Update on FETS RFQ coupler activities on ESS Bilbao

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4. Summary, conclusions and future work
1. Introduction

- Several coupler designs have been simulated. Simulations are preliminary and no optimization of parameters to get optimum matching have been done until now (this work is ongoing).

- Models are 2D axysimetric.

- Simulations with 3D models (Isis and “Hybrid”) have also been done, but results are not good (help wanted... )
1. Introduction

- All simulations are made using Perfect Electric Conductor surface boundary conditions.
- Ceramic window always has 10 mm thickness, and is modeled with an $\varepsilon_r=10$ (results with $\varepsilon_r=1$ (“air window”) are also shown for comparison)
- Parameter $S11$ is computed for all cases in the frequency range 1-10 Mhz
- Results for $freq=324$ Mhz are also shown in some cases.
1. Introduction

- Common data for all models (input and output coaxial dimensions)

<table>
<thead>
<tr>
<th>(All in mm)</th>
<th>Input internal radius (a1)</th>
<th>Input external radius (b1)</th>
<th>Output internal radius (a3)</th>
<th>Output external radius (b3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21.75</td>
<td>50</td>
<td>6.217</td>
<td>14.13</td>
</tr>
</tbody>
</table>
2. 2D simulations: Model A

- Pure coaxial model, no special corrections for window matching
2. 2D simulations: - Model A

• Electric field and energy density for 324 Mhz, 100 kW)
2. 2D simulations: Model A

- Model A: Pure coaxial window (ceramic $\varepsilon_r = 10$)

![Graph showing S11 (dB) vs. frequency (GHz) for two different permittivity values. The graph indicates poor matching.]
2. 2D simulations: Model B

- Model B is a 2D simplification of the “hybrid” model by P. Savage:

This complex structure is not reproduced in this model
2. 2D simulations: Model B

- Electric field and energy density for 324 Mhz, 100 kW)
2. 2D simulations: Model B

- Not good matching (problem of not considering the window geometry?)

![Graph showing poor matching](image)
2. 2D simulations: Model C

- Based on paper by J. Plouin for IFMIF QWR*

* J. Plouin et al, Proceedings of SRF2009

Length of this section, and position of window are the optimization parameters
2. 2D simulations: Model C

- Electric field and energy density for 324 Mhz, 100 kW)
2. 2D simulations: Model C

- Simulations for optimize parameter S11 by changing length of transition section are being carried out now.
- Results are promising anyway:

![Graph showing S11 parameters](image)
2. 2D simulations: Model D

• Based on IFNIF RFQ coupler*. Matches window with no chokes:

Radius selected to have 50 Ohm with an $\varepsilon_r=10$ window. Further optimization possible.

*S. Maebara, Proceedings IPAC10
2. 2D simulations: Model D

- Electric field and energy density for 324 MHz, 100 kW)
2. 2D simulations: Model D

- Good results even with no geometry optimization

![Graph showing FETS RFQ coupler model D results](image)
3. 3D models

- 3D simulations with the models sent by P. Savage have also been done.
- Certain manipulation has been done to the models to simplify them for electromagnetic computations
- Only coaxial section is simulated (loop removed)
3. 3D models: Original models

- ISIS and Hybrid models have been simulated:

From ISIS coupler to FETS coupler

1. Reuses ISIS coupler back end – need to design this to suit coax connector.
2. Reuses ISIS design ceramic window.
3. Extended and reduced diameter nose to suit DN40CF tuner port flange.
4. Diameters of inner and outer coax conductors follow ratio of 2.3 maintaining impedance of 50 ohms.
5. Coupling loop is water cooled.
6. Outer copper conductor is a vacuum brazed assembly.
3. 3D models: ISIS coupler

- Coupler modifications to facilitate EM model:

  - Central conductor prolongation
  - External conductor prolongation

This area removed “soldified” (meshing problems)
3. 3D models: ISIS coupler

Original model

Internal cond filled and extended

Back output conductor simplified (keeping 50 Ohm)

Final model to solve

Air
Copper
Window
3. 3D models: Isis coupler

• Electric field for 200 Mhz, 100 kW
3. 3D models: ISIS coupler

• Nor very goot matching found. (Am I missing something?)
3. 3D models: Hybrid coupler

• Similar procedure for the hybrid model:
3. 3D models: Hybrid coupler

• Results at 324 MHz and 100 kW
3. 3D models: Hybrid coupler

- Better results than with previous model, but more optimization needed.
4. Summary of 2D models

- **Model A** (pure coaxial):
  - No matching possible

- **Model B** (pure coaxial):
  - No good results

- **Model C** (sharp transition):
  - Two optimizing parameters, perfect match possible.

- **Model D** (IFMIF RFQ-like):
  - Nice results, possible optimization
4. Summary of 3D models

- Simulations with 3D models have also started, but results (S11) are no good until now.

- Simulations will be done again with higher mesh densities (new workstation available!)

- Any suggestion/comment/correction will be appreciated
4. General questions/comments

• What's your opinion about these models?

• Concerning model C, that can be optimized pretty well, do you think it is feasible from a mechanical point of view?

• About 3D models, what do you think of the S11 results and the simulation procedure followed?

• What further steps do you suggest?
Future work

- Optimization of 2D model geometries to 324 MHz and 352 MHz
- Revisit 3D models with finer meshes to verify results
- Compute power dissipation, fields in the window and temperatures in the conductors
- Cavity design proposal for coupler testing