FRIB Accelerator DAQ/Controls Overview

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Outline

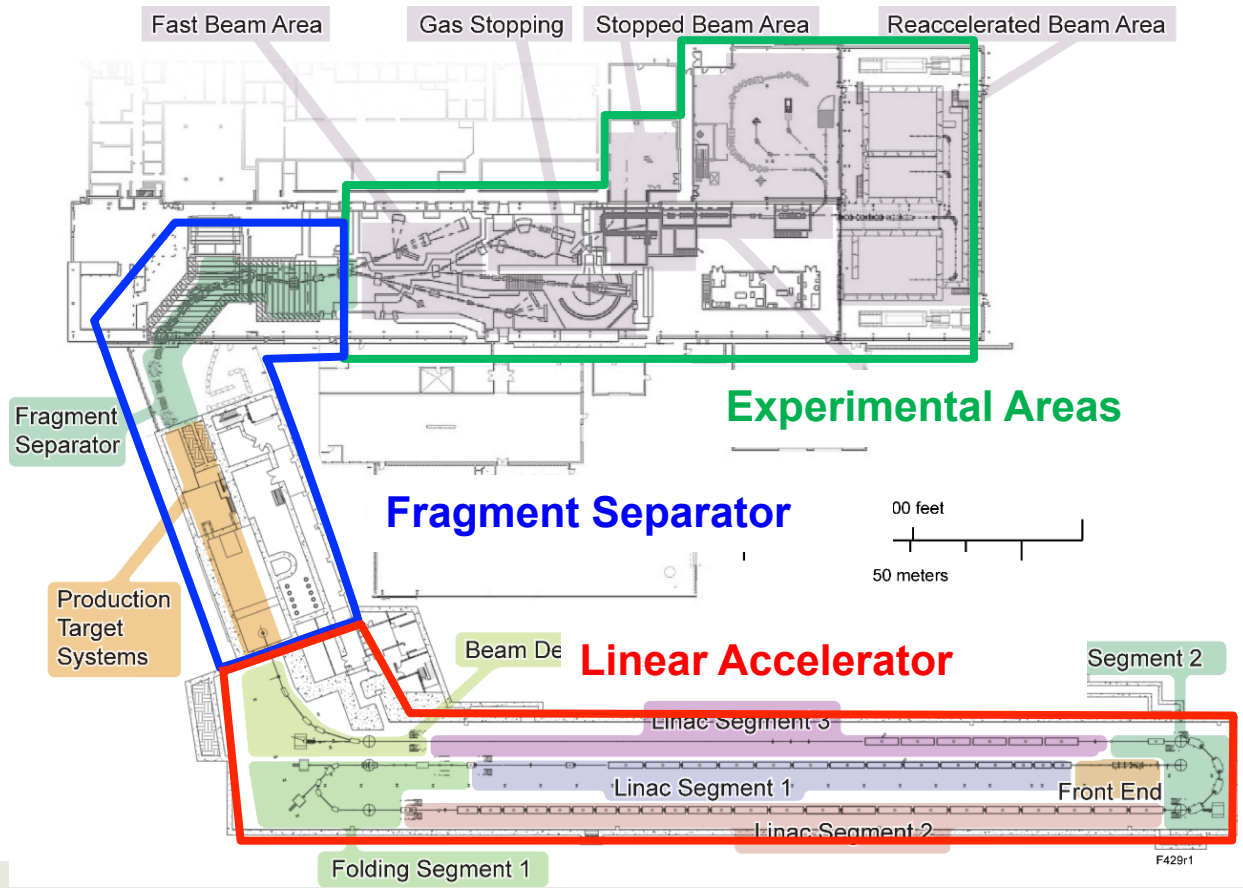
- Fragment separator overview
- Diagnostics potentially useful for experimenters
- Plans for fragment separator DAQ
- Signals from LINAC potentially useful for experimenters
- Summary

FRIB Accelerator Facility

- FRIB Facility will consist of three areas (plus infrastructure):
  - Linear accelerator
  - Fragment separator
  - Experimental areas

