Bundesministerium
für Bildung
und Forschung

The CASCADE Project
a multi-layer ^{10}B neutron detection system

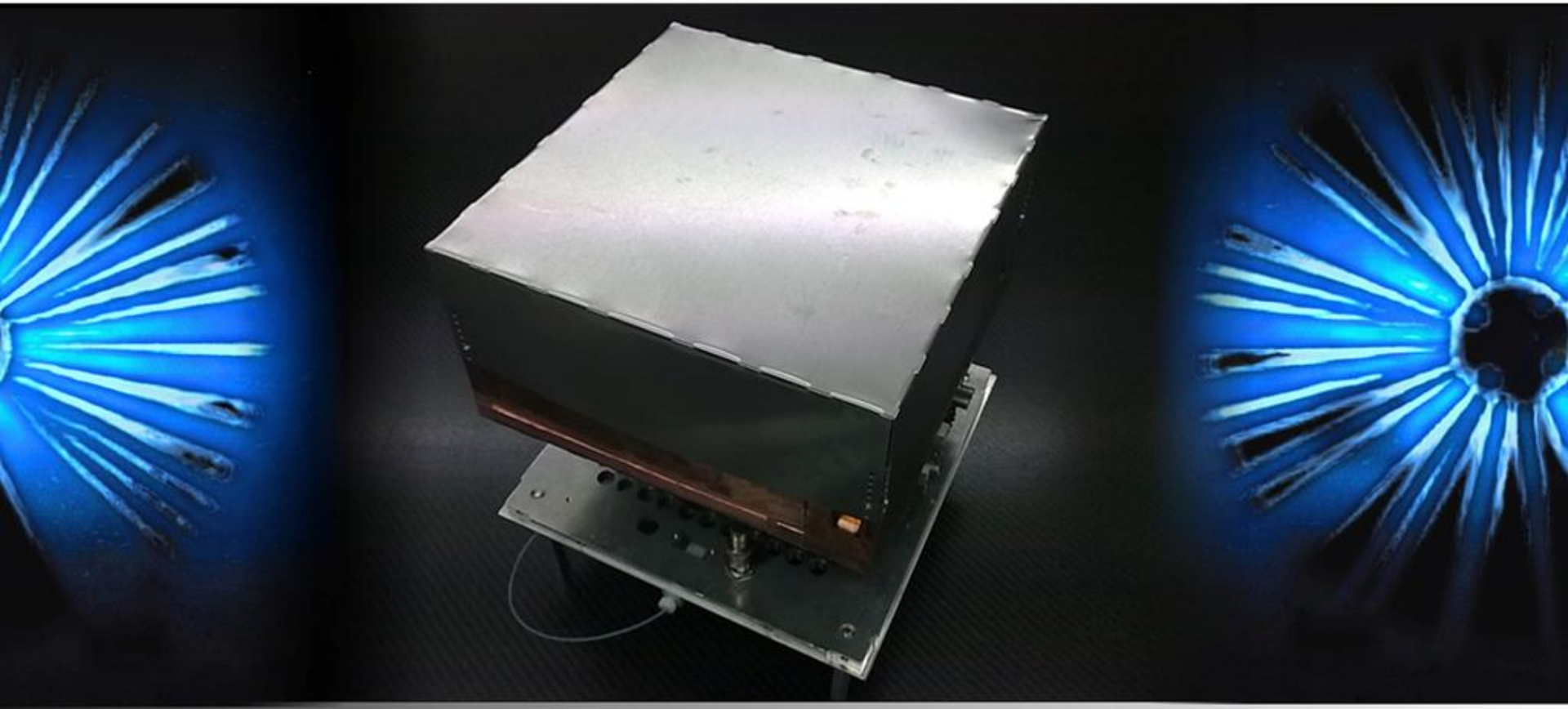
Physikalisches Institut

Ruprecht-Karls-Universität Heidelberg

Markus Köhli

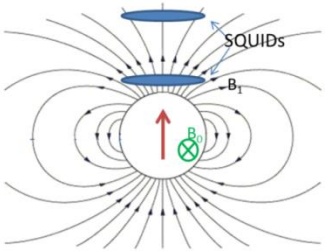
U. Schmidt

AG Dubbers

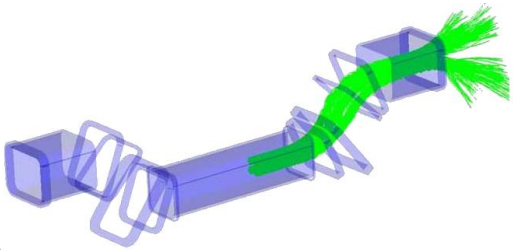


Heidelberg Research Fields

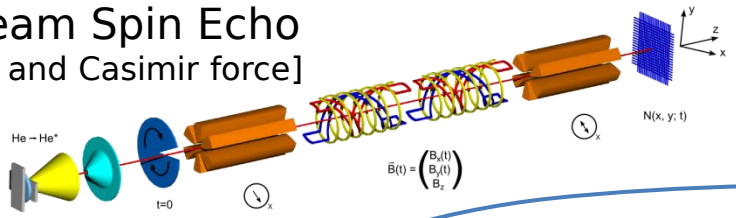
Helium-Xenon EDM
[test of Lorentz invariance]



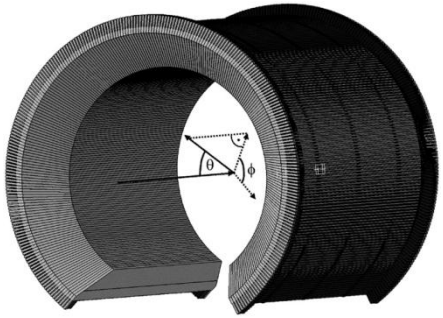
PERC and PERKEO
[v_{ud} via neutron beta decay]

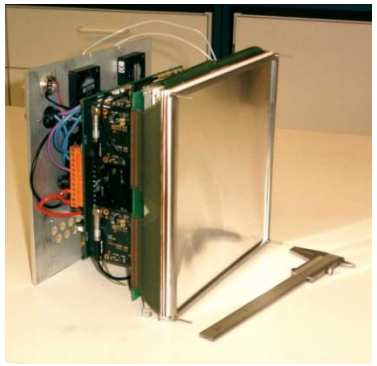


Atomic Beam Spin Echo
[Berry phase and Casimir force]

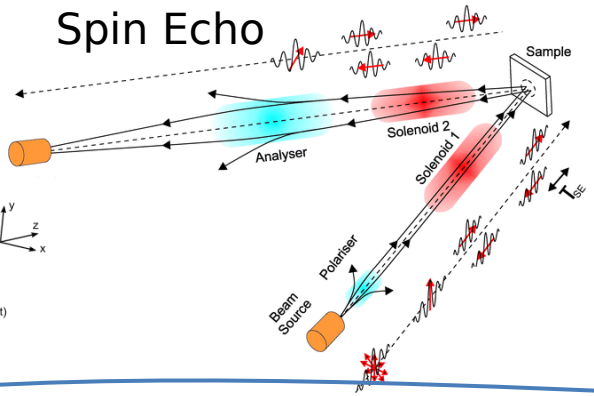


^{10}B Neutron Detectors
[large area and high time resolution]





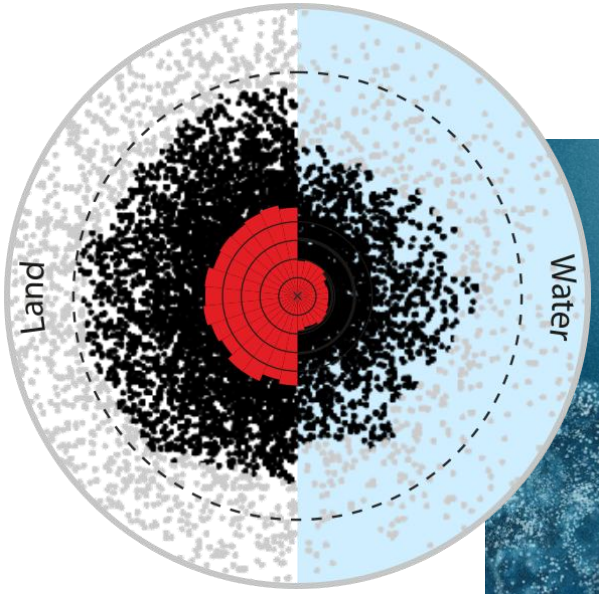
Spin Echo

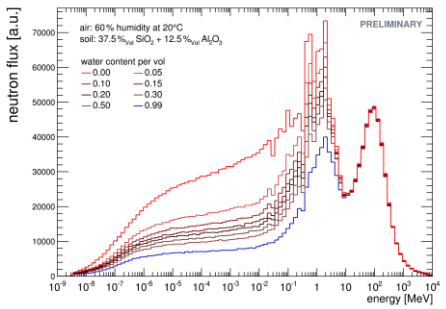


Heidelberg Research Fields

COSMOS Project, UFZ Leipzig

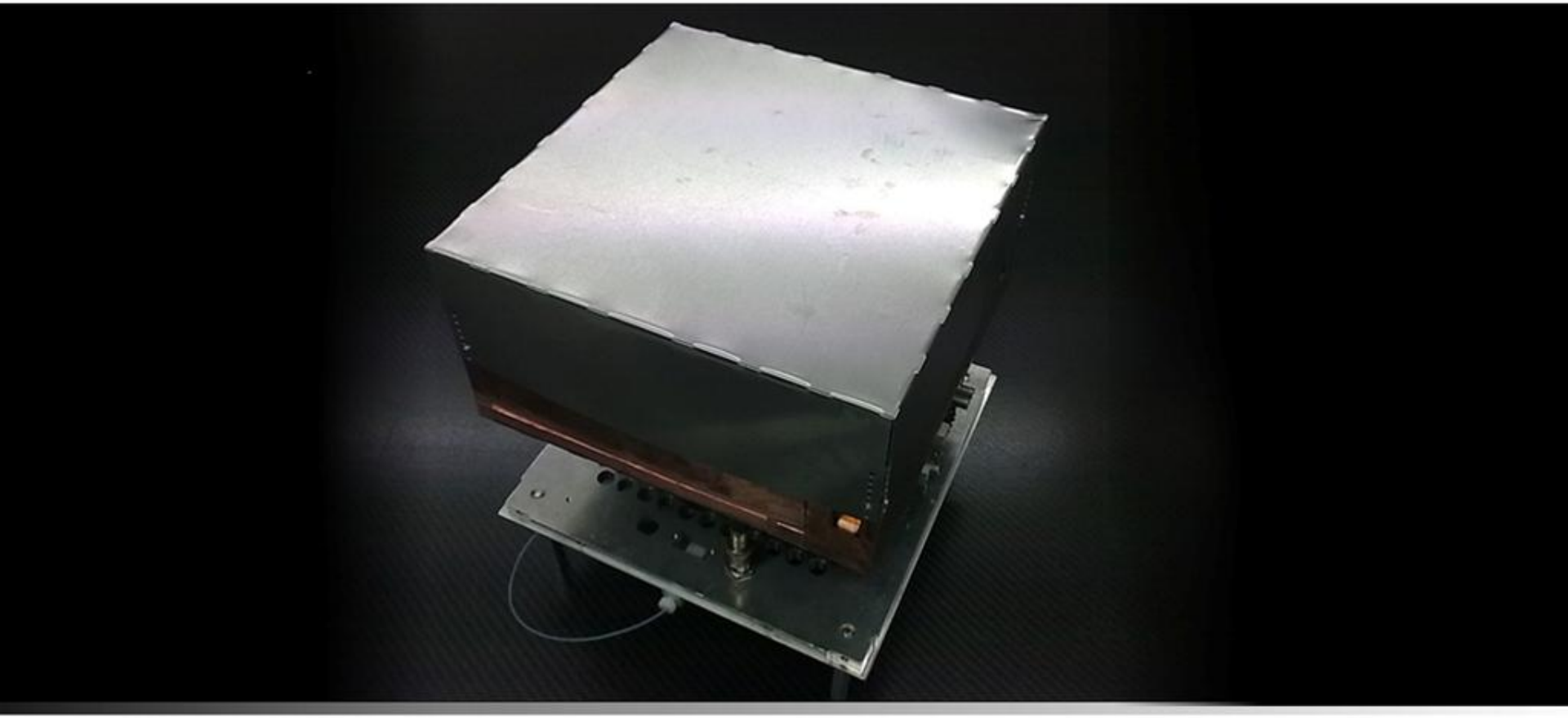
Ground water sensing by
cosmic ray induced neutron showers





