A1900 Tasklist for Exp 15507

Chajecki, Z: **Beam development and detector tests in preparation for e12014** A1900 Contact: ginter

Overview

Beams to be delivered to Z015

Beam	Energy [MeV/u]	SDT [hours]	XDT [hours]	BOT (excluding XDT) [hours]
Pb-208	85	0	0	48

Context

- A1900+S2 G-Line experiment to establish high-Z PID for Pb fragmentation
- Experimenters operating A1900 as a facility supported experimental device
- MCP mounted on FP_Stack drive in FP
    - Vault entry required to bias/unbias MCP
    - MCP bias is interlocked against bad vacuum or use of viewer lights in A1900
    - Do not put gas in FP_PPACs when MCP is biased
    - Close bypass valve between FP chamber and PPAC (to reduce virtual leak) while MCP is biased
    - MCP permanent magnets interfere with use of FP_Sci
    - Alpha source for testing MCP is mounted facing upstream on downstream wall of FP box
- Special “low profile” Al slit blocks are mounted at I2: beam facing side of slit blocks have a thickness of only ~2 mm along beam path at beam gap
- A sample MCP foil is mounted above the I2 viewer (at the 2” position of the Z059TL wedge drive)
- More info on the experiment setup is provided below
- No target damage from beam power or dose is expected

Background

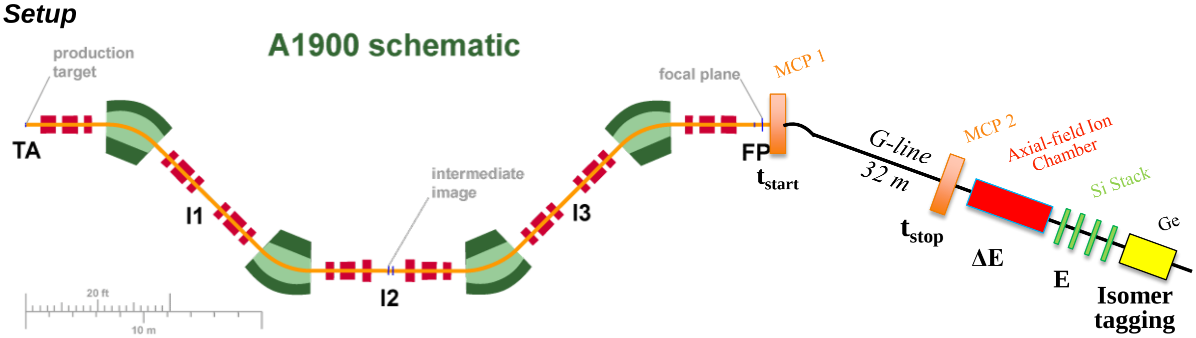
Approved Exp 12014 has not been scheduled because the capability to do the required beam development has not been demonstrated. The purpose of this discretionary beamtime request is to combine the expertise of the A1900 group and the experiment collaboration to demonstrate the feasibility of the beam delivery and of the experiment.

Goals

- 0^{th} Order: Demonstrate PID
    - Use a single production setting
    - Microsecond gamma isomers are probably crucial for success
    - First, with FP_PIN stack to stop fragments in front of Ge detector for correlation to known microsecond isomers
    - Second, with upstream TOF and ion chambers by implanting fragments into a passive stopper in front of Ge detector for correlation to known microsecond isomers (hopefully most of the time can be spent on this setting)
- 1^{st} Order: Make Tl-195
    - 1000 pps/pnA are needed for experiment with AT-TPC
    - PID isomers: Pb-196 (0.2% purity), Pb-197 (5%), Pb-198(7%), Tl-200 (0.3%)
- Backup Setting: Make Tl-200
    - Closer to primary beam/stability

- PID isomers: Tl-200 (11% purity), Pb-204 (4%)
- Another Backup Setting: Make Tl-207
  - Even closer to primary beam/stability
  - PID isomers: Tl-205 (5% purity), Pb-204 (0.9%), Pb-205 (0.9%), Hg-203 (0.5%)

Setup



A1900 Image 2:

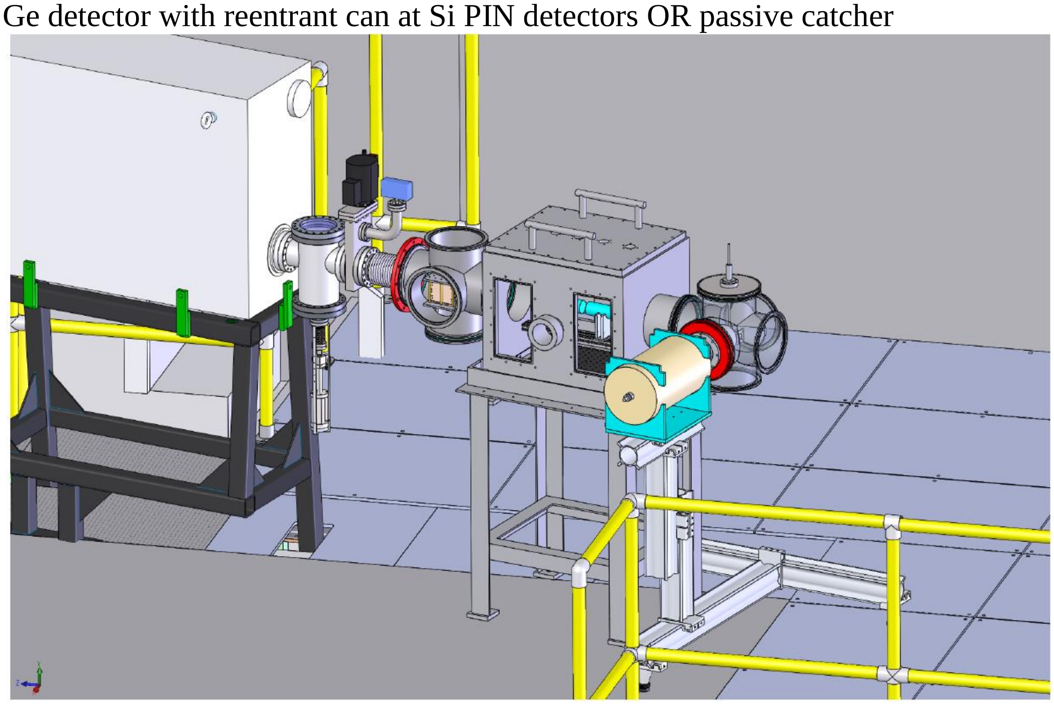
- Narrow slits (2 mm)
- Thin wedge (Kapton 20)
- MCP foil sample (50 ug/cm2) to check charge states (inclined/not inclined with respect to beam)

A1900 Focal Plane:

