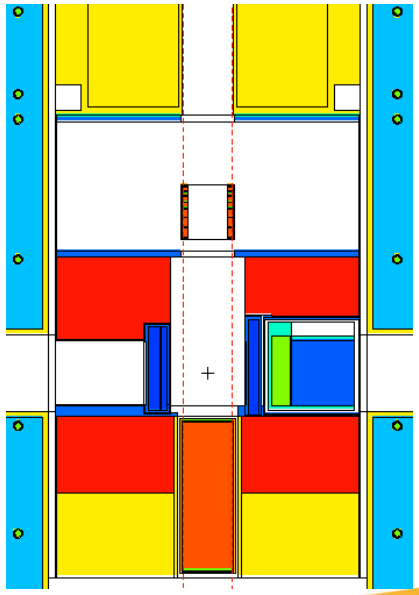


4 cm diameter hole



6 cm diameter hole

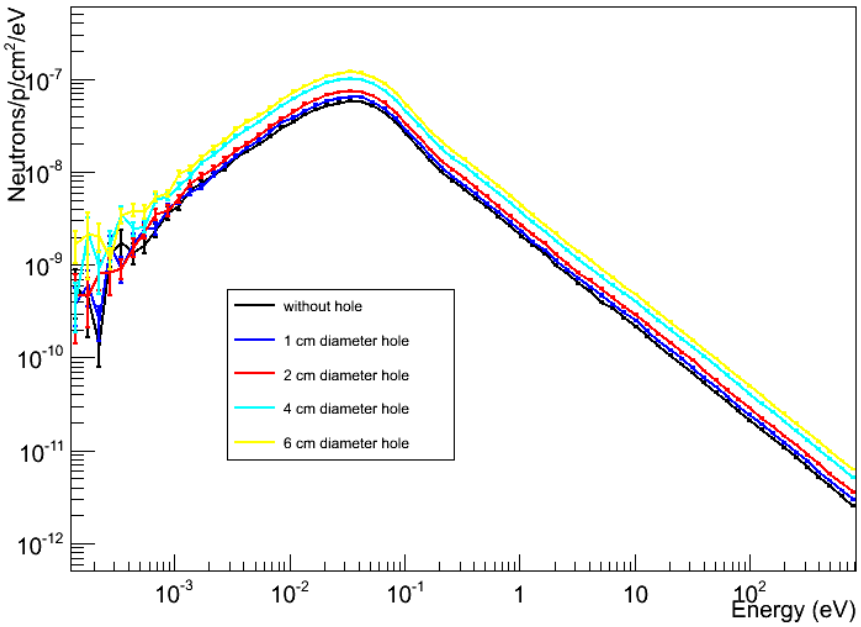




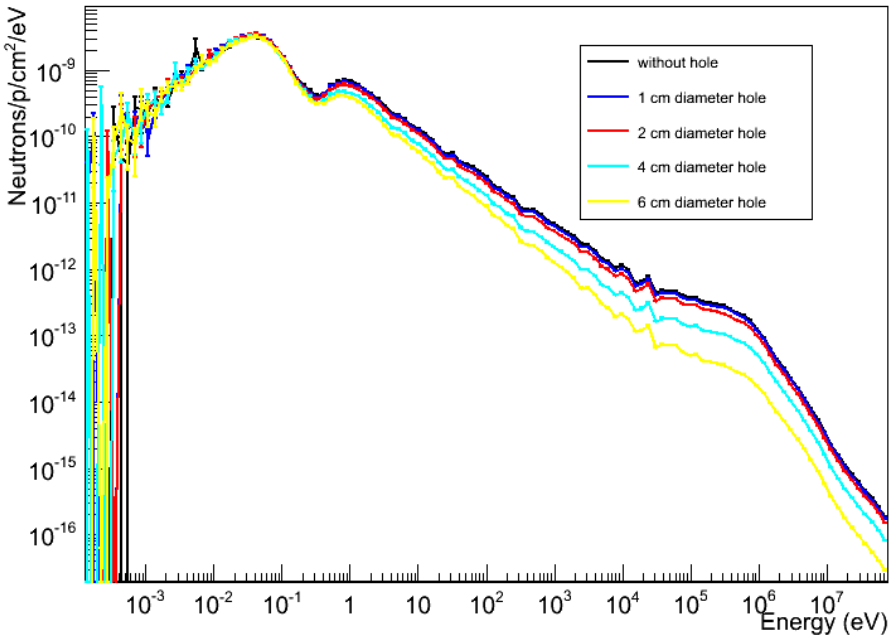
8 cm diameter hole

Neutron spectrum : hole study

Lower tier (FP-1)



