

The miniBETA spectrometer for the determination of weak magnetism and the Fierz interference term

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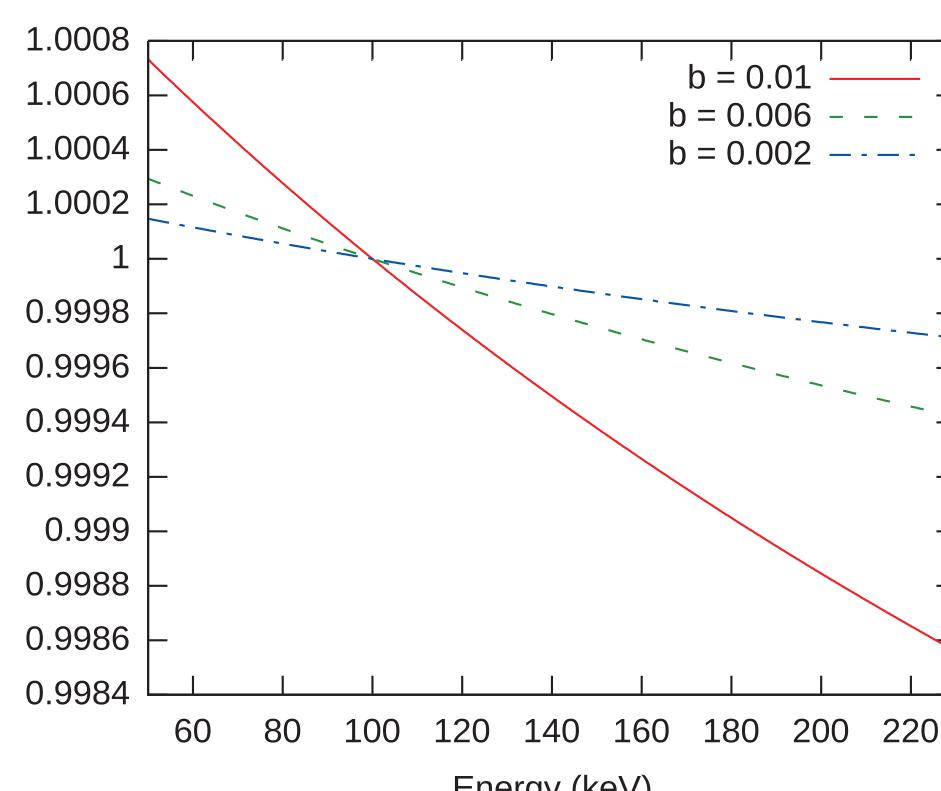
Physics from precision measurements of the beta spectrum shape

Fierz interference

- search for tensor and scalar weak coupling constants
- multiplicative factor in the expression of spectrum shape $(1 + \frac{m_e}{E_e} b_F)$
- current limits on the percent level for tensor type coupling constants
- candidate isotope: ^{45}Ca

N. Severijns, M. Beck, O. Naviliat-Cuncic, RMP 78 (2006) 991
 N. Severijns and O. Naviliat-Cuncic, Annu Rev Nucl Sci 61 (2011) 23

