ELENA - Electron Cooler

on behalf of Electron Cooler team

- **Map Presentation :**

  Electrons Cooling generalities

  Electron Cooler at CERN

  ELENA E-Cooler

  E-Gun & Collector

Jean Cenede

BI Day June 10th 2016

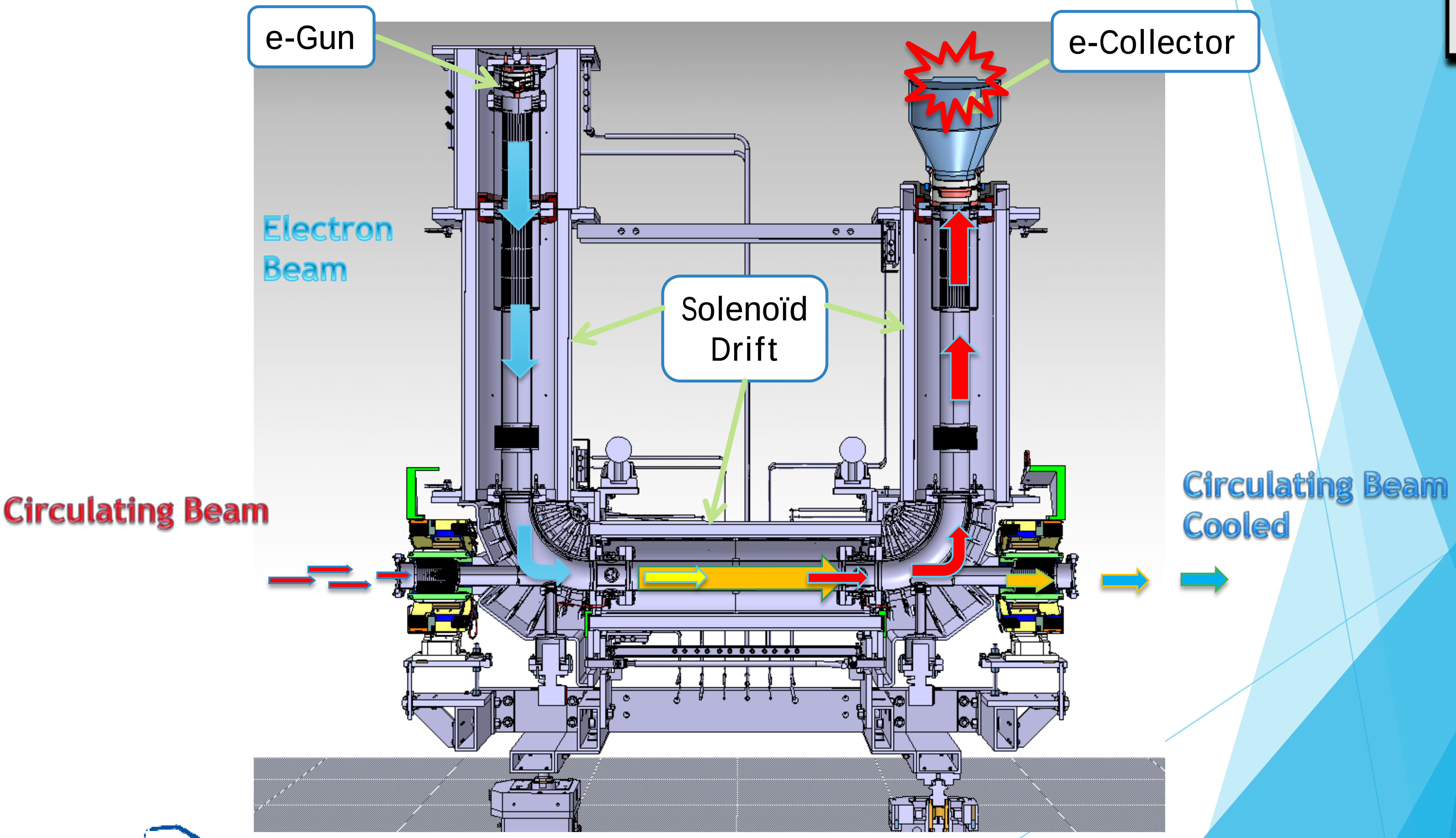
What‘s a Electron Cooling

2 ECOOL

- **Means to increase the phase space density of a stored ion beam.**
- **Mono-energetic cold electron beam is merged with ion beam which is cooled through Coulomb interaction.**
- **Electron beam is renewed and the velocity spread of the ion beam is reduced in all three planes.**

ELENA

Concept overview of a E-cooler



Electron Cooler system is composed of :

- Low velocity Electrons Source :

The E-GUN

- *final current given by Child's Law:*

$$I = \mu \, .V^{3/2}$$

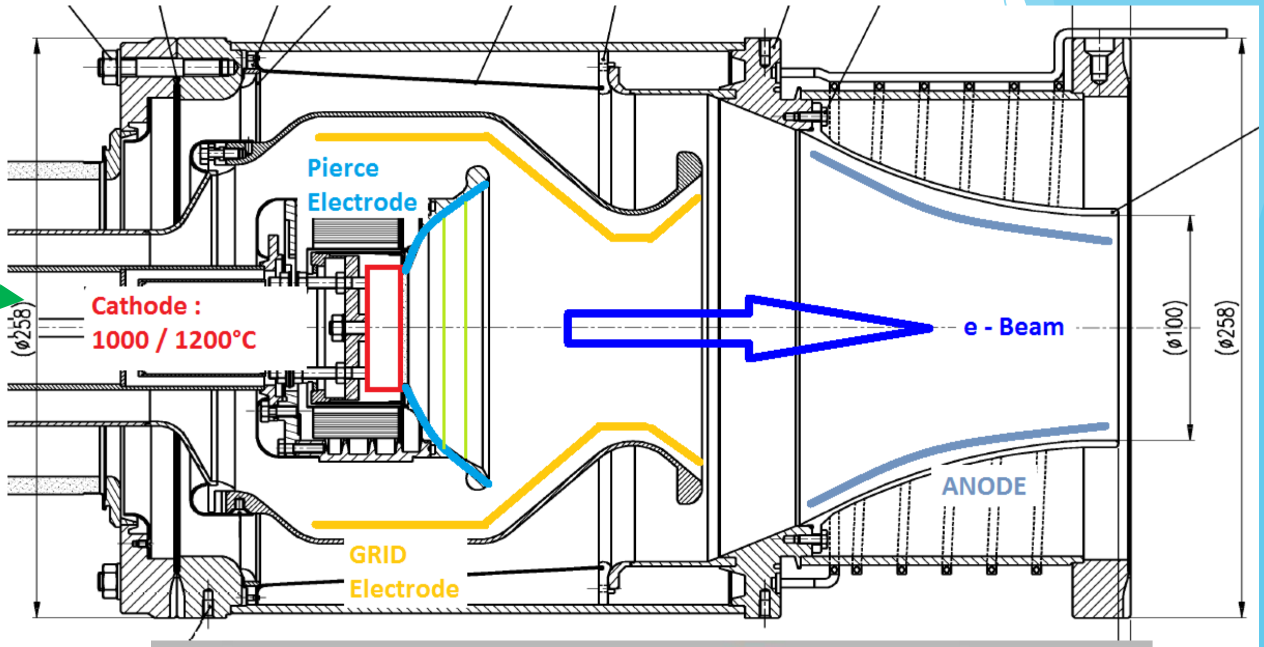
- A set of Magnetic circuit :

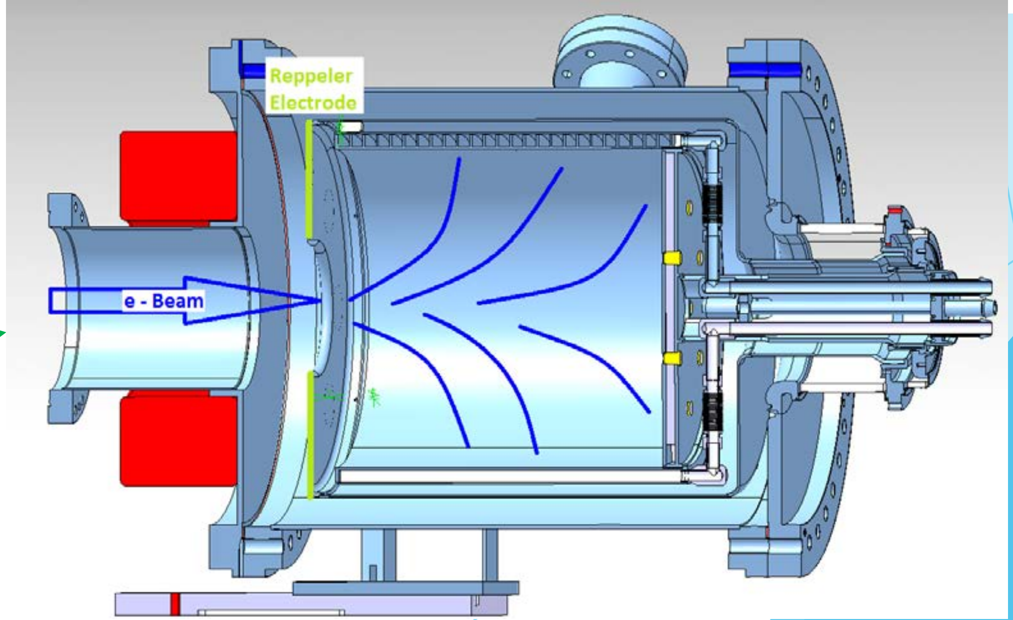
Expansion Solenoïd, Drift, Toroids, Squeezes coils ….

