In-beam spectroscopy at HIE-ISOLDE
- detector for conversion electron -

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&
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Outline

Physics motivation

- Obtaining nuclear structure information by studying excited states
- In-beam γ-ray or electron spectroscopy provides only partial picture
  =>
  simultaneous observation needed to fully understand de-excitation processes
- E0 transitions, M1 and E2 transitions in heavy nuclei

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E0 transitions

- Nuclear radius, changes in r_{rms}
- Wave functions of especially 0^+ states, deformation
- Compressibility of nuclear matter

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At HIE-ISOLDE

- Improved beam intensity
  => access to smaller cross-sections
- Higher beam energy
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- The HIE-ISOLDE spectrometer
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Endorsed HIE-ISOLDE Letter of Intents

- INTC-I-091; Measurements of octupole collectivity in odd-mass Rn, Fr and Ra isotopes (INTC-P-244)
- INTC-I-096; Shape studies in the neutron rich N$\sim$60 region
- INTC-I-101; Exploration of K-isomerism using unique high-K isomeric beams
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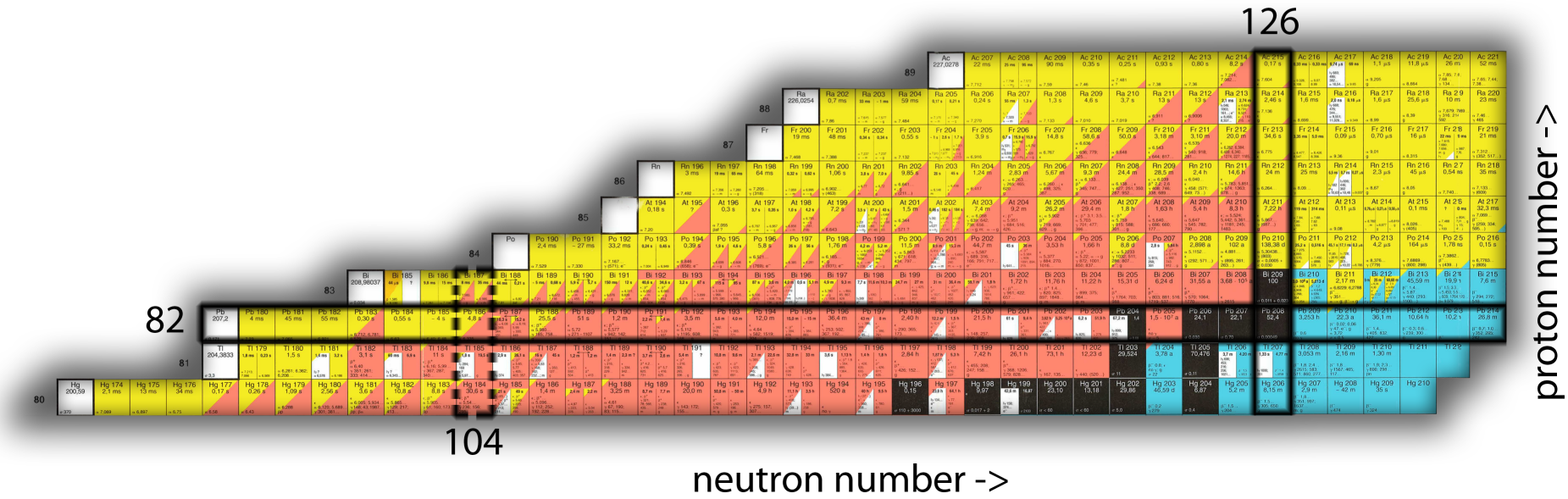
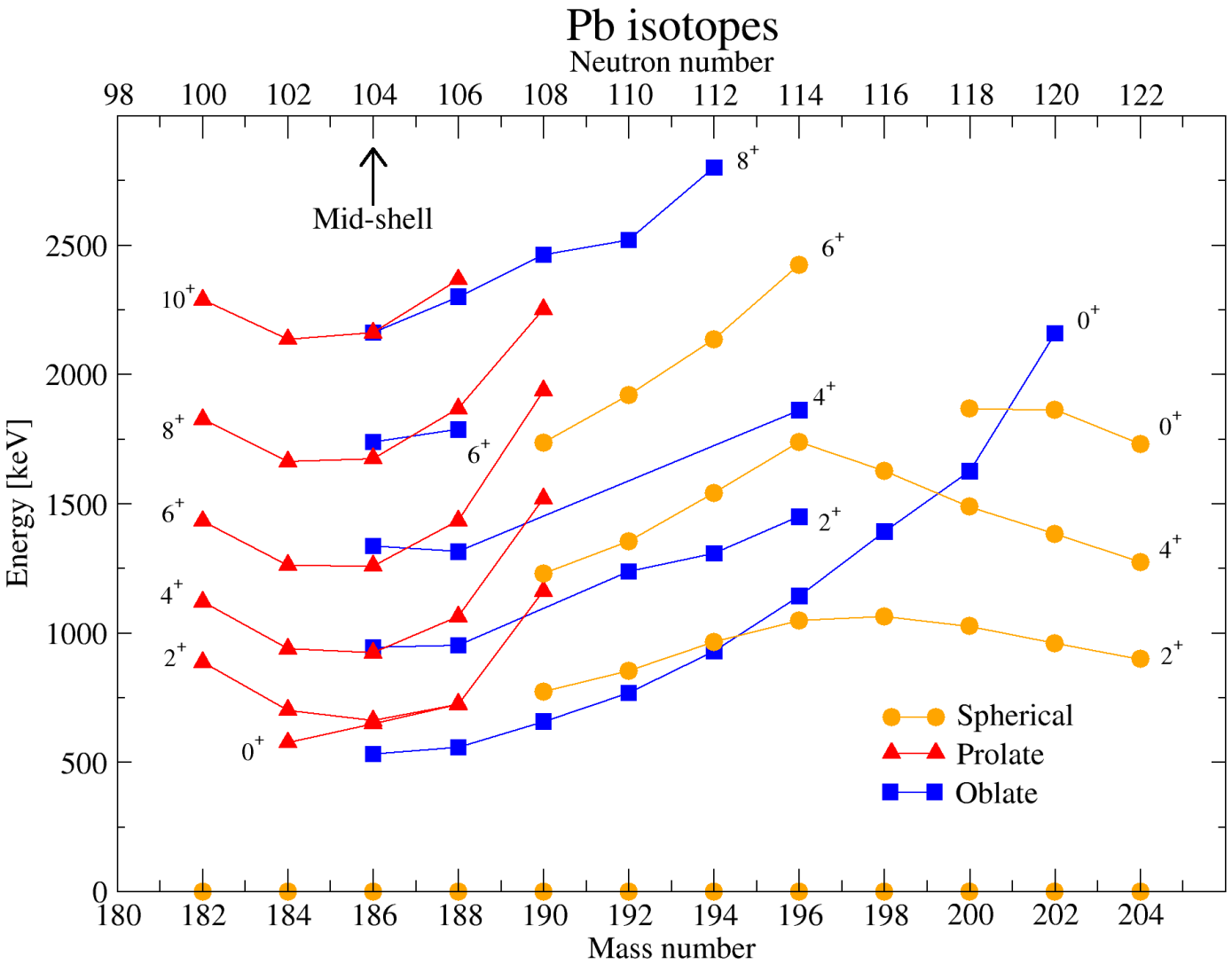
Chart of nuclides in the vicinity of light Pb nuclei