- MCP for TOF start (foil: 50 ug/cm2, not inclined with respect to beam)

S2 G-line (TAMU chamber)

- MCP
- 2 compact axial field ion chambers
- Manual drive (locally inserted)
  - Si PIN detectors (1000 microns, 500 microns) drive
  - OR passive catcher
- Ge detector with reentrant can at Si PIN detectors OR passive catcher



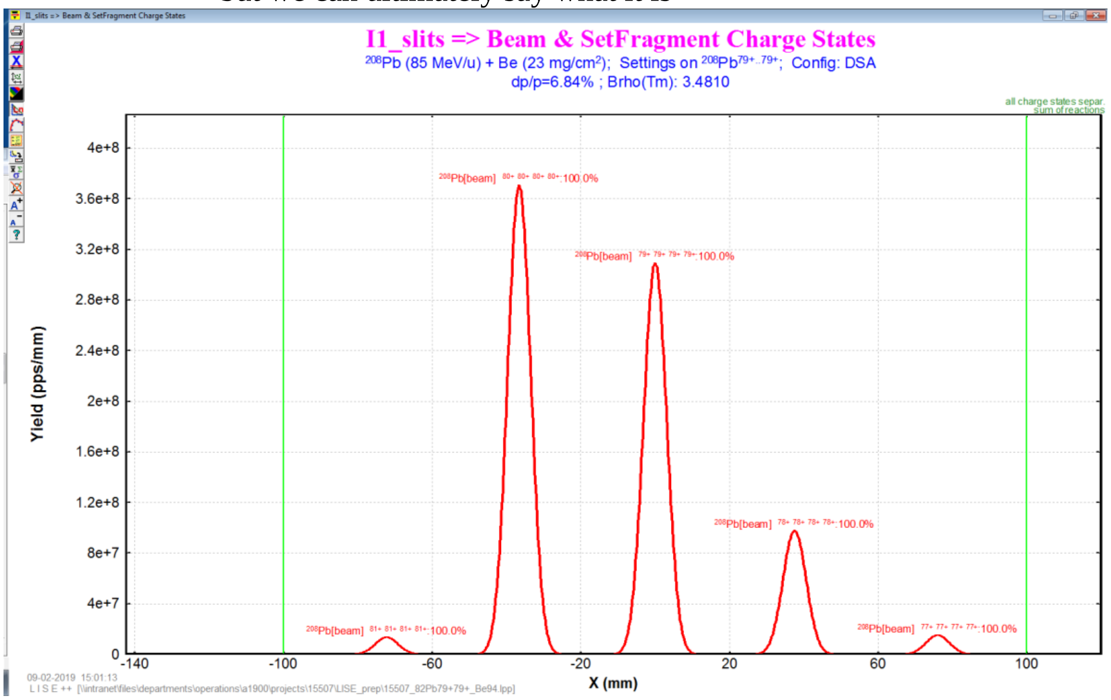
Beam Development Considerations

- We have very limited experience from work with Pb fragmentation
- We rely on microsecond gammas for PID
- Planned Tl-195(79+,79+) setting looks beautiful in LISE
  - Plenty of rate
  - Plenty of isomers
  - Meets energy requirements of experiment
- There are doubts about nominal Tl-195(79+,79+) setting working as planned
  - Population of q-states might be different than expected
  - Rates may be lower given we are removing 12 neutrons and only 1 proton
  - Will the isomers we expect really be populated?
- Options for managing q-state doubt
  - Measure q-state distribution of Pb-208 primary beam from target, wedge, MCP foil
  - Move towards equilibrium target thickness of Be 120 (but can only go to Be 47 before we drop below required energy of ~65 MeV/u for fragment leaving axial ICs)
  - Look for fragments to be populated with more electrons (i.e., more similar to primary beam which comes with 19 electrons)
- Options for managing isomer doubt
  - Check literature for whatever information is available (isomers we missed, how isomers were populated, rates)
  - Be ready to see any isomer in any setting
    - Table at end of this document lists candidate isomers from LISE/NNCD
  - Center Tl-195(79+,79+) setting instead on strong isomer Pb-196(80+,80+) – only somewhat at the expense of Tl-195 rate
- Option for managing rate doubt: Look for fragment settings with isomers nearer to the primary beam
  - Tl-200(79+,79+)
  - Tl-205(79+,79+)
- Primary beam for setup/calibration
  - Don’t plan on using undegraded primary beam
  - Probably can use pilot beam
    - But we probably have to check the whole q-state distribution to know which q-sate we’re sending
  - Another beam probably not needed
- Options for production settings (also listed in tables at end of taklist):
  - Tl-195(79+,79+), Be 23
  - Pb-196(80+,80+), Be 23
  - Tl-195(75+,75+), Be-23
  - Tl-195(79+,79+), Be 47
  - Tl-200(79+,79+), Be 23
  - Tl-205(79+,79+), Be 23

Run-plan Overview

- Measure Pb-208 energy

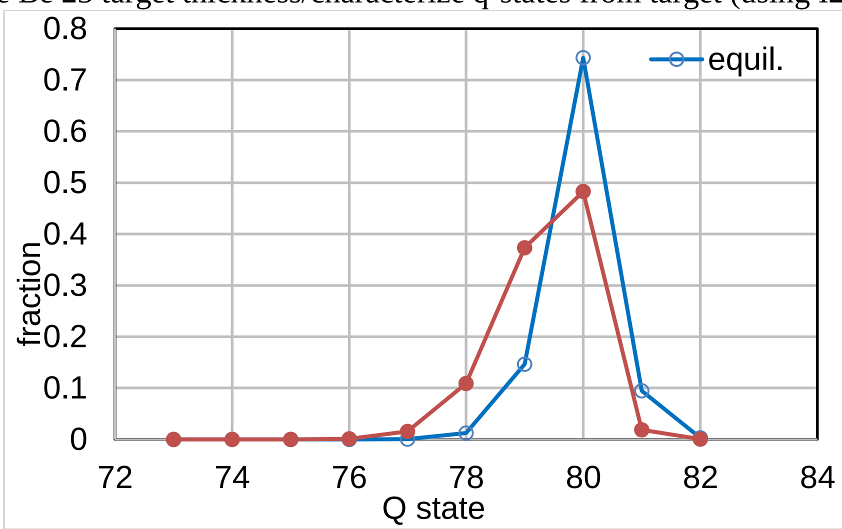
- Optional: Early "Quick" beam through to S2 detector setup for initial system check
    - Use Pb-208 q-state from Be 23 at Brho ~3.48 Tm
        - Gives head start for measuring beam q-state distribution through Be 23
        - Won't know q-state we're sending until we measure full distribution later, but we can ultimately say what it is



