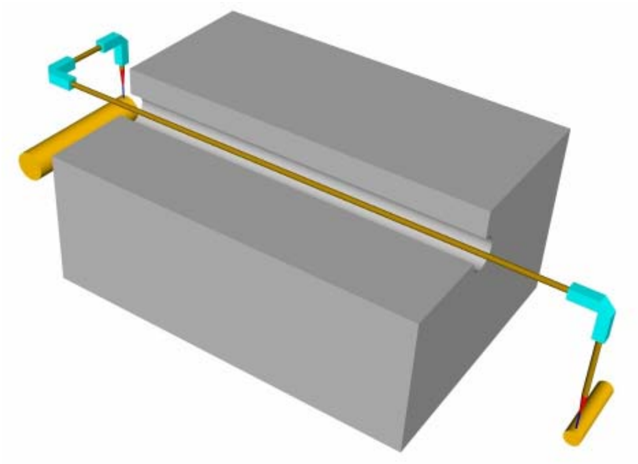
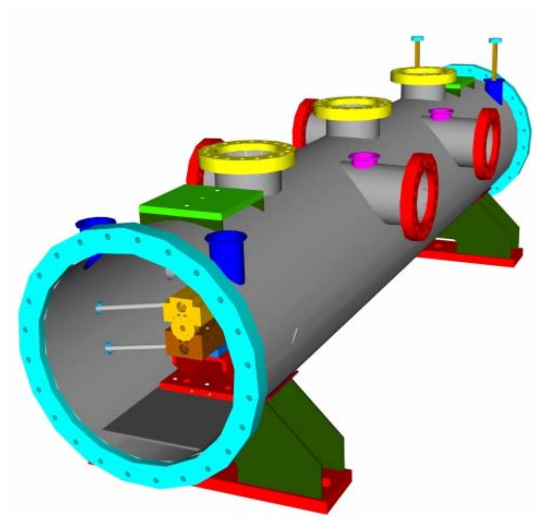
30 GHz RF Power production in CTF3.
Technical aspects and status.

I. Syratchev for CLIC team





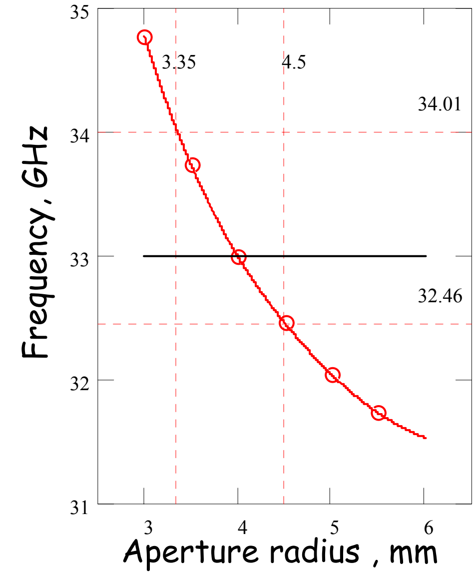
Design parameters:

- Initial beam energy : ~70 MeV
- Power to be produced at 30 GHz: ~ 100 MW
- Maximal electric field on a surface: < 150 MV/m
- 30 GHz RF pulse length (CLIC spec): ~140 ns
- Beam current : 5 A
- Beam stability issues

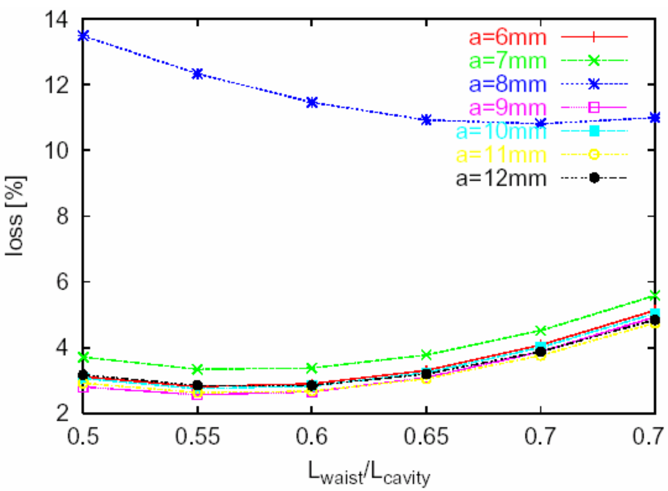
After many iterations, basically following beam stability simulations, the structure architecture was chosen to be aligned to the beam waist profile along beam trajectory. The cell dimensions and structure length were both optimized to satisfy the design parameters together with low beam losses. With this choice, no damping of the transverse HOM is needed.

Beam losses. Choice of the beam aperture.

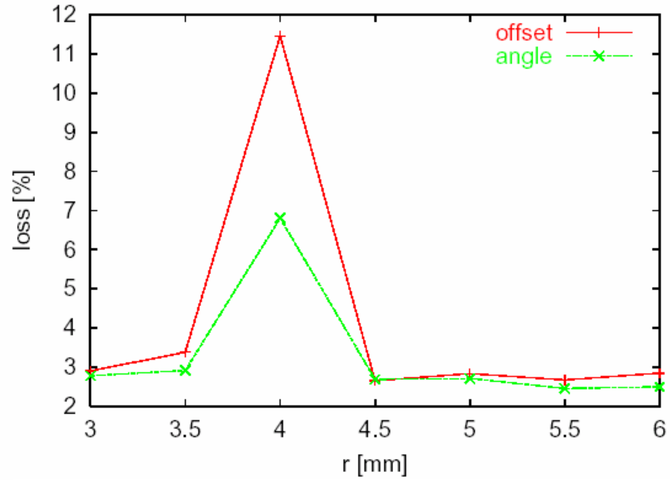
Dipole frequency scaling with aperture



- The optimum of beta function for both planes would be - L/2 and waist of the beam should be centered in the structure.
- Since the structure length scales $L \propto a^2$, the geometric acceptance remains about 3σ independent of the choice of aperture.
- Since the beam is decelerated it is advantageous to shift the waist of the beam towards the end of the structure.
- The wakefields effect (using PLACET) was estimated with assumption of 0.3σ or $0.3\sigma'$ for the whole beam offset.



Total losses for different structures as a function of the relative waits shift.



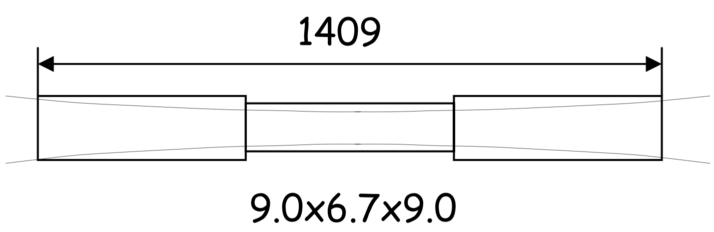
Beam losses vs. beam aperture.

