Microstrip PSD detectors

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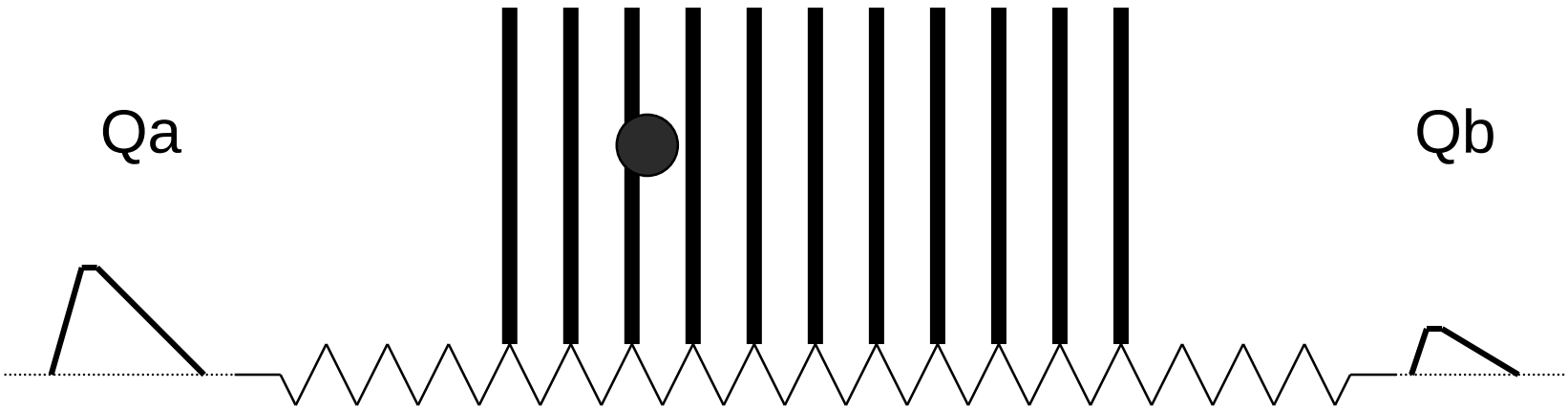
Outline

- Present state of the art at the LLB
  - micro-strip detectors (MS) geometry
  - electronics
  - performances
  - projects, problems and improvements
- Projects within TECHNI
  - large size (300×300mm²) detectors

Principle: charge division

- Position determination :

$$Pos = \frac{Q_a}{Q_a + Q_b}$$



Microstrip geometry

- Typical voltages: Anode 1000-1200V
  Cathode 400V
  - V_{AC} max = 1000V; avalanche gain ~ typ. 10^6 (10^{5-} 10^7)
- Use of the ILL geometry; line resistance = 6 kΩ
  Pitch 0.5 mm or 1 mm
- Size : 100×100 mm² or 200×100 mm²
  Possible to make 200 × 200 mm²

