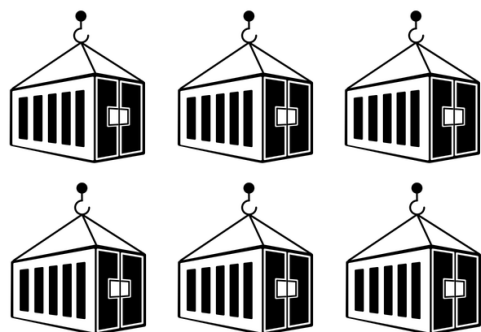


Characterization of fission chambers at high temperature

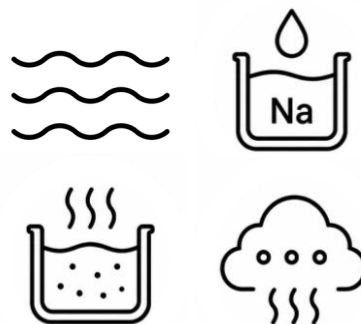
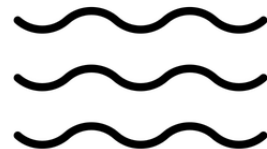
A. Rizzo, K. Irazoqui,
C. Payne, J. Thompson

TRTR annual meeting
September 21-25, 2026
Austin, TX (USA)

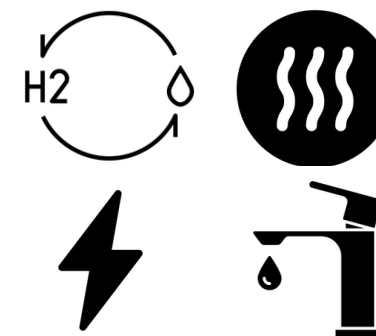
Context – evolution of the nuclear reactor fleets



