

Neutron Applications with Diamond Detectors

ADAMAS 2017

Zagreb, 28.11.2017

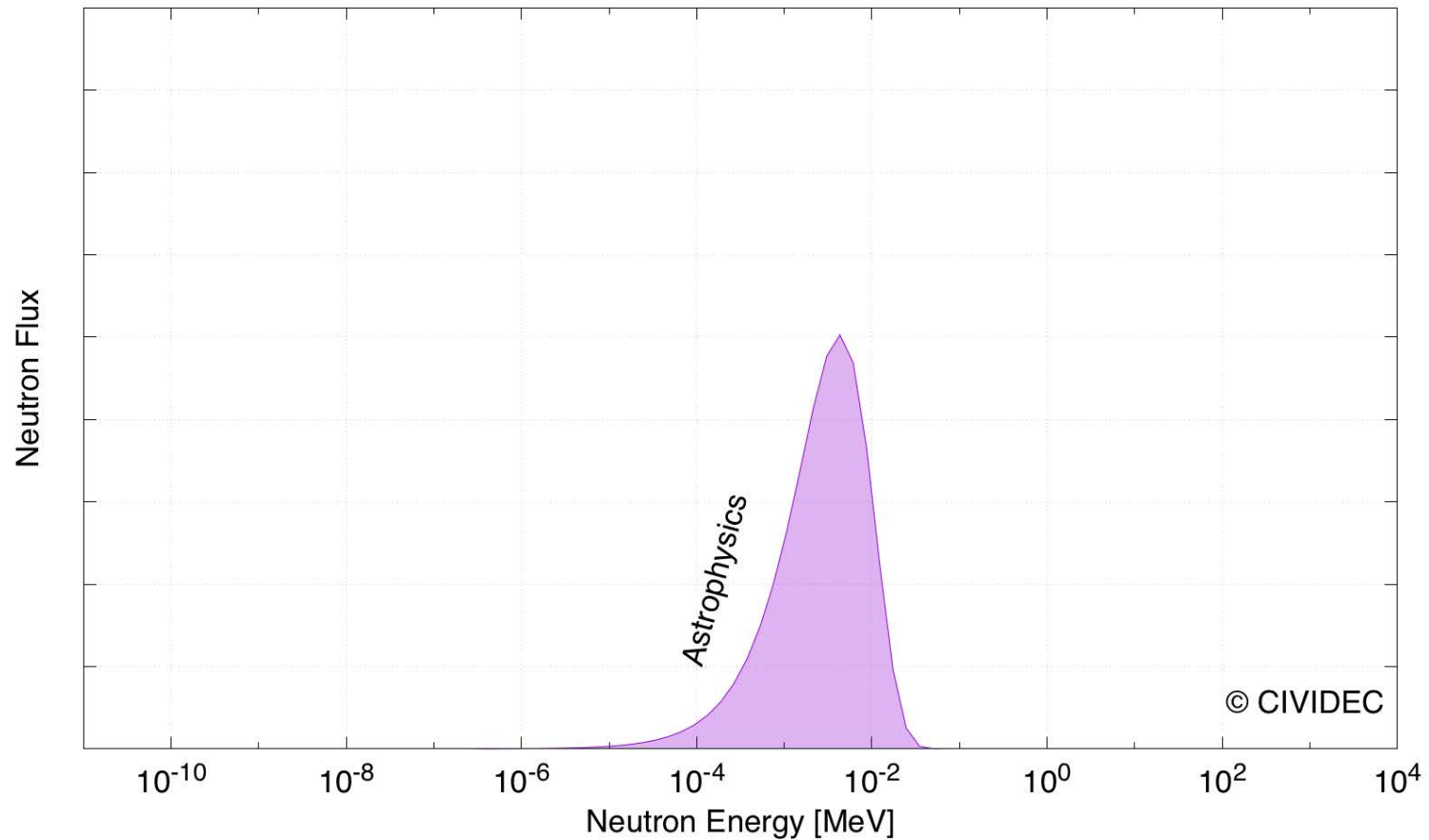
Christina Weiss
CIVIDEC Instrumentation



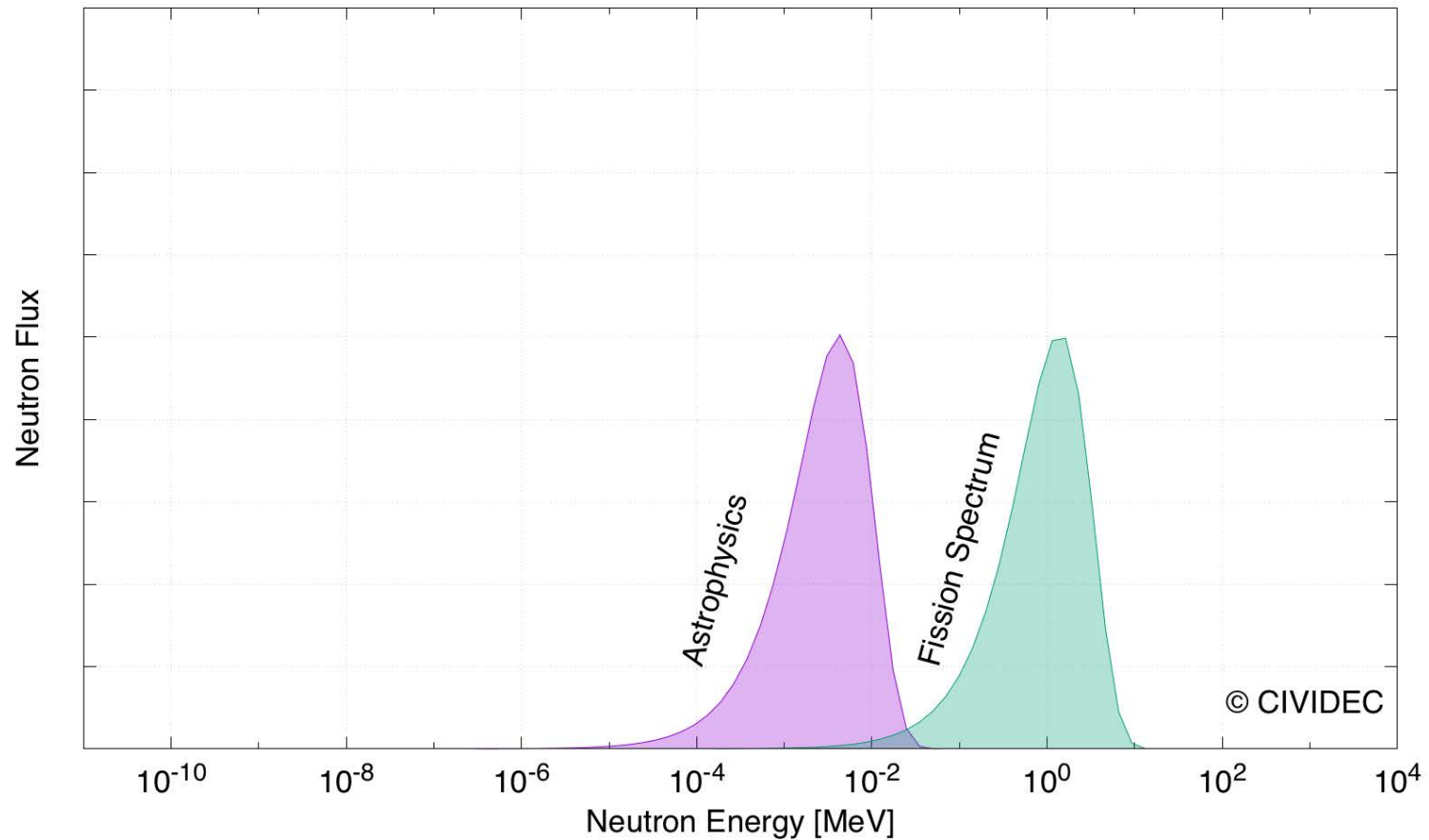
Outline

- Neutron Classification
- Fusion Neutron Detection:
 - Deuterium – Tritium Fusion
 - Deuterium – Deuterium Fusion
- Conclusions

