



High power RF components developed at CERN

I. Syratchev, CERN



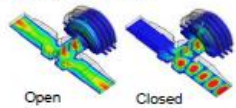
General purpose X-band High RF power components developed within CLIC collaboration.

S. Atieh, D. Gudkov, S. Lebet, R. Leuxe, A. Olyunin, G. Riddone, A. Samoshkin, V. Soldatov, A. Solodko, I. Syratcev (CERN), F. Peauger (CEA)

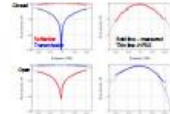


To operate the future high RF power test stands at CERN and potentially in the other Labs, a big number of specialised waveguide RF components will be needed. We have launched the dedicated campaign to develop compact (broadband), simple in RF design (inexpensive) components. The "shopping" list of such devices is presented.

Variable RF reflector



Open Closed



Two prototypes have been fabricated. Tested in TBT5 up to 150 MW x 200 ns.

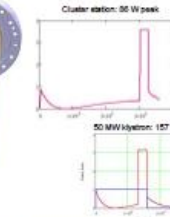
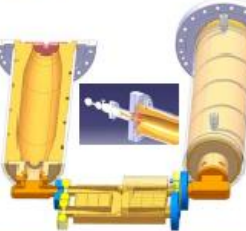


SLED RF pulse compressor

Q_L : 180000 at 12 GHz. Cavity length: 444mm



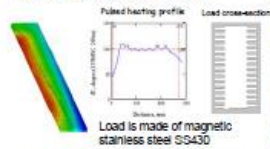
The frequency tuning will be done with re-machining of the pistons faces. Final tuning with cooling water temperature regulation. Cavities equipped with detuning pistons



Two cavities are in production. The first PC prototype to be ready in July 2012.



Broadband dry RF load



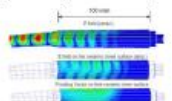
Load is made of magnetic stainless steel S3430



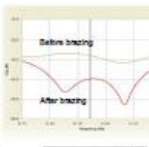
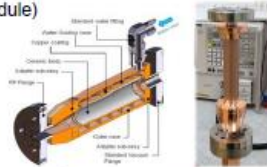
About 50 loads have been fabricated. The loads were tested up to 60MWx400ns (KEK) and 25MWx1600ns (SLAC). Currently loads are in operation at CERN, SLAC, KEK, PSI and Trieste.



Compact dry RF load (CLIC module)



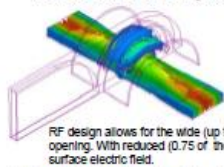
RF power is absorbed in a SiC thin wall cylinder. At 15 MW, E field on ceramic surface < 7MV/m.



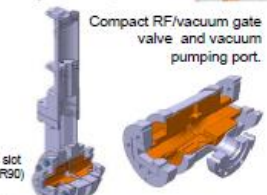
The first low power prototype showed good RF performance (reflection < -40 dB). The SiC to copper bonding technology development (electro-galvanic and brazing) is in progress. The first full high RF power prototype to be ready early 2013. The load is expected to operate at a medium (<20 MW) peak RF power level.



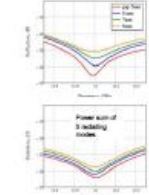
Doubled-choke WG joint



RF design allows for the wide (up to 0.32λ) slot opening. With reduced (0.75 of those in WR90) surface electric field.



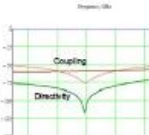
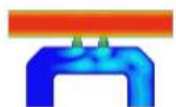
Compact RF/vacuum gate valve and vacuum pumping port.



The fabrication of medium series (20-30 units of each type) have been launched. The first prototypes to be ready in autumn 2012.



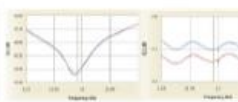
"Simple" -60 dB directional coupler



About 20 splitters have been fabricated. The splitters were tested up to 150MWx250ns (SLAC) and 200MWx200ns (CERN).



3 dB H-plane splitter



During last HG2012 workshop, we have presented our program of development of the new general purpose RF components.



