ISAC front end and low energy beam transport tuning

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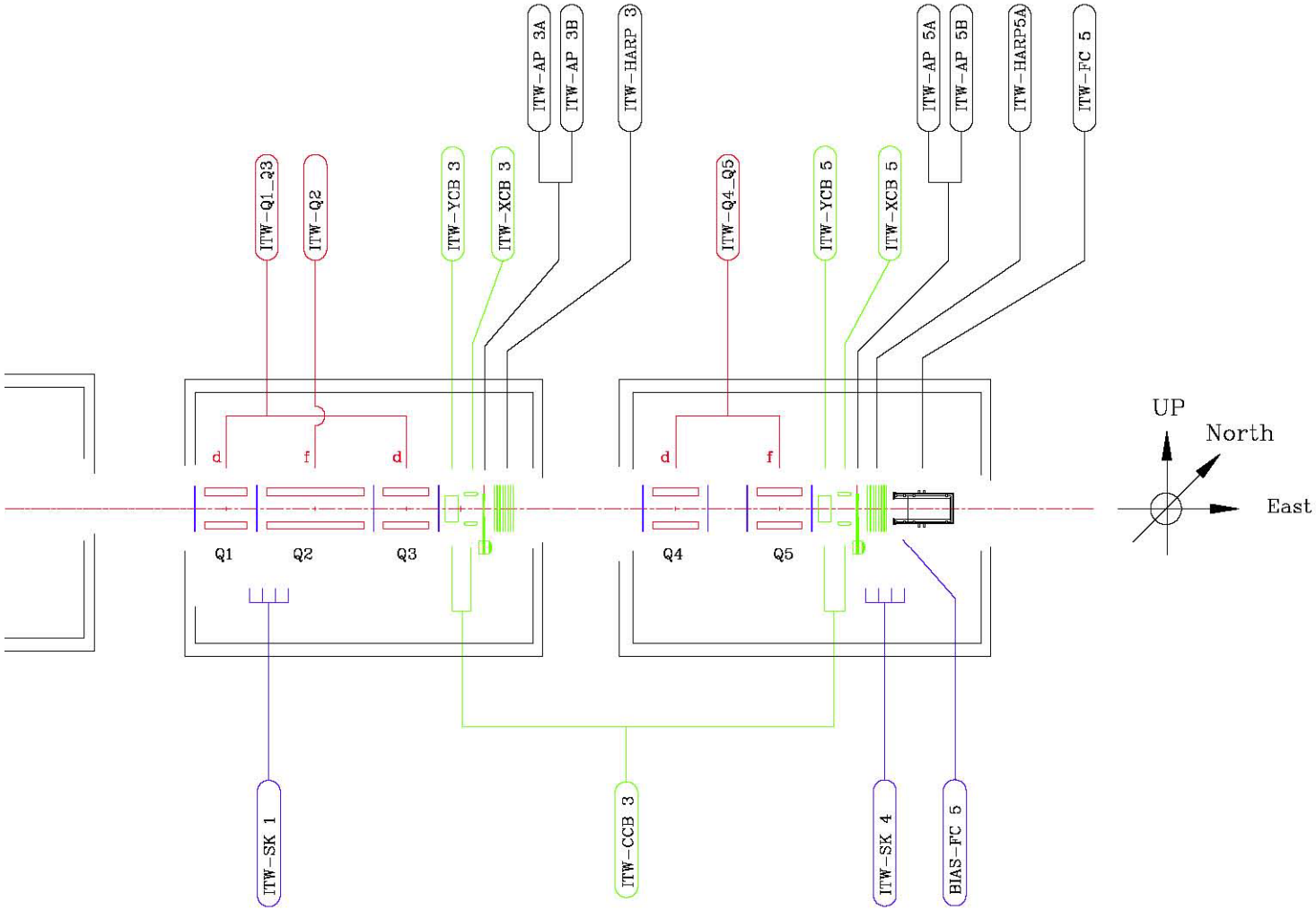
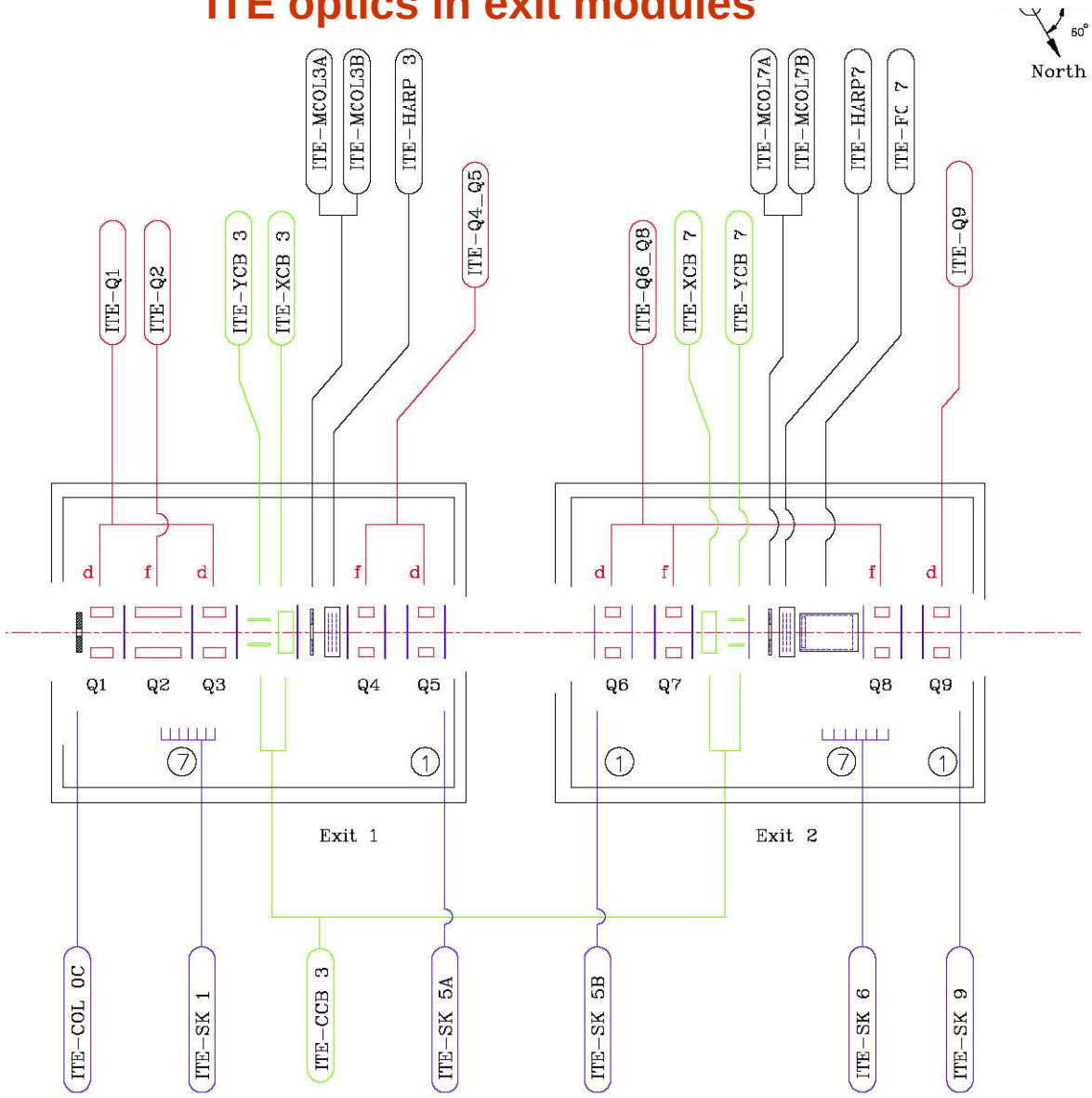
http://trshare.triumf.ca/~ames/PH555/injector-2.pdf

sources of information
tuning instructions in operator manual and on plone side
beam line diagrams

