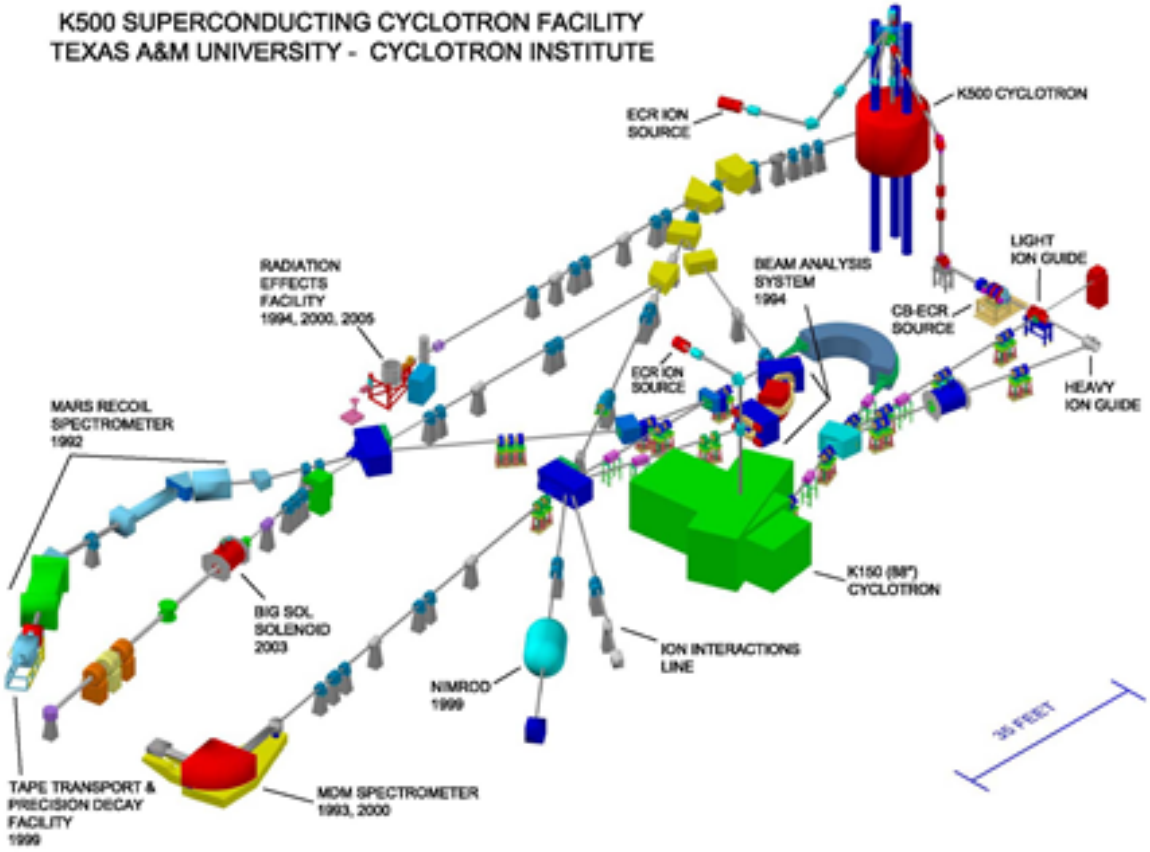
CYCLOTRON INSTITUTE
Texas A&M University