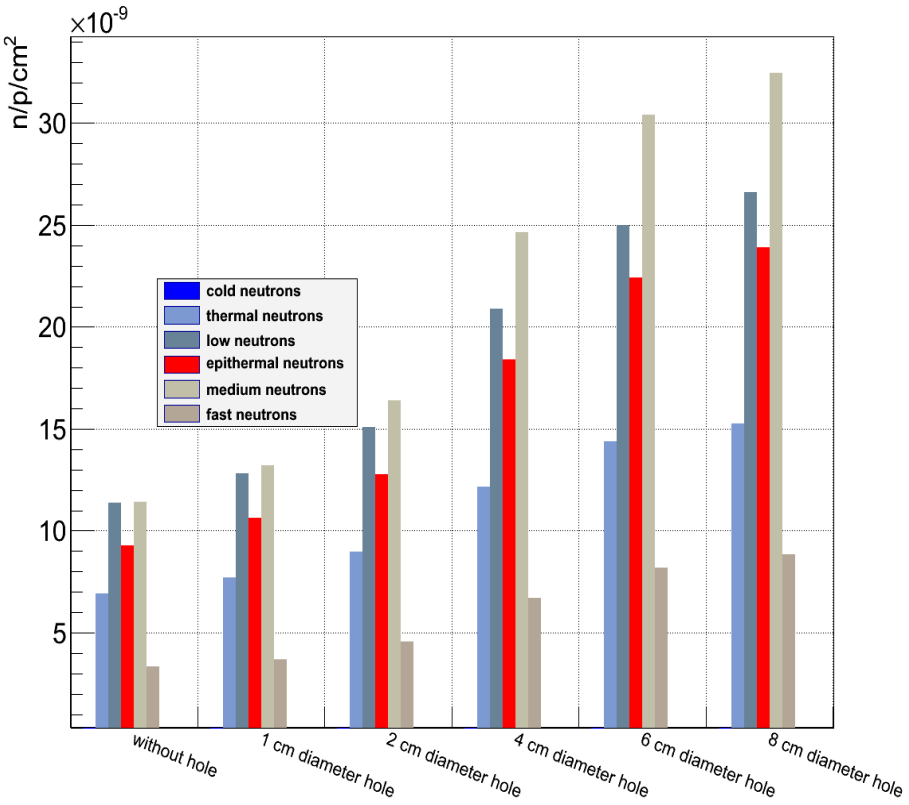
Upper tier (FP-12)



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)

