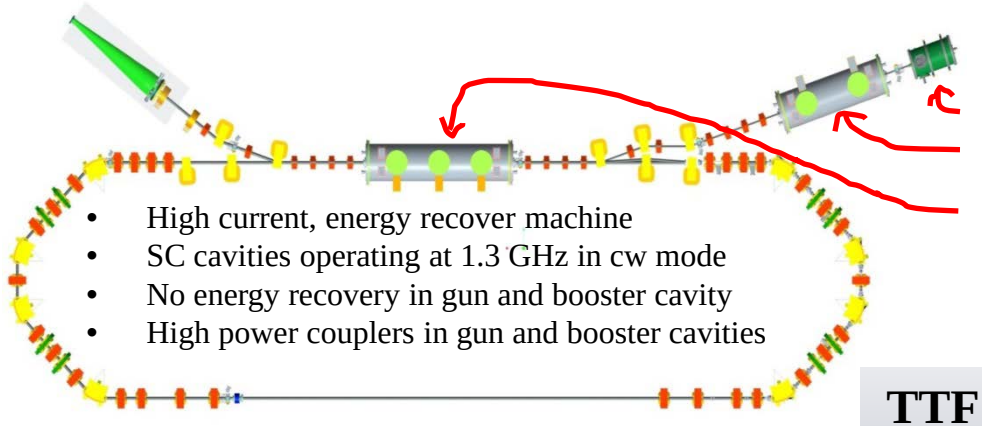
CW power couplers for B*ERL*inPro

Vasim Khan
25/03/2014

B*ERL*inPro power couplers

HZB Helmholtz Zentrum Berlin

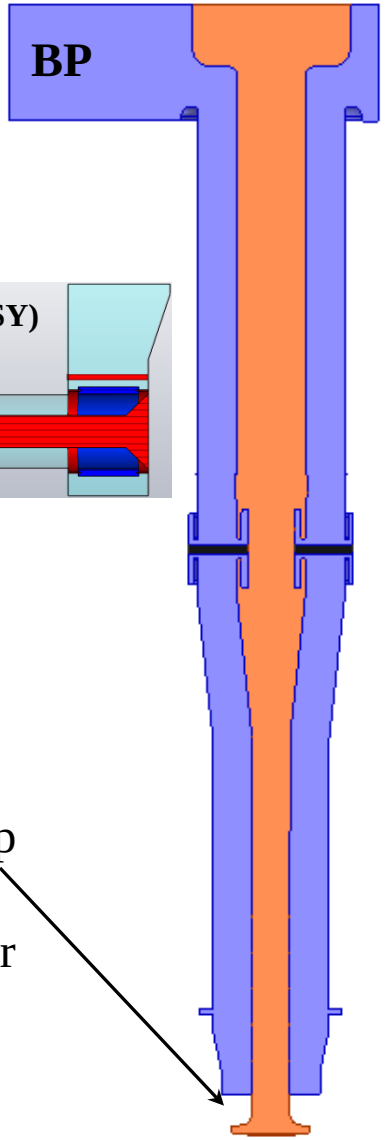


- High current, energy recover machine
- SC cavities operating at 1.3 GHz in cw mode
- No energy recovery in gun and booster cavity
- High power couplers in gun and booster cavities

B*ERL*inPro : power coupler requirement

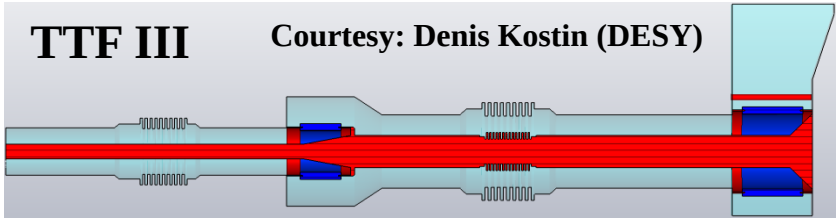
Gun* (s) (low and high power)
Booster cavity** (high power)
Main linac cavity (low power)

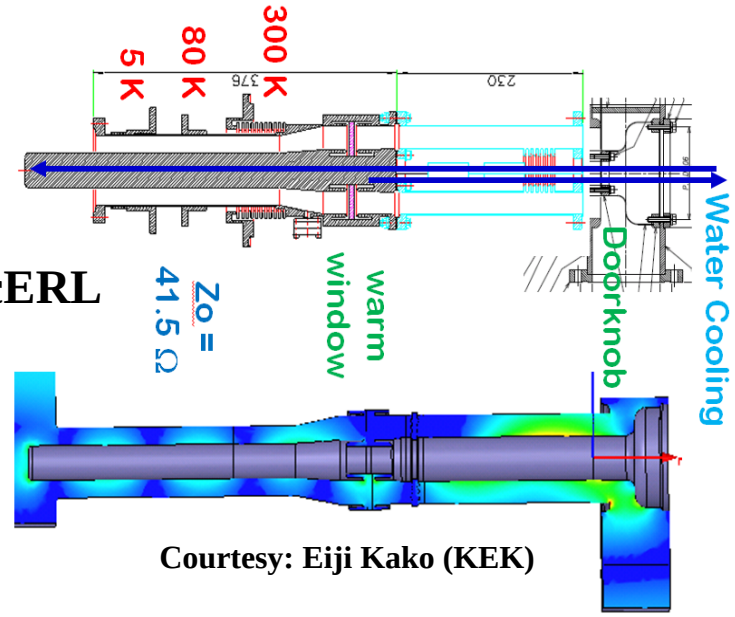
***Gun0: JLab+DESY**
***Booster cavity design: Cornell Uni.**



TTF III (~10 kW):

Modification: air cooling of inner condt
To be used for: Gun0, Gun1 and main linacs





Courtesy: Eiji Kako (KEK)

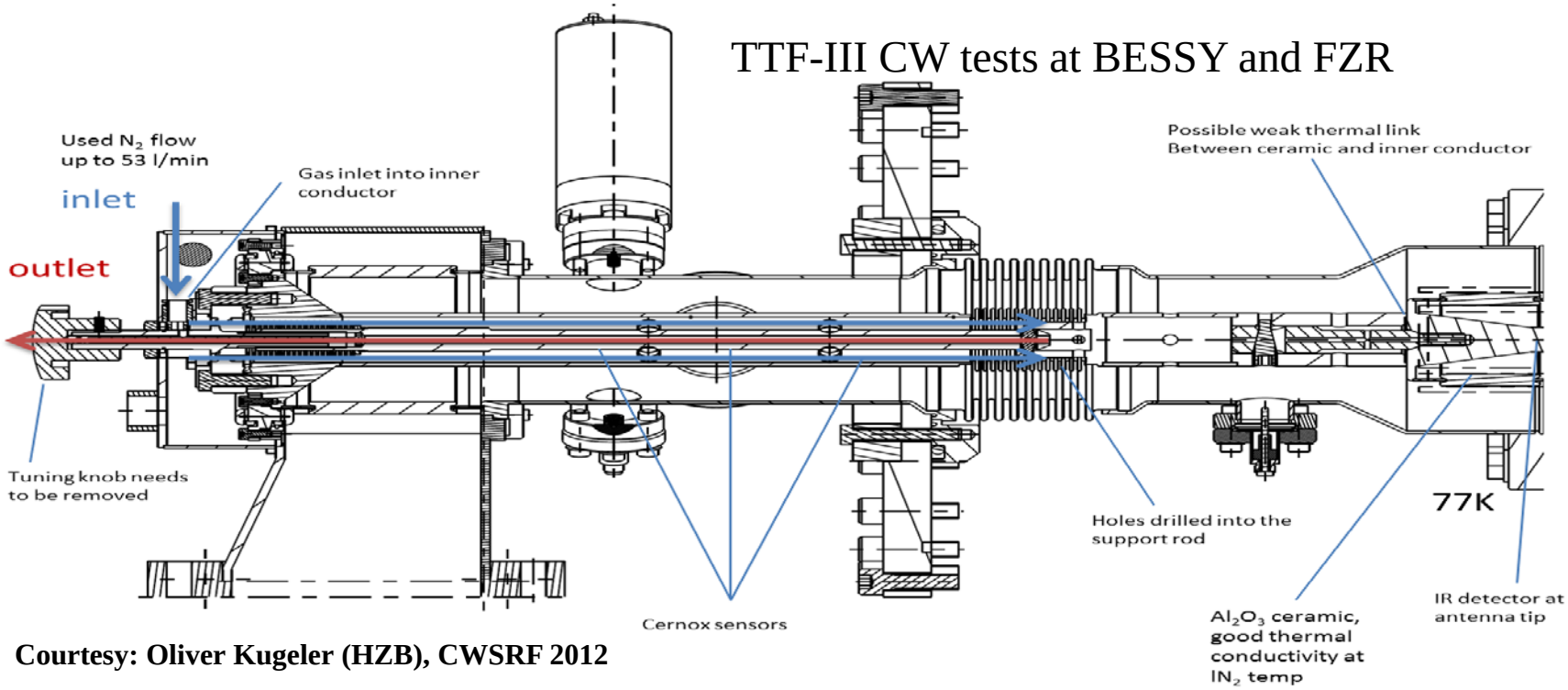
cERL (~130 kW):