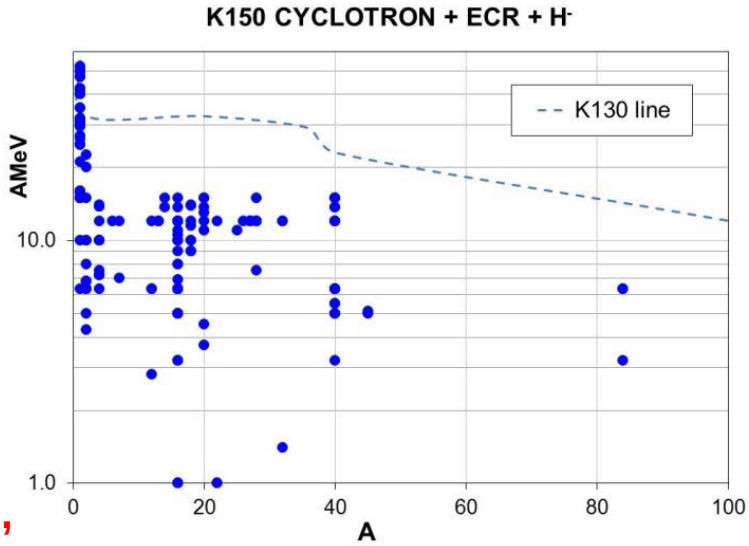
STATUS OF THE TEXAS A&M RADIOACTIVE BEAM PROJECT

D. P. May, G. Tabacaru, J. Ärje, G. J. Kim, & B. T. Roeder

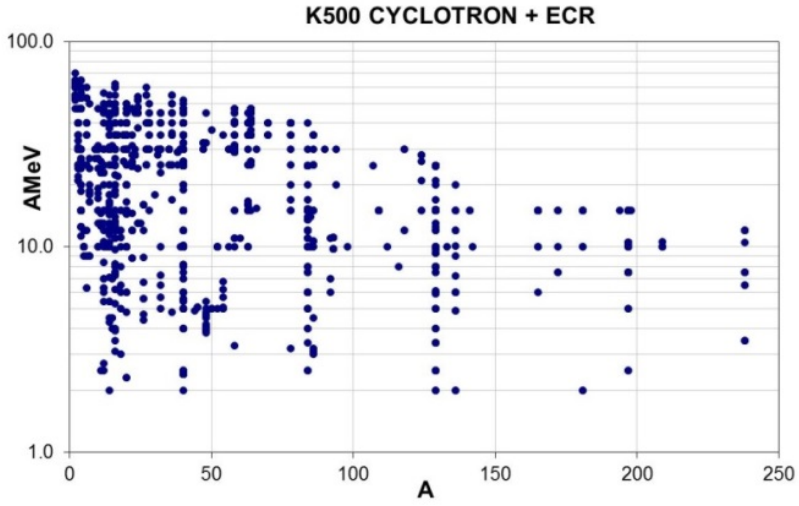


FACILITY CAPABILITY and ACTIVITIES

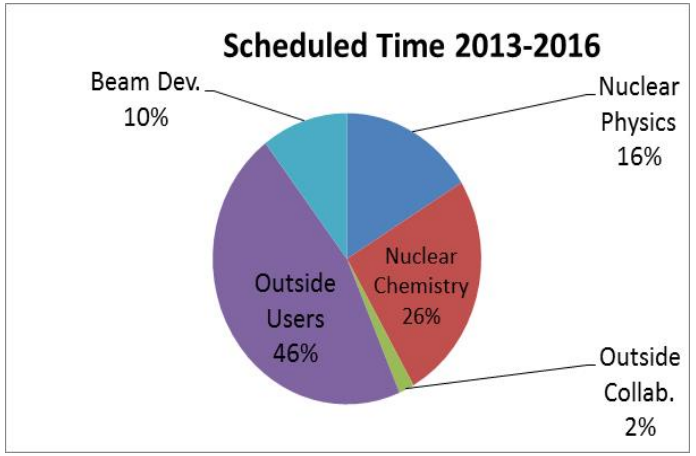
K150 conventional cyclotron (88”) injected by a 14.5+11 GHz ECR ion source and a H/D-minus ion source. Still lacking cryopanel operation.



K500 superconducting cyclotron injected by a 6.4 GHz ECR ion source, H2+ to U.

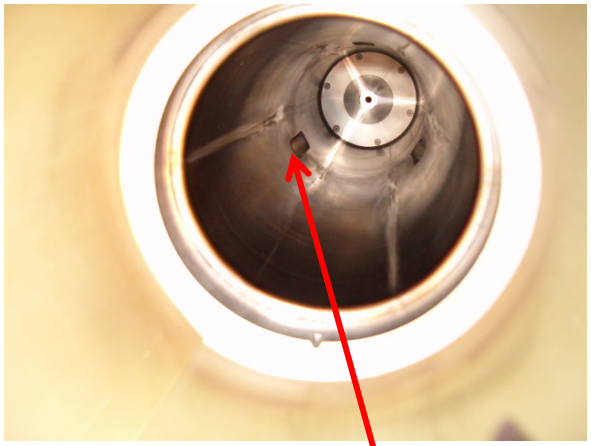


K500



K500 ECR1 ion source – useful for producing analogs to RIBs

Looking toward extraction



Radial port

So in addition to gases we can choose species from:

A low-temp oven

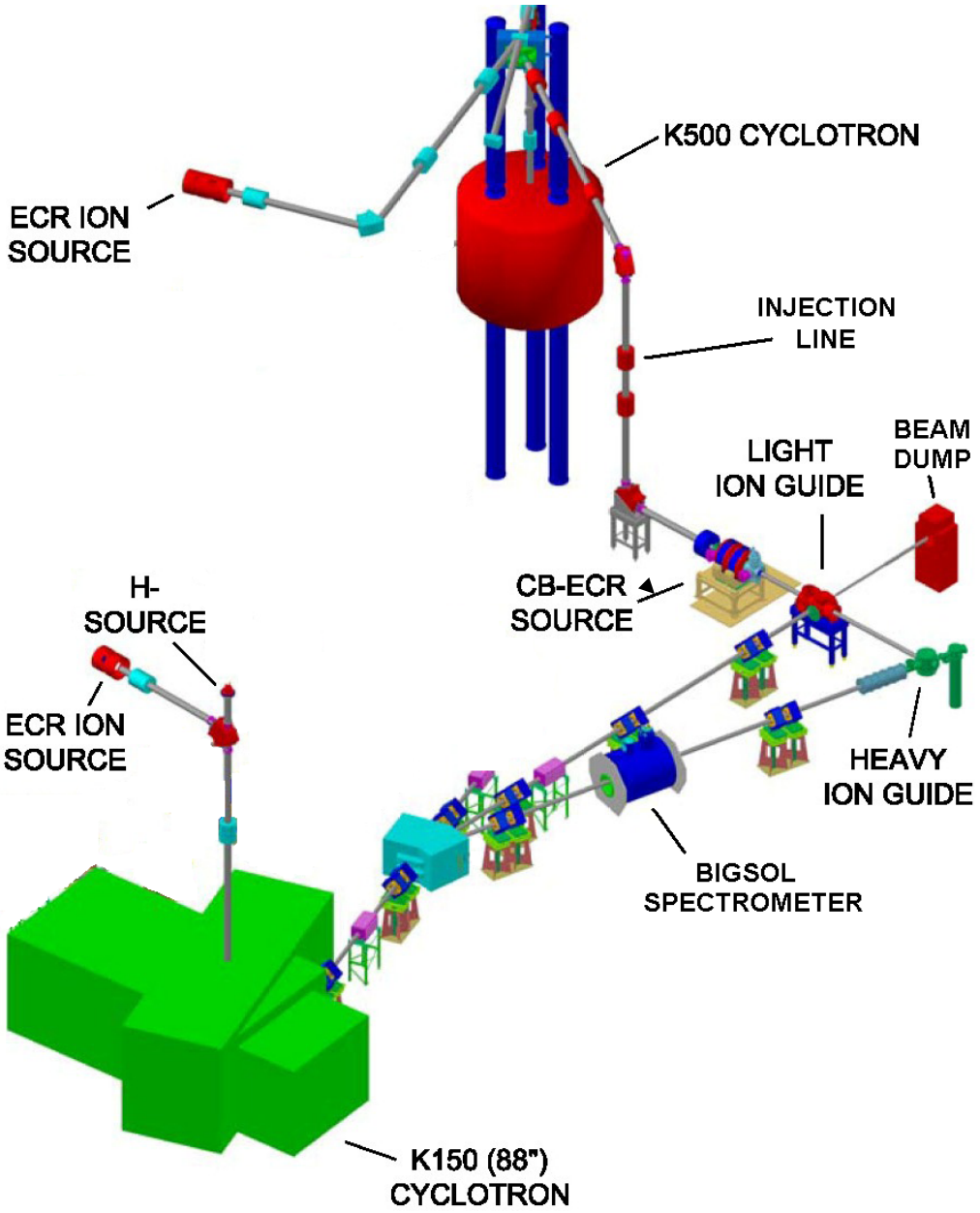
A hi-temp oven

Or a sputter fixture

And we are constructing an ultra high-temp oven, a copy of the one on the K150 ECR2.

Focus on the light-ion guide (LIG) and the charge-breeding electron-cyclotron-resonance ion source (CB-ECRIS).

