Characterization of a compact neutron generator with a NE-213 neutron spectrometer for the JET monitoring system calibration

A. Klix[a], M. Angelone[b], P. Batistoni[b], A. Cufar[c], Z. Ghani[d], L. Giacomelli[e], S. Jednorog[f], E. Laszynska[f], I. Lengar[c], S. Loreti[b], A. Milocco[d], L. W. Packer[d], M. Pillon[b], S. Popovichev[d], M. Rebai[g], D. Rigamonti[g], N. Roberts[h], P. Salvador Castineira[h], L. Snoj[c], M. Tardocchi[e], D. Thomas[h] and JET Contributors*

[a] *Karlsruhe Institute of Technology, D-76344 Eggenstein-Leopoldshafen, Germany*
[b] *ENEA, Department of Fusion and Nuclear Safety Technology, I-00044 Frascati, Italy*
[c] *Reactor Physics Department, Jozef Stefan Institute, SI-1000 Ljubljana, Slovenia*
[d] *Culham Centre for Fusion Energy, Abingdon, OX14 3DB, UK*
[e] *Istituto di Fisica del Plasma CNR, Milano, Italy*
[f] *Institute of Plasma Physics and Laser Microfusion, 01-497 Warsaw, Poland*
[g] *Dipartimento di Fisica Università degli Studi di Milano-Bicocca, Milano, Italy*
[h] *National Physical Laboratory, Teddington, TW11 OLW, United Kingdom*

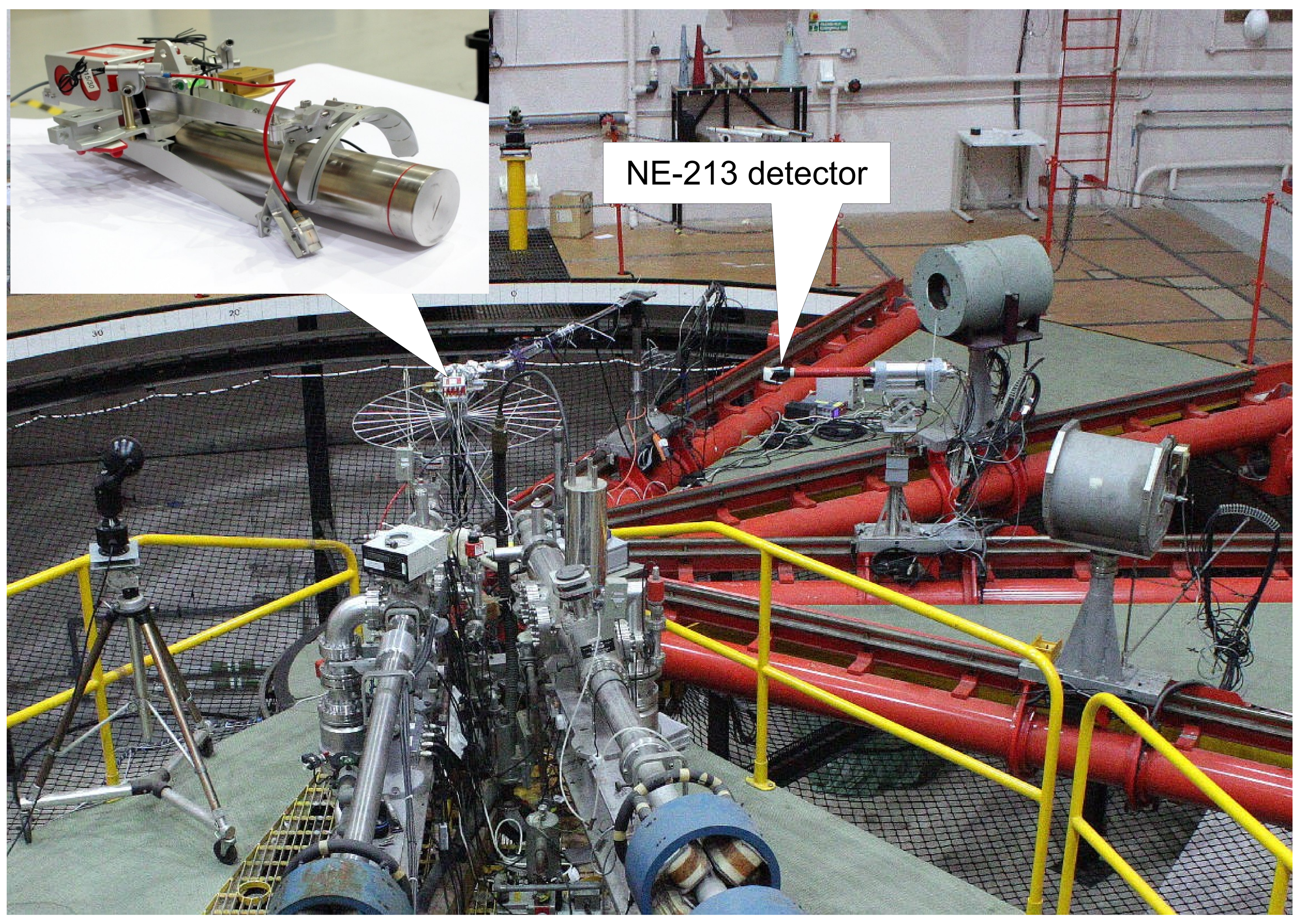
* *See the Appendix of F. Romanelli et al., Proceedings of the 25th IAEA Fusion Energy Conference 2014, Saint Petersburg, Russia*

