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VERTICAL ELECTRO-POLISHING (VEP) FOR PROTON CAVITY APPLICATION

F. Eozénou

OUTLINE

- **CONTEXT**
- **STATUS**
- **MODELLING OF VERTICAL ELECTRO-POLISHING**

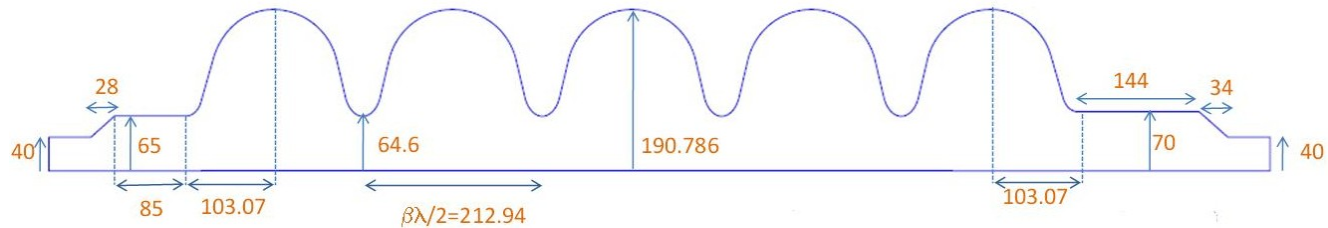
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CONTEXT

CHARACTERISTICS OF 5CELL CAVITIES TO BE TRATED / VERTICAL ELECTRO-POLISHING (VEP) ADAPTED



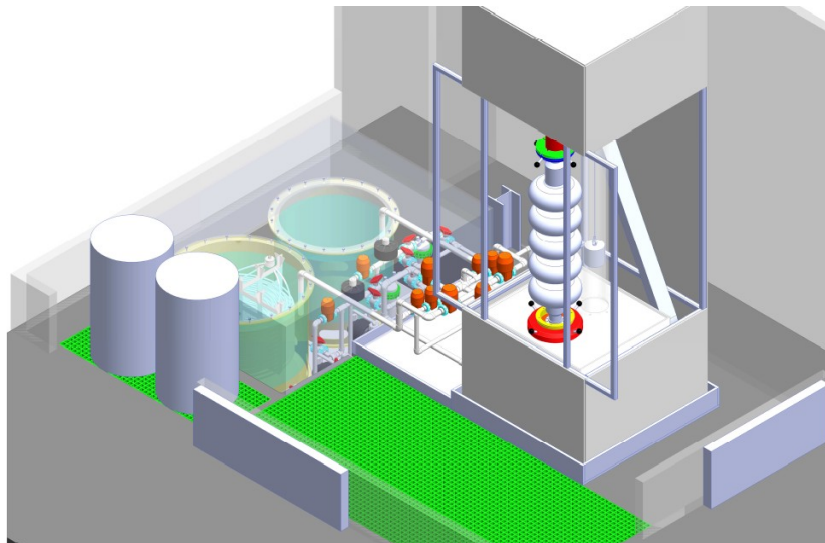
Ø382mm L>1430mm 1,76 m² 88L

(Tesla: Ø=211mm L=1283mm)

$\beta = 1$ cavity $E_{acc} = 25$ MV/m

Need for an efficient surface treatment → Choice for Electro – Polishing

Large Cavity: Vertical configuration well adapted



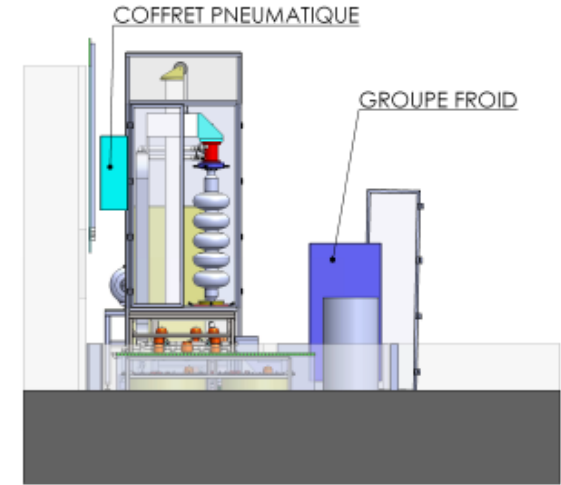
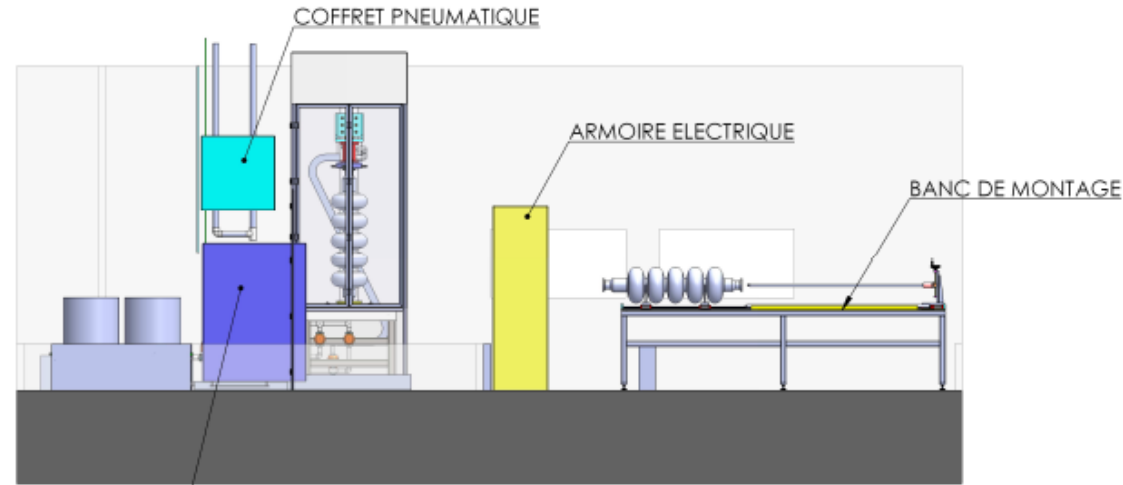
Precise design of the set-up by:

