Auxiliary Charged Particle Detection

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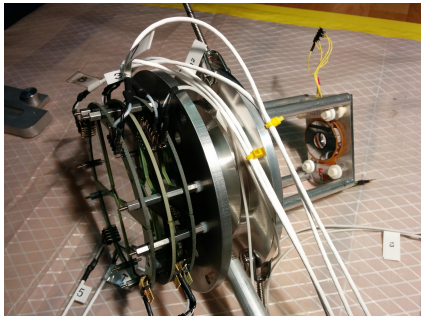
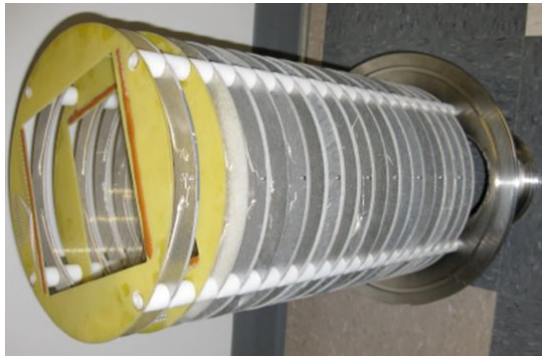
ReA Solenoid Spectrometer Workshop

Outline

What systems/schemes have been used in HELIOS

Challenges and Issues for studies at ReA



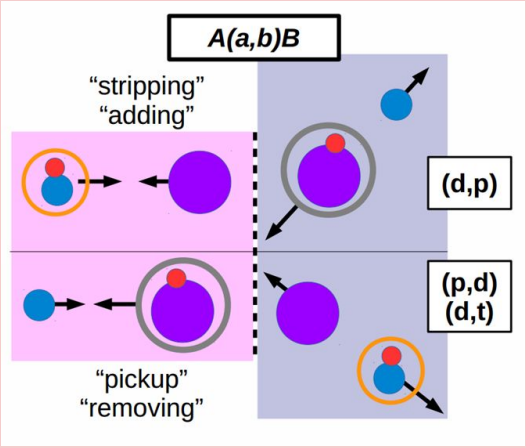


Auxiliary Detectors for HELIOS

Recoil Detection

To identify (A,Z) of beam-like reaction products

At minimum: A±1 nucleon



Monitor Detectors

Beam Monitors:

Normalization → Abs. cross section

Tuning, Beam Purity

(time-dependent)

Target Monitor:

Measure target stoichiometry.

Monitor light target content in high dose measurements with heavy beams (CH_2, CD_2 targets)

"Decay" Detectors

γ-rays:

APOLLO covered by

A. Couture & J. Winkelbauer

Not many cases for charged particles, but one worth mentioning...

All will be more important for ReA studies:

More intense RIBs

Heavier isotopes

Particle Decay Channels

Recoil Detection - Silicon Arrays

Primarily Planar Si Arrays In ΔE-E Telescope

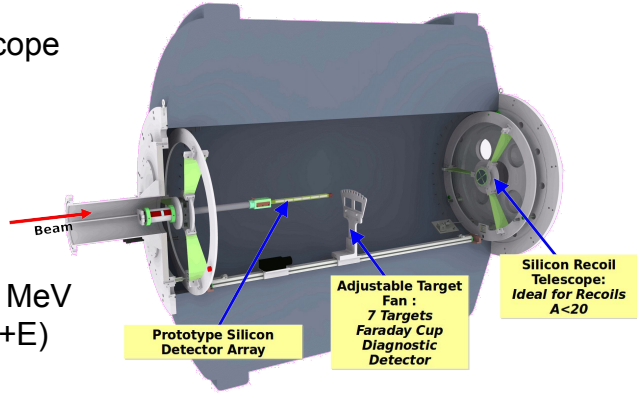
Element identification up to Z=12-13
Mass identification up to ~Z=7

