# Tuning procedure for H8 ion beam setting

22nd of January 2020

The ion beam in the H8 beamline can be either primary, directly extracted from SPS and transported through the beamline at the same energy, or fragmented, propagating through the

1. BEAM FILE SETUP

- Set TAX1 (XTAX.042.018) position to -140 mm (80 mm opening)
- Set TAX2 (XTAX.042.020) position to -140 mm (80 mm opening)
- Load beam file H8A.R2E.010 (date: 12.11.2018). The AppLE.py graphical output for the optics for this beam file is displayed below.
  The optics file is called h8micro07.

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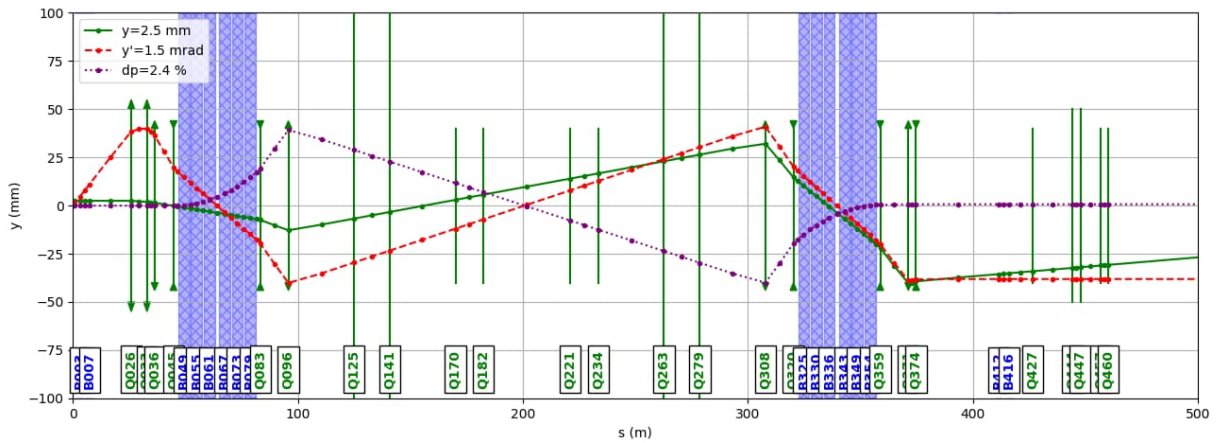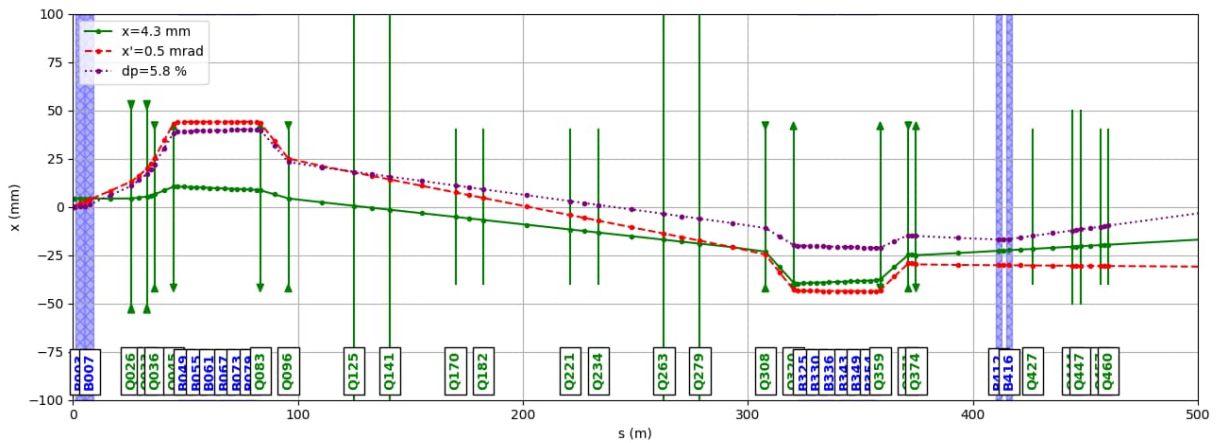
- Attention! Primary ion beam can have a very high intensity and it is essential to ensure that the readings of the radiation monitors do not exceed the limits prescribed by the RP!
- Check that the collimator settings are as follows:
  - COLL01 (XCSH.042.064) = ± 2 mm
  - COLL02 (XCSH.042.128) = ± 4 mm
  - COLL03 (XCSV.042.132) = ± 2 mm
  - COLL04 (XCSV.042.185) = ± 2 mm
  - COLL05 (XCHV.042.202) = ± 2 mm
  - COLL06 (XCHV.042.203) = ± 3 mm