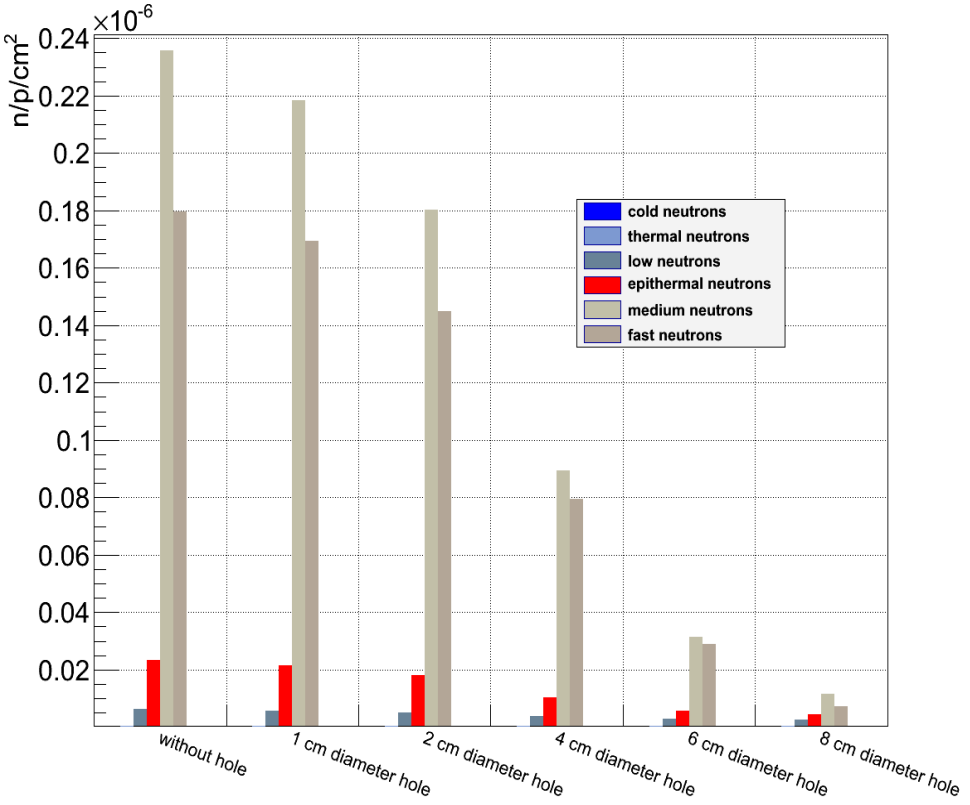
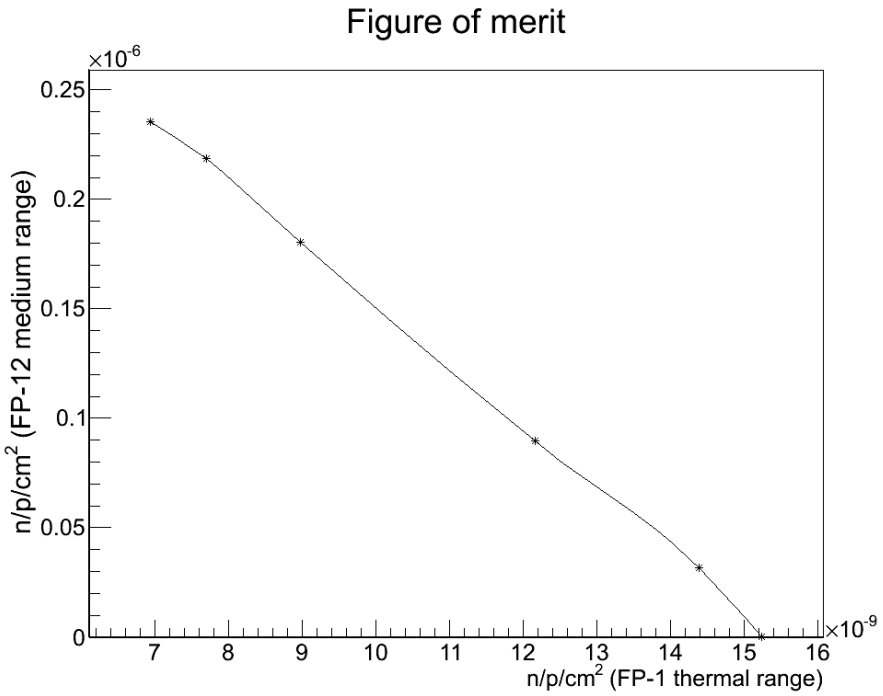
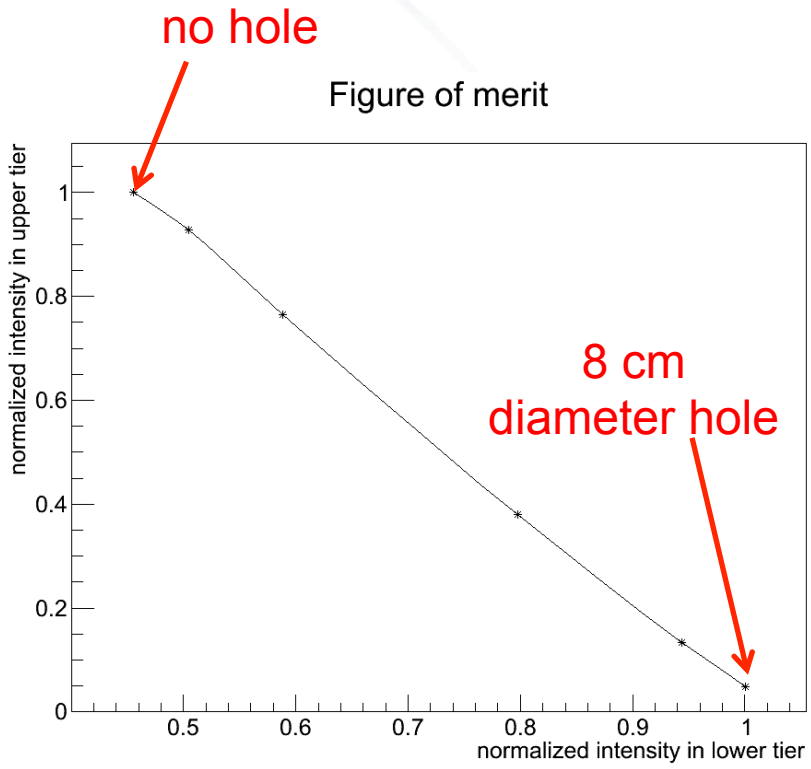
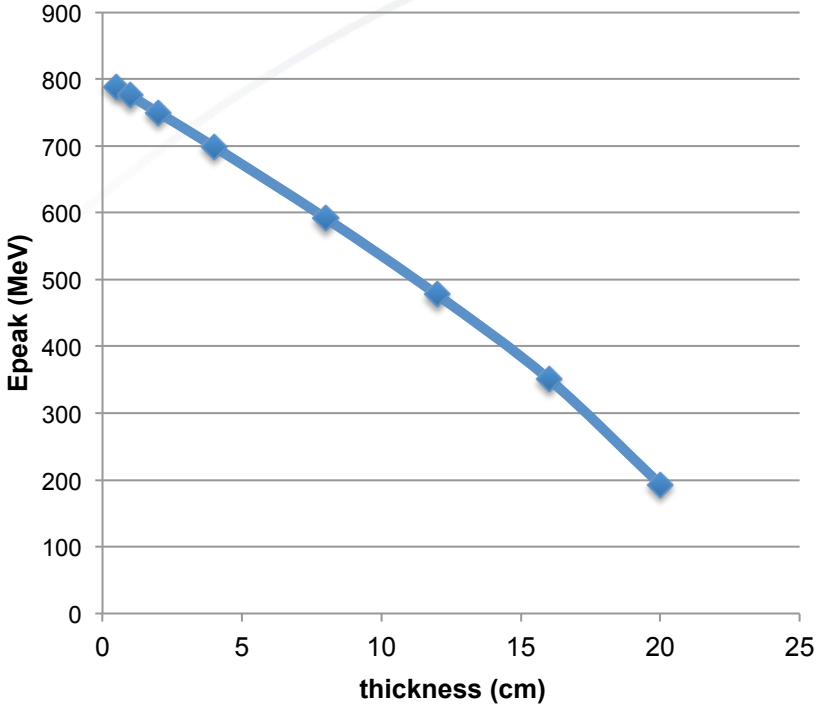


