^{30}S RI Beam Production Run Plan
CRIB
2009.7.19–21

Section I. Send ^{28}Si primary beam through system

Goal: Confirm ion species and energy, test detectors, electronics, DAQ, and F0 stripper foils.
Estimated time: 2 – 4 hours

Expected charge state: $^{28}Si^{9+}$
Expected energy: 7.4 MeV/u
(Fill in when you know) **Actual beam energy: ________________________**
Maximum intensity for F0 exit window: 1.3 eμA
We had 1.2 eμA in December 2006 with 6.9 MeV/u beam, maybe higher is also safe?

For calculation estimates in the run plan, I use 7.4 MeV/u, so you may need to re-calculate!

When the beam operators confirm ZnS spot, draw the beam profile at the F0 ZnS (82.8 mm setting)
Check and draw the halo with the ZnS w/ hole (102.8 mm setting)
A halo may be a problem resulting from multi-turn cyclotron extraction.
Please always document the halo each time primary beam is checked on ZnS!

Turn on detector biases, fill PPACs, send LN_2 to cryogenic gas target.
Please be careful with the PPAC filling, because we have no replacement!!
F2 SSD: -100 V
F3 DSSD: -80 V
F3 Ge detector: 2000 V

Expected Bρ: 1.21988 Tm

At first, open all slits.

Section I, A: Check at F1: Close F1 slits to 0 ± 1 mm to confirm beam center and F1 PPAC alignment

Section I, B: Check at F2:
Check with only F2 SSD to confirm the beam energy based on alpha calibration
Note data for F2 SSD channel and beam energy for high energy calibration
Check with F2 PPAC and F2 SSD
Confirm energy loss of beam in PPAC matches calculation
6.74421 MeV/amu (188.83791 MeV) by Ziegler's method (13.78 um mylar)
Check beam position at F2 PPAC
Slits open first
Close slits to 0 ± 1 mm to confirm beam center and F2 PPAC alignment
Note beam intensity at F2 by PPAC or SSD with F1 slit open
Close F1 slit to 0 ± 1 mm, compare intensity.
If no difference, leave F1 slit closed, otherwise open the F1 slit.

Section I, C: Check at F3:
Check with PPACa and PPACb
Check beam spot

Compare intensity to F2 (WF off)

Calculate WF transmission (%): Expect ~100 % transmission of primary beam

If transmission is poor, consider turning on WF and check again

If F1 slit is open, close to 0 ± 1 mm, compare to F2 data.

Check with only DSSD – the beam spot is reasonable for channel assignment?

The gain may not be low enough due to amplifier limits

The Y1-8 should have low enough gain to get raw primary beam energy

Insert PPACa, check beam spot

Check F3 ToF via PPACa start DSSD stop

Check energy at DSSD (mainly on channels Y1-8)

6.95433 MeV/amu (194.72112 MeV) by Ziegler's method (9.45 um mylar)

Section I, D: Check the F0 stripper foils

The foils are damaged, so we check the energy loss of the beam and 14+ production

Be foil: 2.5 um, F0 wheel setting 185°

Set Bρ for $^{28}Si^{14+}$ assuming it passes the Be foil

Check intensity at F2 (F1 slits narrow)

If you don't see anything, the foil has some problem

If you think the foil has a problem, follow these steps (otherwise skip)

Set Bρ for $^{28}Si^{9+}$ assuming the beam passes through the foil

Get F2 Intensity

Set Bρ for $^{28}Si^{9+}$ assuming the Be foil is not present

Get F2 Intensity, compare

Make a conclusion about status of Be foil

C foil: 0.6 mg/cm^2, F0 wheel setting 245°

Set Bρ for $^{28}Si^{14+}$ assuming it passes the C foil

Check intensity at F2 (F1 slits narrow)

If you don't see anything, the foil has some problem

If you think the foil has a problem, follow these steps (otherwise skip)

Set Bρ for $^{28}Si^{9+}$ assuming the beam passes through the foil

Get F2 Intensity

Set Bρ for $^{28}Si^{9+}$ assuming the C foil is not present

Get F2 Intensity, compare

Make a conclusion about status of C foil

The F0 stripper foil status (please circle):