Effect of Fierz interference term on the beta spectrum of ^{45}Ca

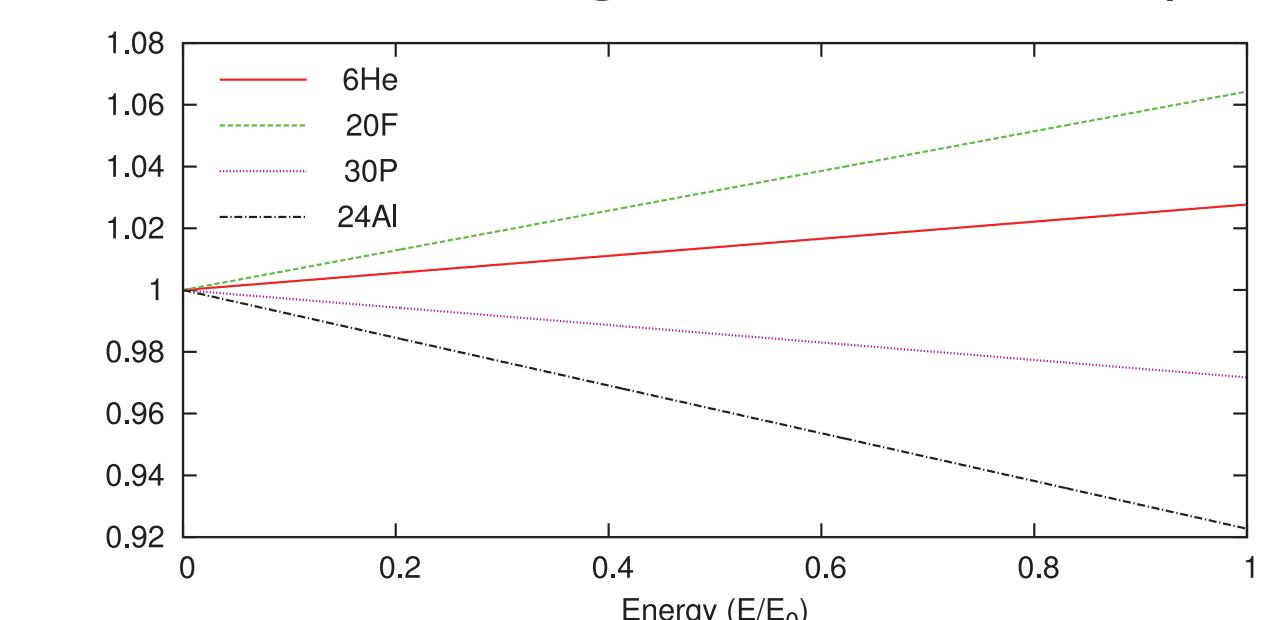


Electron scattering studies

- record high precision electron scattering and transmission data
- compare it with Geant4 simulations

J. Martin, PRC 68 (2003) 055503
 G. Soti, NIM A 728 (2013) 11

Effect of weak magnetism on beta spectra



Weak magnetism

- the effect of the strong interaction on the decaying quarks
- multiplicative factor in the expression of spectrum shape $1 + \frac{2E}{3M} (5 \pm 2 \frac{b_{WM}}{c})$
- also influences the values of correlation coefficients in β decay up to a percent level
- candidate isotopes: ^{32}P , ^{61}Co , ^{114}In

B. R. Holstein, RMP 46 (1974) 789
 V. De Leebeck, in preparation

Other

- spectrum shape of highly retarded allowed decays: ^{14}C , ^{32}P , ^{60}Co ...
- spectrum shape of first and second forbidden transitions
- determination of antineutrino spectra