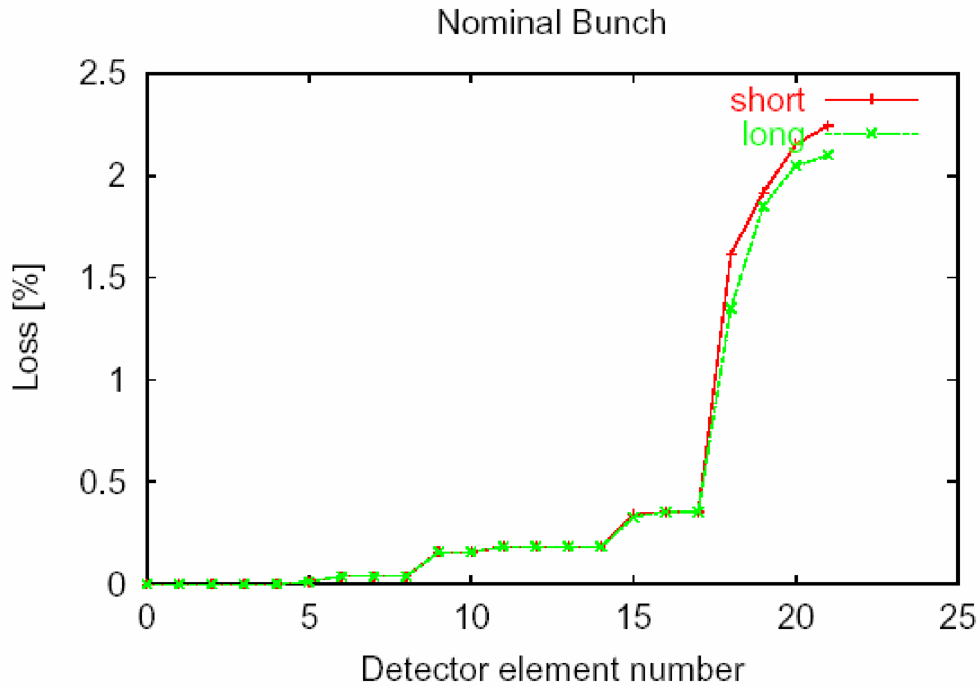
Summary:

1. The optimum of the beam waist is always found between 0.55-0.60 L.
2. The around 8 mm apertures (F_d~33 GHz) clearly should be avoided.
3. The HOM damping does not improve significantly the situation.

- The geometric limitations favors a design which uses a smaller beam aperture in the central part.
- Two types of structures where studied: SHORT – 9.0x6.7x9.0 mm and LONG: 10x9x10

SHORT
all structures are equal in length.





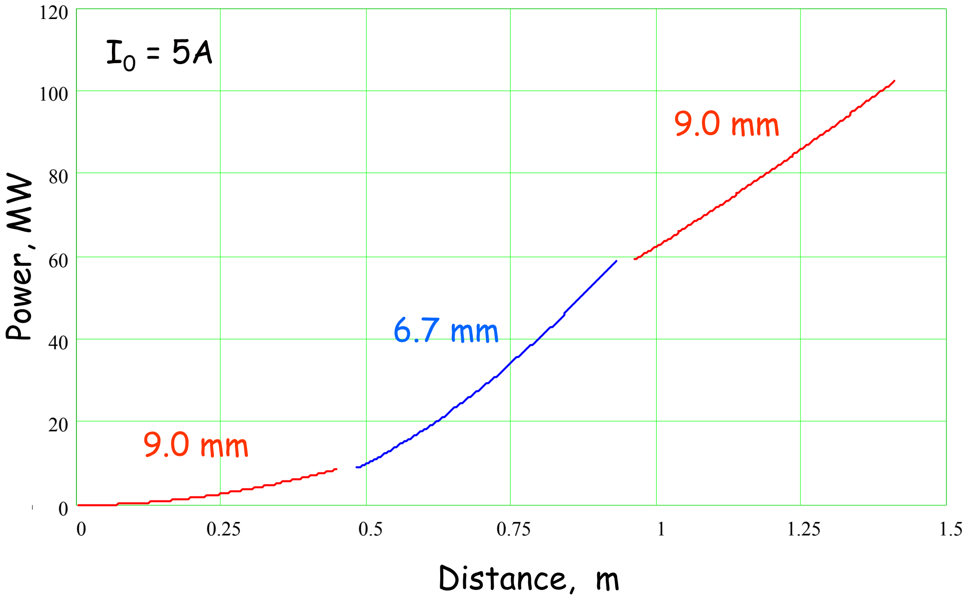
Beam losses along the structure using a realistic bunch but no imperfections in realistic lattice. Bunches earlier in the train may experience larger losses.

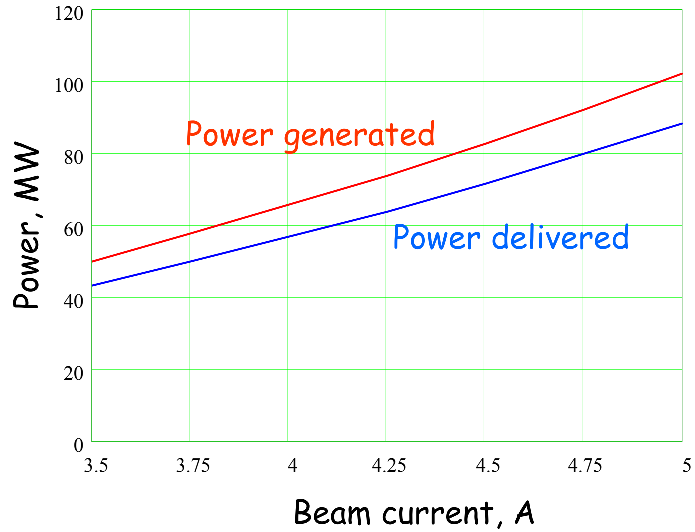
Conclusion:

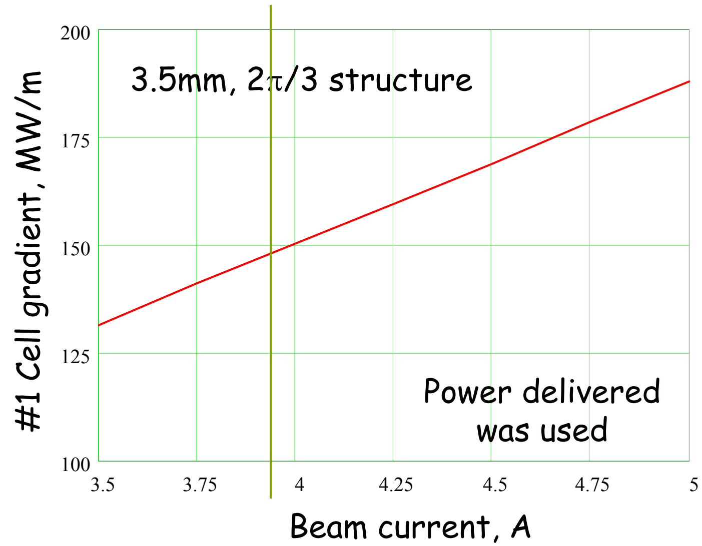
The waist with required parameters can be achieved in the structure from using the foreseen linac magnets. Bunches which resulted from realistic simulation of the drive beam injector have Been tracked through the optimised lattice (assuming no imperfections).