Introduction

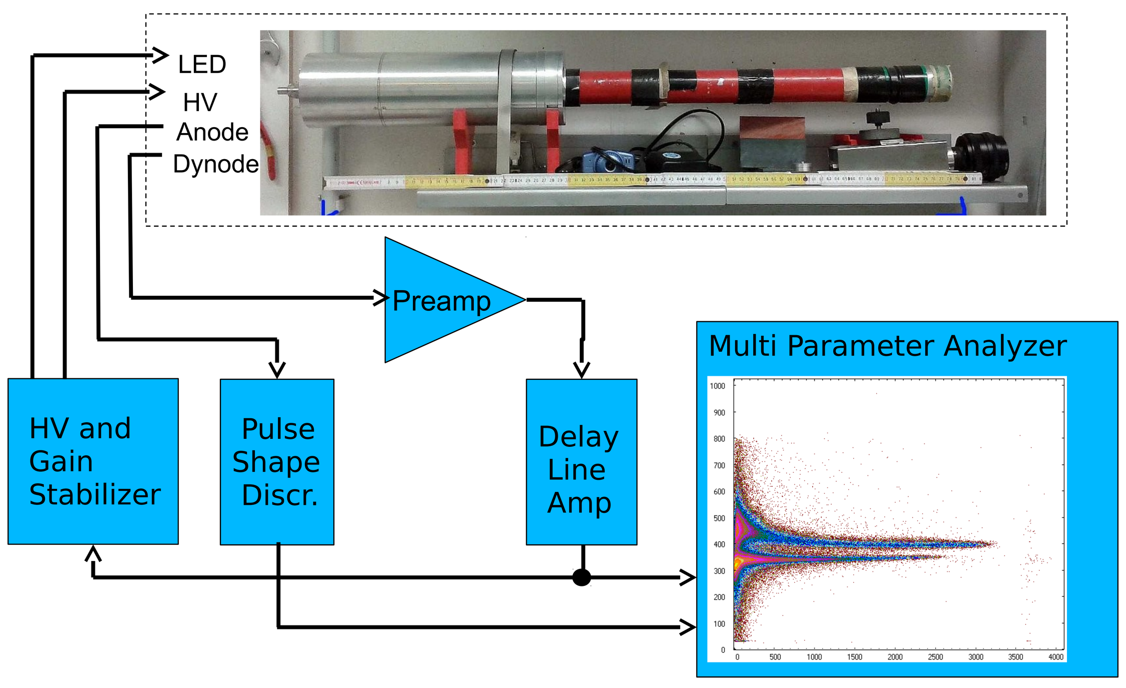
- Second experimental deuterium-tritium (DT2) campaign planned at JET for 2019
- Calibration of the JET neutron emission monitoring system in preparation
- Utilization of a a compact deuterium-tritium neutron generator (NG) with ≈5×10^8 n/s
- Accuracy goal: <10% uncertainty at 14 MeV neutron energy
- Two compact NG fabricated by VNIIA (ROSATOM) intensively examined at the National Physical Laboratory (NPL) Teddington
- Neutron emission spectra and emission intensities measured at different angles
- Examination with diamond diodes, long counters, silicon diodes, foil activation techniques, and a NE-213 scintillator spectrometer
- MCNP model of the NG under development for the JET neutron monitor calibration

