SPIRAL2/DESIR-High Resolution Separator

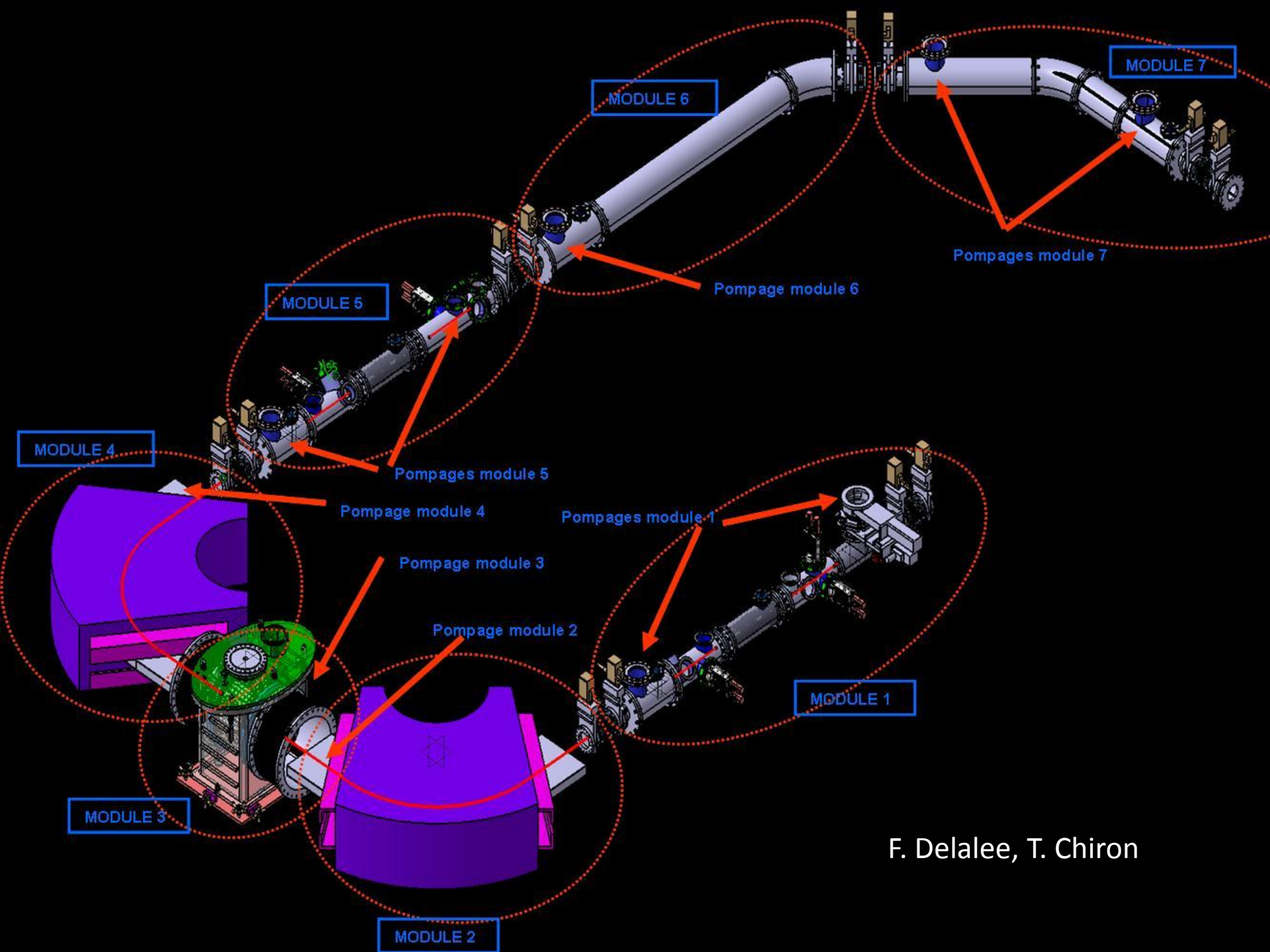
Teresa Kurtukian-Nieto

CENBG/CNRS/IN2P3-Université Bordeaux 1

EMIS2012

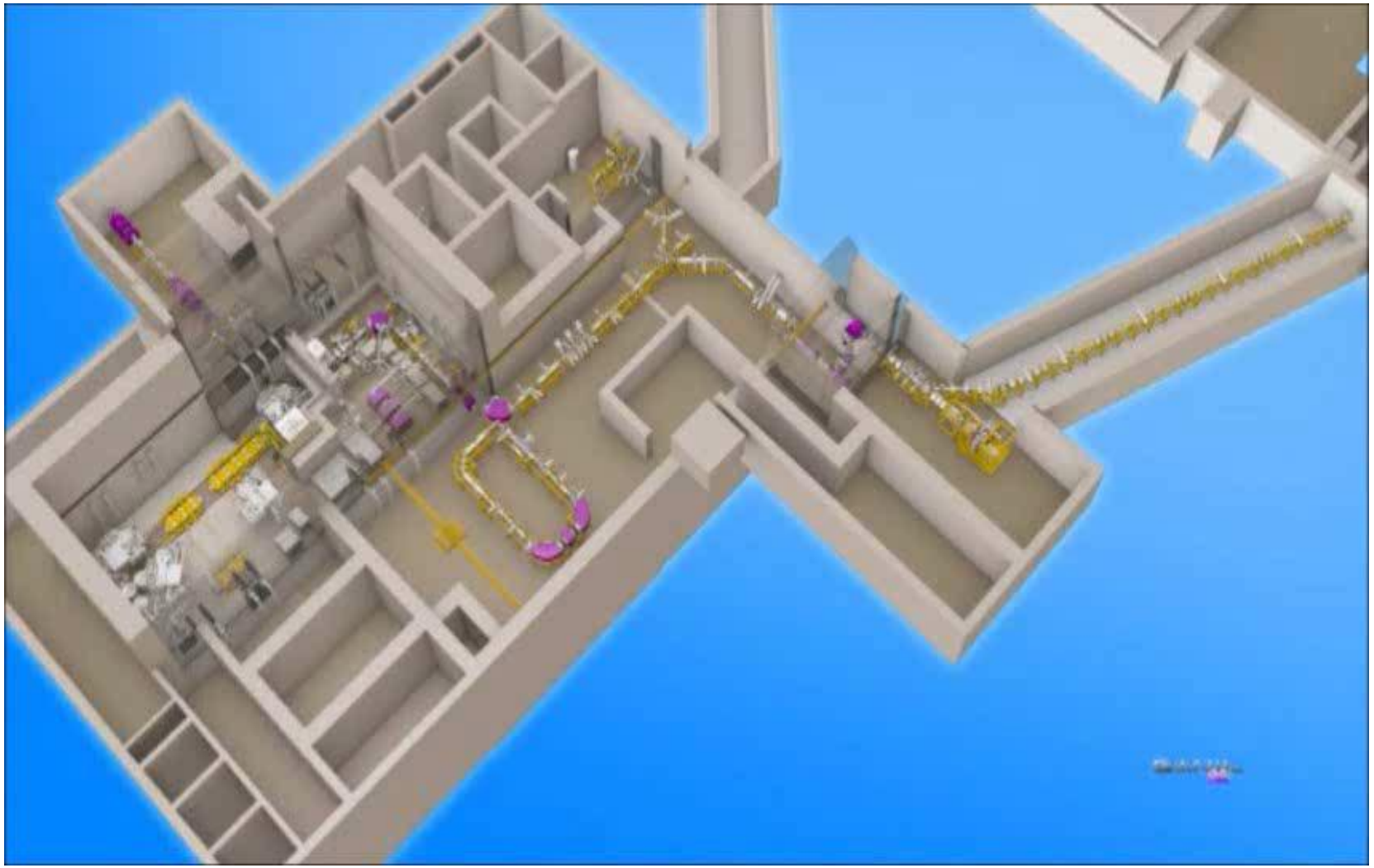
2nd December –7th December, 2012

Matsue, Japan



F. Delalee, T. Chiron

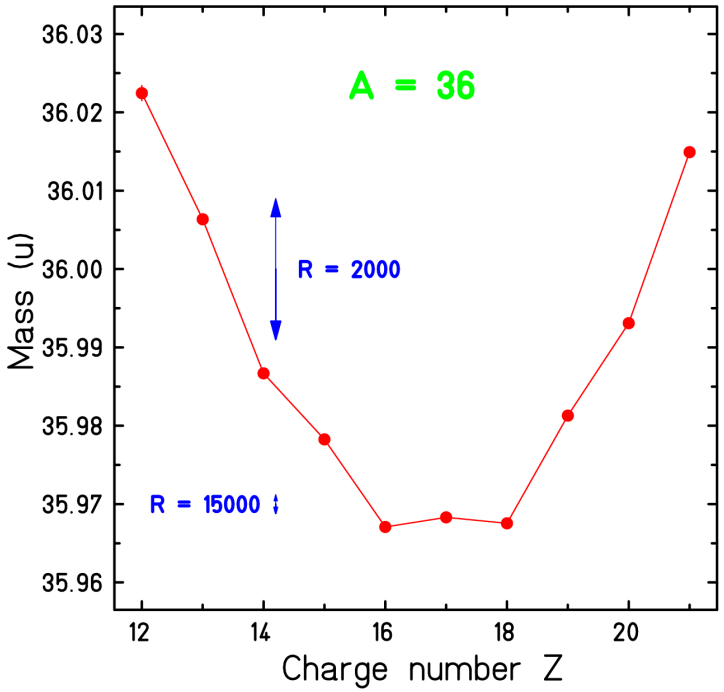
DESIR-HRS@SPIRAL2

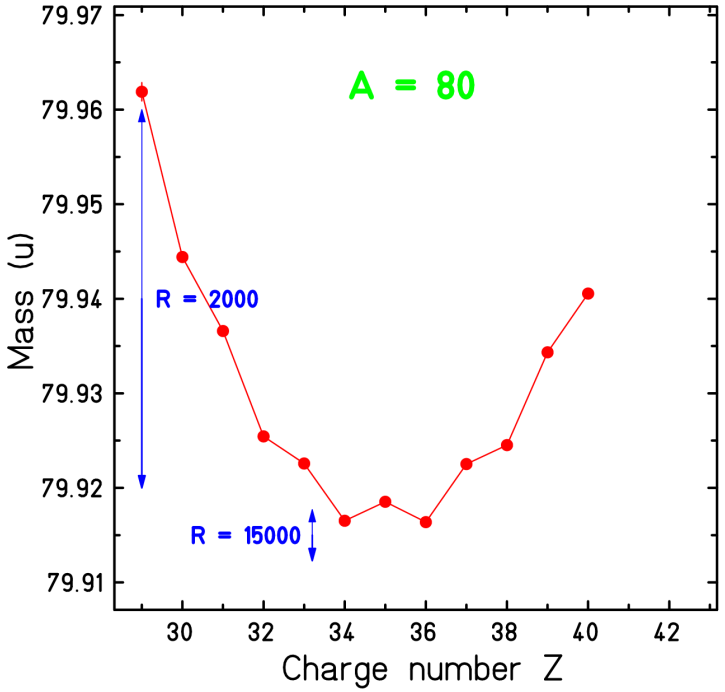


© GANIL 2011

Why a High Resolution Separator?