Figure of merit : hole study

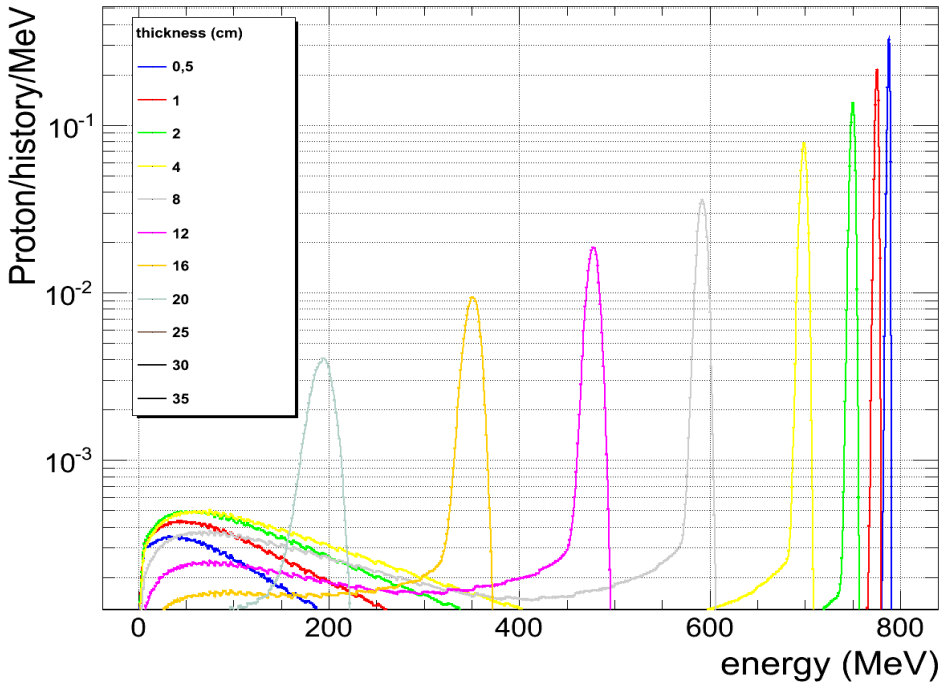




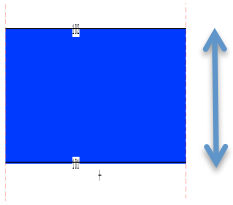
Thickness variation studies



Lower surface of the upper target (101)