auxitec
INGENIERIE

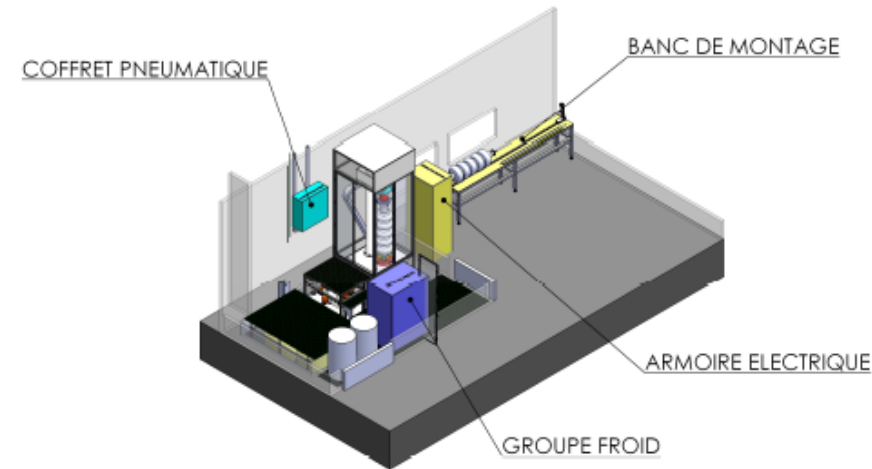
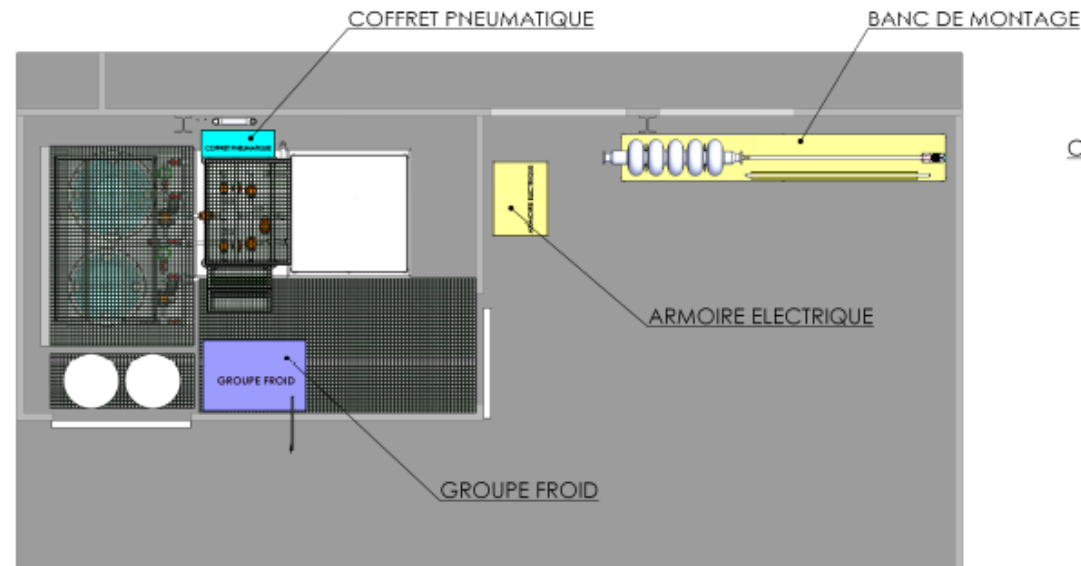
Status at last Eucard Meeting:

- Reception of all the drawings
- Preparation of the call for tender for the fabrication

VIEW OF THE SET-UP AND OF THE PREPARATION AREA



GROUPES FROID



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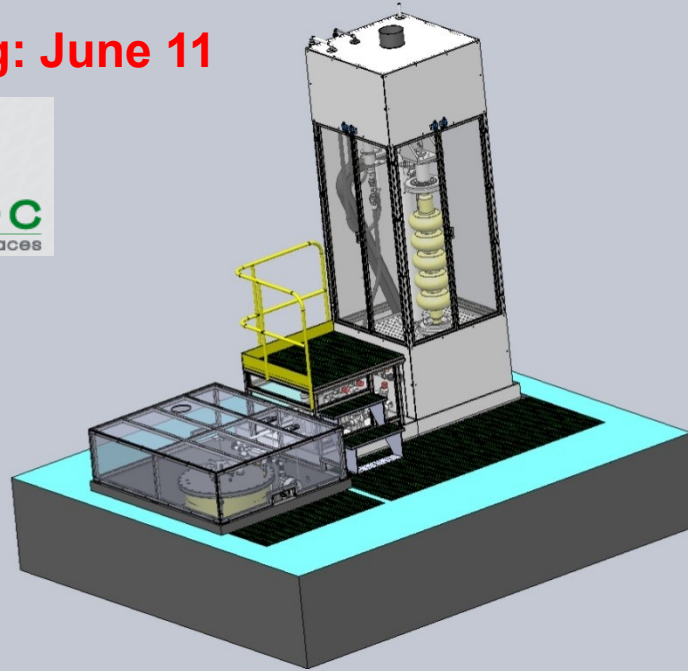
STATUS

UPDATE

CORELEC Industries chosen for the set-up fabrication

- 3 companies have answered the call for tender
- CORELEC has submitted the best offer (cost and delivery date)
- Contract signed on november 2010
- Single-tank set-up has been chosen
- CORELEC satisfied with the study by Auxitec: only few corrections (tank)
- Local Safety Meeting on May 10th.