Modularity

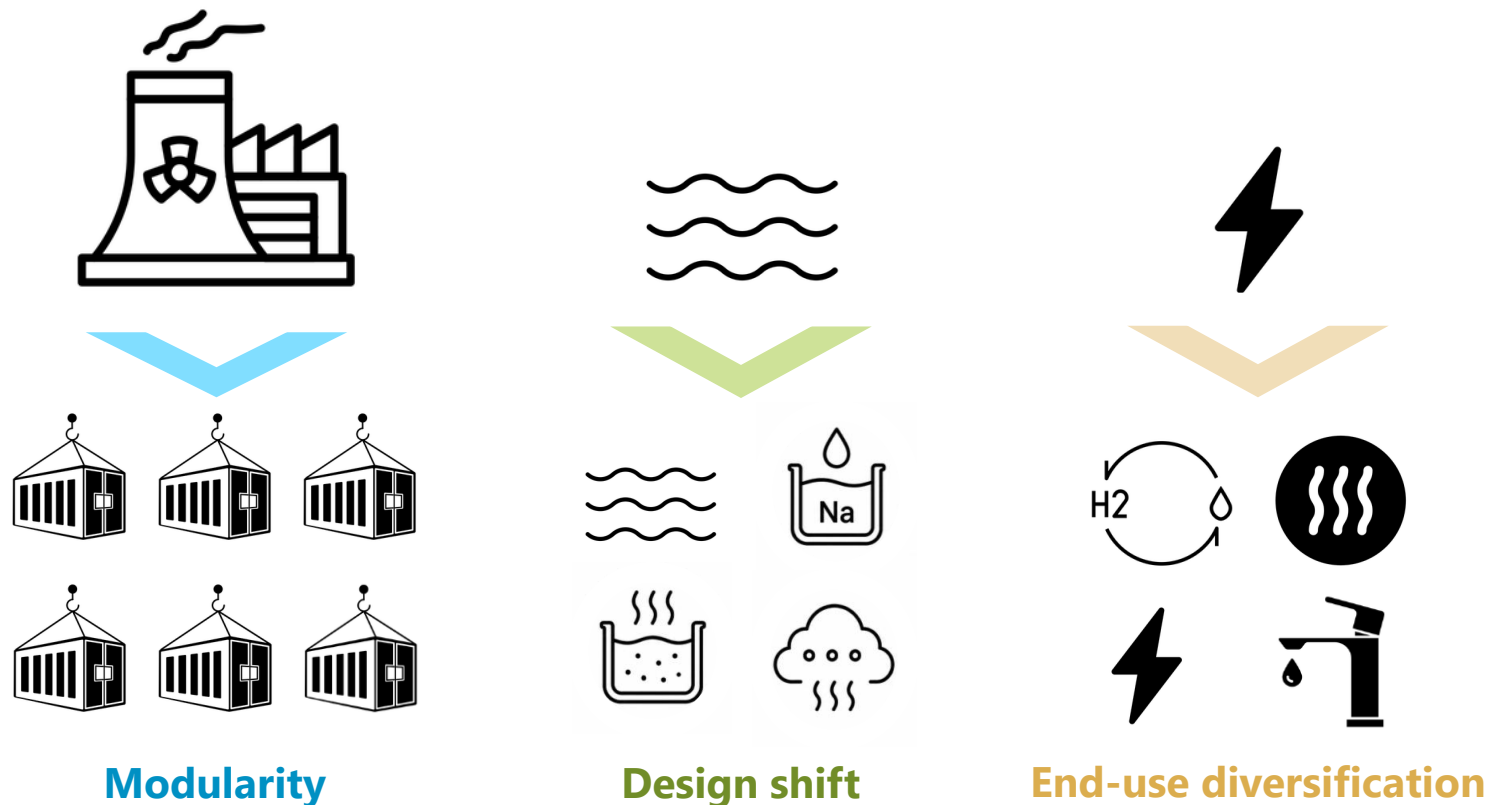


Design shift



End-use diversification

Context – evolution of the nuclear reactor fleets

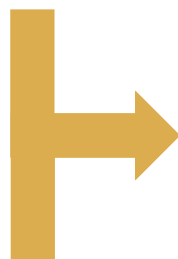


Smaller core / vessel and more compact design → Instrumentation **closer to hot zone**

Higher temperature of operation / hotter coolant → Instrumentation **exposed to higher temperature**

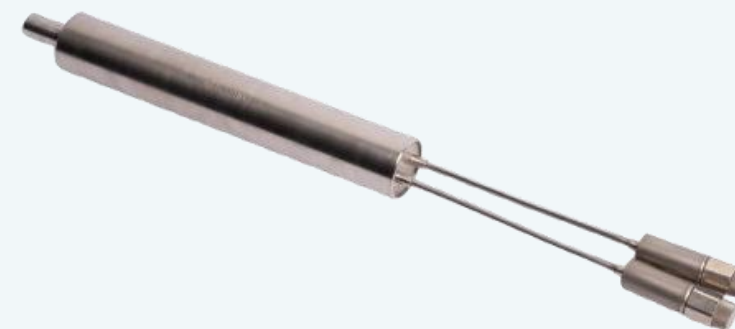
High temperature detectors

A long story for EXOSENS in Europe



- **Advanced Gas-cooled Reactors** site in the UK
- **Sodium Fast Reactors** site in France

CASE STUDY FOR THIS PRESENTATION CFUC16 FISSION CHAMBER



- Evolutionary version of the CFUC design used in Phénix and Superphénix ⁽¹⁾
- Materials and processes selected for mechanical integrity up to 850 °C
- Standard maximum temperature rating 600 °C based on gap analysis
- **Need to confirm its neutron performances**

⁽¹⁾ J.P. Trapp *et al.*, "High temperature fission chambers: State-of-the-art", Proc. Specialists' meeting, In-core instrumentation and core assessment, Mito-shi, Japan (1996)

CFUC16 tests conducted in 2026

Setup overview

- Tests conducted in Centronic Limited – EXOSENS Detection UK with Cooknell Electronics
- Tubular oven and thermocouples
- Low neutron source on top of the oven
- Characterization of output signals from 20 °C to 600 °C