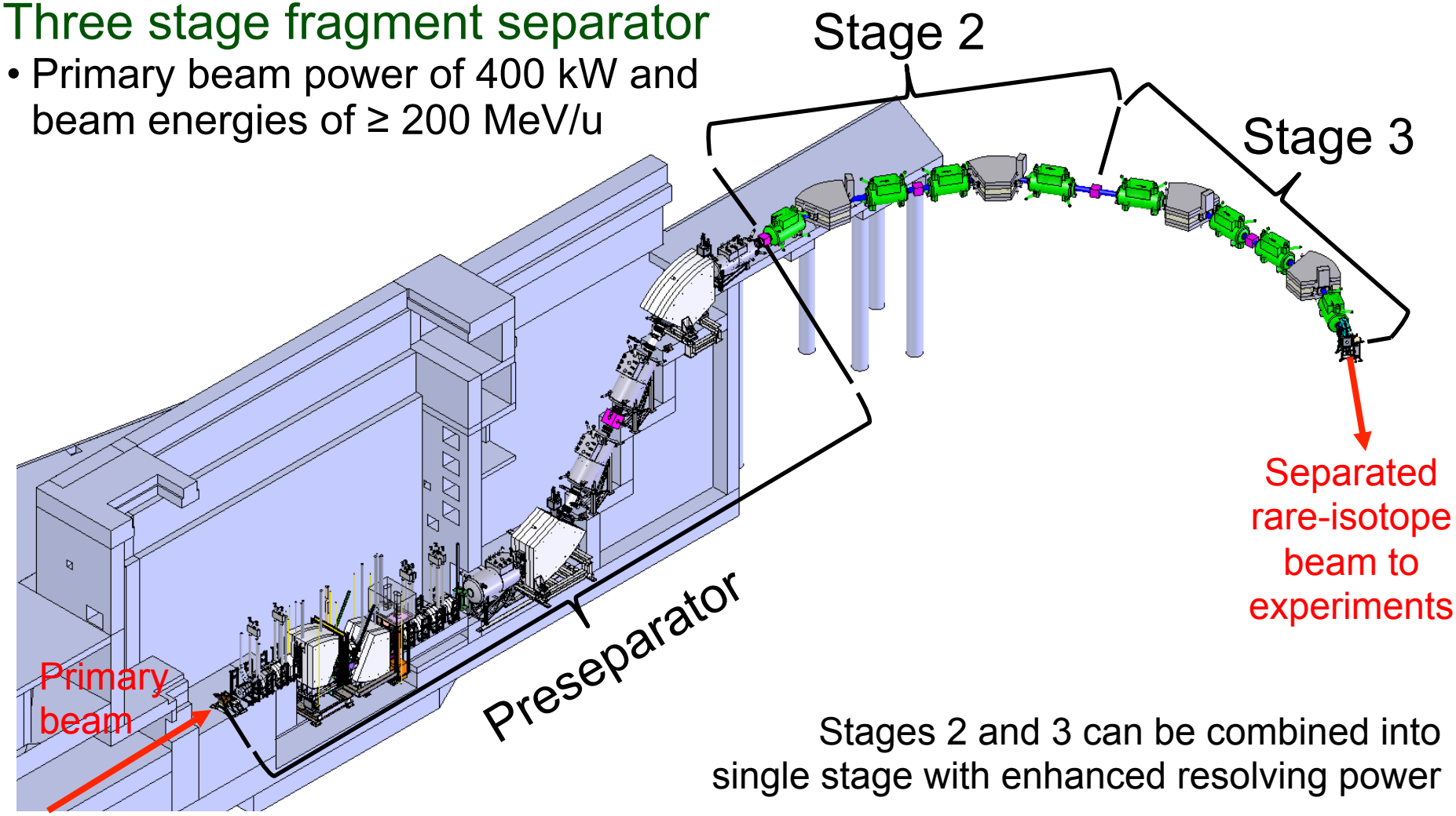
  } FRIB project

- DAQ/controls for each area, but will focus on fragment separator in this presentation
  - Many details of primary beam less relevant for experiments
  - DAQ/controls for experimental areas are covered in other talks



