3 GHZ SINGLE CELL CAVITY OPTIMIZATION DESIGN

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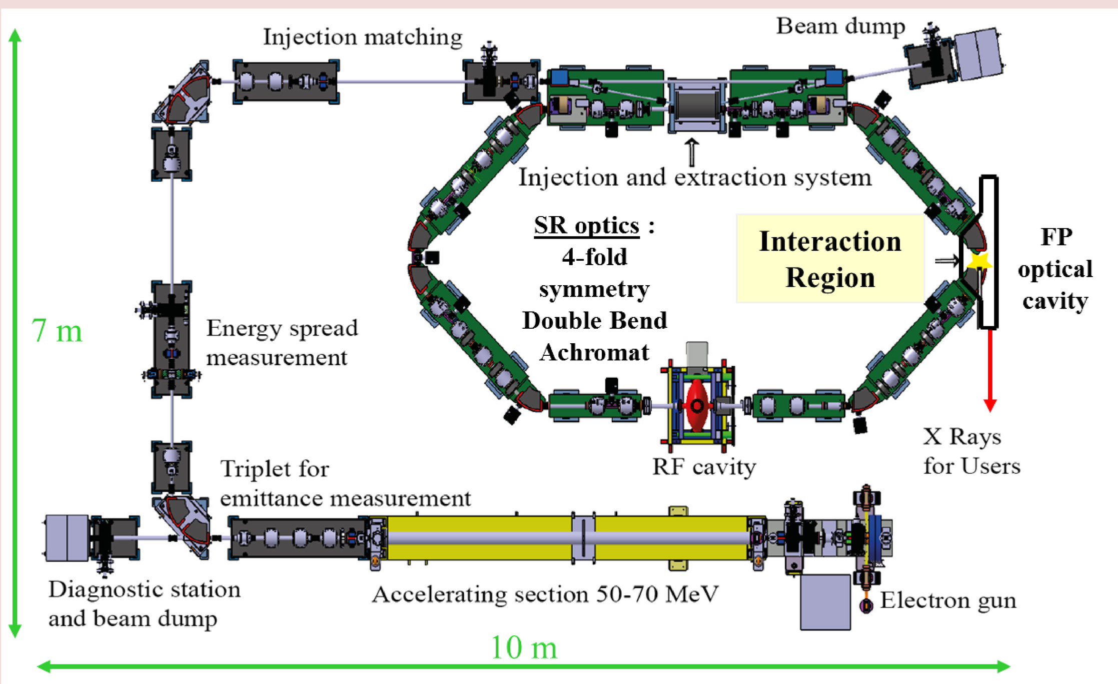
THOMX PROJECT



ThomX project is a Compton source in the range of the hard X-rays (45-90 keV). The machine consists of an injector Linac and a storage ring where the electron bunch collides with a laser pulse accumulated in a Fabry-Perot resonator. The final goal is to provide an X rays average flux of 10^{12}-10^{13} ph/sec. Different users are partners in the ThomX project, especially from medical science and cultural heritage. Their main goal will be the transfer of all the experimental techniques developed on big synchrotron rings to these more compact and flexible machines. The project ThomX has already been recently funded and will be located on the Orsay University site.