The resulting losses (see the picture) seem acceptable

To avoid complications, the 9 X 6.7 X 9 structure was chosen







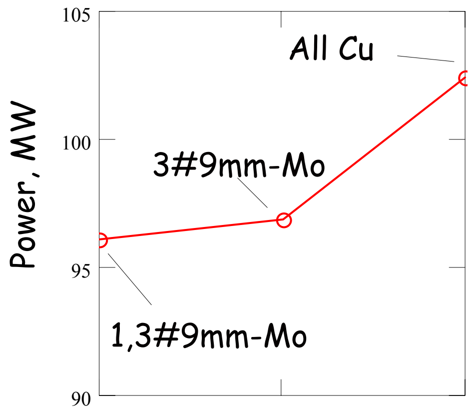
Assumptions:
#1. Beam current: $I = I_0 \times (0.8)^{0.5}$
(0.8 – RF power Form-factor)
#2. Quality factor: $Q = Q_0 \times 0.95$

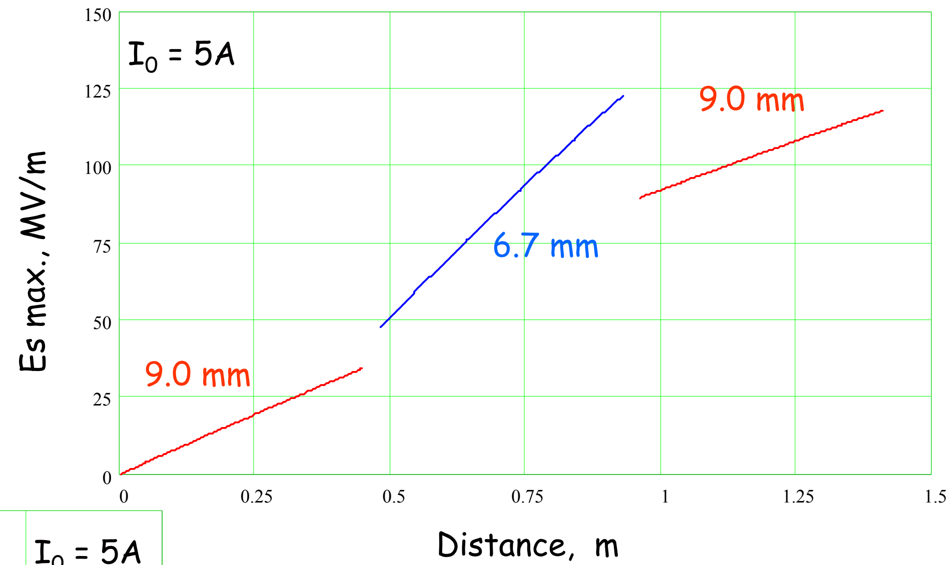
Power D. = Power G. x0.96x0.9

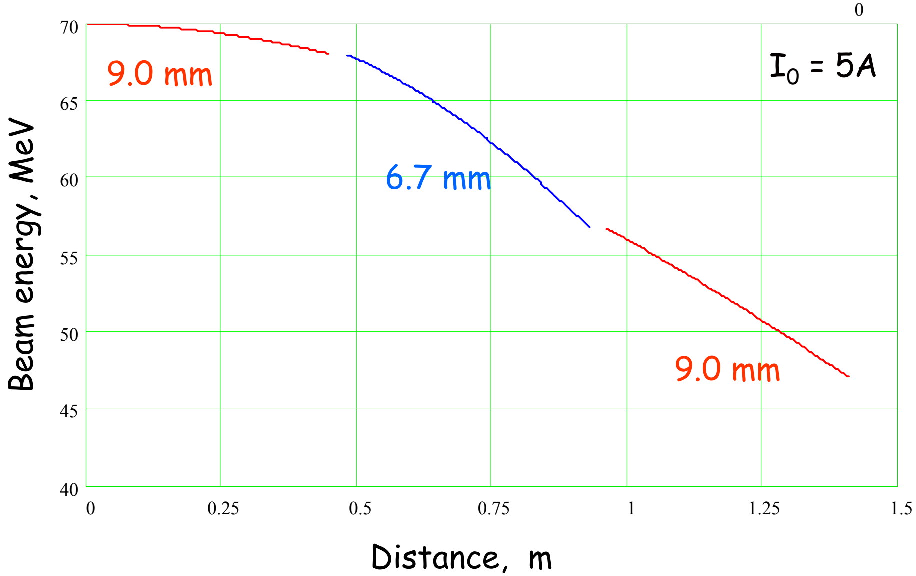
Extraction

Transportation (H01)

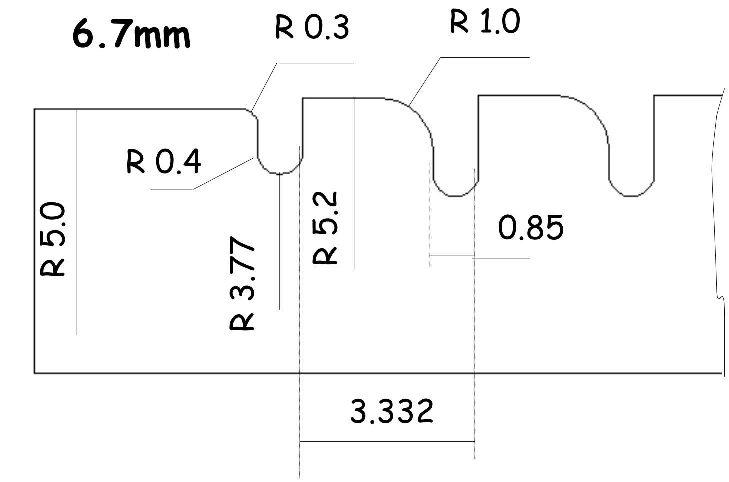
Surface field and beam deceleration.