High power coupler
Qext ~ 10^5 - 10^6

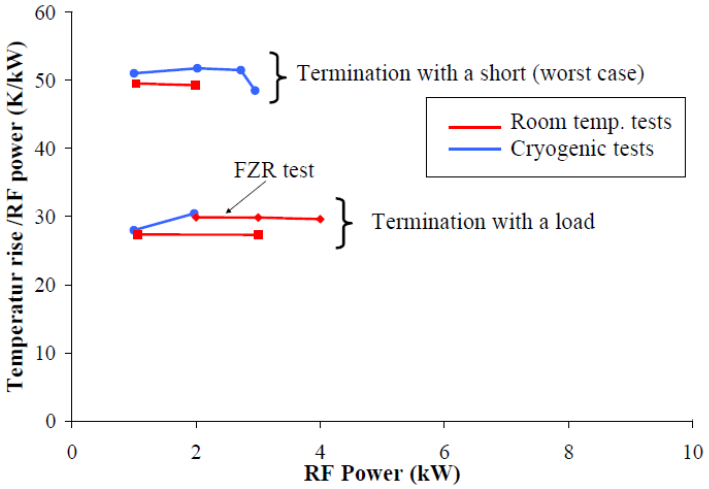
B*ERL*inPro couplers

BP: cERL + modified antenna tip
Qext ~ 10^5
To be used for: Gun2 and booster

Modifications in TTF III coupler

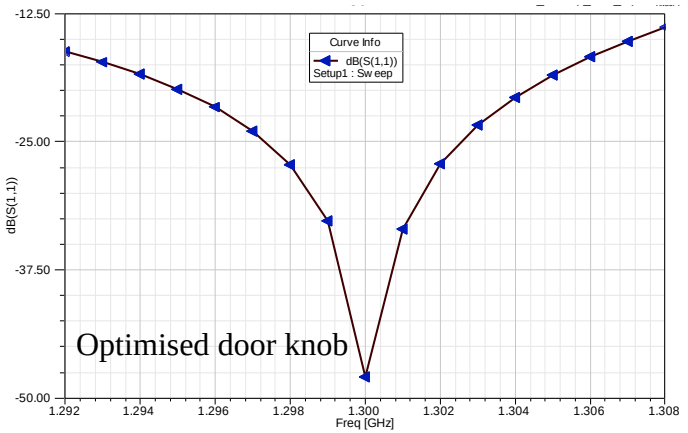


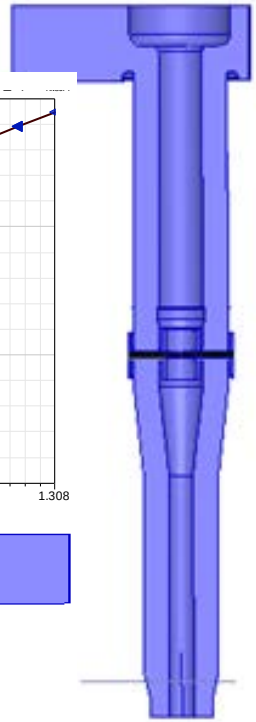
Courtesy: Oliver Kugeler (HZB), CWSRF 2012

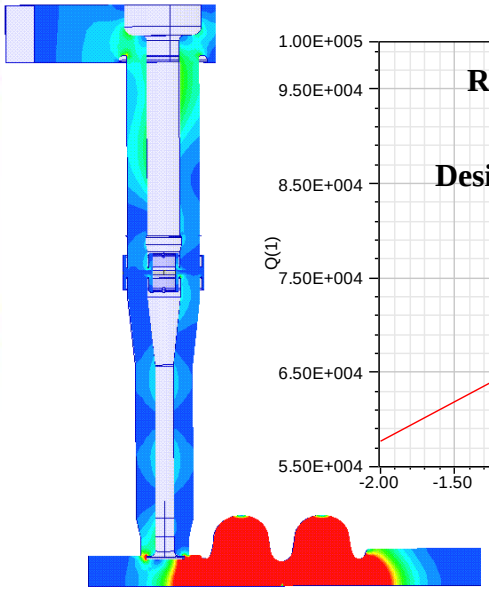


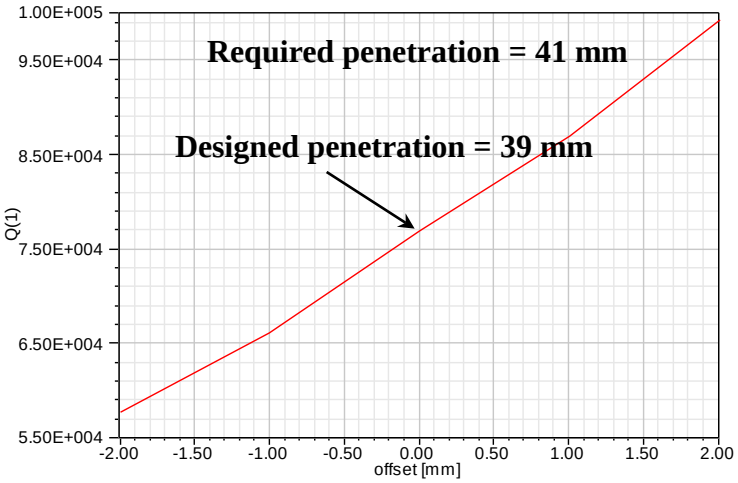
	Original TTF-III	**Air cooling of inner conductor**
Max. temp increase	50 K/kW	13.5 K/kW
Location of weakest spot	Inner conductor	Cold antenna

