The hybrid TW-SW photoinjector

David Alesini
for the hybrid gun study group*

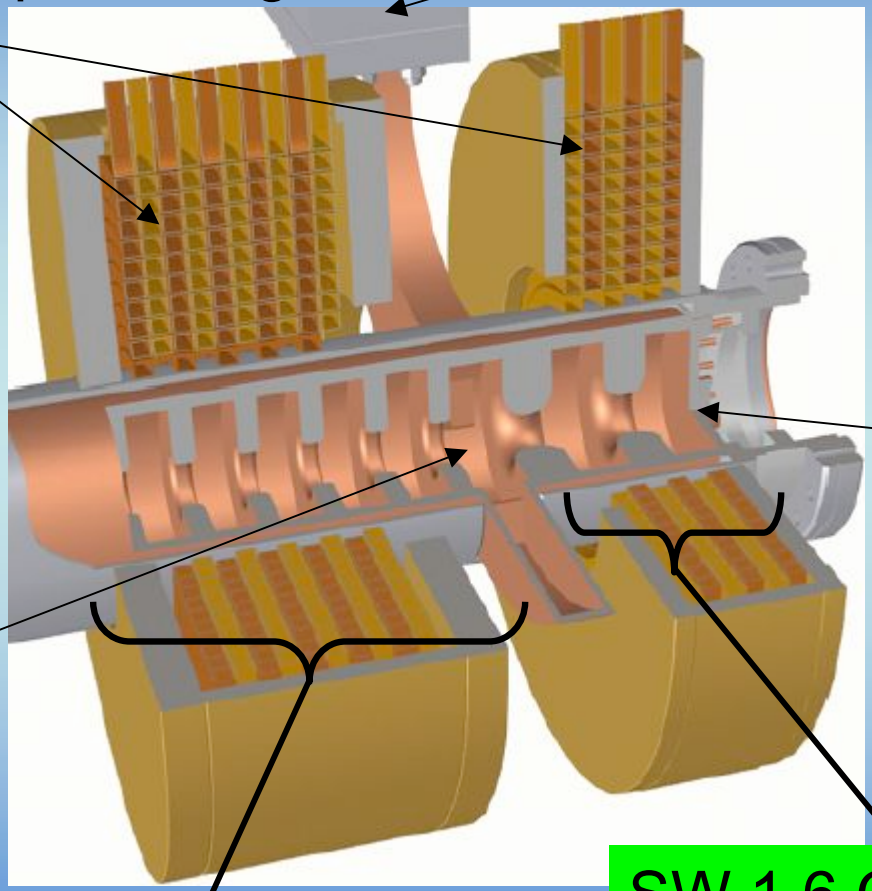
(LNF-INFN, Frascati, Rome)

***J. Rosenzweig, B. O'Shea, L. Palumbo, A. Mostacci, B. Spataro, M. Ferrario, G. Caretti, A. Marinelli**

OUTLINE

1) The idea
2) Beam dynamics simulation results
3) Electromagnetic design results

1) The Idea: sketch



1) The idea: advantages

1) Eliminate transient reflection associated with SW structures (especially needed for X-band);

2) Compactness:
   - -simplicity (RF distribution system, etc.)
   - -energy efficiency from TW section

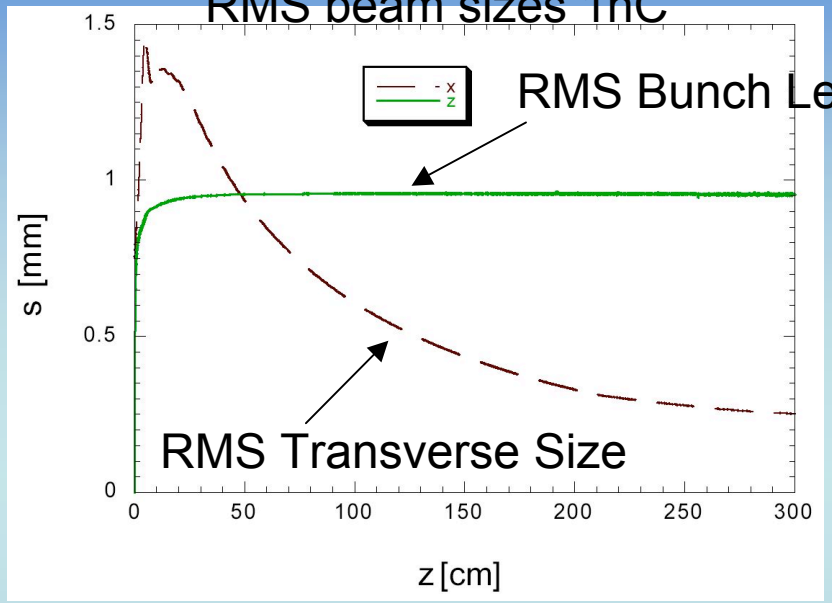
3) Promising good beam dynamics:
   - -Shorter pulses (no expansion after gun)
   - -Flexible energy; velocity bunching (?),…