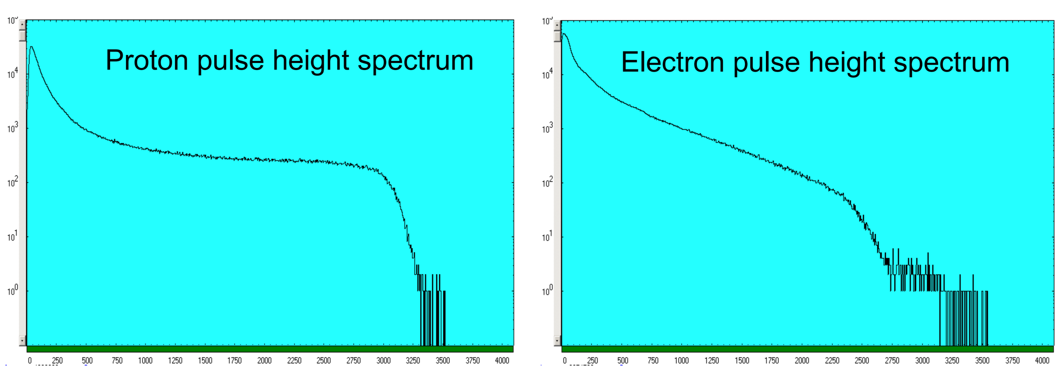
This work:

- Measurement of fast neutron spectra with a NE-213 scintillator based neutron spectrometer placed at several angles covering a full circle with a radius of 146 cm
- Expected to provide information on a possible DD neutron contribution which would affect the Long Counter (LC) results.