(Used to transport the electrons Beam)

- A Electron Anode Recuperator :

The COLLECTOR





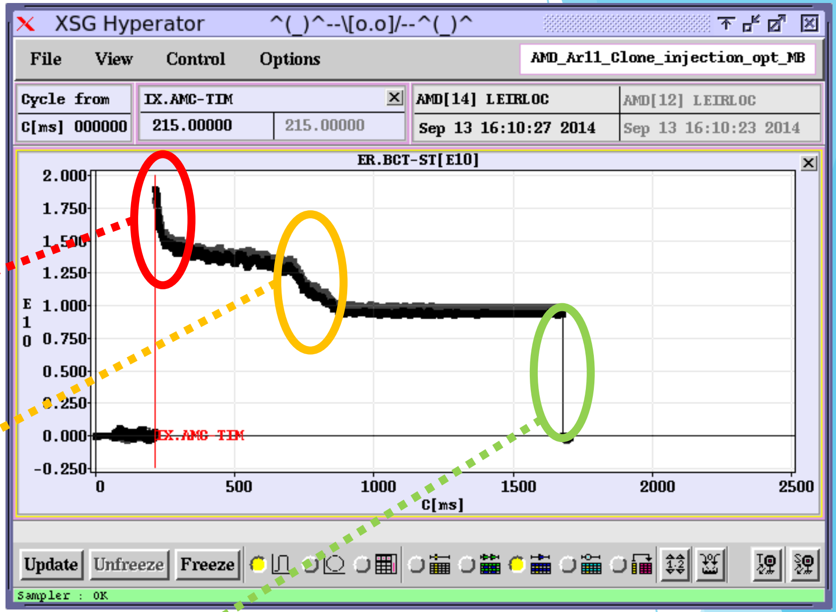
Cooling effects on Beam viewed by

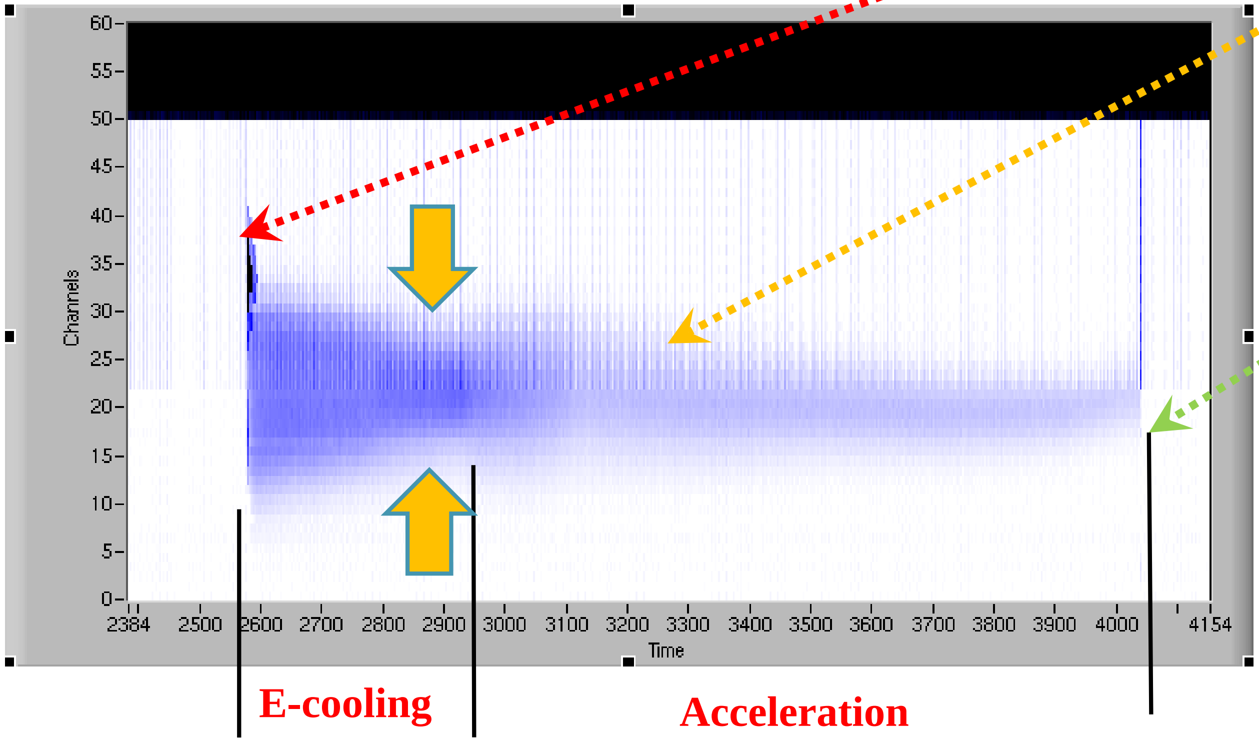
- **Beam Ionization Profile Monitor**

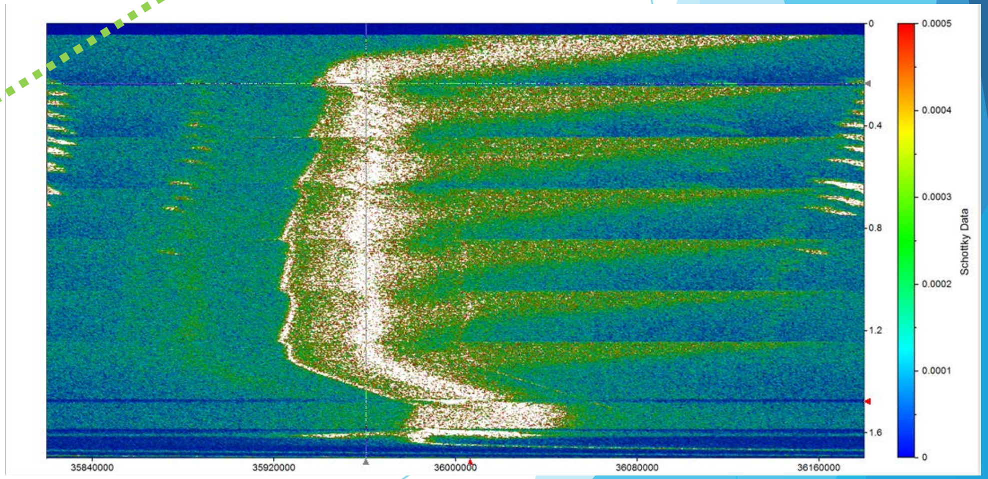
  (LEIR Vertical datas acquisitions : A.Frassier)

- **Schottky Monitor**

  (Beam Revolution Frequences)

