Multigan® : A new multicharged ion source based on axisymetric magnetic structure

L. MAUNOURY – GANIL – Caen

The objectives

- Framework of SPIRAL1 update
  - 1+ => n+ project High Density 1+ ECRIS
  - New TIS instead of the actual NANOGANIII

- Multicharged ion source based on axisymetric magnetic structure => better beam quality

- Multicharged ion source with opened spaces in the middle of the source => enlarge possibilities

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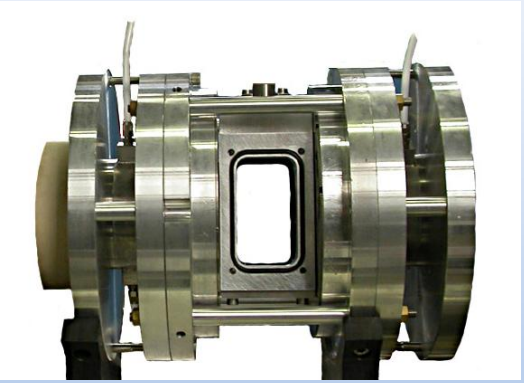
Development of a prototype was undertaken !

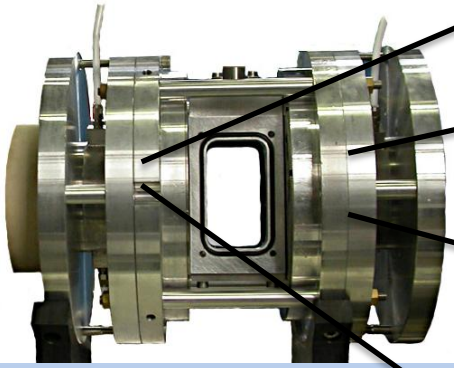
It is made in collaboration with the Pantechnik company

Magnetic structure



MONO1000 ECRIS

Magnetic structure



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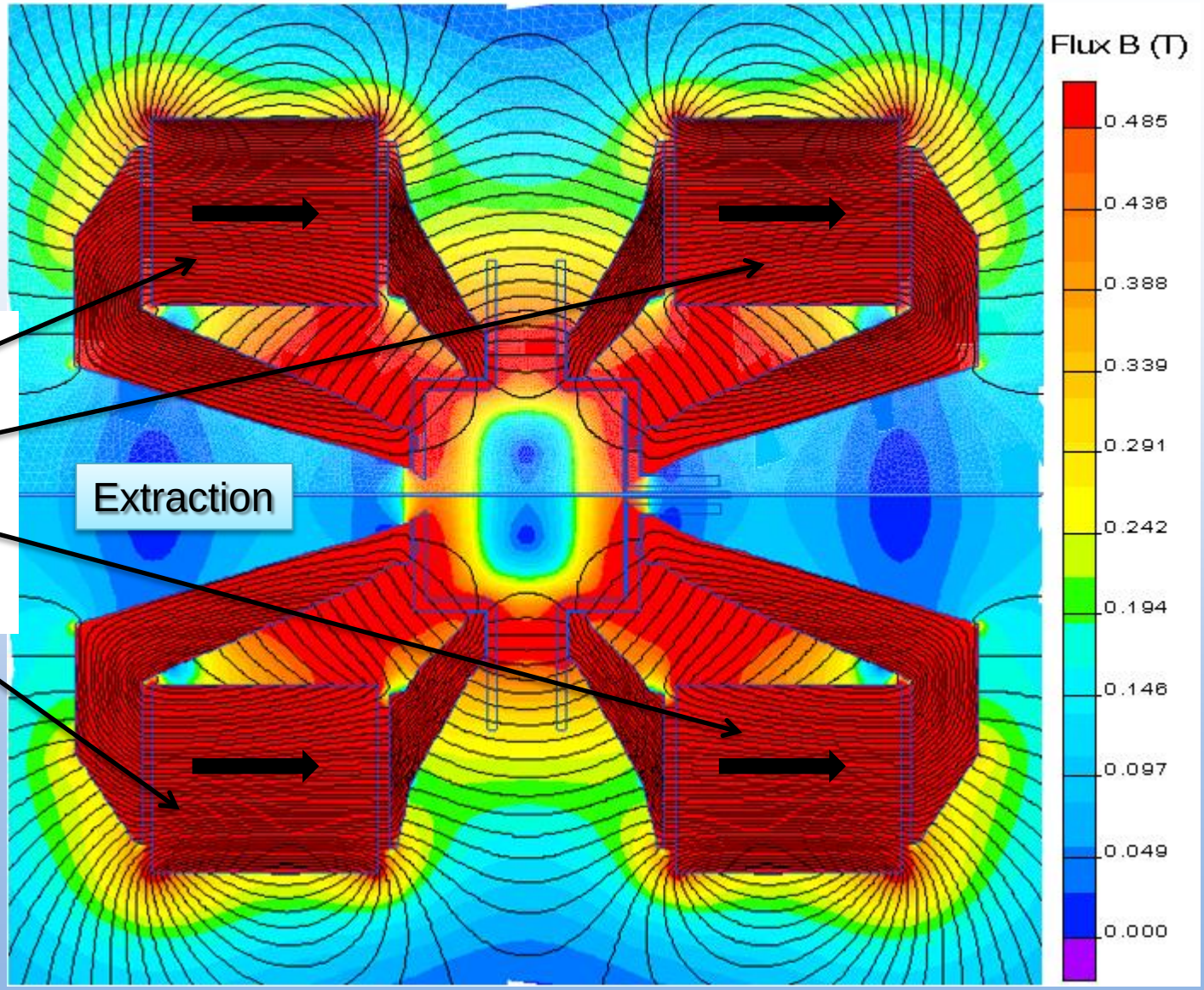
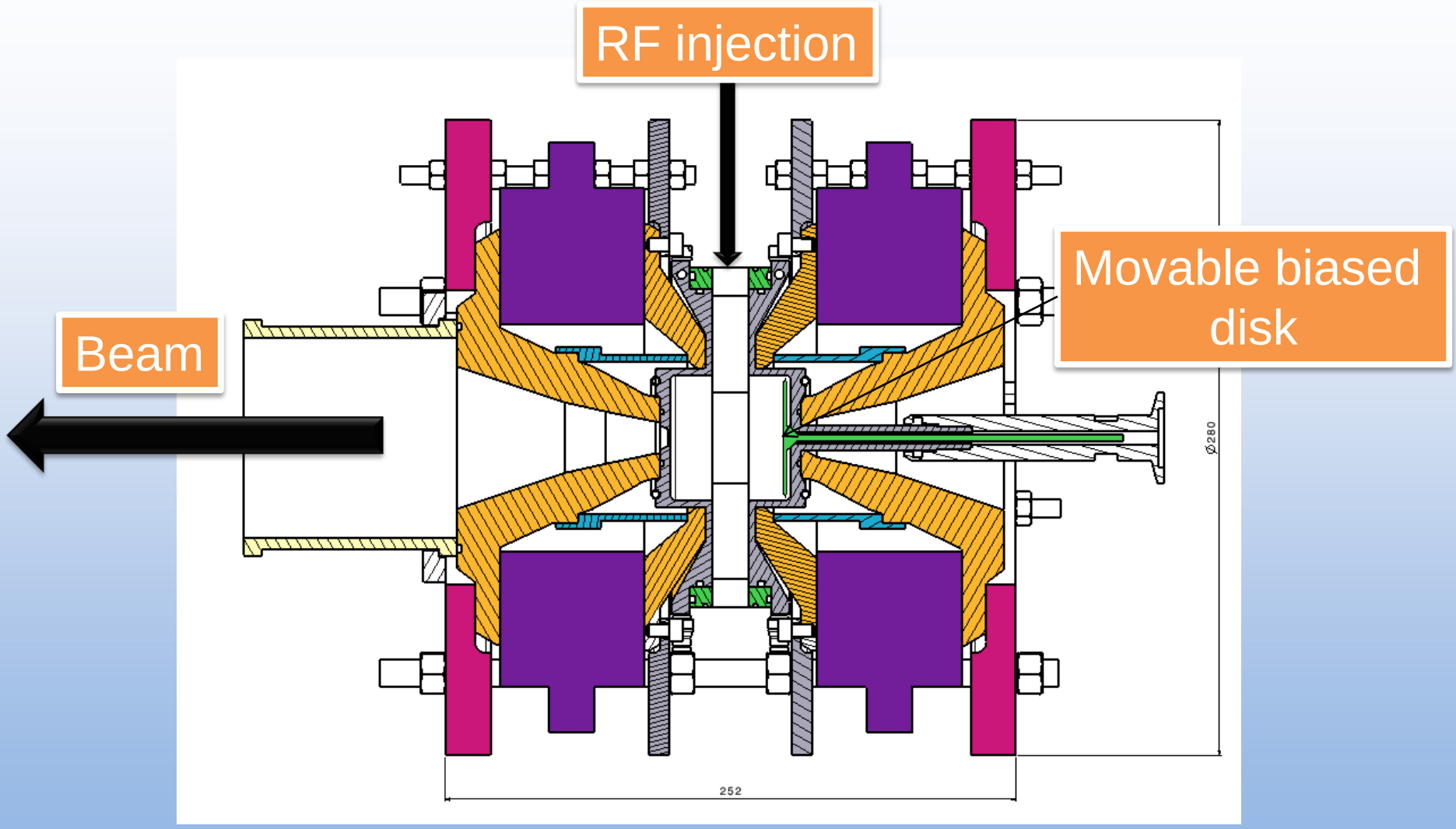
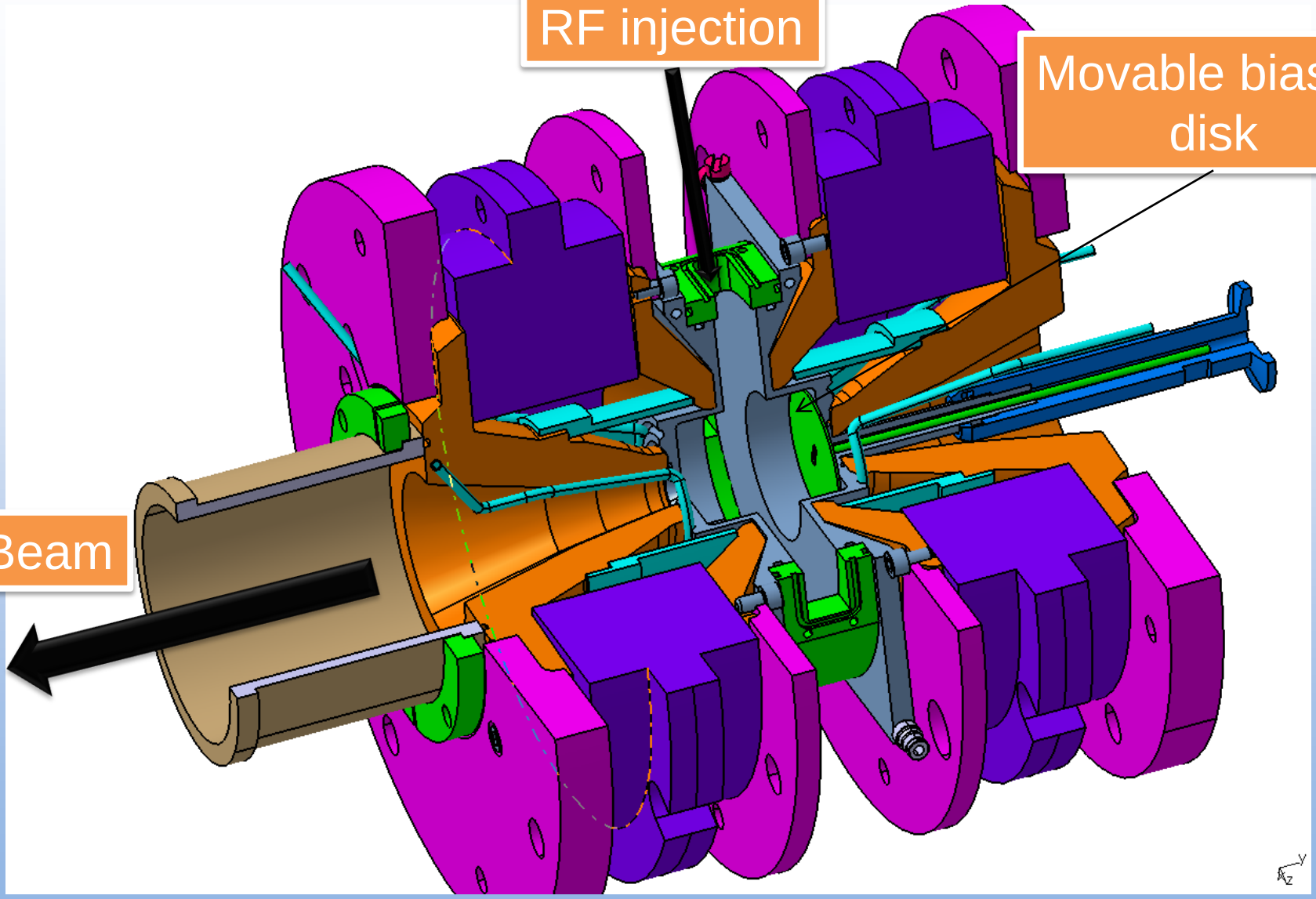