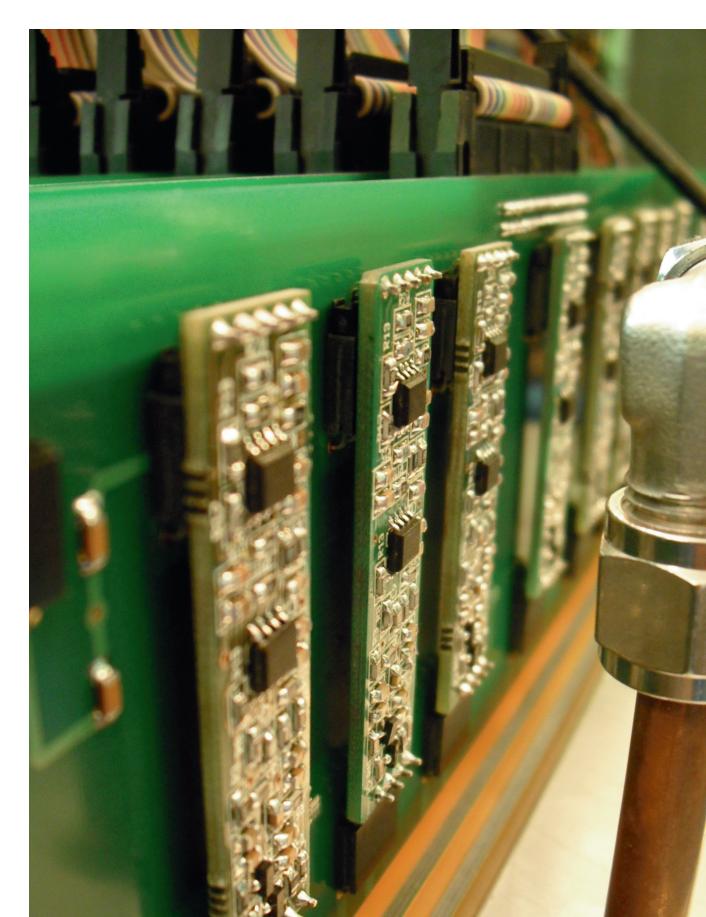
The miniBETA spectrometer

Properties

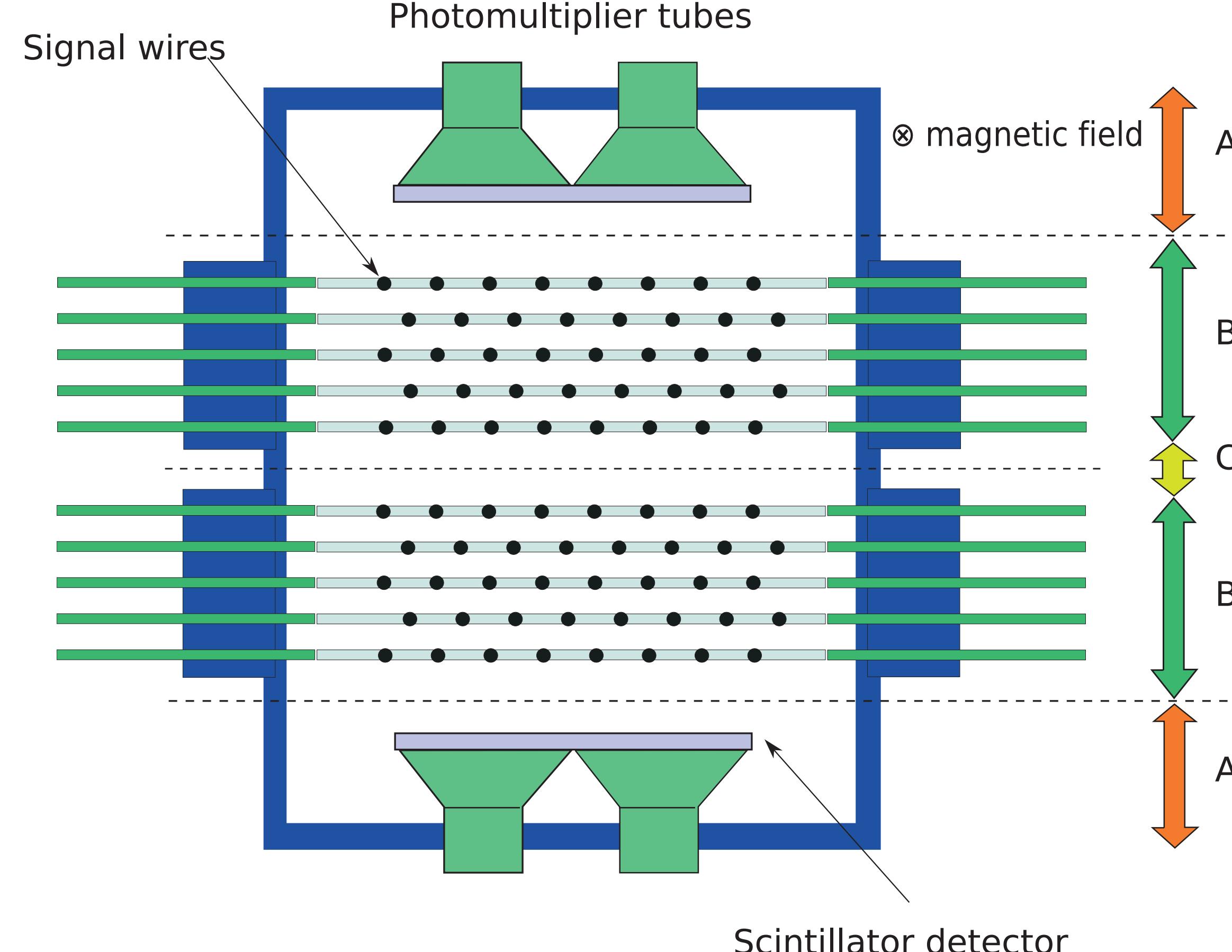
- drift chamber for high precision X-Y positioning
- Z position (along the wire) by the charge division technique
- hexagonal cell structure - minimize amount of wires
- plastic scintillators provide common STOP signal
- magnetic field to obtain energy from curved electron tracks