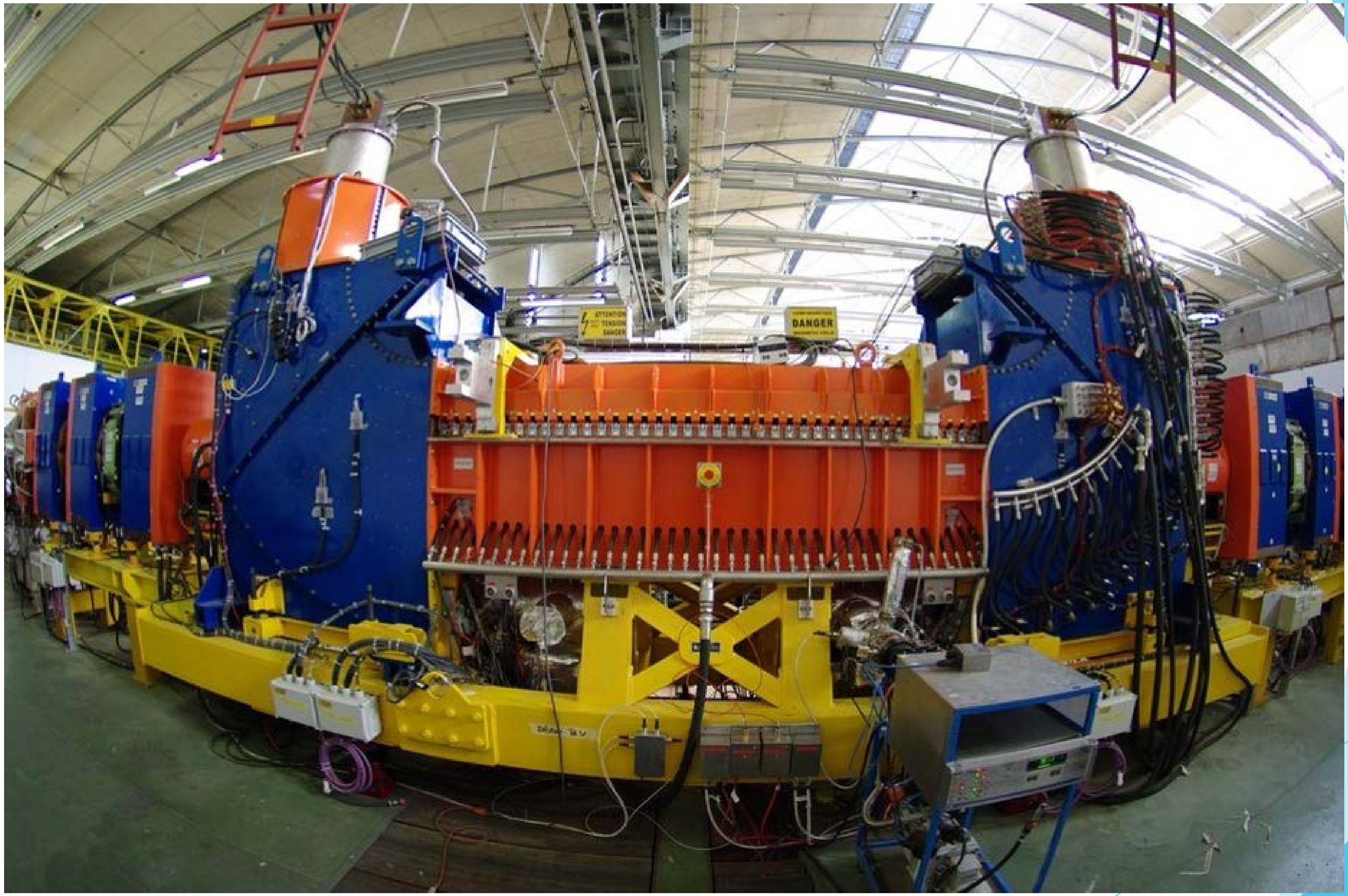






CERN's Electron Cooler : AD and LEIR

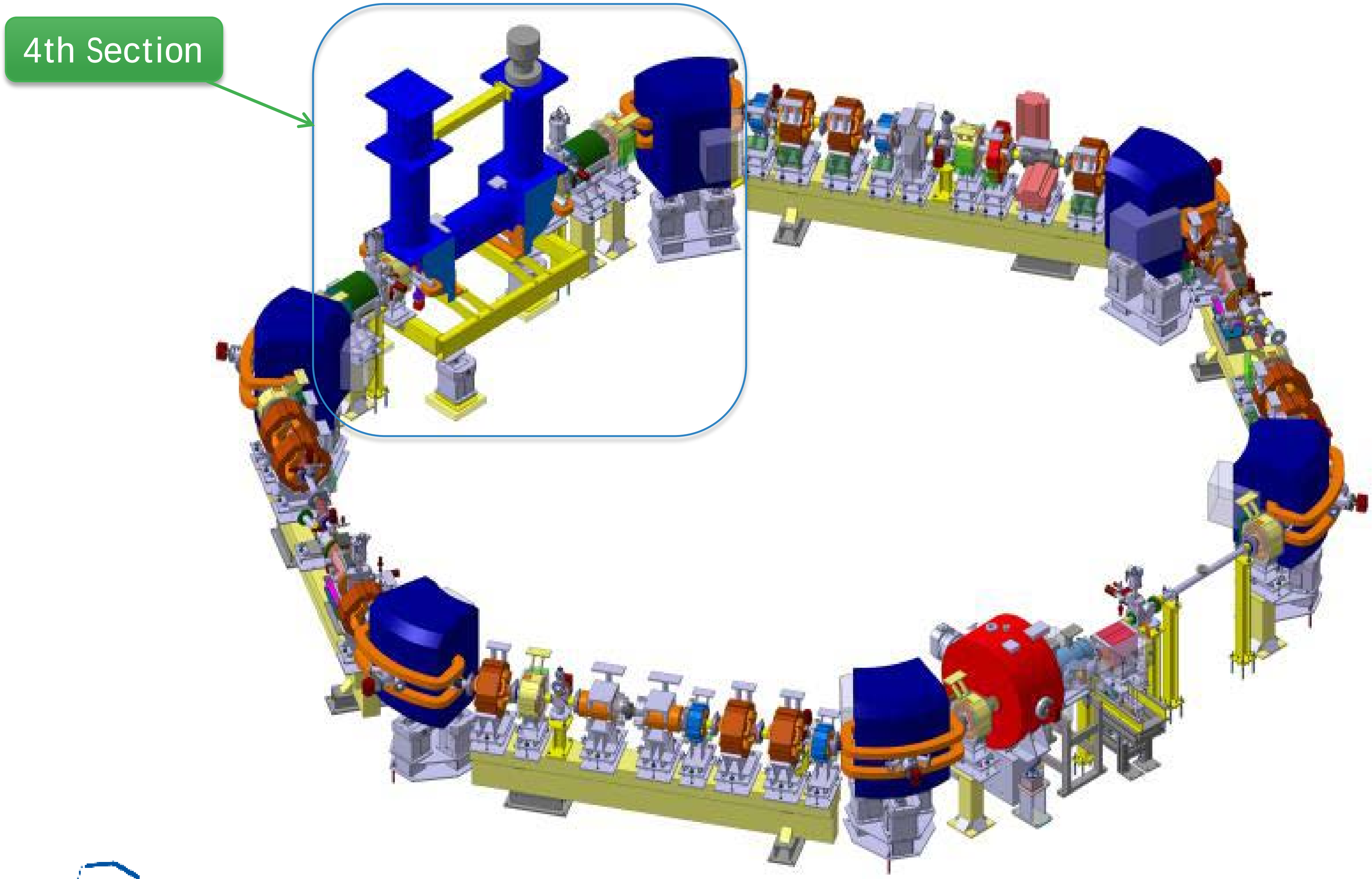
6 ECOOL



ELENA

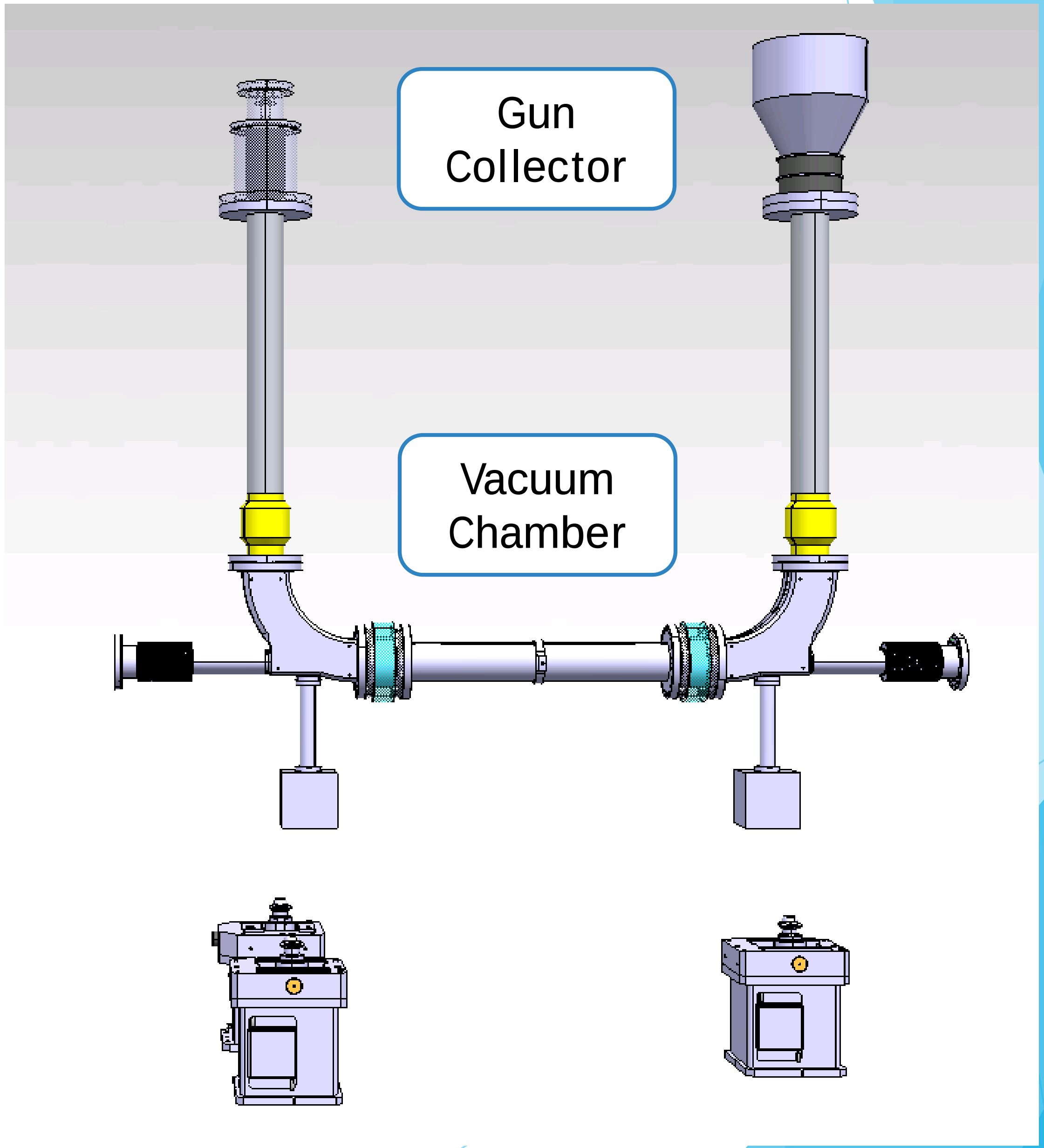
Location

Soon in ELENA Ring



Concept overview of Vacuum Elements

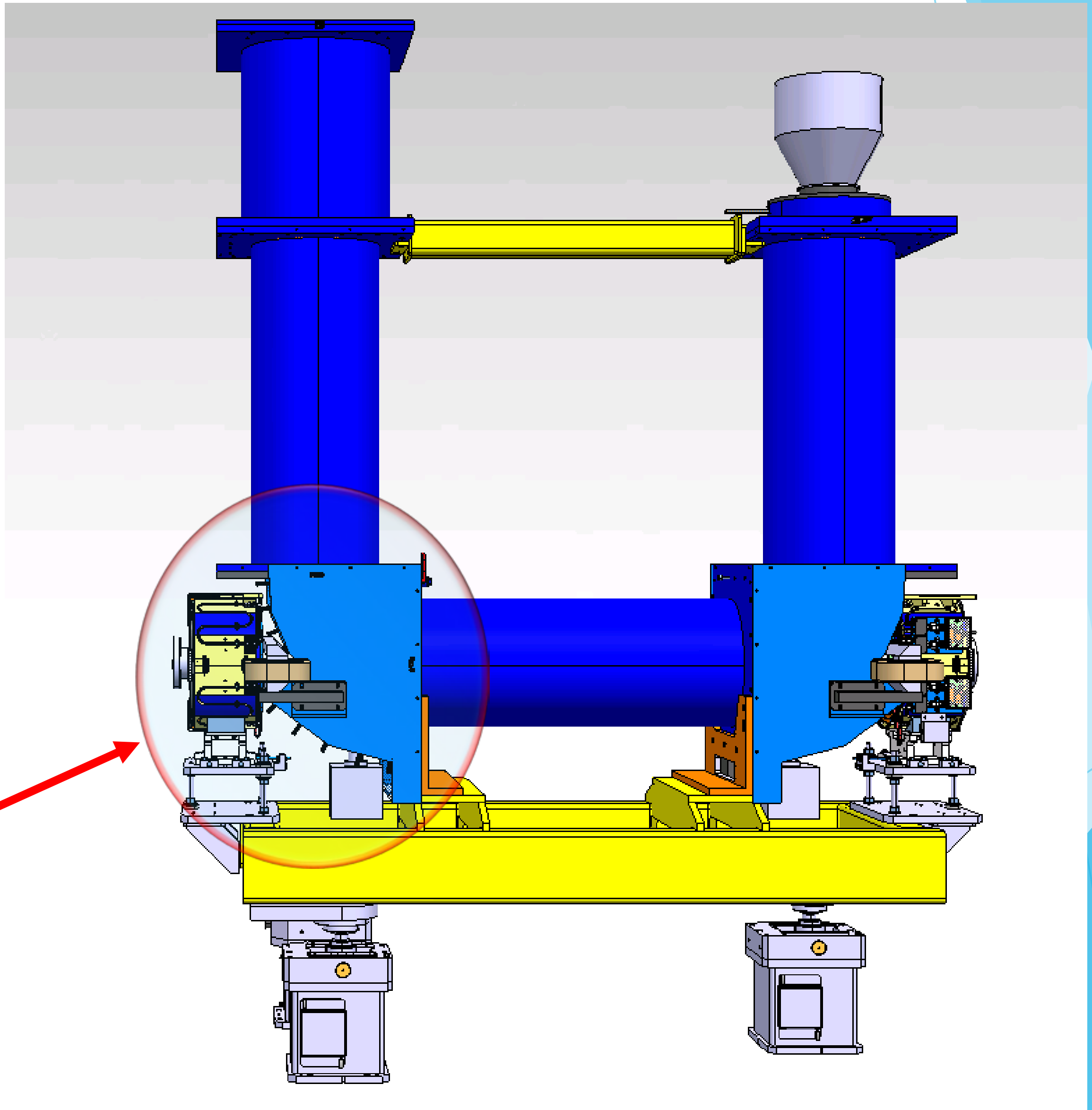
- Vacuum system
- Gun & Collector



Concept overview of Magnets Elements

- Magnets
- Supporting system

