ISLA: Isochronous Spectrometer with Large Acceptances

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Physics drivers in need for a spectrometer @ ReA12

- Deep-inelastic reactions using neutron-rich beams
- in-beam γ-ray spectroscopy of high-spin states
- Transfer and resonant reactions
- Fusion-evaporation reactions for spectroscopic studies
- Fusion reactions with neutron-rich beams
- Study of fission barriers
- Astrophysics and decay studies
- …

Requirements for a High Efficiency Spectrometer using ReA12 beams

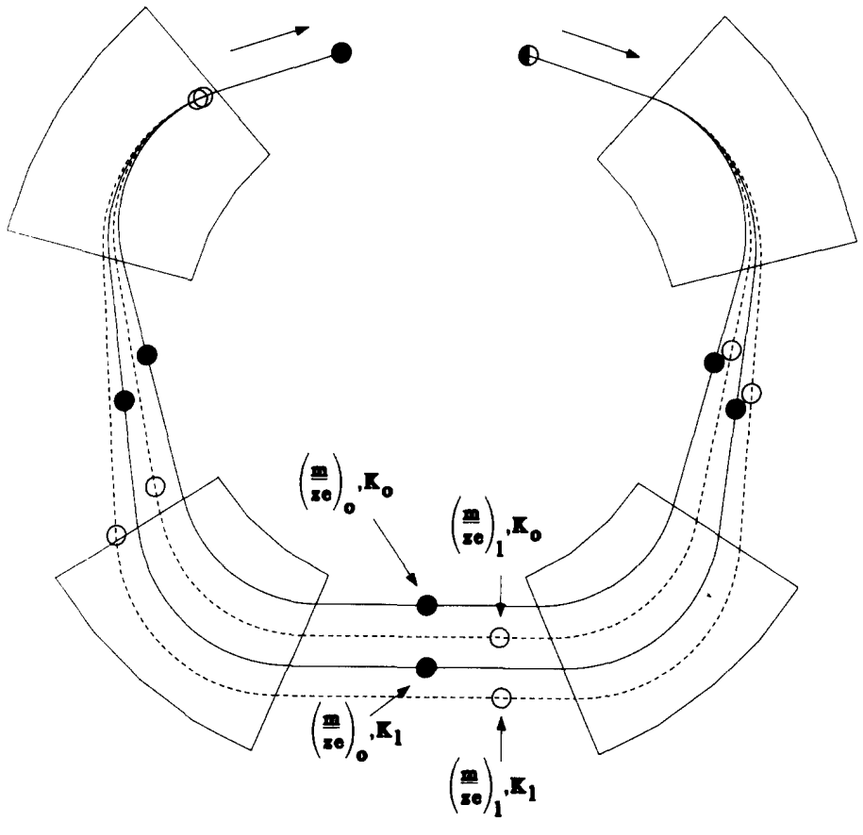
- Collect reaction products in large kinematic space
- Transmit several charge states for high efficiency
- Identify reaction products with good elemental and mass resolutions
- Reject unreacted beam
- Accommodate auxiliary detector array around target
- Possibly rotate beam around target