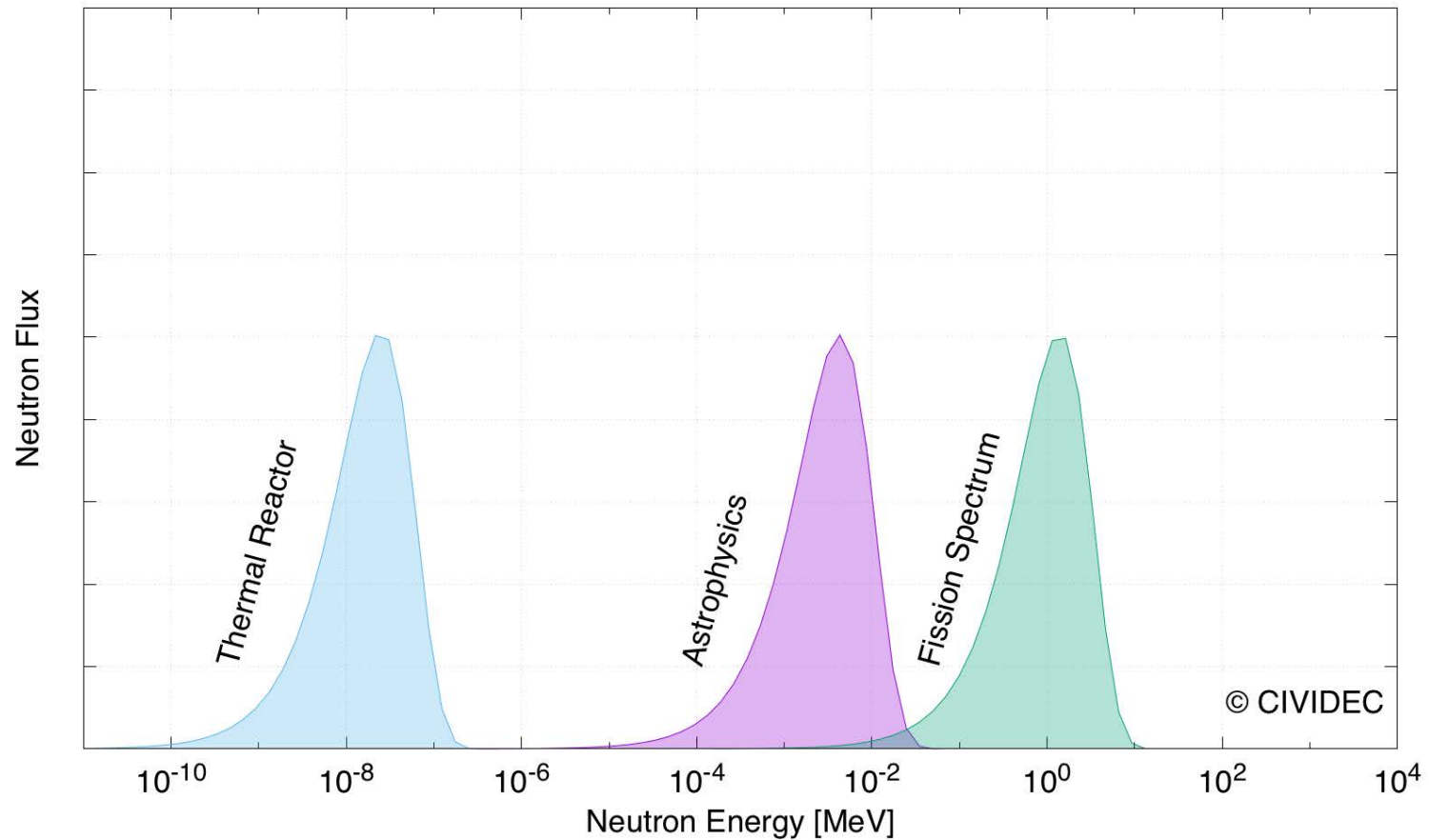
Classification of Neutrons



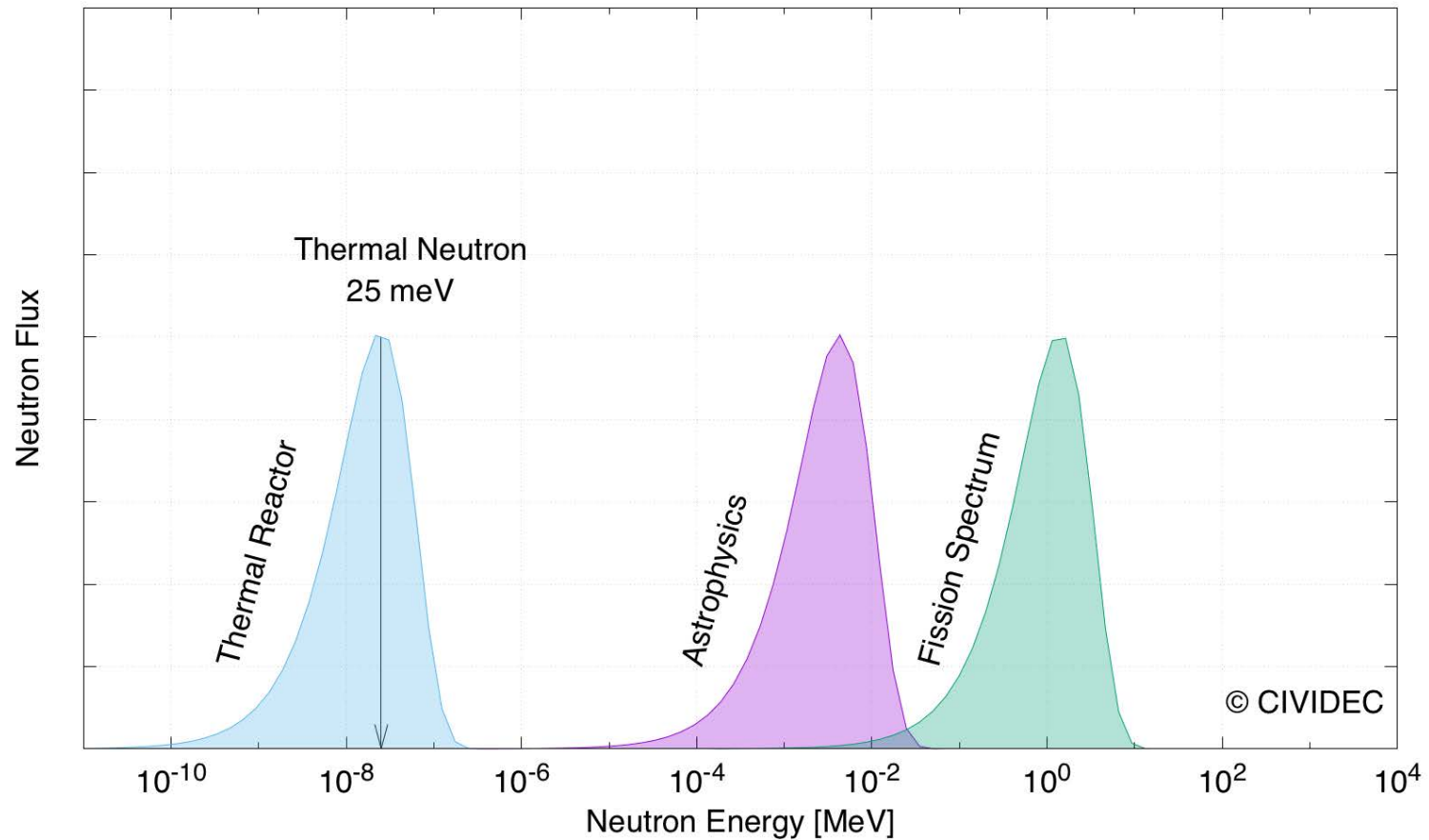
Classification of Neutrons



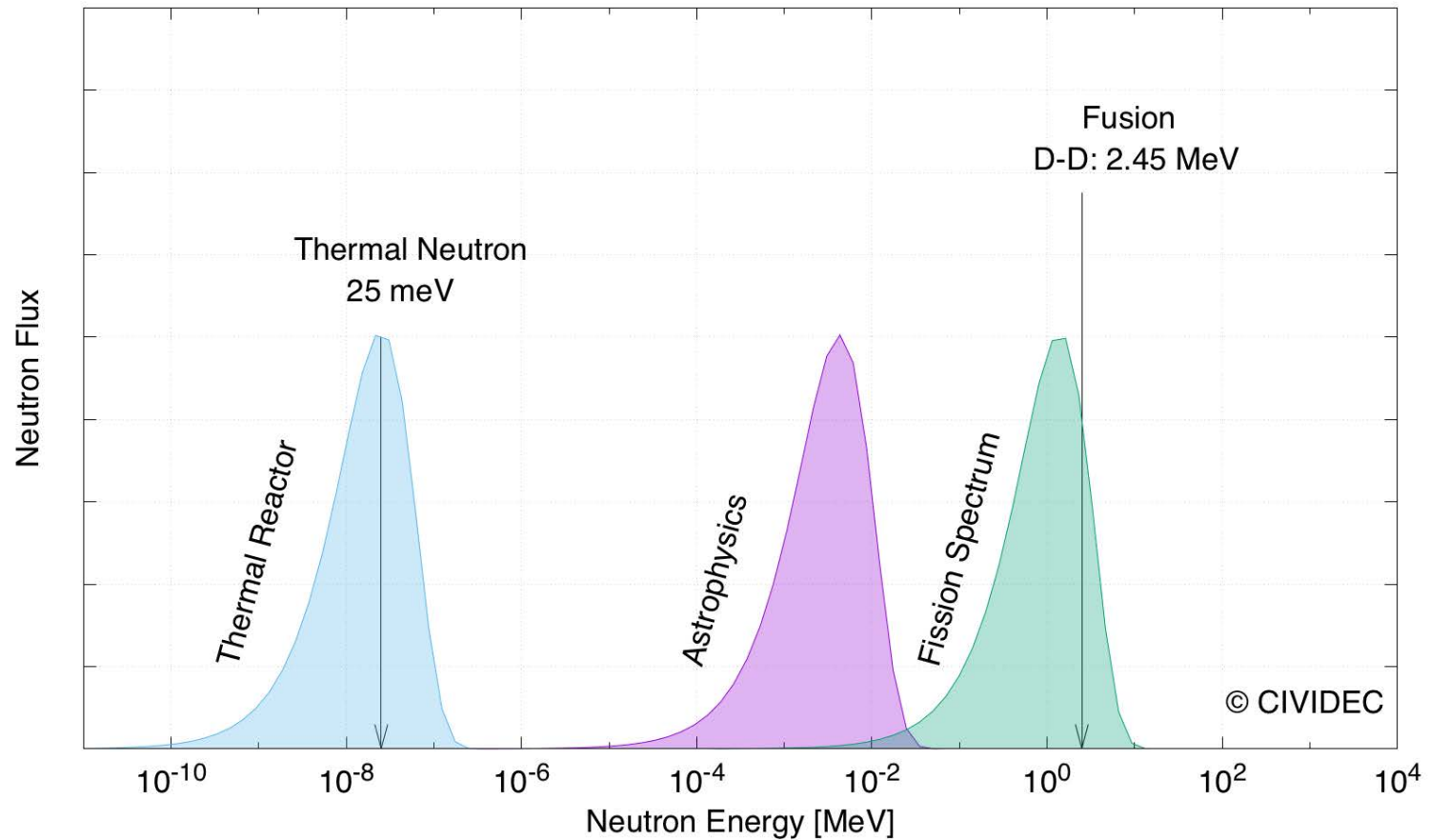
Classification of Neutrons



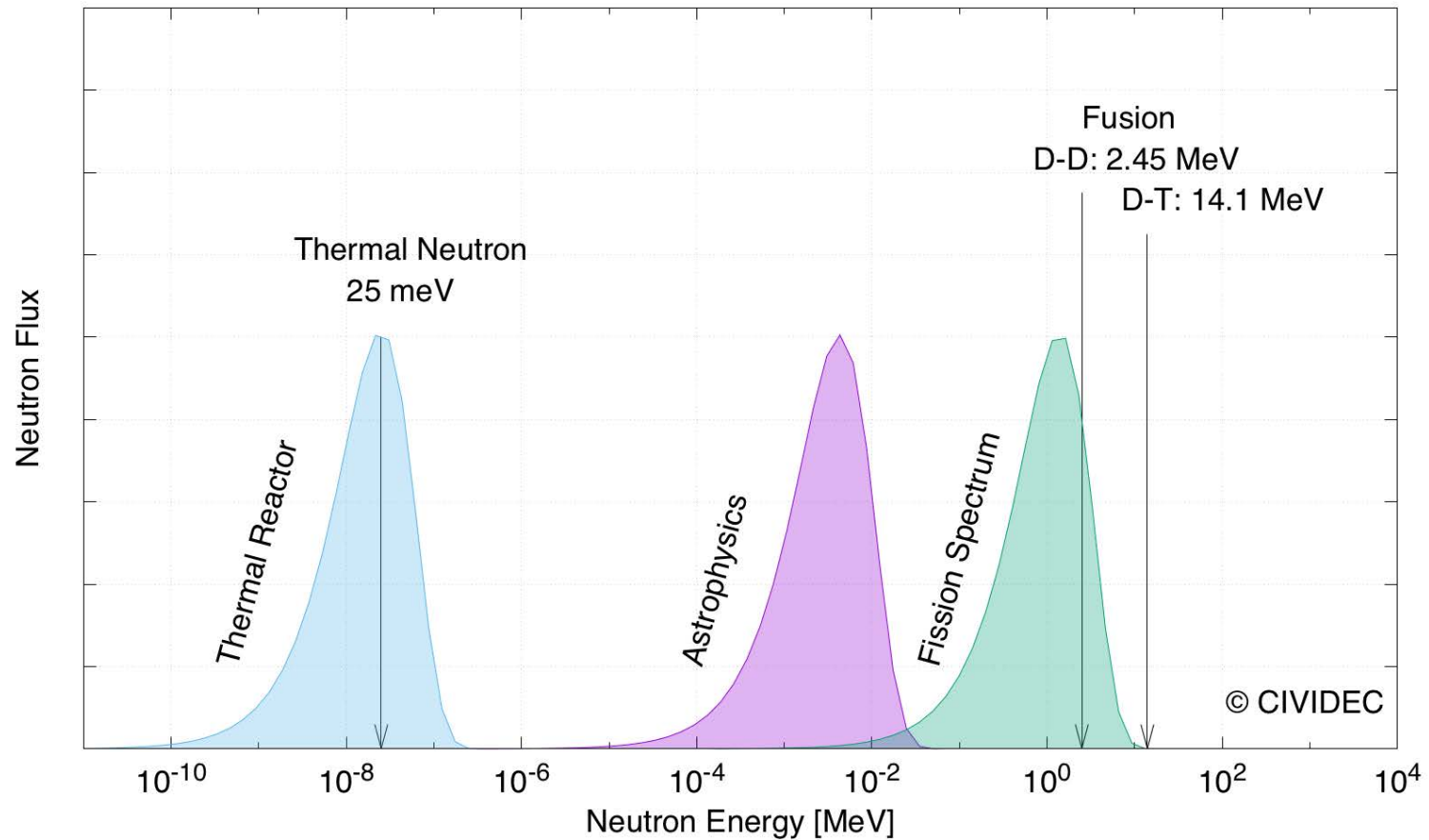