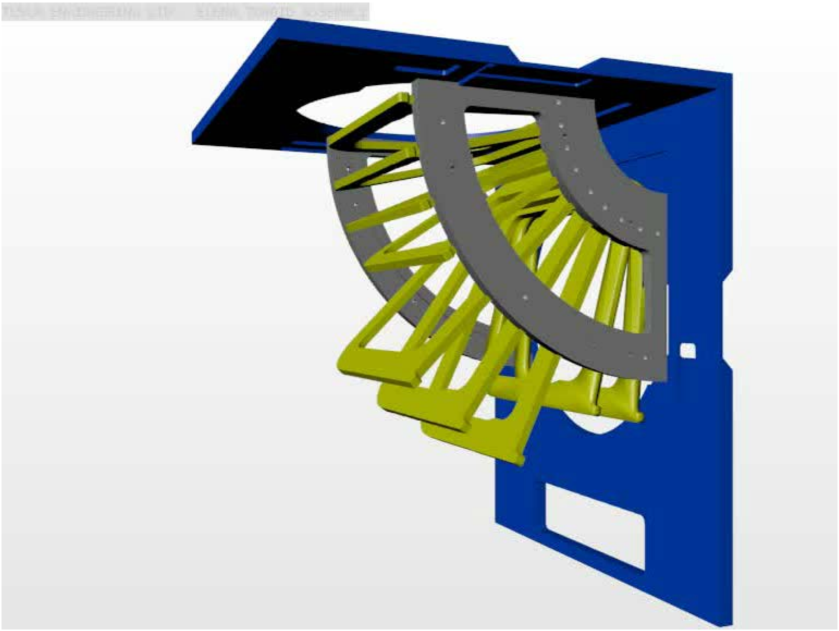
tesla

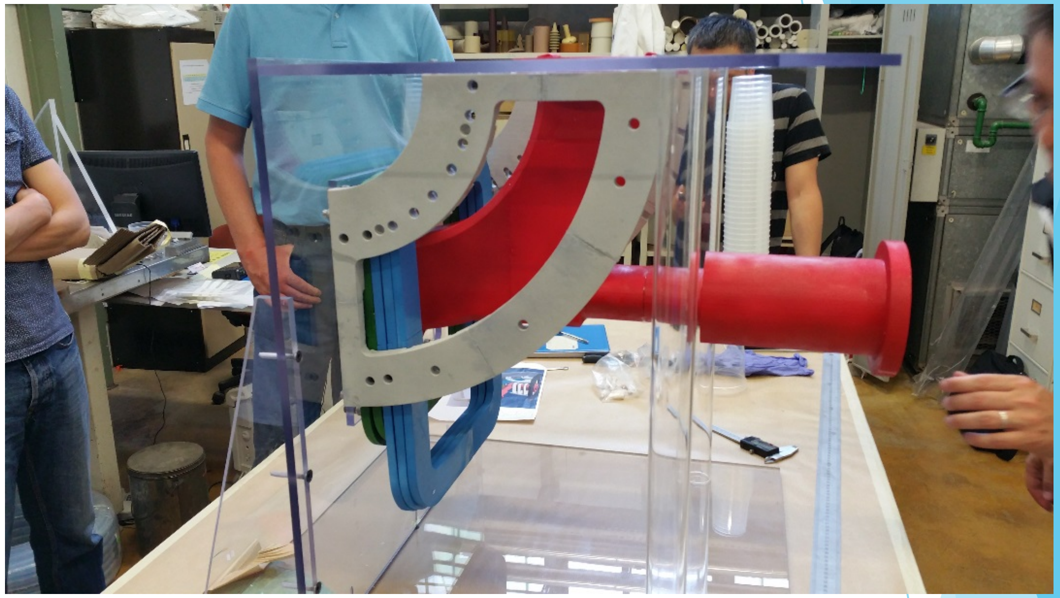


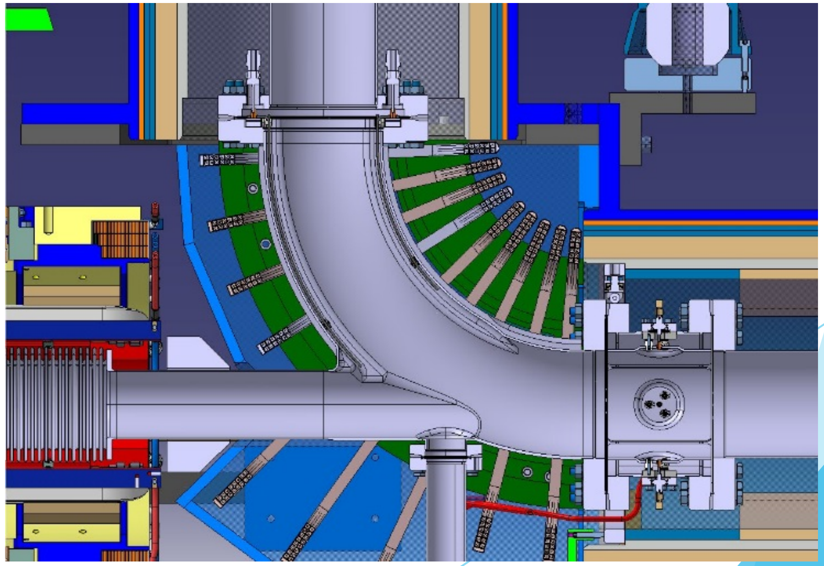
Toroid

Toroid Assembling details

- 3D Printing Simulations
- Assembling Sequences





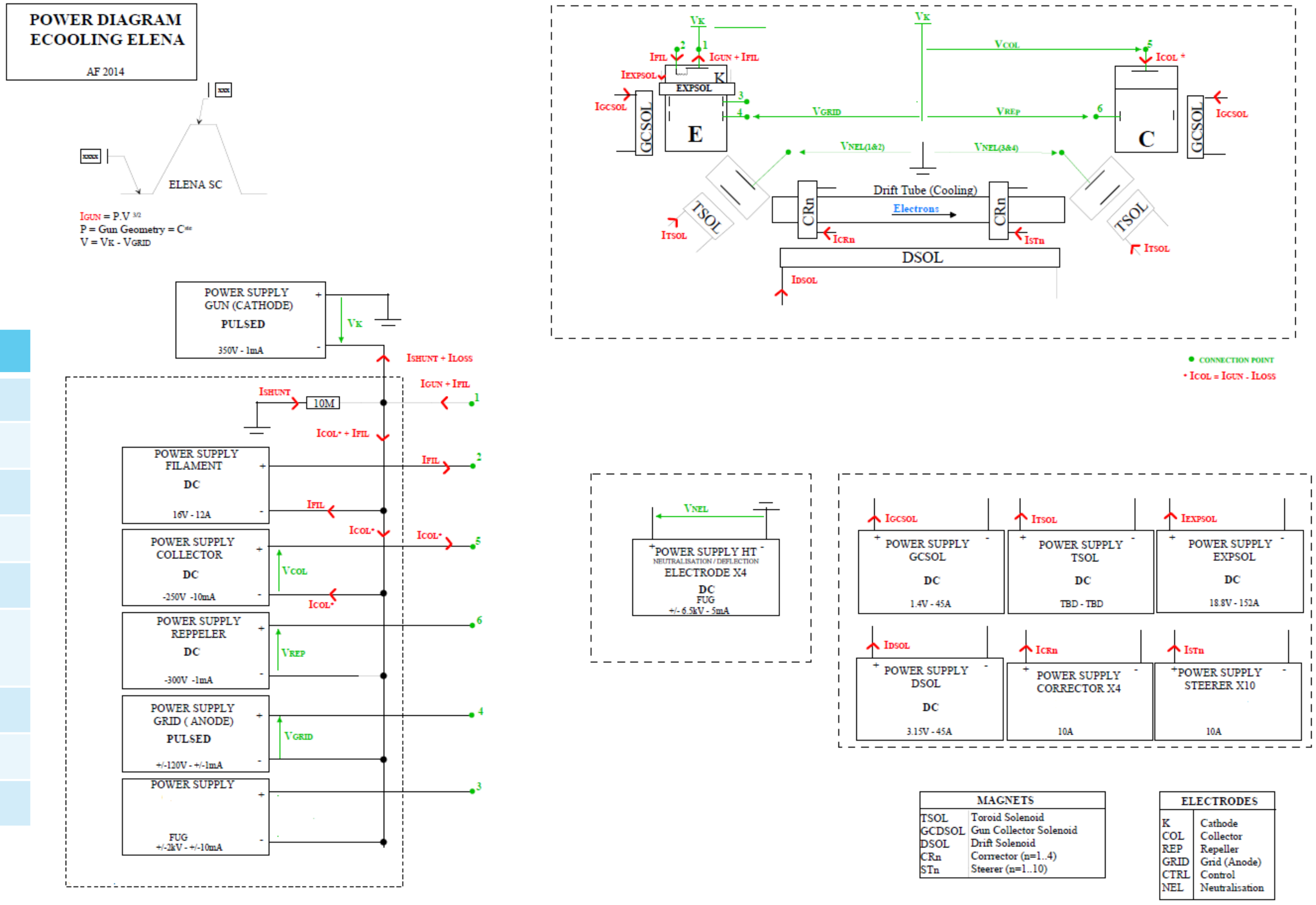


ELENA E-COOLER Power Diagram

11 ECOOL

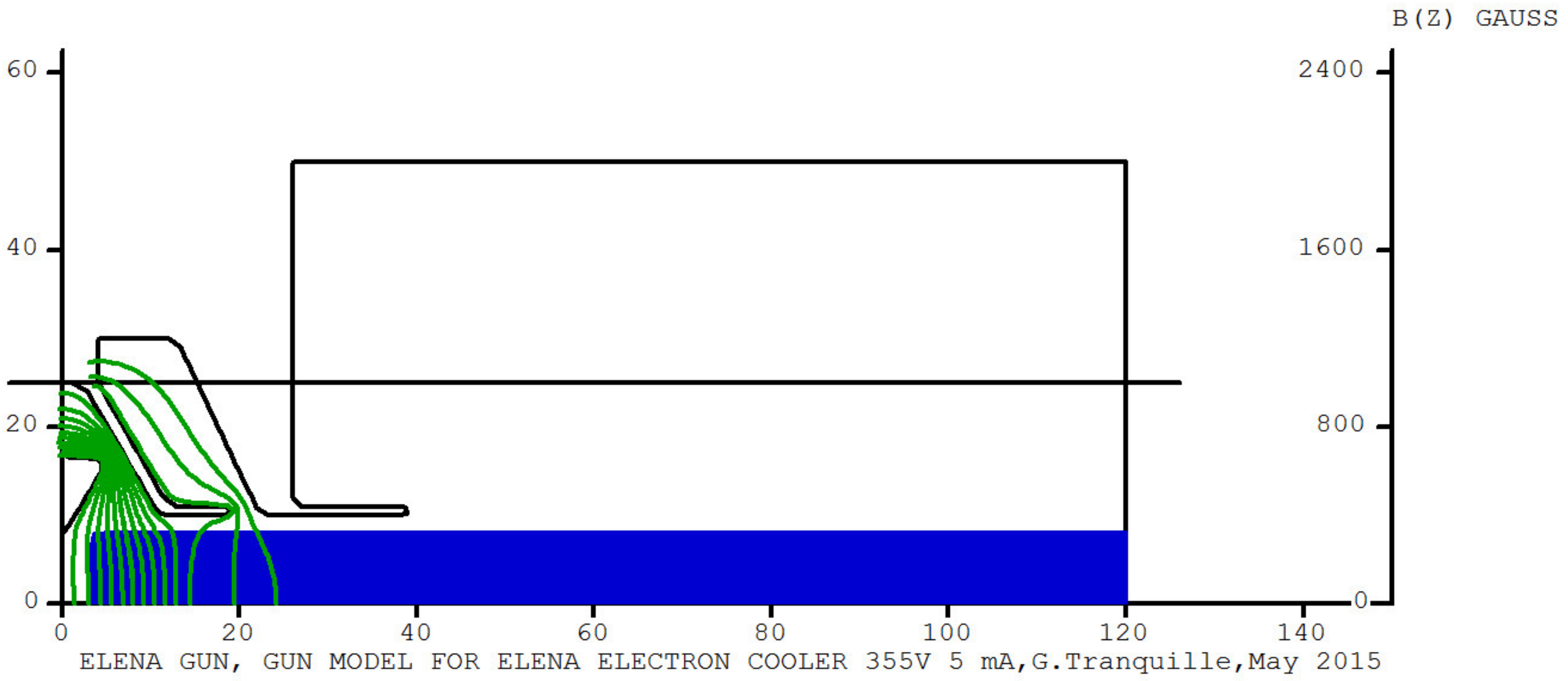
- Beam Specifications :
- I e- : 1/5mA
- U e- : -55/-355 V
- No High Voltage Cage