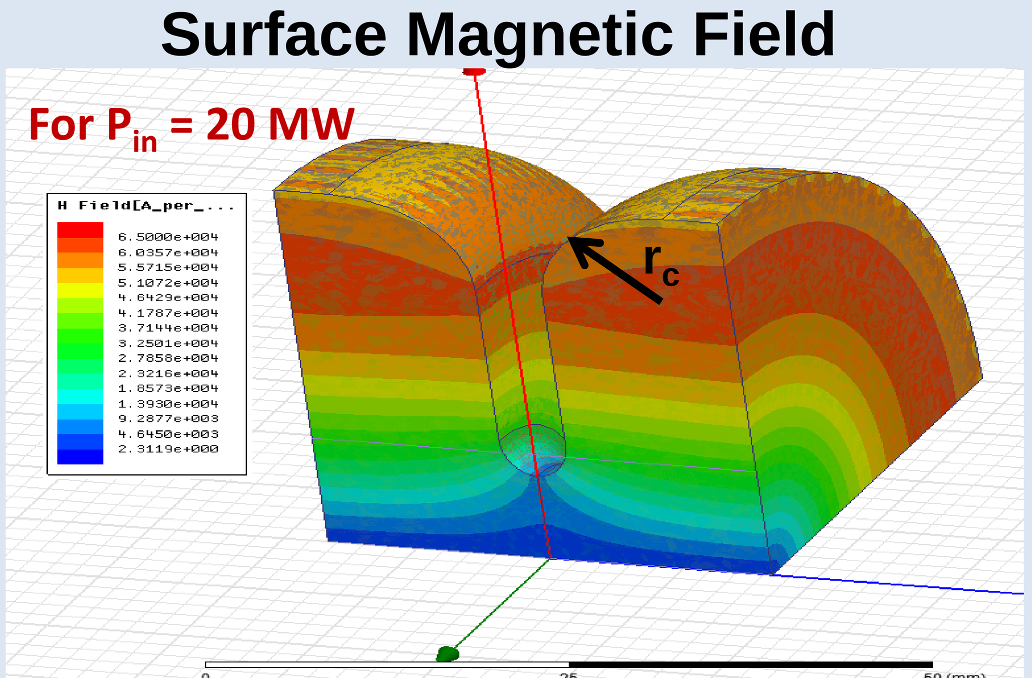
MOTIVATIONS

- **ThomX Linac energy upgrade from 50 MeV to 70 MeV.**
- **A growing demand and interest in more compact high-energy LINACS for many application areas:**
  - **homeland security,**
  - **radiotherapy,**
  - **future compact XFELs and Compton light sources.**

SINGLE CELL OPTIMIZATION

- **The accelerating gradient is limited by RF breakdown (BD) in vacuum,**
- **Operating at HG requires special attention to minimize surface fields,**
- **Optimization design of cells => improvement of RF parameters**
- **Cell optimization criteria: high r/Q, minimum E_{speak}/ <E_a>, S_c ,etc.**