Detector casing

- 100 × 100 detector

Gas

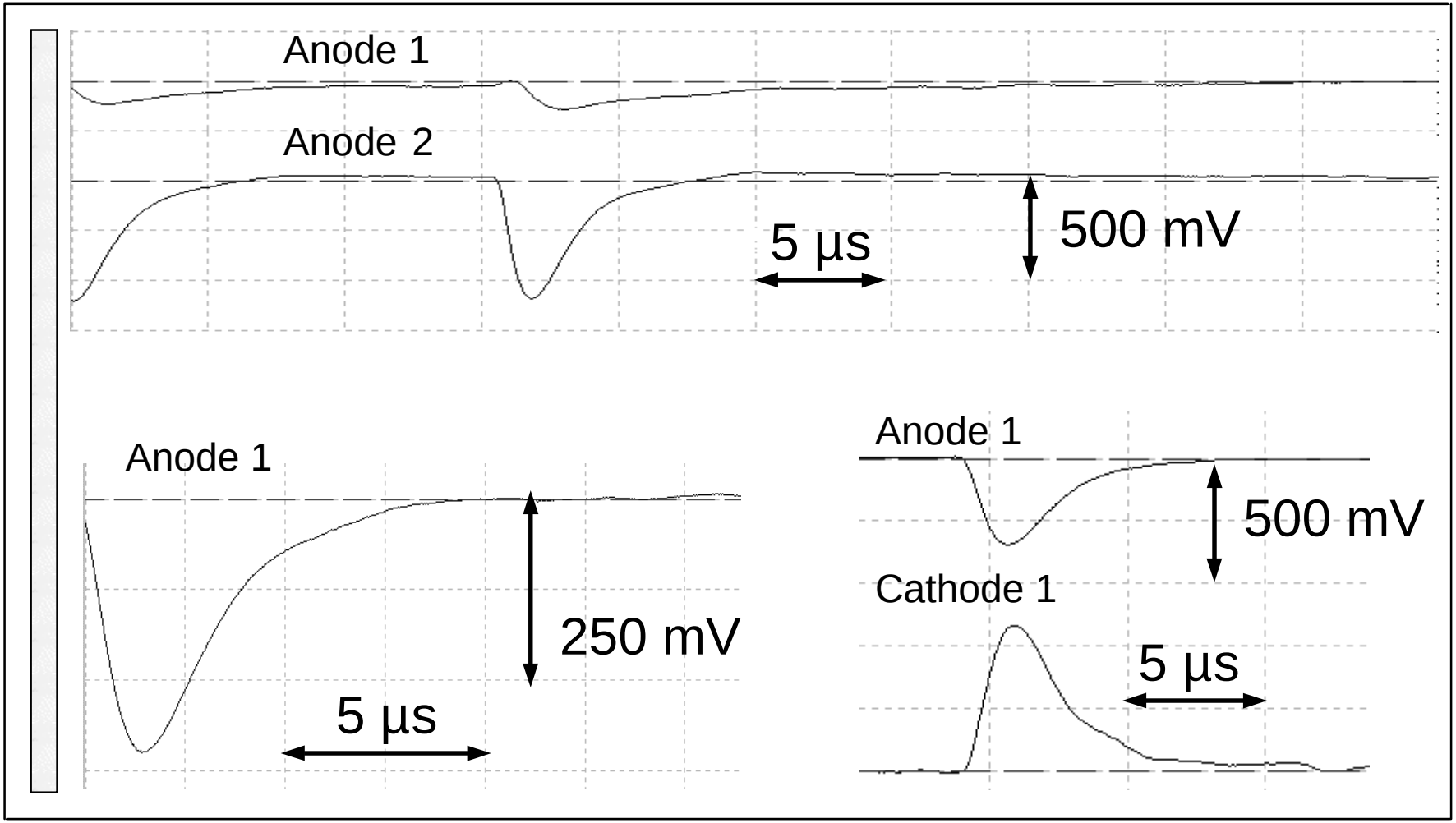
- Maximum pressure in the casing is 10 bars
  - Flat Al window, 4-5 mm thick
- Typically
  - 1.5 bar CF_4
  - 2-4 bar ^3He (depending on the wavelength)
- Use of indium seals (Cu or Al did not work)
- Pumping down to 10^{-7} mbar + etuvage at 80°C
- Purification of the gas:
  - ⇒ nitrogen trap while filling the detector (for ^3He)
  - ⇒ fractional distillation for CF_4

⇒ In the future, use of oxygen getter
(provided by SAES)

