Simulation of the ILL High Flux Reactor using MCNP and Tripoli

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Source models not satisfactory

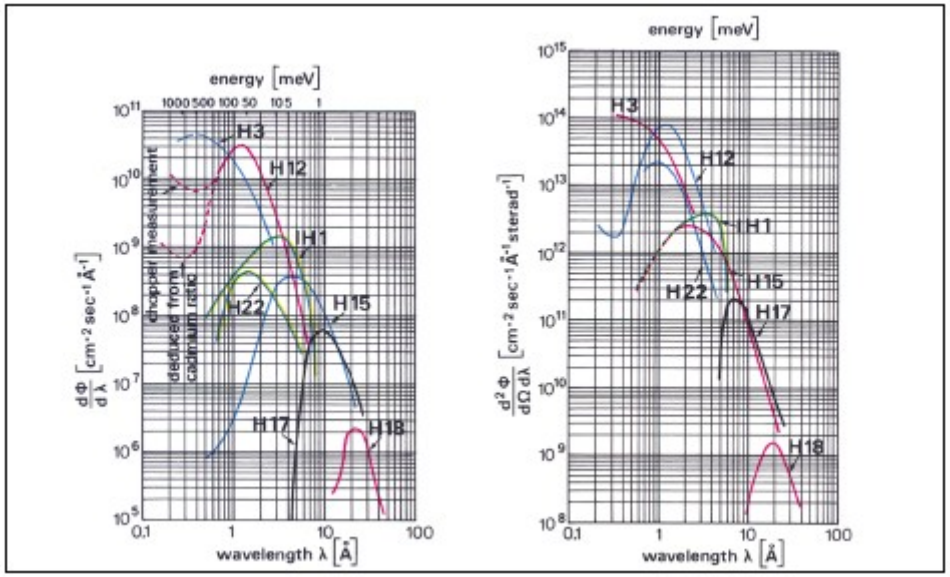
What do we know about the flux feeding ILL instruments ?

Not much... (nobody wants to go there)

- measurements on instruments (depends highly on configuration)
- gold foil capture flux
- flux models for beam tubes. few measurements (Ageron)

All these **do not match** each other.
Not satisfactory for simulations

Can we do better ?



Existing MC transport codes

MCNP

Computed the A-bomb
Invented the MC technique
Uses JEF2 and 3 (σ data base)