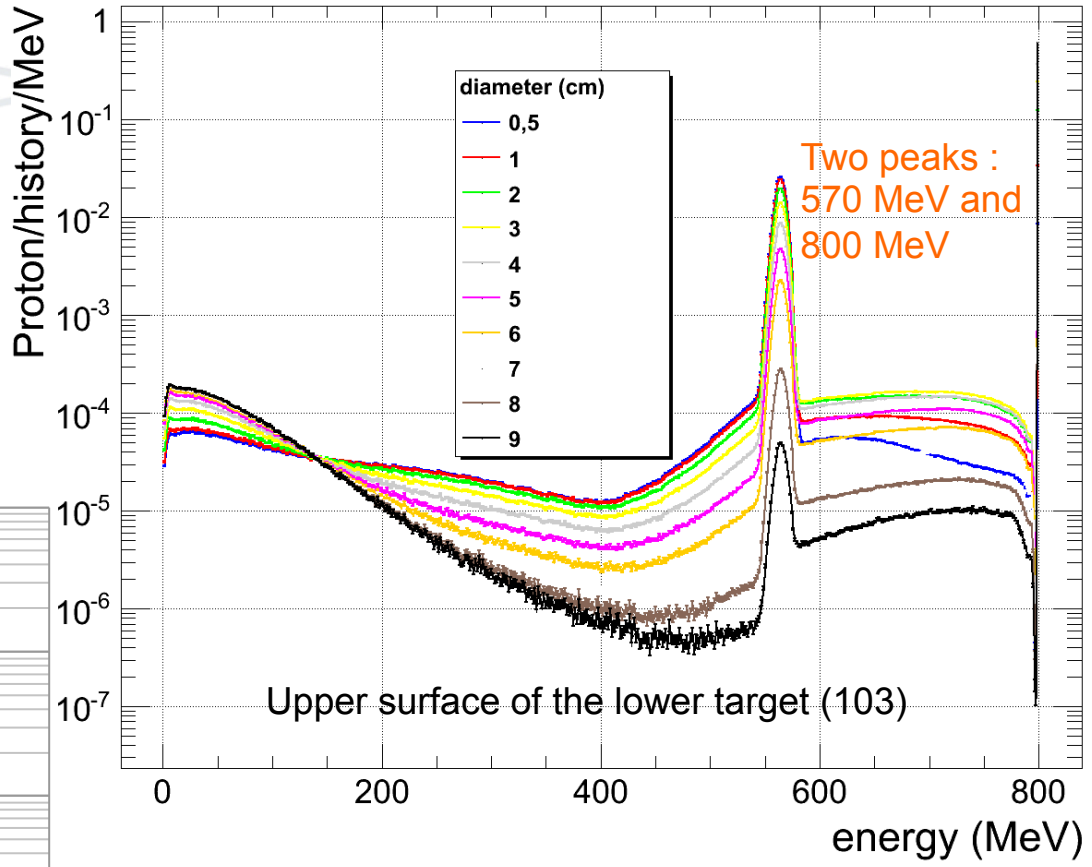


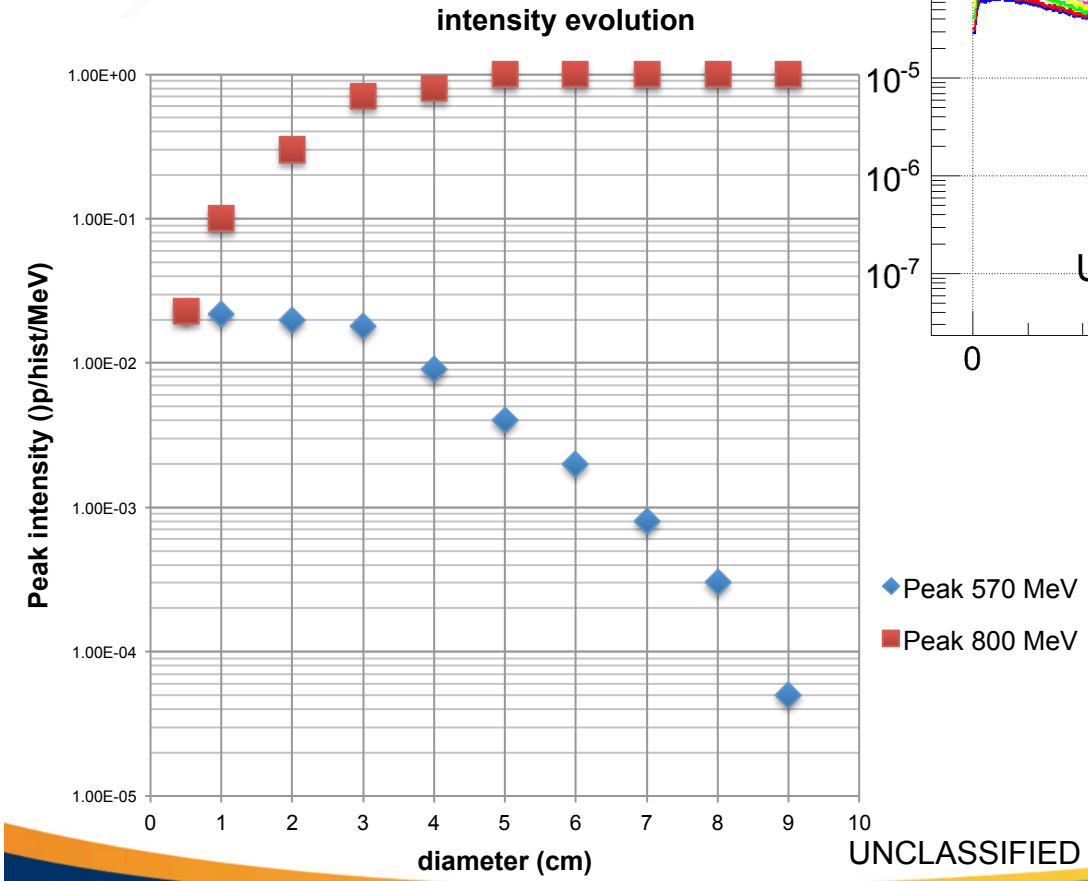
By increasing the thickness of the target, the energy and the intensity of the protons that reach the lower surface of the target decrease.



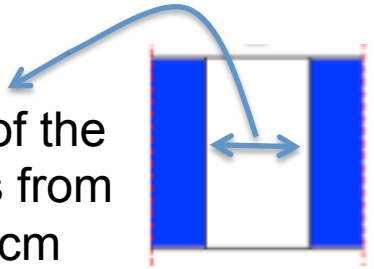
Thickness of upper target varies from 0.5 to 35 cm.