J.Y. Pacquet GANIL

Mechanical design

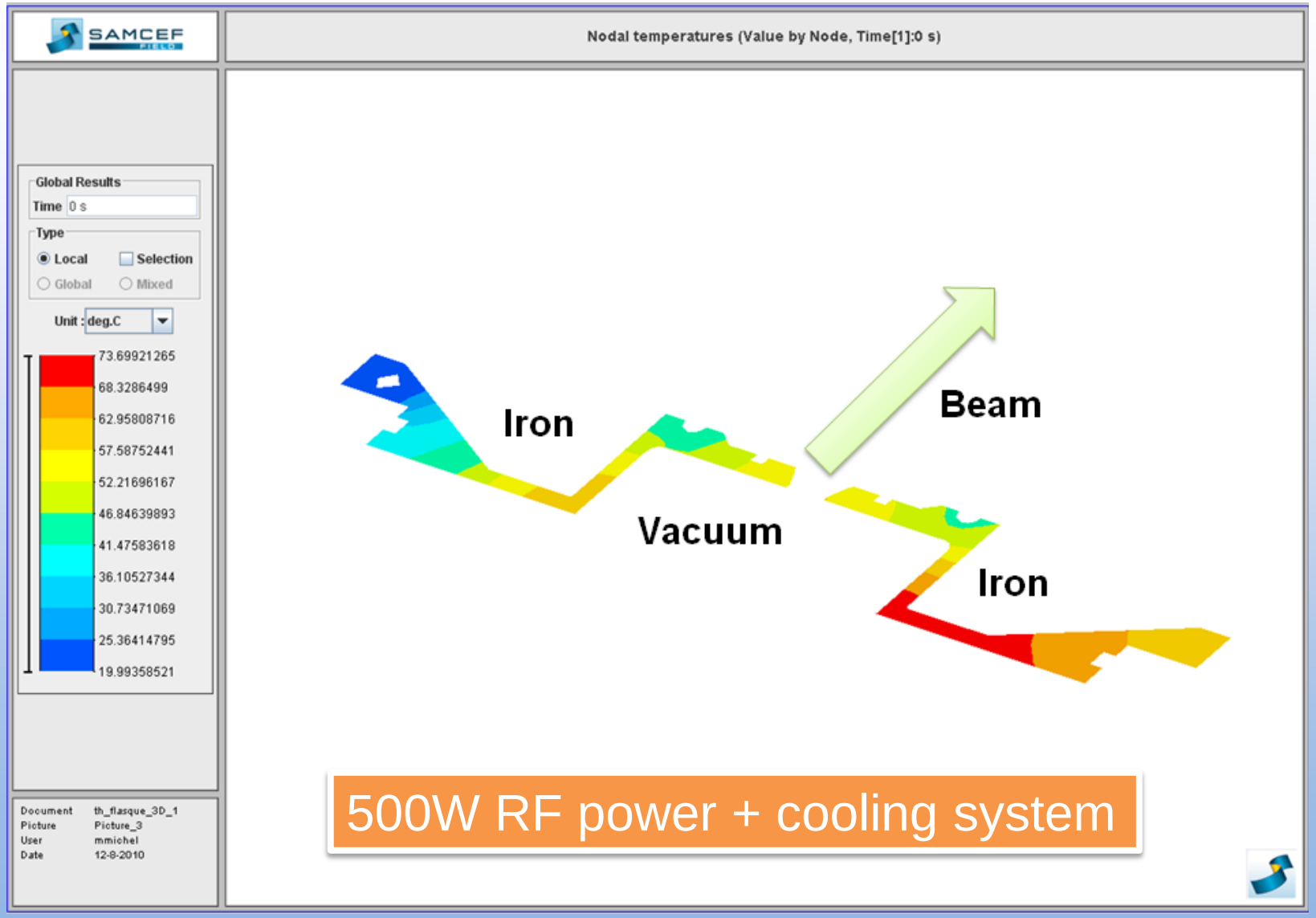


Mechanical design – 3D view



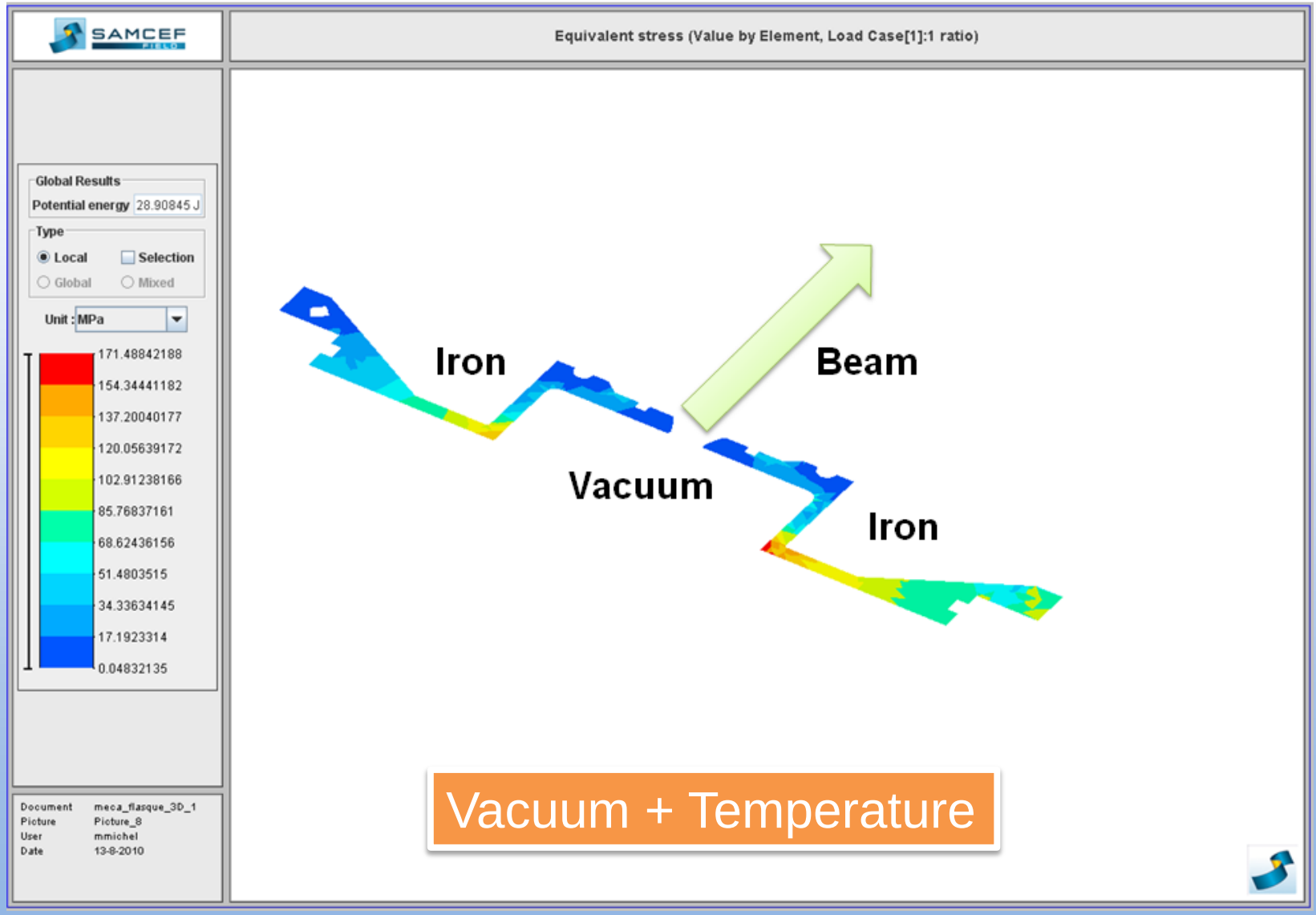
M. Michel GANIL

Mechanical design - température distribution

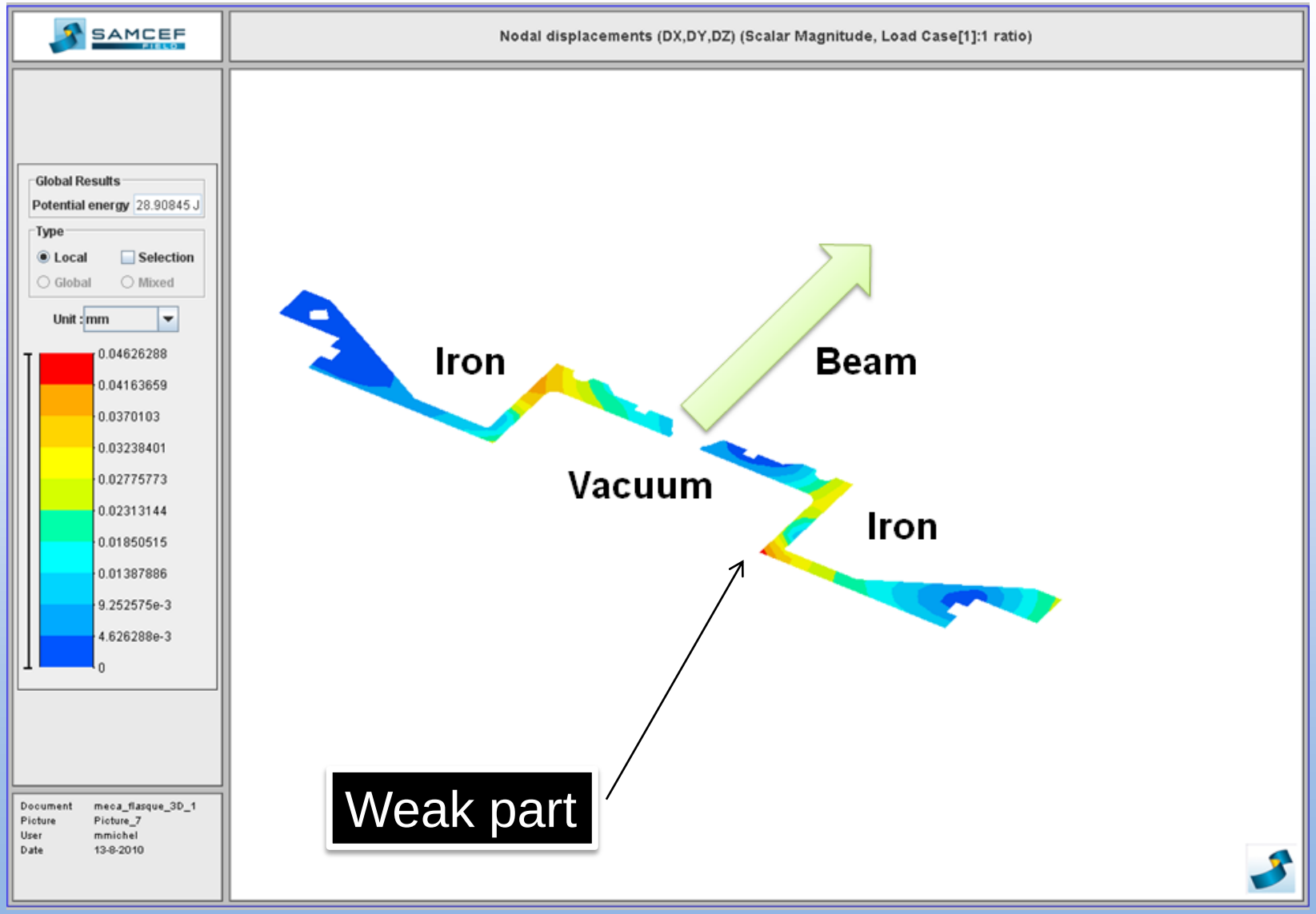


M. Michel GANIL

Mechanical design - stress calculation



