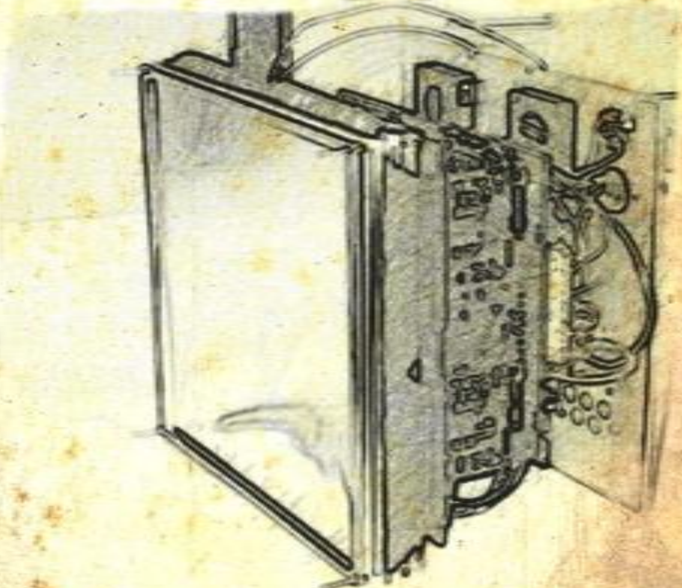
The CASCADE Project

a perspective for Solid State Detectors

3.06.2014

PSND 2014



Markus Köhli

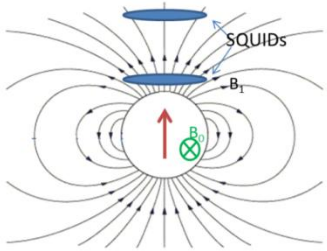
M. Klein, U. Schmidt
AG Dubbers

Physikalisches Institut
Ruprecht-Karls-Universität
Heidelberg

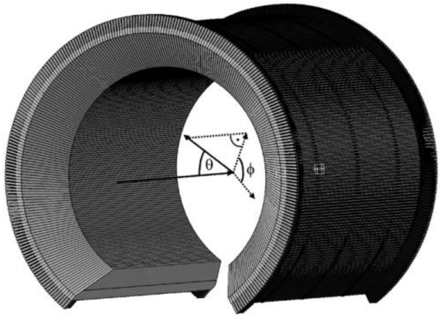
Bundesministerium
für Bildung
und Forschung

Heidelberg Research Fields

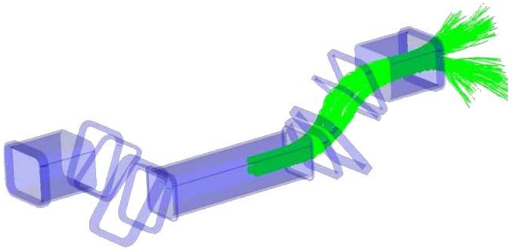
Helium-Xenon EDM
[test of Lorentz invariance]



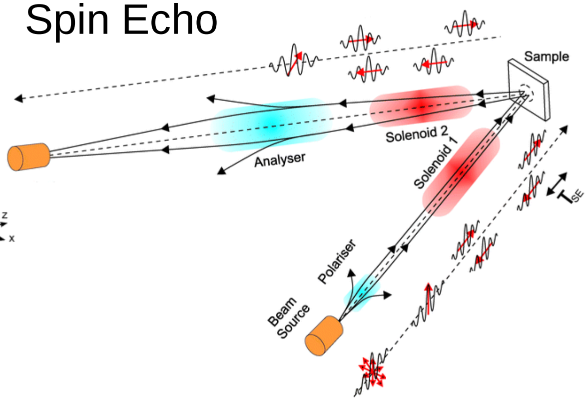
Neutron Detectors
[large area and **high time resolution]**



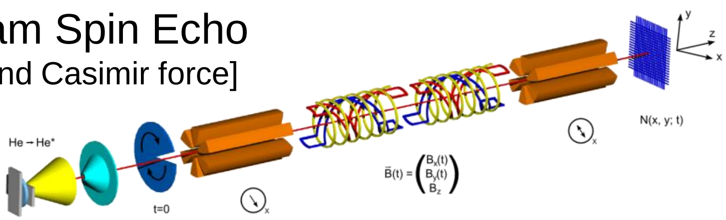
PERC and PERKEO
[V_{ud} via neutron beta decay]



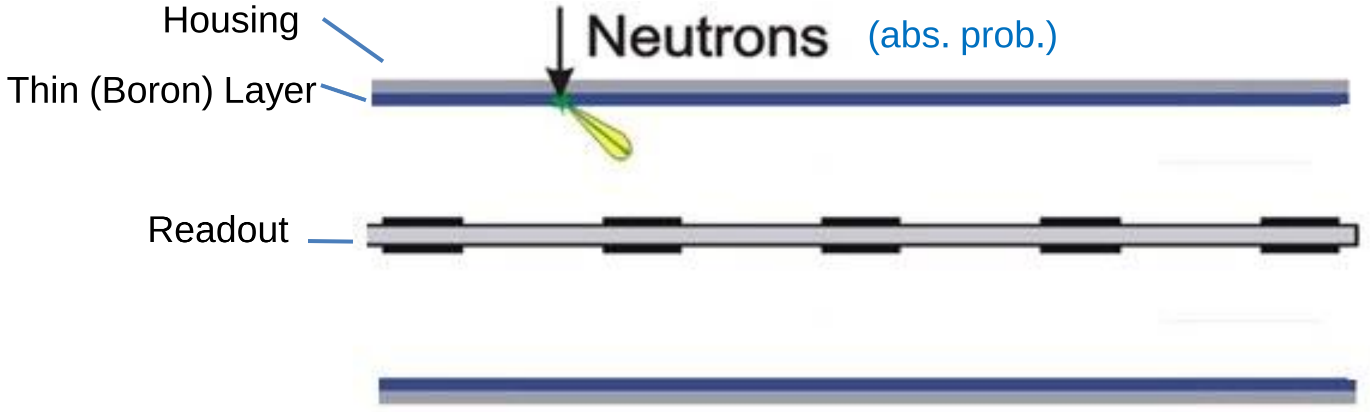
Spin Echo



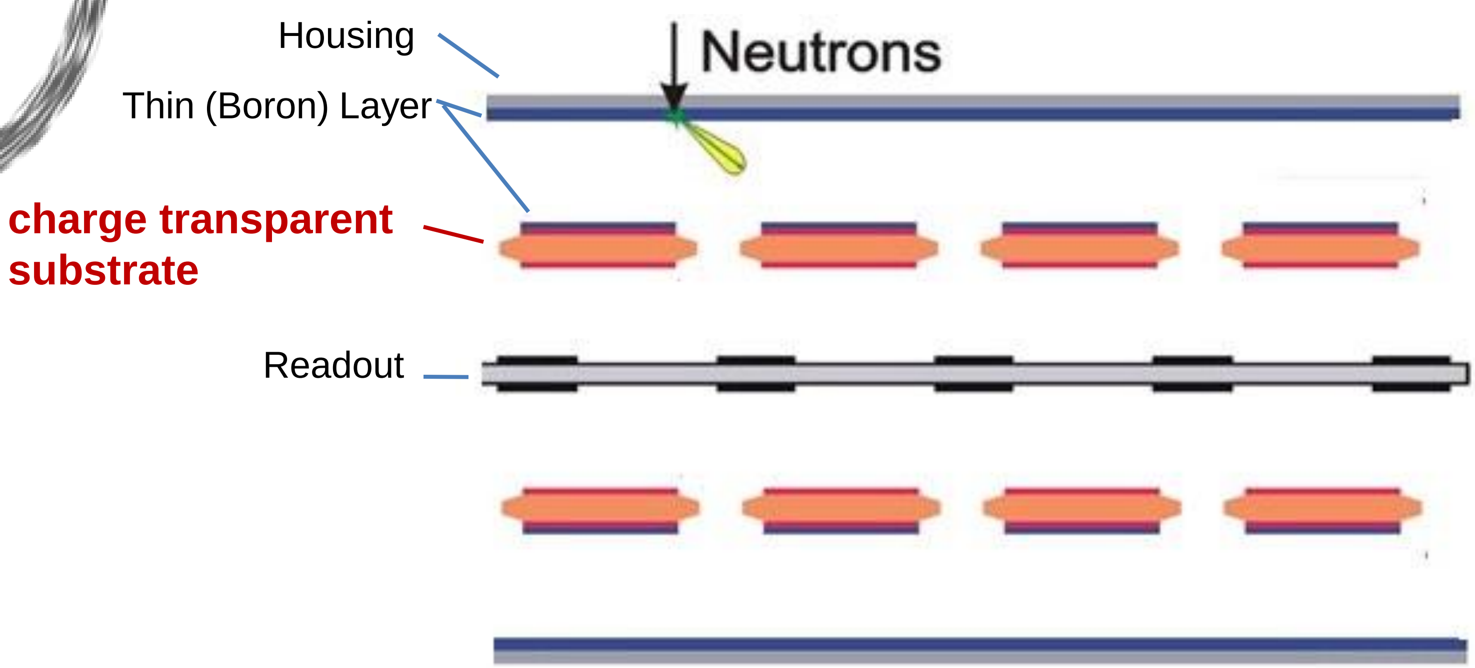
Atomic Beam Spin Echo
[Berry phase and Casimir force]



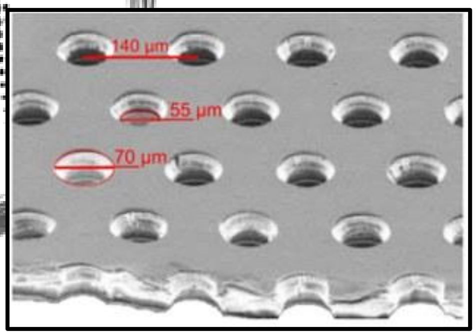
The CASCADE Concept

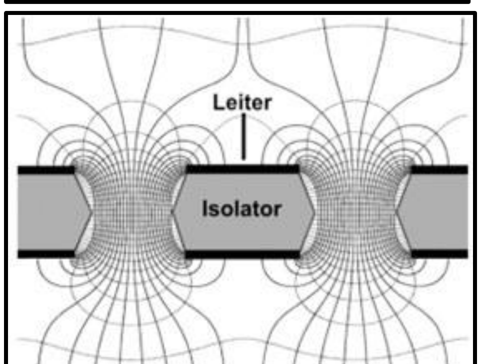


The CASCADE Concept

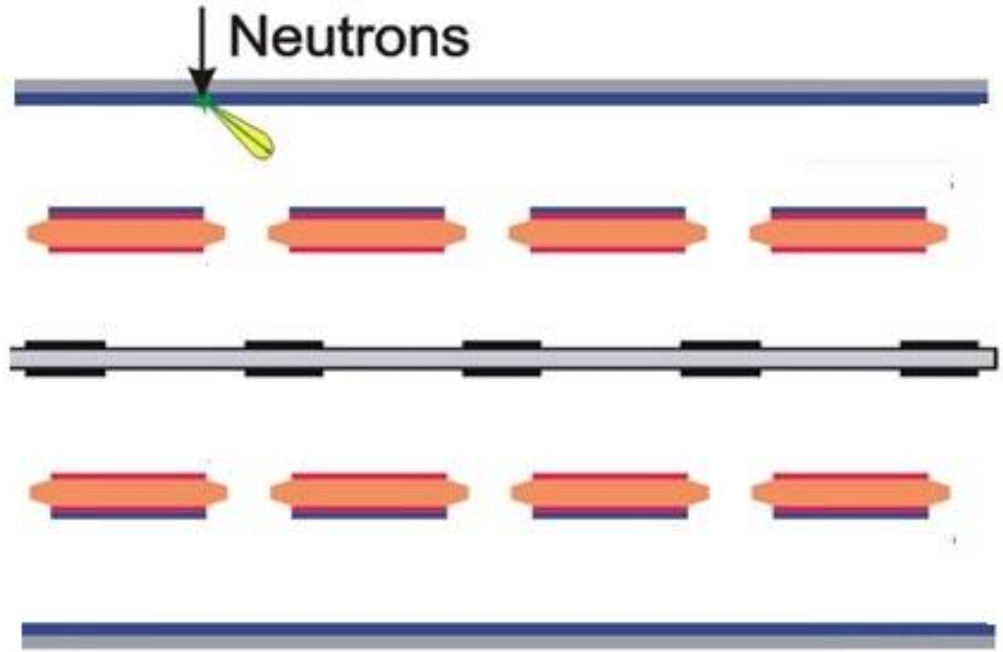


The CASCADE Concept





GEM
(Gas Electron Multiplier foil)