very HEAVY to handle
Considered as bug-free

http://mcnp-green.lanl.gov/index.html

Tripoli

The French MC-transport code
Uses JEF2 currently

Easy to handle
Still being developed

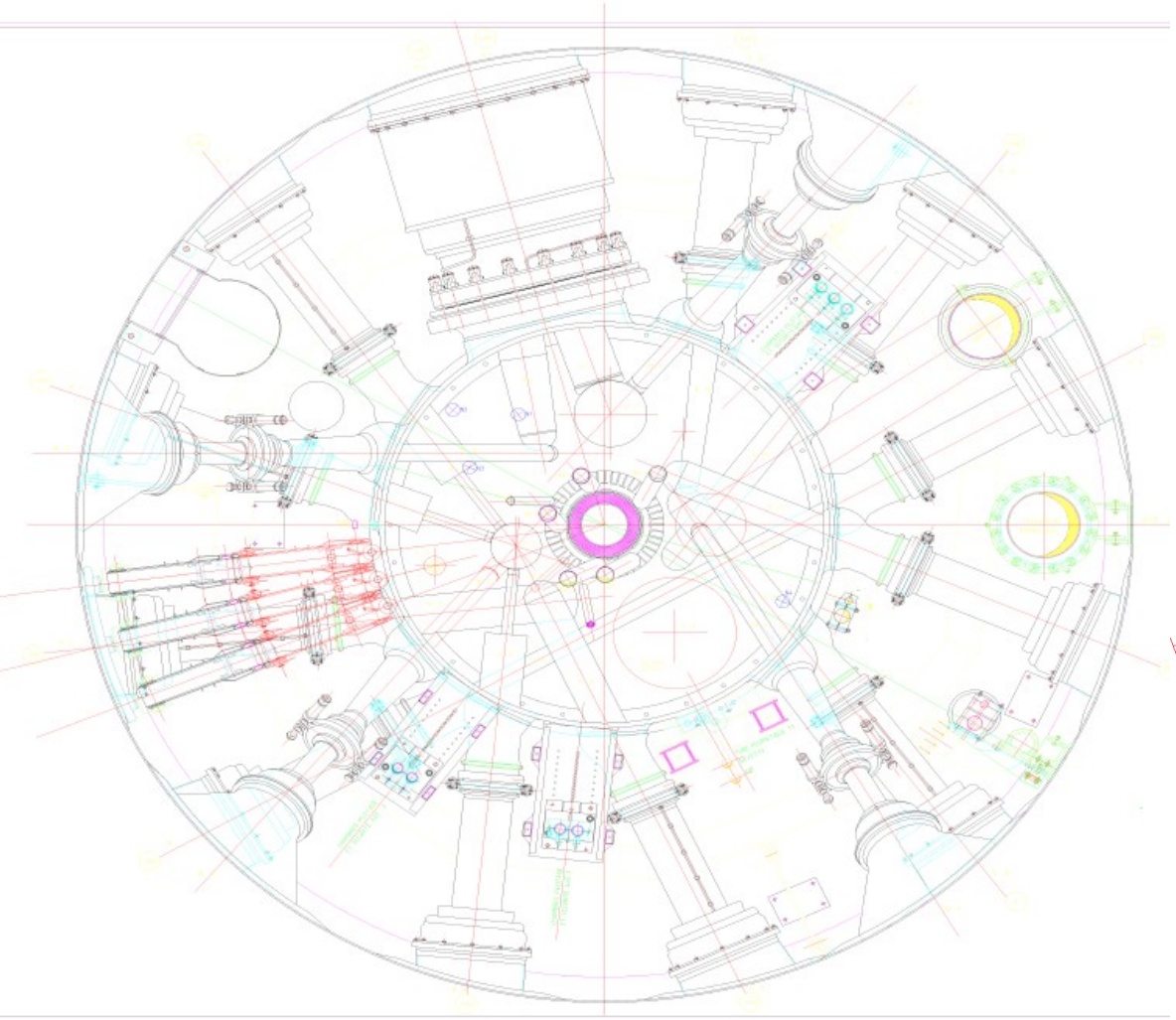
http://www.nea.fr/html/dbprog/tripoli-abs.html