Mechanical design - displacement calculation



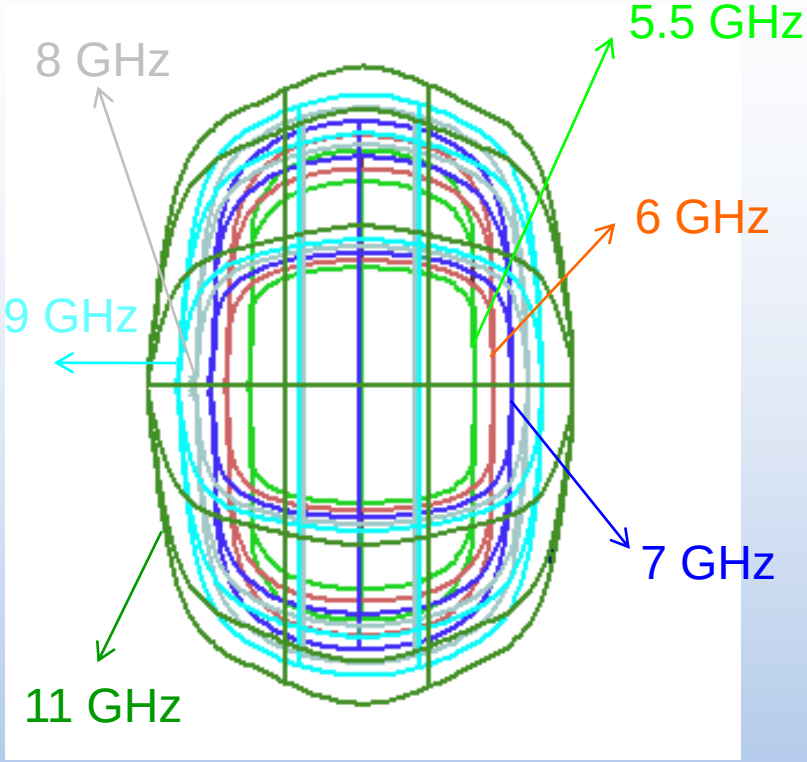
M. Michel GANIL

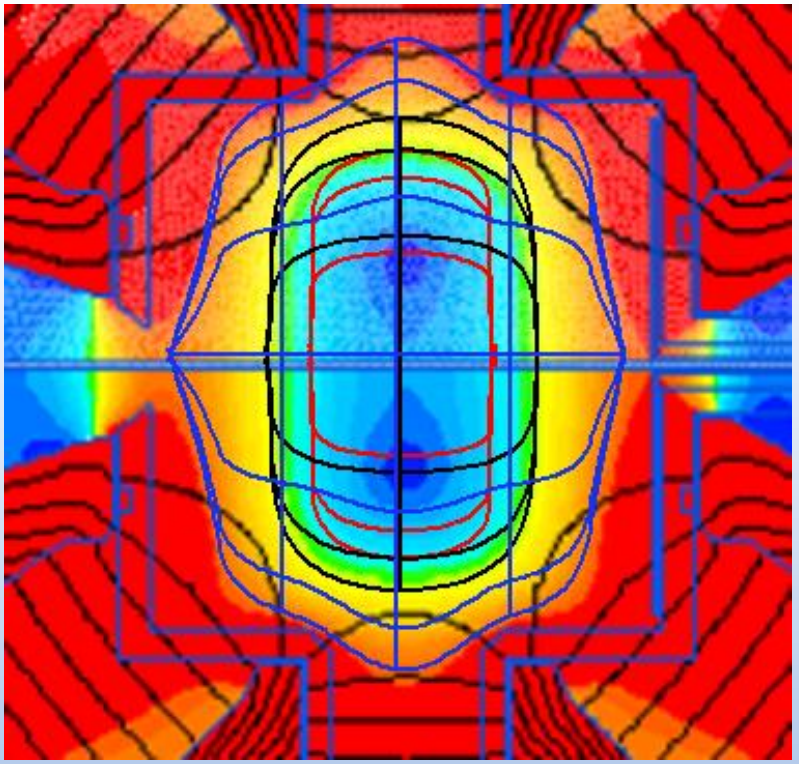
TrapCad Calculations - goal

- Dynamic calculation of the ECR electron population => average energy, electron losses etc…
- Allow to predict the best RF frequency
- Allow to predict performances of an ECRIS