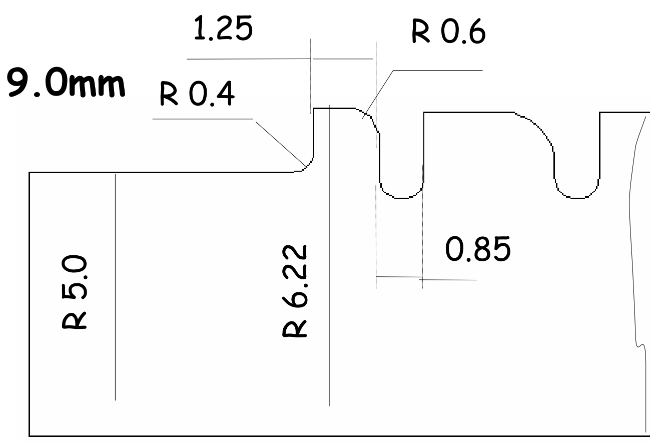




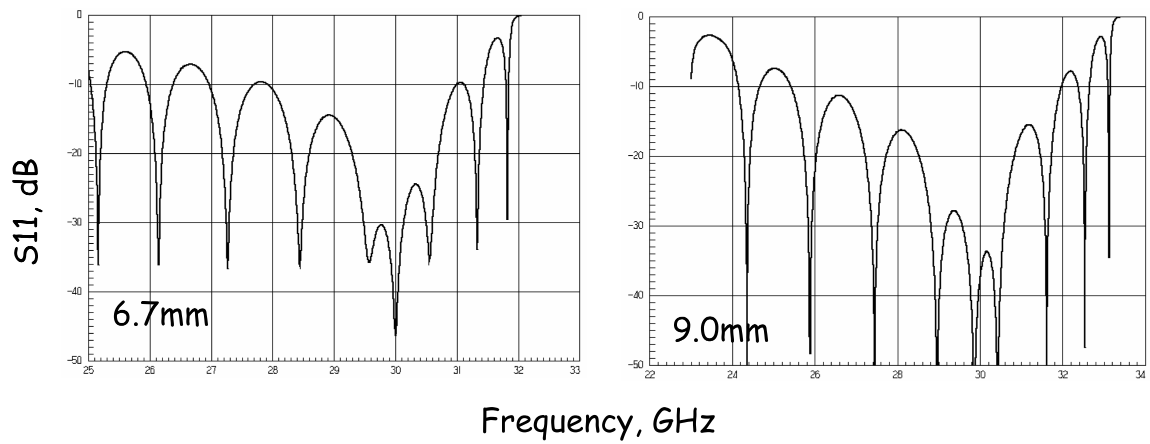
#1. Surface field does not exceed 125 MV/m at the end of central 6.7 mm section.
#2. Total beam energy losses of ~23 MeV for 5 A beam current are expected.

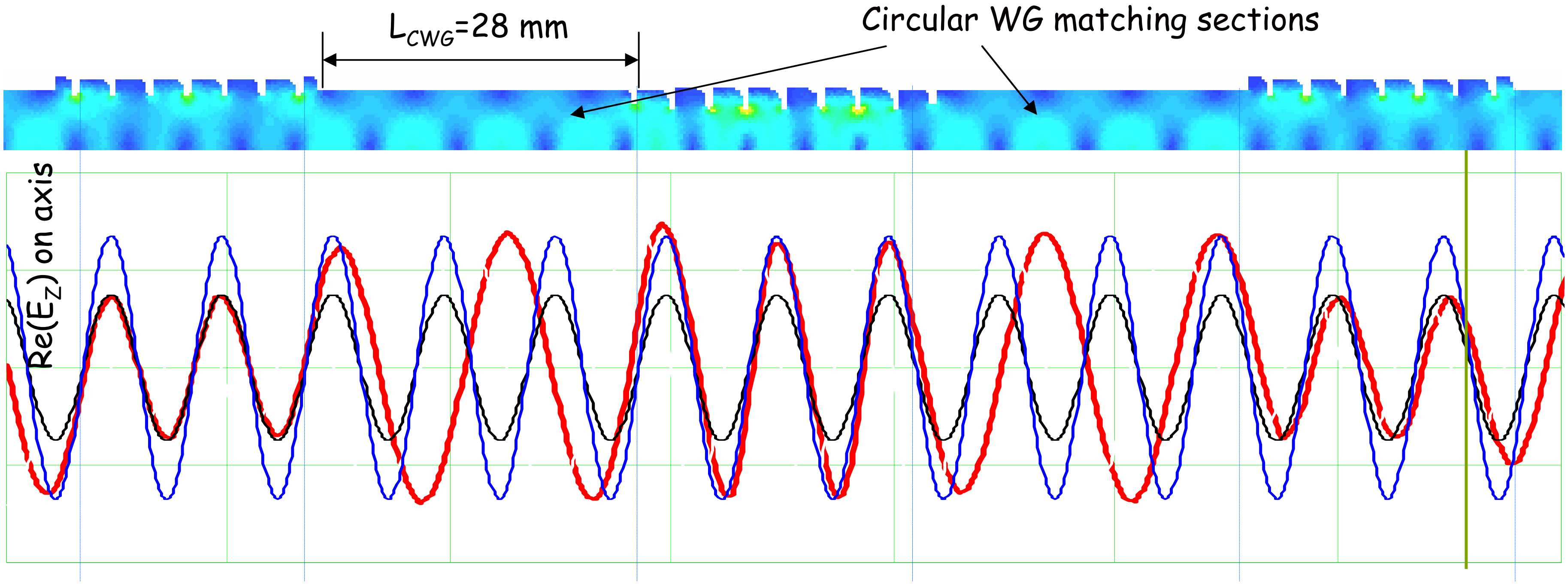


Parameter	#6.7 mm	#9.0 mm
R/Q, kΩ/m	11.26	5.87
Beta (Vg/c),%	24.35	39.82
Q	4700	5110
F_D, GHz	34.01	32.46
K_T, V/pC/mm/m	105.0	31.65
Q_D	4420	5380
$Beta_D$, %	23.68	43.57