- The production of the most exotic isotopes generally accompanied with a high contamination by the less exotic isobars of longer half-lives.



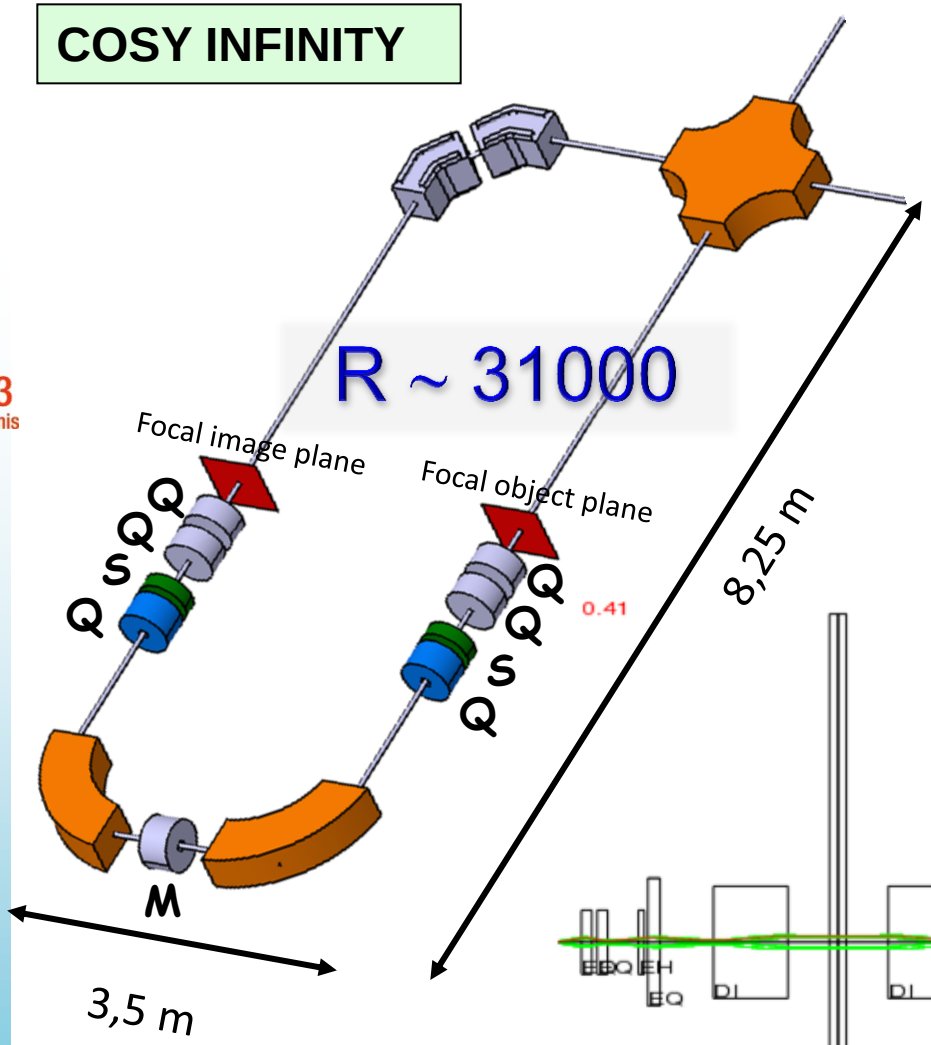


- Aime of HRS → provide mono-isotopic beam of exotic nuclei coming from the 1+ line of the production building of SPIRAL2 (60 keV).

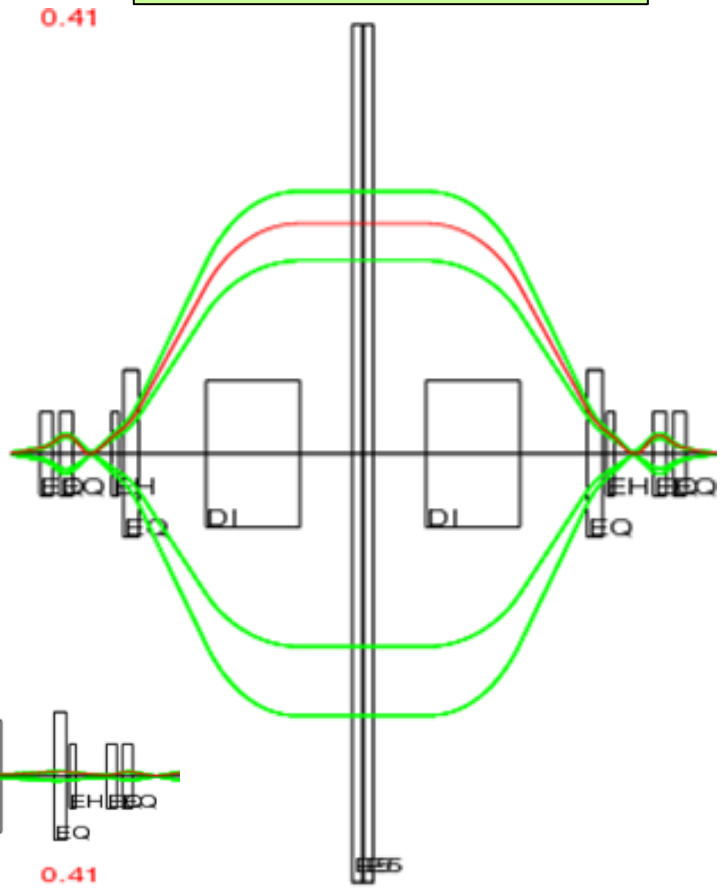
$$R \sim 20000 = \frac{(x\,|\,\delta)}{2x_{00}(x\,|\,x)+\Delta}$$