Be foil:	Good	Bad	Not sure
C foil:	Good	Bad	Not sure

<u>Section II. Insert F0 target with no gas.</u>

Goals: Get more SSD/DSSD calibration data, check WF transmission, test ToF

Estimated time: 1 – 1.5 hours

Repeat steps in <u>Section I</u> **A-C** assuming a 13+ charge state

Be sure to get F2 SSD data

F0 target only: 6.52965 MeV/amu (182.83025 MeV) by Ziegler's method

F0 target + F2 PPAC: 5.81885 MeV/amu (162.92773 MeV) by Ziegler's method

F0 target + F3 PPACa: 6.04721 MeV/amu (169.32176 MeV) by Ziegler's method

Be sure to consider the F1 momentum spread and resulting WF transmission

Check NDBM vs. F0 Plastic vs. RF time for time-of-flight

Take some run data in this section for later analysis

F2 PPAC trigger

F3 PPACa trigger (pull out PPACb)

May take 1 hour for this data

Consider the resolution of the different methods

Consider threshold of Plastic signal

Check NDBM intensity against operator reported intensity

Ask the operators to change the attenuation many times

Use F1 PPAC to get the intensity also

You may need to additionally insert F0 havar stripper used in ^{11}C experiment

The beam energy might be too high for the SSD gains

We need to check the ^{11}C log book to get the thickness and F0 settings (write below)

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We can also use some gas in F0 if we need, but this is worse because of RI contamination

We shouldn't have to treat the ^{30}S like it is contamination! It's very sad for me.

Section III: $^{30}S^{16+}$ Production

Goals: Get a $^{30}S^{16+}$ beam of 10^5 pps at F3, get halflife data for PID

Estimated time: 12 – 14 hours

Put in 400 Torr of ^3He gas at F0 cryogenic target

Section III, A: Check F0 target thickness using primary beam

This is for checking the energy loss theories and checking for ice!

Use $^{28}Si^{13+}$ charge state for Bρ

Check beam at F2 with wide F1 slits

What kind of particles do we see (ToF vs. E)?

Check beam at F2 with narrow F1 slits

What kind of particles do we see (ToF vs. E)?

Compare to Ziegler's predictions, using a 4/3 factor for thickness (it uses ^4He data)

Compare to CRIB Optimizer predictions (also needs factor ~1.41 or maybe 4/3)

Insert F0 stripper, according to **Section I, D**

Order of preference: 1 – Be ; 2 – C ; 3 – crying ; 4 – nothing

When setting Bρ, consider the thickness we decided above for $^{28}Si^{13+}$

For the May 2008 experiment, we found best $^{30}S^{16,14+}$ at much lower Bρ than predicted!

Section III, B: $^{30}S^{16+}$ PID at F2

Make the F1 slits narrow (no more than ±5 mm)

Check the beam intensity at F2 SSD

Ask the operators to increase the primary intensity until it is ~10^3 pps at F2 SSD

$^{30}S^{16+}$ PID took a long time in May 2008 due to low primary intensity

PID on $^{30}S^{16+}$; of course you should PID other ions as well
Compare results with May 2008
Take PID data to disk

Section III, C: Optimize the F1 slit position for $^{30}S^{16+}$ transmission
You know the drill
Change F1 slits, check intensity at F2, check purity at F2
Regularly check the beam intensity with NDBM or operators.
Take the data to disk

Section III, D: Send the beam to F3
Take most of the data in this section to disk!
PPACa & DSSD data, WF off
PID with F0-F3 ToF vs. E
Can we gate ^{30}S in "RF vs. F3 ToF" data?
Can we gate ^{30}S in "RF vs. F3 PPACa X" data?
What other RI ions do we see?
Half lives, characteristic gammas?
Do we see any of these gammas in the Ge?
Check WF transmission
Turn on WF (~60 kV)
Check WF transmission
Check the beam profile, especially at PPACa
Full beam intensity check
Insert F3 PPACb (& beam stop attached to PPACb)
Check beam profile at PPACa
Compare intensity and profile
1) Does the ^{30}S intensity scale linearly with primary beam intensity?
2) Do the attenuators affect the RI beam profile at F3?
If "yes" to 1 or 2, check beam spot at F0 ZnS (w/o hole and w/ hole)
What is the maximum $^{30}S^{16+}$ intensity and purity we get at F3?
Is it >10% purity and ~10^5 pps?
Did you have any experiment you want to do with a ^{28}Si beam today?
Did you break radiation safety rules and bring nihonshu to J1?
What about in the waiting room, you brought beer right?
Call operators and ask if they prefer to work or party.
Get ^{30}S decay data
Pulsed beam (2 seconds on, 3 seconds off)
Get beta in coincidence with ^{30}S gamma ray
Decay curve for half-life (published: 1.178 seconds)
Does our decay data seem consistent with ^{30}S purity and intensity?