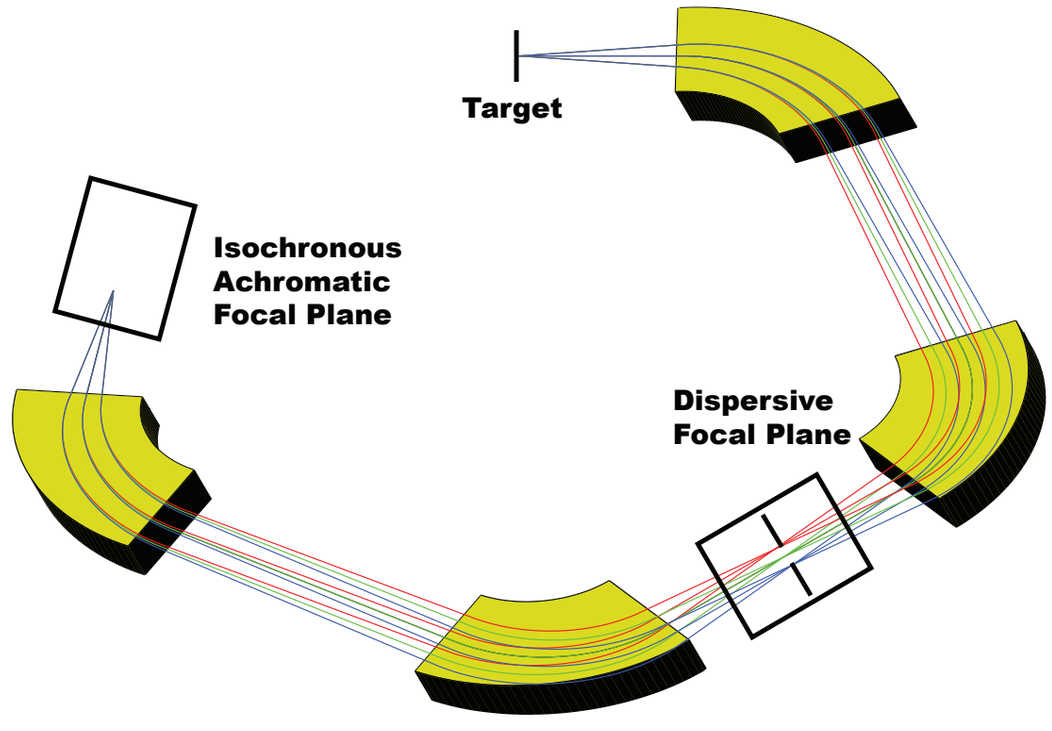
Existing spectrometers

- Compromises between acceptance, resolution and focal plane size
  - Small acceptance spectrometers
    - Small acceptances ☹, small aberrations ☺, small focal plane ☺
    - Examples: FMA, RMS, Wien filters
  - Large acceptance spectrometers
    - Large acceptances ☺, large aberrations ☹, large focal plane ☹
    - Examples: VAMOS, PRISMA, MAGNEX
  - Gas-filled spectrometers
    - Large charge state acceptance ☺, poor resolution ☹

ISLA concept

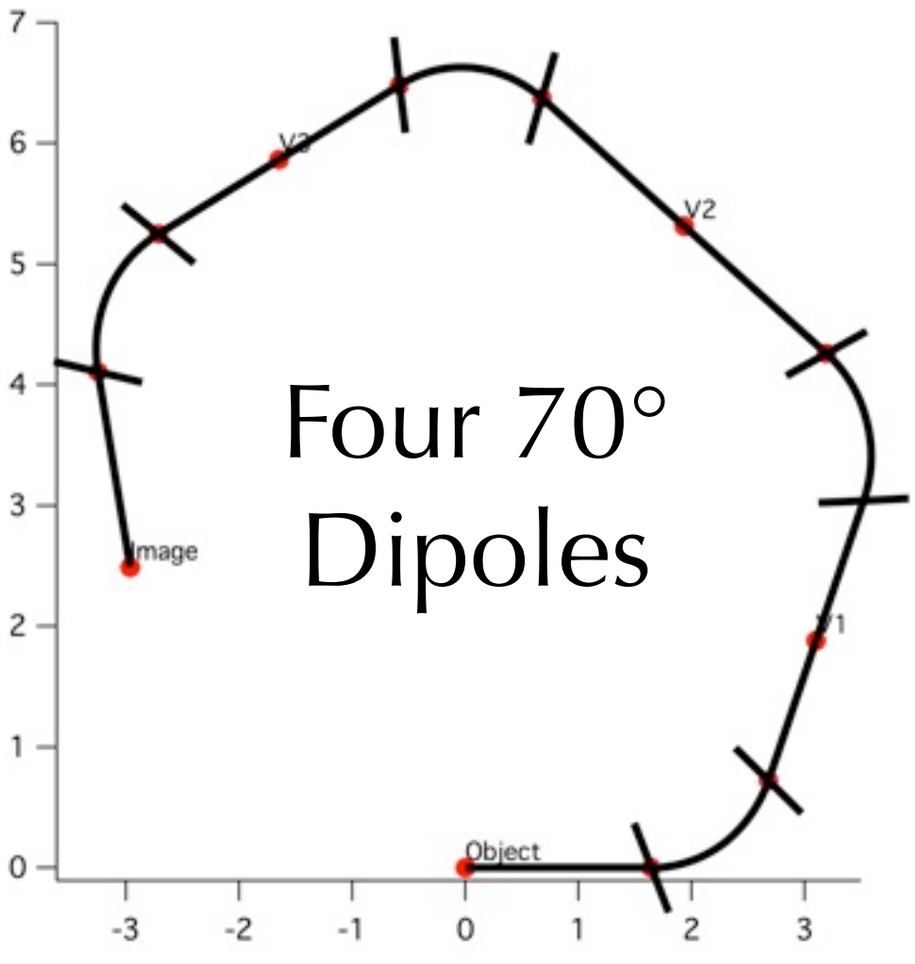
- Best of both worlds
  - Large acceptances, small aberrations, high resolution, small focal plane
  - Inspired from the TOFI design (LANL), isochronous, quadrupole-free, iron-free spectrometer