S. Biri, A. Derzsi, E. Kekete and I. Ivan, *Upgraded TrapCAD code.* High Energy Physics and Nuclear Physics, **31** 165 (2007)
L. Maunoury et al., “Studies of the ECR plasma using the TrapCad code”, PSST, **18**, 015019 (2009)

TrapCad Calculations - ECR zones





RF Frequency (GHz)	B (Gauss)	Mirror Ratio	Lengh (cm)	Diameter (cm)	Surface (cm^2)	Volume (cm^3)
5.5	**1964**	**2.4**	**2.4**	**4.4**	**15.4**	**16.7**
6	**2143**	**2.2**	**2.4**	**4.5**	**16.9**	**18.9**
7	**2500**	**1.9**	**2.7**	**4.7**	**20.4**	**23.9**
8	**2857**	**1.7**	**3.0**	**5.0**	**30.8**	**37.3**
9	**3214**	**1.5**	**3.3**	**5.2**	**34.6**	**43.5**
11	**3928**	**1.2**	**3.9**	**5.7**	**43.6**	**58.3**

TrapCad Calculations - assumptions

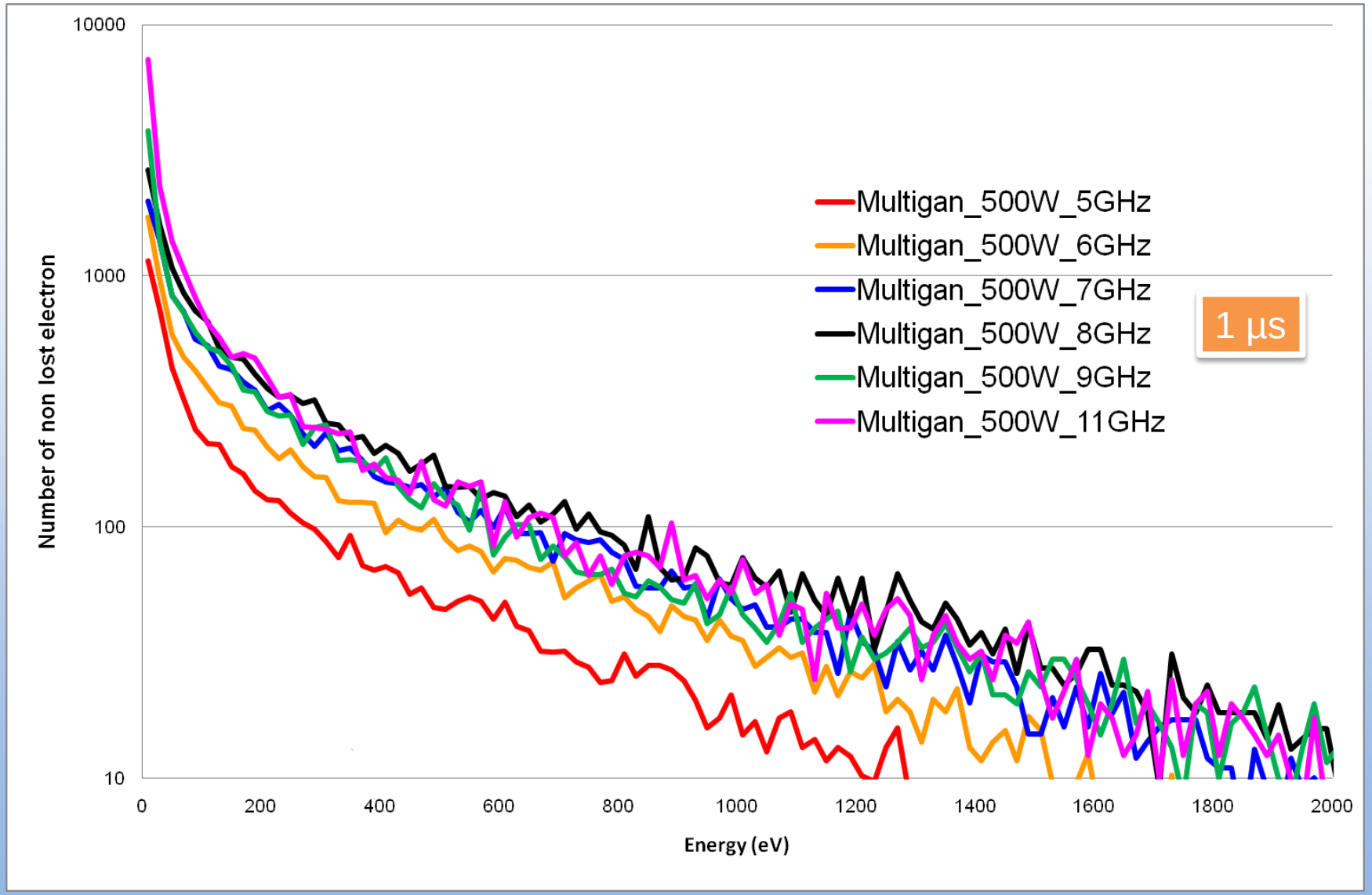
Fixed parameters

- 20000 particles randomly distributed on the ECR surface
- Energy range 0.1 – 1 eV
- Time step 3 ps

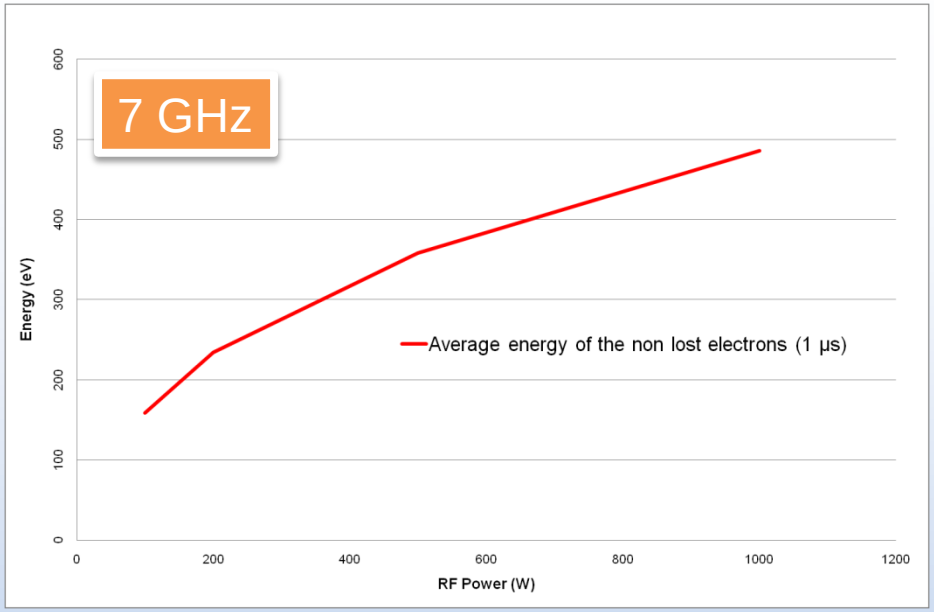
Variable parameters

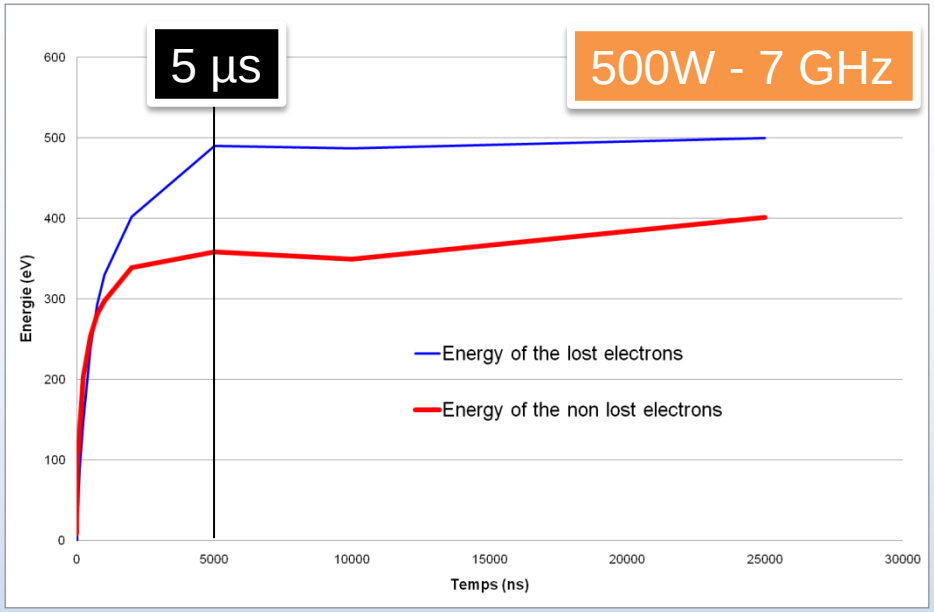
- Calculation time
- RF frequency
- RF power