Momentum	35 MeV/c	13.7 MeV/c
Pbar-beam energy	648 keV	100 keV
E-beam energy	355 eV	55 eV
I e	5 mA	2 mA
Bgun	1000 G	
Bdrift	100 G	
Toroid bending radius	0.25 m	
Cathode radius	8 mm	
E-beam radius	25 mm	
Cooling drift length	1.0 m	



Gun & Collector Design

Gun and collector design optimization performed with EGUN



$(I = \mu \cdot V^{3/2})$

Gun and Collector Specifications :

(Inspired by : AD, LEIR E-COOLER & FERMILAB design)

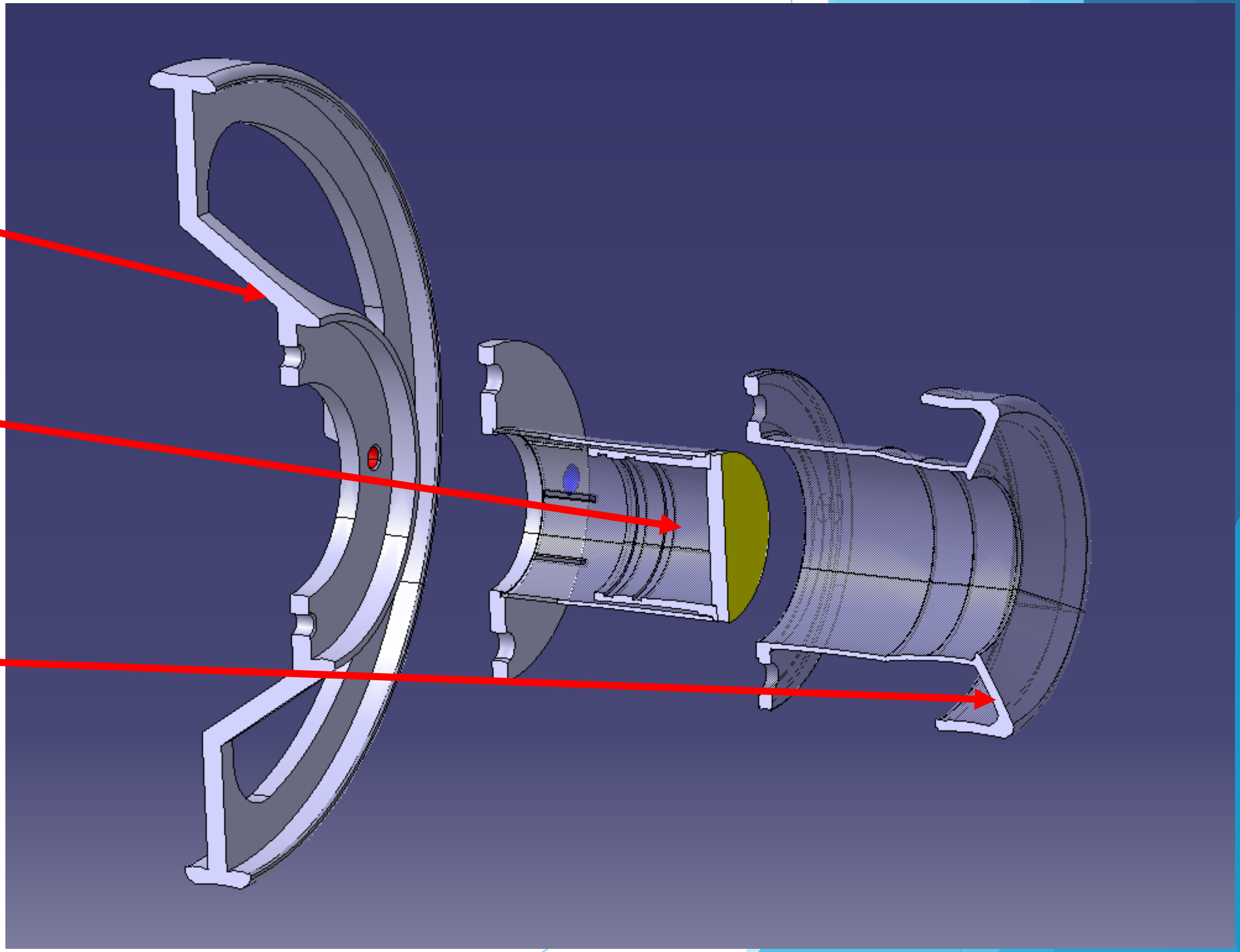
- Adapted to cathode design, electricals, thermals requirements
- Differents electrodes with differents forms, positions & voltages
- Modularity for eventuality modifications
- XH-Vacuum : 10-12 mmb
- Hight temperature Back-out : 200 to 300°

Cathode Assembly Concept overview

- Support Cathode
- Cathode :

(Provider SAES Getters)

- Pierce Electrode



Gun Concept overview

(on CDD: AD_NECGA%)

- Gun Flange

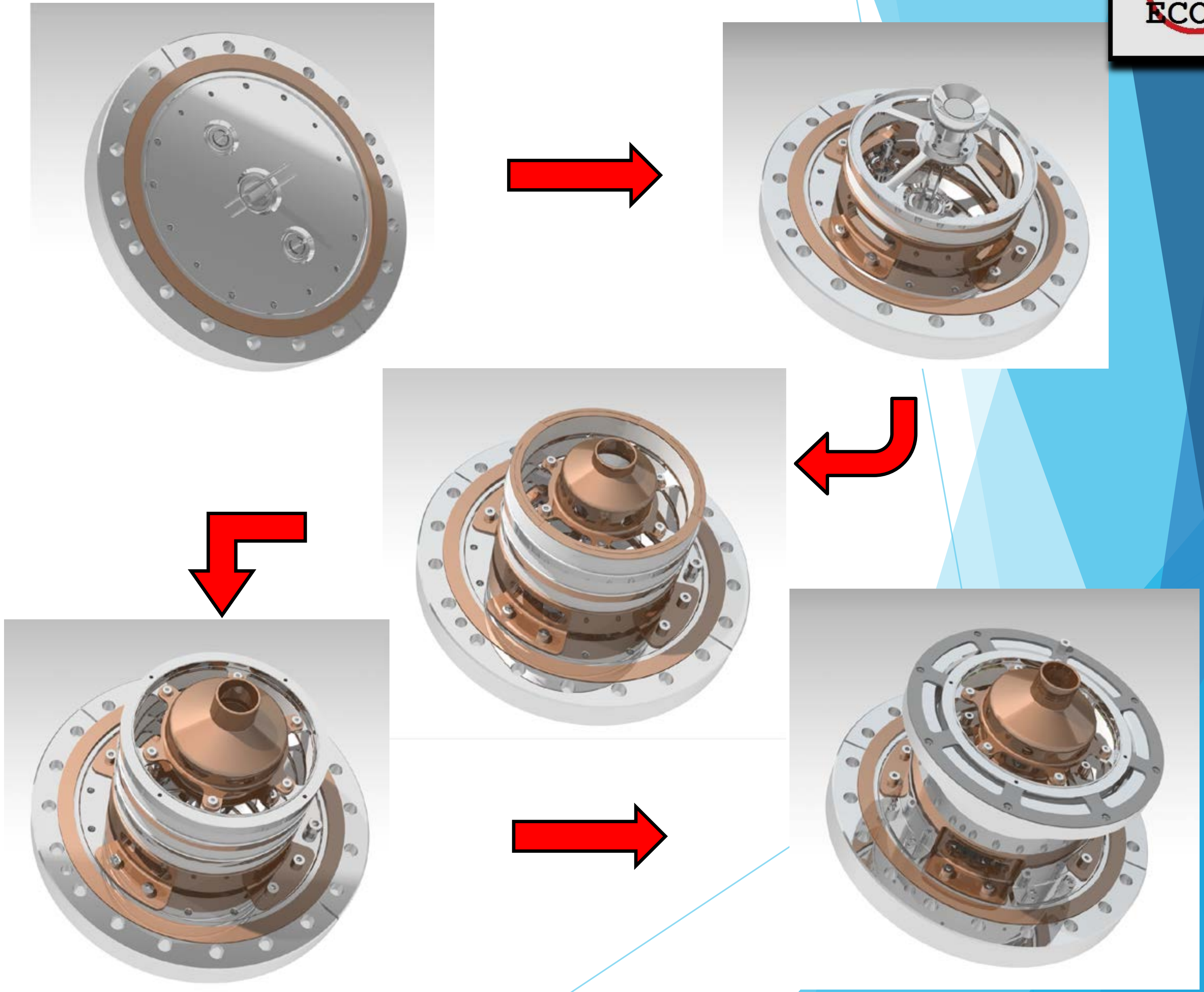
(DN160CF + SHV + Fil. connector)

- Cathode Assembly
- Grid Electrode
- Anode Electrode
- Each Potential is separate by