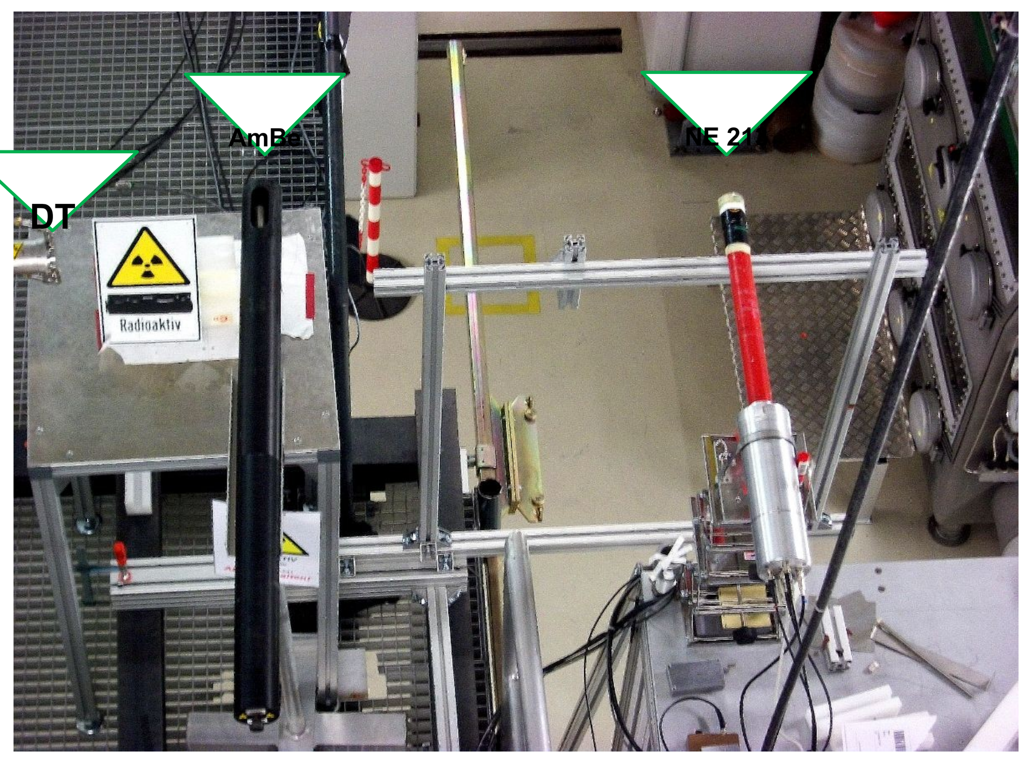
The NE-213 neutron/photon spectrometer



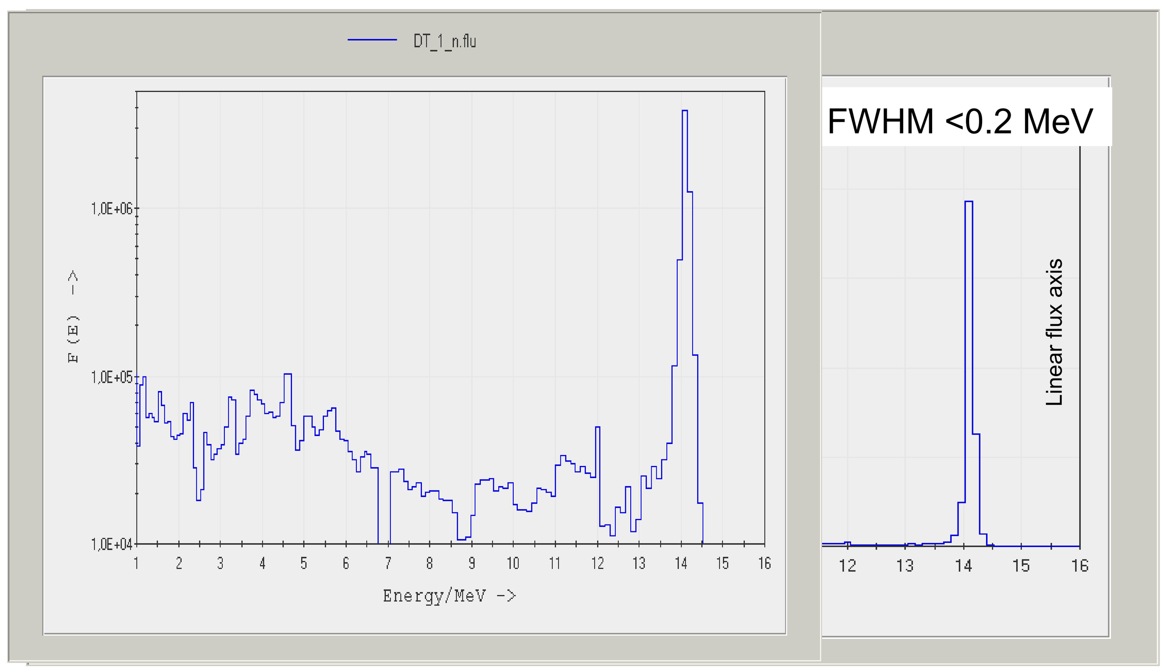


Neutron/photon separation method: Zero-crossing
Typical pulse shape and derived pulse height spectra
Neutrons -> protons Gammas -> Compton electrons