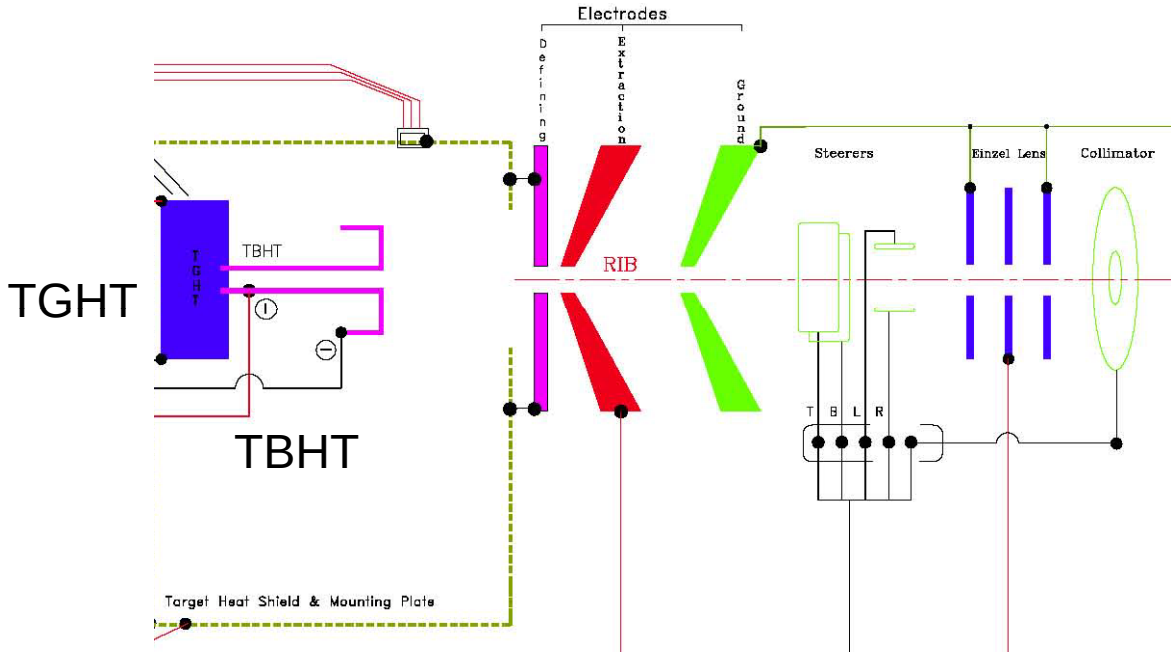
ITW optics in exit modules



ITE optics in exit modules



surface/laser ion source



TGHT

TBHT

BIAS

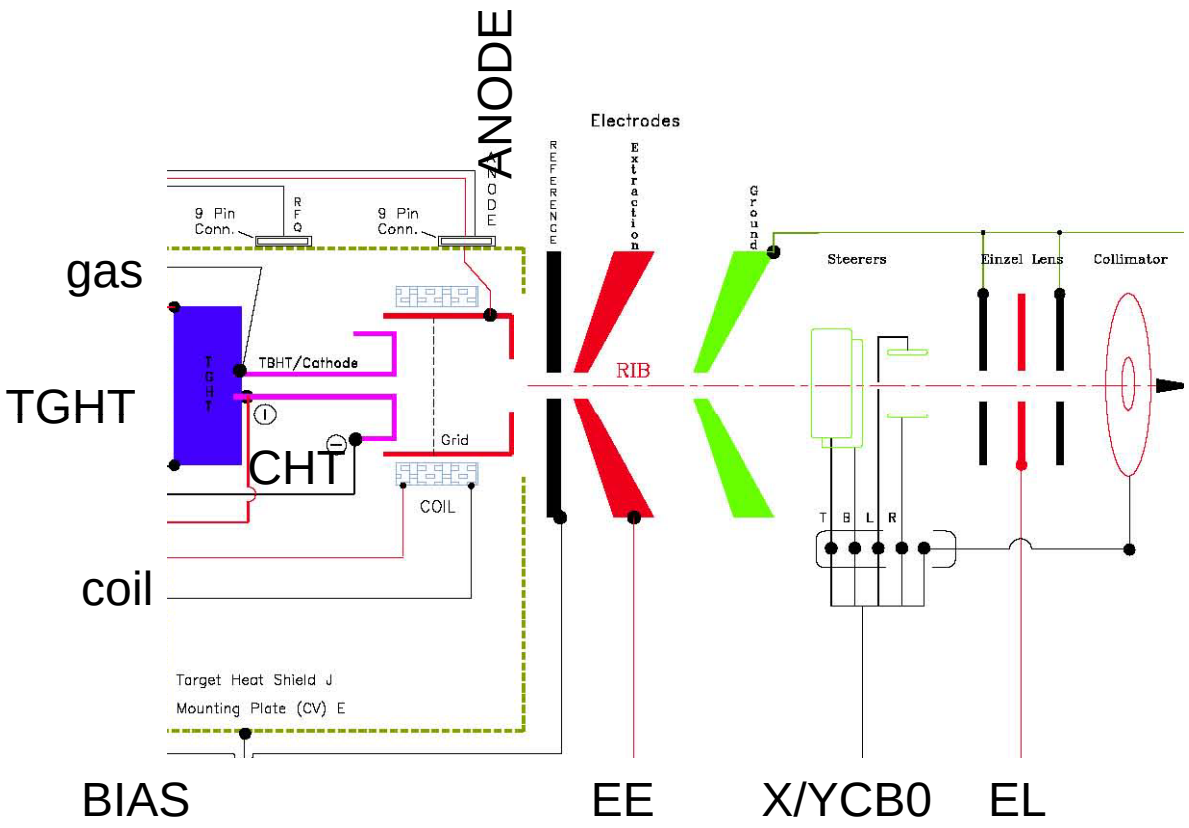
EE

X/YCB0

EL
(not installed in TM1)

laser

FEBIAD ion source



ion source start up

surface source

after high voltage conditioning up to intended running voltage +10%

nominal parameters for heaters

TBHT 235 A

TGHT 580 A maximum without p beam

(may be specified lower depending on target material)

with BIAS, EE, EL and optics switched on and set to nominal values

ITW:Fc5 or ITE:Fc7 in

ramp up speed at start <10 A /5 min

(can be faster if the target has been at high temperature before)

pressure PNG1 <1e-5 , IG1 <5e-6 T

ion source start up

FEBIAD source

before high voltage and heaters are started gas lines have to be purged and ballast pumped.

high voltage conditioning up to intended running voltage +10%

set ANODE to 150 V

COIL to 40 A

nominal parameters for heaters

TBHT 280 A

TGHT 580 A maximum without p beam

(may be specified lower depending on target material)

with BIAS, EE, EL, ANODE, COIL and optics switched on and set to nominal values

ITW:Fc5 or ITE:Fc7 in

ramp up speed <10 A /5 min

(can be faster if the target has been at high temperature before)