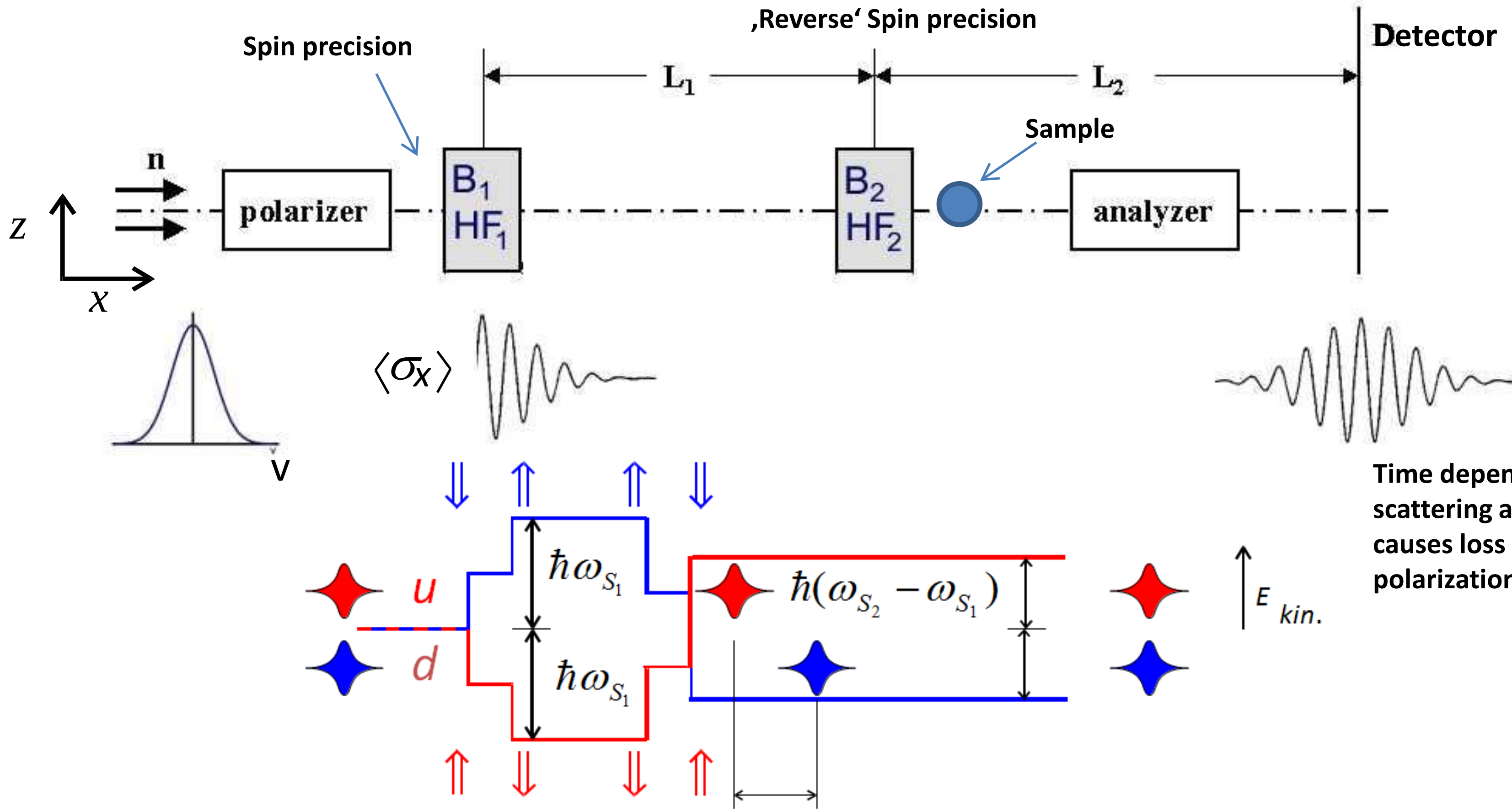


Neutron Resonance Spin Echo Methods

The MIEZE setup

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

e.g. Ramsey Interferometer



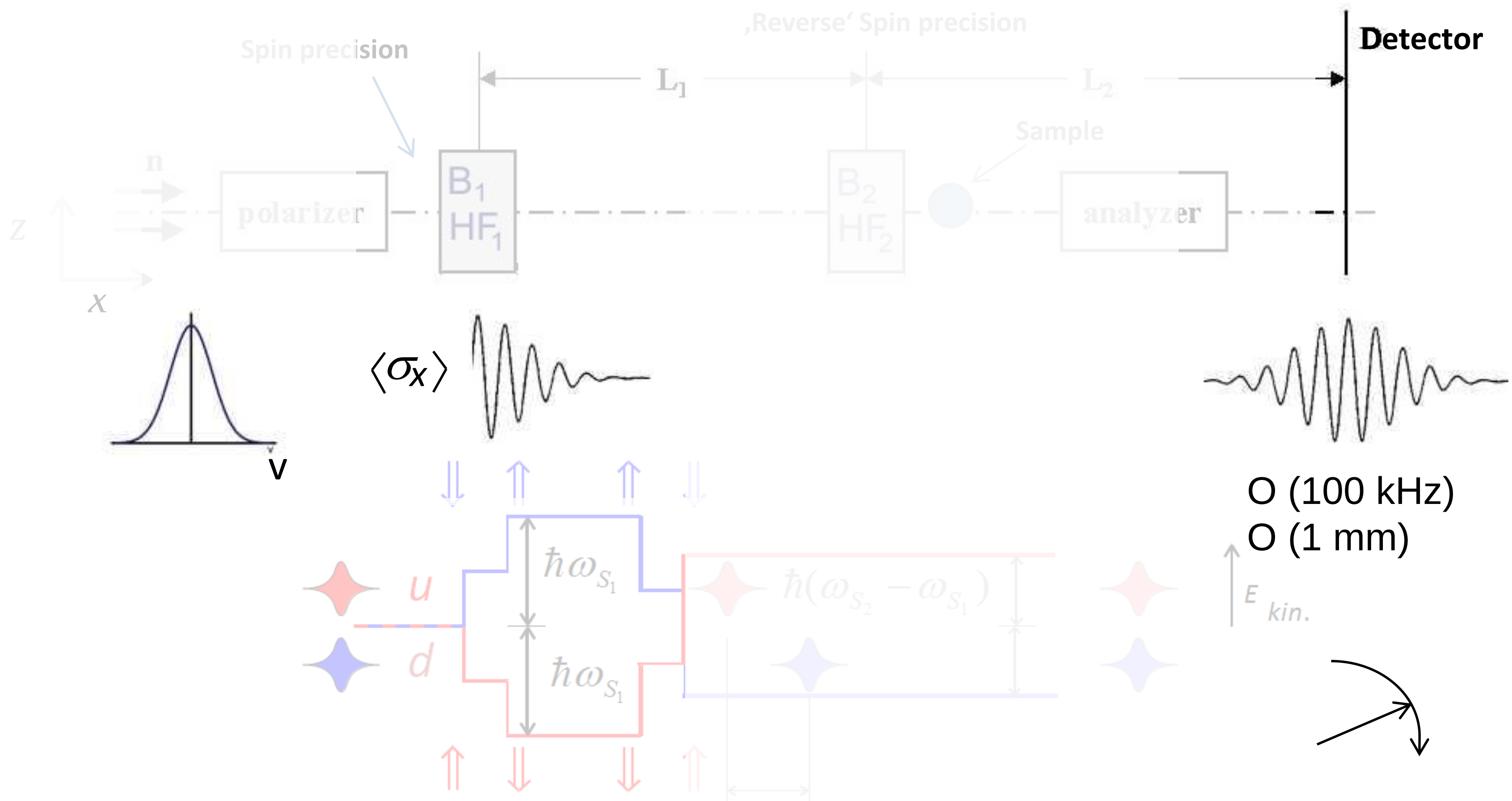
Time dependent scattering at sample causes loss in polarization

Neutron Resonance Spin Echo Methods

The MIEZE setup

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

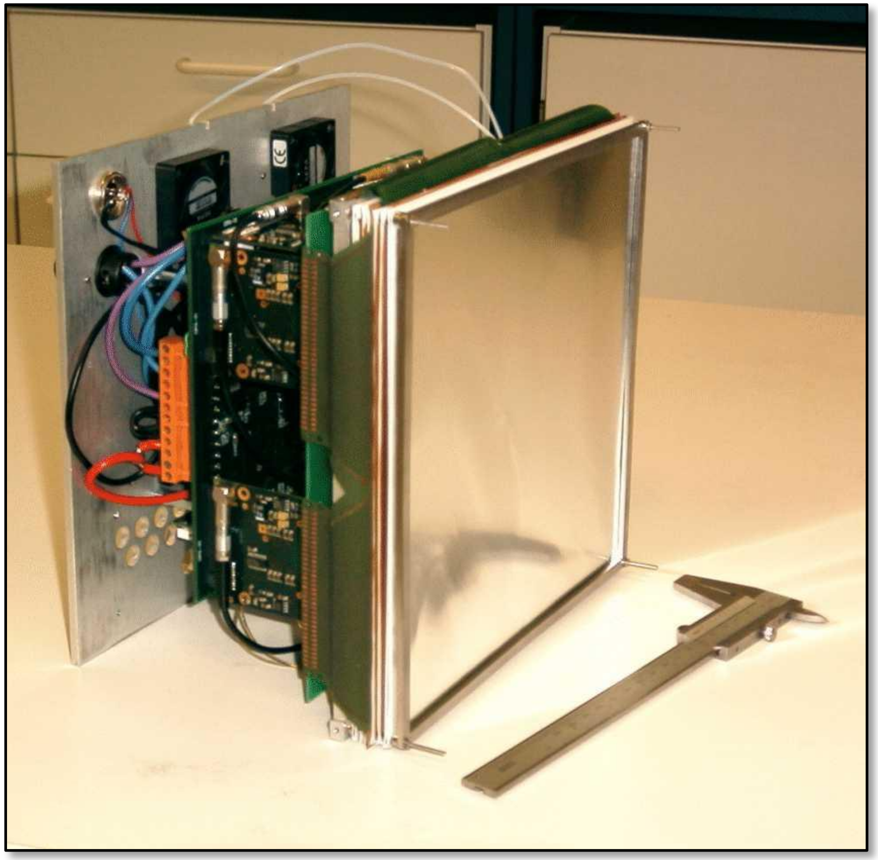
e.g. Ramsey Interferometer



O (100 kHz)
O (1 mm)

