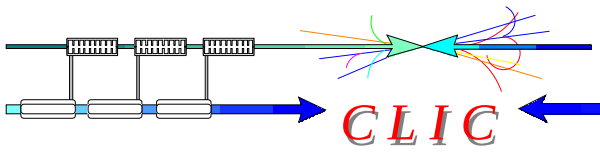
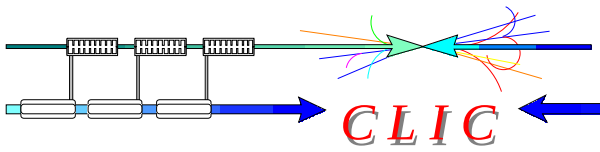


Possible improvement of the CLIC accelerating structure. From CLIC_G to CLIC_K.

2.07.2009

Alexej Grudiev
CERN

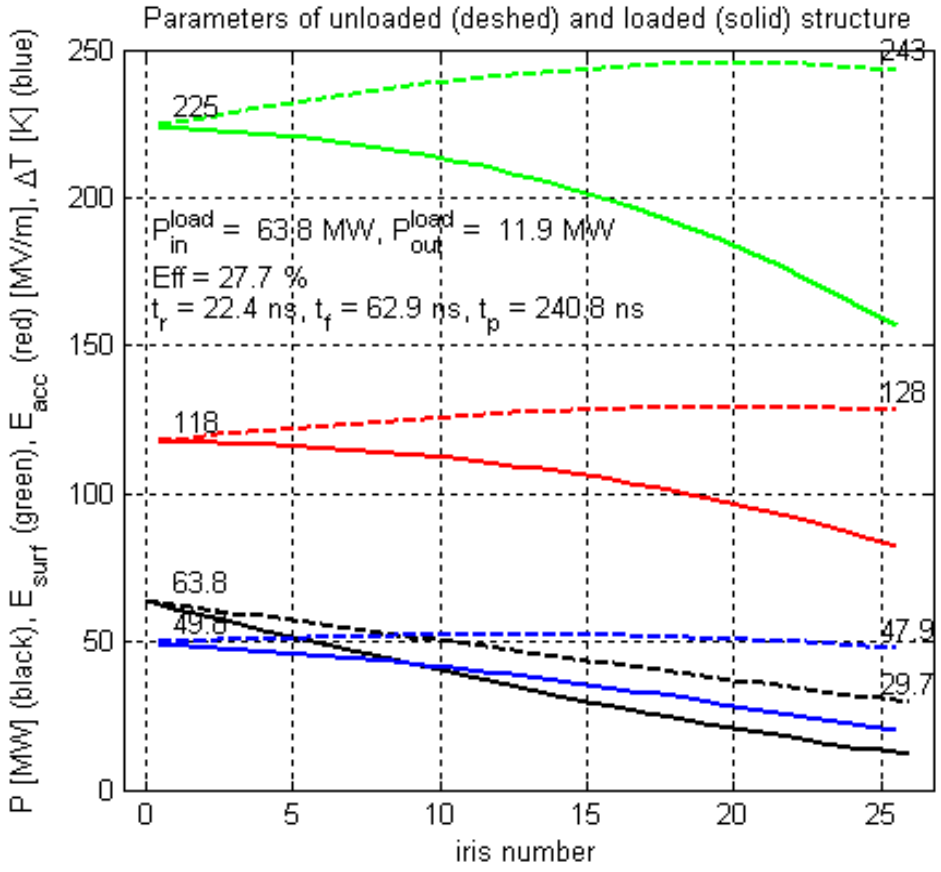


Outline

- Current CLIC accelerating structure: CLIC_G
- Compact coupler design with damping
- Comparison of rounded and not rounded cell geometry
- New type of waveguide damping for lower pulsed surface heating – a ridged waveguide damping
- Constant Sc structure as an optimally tapered accelerating structure

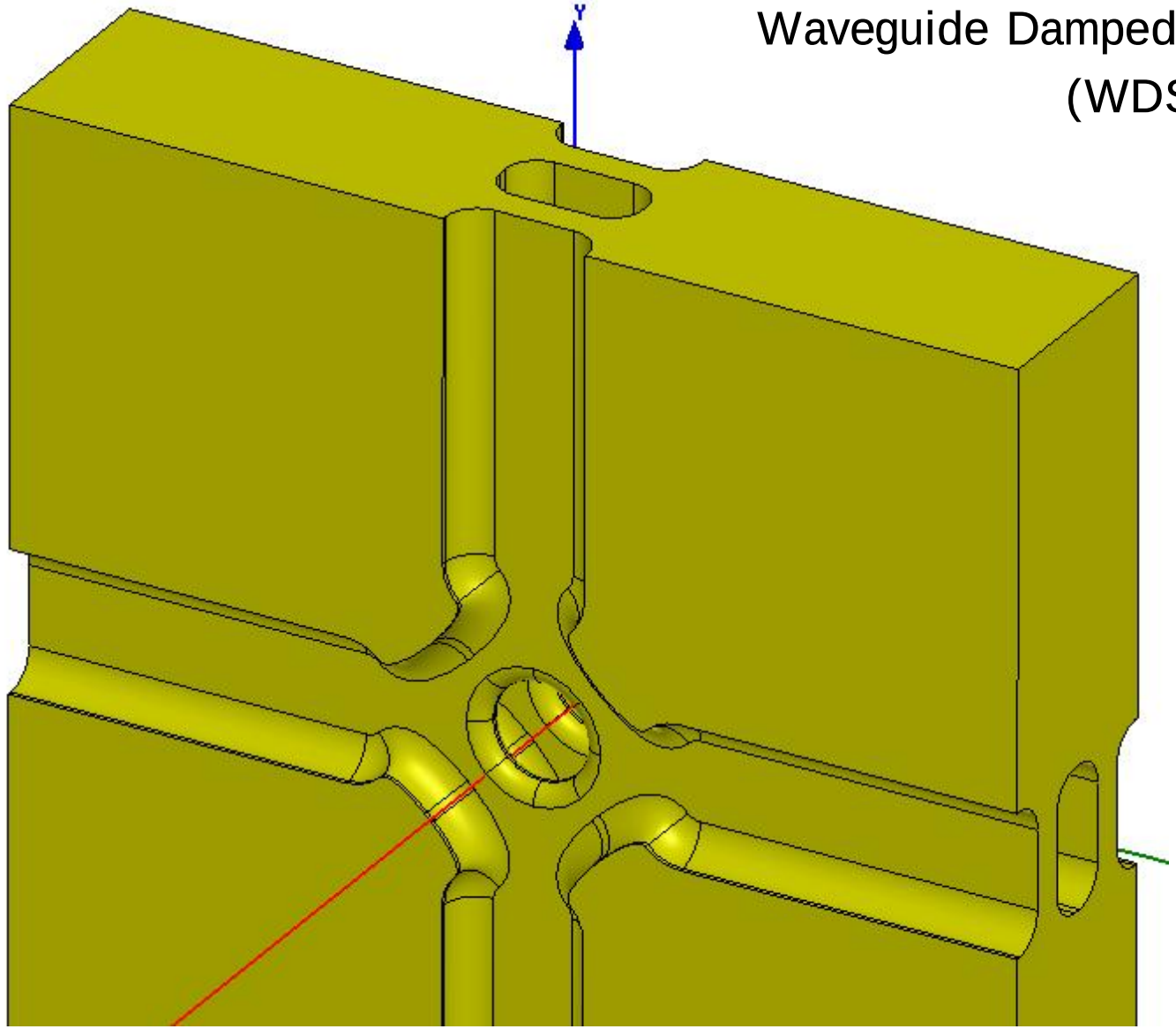
Parameters of CLIC_G

Structure	CLIC_G
Frequency: f [GHz]	12
Average iris radius/wavelength: $\langle a \rangle/\lambda$	0.11
Input/Output iris radii: $a_{1,2}$ [mm]	3.15, 2.35
Input/Output iris thickness: $d_{1,2}$ [mm]	1.67, 1.00
Group velocity: $v_g^{(1,2)}/c$ [%]	1.66, 0.83
N. of reg. cells, str. length: N_c, l [mm]	24, 229
Bunch separation: N_s [rf cycles]	6
Luminosity per bunch X-ing: $L_{b\times}$ [m^{-2}]	1.22×10^{34}
Bunch population: N	3.72×10^{9}
Number of bunches in a train: N_b	312
Filling time, rise time: τ_f, τ_r [ns]	62.9, 22.4
Pulse length: τ_p [ns]	240.8
Input power: P_{in} [MW]	63.8
$P_{in}/Ct_p^{P\ 1/3}$[MW/mm ns$^{1/3}$]	18
Max. surface field: E_{surf}^{max} [MV/m]	245
Max. temperature rise: ΔT^{max} [K]	53
Efficiency: η [%]	27.7
Figure of merit: $\eta L_{b\times}/N$ [a.u.]	9.1



