

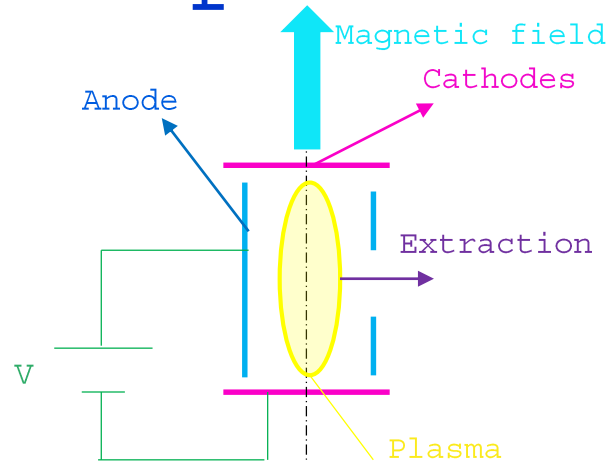


16-11-2021 / I.FAST Open Steering
Committee Meeting

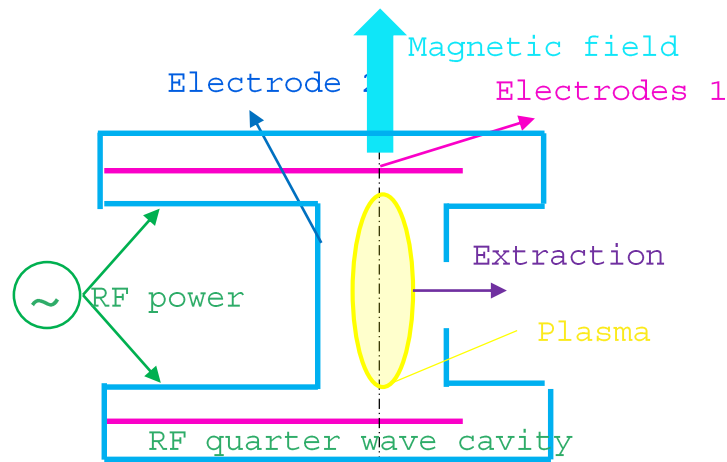
Daniel Gavela / Ciemat



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

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24
WP1	█	█	█																					
Study of cyclotron market context	█	█	█																					
Internal ion sources benchmarking	█	█	█																					
Project IP definition	█	█	█																					
WP2				█	█	█	█	█	█	█	█	█	█	█										
Design specification				█	█	█	█	█	█	█	█	█	█	█										
RF simulations				█	█	█	█	█	█	█	█	█	█	█										
Thermomechanical simulations										█	█	█	█	█										
3D modelling and tooling design										█	█	█	█	█										
WP3																								
Ion source manufacturing																								
RF system definition																								
RF power device development	█	█	█	█	█	█	█	█	█	█	█	█	█	█										
Ancilliary systems purchase																								
WP4																								
Assembly and integration																								
Experimental plan definition																								
Test and first plasma ignition																								
MILESTONE 1 (Plasma ignition)																								
WP5																								
Ion source characterization																								
Long term studies																								
Discussion of results																								
Report writing																								
DELIVERABLE 1 (Report)																								