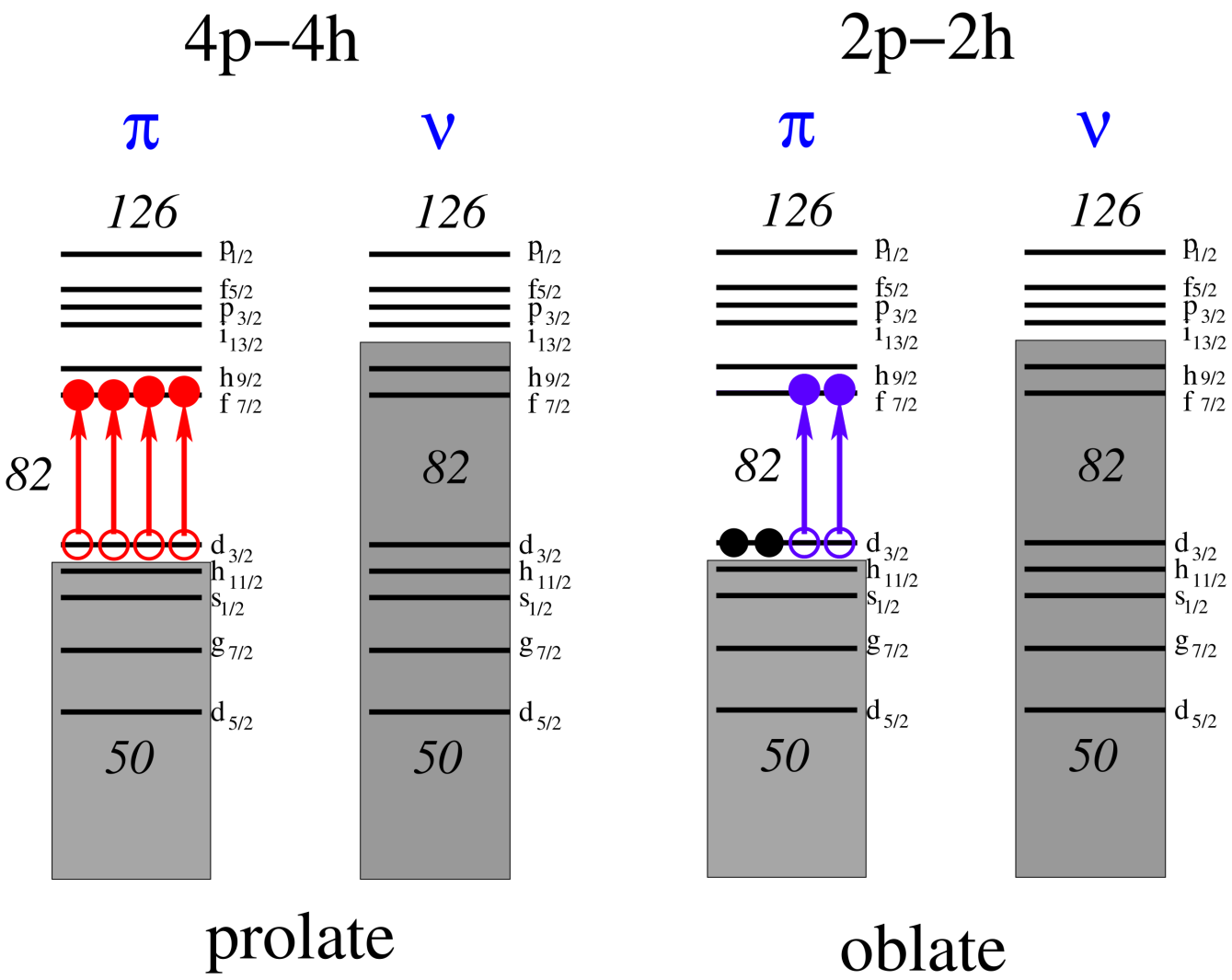
- Unique laboratory to study shape-coexistence phenomena