Preliminary tests at the TU Dresden neutron generator laboratory



DT neutron generator lowest setting **~10^8 n/s**
AmBe source: 171 GBq ^{241}Am, **1.25×10^7 n/s**

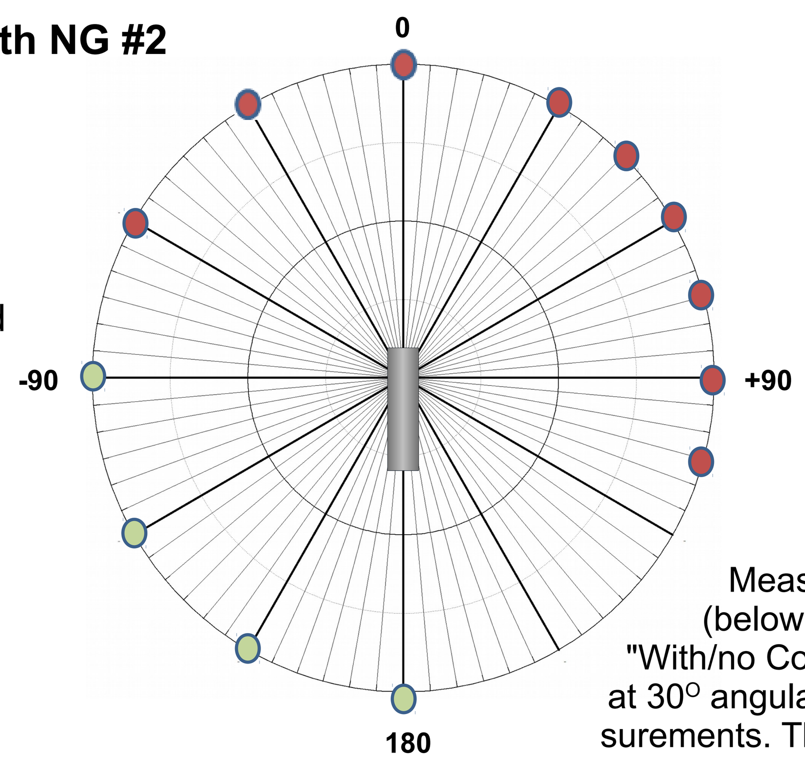


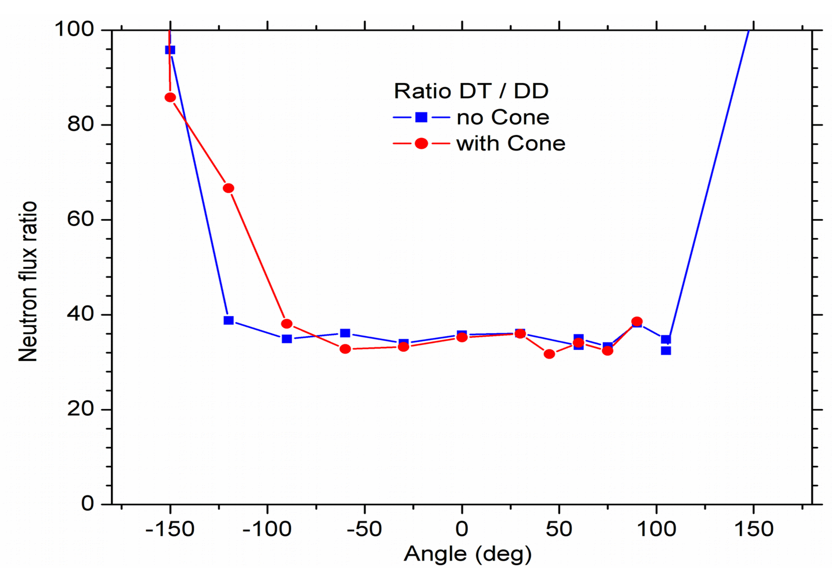
Unfolded neutron spectrum from recorded proton pulse height spectrum under pure DT neutron irradiation. Computed with the MAXED code from the UMG-3.3 package and the response matrix of the detector.