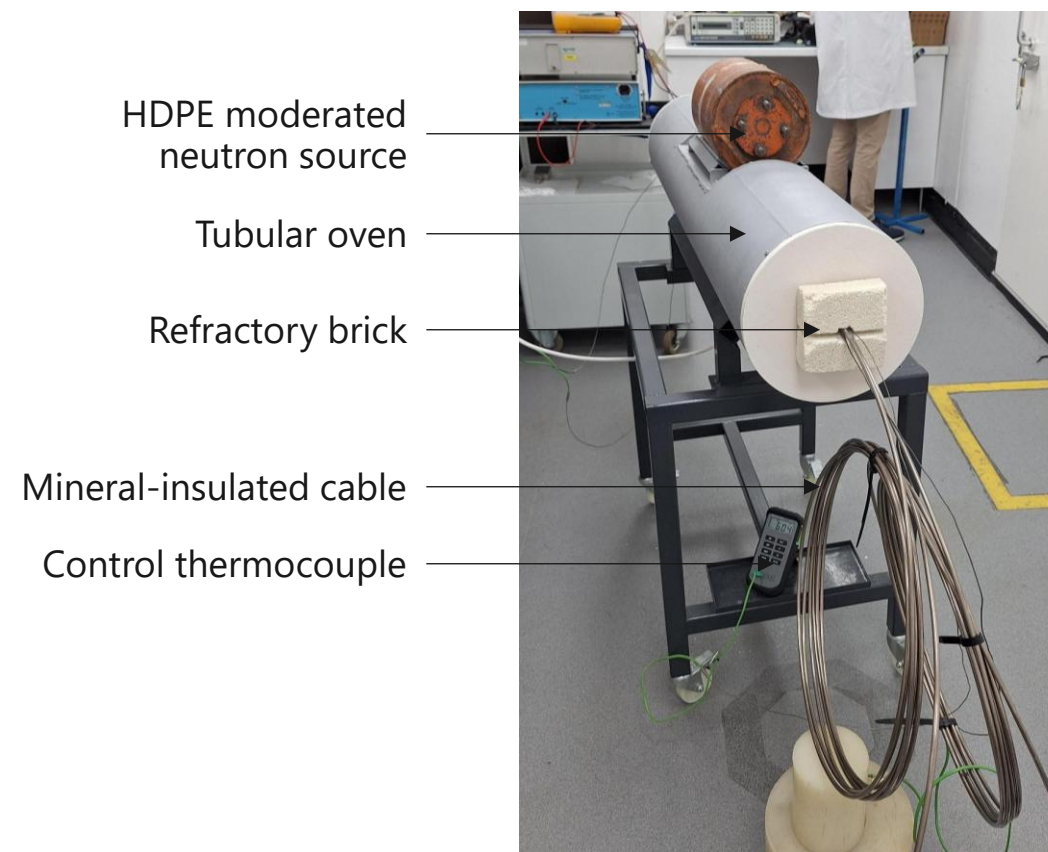
Tests ran per temperature step

Background noise

Discrimination curve

Plateau curve

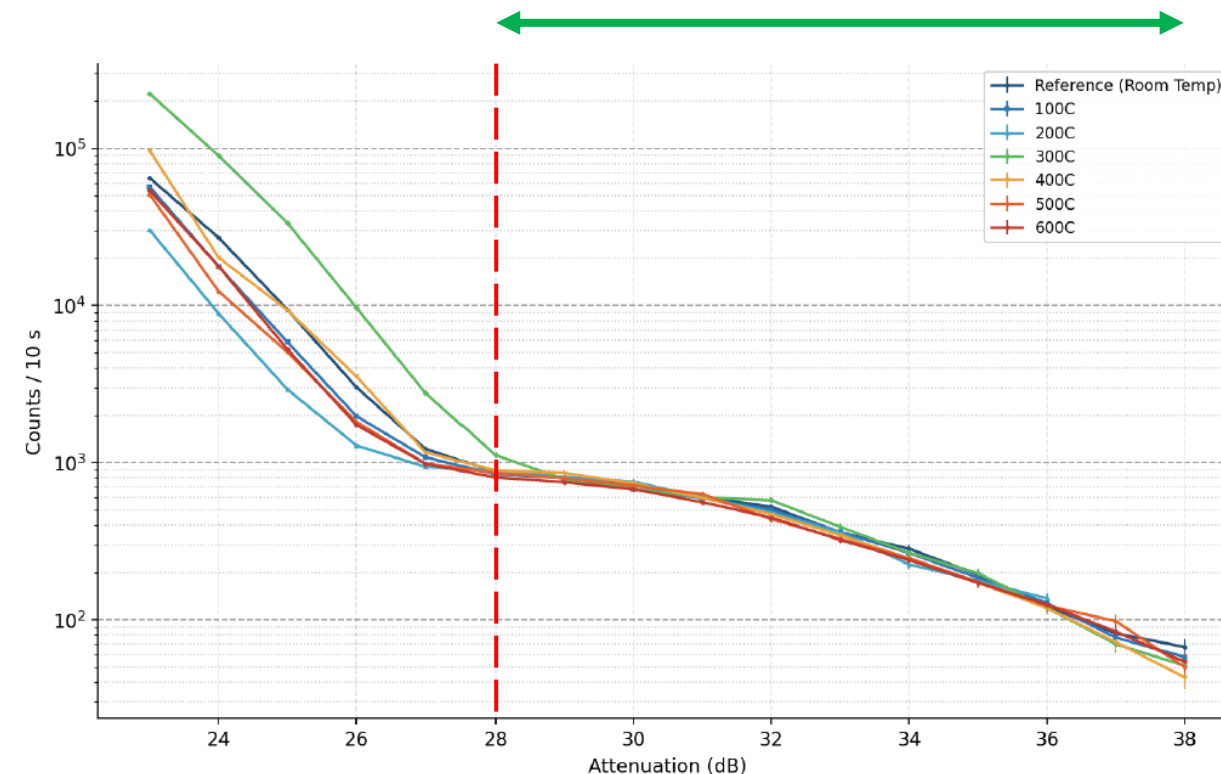
Pulse shape analysis



CFUC16 tests conducted in 2026

Results – discrimination curve

- Discrimination curves overlap after 28 dB (~32 mV threshold in our setup)
→ **No significant effect of temperature on counting rate**
- Next step → pulse shape analysis at the curve level of the curve bend
➤ Effect of temperature on pulses?