Classification of Neutrons



Classification of Neutrons

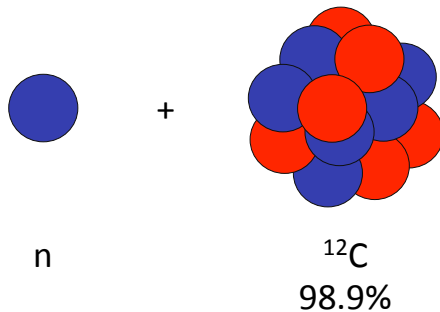


Classification of Neutrons



Detecting neutrons with diamond detectors

Neutron Interactions with ^{12}C



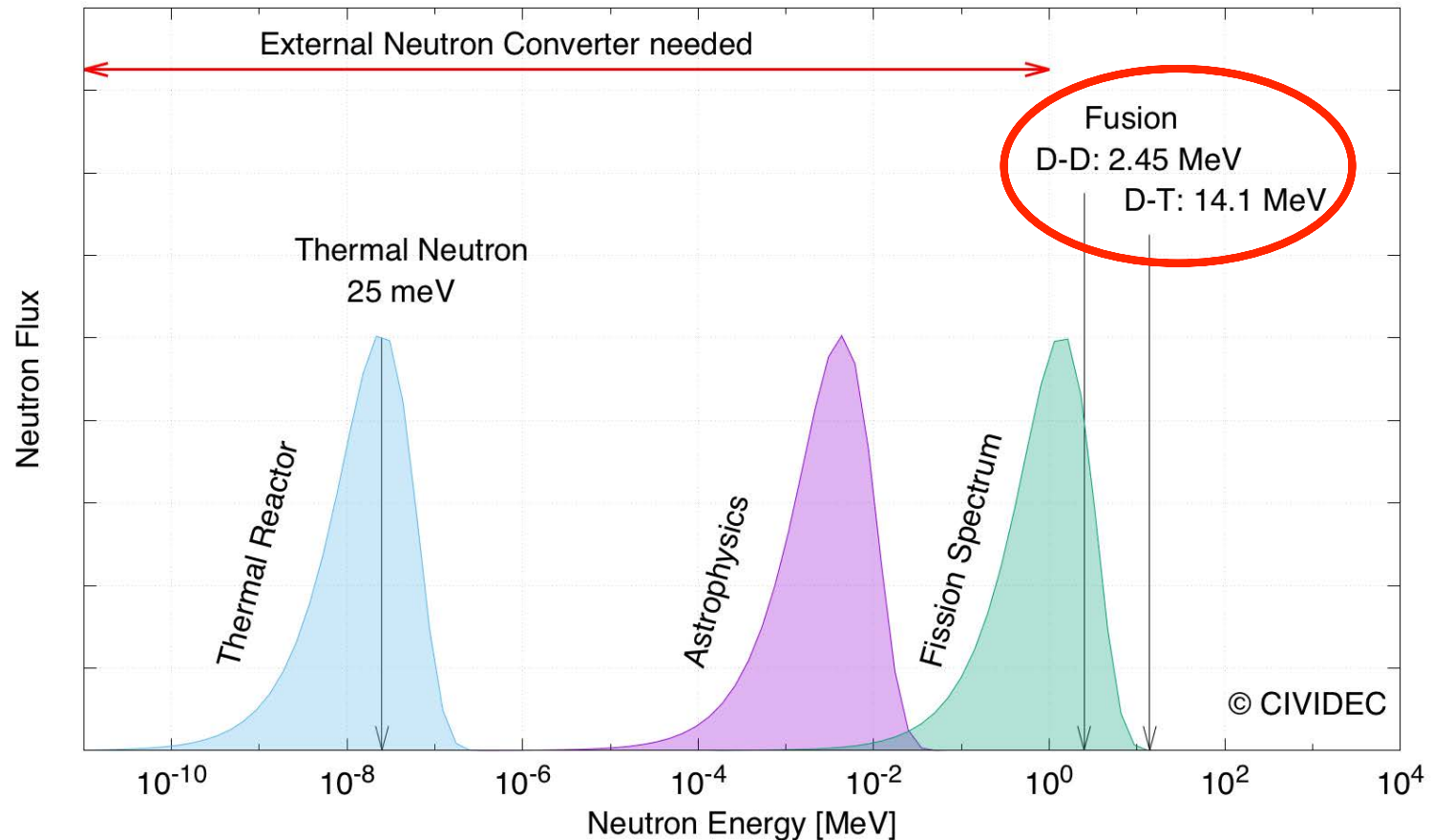
Q-value Calculator (QCalc)

