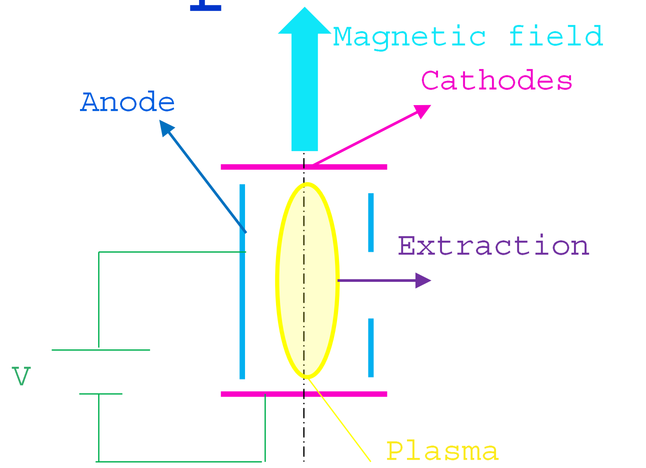
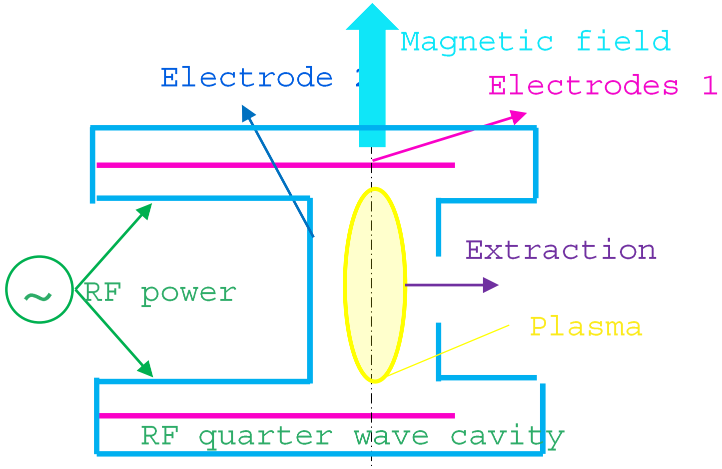
16-11-2021 / I.FAST Open Steering Committee Meeting

Daniel Gavela / Ciemat

Proposed Ion Source Concept



CONVENTIONAL PENNING ION SOURCE



PROPOSED RF ION SOURCE

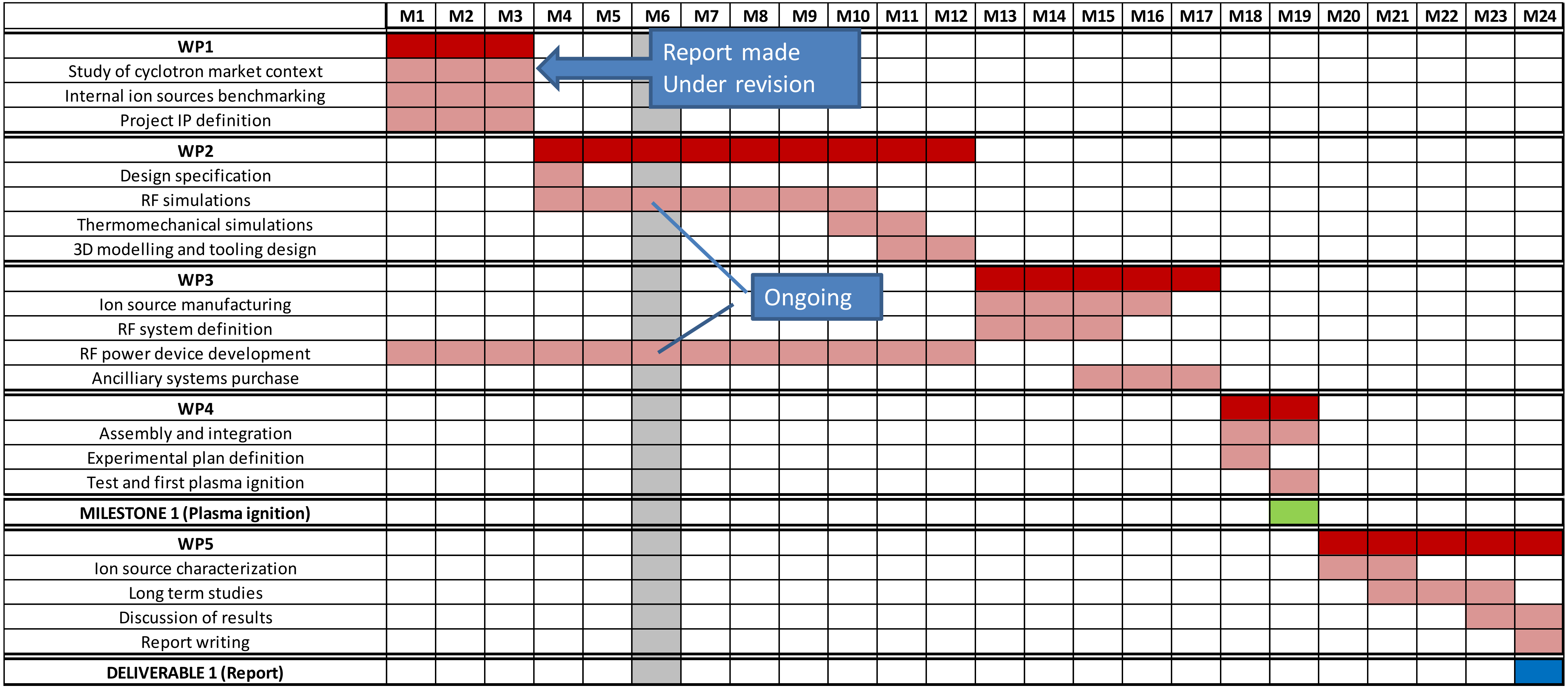
Expected advantages of RF ion source versus Penning:

- **Lower cathode wear** (no sputtering). Less maintenance time, irradiation and cost.
- Possibly **better efficiency** of producing H^-, due to lower electron energies, leading to possible reduction of H_2 flow needed and **better vacuum** in the cyclotron.
- **No high voltage**

Project Objectives

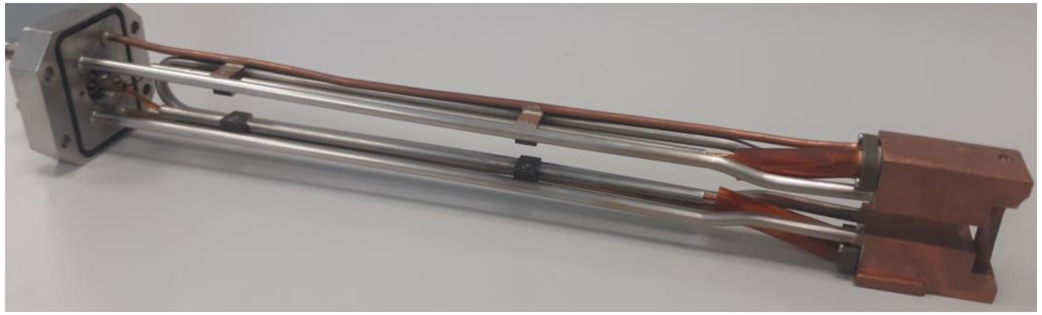
- Design & manufacture a RF based ion source to replace current internal Penning ion sources in cyclotrons
- Experimental characterization (plasma & beam) of the RF based ion source

Working Schedule

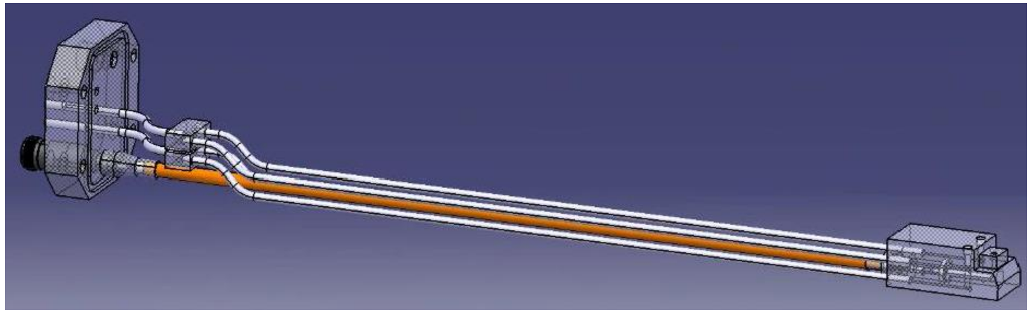


Ion Source Proposal. Design spec

- Capacitively coupled plasma at high frequency
- $\lambda/4$ Cavity resonator to enhance E field for plasma ignition
- Frequency in the 2.4-2.5 GHz range:
  - λ = 12.5 – 12 cm, compatible with current ion sources dimensions
  - Readily available power generators
- Retrofit into existing cyclotrons