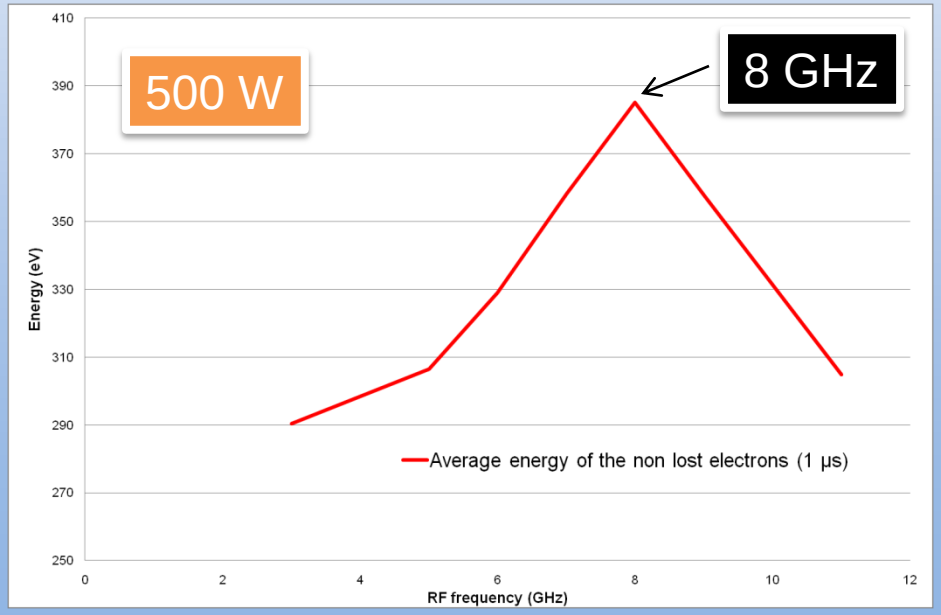
TrapCad Calculations - RF frequency

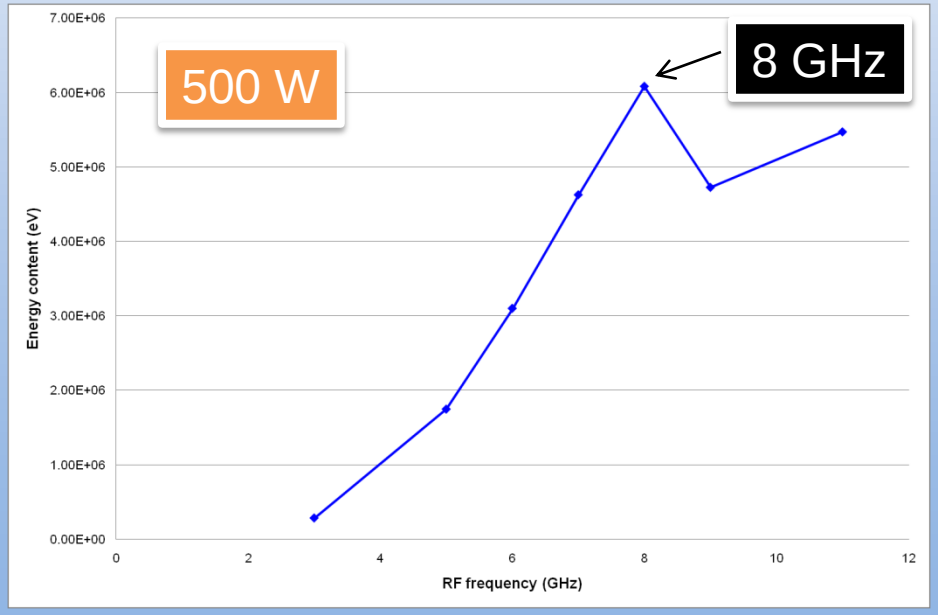


TrapCad Calculations - energy

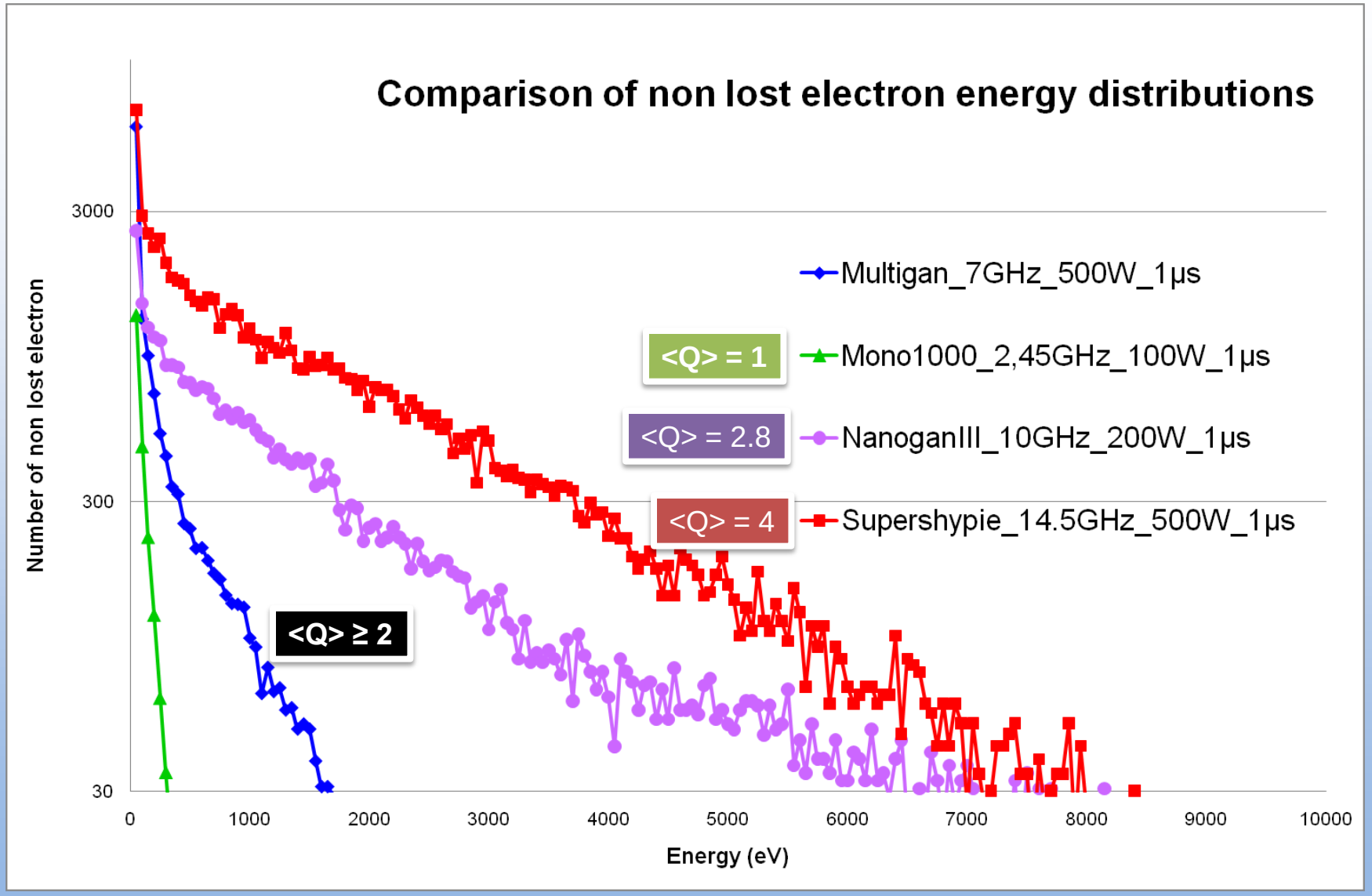








Trapcad calculations - performances



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