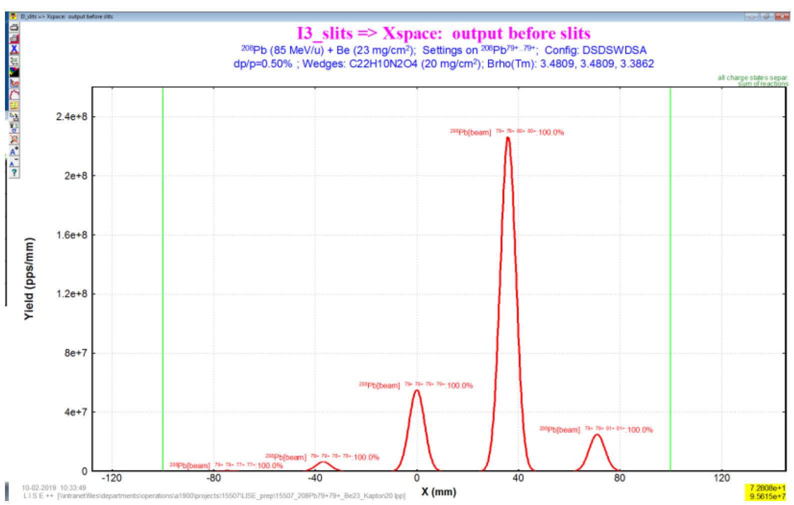
            - Should be in midst of 3 strongest q-states as predicted by LISE
        - Potentially provides 2nd primary beam calibration point
            - In addition to pilot beam we send later at closer to fragment rigidity
            - If data from this calibration point is good we can skip taking calibration data from other pilot beam and hence not have to measure q-state distribution to figure out which q-state we're sending then
    - Activities at viewer intensity
        - Quick-and-dirty early check of q-state distribution by viewers
            - At I3 if acceptance is wide enough
            - At FP using I1 slits to block left and right q-state
            - Also can quickly check if q-states visible from Be 47 target
        - We can establish a good pilot beam at high end of rigidity range which can serve as a basis for scaling the beamline later when we know which rigidity we want to run
        - Beam size/position evaluation
        - Look for changes to beam size/intensity when FP MCP foil is inserted without shifting rigidity (to get a visual indication of impact of using MCP foil or not)
    - Activities with low intensity beam (avoids confusion from multiple beam components)

- ▪ Detector setup
  - MCPs
  - TOF
  - Axial_ICs
  - PIN detectors
    - o Check bias for full depletion
    - o Check signals for saturation
- ▪ Evaluate transmission based on detector rates
- ▪ Evaluate for impact of A1900 FP MCP foil being inserted/retracted
- ▪ Evaluate for bad impacts from scattering on 2 mm I2 slits
  - Run with and without narrow slits
  - Switch between low-profile and normal-profile slits
- ▪ Record calibration point on full setup to S2
- ▪ Record quick reference data at A1900 FP

- Measure Be 23 target thickness/characterize q-states from target (using I2_Sci)

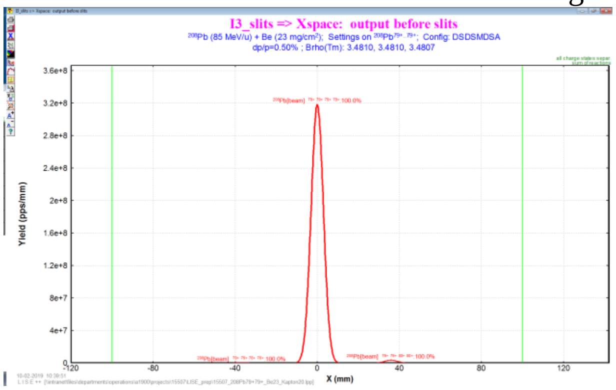


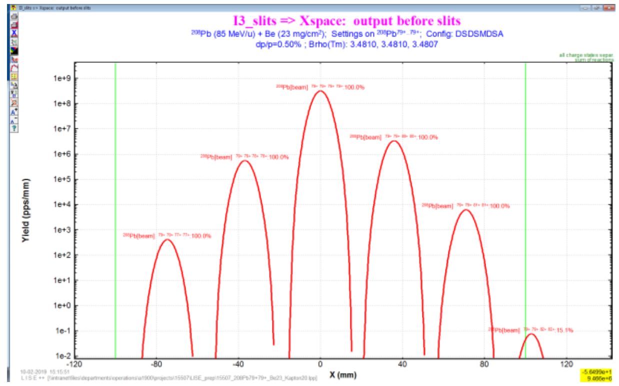
- Measure Kapton 20 wedge thickness/characterize q-states from wedge (using FP detectors)



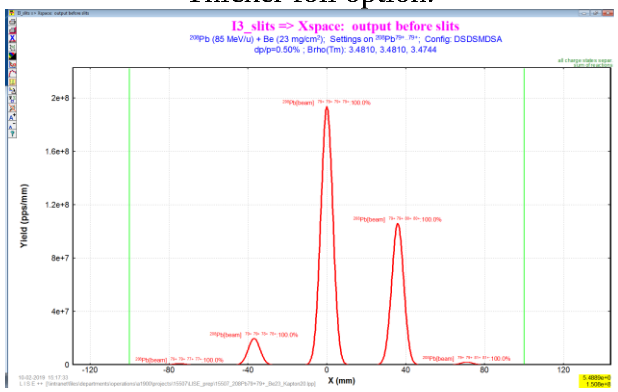
- Measure MCP foil thickness/characterize q-states from MCP foil (at FP detectors with foil mounted at I2)

50 microgram/cm2 C foil

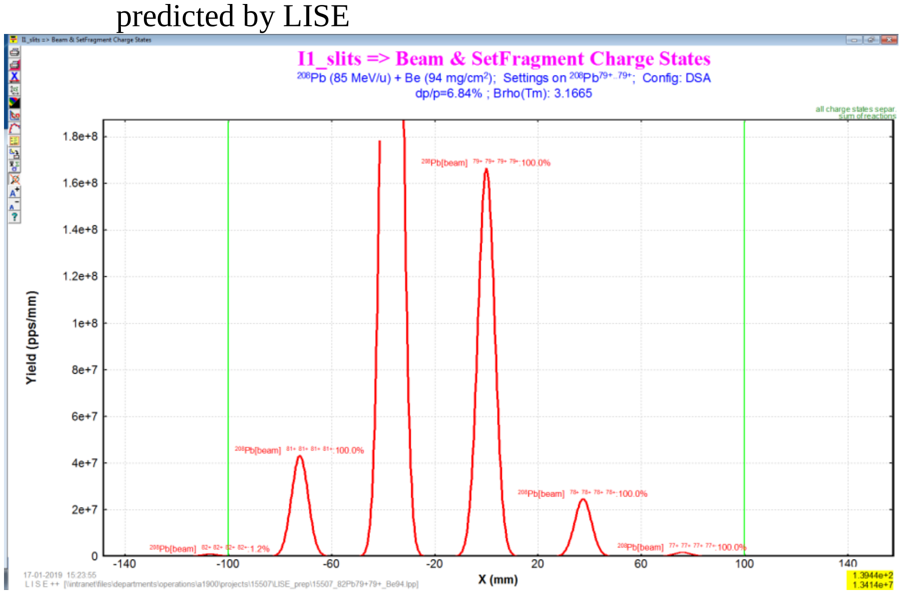




Thicker foil option.