Commissioning: June 11



CONSTRUCTION PROGRESS @ CORELEC



Main cabinet



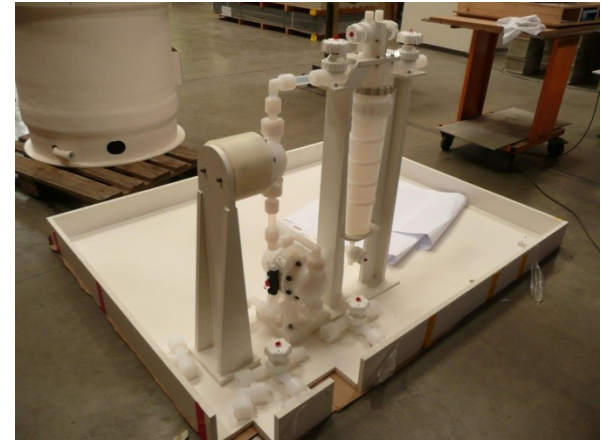
Electric cabinet



CONSTRUCTION PROGRESS @ CORELEC



acid tank with teflon inner coating

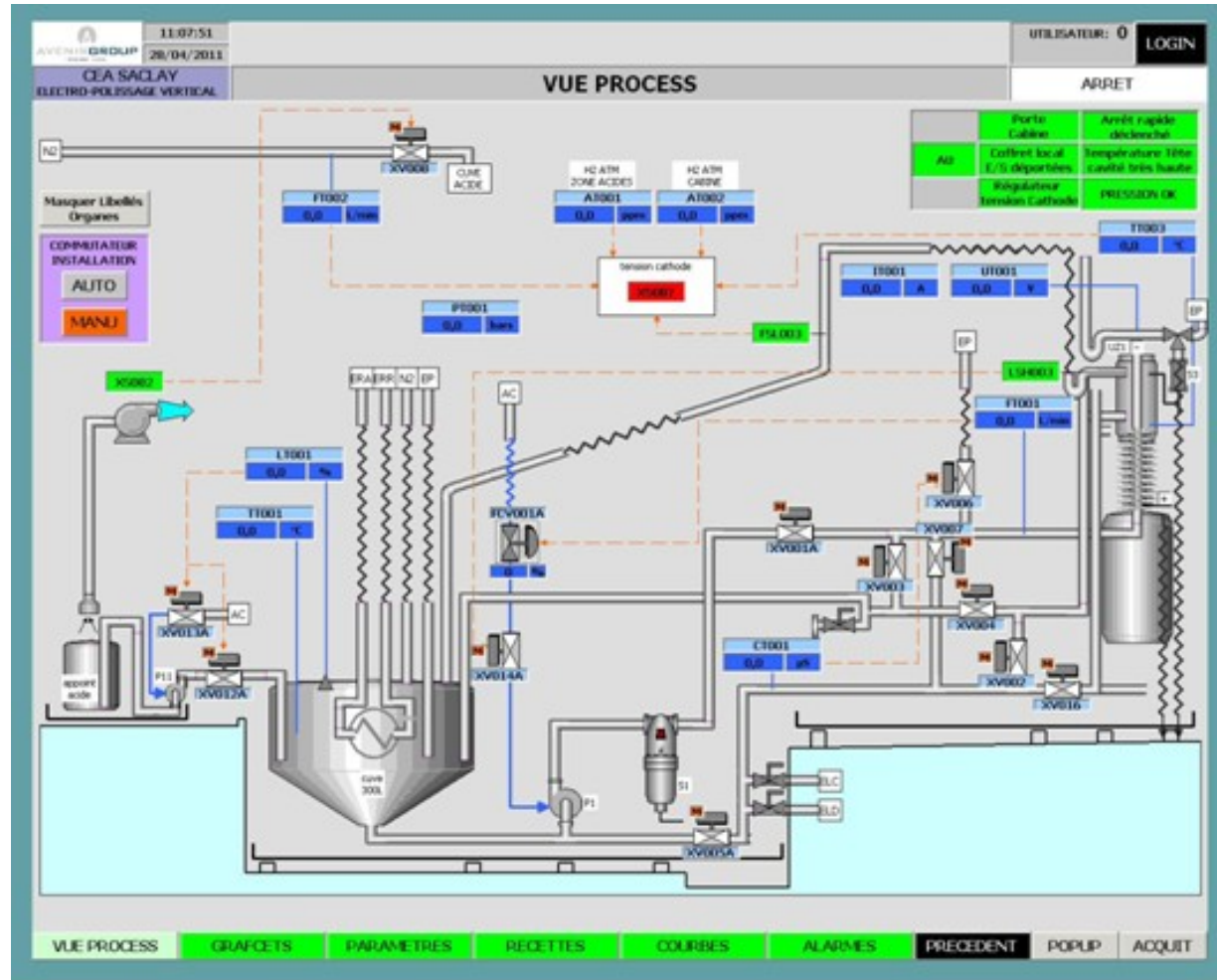


pump + filter



fluid distribution valves (PFA)

PROGRAMMING OF THE AUTOMAT



- Automated process piloted through a touch screen
- Manual mode or programmed sequences

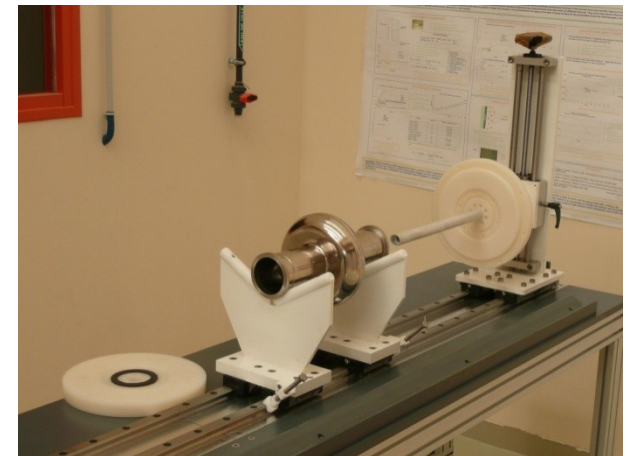
PREPARATION OF THE AREA AT CEA



Civil engineering and floor covered with acid-resistant painting



Set-up for cavity preparation



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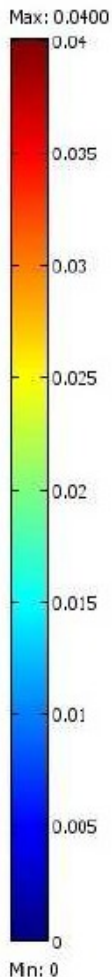


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MODELLING OF THE PROCESS

Z. Wang

PREVIOUS STUDIES WITH COMSOL Software

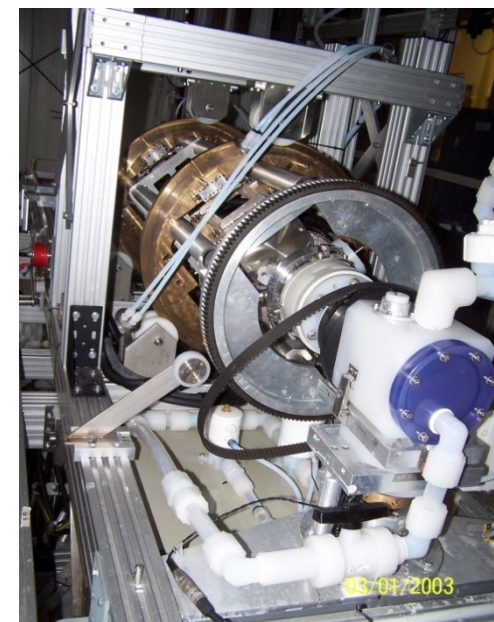


- Horizontal EP
- Hydrodynamic, acid concentrations
- 2D-Geometry

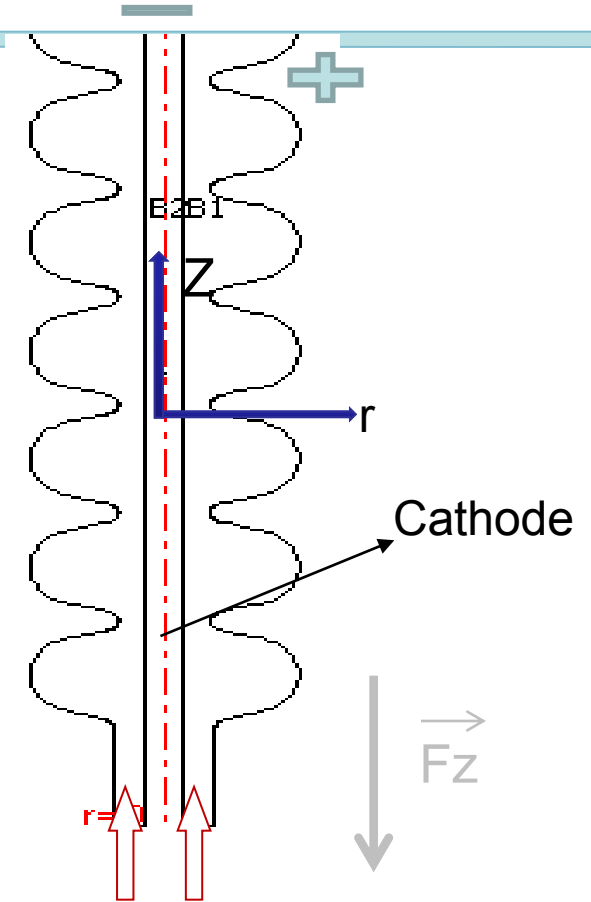
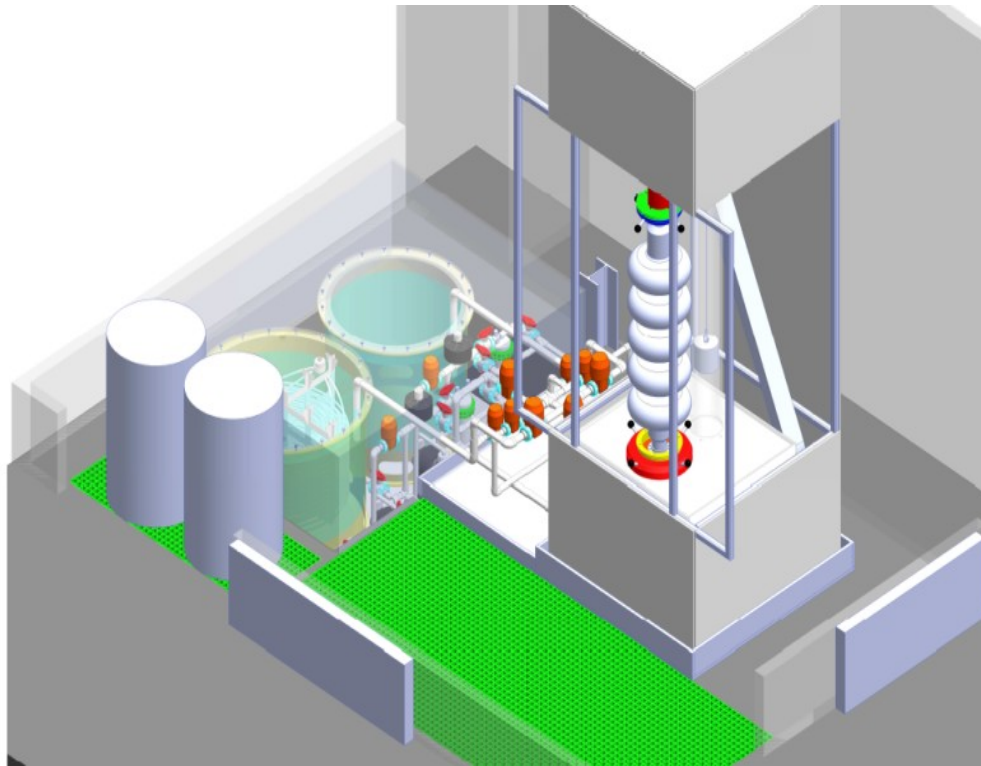
→ fluid velocity depends on the cell position