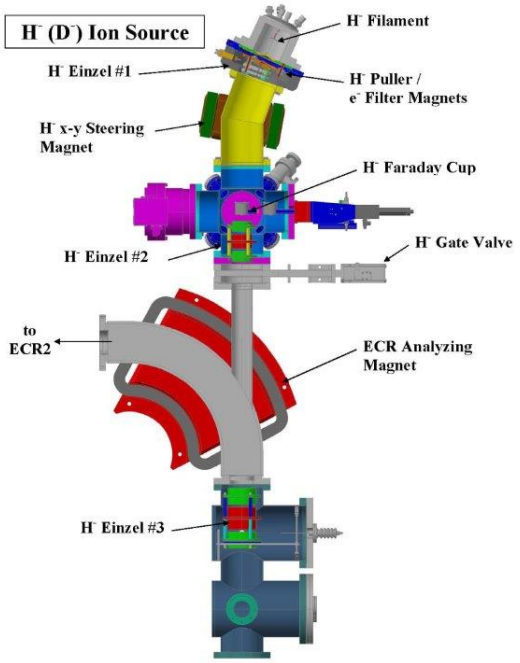
A spectrometer for heavy-ion guide has not been chosen.



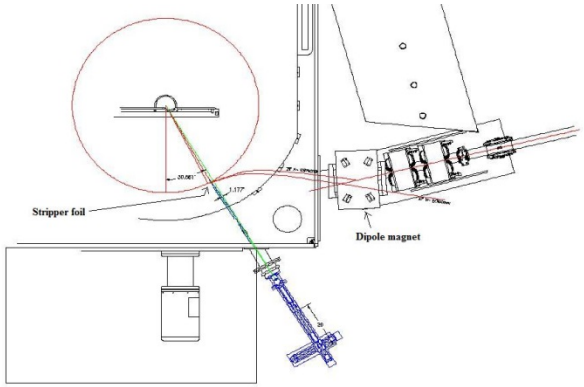
Steps for Radioactive Beams from LIG

- Intense proton beams from the K150.
- High production of radioactive 1+ beams from LIG.
- Efficient boosting to high-charge states.
- Tuning of the K500 and beam lines for RIBs.

