Neutron source at JIPNR-SOSNY for electronics qualification of radiation hardness.

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Technical requirements

(information is taken from presentation of Andrei Patapenka)

Table 1 – DB, Energy 2.4 GeV – influences on electronics

Shielding type	Energy [GeV] / Beam type	Module position	Dose, [Gy/year]	Dose, Stat.err%	Si-1-MeV-N, 1/cm^2/year	Si-1-MeV-N, Stat.err%
No	2.4/DB	U	97	10	7.28E+10	estimation
No	2.4/DB	M	97	18	4.85E+10	estimation
Pb/10cm	2.4/DB	U	8*	-	2.72E+10	estimation
Pb/10cm	2.4/DB	M	11*	-	4.74E+10	estimation

* – estimation (stat. error > 30 %)

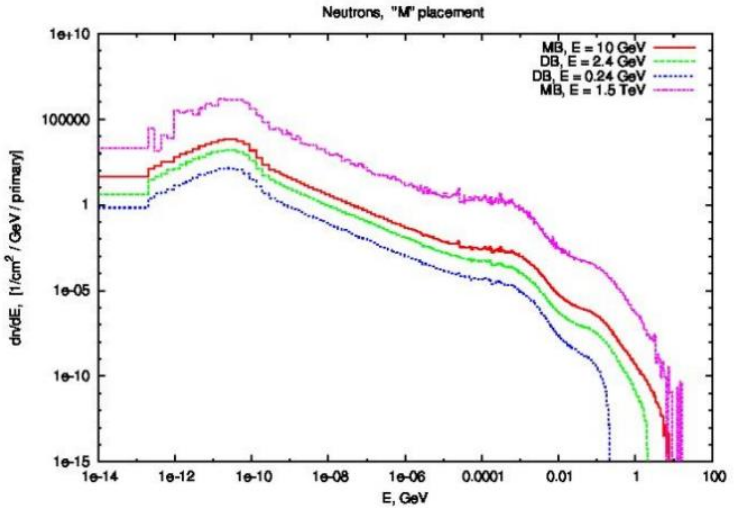
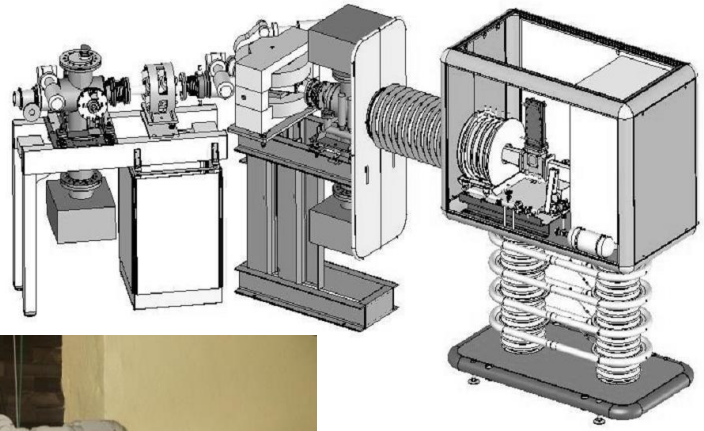


Fig. 5 – Particle's fluences in the region "M":

Yalina facility

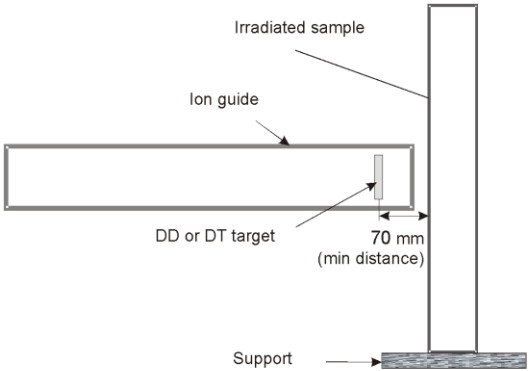
- Investigations of physics of subcritical systems
- Testing and development methods for on-line reactivity measurements

Neutron generator “NG-12”



- 240 kV Acceleration voltage
- DD target:
  - 2.5 MeV
  - 5E+9 n/s (total)
- DT target:
  - 14.1 MeV
  - 2E+11 n/s (total)

