FFAG'23 WORKSHOP

Jefferson National Laboratory

September 10-15, 2023

FFAG CLASS

Sept. 10

A 1.5HR WORK PLAN

An introduction to stepwise raytracing techniques, using Zgoubi

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1/ Confirm all participants' install work?

Confirm gnuplot runs on your computer?

- Yes: fine, simulations to come will be on your computer

- No: team with someone who has that working

1/ Let's move on: we'll use eRHIC-LL material

*** Why eRHIC-LL ?**

Well, workshop host is Jlab ...
on-going FFAG R/D for CEBAF energy upgrade, we're not far from eRHIC-LL design:

- arcs are FFAG lattice

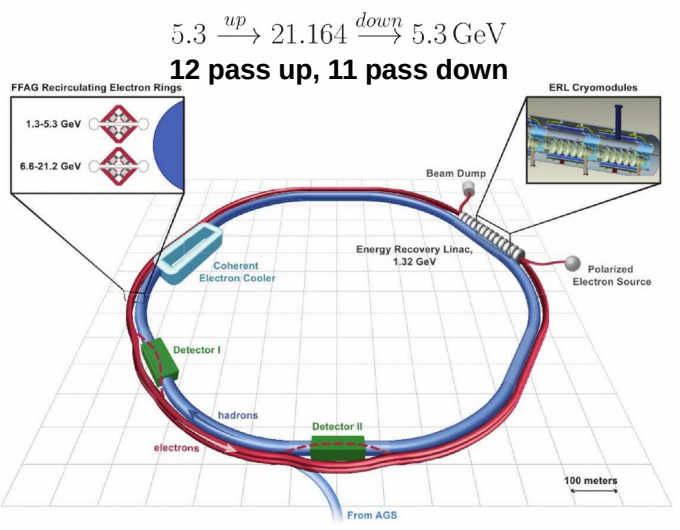
- that's GeV energy range

- there is SR

- there is spin diffusion

That's all ingredients met in the arcs of the

20 GeV eRHIC-LinacLinac 23-pass ERL.



*** I'll use this document as a guideline – my speech at FFAG'16 Workshop:**

https://indico.cern.ch/event/543264/contributions/2295871/attachments/1334156/2006132/slides_FMeot_eRHICSimulations.pdf

1/ eRHIC FFAG2 ring cell

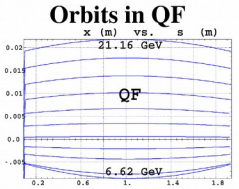
1.a - Get the material from there:

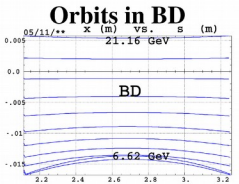
https://sourceforge.net/p/zgoubi/code/HEAD/tree/branches/exemples/FFAG/eRHIC-FFAG/FFAG2/cell/

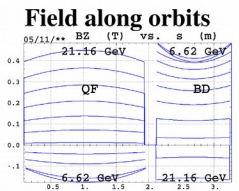
1.b - We can try an orbit scan (slide 3, left column):

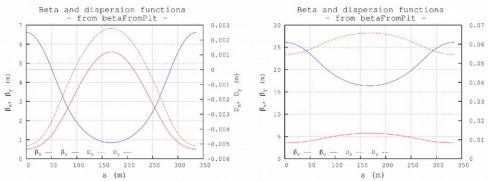
2 FFAG2 loop

• Quadrupole doublet optics

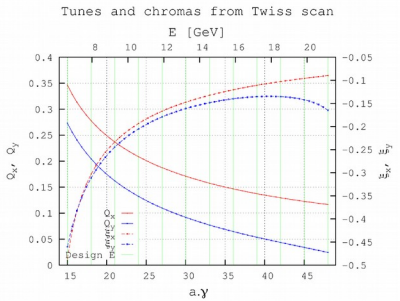








Optical functions at 6.622 GeV (left) and 21.164 GeV (right)



Tunes and chromaticities as a function of energy.