FRIB Fragment Separator ARIS

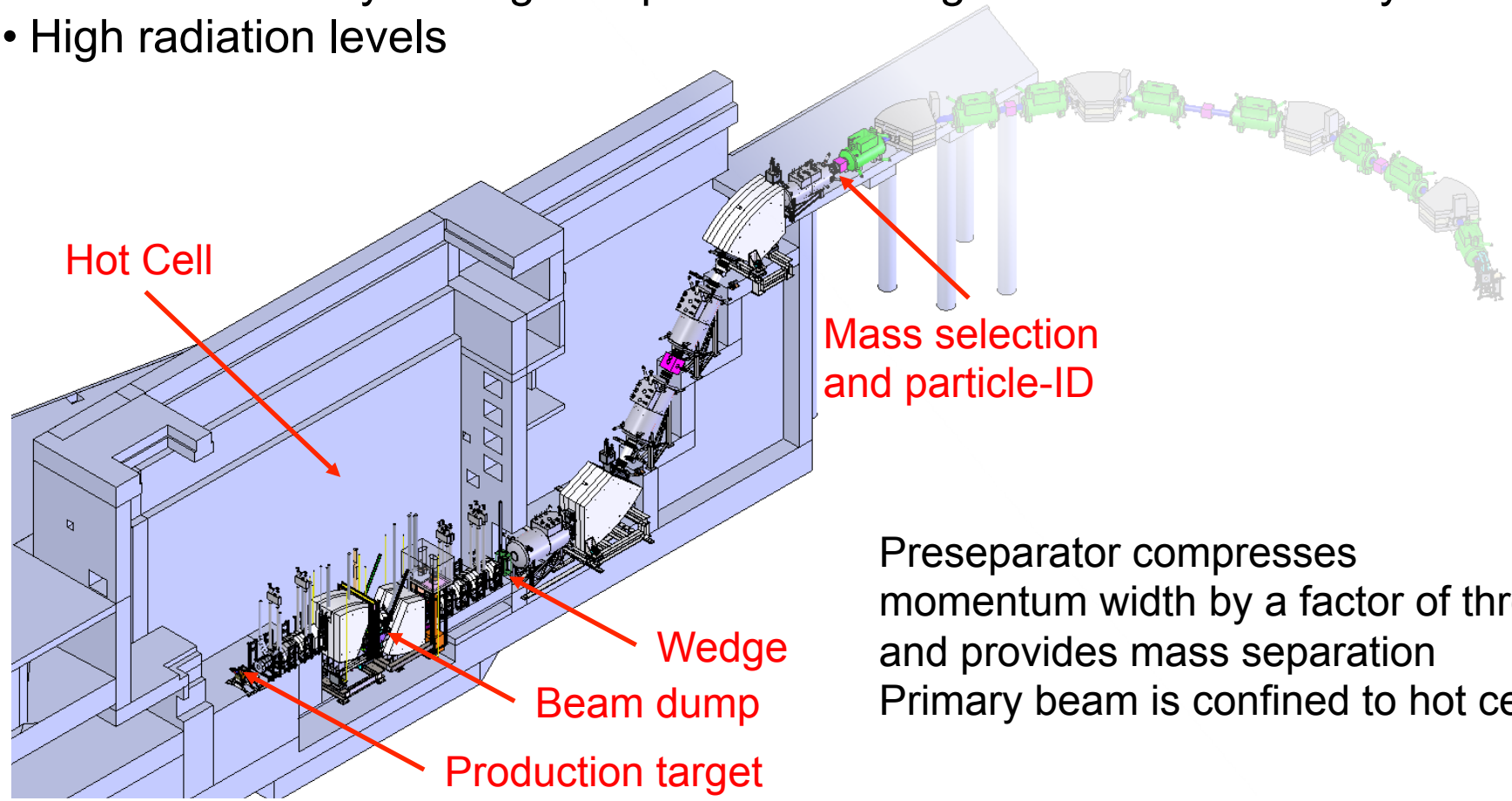
- Three stage fragment separator
  - Primary beam power of 400 kW and beam energies of ≥ 200 MeV/u