Level energy systematics for Pb isotopes

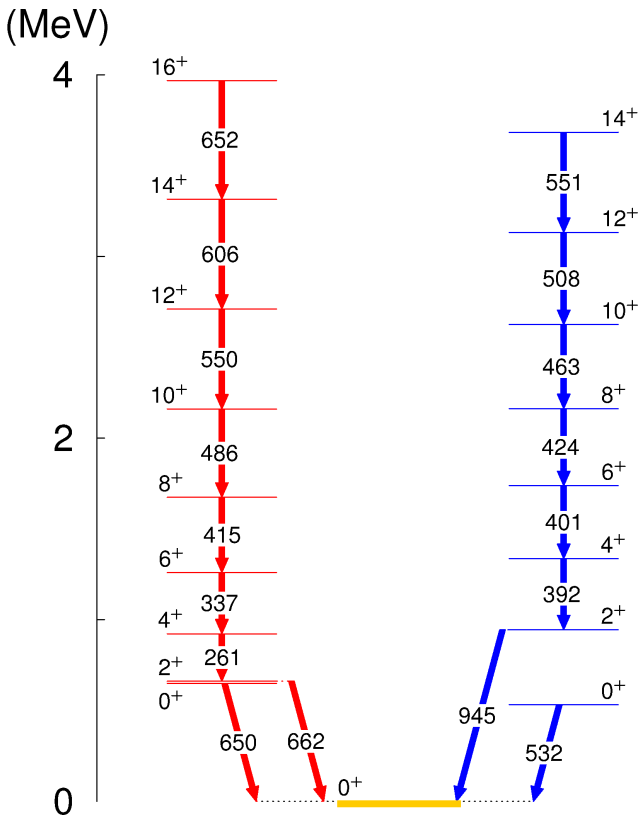


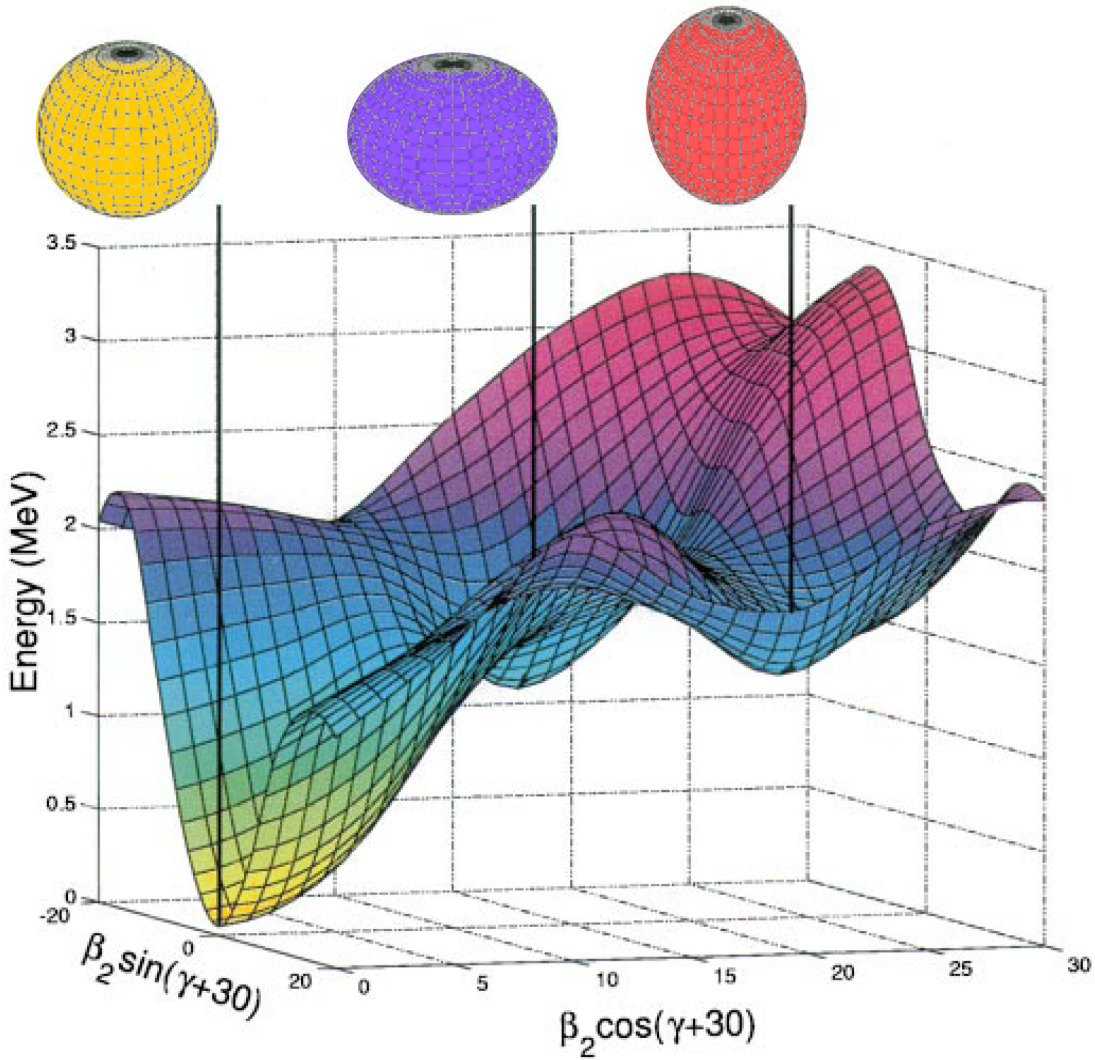
Shape coexistence in neutron-deficient Pb isotopes



Courtesy of P. Greenlees, see e.g. J.L. Wood *et al.*, Phys. Rep. **215**, 101 (1992).