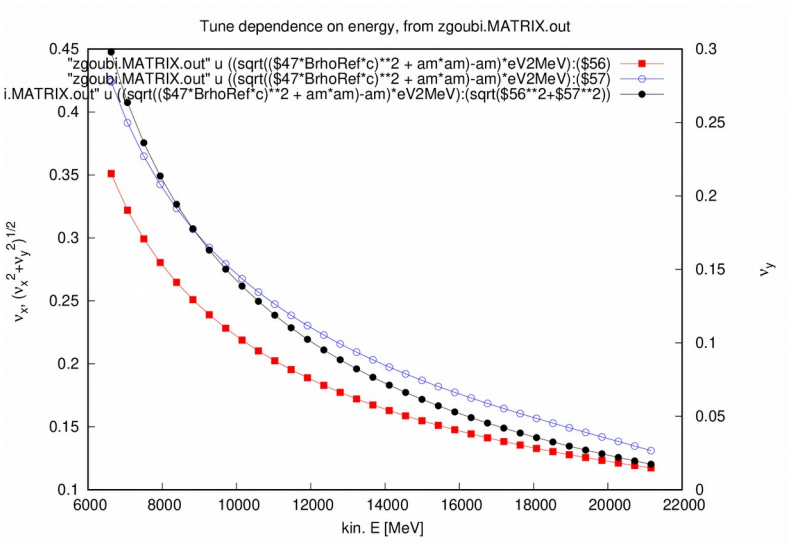
FFAG'16 Workshop, Imperial College, London, 6-9 September 2016

*** Read the README, it says:**

[path2]/zgoubi-code/zgoubi/zgoubi -in cell_scanOrbits.INC.dat

*** Figure out what's going on in cell_scanOrbits.INC.dat**

1.c – Or a tune scan (slide 3, bottom right):



*** The README says:**

[path2]/zgoubi-code/zgoubi/zgoubi -in cell_scanTunes.INC.dat

*** Figure out what's going on in cell_scanTunes.INC.dat**

2/ SR loss and spin diffusion in eRHIC FFAG2 cell

2.a - Get the material from there:

https://sourceforge.net/p/zgoubi/code/HEAD/tree/branches/exemples/FFAG/eRHIC-FFAG/FFAG2/SRLoss/

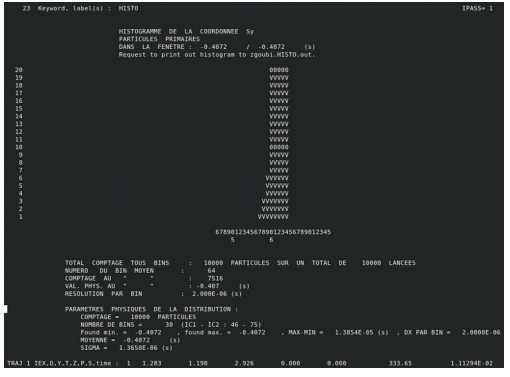
2.b – Let's see SR loss at top energy, 21.164 GeV

*** The README says:**
[path2]/zgoubi-code/zgoubi/zgoubi -in SRLoss_21.16GeV.INC.dat

*** Figure out what's going on in SRLoss_21.16GeV.INC.dat**

*** See spin diffusion, from the HISTO in zgoubi.res**

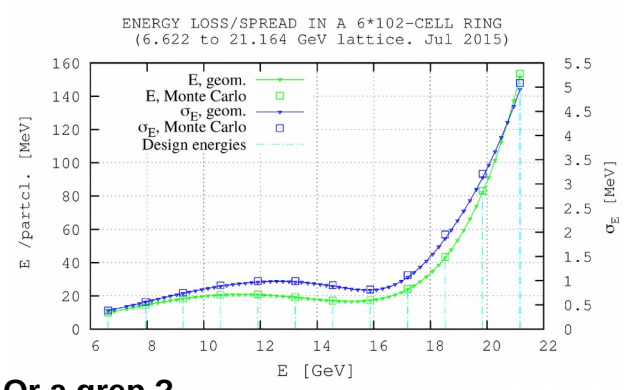
SX (long.) **SY (radial)**



*** Suggestion: gnuplot using zgoubi.HISTO.out ...**

2.b - We can try something in the lines below (slides 4, 9),

using REBELOTE to scan initial D=p/p_ref:
[path2]/zgoubi-code/zgoubi/zgoubi -in SRLoss_21.16GeV.INC.dat



All 1,000 particles are logged in zgoubi.fai, pass by pass. Therefore, use gnuplot and awk to the get average and sigmas of energy loss, this graph.

