Investigation of the systematic uncertainties of the *a*SPECT experiment

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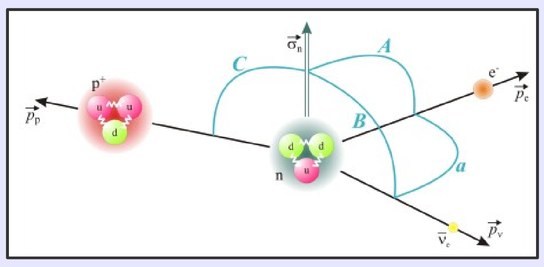
The *a*SPECT experiment:

Goal: Determination of the β-ν angular correlation coefficient *a* in free neutron decay with unprecedented precision

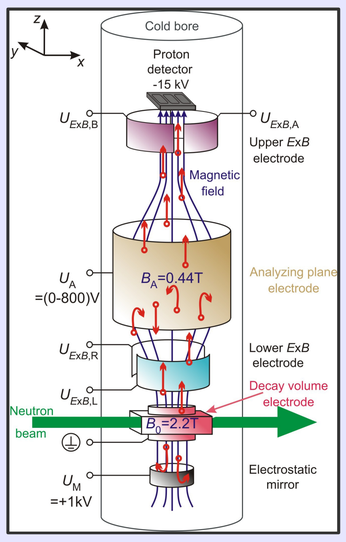
How to reach it: Measurement of the proton spectrum with high precision using a MAC-E type spectrometer

Where we are: Completed in August 2013 a beamtime of 100 days at PF1b at the Institut Laue-Langevin with more than 40 days of data taking

How to continue: 1. Check of integrity and consistency of data
2. Investigation of systematic effects
3. Determination of overall uncertainty



Top: Sketch of various correlation coefficients in free neutron decay
Right: Sketch of the measuring principle of *a*SPECT



Systematic effects:

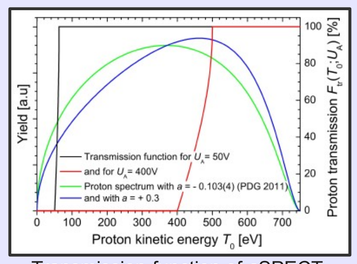
Uncertainty of transmission-function:
- Uncertainty of retardation voltage
  - Patch effect due to surface potential differences and field leakage into decay volume
  - Error of multimeter
  - RF noise
- Uncertainty of magnetic field ratio
  - Absolute value
  - Stability
  - Homogeneity

Retardation voltage and time dependent background
- Traps with different time constants of the filling for protons or electrons in the set-up
- Low energetic electrons
- Environmental background, e.g. from other experiments

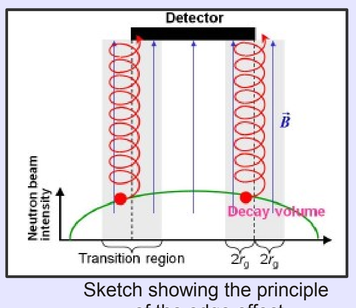
Edge effect
- Uncertainty in beam profile
- Uncertainty of detector position/tilting
- Drift of protons in ExBs and other electrodes

Detector efficiency and DAQ
- Dead time
- Dead layer
- TOF dependent amplification of signal