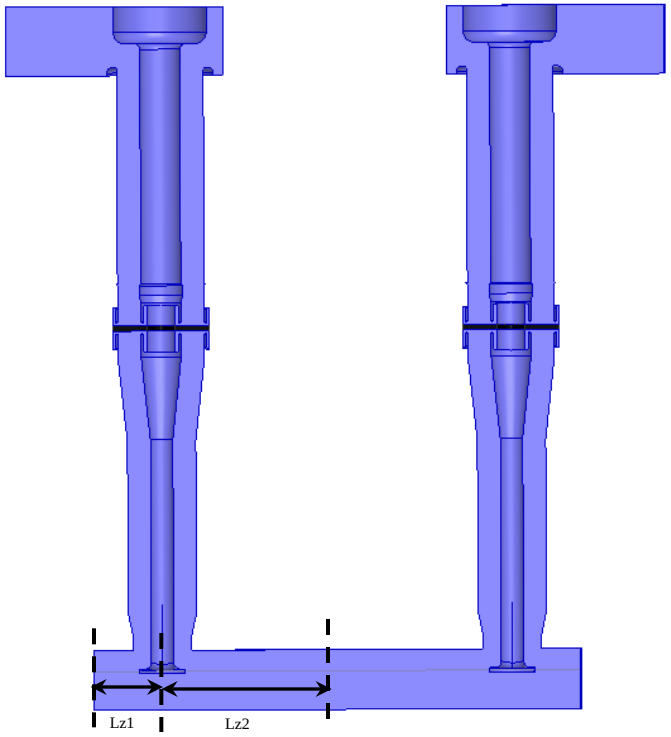
BP couplers: Q_{ext} & resonator box

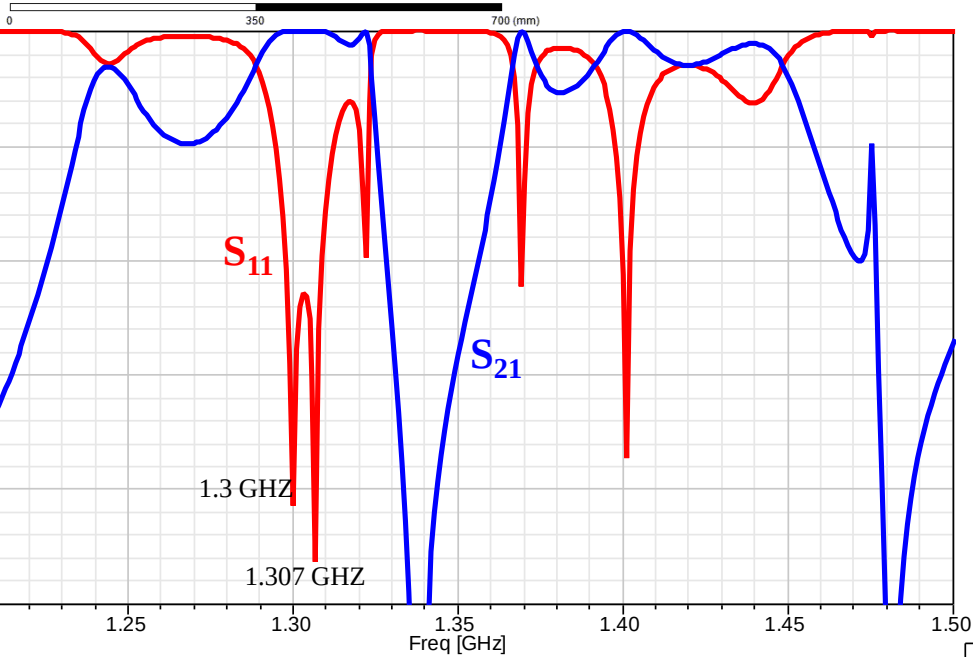




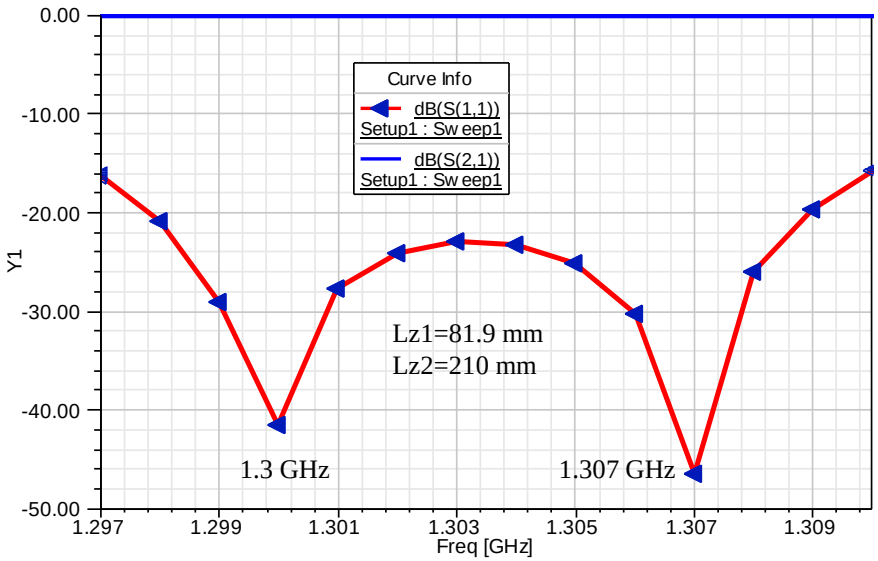


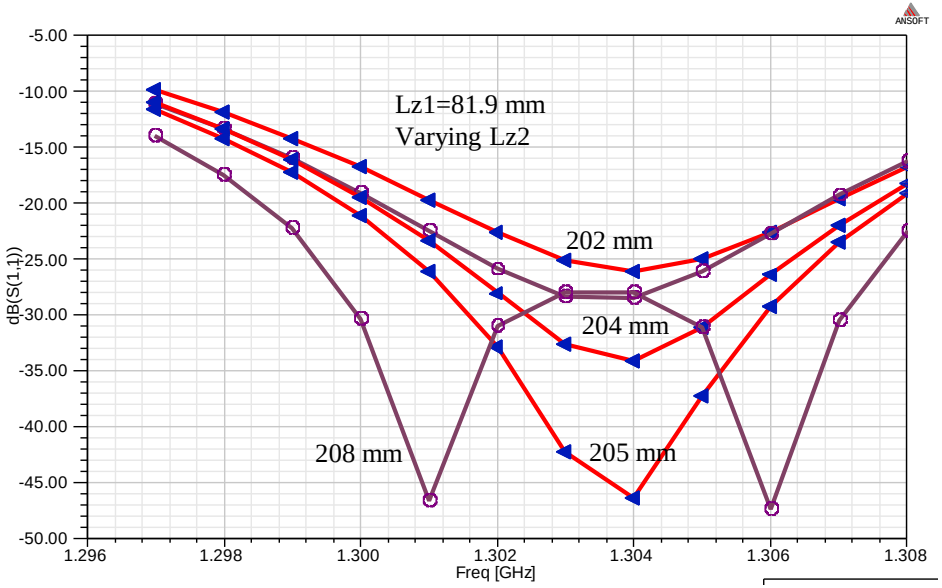


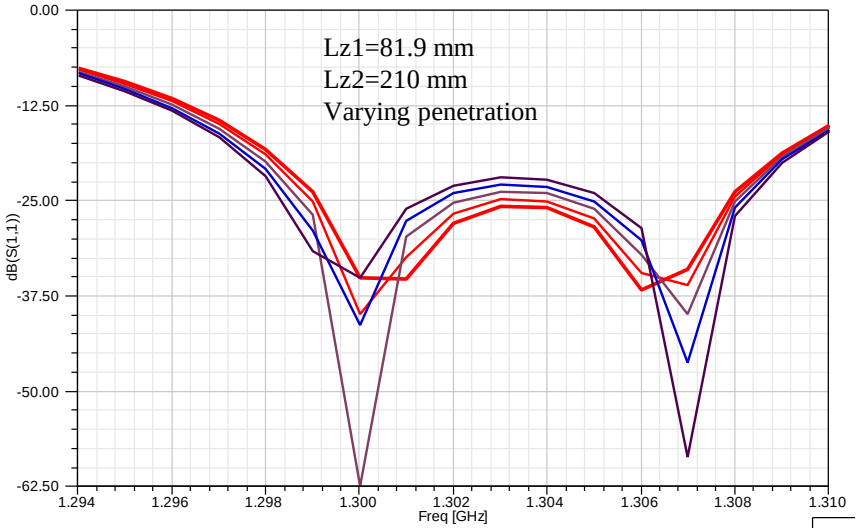




Resonator box: minimising reflection

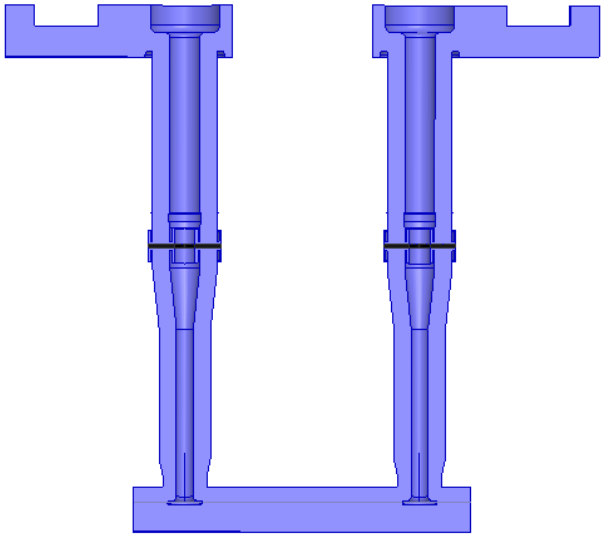


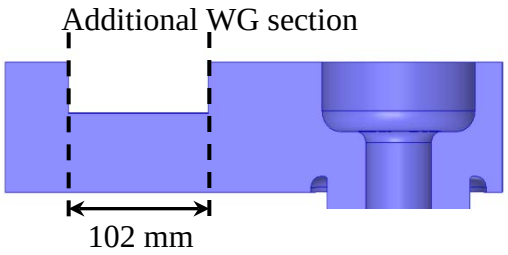


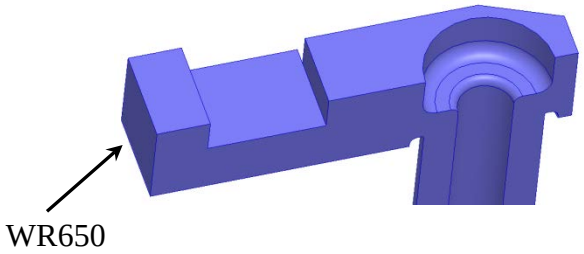


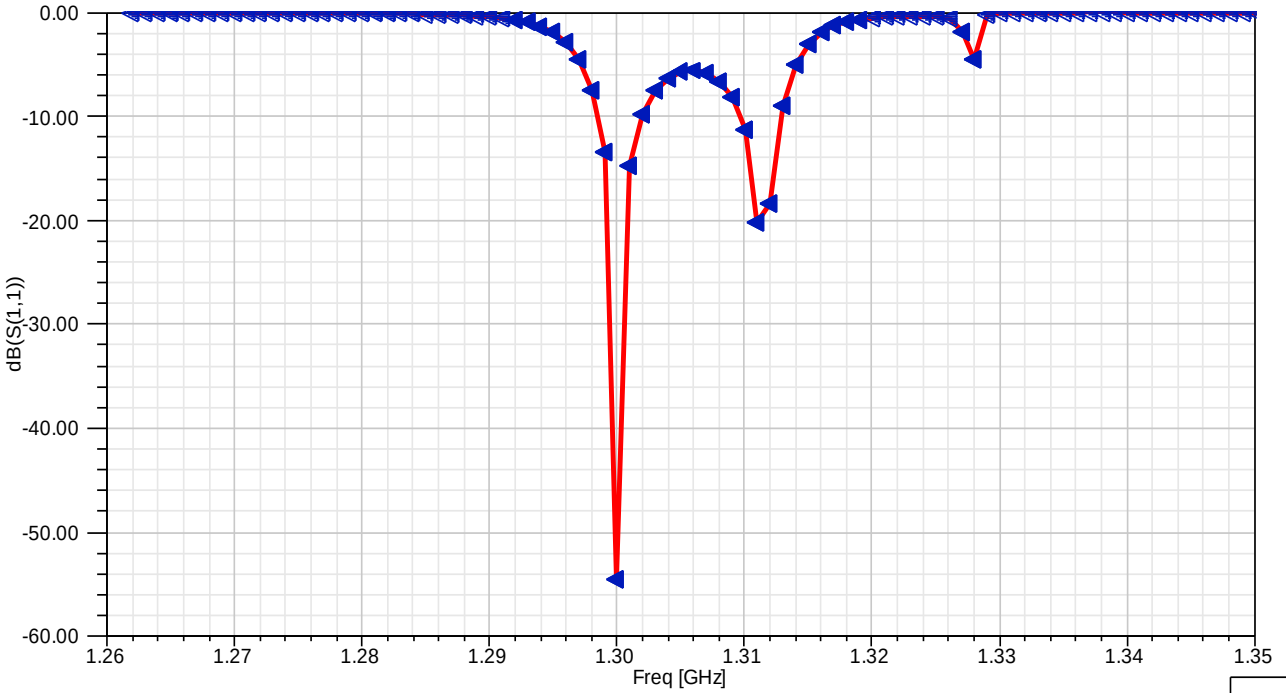
- Both modes have same field pattern
- Should there be only one mode?
- Is 1.307 GHz mode too close?
- Geometric change in the box moves the modes a little but not much