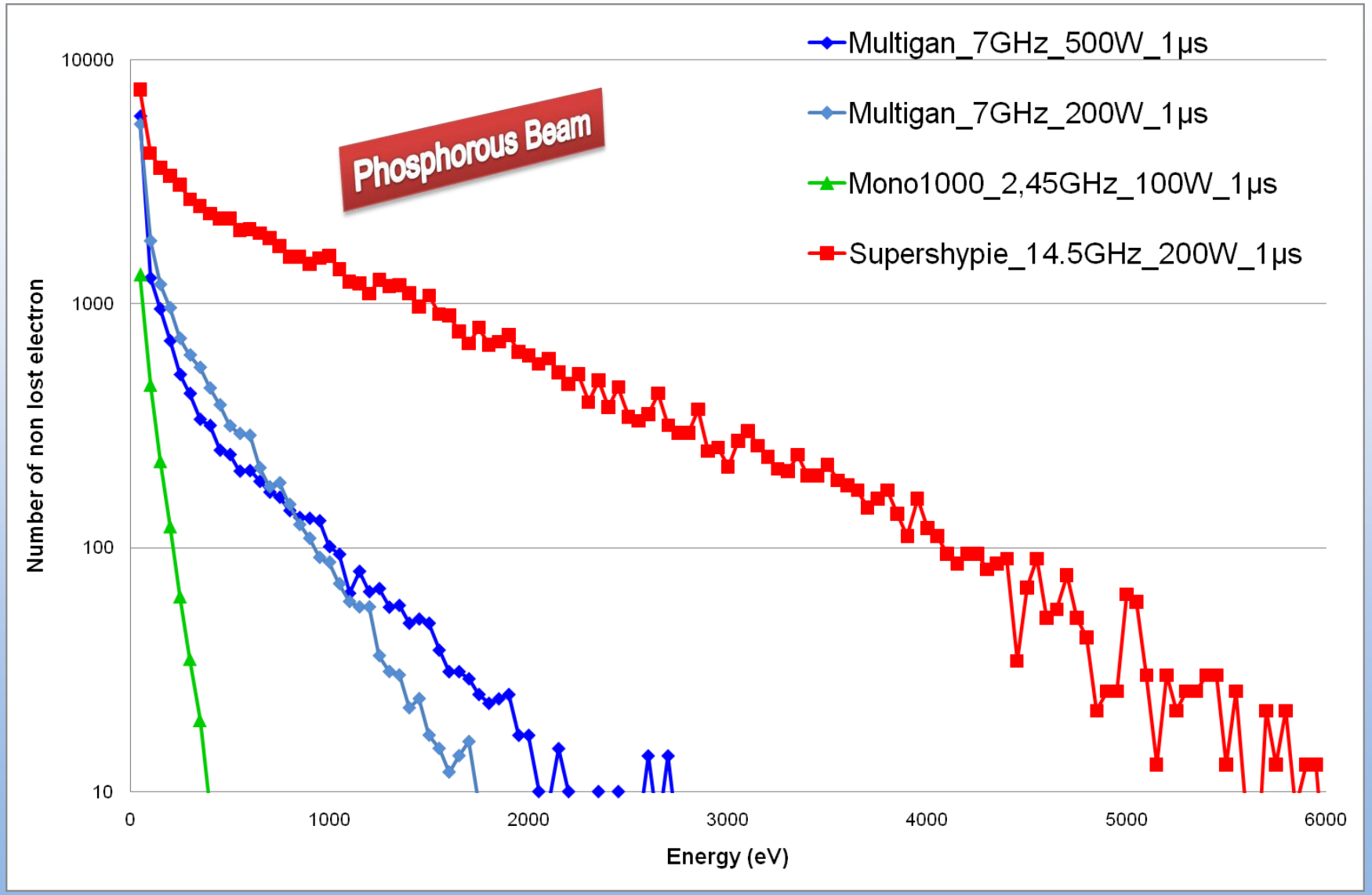
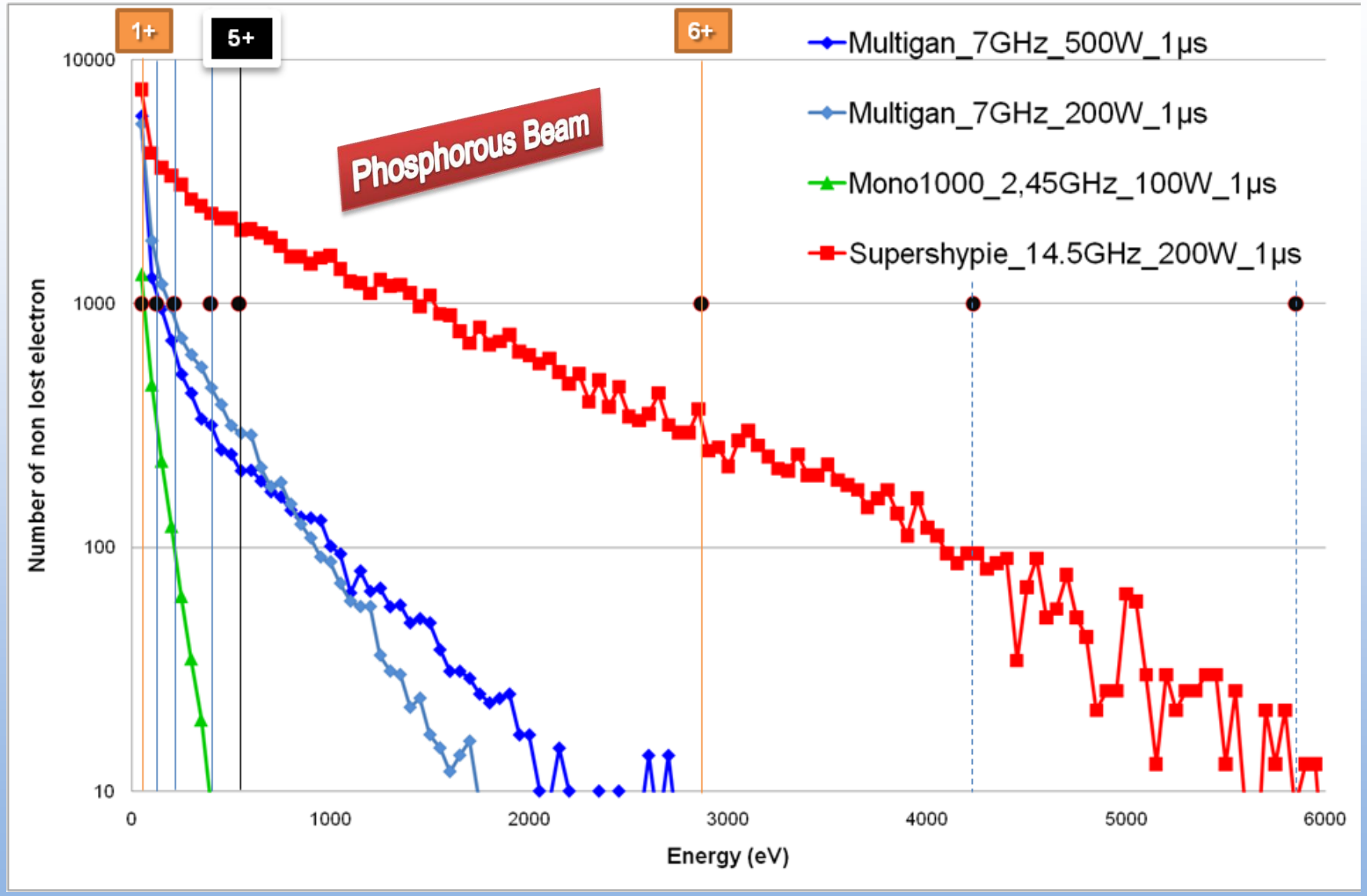
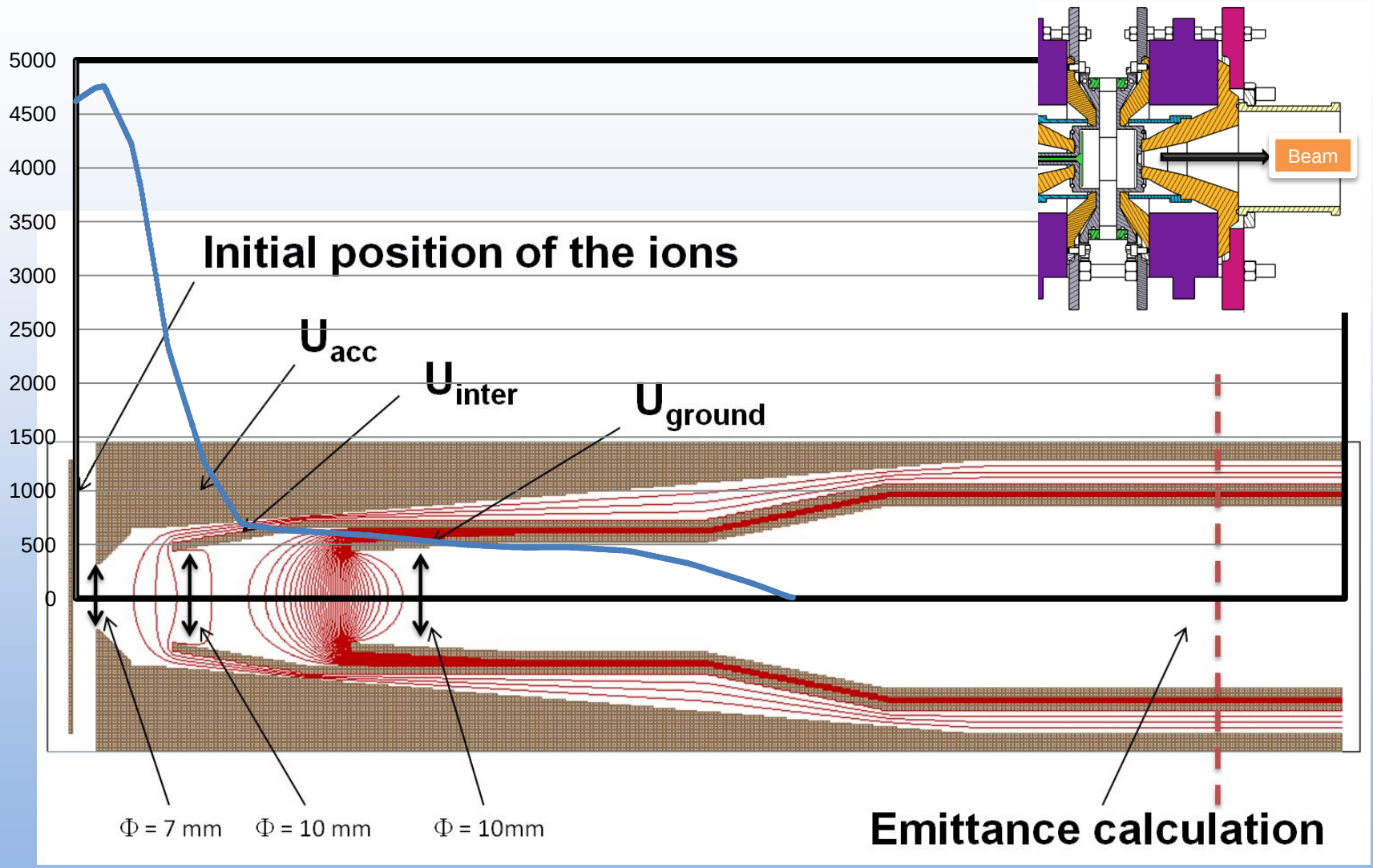


L. Maunoury et al., "Production of charged (singly and multiply) phosphorous beams with electron cylotron resonance ions source", RSI, **77**, 03A324 (2006)