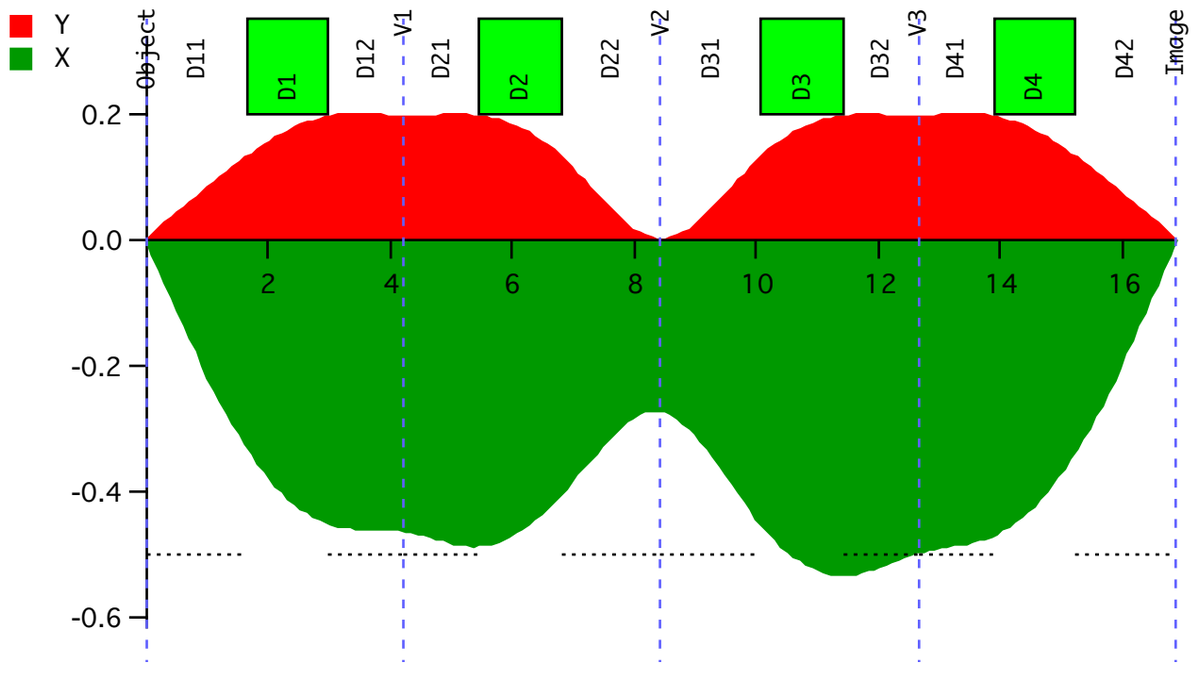




Optical properties

- First order optics
  - Dispersive focal plane at mid-point
  - Isochronous, achromatic final focal plane