AMIT cyclotron ion source

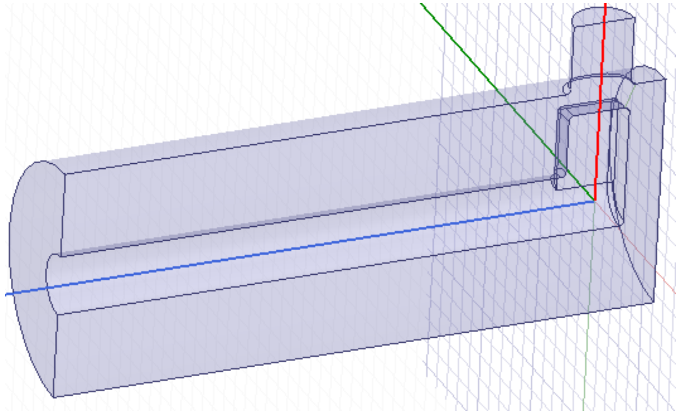


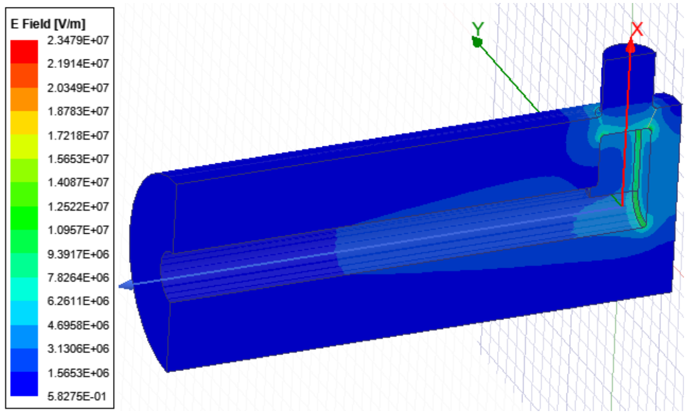
Provisional Proposed ion source (only half of it)

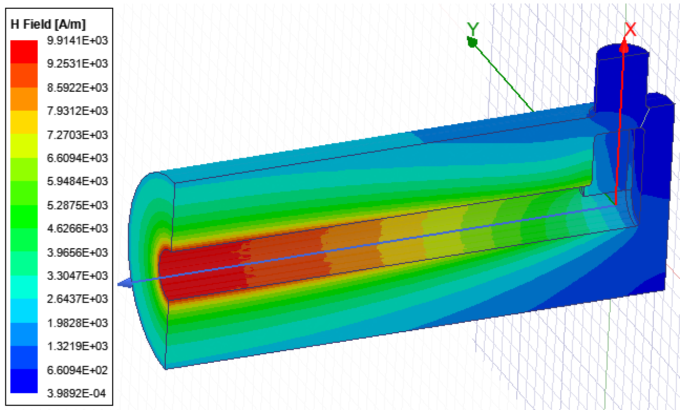
RF simulations status

- Initial basic cavity design parameters establishment. Length, inner volume, stem dimensions …
- Coupling study
- Cavity design optimization

Initial design





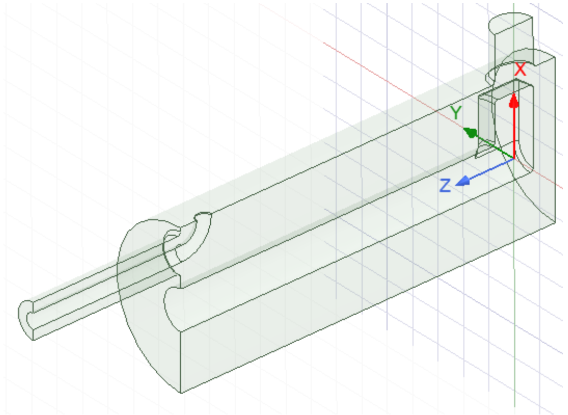


Dimensions:
- Cavity inner diameter: 10 mm
- Stem diameter: 2.6 mm
- Stem length: 24.3 mm