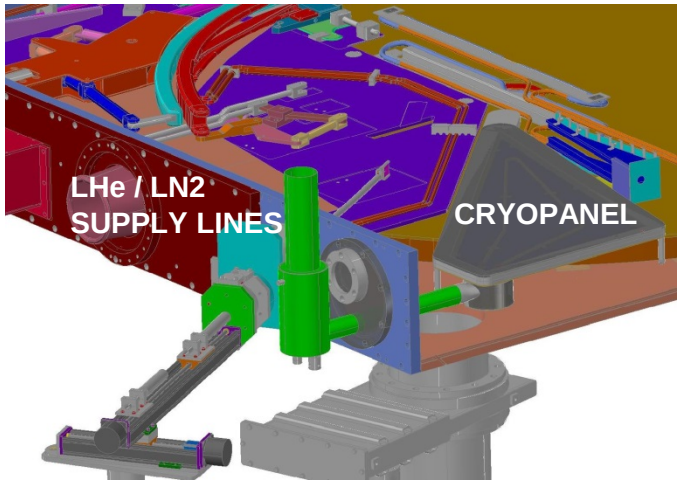
K150 proton beams



Multi-cusp H- source (JYFL), axially injected

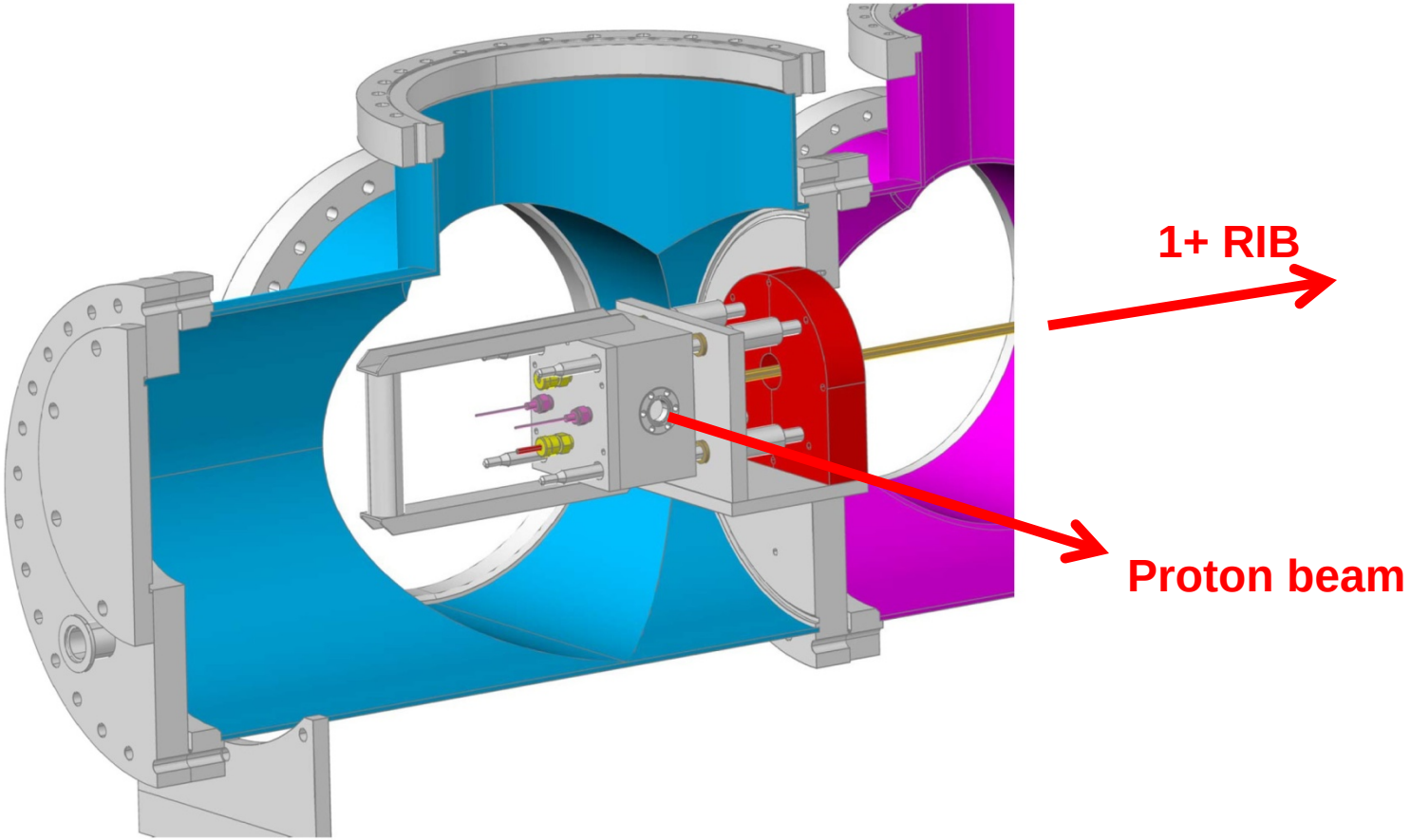


Stripper foil and exit dipole

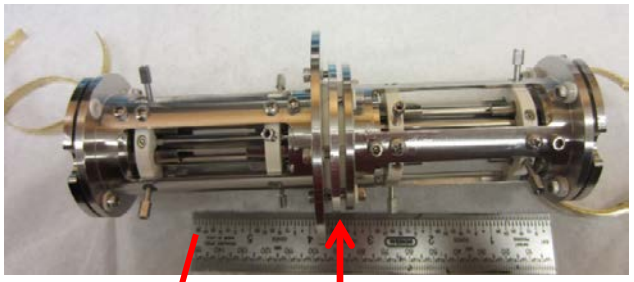


With LN_2 intensity of 6 AMeV $^{84}Kr^{23+}$ beam increased by about a factor of 30, but cryopanel still not connected to coolant source – LHe refrigerator being refurbished.

LIGHT-ION GUIDE – Gabriel Tabacaru and Juha Ärje



SPIG + CB-ECRIS Line, Accel-Decel – first trials

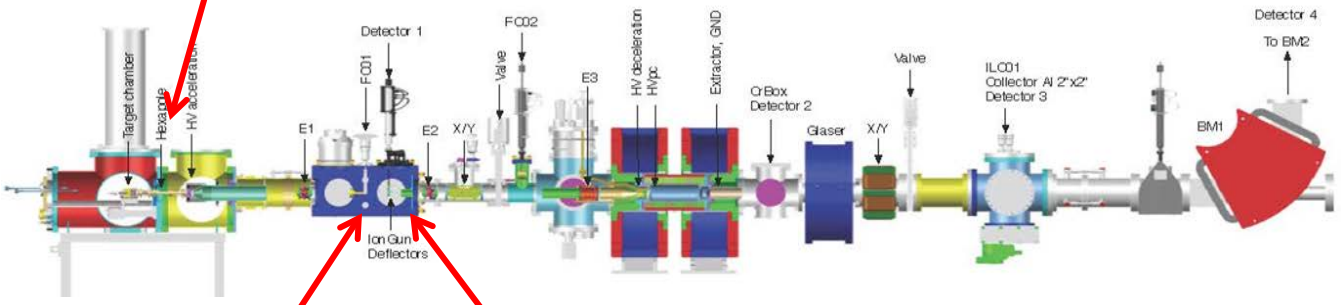


RF-only Sextupole Guide following JYFL design

Above shielding charge-bred beam of Ga-64 12+ at 23 pps

Smaller flux of Rn-220 29+ (from thorium)

