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

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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.

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

E > 1 MeV
ECHIR Line: Introduction

- ECHIR = Ess CHip Irradiation
- Proposal at SAC
- Reference neutron spectrum from QINETIQ atmospheric 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.

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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 degrees to the left in the horizontal plane
- The flood room would be installed at an utility room in the ESS basement
ECHIR Line: MCNP modeling
Detectors for ECHIR Flux Calculations
Excellent agreement with reference spectrum above 20 MeV
Flux greater than 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 EFFECT: LOWER LEFT BAY GUIDE

ECHIR EFFECT: LOWER RIGHT BAY GUIDE

ECHIR EFFECT: UPPER RIGHT BAY GUIDE

ECHIR EFFECT: RIGHT LOWER FLIGHTLINES

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ECHIR Line: Flux Shaping

10 CM SHIELDING IN ECHIR

10 CM WATER SHIELDING

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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

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