Stages 2 and 3 can be combined into single stage with enhanced resolving power

Preseparator

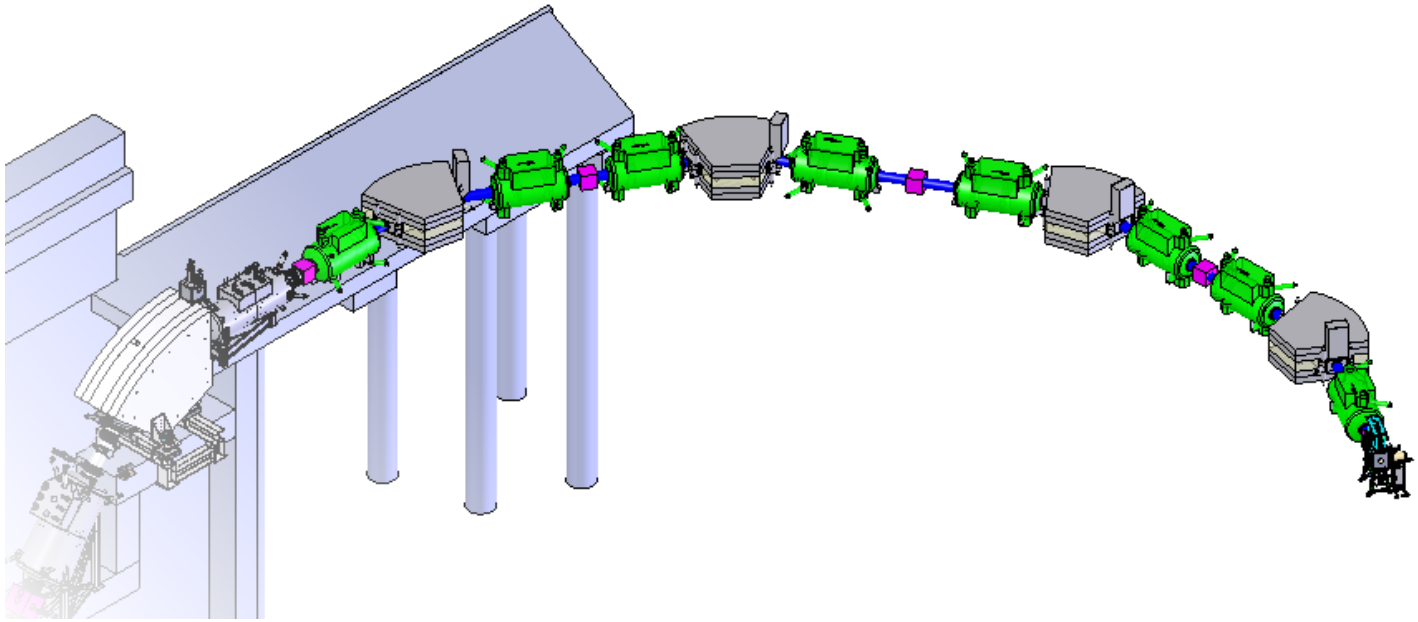
- Limited diagnostics/DAQ in front end for beam tuning
  - Beam rates likely too high for particle tracking at full beam intensity
  - High radiation levels



Preseparator compresses momentum width by a factor of three and provides mass separation
Primary beam is confined to hot cell.