→ non uniform process

Fluid
velocity

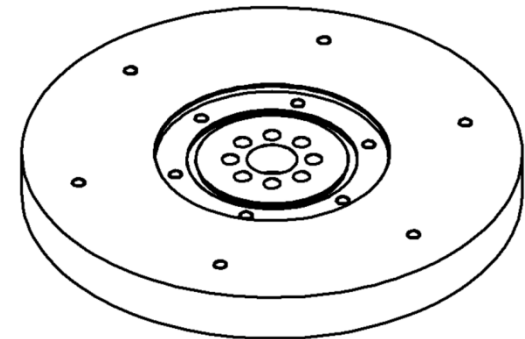


VERTICAL CONFIGURATION



Symmetry according to z-axis

→ 2D axisymmetry model



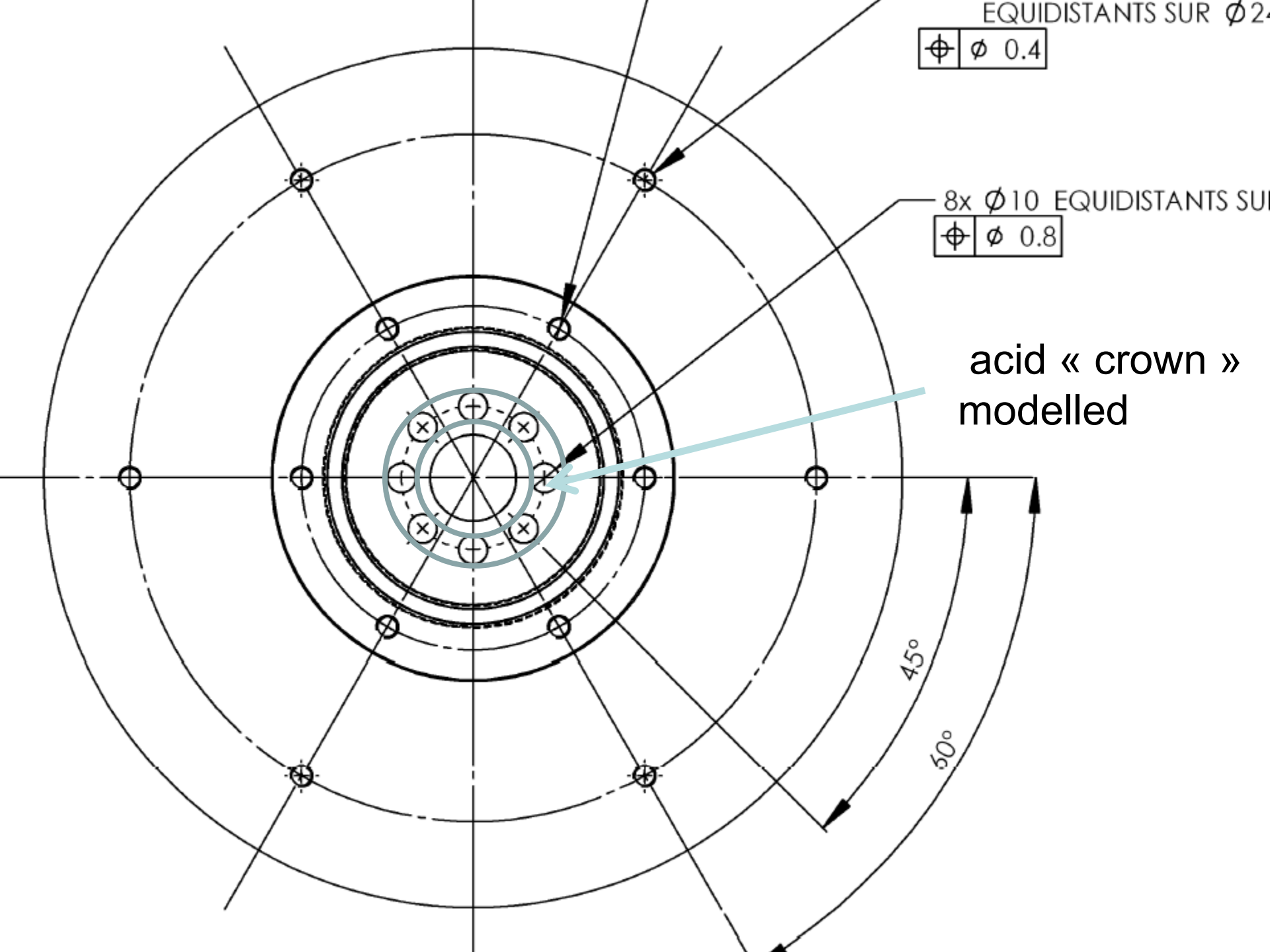
EQUIDISTANTS SUR $\phi 24$

$\oplus \phi 0.4$

8x $\phi 10$ EQUIDISTANTS SUR

$\oplus \phi 0.8$

acid « crown »
modelled



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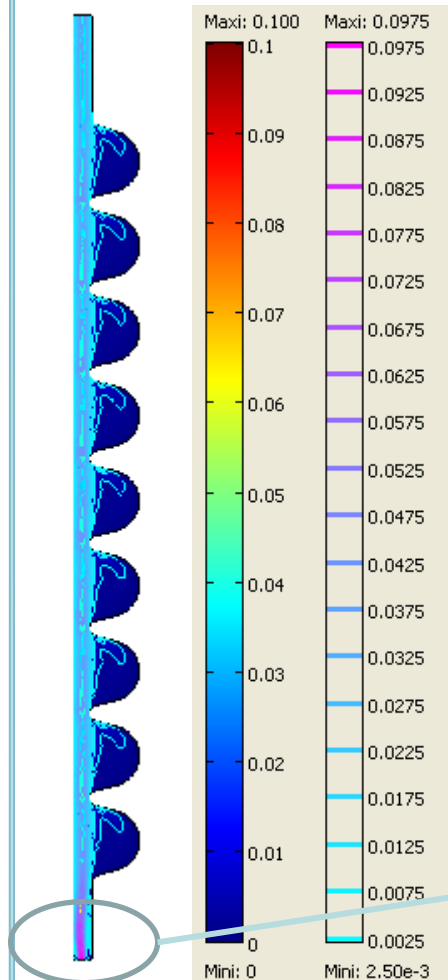