Surface Magnetic Field

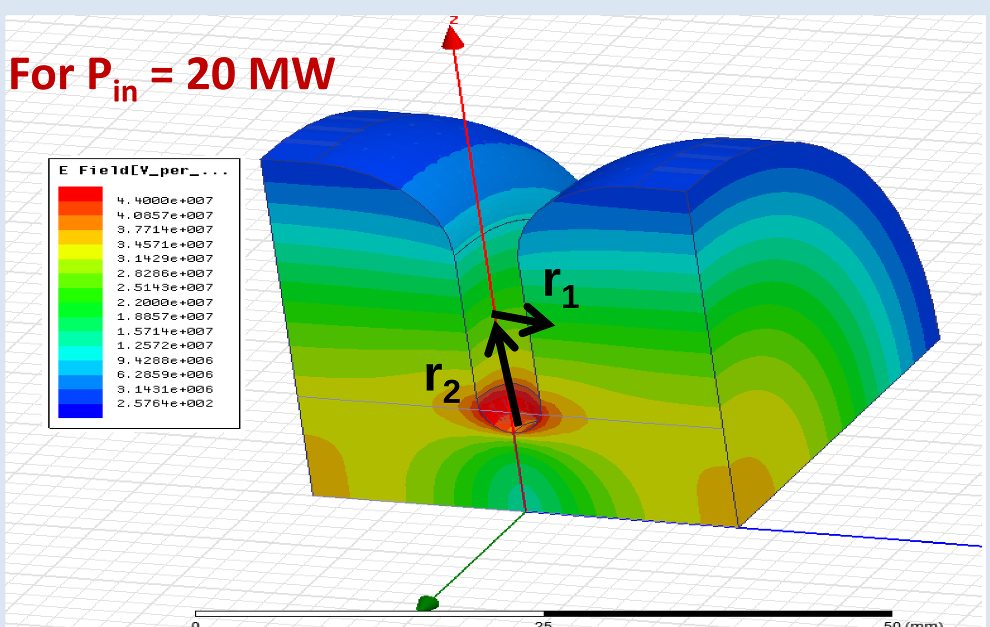


$H_{s\ peak}$ = 65 kA / m

Round inner edge r_c = 10 mm,

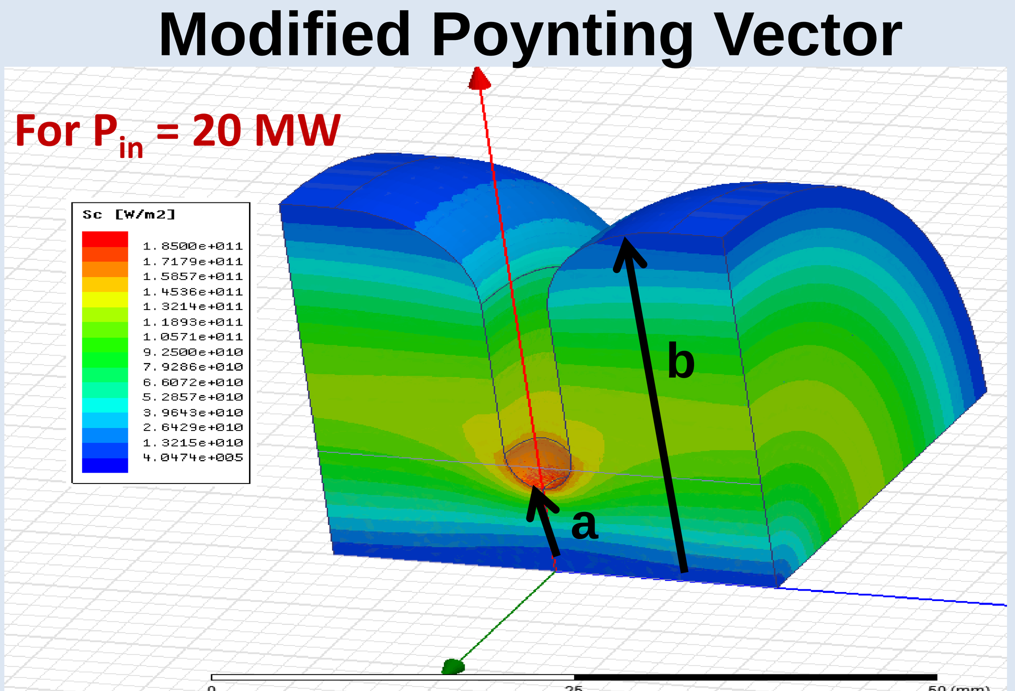
Q-value increases of 10%,

Surface Electric Field



$E_{s\ peak}$ = 44 MV / m

Modified Poynting Vector



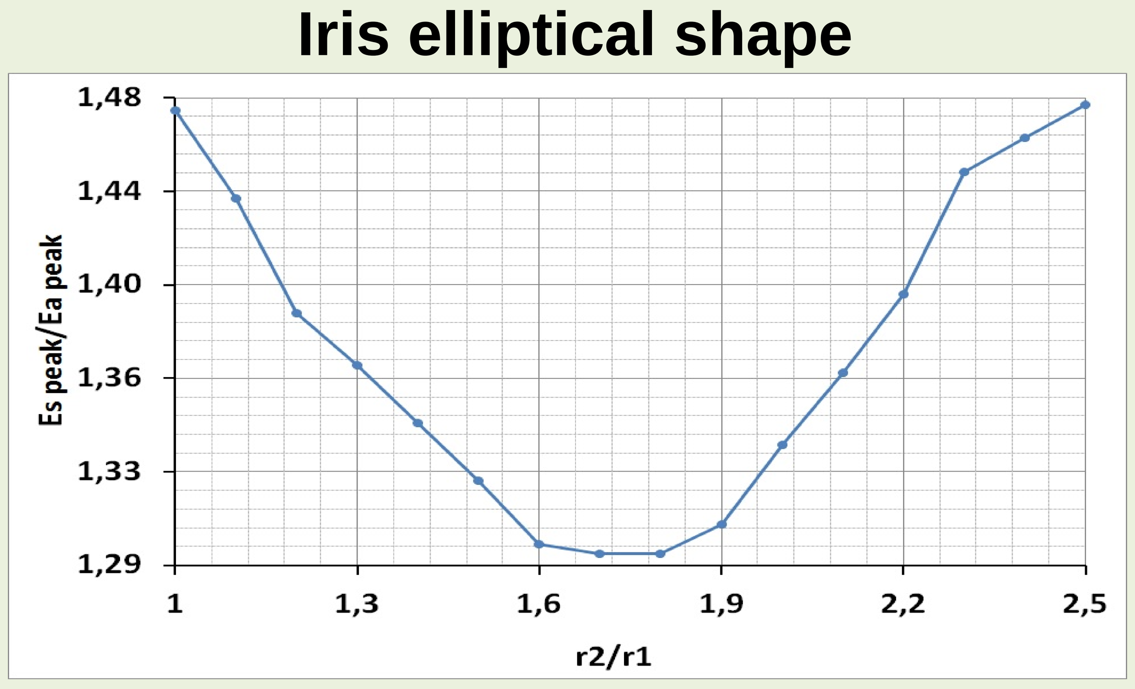
$S_{c\ max}$ = 0,185 MW / mm²

- **Both $E_{s\ peak}$ and S_c are localized in the Iris area**