Triple-shape coexistence in ^{186}Pb





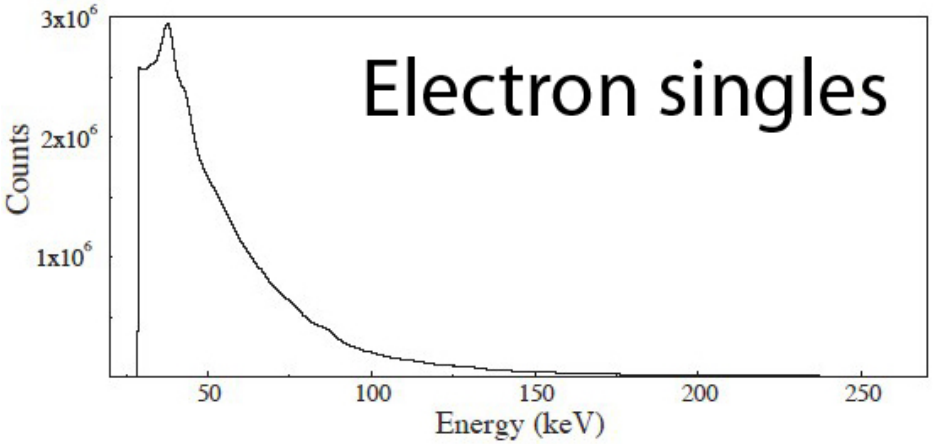
A.N. Andreyev *et al.*, Nature **405**, 430 (2000).

J. Pakarinen *et al.*, Phys. Rev. C **75**, 014302 (2007).

Outline

Different methods

- Difficult background conditions; β^+, β^-, Δe^-, secondary e^-
- Transporting electrons away from the target area; mini-orange, sacred, sage, spice...
- Coincidence gates to purify e^- spectra



H. Kankaanpää *et al.* NIM A **534**, 503 (2004)

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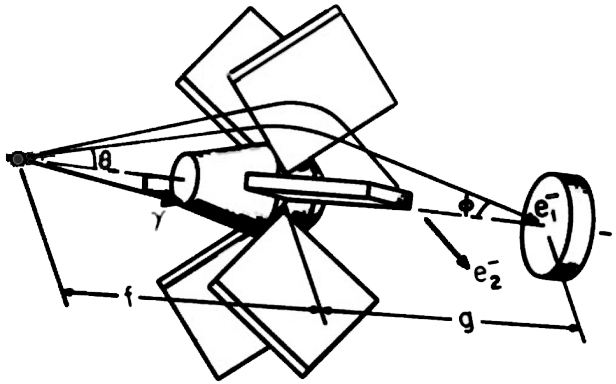