In progress



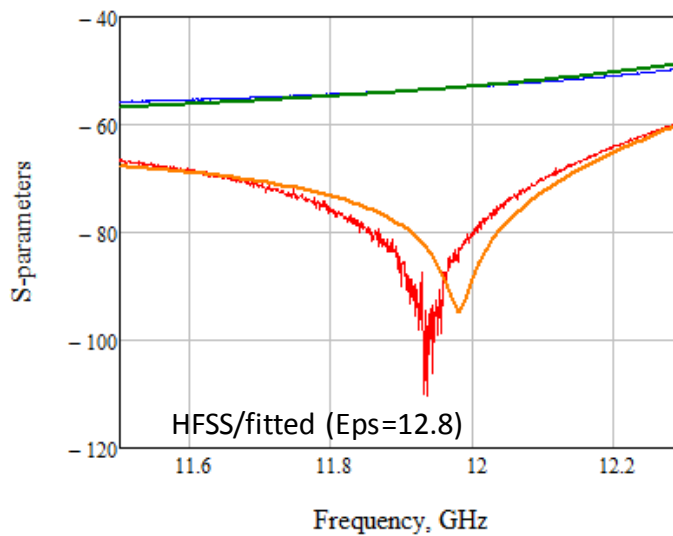
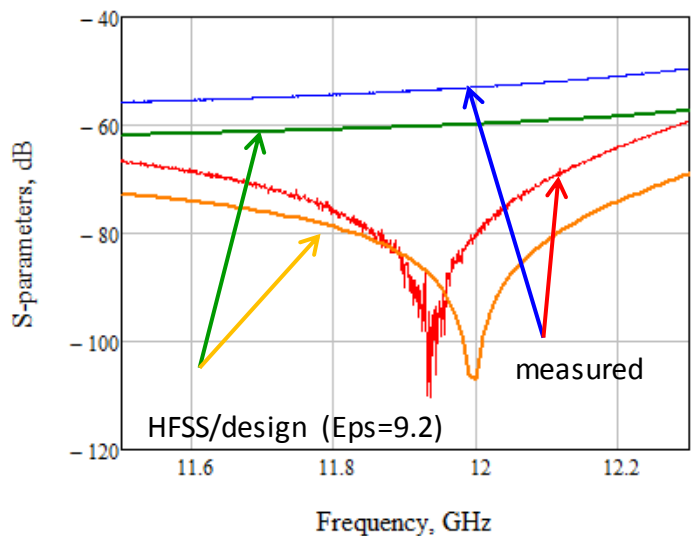
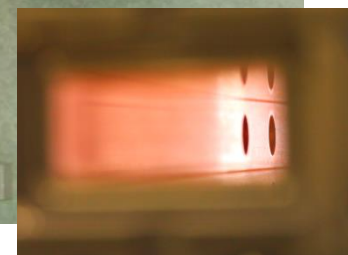
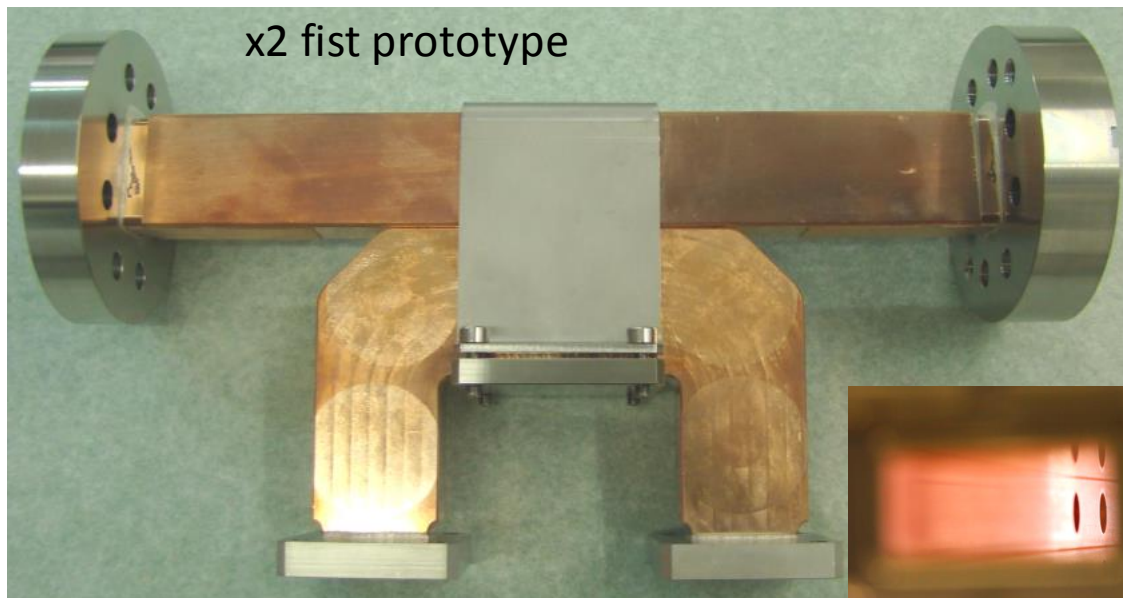
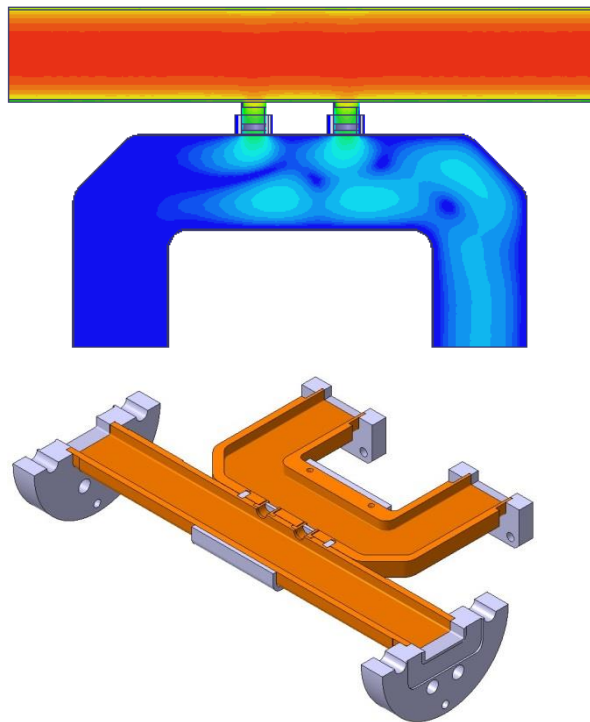
High RF power tested



Prototypes received



'Simple' -60 dB directional coupler

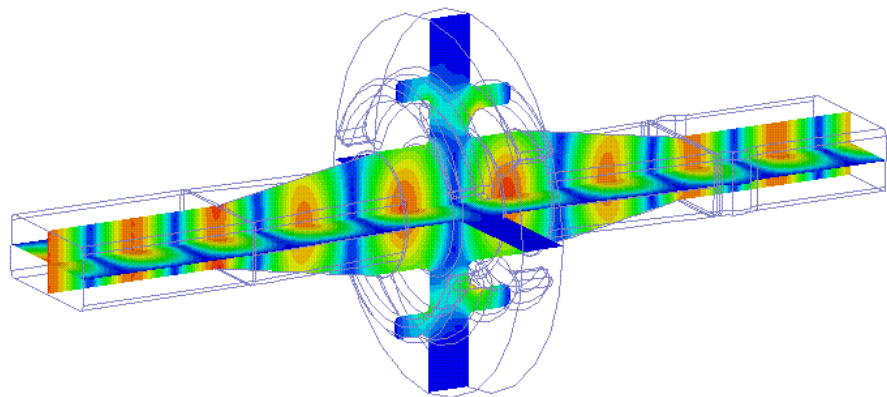


For the next generation, RF design was slightly modified, to bring coupling from -53dB down to -60 dB

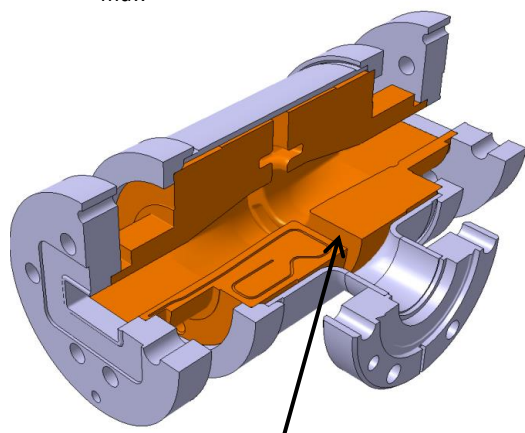
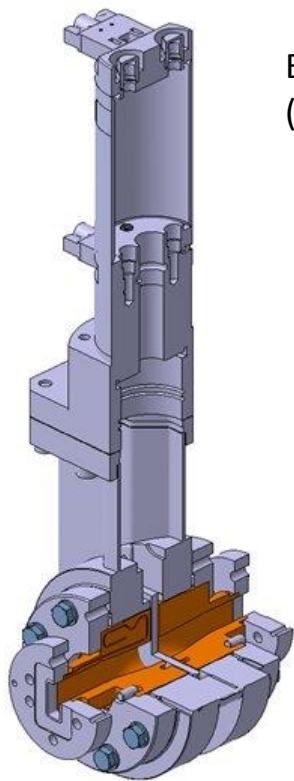