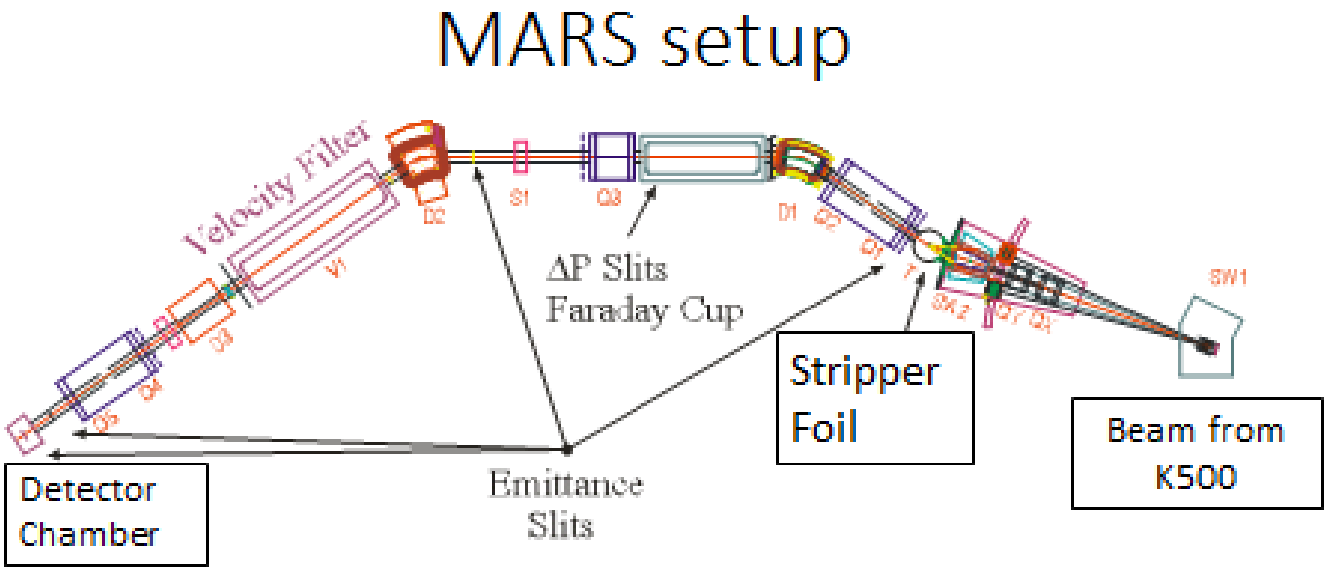
aperture



2X1E4 pps of Ga-64 with a 4μA proton beam

1+ alkali ion source + ES 90° deflector

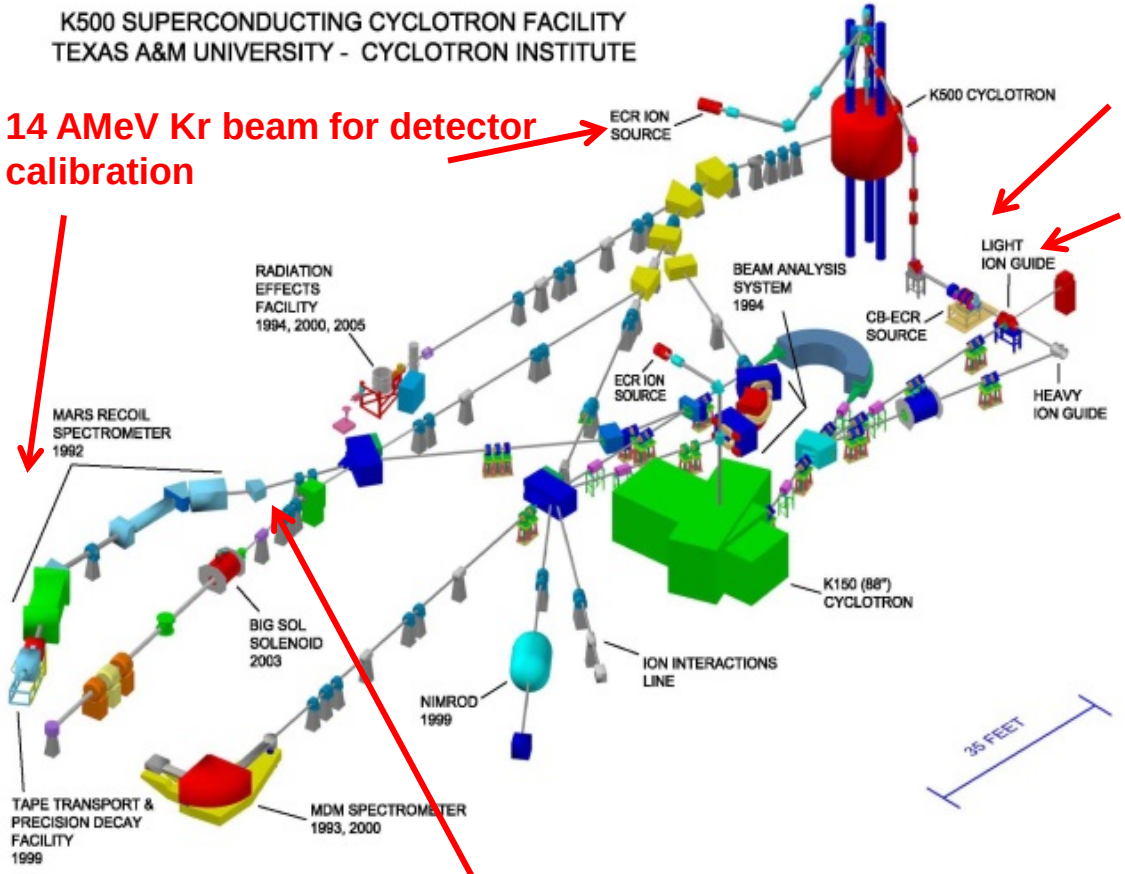
Accelerated RIB identification – Brian Roeder



- ^{27}Al foil (1/4 mil thick), thin ^{12}C (100 ug/cm^2) in target chamber
- MARS arm at 0° (With arm at 0°, velocity filter~constant, only tune rigidity).
- ΔE-E silicon telescope (64 µm + 500 µm) for particle ID, measurement

TUNING THE K500 AND ITS BEAM-LINE FOR RIBS – George Kim and Brian Roeder

First use charge-bred rubidium beam



14 AMeV Kr beam for detector calibration

14 AMeV O 3+ (.1876)

14 AMeV Rb 16+ (.1885) with shift in RF of 56 kHz

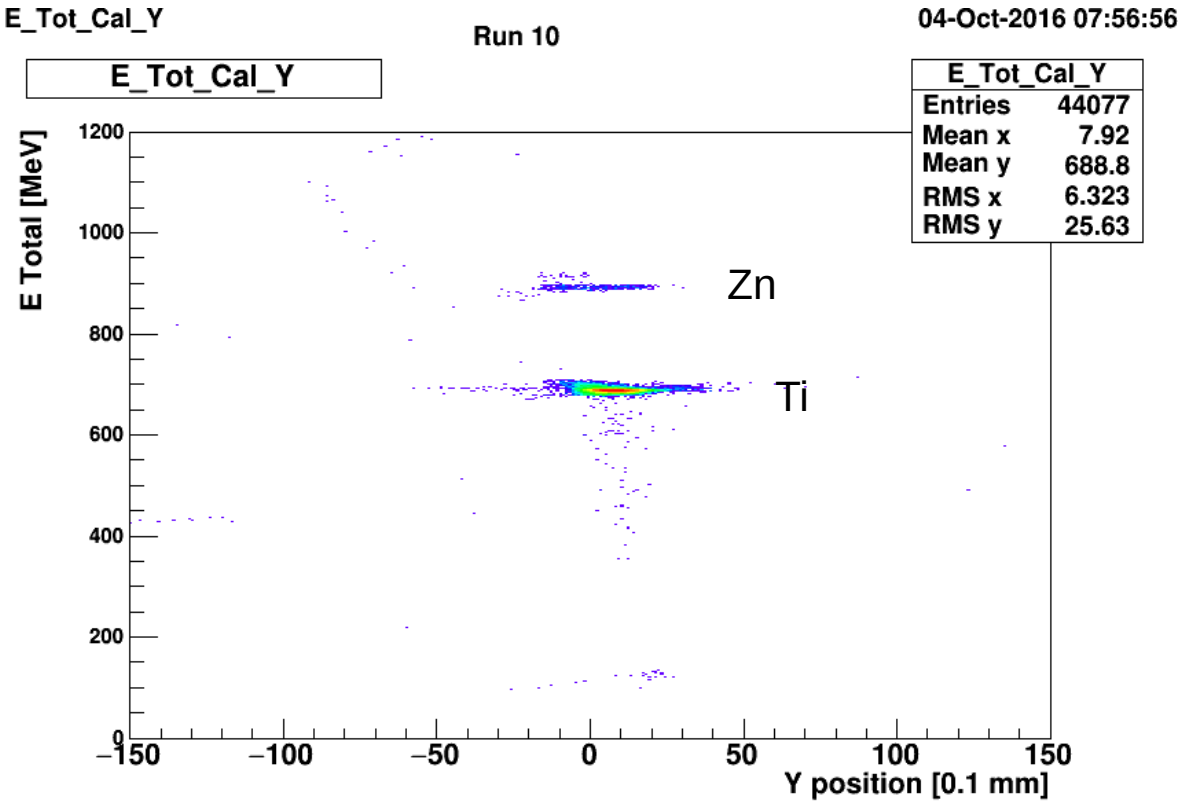
12 kHz to make the oxygen completely disappear from the detector. (RF = 12.24 MHz)