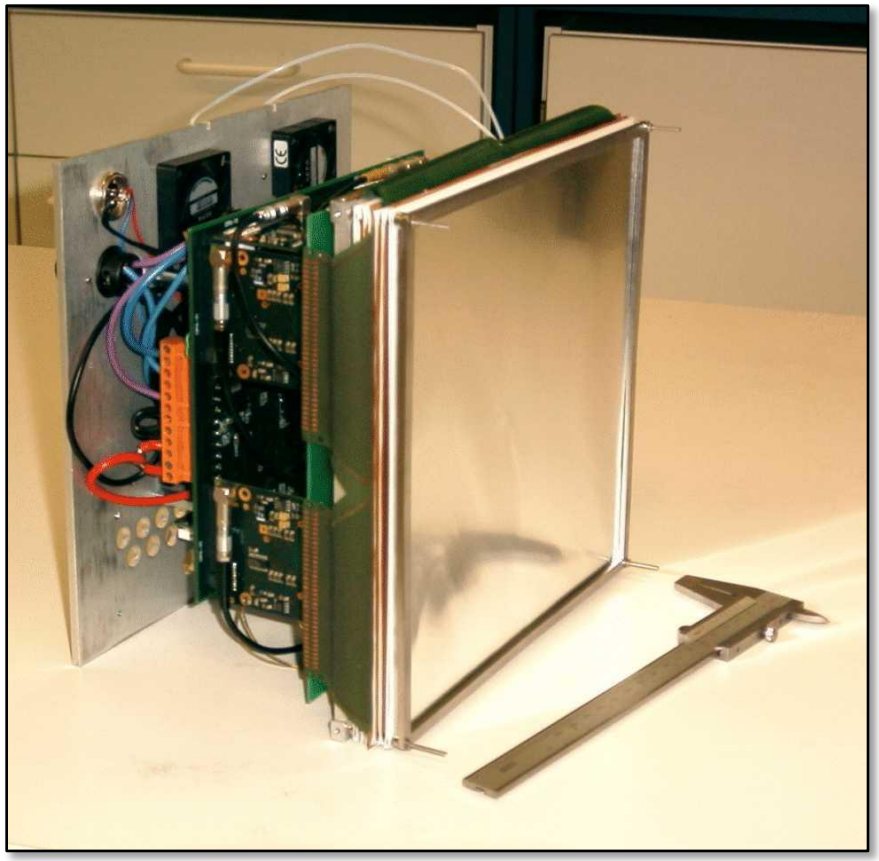
CASCADE

The Detector



The CASCADE Detector

CASCADE detector without housing



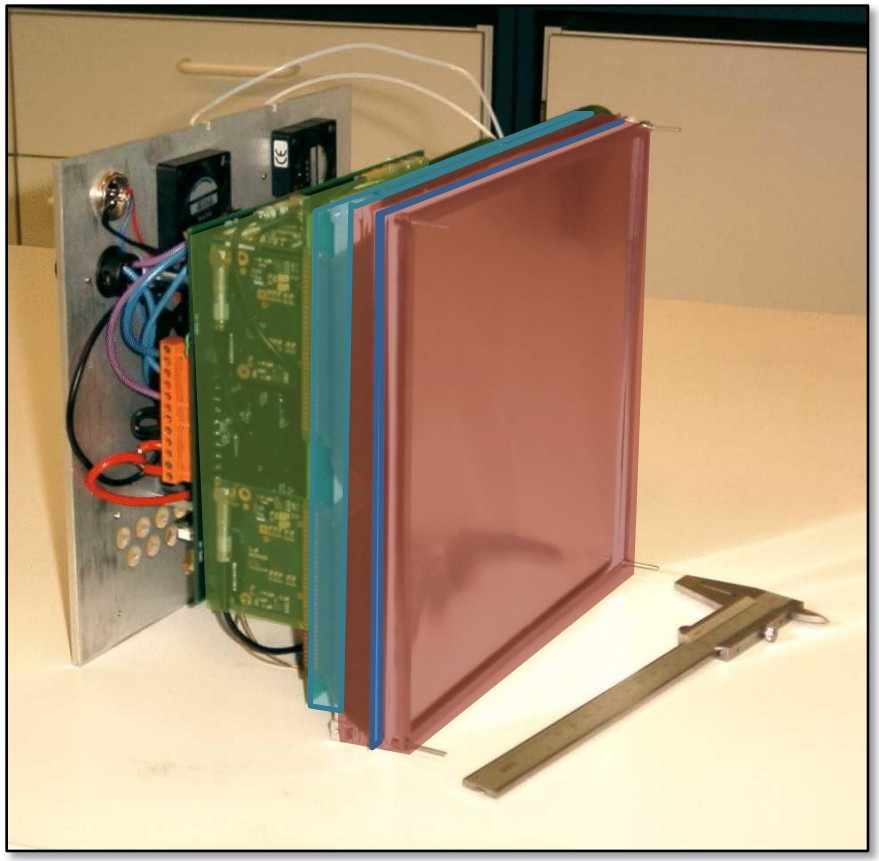
The CASCADE Detector

Active Detection Volume

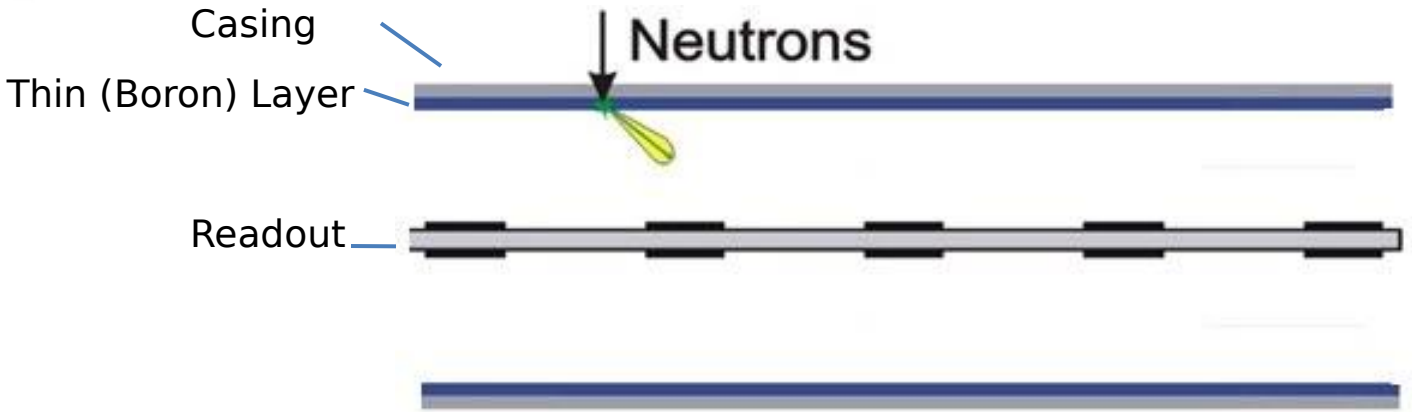
Readout

Electronics

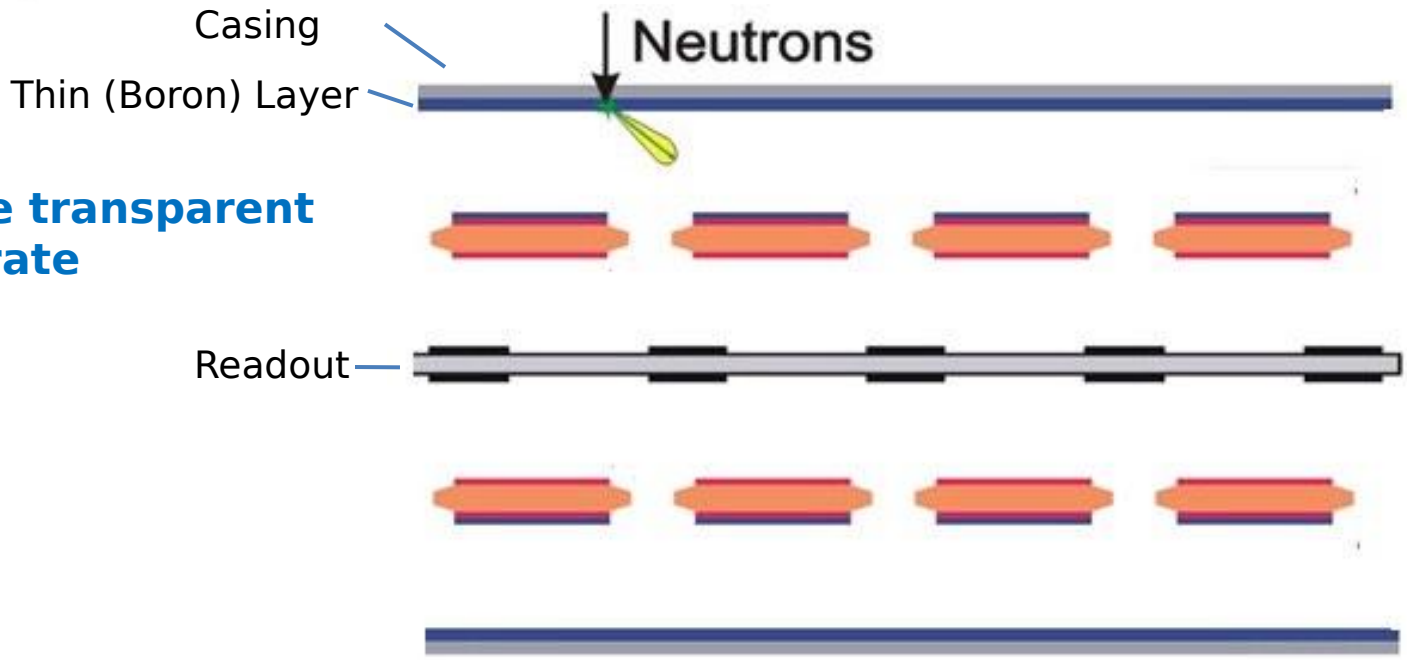
CASCADE detector without housing



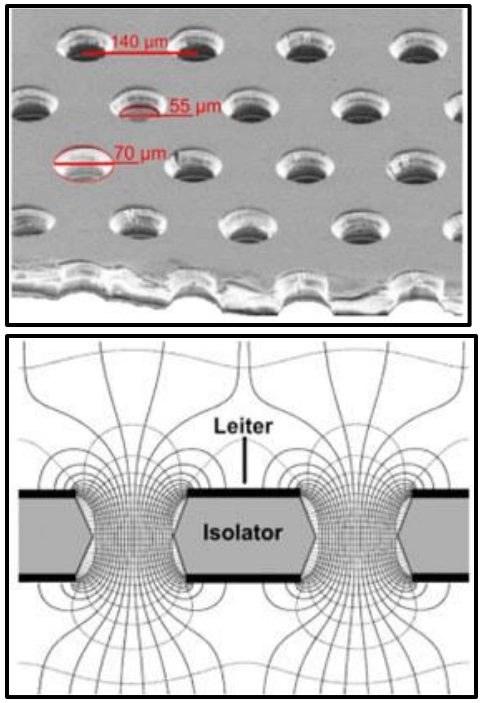
The CASCADE Concept



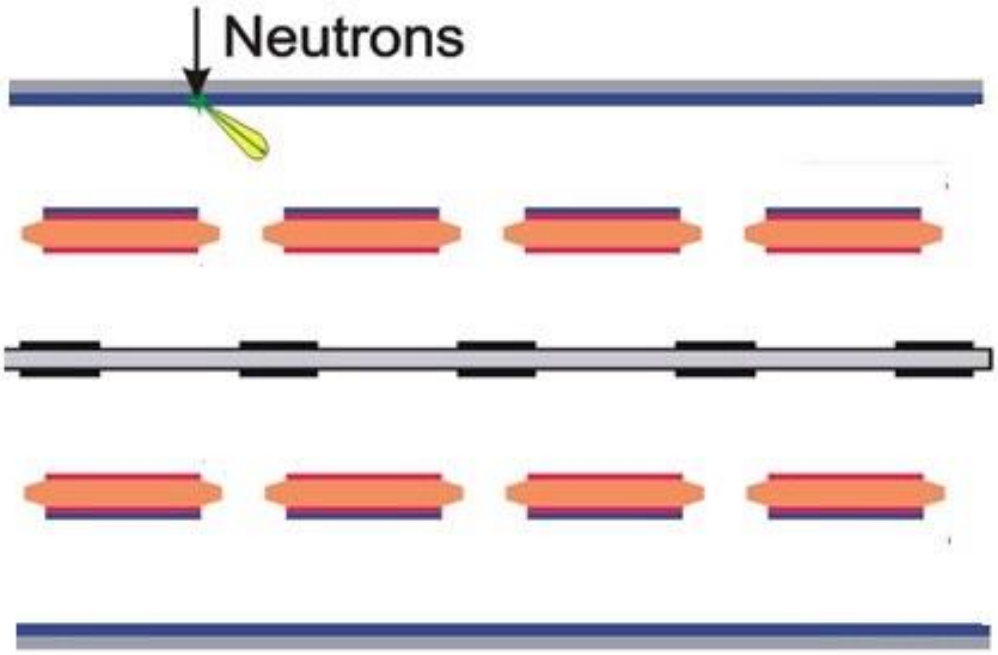
The CASCADE Concept



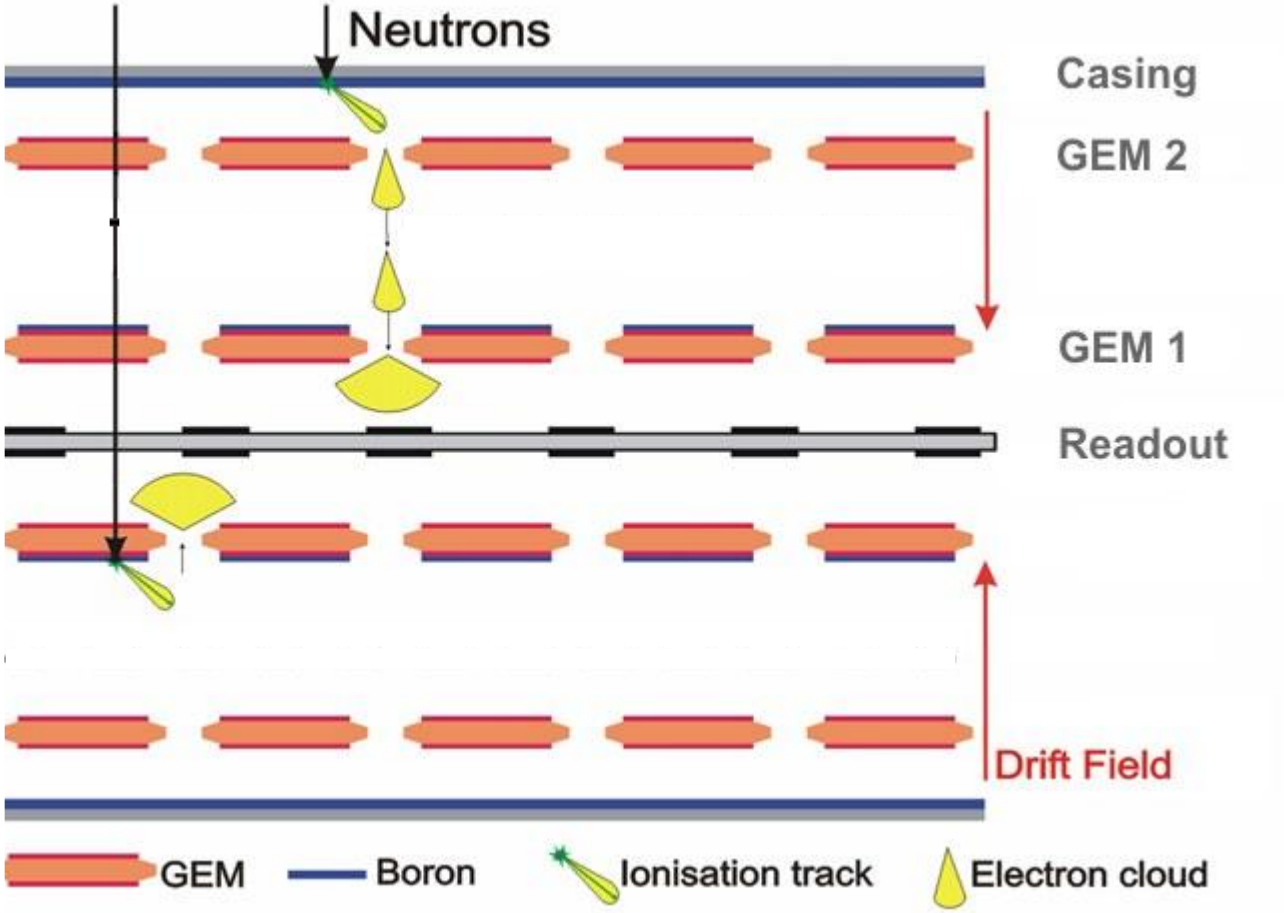
The CASCADE Concept



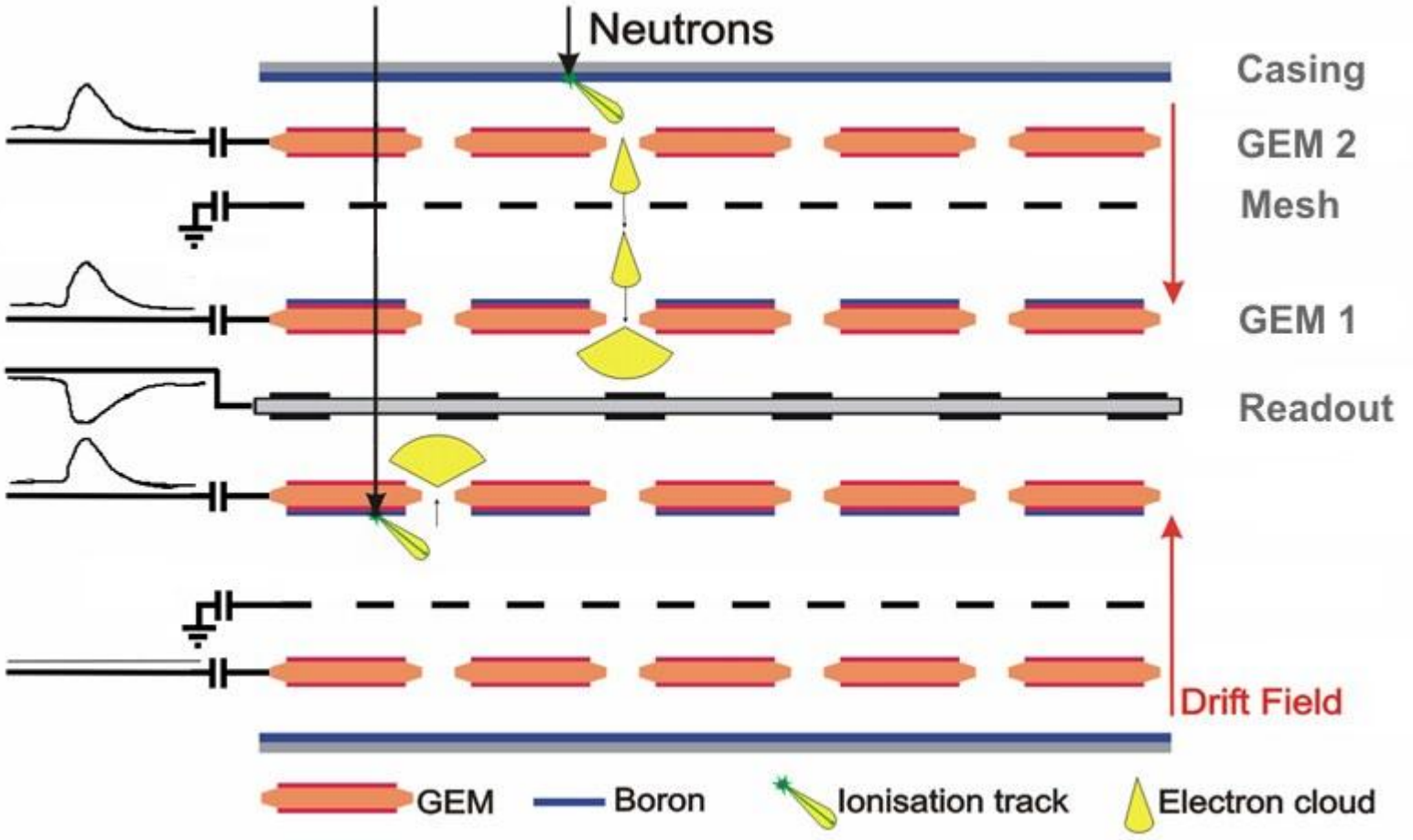
GEM
(Gas Electron Multiplier foil)



