A DAMPED AND DETUNED STRUCTURE FOR THE MAIN LINACS FOR CLIC

V. F. Khan[†*], A. D'Elia[†*‡], A. Grudiev[‡], R. M. Jones[†*], G. Riddone[‡], V. Soldatov[‡°], W. Wuensch[‡], R. Zennaro[ℑ]

[†] School of Physics and Astronomy, The University of Manchester, Manchester, U.K.
[*] The Cockcroft Institute of Accelerator Science and Technology, Daresbury, U.K.
[‡] CERN, Geneva, Switzerland.
[°] JINR, Dubna, Russia
[ℑ] PSI, Villigen, Switzerland

ABSTRACT

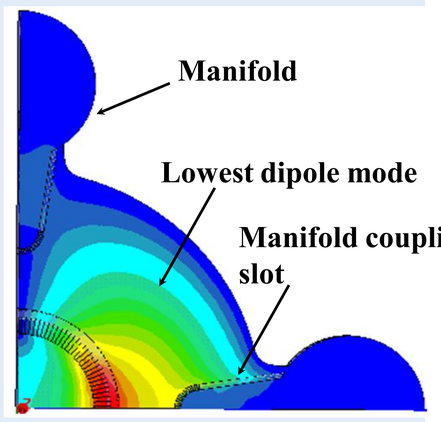
A damped detuned structure (DDS) for the main linacs of CLIC is being studied as an alternative design to the present baseline heavily damped structure (CLIC_G). In our earlier designs [1-2] we studied a detuned structure, operating at 11.994 GHz, with a range of dipole bandwidths in order to ensure the structure satisfies beam dynamics and rf breakdown constraints [3]. Here we report on the development of a damped and detuned structure which satisfies both constraints. Finally we will focus on a structure (CLIC_DDS_A) which has been fully designed and presently under construction, conceived to be submitted to High Power tests at CERN.

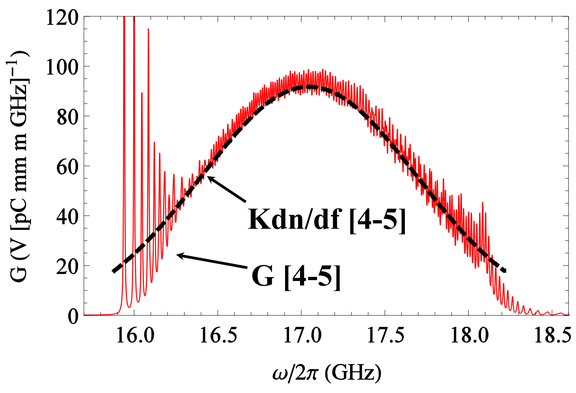
STRUCTURE WITH RELAXED PARAMETERS: CLIC_DDS_C

Modifying the bunch spacing to 8 rf cycles (~0.67 ns) allowed the transverse wakefield to be damped sufficiently once the structure is provided with a bandwidth of ~ 2.3 GHz. The dipole frequencies of 24 cells are detuned by employing an erf (error) function variation of each iris with cell number. The recoherence in the wakefield is prevented by coupling it out through slots in each cell to the attached manifolds. This adversely affects the magnetic field and gives rise to an unacceptable surface pulse temperature rise (ΔT).

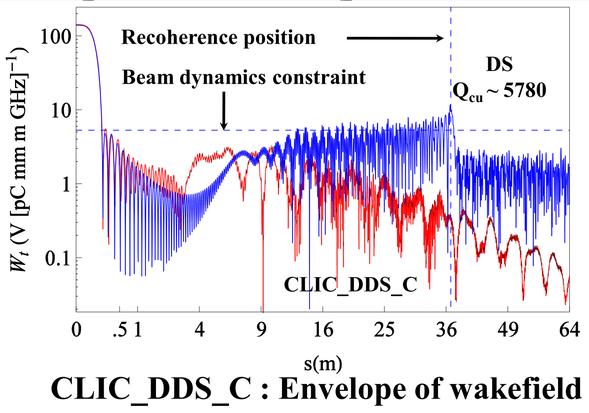
CLIC_DDS_C SPECIFICATIONS

- Twenty four cells per structure
- Eight structures interleaved
- Dipole bandwidth, Δf = 2.3 GHz =3.6 σ
- Detuning : 13.7 % of central frequency
- Taper in iris : 4 mm to 2.3 mm
- Excellent wakefield suppression
- Unacceptable rise in surface fields due to coupling slots.