Section III, E: Check the F0 stripper foils as in *Section I, D*
Skip this step if the F0 strippers are all marked as Bad
Remember to remove the F0 cryogenic gas target for this step
If the F0 stripper(s) was okay before we went to ^{30}S production are they still okay?
Make any changes in *Section I, D* for Good / Bad / Not sure

Section IV: $^{30}S^{14+}$ Production

Goals: Get a $^{30}S^{14+}$ beam of 10^5 pps at F3, confirm half-life data with $^{30}S^{16+}$ for PID, check F1 degraders
Estimated time: 12 – 14 hours

Make sure it's still 400 Torr of ^3He gas at F0 cryogenic target
  Take out the F0 stripper foils

Section IV, A: Check F0 target thickness using primary beam
  This is checking for ice!
  Use $^{28}Si^{13+}$ charge state for Bρ
  Check beam at F2

When setting Bρ, consider the thickness we decided above for $^{28}Si^{13+}$
  For the May 2008 experiment, we found best $^{30}S^{16,14+}$ at much lower Bρ than predicted!

Section IV, B: $^{30}S^{14+}$ PID at F2
  Make the F1 slits narrow (no more than ±5 mm)
  Check the beam intensity at F2 SSD
    Ask the operators to increase the primary intensity until it is ~10^3 pps at F2 SSD
  PID on $^{30}S^{14+}$; of course you should PID other ions as well
  Compare results with May 2008
  Take PID data to disk

Section IV, C: Optimize the F1 slit position for $^{30}S^{14+}$ transmission
  You know the drill
    Change F1 slits, check intensity at F2, check purity at F2
  Regularly check the beam intensity with NDBM or operators.
  Take the data to disk

Section IV, D: Send the beam to F3
  Take most of these data to disk
  PPACa & DSSD data, WF off
    PID with F0-F3 ToF vs. E
      Can we gate ^{30}S in "RF vs. F3 ToF" data?
      Can we gate ^{30}S in "RF vs. F3 PPACa X" data?
      What other RI ions do we see?
        Half lives, characteristic gammas?
        Do we see any of these gammas in the Ge?
  Check WF transmission
  Turn on WF (~60 kV)
  Check WF transmission
  Check the beam profile, especially at PPACa
  Full beam intensity check
    Insert F3 PPACb (& beam stop attached to PPACb)
      Check beam profile at PPACa
      Compare intensity and profile
    1) Does the ^{30}S intensity scale linearly with primary beam intensity?
    2) Do the attenuators affect the RI beam profile at F3?
      If "yes" to 1 or 2, check beam spot at F0 ZnS (w/o hole and w/ hole)
    What is the maximum $^{30}S^{14+}$ intensity and purity we get at F3?

            Is it >10% purity and ~10^5 pps?
                Do you remember what I said about meeting this condition?
    Get ^{30}S decay data
        Pulsed beam (2 seconds on, 3 seconds off)
        Get beta in coincidence with ^{30}S gamma ray
        Decay curve for half-life (published: 1.178 seconds)
        Does our decay data seem consistent with ^{30}S purity and intensity?

Section IV, E: Put in F1 degrader

- Use 0.6 µm mylar F1 degrader
- Check beam at F2
- Re-tune D2
- Send beam to F3
- Repeat most of Section IV, D
    - May skip half-life measurement if we are firm on the PID
    - Emphasize WF transmission
        - Try different settings on Q4-7 for target focus and transmission
        - If transmission is poor (<50% from w/o degrader), consider D2 tuning
- Use 0.7 µm mylar F1 degrader
- Check beam at F2
- Re-tune D2
- Send beam to F3
- Repeat most of Section IV, D
    - May skip half-life measurement if we are firm on the PID
    - Emphasize WF transmission
        - Try different settings on Q4-7 for target focus and transmission
        - How does this transmission compare to the 0.6 µm transmission?

<u>Sections V+</u>

To be decided based on above results

Basic ideas:

- 16+ or 14+ is better?
- 500 Torr or other higher pressures at F0
- Proper charge-state distribution measurements
    - $^{28}Si^{11,12,13,14+}$
    - $^{30}S^{14,15,16+}$
        - For this case, compare to no stripper foil data (havar at higher energy)