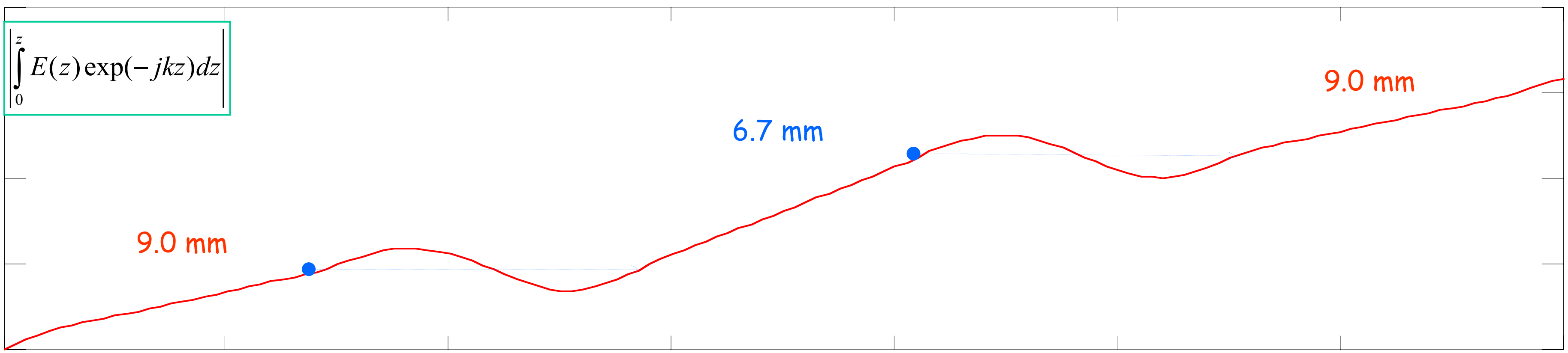


Structures matching

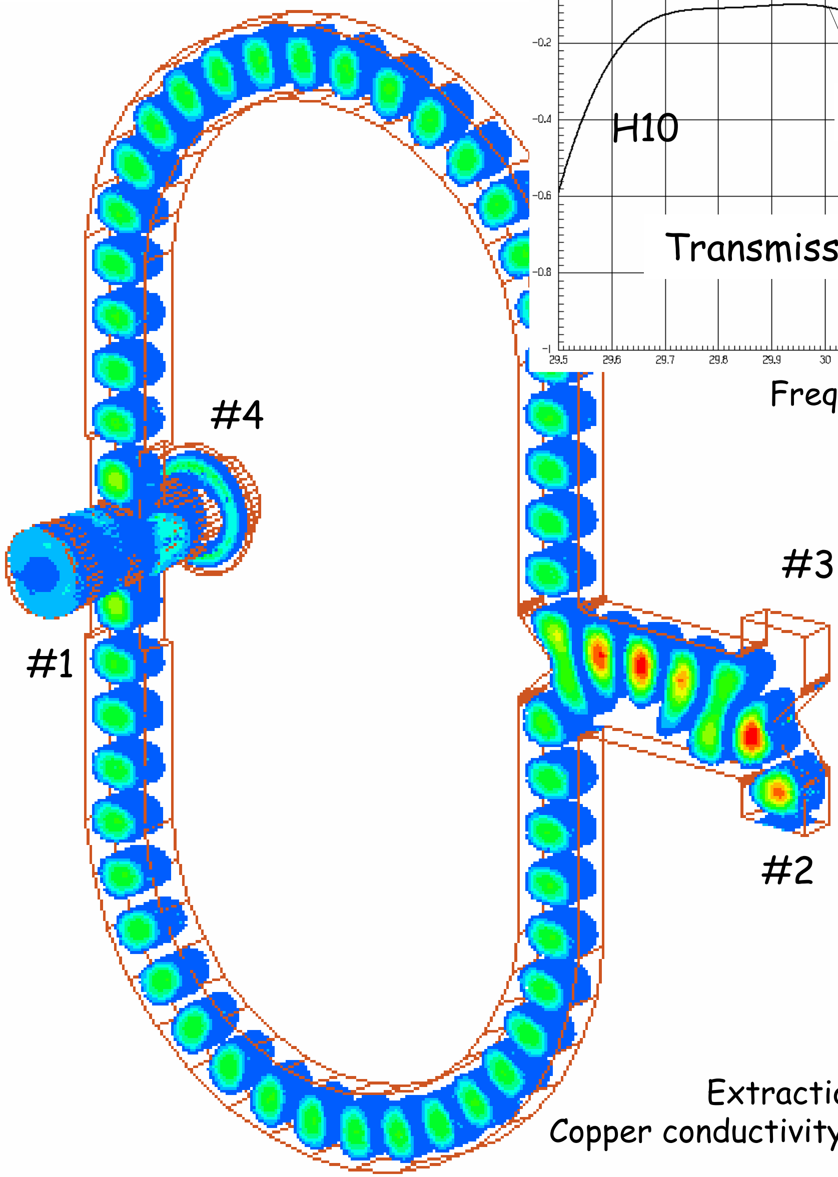


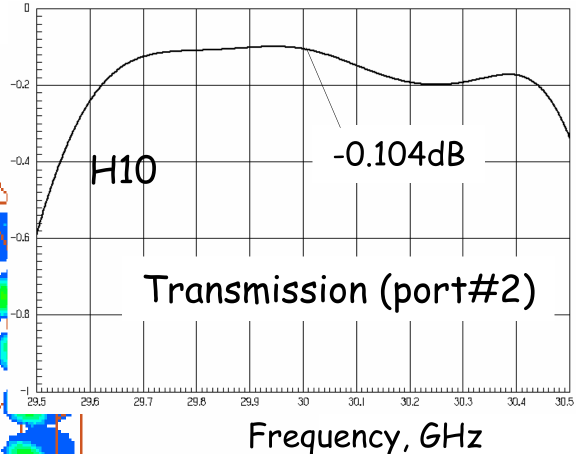


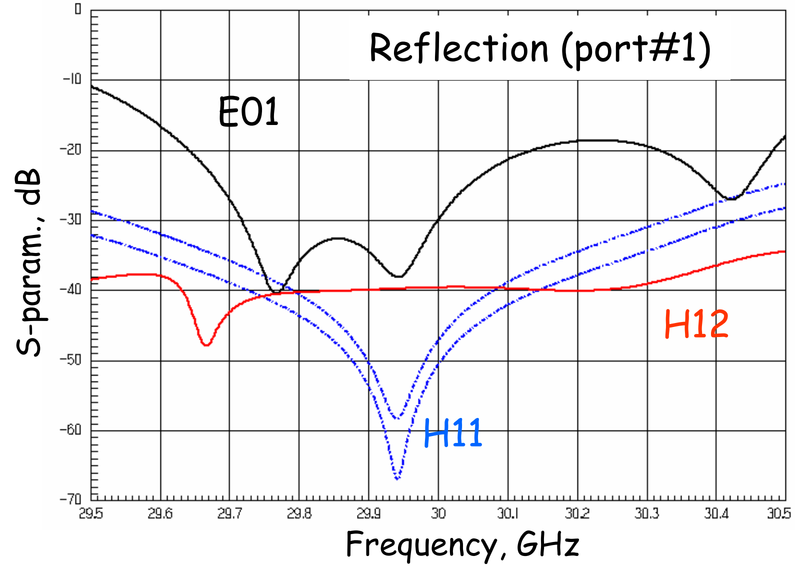
L_{CWG}=28 mm
Circular WG matching sections
$Re(E_Z)$ on axis