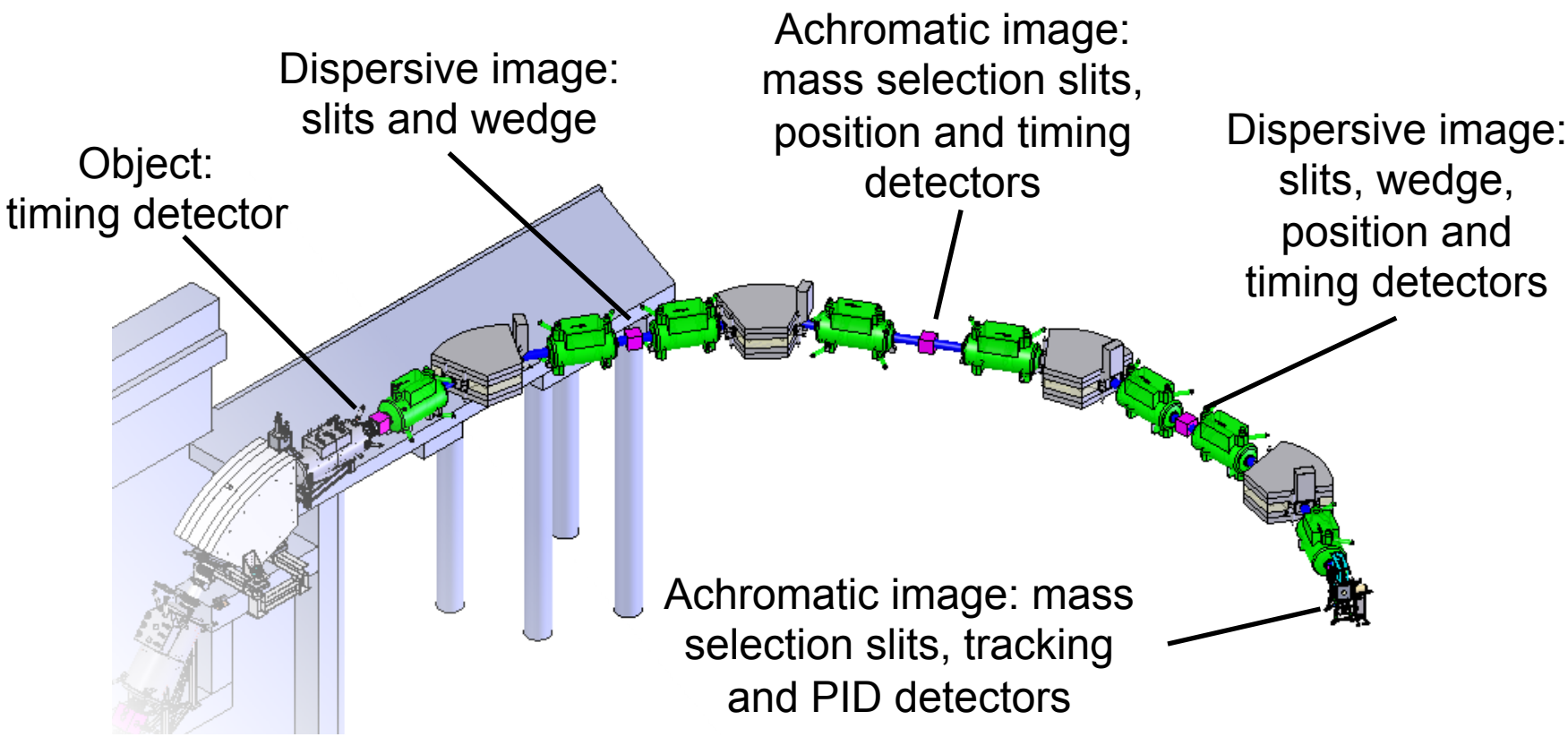
Horizontal Separator Stages

- Reconfiguration of existing A1900 fragment separator
- Different operational modes for different experiments
  - Two separation stages (three including preseparator) for maximum purification of rare isotopes with very small production cross sections
  - Momentum- or phase-space tagging in last stage for PID (e.g. knockout experiments with incoming cocktail beams) or improved Doppler correction
  - Single separation stage with higher resolving power for in-flight charge-state identification



