The Line for Fast Neutron Irradiation of Electronic Components at the European Spallation Source

Alberto Milocco (Milano-Bicocca University, Milano, Italy)
Giuseppe Gorini (Milano-Bicocca University, Milano, Italy)
Stuart Ansell (Rutherford Appleton Labs, Harwell, UK)
Rikard Linander (ESS AB, Lund, Sweden)
Luca Zanini (ESS AB, Lund, Sweden)

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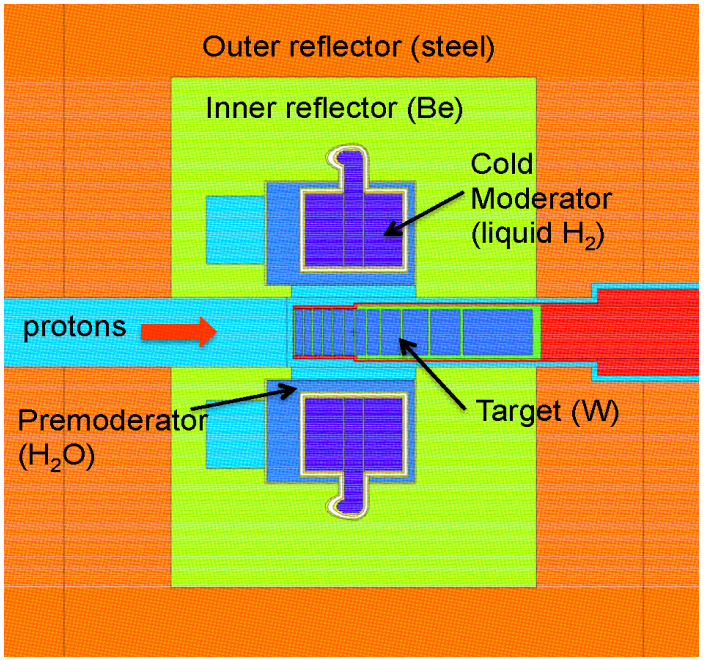
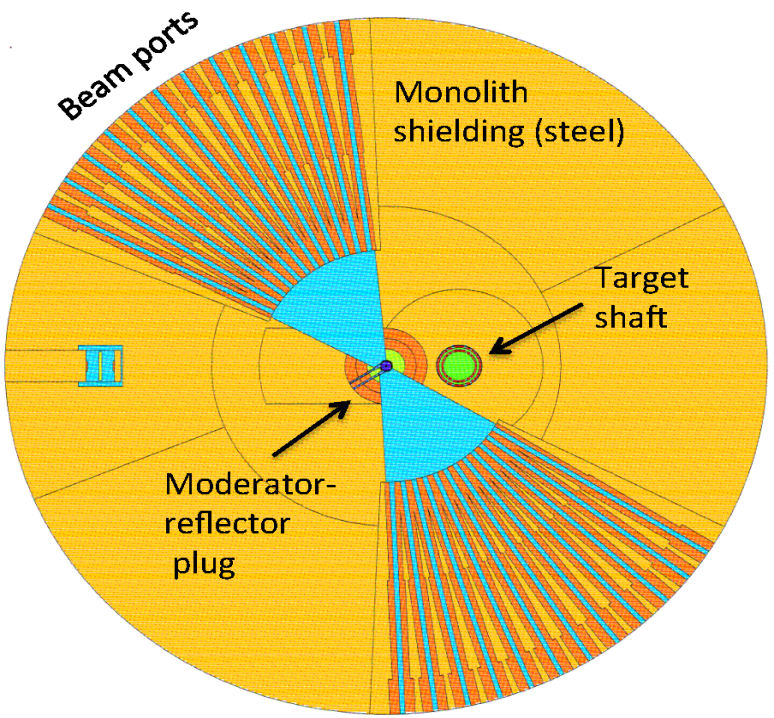
Major ESS parameters

- ✗ Proton kinetic energy: 2.0 GeV
- ✗ Average beam power: 5 MW
- ✗ Annual operating period: 5200 hours
- ✗ Target material: Tungsten
- ✗ Target geometry: 2.5 m diameter wheel
- ✗ Number of moderators: 2 (symmetrical)
- ✗ Moderator material: H_2
- ✗ Moderator geometry: 13 cm (h), 8 cm (r)
- ✗ Premoderator: 1 cm water layer
- ✗ Potential number of instruments: 44
- ✗ Separation of ports: 5 degrees

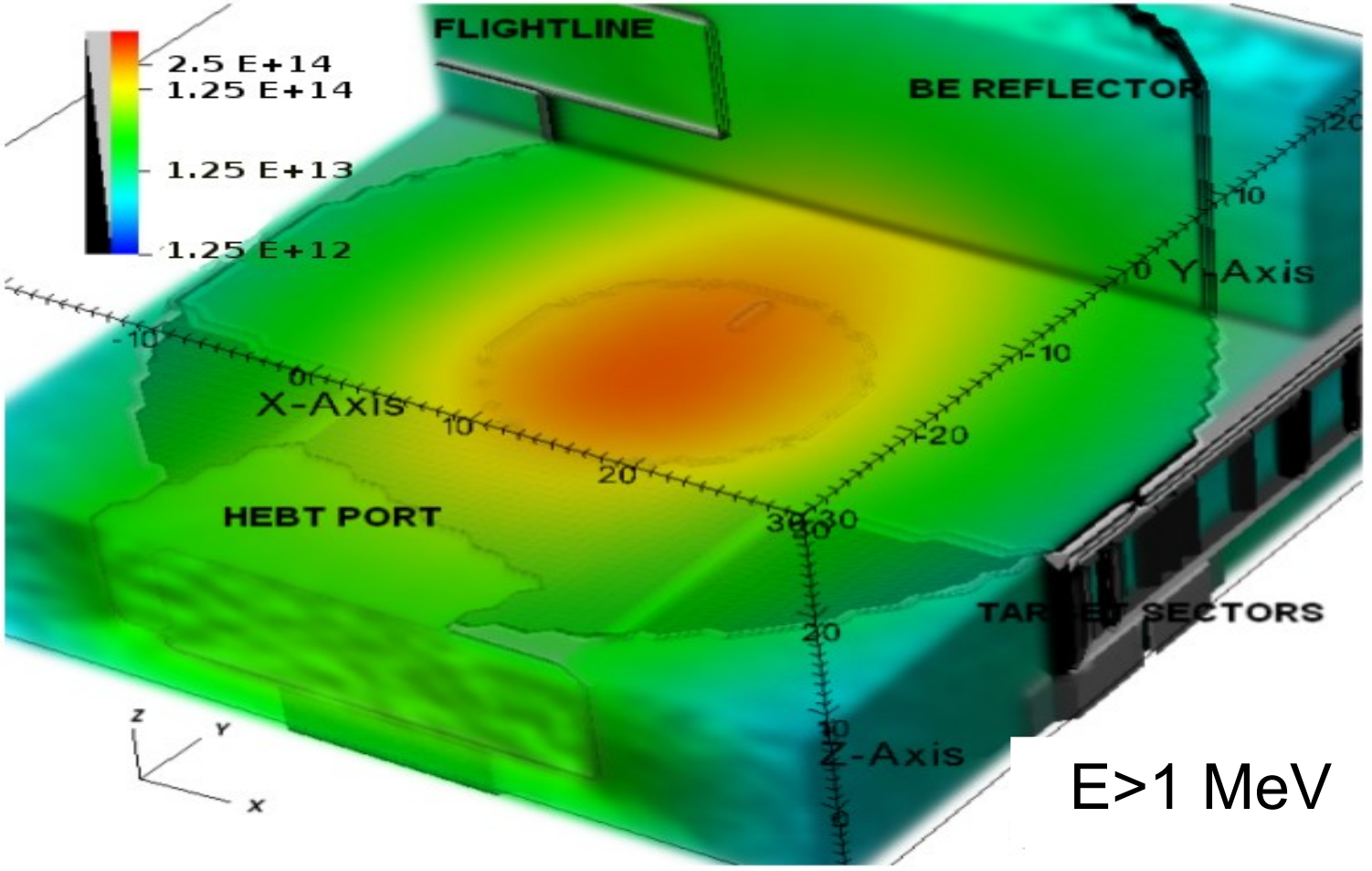




ESS Neutronics

- **MCNPX** is the proton & neutron transport code outside beamlines
- The **CombLayer** code is used for building the MCNPX input files
- The reference ESS model is modified to include in the monolith **fast neutron irradiation lines**, based on consideration of the high energy neutron fluxes achievable close to the target