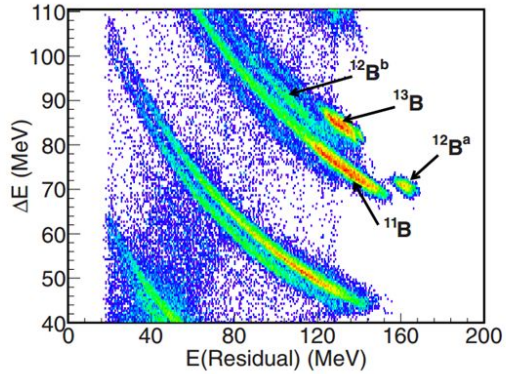
Example: ^{24,25}Mg at 10 MeV/u
Energy Deposited in 40μm Detector ≈ 46 MeV
Require good total energy resolution (ΔE+E)

Thickest stack: ~1500 μm
Max proton energy ~ 15.5 MeV
Max alpha energy ~ 63 MeV

Max. Rates: 10's of kHZ

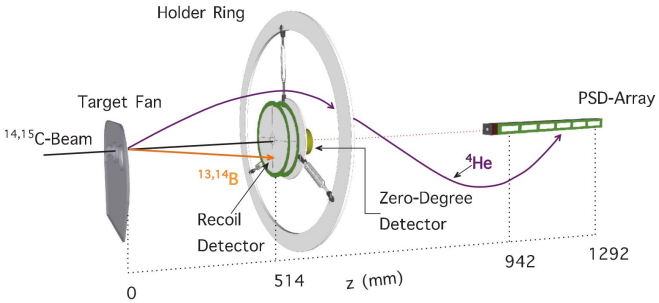
The standard recoil solution for studies with light ion beams





S. Bedoor, et al., PRC 90, 061301(R)

In HELIOS:
Si Recoil Arrays implemented covering forward lab angles for reaction studies in both "backward" ((*d*,*p*), (^{6}Li,*d*)) and "forward" ((*d*,^{3}He), (*d*,α), …) hemisphere configurations



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Recoil Detectors - Ionization Chamber

Modular, high-rate, Ionization chamber at HELIOS
Developed by LSU (Deibel, Lai, Santiago-Gonzalez)

Kapton entrance windows
- Different diameters and thicknesses

IC Gas: CF_4 or isobutane (50-300 torr)

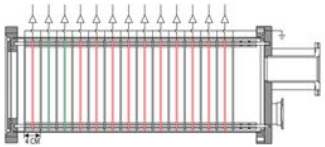
Energy Resolution: >5% (increases with higher rate)

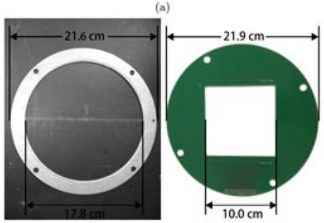
Rate: up to 500kHz
- Need to use beam blocker at zero degrees

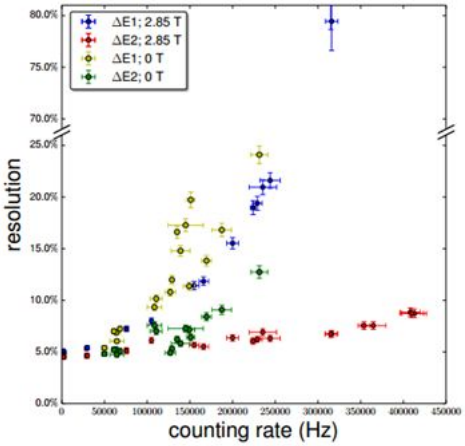
Position-Sensitivity: 3 x 3 mm wire spacing
- Provides angular information, pileup rejection