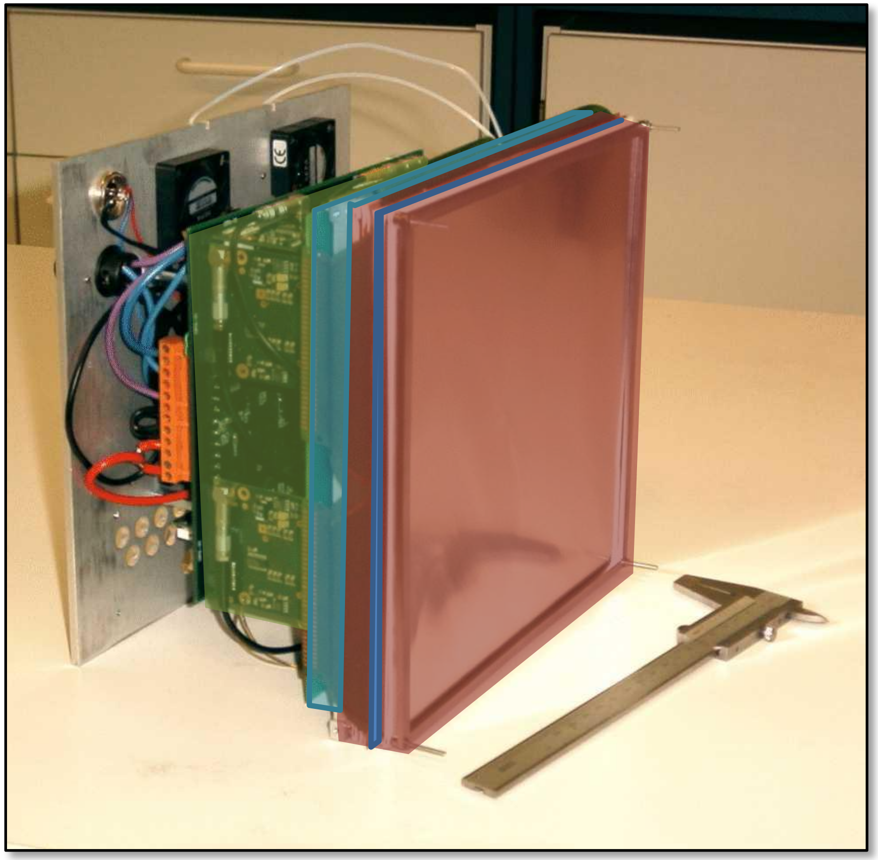
The CASCADE Detector

CASCADE detector without housing



The CASCADE Detector

CASCADE detector without housing



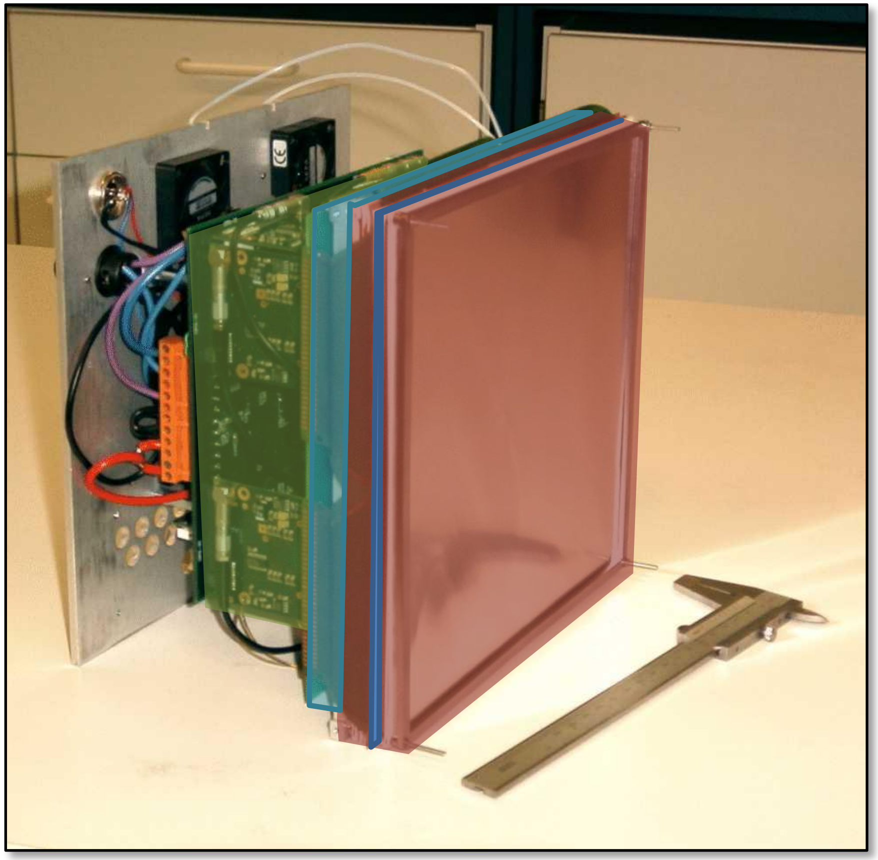
Active Detection Volume

Readout

Electronics

The CASCADE Detector

CASCADE detector without housing



Active Detection Volume

- Neutron conversion, pure Boron-10

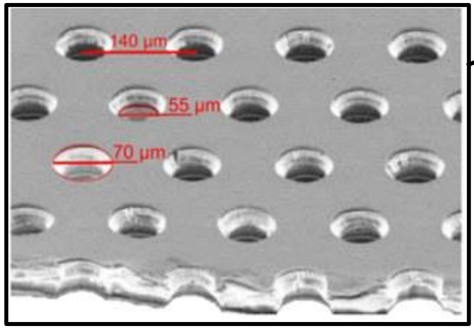
$$^{10}B + n \rightarrow {}^{7}Li + \alpha + 2.79\ \text{MeV} \quad (\ 6\%)$$
$$\phantom{^{10}B + n \rightarrow}\ {}^{7}Li^{*} + \alpha + 2.31\ \text{MeV} \quad (94\%)$$

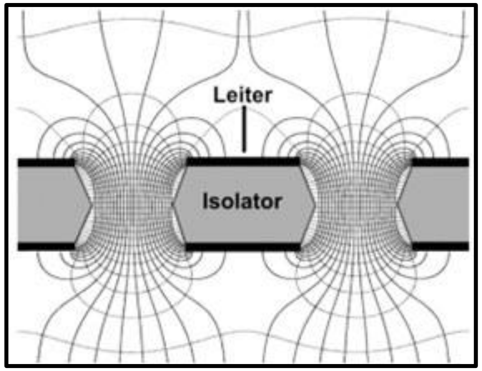
- Charge amplification with GEMs in Standard Gas