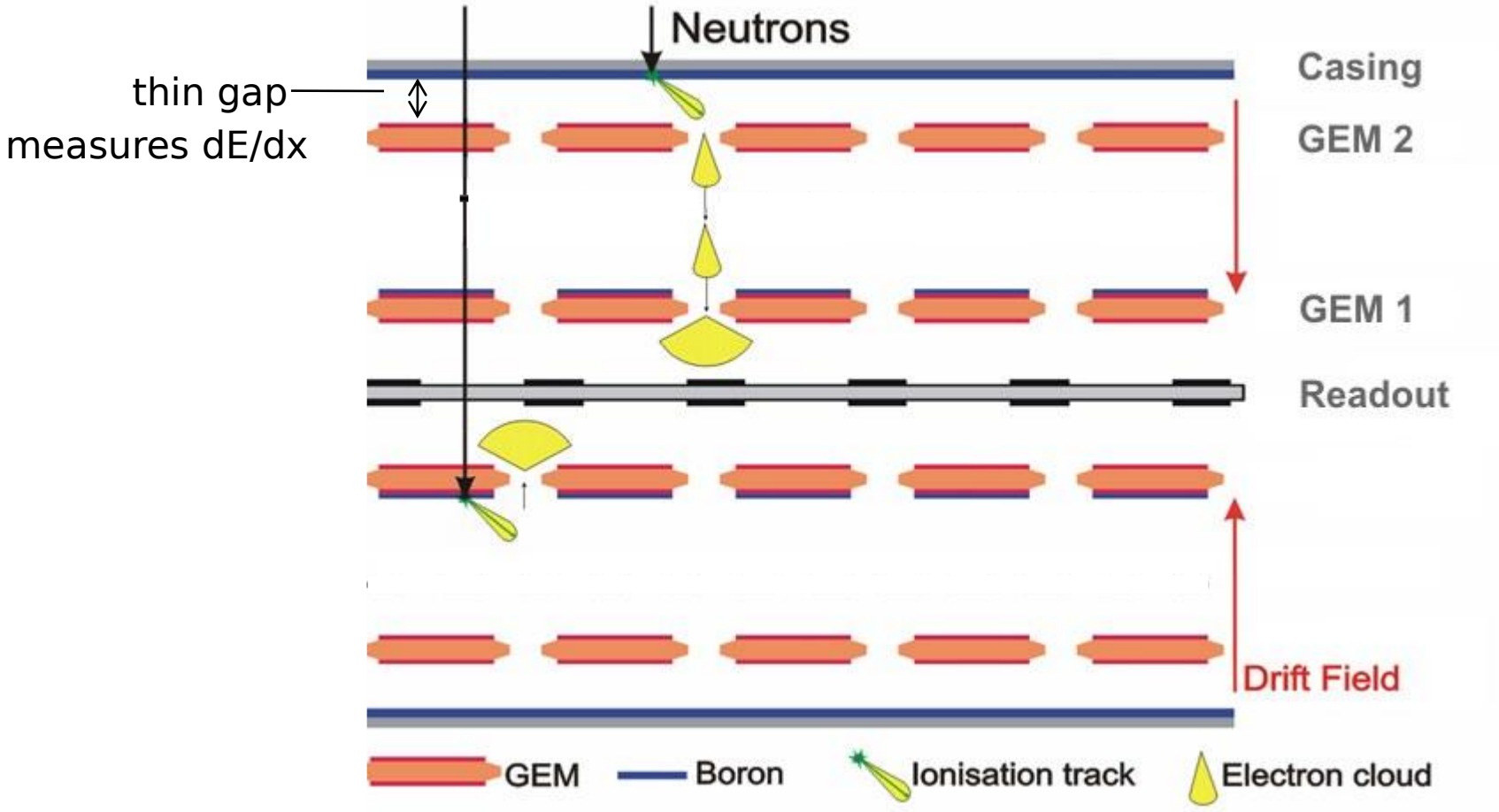
The CASCADE Concept



The CASCADE Concept

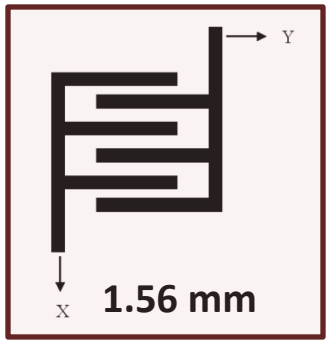


The CASCADE Concept



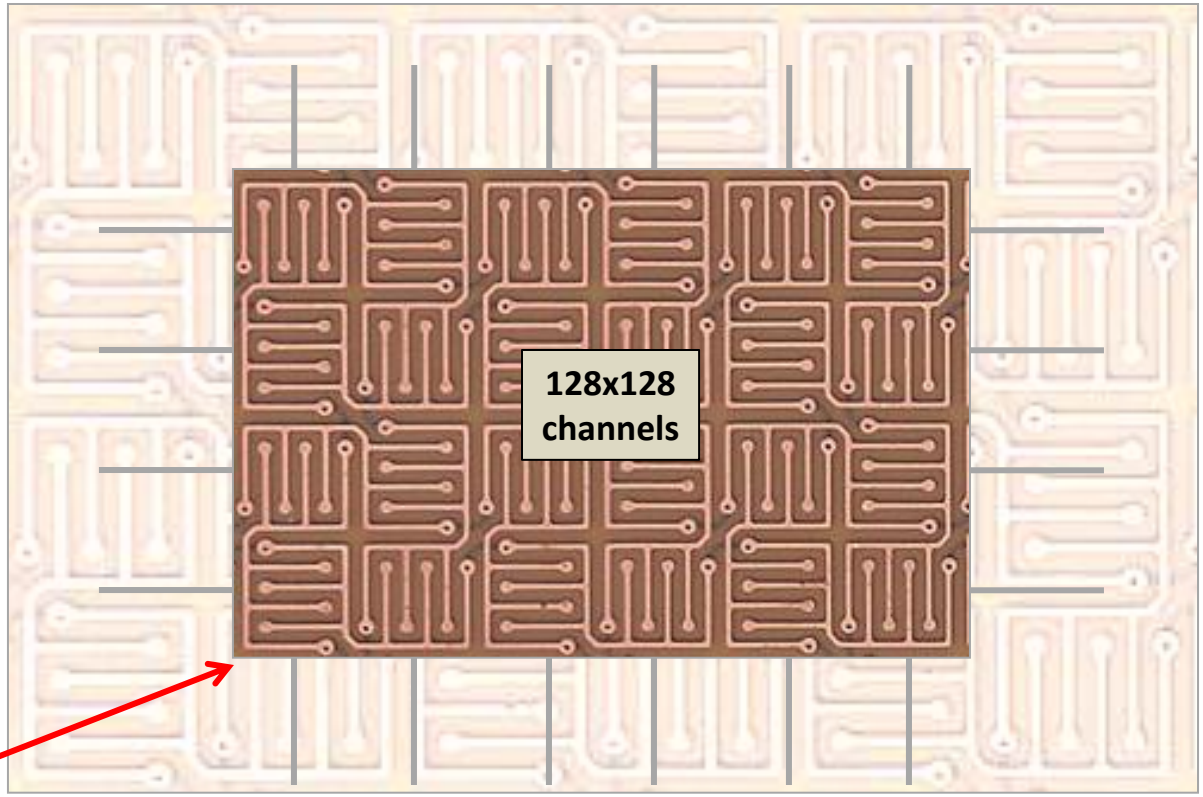
Readout

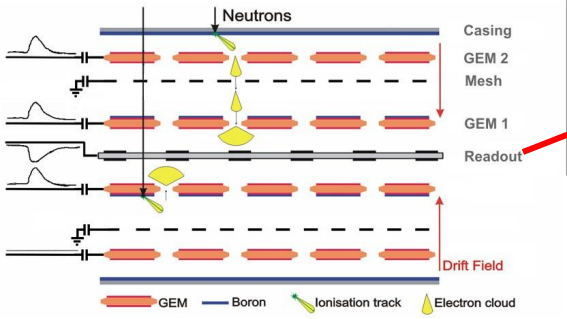
Unit Cell:



Y stripes

X stripes





Crossed stripes: reduces noise correlating x and y

CIPix Readout ASIC

- 64 channels
- 10 MHz (40 MHz) readout clock

Timeline

FElix chip (RD20, LHC) **[1993]**

HELIX 1.0

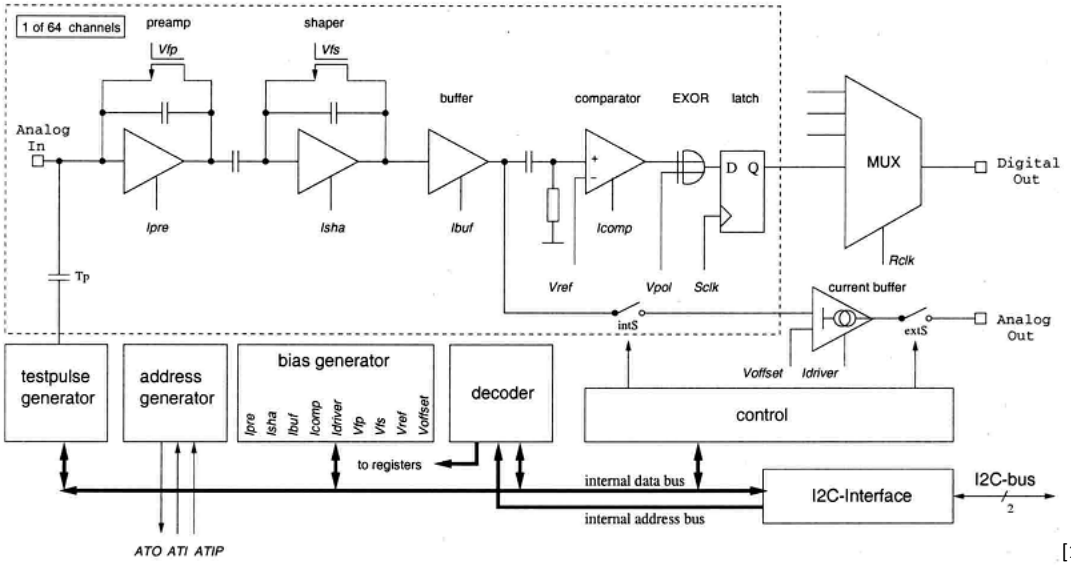
HELIX 32 **[1998]**

HELIX128-2.2 (HERA-B)

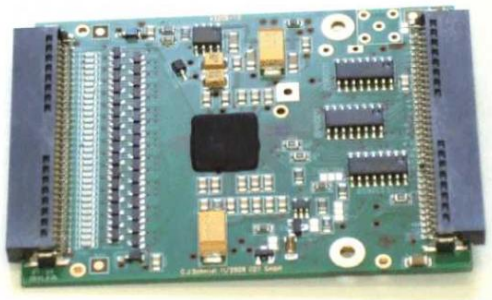
HELIX128-3.0 (Zeus)

CIPix (H1)

BEETLE (LHCb)

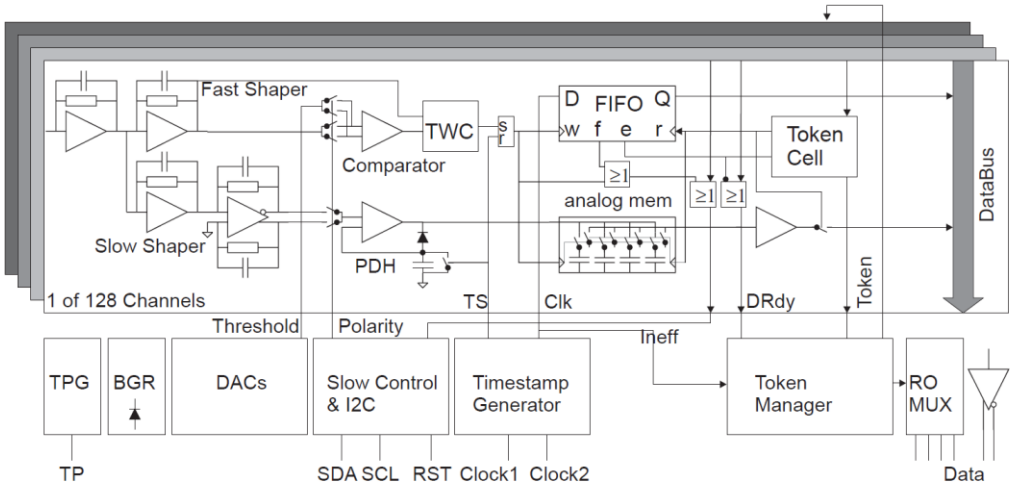


[1]



nXYter ASIC

- 128 channels
- 1 ns time resolution
- Token Ring Readout

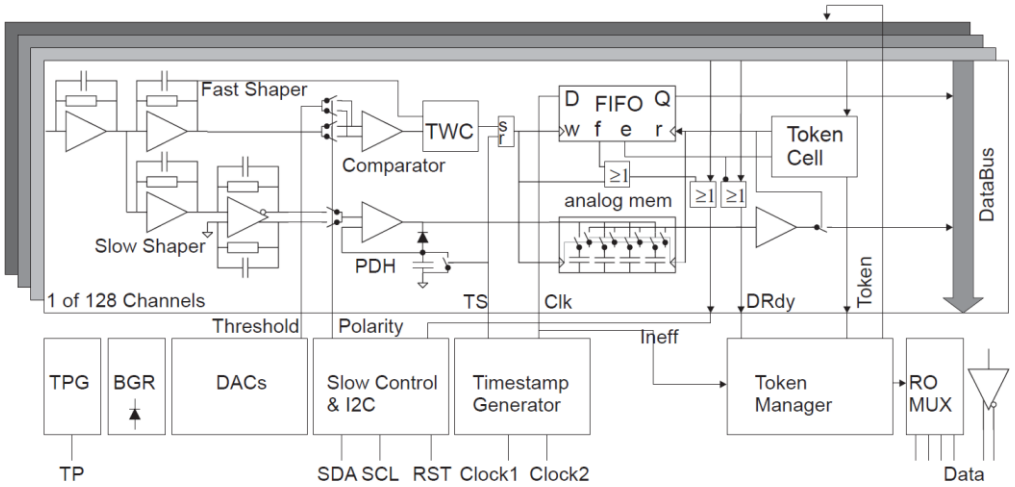


[1]