pressure PNG1 <1e-5 , IG1 <5e-6 T

general tuning remarks

Tuning goals

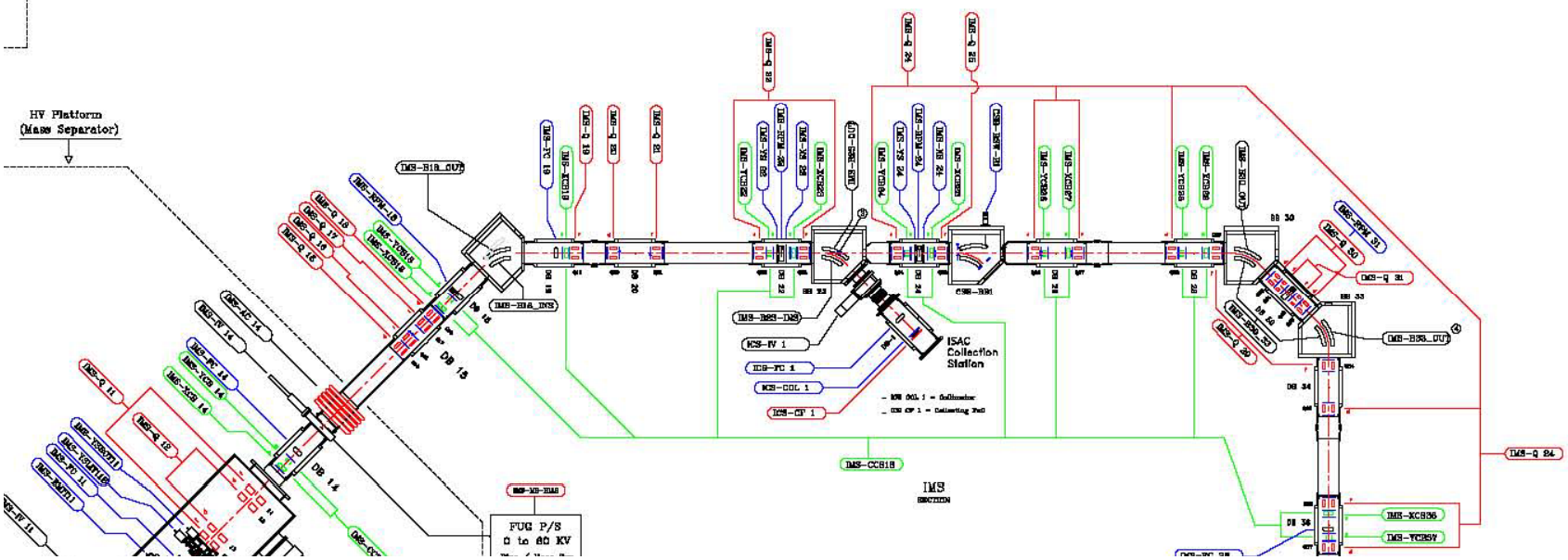
1. Maximize the intensity at the experiment
2. Maximize beam purity (mass resolution)
3. Ensure optimum size and position of the beam at the experiment

Tuning strategies

- Be patient.
  The beam intensity from the ion source may be low and may vary with time. Frequently check upstream Faraday cups to make sure the changes you see are really related to the changes you applied.
- If you change a setting and you do not see any significant effect go back to the original value
- Do not change elements far upstream from the diagnostic you are looking at. If necessary go back.
- Make use of all available diagnostic elements.
- Steering should be minimized
- Quadrupoles in periodic sections should be kept at theoretical values.
- Bender voltages may be adjusted for centering the beam in horizontal direction. Use RPMs if doing so.

matching section

periodic section



general tuning remarks

Beams for tuning

In general a stable isotope with a mass close to the isotope of interest for the experiment(s) should be chosen.
After the target has received protons only those isotopes specified by the target experts have to be used. This is to avoid contaminations resulting from radioactive isobars, the amount of which depends on the target material and ion source. In some cases yield measurements are necessary to determine if a beam is “safe” for tuning.