Compact RF/vacuum gate valve and vacuum pumping port

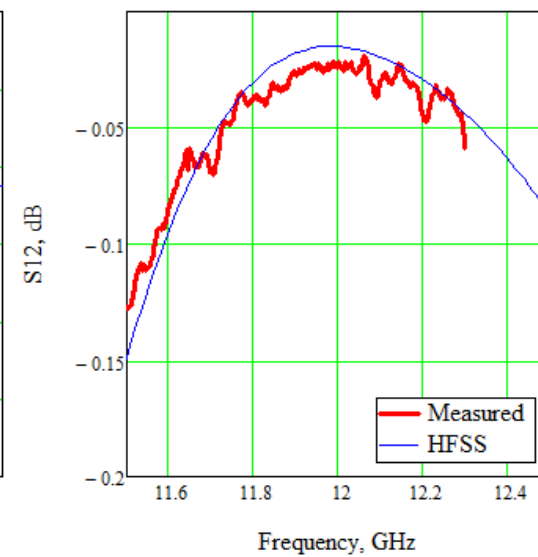
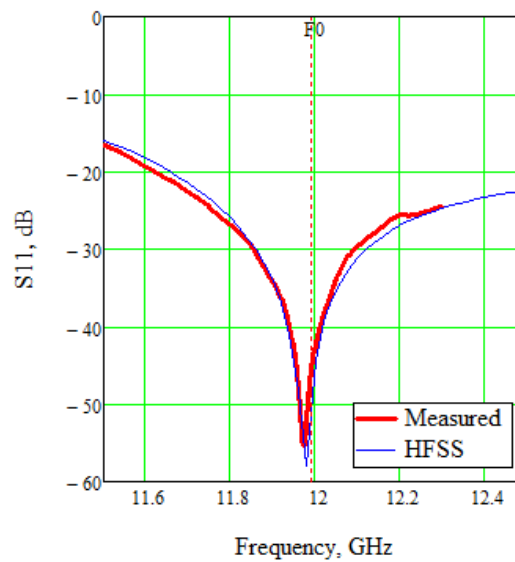
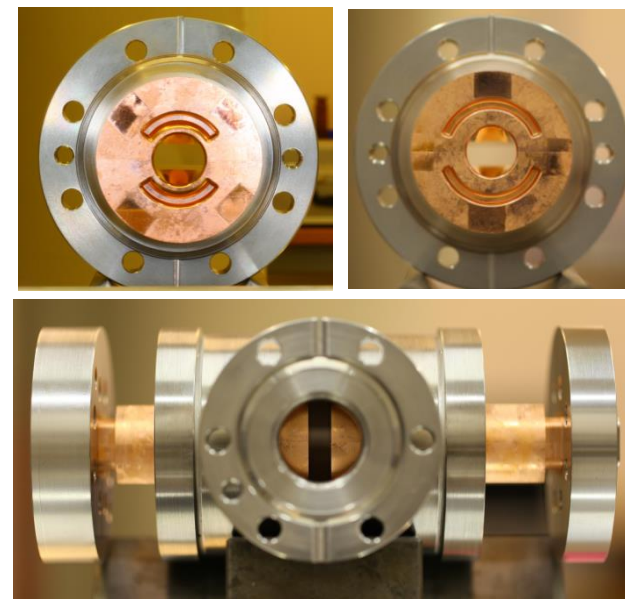
Doubled-choke WG joint



$$E_{\text{choke}/\text{max}} (100 \text{ MW}) = 23.7 \text{ MV/m} \\ (0.75 \times E_{\text{max}} \text{ in WR90})$$