These code can not 'go' far from the core

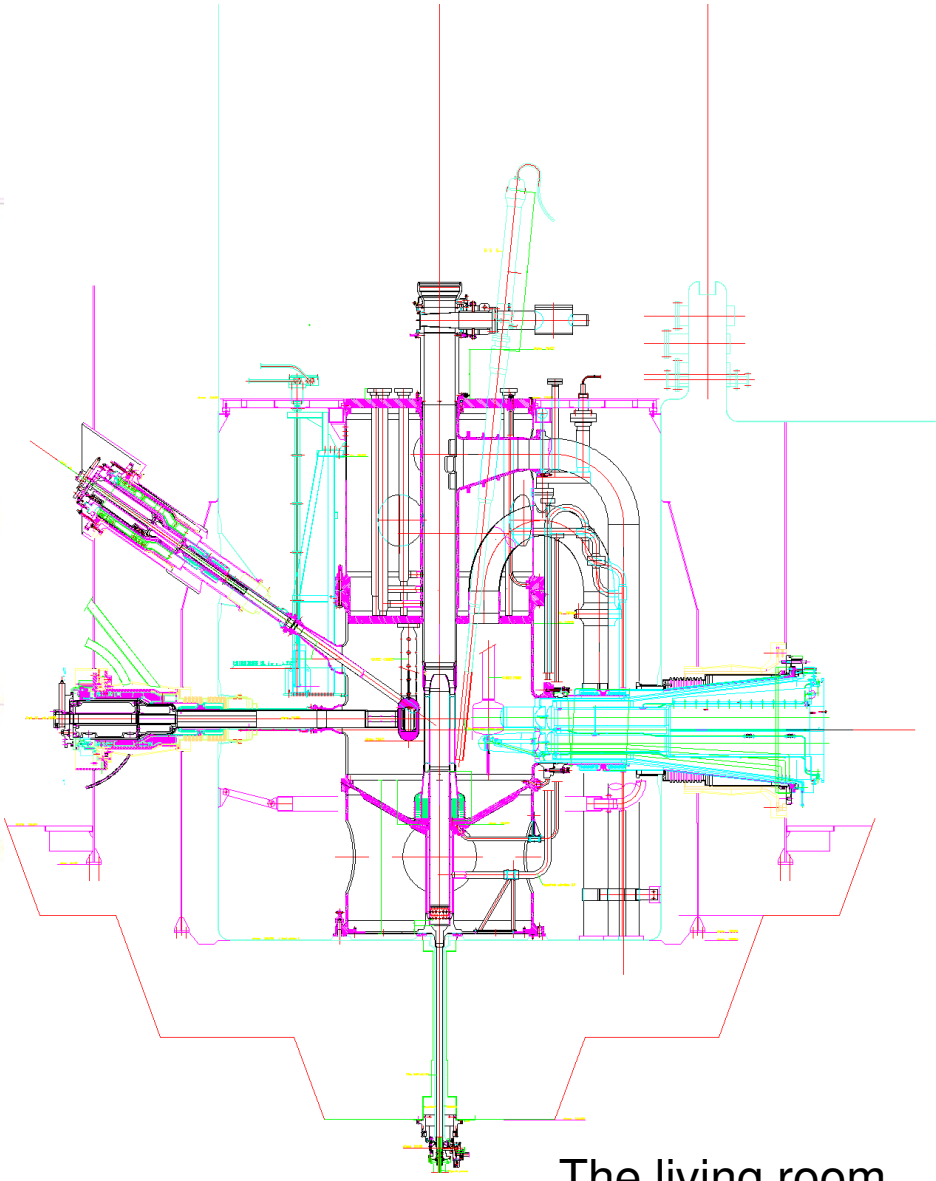
Require benchmarking closest as possible from reactor