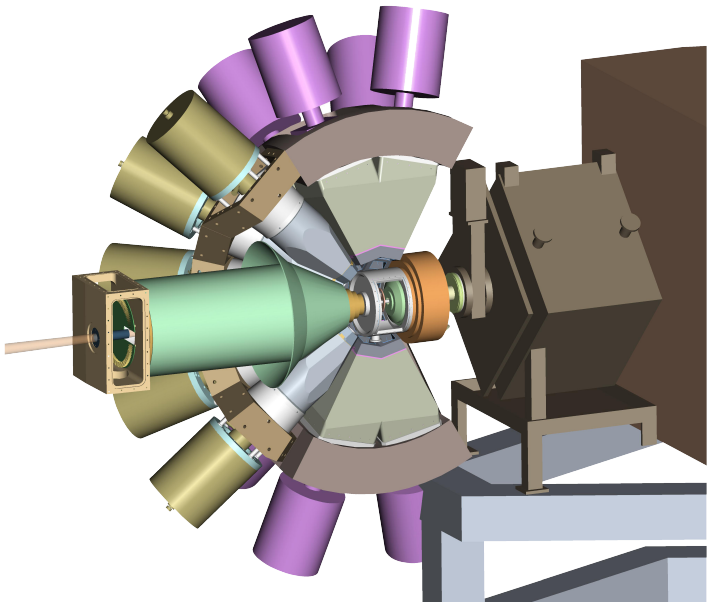

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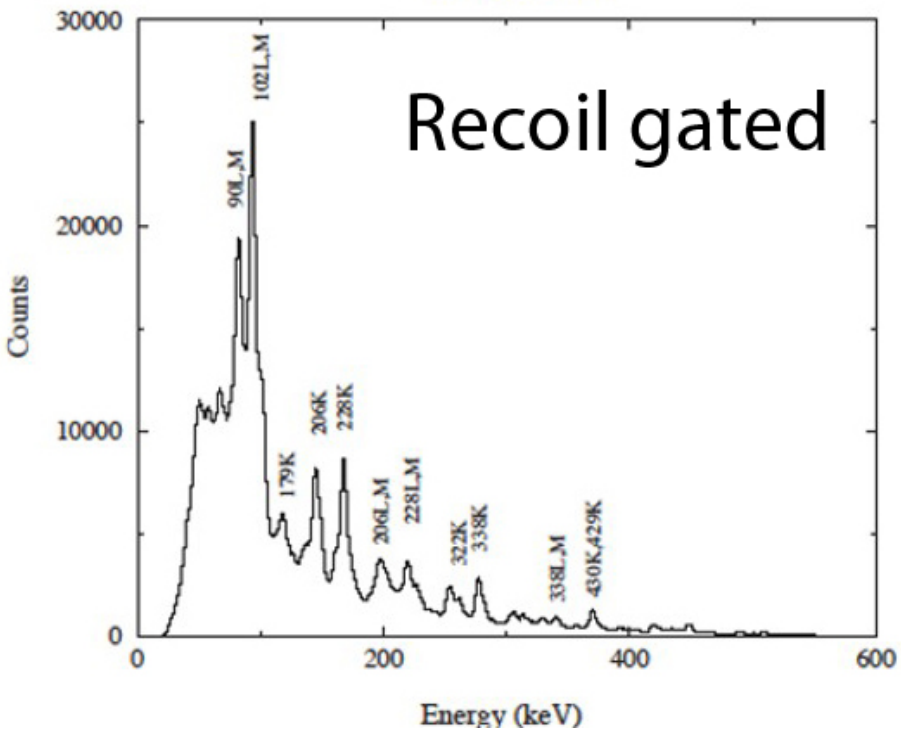
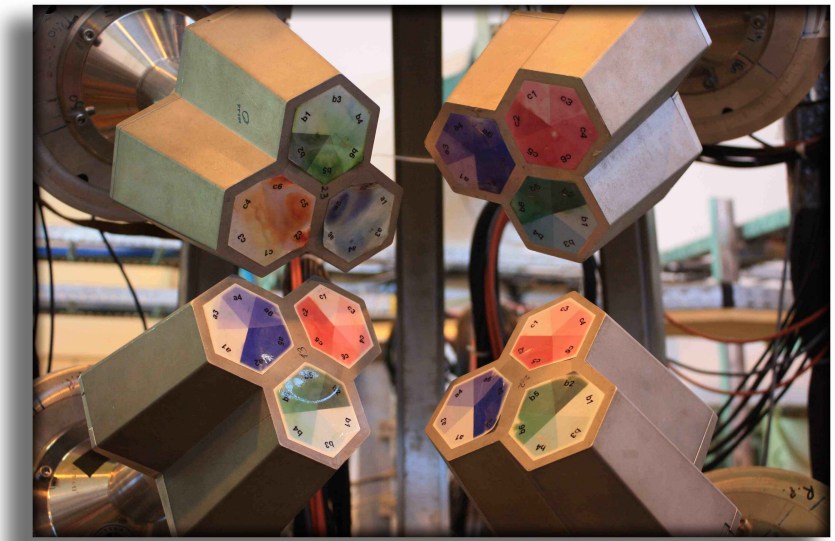


^{172}Yb*, H. Kankaanpää *et al.* NIM A **534**, 503 (2004)

Design criteria

- Versatile set-up in conjunction with MINIBALL (CoulEx and transfer reactions)
- Broad conversion electron energy range
- Enable high beam intensities
- Good energy resolution
- Easy to operate
- Main concern: Δe^--background



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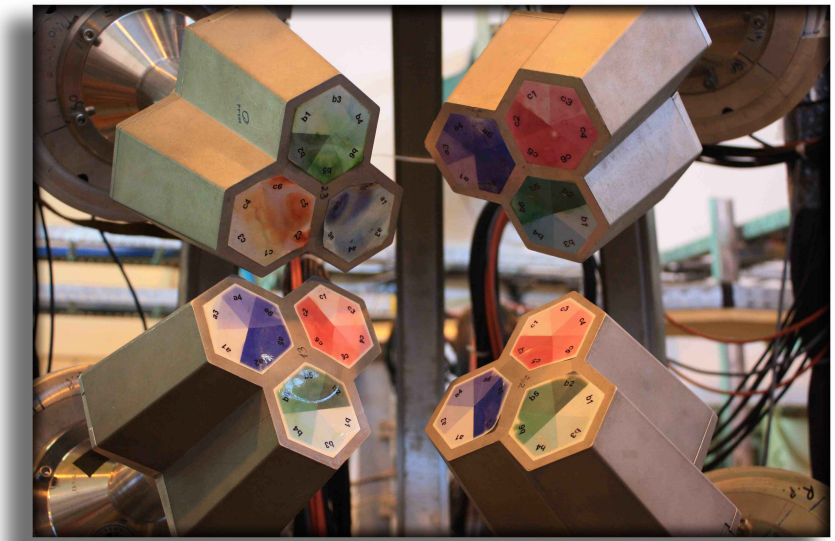