Reaction Q-values for $^{12}\text{C} + n(E_{\text{lab}}=20 \text{ MeV})$

Reaction Products	Q-value (keV)	Threshold (keV)
$^{13}\text{C}+\gamma$	4946.31 0.0	0.0 0.0
$^{12}\text{C}+n$	0.0 0.0	0.0 0.0
$^9\text{Be}+\alpha$	-5702.05 0.08	6181.469 0.0867
$^4\text{He}+n+2\alpha$	-7274.7466 6.59E-4	7886.396 7.14E-4
$^8\text{Be}+n+\alpha$	-7366.5864 0.035	7985.9575 0.0379
$^5\text{He}+2\alpha$	-8009.7 20.0	8683.2 21.7
$^{12}\text{B}+p$	-12587.05 1.32	13645.35 1.43
$^{11}\text{B}+d$	-13732.113 0.01	14886.688 0.0108
$^{11}\text{B}+n+p$	-15956.678 0.012	17298.291 0.013

Charged Particle as
reaction product

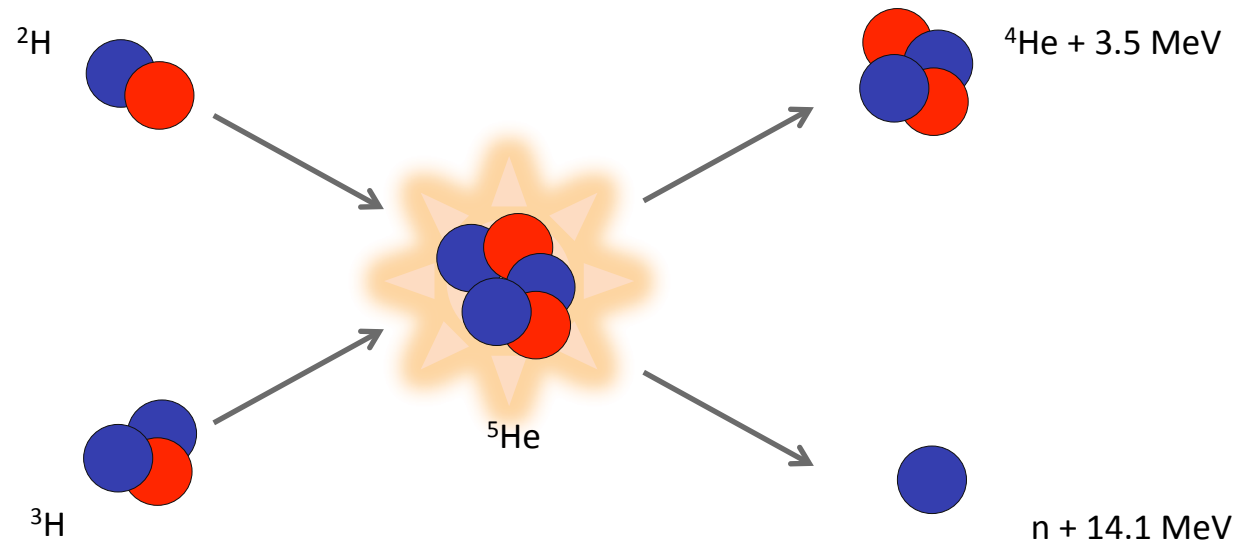
Classification of Neutrons



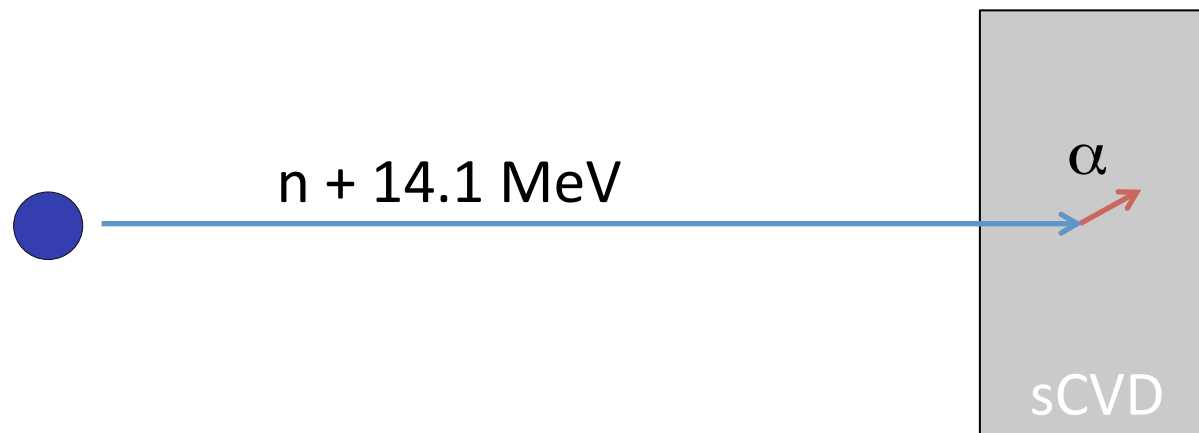
Diamond Detector Response to Fusion Neutrons