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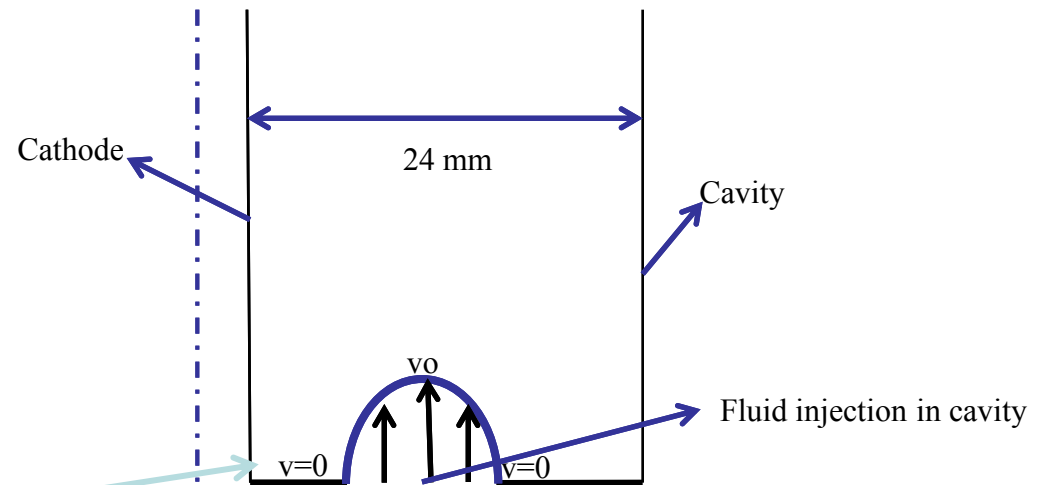
RESULTS WITH 9-CELL TESLA CAVITIES



HYDRODYNAMICS MODELLING



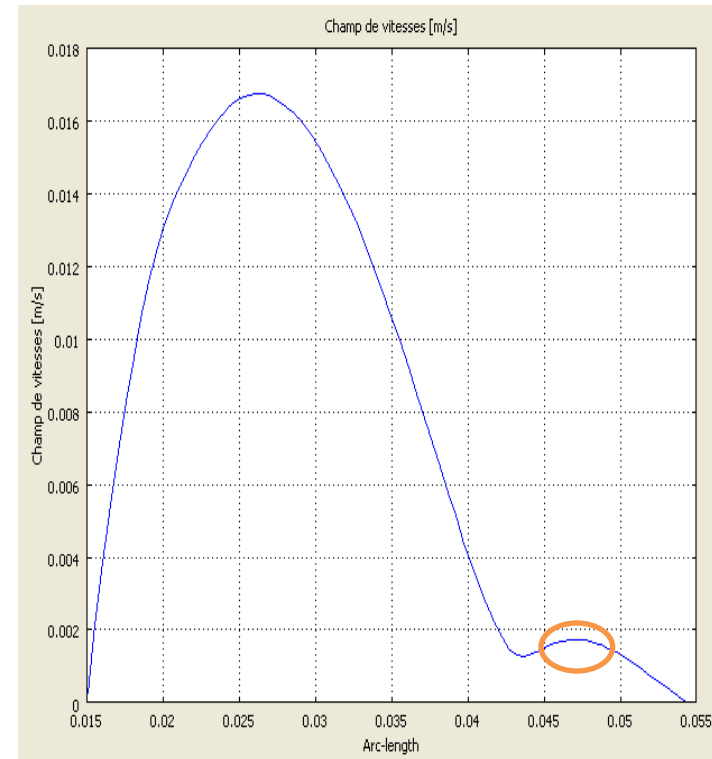
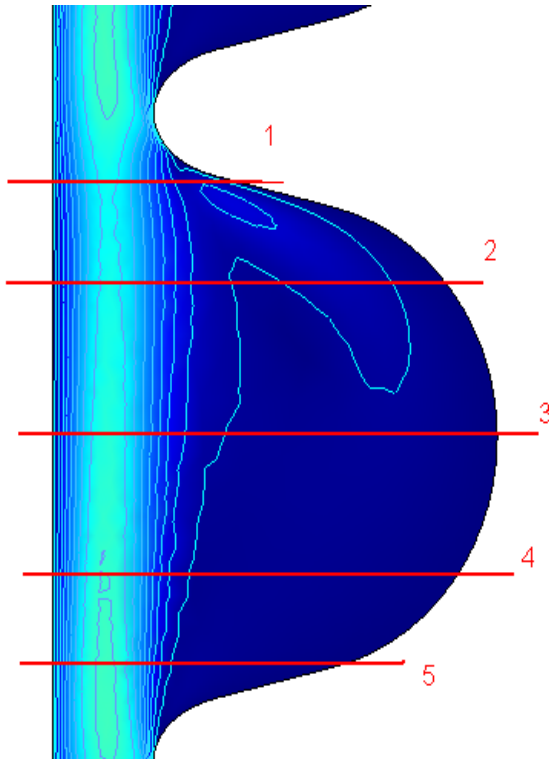
- Modelling in stationary regime
- « Navier-Stokes laminar » equations
- No slip at the cavity and cathode surfaces
- Parabolic profile for entering flow



Contrary to horizontal EP, flowrate does not depend on the cell location

→ Study of the central cell #5

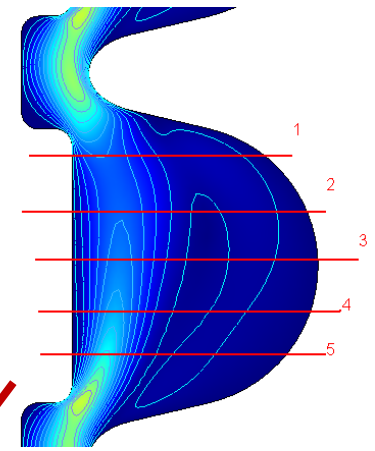
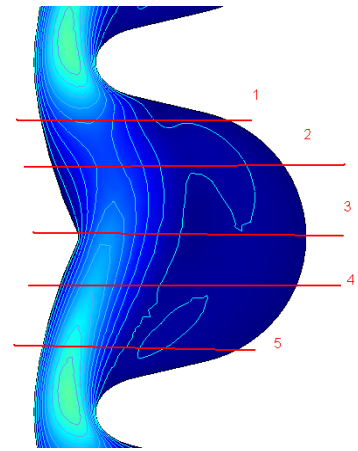
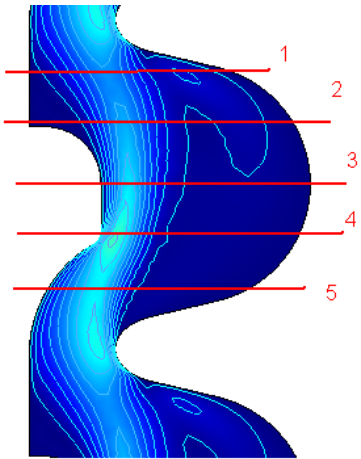
LOW ACID FLOWRATE AT THE CAVITY SURFACE