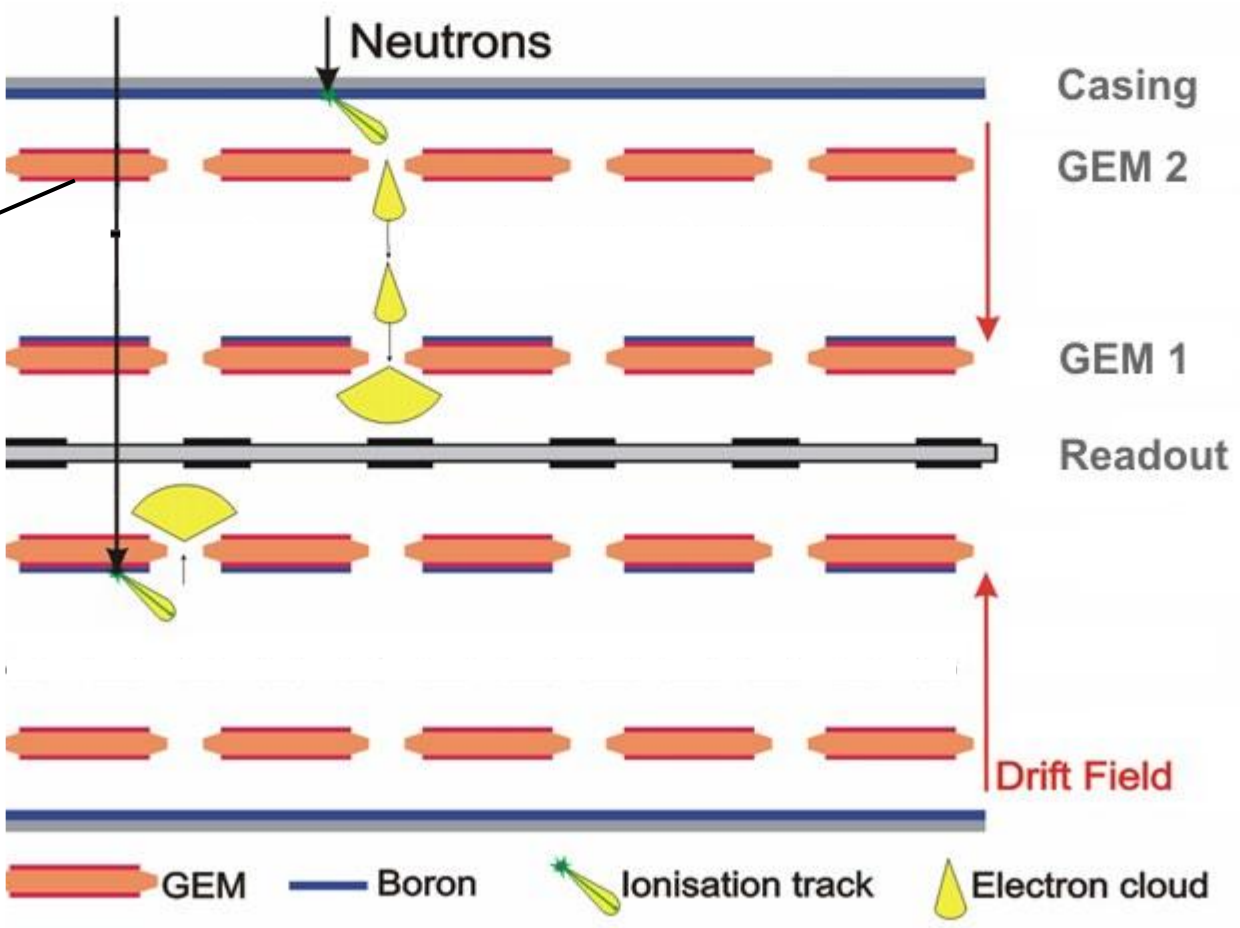
Readout

Electronics

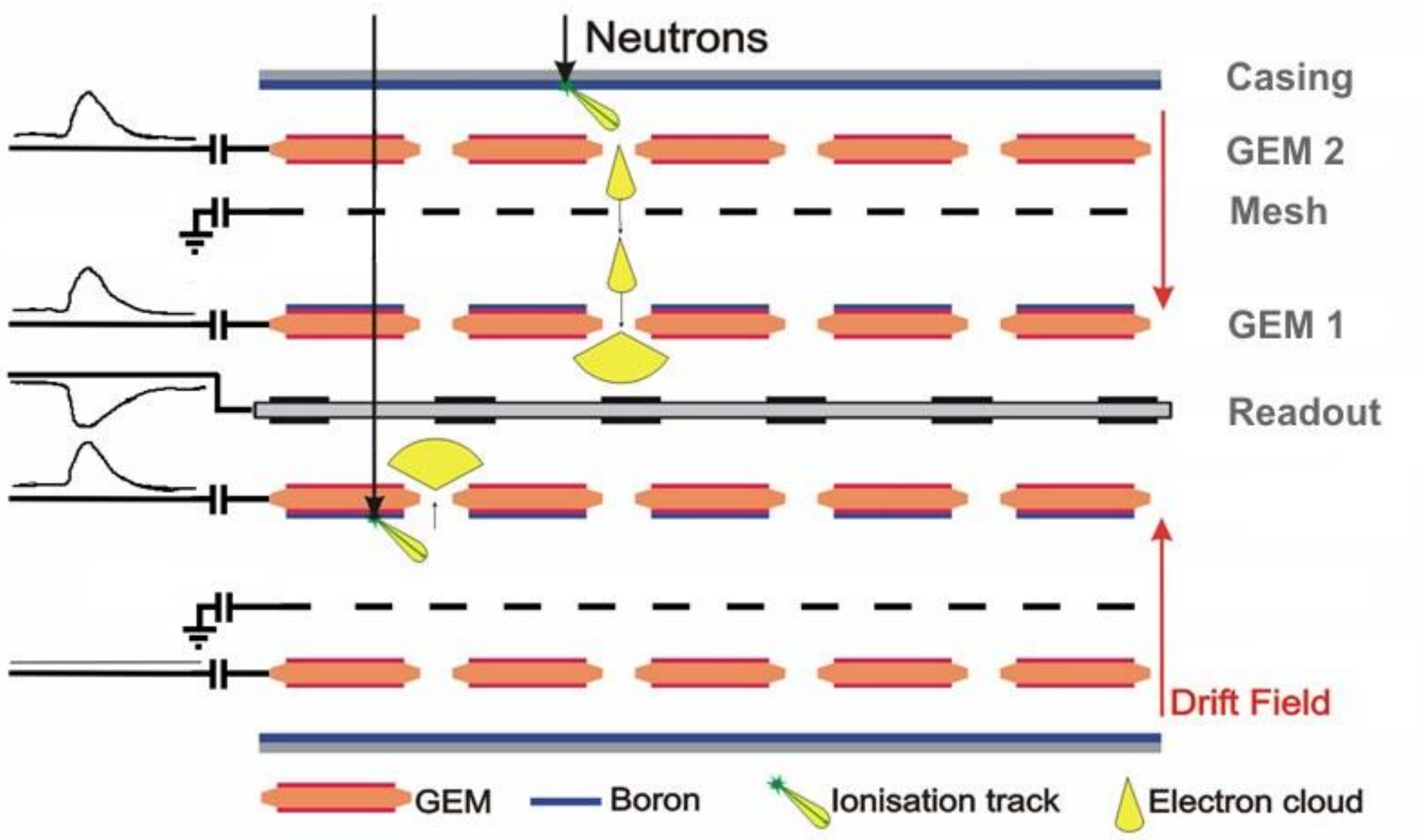
Active Detection Volume





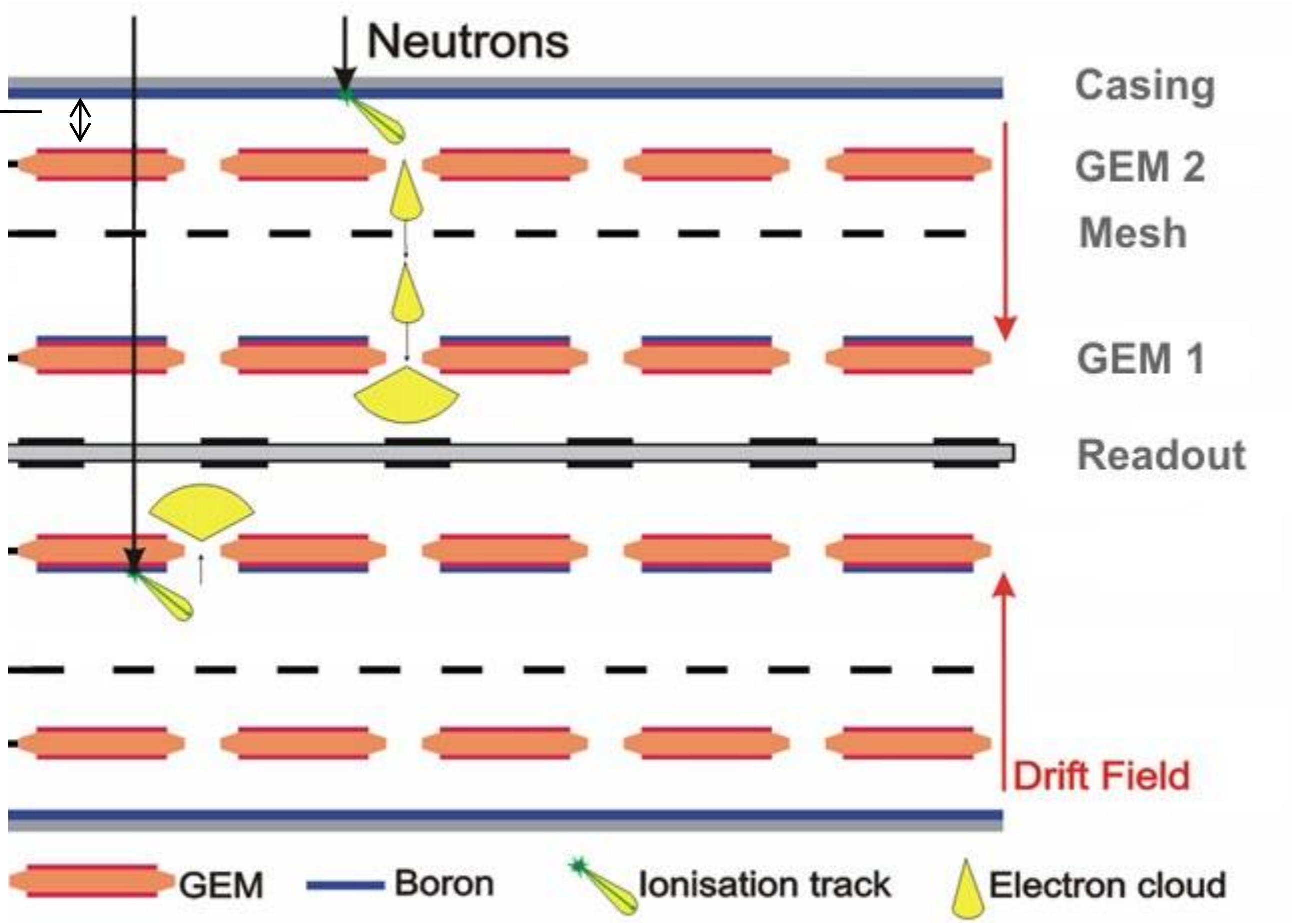


Active Detection Volume



Active Detection Volume

thin gap
measures dE/dx



The CASCADE Detector

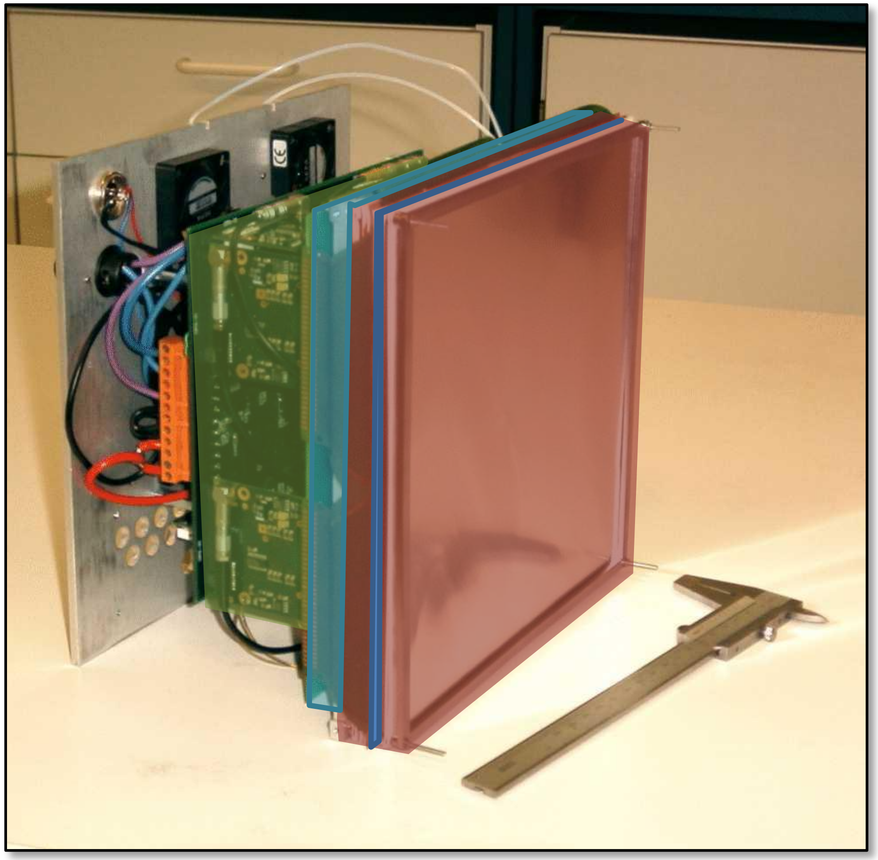
Active Detection Volume

Readout

- readout stripes: 128 x | 128 y @ 1.56mm
- double sided

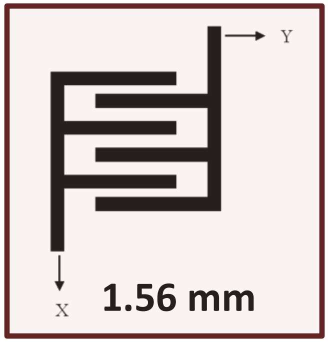
Electronics

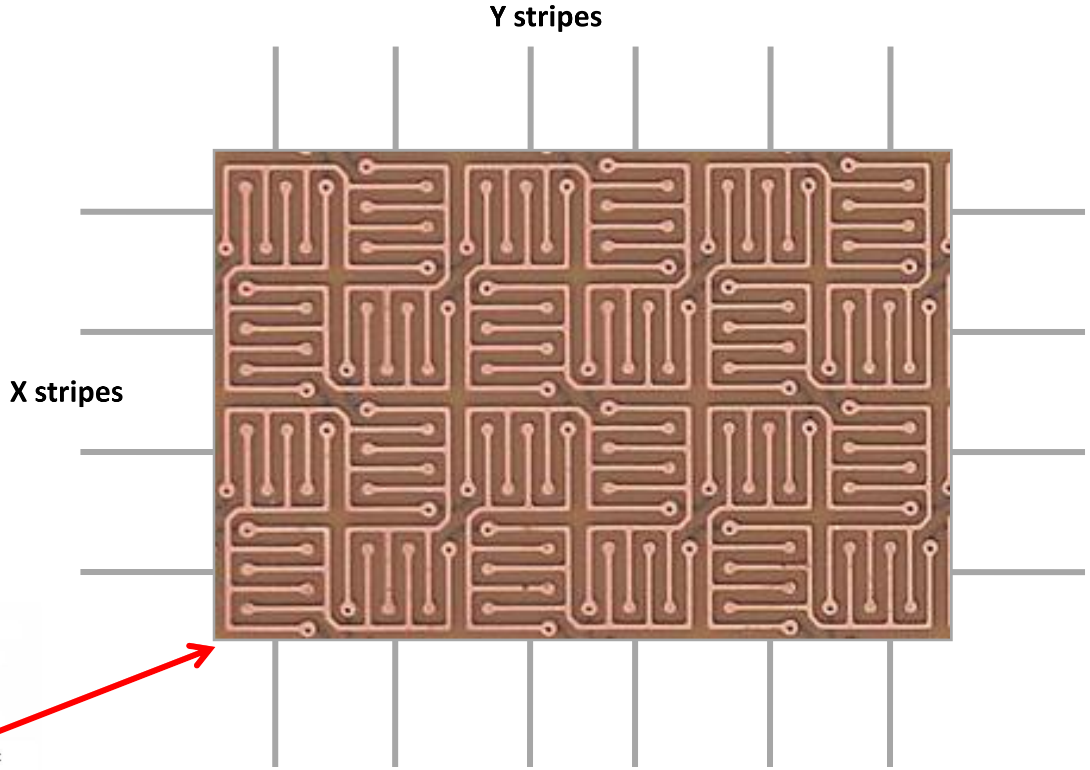
CASCADE detector without housing

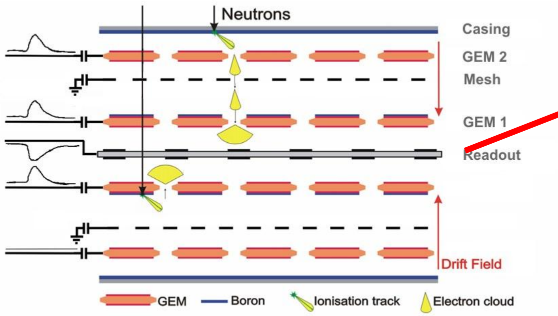


Double Sided Readout

Unit Cell:



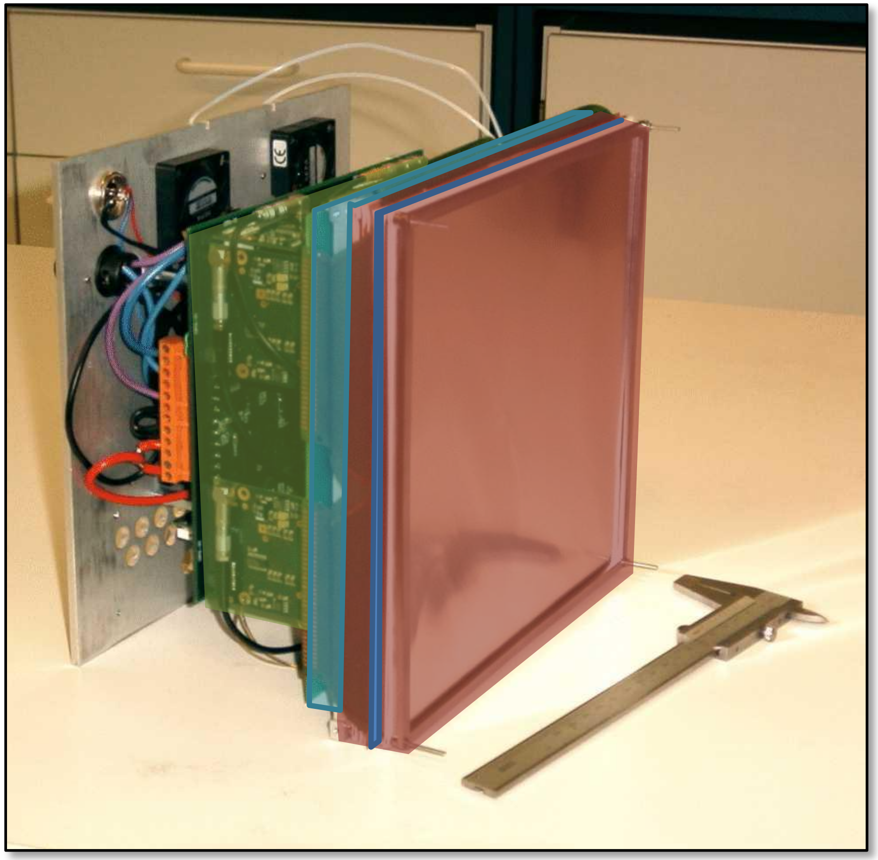




Crossed stripes: reduces noise by correlating x and y

The CASCADE Detector

CASCADE detector without housing



Active Detection Volume

Readout

Electronics

-A/D: CiPix –Chip (ASIC) with 10 MHz
-FPGA based data preprocessing
o histogram (on the fly)
- Optical GBit Interface