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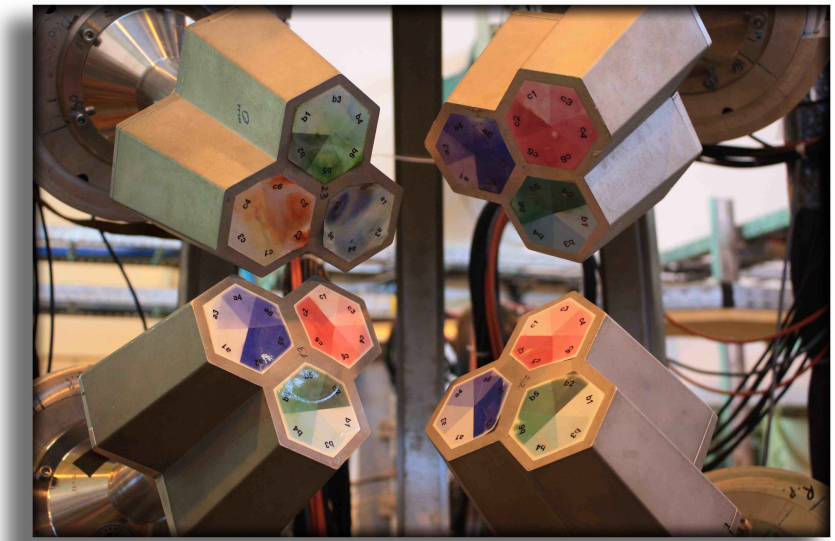

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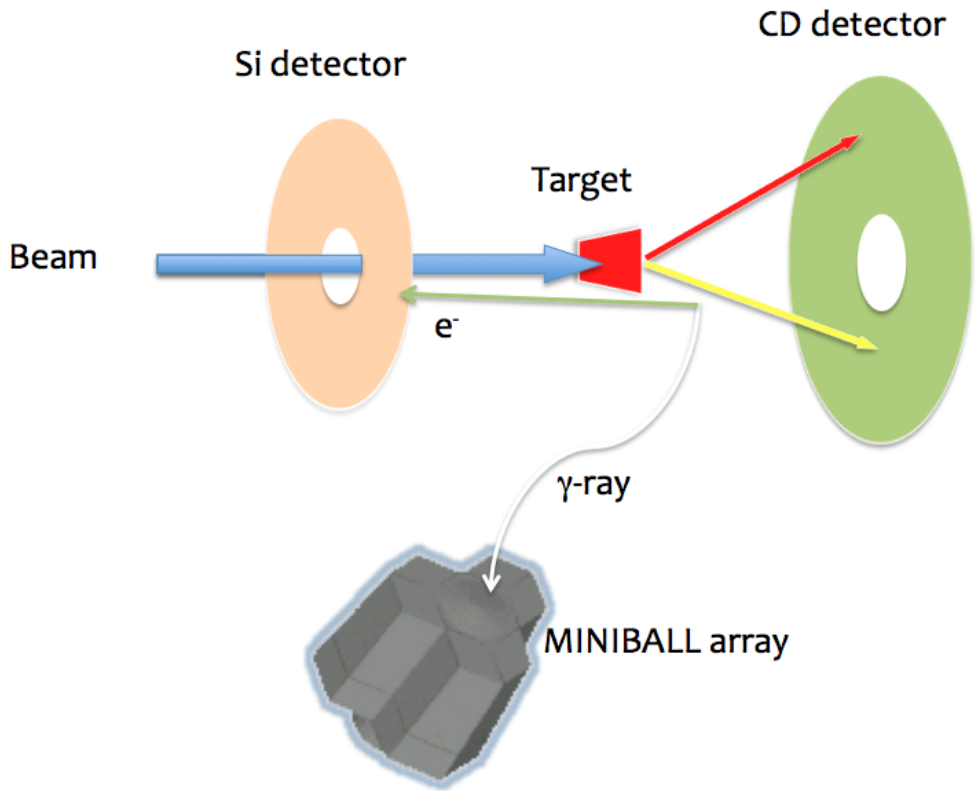
- Conversion electron detector in backward direction
- CD-detector in forward direction
- Coupled to the MINIBALL array



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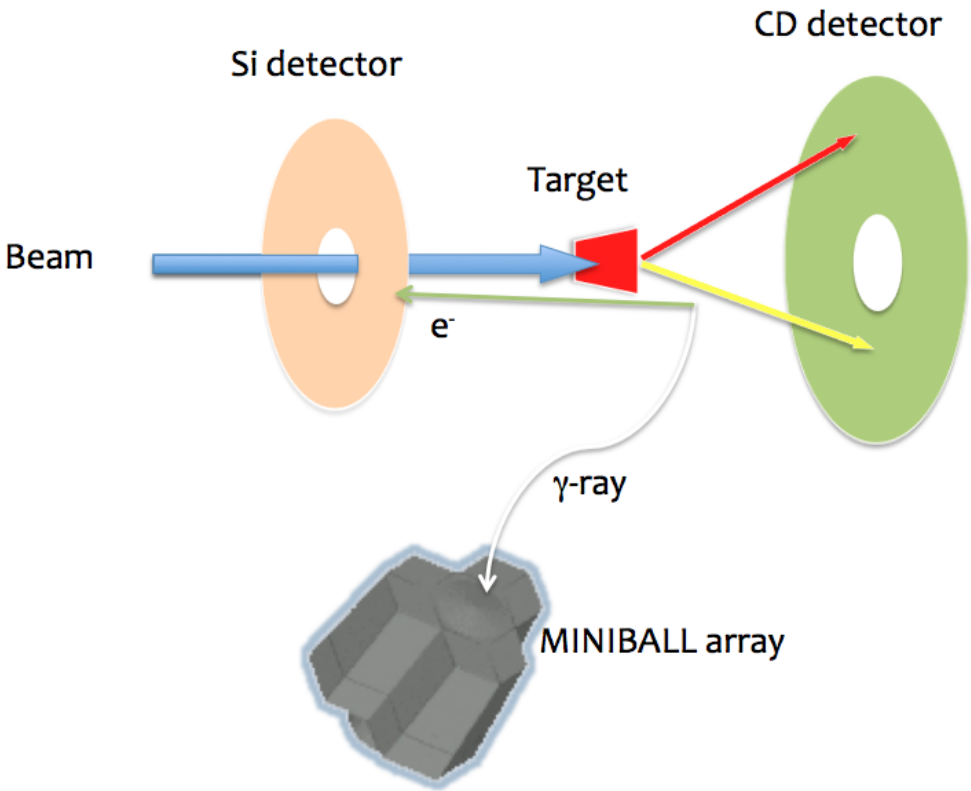