- Changing the box length merges the modes at 1.304!
- We don't want to change the doorknob geometry as it is to minimise reflection at 1.3 GHz
- Using lossy walls (Cu), doesn't change any thing
- Full geometry without symmetry planes: No change

Is it feasible?



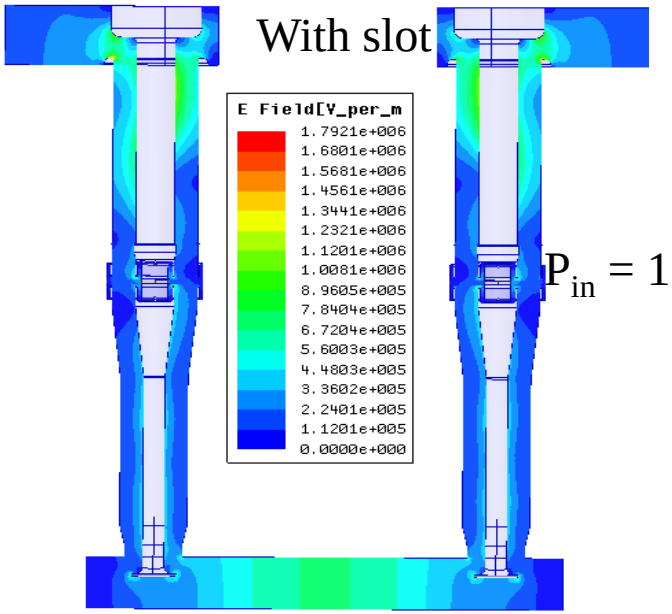




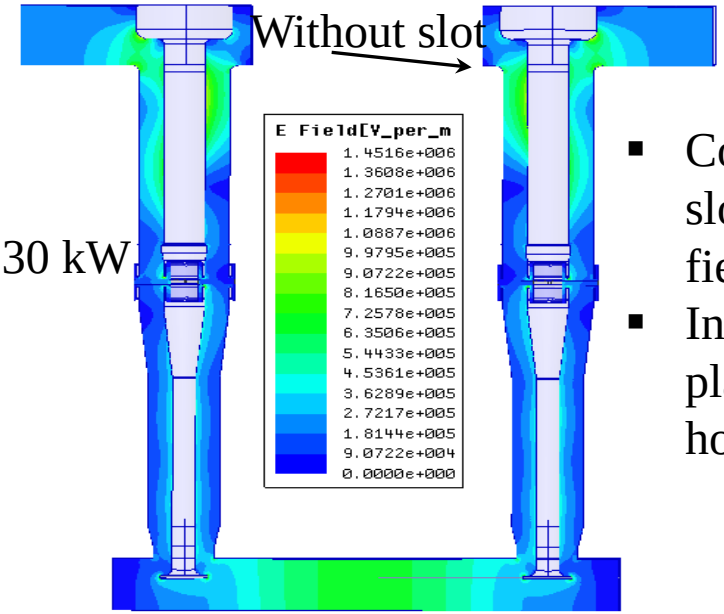


- Advantage:
  Separation of modes
- Disadvantage:
  Possible higher surface field

Surface E-field



P_{in} = 130 kW



- Could we remove these slots, to reduce the surface fields?
- In HoBiCaT (@ HZB) we plan to mount the coupelrs horizontally!