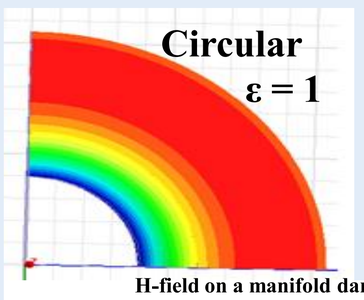
CLIC_DDS_C : Spectral function(G)

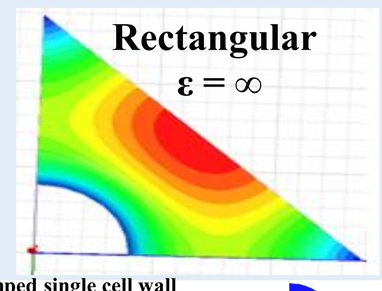


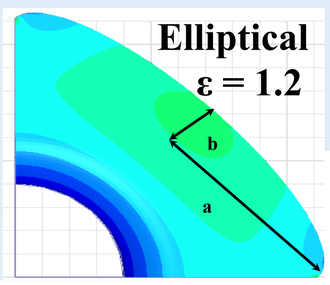
CLIC_DDS_C : Envelope of wakefield in an *8-fold interleaved structure*

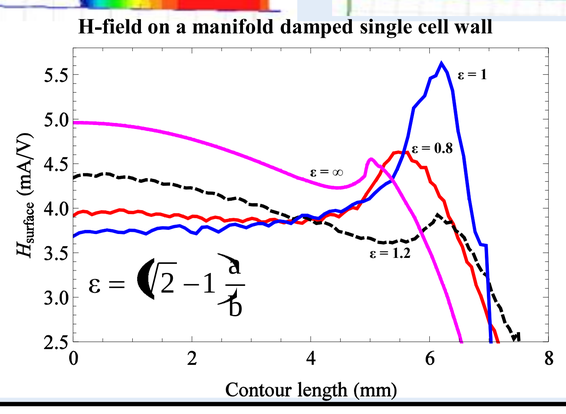
H-FIELD OPTIMISATION

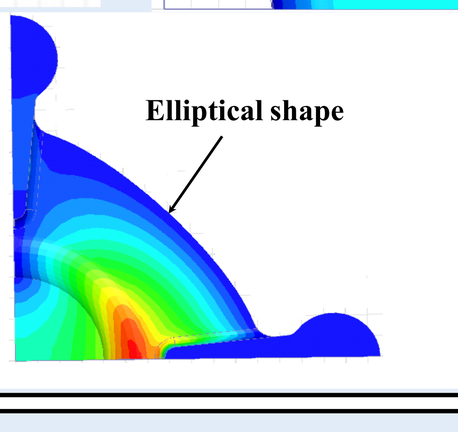
- In order to redistribute the field in the region of the slot-coupeld manifold we considered various elliptical wall geometries.
- Both convex and concave were considered.
- Final optimised shape reduces ΔT by ~ 23% (65 ^{0}K to 51 ^{0}K).