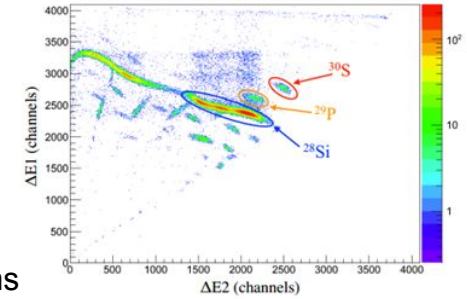
Has been used up to evaluate (pre-EBIS era) CARIBU beams . Isobars can be an issue…

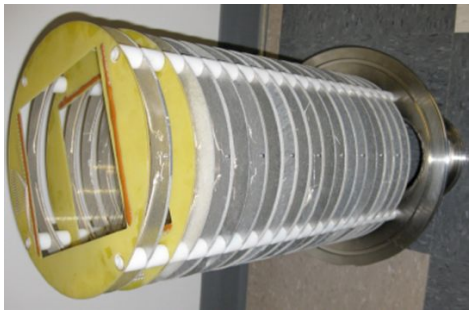
Effective solution for "lighter" intermediate mass beams (up to Z ~ 50)











J. Lai, NIMA, in preparation

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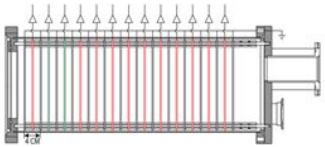
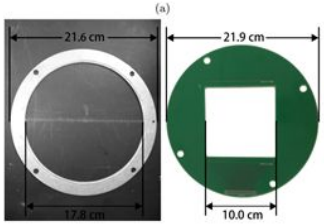
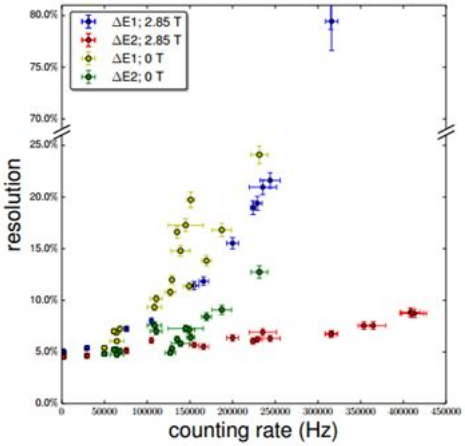
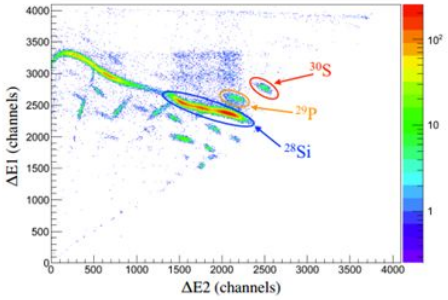
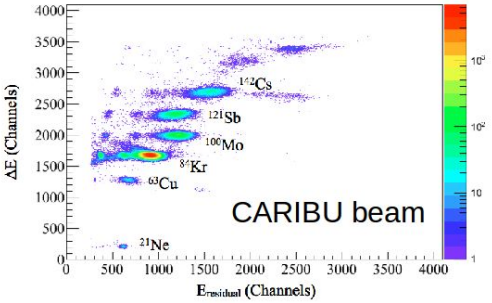