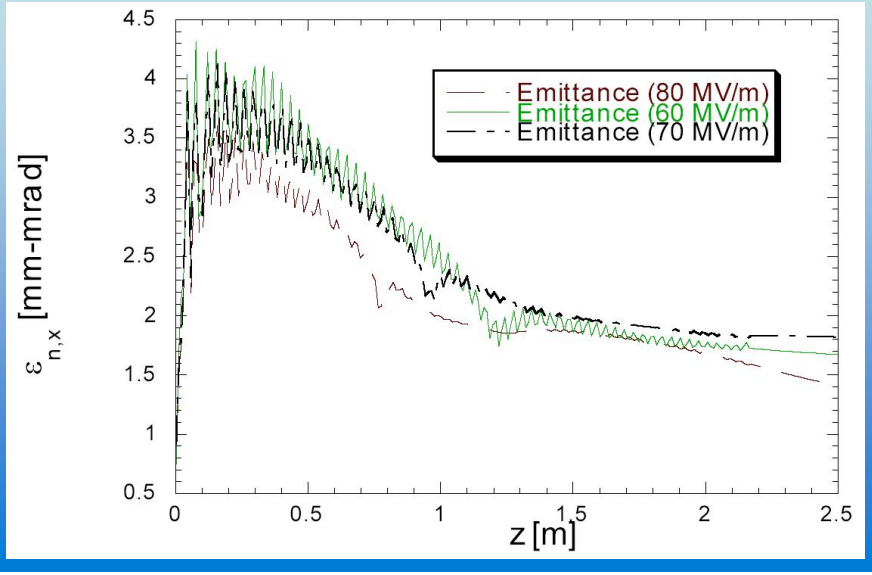
4) In S-band, E_B >30 MeV in single structure.