CIPix Preamplifier

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

FElix chip (RD20, LHC) 1993

HELIX 1.0

Timeline

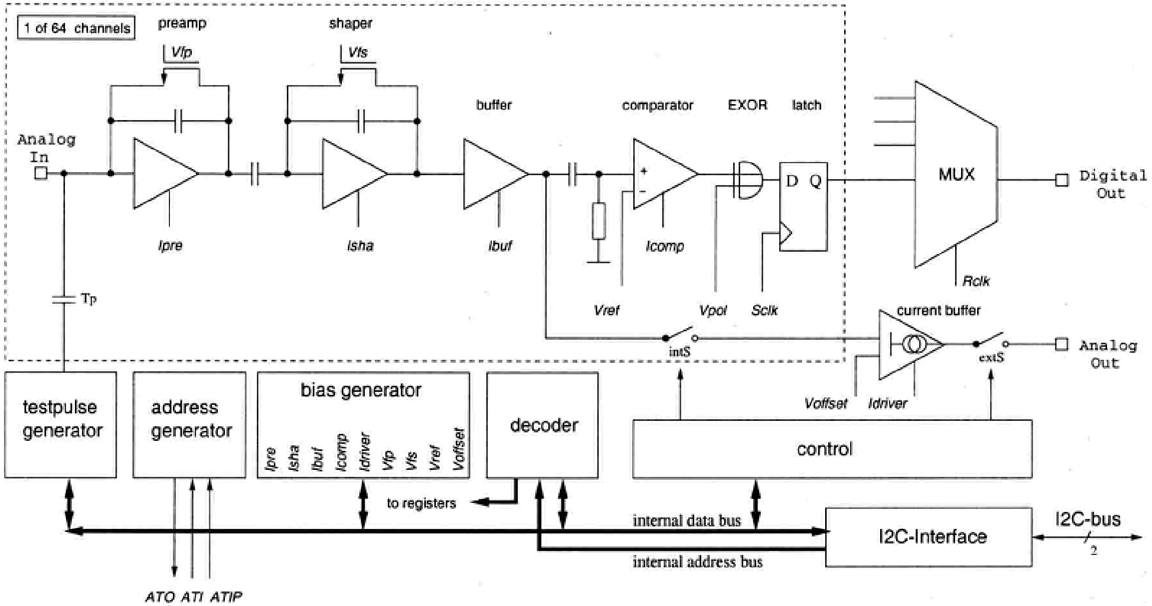
HELIX 32 1998

HELIX128-2.2 (HERA-B)

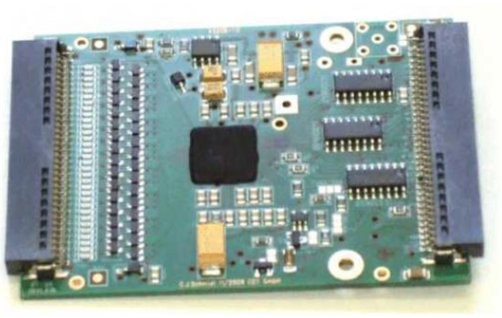
HELIX128-3.0 (Zeus)

CIPix (H1)

BEETLE (LHCb)

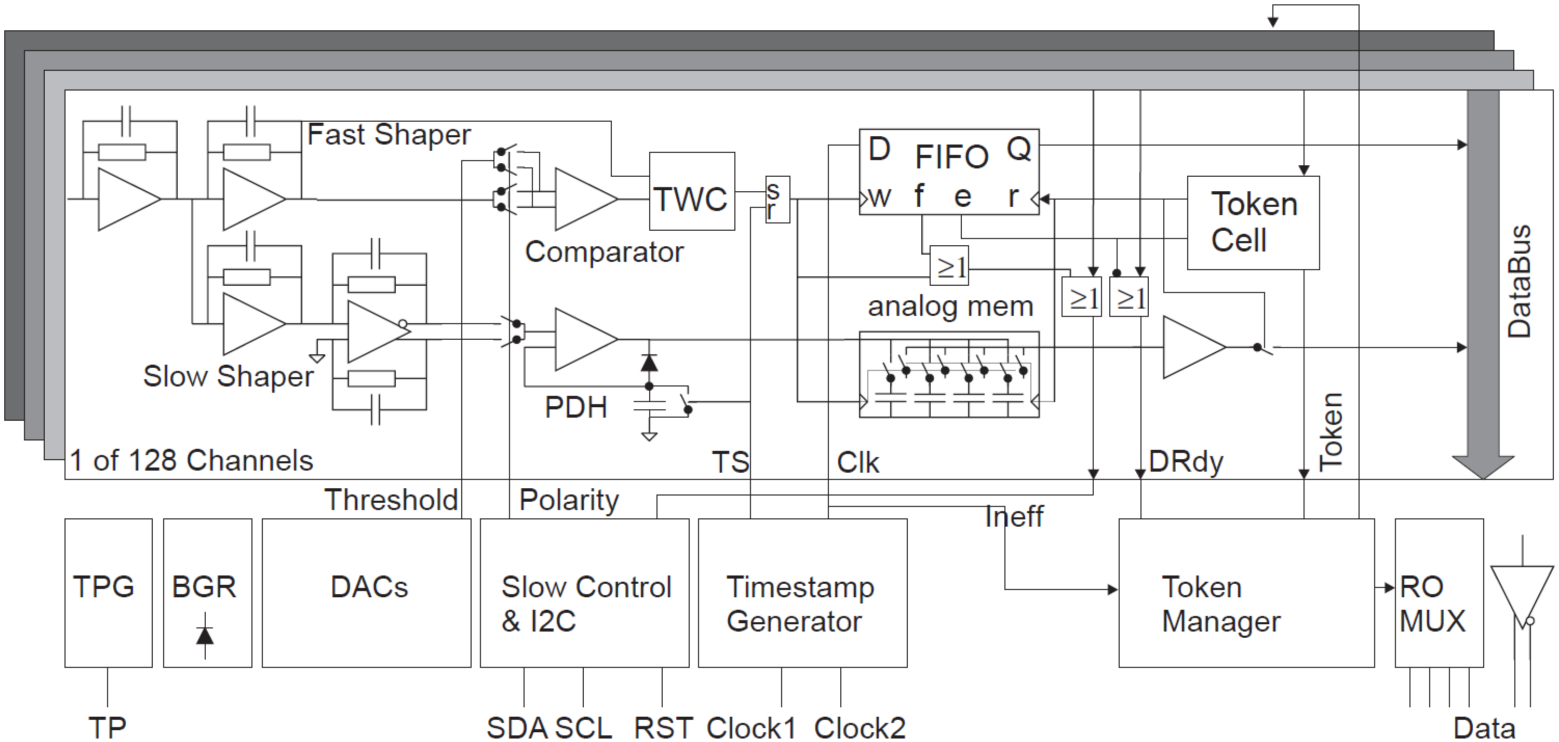


[1]



Outlook: nXYTER

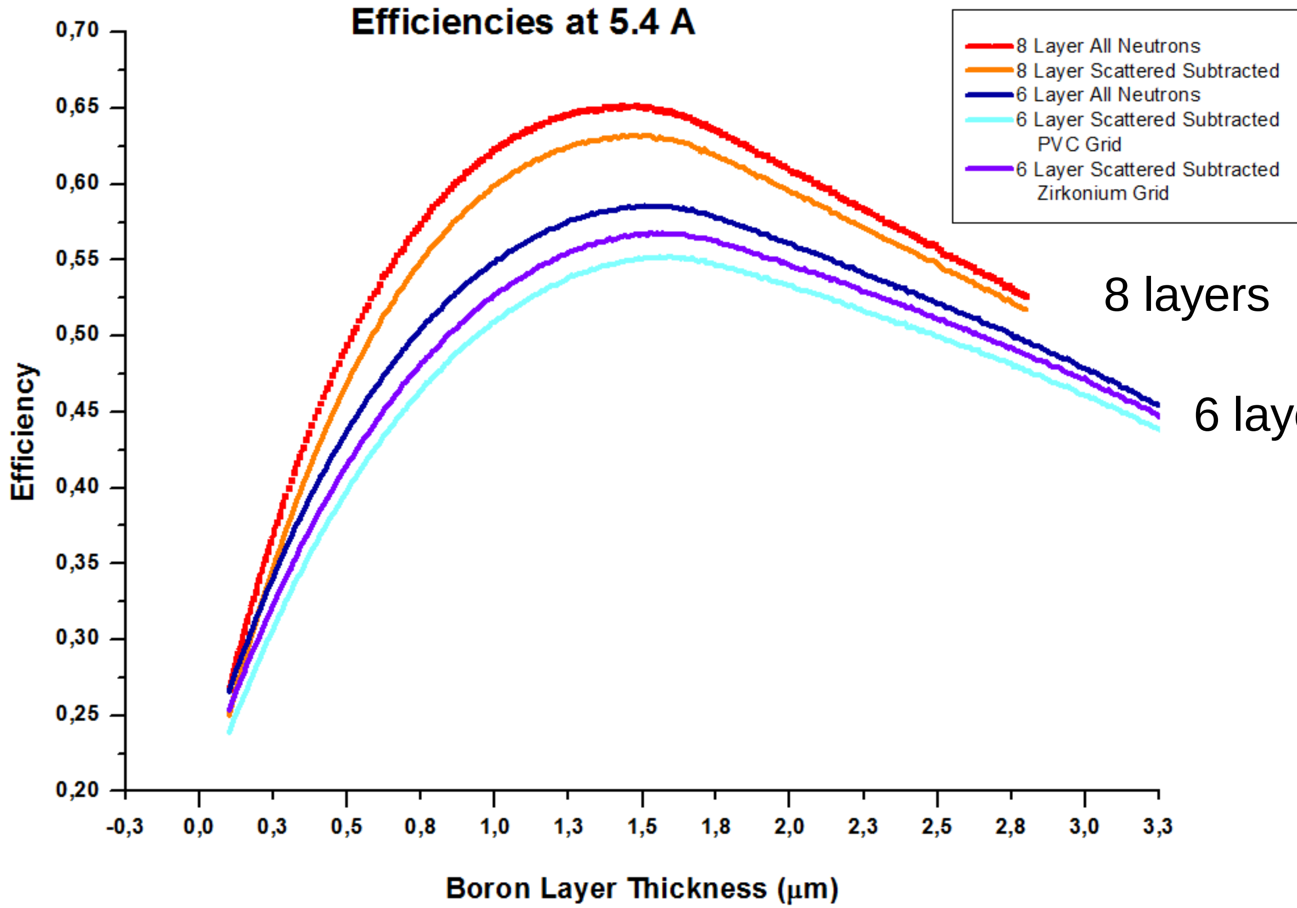
- 128 channels
- 1 ns time resolution
- Token Ring Readout



[1]