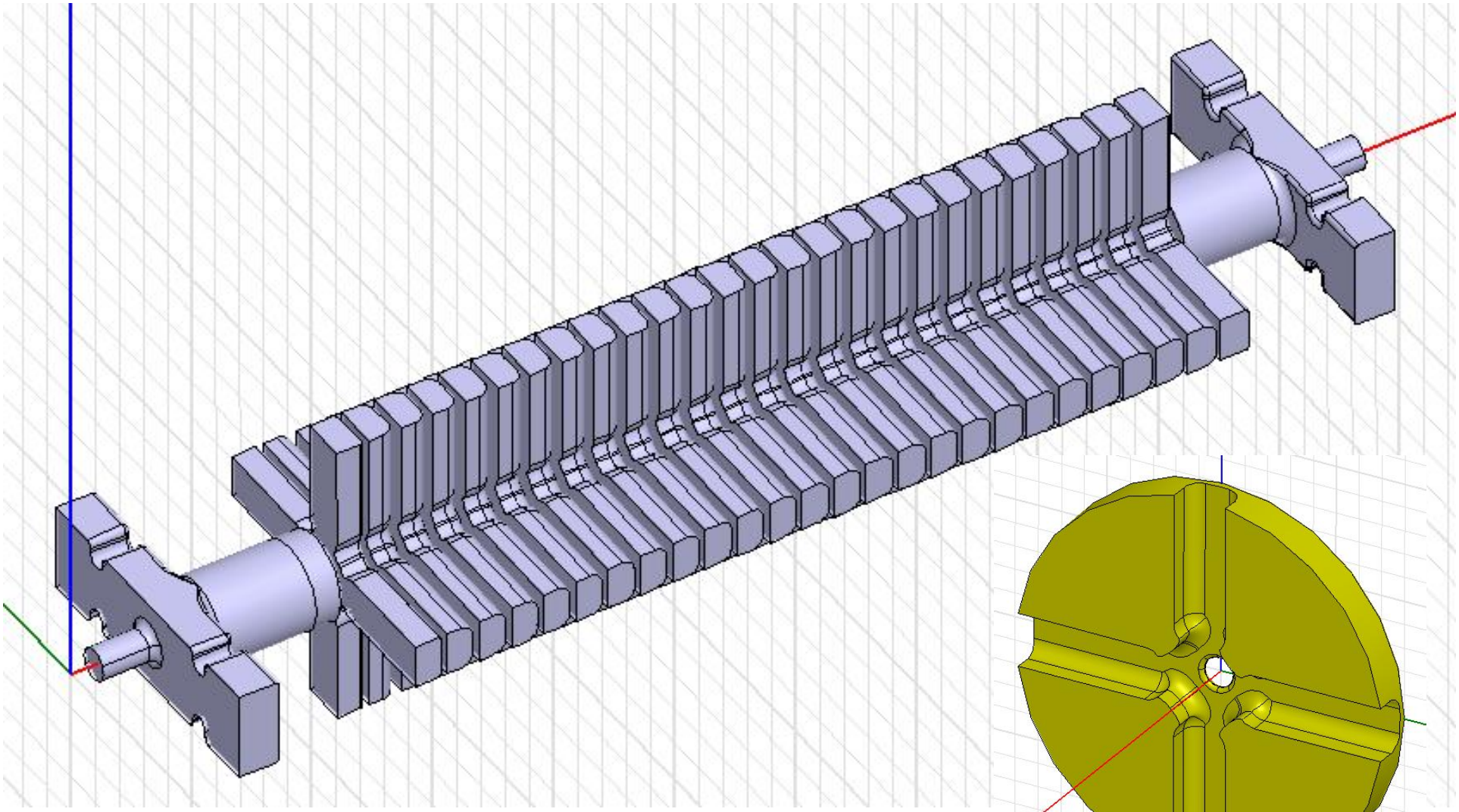
WDS cell geometry

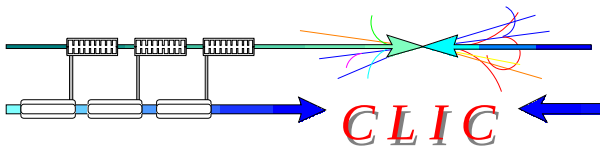
Waveguide Damped Structure (WDS) 2 cells



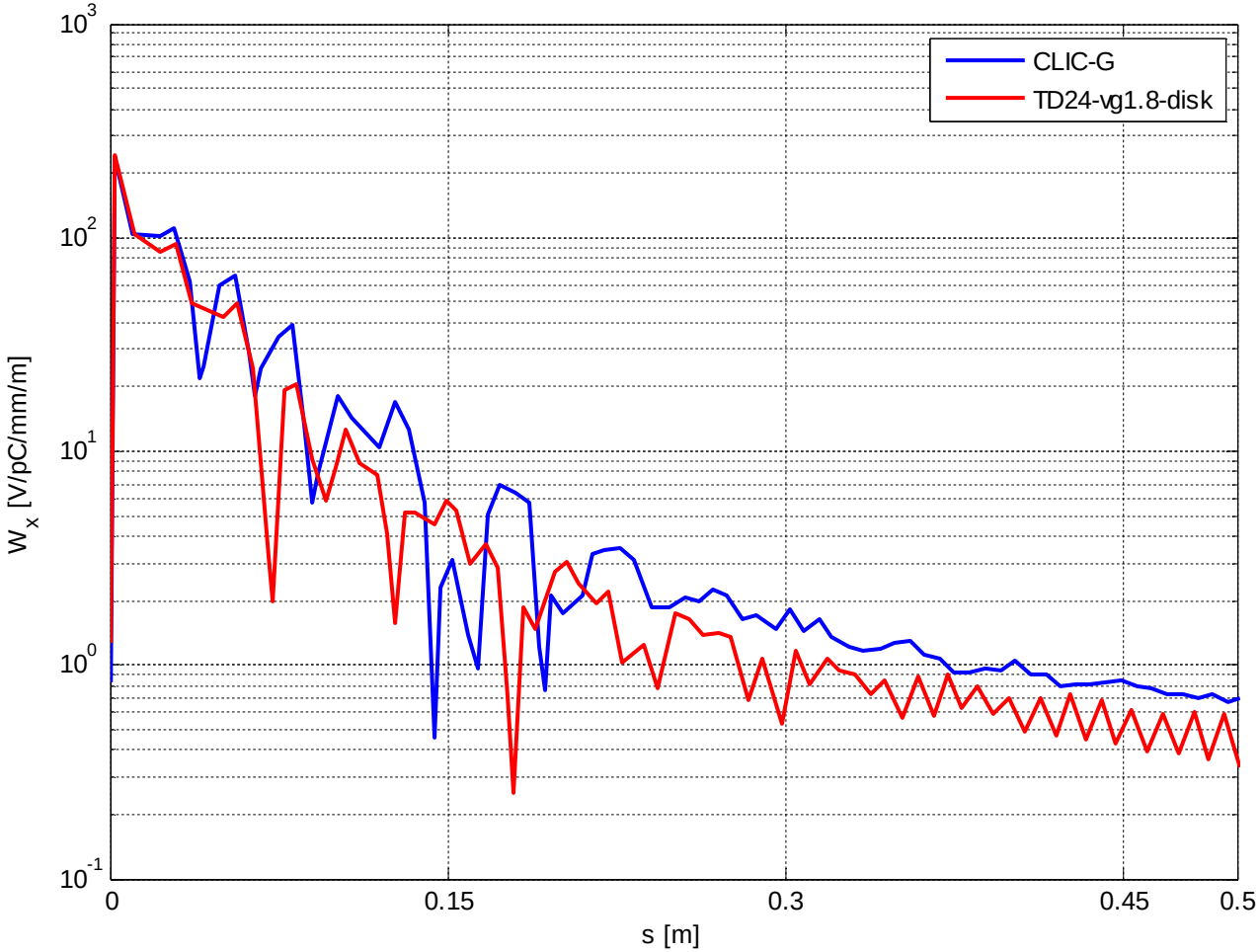
- Minimize E-field
- Minimize H-field
- Provide good HOM damping
- Provide good vacuum pumping