Measurement positions with NG #2

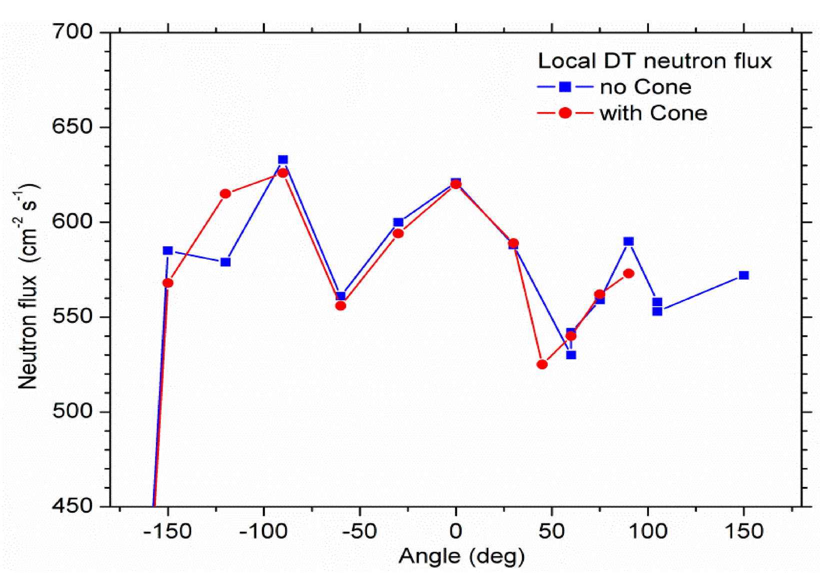
- forward position
- rotated 180 degree about vertical axis

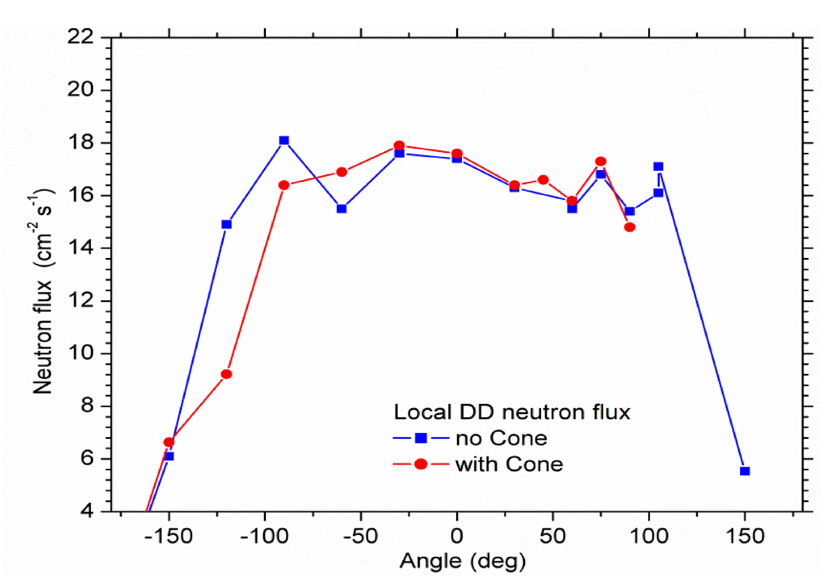
Distance between detector and neutron generator 146±1 cm