10^{15}n/cm^2/sec
at 5 MW
above .1 MeV



ECHIR Line: Introduction

- ECHIR=Ess CHip Irradiation
- Proposal at SAC
- Reference neutron spectrum from QINETIQ athmospheric model at 15 Km

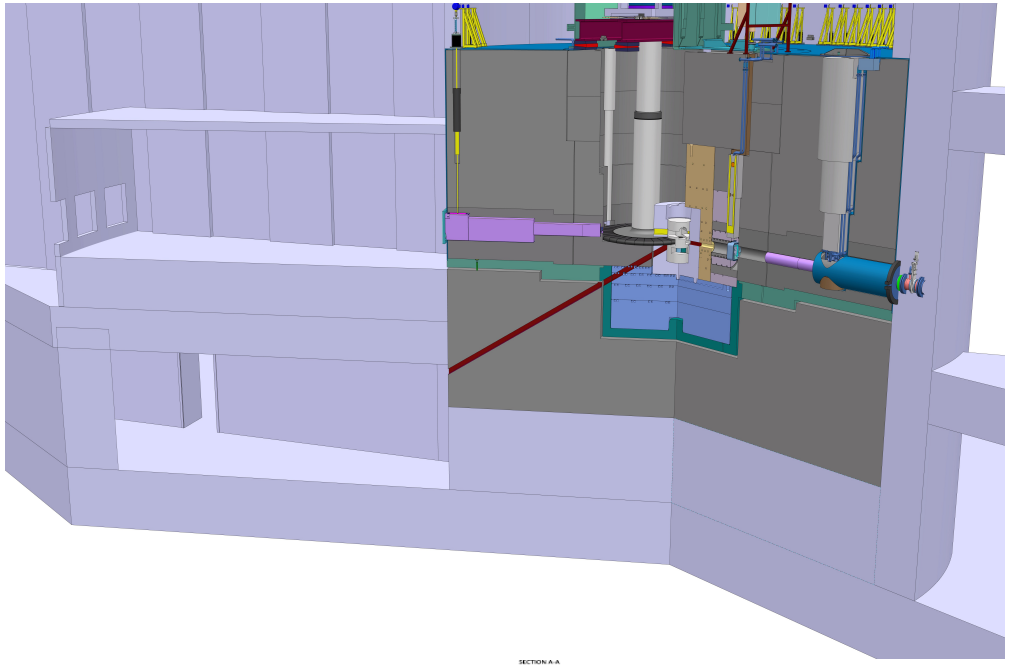
ECHIR Line: Preliminary Outcomes

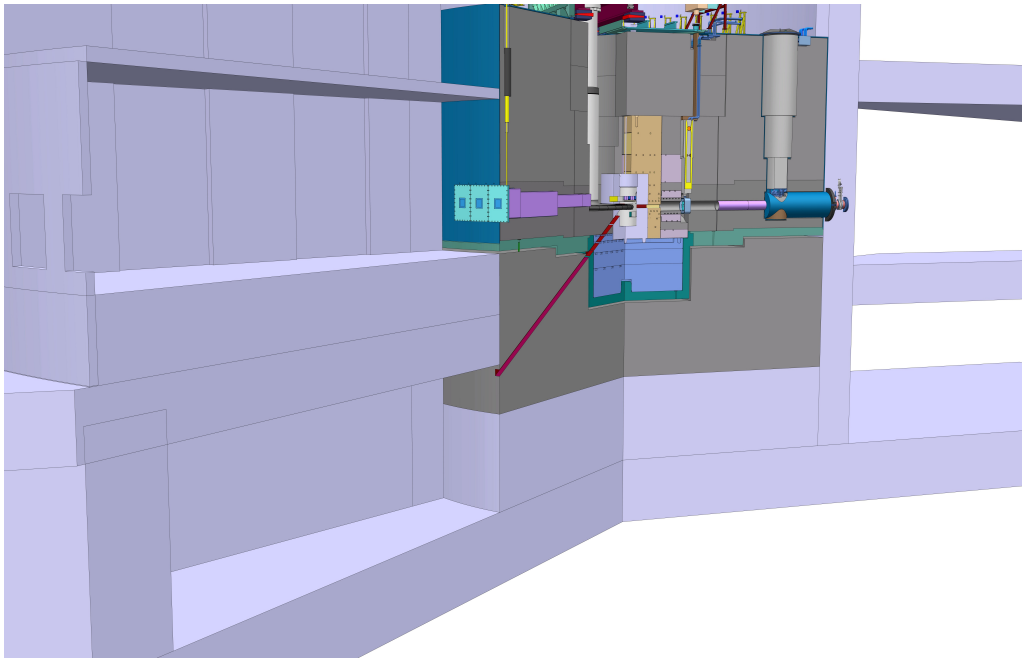
- Forward high energy tail of source neutrons is beneficial
- Rotation in the vertical plane is better to avoid target wheel shielding
- Closer the monolith edge, higher the usable flux magnitude