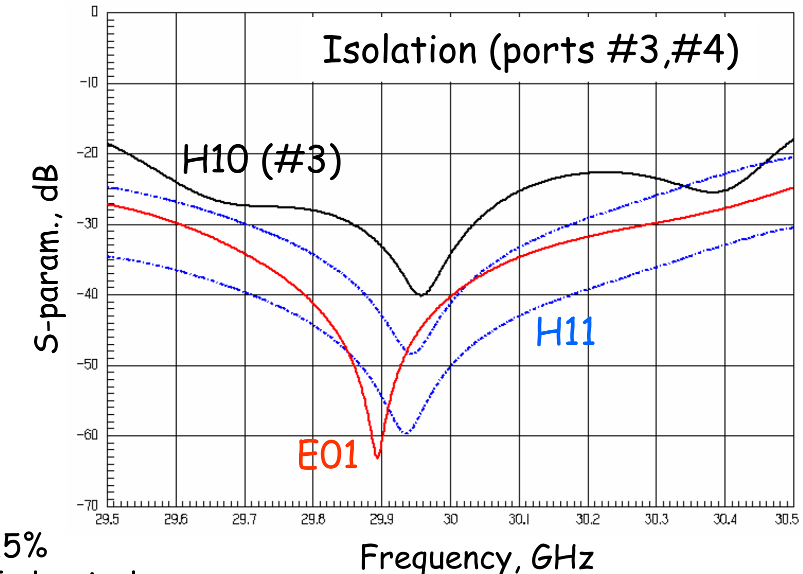


$\left|\int_0^z E(z)\exp(-jkz)dz\right|$
9.0 mm
6.7 mm
9.0 mm

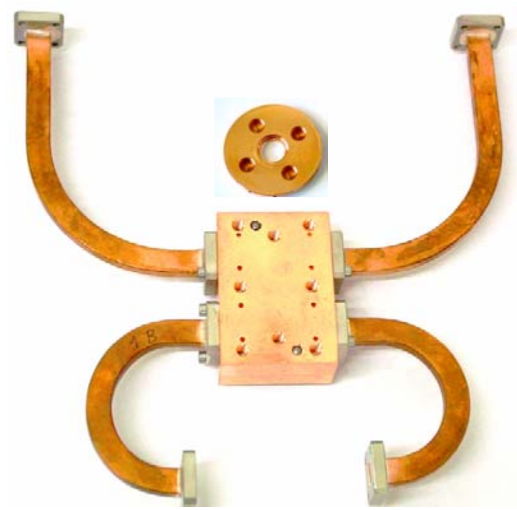




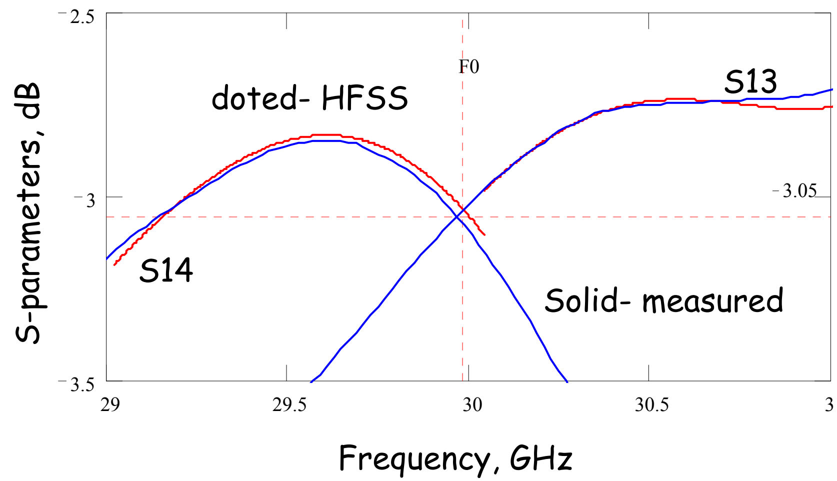




Extraction Efficiency ~ 97.5%
Copper conductivity was taken 90% of classical one.



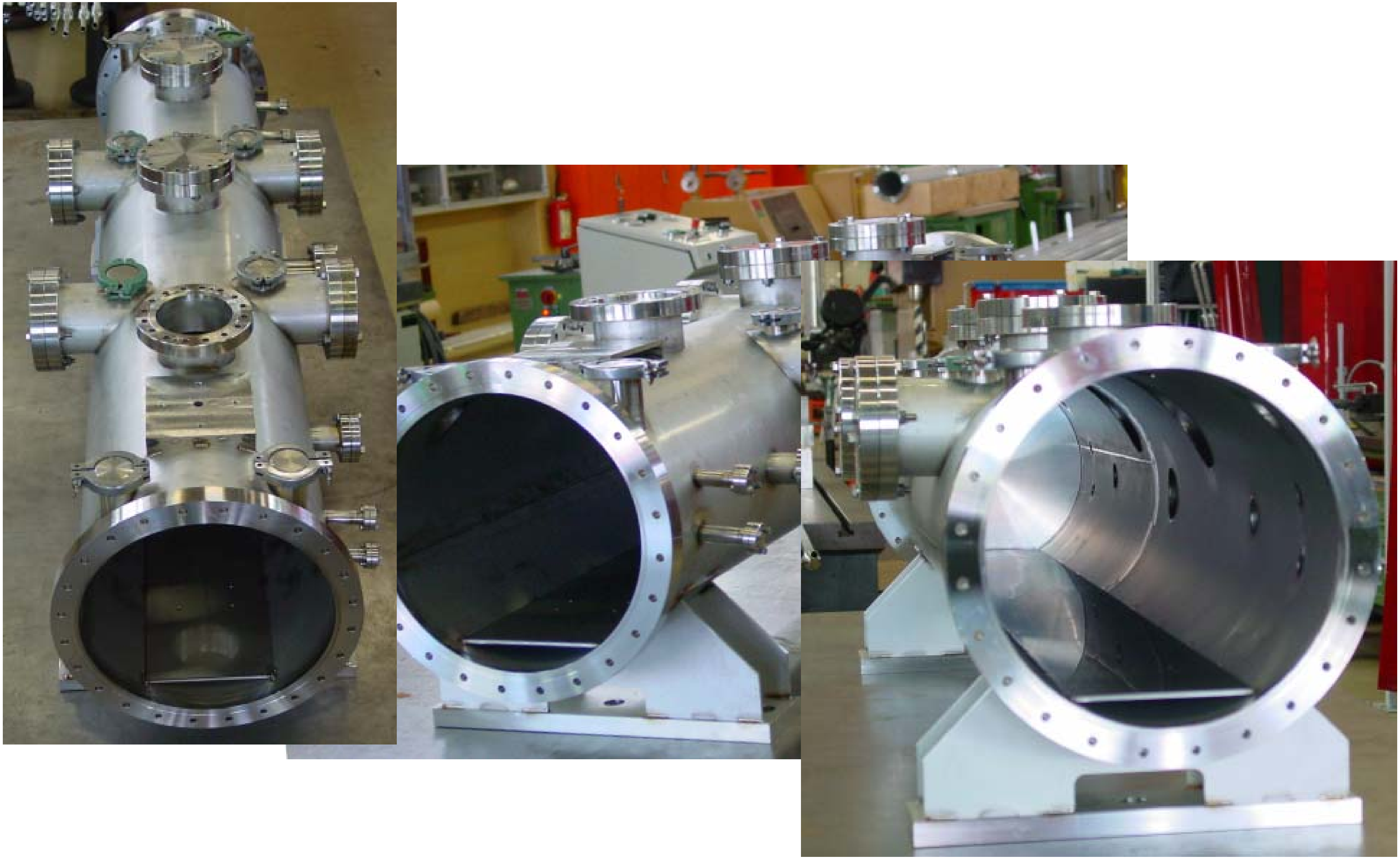
#1. The three 3-dB hybrids are manufactured and tested. Performance in a good agreement with design (see picture)