TD24_vg1.8_disk





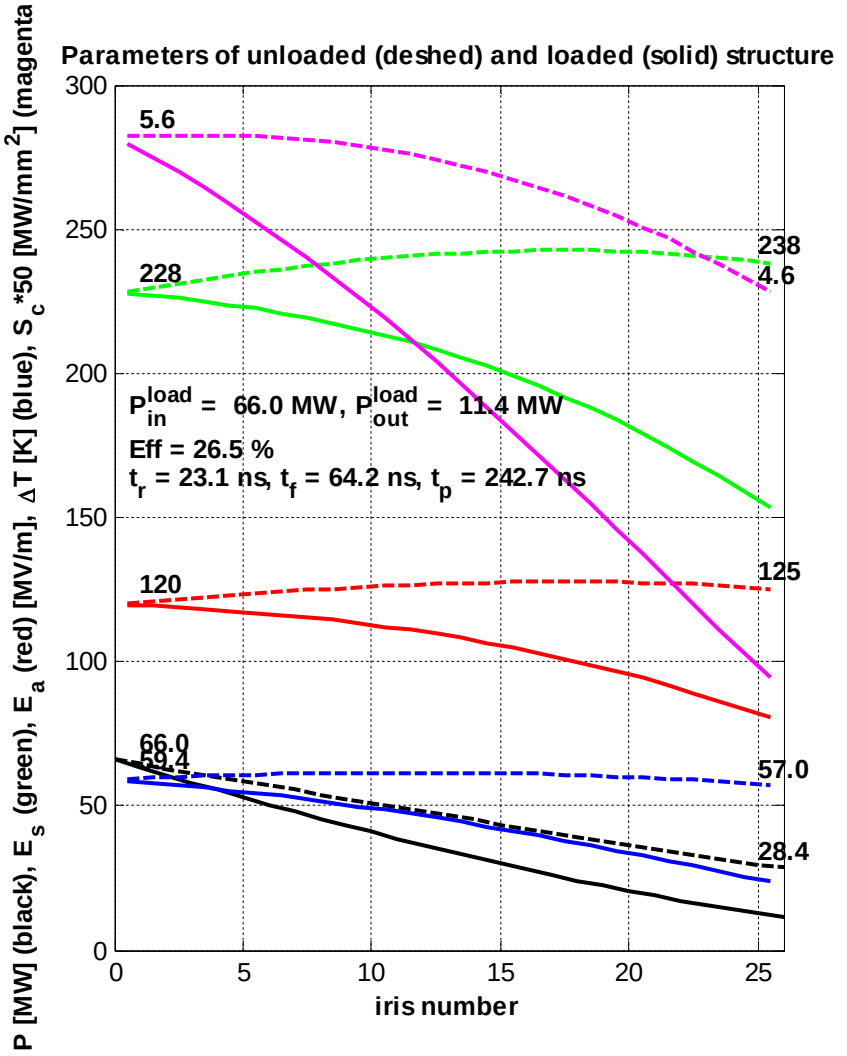
TD24_vg1.8_disk transverse wake



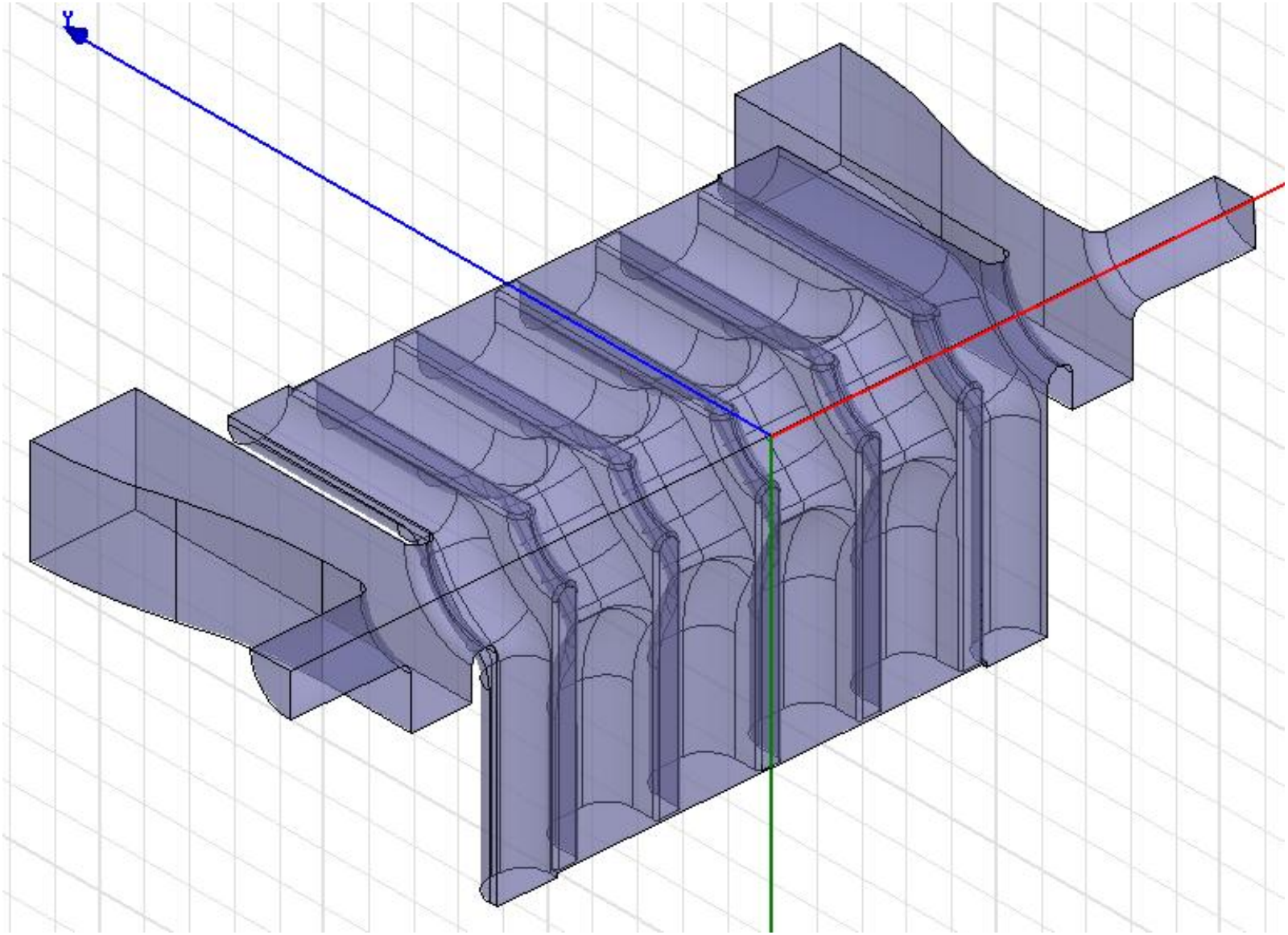
Parameters of TD24_vg1.8_disk

Structure	CLIC_G	TD24
Frequency: f [GHz]	12	12
Av. iris radius/wavelength: $\langle a \rangle/\lambda$	0.11	0.11
In/Output iris radii: $a_{1,2}$ [mm]	3.15, 2.35	3.15, 2.35
In/Output iris thickness: $d_{1,2}$ [mm]	1.67, 1.00	1.67, 1.00
Group velocity: $v_g^{(1,2)}/c$ [%]	1.66, 0.83	1.62, 0.81
N. of reg. cells, str. length: N_c, l [mm]	24, 229	24, 229
Bunch separation: N_s [rf cycles]	6	6
Lumi. per bunch X-ing: $L_{b\times}$ [m^{-2}]	1.22×10^{34}	1.22×10^{34}
Bunch population: N	3.72×10^{9}	3.72×10^{9}
Number of bunches in a train: N_b	312	312
Filling time, rise time: τ_f, τ_r [ns]	62.9, 22.4	64.2, 23.1
Pulse length: τ_p [ns]	240.8	242.7
Input power: P_{in} [MW]	63.8	66.0
$P_{in}/Ct_p^{1/3}$[MW/mm ns$^{1/3}$]	18	18.6
S_c^{max} [MW/mm^2]	5.4	5.6
Max. surface field: E_{surf}^{max} [MV/m]	245	240
Max. temperature rise: ΔT^{max} [K]	53	62
Efficiency: η [%]	27.7	26.5
Figure of merit: $\eta L_{b\times}/N$ [a.u.]	9.1	8.7

