EUROfusion

Compton Suppressed Gamma Spectrometry for activation analysis of materials irradiated at JET

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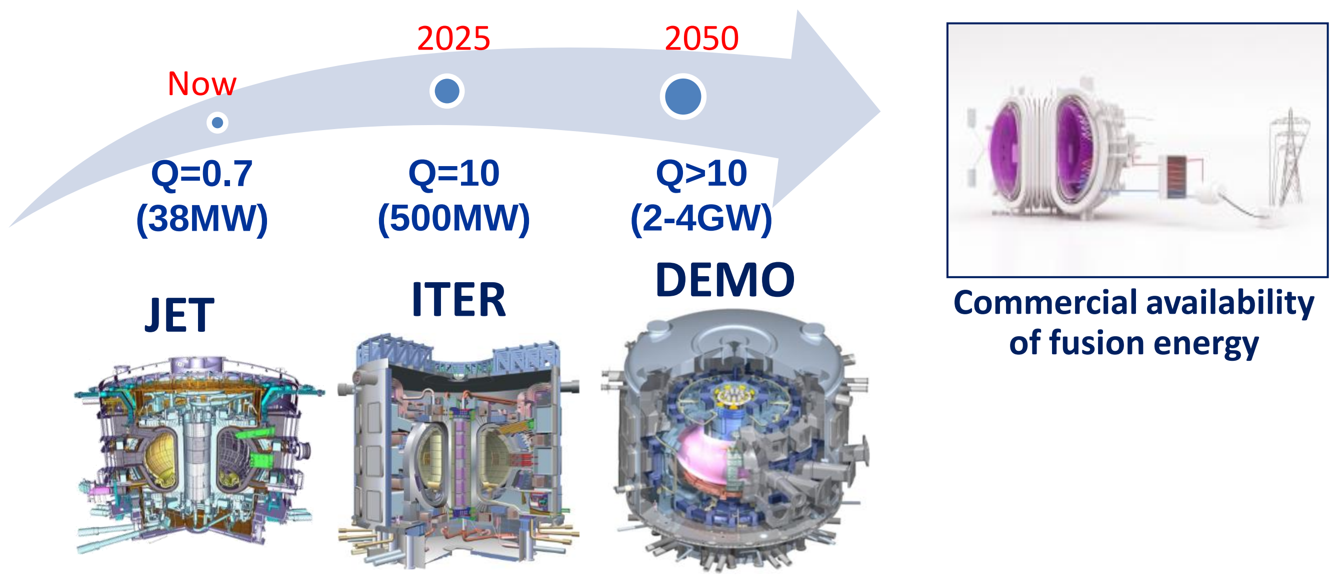
This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Scope

- Scope of this work is to evaluate the performance of the NCSRD Fusion Technology Group Compton Suppression System for the analysis of different material samples irradiated in a real fusion environment

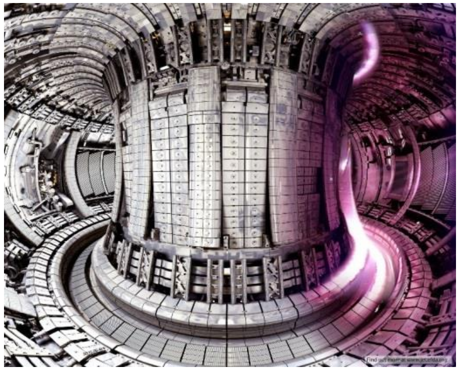


Irradiations at JET

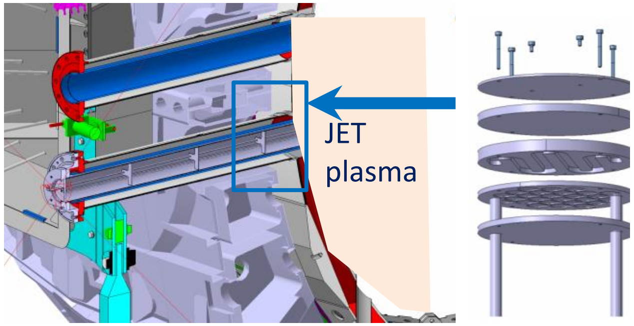
- Activation foils were irradiated at the Long Term Irradiation Station (LTIS) of JET during the 2019 DD campaign (143 days of irradiation, ~1.90E+14 n/cm^2)

- Post irradiation gamma spectrometric analysis using Compton suppressed gamma spectrometry