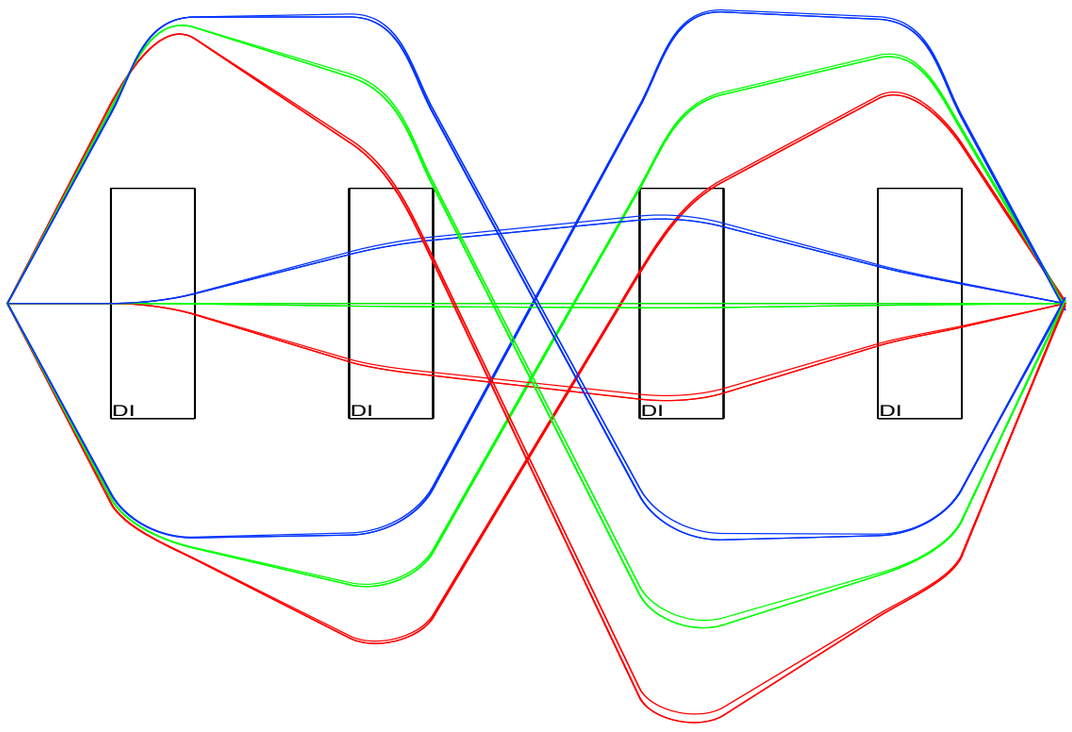




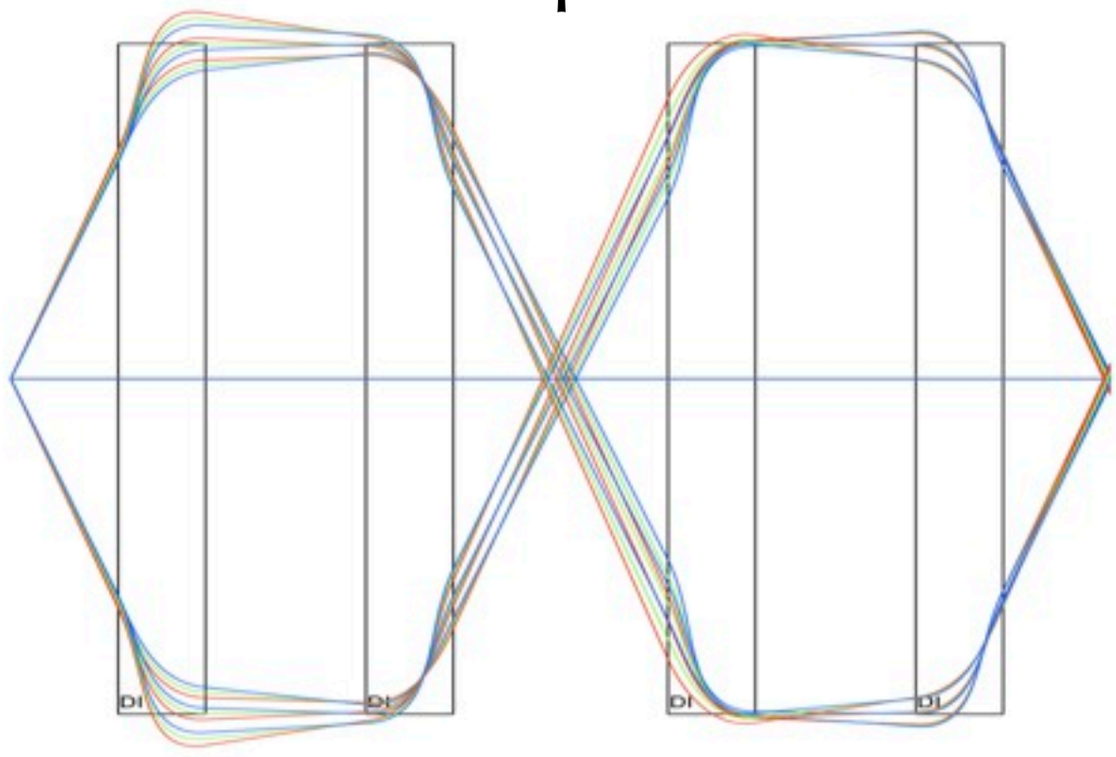
Optical qualities

- Large acceptances, small aberrations, high M/Q resolution
- 3rd order calculations using iron-free dipole design fringe fields