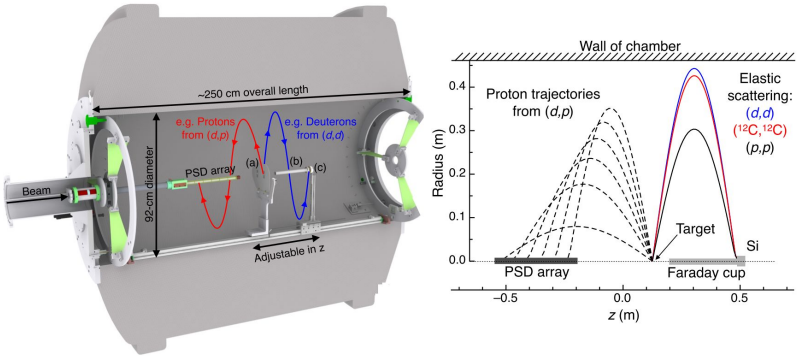




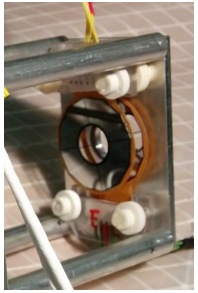
J. Lai, NIMA, in preparation

Monitor & Charged-Particle Detectors

Target Monitoring: Si detectors



B. P. Kay JoP: Conf. 312, 092034 (2011)



Beam Monitoring

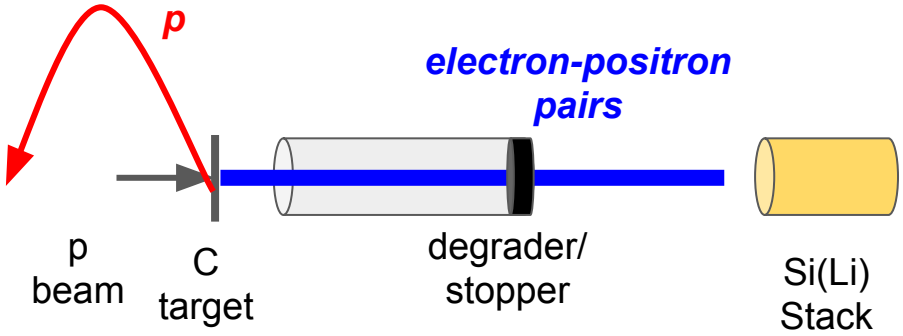
Attenuated SSB Detectors @ 0°

Successes with using small annular Si arrays at very forward & backward lab angles

The Study of $^{12}C(p,p')^{12}C(0^+_2)$

Measure the pair decay branch for the Hoyle State

Measure (Γ_{π}/Γ) to 5% or better... = 6.7×10^{-6}



Measurement to be continued...
[J. Smith, A.H. Wuosmaa, U.Conn]

(Very General) ReA SS Recoil Detector Parameters

	A≤50	***A>50***
$10^{3\text{-}8}$ *pps*	The current intensity & stopping power regime Established recoil detector technologies can be used	Inverse Kinematics Consequences: Recoils emitted very small angles! ***Require ability to distinguish beam and recoils at nearly zero degrees!***
$>10^{8}$ *pps*	High rates threaten recoil detector performance and health ***Require reliable beam rejection...***	**"Worst Case Scenario"** Heavy, Intense beams at 5-15 MeV/u (huge stopping powers) ***Rate and Z-resolution limited***

ReA Beams: Assuming pure beams with good emittance, and $t_{1/2} \gtrsim$ 100ms

Intensities: Many measurements achievable at $>10^3$ pps (i.e., transfer).

Reaction studies with new solenoid spectrometer many require higher beam intensities:

Measurement of small cross sections (<μb)

Compensate for low-efficiency auxiliary detectors

Solutions?

Short-term:use the established recoil detector designs to perform studies in the lighter mass, <10^8 pps beams

Silicon Arrays
- **Raid the Micron Catalog...**
- **Highly segmented Si array w/ CsI(Tl) layer (HiRa-like) to identify charged particles from unbound states…**

Ionization Chamber(s)
- **Development of new designs, featuring diff. lengths, anode configurations, preamps, ...**
- **Perhaps obtain gain of 50%-100% in rate (~ MHz) with acceptable resolution?**

Both have compact, established electronic and DAQ systems... Silicon arrays and ICs available on Day One

Long term: New Ideas! We need to actively start thinking outside the box

New Materials? Novel particle identification schemes?

Zero Degree Detectors for high rates and/or heavy beams...Recoil Separator?
A device that can "eat" and separate the beam (SECAR-like)

This is the time to discuss "wacky" ideas...

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