ANASEN 2.0 & DAQ


1Louisiana State University  2Texas A&M University  3Florida State University  4IAEA

ANASEN Concept:
- Active gas target for $\alpha, p$ reactions
- Designed for “high” beam rates at FRIB
- Active Target Design 1.0
- Characterization

ANASEN 2.0
- Active Target Design Modifications
- Marriage of Caen 1730’s & “Conventional”
- DAQ Challenges/Needs
• Extended active gas target/detector
• He-CO$_2$ gas for ($\alpha$,p) reaction studies
• Cylindrical proportional counter surrounding beam axis
  — 7\textmu m diam carbon fiber $\rightarrow$ High Gain
• Over 1000 cm$^2$ of Si (28+ det, $\sim$500 chan) w/ CsI & ASIC electronics (Sobotka et al.)

PC: 19 individual sensitive volumes
ANASEN Concept

Array for Nuclear Astrophysics and Structure with Exotic Nuclei

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1. $\Delta E$ in PC $\rightarrow$ particle identification
2. Position Si + Position PC $\rightarrow$ $\theta_{\text{lab}}$
3. Energy Si +$\theta_{\text{lab}}$ $\rightarrow$ $E_{\text{cm}}$
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Entire excitation function simultaneously measured
ANASEN 1.0 in Practice

Array for Nuclear Astrophysics and Structure with Exotic Nuclei

2x12 Super-X3 (4x4 Resistive)

End View w/o PC

New QQQ (16x16)

CsI

Side View

PC wires

RIB window

07/20/2011

Blackmon et al. FRIB DAQ Workshop ANL July 29, 2015 Slide 7
$^{14}N + ^4He \rightarrow ^{17}O + p$ ANASEN Test

- Stable beam test of approach for ($\alpha$,p) reactions
- Stable $^{14}N$ beam from FSU tandem at 30 MeV ($E_{cm}$=6.7 MeV)
- He gas (1% CO$_2$) @ 350 Torr

- Clear proton identification
- Excellent $E_{cm}$ reconstruction over forward angles, but degrades at larger cm angles

- Energy resolution consistent with previous width measurements ($\delta E_{cm} < 100$ keV)
ANASEN 2.0

Goals: improved PC resolution (z, t, E) and dynamic range

- 19 → 24 anode wires in PC (48 channels)
- Better MCP-RF timing for Particle ID
- 2nd stage linear amplification – MDU-16
- Caen 1730 waveform digitizers (500 MHz)
  - Long sampling times
  - PC signals not like Si/Ge

![Diagram of avalanche and ion drift]

- Avalanche → \( E_{\text{dep}} \)
- Ion drift → timing

![Graph showing preamp output over time](image)
ANASEN 2.0

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One challenge is mismatch of preamp signal size to digitizer dynamic range

- 2\textsuperscript{nd} stage linear amplification:
  - Mesytec MDU-16

New low gain IC region for heavy ion detection
ANASEN 2.0

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Avalanche → timing

Ion drift → $E_{dep}$

Preamp + MDU-16 Output

Gains adjustable!

0.12x → 12x
Continue to use Wash U HINP ASICs for silicon
  • Lots (500+) channels available and it works!

Caen 1730 for PC:
  • Time-stamp events for event building with ASICs
  • Waveform analysis
    o Offline: Must keep rates low to swallow waveforms
      ➔ Not all PC signals are textbook
      ➔ New IC uses differential signals
    o Onboard: Customized firmware needed
  • Measurements of with $^{47}$K beam at NSCL in 2016?!

General thoughts:
  • New systems will continue to be developed
  • Old systems will not go away soon
  • Compatibility must be developed

Thanks:
  • Collaborators and Faculty/Staff at NSCL and FSU
  • The U.S. National Science Foundation and U.S. Department of Energy
    Office of Nuclear Physics
Waveform Analysis with Heavy-Ion Detector

Non Collecting

Collecting

Difference

Trapezoidal Filter

Derivative Filter

Second Derivative Filter