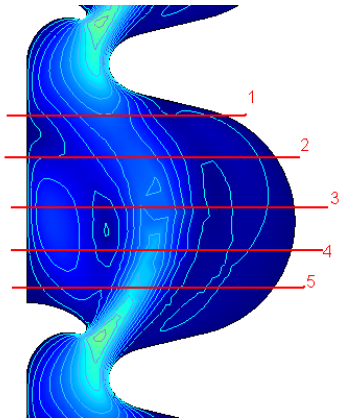
General shape of the fluid profile for each line

- Higher flow close to the cavity
- Different shapes tested to increase flow at the cavity surface

FOUR SHAPES TESTED

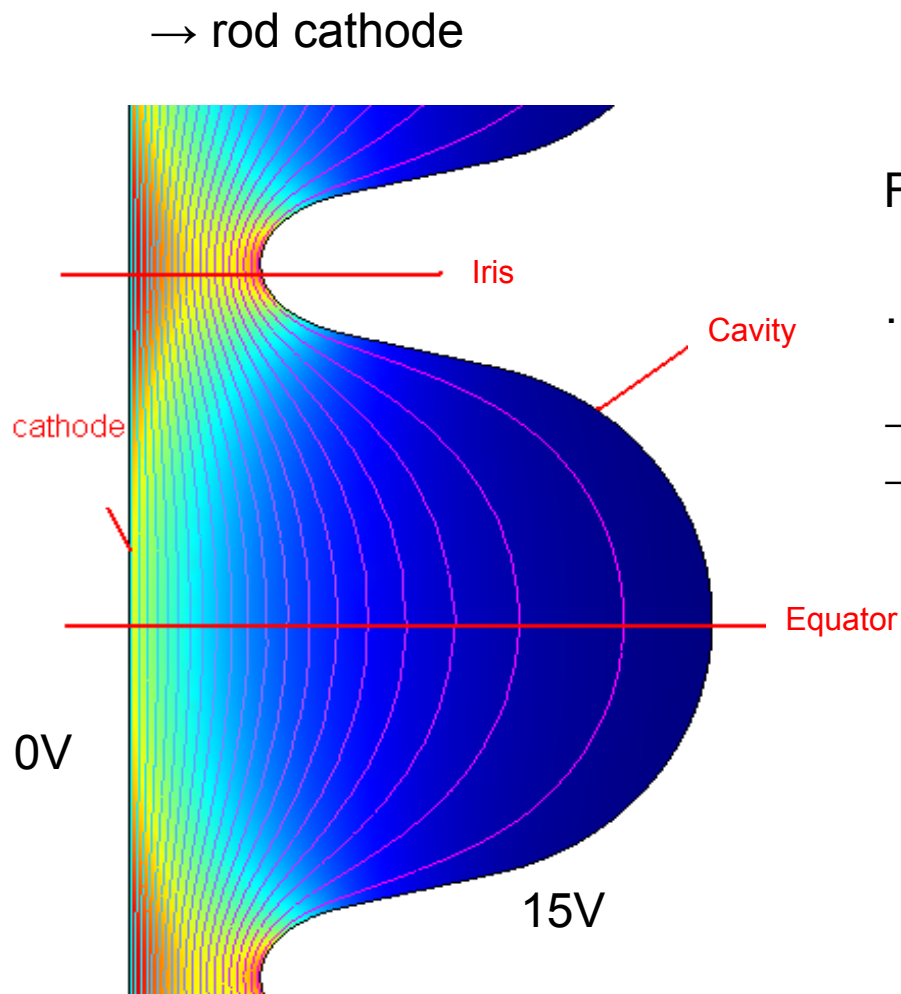


flowrate at cavity surface:
+39%



flow uniformity: +33%

ELECTRIC FIELD MODELLING



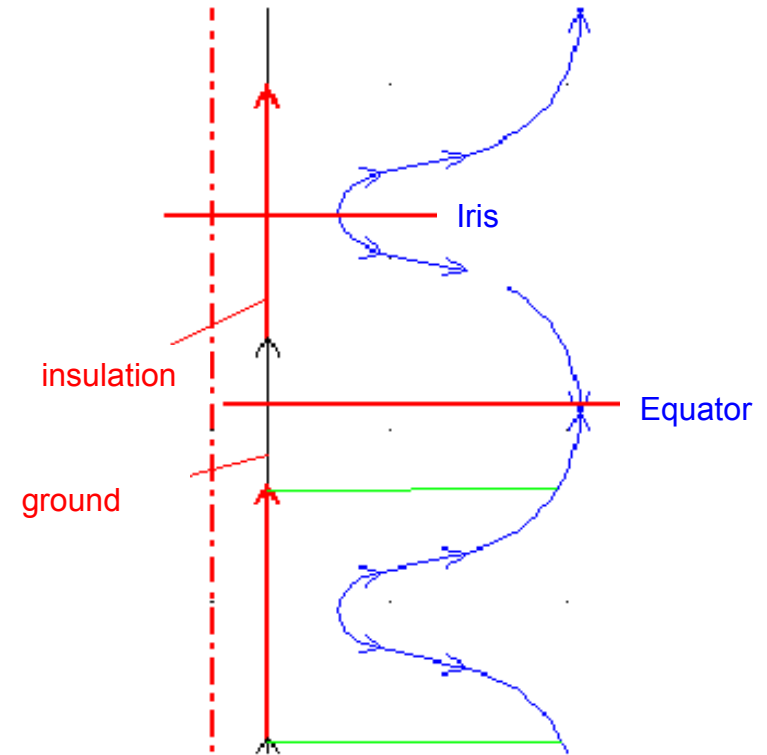
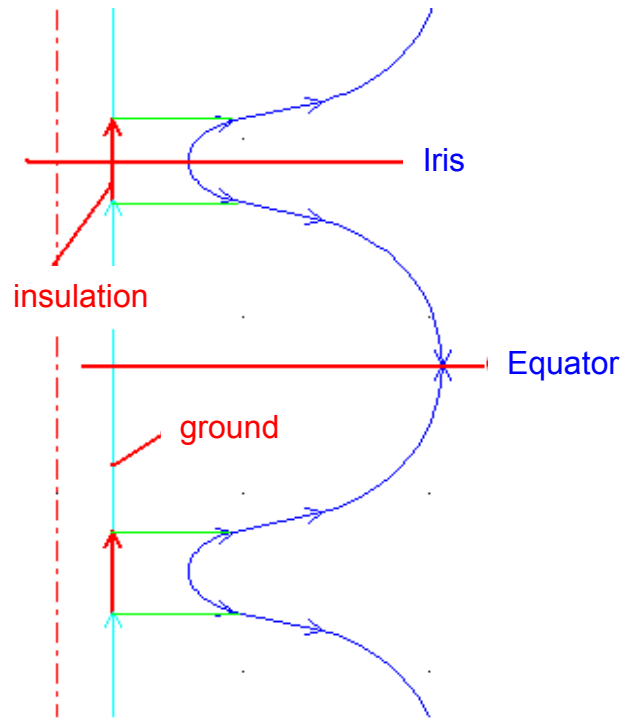
Field Ratio: $E_{\text{Iris}}/E_{\text{Equator}} = R > 41$

... Needs optimization:

→ Iris insulation

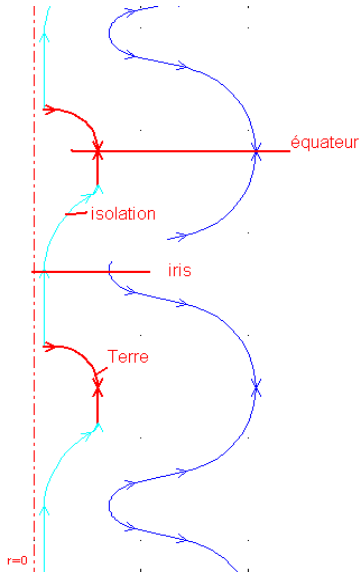
→ Alternative cathode shapes

INSULATED ROD CATHODE

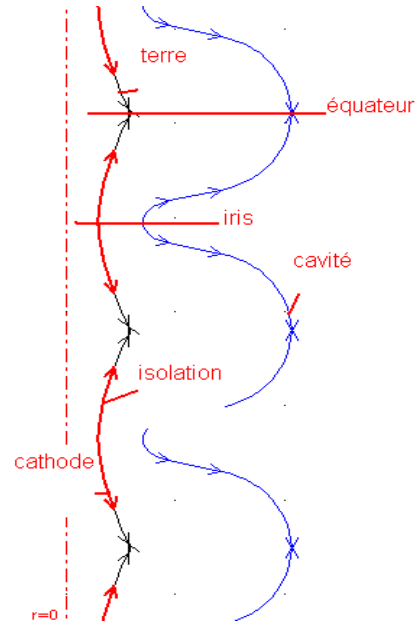


- By increasing the insulation, R decreases from 31 to 4
- ... But removal rate will decrease