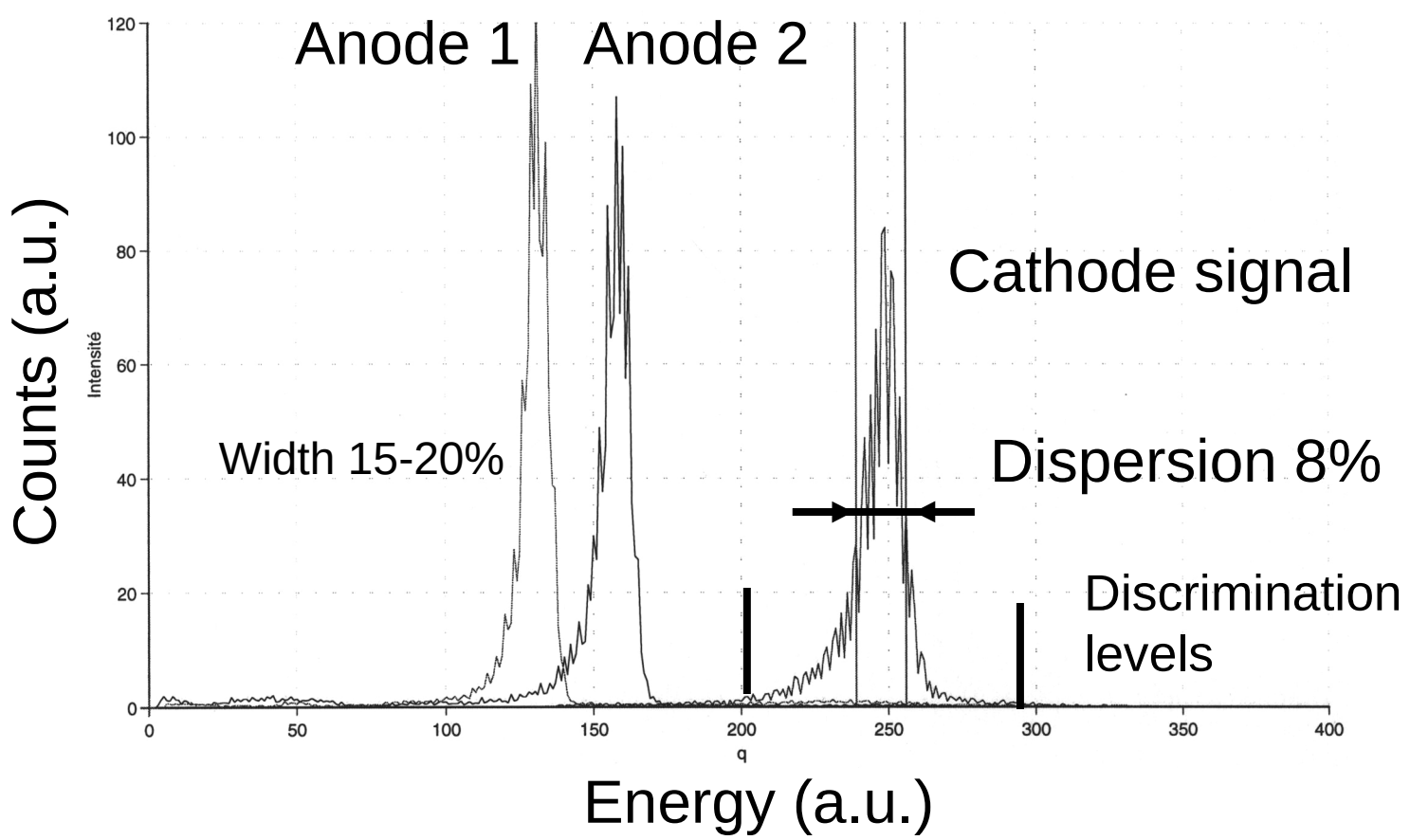
Preamplifiers

- "Home made" charge amplifier (based on OPA621) associated with a 50Ω line driver.
- Gain: 10 mV/fC (with an input capacitance of 20 pF)
  - Small detector (100x100 mm²): 20 pF
  - Large detector (100x200 mm²): 40 pF
- Output noise 15 mV
- Typical avalanche gain = 10^6 (at V_{AC} = 900V)
  - Output signal = 1 V
- Rise time 1.3 µs; Signal length = 5 µs
- tests of (8) integrated charge amplifiers (from Delft, van Eijk): smaller signals because of the high input capacitance