Preamplifiers

- charge sensitive
- custom made
- 2x per wire
- their signals are combined in custom made units

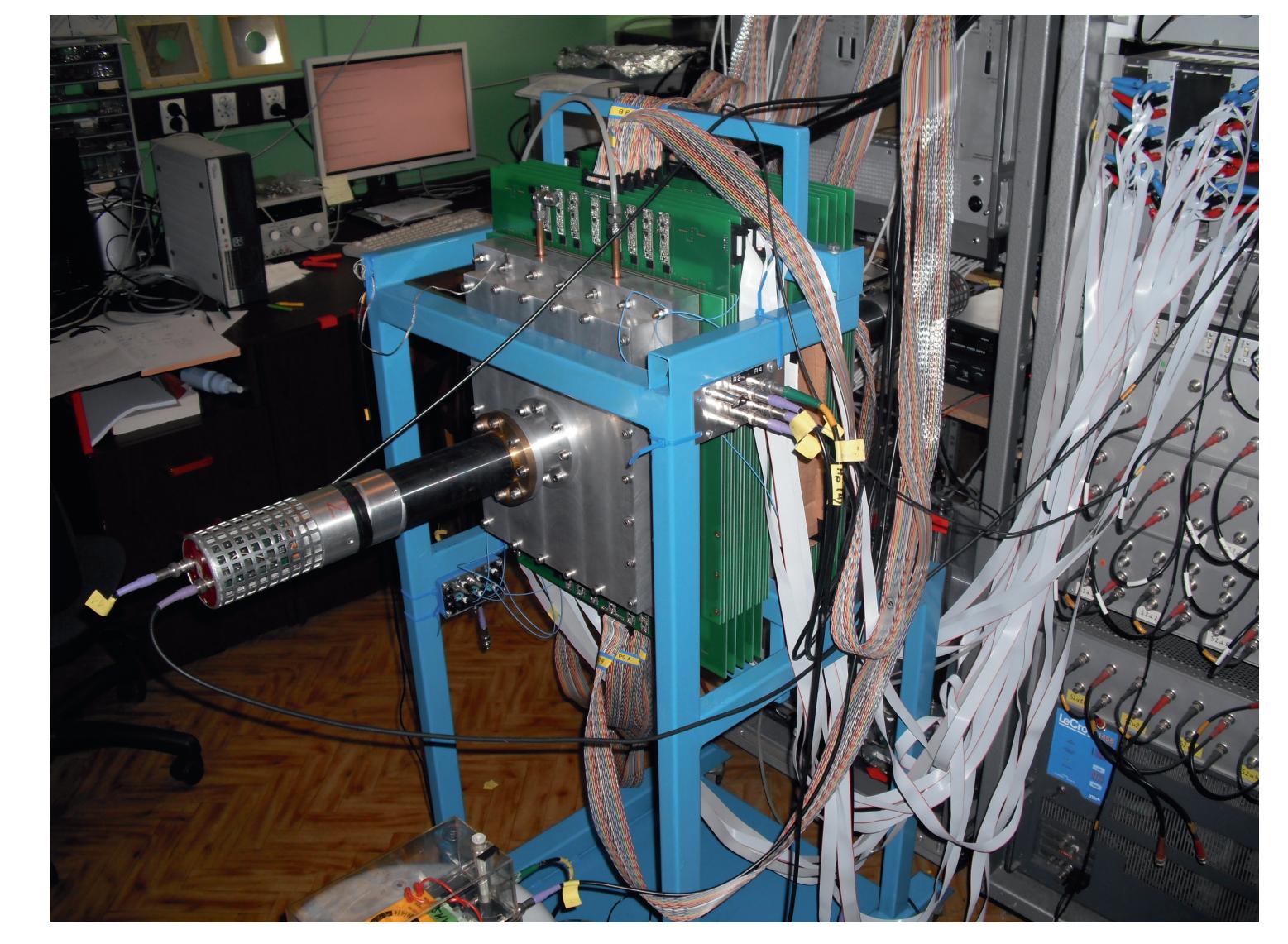