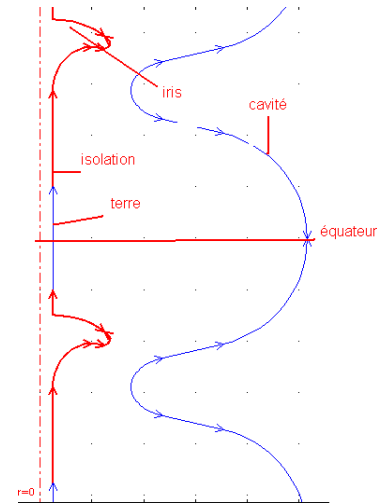
RESULTS WITH ALTERNATIVE SHAPES



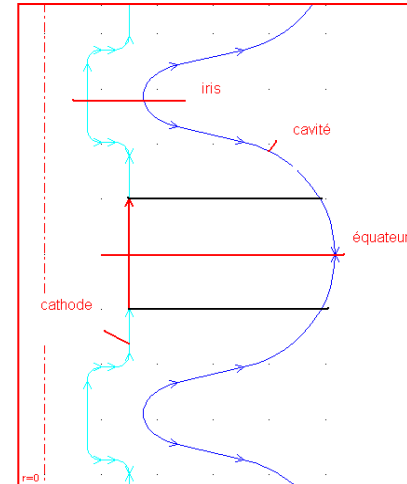
R=7,5



R=7,5

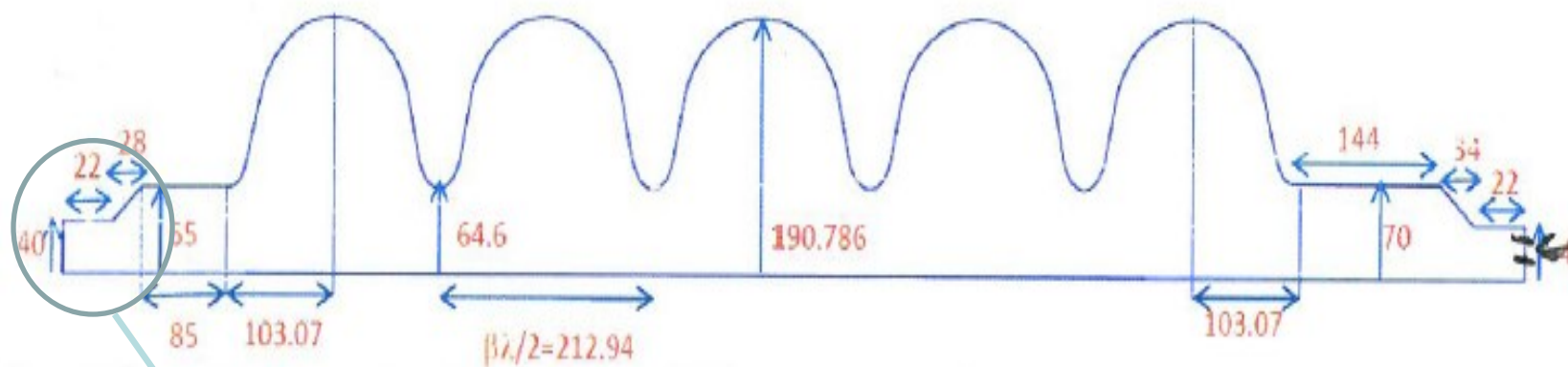


R=6,4



R=3,7

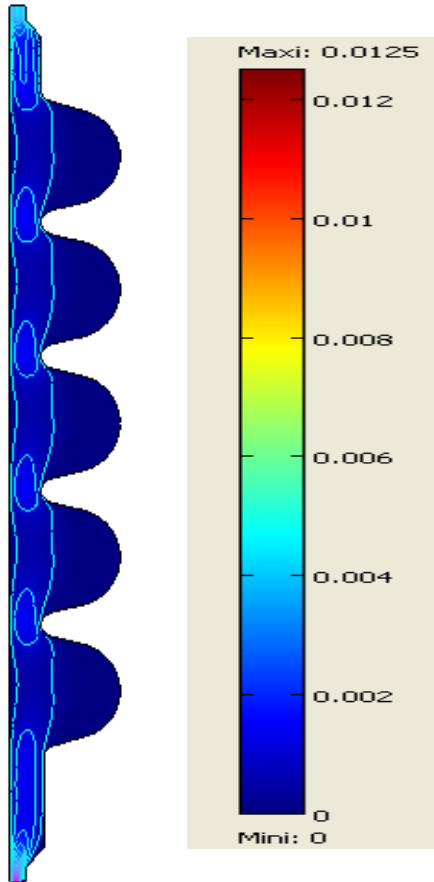
RESULTS WITH 5-CELL SPL CAVITY



Larger cavity compared to TESLA

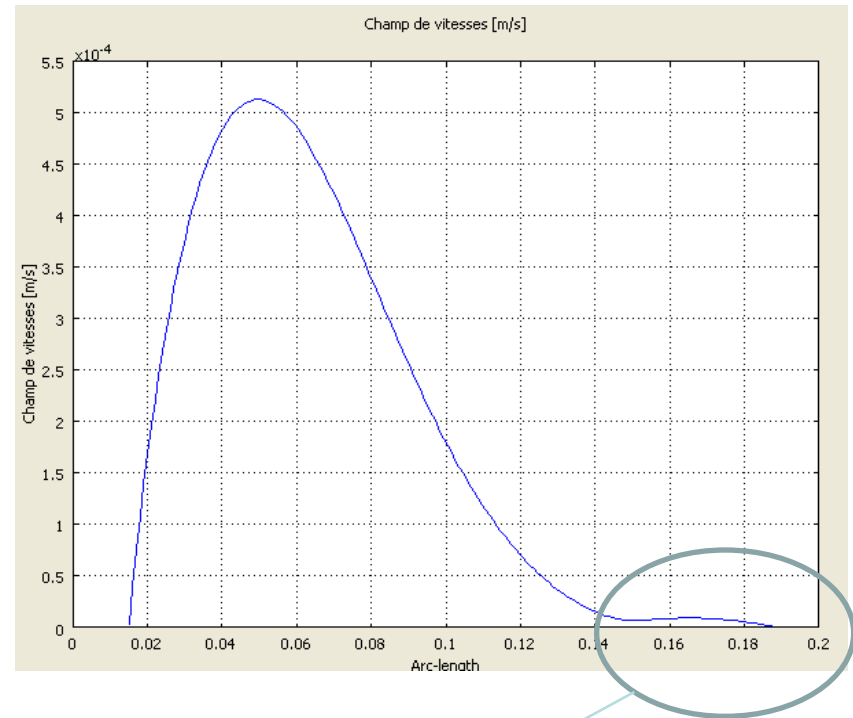
Shrinking

HYDRODYNAMICS MODELLING



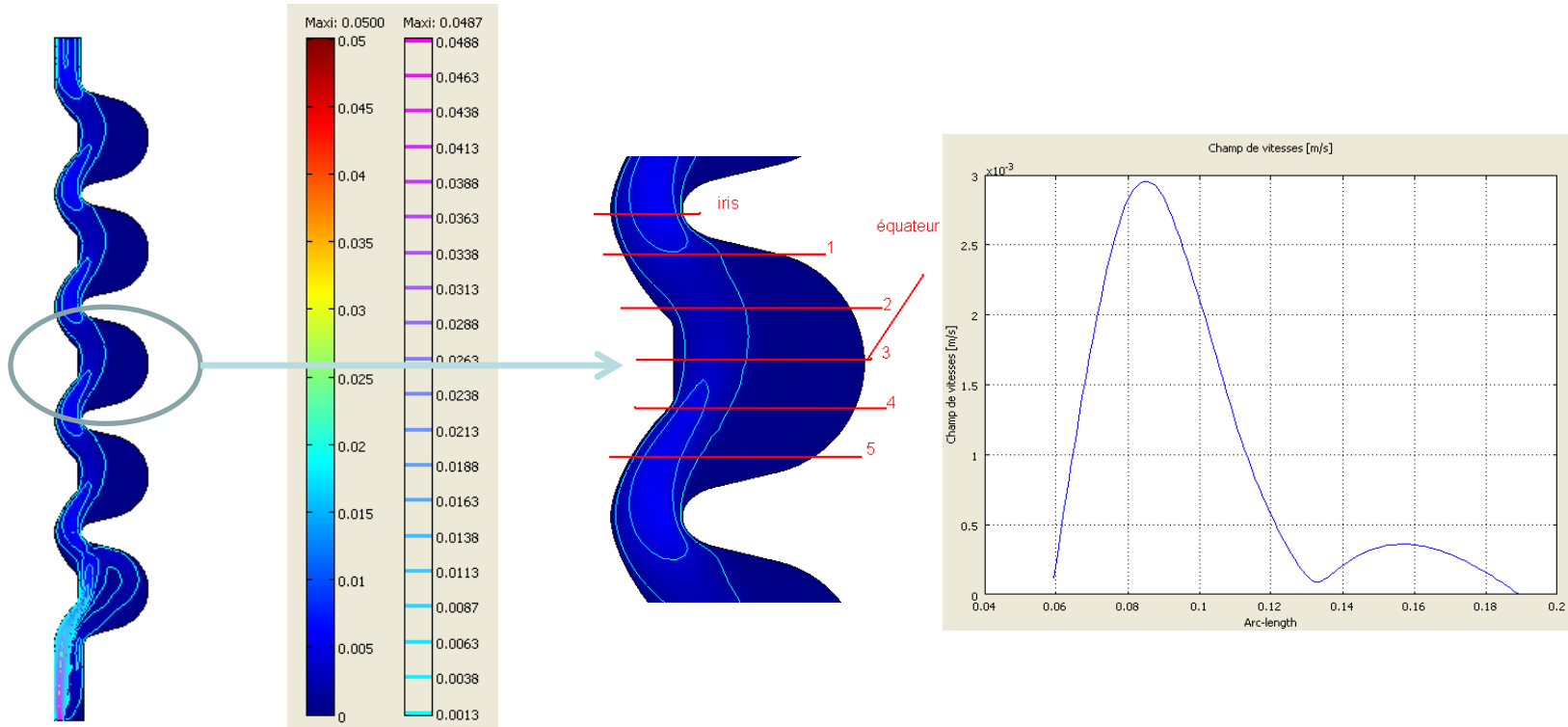
Electrolyte velocity: m/s

Flow profile from the cathode to the cavity:



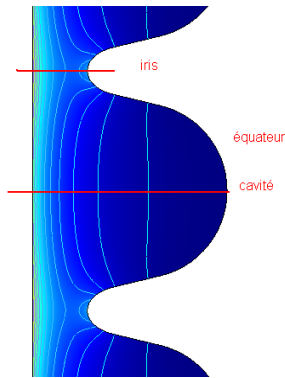
- Area close to the cell poorly swept
- Possible improvement limited by taper
- Modelling with cylindrical beam pipe

PROPOSAL: ALTERNATIVE SHAPES



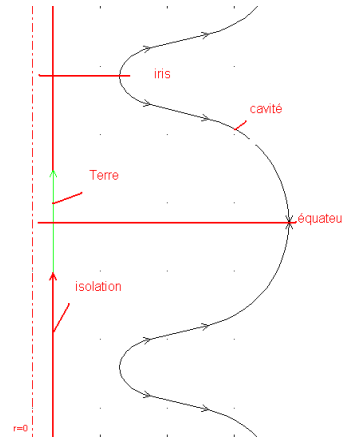
Shaped cathode makes it possible to improve the fluid distribution in the cells

ELECTRIC FIELD MODELLING



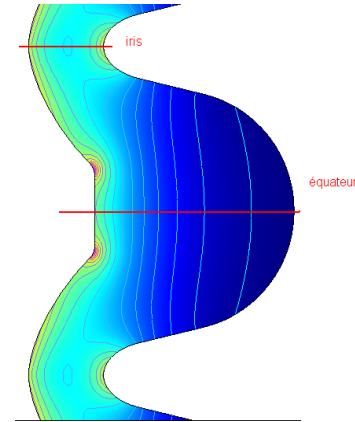
Rod Cathode

R=36.14



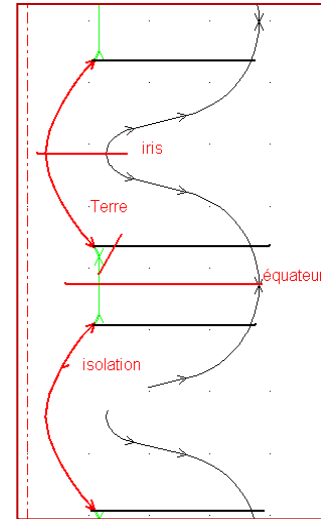
Rod Cathode
+ insulation

R=14.06



Modified
shape

R=18.87



Modified
shape +
insulation

R=5.88

Conclusion:

- Less favourable configuration compared to TESLA cavity
- Optimization possible
- Gaz flow (N_2 , O_2) not studied in the model
- Possibility to use stirring (rotating cathode) to improve VEP

CONCLUSION

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- Fabrication of the set-up is on going
 - CORELEC makes a good impression
 - Safety report delivered to local safety authorities
 - Commissioning expected for June 2011
-
- VEP modelled for 9-celles and 5-cells
 - Process more challenging for large cavities
 - Several leads investigated to optimize the process

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THANK YOU FOR YOUR ATTENTION!