Setting up the model

We first get the ILL drawings...
with the materials in use



The kitchen



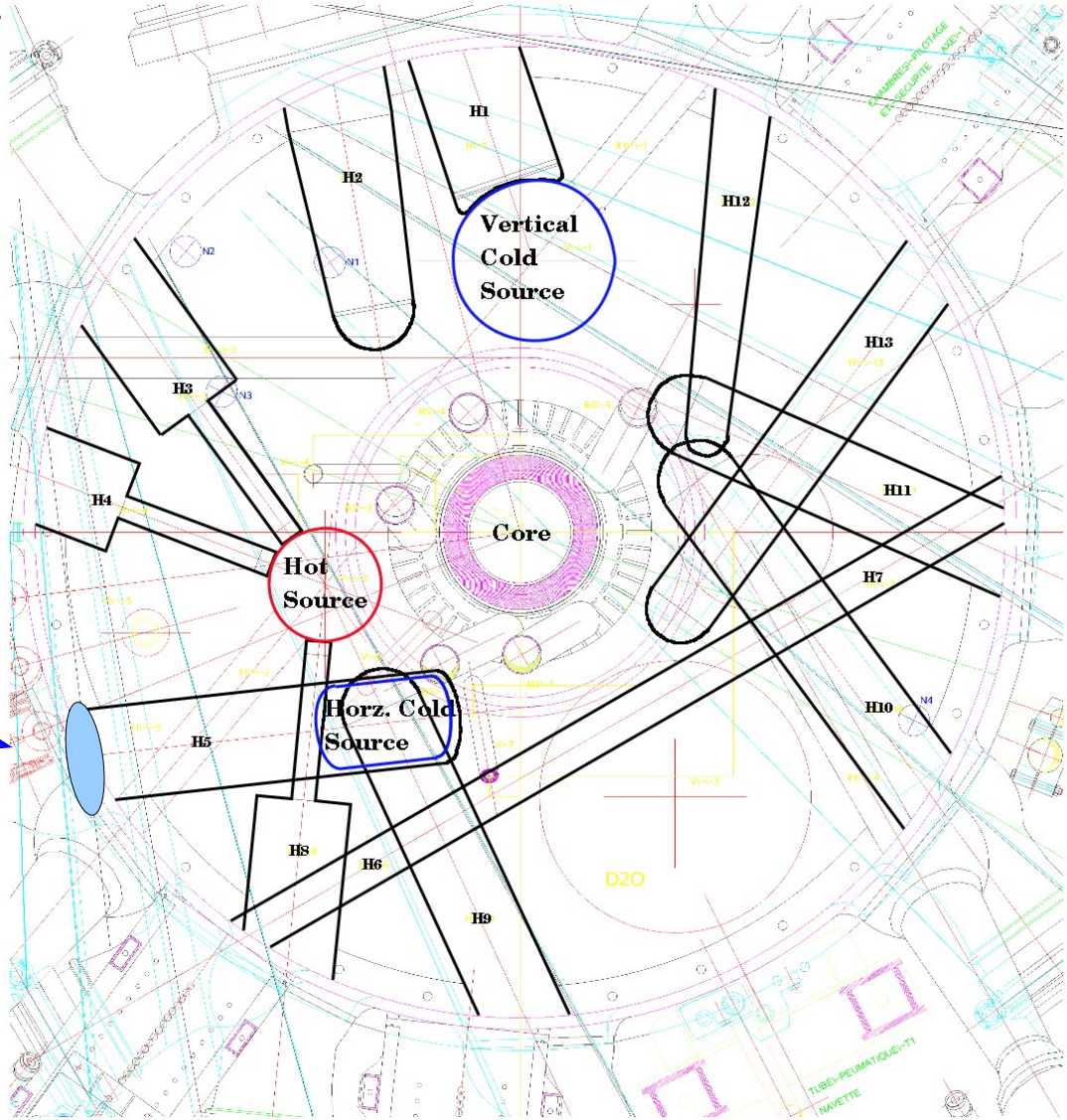
The living room

Defining the beam tubes

Beam tubes are defined as well as storage areas:

13 tubes

Exit of D2O vessel



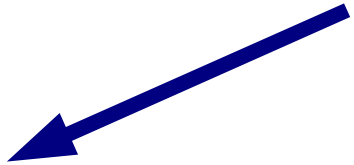
Simulating events from the core

MCNP	Tripoli
Each beam tube simulated	Complete reactor model All beam tubes together
Using variance reduction Simulation time 1 week/tube	No variance reduction Simulation 6 months
Data files 200 Mb with 10^6 events PTRAC card	Data files 100 Mb for 10^6 events BATCH file

Example files

Tripoli BATCH file

```
STOCKAGE 1
/users/Stockcoeur2/stockcoeur
TAILLE LIMITE 150
NEUTRON 3. 1.e-11
FILTRE OU
VOLUME LISTE 3 1 7 12
FRONTIERE LISTE 19
<list of volume boarders>
  FIN STOCKAGE
```



Storage of particles crossing surface(s) from volumes :
201 to volume 20161
Their energies are between : 3 and 1e-11 MeV.
Following lines are : type, energy in MeV, position = (x,y,z) in cm, direction = (u,v,w), statistical w

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Data on the original simulation which generates this file :

```
NB_BATCH     20000
TAILLE     10000
PARTICULE    NEUTRON
INTENSITE     1.00002
SIMULATION   CRITICITE
```

```
BEGIN_OF_BATCH      1
NEUTRON      1.76158e-08 -12.0517130.052 13.9544 -0.128722     0.721192      -0.680671
NEUTRON      6.21019e-08 -3.39159132.859 16.9216 -0.228279     0.766565      0.600223
```