Parameters assuming coupler overhead

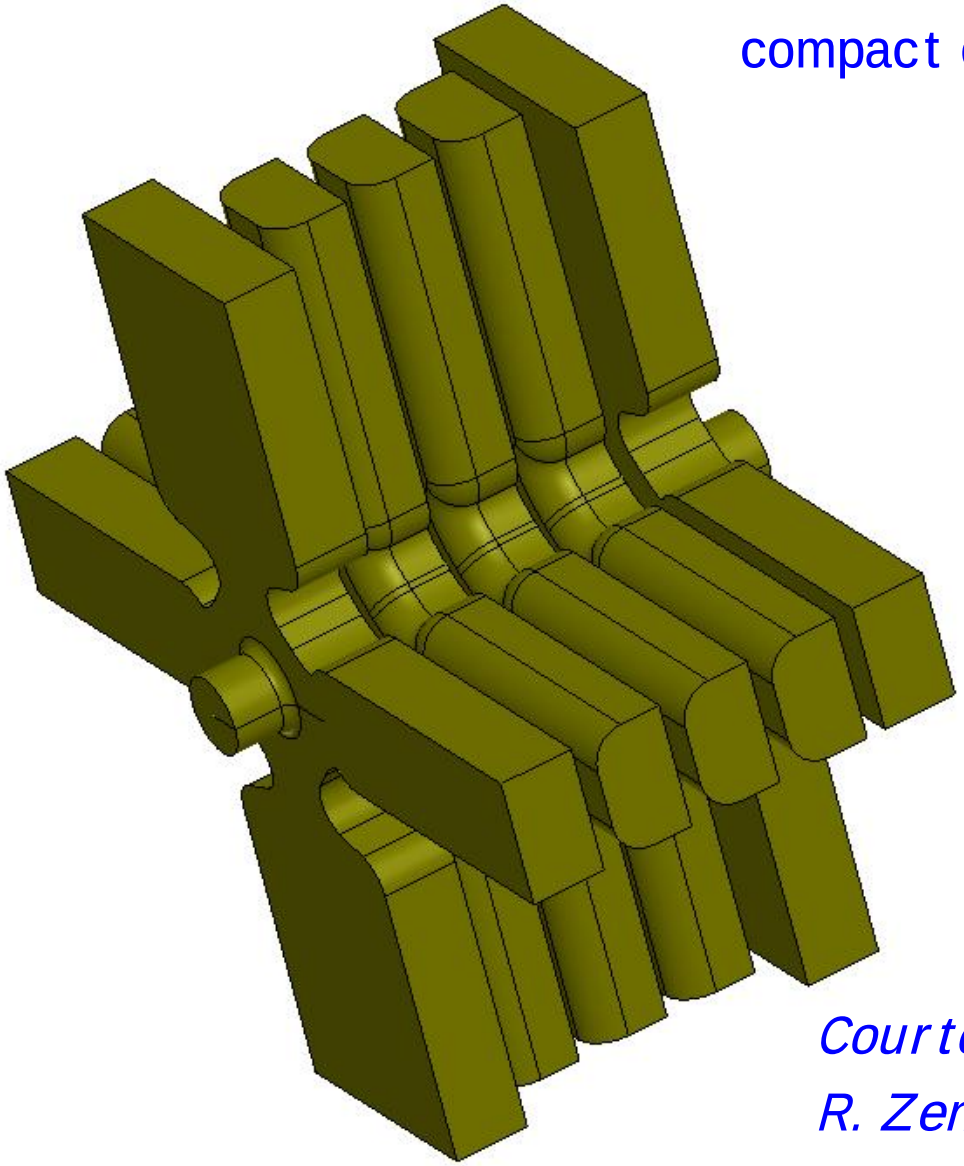


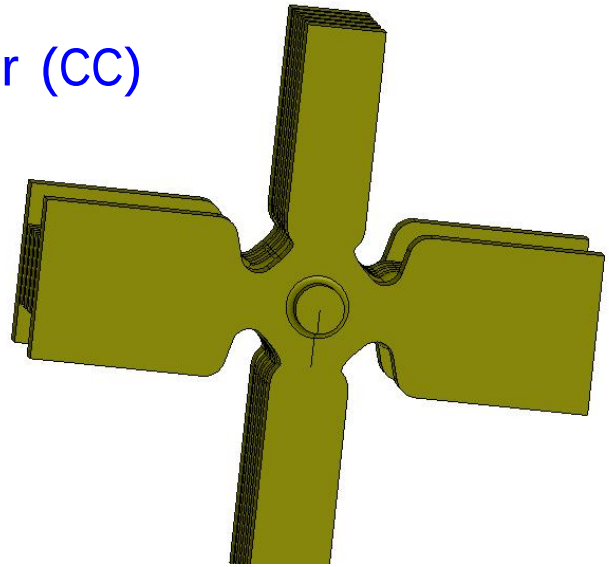
Electric field coupler

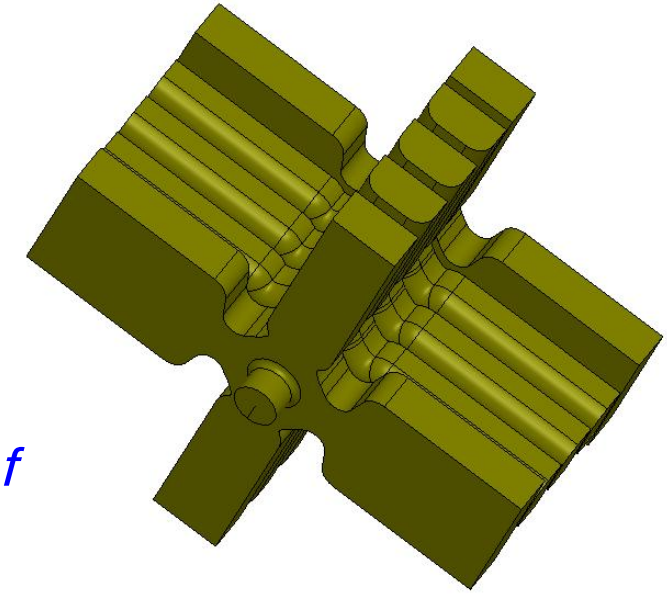


Magnetic field coupler with damping

compact coupler (CC)