JET tokamak

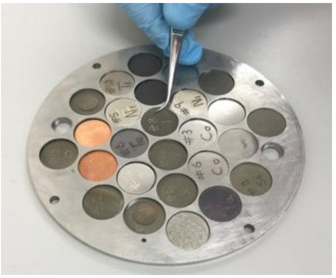


JET irradiation end



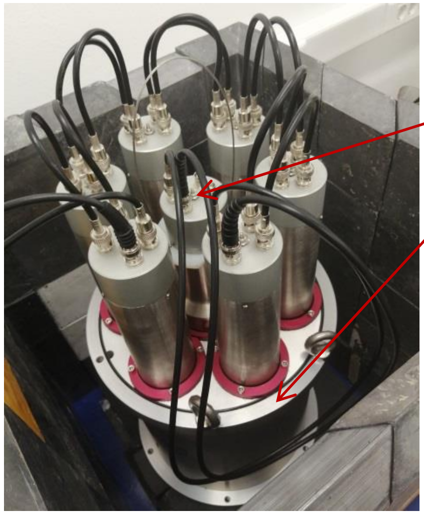
Activation foils

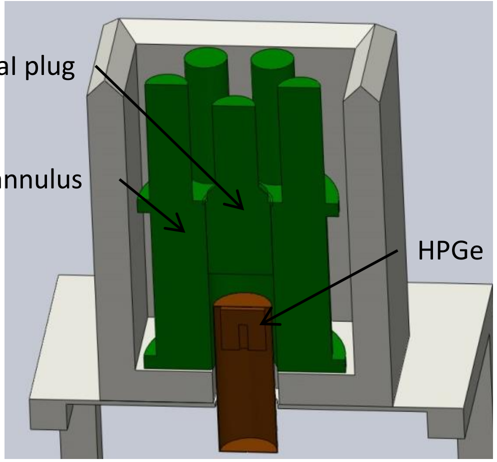
Co, Ni, Ta



The Compton Suppression System

- The Compton Suppress System consists of:
  - a 40% HPGe
  - a NaI detector
    - NaI annulus
    - NaI plug