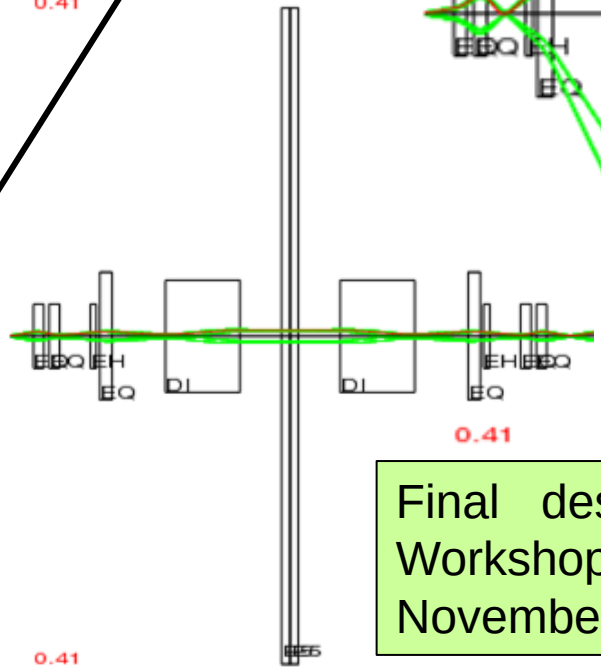
DESIR-HRS @SPIRAL2

COSY INFINITY



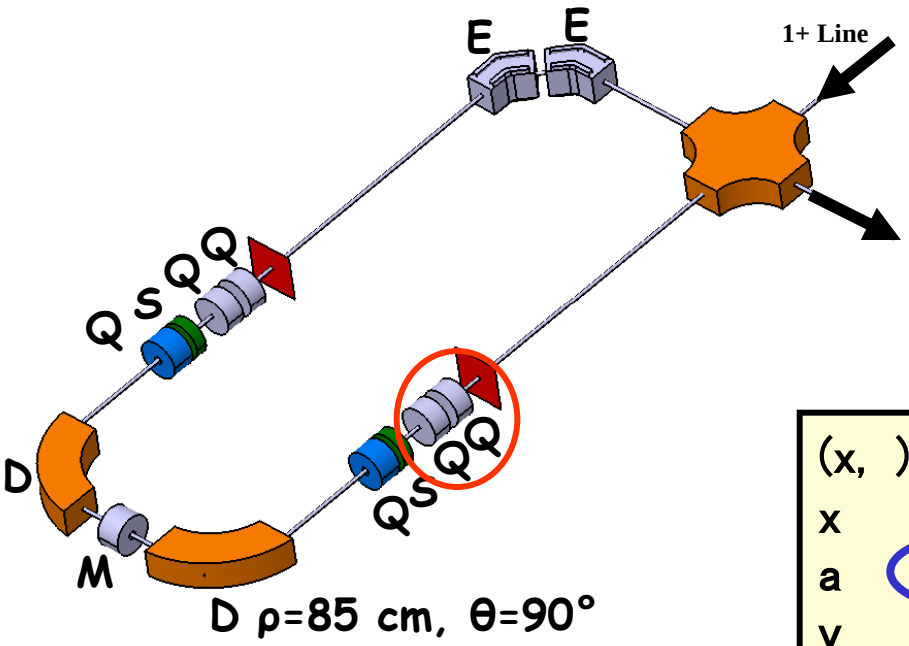
Design, inspired by CARIBU HRS at ANL





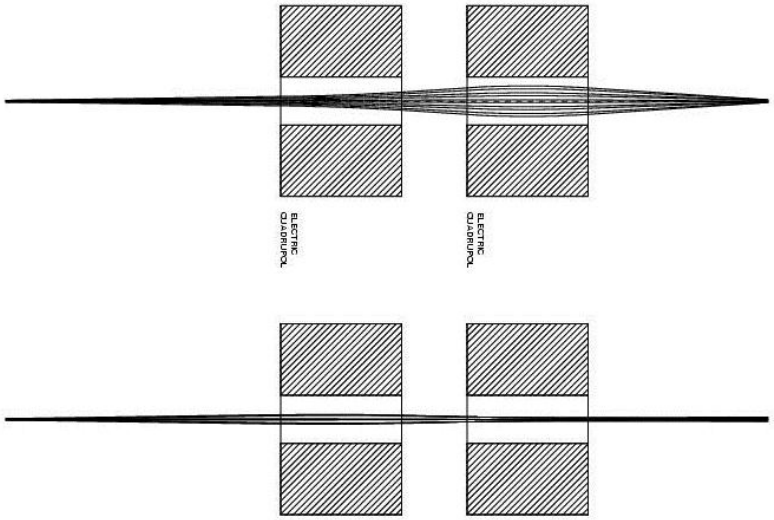
Final design validated at the Workshop HRS held in November 2011 at Bordeaux

HRS: “U-180”



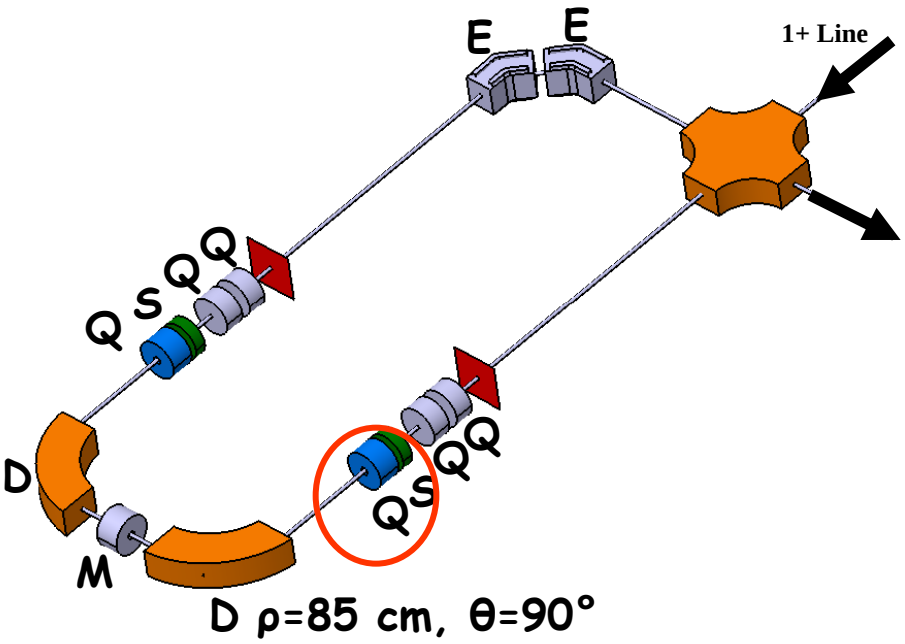
- The quadrupole doublet matching section produces a ribbon-shaped beam.

(x,)(a,)		(y,)	(b,)	
x	−0.2342	−8.0416	0.0000	0.0000
a	−0.76E−2	−4.5302	0.0000	0.0000
y	0.0000	0.0000	−2.6125	−6.5271
b	0.0000	0.0000	0.63E−1	−0.2242
δ m	0.0000	0.0000	0.0000	0.0000

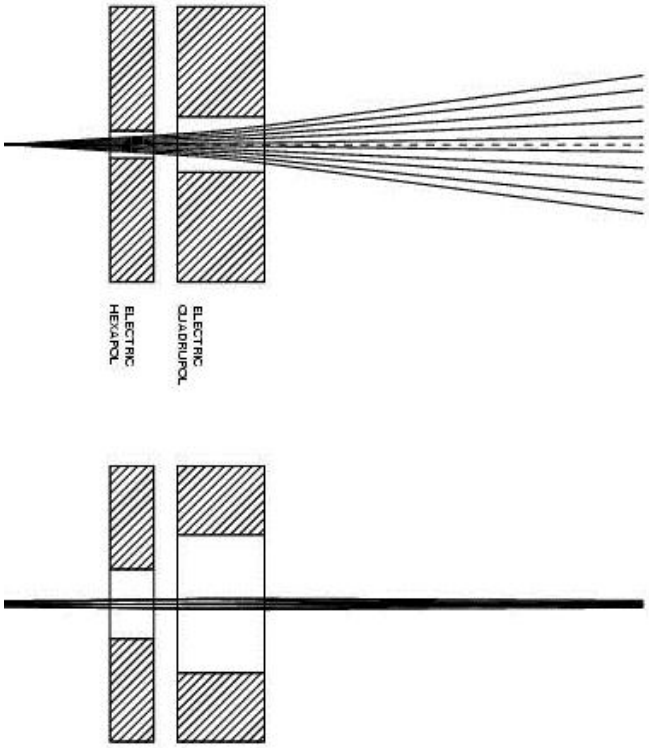


- y-angles are small, minimizing b aberrations

HRS: "U-180"