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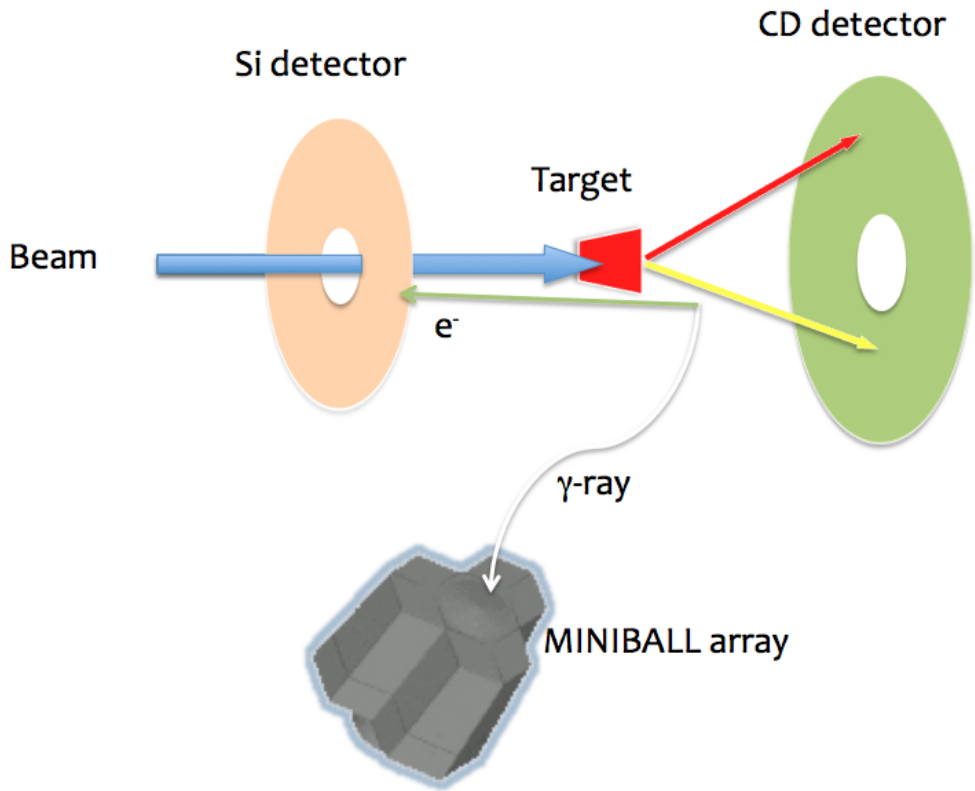

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Δe^- background substraction

- RIB yields typically 10^6 pps
  (typical stable beams 10^{10} pps)
- Double differential electron emission cross sections in the collision system 5.88 MeV/u U^{28+} on C_3F_8
  Bechthold *et al.* PRL **79**, 2034 (1997)
- Applying target in HV
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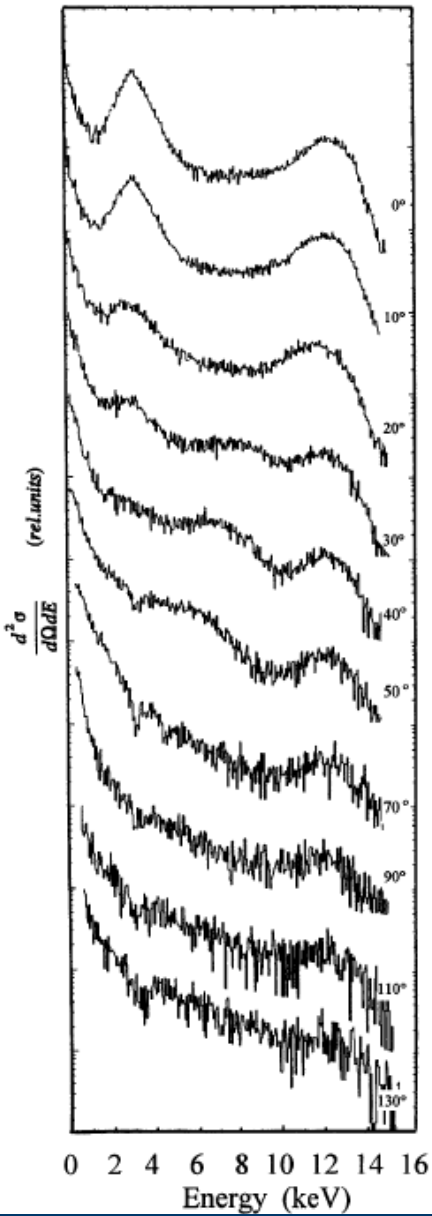