- **$E_{s\ peak}$ could not serve as the only constraint for HG (according to experimental data).**
- **New ideas P/C & S_c = ||Re(S)||+||Im(S)||/6 => better constraint in RF design & BRD limit.**

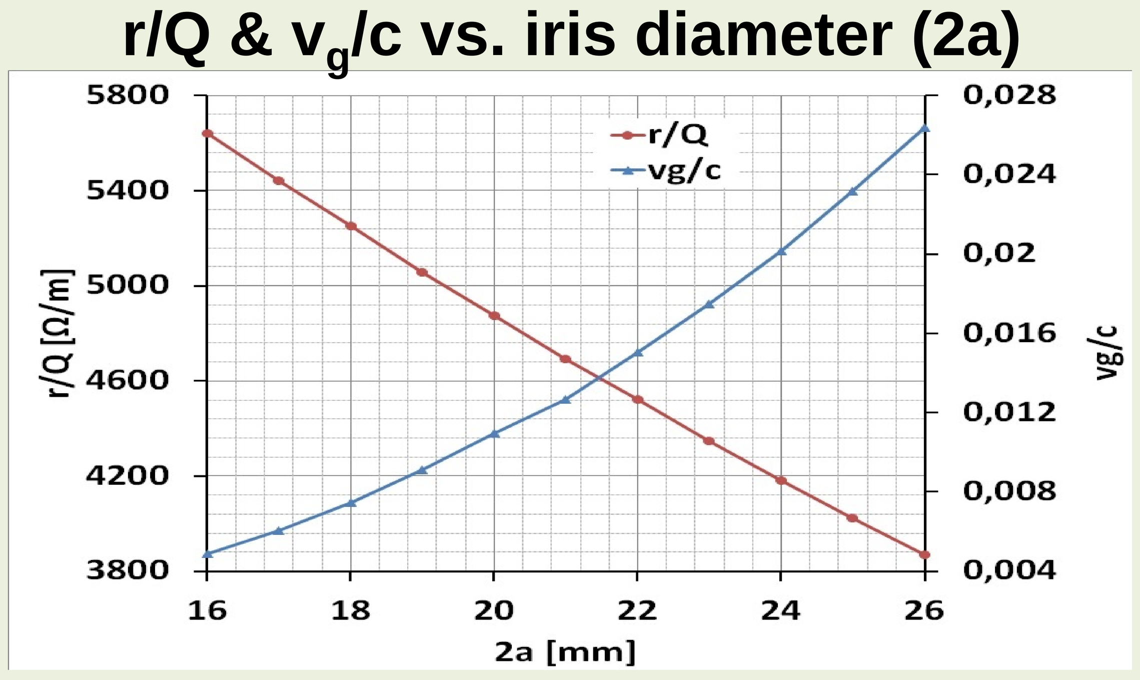
EM SIMULATIONS AND RESULTS

- **How get High Gradient Accelerating => optimization geometry, improvement of fabrication process & cleaning procedures.**