Dispersive



Non dispersive

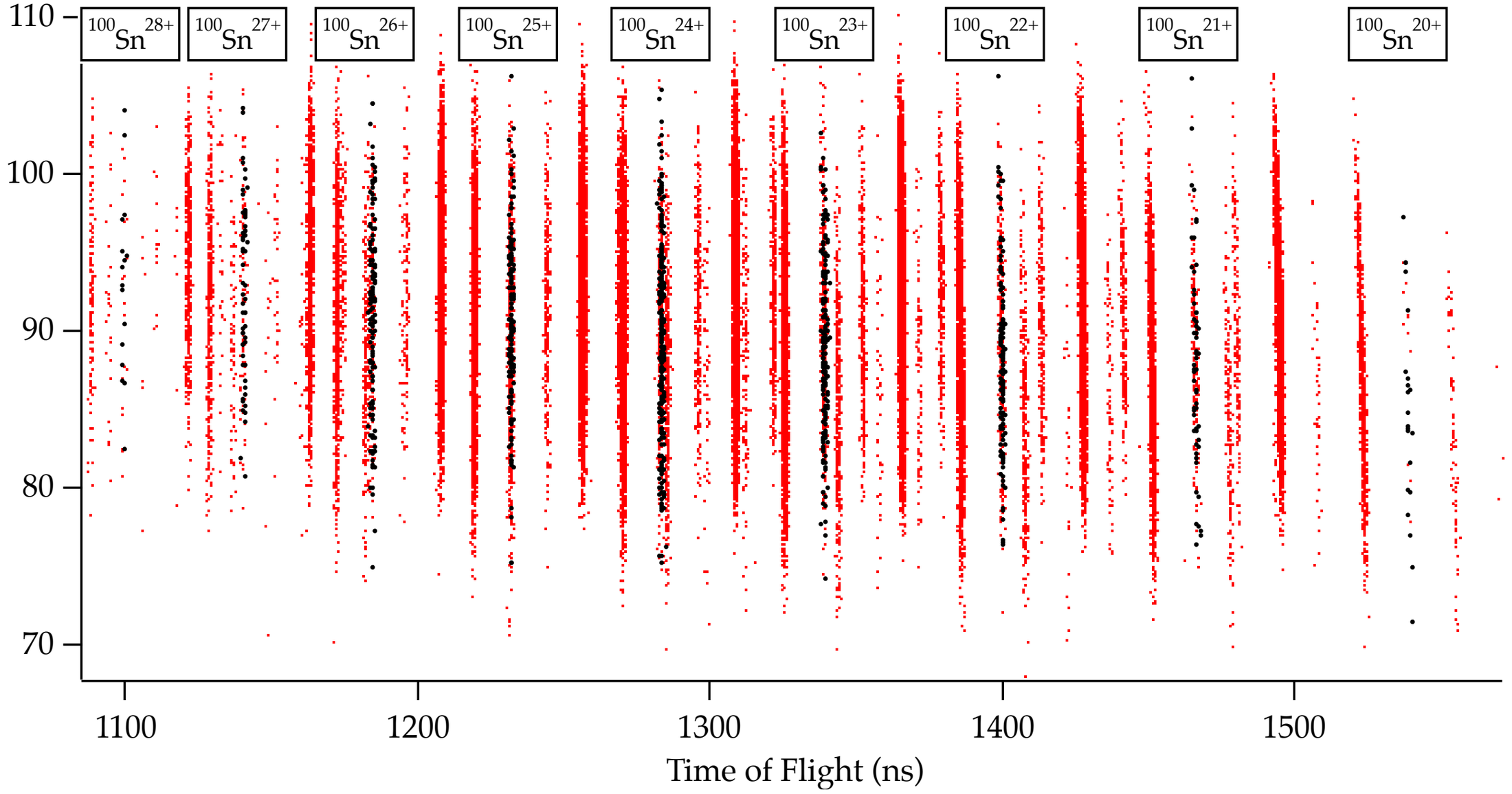


ISLA performance

- Acceptances
  - 64 msr (± 200 mrad dispersif, ± 80 mrad non-dispersif)
  - 10% ΔP/P (and M/Q) @ 64 msr, 16% @ 32 msr
- Optical properties
  - M/Q: ~1/2000 intrinsic at full acceptance and without corrections, depends also on RF bunch size