[1] The n-XYTER Reference Manual 1.50, 2009

nXYter ASIC

- 128 channels
- 1 ns time resolution
- Token Ring Readout

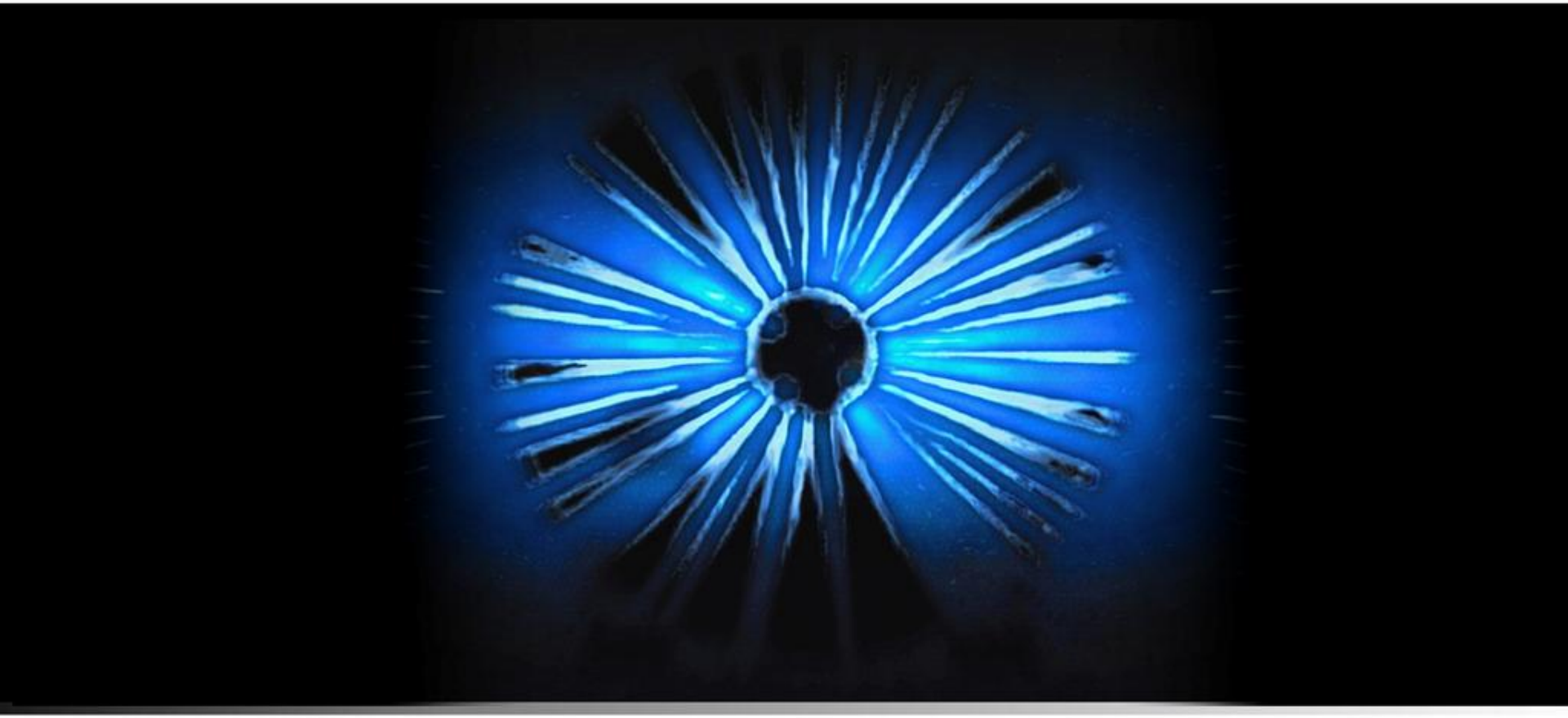


[1]

[1] The n-XYTER Reference Manual 1.50, 2009

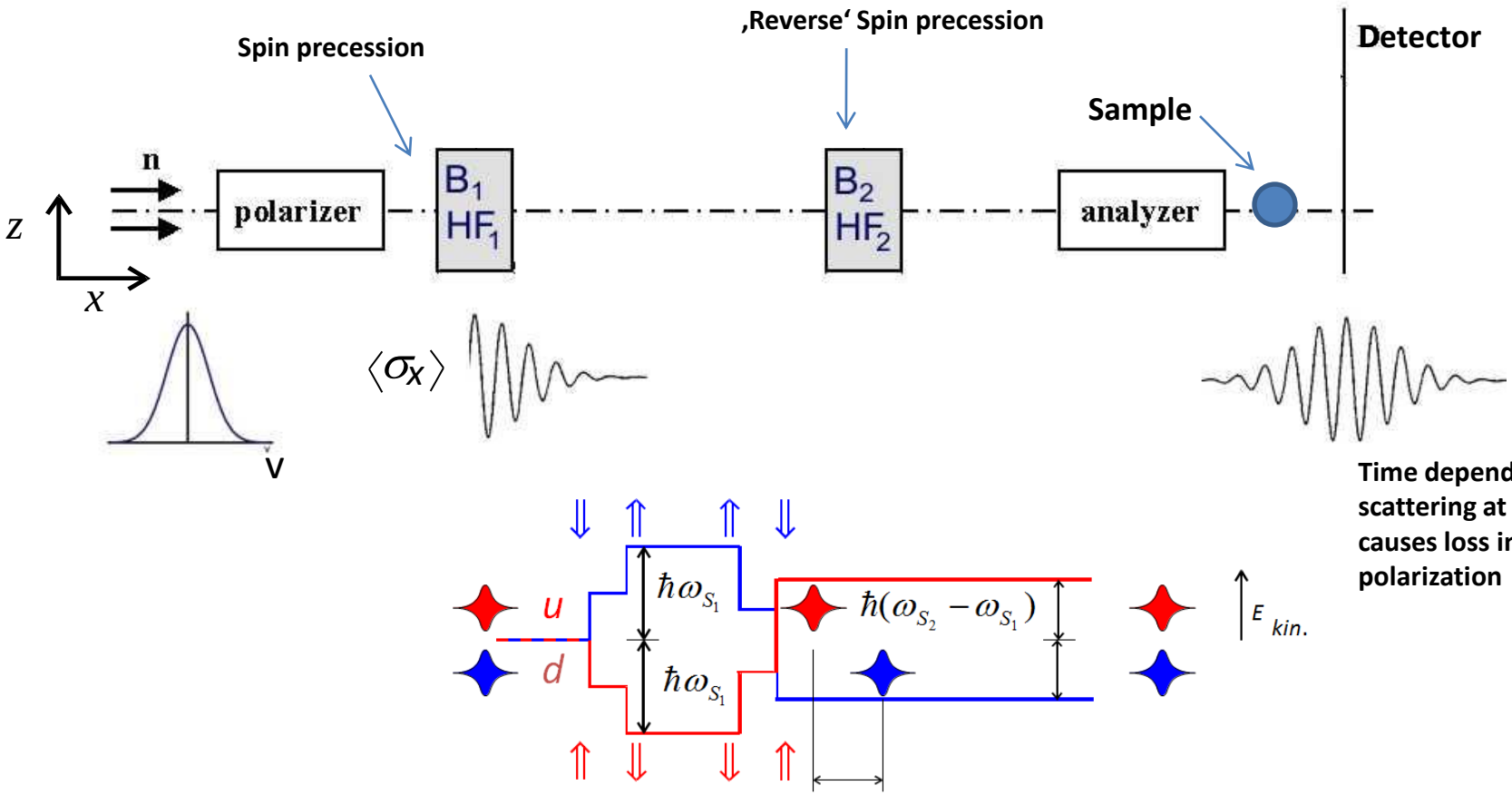
CASCADE

Characterization Measurements



Neutron Resonance Spin Echo - MIEZE

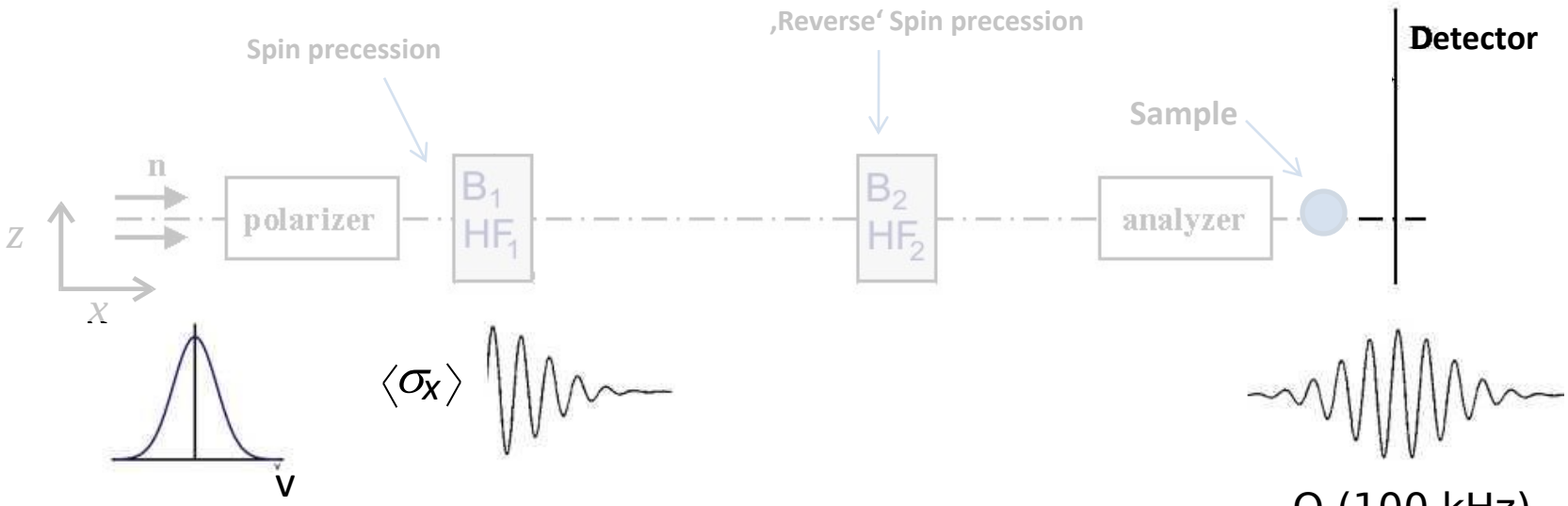
Principle: Use Neutron Spin as Obervable in Interference Time Of Flight Experiments



Time dependent scattering at sample causes loss in polarization

Neutron Resonance Spin Echo - MIEZE

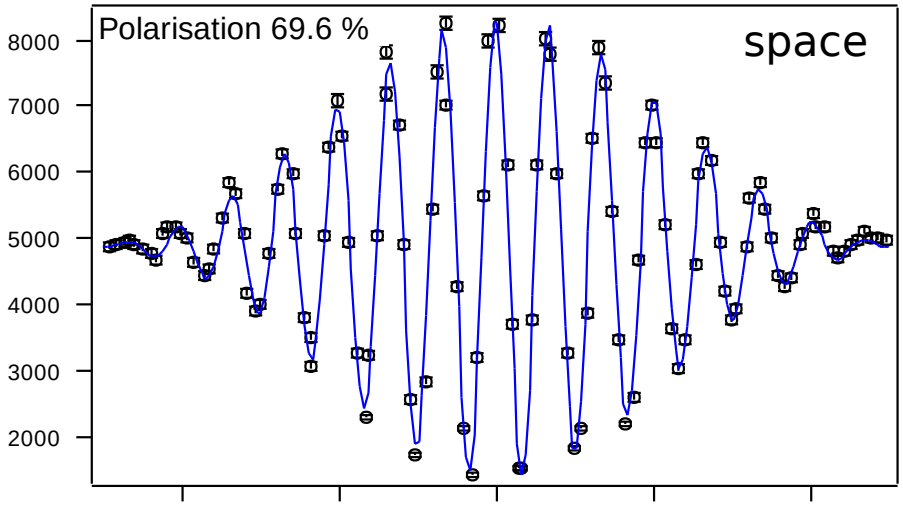
Principle: Use Neutron Spin as Obervable in Interference Time Of Flight Experiments



O (100 kHz)
O (1 mm)

Spin Echo Measurements

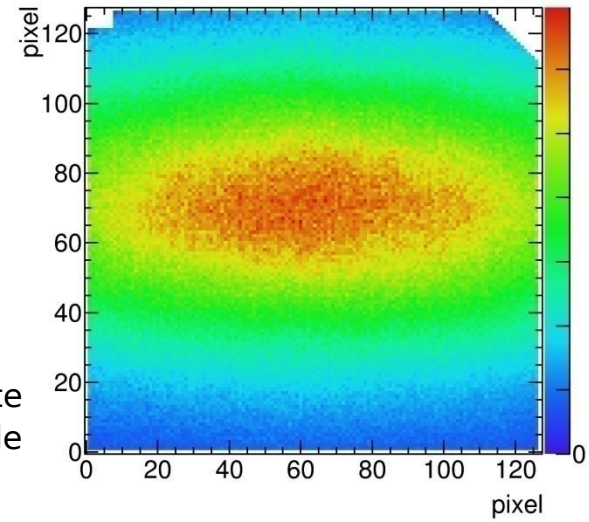
RESEDA, FRMII: spectrometer arms
3 – 15 Å @ 11% FWHM