2) Beam dynamics simulation results

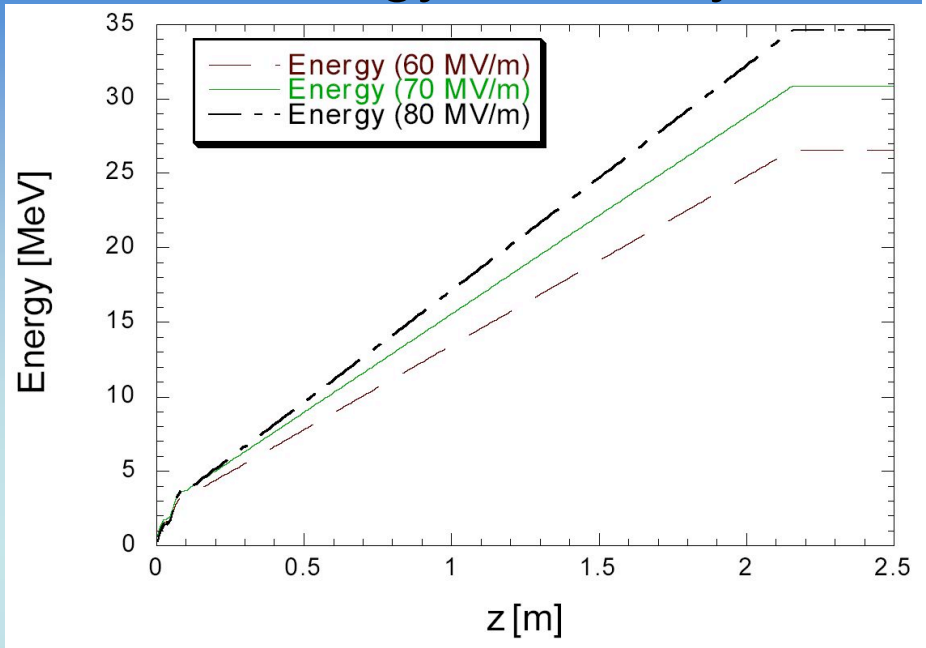
Calculations made by M. Ferrario

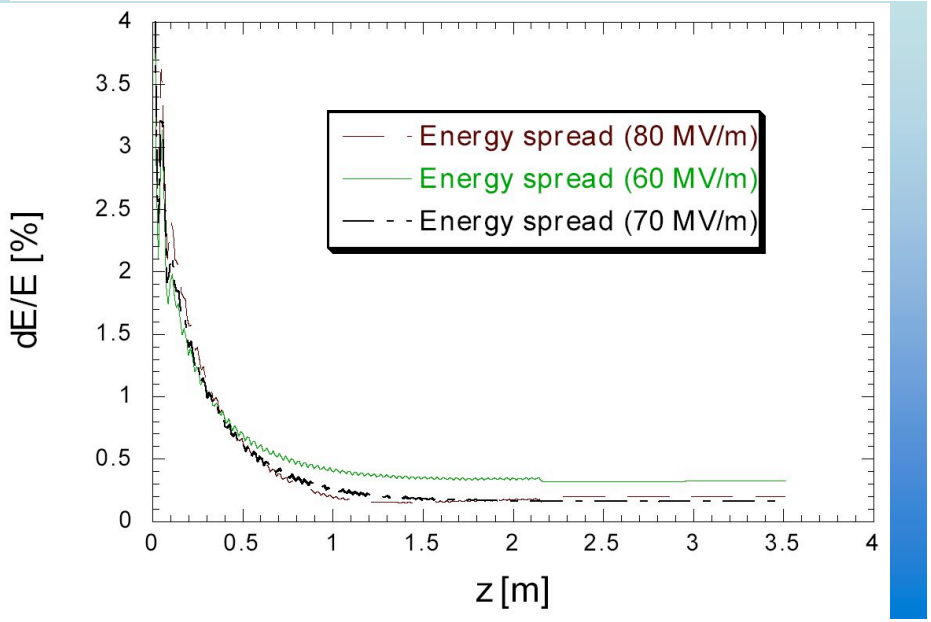
RMS beam sizes 1nC





Energy Tunability





3) Electromagnetic design

a) Non trivial…challenge!

b) Different possible approach for design:

a) ***Direct coupling*** between the TW structure and the SW structure

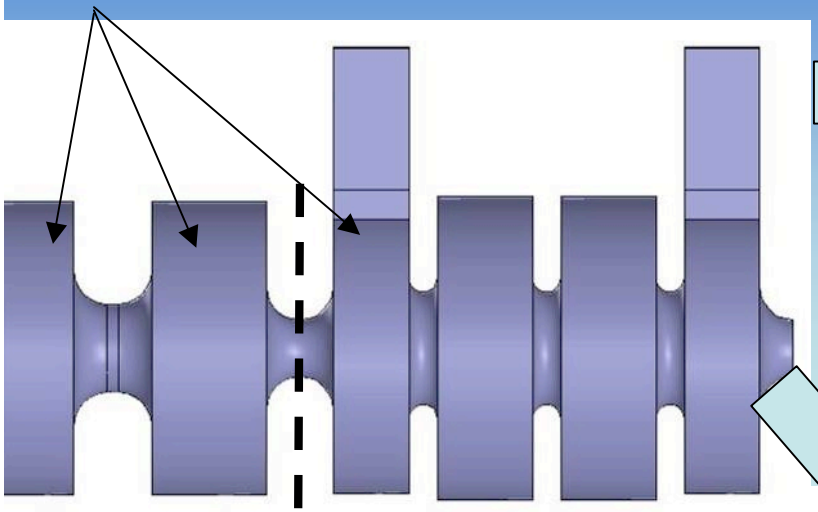
b) ***Adiabatic coupling*** between the SW and the TW structure

-beam tube length decrease

-coupling iris diameter increase

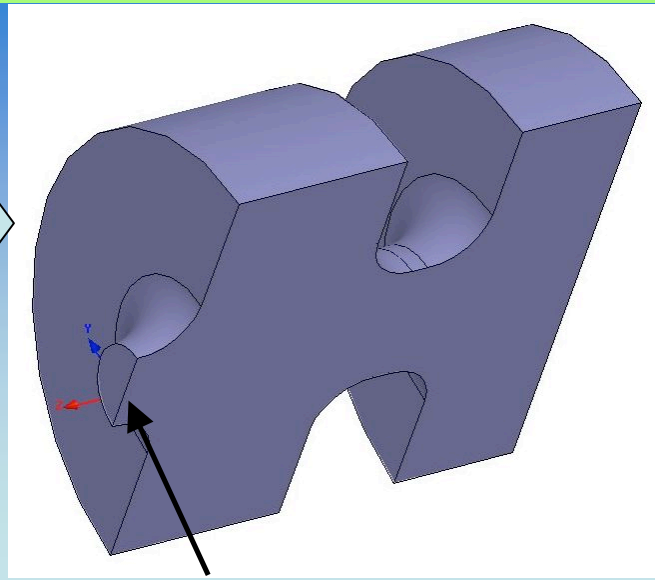
3) Electromagnetic design: *direct coupling between the TW and the SW*

***π* Phase advance**

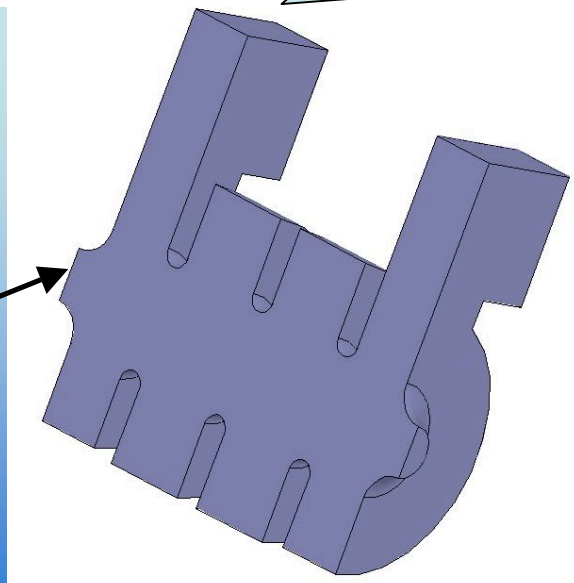


D D

Perfect magnetic boundary condition (PM)



(PM)