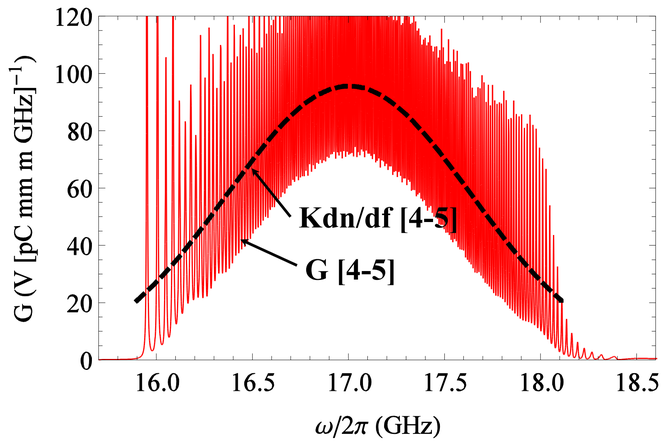




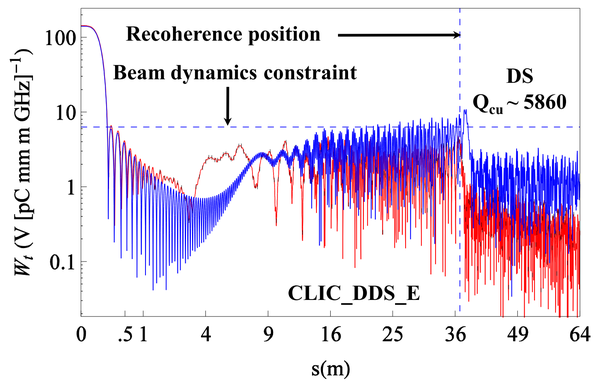


ELLIPTICAL WALL : CLIC_DDS_E

- Modifying the surface of the outer wall succeeds in reducing monopole H-field and ΔT .
- This reduces the dipole e.m. field in the vicinity of the slots and hence reduces the efficacy of manifold damping.
- Mechanical engineering considerations (rounding of edges and corners) exacerbates the reduction in coupling.
- Nonetheless, the wakefield is still more than adequately suppressed!



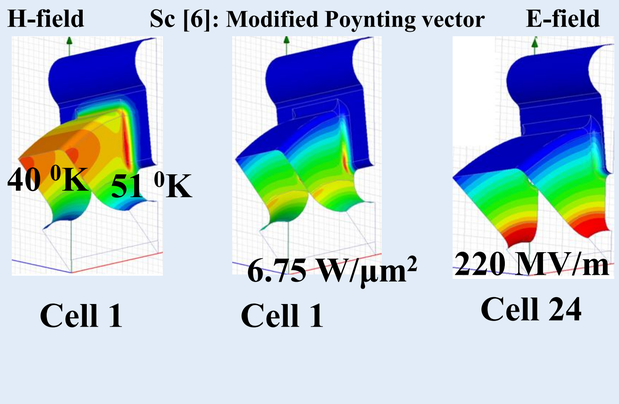
CLIC_DDS_E : Spectral function(G)