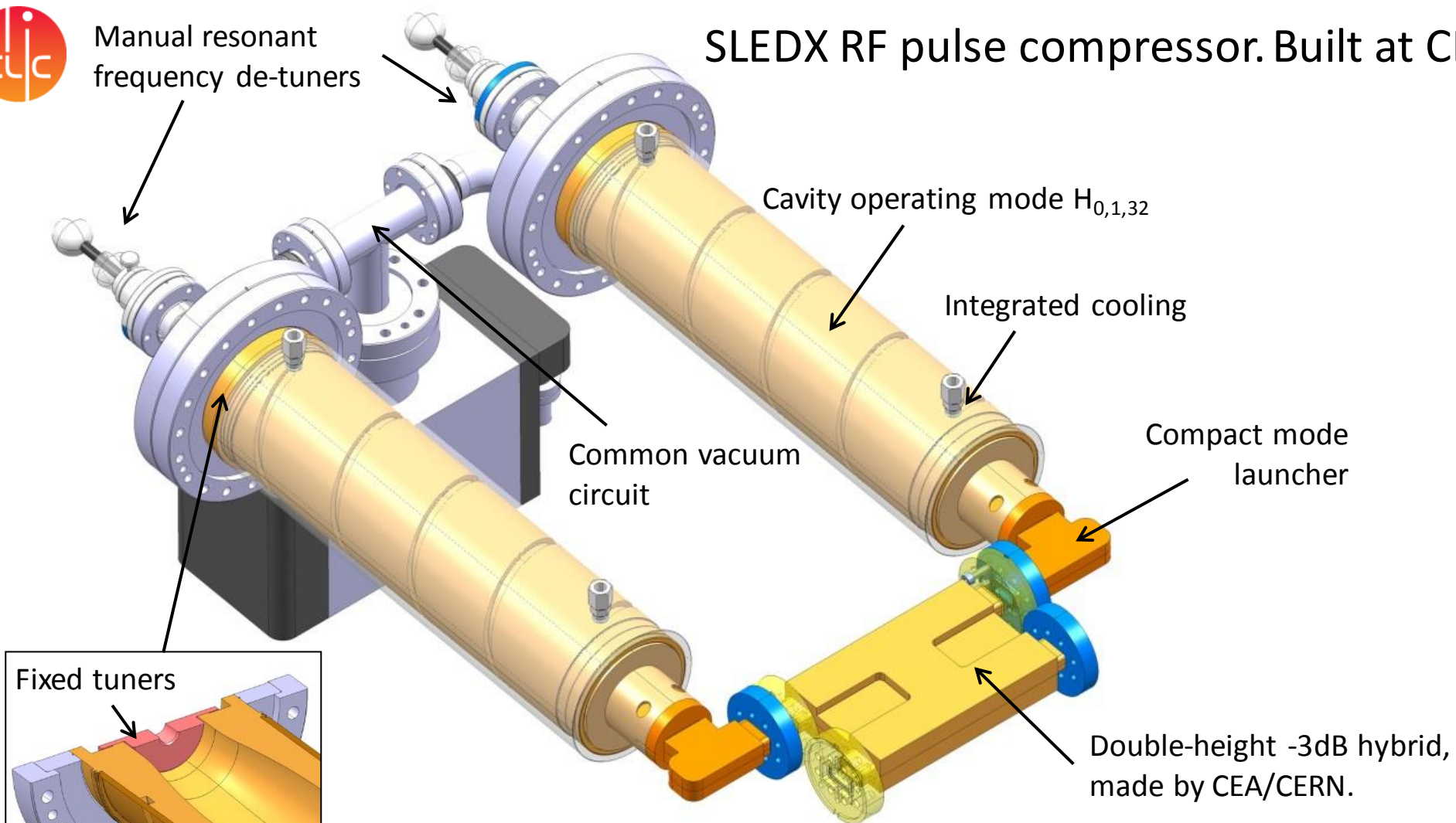
Slot width: 7mm





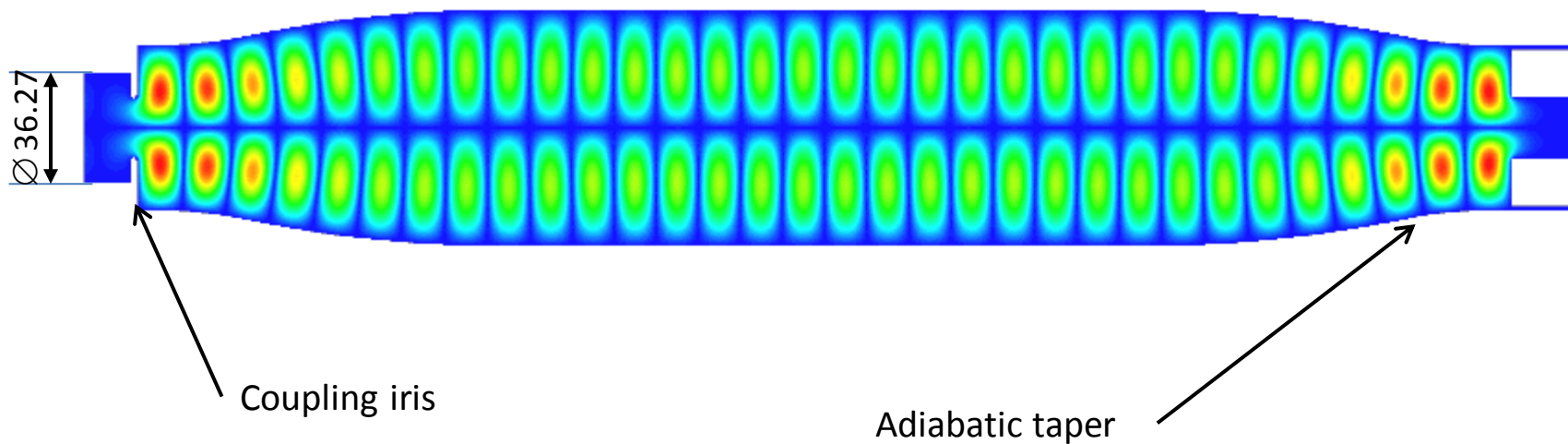
Manual resonant frequency de-tuners

SLEDX RF pulse compressor. Built at CERN.

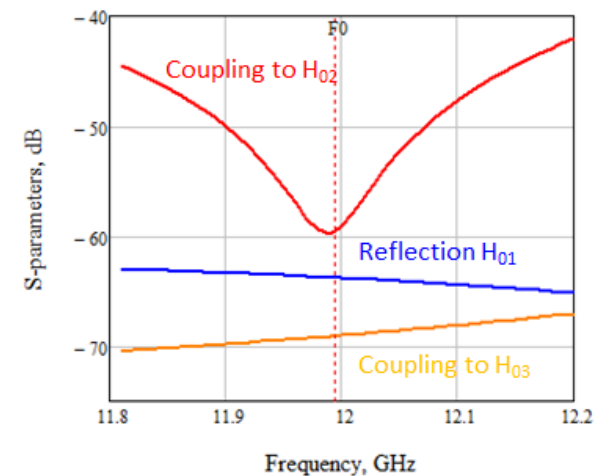
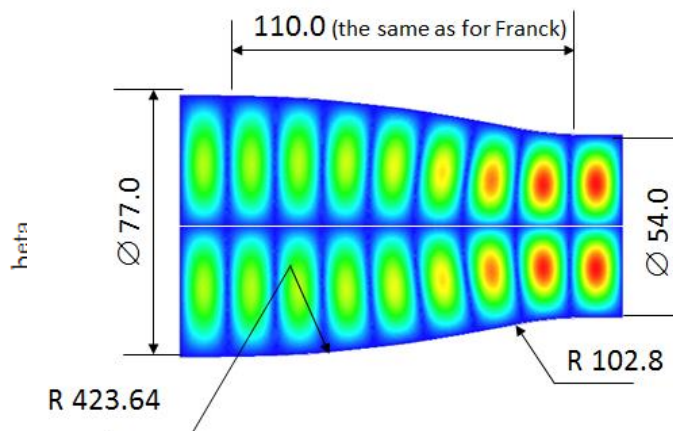
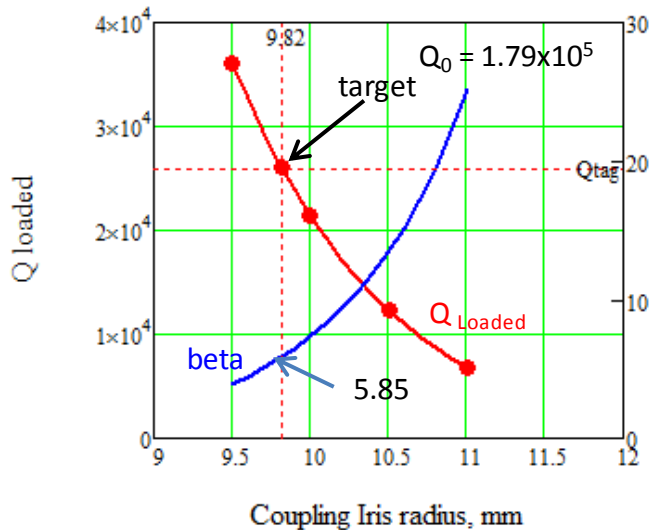


- Objectives:
1. Compact (inexpensive).
 2. Relaxed fabrication tolerances.
 3. Fixed frequency tuners (frequency control by temperature).
 4. Detuning option.