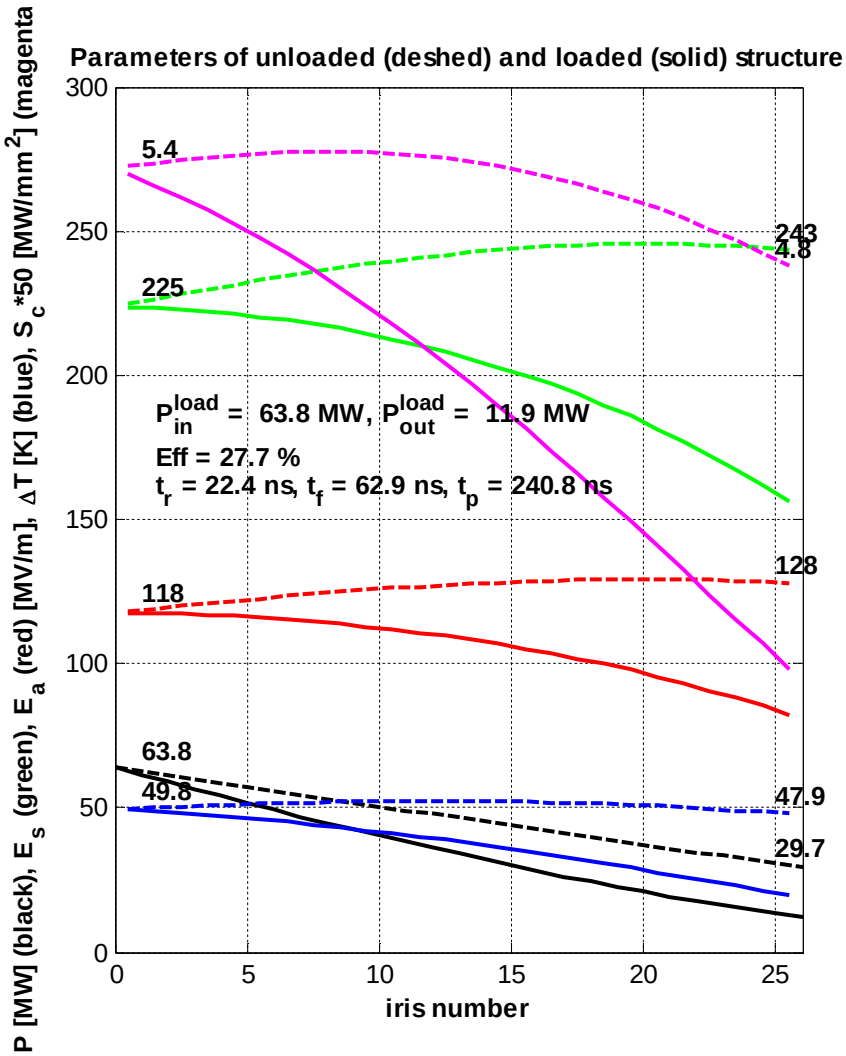




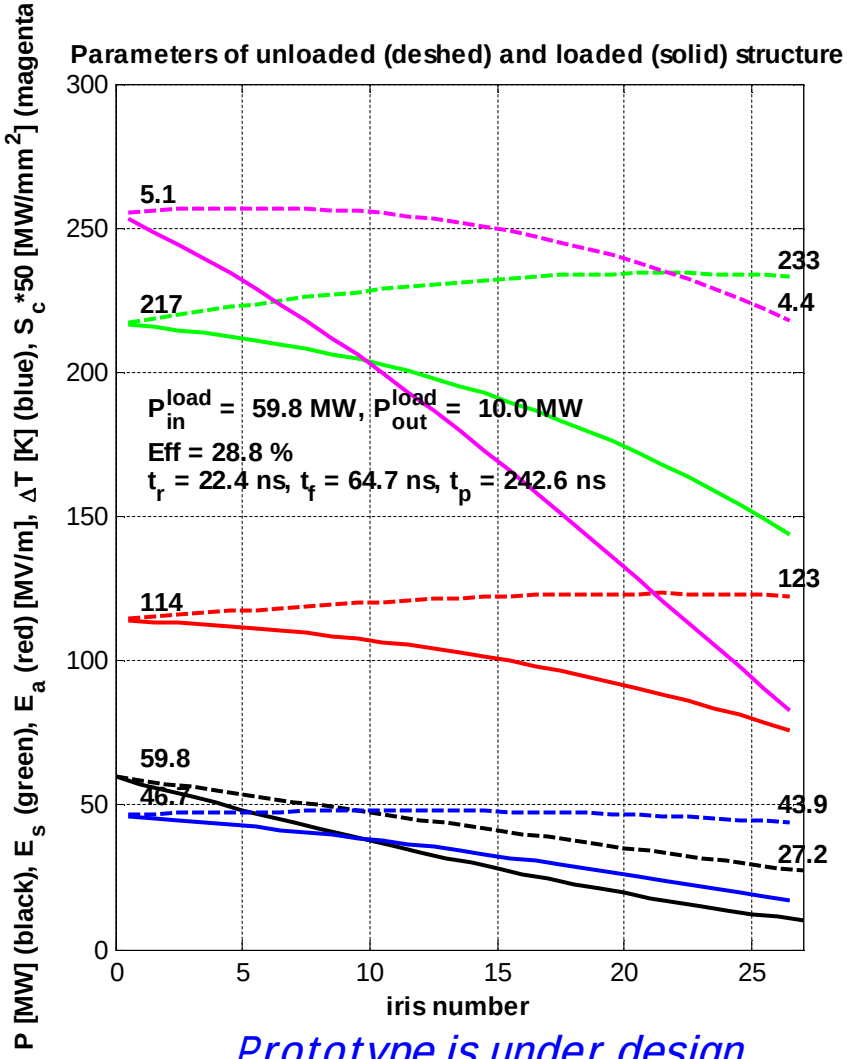
Courtesy of R. Zennaro

CLIC_G + compact coupler

CLIC_G



CLIC_GCC



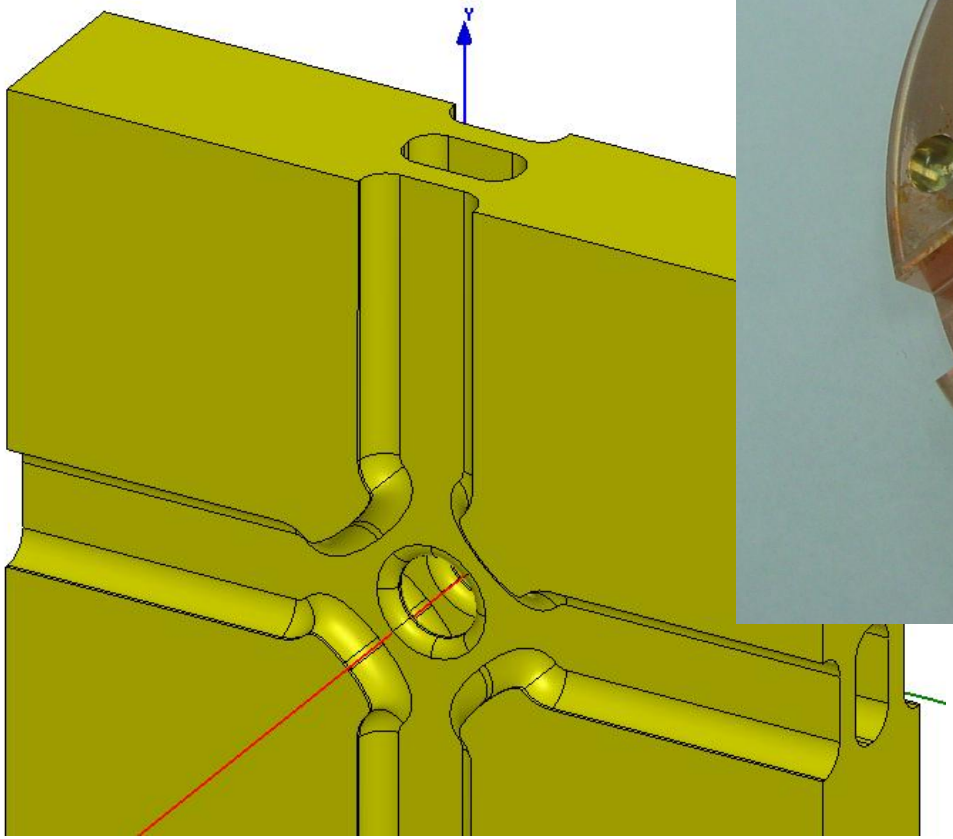
Prototype is under design

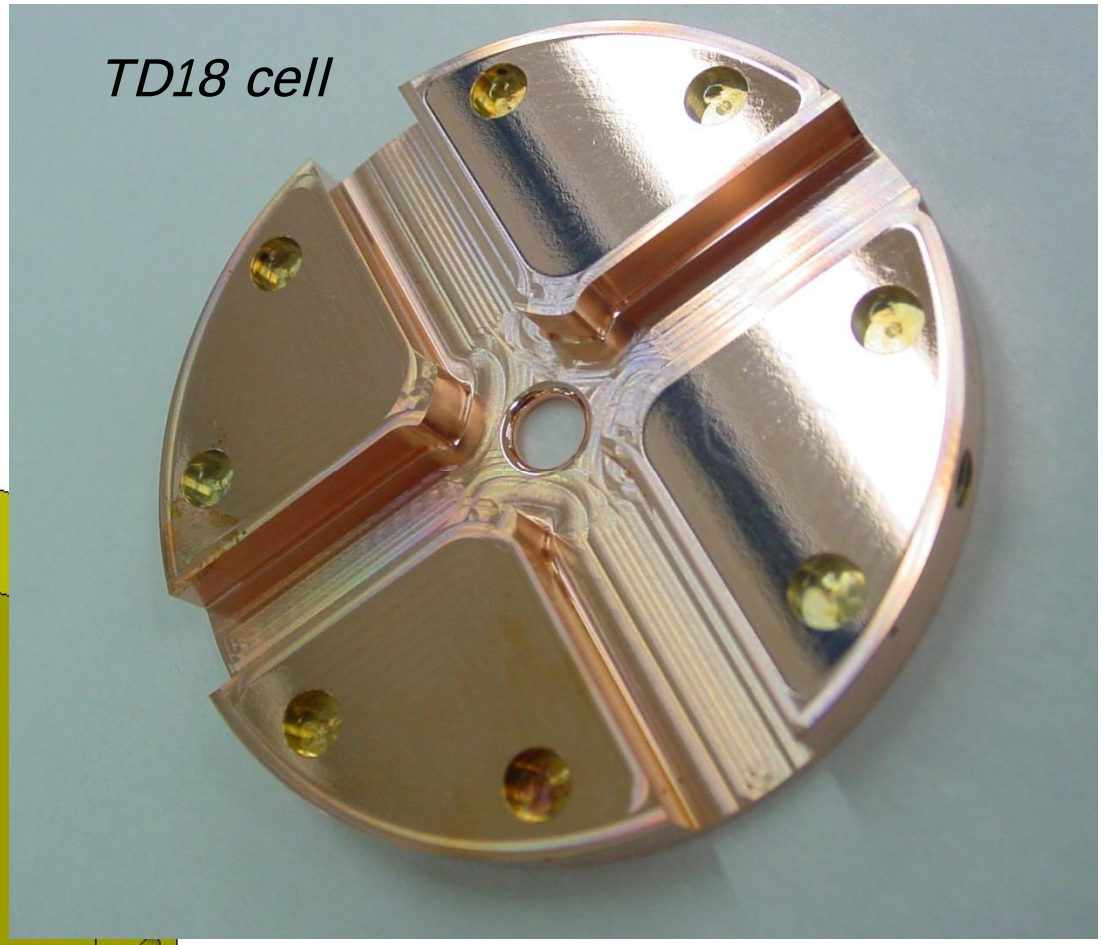
Rounded and non-rounded damped cells

CLIC_G rounded

idw = 8.75 mm

adw = 11.25 mm

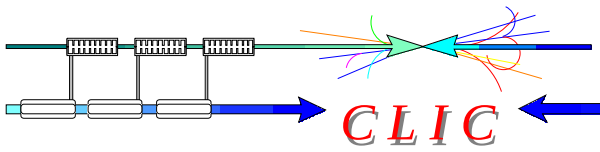




CLIC_G non-rounded

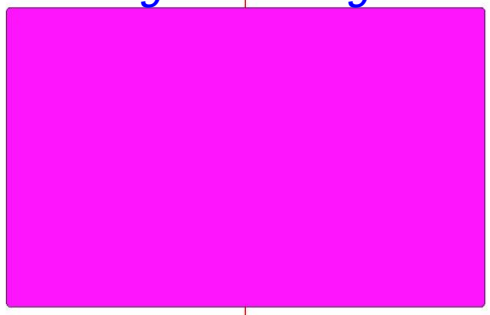
idw = 8.2 mm

adw = 10.1 mm

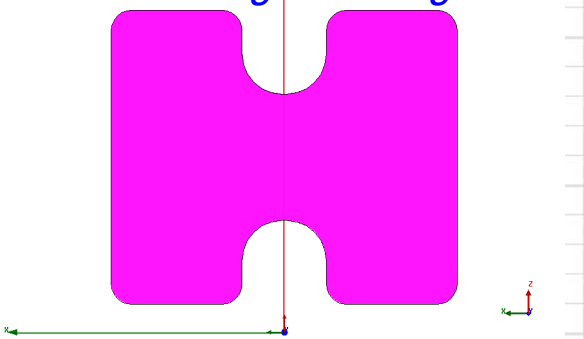