- Use LISE to define best shot at Tl-195 production setting based on q-state results
- Pilot beam
    - Probably: Pb-208(79+,79+) from Be 94
        - Brho = 3.1665 Tm
        - 2nd strongest beam q-state (between strongest and 4th strongest) as predicted by LISE



        - Won't know q-state we're sending unless we measure full q-state distribution
            - Can skip the q-state determination if we already have a good calibration point from the high-rigidity pilot beam earlier
    - Activities at viewer intensity
        - Quick-and-dirty check of q-state distribution by viewers
            - At I3 if acceptance is wide enough
            - At FP using I1 slits to block left and right q-state
            - Also quickly check if q-states visible from other targets (e.g., Be 66 + degraders)
        - Beam size/position evaluation
        - Look for changes to beam size/intensity when FP MCP foil is inserted without shifting rigidity (to get a visual indication of impact of using MCP foil or not)
    - Activities with low intensity beam (avoids confusion from multiple beam components)
        - Detector setup
            - MCPs
            - TOF
            - Axial_ICs
            - PIN detectors
                - Check bias for full depletion
                - Check signals for saturation
        - Evaluate transmission based on detector rates
        - Evaluate for impact of A1900 FP MCP foil being inserted/retracted
        - Evaluate for bad impacts from scattering on 2 mm I2 slits
            - Run with and without narrow slits
            - Switch between low-profile and normal-profile slits
        - Record calibration point on full setup to S2
        - Record quick reference data at A1900 FP
- If needed, measure full q-state distribution from Be 94 target to tell which q-state we sent with pilot as calibration point
- Tl-195 production setting
    - Center on Pb-206 instead for good Pb-206 isomer only partly at expense of Tl-195
    - MCP/TOF/Axial_IC/PIN/Ge detector
        - Establish PID with optimum detector setup (including isomers)
    - MCP/TOP/Axial_IC/catcher/Ge detector
        - Demonstrate PID (confirmed with isomers) with transmission detector setup
    - If needed, revert to appropriate alternate setting
        - No rate?
            - Option I: Use thicker target (Be 47)
            - Option II: Use Tl-200 or Tl-205 setting closer to primary beam
            - Option III: Shift to lower q-states to look for rate

            - But our results from the beam q-state distribution check from target/wedge should give us an indication if this will help
    - No isomers?
        - Double check
            - Are we sure the correlation window is established correctly in electronics/DAQ?
            - Have we waited long enough?
        - Shift settings
            - Option I: Use Tl-200 or Tl-205 setting to look for different isomers
            - Option II: Shift to lower q-states to look for rate
- Record a bit of data from selected production setting on A1900 FP detectors for context/reference
- If needed, send alternate calibration beams

A1900 Preparations Before Beam Time

SDT preparations

- ☐ Complete beamline checklist
- ☐ Targets installed
    - Z015TL: Be 23, Be 47, Be 94
    - Z013TL: Be 9, Be 66, Be 141
    - Z014TL: Be 23
- ☐ I2 configured: Kapton 20, 2 mm slit with low-profile Al blocks, MCP foil clamped to viewer
- ☐ MCP installed on FP_Stack drive
- ☐ Switch from standard 2 GeV FP_PIN preamp to 10 GeV preamp
- ☐ u1pc3 rebooted/software running
- ☐ u1pc1 rebooted/software running
- ☐ Beamdump program running
- ☐ spdaq25 rebooted
- ☐ u1pc2 rebooted/software running
- ☐ Data-U1 patch panel isolated from ground loops in central patch panel
- ☐ I2_Sci thresholds set to 35 mV
- ☐ Trigger set to I2_Sci
- ☐ Selectable TOF stop set to FP_PIN
- ☐ L19S1G_V3b optics and ratios loaded
- ☐ Ratios modified
    - `G191QB:  1.000` → `0.950`
    - `G200QA:  1.000` → `1.075`
    - `G202QB:  1.000` → `1.050`
- ☐ Polynomial calculation of A1900 dipole rhos enabled
- ☐ Initial frozen radii loaded and steerers set
    - A116DS = 3.11296 m
    - A132DS = 95.25794 m
    - G143DH = -5 A

- ☐ Segments 0-2 set to 4.4801 Tm
- ☐ Segment 3-6 set to 3.50 Tm
- ☐ Request in person and in hourlog for operators to monitor beamlines
    - Give Segment 0 status
    - Inform them that Faraday bar tuning is not set up
- ☐ Enter experiment number and title for Barney saveset headers

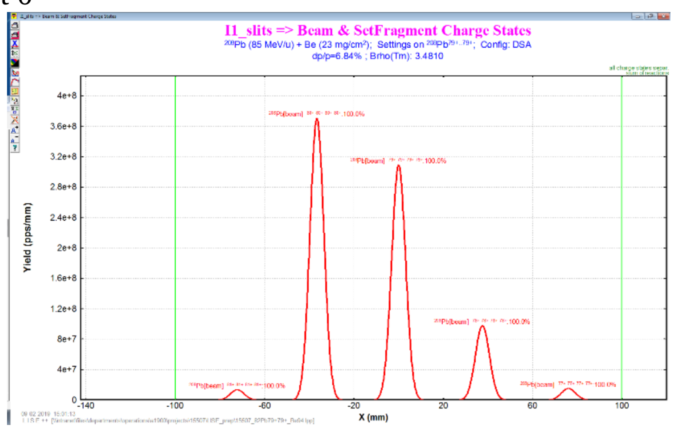
Preparations with Primary Beam (SDT)

Beam energy measurement

- ☐ Segment 1 set to 4.4801 Tm
- ☐ Verify segment 0
- ☐ Undegraded primary beam to I2 (**L19S1G_V3b optics and ratios**, Brho1,2 = 4.4801Tm)
    - Adjust rigidity as needed to center beam at I1 slits and on I2 viewer
    - Document effective beam energy

Optional Early Pilot Beam for System Check (SDT)