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

Efficiency and internal scattering

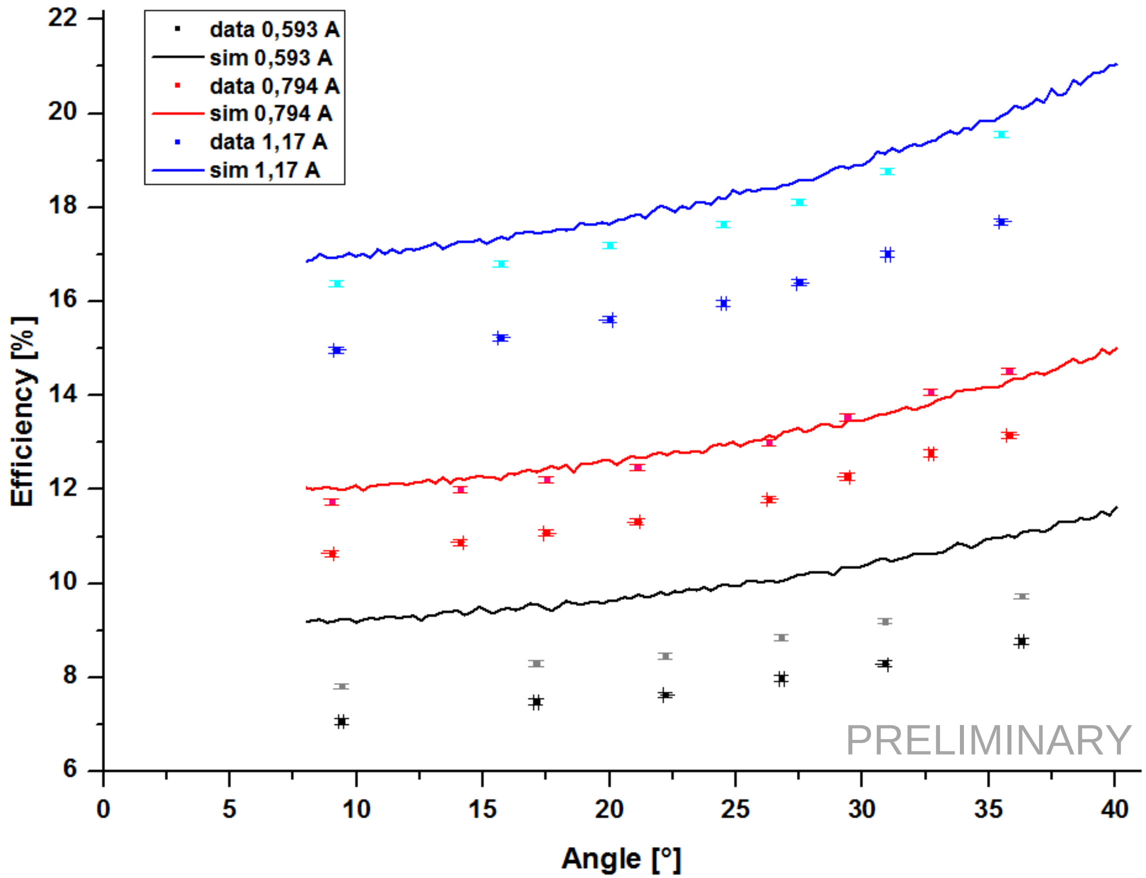


8 layers

6 layers

Efficiency measured at HEIDI

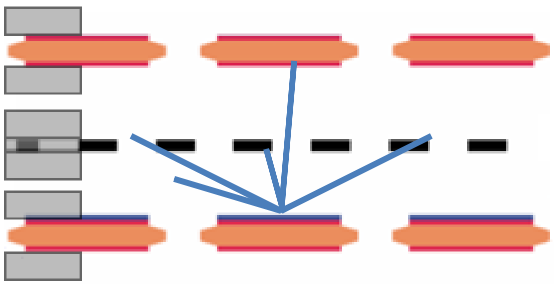
Efficiencies of the detector at different wavelengths



- Simulation
- Data
- Ghost event corrected data

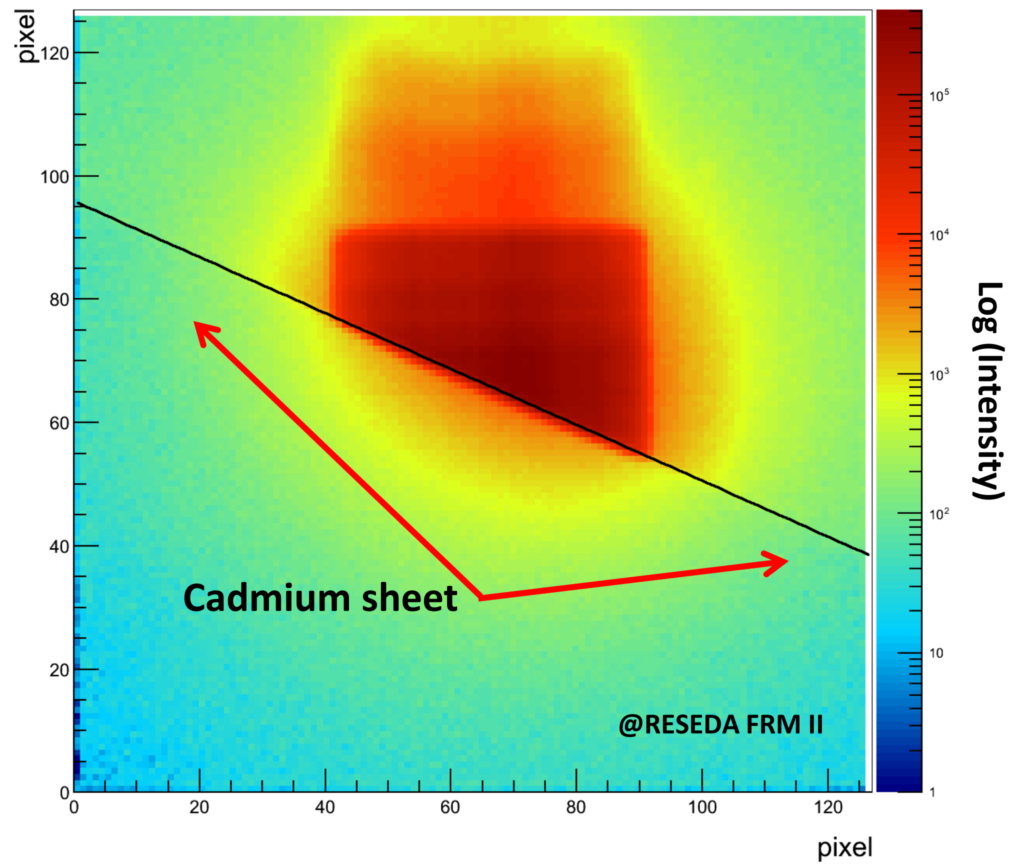
@HEIDI FRM II

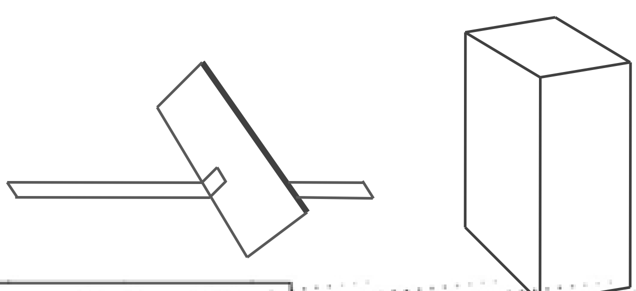
Spatial Resolution



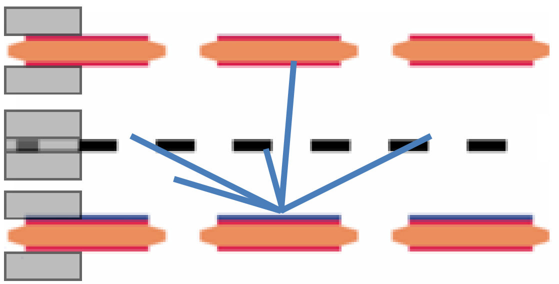
Spatial resolution: 2.4 mm

Image of a thermal neutron beam (after guide)