Hole studies on upper target



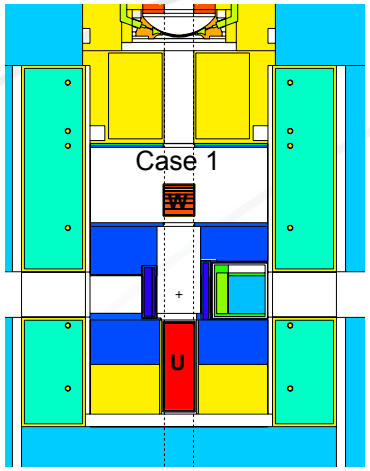


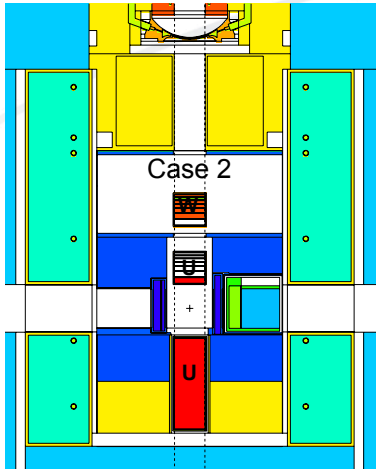
Diameter of the hole varies from 0.5 to 9 cm