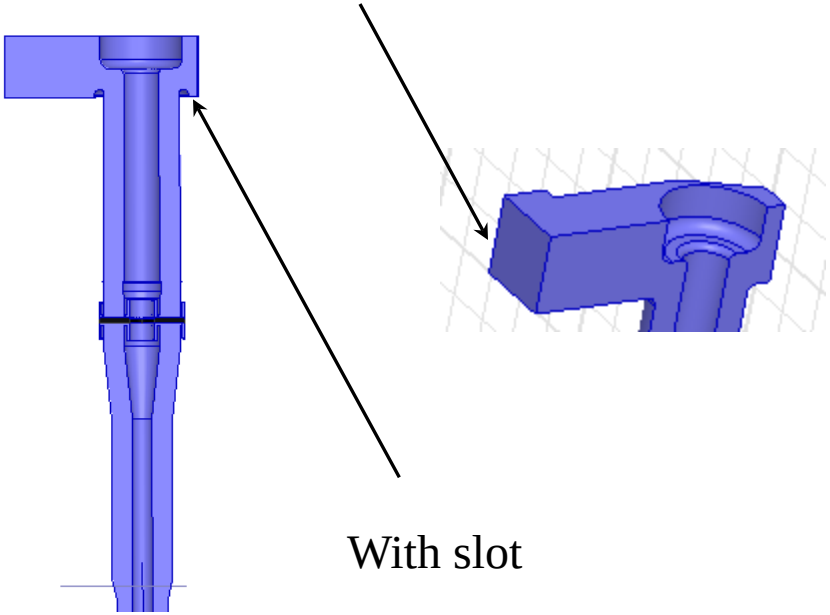
Acknowledgements

We would like to thank our colleagues from **HZB**, collaborators from **DESY**, **JLab**, **Cornell Uni** and **KEK** for fruitful discussions and encouragements.