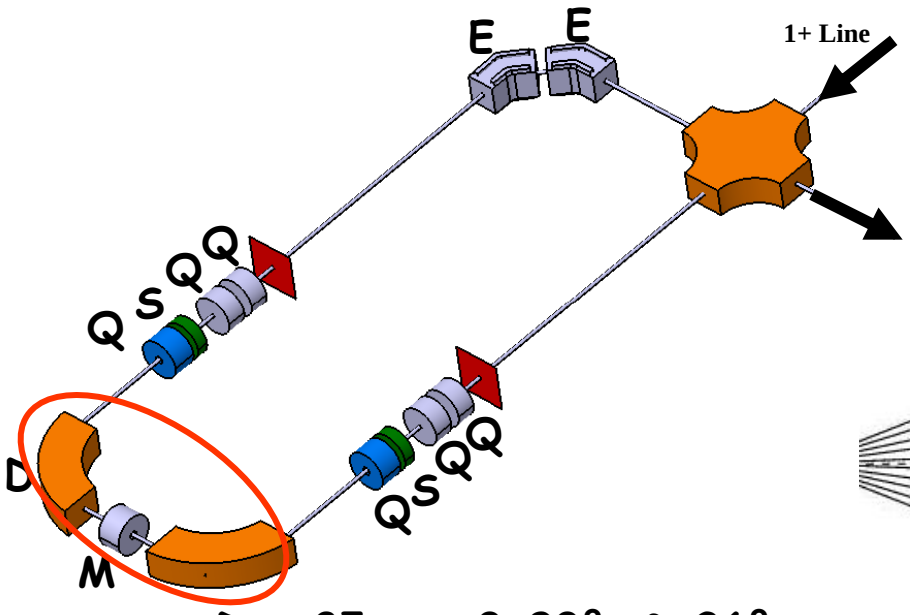
- The first quadrupole diverges in *horizontal* and converges in *vertical*, giving a small y size which minimizes y aberrations
- The large x area in the magnets gives mass dispersion



Matrice de transfert

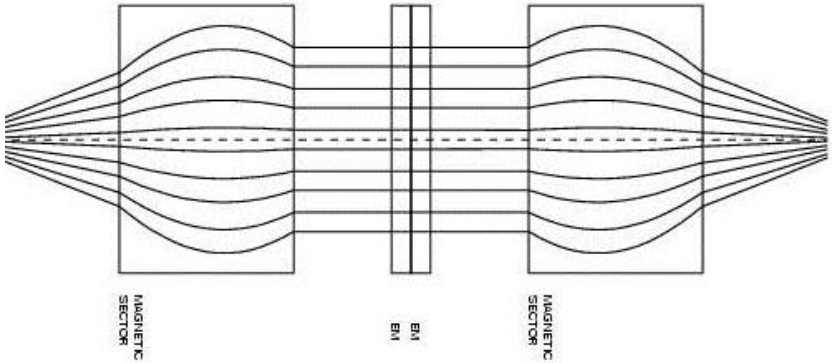
(x,)(a,)	(y,)	(b,)	
x	−24.134	−18.375	0.0000	0.0000
a	−13.179	−10.076	0.0000	0.0000
y	0.0000	0.0000	−0.6600	5.2412
b	0.0000	0.0000	−0.1773	−0.1075
δ m	0.0000	0.0000	0.0000	0.0000

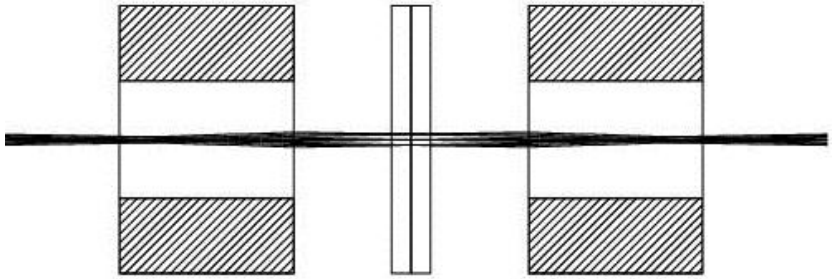
HRS: “U-180”



D ρ=85 cm, θ=90°, β=36°

- Focus conditions in centre:
  (a, a) = (y, b) = (b, y) = 0



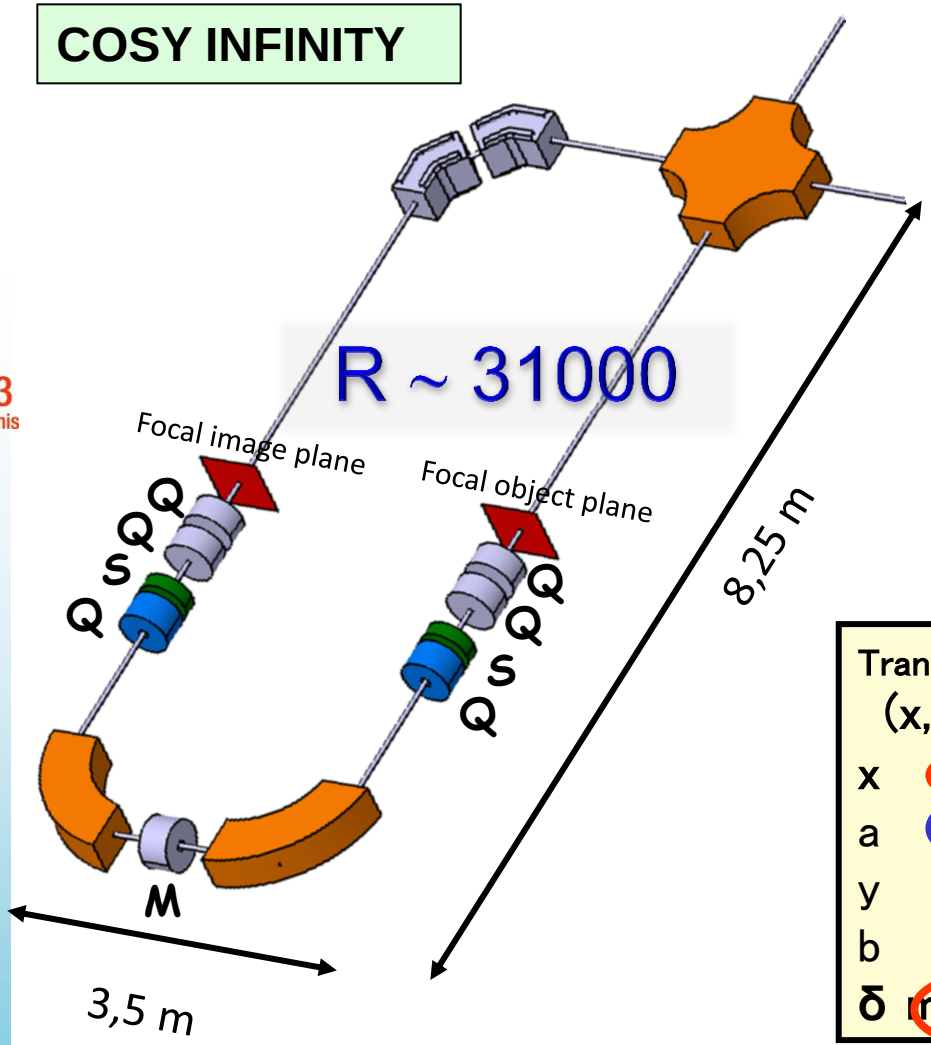


Matrice de transfert

(x,)	(a,)	(y,)	(b,)	
x	−33.104	0.55E−1	0.0000	0.0000
a	−18.139	0.79E−4	0.0000	0.0000
y	0.0000	0.0000	7.0741	−0.17E−4
b	0.0000	0.0000	−0.56E−4	0.1414
δ m	1.2020	0.8633	0.0000	0.0000