Cavity operating mode $H_{0,1,32}$, length 0.444 m, Q_0 (HFSS) = 1.79×10^5

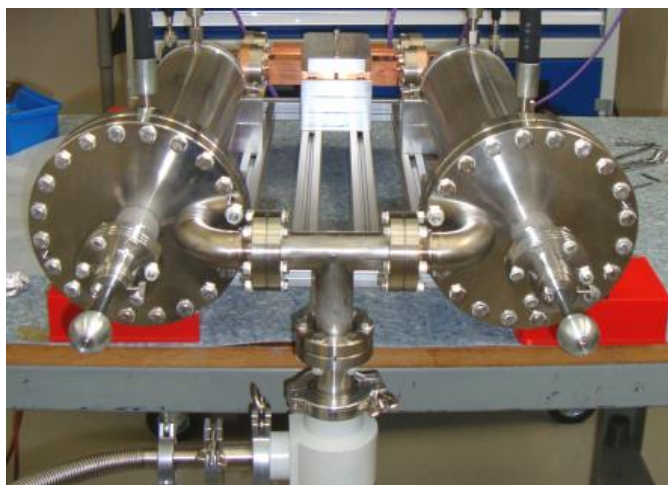
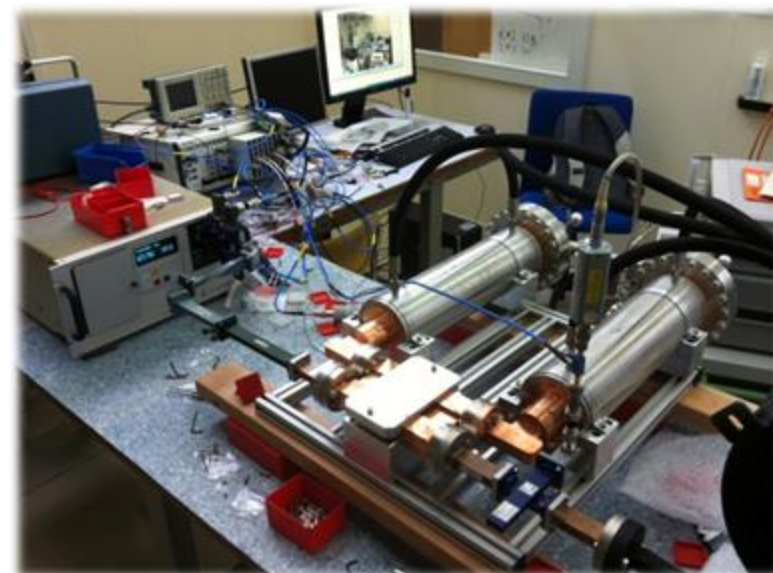
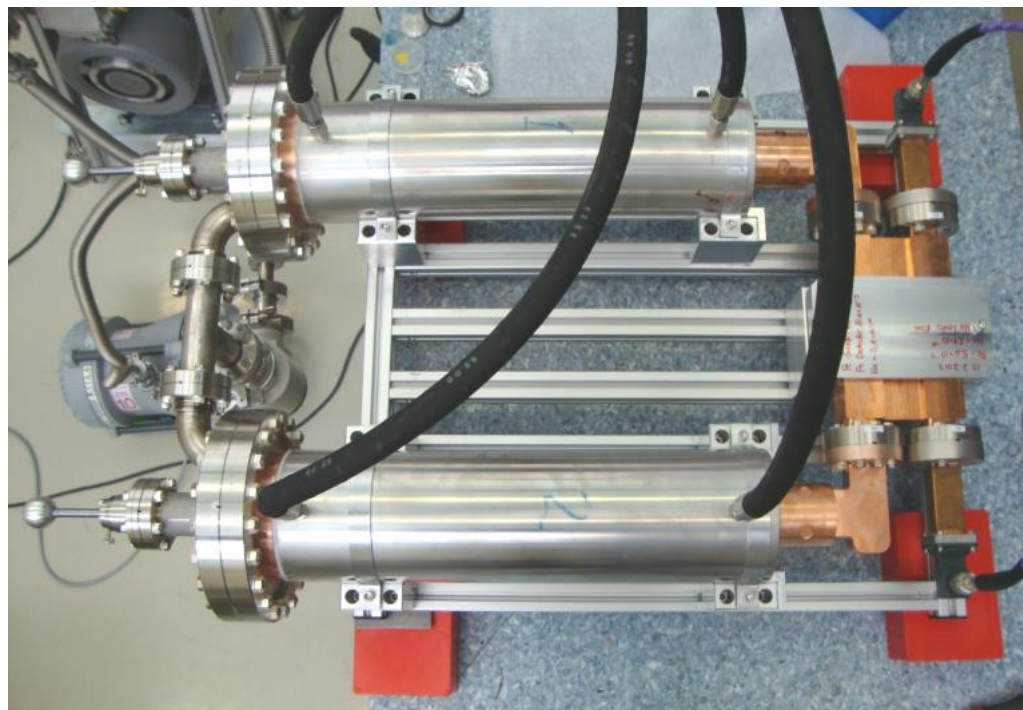


Iris thickness 2 mm with inner filler radius 1 mm





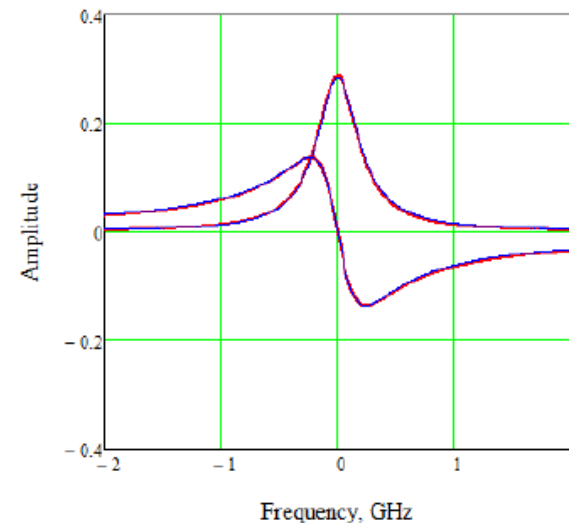
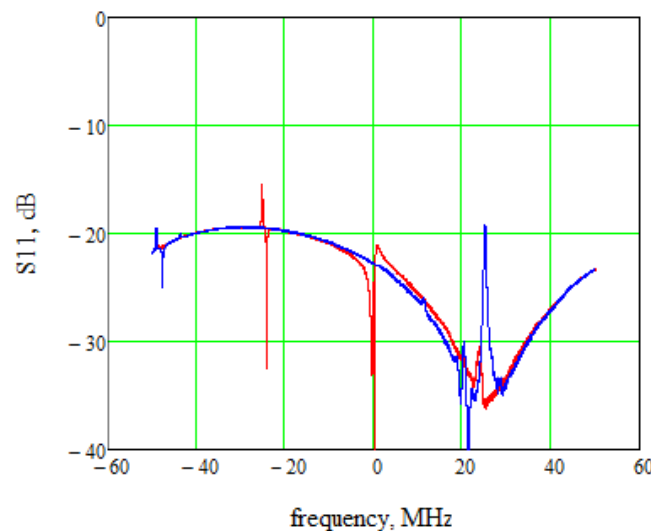
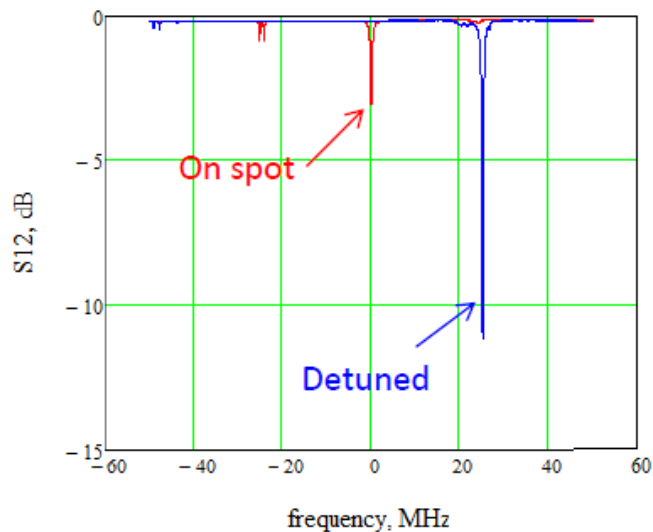
SLEDX under RF tests