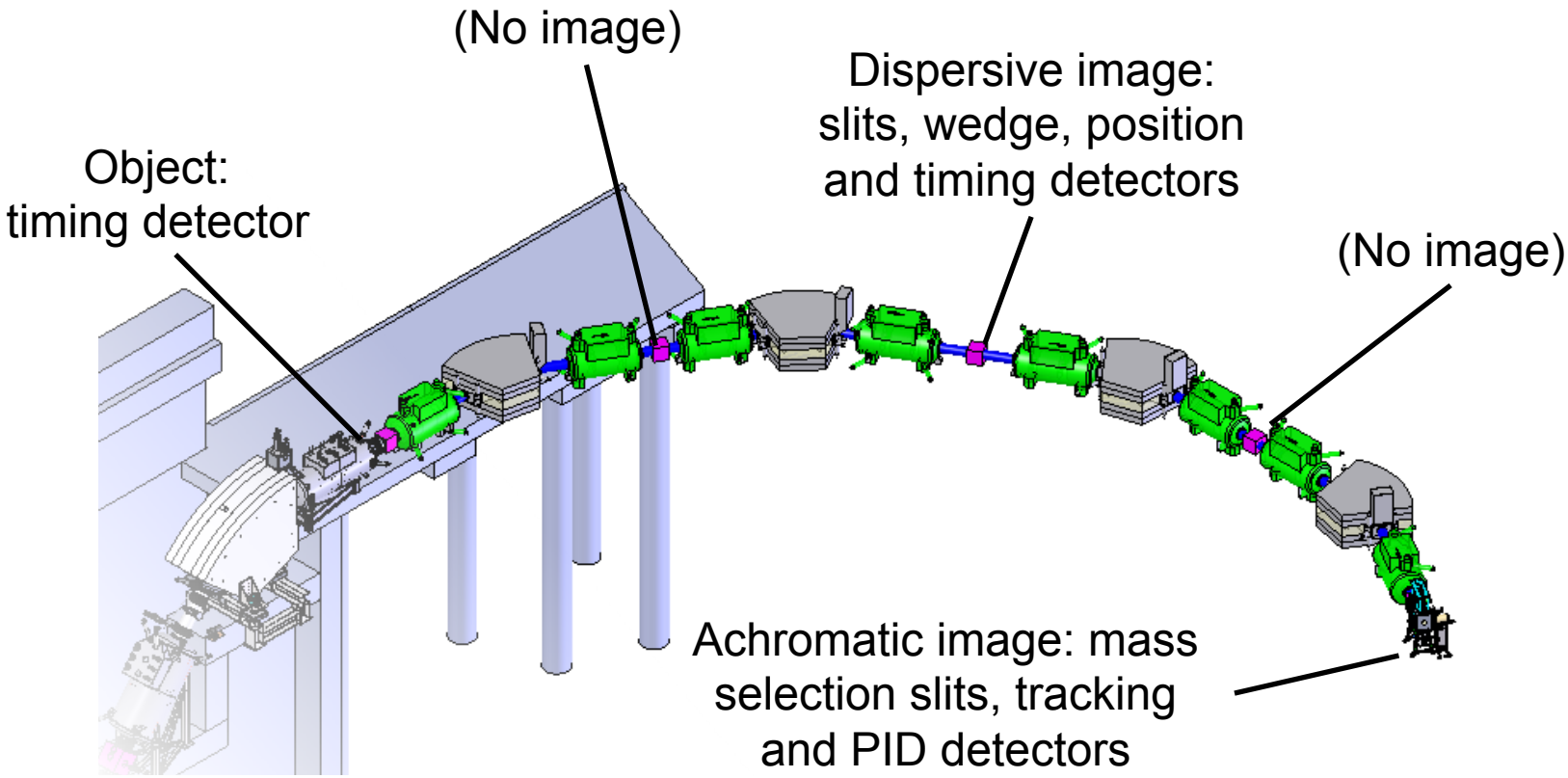
DAQ/Diagnostics for Two Stages

- Detectors and DAQ will be based on existing A1900 (PPACs, PINs, …)
  - Some diagnostics for beam tuning omitted
  - Detector info could be made available



DAQ/Diagnostics for Single Stages

- Increased momentum resolving power
  - Detector info could be made available



Potentially Useful Data

- Time-of-flight for PID at experiment
  - Scintillators or diamond detectors
  - Alternatives?
- Particle position at dispersive focal plane for magnetic rigidity determination
  - Scintillators or gas-filled detectors
  - Large, segmented diamond detectors would be great, but have not found any yet
  - Alternatives?
    - » Thin, homogenous thickness, high efficiency, high rate
- Multiple position detectors
  - Angles
  - Tracking between focal planes for rigidity reconstruction
  - Need to consider straggling in detectors

Fragment Separator Data Acquisition

- Will be based on A1900 DAQ
  - Currently phasing out CAMAC
  - Going towards all-VME system
  - “Classic” readout with ADCs, TDCs, etc. (not digitizing waveforms)
- Will be based on current/future NSCL-DAQ

- Input welcome on
  - What detector information will be useful for experimenters
  - Preferred way to access detector information
    - » Signal cables into user DAQ?
    - » Feeding part of fragment separator DAQ into used data stream?

Input from Accelerator

- Timing signal corresponding to micro bunch hitting target
- Bunch length on target ≤ 3 ns
  - Simulations show that this can be achieved with a multi charge-state beam
- LINAC base frequency is 80.5 MHz
  - Heavy beams will have bunches at 80.5 MHz
  - Lighter beams will use every other cycle: 40.25 MHz
  - Depends on number of charge states from ion source used (1 or 2)
  - Bunch distance short → potential ambiguities in time-of-flight
- Jitter of 80.5 MHz reference signal under investigation
  - Martin Konrad achieved ~30 ps RMS jitter in test setup
  - Some additional jitter from fan-out modules and longer cables expected
- Future upgrade/enhancement options
  - Reduced bunch length of ≤ 1.5 ns
  - Optional operation at 20.125 MHz at reduced intensity (e.g. for RF kicker)

Summary

- FRIB will have three-stage fragment separator
- Diagnostics/detectors at various focal planes throughout separator
  - Particles rates at full beam intensity expected high in preseparator
  - Particles rates in downstream stages more consistent with data taking at full beam intensity
- Anticipate making timing and position data available to users
  - Details tbd and input on preferences welcome
- Timing signal from LINAC at 80.5 MHz or 40.25 MHz
  - Short bunch distance may cause timing ambiguities