Deuterium – Tritium Fusion

Deuterium – Tritium Fusion

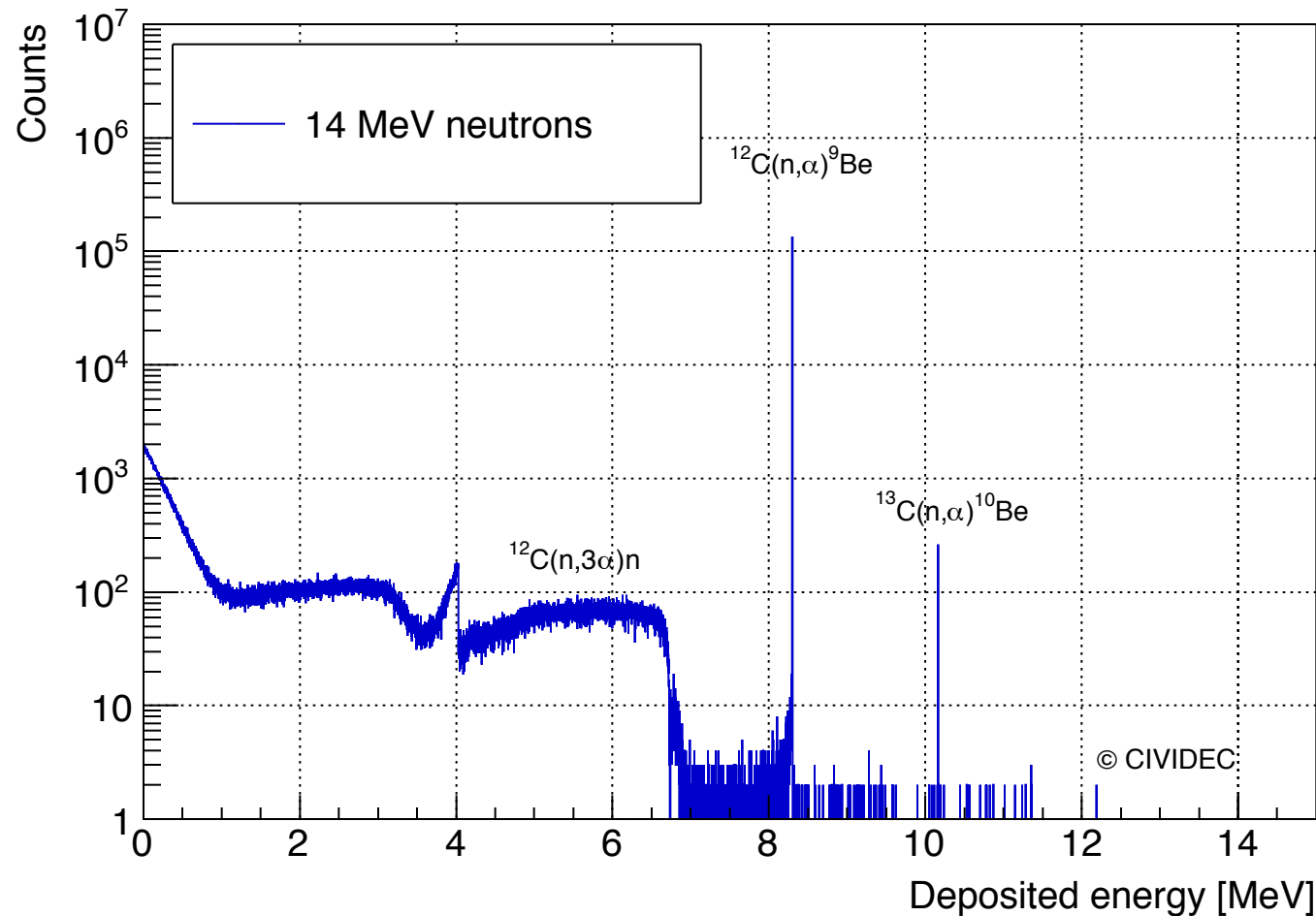


Diamond as Neutron Converter

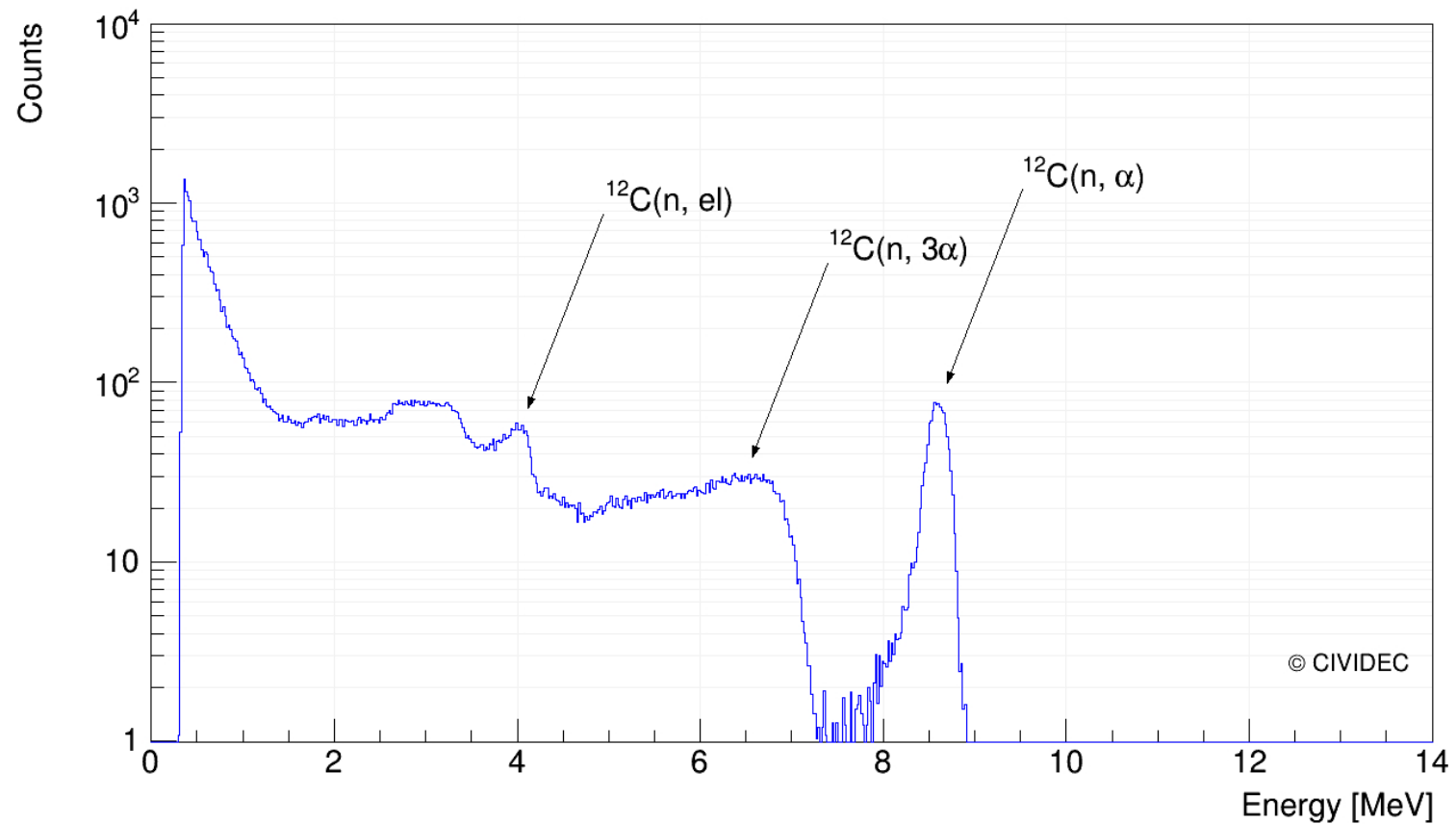


Nuclear reactions with ^{12}C (98.9%) and ^{13}C (1.1%).