- ☐ Pb-208(79+) to G204 (Brho ~3.48, Be 23)
- ☐ Verify segment 0



- ☐ Find a beam q-state bright enough to see on viewers
    - Do a quick-and-dirty early check of q-state distribution by viewers
        - At I3 if acceptance is wide enough
        - At FP using I1 slits to block left and right q-state
        - Also can quickly check if q-states visible from Be 47 target
    - Block off-axis q-states with I1 slits
    - Nudge rigidity as needed to center at I2
- ☐ Center beam vertically at I3 by adjusting Z003DV
    - Retune segment 0 to minimize vertical steering at new Z015TL beam position
- ☐ Confirm that beam is centered horizontally at I3 and FP viewer
    - Close Z104 x gap as needed to define beam position
- ☐ Ensure
    - Rigidities are set consistently between A1900 and downstream segments
    - S2 vault is secure
    - G204 viewer remains inserted and G204 gate valve stays closed to protect experiment setup from beam

- ☐ Confirm that level of vertical steering from quads between A1900 FP and G204 (with vertical steerers off) is acceptable; otherwise:
  - o Use Z003DV to find beam position at Z015TL that minimizes vertical steering
    - ▪ Retune segment 0 to minimize steering at new Z015TL beam position
    - ▪ If needed, use vertical steerers along beamline to minimize steering
- ☐ Set dipoles/steerers between A1900 FP and G204 to minimize horizontal steering
- ☐ Can skip this step until actual pilot beam: Note how quads in last two doublets affect beam size on G204 viewer (*circle as appropriate*)
  - o Strengthening G189QA field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)
  - o Strengthening G191QB field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)
  - o Strengthening G202QA field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)
  - o Strengthening G204QB field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)
- ☐ Can skip this step until actual pilot beam: Note how last two steerers affect beam position on G204 viewer (*circle as appropriate*)
  - o Strengthening G193DH by _____A moves beam (*left/right*) by a beam spot width
  - o Strengthening G195DV by _____A moves beam (*up/down*) by a beam spot width
- ☐ If safe for MCP foil, look for changes to beam size/intensity when FP MCP foil is inserted without shifting rigidity (to get a visual indication of impact of using MCP foil or not)
- ☐ Document tune in S2 with campics and Barney saveset
- ☐ Inform experimenters that they can enter vault briefly, if needed
- ☐ Complete documentation of tune upstream from vault
- ☐ Post segment 0 reference photos for operators

Optional Beam Delivery (SDT)

Pb-208(79+) to G204

- ☐ Pb-208(79+) to G204 (Brho ~3.48, Be 23)
- ☐ Be 23, Brho1-6 ~3.48 Tm, Z037 gap = ±8 mm, I2 slit out, I3 slits open, FP slits open
- ☐ Set Z104 slits to 10 mm x gap
- ☐ Hand over beam at I3 beamstop at an initial rate of ~100 Hz
- ☐ Monitor rate from experimenters
- ☐ Open G204 gate valve and retract G204 viewer
- ☐ Ensure FP_PPACs are unbiased and remove gas before operating FP MCP
- ☐ Set up alert with operators
- ☐ Detector setup
  - o MCPs
    - ▪ TOF
    - ▪ Axial_ICs
    - ▪ PIN detectors
      - • Check bias for full depletion
      - • Check signals for saturation
- ☐ Evaluate for impact of A1900 FP MCP foil being inserted/retracted
- ☐ Evaluate transmission based on detector rates
- ☐ Evaluate for bad impacts from scattering on 2 mm I2 slits
  - o Run with and without narrow slits
  - o Switch between low-profile and normal-profile slits

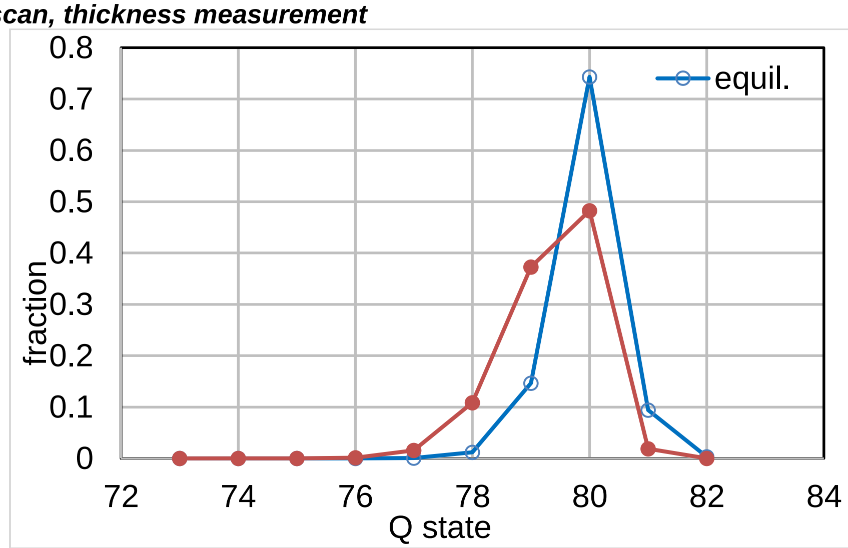
- ☐ If detector setup is finalized
    - Record calibration point with full setup to S2
    - Record quick reference data at A1900 FP (will need to switch to FP_PIN trigger and check setting of shaping amp gain)
- ☐ Ensure experimenters have printout(s) documenting the setting

Preparations with Primary Beam (SDT)

I2_Sci setup

- ☐ Use I2_Sci trigger
- ☐ Brho1,2 ~3.50 Tm, Be 23
- ☐ Adjust beam position over different parts of the I2_Sci by sweeping beam with D2 (with I1 slits open, I2 slits out, I3 blocker inserted)
    - Be 9 and other thin targets can also be used to shift beam position across detector
    - Adjust bias; signals can be at about full scale when the beam is adjacent to the PMT being adjusted
    - Confirm position response based on TAC5 spectrum
    - Check that timing cfd thresholds are reasonably and consistently set
- ☐ Record run while using D2 to sweep beam across I2 scintillator to document absence of dead spots
    - Use I1 slits to block all but 1 q-state past I1
    - If necessary, use I2_Sci drive shims to look for a vertical position on the I2_Sci without dead spots
- ☐ Restore D2 setting (~3.50 Tm)