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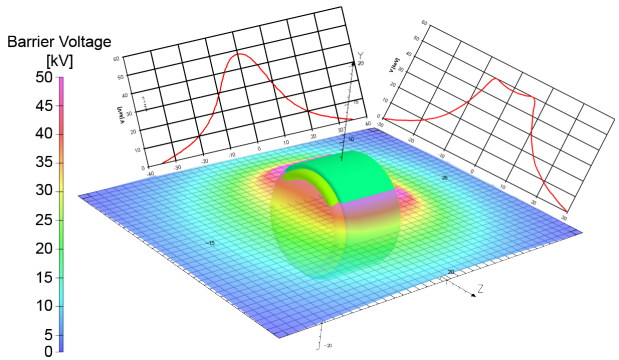

P. Papadakis, Phd. thesis

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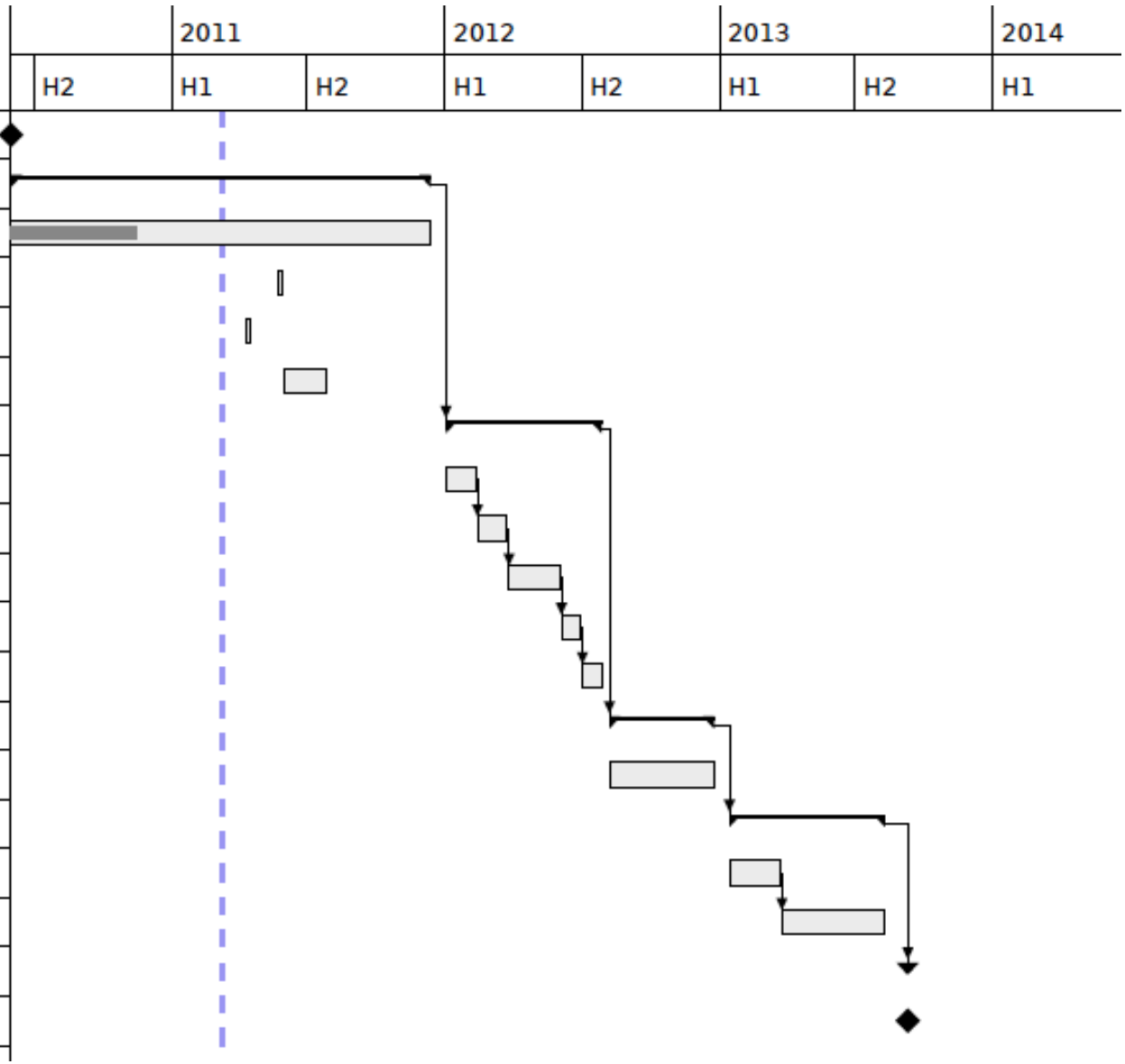
Outline

Timeline

Name	Work
Letter of Intent	
Conceptual design	**450d**
G4 simulations	400d
In-beam test	5d
Preamp tests	5d
Detector configuration	40d
Mechanical design	**150d**
Vacuum chamber	30d
Support structure	30d
PCB design	50d
Detector cooling	20d
HV 'barrier' at target	20d
Construction	**100d**
Mechanical assembly	100d
DAQ and electronics	**150d**
MINIBALL DAQ	50d
Software	100d
Commissioning	
In-beam	



Open questions

- Δe^- background subtraction (HV-barrier, foils)
- Detector segmentation (count rates, Doppler correction)
- General infrastructure (target chamber, detector cooling, support structure, HV...)
- Electronics (number of channels, low-noise high-gain preamps)
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