2. ION BEAM TO T4 REGION

- Switch on the T4 wobbling by loading e.g. the file T4A.SBA.000 with properties
  - P0 beam is off
  - H8 beam is switched to primary
  - H6 beam is off
- Set T4 target head to position -100 mm (Air).
- Combined symmetry (position and angle) of proton beam incident onto T4 ≥ 90 % (SPS Page 1). Ask CCC to re-steer if necessary.

3. STEER ION BEAM THOUGH THE BEAMLINES

- The settings below apply to the maximal momentum of the ion beam of +380.45 GeV/c proton equivalent. Please scale the magnet settings proportionally to momentum in case ions with different momentum are extracted.

- Horizontal Steering through COLL01 and COLL02
  - Scan COLL01 collimator
    - Scan COLL1 from -3 to +2 mm onto SCINT01 with slit 1 mm and 11 steps
    - Set COLL01 center to the value providing maximal beam intensity at SCINT01
    - Open COLL01 gap to ± 2 mm around this center
  - Scan TRIM11 (TRIM.042.094) through collimator COLL02 onto SCINT01
    - Set COLL02 collimator jaws to ± 0.6 mm
    - Scan TRIM11 from -30 A to +0 A in steps of 2 A
    - Set COLL02 collimator jaws ± 4 mm
- Vertical Steering through COLL03
  - Set COLL03 collimator jaws to ± 0.5 mm
  - Double scan BEND01 (BEND.042.049) and BEND01 (BEND.042.061) from -1240 A and -1200 A in 11 steps of 2 Amps with factor 1.0, counting on SCINT01
    (Sensitivity: 1.0 mm position change at COLL03 per Ampere of bend current change)
  - Set COLL03 collimator jaws back to ± 2.0 mm

- Vertical parallel displacement
  - In case no sufficient (~10^5 ions per spill) beam intensity can be achieved by the vertical steering above:
  - Set COLL03 collimator jaws to ± 0.5 mm
  - Double scan BEND01 (BEND.042.049) and BEND02 (BEND.042.061) from -1270 A to - 1170 A in 11 steps of 10 Amps with factor -1.0, counting on SCINT01
    (Sensitivity: 0.01 mm position change at COLL03 per Ampere of bend current change)
  - Set COLL03 collimator jaws back to ± 2 mm

4. STEERING ION BEAM TO THE EXPERIMENTAL ZONES

- Open COLL09 (XCHV.042.407), COLL10 (XCSH.042.424) and COLL11 (XCSH.042.442) to ± 40.0 mm
- Vertical steering
  - Set collimators COLL07 (XCSV.042.404) and COLL08 (XCHV.042.406) to ± 1.0 mm
  - Double scan BEND03 (BEND.042.325) and BEND04 (BEND.042.330) from from -1240 A and -1200 A in 11 steps of 2 Amps, counting on SCINT05 (XSCI.042.463)
    (Sensitivity: 1.4 mm position change at COLL07 per Ampere of bend current change)

- Horizontal steering
  - Set collimator COLL10 (XCSH.042.424) to ± 1.0 mm
  - Double scan BEND05 (BEND.042.412) and BEND06 (BEND.042.416) from -830 A to – 1030 A in 11 steps of 20 Amps with factor 1.0, counting on SCINT05 (XSCI.042.463)
    (Sensitivity: 1 mm position change at COLL10 per 50 Amperes of bend current change)

5. SET THE REQUIRED BEAM PARAMETERS AND CLEAN THE BEAM

For the baseline beam optics (H8A.R2E.010) suggested for the set-up in Section 1 the beam is parallel at the experiment location. In case the parallelism is to be maintained, the beam size can be modified by collimating the beam. This, however, has direct consequence on the beam intensity, which reduces when the beam is collimated to a smaller size.