MCNP PTRAC file

```
ptrac      file = asc
           max  = -1000000   // number of neutrons to generate and stop
           write = all
           event = sur
           filter = 1020,jsu // surface id
```

```
  -1
mcnpx   2.4.0Thu Aug 01 08:00:01 MST 2002  08/23/06 14:43:11
HFR Grenoble
  1.3000E+01  1.0000E+00  1.0000E+02  0.0000E+00  1.0000E+00  3.0000E+00  1.0000E+00  1
  1.0200E+03  1.8000E+01  9.9620E-01  1.0000E+00  4.0000E+00  1.0000E+00  1.0000E+06  0.
  0.0000E+00  0.0000E+00  0.0000E+00  1.0000E+00  2.0000E+00  0.0000E+00  0.0000E+00  0
   2   6   9   7   9   7   9   7   9   7   9   1   4   0   0 0   0   0   0   0
   1   2   7   8   9 17 18 19 20 21 22 23 24 25 26 27 28   7   8 10 11 17 18 19 20 21 22
  26 27 28   7   8 12 13 17 18 19 20 21 22 23 24 25 26 27 28 7   8 10 11 17 18 19 2
  24 25 26 27 28   7   8 14 15 17 18 19 20 21 22 23 24 25 26 27 28
    10001      3000
     9000        3      1020        1      1001         0         0
  0.12514E+03 -0.14956E+02  0.22558E+02  0.99954E+00 -0.15686E-01  0.25806E-01  0.21912
...
```

Simulating capture fluxes

McStas new components

Virtual_mcnp_input

Reads a PTRAC as a source

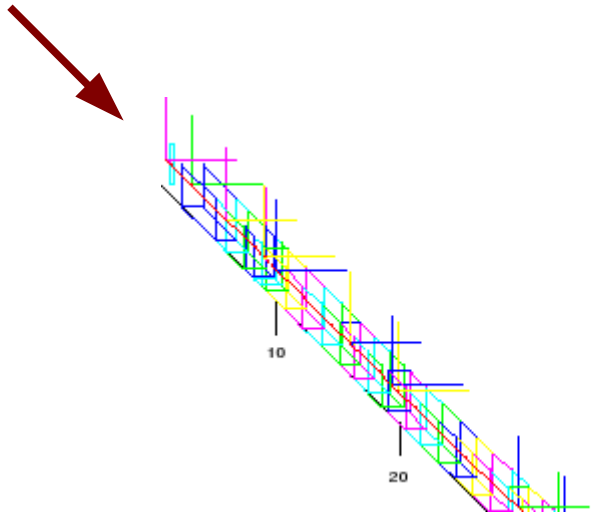
Virtual_tripoli_input

Reads a BATCH as a source

Capture flux (gold)

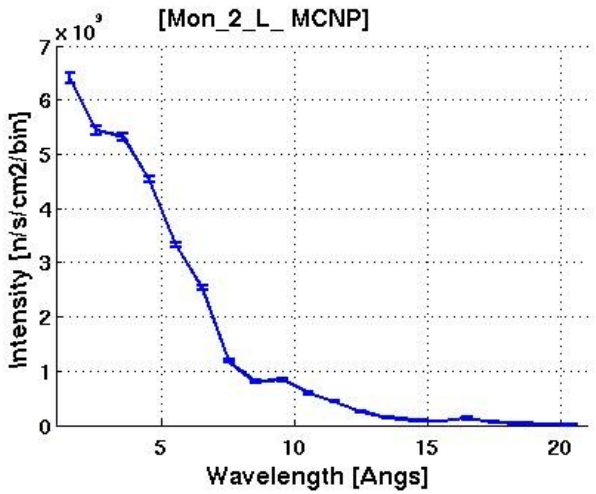
$$\Phi_c = \int_0^{500\,meV} \Phi(\omega)\frac{\lambda}{\lambda_{2200}}\,d\omega$$