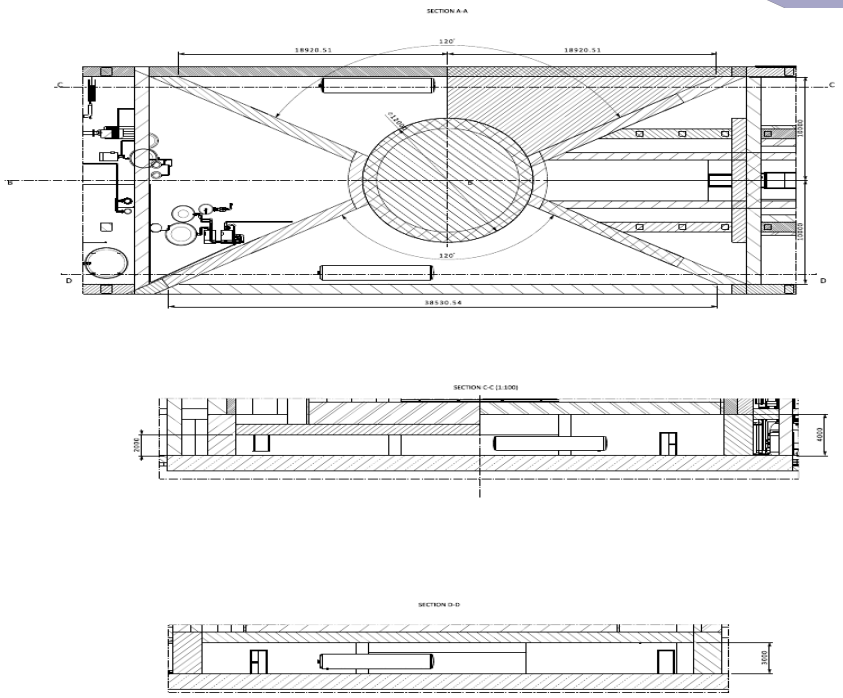
ECHIR Line: Design Choices

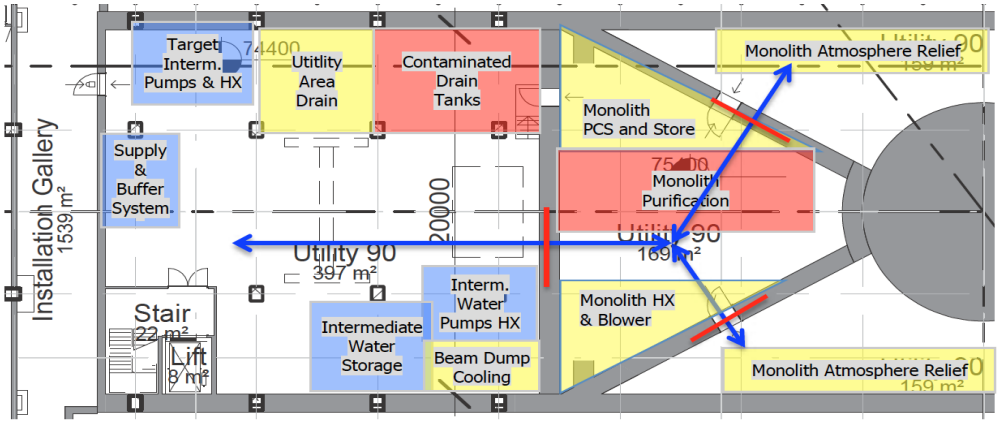
- ECHIR attaines neutrons from the irradiated Tungsten wedge
- Neutrons stream across a rectangular duct in the monolith (10 cm X 22 cm cross section)
- The duct goes in a forward direction, rotated by 30 degrees downwards in the vertical plane and 42 degress to the left in the horizontal plane
- The flood room would be intalled at an utility room in the ESS basement