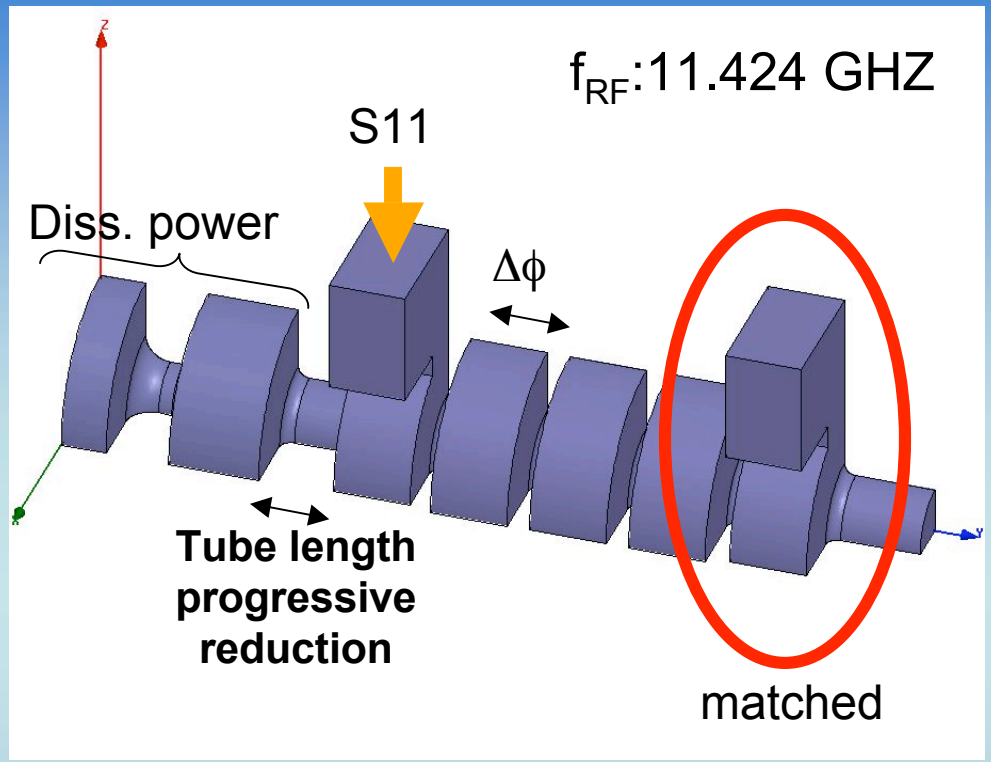


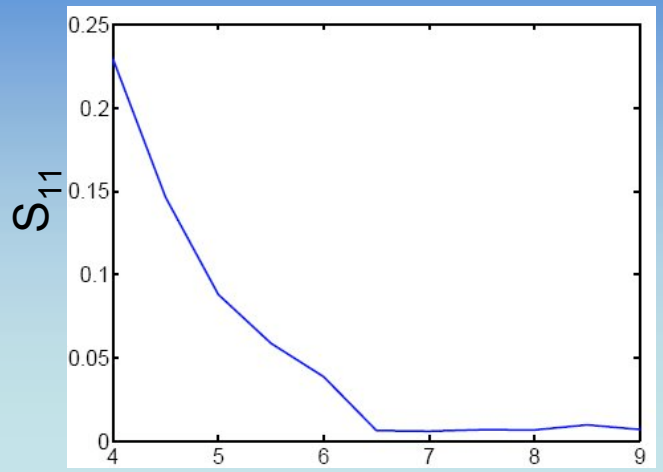
(PM)

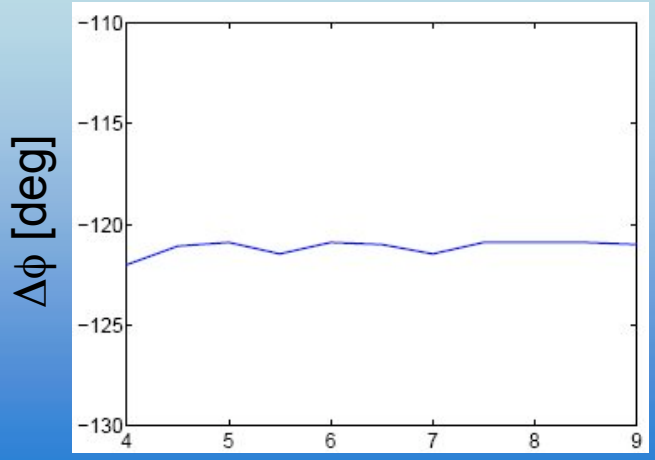
RESULTS with "unperturbed irises"