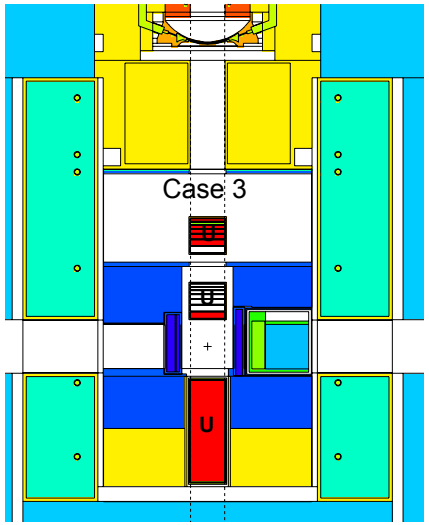


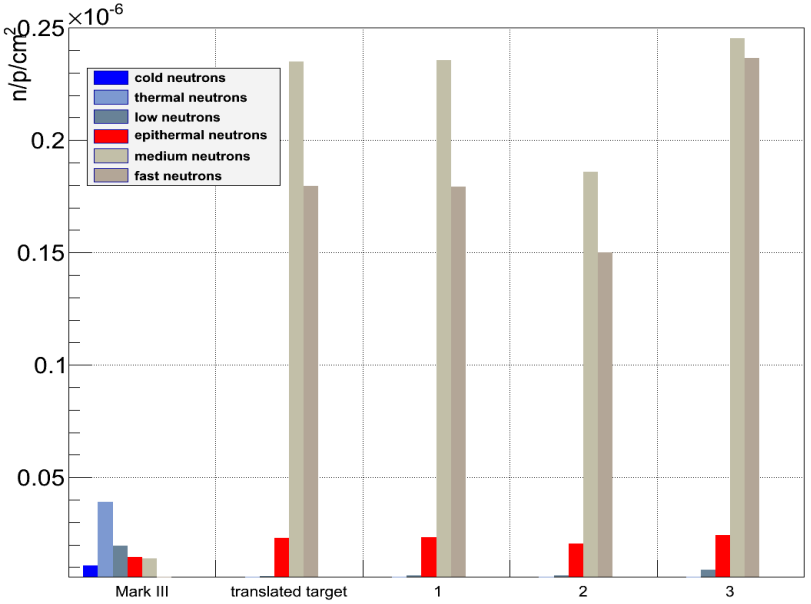
Uranium studies

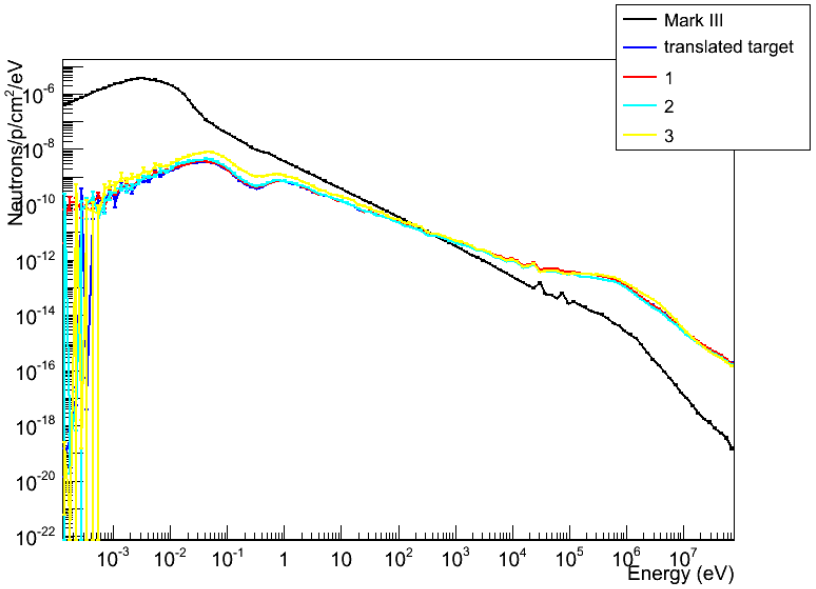
upper Tier







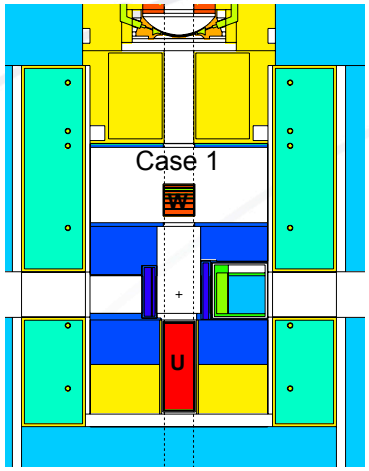


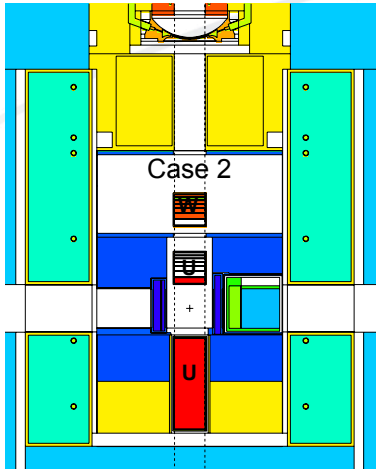


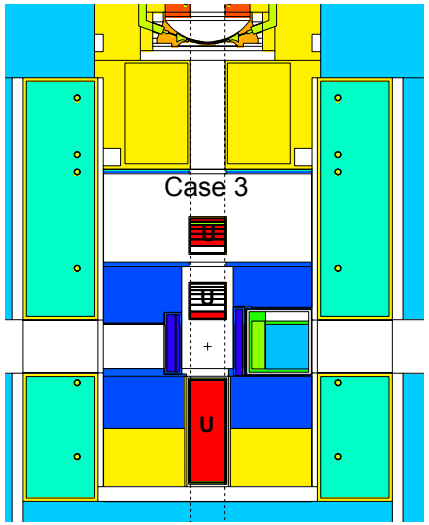
Results :

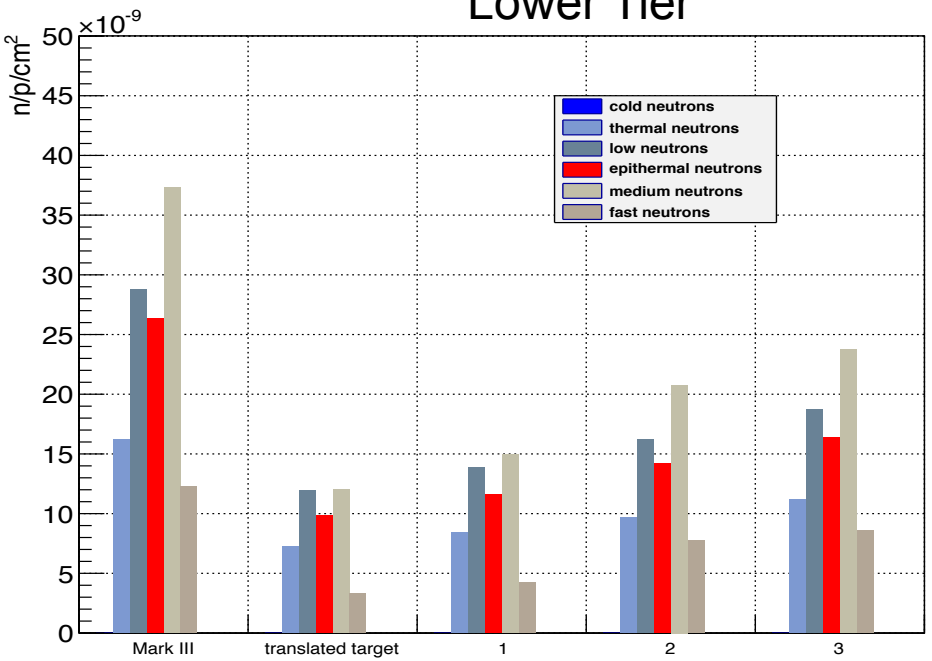
- Thermal neutrons decrease a lot : who cares because only medium and fast neutrons are interesting
- Medium and fast neutrons increase a lot : good but delayed neutron have to be considered