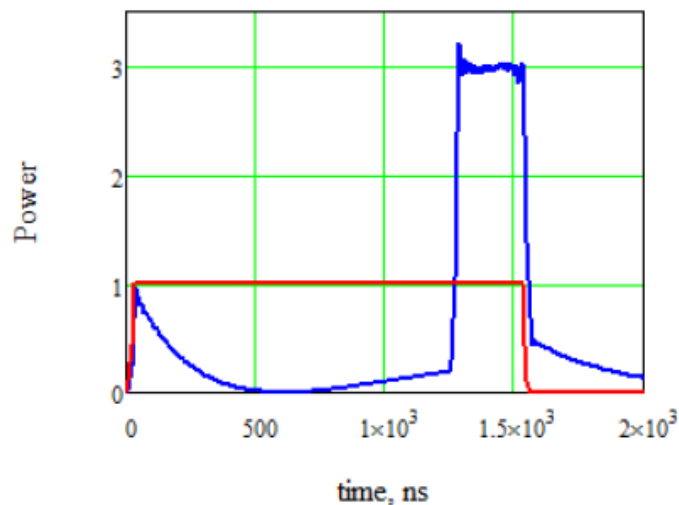


Central frequency: 11.99424 GHz. Measured at vacuum and 27.7 °C

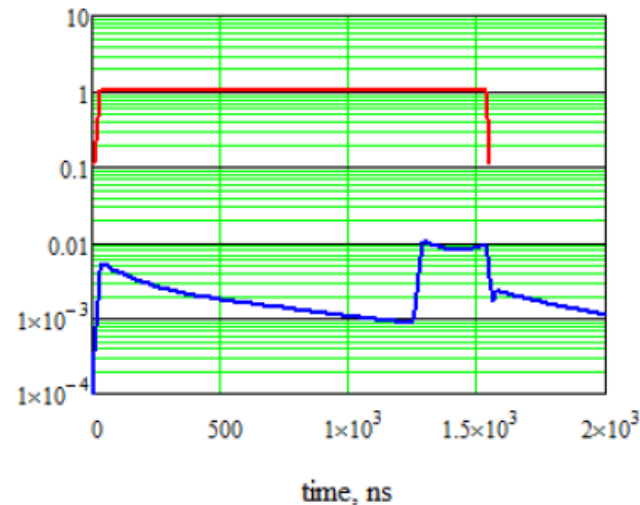
Cavities impedance



Compression (simulation)