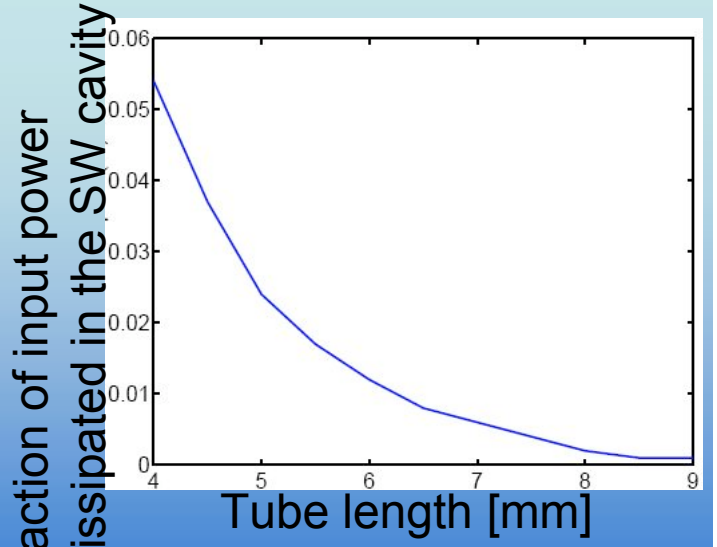
Strong coupling between the input coupler and the SW structure (the field in the SW gun is more than 50 times the field in the TW)

3) Electrom. design: *adiabatic coupling SW-TW tube length decrease (1/2)*



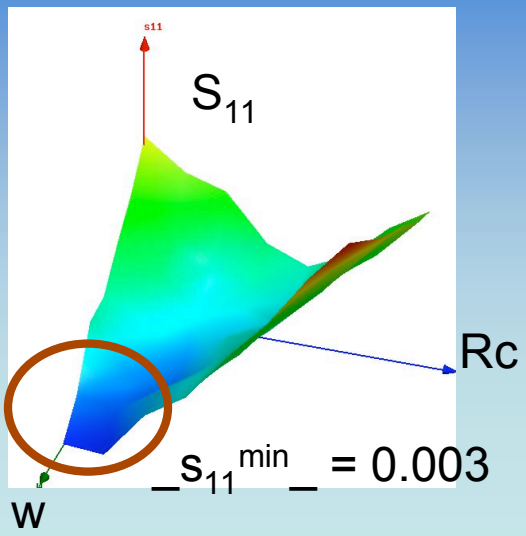


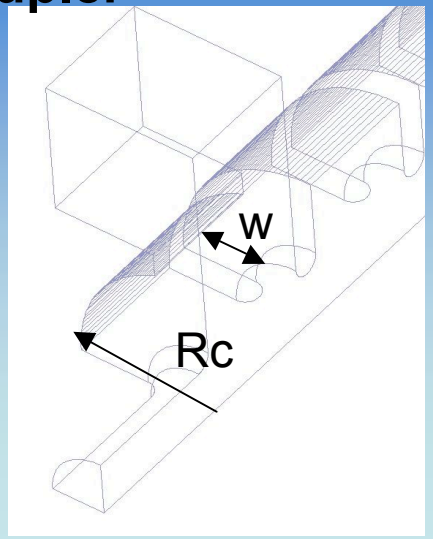




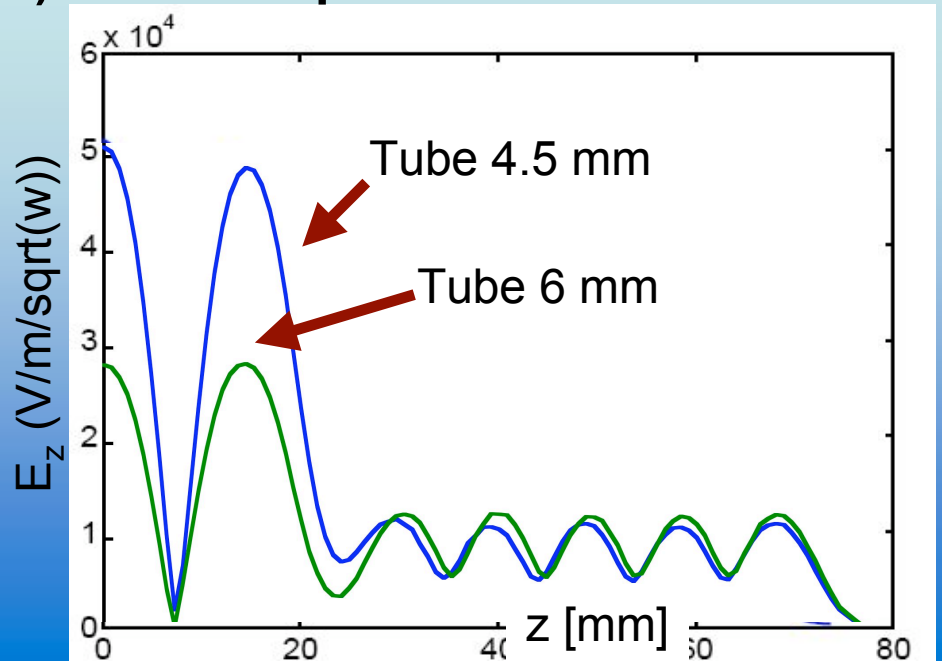
3) Electrom. design: *adiabatic coupling SW-TW tube length decrease (2/2)*