DESIR-HRS @SPIRAL2

COSY INFINITY



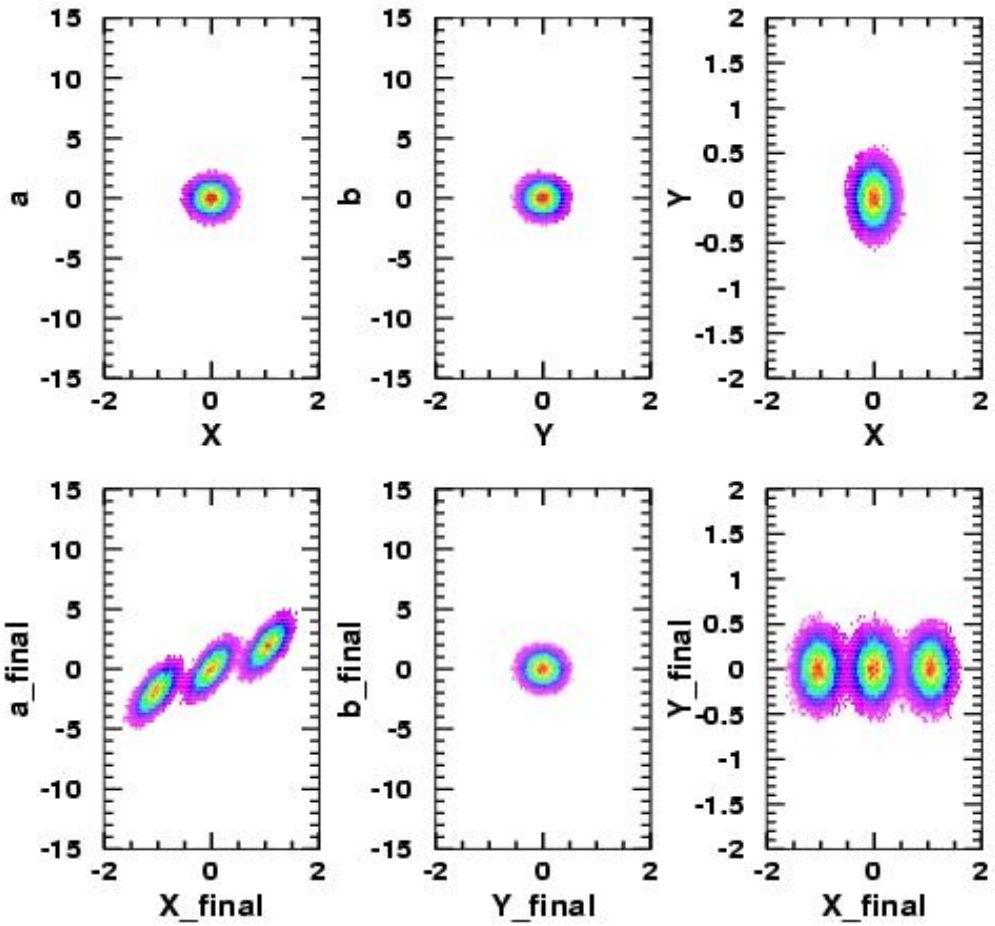
- ✓ (x|δ) = -31.32 cm/%
- ✓ Mirror symmetric
- ✓ point-to-point both x and y

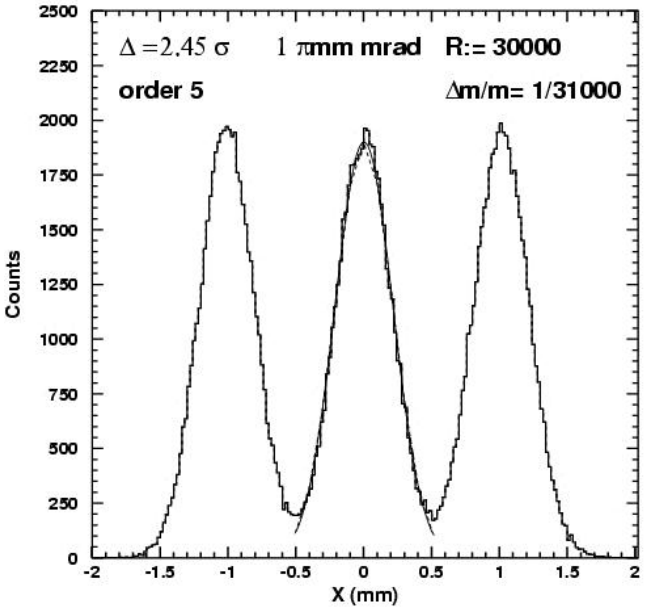
Transfer matrix

(x,)	(a,)	(y,)	(b,)
x −1.0000	−3.6499	0.0	0.0
a −0.40E−5	−1.0000	0.0	0.0
y 0.0	0.0	1.0000	0.50E−4
b 0.0	0.0	−0.60E−6	1.0000
δ m −31.32	−57.16	0.0	0.0

- Optimal performances for a 1 π.mm.mrad.
- Acceptance : 5 π.mm.mrad (90% transmission)

Mass separation

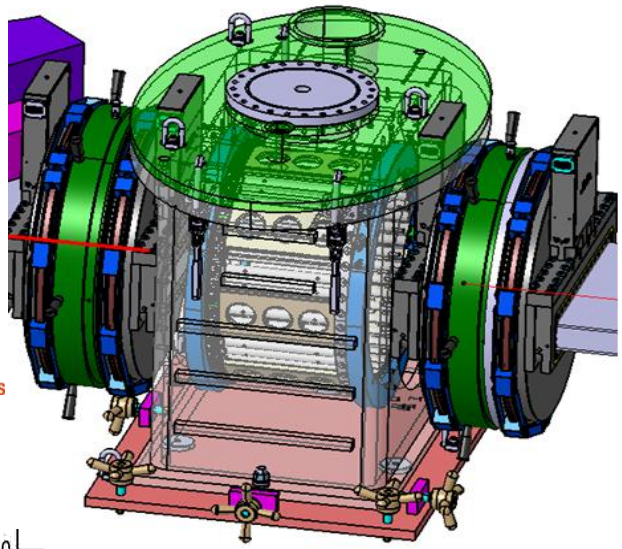




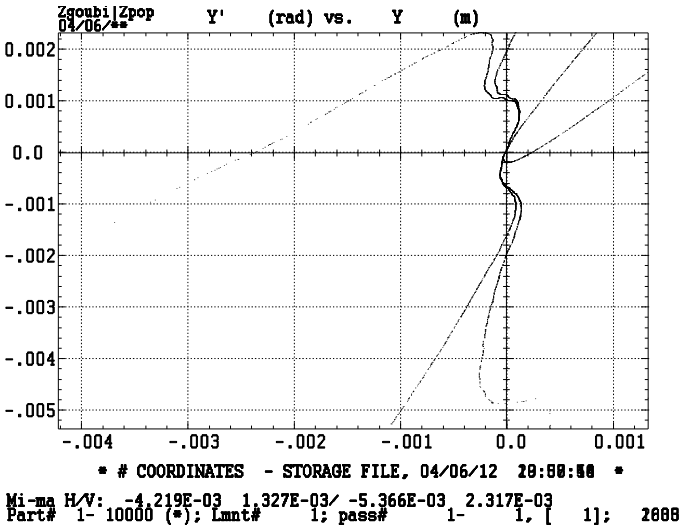
TKN-montecarlo

High order aberrations corrected up to 5th order allows to obtain a Resolution of ~30000