Anodes and Cathode signals

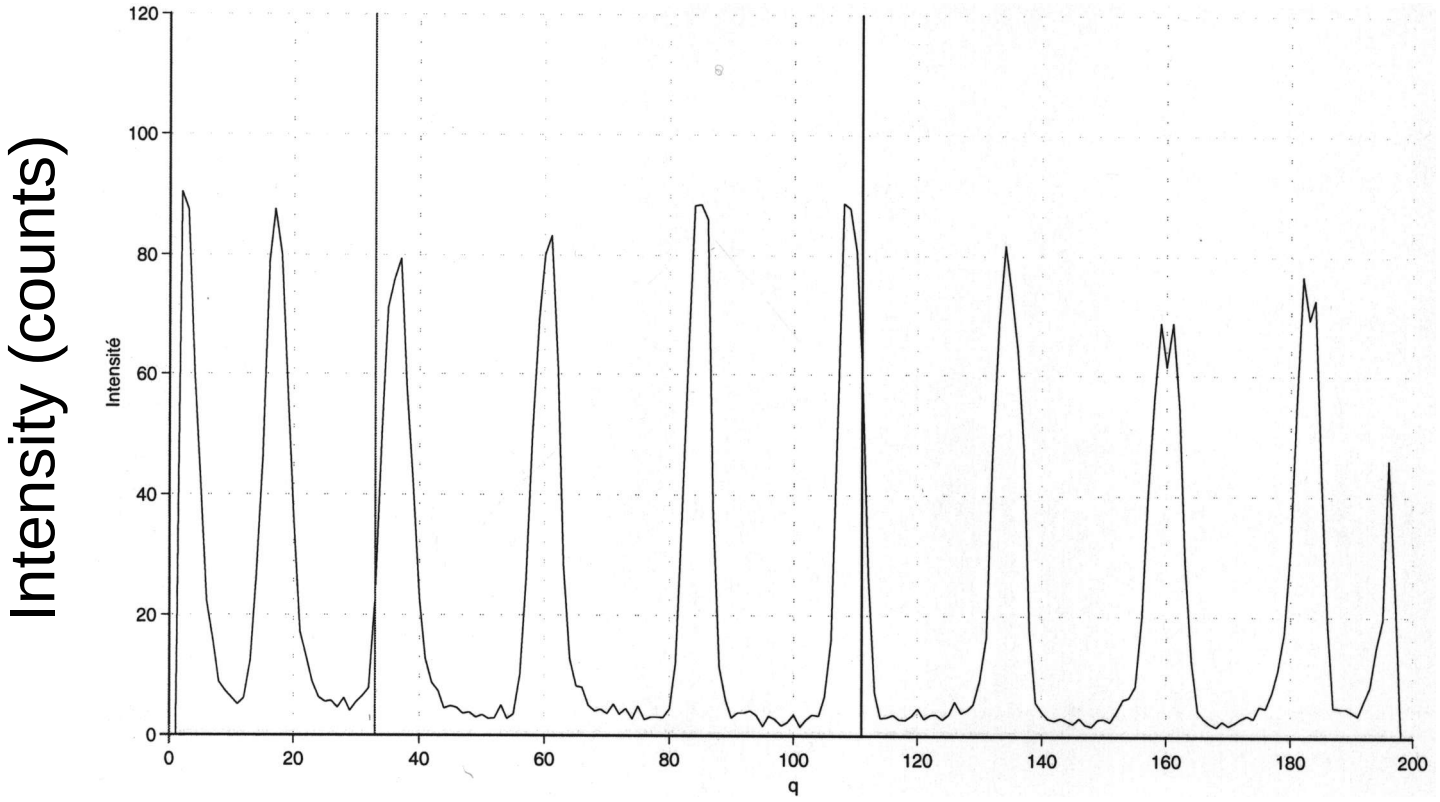


Signals outputs dispersion

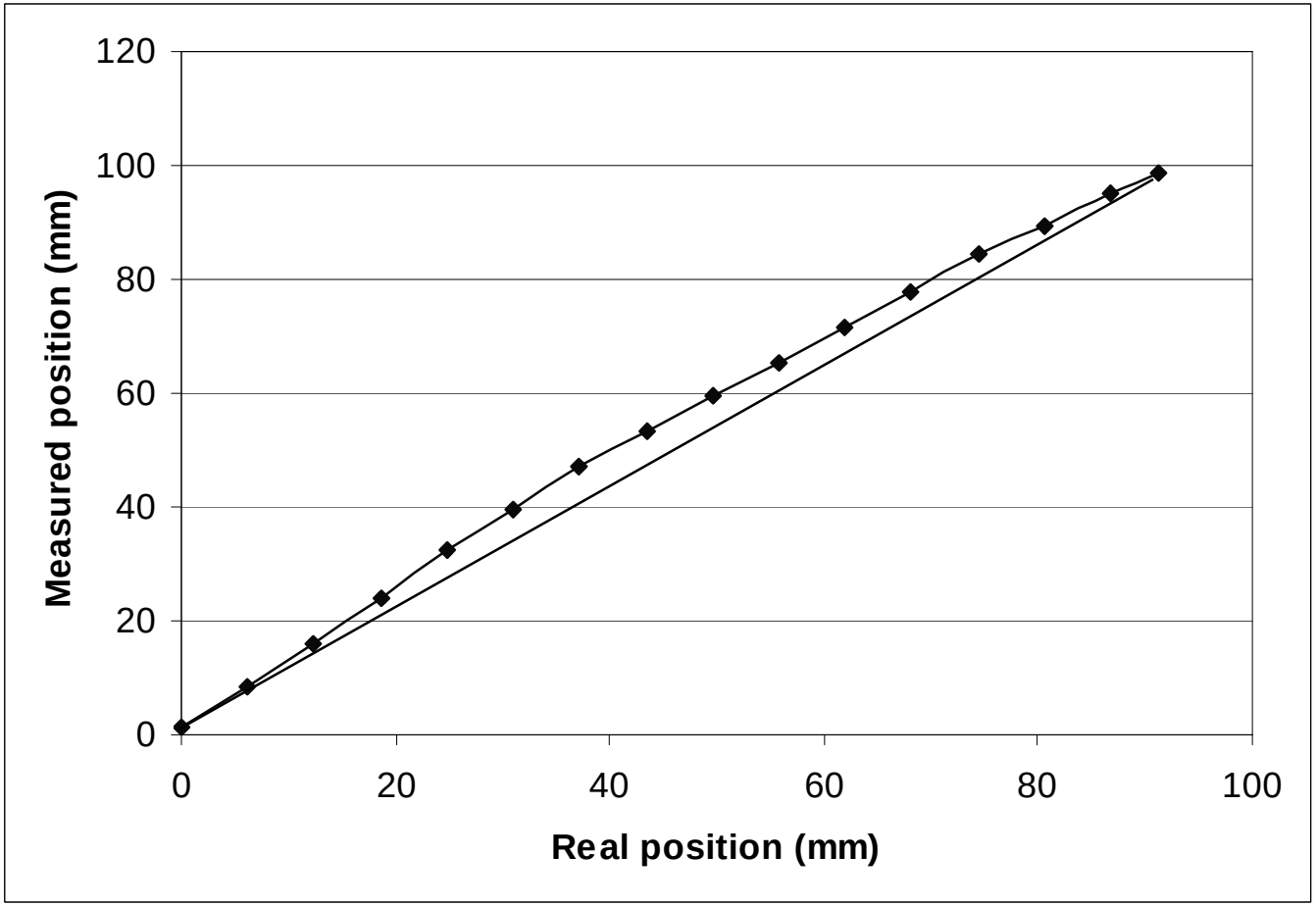


Translation scan

- Scan over 100 mm with a 0.5 mm slit



Detector linearity (w/o correction)



Overall characteristics

- Spatial resolution:
  - 1.3 mm on the small detector
  - 2-2.5 mm on the large detectors
- Background noise:
  - 0.2 count per minute over whole detector (because of the good discrimination)
- Maximum counting rate:
  - 10^4 n/s without deformation of the peak.
  - 10^5 n/s if one allows a 5% error on the total counting.
- Efficiency : 95% (2.5 bars at 0.4 nm)

Time and flux stability

- Time stability:
  - Small detector has been under vacuum for under 18 months:

  ➔ no deterioration of the output signals (amplitude nor energy spectrum)
- High flux illumination
  - has sustained a flux of 3×10^7 n/s for over 1 month (fluence of 2×10^6 n/s.cm²)

Detector cost (w/o manpower)

Microstrip	1.4 k€		(double side)
	0.7 k€		(single side)
He_3 gas	1 k€		(at 4 bar)
Casing	3 k€		
Electronics	3 k€		
Shielding	-		(B_4C)
2 HV Power supply			
TOTAL	8.4 k€		

Short term projects (year 2000)

- Use of the detectors (200×100) for the reflectivity spectrometer PRISM.
  (and later for EROS)
- Building of a banana shaped set of 12 detectors for 7C2 (liquid and amorphous materials on the hot source)
- Validation of the long term stability while in operation (but in a limited flux environment however)