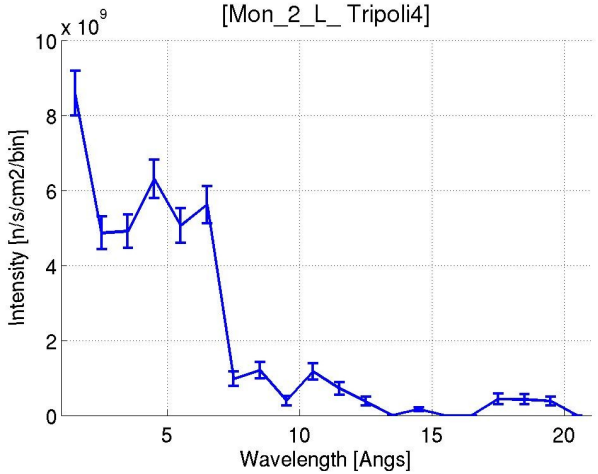
(cf Ageron)

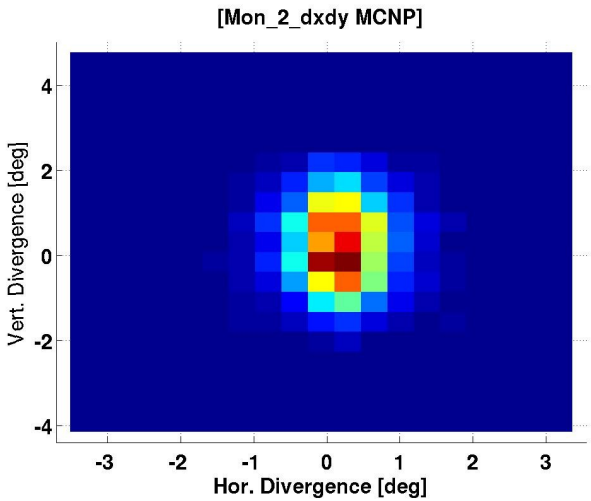


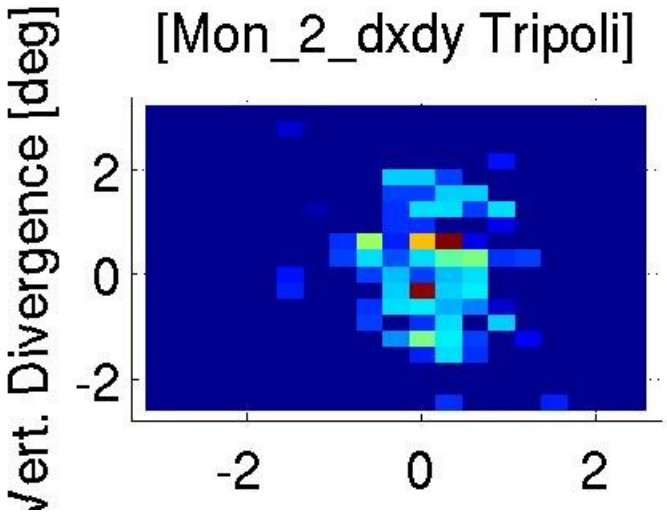
Beam tubes: H1 (cold)

MCNP	Measure	Tripoli	
2.4	2.0 (11.9 m)	5.0	x10^{10} n/s/cm^2
1.56	1.6 (21.6 m)	4.0	