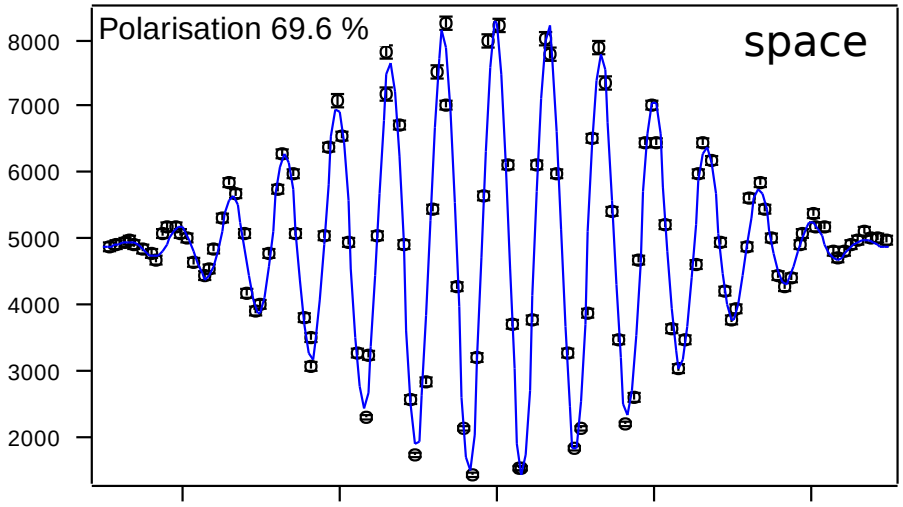


Typical Spin Echo group

Spin Echo Measurements

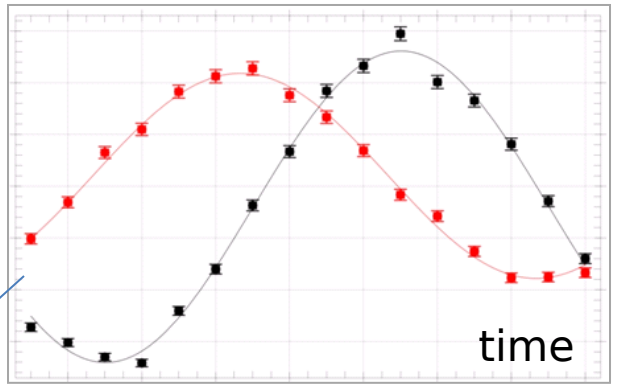
Graphite Sample

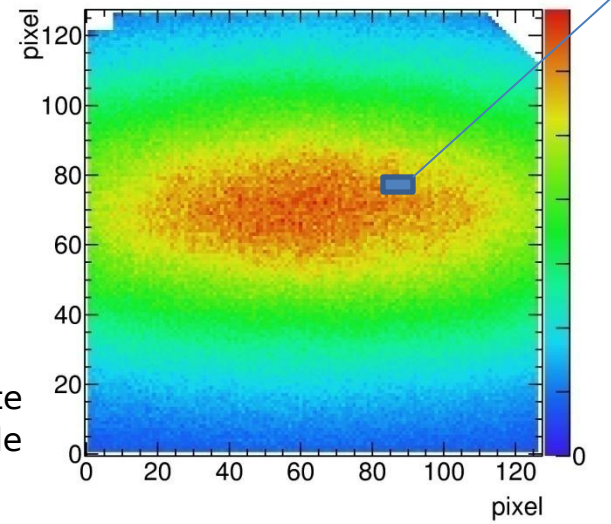




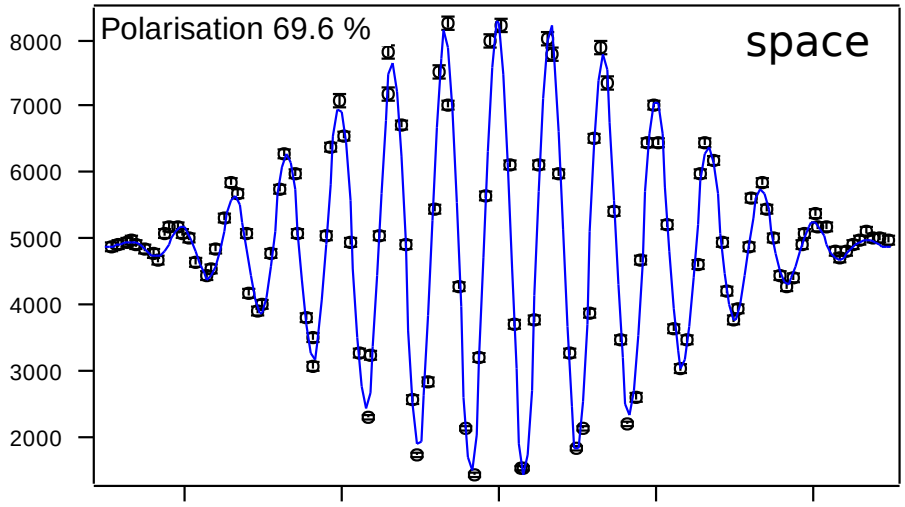
Typical Spin Echo group

Spin Echo Measurements



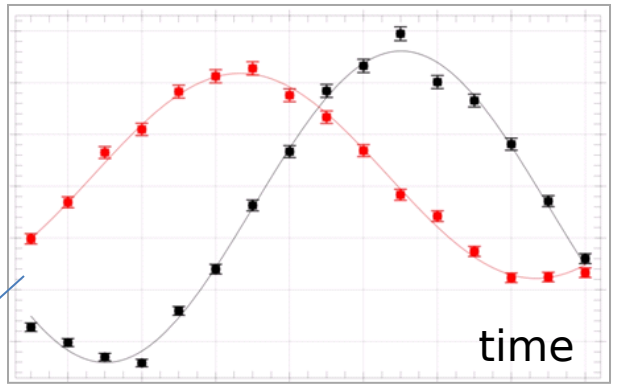


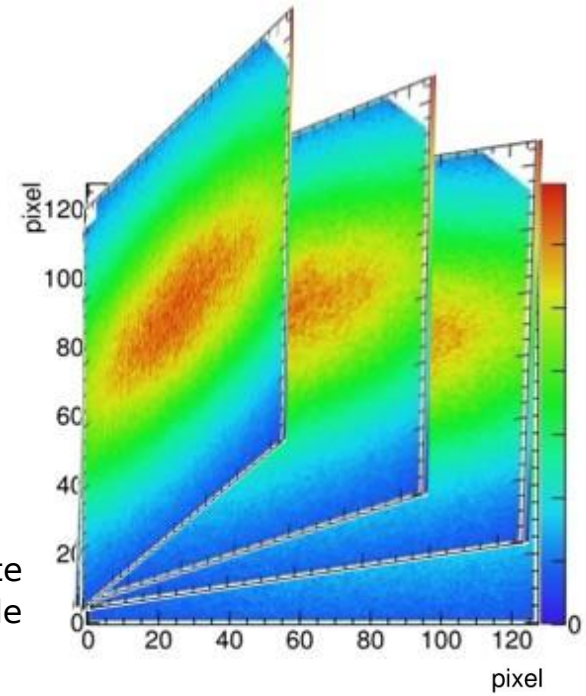
Graphite Sample



Typical Spin Echo group

Spin Echo Measurements





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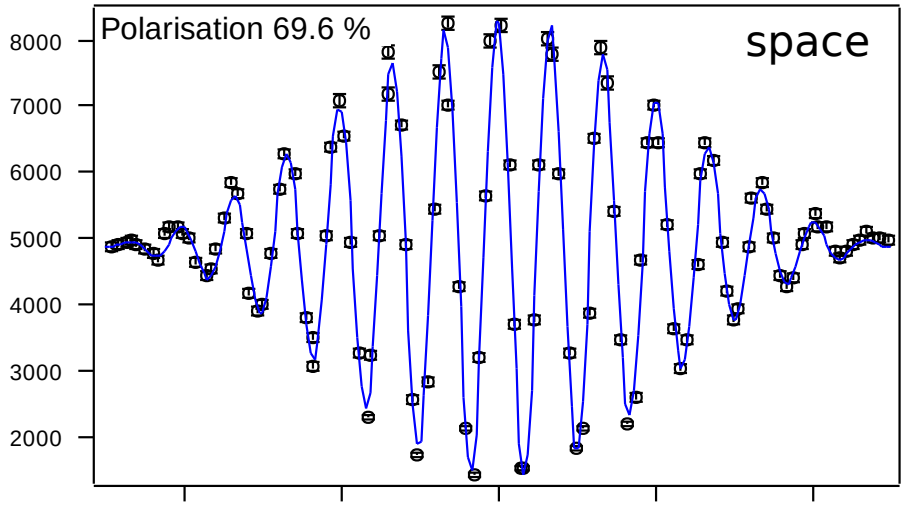
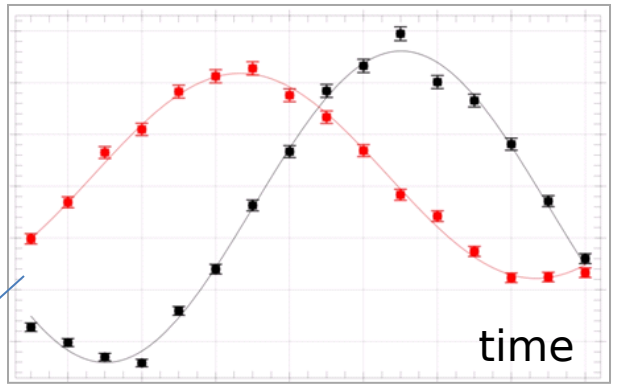
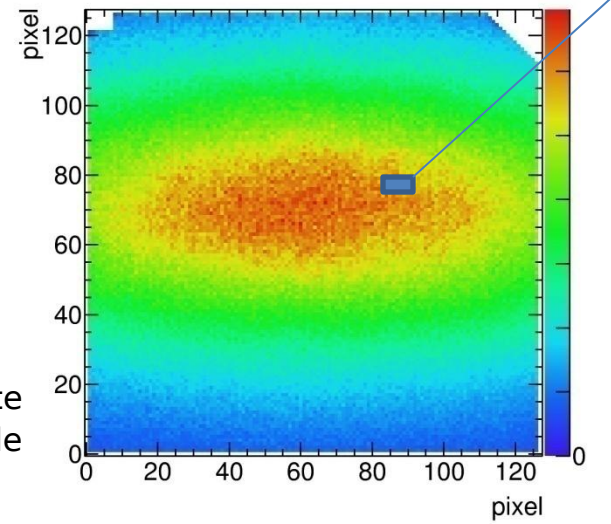


Typical Spin Echo group

Spin Echo Measurements





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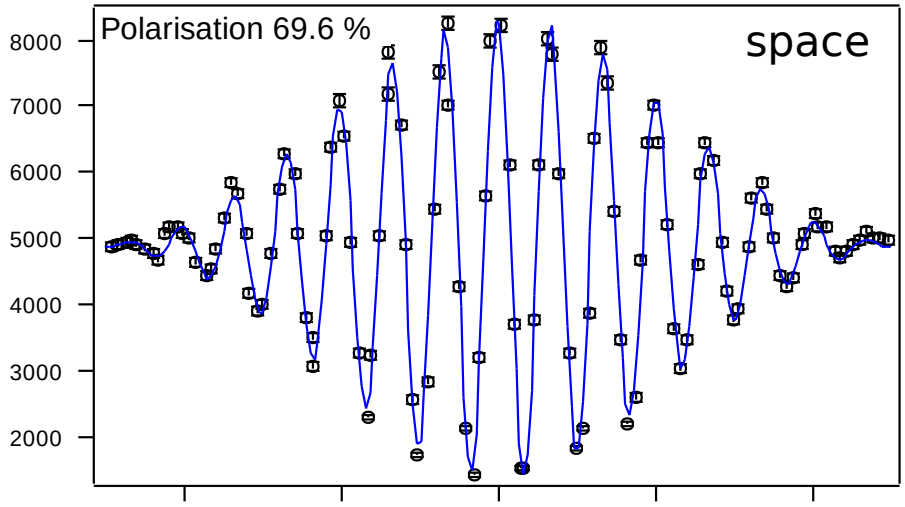
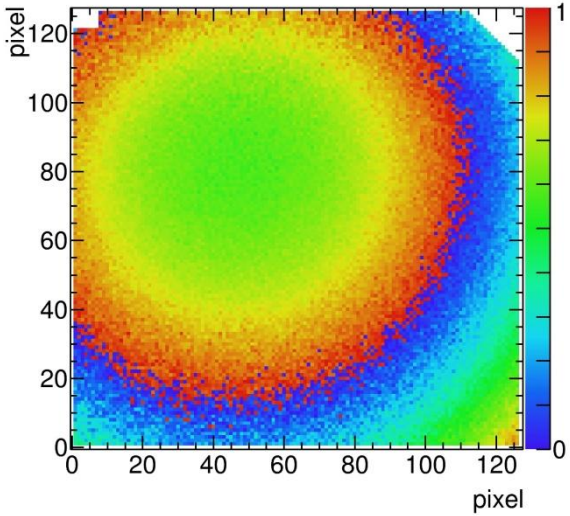
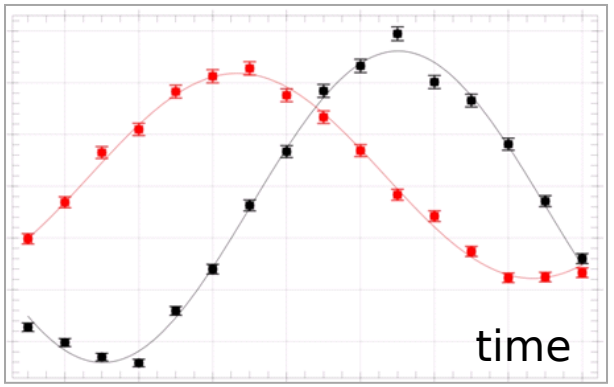
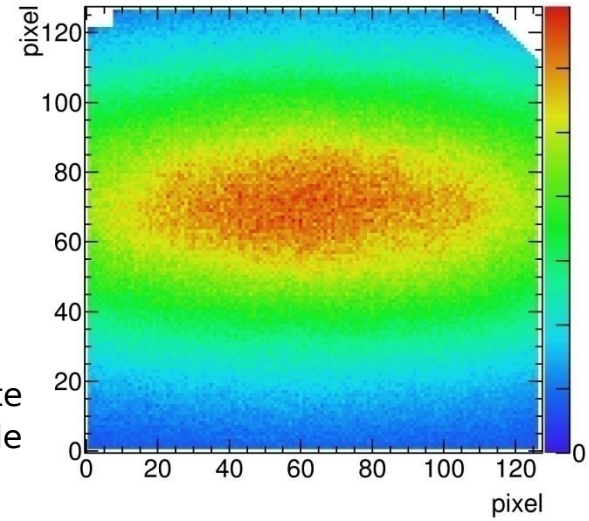


Typical Spin Echo group

Spin Echo Measurements







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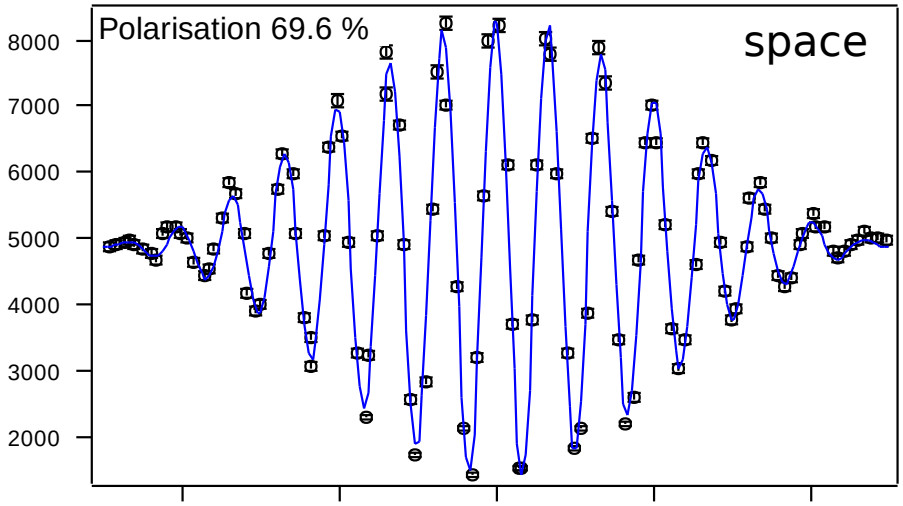
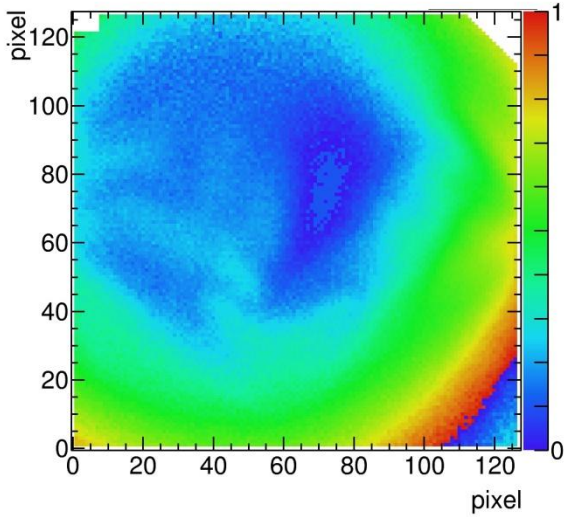
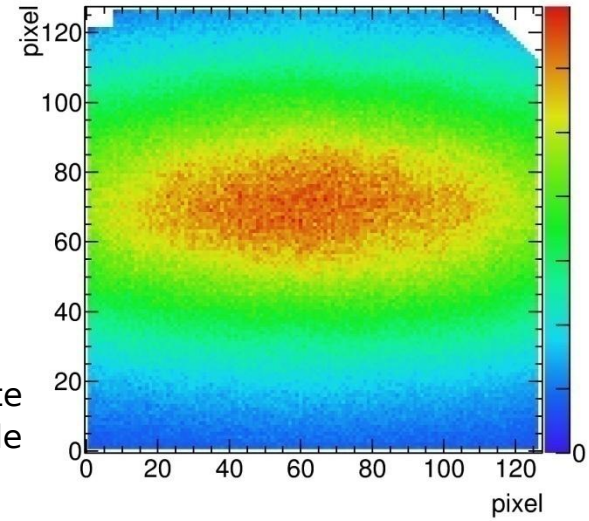