Commissioning ongoing



Modular construction

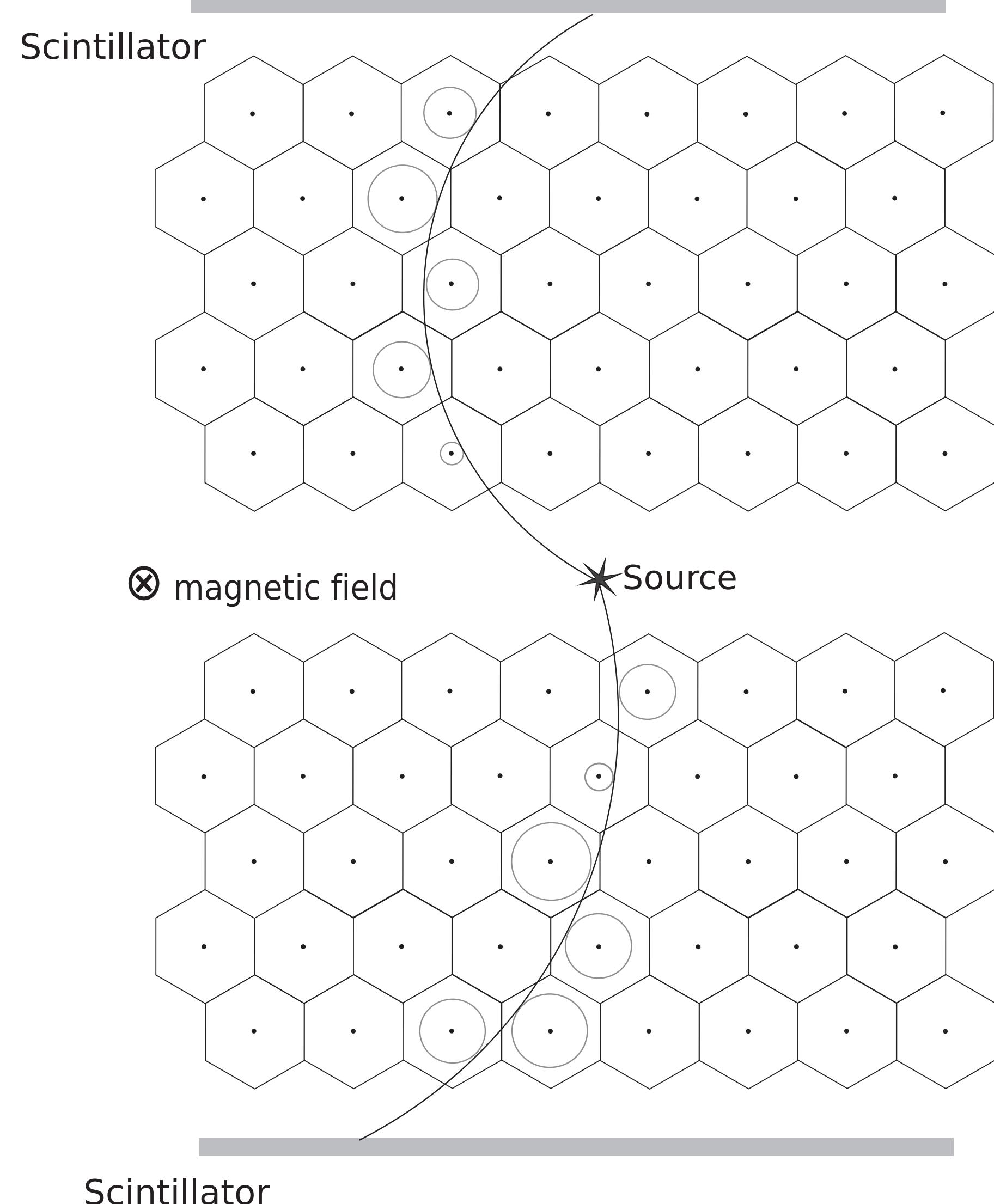
A - endcap section - detector
 B - wire planes
 C - central section - radioactive source