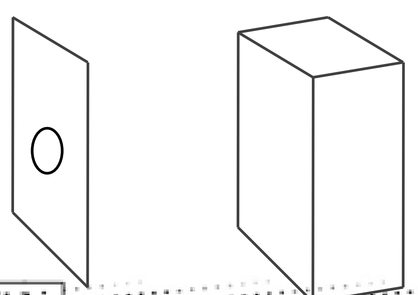




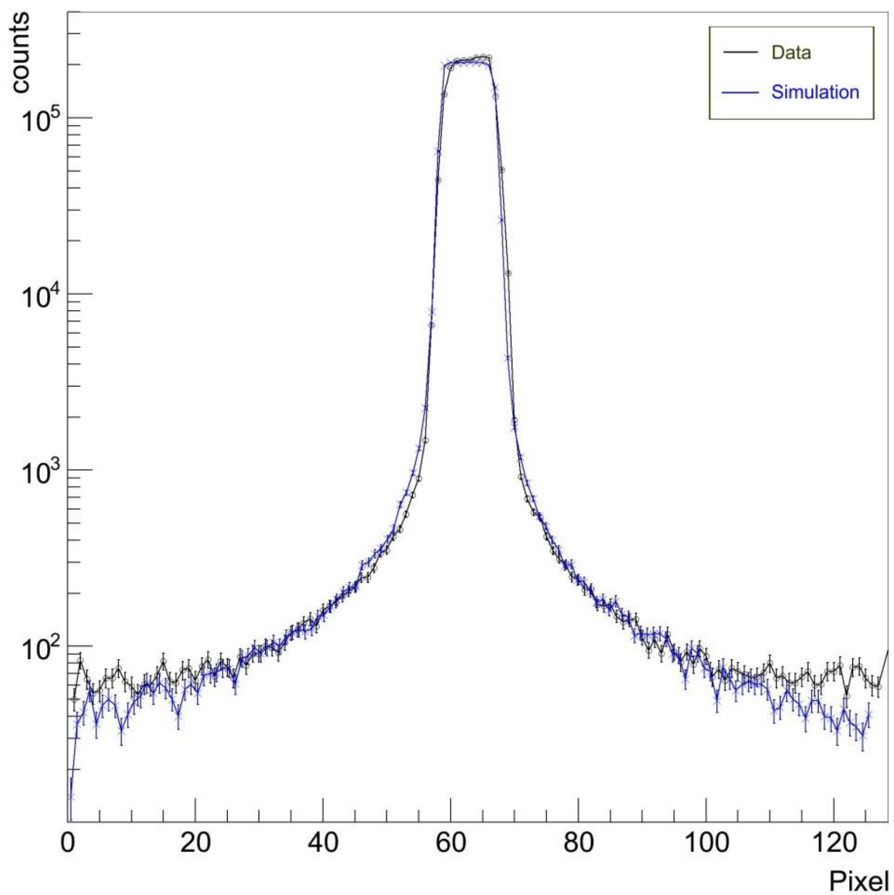
Spatial Resolution



Spatial resolution: 2.4 mm

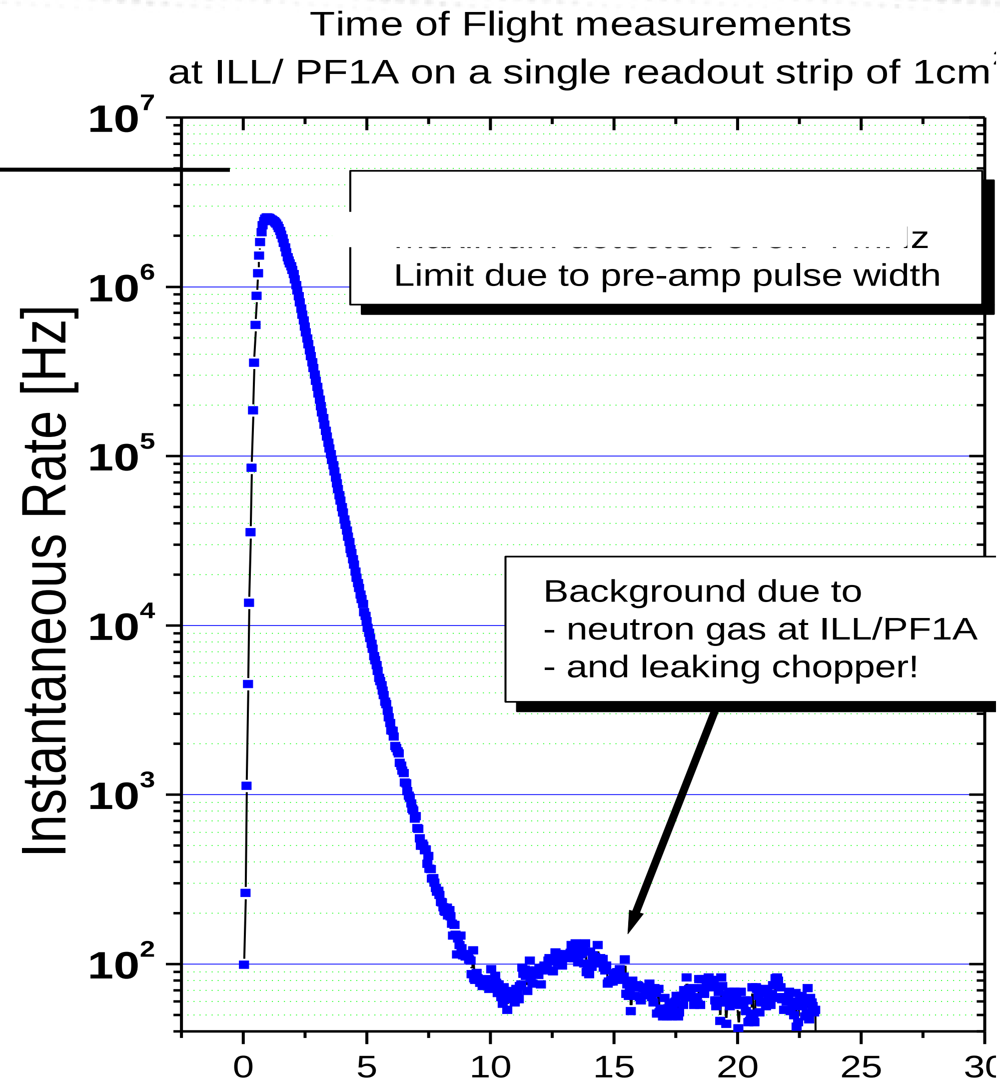


Cross section of a collimated n-beam



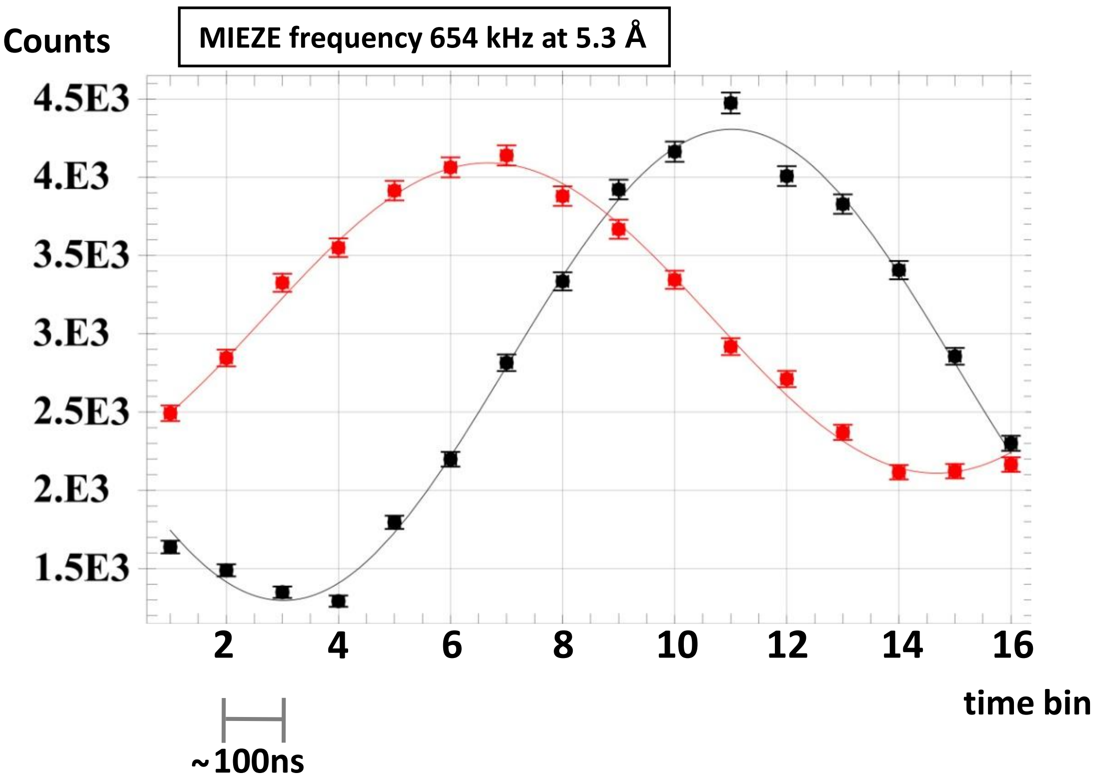
Count rate measurements

count rate
2-3 MHz



A Spin Echo Signal

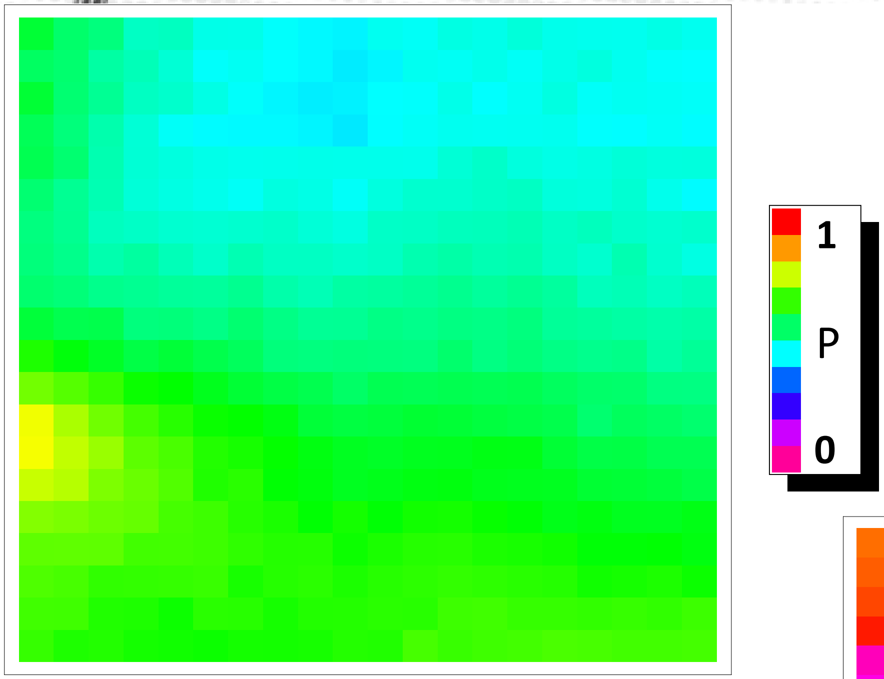
Polarization in two pixels:



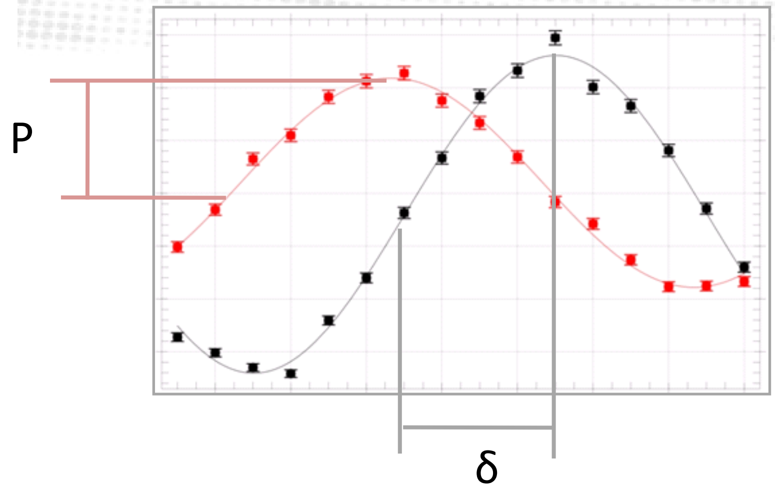
@ RESEDA, FRM II

Signal can be obtained in every single pixel and layer

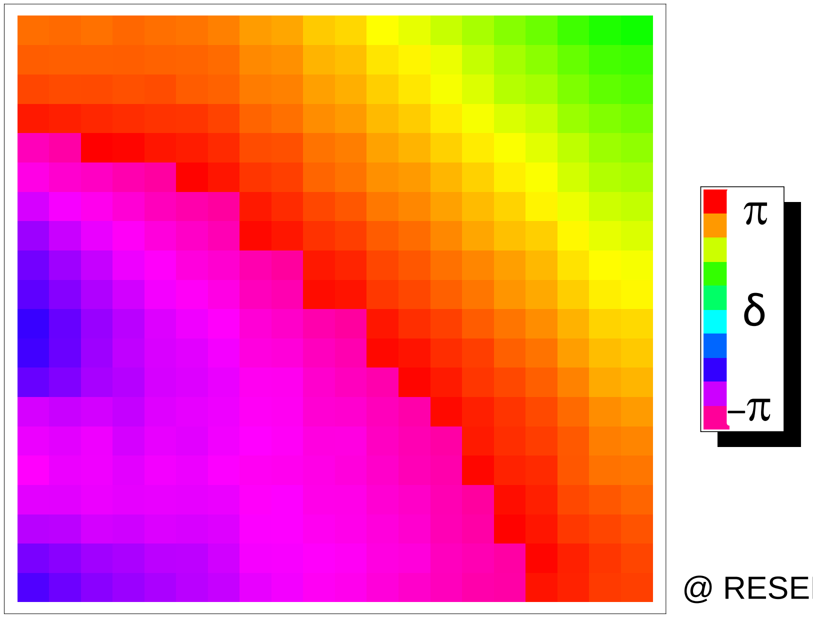
Spin Echo @ CASCADE



polarization map



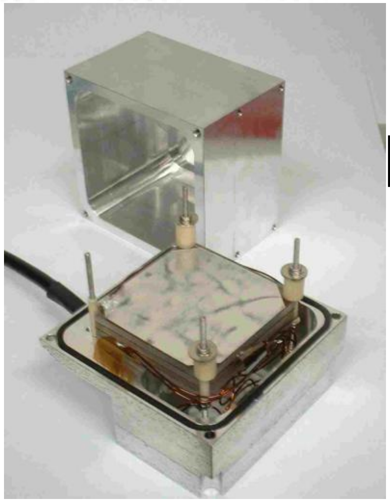
phase front map



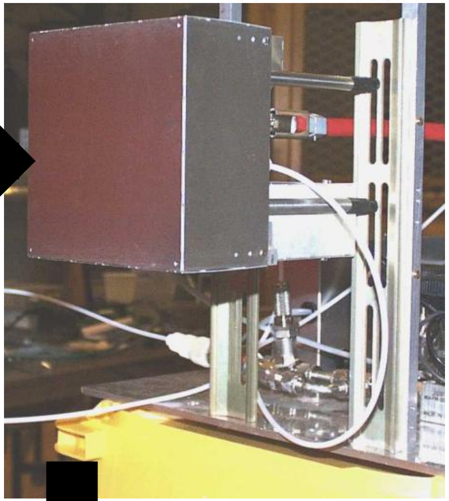
@ RESEDA, FRM II

Prototypes

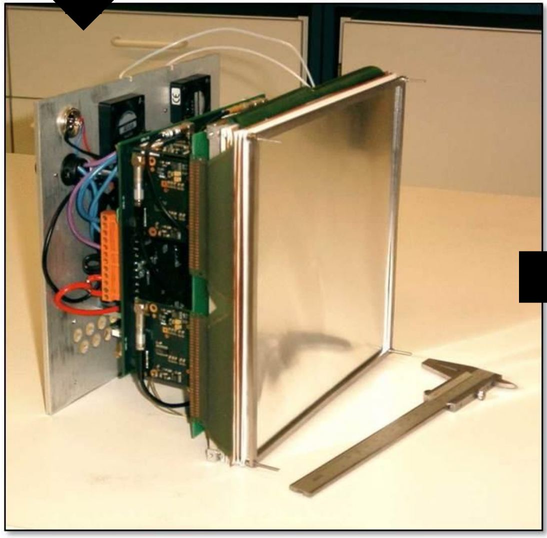
50 X 50



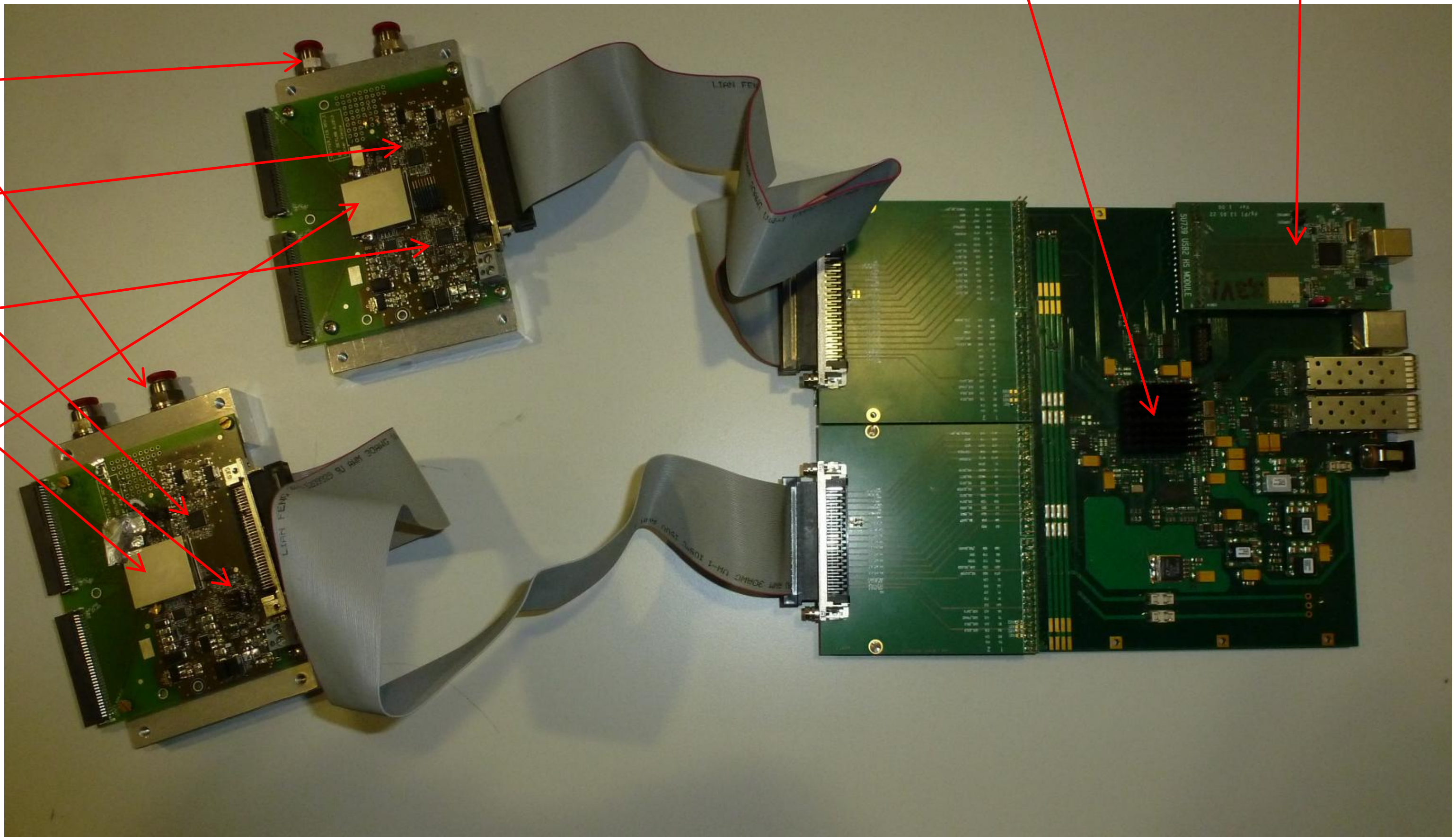
100 X 100



200 X 200

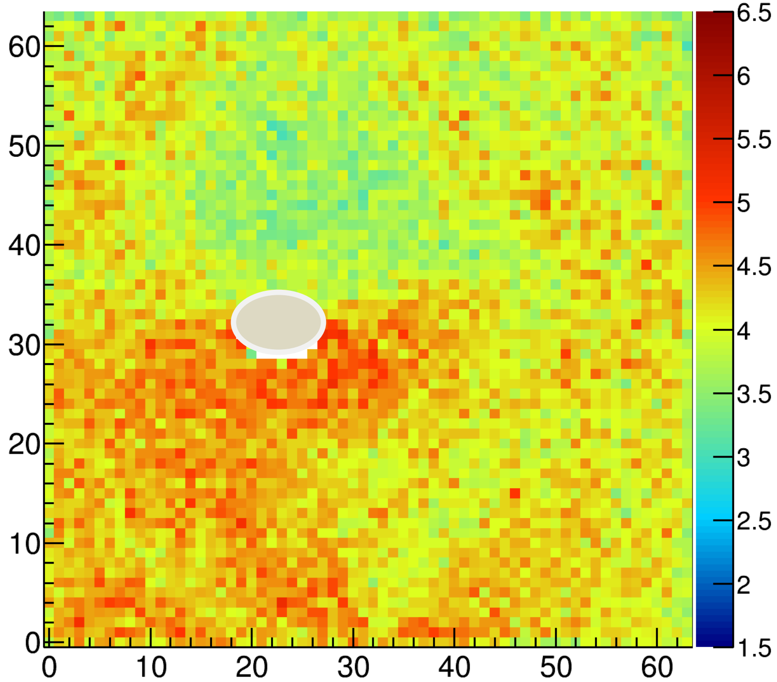


nXYTER Readout Electronics

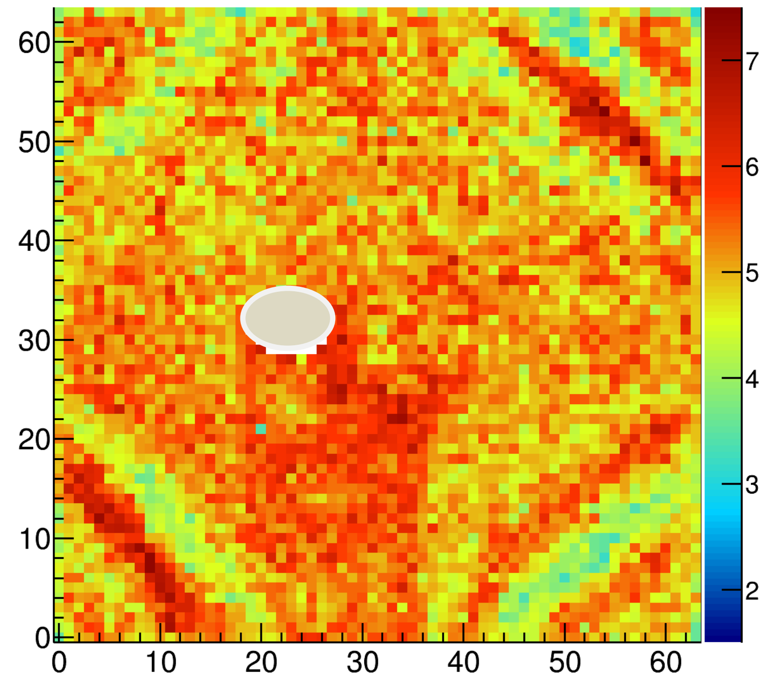


A Spin Echo Signal

Mean local gas gain

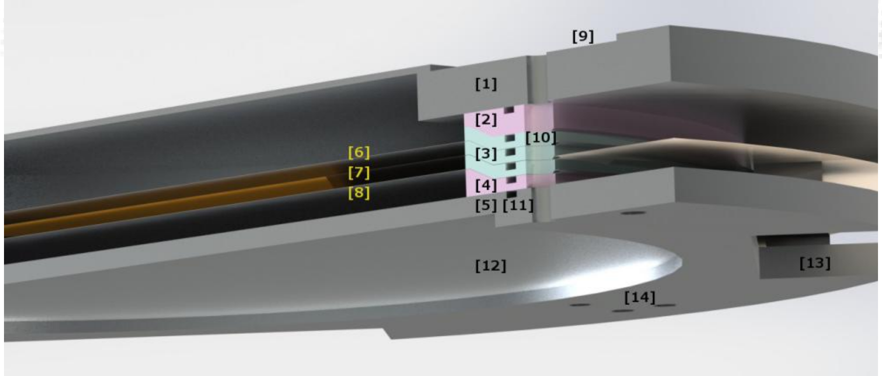


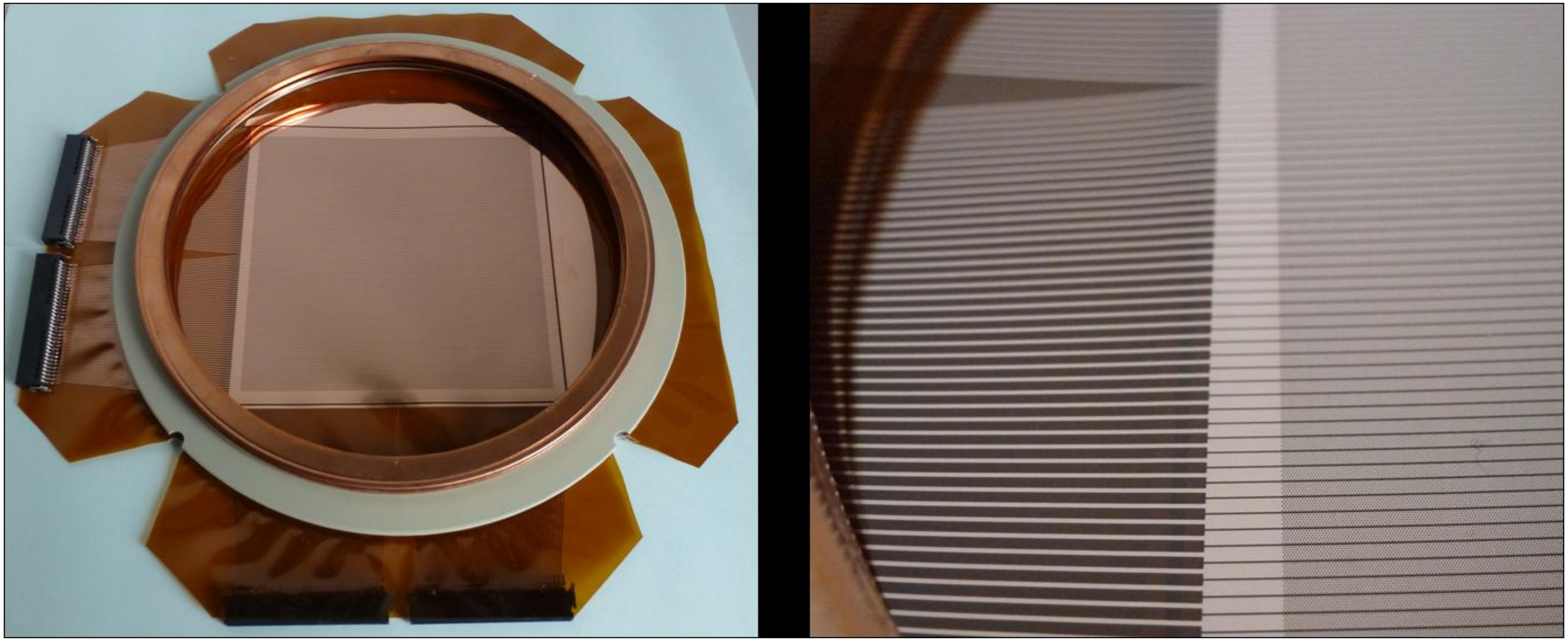
Drift cathode with bump



GEM strained

Outlook





Summary

GEMs plus standard gas detectors
are a promising alternative technology

a broad range of technologies
is available from particle physics

CASCADE

____features

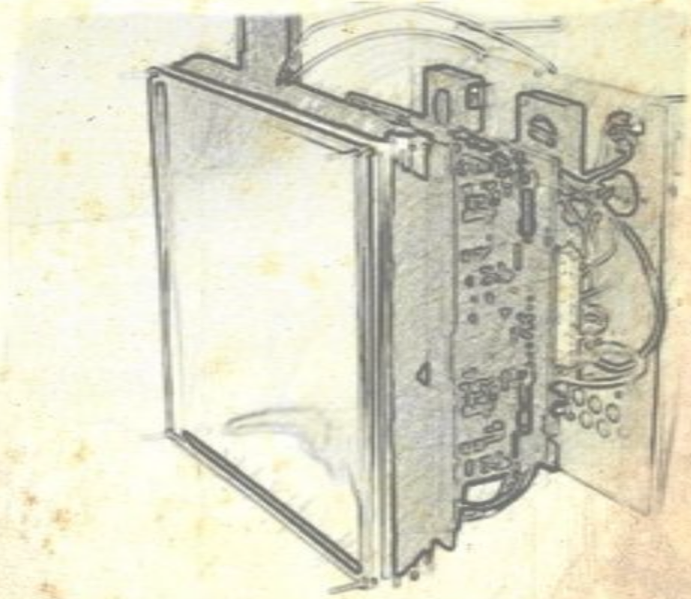
- conversion layer identification
  ⟶ high TOF resolution (Spin Echo)
- 2.4 mm spatial resolution
- 2 MHz rate capability
- 20% thermal neutron efficiency @ 6 layers
- 50% efficiency for 5 Angstroms @ 8 layers

The CASCADE Project

a perspective for Solid State Detectors

3.06.2014

fin



PSND 2014

Markus Köhli

M. Klein, U. Schmidt
AG Dubbers

Physikalisches Institut
Ruprecht-Karls-Universität
Heidelberg

Bundesministerium
für Bildung
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