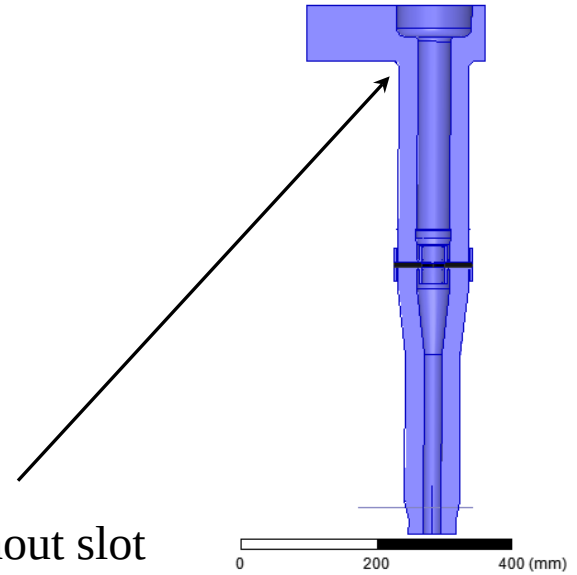
Thank you

Additional slides

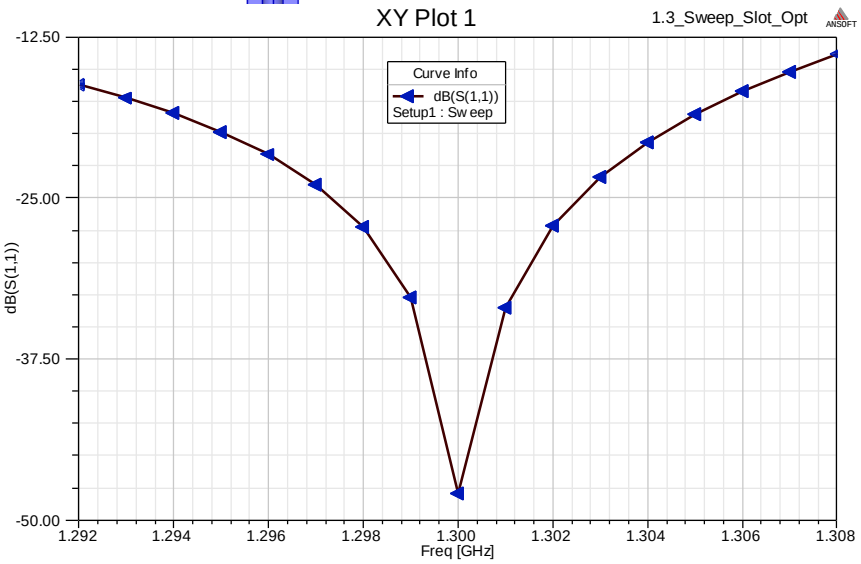
Standard WR650 WG section on the doorkn

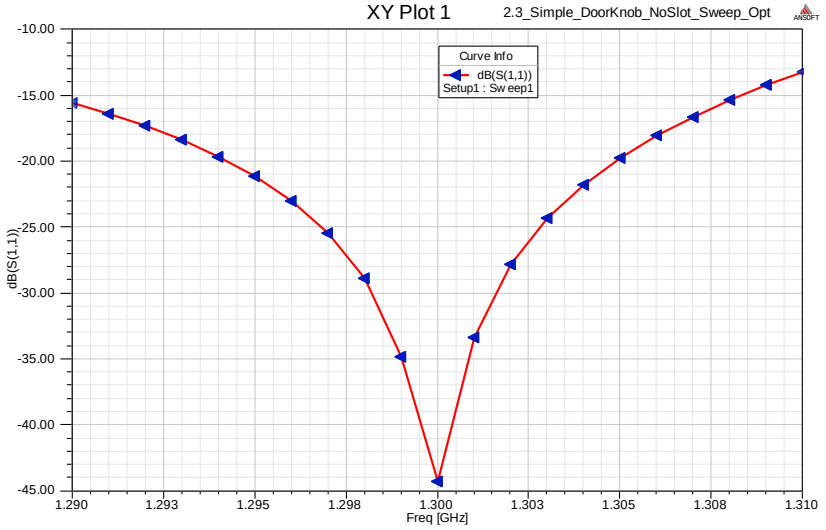


With slot



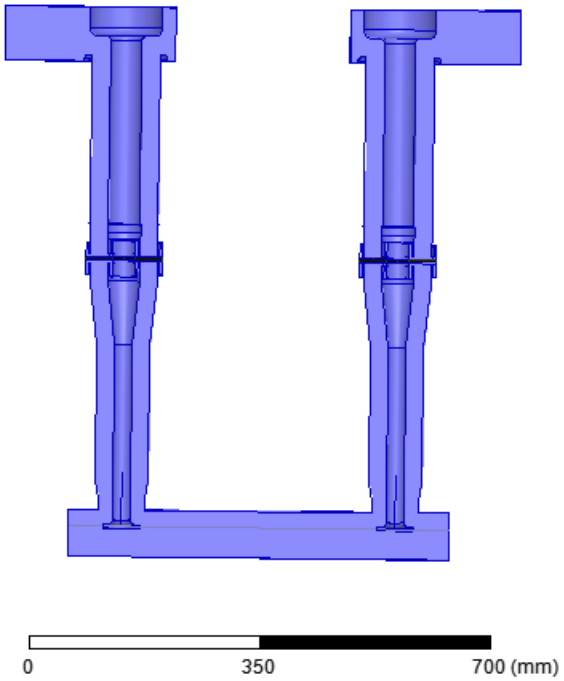
Without slot



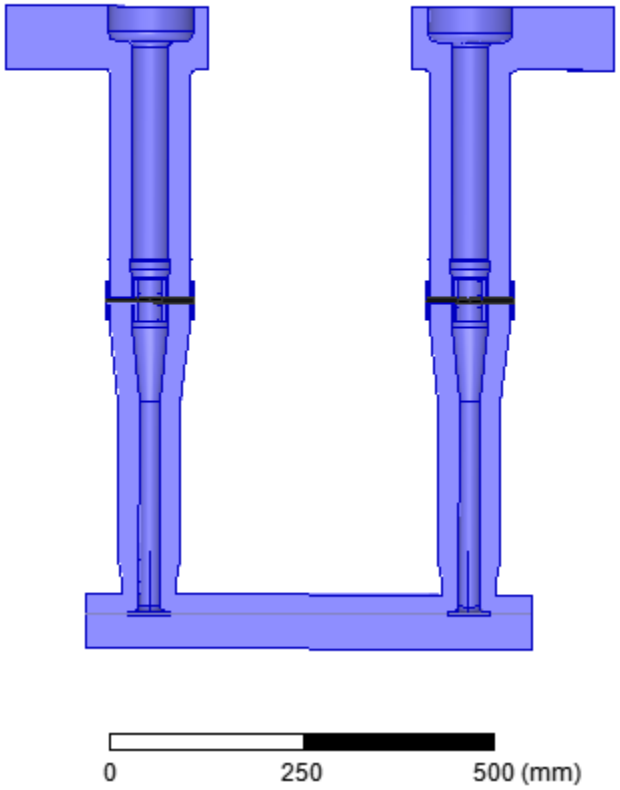


Resonator box for testing

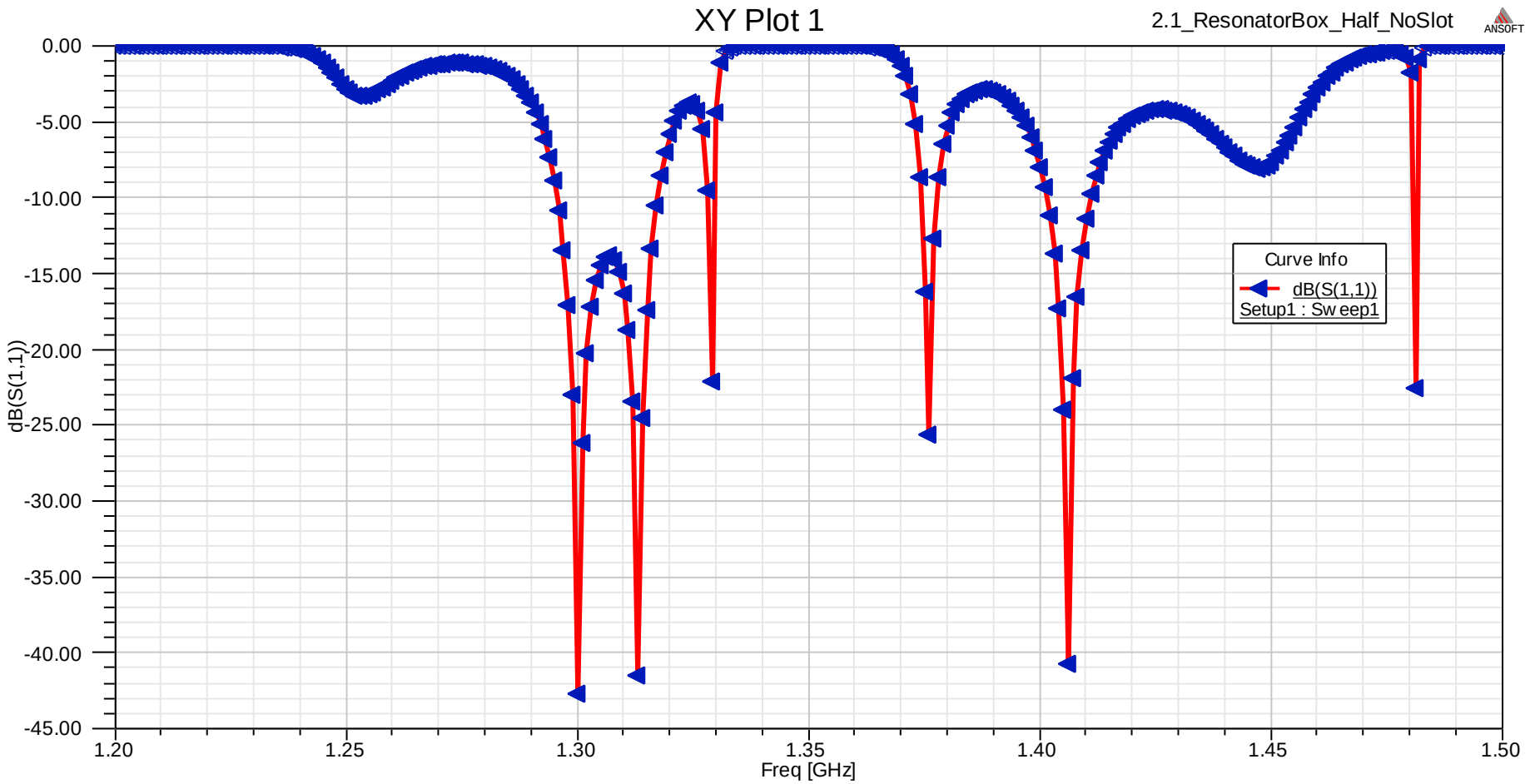
With slot



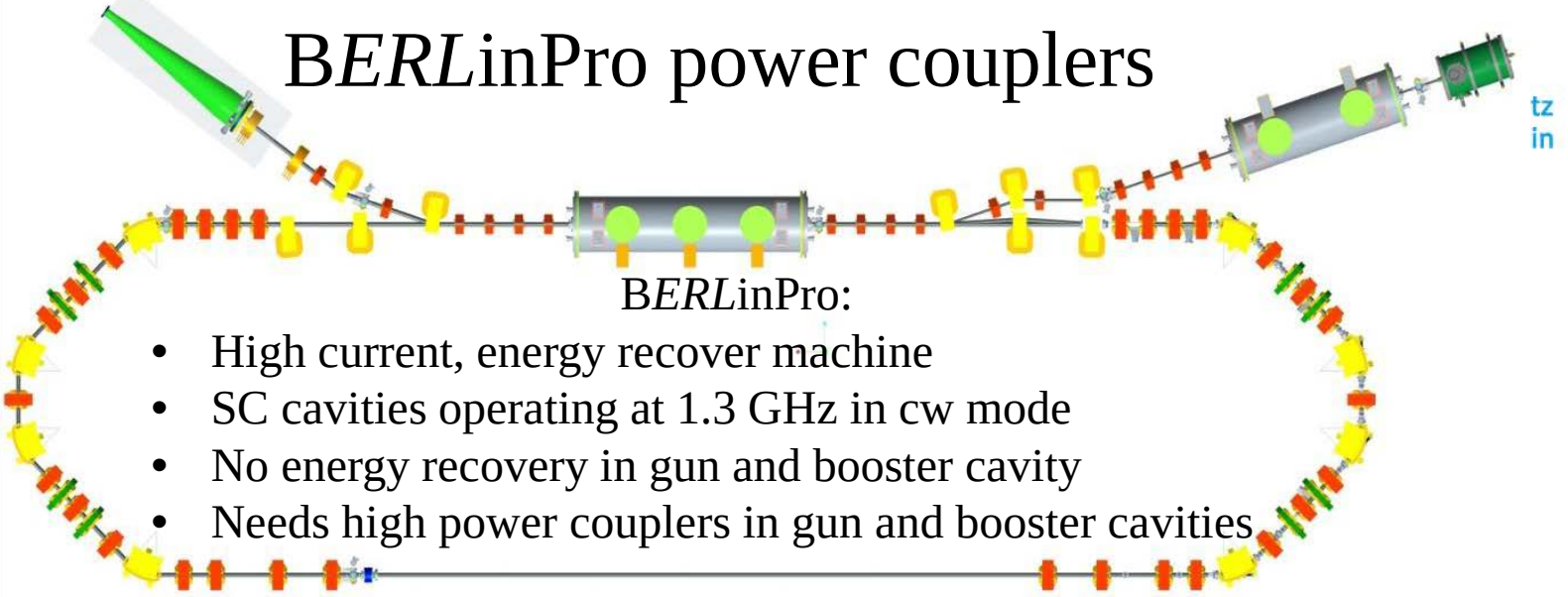
Without slot



Without slot

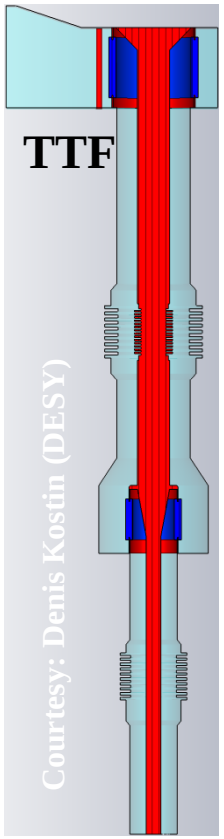


B*ERL*inPro power couplers