Typical Spin Echo group

Spin Echo Measurements





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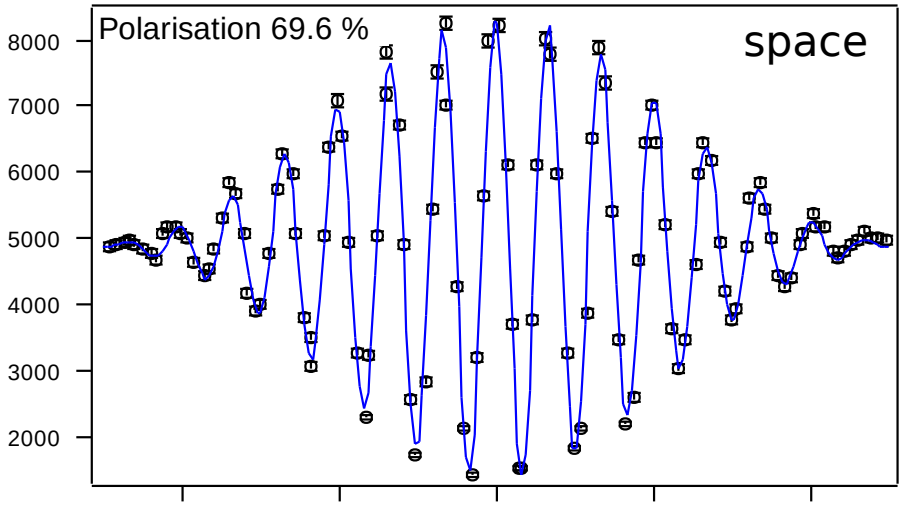
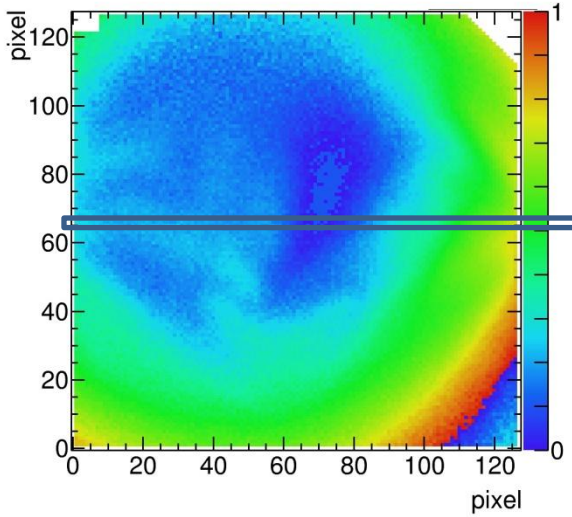
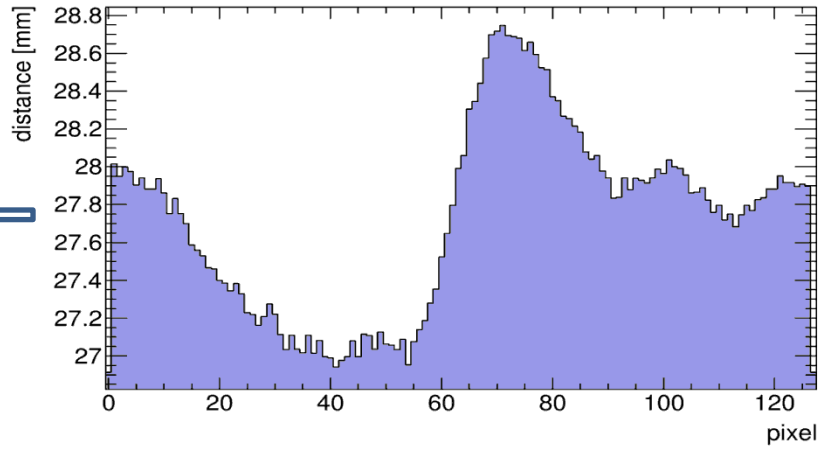
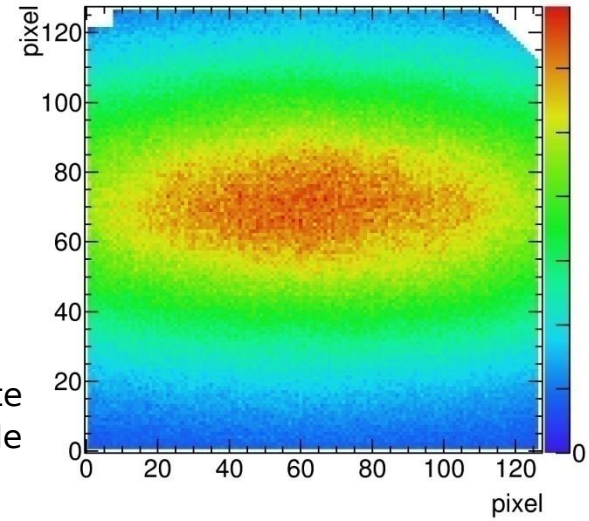


Typical Spin Echo group

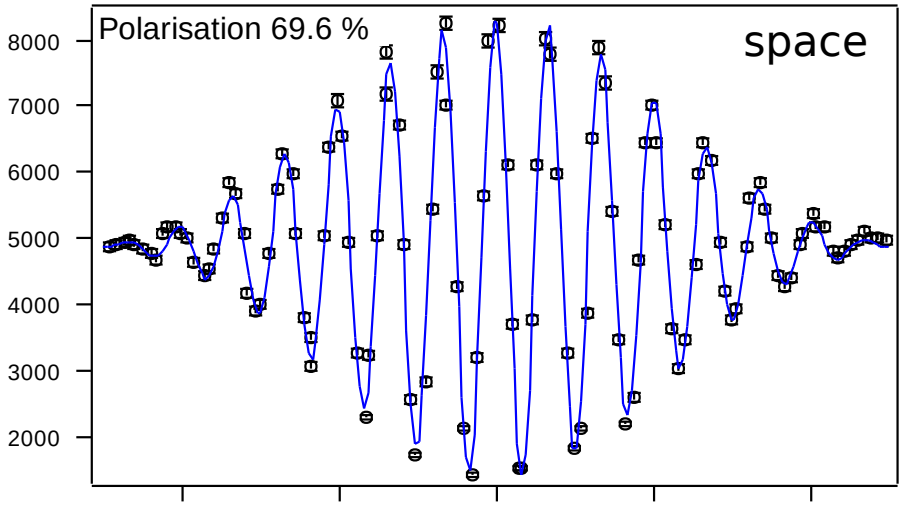
Spin Echo Measurements





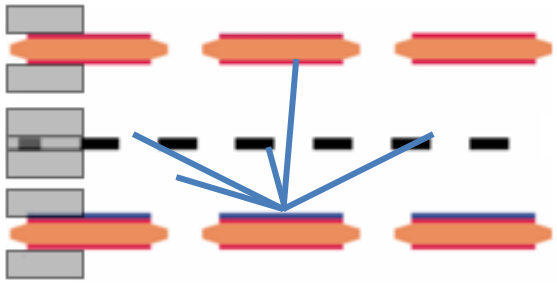


Graphite Sample



Typical Spin Echo group

Spatial Resolution



Spatial resolution: 2.4 mm FWHM

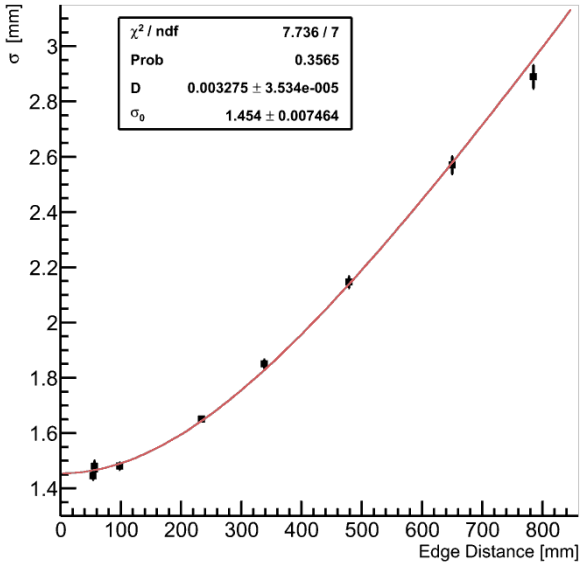
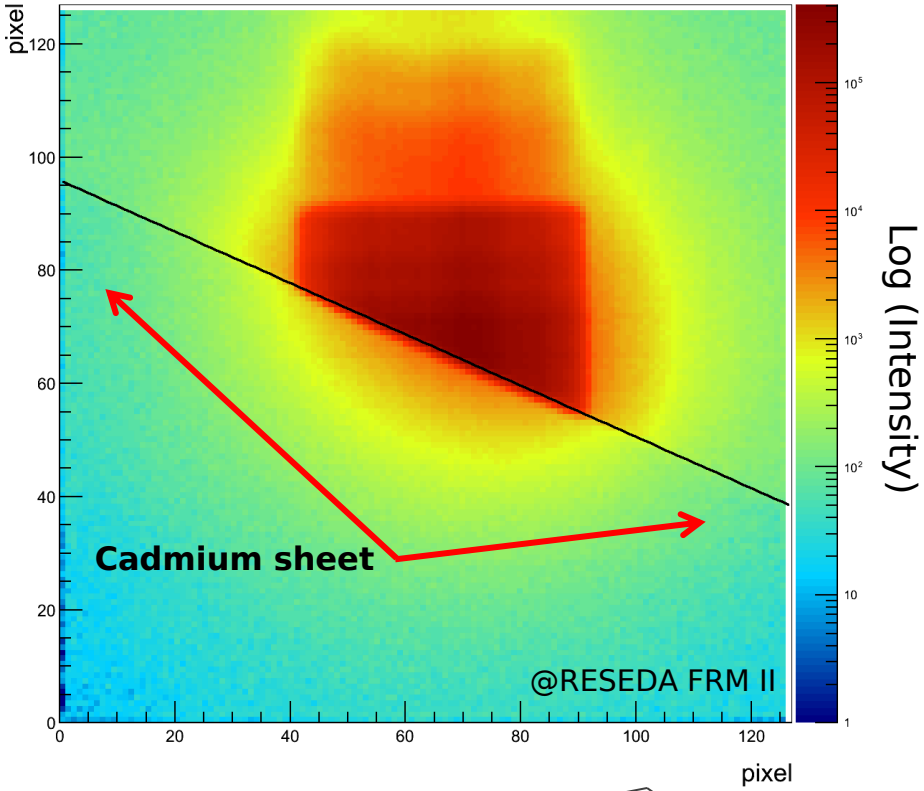
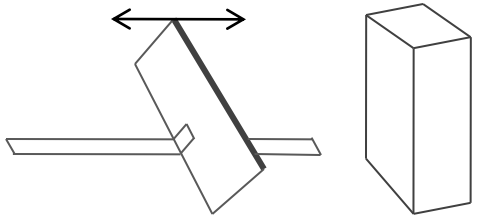
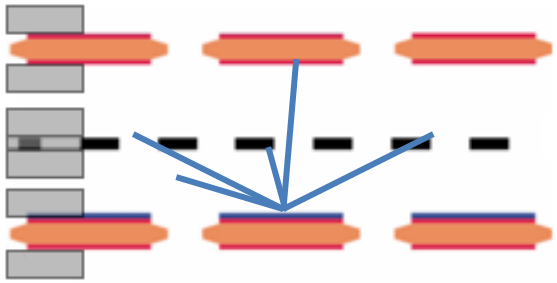


Image of a cold neutron beam (after guide)