Be 23 Q-state scan, thickness measurement

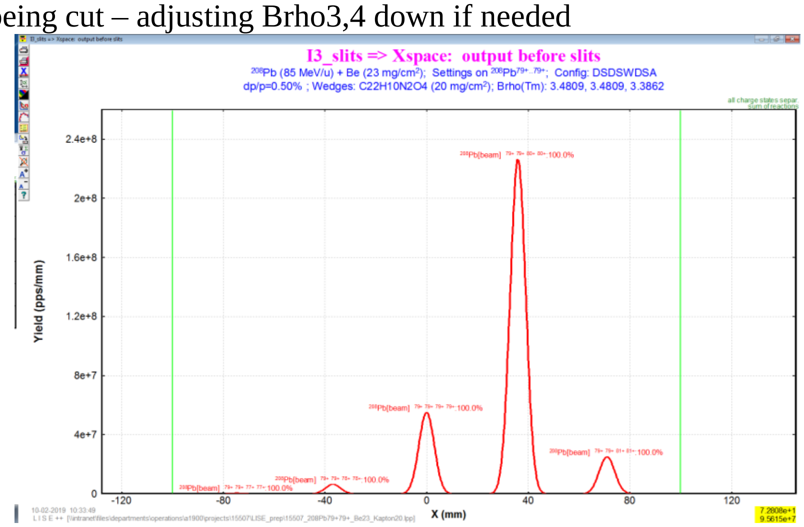


- ☐ Check segment 0
- ☐ I1 slits open, I3 blocker inserted
- ☐ With I2 scintillator retracted and unbiased, carefully center the nearest q-state strong enough to be visible on the viewer by lowering Brho1,2
    - Record result with campic and saveset
    - This will be used to determine the target thickness measurement once we know which q-state is which
- ☐ Reduce beam intensity and insert and bias I2 scintillator

- ☐ Record run to document present position and relative intensity of at least 3 q-states at I2
    - Document bias
    - If needed, repeat run using I1 slits to block stronger q-states to reveal weaker ones
- ☐ Shift rigidity down by 1% and record run to document new position and relative intensity of q-states
    - I1 slits open
    - Ensure that at least two q-states from the previous run are well within the acceptance so that it is possible to normalize on their relative intensities
    - If needed, repeat run using I1 slits to block stronger q-states to reveal weaker ones
- ☐ Continue shifting rigidity down in 1% steps and recording runs as above until the end of the q-state distribution is reached – should not need more than 2-3 more rigidity steps
- ☐ Record measured target thickness as determined with the rigidity of the centered q-state whose value can now be assigned

Kapton 20 Q-state scan and thickness measurement

- ☐ Put gas in FP PPACs (MCPs unbiased)
- ☐ Check segment 0
- ☐ Center the strongest q-state from the distribution as just determined at the I2 viewer
- ☐ Close I1 slits to block all but the q-state centered at I2
- ☐ Ensure FP slits are open fully
- ☐ Switch to FP_PIN trigger
- ☐ Check FP_PIN gain and adjust as needed
- ☐ Confirm that beam is roughly centered at FP based on detector rates
- ☐ Check/adjust delays for I2_Sci/FP timing
    - Check spectra for TAC1 and TAC2
- ☐ Scale Brho3,4 (assuming the nominal Kapton thickness to center the q-state from the Kapton wedge with 1 more electron than the q-state now centered at I2)
- ☐ Insert the Kapton 20 wedge and ensure that at least 2 q-states make it to the FP detectors without being cut – adjusting Brho3,4 down if needed



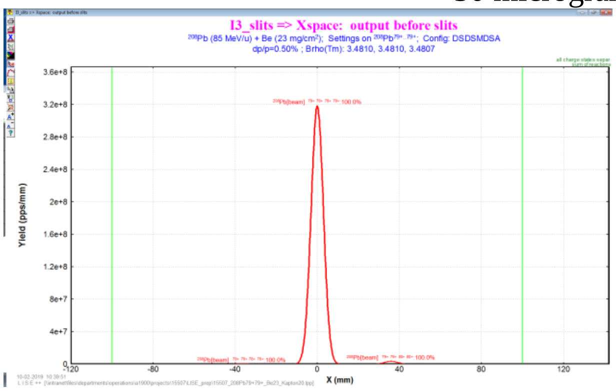
- ☐ Record run to document present position and relative intensity of the two non-cut q-states
    - Document bias
- ☐ Shift rigidity down by 1% and record run to document new position and relative intensity of q-states

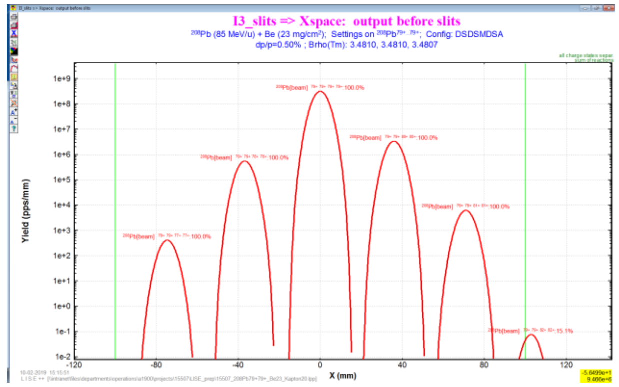
  - Ensure that two non-cut q-states are well within the acceptance (with one being one from the previous setting) so that it is possible to normalize on their relative intensity

- ☐ Continue shifting rigidity down in ~1% steps and recording runs as above until the end of the q-state distribution is reached
- ☐ Use FP detectors to carefully center strongest q-state at FP and record run to document the result
- ☐ Record measured wedge thickness as determined from the rigidities before and after the wedge and of the now-assigned strongest q-states

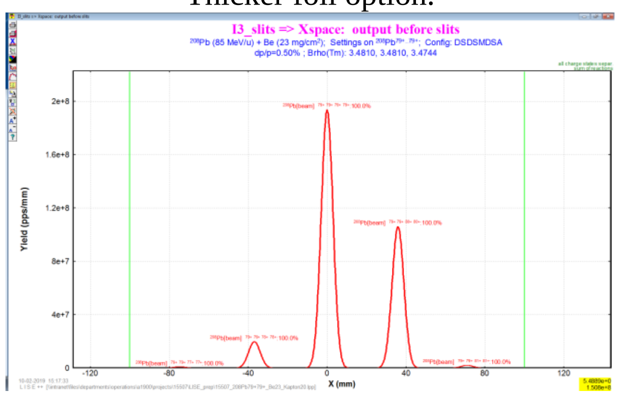
MCP foil Q-state scan and thickness check

50 microgram/cm2 C foil





Thicker foil option.