- Vertical beam size
  - Scan collimators COLL07 (XCSV.042.404) and COLL08 (XCHV.042.406)
    - Open collimator COLL08 to ± 10.0mm
    - Scan COLL07 jaws symmetrically from ± 1.0 mm to ± 5.0 mm in 9 steps
    - Set COLL07 jaws to the values approximately providing desired vertical beam size at the profile monitor XWCA.042.404
    - Scan COLL08 jaws symmetrically from ± 1.0 mm to ± 5.0 mm in 9 steps
    - Set COLL08 jaws to the values providing desired vertical beam size at the profile monitor XDWC.042.476 and removing the beam halo to a sufficient degree

- Horizontal beam size
    - Scan collimator COLL10 (XCSH.042.424)
        - Start with following jaw settings: left: ± 1.0 mm
        - Scan until following jaw settings: left: ± 10.0 mm
        - Number of steps: 10
    - Set COLL10 to the values providing desired horizontal beam size at the profile monitor XDWC.042.475
    - Verify if the horizontal beam size is as desired on the monitor MWPC03 (XWCA.042.403)
    - Verify if the vertical beam size is as desired on the monitor MWPC04 (XWCA.042.404)

An alternative for beam size modification is the focusing of the beam with help of the focusing quadrupoles. However, at the maximal primary ion beam momentum the strength of the focusing quadrupoles upstream of the zones H8Z and H8Z does not suffice to achieve a focal point in the aforementioned user zones. Setting the last two quadrupoles to the following values:

- QUAD.042.371 = -601.4 A
- QUAD.042.374 = +115.1 A

Ensures the minimal beam size in the zones H8Z and H8A. Afterwards

- Verify if the horizontal beam size is as desired on the monitor MWPC03 (XWCA.042.403)
- Verify if the vertical beam size is as desired on the monitor MWPC04 (XWCA.042.404)

- Beam intensity modulation
    - Open collimator COLL01 (XCSH.042.064) to the values providing desired beam intensity at scintillator SCINT02 (XSCI.042.403) at the location of the experiment in H8Z or H8A
    - If the required beam intensity has not been achieved set COLL01 (XCSH.042.064) to the value closest to the required intensity
    - Open collimator COLL02 (XCSH.042.128) to the values providing desired beam intensity at scintillator SCINT02 (XSCI.042.403) at the location of the experiment in H8Z or H8A
    - If the required beam intensity has not been achieved set COLL02 (XCSH.042.128) to the value closest to the required intensity
    - Open collimator COLL04 (XCSH.042.185) to the values providing desired beam intensity at scintillator SCINT02 (XSCI.042.403) at the location of the experiment in H8Z or H8A

6. FRAGMENTED ION BEAM

The primary ions can be fragmented into smaller ions with lower Z and A by introducing material into the beam path.

- Open Obstacle Status window
- Set obstacle XCON.042.130 to position -90 mm (Polyethylene of 40 mm length)
- In the beam file browser, click on the beam file for the hadron beam with FM (Filter Mode) in the comment line (e.g. H8A.NUCLEON.005). Filter mode optics ensures that there is a focal point at the location of the secondary target and the acceptance is maximal downstream of it.
- Press "Extrapolate" button on the bottom.
- Keep Conversion Type at "Hadron => Hadron".
- Change the secondary momentum to the proton equivalent momentum of the primary ion beam.
- Set "Momentum change at" to TRIM.042.133
- Set "Tertiary Momentum" to the required momentum value for the fragments in GeV/c.
- Load the created beam file.
- Verify if the target (XCON.042.130) is set to 40 mm of polyethylene. If it is not the case, set it to 40 mm of polyethylene.

For the centering of the beam and optimization of the transmission repeat steps described in sections 3 and 4.

7. SETTING THE CORRECT USER

The beam line elements can be controlled via CESAR not only by the operators and beam physicists and not only from the CCC, but also by the users from the user barracks in EHN1.

For the moment there are four test zones in H8 (in order from upstream to downstream of the beam):

- H8Z (door PPE128, control from barrack HNA-451) for the CERF experiment,
- H8A (door PPE138, control from barrack HNA-443),
- H8B (door PPE158, control from barracks HNA-257 and HNA-262),
- H8C (door PPE168, control from barracks HNA-468, HNA-480, HNA-483 and HNA-484).

In order to set the correct location and group as a master user, the steps below must be followed:

- Open "Terminals Info" window
- Click on the terminal corresponding to the barrack, in which the master user is located
- Click on "Set Experiment" button
- Select the experiment to which the master user belongs
    - In case the experiment is not listed click on "Add experiment" button and enter the name of the experiment
- Click on "Set To Main Terminal" button