a) Re-tuning of the input coupler

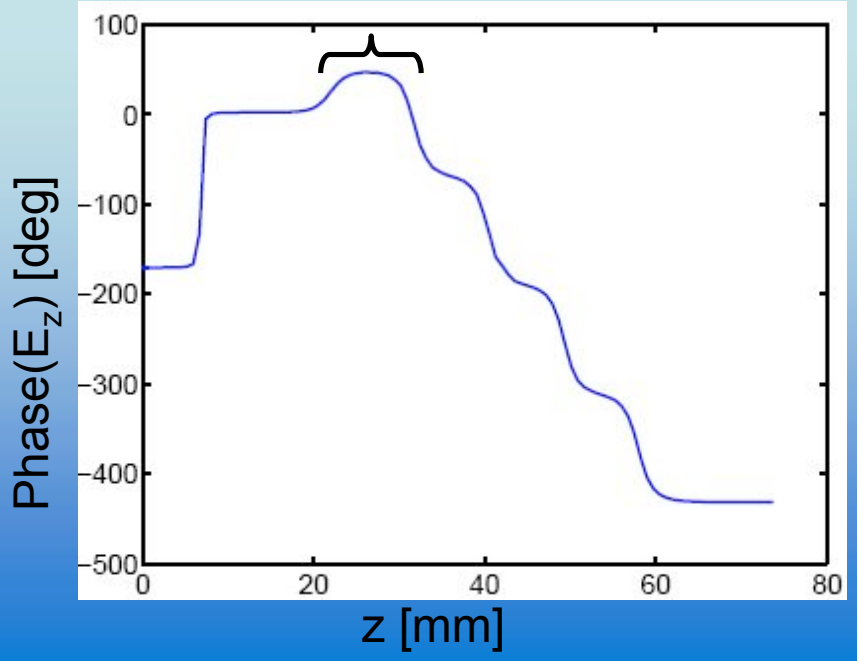




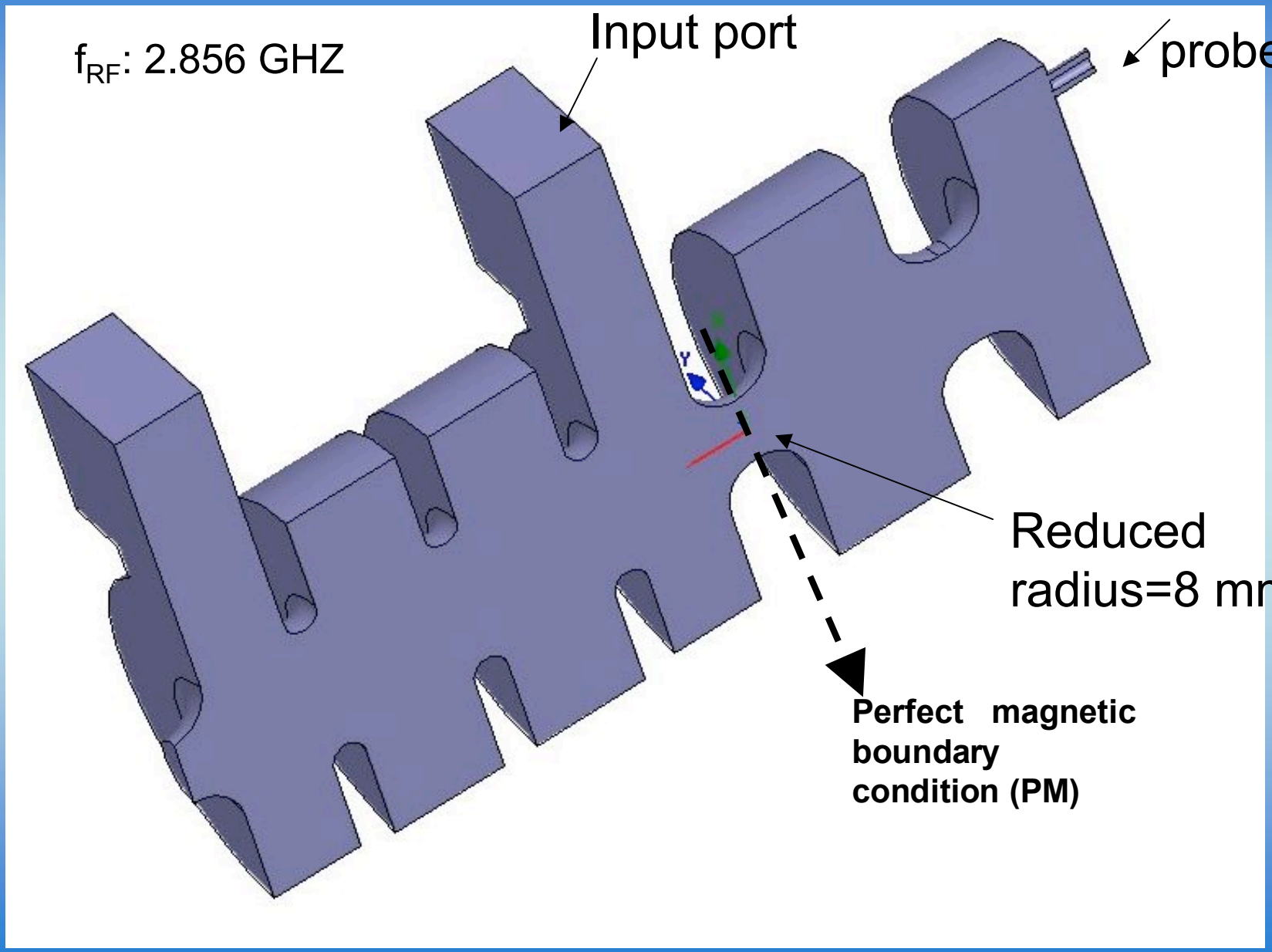
a) E.M. field profile



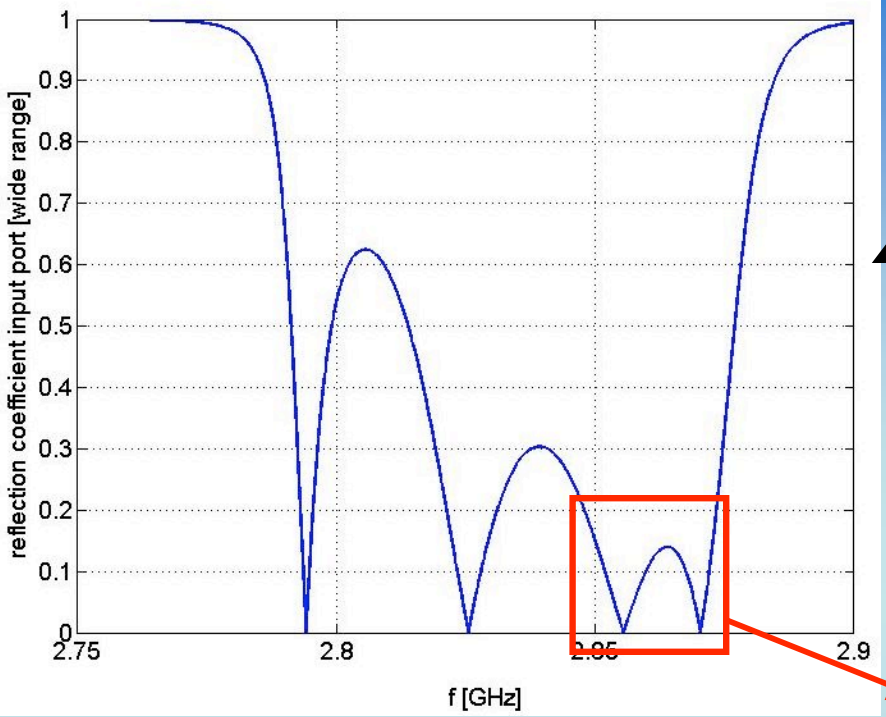
Input coupler



3) Electrom. design: *adiabatic coupling SW –TW, coupling iris increase(1/3)*

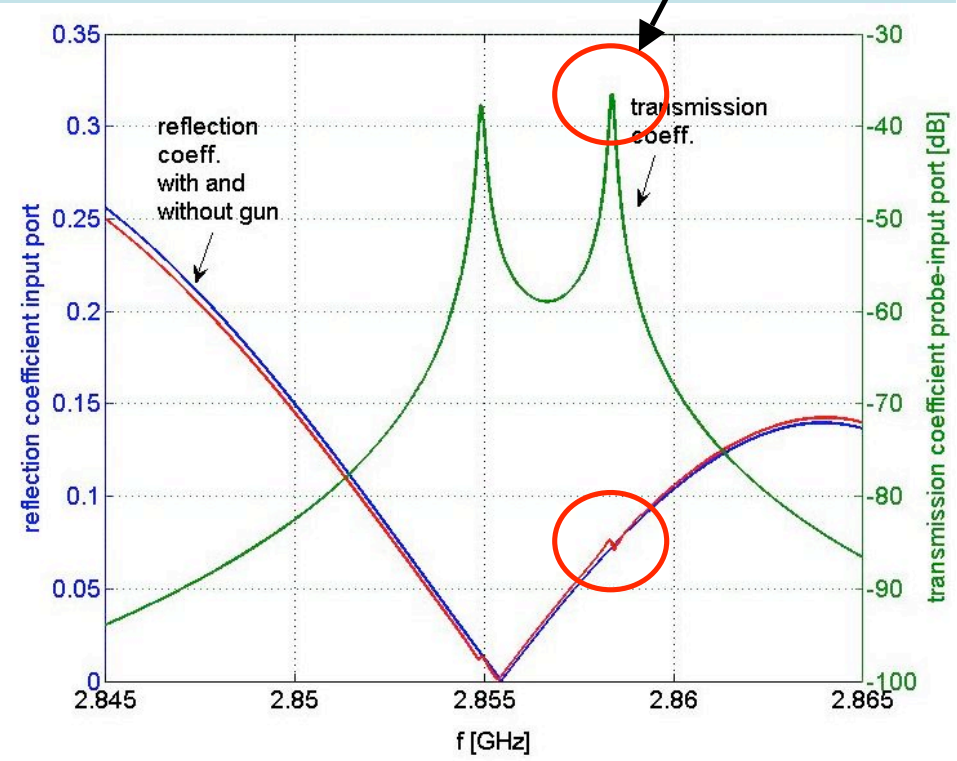


3) Electrom. design: *adiabatic coupling SW –TW, coupling iris increase(2/3)*



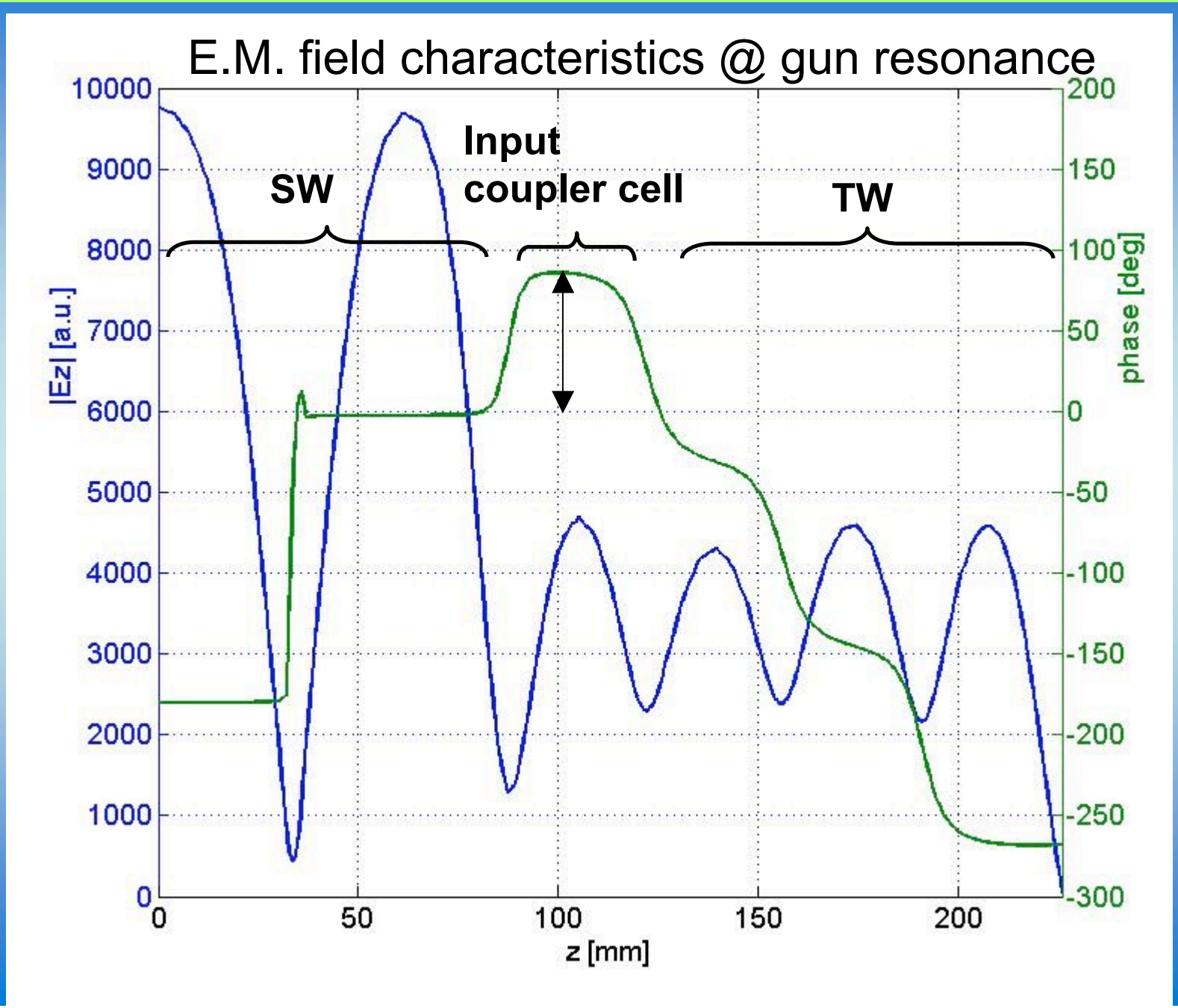
Without gun

π Mode of the gun



Compare with and without SW gun

3) Electrom. design: *adiabatic coupling SW –TW, coupling iris increase(3/3)*



CONCLUSIONS

1) Hybrid SW-TW gun is a ***very promising device*** from the point of view of compactness simplicity, efficiency and beam dynamics;

2) ***RF design is not trivial*** but feasible: different ways to tune the gun have been investigated.

TO BE DONE

1) ***Final structure dimensions have to be found*** to perfectly matched the TW to the SW cavity from the point of view of E_z phase

2) Understand ***transient RF response*** (as well as steady state)

3) Different ***modes of operation*** have to be investigated from the beam dynamics point of view (SW cavity slightly detuned, temperature tuning,…)

4) Possible ***RF measurements*** on the device have to be analyzed

5) Beam dynamics optimization.