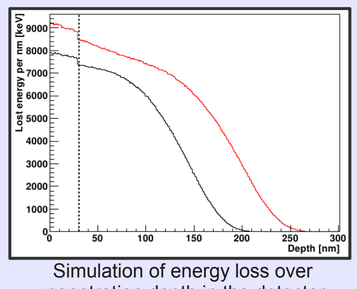
Adiabaticity
- RF noise on electrodes



Transmission-function of *a*SPECT



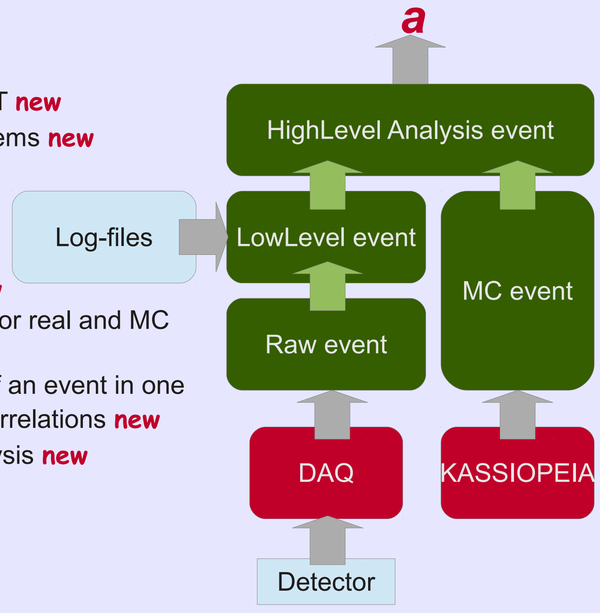
Sketch showing the principle of the edge effect



Simulation of energy loss over penetration depth in the detector

THEIa:

- Event based data structure build on ROOT **new**
- Integration of data from different sub-systems **new**
  - pressure log files
  - magnet read outs
  - voltage read outs
  - etc.
- Easily adapted to different/new DAQs **new**
- One data structure and analysis routines for real and MC data **new**
- Combines all 'environmental' conditions of an event in one place => extremely useful to search for correlations **new**
- One software package for the whole analysis **new**
  - pulse shape analysis
  - statistic investigations
  - error calculations
  - fits
  - etc.



KASSIOPEIA:

3D particle tracking simulation framework from the KATRIN experiment.

Will be used to investigate several systematic effects:
- Edge effect
- Drift of protons due to various ExBs and other electrodes
- Different start and retardation potentials due to patches and field leakage into decay volume **new**
- Reflection of protons, due to patches and field leakage into decay volume **new**
- Small traps for ionised residual gas producing background **new**
- Non-adiabatic motions due to RF noise **new**

How to investigate these effects:
- Detailed field map for the electric and magnetic field including the measured surface-contact-potential fluctuations! **new**
- Implementation of 'time' to investigate RF noise, etc. **new**
- Detailed implementation of detector, e.g reduced sensitivity at the edges **new**

Investigation of systematic uncertainties via measurements at different settings

Investigation of the background:
- Investigation of background (ionised residual gas, low energetic electrons, X-rays) for absolute values and retardation voltage dependence
- Measurements without neutron beam, with retardation voltages above the end point, with different time constants of the trap filling
- Details see poster of R. Maisonobe

New FlashADC DAQ system:
- FlashADC (14 bit, 10 ns resolution) **new**
- Direct measurement of the pre-amplified signal pulse, no hardware shaping **new**
- Possible investigation of pulse shapes **new** => identification of background, identification of position of proton impact
- Details see poster of R. Virot

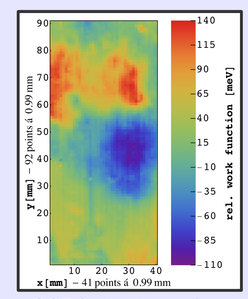
Investigation of edge effect:
- Detailed scans with various ExB settings to determine the energy and angle dependent shift of protons

and more ...

Support measurements

Investigation of patch effect:
- Measurement of the fluctuations of surface-contact-potential with a Kelvin Probe at air
- Measurement of the surface-contact-potential differences between different samples/materials
- Investigation of freeze out with UHV Kelvin probe (ordered) **new**
- Details see poster of C. Schmidt

Determination of the magnetic field:
- Measurement of the field shape with high precision hall probe
- Determination of the magnetic field ratio with high precision hall probe
- Measurement of the stability with nuclear-magnetic-resonance system, as well as high precision hall probes



SCP fluctuations of an *a*SPECT electrode

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