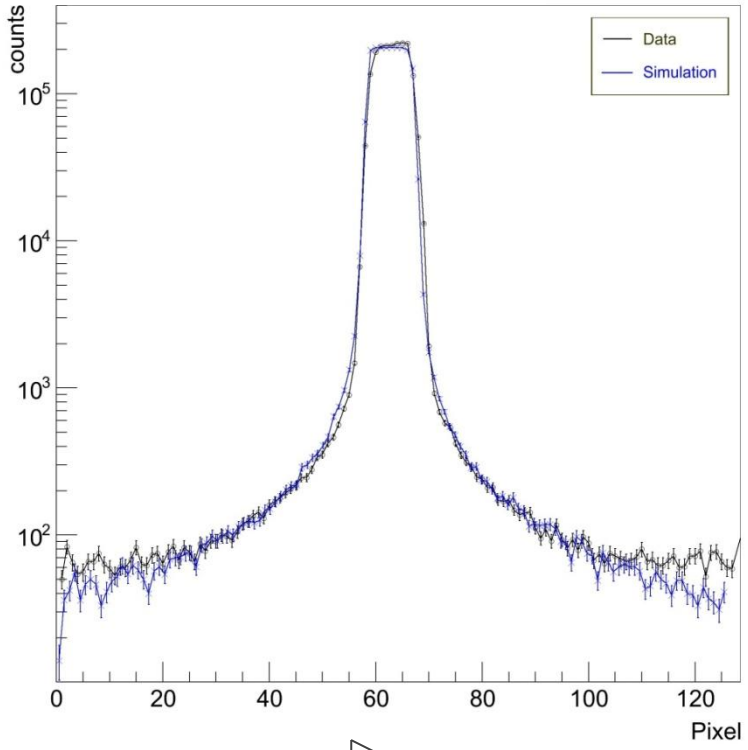


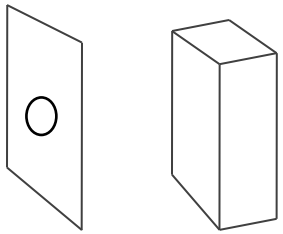
Spatial Resolution



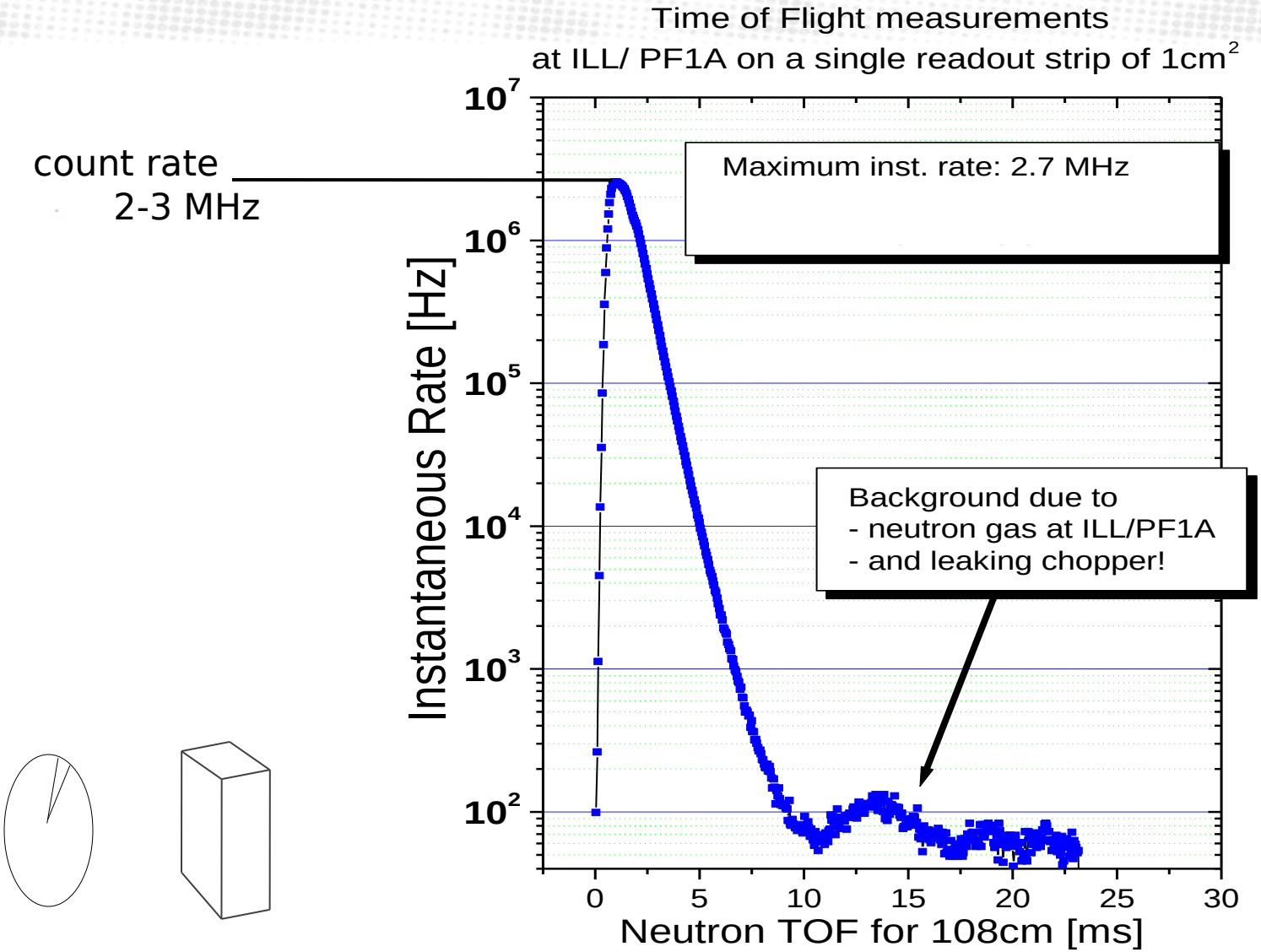
Spatial resolution: 2.4 mm FWHM

Cross section of a collimated n beam



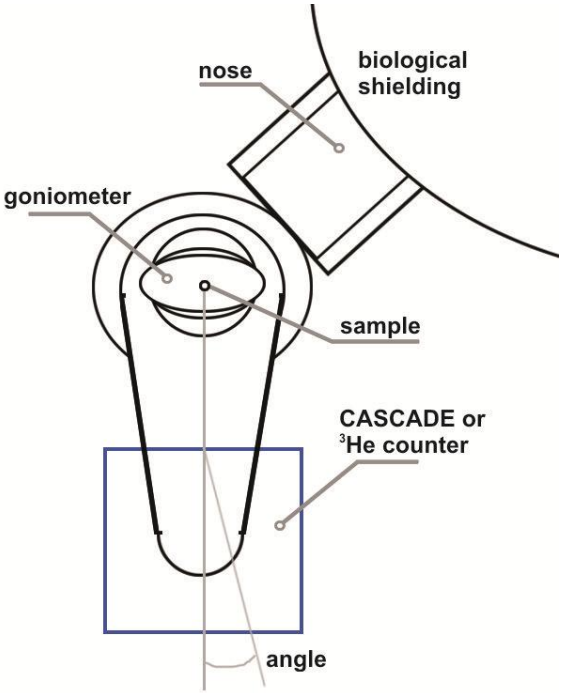


Rate Capability

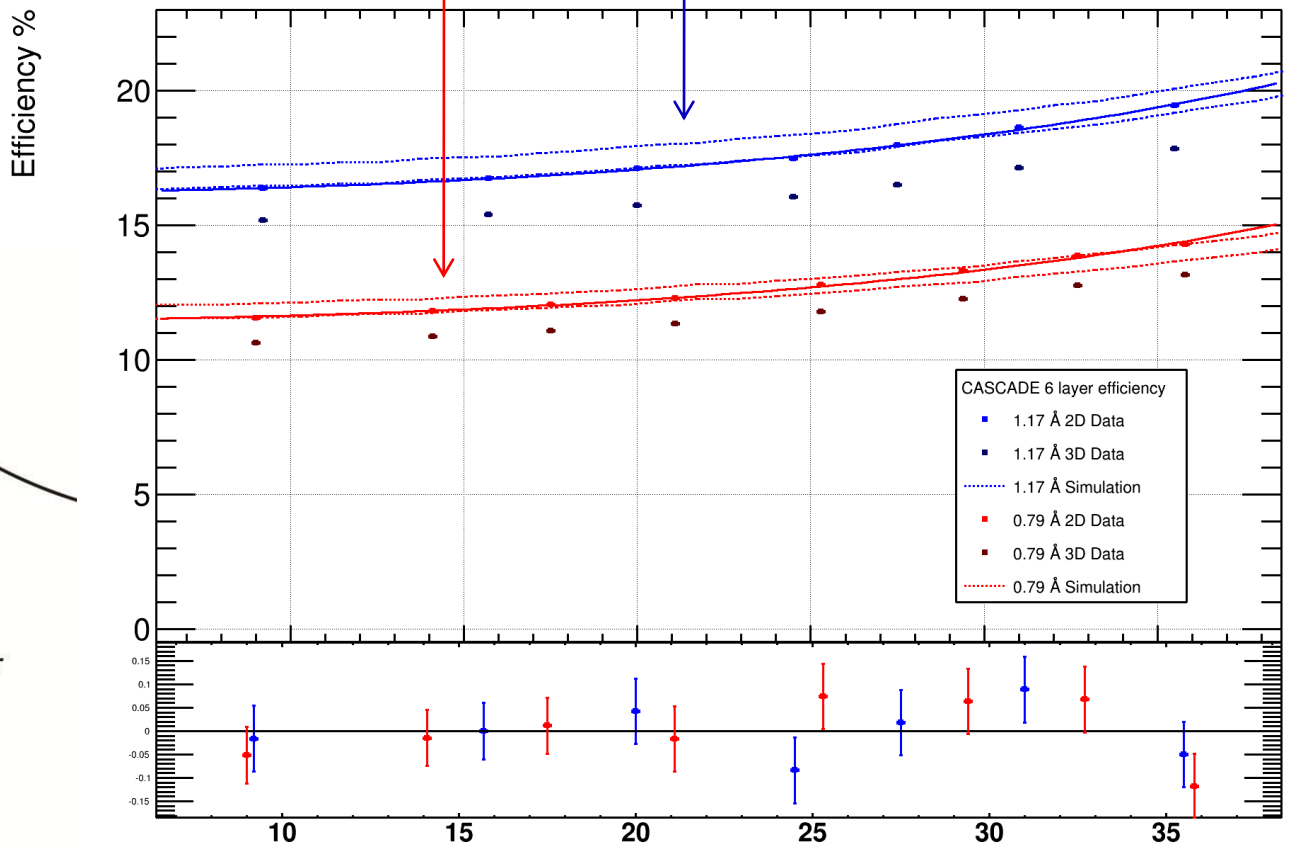


Detection Efficiency

1.5 – 0.8 – 1.0 – 1.0 – 0.8 – 2.0



Efficiency at 0.8 Å and 1.2 Å in 2D and 3D

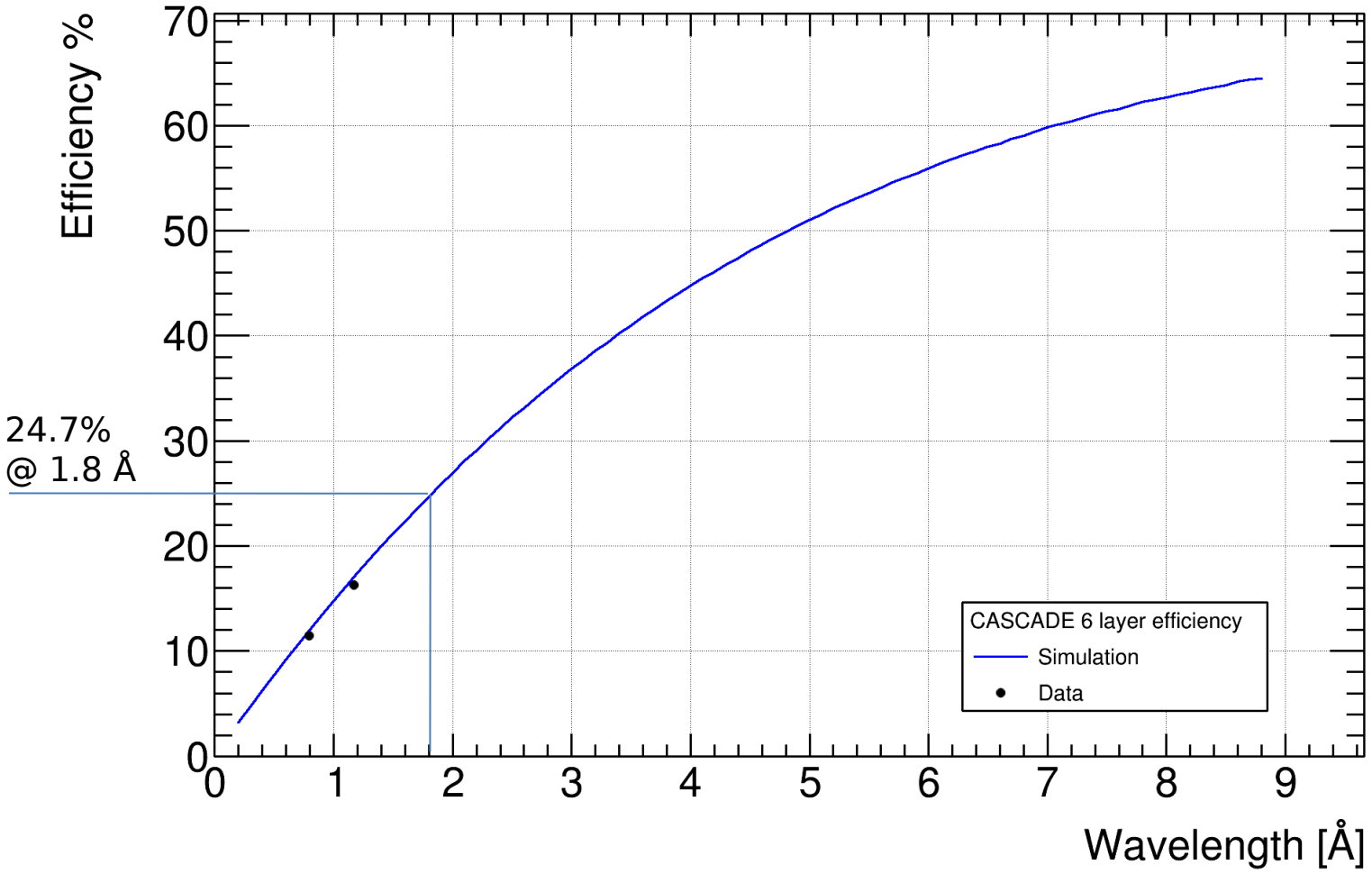


@HEIDI FRM II

Detection Efficiency

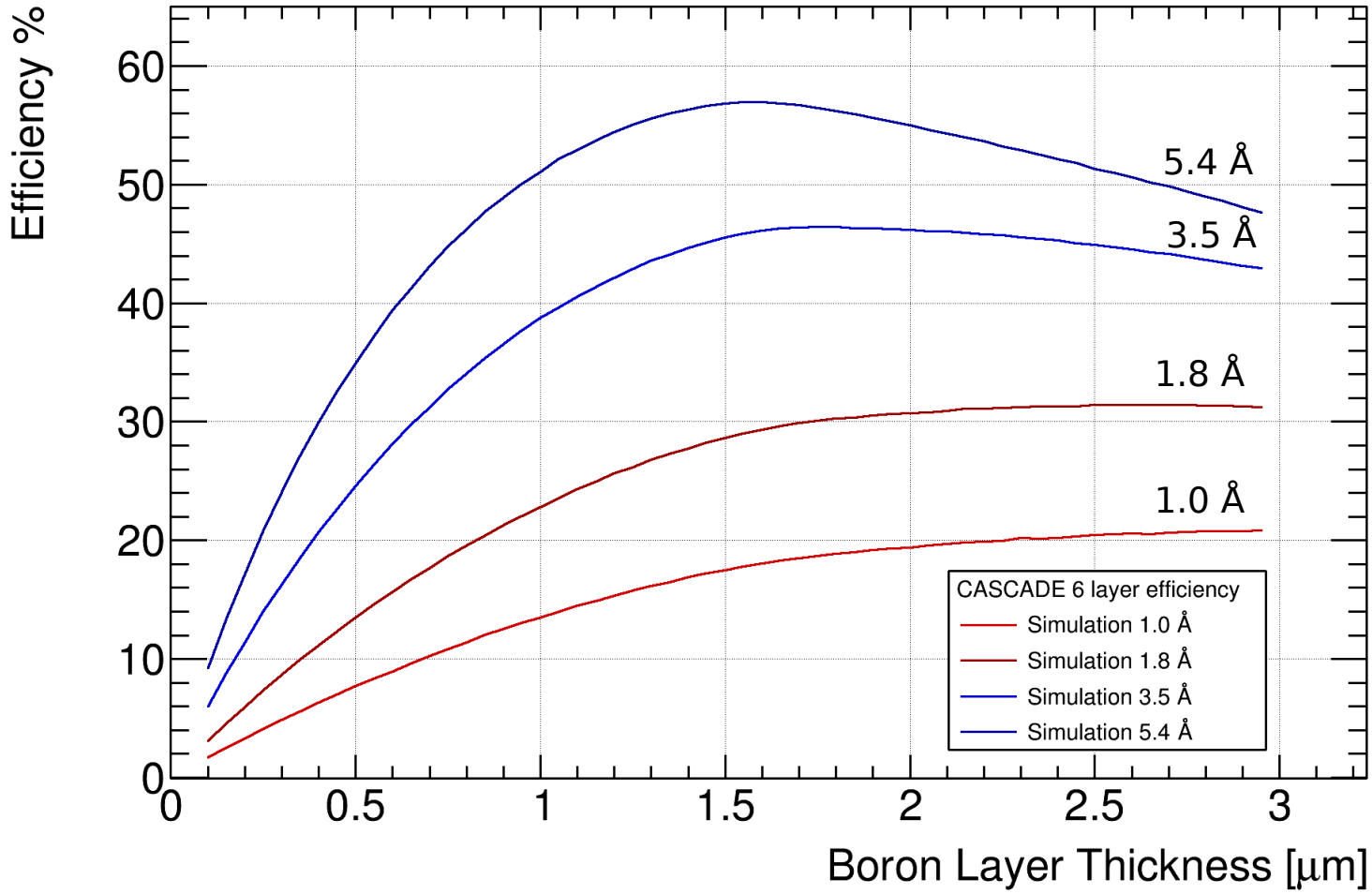
1.5 – 0.8 – 1.0 – 1.0 – 0.8 – 2.0

Simulation of the 2D efficiency and data of 0.8 Å and 1.2 Å



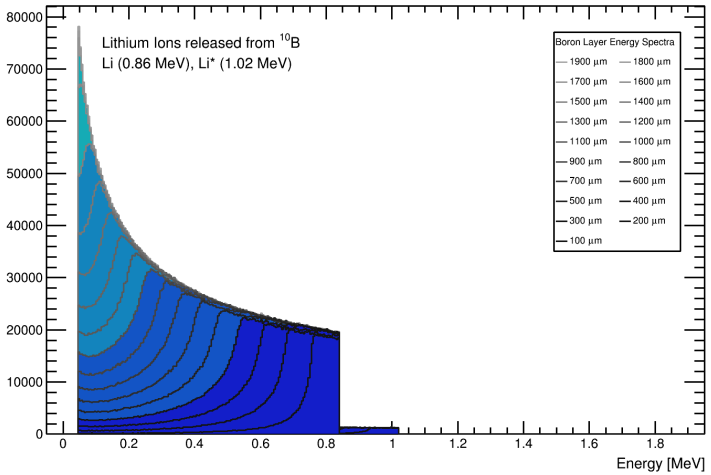
Detection Efficiency

Simulation of the 2D efficiency with different coating thicknesses



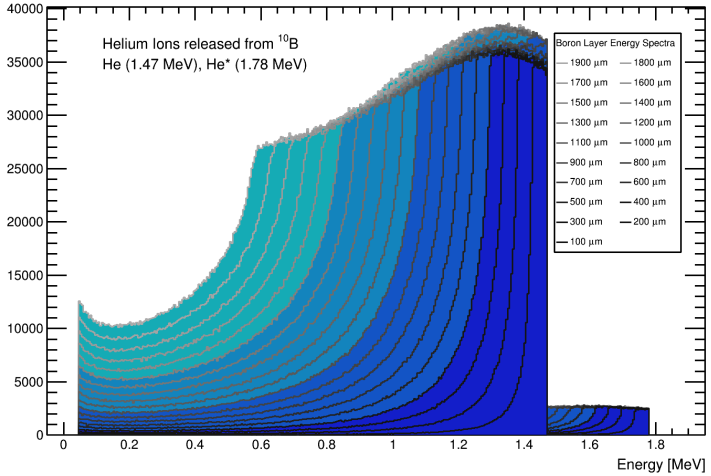
Conversion Products: Energy Spectra

Li

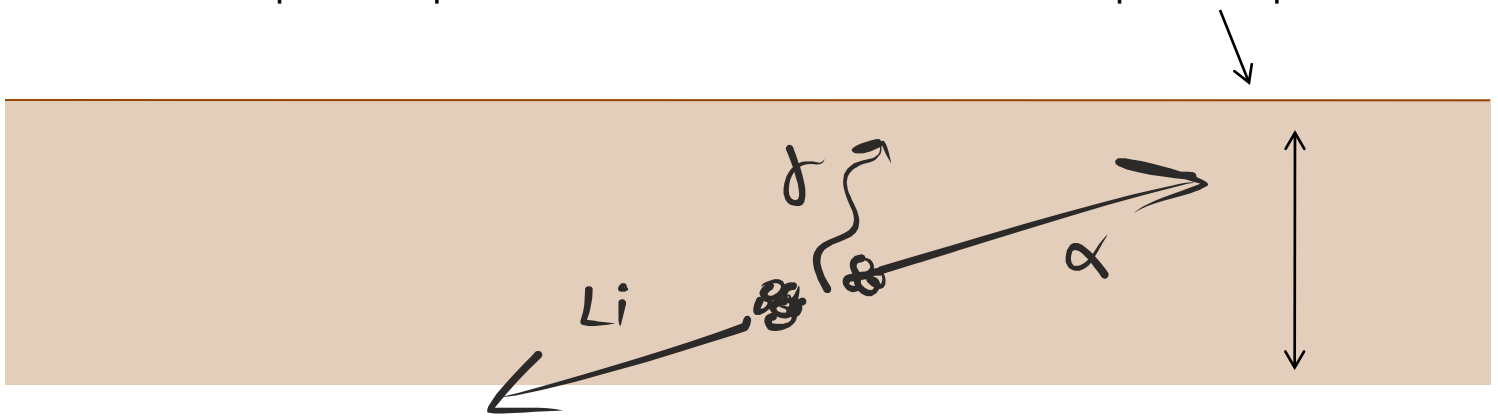


From 0.1 µm to 2 µm ^{10}B

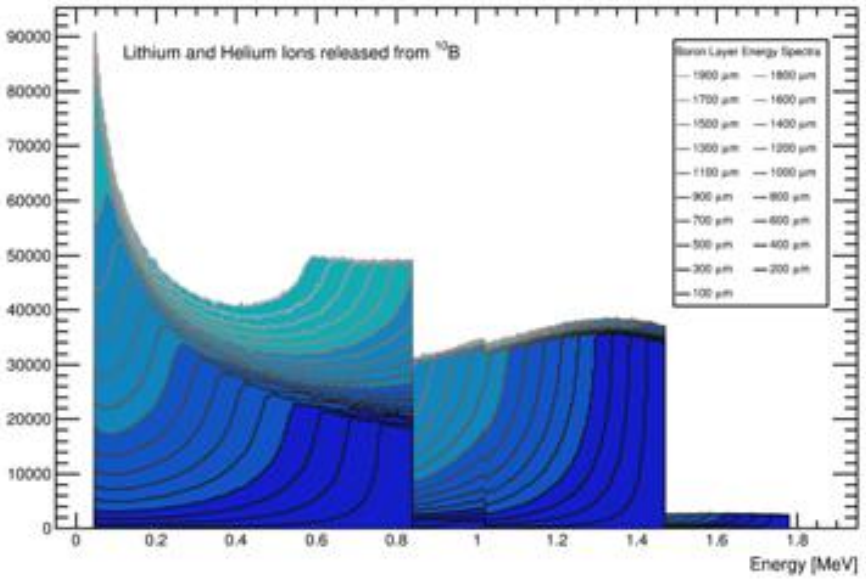
α

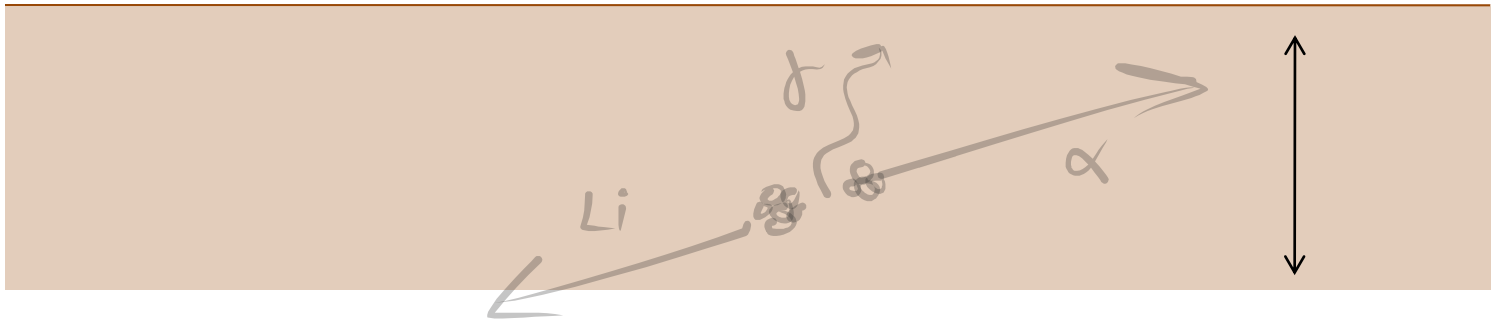


From 0.1 µm to 2 µm ^{10}B