ceramic Isolator

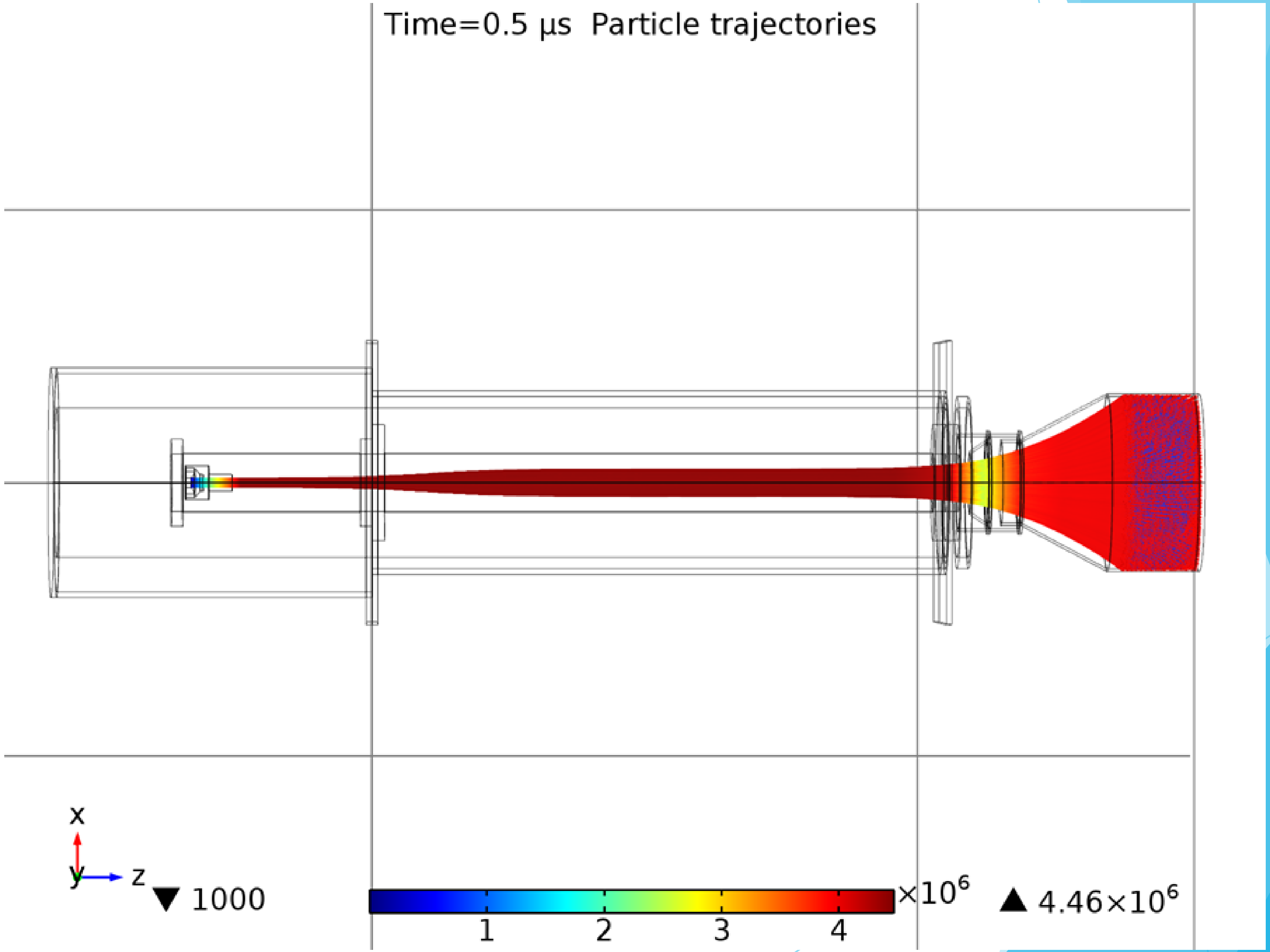
- Sleeve & Elastique compress ring

(total : 135mm height)



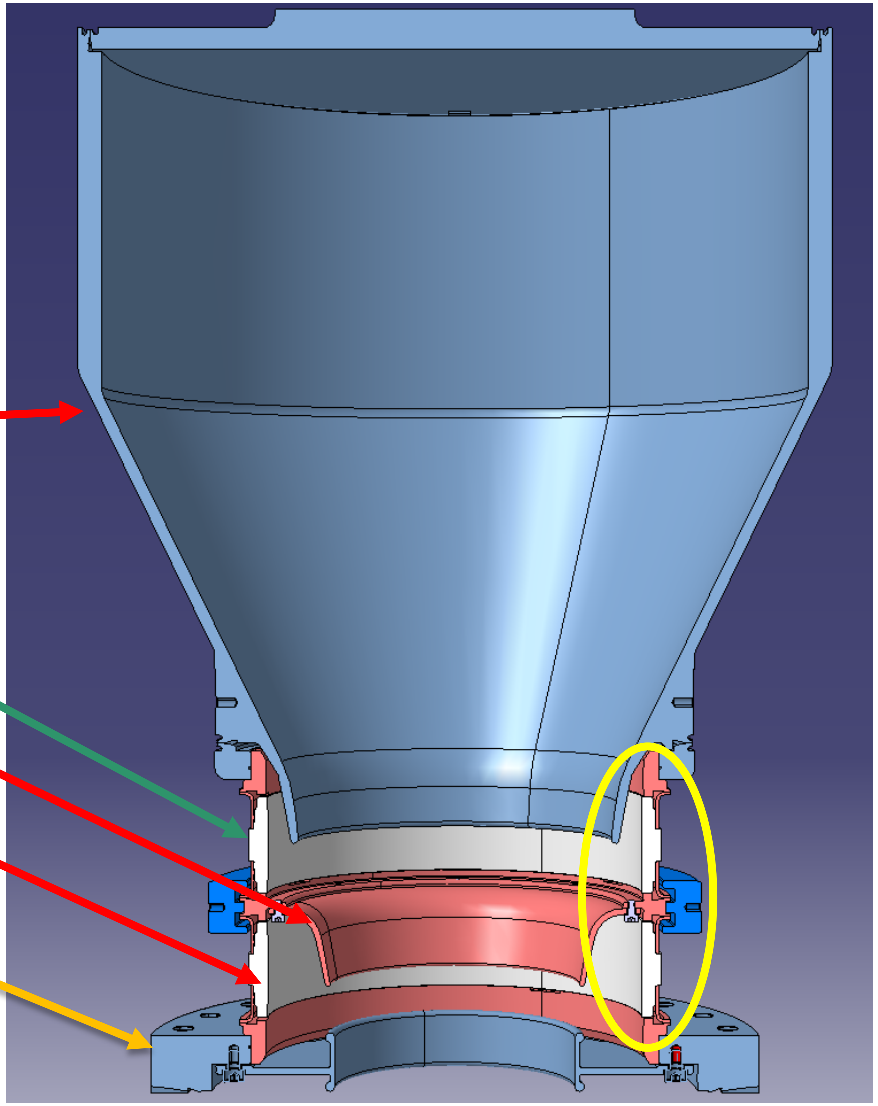
Gun to Collector Design

Gun and collector design optimization performed with COMSOL Multiphysics
(G. TRANQUILLE)

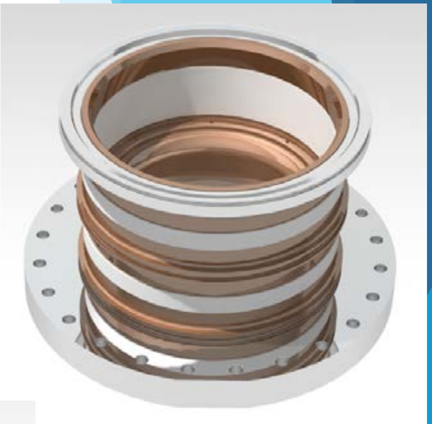


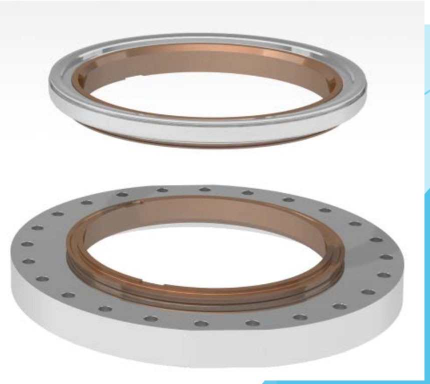
Collector Concept overview

(on CDD : AD_TER% dimensions Ø 314 x 455mm)



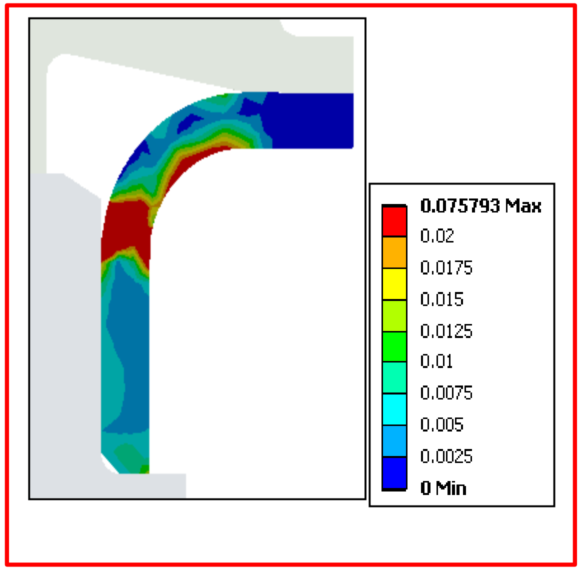
- Collector (Anode)
- Ceramic Isolator
- Reppeler Electrode
- Ceramic Isolator
- Collector flange (DN200CF)