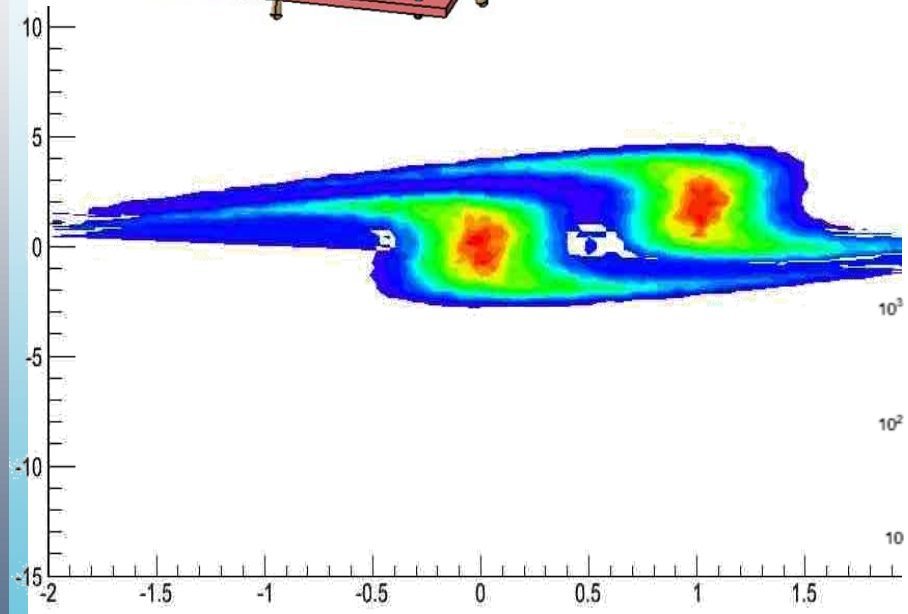
Multipole: high order aberrations

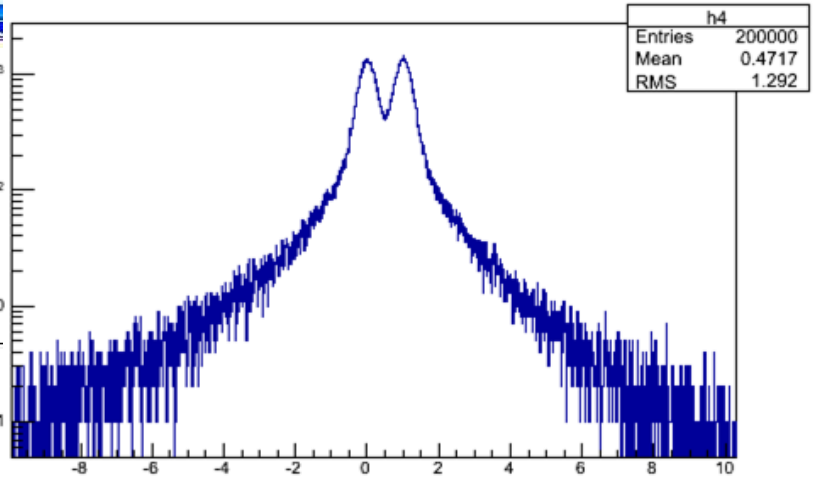


- Hexapole
- Octupole
- Decapole
- Dodecapole



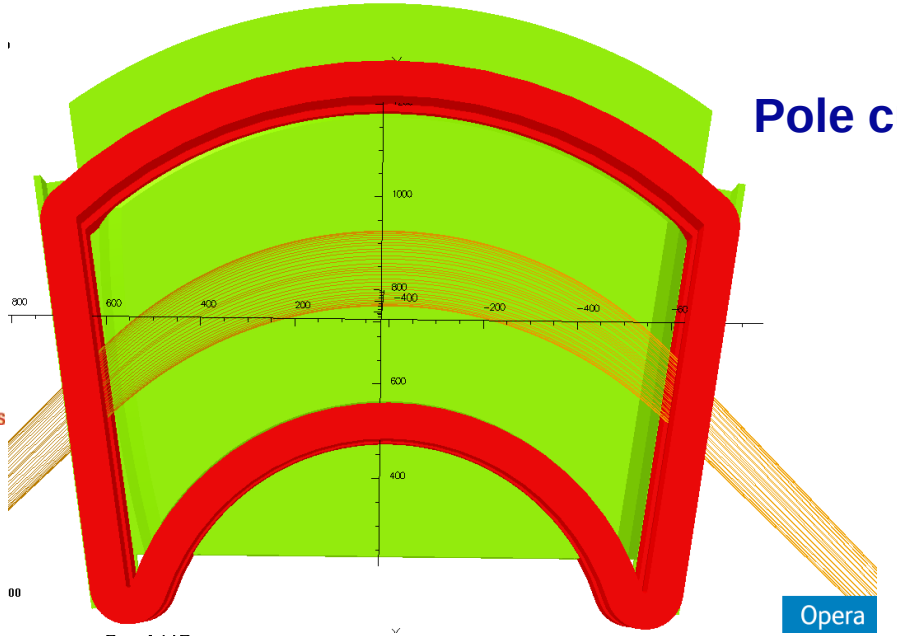
Zgouby by Laurent Serani





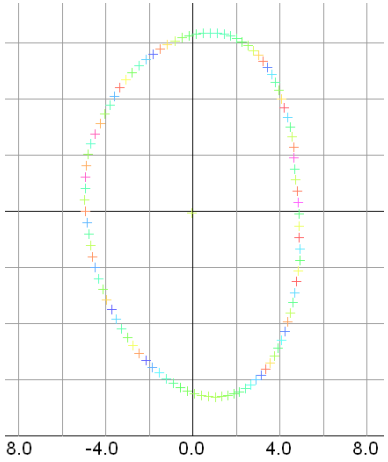
TKN-montecarlo

Dipoles: 2nd order correction

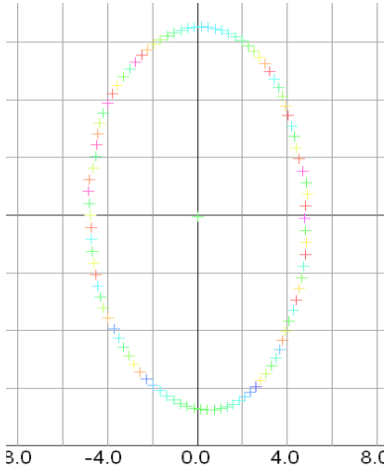


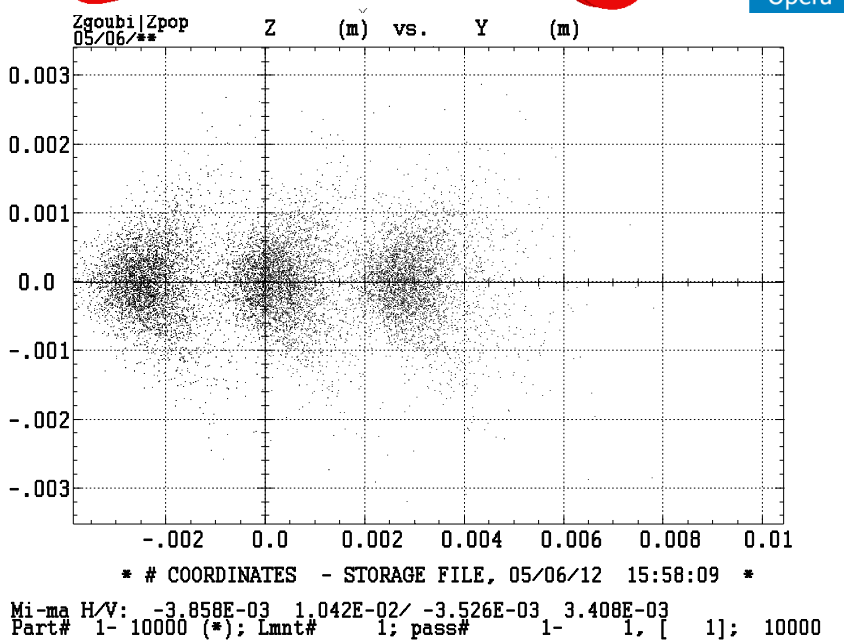
Pole curvature R

R=4500mm



R=3000mm





R = 4 m on both side of each Dipole without correction with the Multipole

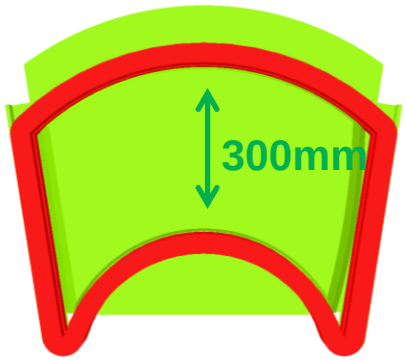
Coupling with the sextupoles placed before dipoles

What can decrease de calculated resolution?

R ~ 30000

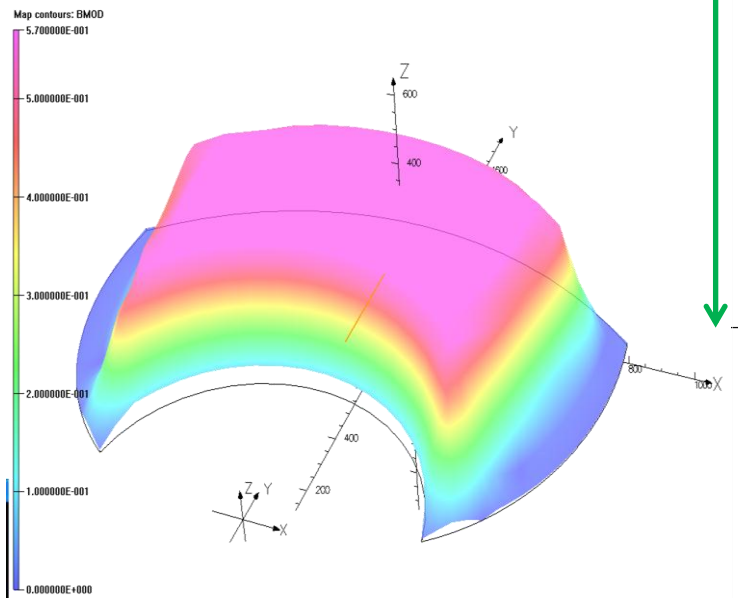
- Field homogeneity
- Mechanical defects and positioning precision
- Beam quality:
  - Beam emittance
  - Energy dispersion