  - Dispersion at dispersive focal plane: 5.4 cm/% ΔP/P
  - Point-to-point imaging at isochronous focal plane
  - Maximum rigidity: 3.2 T.m.

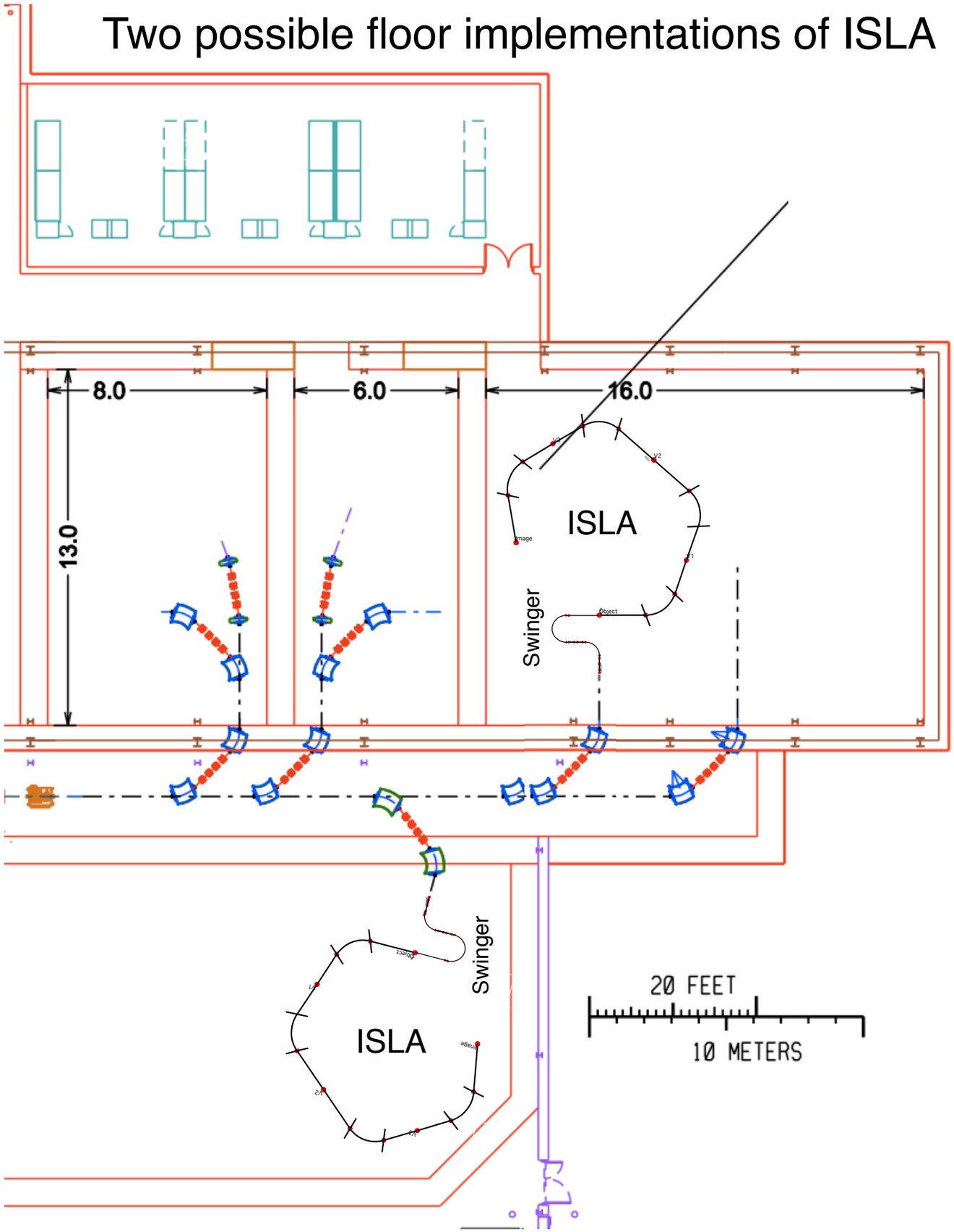
Monte-Carlo simulation

- Symmetric fusion-evaporation $^{56}Ni+^{50}Cr$: ^{100}Sn
- Time of Flight resolution: 1 ns from RF bunch