Trapcad calculations - performances



Extraction: geometry



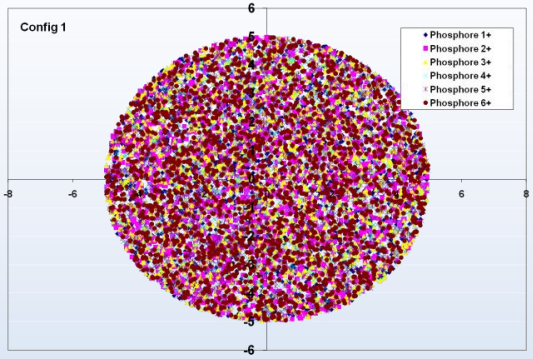
L. Maunoury et al., “Extraction from ecr ion sources: a new way to increase beam brightness”, proceedings of the International Workshop on ECRIS, Chicago, IL, USA, 224 (2008)

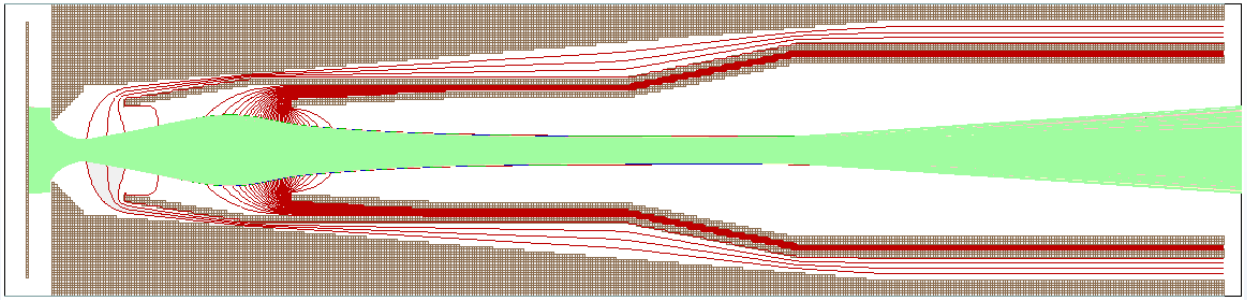
Extraction: assumptions

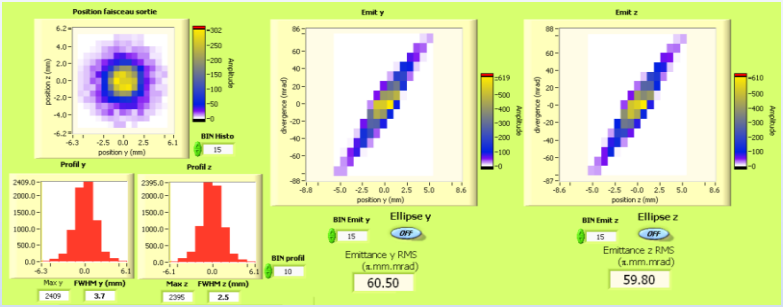
- High magnetic gradient ~39 T/m
- No space charge
- Mass 31 and charge states from 1 to 6
- Ions are distributed on a disk of 10 mm diameter either randomly either concentrated
- Ion energy fixed at 0.5 eV
- Ion angle range from -90° to 90°
- 10 V of plasma potential

Extraction: the beams

U_{acc} 20 kV
U_{inter} 18 kV







Extraction: the beams

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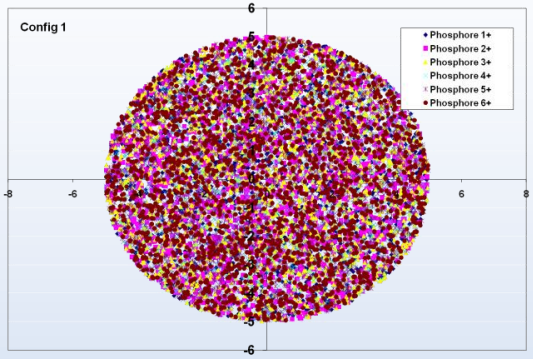

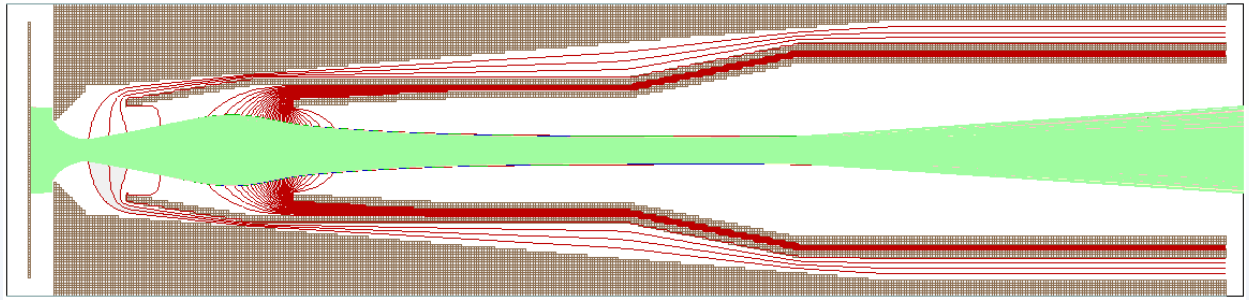

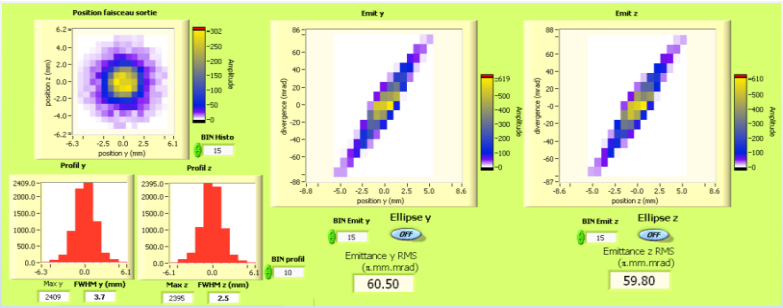

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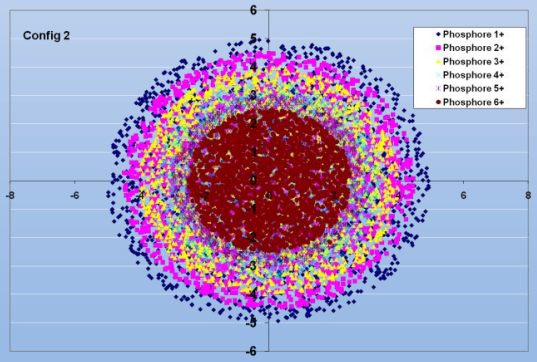
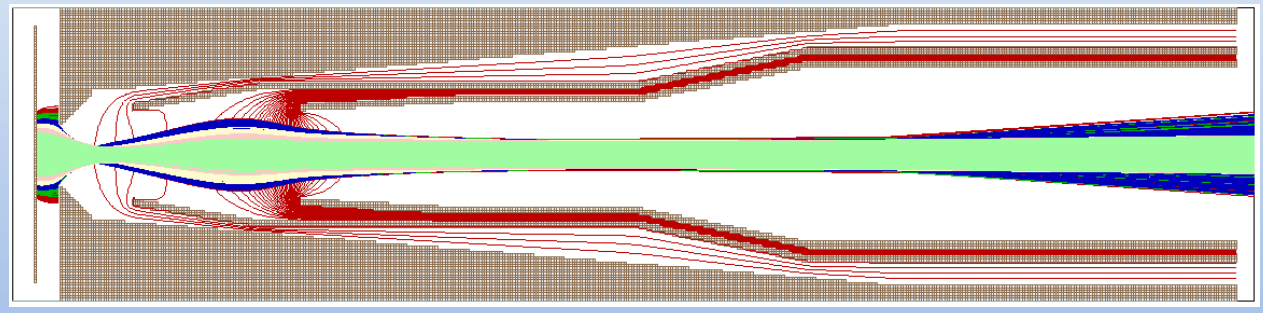
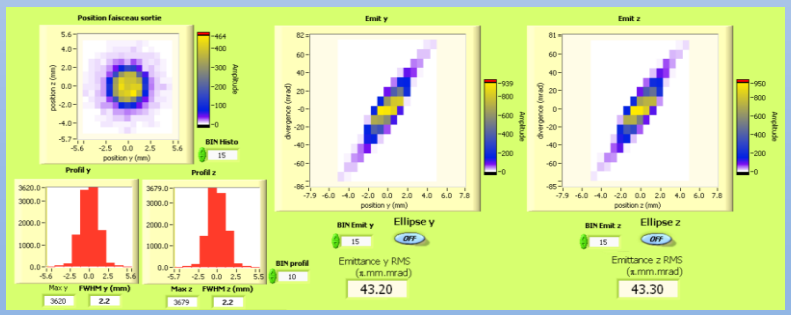
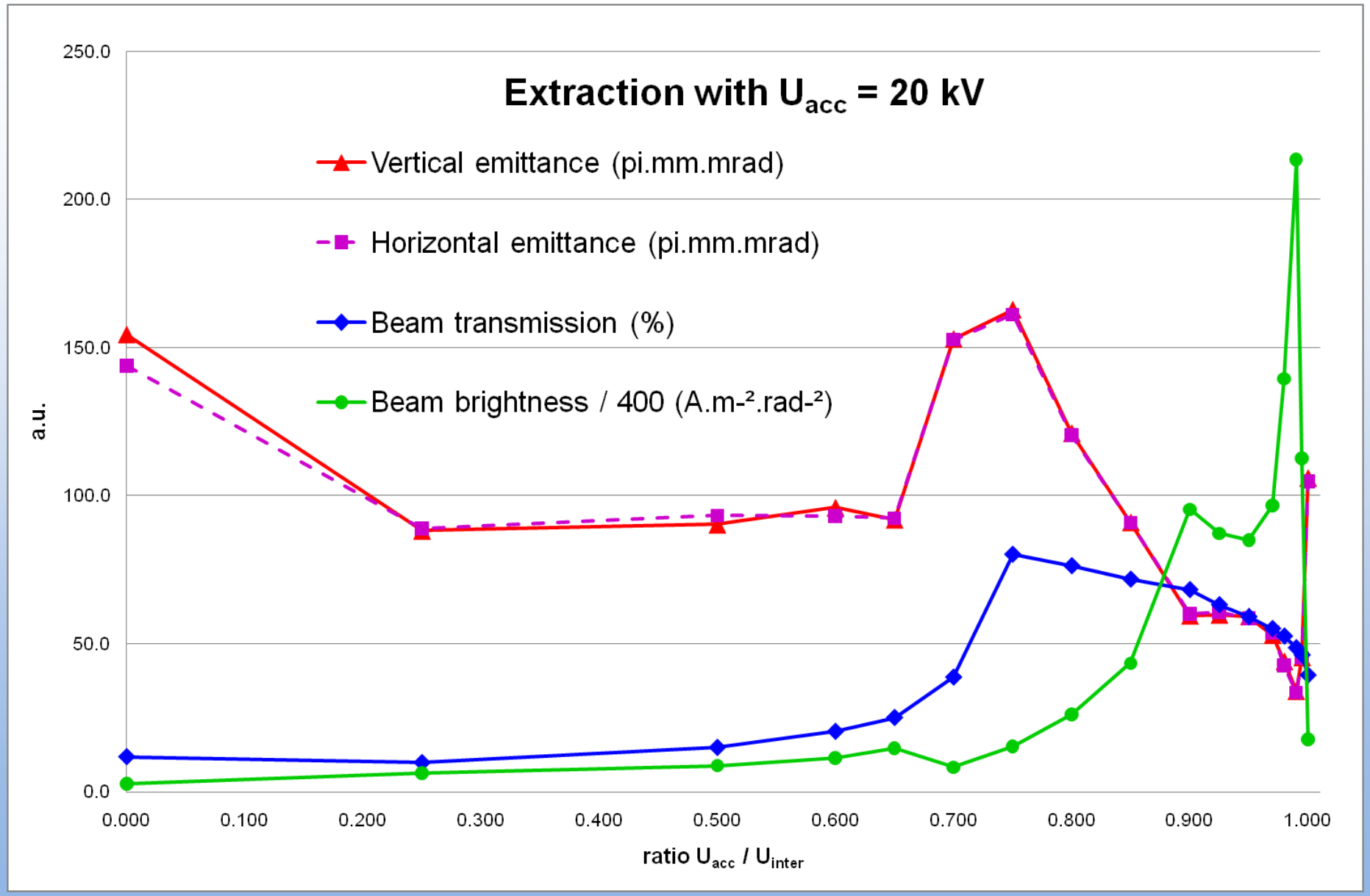