Beam Spot

Effort to detect accelerated RIB

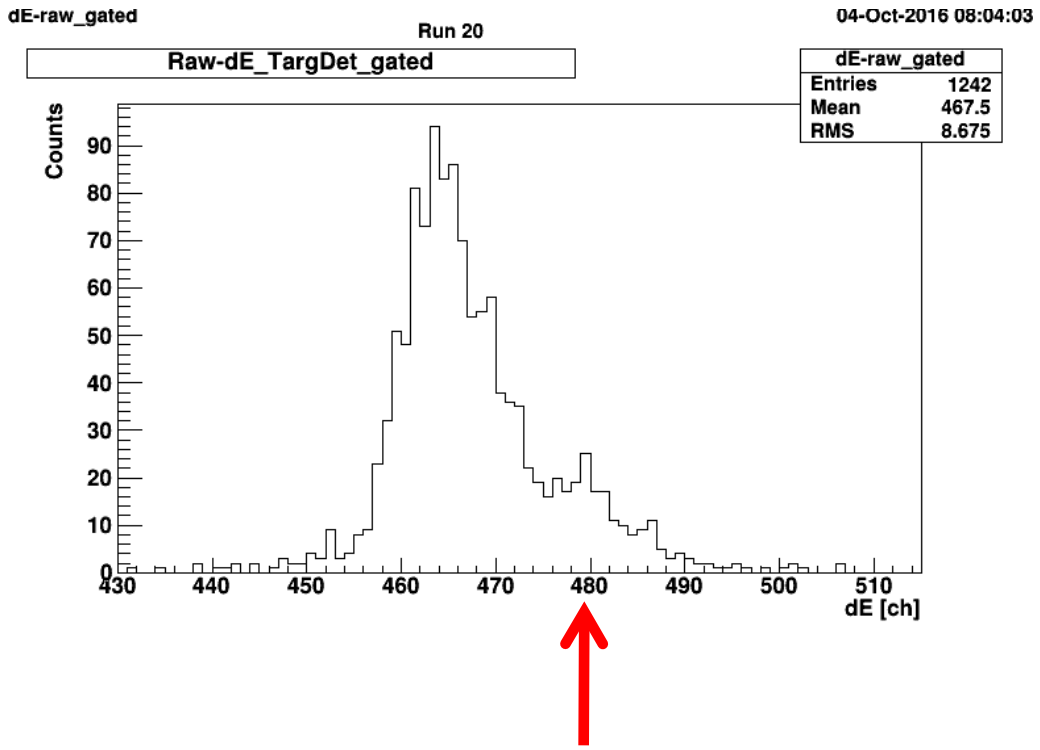
- MARS setup
- Day One – Calibration with ^{63}Cu at 14 MeV/u from ECR1.
  - Tuning
  - Calibration of MARS target detector
- Day Two – Measurement of $^{16}O^{3+}$, $^{64}Ga^{12+}$ charge states from ECR3 @ 14 MeV/u
  - Tuning
  - ^{16}O measurements
  - Shifting the K500 frequency
  - ^{64}Zn, ^{64}Ga measurements

MARS settings with $^{64}Zn^{29+}$, $^{64}Ga^{29+}$



- Saw a peak around 890 MeV consistent with ^{64}Zn.
- ^{64}Zn peak was still present at about the same rate with SPIG or proton beam off.
- High rate of $^{48}Ti^{22+}$ present. Why? (Al alloy 7075)
- No indication of ^{64}Ga at +9 kHz shift of K500 frequency.