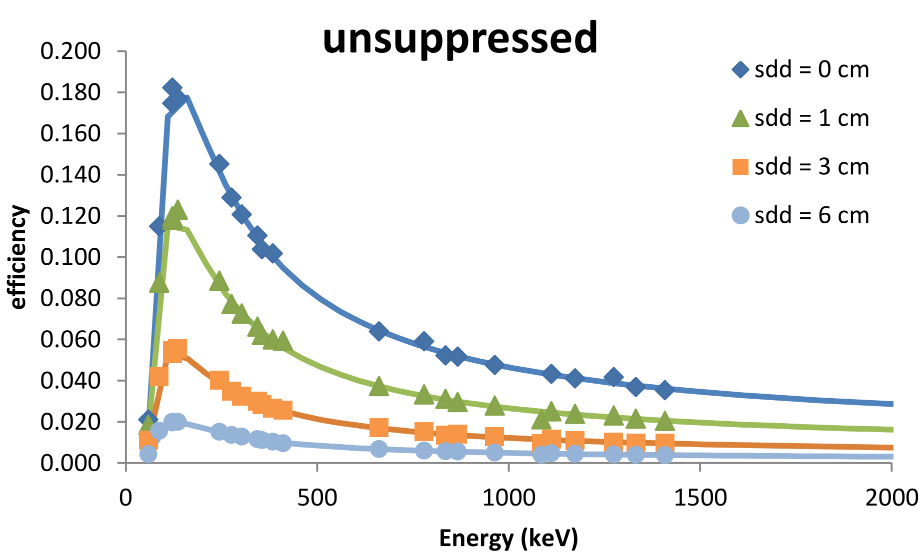


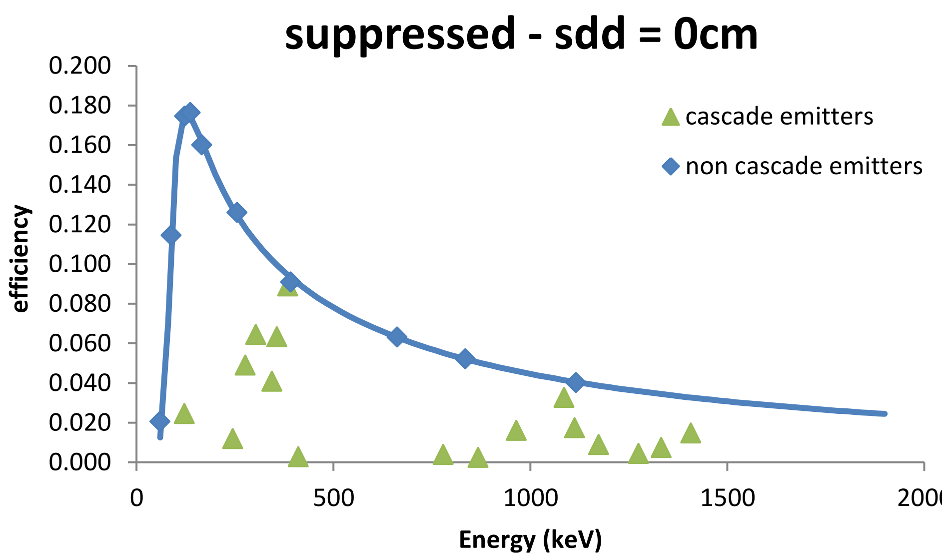


- Simultaneous collection of suppressed and unsuppressed spectra
  - selection of the best collection mode for each isotope, depending on the decay scheme

Efficiency calibration

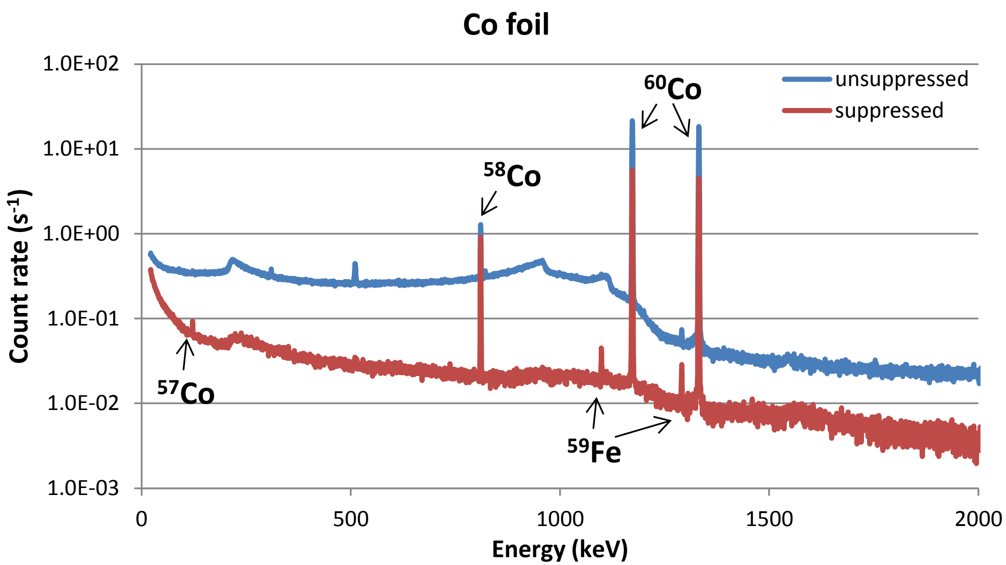
- Efficiency calibration using point sources
  - non cascade emitters: ^{241}Am, ^{109}Cd, ^{139}Ce, ^{57}Co, ^{137}Cs, ^{54}Mn, ^{113}Sn, ^{65}Zn
  - cascade emitters: ^{133}Ba, ^{60}Co, ^{152}Eu, ^{22}Na
- Cascade emitters suffer reductions in the suppressed spectrum → cannot be used for efficiency calibration





Analysis of samples

- Reduction of the continuous background in the suppressed spectrum leading to:
  - better determination of non cascade isotopes (lower peak area uncertainties)
  - detection of additional isotopes: such as ^{59}Fe and ^{57}Co in Co foils



- Reduction of the cascade isotopes peaks net area leading to lower detection efficiency
  - ~15% for the two ^{60}Co peaks

Concluding remarks

- The system significantly **reduced the Compton continuum** and provided **better peak identification** of weak peaks of non cascade nuclides
- **Monoenergetic** isotopes do **not** show statistically significant **differences** in terms of peak area between the unsuppressed and suppressed spectra
- The same applies for polyenergetic isotope which however do not emit photons in cascade
- **Cascade emitters** are subject to **reductions** in the suppressed spectrum depending on the decay scheme
- All isotopes are subject to reductions if the activity of the sample is high