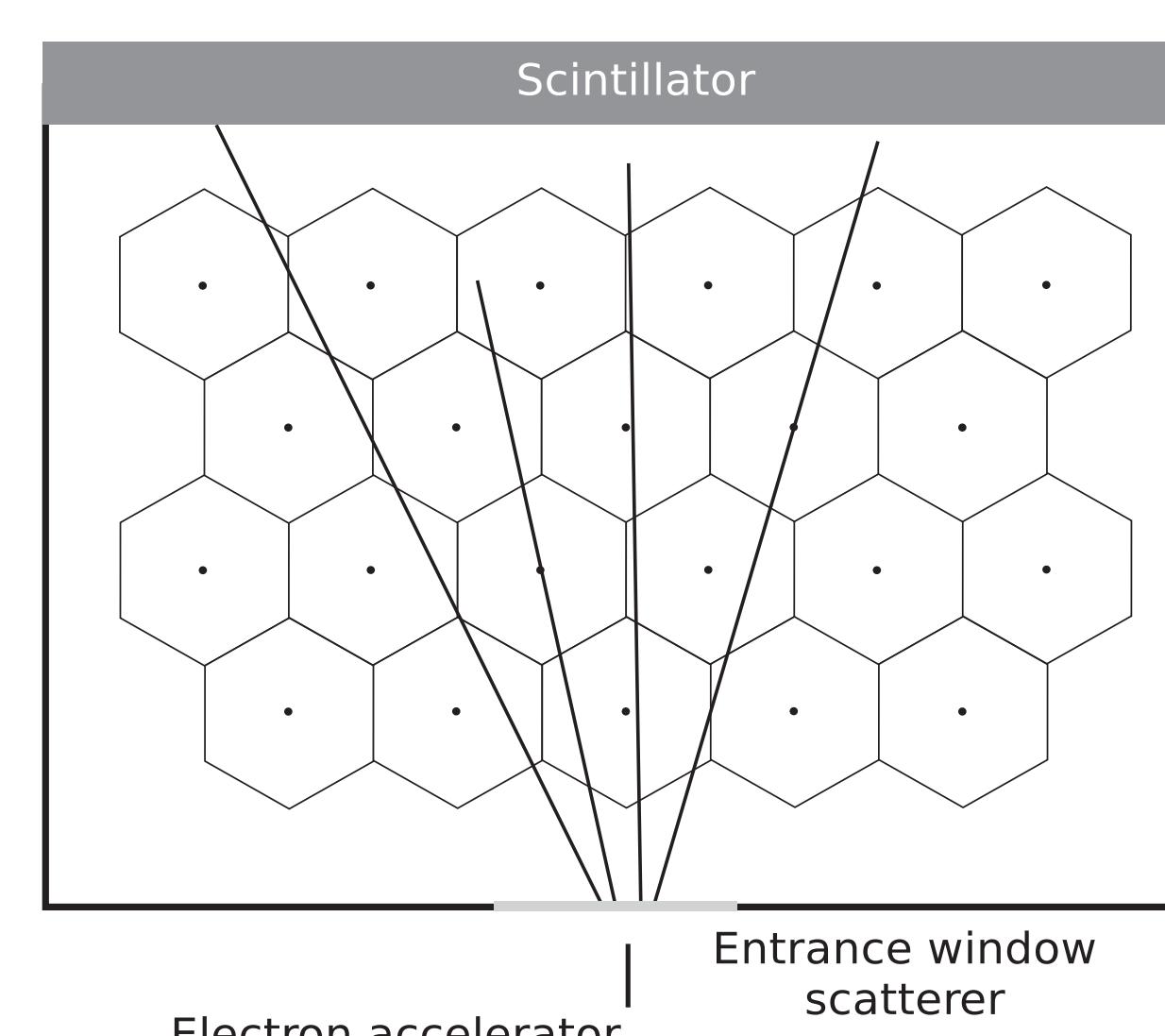
Setup currently at the Institute of Physics, Jagiellonian University, Cracow, Poland
 K. Lojek, NIM A 611 (2009) 284