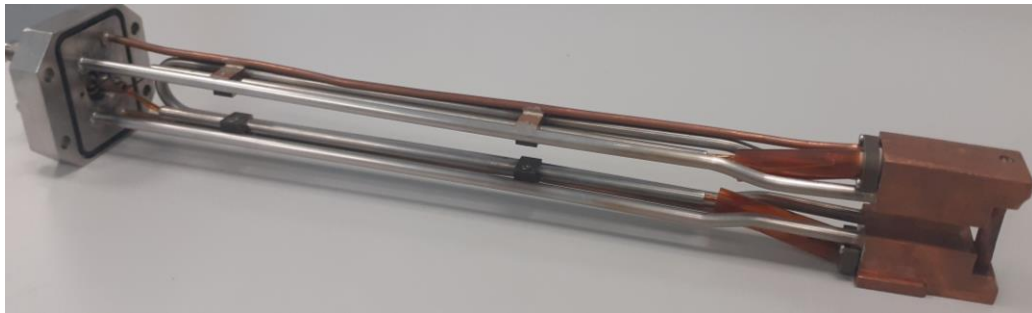
Report made Under revision

Ongoing

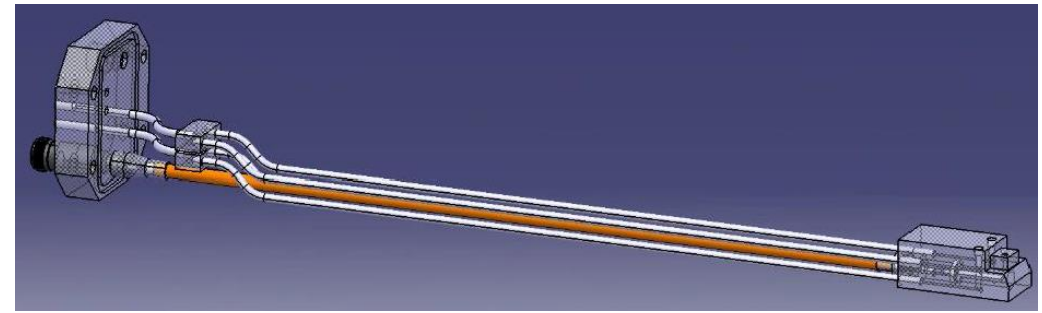


Ion Source Proposal. Design spec

- 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:
 - $\lambda = 12.5 - 12$ cm, compatible with current ion sources dimensions
 - Readily available power generators
- Retrofit into existing cyclotrons



AMIT cyclotron ion source



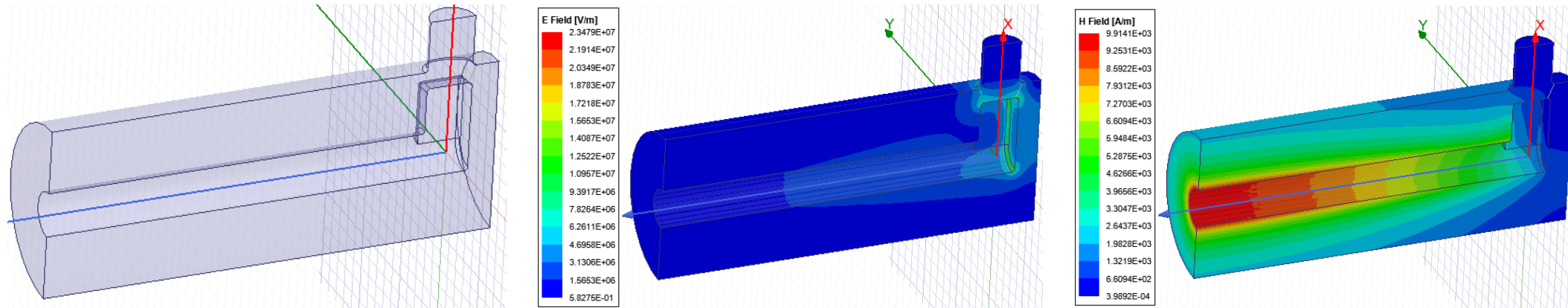
Provisional Proposed ion source (only half of it)

RF simulations status

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



Initial design



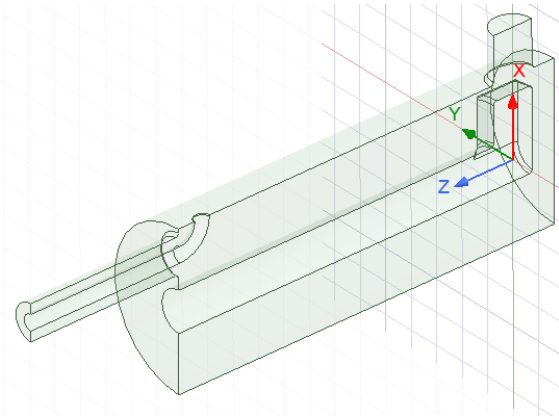
Dimensions:

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

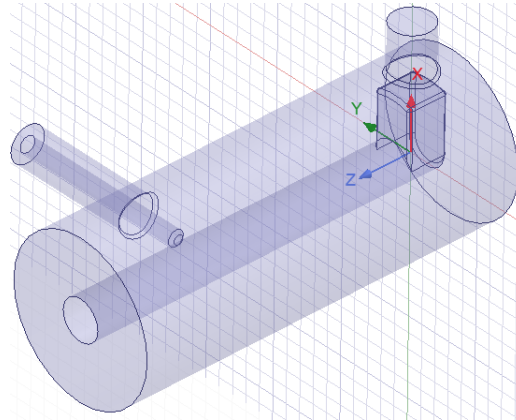
Operating parameters:

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

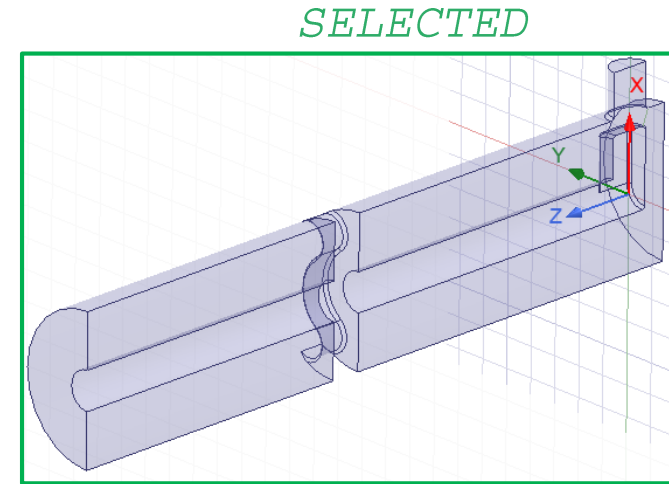
Coupling study



Loop



Antenna

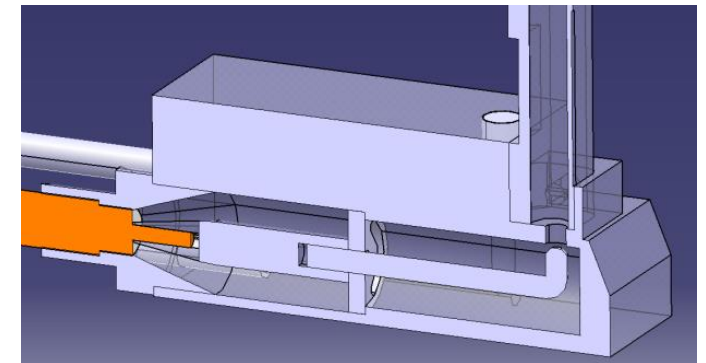


Coupling slit

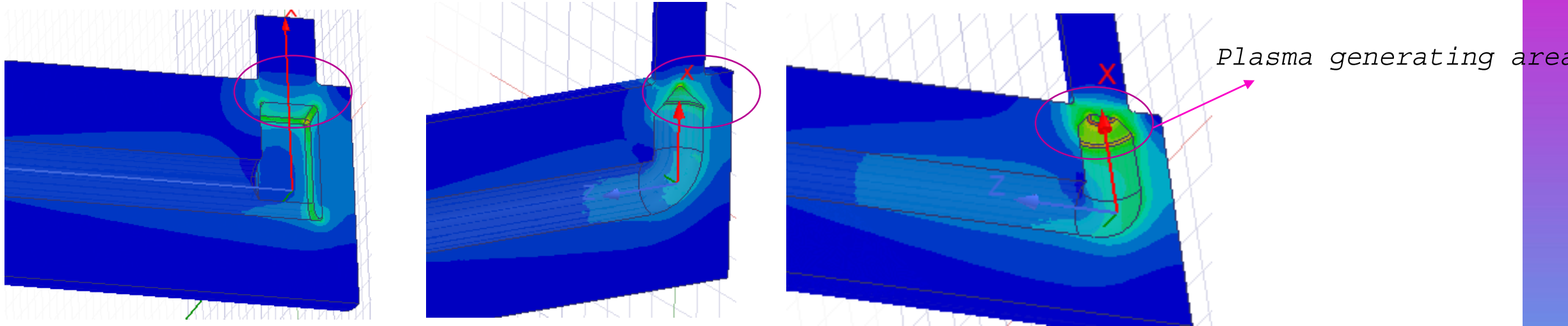
All of them can work from RF point of view, allowing for the required matching.

Coupling slit was selected due to:

- Easy to manufacture
- Appropriate 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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