Or a grep ?
grep '*Average energy loss per particle per pass* **' zgoubi.res.**
and btw, * 6 arcs * 102 cells er arc !

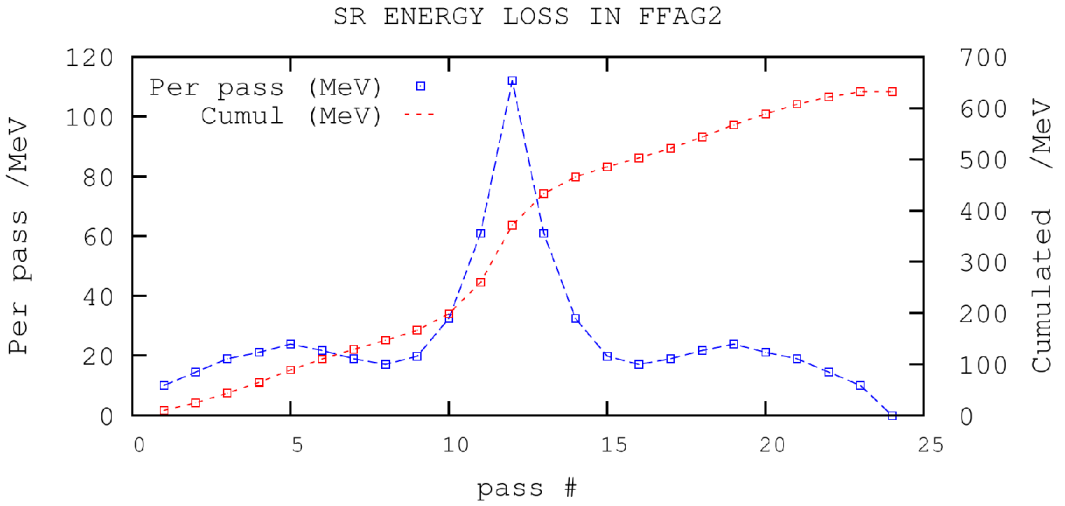
```
47_fmeot:/home/meot/zgoubi/SVN/exemples/FFAG/eRHIC-FFAG/FFAG2/SRLoss$ grep '  Average energy loss per particle per pass '
  Average energy loss per particle per pass :        13.67140     keV.      Relative to inittial energy :  8.2856997E-07
  Average energy loss per particle per pass :        13.60228     keV.      Relative to inittial energy :  8.2438046E-07
  Average energy loss per particle per pass :        17.88081     keV.      Relative to inittial energy :  1.0836855E-06
  Average energy loss per particle per pass :        24.66686     keV.      Relative to inittial energy :  1.4949614E-06
  Average energy loss per particle per pass :        33.43888     keV.      Relative to inittial energy :  2.0265991E-06
  Average energy loss per particle per pass :        44.05808     keV.      Relative to inittial energy :  2.6701866E-06
  Average energy loss per particle per pass :        56.52296     keV.      Relative to inittial energy :  3.4256342E-06
  Average energy loss per particle per pass :        71.13720     keV.      Relative to inittial energy :  4.3113455E-06
  Average energy loss per particle per pass :        86.38978     keV.      Relative to inittial energy :  5.2357439E-06
  Average energy loss per particle per pass :        104.9274     keV.      Relative to inittial energy :  6.3592386E-06
  Average energy loss per particle per pass :        124.2423     keV.      Relative to inittial energy :  7.5298352E-06
  Average energy loss per particle per pass :        146.5472     keV.      Relative to inittial energy :  8.8816482E-06
  Average energy loss per particle per pass :        170.5916     keV.      Relative to inittial energy :  1.0338885E-05
47_fmeot:/home/meot/zgoubi/SVN/exemples/FFAG/eRHIC-FFAG/FFAG2/SRLoss$
```

There is various other possibilities … zgoubi.HISTO.out is one

2/ GOTO keyword: useful to (for instance) assemble an ERL

2.a - Get the material from there:

Typically, what we are looking for is this, 12 passes up, 11 passes down, in 1 go,:



Reasonable statistics requires ~1e3 particles

*** Figure out**

- what is going on in upDown.INC.dat

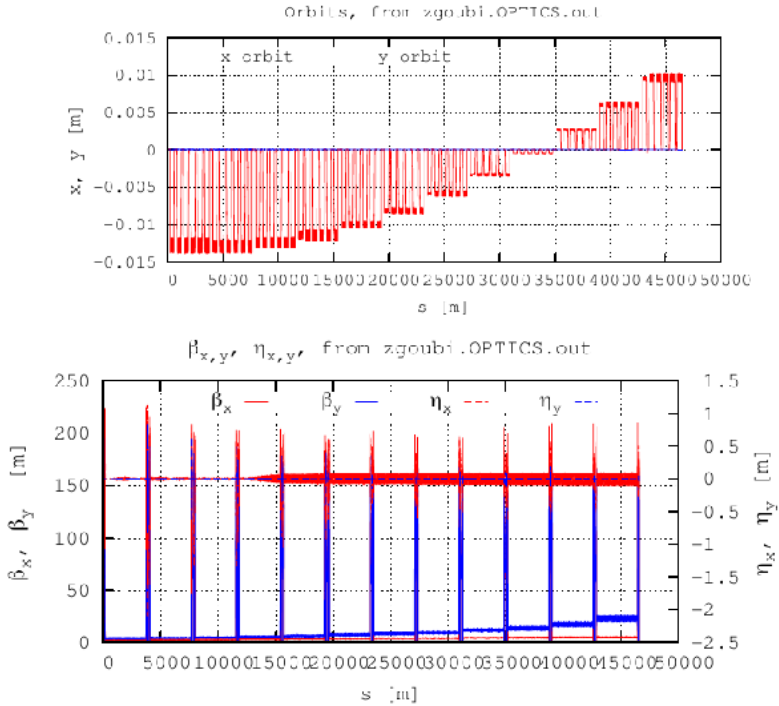
- what's the role of GOTOs, how they work

*** What if I replace MCOBJET with OBJET[KOBJ=5] and uncomment OPTICS?**

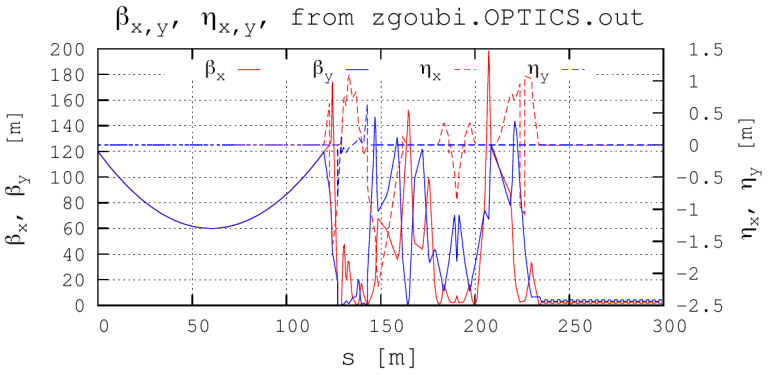
*** OBJET[KOBJ=5] and OPTICS produce the orbit and optical functions, over the 12 loops, or segments:**

- **Orbits and optical functions : complete transport of initial values**

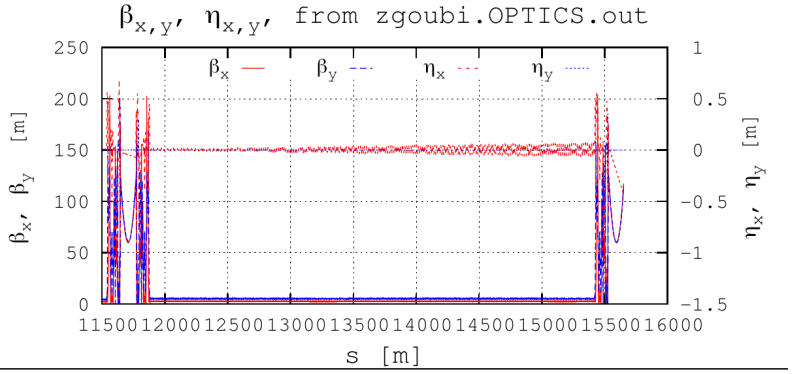
5.3 to 21.1 GeV - 12 loops



- **5.3 to 6.622 GeV linac pass**



- **9.2 to 11.9 GeV linac passes**



We are done !

Thanks for your concentration

Have fun during this FFA’23 workshop