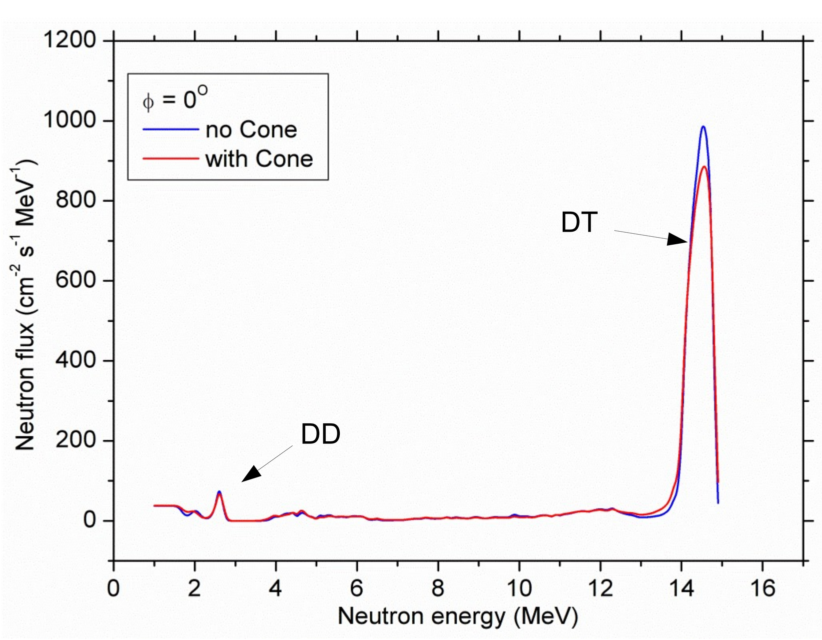


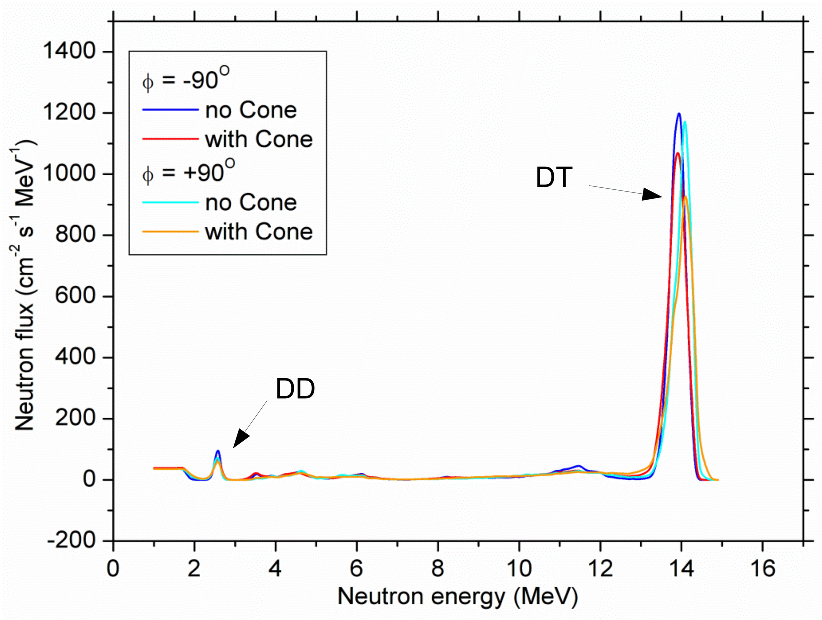
Measured DT and DD neutron fluxes at each detector position (below) and ratio of the flux densities at these energies (above). "With/no Cone" refers to a shadow cone for a DePangher LC located at 30° angular distance and near the NE-213 scintillator in some measurements. There is apparently no significant influence.





Measured neutron spectra





Examples of measured neutron flux spectra at angles of 0^{O} and 90^{O}. Clearly seen is a small contribution from DD neutrons. Unfolding was done with a flat guess spectrum. Despite application of a gain stabilizer the gain was frequently checked with a Na-22 source between measurements.

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