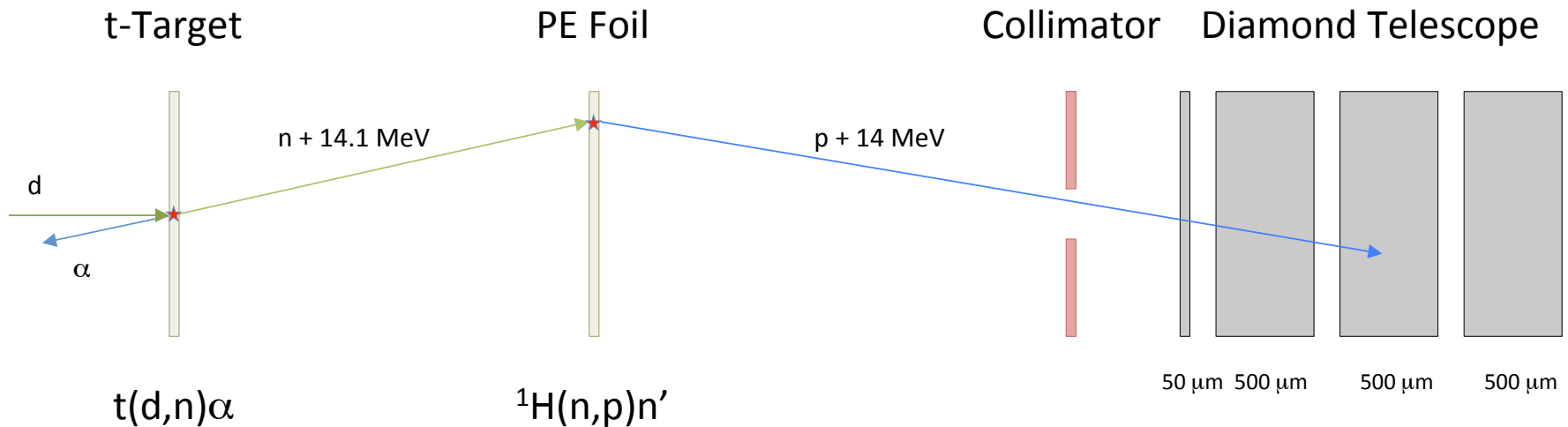
Simulated Response Function



Measurement

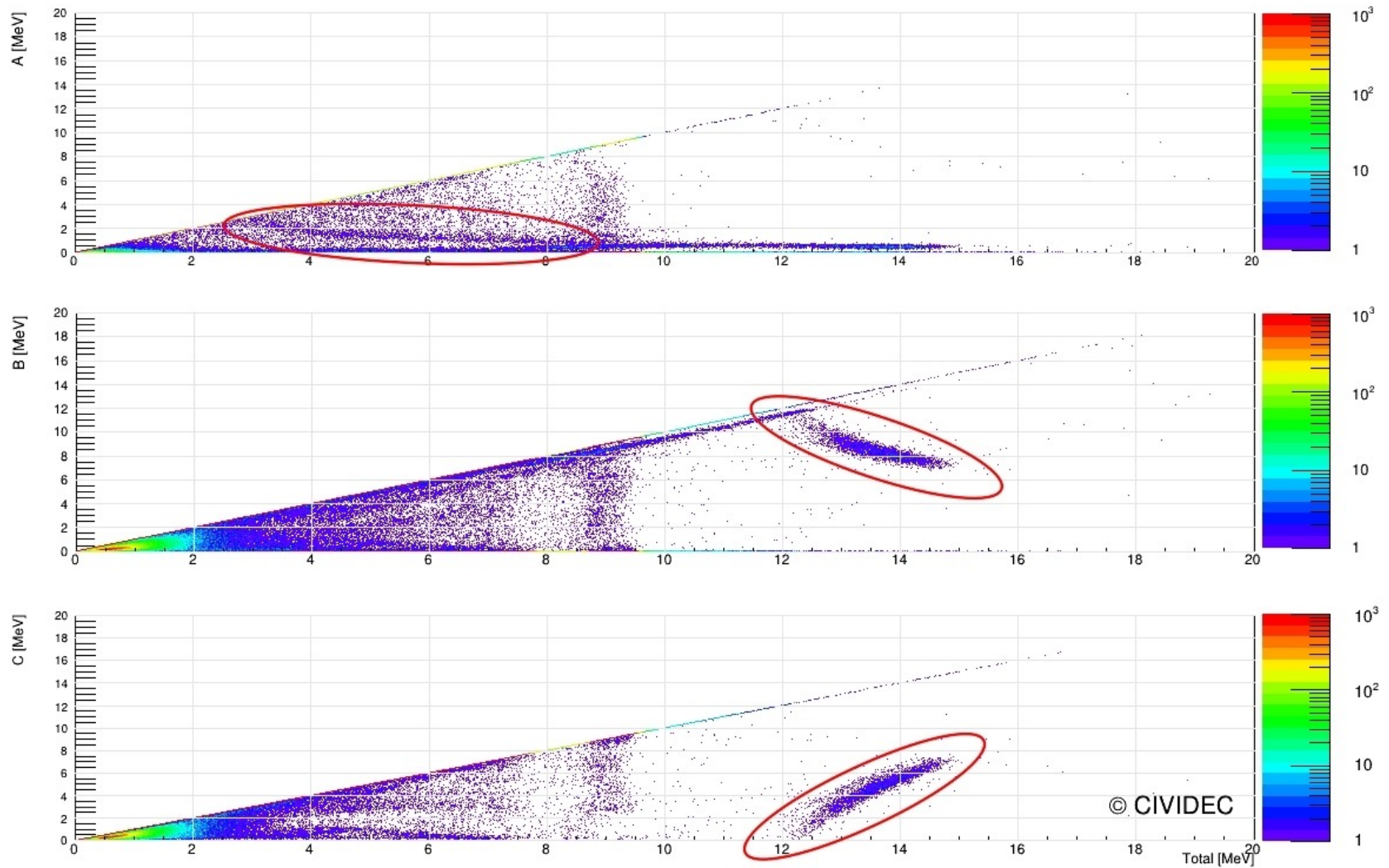


With external Converter

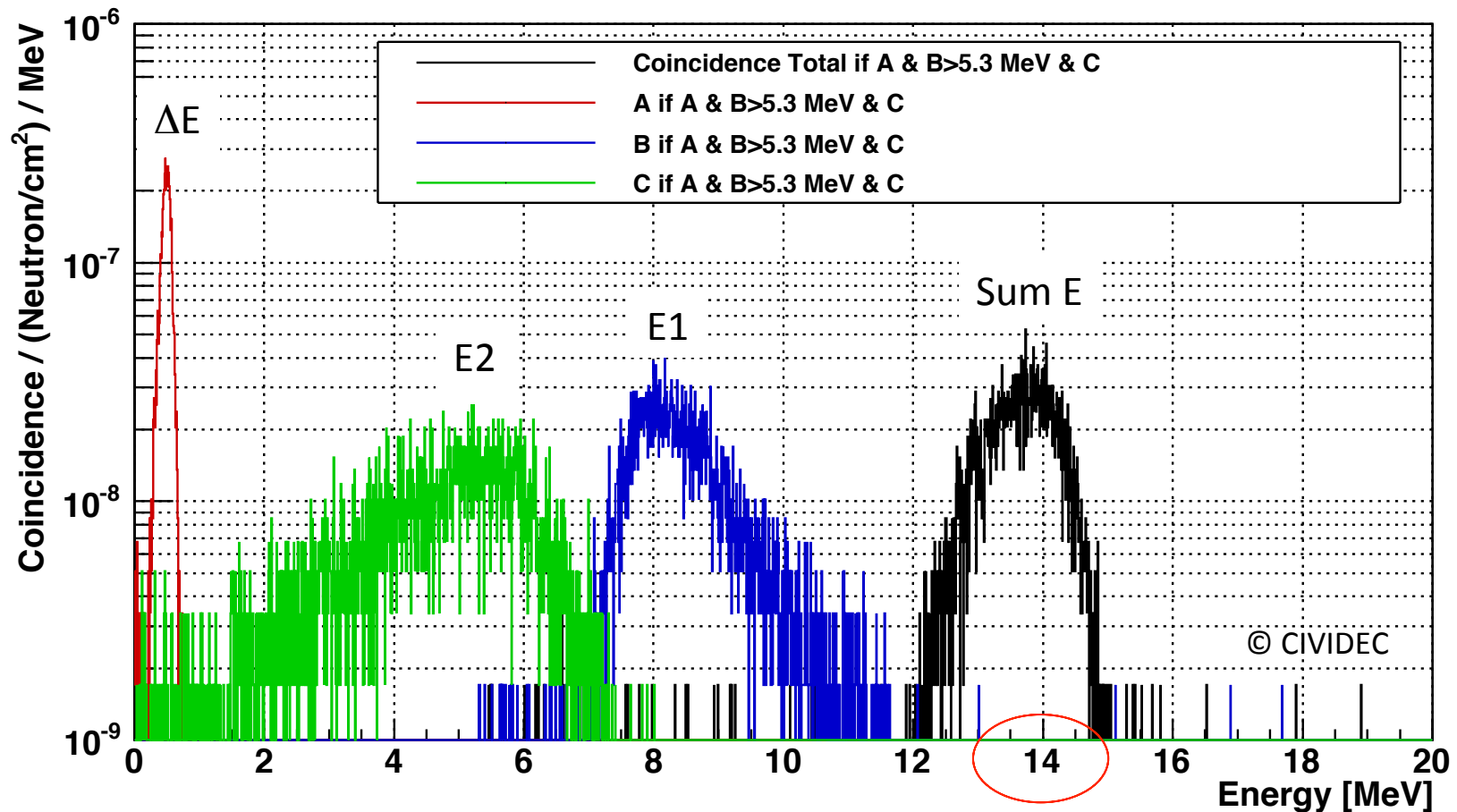


Proton-Recoil Telescope – Principle

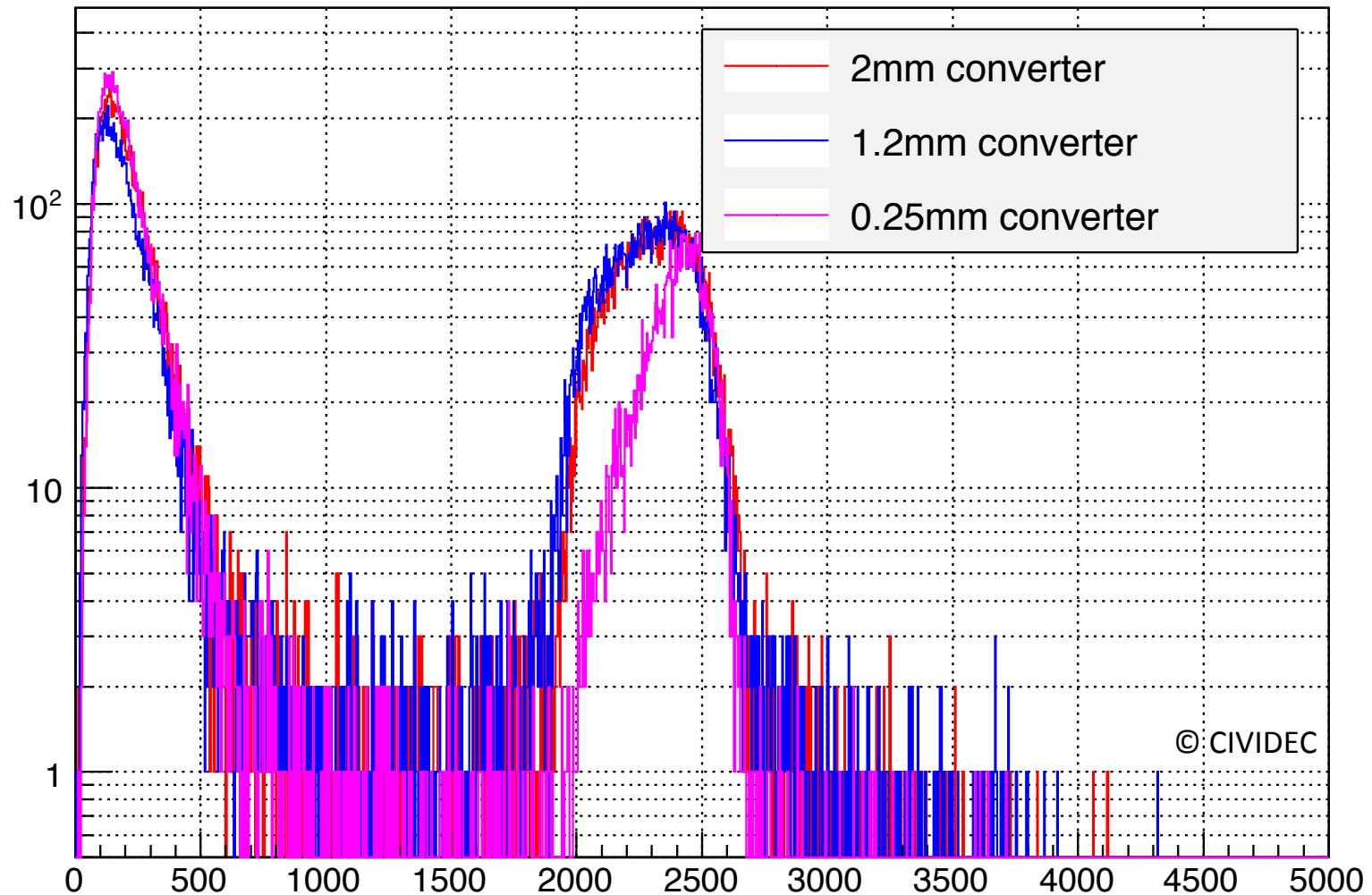
Total Spectra



Coincidences

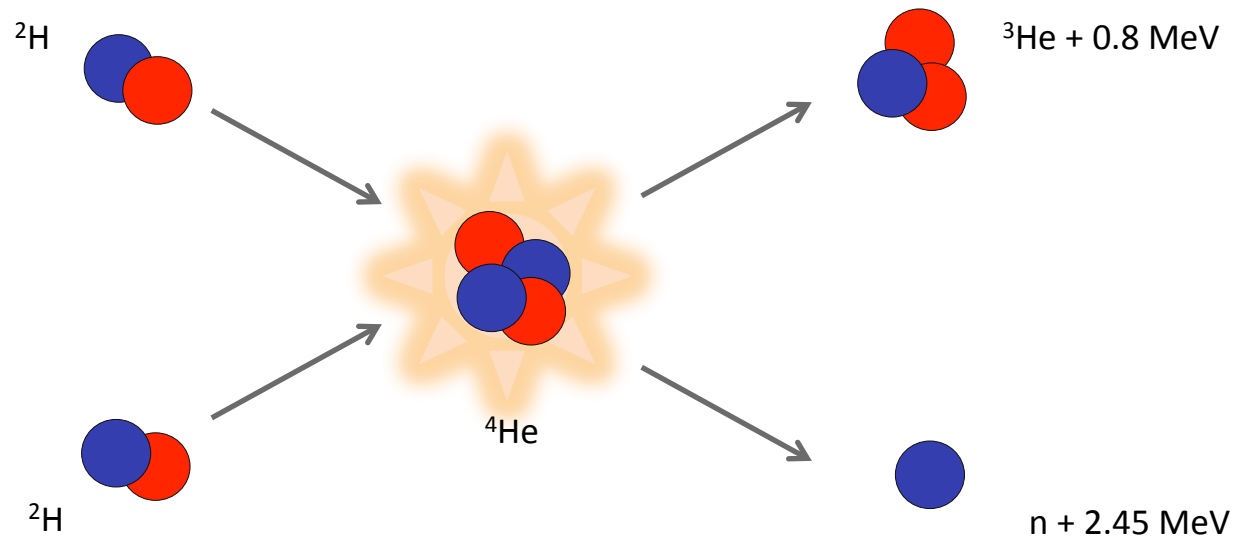


PE Converter Thickness