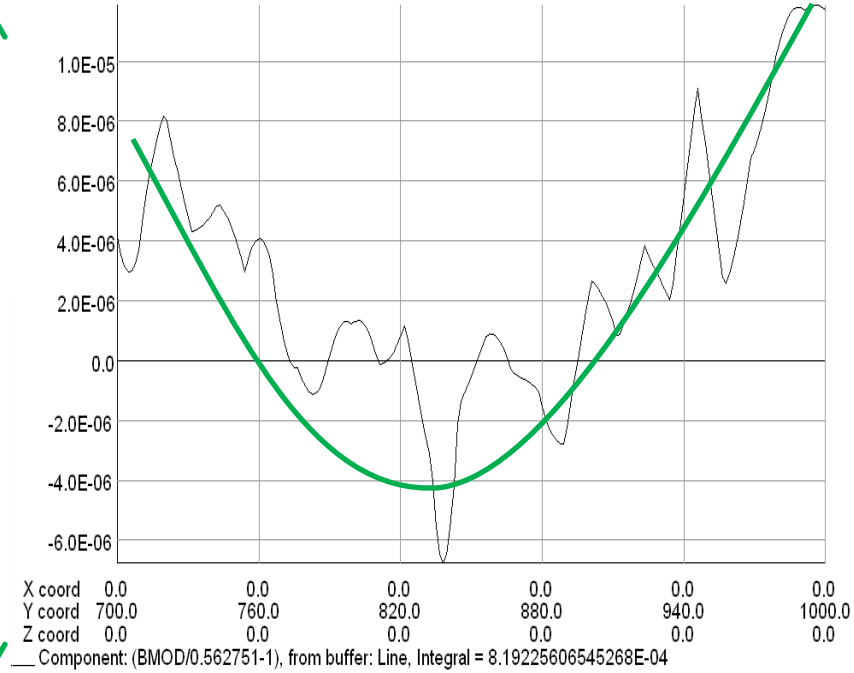
Field Homogeneity in Dipole Magnets



Homogeneity 1.6 10^{-5}

0.09 Gauss !!!





Maurice Duval,

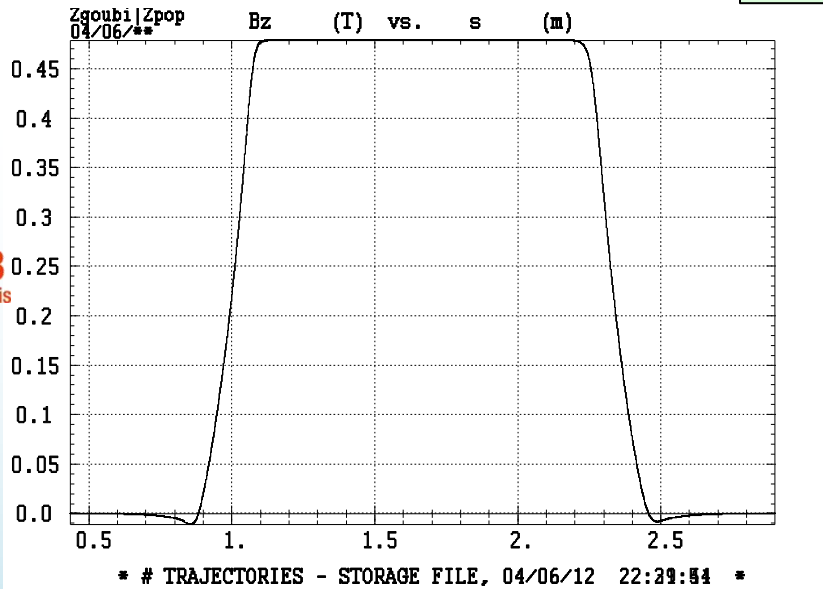
Marc-Hervé Stodel

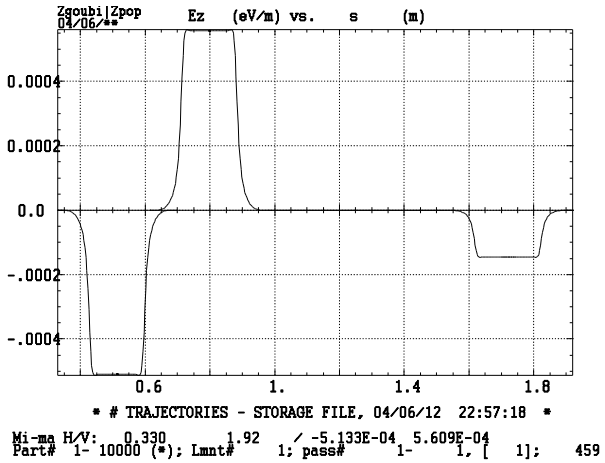
GANIL

Zgouby and Geant4 simulations

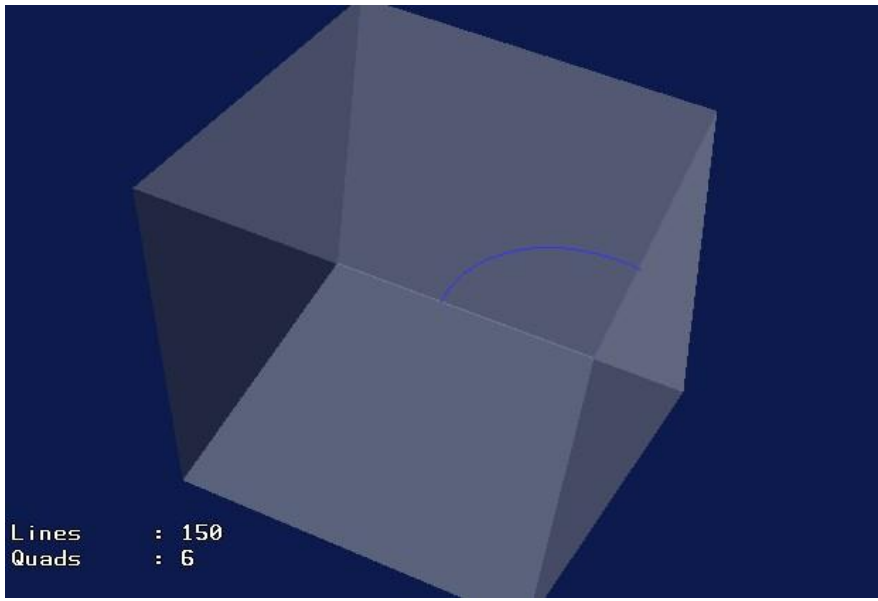
Zgouby by Laurent Serani

Tosca Map





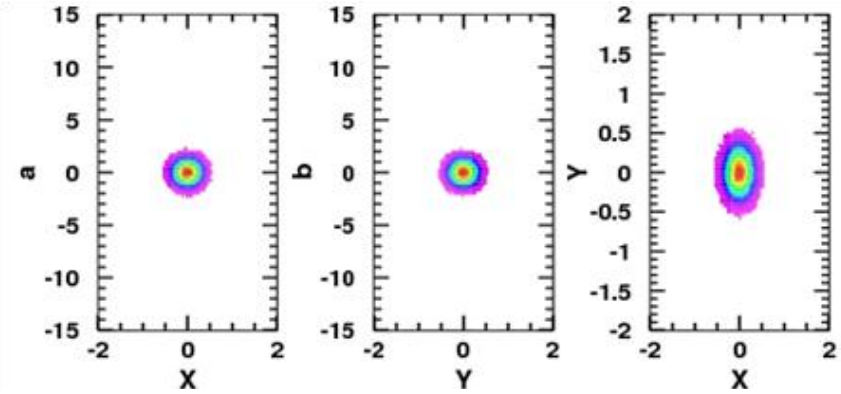
GEANT4 by Teresa Kurtukian-Nieto



Quadrupole with Fringe Field
Going across at z=1.5cm

Positioning precision

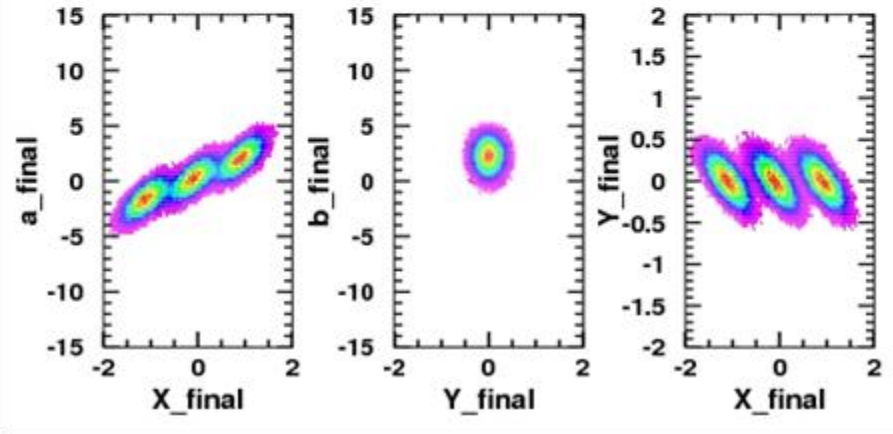
Entrance beam to HRS

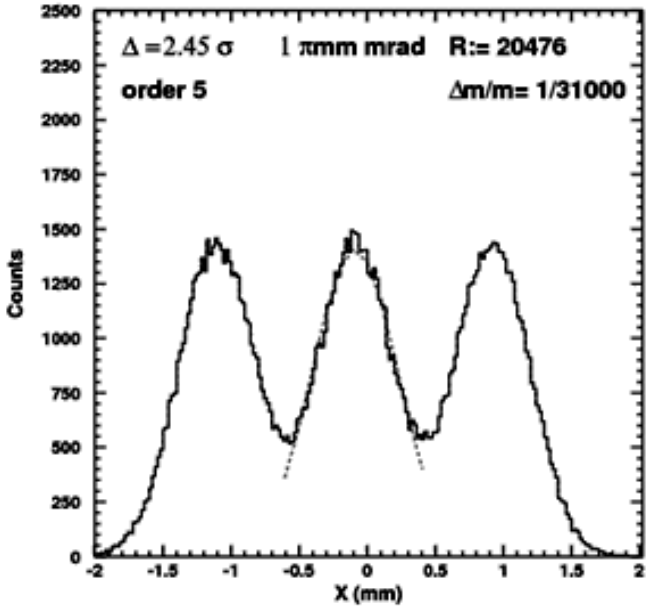


Tolerances

	X shift (mm)	Y shift (mm)	X Tilt (mrad)	Y Tilt (mrad)	Θ (mrad)
QQ1	±0.1	±0.1	±3.5	±3.5	±3.5
HQ1	±0.1	±0.1	±0.35	±3.5	±3.5
D1	±0.1	±0.1	±0.35	±3.5	±3.5
M	±0.1	±0.1	±3.5	±3.5	±3.5
D2	±0.1	±0.1	±0.35	±3.5	±3.5
HQ2	±0.1	±0.1	±0.35	±3.5	±3.5
QQ2	±0.1	±0.1	±3.5	±3.5	±3.5

Exit beam from HRS

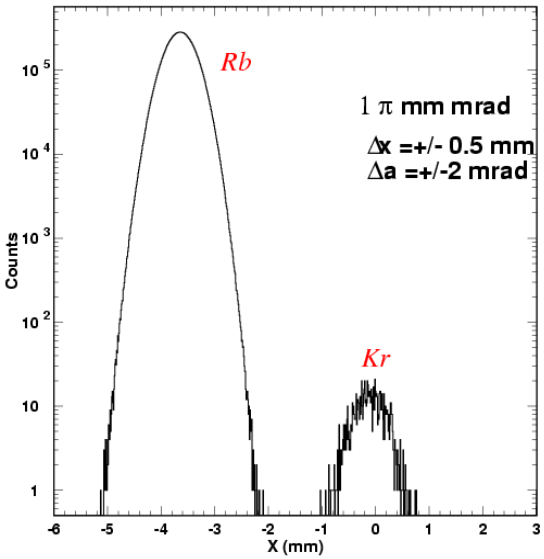


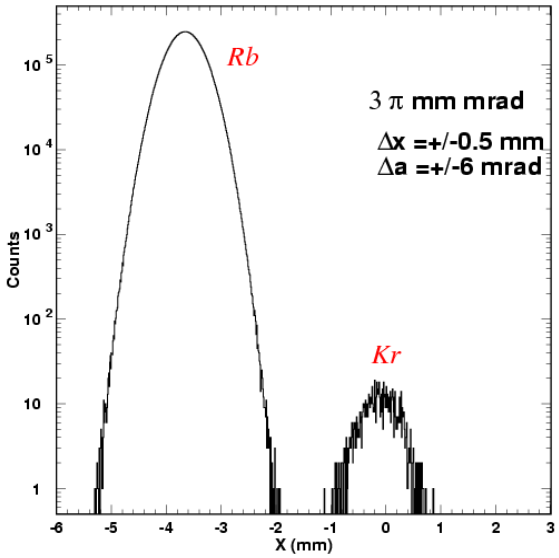


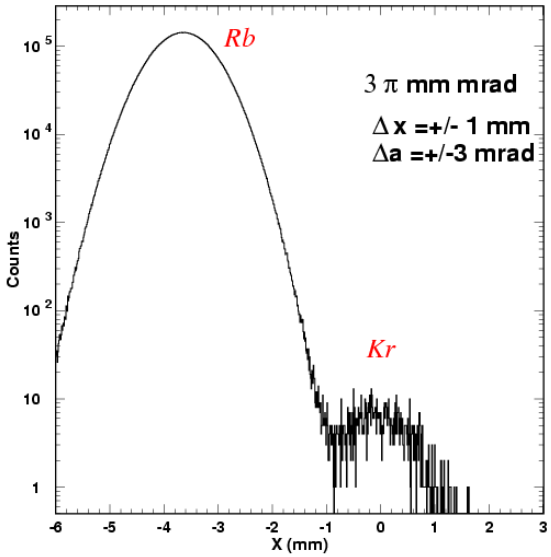
Beam Emittance and Energy dispersion