ECHIR Line: CAD Layouts

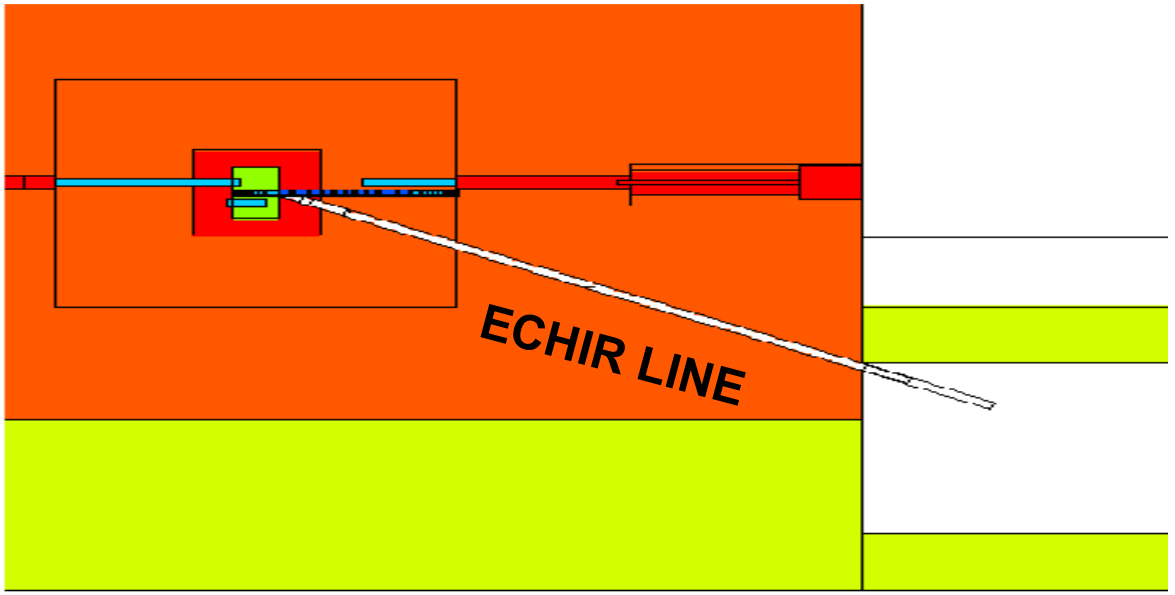


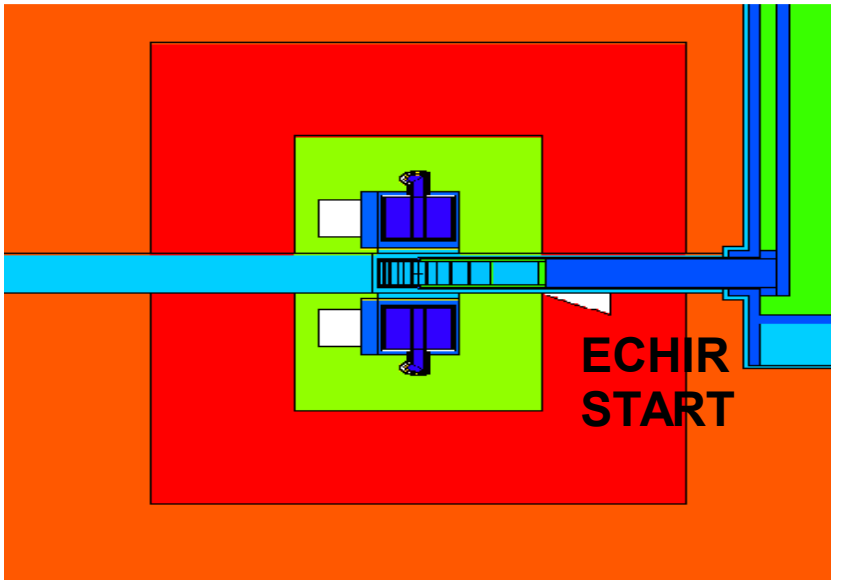


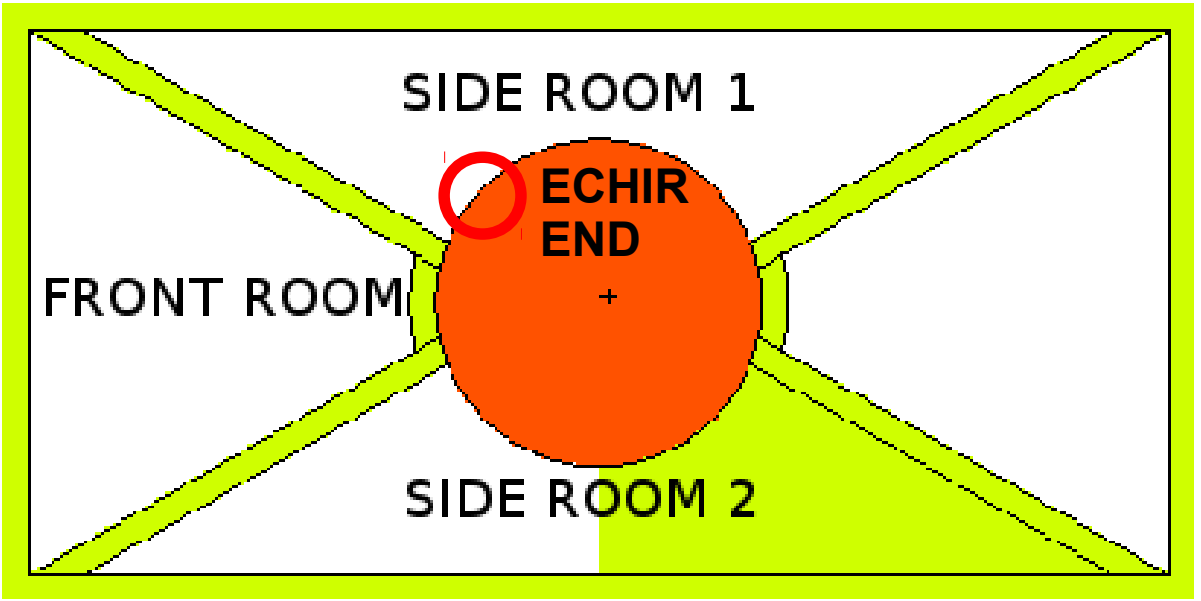


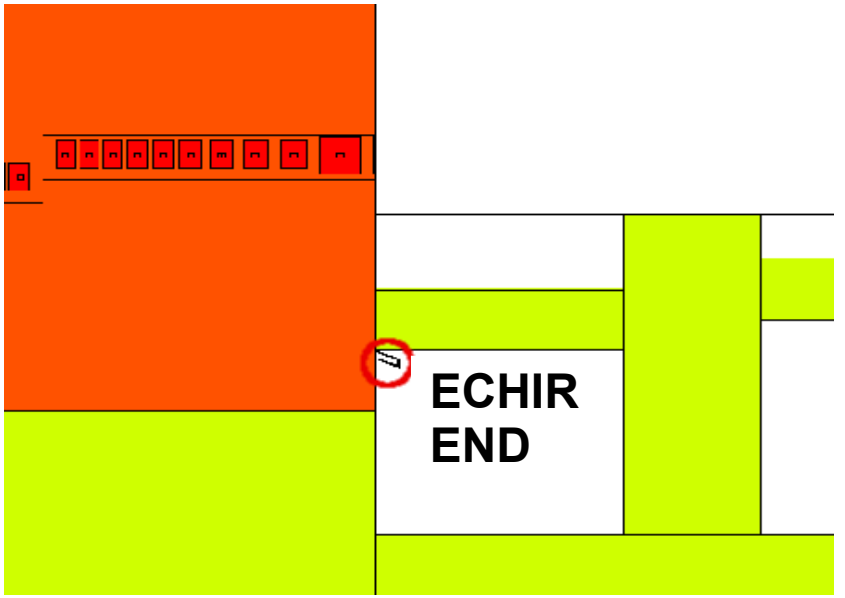


ECHIR Line: MCNP modeling

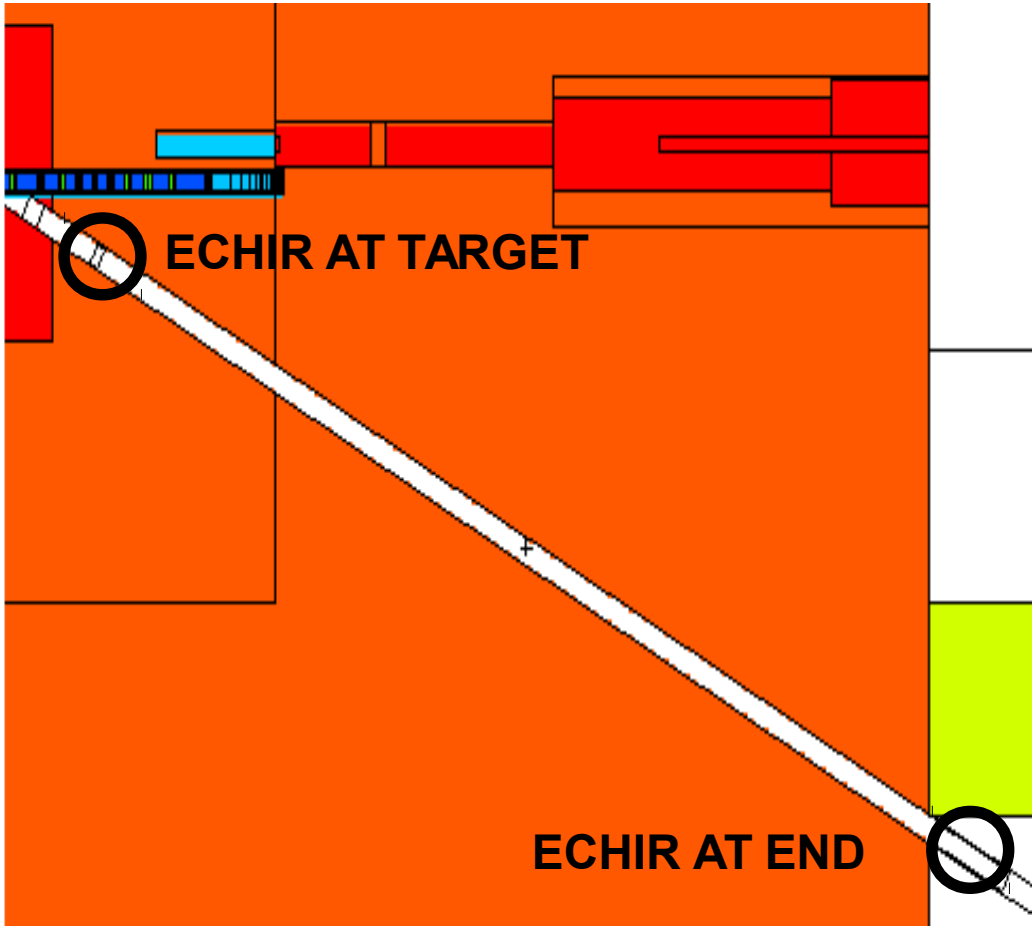