Reflection



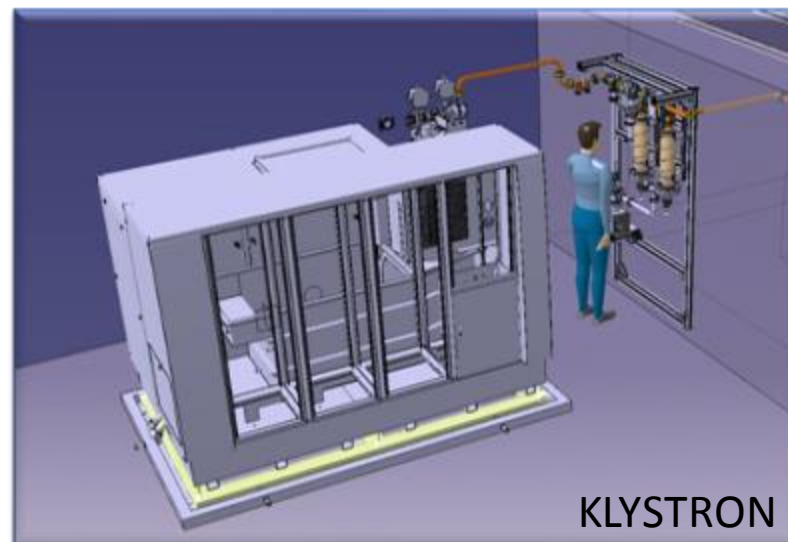
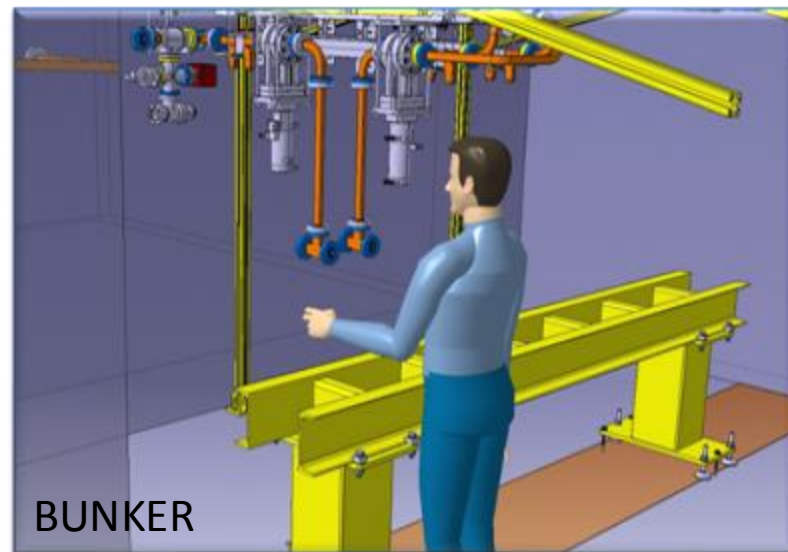
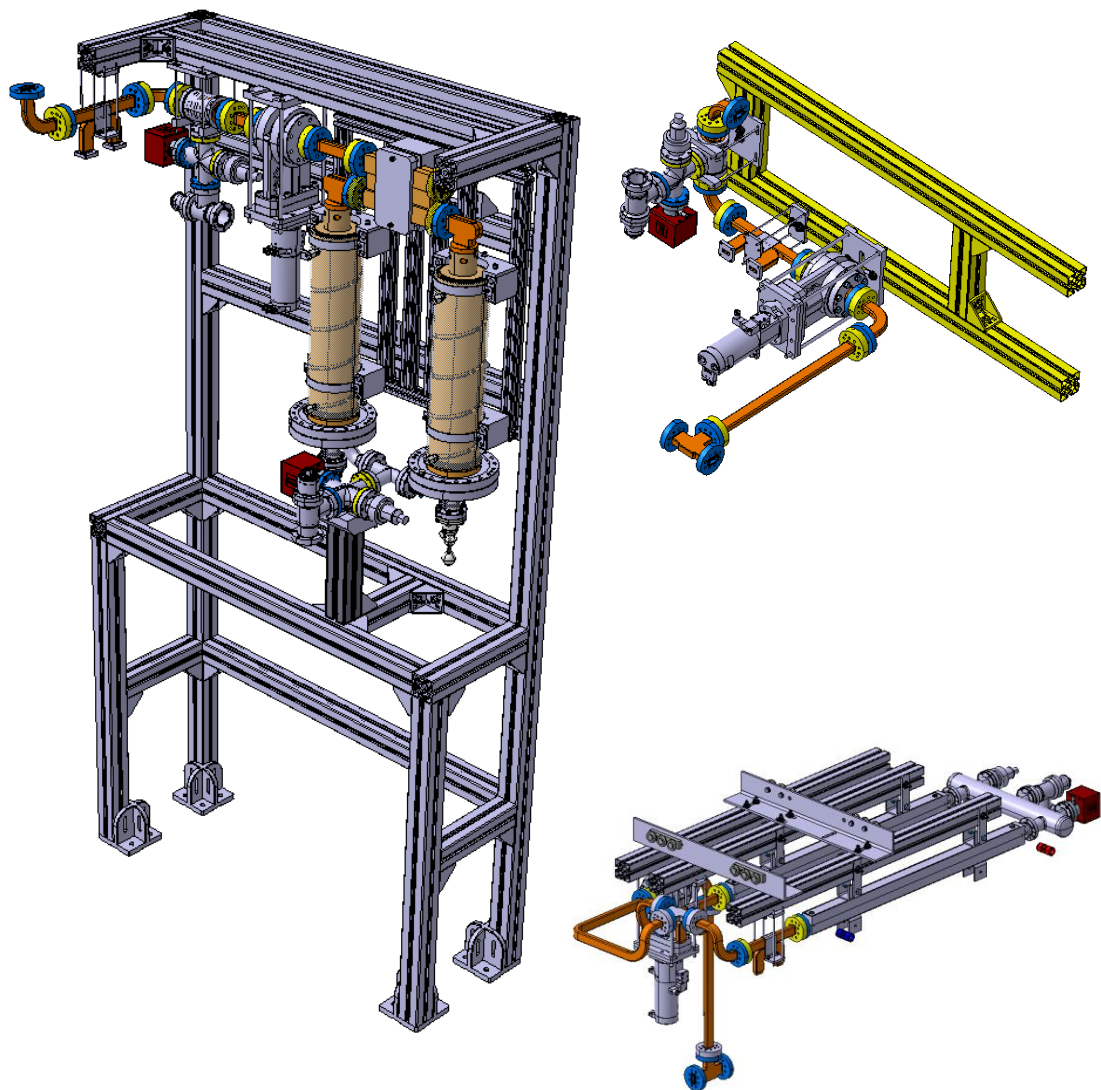
Cavities parameters

	By design	Measured
Q_0	1.79×10^5	1.77×10^5
β	5.85	5.98

3dB hybrid is slightly (+25 MHz) detuned.

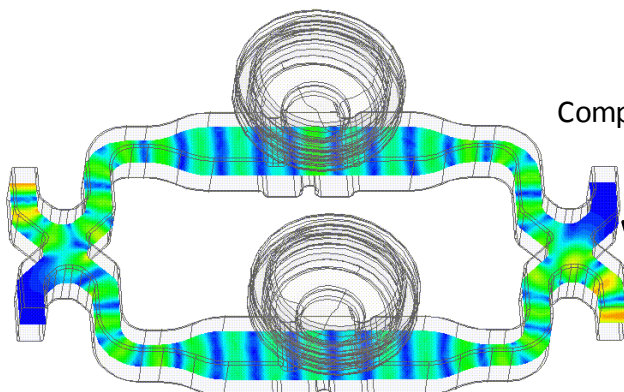
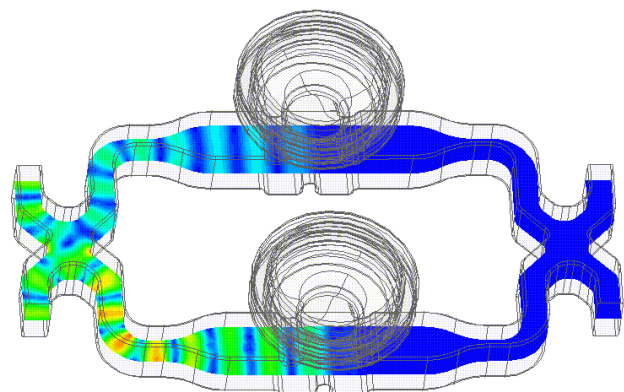