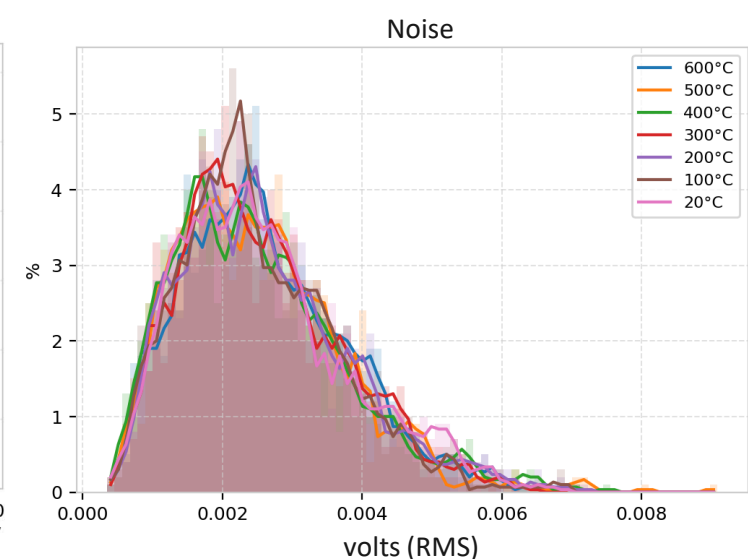
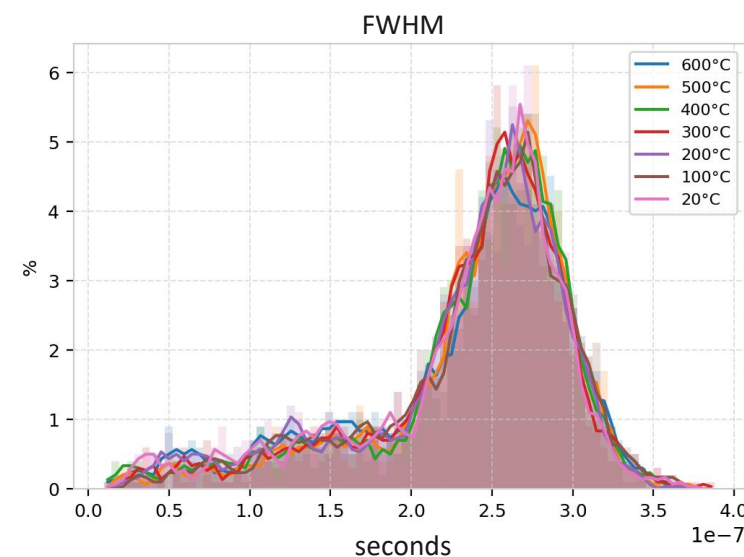
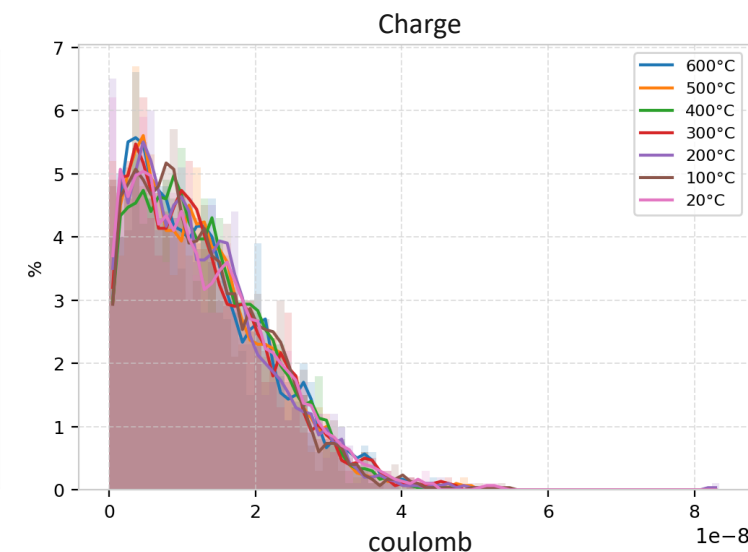
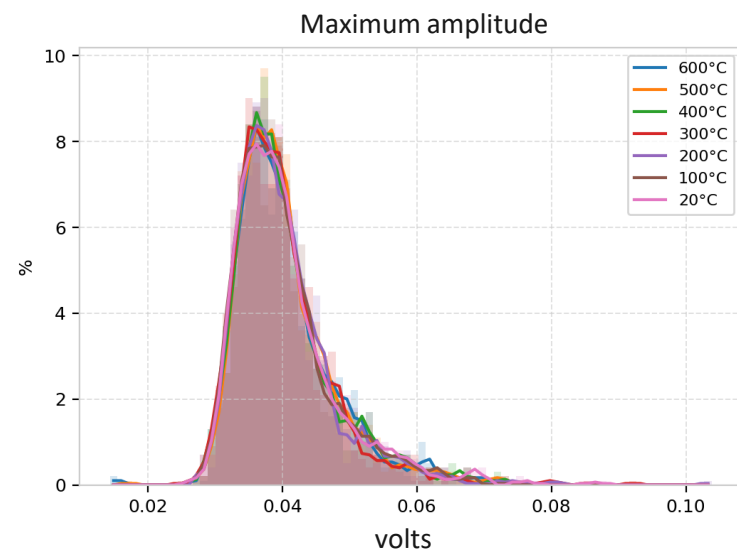