Ridged waveguide for HOM damping

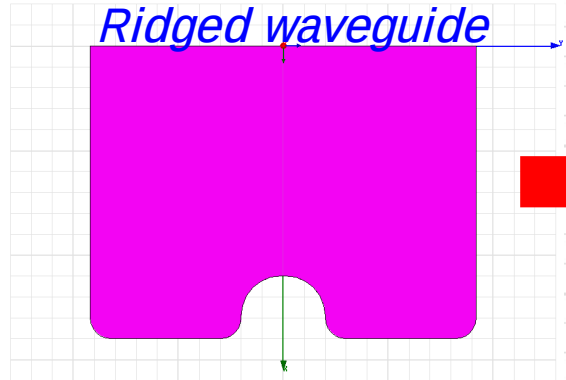
Rectangular waveguide



Double-ridged waveguide



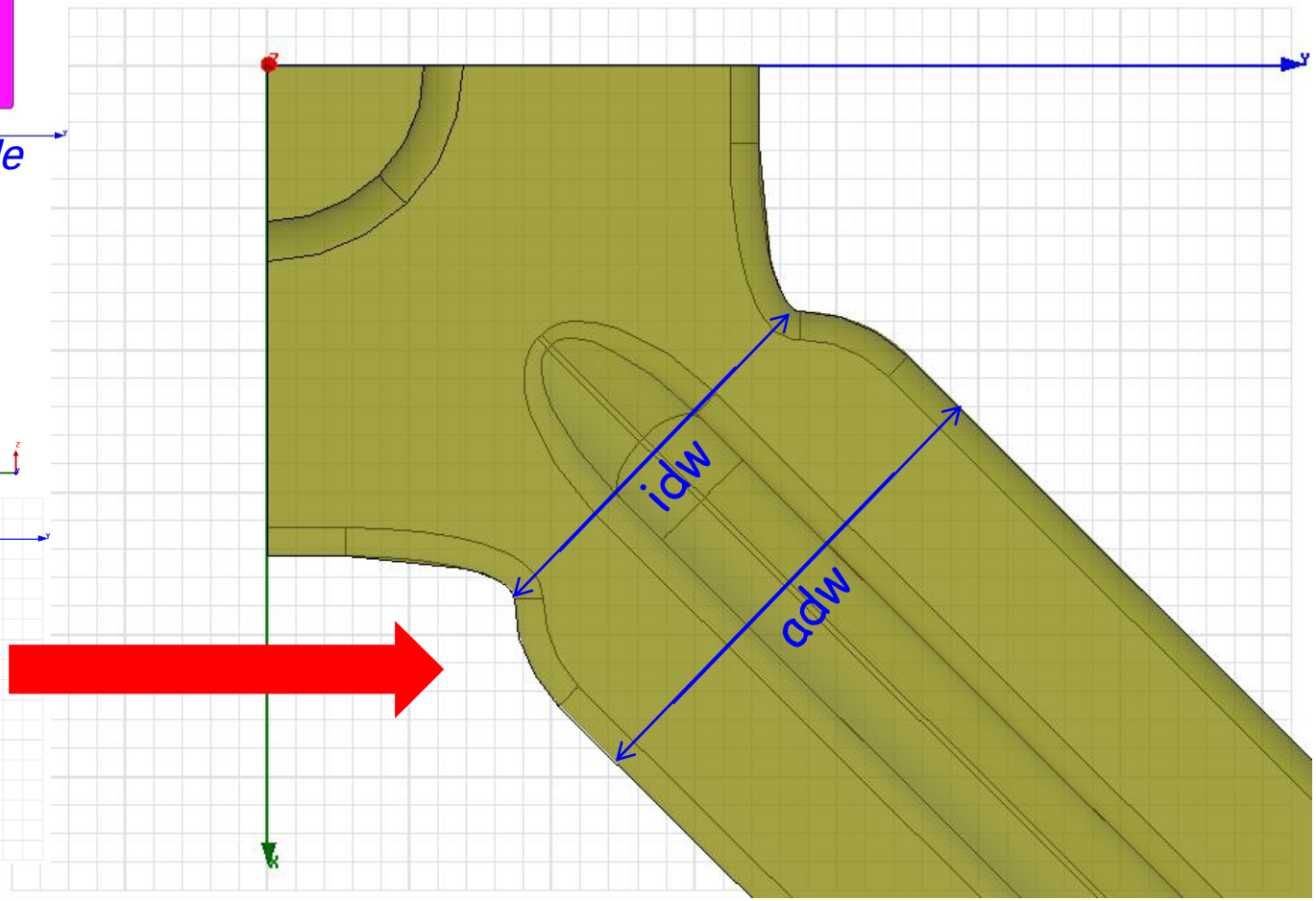
Ridged waveguide



CLIC_GLDT (low ΔT)

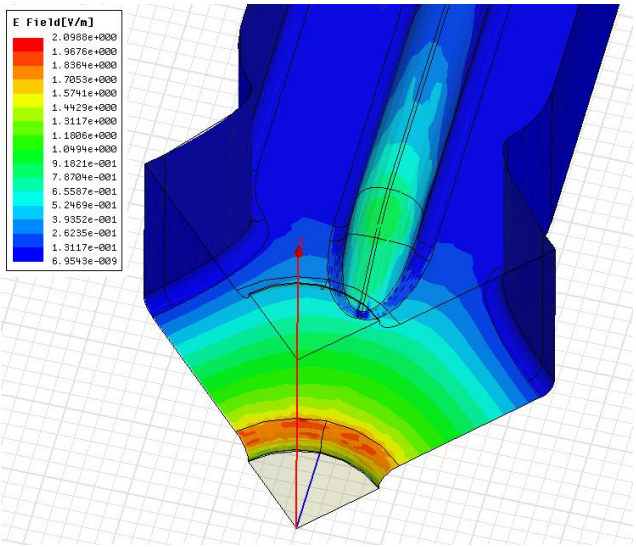
idw = 7.5 mm

adw = 9.25 mm

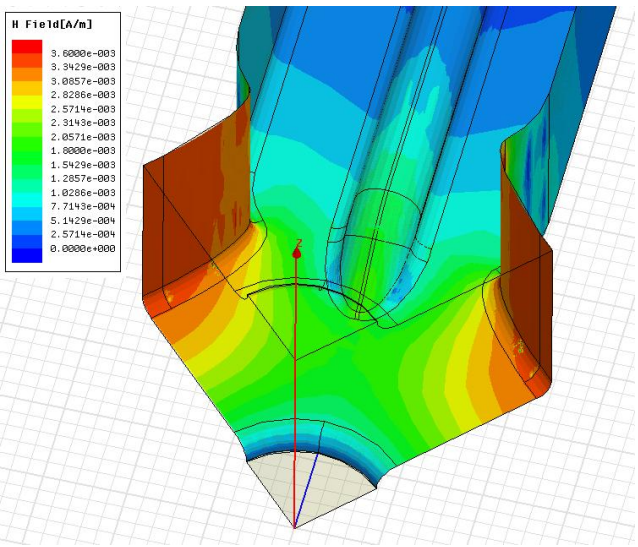


EM field configuration in RWDS

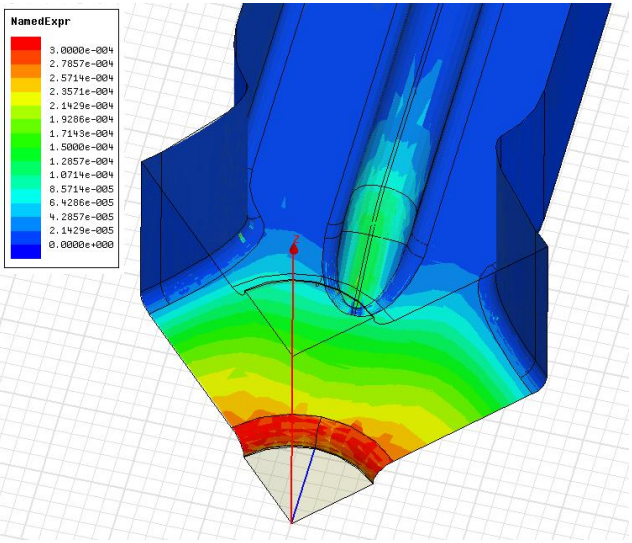
Electromagnetic field configuration on the surface of a Ridged waveguide damped structure (RWDS) cell