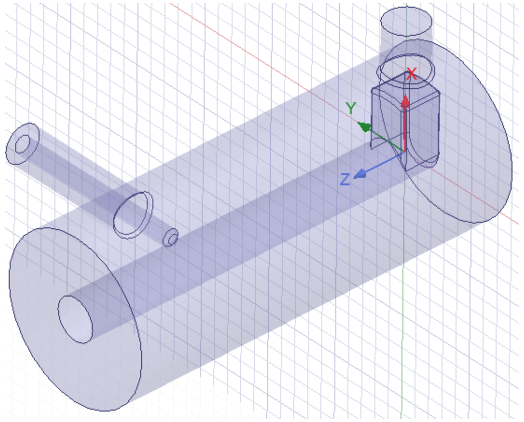
Operating parameters:
- Resonant frequency = 2,428 GHz
- Q_0 = 1877
- Tip voltage: 5.88 kV
- Power loss: 100 W

Coupling study

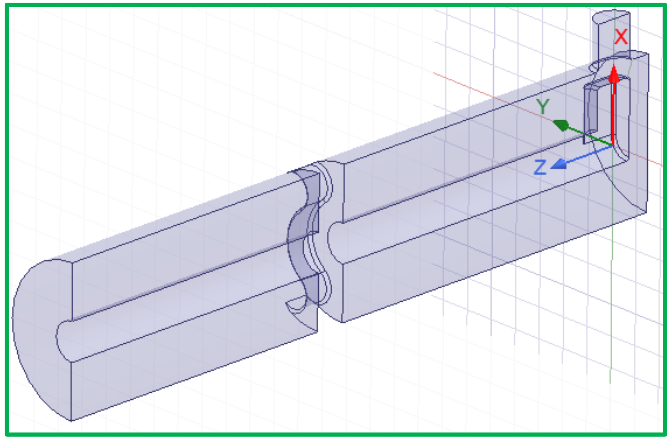
SELECTED



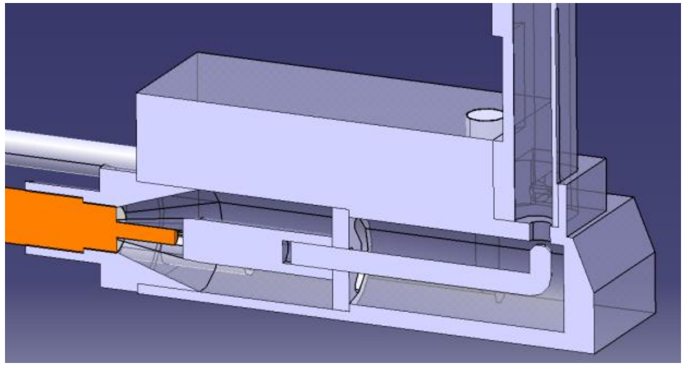
Loop



Antenna



Coupling slit

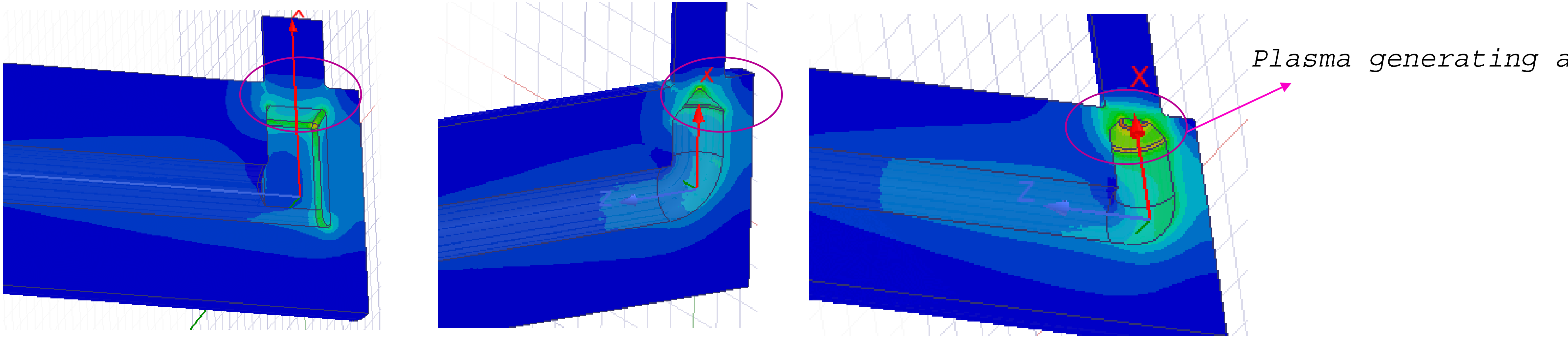


All of them can work from RF point of view, allowing for the required matching.