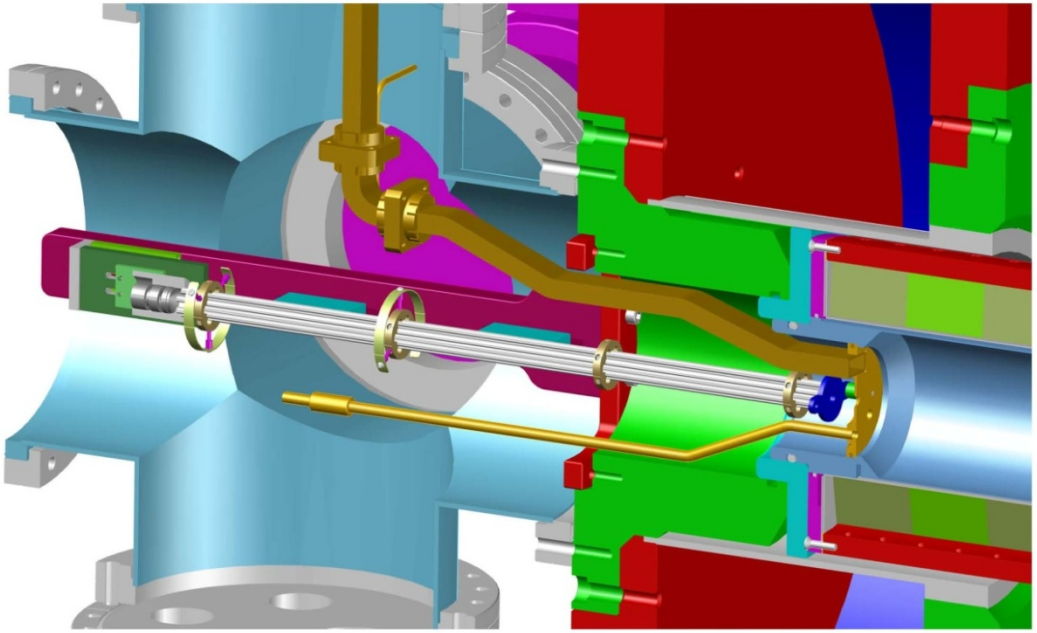
With small K500 frequency shift

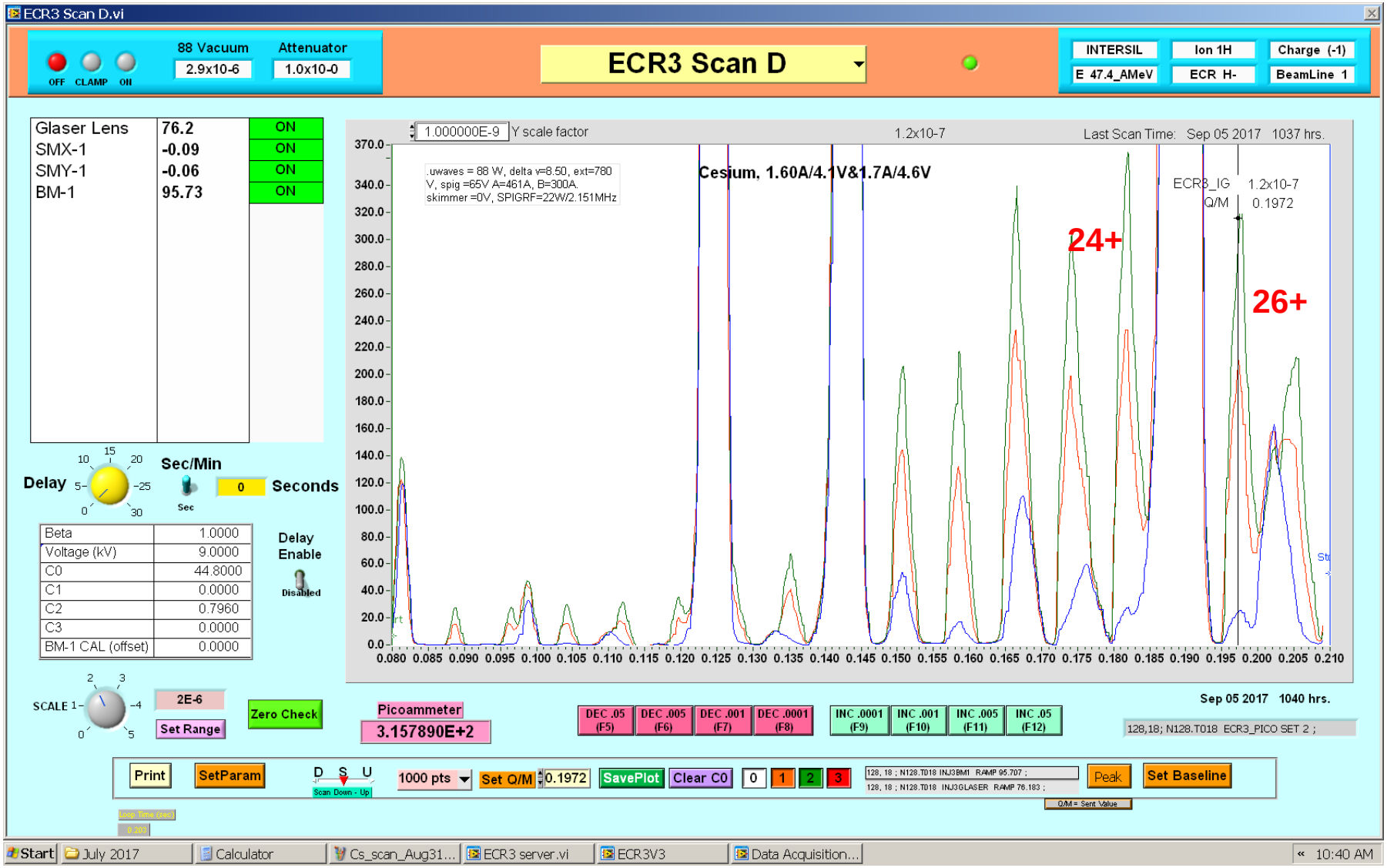


- For 29+, observed a “shoulder” on the Zinc peak. Saw about ~100 counts above ^{64}Zn background “tail”.
- Would be consistent with a ^{64}Ga observation.
- Could not separate species better with this detector setup. Indication not 100% clear.
- Need more Ga intensity!

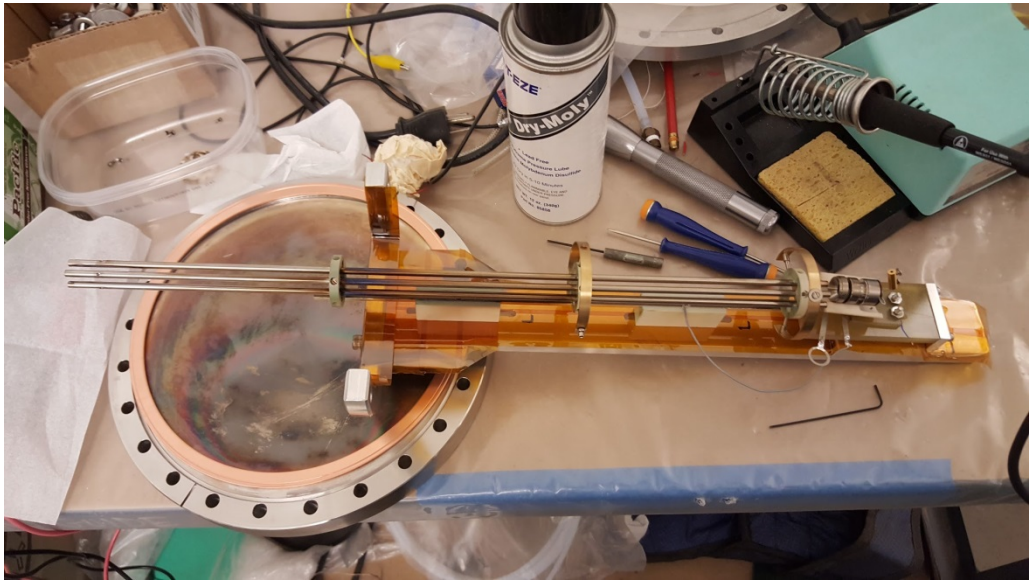
Test of direct SPIG injection into CB-ECRIS – Juha Ärje