Electric field



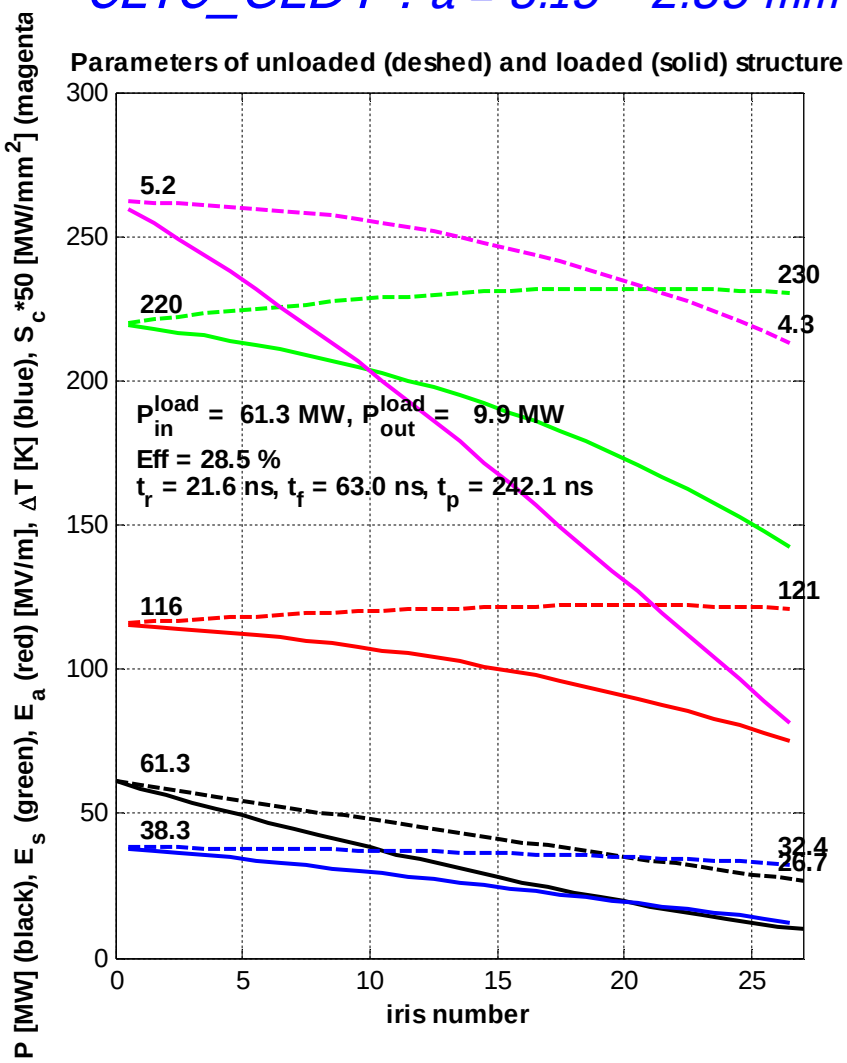
Magnetic field



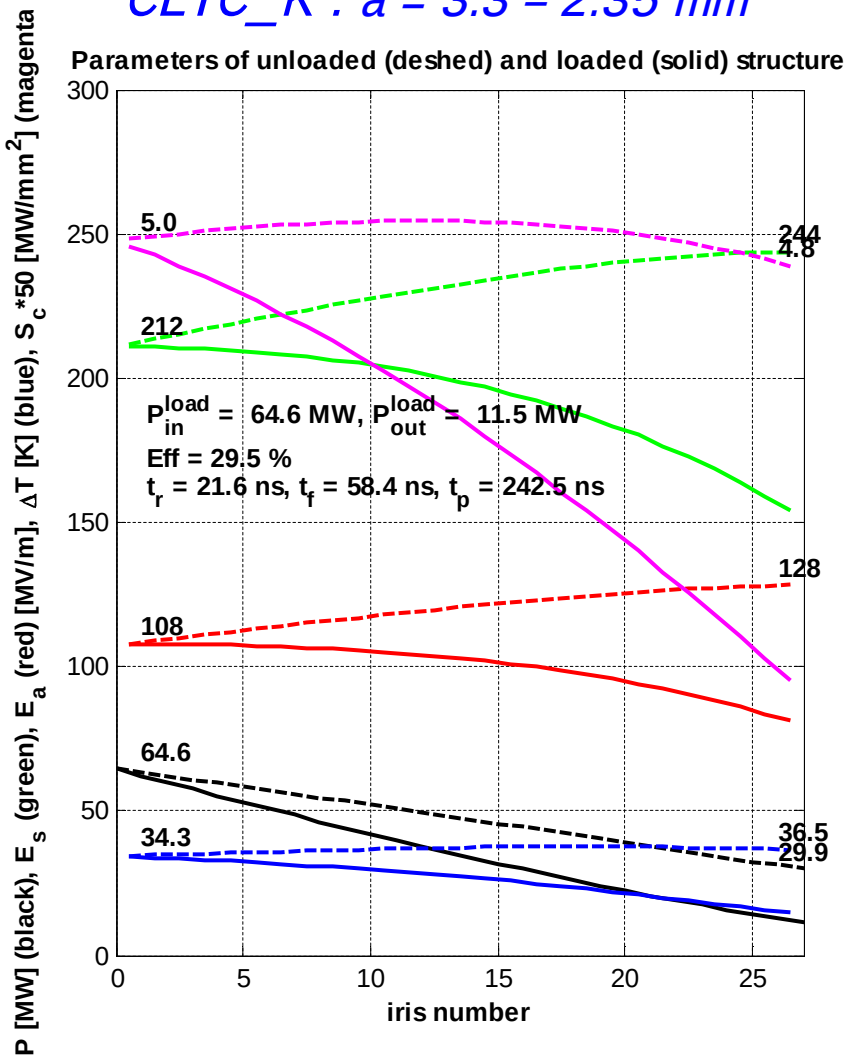
Sc

Structures with ridged waveguide damping

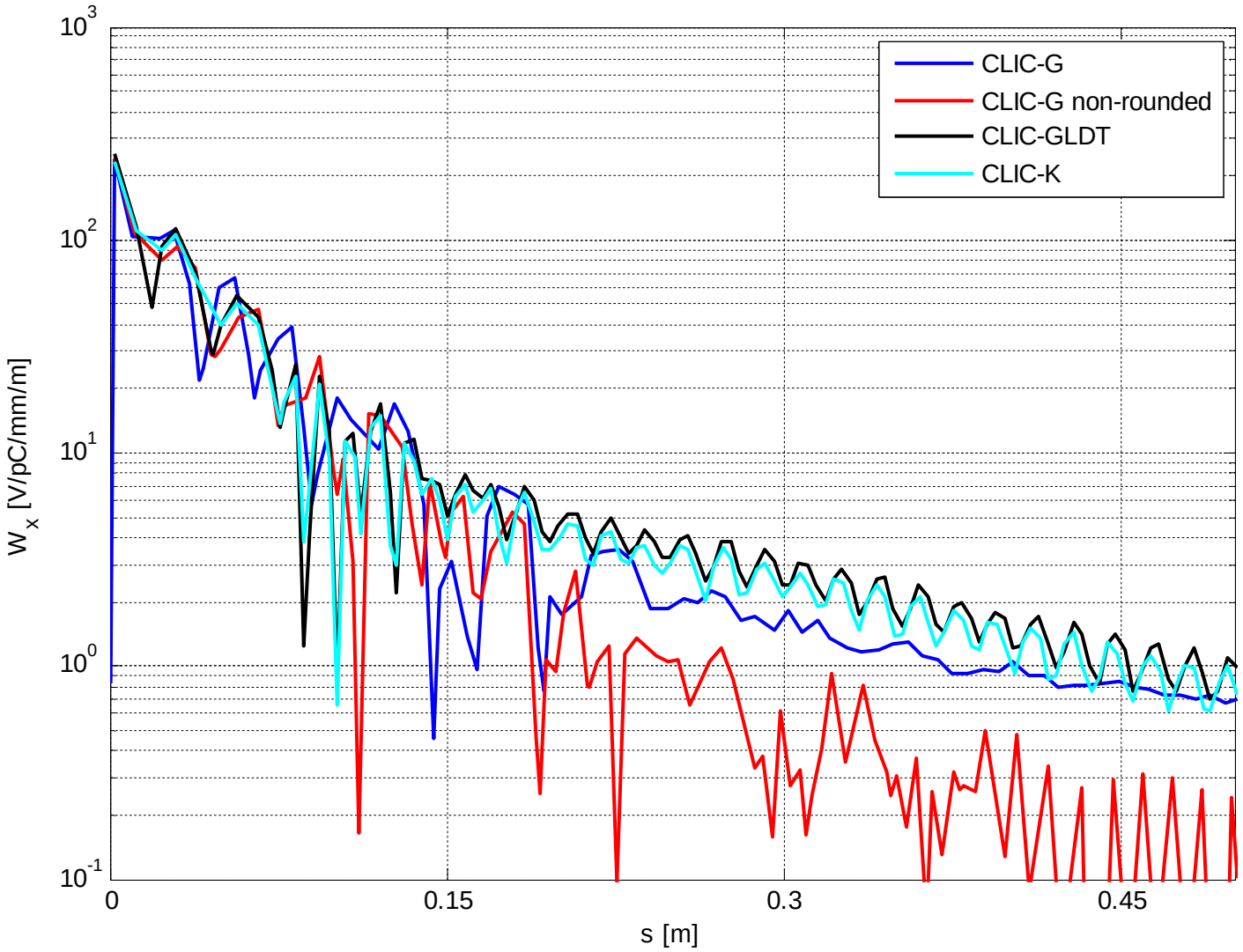
CLIC_GLDT : a = 3.15 – 2.35 mm



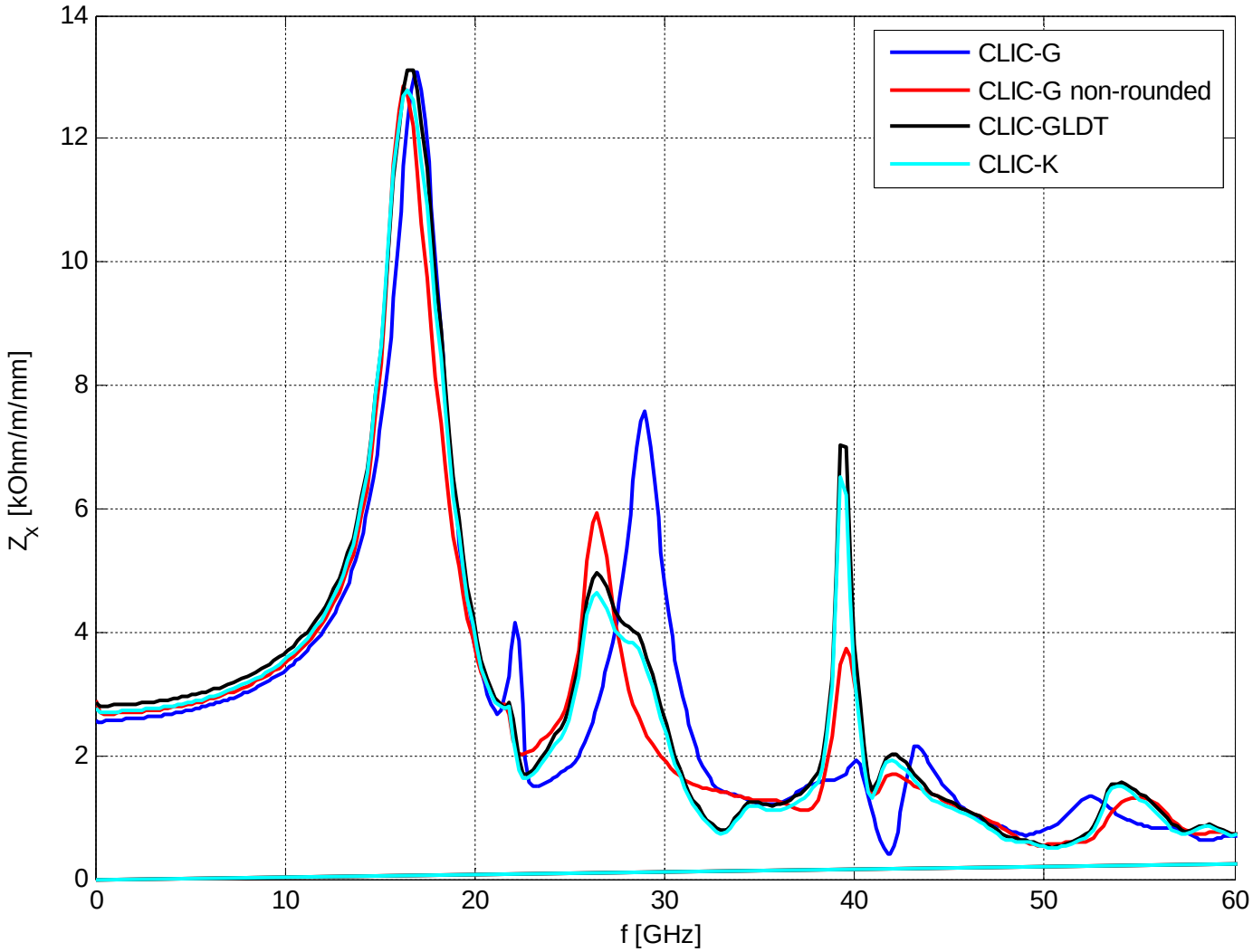
CLIC_K : a = 3.3 – 2.35 mm

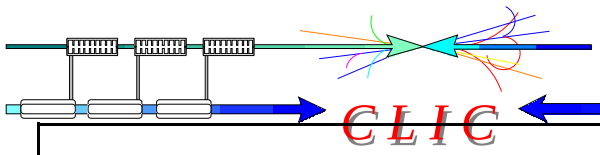


Wake field of proposed structures



Transverse impedance

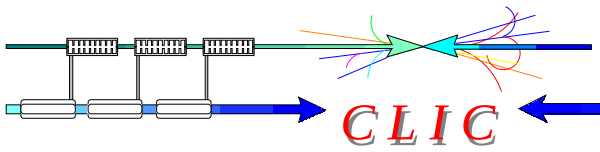




Parameters of the structures

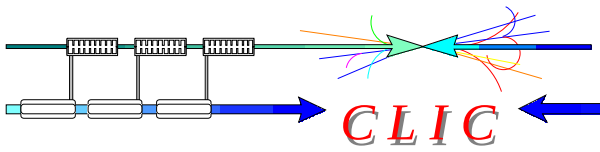
Structure	CLIC_G	CLIC_GCC	CLIC_GCC non-rounded	CLIC_GLDT	CLIC_K
Frequency: f [GHz]	12	12	12	12	12
Average iris radius/wavelength: $\langle a \rangle/\lambda$	0.11	0.11	0.11	0.11	0.113
Input/Output iris radii: $a_{1,2}$ [mm]	3.15, 2.35	3.15, 2.35	3.15, 2.35	3.15, 2.35	3.3, 2.35
Input/Output iris thickness: $d_{1,2}$ [mm]	1.67, 1.00	1.67, 1.00	1.67, 1.00	1.67, 1.00	1.67, 1.00
Group velocity: $v_g^{(1,2)}/c$ [%]	1.66, 0.83	1.66, 0.83	1.67, 0.84	1.68, 0.86	1.97, 0.86
N. of reg. cells, str. length: N_c, l [mm]	24, 229	25, 225	25, 225	25, 225	25, 225
Bunch separation: N_s [rf cycles]	6	6	6	6	6
Luminosity per bunch X-ing: $L_{b\times}$ [m^{-2}]	1.22×10^{34}	1.22×10^{34}	1.22×10^{34}	1.22×10^{34}	1.28×10^{34}
Bunch population: N	3.72×10^{9}	3.72×10^{9}	3.72×10^{9}	3.72×10^{9}	3.94×10^{9}