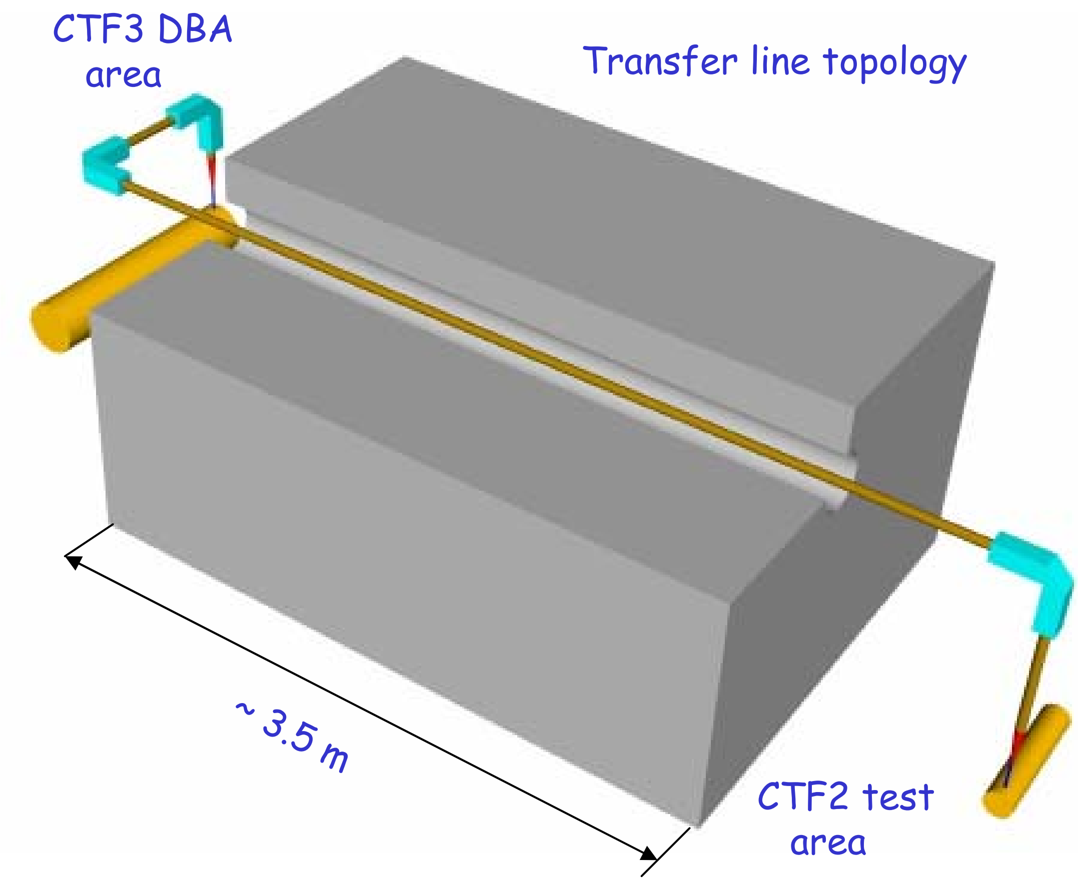
#2. All the parts for 3 output couplers are manufactured. Waiting for brazing.

The 450 cell (6.7 and 9.0 mm plus matching cells) have been ordered from Granfield. 162 cells of 9.0 mm aperture already arrived (see photo).

Hardware fabrication



With original scenario, the 30 GHz test stand is planned to be kept at a previous location in former CTF2 area. This requires development of the special high-power low-loss transfer WG line. Note that losses in WR-34 WG line are about 65% per 10 m . Such a line operating at low-loss H01 mode will be manufactured in Russia (IAP) and delivered to CERN in April 2004. The line consists of 50 mm diameter circular waveguide, matching transitions, H11-H01 mode converters and quasi-optical 90^0 Mittre bends.



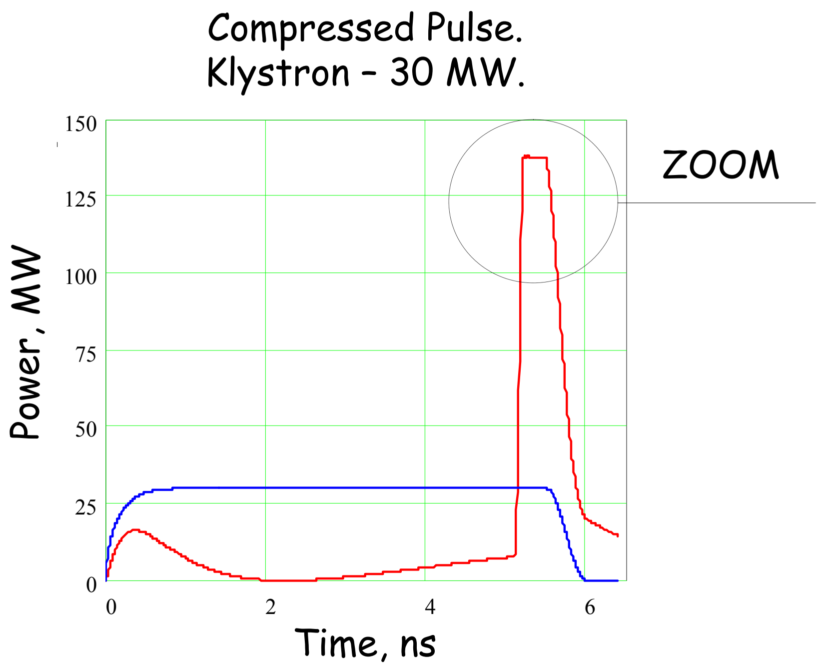
Transfer line components efficiency budget:

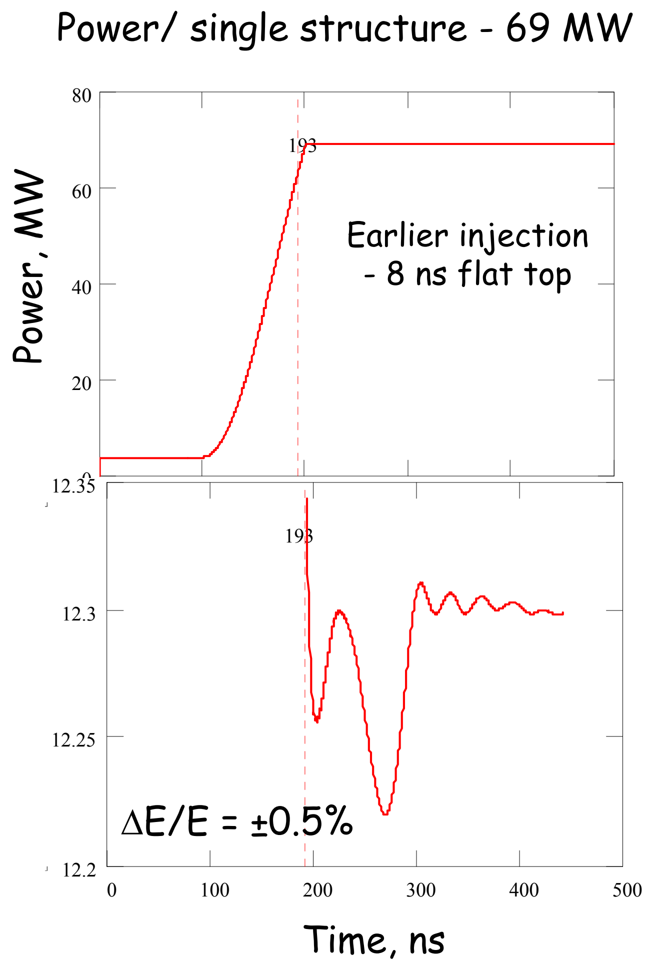
H10 – H11 taper (2) – 0.988
H11 – H01 MC (2) – 0.97
H01 – H01 taper (2) – 0.988
90^0 MB (3) – 0.96
All components – 0.91

∅50mm H01 circ. WG – 0.993/10 m

Transfer line efficiency

Low energy (~8 m) – 0.905
High energy (~60 m) – 0.872



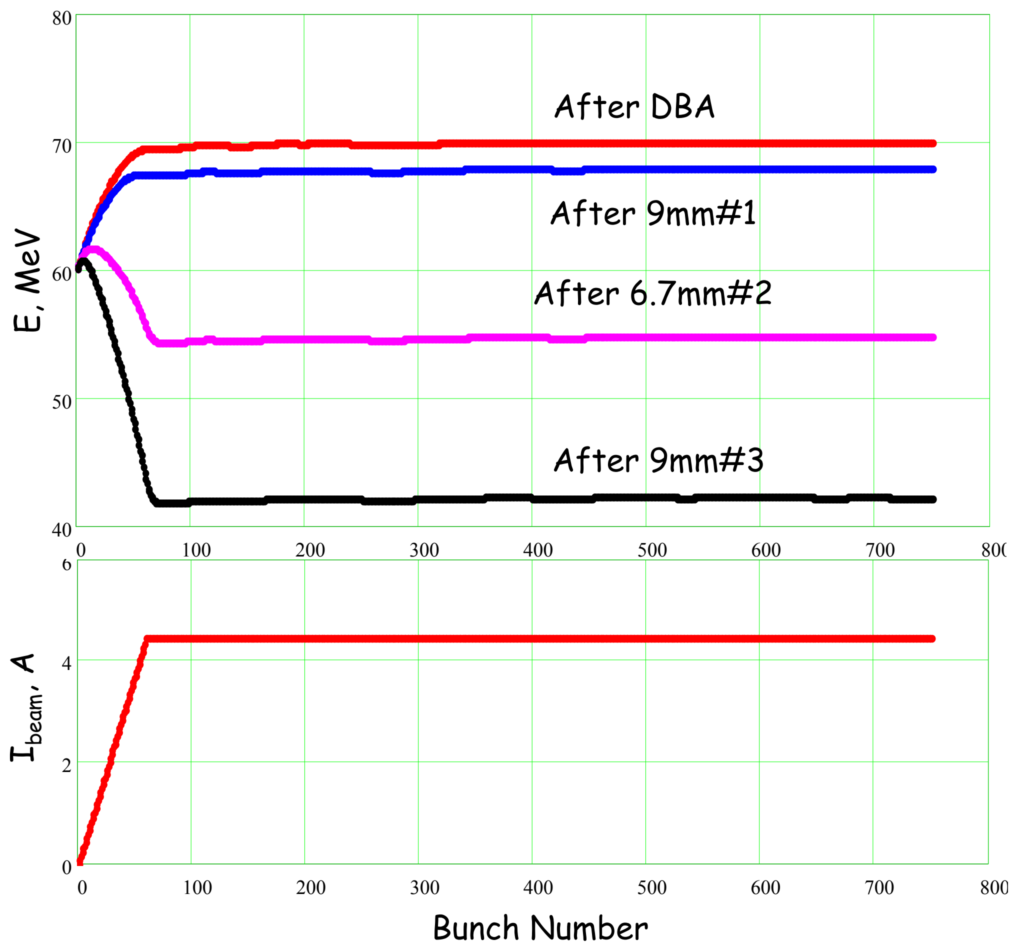


Notes: Current rise time = 0 ns

With 5A beam current, energy gain/structure – 12.3 MeV. For 6 structures – 73.8 MeV

Effect of charge ramp.

Charge ramp 20 ns. Beam current I=5A



Effect of charge ramp