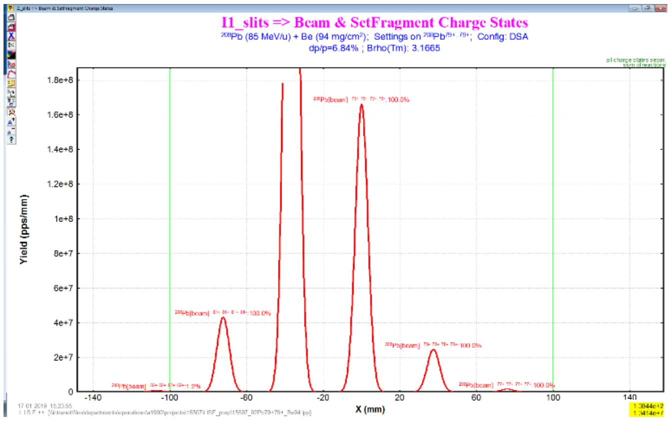
- ☐ Set Brho3,4 to rigidity of Brho1,2 used to center strongest q-state from Be 23 at I2
  - Keep I1 slits blocking other q-states
- ☐ With no material inserted at I2 record a run to document the beam position at FP
- ☐ Insert MCP foil sample at I2 and note the result on the beam position at the FP
  - If beam still makes it to the FP, record a run to document the result
- ☐ Carefully shift rigidity lower to center next available q-state at FP
- ☐ Record run to document the result
- ☐ Insert I2_Sci and note, based on scaler rates, if this is the dominant q-state from MCP foil at I2
- ☐ Lower rigidity (and, if needed, increase it) and record runs and scaler readings as needed to center q-states populated until all of the intensity from I2 is accounted for
- ☐ Empty gas from PPACs and close bypass

Determine production setting and pilot beam with LISE

- ☐ If strongest q-states are as predicted, use measured beam energy, target thickness, to find the rigidities for the Pb-206(80+80+) production setting
- ☐ Otherwise, define a Pb-206 production setting based on the measured values and strongest q-states as populated
- ☐ Determine appropriate target and q-state/rigidity to use as a pilot beam for the selected production setting

Pilot Beam (SDT)

- ☐ E.g., Pb-208(80+) to G204 (Brho ~3.13, Be 94)
- ☐ Verify segment 0



- ☐ Find a beam q-state bright enough to see on viewers
  - Do a quick-and-dirty check of q-state distribution by viewers
    - At I3 if acceptance is wide enough
    - At FP using I1 slits to block left and right q-state
    - Also can quickly check if q-states visible from Be 66 target + degraders
  - Block off-axis q-states with I1 slits
  - Nudge rigidity as needed to center at I2
- ☐ Center beam vertically at I3 by adjusting Z003DV
  - Retune segment 0 to minimize vertical steering at new Z015TL beam position
- ☐ Confirm that beam is centered horizontally at I3 and FP viewer
  - Close Z104 x gap as needed to define beam position
- ☐ Ensure
  - Rigidities are set consistently between A1900 and downstream segments
  - S2 vault is secure
  - G204 viewer remains inserted and G204 gate valve stays closed to protect experiment setup from beam
- ☐ Confirm that level of vertical steering from quads between A1900 FP and G204 (with vertical steerers off) is acceptable; otherwise:
  - Use Z003DV to find beam position at Z015TL that minimizes vertical steering
    - Retune segment 0 to minimize steering at new Z015TL beam position
    - If needed, use vertical steerers along beamline to minimize steering
- ☐ Set dipoles/steerers between A1900 FP and G204 to minimize horizontal steering
- ☐ Note how quads in last two doublets affect beam size on G204 viewer (*circle as appropriate*)
  - Strengthening G189QA field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)

  - Strengthening G191QB field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)
  - Strengthening G202QA field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)
  - Strengthening G204QB field makes (*horizontal*/*vertical*) spotsize (*larger*/*smaller*)
- ☐ Note how last two steerers affect beam position on G204 viewer (*circle as appropriate*)
  - Strengthening G193DH by _____A moves beam (*left/right*) by a beam spot width
  - Strengthening G195DV by _____A moves beam (*up/down*) by a beam spot width
- ☐ If safe for MCP foil, look for changes to beam size/intensity when FP MCP foil is inserted without shifting rigidity (to get a visual indication of impact of using MCP foil or not)
- ☐ Document tune in S2 with campics and Barney saveset
- ☐ Inform experimenters that they can enter vault briefly, if needed
- ☐ Complete documentation of tune upstream from vault
- ☐ Post segment 0 reference photos for operators

Beam Delivery (SDT)

Pb-208(80+) to G204 (Only if needed – i.e, if we need to evaluate transmission and if early optional beam did not yield a good calibration/setup point)

- ☐ Be 94, Brho1-6 ~3.13 Tm, Z037 gap = ±8 mm, I2 slit out, I3 slits open, FP slits open
- ☐ Set Z104 slits to 10 mm x gap
- ☐ Hand over beam at I3 beamstop at an initial rate of ~100 Hz
- ☐ Monitor rate from experimenters
- ☐ Open G204 gate valve and retract G204 viewer
- ☐ Ensure FP_PPACs are unbiased and remove gas before operating FP MCP
- ☐ Set up alert with operators
- ☐ Detector setup
  - MCPs
    - TOF
    - Axial_ICs
    - PIN detectors
      - Check bias for full depletion
      - Check signals for saturation
- ☐ Evaluate for impact of A1900 FP MCP foil being inserted/retracted
- ☐ Evaluate transmission based on detector rates
- ☐ Evaluate for bad impacts from scattering on 2 mm I2 slits
  - Run with and without narrow slits
  - Switch between low-profile and normal-profile slits
- ☐ When detector setup is finalized
  - Record calibration point with full setup to S2
  - Record quick reference data at A1900 FP (will need to switch to FP_PIN trigger and check setting of shaping amp gain)
- ☐ Ensure experimenters have printout(s) documenting the setting

Preparations with Primary Beam (SDT)

Establish charge state used for pilot beam from Be 94 target

- ☐ Needed only if Be 94 pilot was used as a calibration point for the setup
- ☐ Follow plan analogous to the one given above for the Be 23 target

Beam Delivery (SDT)

Pb-206(80+80+) to G204

- ☐ Be 23, Brho1,2 = 3.2300Tm, Z037 gap = ±8 mm, I2 slit = 2 mm gap, Kapton 20, Brho3-6 ~3.1356 Tm, I3 slits open, FP slits x gap = 10 mm, FP_MCP retracted
- ☐ Ensure FP_PPACs are unbiased and remove gas before operating FP MCP
- ☐ Record cross reading between Z001F-C, rate at FP
- ☐ Hand over beam at I3 beamstop at an initial rate of ~100 Hz
- ☐ Monitor rate from experimenters
- ☐ Open G204 gate valve and retract G204 viewer
- ☐ Set up alert with operators
- ☐ Evaluate for impact of A1900 FP MCP foil being inserted/retracted
- ☐ Evaluate transmission based on detector rates
- ☐ Adjust Brho5 as needed to account for MCP foil
- ☐ Ensure experimenters have printout(s) documenting the setting
- ☐ Record a bit of data from selected production setting on A1900 FP detectors for context/reference
- ☐ If needed, send alternate calibration beams