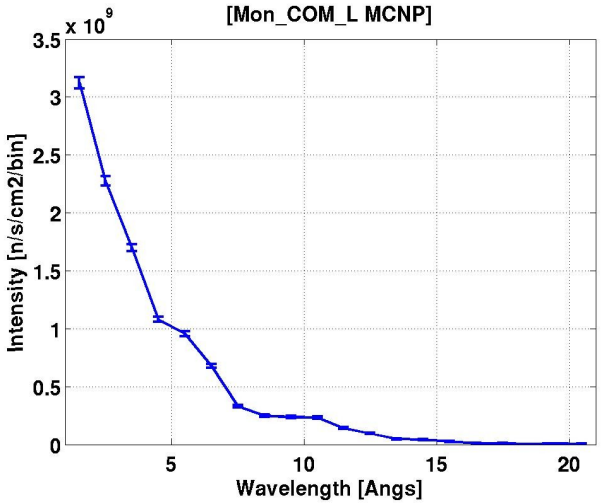


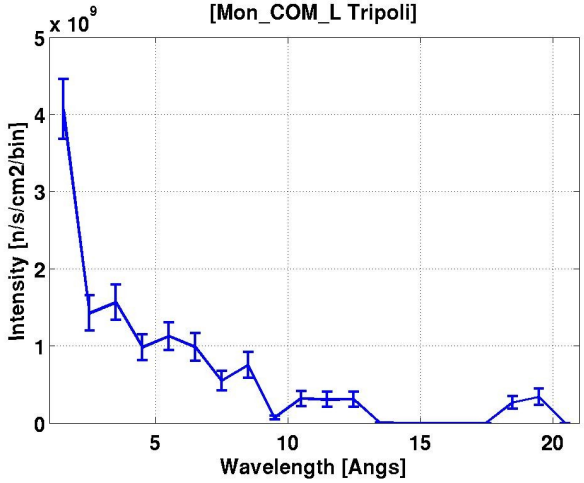


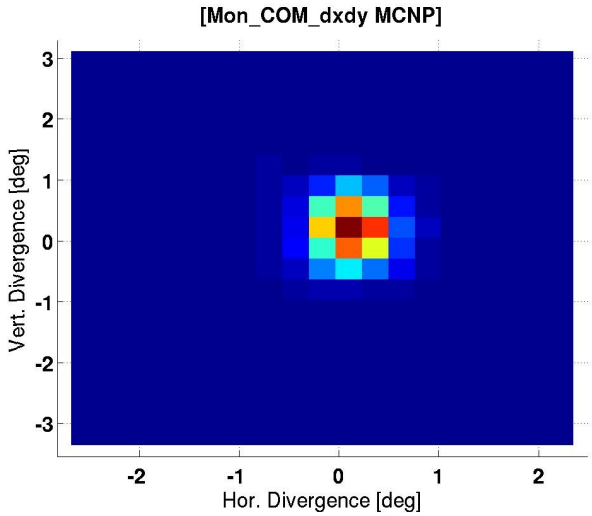


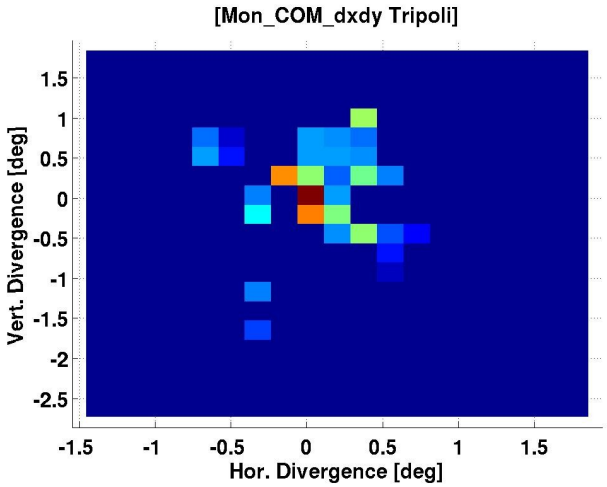
Beam tubes: H5 (cold)

MCNP	Measure	Tripoli	
2.56	4.3 (9.5 m)	3.6	x10^{10} n/s/cm^2
1.68	2.7 (19 m)	2.57	