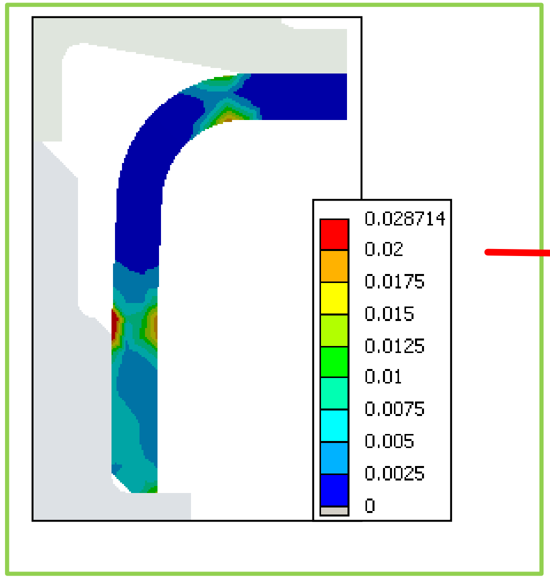


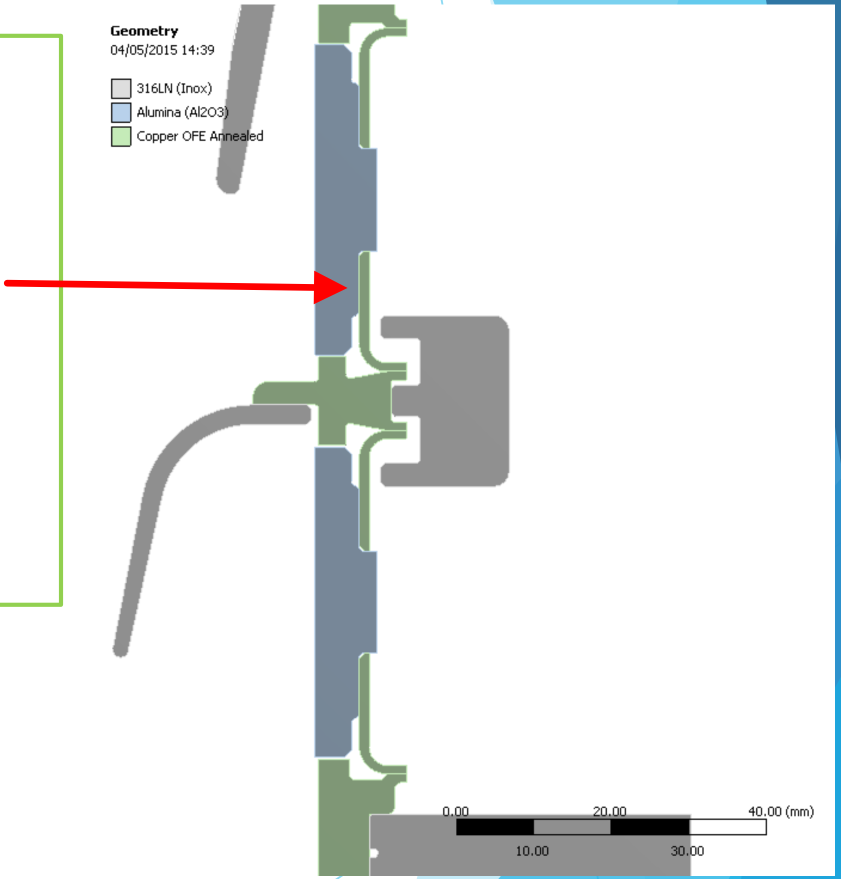


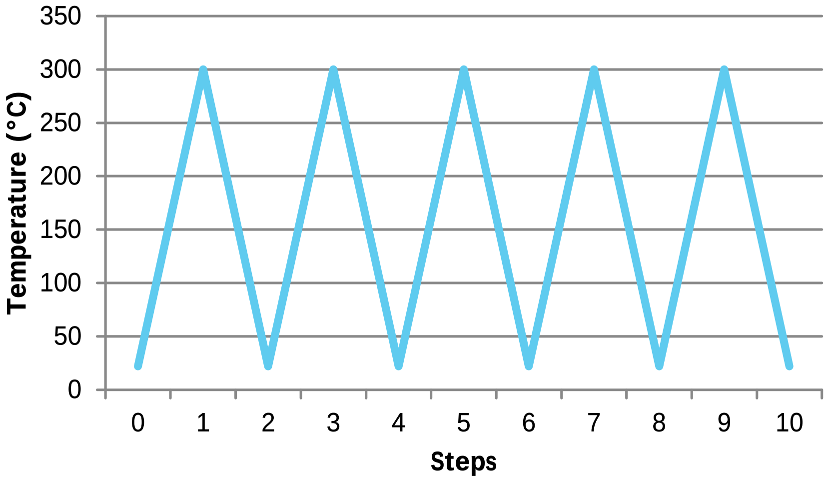
Bake Out Brazing Stress
Simulation modification & validation

(ANSYS by EN-MME)









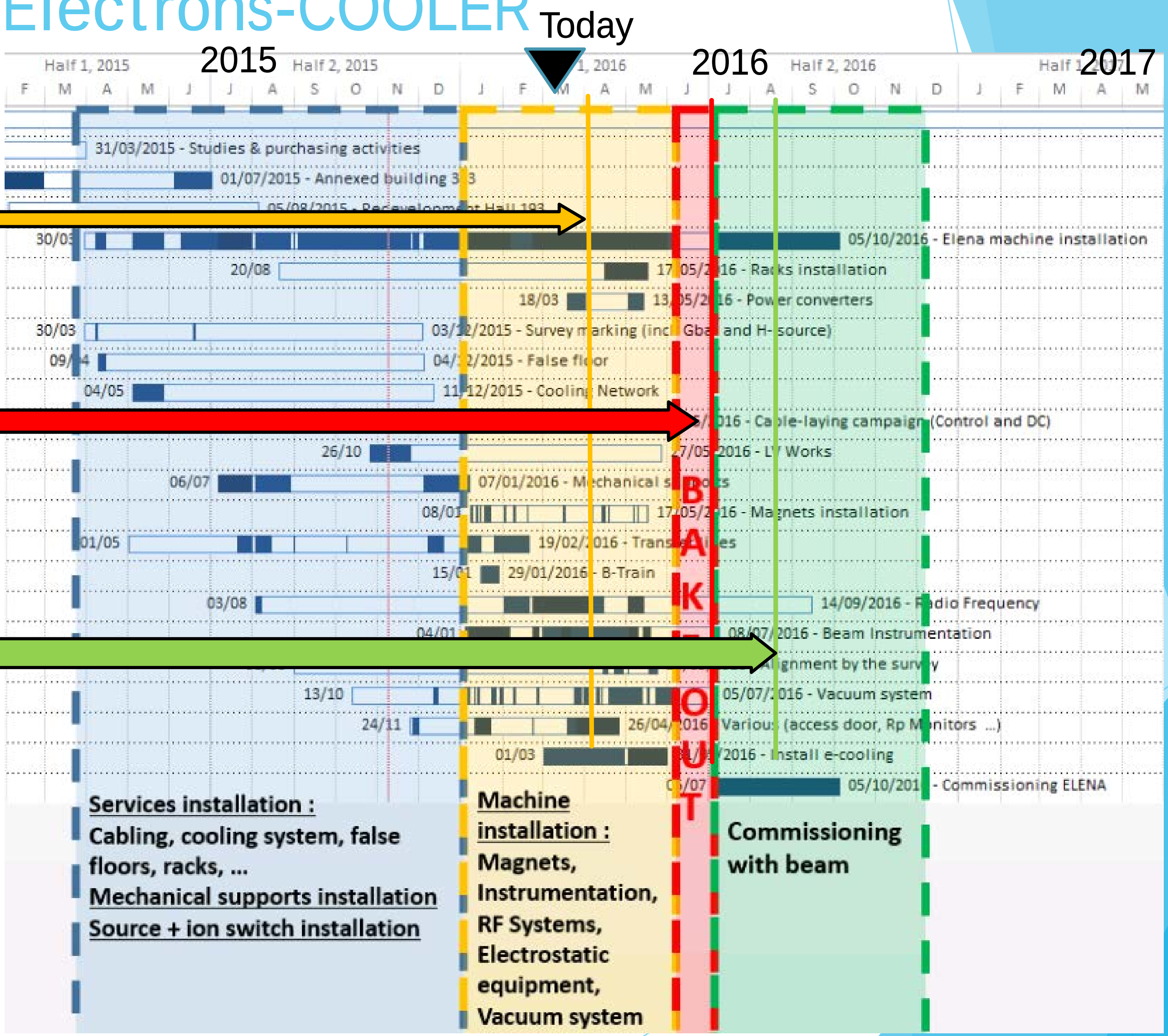
Planning ELENA Electrons-COOLER

GUN & COLLECTOR : Ready

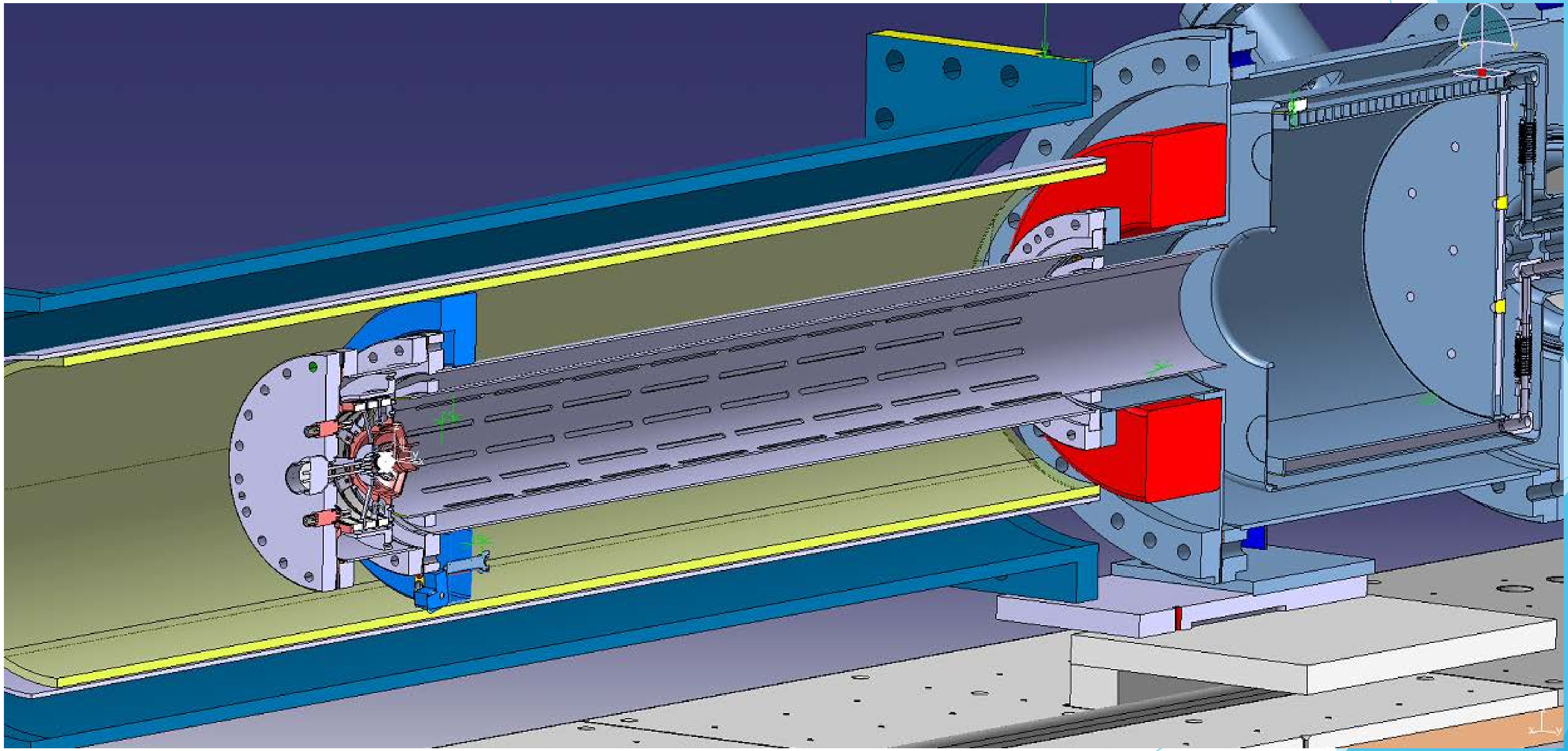
E-COOLING Assembling in the midle of ring ELENA

Connecting E-COOLER to ELENA ring

I hope it will live Happily !!!!



ELENA E-cooler Gun configuration on a lovely Test bench for validation.



Soon ELENA E-COOLER Gun Beam tests

(Test bench bat 236: Started by R.Sautier)

Thanking to Electron Cooler team :

Gerard Tranquille
Alexandre Frassier
Lars Soby
Lars Varming J.