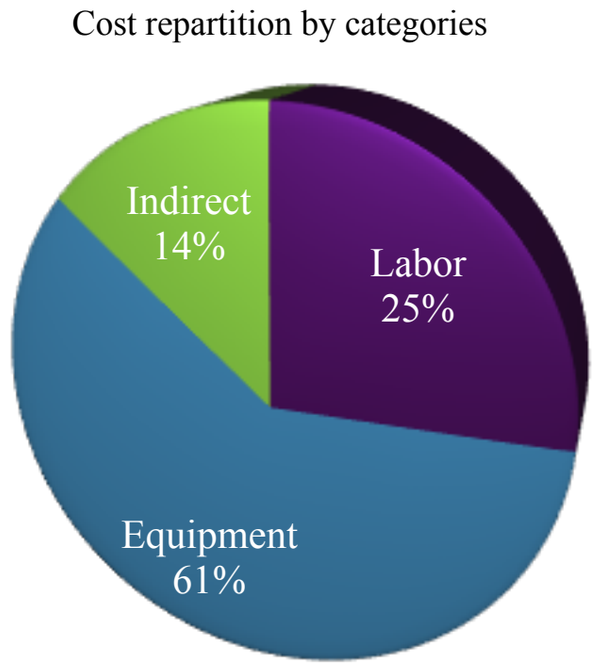
Possible vault implementations

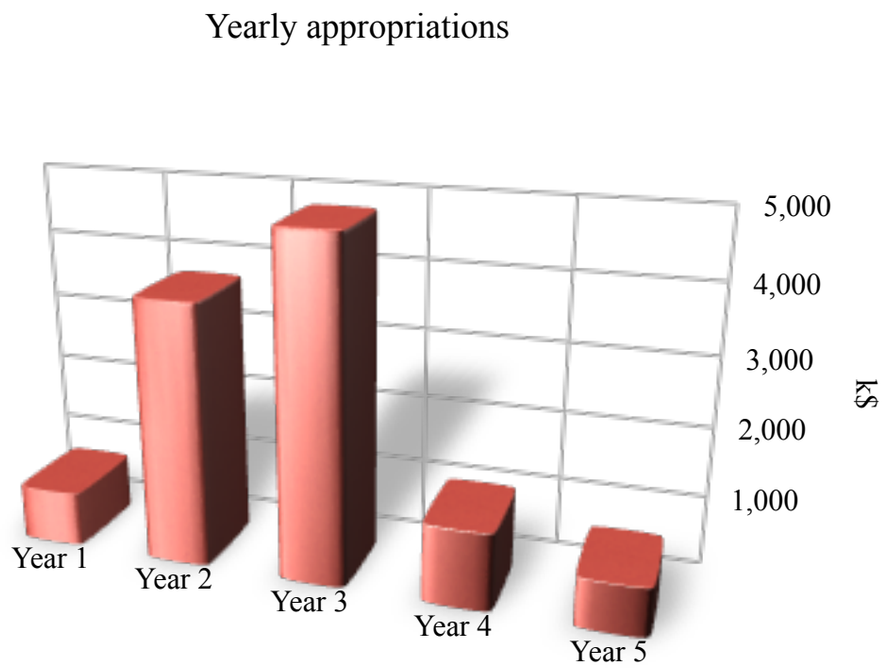
- ISLA and its beam swinger drawn to scale
- Two possible locations in ReA12 experimental areas



Preliminary budget

Items	Cost in M$ (25% cont.)
Dipoles	5.5
Swinger & others	0.6
Infrastructure	0.4
Detectors	0.3
Indirect	1.5
Labor	2.8
Total	11.1





Workgroup and web site

- 29 members from 7 institutions
- Web site main communication channel
- Contacts:
  - bazin@nscl.msu.edu
  - mittig@nscl.msu.edu

https://groups.frib.msu.edu/group/isla