Problems and improvements

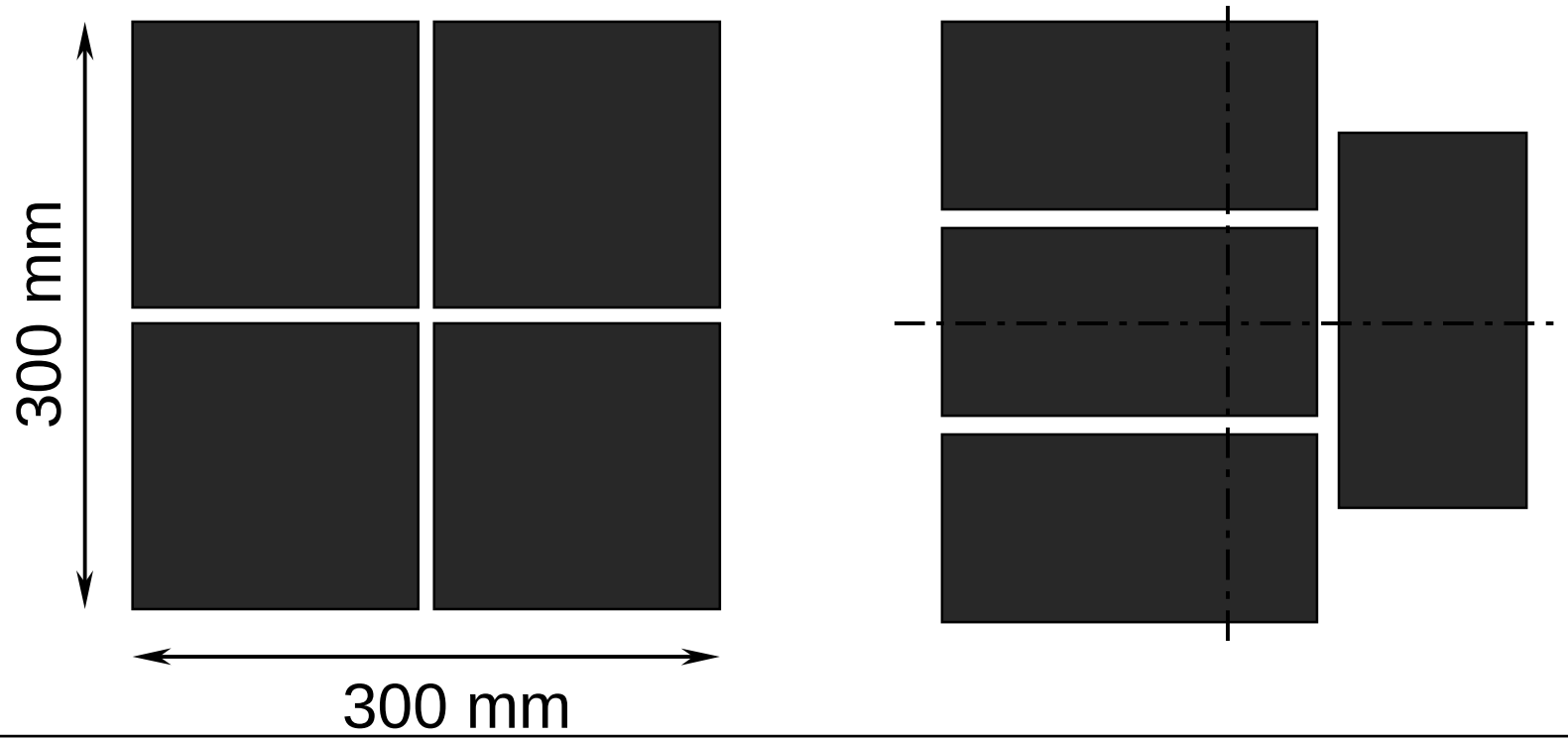
- Large spread of performances between the MS plates:
  - gain varying by a factor of ten between plates
  - no explanation yet
- Building of a standard interface (hardware and software) with the LLB electronics (Daffodil) => swappable devices
- Improvement in the signal conversion: integration or averaging.
- Band pass filters
- Use of FPGA components for processing and linearisation (to replace the use of EPROMs.)