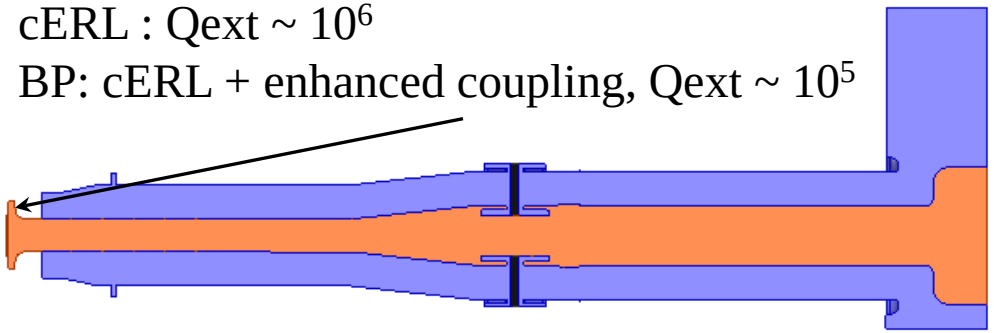
B*ERL*inPro:

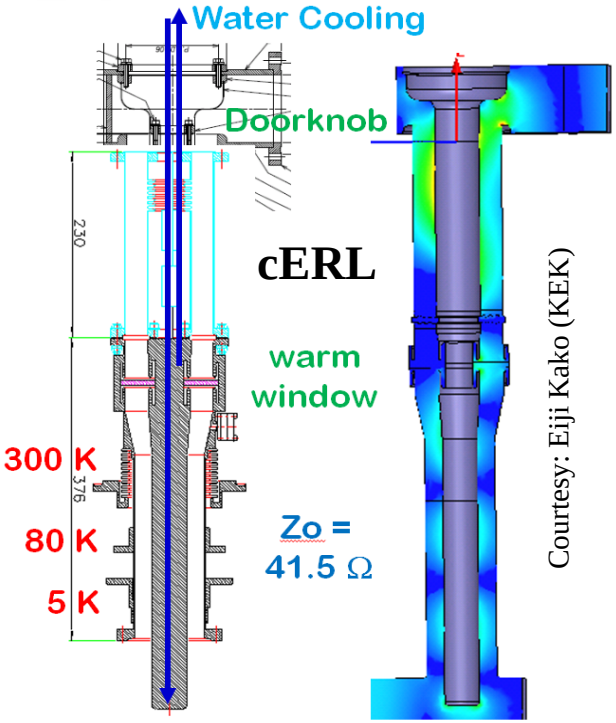
- High current, energy recover machine
- SC cavities operating at 1.3 GHz in cw mode
- No energy recovery in gun and booster cavity
- Needs high power couplers in gun and booster cavities



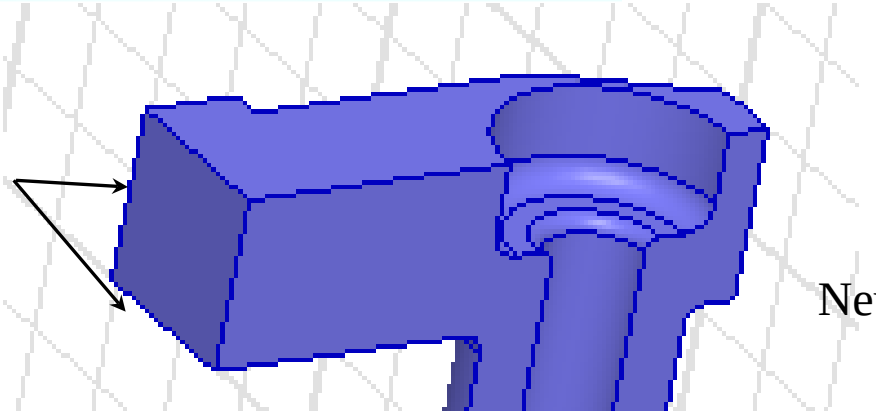
TTF (~10 kW): Gun0, Gun1 and main linacs
cERL/BP (~130 kW): Gun2 and booster

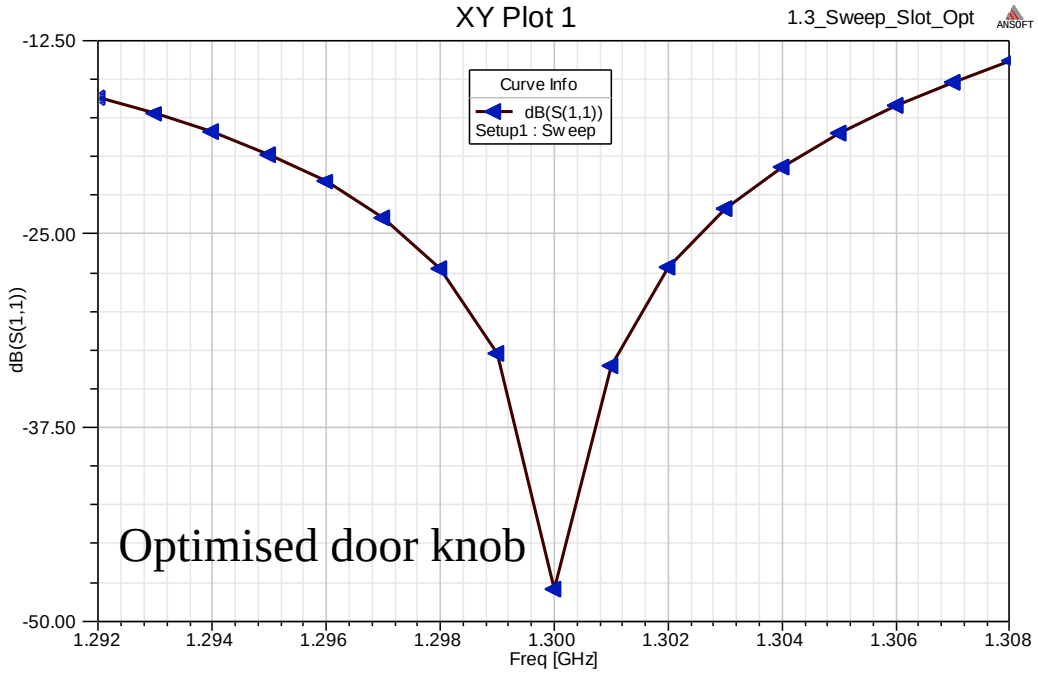
cERL : Qext ~ 10^6
BP: cERL + enhanced coupling, Qext ~ 10^5