Beam emittance

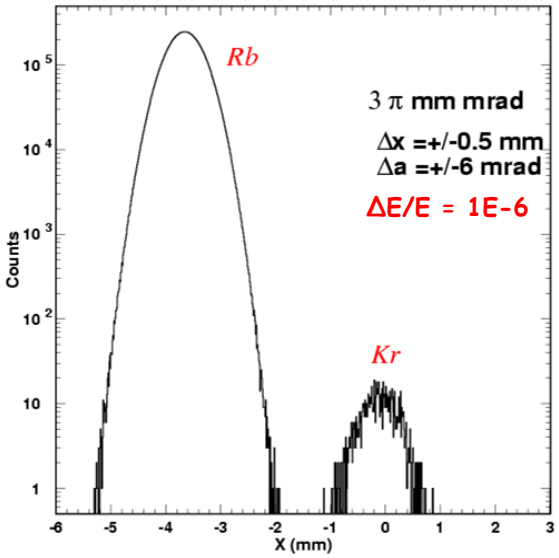
^{100}Kr :

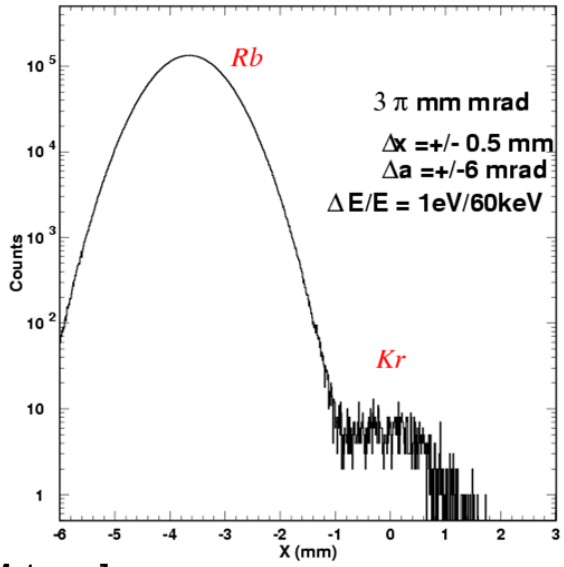






Energy dispersion



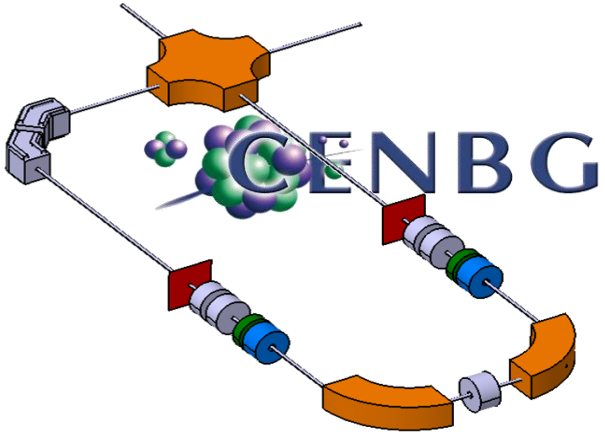


Status of the project

- Global optical design finished and validated.
- Mechanical design and integration in progress.
- Dipoles ordered in 2012.
- Manufacturing of other elements by CENBG:
  - First module to be constructed in 2013
- Installation at CENBG during 2014.
- Tests (transmission, resolution) 2014-2015
- Transfer to GANIL once the building is ready

SPIRAL2/DESIR-HRS working group:

Technical Coordinator: L. Serani
Scientific Coordinator: T. Kurtukian-Nieto, B. Blank



Mechanical design:
- ✓ Delalee, F.
- ✓ Chiron, T.
- ✓ S. El Abbeir
- ✓ A. Fournier

Command/control:
- ✓ L. Daudin

GANIL
laboratoire commun CEA/DSM Spiral2 CNRS/IN2P3

Magnetic design:
- ✓ Duval, M.
- ✓ Stodel, M.-H.

SPIRAL2 RIB Responsible: F. Varenne

Collaboration:

C. Davids — Argonne NATIONAL LABORATORY

D. Lunney — CSNSM

F. Méot — BROOKHAVEN NATIONAL LABORATORY

H. Weick — GSI

Thank you