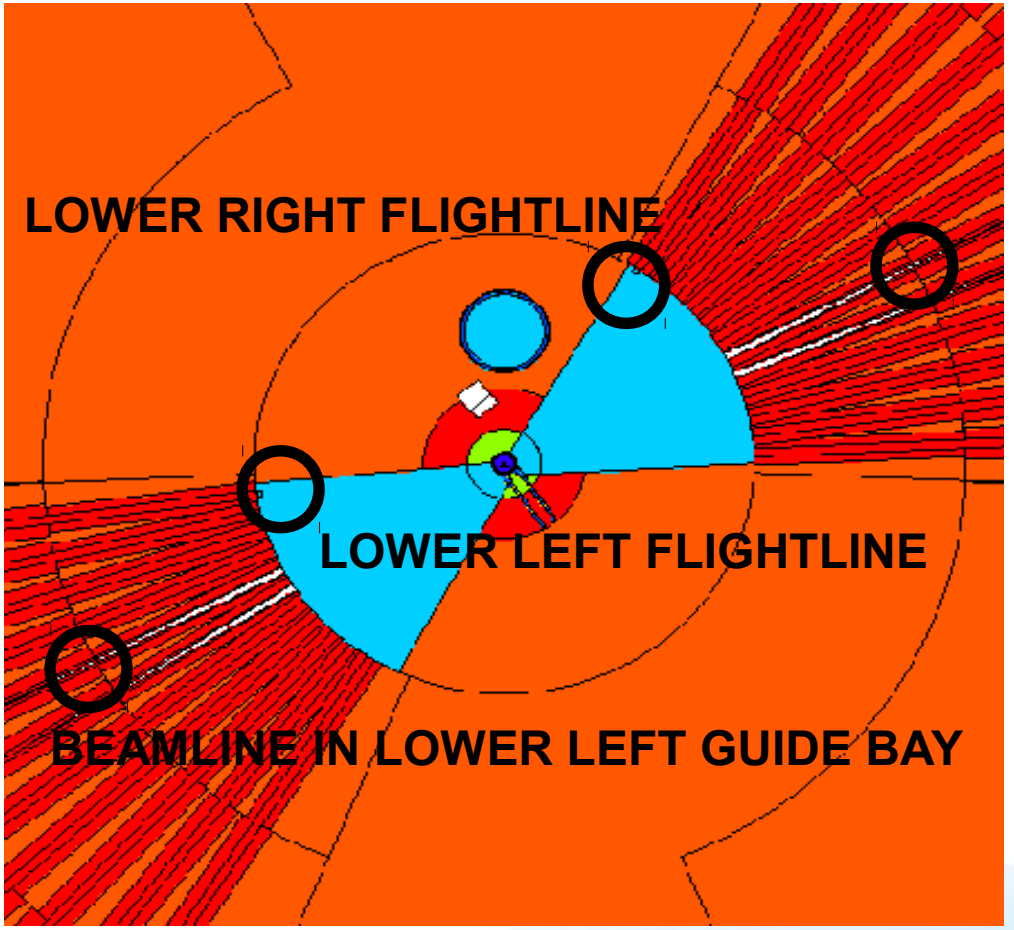




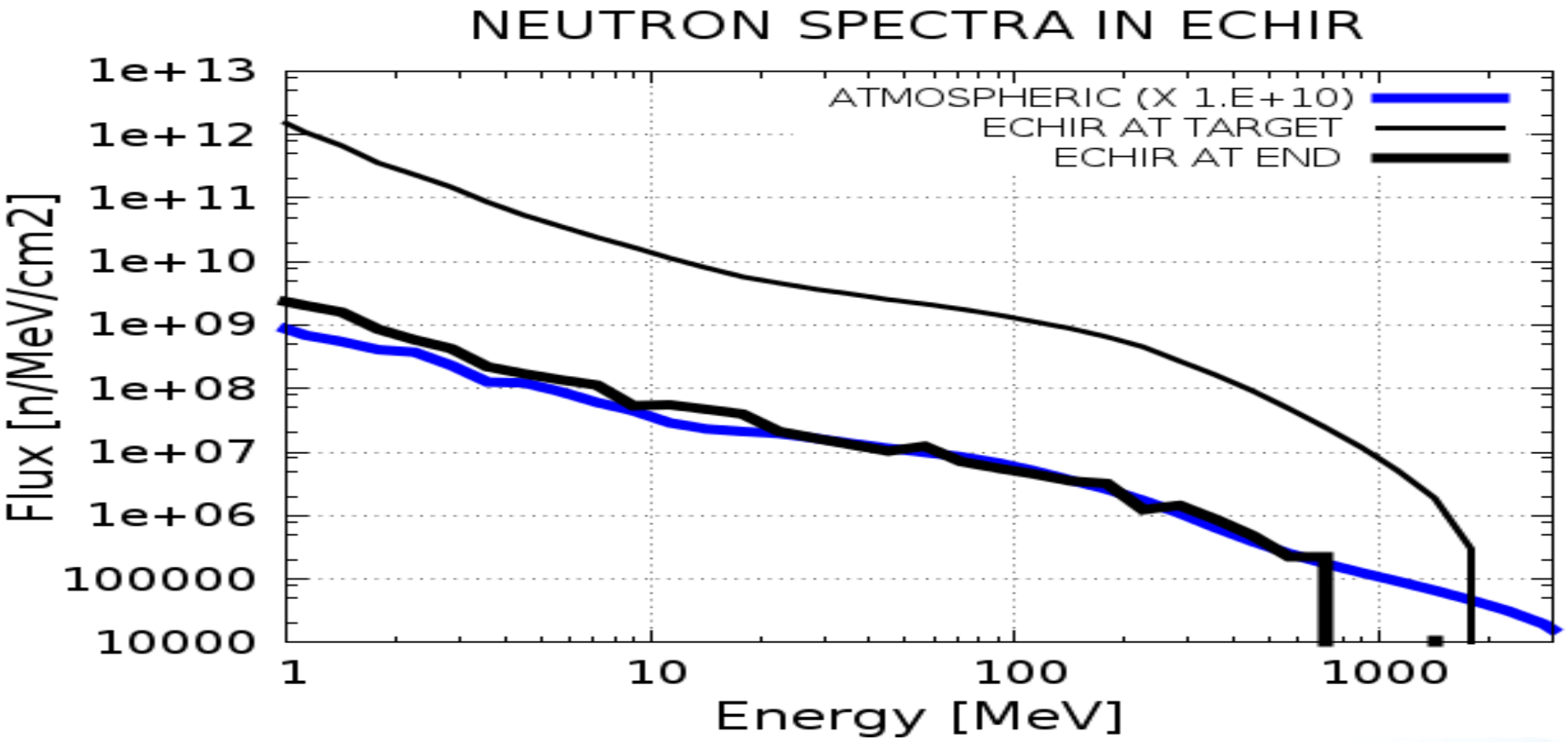


Detectors for ECHIR Flux Calculations



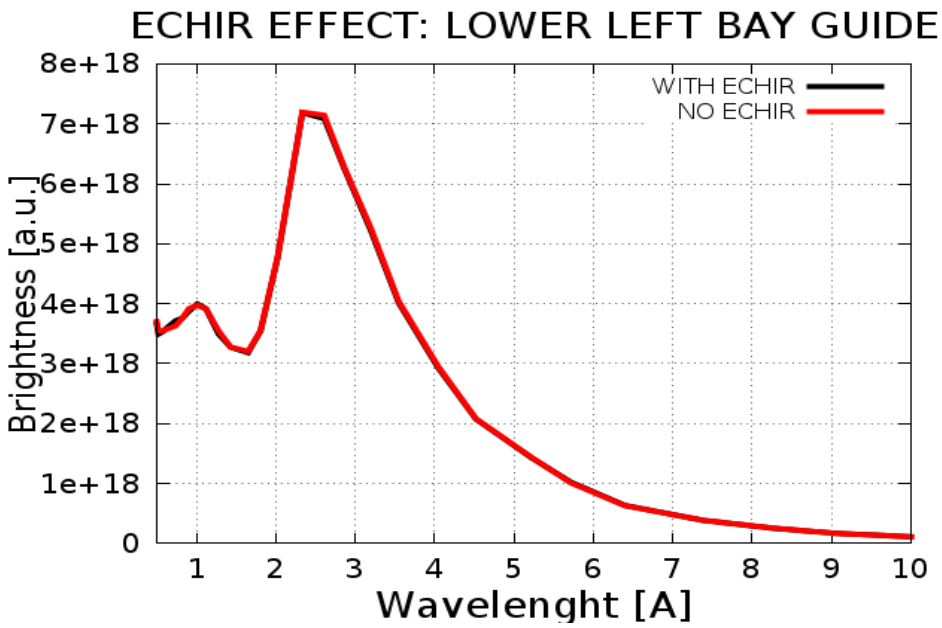


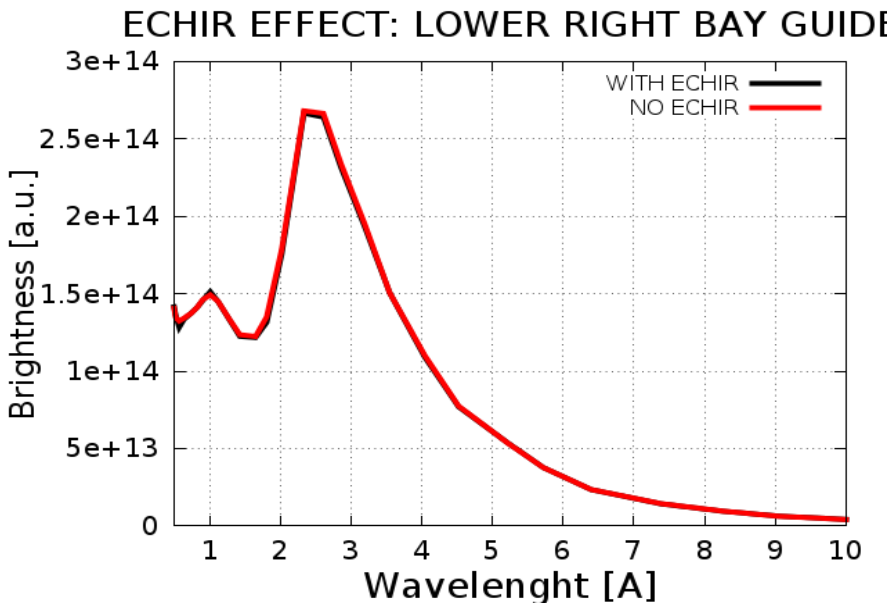
ECHIR Line: Neutron Flux

