HiRA deadlayer determination at the NSCL

Research Experience for Undergraduates (2006)

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Outline

• HiRA
• Detectors (why characterization necessary)
• Experimental approach
• Problems/limitations
• Results
HiRA (High Resolution Array)
HiRA Telescopes

Si-ΔE 65 μm

32 strips v. (front)

Si-E 1.5 mm

32 strips h. (back)

32 strips v. (front)

pixel
Dead layer

- Important for accurate calibration and data analysis
$^{232}$U decay

- $^{232}$U decays to $^{228}$Th via an alpha particle with 5263.5 keV and 5320.3 keV.
- $^{228}$Th decays to $^{224}$Ra via an alpha particle with 5423.15 keV and 5340.36 keV.
- $^{224}$Ra decays to $^{220}$Rn via an alpha particle with 5685.37 keV.
- $^{220}$Rn decays to $^{216}$Po via an alpha particle with 5685.37 keV.
- $^{216}$Po decays to $^{212}$Pb via an alpha particle with 6778.3 keV.
- $^{212}$Pb decays to $^{208}$Tl via an alpha particle with 6050.8 keV.
- $^{208}$Tl decays to $^{212}$Po via a beta particle with 6778.3 keV.
- $^{212}$Po decays to $^{212}$Bi via a beta particle with 8784.86 keV.
- $^{212}$Bi decays to $^{208}$Pb via a beta particle with 8784.86 keV and 6050.8 keV.
$^{232}$U source fitting

- Pixels made by gating EF strips via EB strips
Experimental Setup (vertical view)

HiRA telescope (Not to Scale)

Dead Layer

Source Pos 1

Source Pos 2

α

θ

α

φ
Experimental Setup

- **Source Pos 1**
- **Source Pos 2**

- active region of detector
- dead-layer

\[ t = \frac{t}{\cos(\Phi)} \]
Calculation

• Alphas from different runs travel through different effective thicknesses of dead layer
• This can be detected by a shift in peak position caused by this extra energy loss
• By knowing the angles the alphas come in at, the dead layer can be calculated

\[ DL = \frac{-\text{slope} \cdot \Delta ch}{dE \left( \frac{1}{\cos \theta} - \frac{1}{\cos \phi} \right)} \]
Limitations

Angle Dependence (large uncertainty with close angles)

Peak 1 (FWHM) Telescope 5

\[ DL = \frac{-slope \times \Delta ch}{dE \left( \frac{1}{\cos \theta} - \frac{1}{\cos \phi} \right)} \]

angle: 0 deg.
angle: 45 deg.
Large Chamber

- Changed angle of detector from 0 to 45
- Relatively large distance separating source and detector
Telescope 1 trails

- Small Chamber Used
- Source at .1 and 8.7 cm
- Detector between 1.7 and 8.1 cm
- Large variance of angle over detector (source close to detector)

Average compilation
High uncertainty region due to nearly equal angles

Dead Layer = (.93 ± .08) μm
Future Plans

• Investigate and reduce uncertainties
• Use hira in conjunction with $4\pi$ in Nov. 2006
Acknowledgements

• Prof. Betty Tsang
• Vladimir Henzl
• HiRA lab group
• NSF
• NSCL