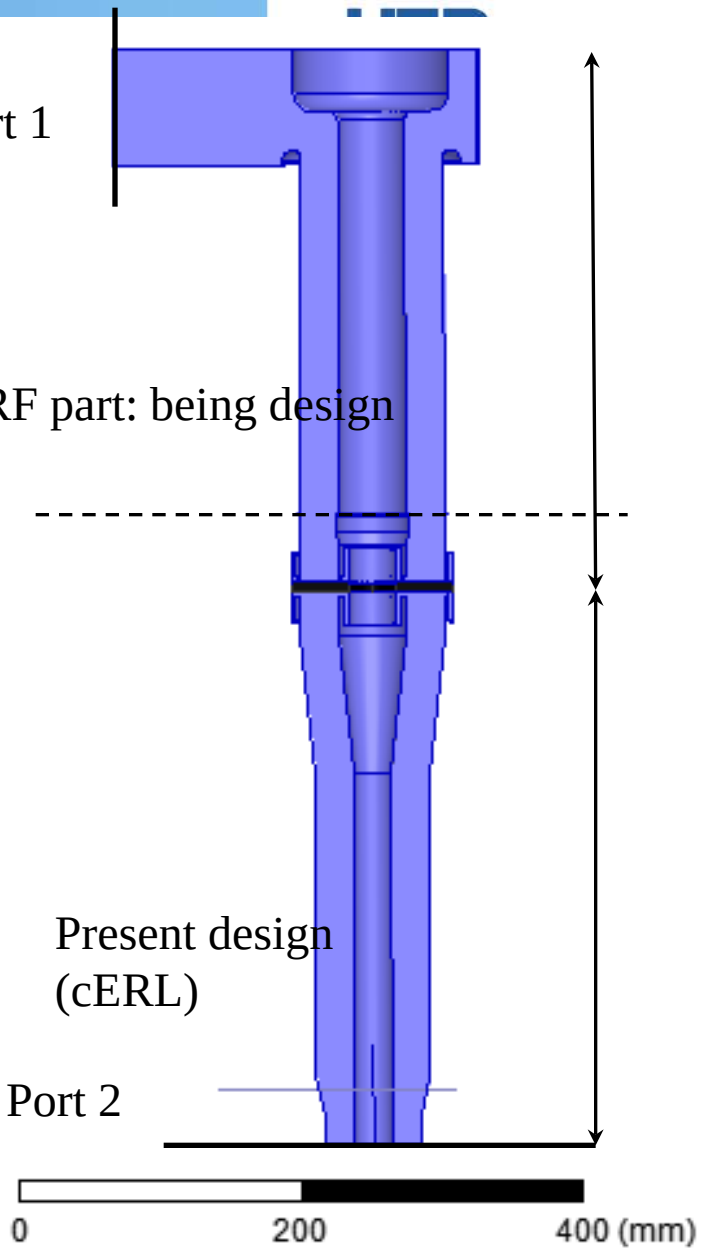




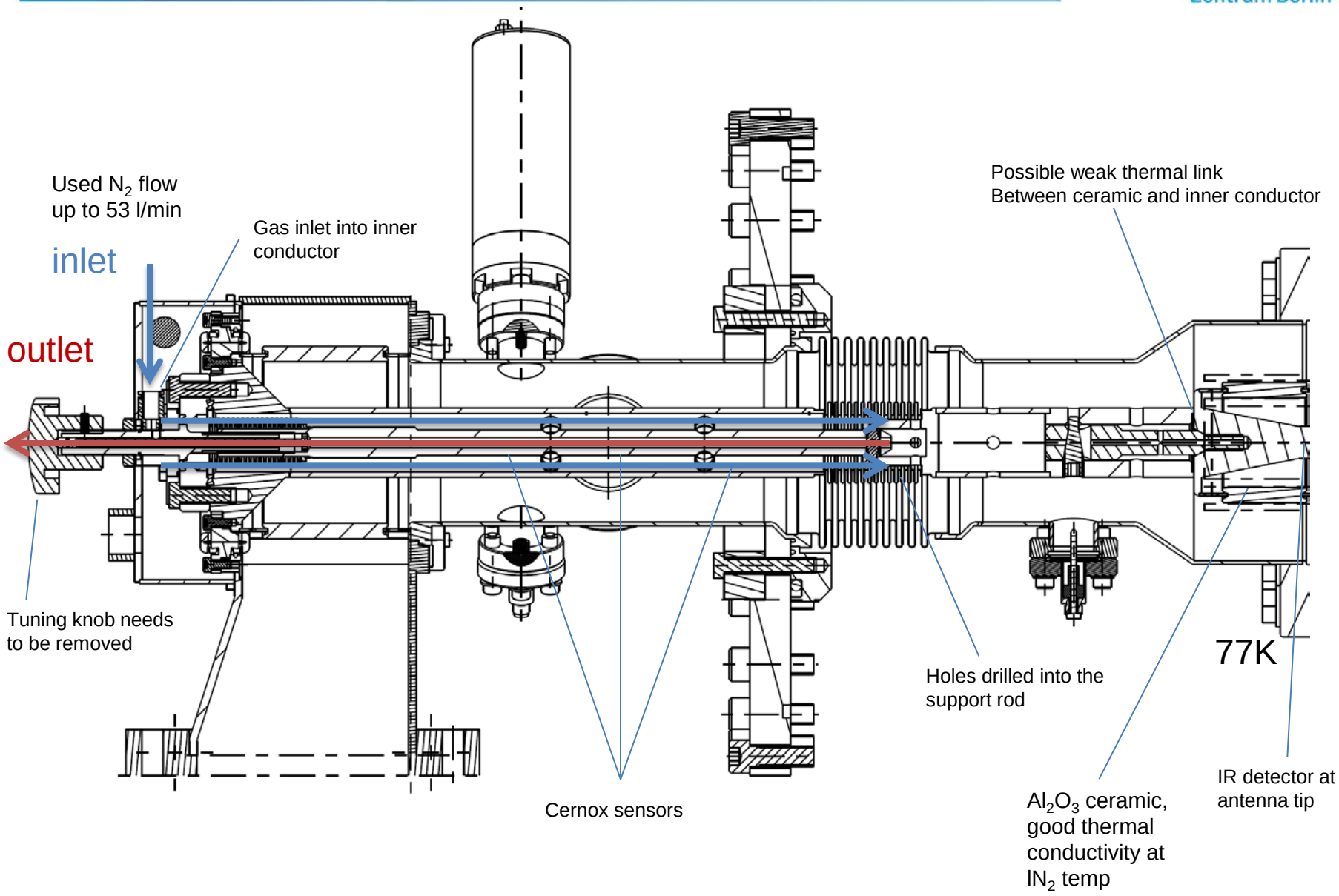
Modified cERL for BERLinPRo







Modifications to ttf-iii coupler



3 stages towards a B*ERL*inPro injector

HZB Helmholtz Zentrum Berlin

J. Knobloch, TTC Meeting 11-2012

	Stage 1 Gun0 (HoBiCaT)	Stage 2 Gun1	Stage 3 Gun2
Goal	Beam Demonstration (First beam April 2011)	High brightness R&D gun with NC cathode	High average current & brightness with NC cathode
Cathode material	**Pb (SC)**	**CsK_2Sb (NC)**	**CsK_2Sb (NC)**
Cathode QE_{max}	10^{-4} @258 nm*	10^{-2} @532 nm	10^{-2} @532 nm
Drive laser wavelength	**258 nm**	**532 nm**	**532 nm**
Drive laser pulse length and shape	2.5 ps fwhm Gauss	≤ 20 ps fwhm Gauss	≤ 20 ps fwhm Gauss
Repetition rate	8 kHz	54 MHz/25 Hz	1.3 GHz
Electric peak field in cavity (on cathode)	**20 MV/m***	**≤ 20…30 MV/m**	**≤ 20…30 MV/m**
Operation launch field on cathode	5 MV/m*	≥ 10 MV/m	≥ 10 MV/m
Electron exit energy	1.8 MeV*	≥ 1.8 MeV	≥ 1.8 MeV
Bunch charge	**6 pC***	**77 pC**	**77 pC**
Electron pulse length	2…4 ps rms*o	≤ 6 ps rms	≤ 6 ps rms
Average current	**50 nA***	**4 mA/40 µA**	**100 mA**
Normalized emittance	2 mm mrad* (proj.)	1 mm mrad (proj.) and 0.5 mm mrad (sliced)	

*Preliminary data / results,
o value represents emission time

T. Kamps *et al*, Proc. IPAC 2011, PRST-AB (in preparation)
A. Neumann *et al.*, Proc. IPAC 2011, PRST-AB (in preparation)
R. Barday *et al.*, Proc. of PSTP 2011
J. Völker, *et al.*, Proc of IPAC 2012
S. Schubert, *et al.*, Proc of IPAC 2012