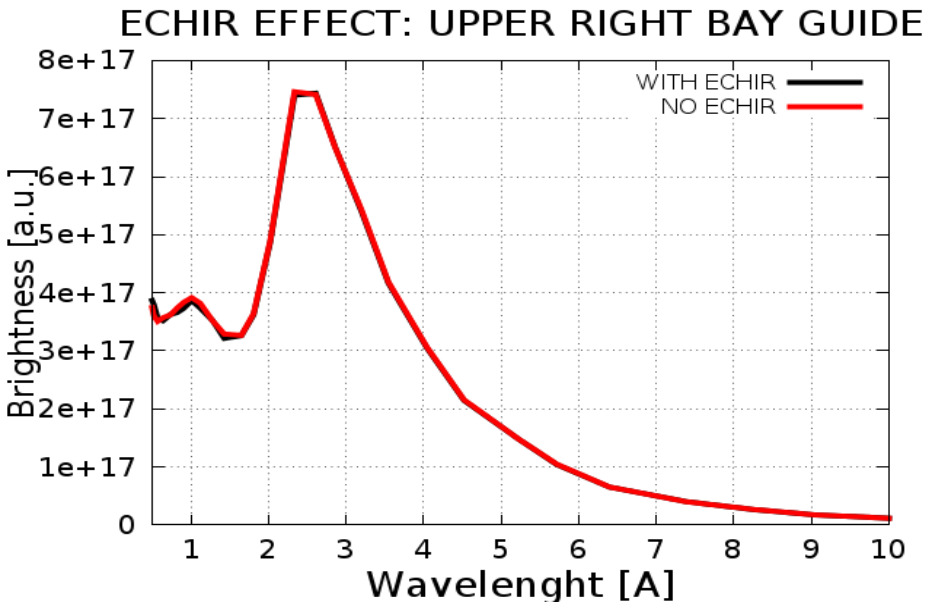


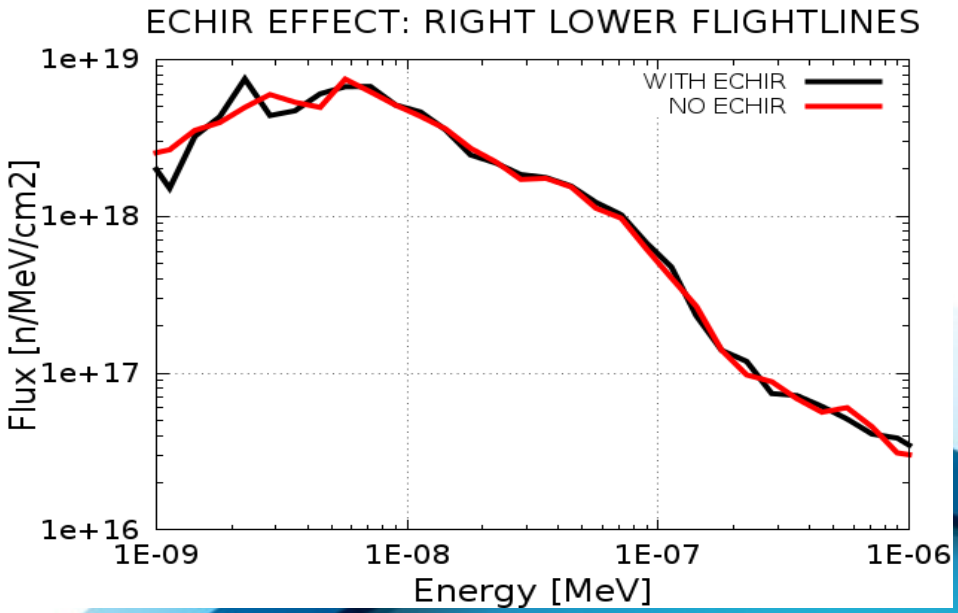
- Excellent agreement with reference spectrum above 20 MeV
- Flux greater then E+5 for E<700 MeV
- ~E+10 n/s at 5 MW in collimator room
- Integral flux in flood room might be high