In case of a surface source alkali salts are added to the target material. As they evaporate fast they can only be used for a few days after start up. Normally ^{27}Al is more stable over a longer period. Although they may show up with a high intensity 23Na or 39K should not be used for tuning, as they are present as impurity in many materials and are easily ionized. This results in high intensity fluctuations and different beam properties. In some cases beams from the target material (for example ^{238}U) may be used as well.

general tuning remarks

Beams for tuning

In case of a FEBIAD source beams from residual gas ions can be used. Those are ^{12}C, ^{14}N, ^{16}O and molecules of those. Be careful when using molecules like for example mass 28. Usually it is one of the highest peaks in the mass spectrum but it contains CO and N_2 . With there mass very close to each other they cannot be resolved by the preseparator but by the main separator. That means you will see low transmission through the main separator or a broad beam. For heavier masses Ar, Kr or Xe gas can be let into the source. Alkali ions can be seen as well, but at lower intensity compared to a surface source.

front end tuning (part 1)

The Goal of the initial front end tuning is to center the beam through the optical elements in the exit modules and transport it with minimal losses to the preseparator.
As the position of the source and the angle of the extracted beam may change with temperature and may be different for every ion source target combination optimization has to be done for every new target or if the high voltage is changed.
For a new target the optimization should start with the steerers set to neutral and the quadrupoles set to their theoretical values.
Theoretical values for EE and EL:
EE 10% of BIAS if no EL is used (TM1) 3-5% of bias with EL
EL 40-50% of BIAS
The beam should be monitored on the harps (ITW:harp3/5A, ITE:harp3/7)
Steerers xcb0 and ycb0 should be adjusted by watching harp3.
A good setting has been achieved if the beam position doesn't move while changing the quadrupoles Q1 and Q2.
After this the other steerers should be optimized by centering the beam on harp5A (harp7) and maximizing the current on the Faraday cup.

front end tuning (part 2)

With the steerers set optimization of the optical elements can be done.
Start with EE and EL and maximize the current on the Faraday cup.
Follow with the other quadrupoles. With the presently used ion sources ITE:Q4 should stay at 0.
After changing EE and EL steering may have to be readjusted.
After optimization the intensity on the skimmers should be minimized.
At this point a “rough” optimization of the quadrupoles is sufficient as Q1 and Q2 may have to be changed again when optimizing the beam through the preseparator.

Now the beam can be send through the preseparator and tuning according to the plone side can follow.

https://isacops.triumf.ca/beam-delivery-tuning-1/tuning-tips/Place-Holder-Front-End-Tuning-Ion-Source-to-IMS

answers to questions

1. How is the IMS:YSLIT10A center position set? Under what circumstances should this be changed from the default (31.50mm)?
   With the correct setting of the steeres the beam position should not change when changing the quadrupoles. This gives the correct position of the slit. It should not change for different beams.

2. Steering (especially horizontal) between the Separator Magnets. Should this be minimized and corrected for in the front-end?
   Yes.

3. Front-end quads. For the last few tunes Q1 & Q2 have had to be set far from theory. Has something changed? Should the "theory" numbers be updated?
   The values for those quadrupoles vary because of differences in the ion sources. Theory values will be updated to reflect changes in the ion sources design.

answers to questions

4. Tips on finding beam after Mass Separator. It is usually easy to tune beam up to IMS:MB2 (after optimizing with IMS:MB1), but often there are difficulties in seeing beam on IMS:FC11 and or IMS:FC14. Often time it required stepping IMS:MB2 until beam is visible on downstream cups, but some times it's far from the set-point that it raised question on the isotope identity. Are there any suggestions on tuning through IMS:MB2?

   The theoretical values for the field settings are being updated at the moment

5. Restriction on EE: Currently, the IOPS manual has EE at ~ 10% of bias, but IOPS sometimes get conflicting information (not considering beam profiles for transport). What is the safe operating limit for EE's that IOPS may use when tuning: Voltage Limit and Current Limit with respects to Bias. Also, there is 2/2.5kV limit on EE for surface source with EL, is this restriction still valid?

   Both target stations should be able to stand 5 kV at the EE
   If an Einzel lens is used not more than 2.5kV are needed.