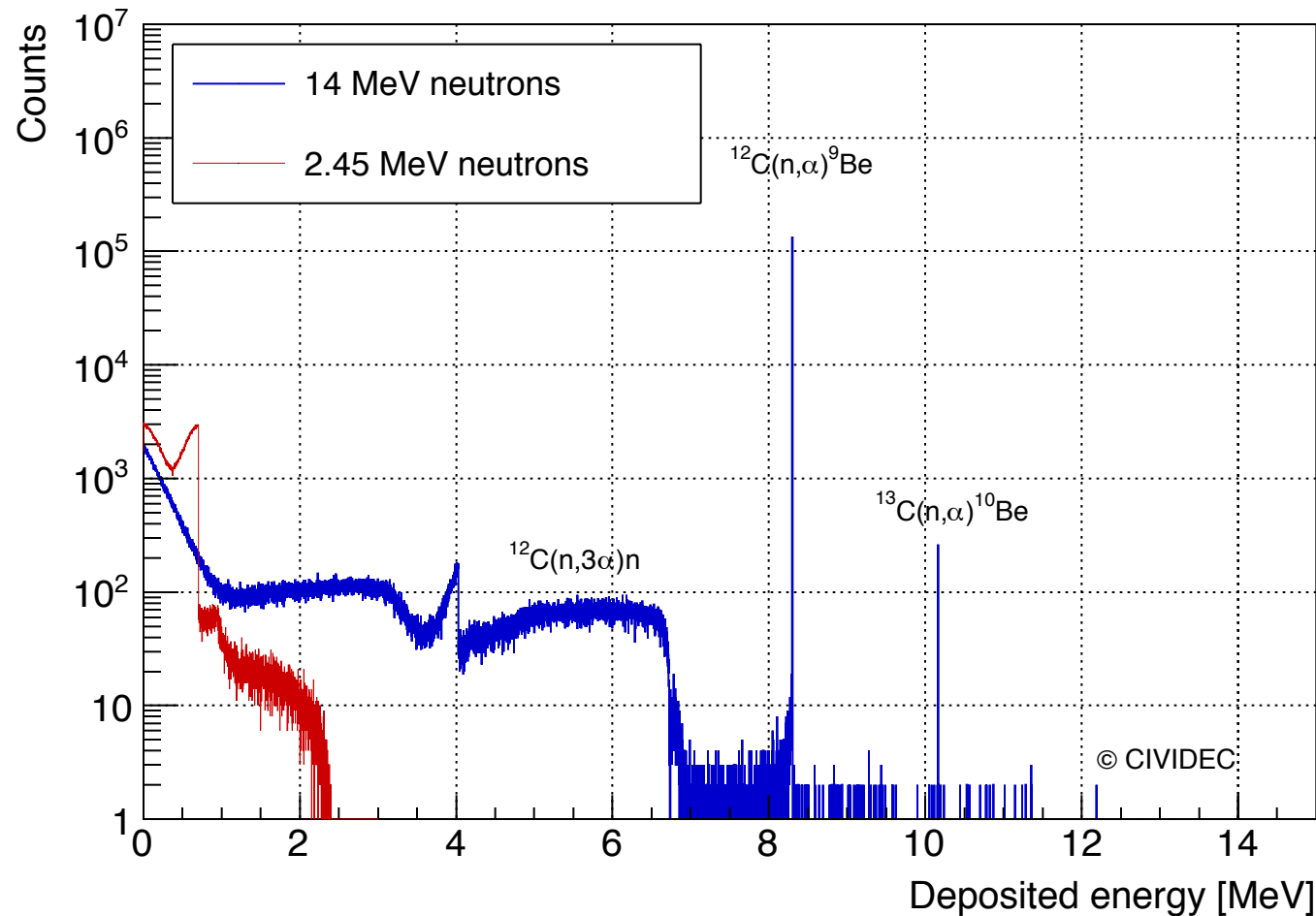


Deuterium – Deuterium Fusion

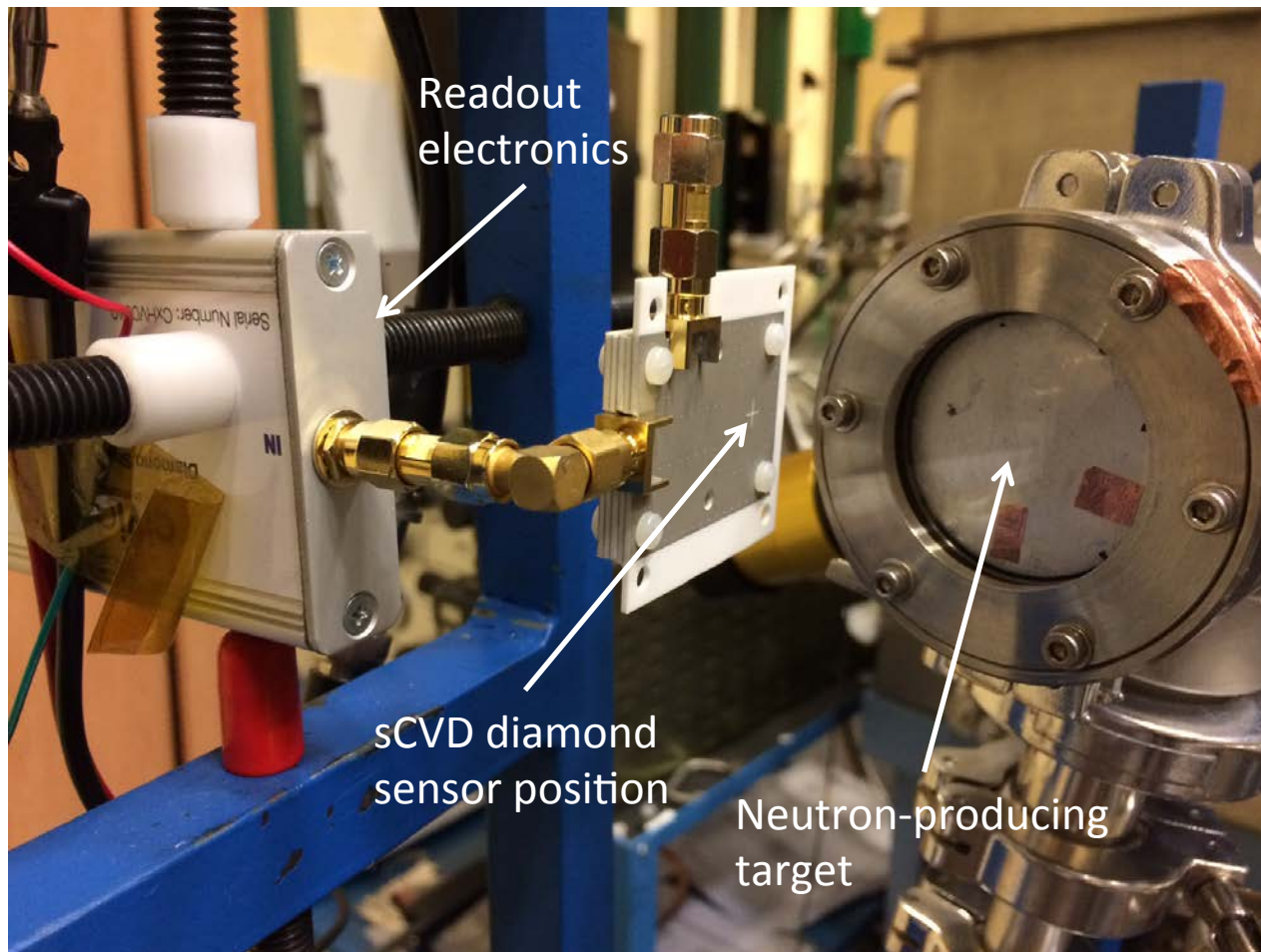
Deuterium – Deuterium Fusion



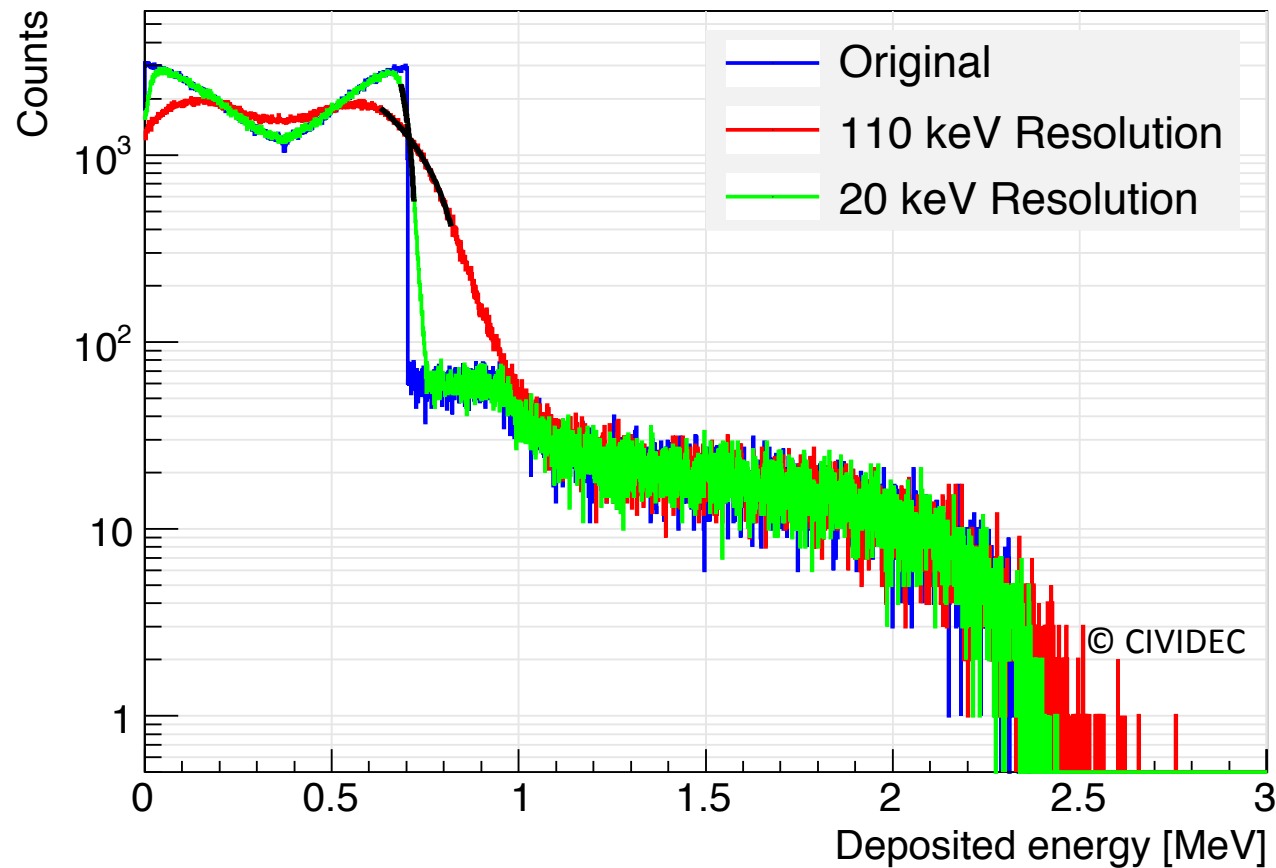
Simulated Response Function



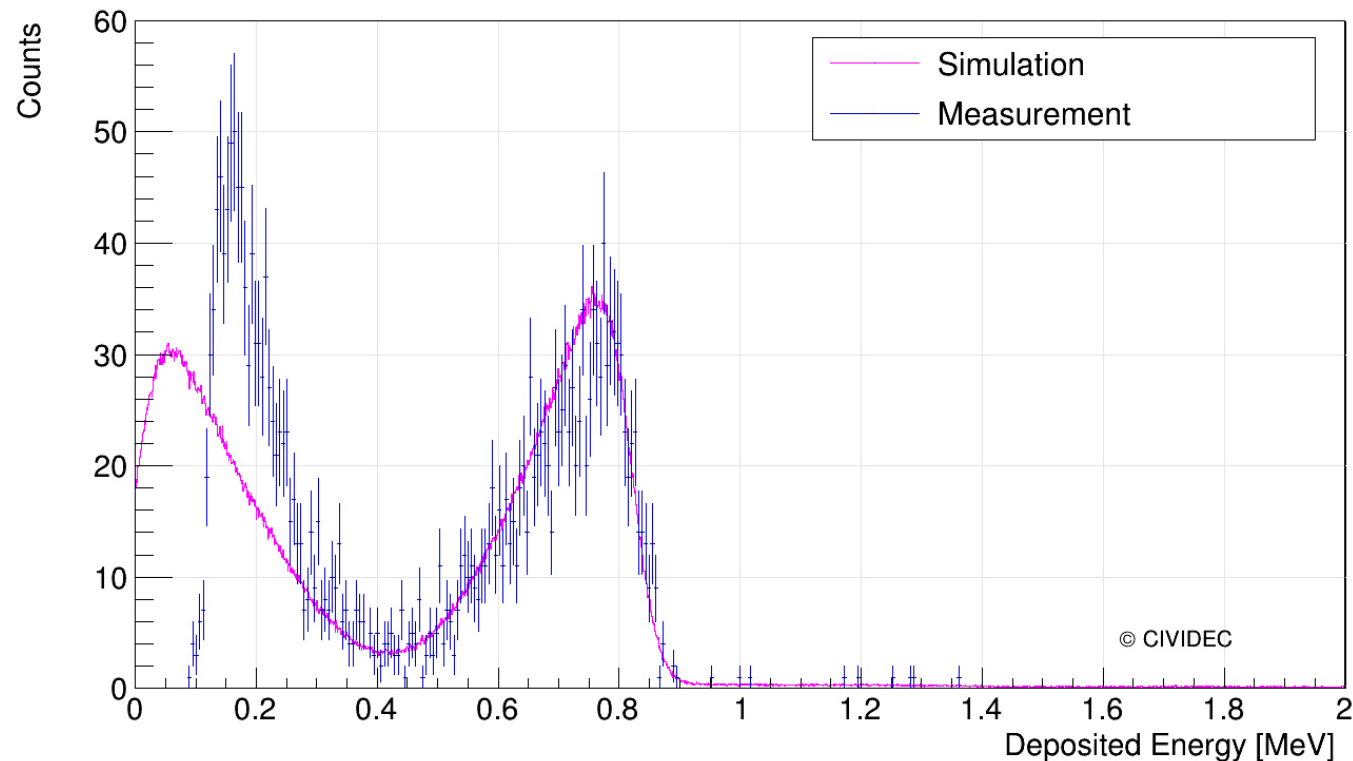
Experiment at Hispanos, Sevilla/Spain



Simulation



Deuterium – Deuterium Fusion



Conclusions

Conclusion

Diamond detectors are an important technological development for fusion neutron diagnostics.

D-T fusion: 14.1 MeV

1. Diamond as neutron converter:
 - Complex spectrum
2. PE converter:
 - Proton-Recoil Telescope

D-D fusion: 2.45 MeV

1. Diamond as neutron converter:
 - Very low energy deposition

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