Number of bunches in a train: N_b	312	312	312	316	326
Filling time, rise time: τ_f, τ_r [ns]	62.9, 22.4	64.7, 22.4	63.8, 22.0	63.0, 21.6	58.4, 21.6
Pulse length: τ_p [ns]	240.8	242.6	241.4	242.1	242.5
Input power: P_{in} [MW]	63.8	59.8	61.5	61.3	64.6 (65.2)
$P_{in}/Ct_p^{P\ 1/3}$[MW/mm ns$^{1/3}$]	17.9	16.8	17.3	17.3	17.5
S_c^{max} [MW/mm^2]	5.4	5.1	5.3	5.2	5.1
Max. surface field: E_{surf}^{max} [MV/m]	245	233	230	230	244
Max. temperature rise: ΔT^{max} [K]	53	48	45	39	37
Efficiency: η [%]	27.7	28.8	28.1	28.5	29.5 (29.2)
Figure of merit: $\eta L_{b\times}/N$ [a.u.]	9.1	9.4	9.3	9.4	9.6

(95% of Cu conductivity)

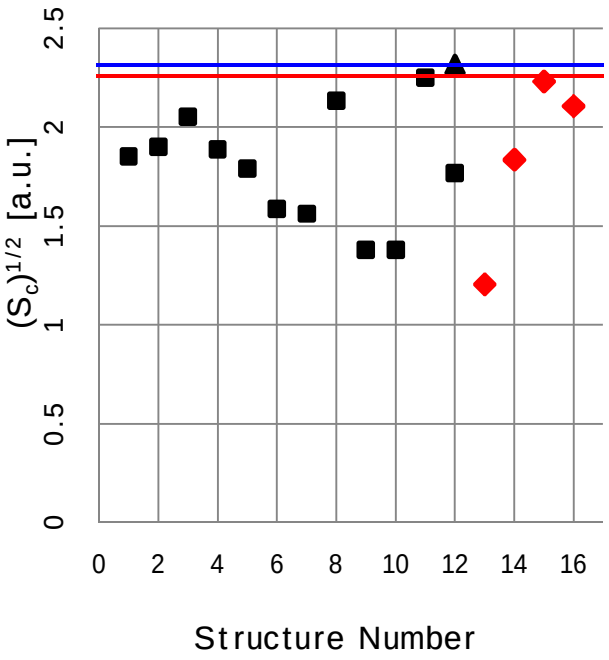


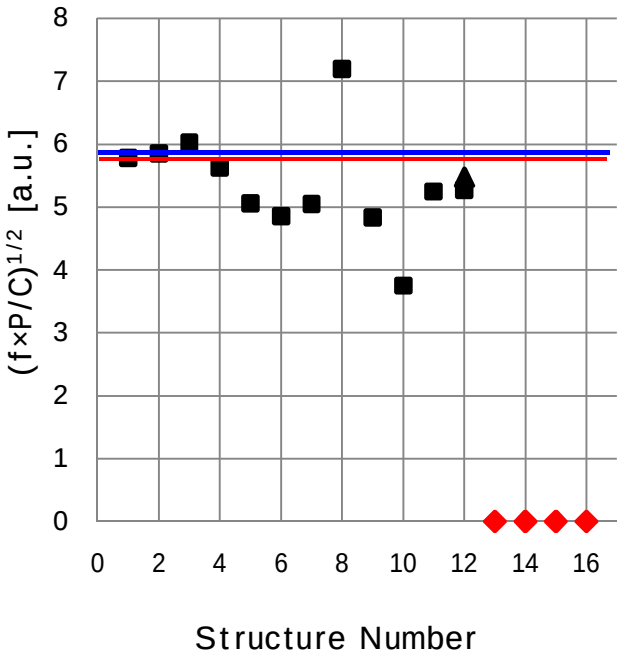
Proposal for new test structures

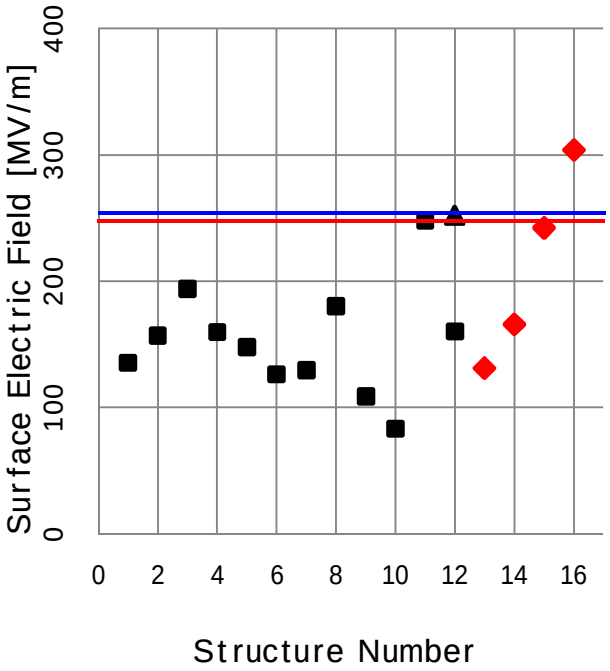
1. CLIC_GCC non-rounded: TD25_vg1.7_disk - an optimized version of TD24-type made in standard disk technology the same as TD18-type.
2. CLIC_GLDT: TD25_vg1.7_dLDT – structure with ridged waveguide damping
3. CLIC_K:
   - T25_vg2_disk – non-damped structure with higher input group velocity and stronger tapering than CLIC_G
   - TD25_vg2_disk – damped version



RF breakdown constraints







Constraints @ {200ns, BDR=10^{-6} bpp/m} ~ {180ns, BDR=3×10^{-7} bpp/m}