Coupling slit was selected due to:

- Easy to manufacture
- Appropiate with the size of the cavity
- Fits specially well in the body of the source, based on AMIT cyclotron
- Preliminary detailed design was done

Cavity design optimization

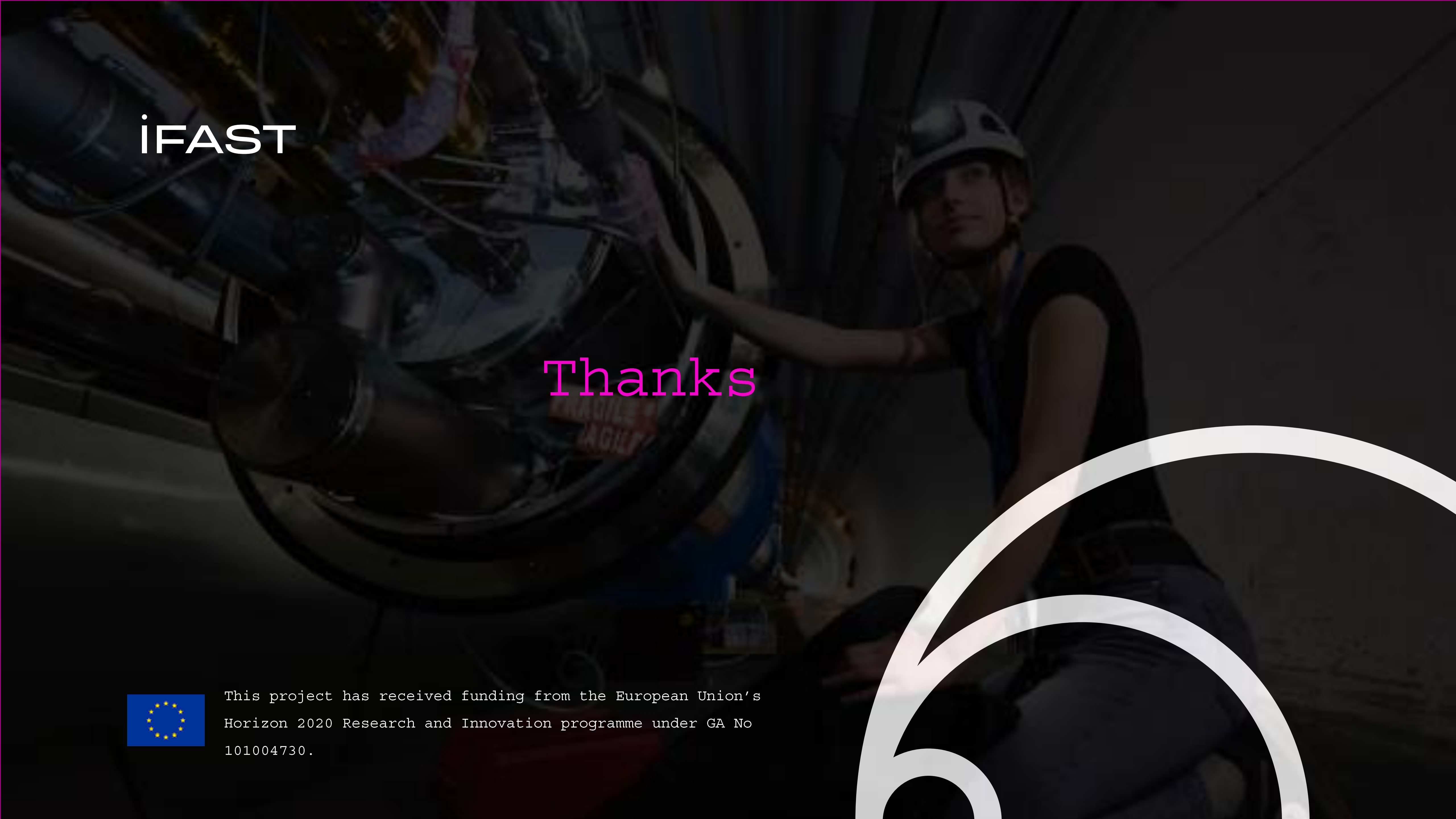


Initial design	Step 2	Step 3
Q_0 = 1877	Q_0 = 1884	Q_0 = 1914
5,88 kV	6,08 kV	6,18 kV

(all data for 100 W RF power)

Next immediate steps

- Tolerance analysis for manufacturing
- Thermomechanical simulations
- Finish RF power generation system


iFAST
Thanks
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