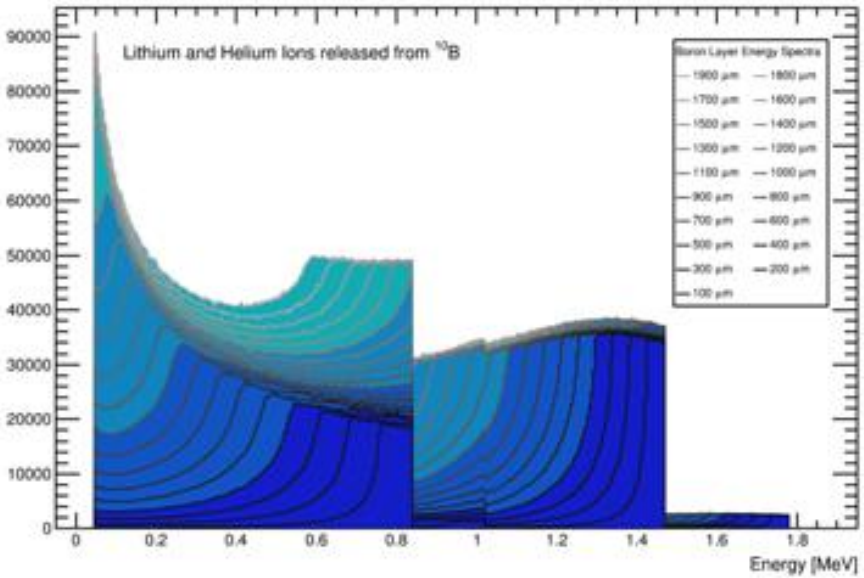


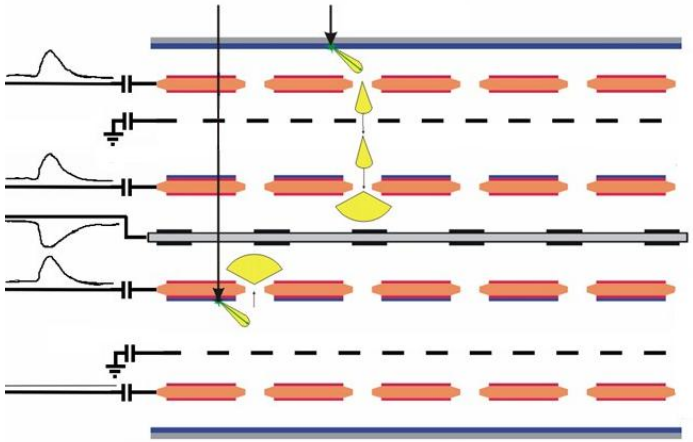
Conversion Products: Energy Spectra



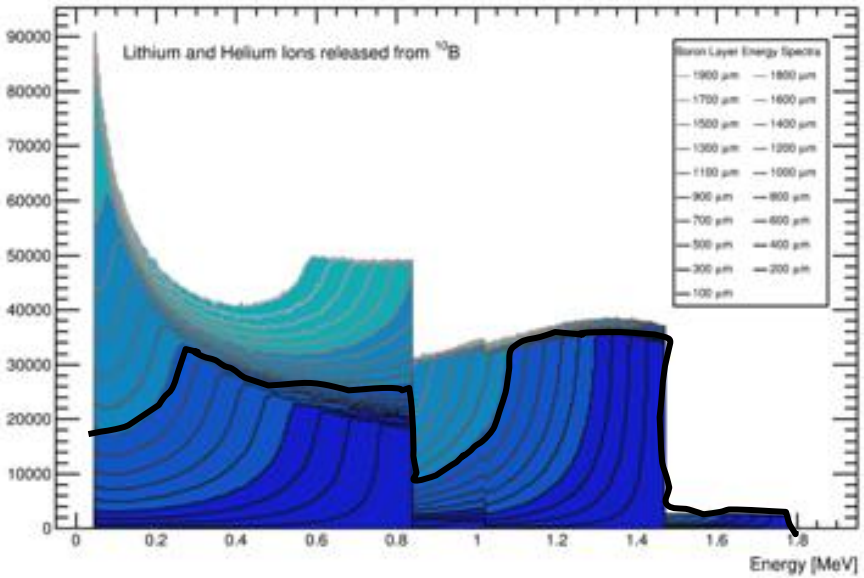


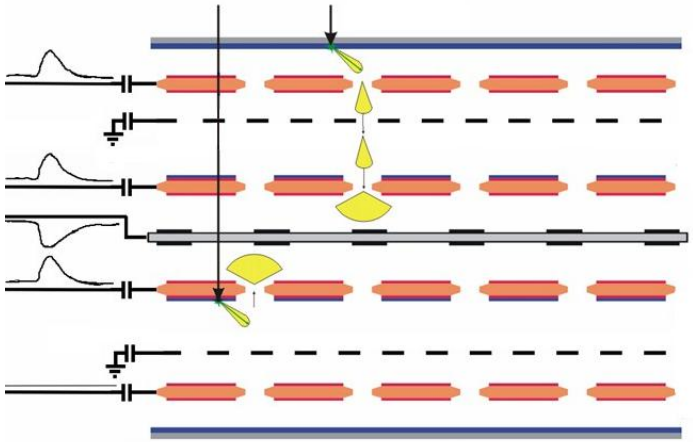
Conversion Products: Energy Spectra





Conversion Products: Energy Spectra

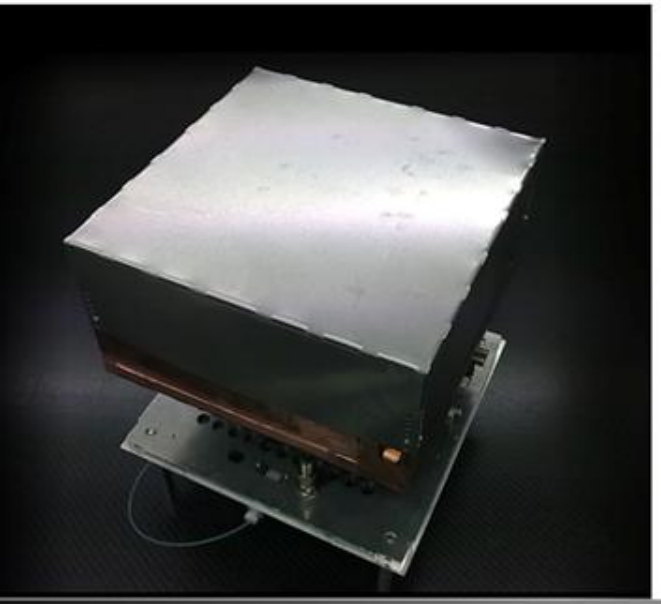




CASCADE

Boron-10 technology

a high rate, spatially and time resolved detector for Spin Echo applications



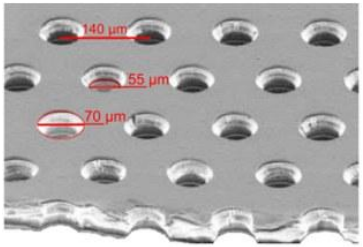
- conversion layer identification
- high TOF resolution (100 ns readout)
- 2.4 mm FWHM spatial resolution
- 2 MHz rate capability
- 25% thermal neutron efficiency @ 6 layers

Outlook

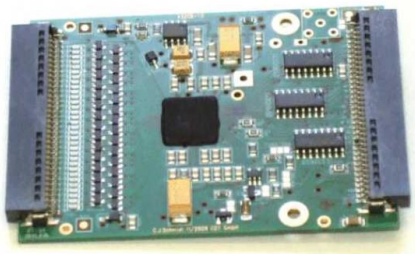
CASCADE

Technology available in 2000

GEM



Multichannel ASIC

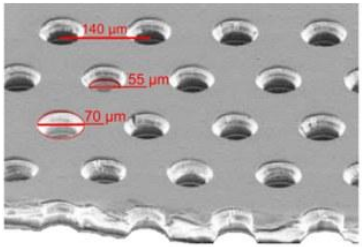


Outlook

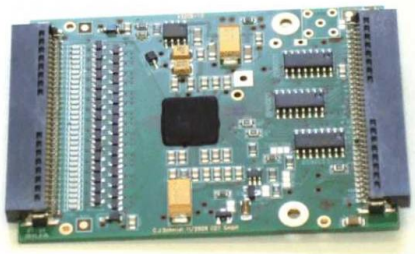
CASCADE

Technology available in 2000

GEM



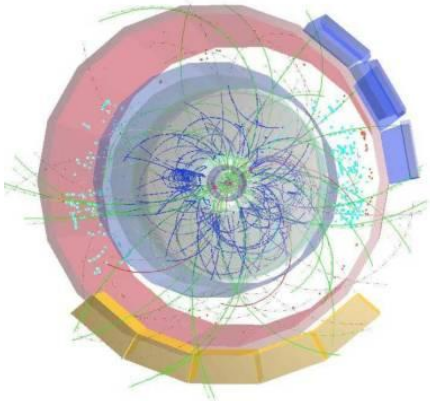
Multichannel ASIC



New Project

Technology available in 2015

TPC



TimePix