

**The 2022 Workshop on Fixed Field Alternating
Gradient Accelerators - FFA school
Cosener's House, OX, UK, 25-26/09/2022**

A quick tour of zgoubi code and methods

**1/ Zgoubi numerical methods, basics:
*let's turn pages in the Users' Guide***

page 3 -	Table of contents PART A : Description of software contents	
page 20 -	Reference frame Pushing a particle	Fig. 1 Fig. 2
page 19 -	Pushing a particle in pure B fields: Lorentz Equation in "reduced" form Its solution Algorithm that calculates the Taylor series coefficients and the field derivatives they require	Eq. 1.2.1 Eq. 1.2.3 Eq. 1.2.4 Eq. 1.2.8 Eq.s 1.2.9, 1.2.10
page 21 -	Pushing a particle in pure E fields	We'll skip that, won't need it
page 24 -	Pushing a particle in pure E & B fields	We'll skip that, won't need it

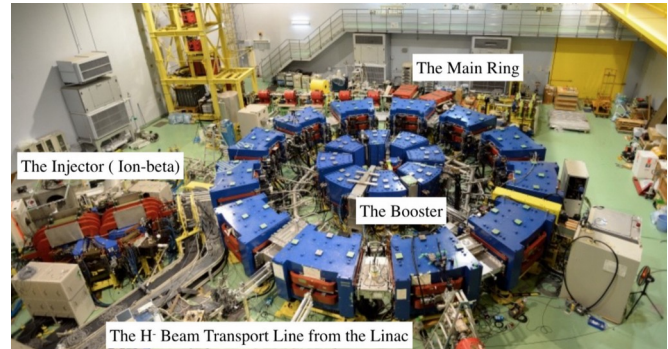
2/ Example, tut exercise #1: Radial FFAG multiple-dipole

Use the INDEX (p. ~367) to stroll around in the Users' Guide

An FFAG radial dipole triplet looks like this in real life (KEK, early 2000s):



Twelve of these triplets are assembled in this 150 MeV proton ring:



Lookup FFAG keyword in the INDEX - 2 **bold** numbers in general:

1st one sends to PART A, "simulation methods, physics content"
2nd one sends to PART: formatting of the input data in zgoubi.dat

p. 114
p. 264

Let's go to p. 115 (PART A):

p. 115 -

A principle sketch. Coding allows up to 5 dipoles within AT sector
Computation of local field and derivatives at particle location are either analytical (all formulas coded in the source code) ...

Eq. 1.3.25

p. 102 -

... or may instead use a small flying grid centered at particle location

Fig. 23

p. 101 -

Individual dipole field and derivatives are then superimposed using

Eqs. 6.3.23, 6.3.24

Coding in zgoubi.dat: back to the INDEX, or a glossary pp. 217, 218 as well will take you PART B, p. 264 ...

We'll go into the details during the radial FFAG tutorial (follows David's spiral FFAG tutorial)

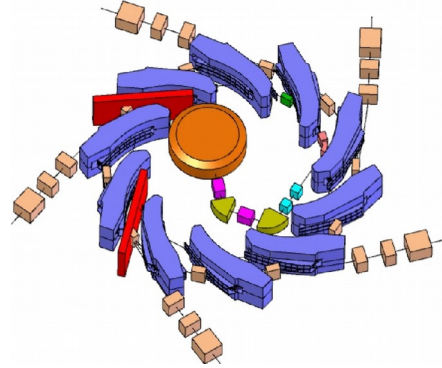
3/ Example, tut exercise #2: Spiral FFAG dipole → David

Use the INDEX (p. ~367) to stroll around in the Users' Guide

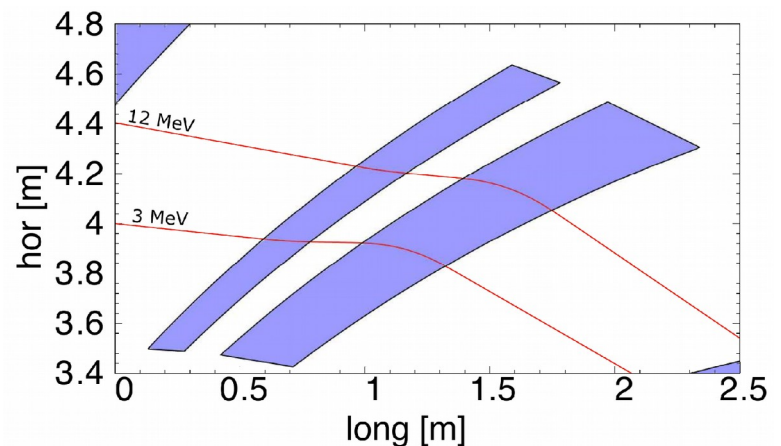
A spiral FFAG dipole looks like this in real life (RACCAM):



Twelve such spiral dipoles are assembled in this principle 180 MeV hadrontherapy ring (RACCAM):



Actually, a spiral dipole doublet is going to be dealt with, with David:



Lookup FFAG-SPI keyword in the INDEX - 2 bold numbers in general:

1st one sends to PART A, "simulation methods, physics content" p. 114
2nd one sends to PART: formatting of the input data in zgoubi.dat p. 265

Let's go to p. 114 (PART A):

p. 118 - A principle sketch. Coding allows up to 5 dipoles within AT sector
Computation of local field and derivatives at particle location are
either analytical (all formulas coded in the source code) ... Eq. 6.3.27

p. 102 - ... or may instead use a small flying grid centered at particle location Fig. 23

p. 101 - Individual dipole field and derivatives are then superimposed using Eqs. 6.3.23, 6.3.24

Coding in zgoubi.dat: PART B, p. 265

4/ Example, tut exercise #3: Vertical FFAG dipole → Marion

Developed in zgoubi the past 2~3 years by Marion and co-workers @ ULB

quite a piece of art form my point of view

*You won't be able to use the INDEX in the Users' Guide: still needs be documented.
Placeholders are in place though, see p. 215 (PART A), p. 218 (PART B),*