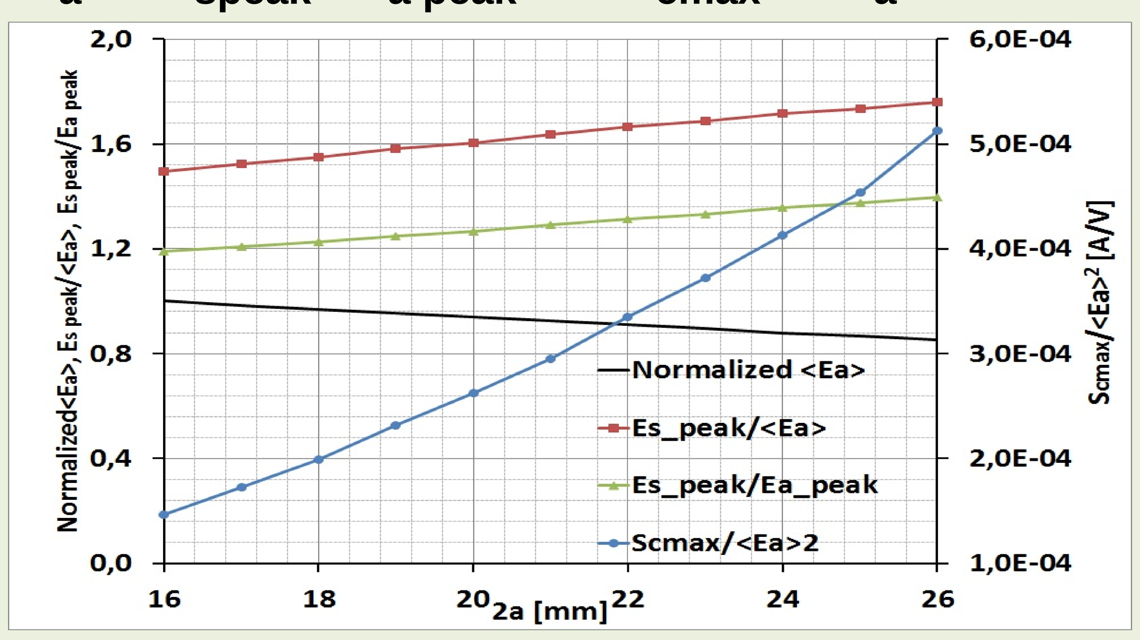
Iris elliptical shape



r/Q & v_g/c vs. iris diameter (2a)



<E_a>, E_{speak}/ $E_{a\ peak}$, & S_{cmax}/ <E_a>^{2} vs. 2a



- **Elliptical iris shape: maximum reduction of the surface field around of 14% compared to circular profile.**
- **r/Q higher for smaller a => reduced wall power diss.,**
- **v_g higher for larger a => reduced FT => shorter t_{pulse},**
- **lower E_{speak}/ $E_{a\ peak}$ (<E_a>), & S_{cmax}/ <E_a>^{2} for smaller a,**
- **S_c is correlated to break down rate (S_c^{15} α BRD)**

Optimum design of the cell is a consequence of the series of trade-off between RF efficiency, reasonable filling time, accelerating gradient, breakdown limitations.

Conclusions and prospects

The single cell shape has been optimized using the 3D electromagnetic simulation codes: HFSS and CST MWS. In order to get a good compromise between high RF efficiency in terms of acceleration and reduced power dissipation on the inner wall of the cell (high r/Q), with a reasonable value of the filling time and the breakdown rate BRD limit based on the modified Poynting vector model. As the optimal set of the single cell geometric dimensions is found, to get a good estimation of the overall effects, thermal analysis and beam dynamics for accelerating section prototypes are underway.