Project for the JINA ion optics for Recoil Separator School: September 2018

Overarching Project: Prepare the measurement of a radiative capture (example: 12C+alpha, 20Ne+p, 15O+alpha, …) with either St. George or SECAR. Choose if you are going to work with SECAR or St. George. Stick to that choice.

Use the wiki, to log your progress (provide description, code…).

This is not a race, nor a competition, it is better if you understand the 5 first parts than to rush it to finish.

Subtasks:

1. Calculate reaction kinematics discuss properties of the beam/recoil after the target, pick your favorite energy
   If you do not have a favorite kinematics code you can use:
   http://skisickness.com/2010/04/relativistic-kinematics-calculator/
2. Research some bibliographical information on the reaction you propose to study
3. Application of the Quadrupole/viewer emittance measurement method:
   Slide 13, Lecture 1 explains the principle of the emittance (epsilon) measurement by Quadrupole Variation. A minimum of 3 measurements for different quadrupole settings is needed to determine epsilon. On p. 13 of the file Emittance _trans in the directory Emittance-measurement, a Procedure is described how to determine a more precise epsilon if more than 3 measurements are available.
   a) Lacking real measurements, use SEC_noWF1_JIOSS.fox to create a set of profile widths (Half Image size) at focal plane FP2 of SECAR by varying the quadrupole strength of Q7.
   b) Change the preset values of the beam parameters XX := 0.001; AX := 0.0002; ... to the values of your reaction.
   c) Extract the distance L from the center of quad Q7 to the focal plane FP2 from the fox file.
   d) Determine the fit parameters a, b, and c and calculate the emittance epsilon per Procedure.
   e) Compare the determined emittance epsilon with the beam emittance.
4. Write a COSY script made of a drift, a dipole and a drift. Extract the first order matrix elements in the horizontal plane. Describe the meaning of each of the value that is related to the horizontal plane. Plot the trajectory of a ray with a small momentum difference (How would a momentum difference be reflected in the eight COSY variable? Despite the complication associated with variable 2 and 4, just implement something that changes variable 6). Calculate with the first order matrix elements the position where you expect the ray to end up. An example is given as file dispersion.fox/zip
5. Find a solution to a change by 1% of the effective length of one quadrupole in either St. George or SECAR
   a. Enge functions are a way to describe the fringe field of a electro-magnetic element, finding one that matches the actual element brings you closer to reality. Fit the fringe field of quad XX (data provided ??) to extract the Enge coefficient. Implement those new coefficients in the SECAR model and find the field correction needed to re-gain mass separation. For the St. George model, realistic coefficient are already provided, remove the one for Q2 and find the field in the quads need to compensate for that change.
6. The concepts of resolving power and mass separation are used to evaluate the quality of the separator. When a parameter is changed, the resolving power and mass separation will change. There is also a risk of changing the acceptance (angle and energy) of the system. What is the

tolerance such that the mass resolution does not decrease by more than 5% in terms of (SECAR or S. George)

   a. Beam position, beam size
   b. Magnet alignment (in any directions). Pick two elements of your choice prior to the first Wien filter and evaluate the impact of longitudinal, transversal and pitch, roll and yaw changes and provided the maximum changes that will not affect the mass resolution more than 5%.

7. Suggests ways to study acceptance (angular and energy) (SECAR or St. George)
   a. Demonstrate that it achieves the goal
8. Propose methods to study charge state fractions with SECAR or St. George
9. What is the link between emittance and beam spot size at various location along the separator?
10. Change radius of WF either up or down (6m or 8m) depending on acceptance and rejection and find a new quadrupole fields solution to maximize mass resolution and maintain acceptance of the recoil you plan to study.