BE BI
BE OP

Marc Timmins
Antti Juhani K.
Alejandro Carlon Z.
Benjamin Moles

EN MME

Next step for E-COOL Team :

- *A new E-COOLER for AD-RING for LS2*

That's All For Now

112-996

Parts List

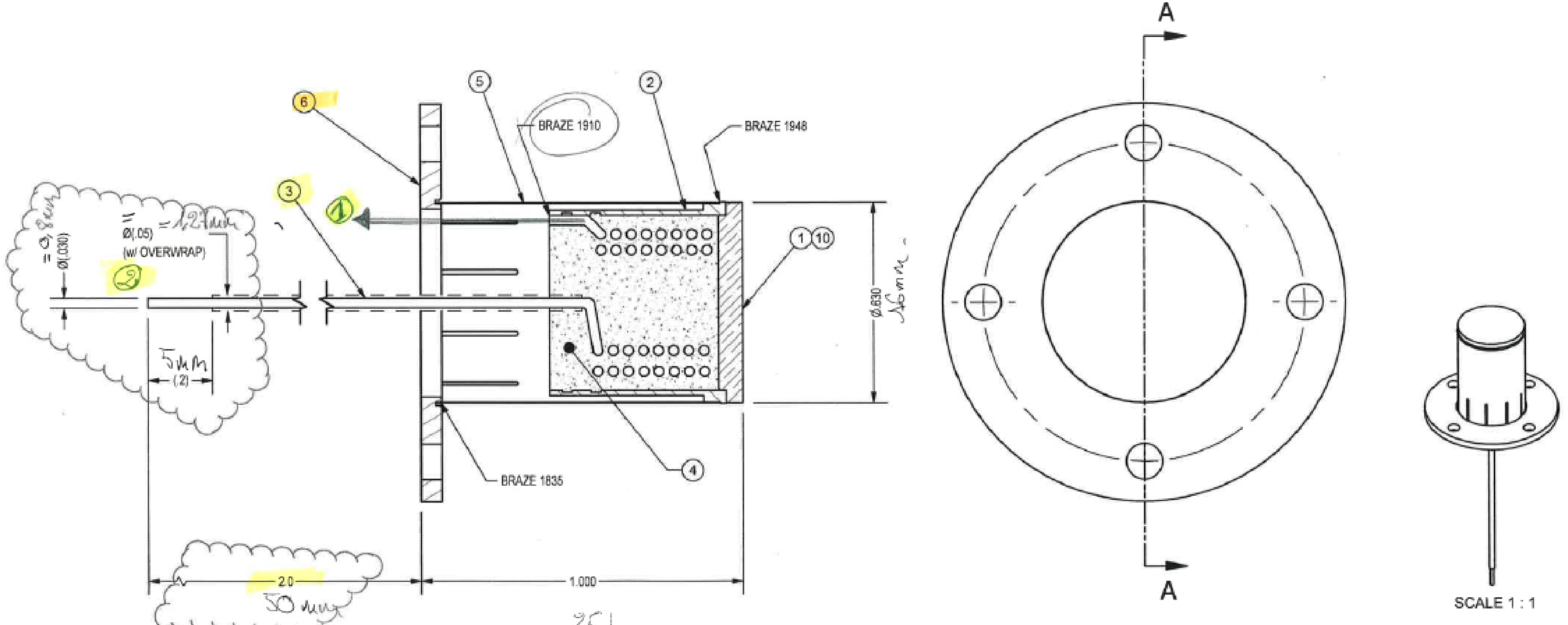
ITEM	PART NO.	REV	DESC'	QTY
1	113-004	A	C-EMIT-Ø.630 = 16 mm ok	1
2	112-220	B	C-BODY-Ø.550 = 14 mm	1
3	113-020	A	C-HTER-COAX-Ø.490 ≃ 12,5 mm	0 → 2
4	Doc 0265	--	SMI STD POTTING	0
5	112-221	A	C-SLEV-2.014-.885-.002 ok	1
6	113-005	A	C-BASE-Ø1.250 = 31,75 mm ok	1
7	113-006	---	J-BRAZE-JIG	1
8	113-007	---	P-PACK-JIG	1
9	#4-40 X .25	---	Socket Head Cap Screw .25" Lg	2
	SWM-420	---	J-SPOT-WELD-MAND-Ø.623	TOOL
	FIPPT-071	---	J-FIPPT-Ø.537-.010	TOOL
	SSJ-022	---	J-SLEV-SETT-JIG-Ø.626	TOOL

Parts List

ITEM	PART NO.	REV	DESC'	QTY
10	Doc 0251	---	IMP Mix 612; Wt. Gain 375.9mg Max / 235.1mg Min	AR

REVISION HISTORY

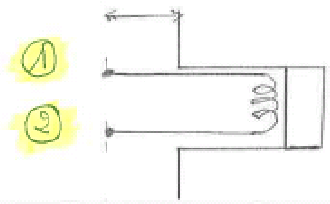
REV	DESCRIPTION	ECO#	DATE	APPROVED
A	INITIAL RELEASE	3980	5/22/15	Jaw / JEP
A	UPDATE TO HEATER TO REFLECT CUSTOMER REQUEST	3980	6/9/15	JEP/



SECTION A-A
SCALE 3 : 1

NOTES:

1.



DRAFT 06/09/15
DO NOT USE FOR MANUFACTURE

Tolerances (U.O.S) x.x = ±.050 x.xxx = ±.005 x.xx = ±.020 x.xxxx = ±.0005 Finish 32 microinches °= ±1° °.x = ±.5° Edges and Corners .002R Max	saes getters SMI	100 Westgate Dr. Watsonville, CA 95076 www.spectramat.com	ph (831) 722-4116 fx (831) 722-4172
DRAWN JEP 5/18/2015	TITLE T-CATH-HTER-Ø.630		
CHECKED JEP 5/22/2015	SIZE B	CAGEC 2H499	DWG NO 112-996 · SCALE 3 : 1 · REV A
ENG APPR JEP 5/22/2015			
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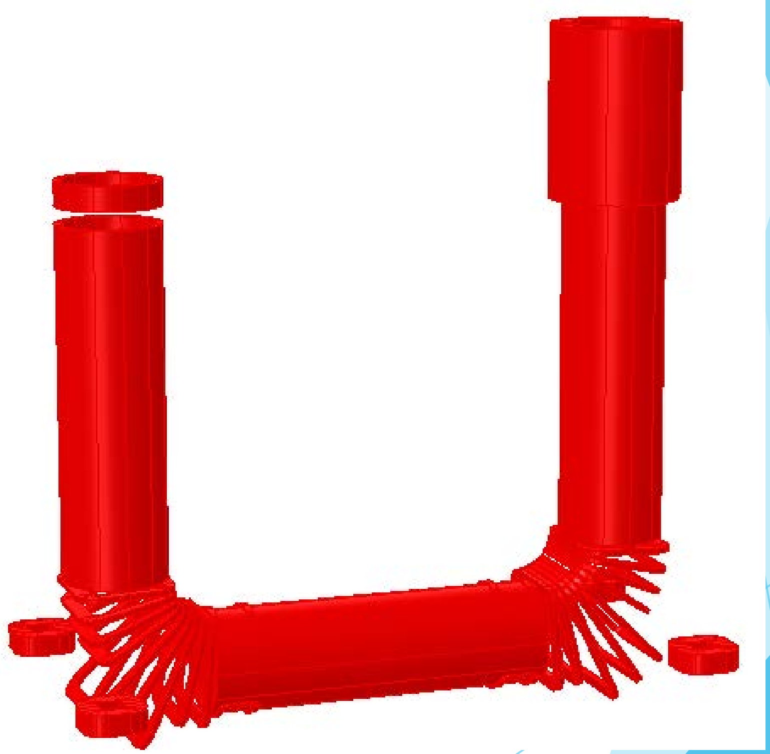
112-996

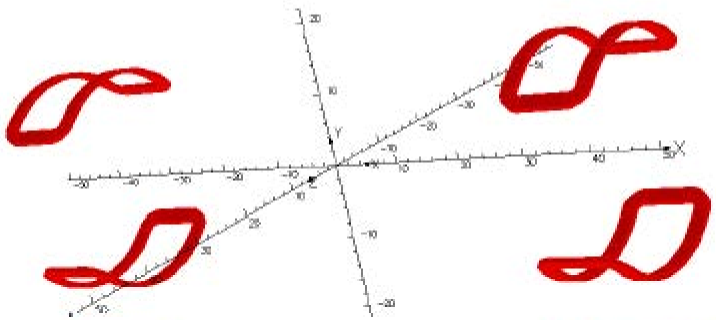
The magnet system

Magnetic system components

- Main cooler solenoid
- Gun solenoid
- Collector solenoid
- Expansion solenoid
- Squeeze coil at collector
- 2 x Toroid section consisting of
  9 racetrack coils each
- Various corrector coils to
  ensure good field quality
- Orbit correctors
- Solenoid compensators



Fine tuning the field



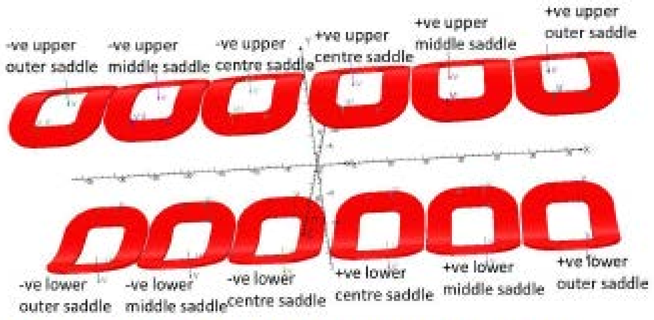


Figure 3.28 Arrangement of the Fine Corrector coils (Y axis)

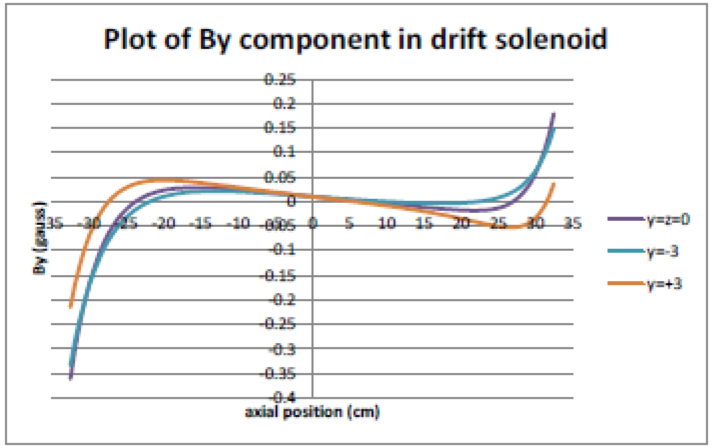


Figure 3.27 Plot By component of the field along the axis of the Drift solenoid (currents in Appendix A).

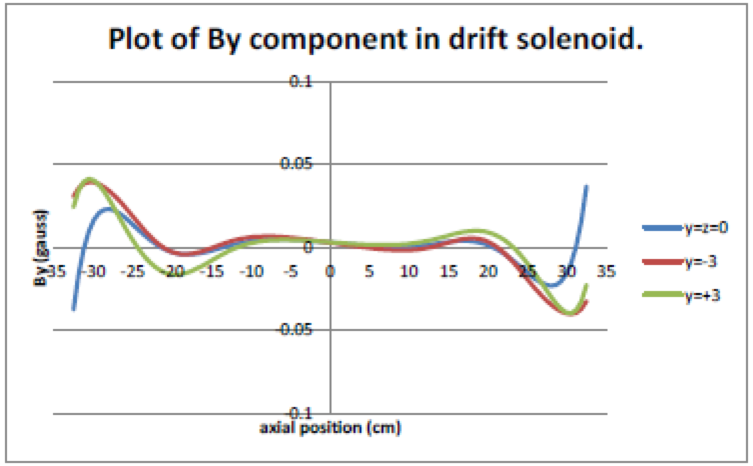


Figure 3.30 Plot of By along drift solenoid with Fine Correction coils in operation

Beam Ionisation Profile Monitors