ECHIR Line: Beamlines' Performance

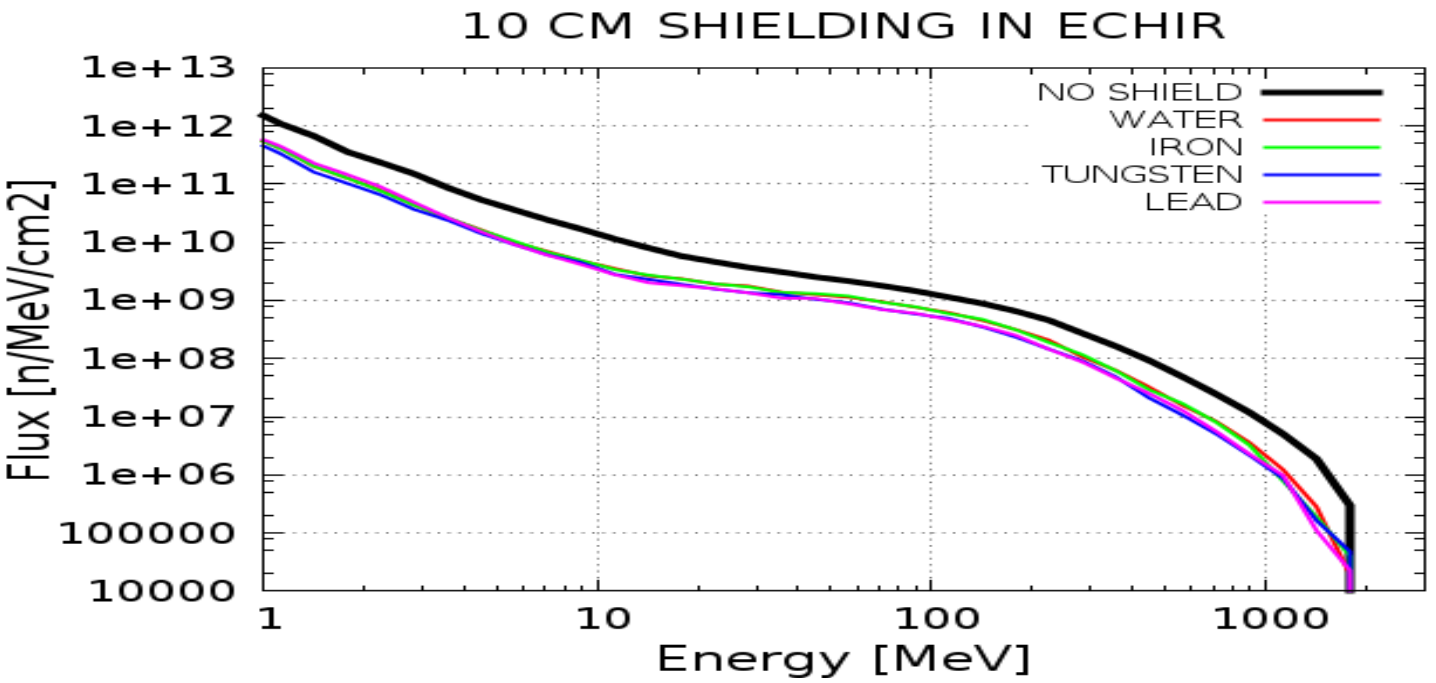


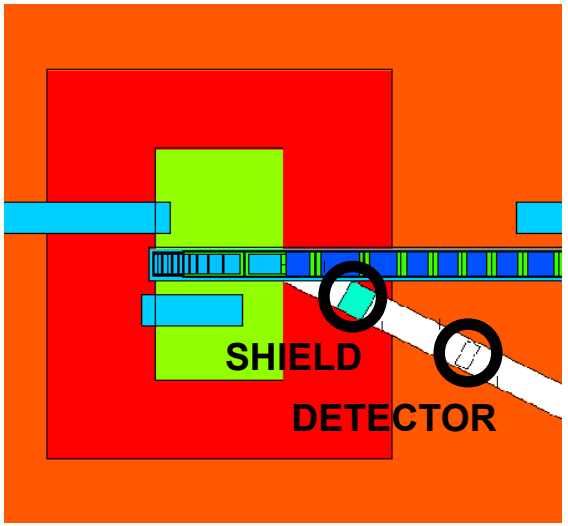


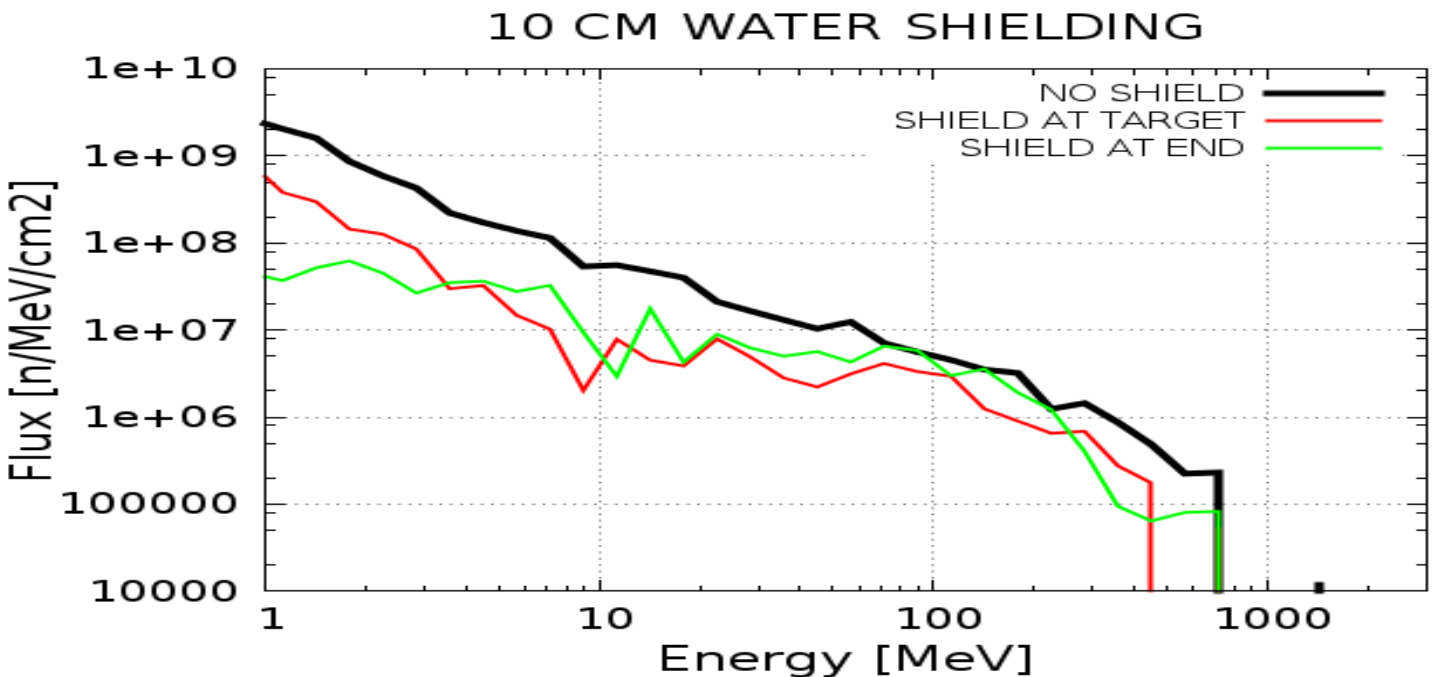


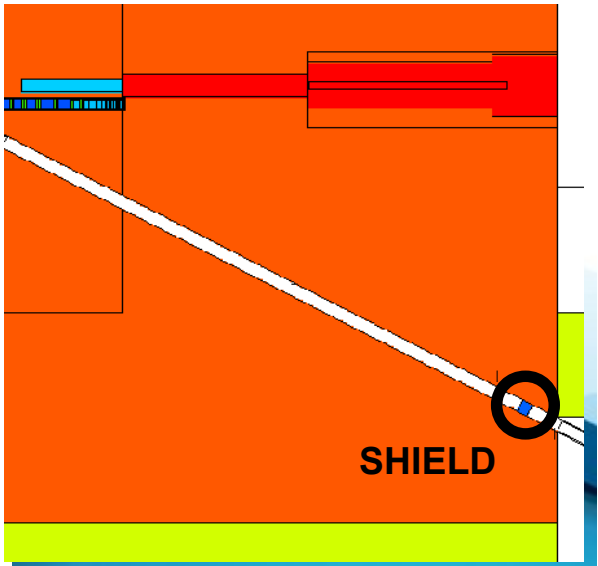


ECHIR Line: Flux Shaping /1

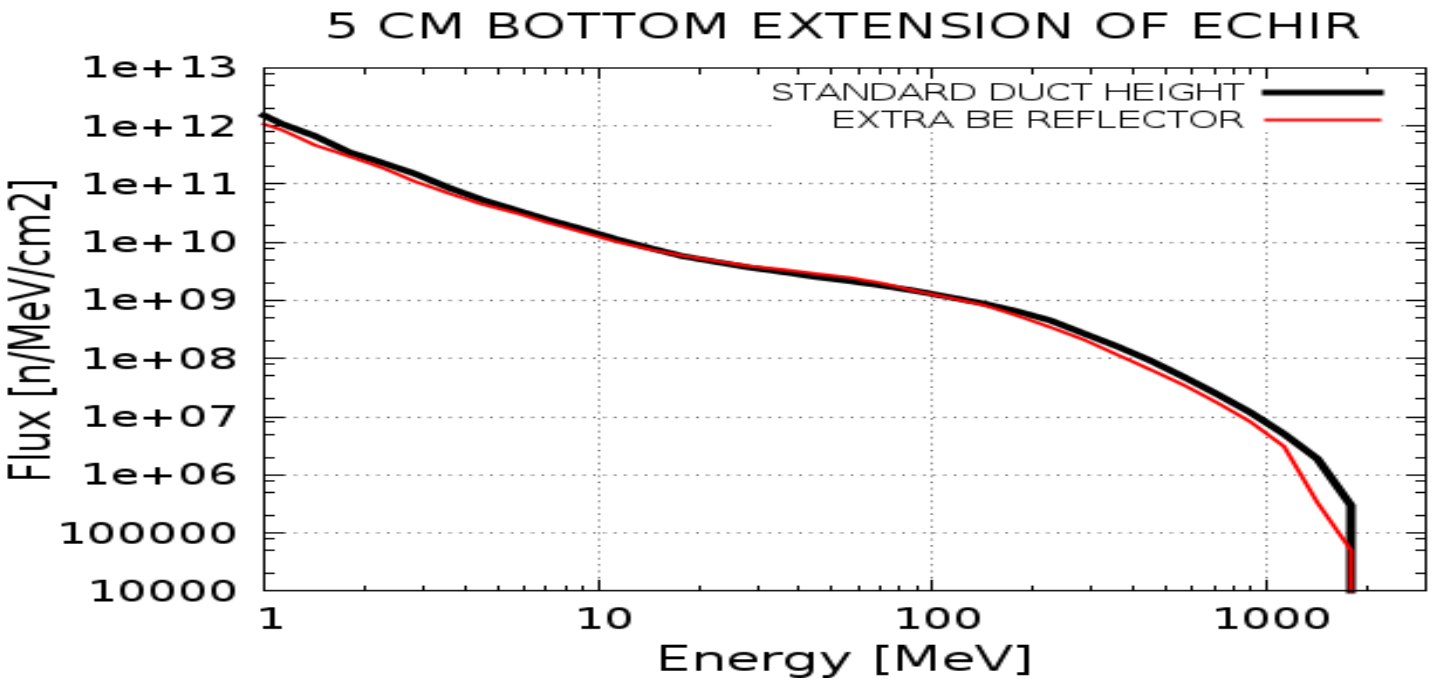


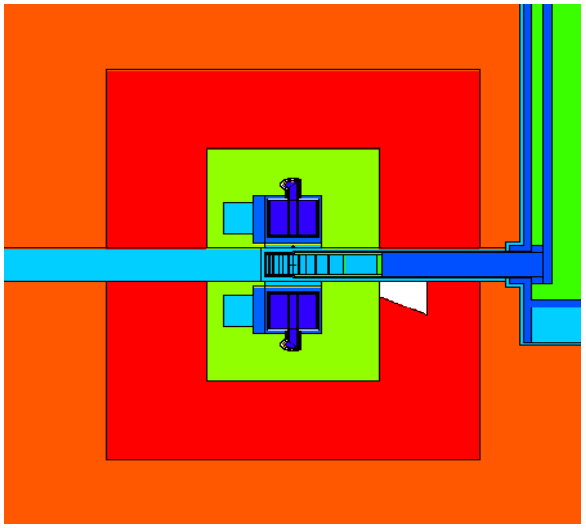


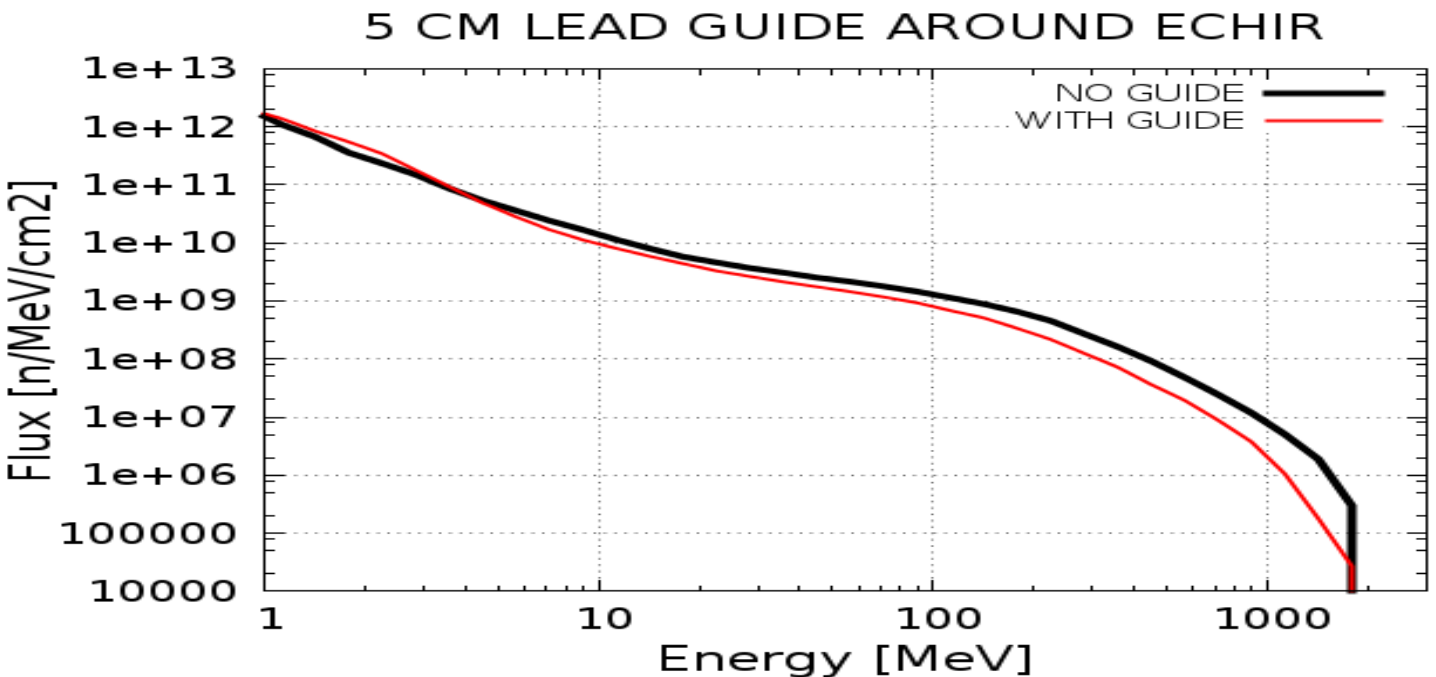


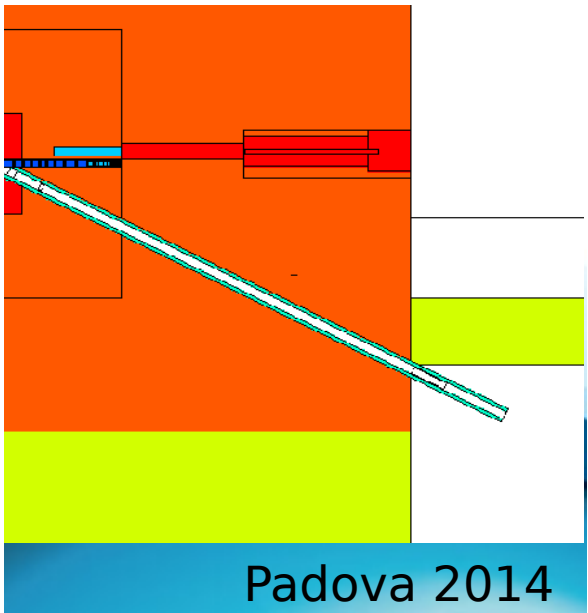


ECHIR Line: Flux Shaping /2









Conclusions

- A facility for test irradiation of electronic components might be installed in the ESS basement

- Outstanding features of the ECHIR line would be:
  1) high energy neutrons
  2) high neutron flux magnitude

- Neutron spectra could be engineered

References

- ✓ESS Technical Design Report, April 2013
- ✓A. Milocco, G. Gorini, L. Zanini, F. Mezei, S.Ansell: ***"Neutronic Design of Fast Neutron irradiation ports for the European Spallation Source"***, Proc. Eleventh International Topical Meeting on Nuclear Applications of Accelerators, 5-8 August 2013, Bruges, Belgium.
- ✓S. Ansell, C. Frost: **"A design of an irradiation beamline for target station 2, ISIS"**, Proc RADECS 2007, 10-14 Sept. 2007, Deauville.