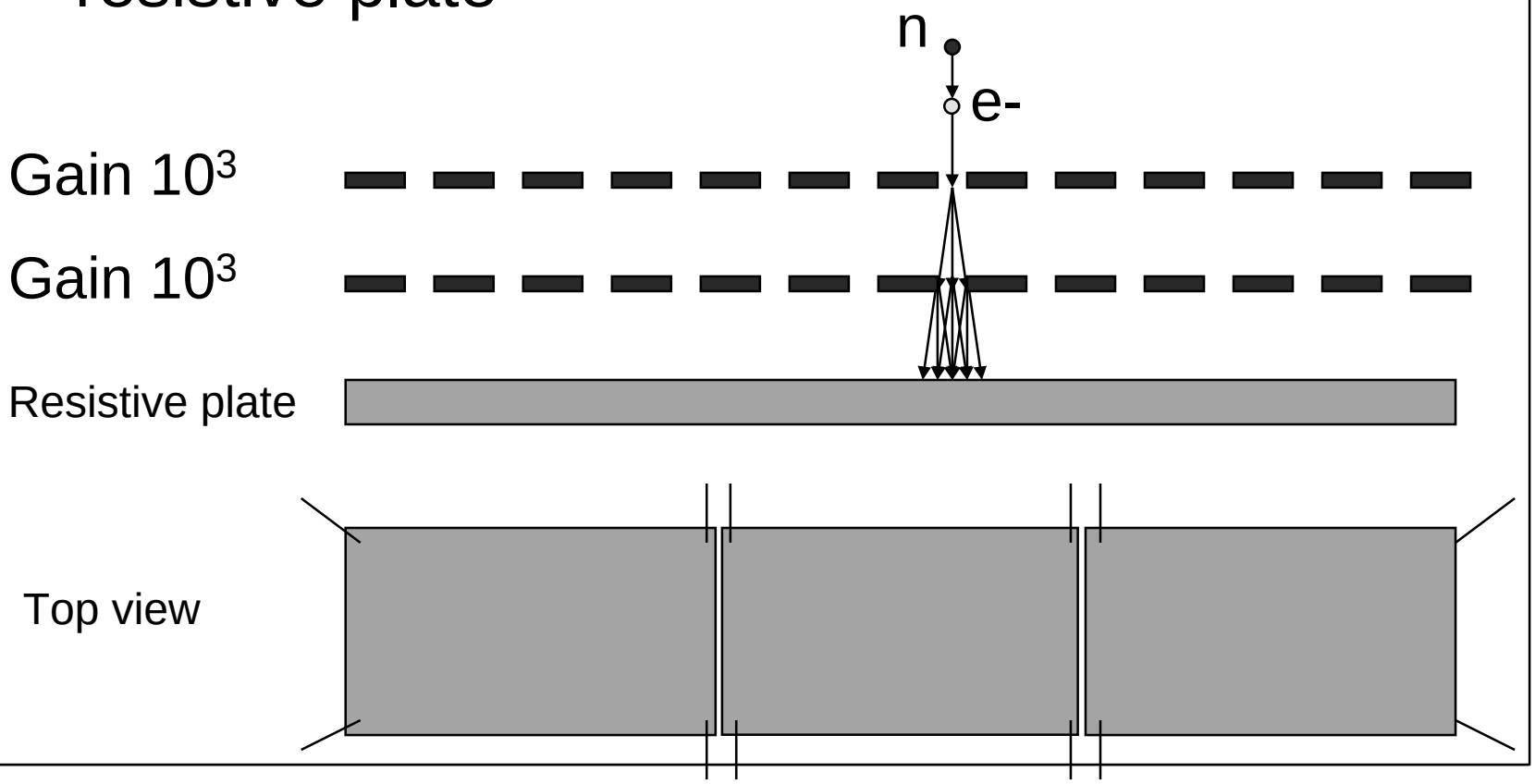
Project within TECHNI

- Project: use of multidetectors for Very Small Angle Neutron Scattering
- Large size (300×300 mm²) detectors set at a distance of 8-10 m :
  - angular opening of 0.03 rad = 1.7°
  - angular resolution of 2×10^{-4} rad (= 0.02°)
    ($\Delta q = 5\times10^{-5}$ nm^{-1} ⇔ objects sizes of 1 µm)
- Solutions
  - assembly of smaller detectors (200×100 mm²)
  - use of GEM and resistive plate

Assembly of detectors

- Set of 4 detectors (6 wires per plate)
  - spacing of 8 mm between the plates grids



GEM scheme

- Two grids (total gain 10^6) associated with a resistive plate