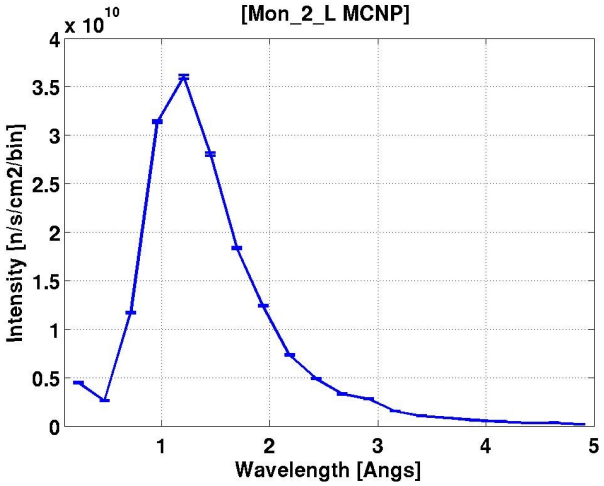


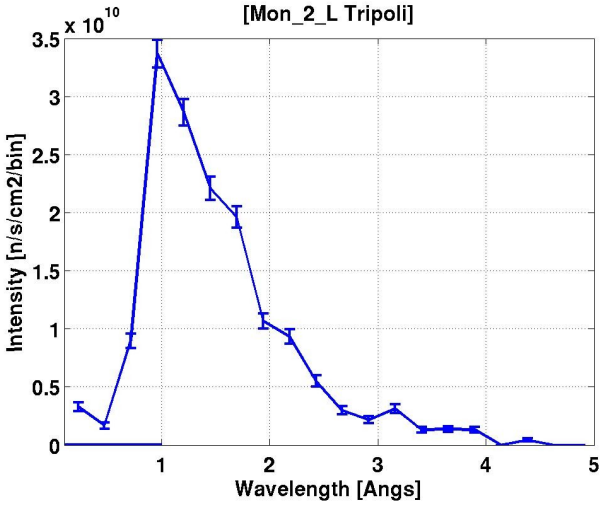


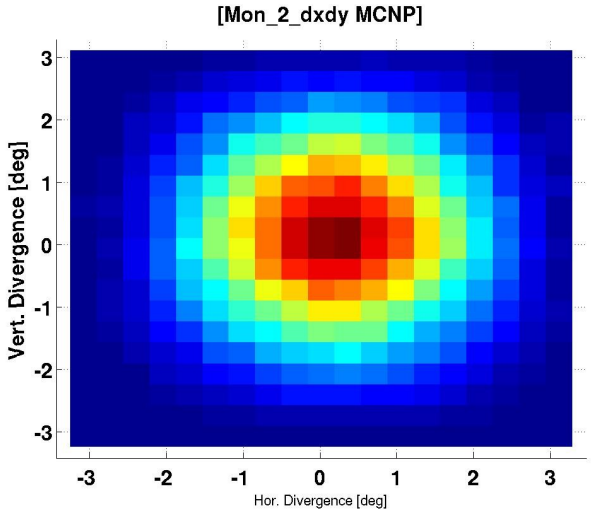


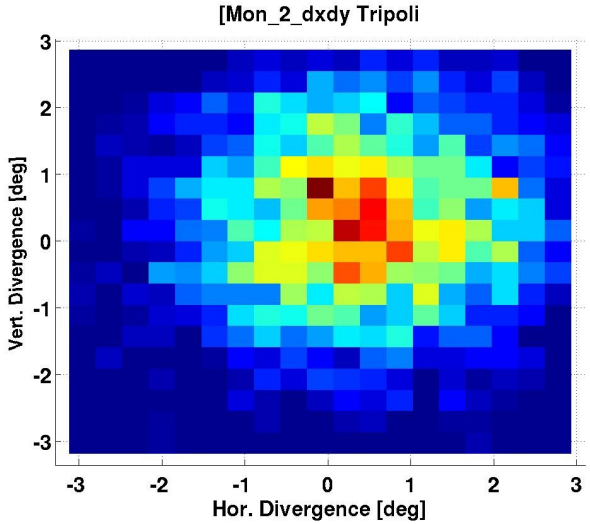
Beam tubes: H10 (thermal)

MCNP	Measure	Tripoli	
11.38	8.5 (5.2 m)	11.29	x10^{10} n/s/cm^2









Conclusion

This study is still going on NOW:

- just wait for neutrons to be stored.

First benchmarking of MCNP, Tripoli and measurements

Accuracy is satisfactory:

- no adjustable parameters !
- only geometry and materials

Limitation: number of events in the file

Components are Available in McStas v1.10