All these components will be used in XBOX2/3 new RF network



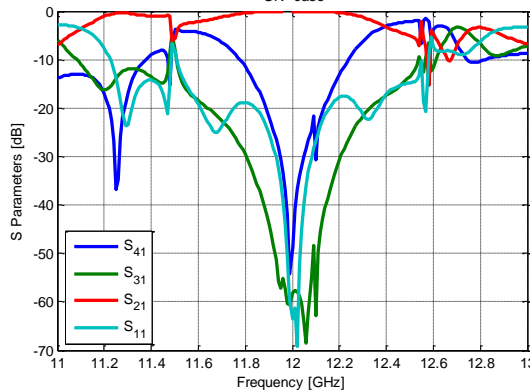
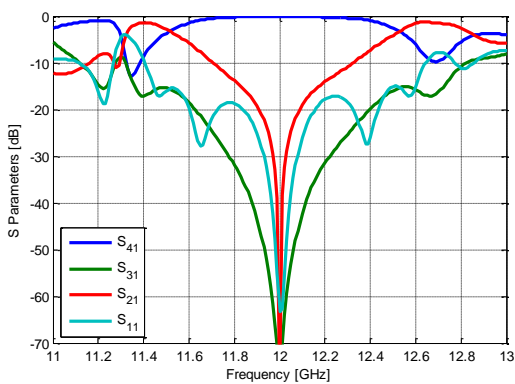
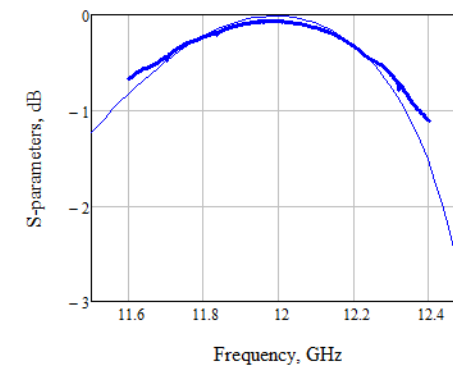
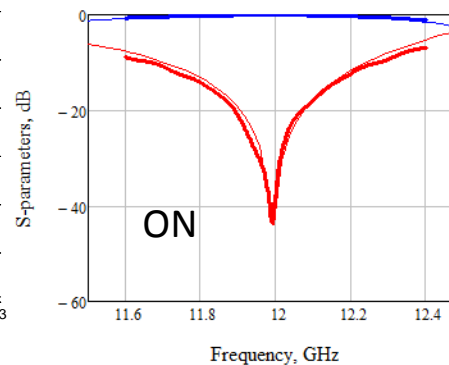
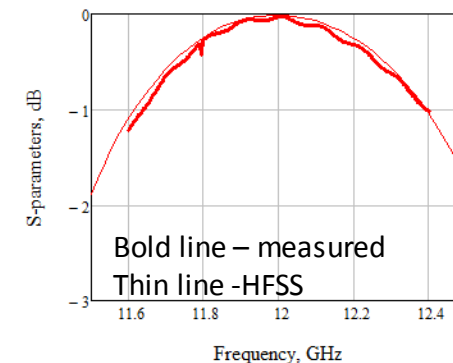
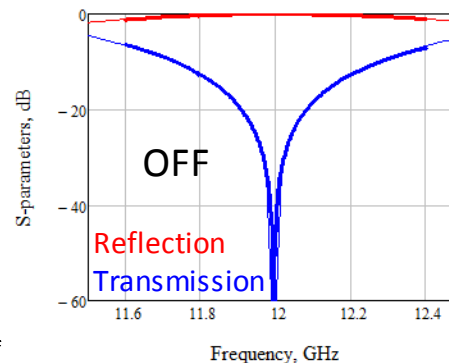
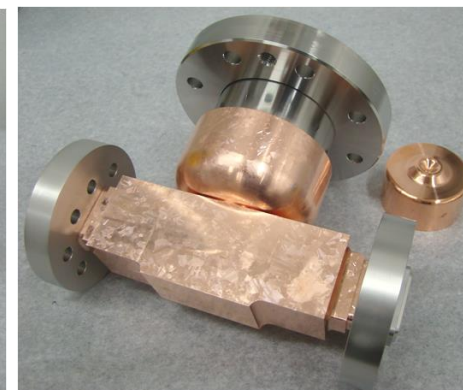
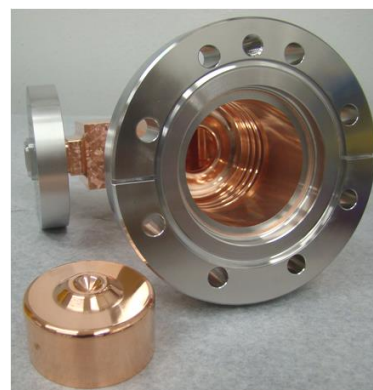


New RF component in development. Compact variable RF power divider.



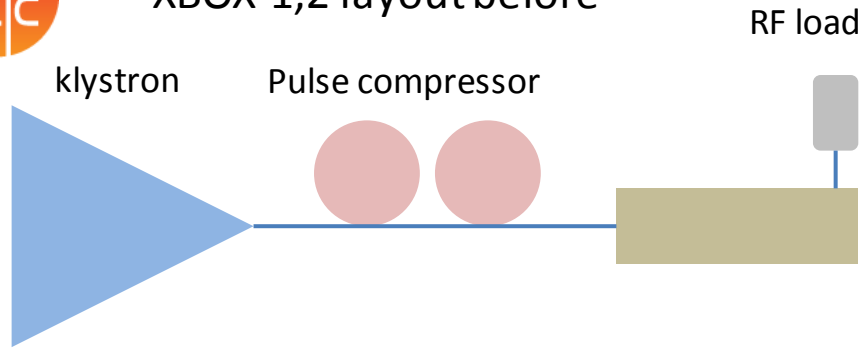
Compact -3dB hybrid by
A. Grudiev

235 mm

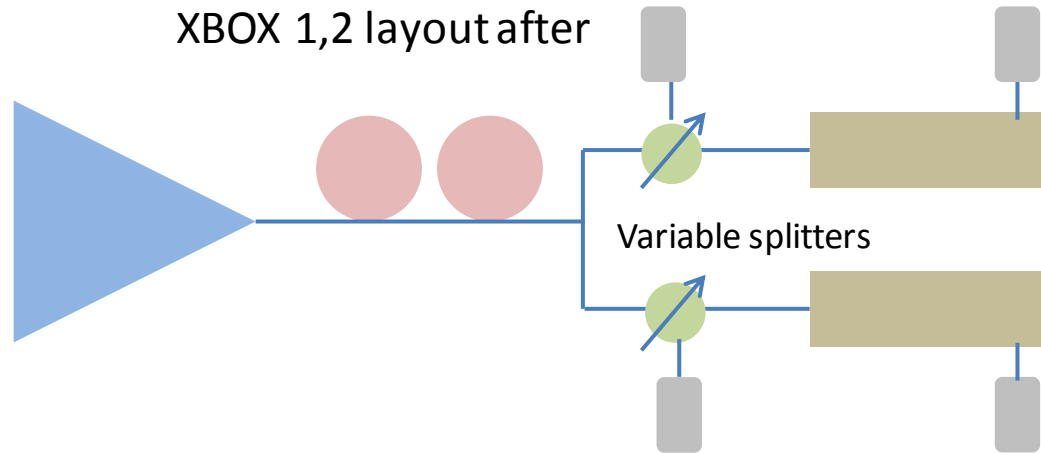




XBOX 1,2 layout before



XBOX 1,2 layout after



Where would we need them?

1. They will allow to process two structure in parallel in the most convenient way, when each of the structure will receive personal RF power handling.
2. They could operate as a part of processing procedure (in the case of the structure breakdown), thus minimising transient thermal load in the pulse compressor.

- Anticipating final testing capability of 8 structures (XBOX #1,2,3), 8 power splitters will be needed
- It will be also useful to replace the old GYCOM devices in CLEX, then 2 more splitters are needed.
- With 1-2 spare, we should plan to fabricate ~ 12 such device.