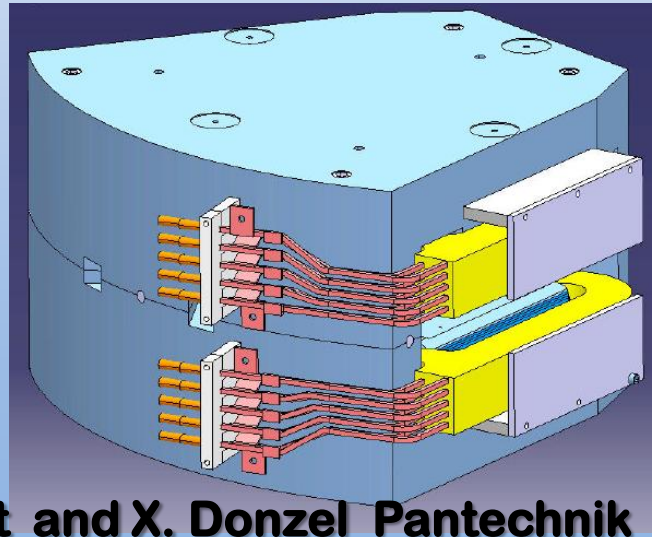


Extraction: first results



Test bench – next program

- Test bench under construction at Pantechnik
- New analyze dipole with $B\rho$ = 0.35 T.m able to analyze a beam of 293^{1+} extracted at 20 kV
- Will be ready for the end of 2010



G. Gaubert and X. Donzel Pantechnik

Conclusion

- Design of the prototype is achieved => some tiny improvements should be done

- Based on the TrapCad calculations,
  - best RF frequency should be around 8 GHz
  - the source will produce multicharged ions up to 5+ (E_i = 67.9 eV) in the case of phosphorous beam and <Q> ~ 2 can be expected

- First extraction calculations have been carried out
  - need of a multi electrode extraction
  - the brightness seems better for a ratio U_{inter}/U_{acc} = 0.9
  - emittance values of the total beam are around 60 π.mm.mrad

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➢ prototype will be mounted and installed on Pantechnik test bench at the end of 2010

➢ experimental tests such as current, emittance, CSD, ionization efficiency measurements will be done at the beginning of 2011

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  - ➢ the bright…
  - ➢ emitta…

And what …

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➢ experimental tests … SD, ionization efficiency measureme… …ng of 2011

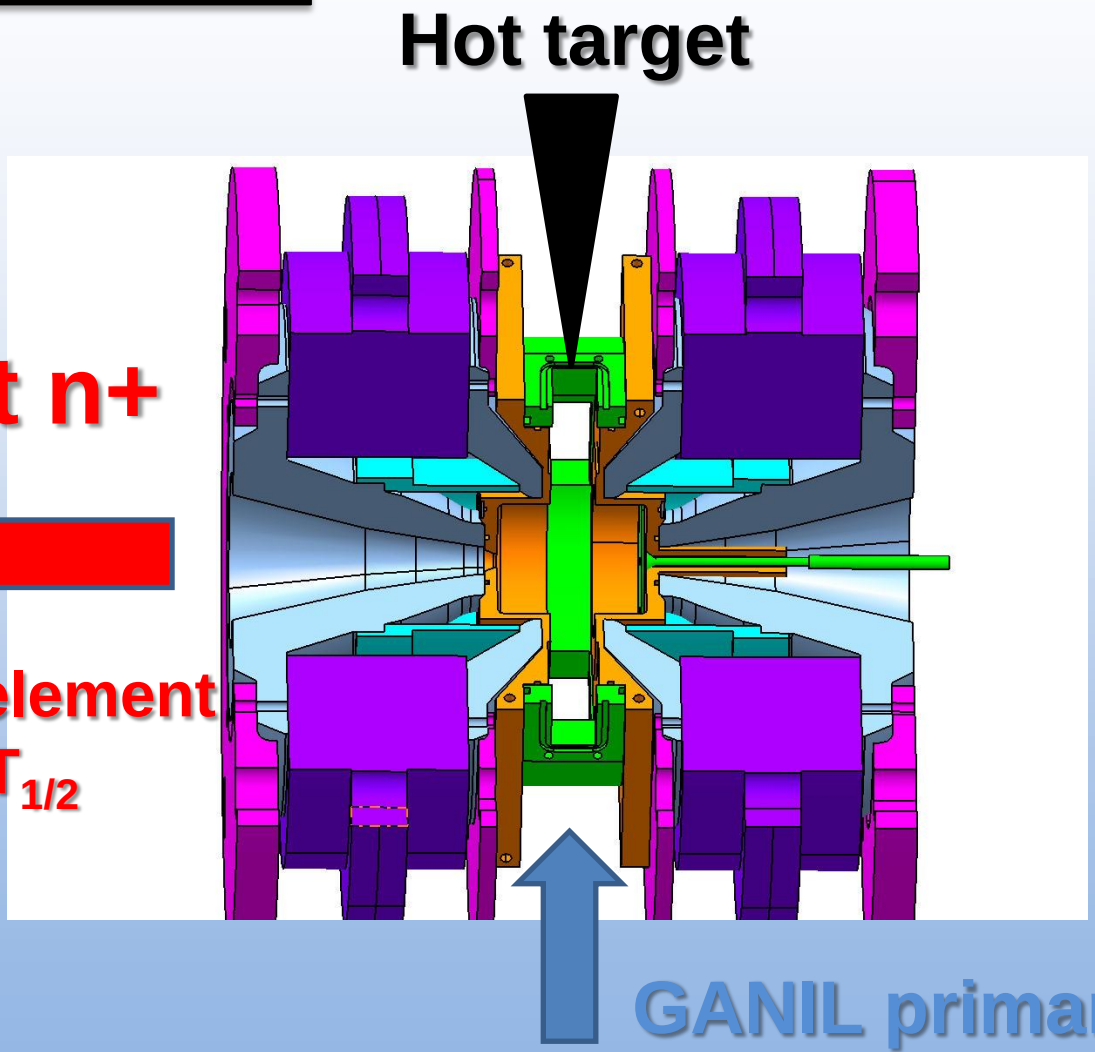
Depending on the results … ECRIS's will be specifically developed towards the objectives of each partner

FOR THE EXPERIMENTAL RESULTS SEE YOU AT THE NEXT ICIS11


THANK YOU

NEW version for SPIRAL1

No more transfer tube !!



Other beam possible

• He => 1+ up to 2+	q/m = ½
• P => 1+ up to 5+	q/m = 0.16
• Kr => 1+ up to 8+	q/ m = 0.10
• Xe => 1+ to 8+	q/m = 0.061
• Sn => 1+ to 7+	q/m = 0.067
• In => 1+ to 7+	q/m = 0.067
• Ba => 1+ to 9+	q/m = 0.064