Modes of operation

Spectrum shape measurements



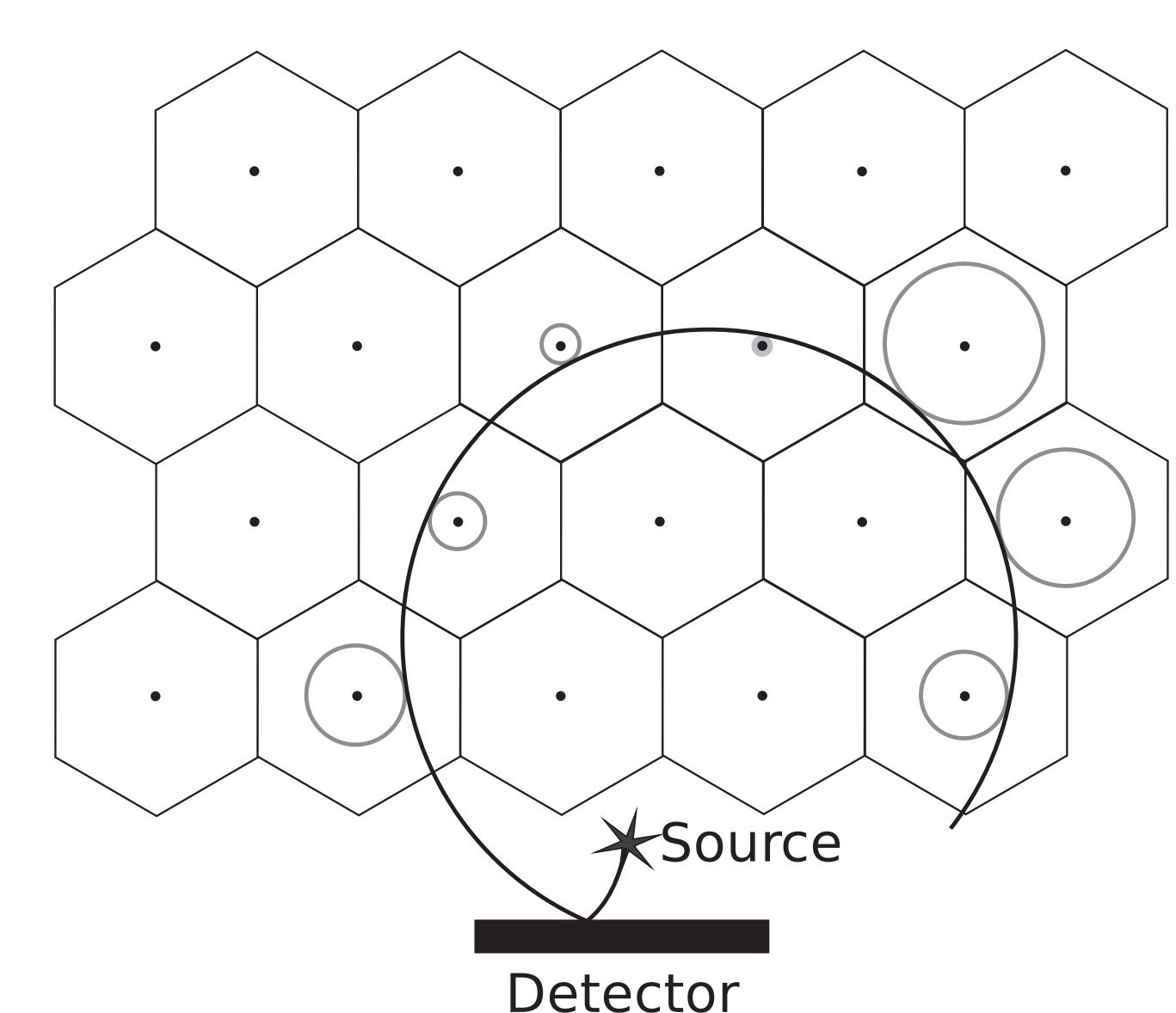
- electron energy from the track curvature
- scintillator provides STOP signal
- depending on endpoint energy, extract Fierz term or weak magnetism from spectrum shape



- measure the angular distribution of electrons after transmission through thin foils
- provide high precision data for the Geant4 collaboration to tune the electron multiple scattering models
- conversion electrons or electron accelerator

Electron scattering studies

using only one half of the miniBETA spectrometer



- initial electron energy from detector + track curvature
- conversion electrons for high precision measurement of the backscattering probability