Alkali ion source (HeatWave) and 0.4 meter SPIG



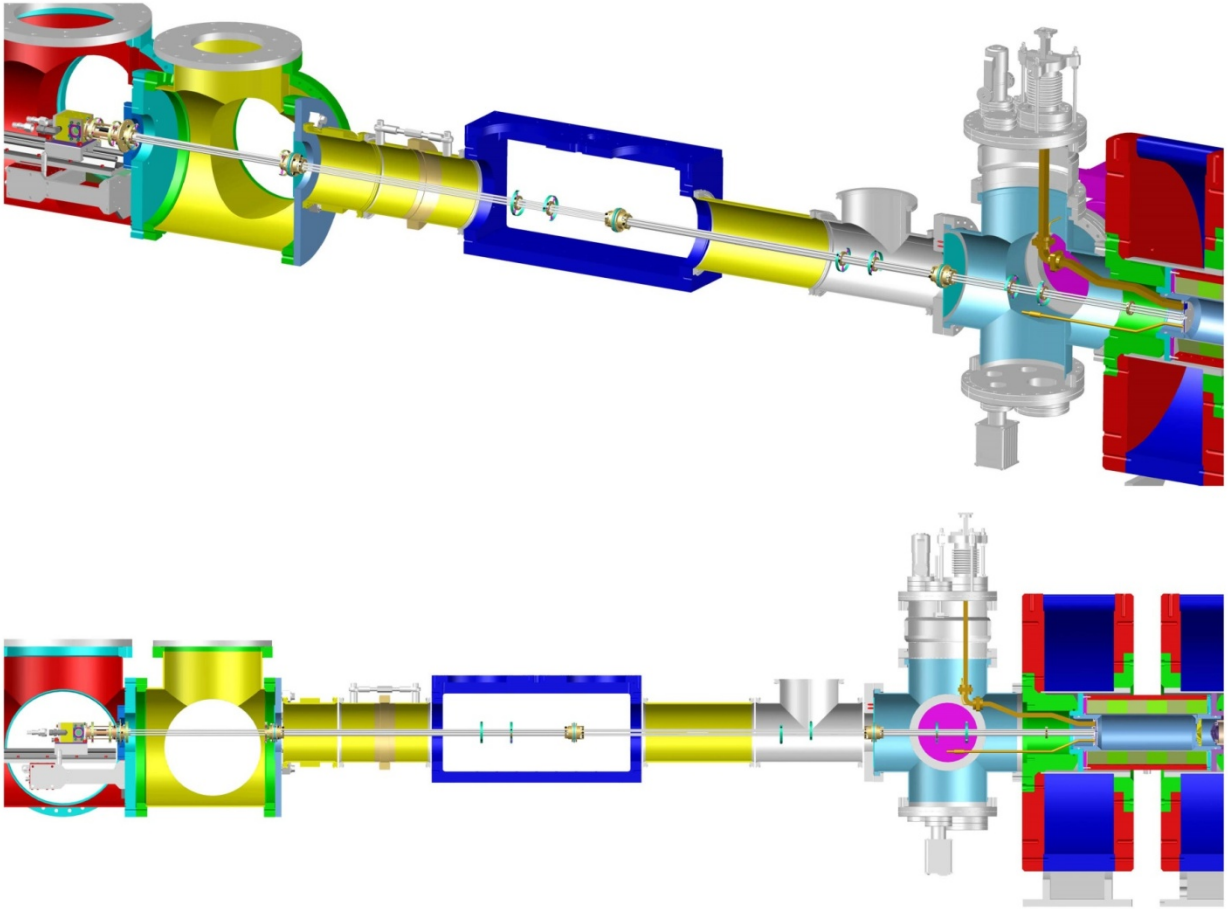

ECR3 Scan D.vi
OFF CLAMP ON
88 Vacuum
2.9x10-6
Attenuator
1.0x10-0
ECR3 Scan D
INTERSIL
Ion 1H
Charge (-1)
E 47.4_AMeV
ECR H-
BeamLine 1
Glaser Lens 76.2 ON
SMX-1 -0.09 ON
SMY-1 -0.06 ON
BM-1 95.73 ON
Delay
Sec/Min
Sec
0
Seconds
Beta 1.0000
Voltage (kV) 9.0000
C0 44.8000
C1 0.0000
C2 0.7960
C3 0.0000
BM-1 CAL (offset) 0.0000
Delay Enable
Disabled
SCALE
2E-6
Set Range
Zero Check
1.000000E-9
Y scale factor
1.2x10-7
Last Scan Time: Sep 05 2017 1037 hrs.
.uwaves = 88 W, delta v=8.50, ext=780
V, spig =65V A=461A, B=300A.
skimmer =0V, SPIGRF=22W/2.151MHz
Cesium, 1.60A/4.1V&1.7A/4.6V
ECR3_IG 1.2x10-7
Q/M 0.1972
24+
26+
370.0
340.0
320.0
300.0
280.0
260.0
240.0
220.0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0.080 0.085 0.090 0.095 0.100 0.105 0.110 0.115 0.120 0.125 0.130 0.135 0.140 0.145 0.150 0.155 0.160 0.165 0.170 0.175 0.180 0.185 0.190 0.195 0.200 0.205 0.210
Picoammeter
3.157890E+2
DEC .05 (F5)
DEC .005 (F6)
DEC .001 (F7)
DEC .0001 (F8)
INC .0001 (F9)
INC .001 (F10)
INC .005 (F11)
INC .05 (F12)
Sep 05 2017 1040 hrs.
128,18; N128.T018 ECR3_PICO SET 2 ;
Print
SetParam
D S U
Scan Down - Up
1000 pts
Set Q/M
0.1972
SavePlot
Clear C0
0 1 2 3
128, 18 ; N128.T018 INJ3BM1 RAMP 95.707 ;
128, 18 ; N128.T018 INJ3GLASER RAMP 76.183 ;
Peak
Set Baseline
Q/M = Sent Value
Start
July 2017
Calculator
Cs_scan_Aug31...
ECR3 server.vi
ECR3V3
Data Acquisition...
10:40 AM

SPIG condition after running



2.5 Meter SPIG

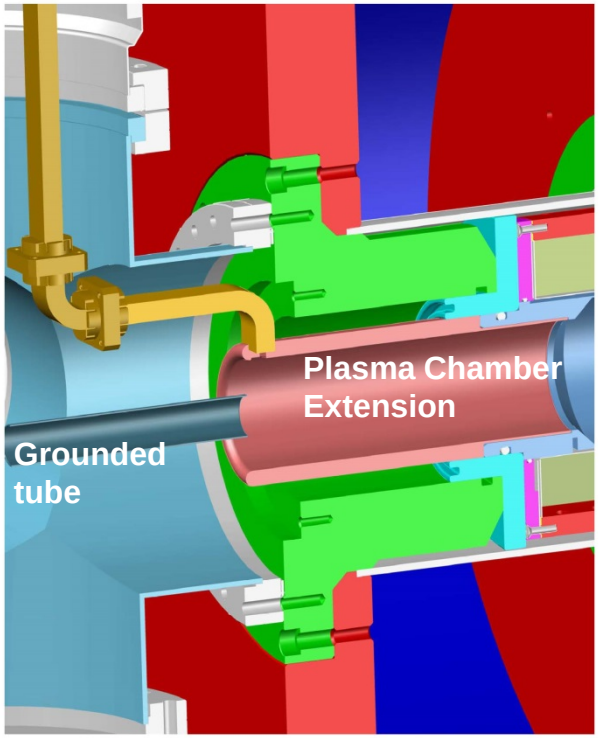
More tolerant of alignment error and also allows for multiple pumps and apertures to limit helium flow into CBECRIS



Next

- Design and detail 2.5 meter SPIG.
- In the meantime, investigate further the accel-decel option for 1+ CB-ECRIS injection.

CB-ECRIS Injection scheme from Richard Vondrasek – already tested as ion source.



If this is unsuccessful, the 2.5 m SPIG will definitely be constructed