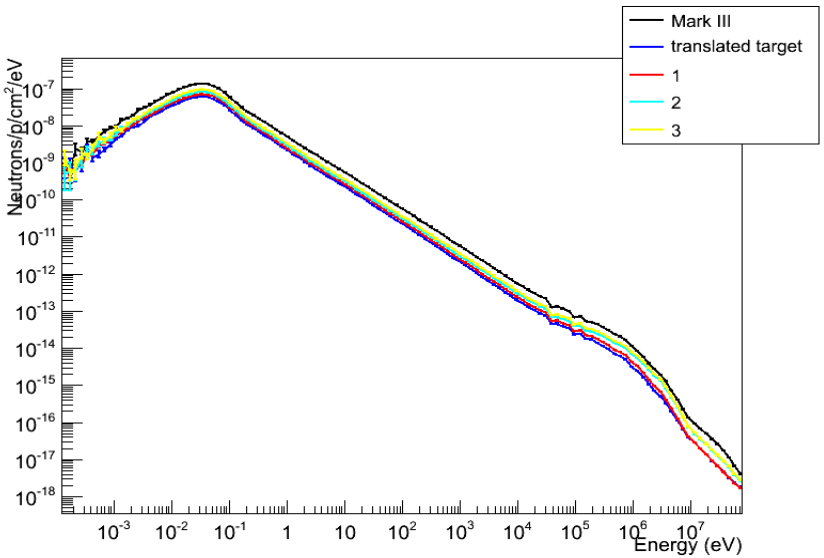
Uranium studies











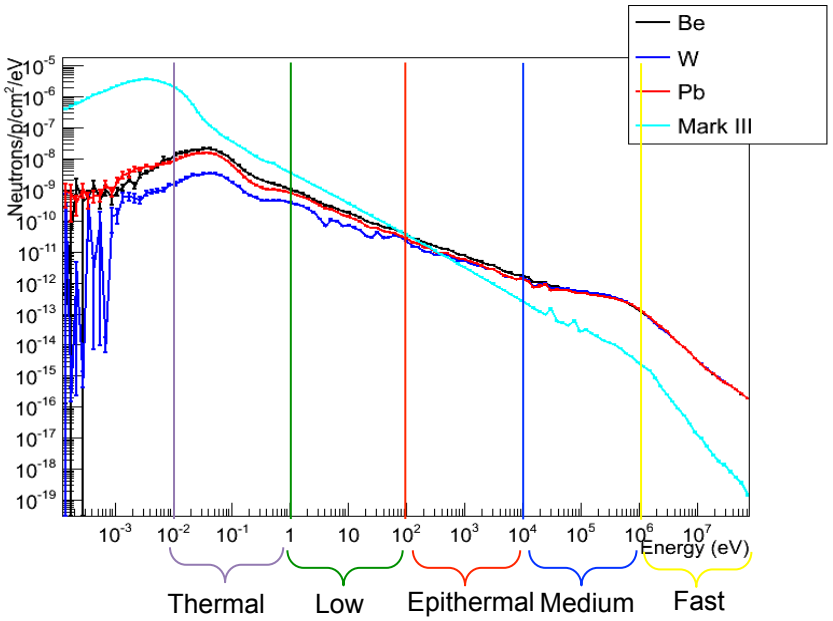
Thermal neutron beam intensity divided by 2 with translated target

Solutions : Uranium instead tungsten

Results :

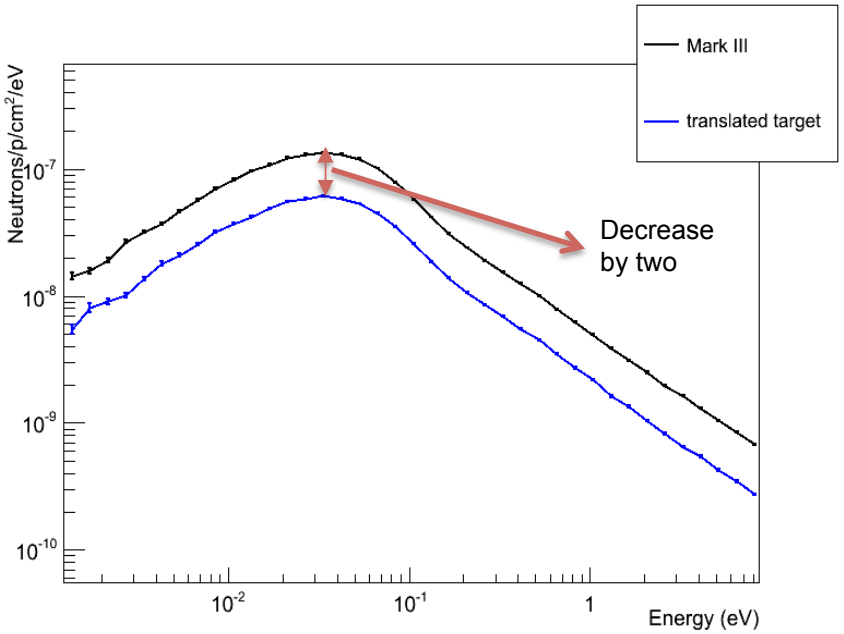
- Thermal neutron beam increase by 60% in the case 3
- Good but uranium target : waste and delayed neutron

Back up slides



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