End Check

A1900

- ☐ Unbias and retract MCP at FP
- ☐ Open FP_PPAC bypass valve
- ☐ Close gate valves to isolate I2 and FP vacuum section from neighbors
- ☐ Survey for beam activation at I2 and FP
- ☐ Switch back to standard 2 GeV FP_PIN preamp
- ☐ Uninstall MCP at FP
- ☐ Uninstall MCP foil at I2
- ☐ Uninstall special I2 slits

Beamline

- ☐ Close gate valves along beamlines between A1900 and xxx
- ☐ Set magnets downstream from A132DS to 0 Tm

Information

Possible useful microsecond gamma isomers in the region (from LISE/NNDC)

- Pb-205: $T_{1/2} = 0.22$ μs; $E_\gamma = 1175$ keV
- Pb-204: $T_{1/2} = 0.265$ μs; $E_\gamma = 374.72, 1273.87$ keV
- Pb-204: $T_{1/2} = 0.45$ μs; $E_\gamma = 990.34$ keV
- Pb-198: $T_{1/2} = 4.19$ μs; $E_\gamma = 317.9$ keV
- Pb-197: $T_{1/2} = 1.15$ μs; $E_\gamma = 589$ keV
- Pb-196: $T_{1/2} = 1.0$ μs; $E_\gamma = 288.7, 689, 1049.21$ keV
- Pb-196: $T_{1/2} = 0.14$ μs; $E_\gamma = 748.4$ keV
- Pb-195: $T_{1/2} = 10$ μs; $E_\gamma = 586.5$ keV
- Pb-194: $T_{1/2} = 0.124$ μs; $E_\gamma = 305, 352.2, 496$ keV
- Tl-205: $T_{1/2} = 2.6$ μs; $E_\gamma = 739.16$ keV
- Tl-204: $T_{1/2} = 63$ μs; $E_\gamma = 689.9$ keV
- Tl-200: $T_{1/2} = 0.33$ μs; $E_\gamma = 221.1$ keV
- Hg-206: $T_{1/2} = 2.15$ μs; $E_\gamma = 1034.01$ keV
- Hg-203: $T_{1/2} = 24$ μs; $E_\gamma = 341.5$ keV
- Hg-201: $T_{1/2} = 94$ μs; $E_\gamma = 218.9$, keV

Info on setting alternatives

Setting	Total Rate [pps/pnA]	Fragment of Interest, Rate [pps/pnA] (Purity)	Microsecond Isomers (Purity)
Pb-196(80+,80+) Be 23 target Production	8100	Tl-195, 500 (6%)	Pb-196 (5%) Pb-197 (5%) Pb-198(3%) Tl-200 (0.1%)
Tl-195(79+,79+) Be 23 target Alternate A	9500	Tl-195, 940 (10%)	Pb-196 (2%) Pb-197 (5%) Pb-198(7%) Tl-200 (0.3%)
Tl-195(75+,75+) Be-23 target Alternate B		Tl-195	
Tl-195(79+,79+) Be 47 target Alternate C	21,000	Tl-195 2300 (10%)	Pb-196 (0.4%) Pb-197 (5%) Pb-198(7%) Tl-200 (0.09%)
Tl-200(79+,79+) Be 23 target Alternate D	12,000	Tl-200 1300 (11%)	Tl-200 (11%) Pb-204 (4%)
Tl-205(79+,79+) Be 23 target Alternate E	10,000	Tl-205 560 (5%)	Tl-205 (5%) Pb-204 (0.9%) Pb-205 (0.9%) Hg-203 (0.5%)

Setting overview

Beam	Be Target [mg/cm^2]	Wedge [mg/cm^2]	Brho1 [Tm]	Brho4 [Tm]	Brho5 [Tm]	FP PIN dE [MeV]	E After 2 MCPs 2 ICs [MeV/u]	Si Range After 2 MCPs 2 ICs [microns]
Pb-208(79+) Early Test Beam	Be 23	---	3.4810	3.4810	3.4807	4670	74.0	1230
Pb-208(79+79+) Q-state check	Be 23	Kapton 20	3.4810	3.3862	---	4818	---	---
Pb-208(79+79+) Q-state check	Be 23	C 0.05	3.4810	3.4807	---		---	---
Pb-196(80+80+) Production	Be 23	Kapton 20	3.2300	3.1359	3.1356	4873	68.5	1040
Pb-208(80+) Pilot	Be 94	---	3.1269	3.1269	3.1267	5200	59.9	920
Tl-195(79+79+) Alternate A	Be 23	Kapton 20	3.2548	3.1615	3.1612	4769	68.7	1060
Pb-208(79+) Pilot	Be 94	---	3.1665	3.1665	3.1663	5200	59.9	920
Tl-195(75+,75+) Alternate B	Be 23	Kapton 20	3.4285	3.3301	3.3299	4769	68.7	1060
Pb-208(80+) Pilot	Be 47	---	3.3382	3.3382				
Tl-195(79+79+) Alternate C	Be 47	Kapton 20	3.1518	3.0592	3.0590	4954	63.8	950
Pb-208(81+) Pilot	Be 94	---	3.0883	3.0883				
Tl-200(79+79+) Alternate D	Be 23	Kapton 20	3.3308	3.2371	3.2368	4766	68.6	1080
Pb-208(78) Pilot	Be 94	---	3.2071	3.2071				
Tl-205(79+79+) Alternate E	Be 23	Kapton 20	3.4158	3.3222	3.3220	4748	69.0	1120
Pb-208(80+) Pilot	Be 47	---	3.3382	3.3382				

Primary beam and targets:

Beam:	82	208	Pb	63		85	[MeV/u]
	Z	A	Element	q		4.4801	[Tm]
						18.8927	[MHz]
				Intensity		Power	
				[pnA]	[enA]	[Watts]	
			Beam List:	1.5	94.5	27	
			Maximum:	4.5	283.5	80	
Targets:							
Element		Be	Be	Be		Be	Be
Thickness [mg/cm^2]		23	47	94		66	141
Max Deposited Power [Watts]		4	8	16		11	26
Energy Remaining [MeV/u]		80.9	76.4	67.4		72.9	57.7
Rigidity [Tm]	Z-q=0	3.35	3.26	3.05		3.18	2.82
	Z-q=1	3.40	3.30	3.09		3.22	2.85
	Z-q=2	3.44	3.34	3.13		3.26	2.89
	Z-q=3	3.48	3.38	3.17		3.30	2.92
Fraction from Target [%] (Global)	Z-q=0	0.0	0.1	0.1		0.1	0.0
	Z-q=1	1.7	5.4	4.9		5.7	2.8
	Z-q=2	45.7	71.9	70.6		72.1	67.2
	Z-q=3	38.4	20.1	21.5		19.7	25.6