CARIBU Decay Station(s)

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CARIBU offers a unique opportunity to study beta decay of isobarically pure neutron rich $^{252}$Cf fission products

- Ge detectors – high-resolution gamma ray spectroscopy
- NaI - high-efficiency gamma-ray spectroscopy (M.L. Smith)
- LaBr – short life times, decent energy resolution
- Si/Plastic detectors – beta particles
- Neutron detectors - beta-delayed neutrons
- Moving tape collector – background reduction (P. Bertone)
- ...

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X-array: decay station for CARIBU and FMA

- 5 clover detectors in a box geometry
- four 60mm x 60mm (~200% each) and one 70mm x 70mm (~300%)
- Funded from Base equipment, ARRA-Funds, ~1$M total
Efficiency Simulations

X-Array MCNP Simulation

Energy (keV)

Efficiency

1 big, 4 small
5 small
5 big

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X-array features

- Each detector can be moved in and out independently
- The whole array can be moved in and out
- The whole array can be easily transported between different experimental areas
- All electronics except ADCs are on board
  - Wiener HV
  - Mesytec shaping amps
  - Mesytec CFDs
  - 8k ORTEC ADCs
  - 4k Phillips TDCs 800 ns range
  - 48-bit microsecond latching scaler
- Automatic LN$_2$ filling system
FMA Implantation-decay station
isomer, $p$-$\gamma$, $\alpha$-$\gamma$, $\beta\gamma$ studies

Ge clovers
160X160 DSSD
Large area Si
Si/PiN box
plastic $\beta$ dets

Small implantation area, good solid angle coverage
FMA implantation station

DSSD 160X160, 64X64mm²

X-array - 5 clovers in box geometry
Recoil-Decay Tagging

Recoils → Prompt $\gamma$ rays
Recoils → Implants

Spatial and time correlations in the DSSD

characteristic decays or chains of decays:
- Protons
- Alphas
- $\beta$-delayed particles
- Isomers
- $\beta$ decay and $\beta$ delayed $\gamma$ rays

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Recoil Beta-Gamma Tagging
GAMMASPHERE-FMA-X-array

Prompt $\gamma$ rays from the $^{40}\text{Ca}+^{24}\text{Mg}$ reaction

Tagging prompt $\gamma$ rays in GAMMASPHERE with “fast” proton-rich $\beta$ emitters, by correlating implants with betas in the DSSD and $\beta$-delayed $\gamma$ rays in X-array at the FMA focal plane.

$^{62}\text{Ga}$ 116 ms
$^{50}\text{Mn}$ 283 ms

Total projection
X-Array Status

- All detectors working
- Characterization (Efficiency, Resolution, “add-back”, stability etc) in progress
- Beta-veto plastic paddles (Seweryniak, Rogers)
- Thick beta detectors
- $\text{LaBr}_2$ fast-timing counters (Zhu, Kondev)

You can see it during the tour.
Plastic “paddles”
to identify beta particles entering a Ge detector

The set of 5 which fit inside the X-array and are mounted in front of each clover.
Tape Transport System
Brad DiGiovine, Peter Bertone

Based on LSU design, as used at ISAC, ORNL, Orsay etc, with modifications for high speed motion. (~5m/s)

THREE systems will eventually exist:

• CARIBU diagnostic tool
• ATLAS diagnostic tool
• Research:
  • Decay Beamline for TAGS and X-Array
  • FMA Focal Plane
  • Gammasphere
Tape Transport Status

First tape station laboratory tested and now deployed at CARIBU

TASKS

• Test long-running stability in-situ
• Determine ultimate maximum speed
• Install plastic and Si-detectors
• Install germanium counters (TWO)
• Install “Scarlet” data acquisition and collect $\beta-\gamma$ coincidences in-situ
• Investigate shielding
• Multi-scale spectra
• Full test of deflector / tape system
X-array + MTC configurations

- detectors at the deposition point
- Deposit-measure+accumulate-move +accumulate
- Tape movement can be faster
- Shorter life times
- box geometry to accommodate other detectors

- detectors away from the deposition point
- Deposit-move+accumulate-measure +accumulate
- Longer life times
- close geometry

Given that the sample preparation takes place in a buncher the detection around the deposition point might be sufficient
Top view

Side views

Ge detectors

Si/Plastic beta detectors

LaBr detectors
Important experimental considerations

- Fission fragment yields
- Isobaric purity
- Room background
- Transport time
- ...

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Your comments and suggestions would be greatly appreciated.

Thank you for your attention!