NG neutron’s yield - 1



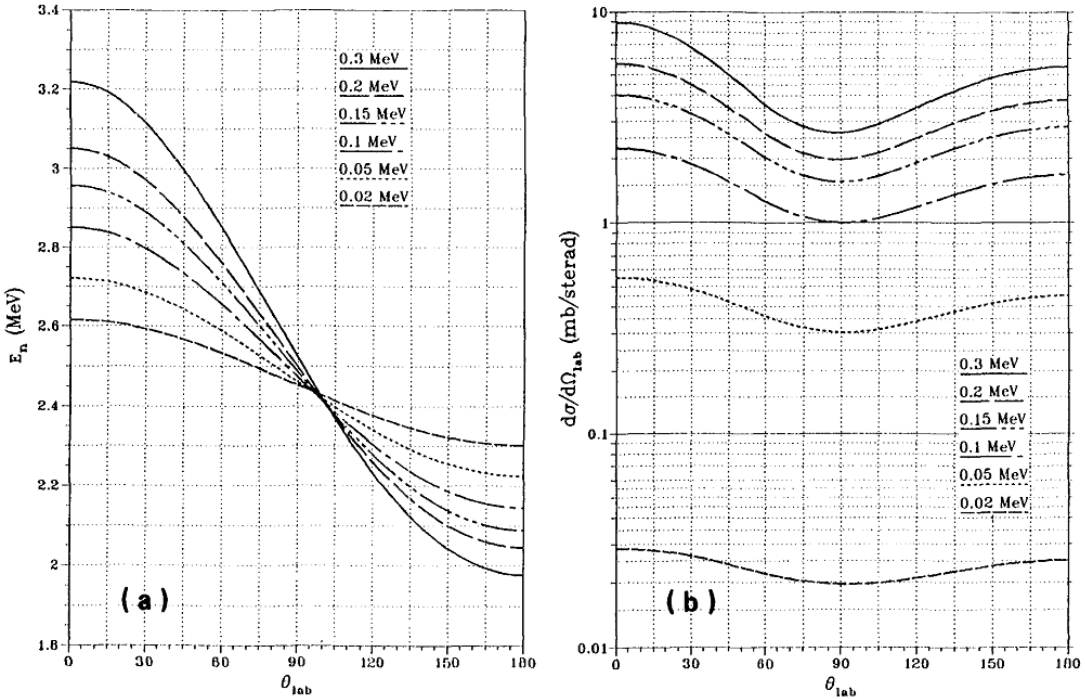
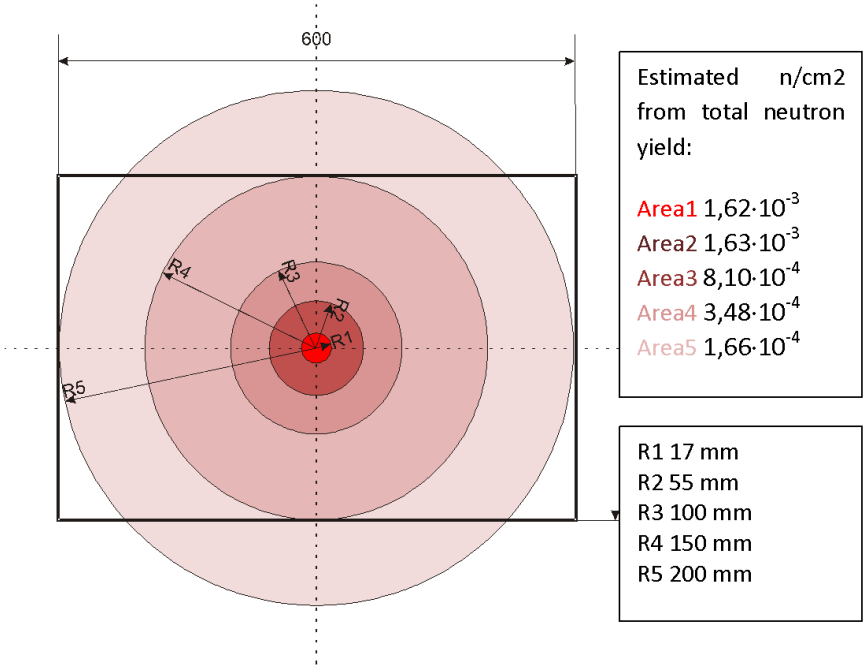


FIG. 17. (a) Neutron energy values and (b) differential cross-sections for the $^2H(d, n)^3He$ reaction: 0.02–0.3 MeV.

NG neutron’s yield - 2



The maximum neutron flux is:

- 8.1E+6 n/s cm^2 for DD
- 3.2E+8 n/s cm^2 for DT

The area with maximum neutron flux is:

- 150 cm^2

Type of IC

Maxwell TECHNOLOGIES

WHITE PAPER

	TID	SEL	SEU
Commercial ICs	3-30 krads (Si)	1 - 120 MeV	1 - 120 MeV
Radiation-Enhanced ICs	Customized to Orbit (100 krads (Si) Target)	Customized to Orbit (Up to 120 MeV)	Customized to Orbit (Up to 120 MeV)
Radiation-Hardened ICs	100 krads (Si) Minimum	Up to 120 MeV	Up to 120 MeV

Radiation resistance depends on:

- IC's line (commercial, rad-hard)
- Manufacturer
- Type of chip (IC, FPGA, CPU, Memory, etc)
- Size and type of memory
- ...

Conclusion

- NG-12 in JIPNR-SOSNY can be used for electronics qualification of radiation hardness
  - value of neutron flux allows to provide estimated year dose in one week;
  - neutron spectra can be adjusted using moderator (polyethylene for example);
  - in one month of irradiation errors for commercial IC can be detected, for rad hard line - year of irradiation is needed (impossible).
- Type and lines of IC should be chosen for testing procedure