CFUC16 tests conducted in 2026

Results – pulse shape analysis

- Pulses recorded after preamplifier at 28 dB (equivalent to 32 mV threshold)
- Computed distributions
 - Maximum pulse amplitude
 - Charge deposited (after preamplification)
 - Pulse length
 - Noise (signal RMS before pulse rise)

No significant change on pulses between 20 °C and 600 °C



Conclusion

- Excellent performances of the CFUC16 up to 600 °C
 - No effect of temperature at low counting rate capability
 - No effect of temperature on signal/average waveform
- Next steps:
 - Endurance tests to be performed
 - Operational conditions to be tested: high neutron flux, high temperature, high γ flux to investigate other modes of operation
 - Full qualification of a CFUC16
- Many designs operating up to 600 °C and capabilities to go up to 850 °C ⁽²⁾ upon demand
 - Including miniature fission chambers for in-core applications



Examples of high temperature fission chambers manufactured by EXOSENS – from Ø7 mm to Ø48 mm

⁽²⁾ M. Hodgson *et al.*, "Revalidation of mature high temperature fission chamber detectors", Proc. Int. Conf. 5th G4SR, Canada (2024)



EXOSENS / Mirion Technologies

A recent partnership for the CFUC16 high temperature fission chamber

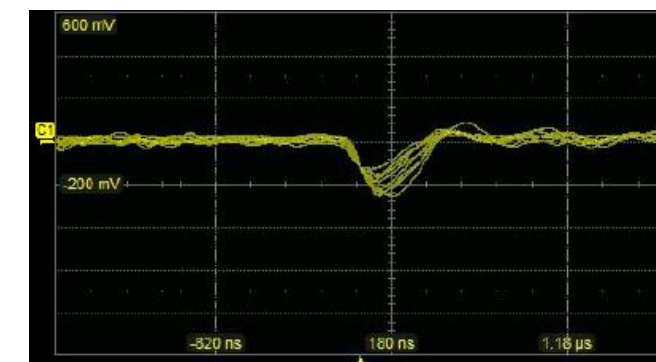
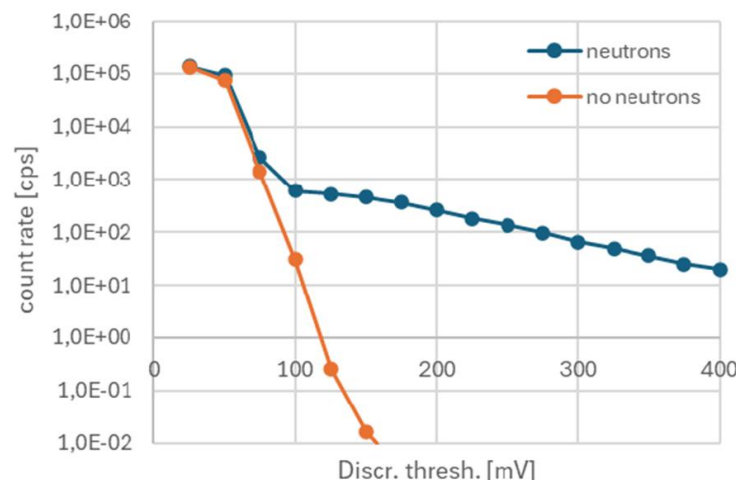
- Tests performed on a CFUC16 in EXOSENS France
 - Low temperature / low flux measurement
 - Temperature cycling (wo/ neutrons)
- Set-up tested
 - NV 230 pre-amplifier – guarded fission chambers
 - DWK 260 signal processing unit
- Pulse mode, discrimination, noise, characterization



DWK 260 signal processing unit



NV 230 pre-amplifier



Thank you for your attention!

Contact:

Sales / technical support – nuclearsales@exosens.com