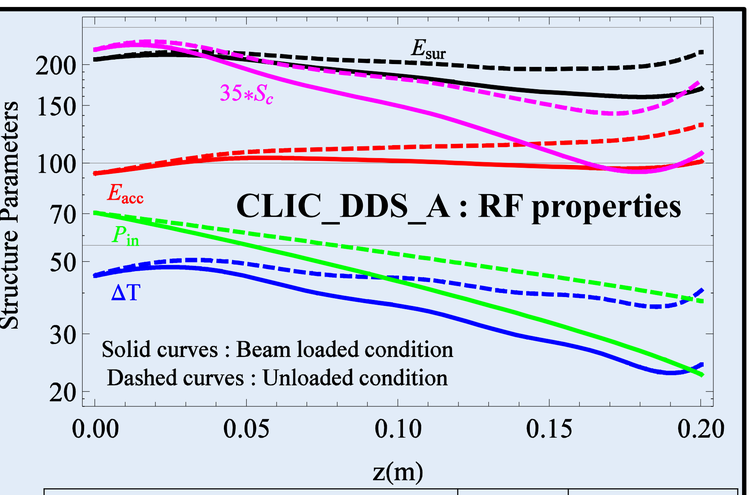


CLIC_DDS_E : Envelope of wakefield in an *8-fold interleaved structure*

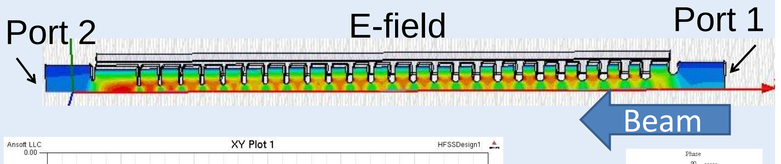
HIGH POWER TEST: CLIC_DDS_A

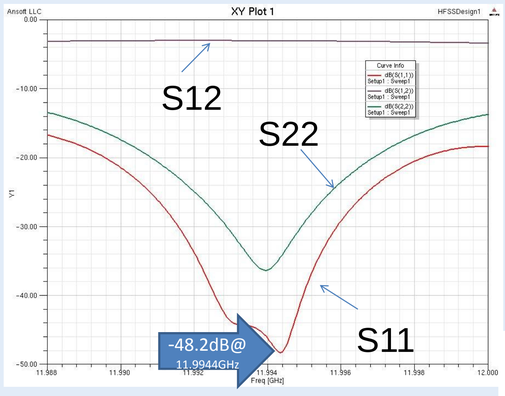
- A single structure will be tested at input power of 71 MW/m to ascertain the suitability of the structure to sustain high e.m. field gradients
- RF and mechanical design completed
- Disks being fabricated by VDL -qualification disks received (Oct 15th 2010)!
- The whole structure will be ready for the end of this year/beginning of next year
- High Power Tests are foreseen in the first quarter of next year

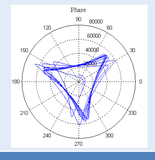


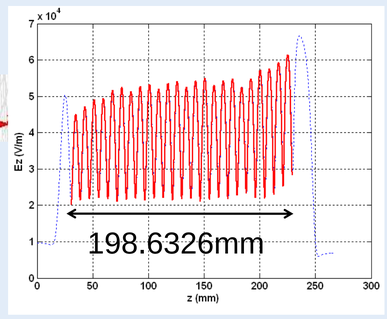


RF check of mechanical design

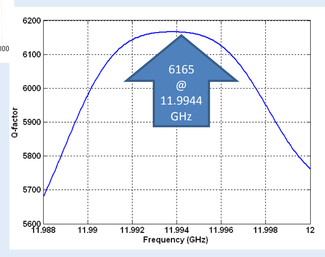


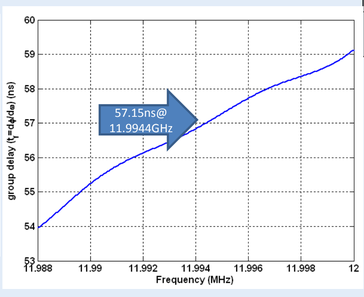




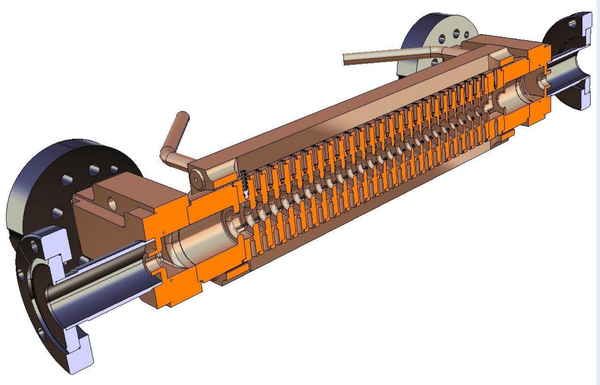


V_{26} [V]@P_{in} = 1 W	2678
G_{26} [V/m]@P_{in} = 1 W	13481
P_{in} [MW]@<G_{26}=100MV/m>	55.03





CLIC_DDS_A : 3D cut-view



CLIC_DDS_A : RF params.	Unit	Values
Fundamental mode Q (In / Out)	-	5020 / 6534
Shunt impedance R' (In / Out)	MΩ/m	51 / 118
Group velocity v_g/c (In / Out)	%	2.07 / 1.0
Bunch population (N_b)	-	4.2 x 10^9
Peak input power (P_{in})	MW	71
Pulse length (Total/ flat top)	ns	277 / 208
Acc. grad. E_{acc}^{max} (Load./Unload.)	MV/m	105 / 132
Pulsed temp. rise ΔT_{sur}^{max}	^{o}K	51
Surface electric field E_{sur}^{max}	MV/m	220
Modified Poynting vector S_c^{max}	W/μm²	6.75
RF-beam efficiency (η)	%	23.5

ACKNOWLEDGEMENTS

V. Khan acknowledges receipt of funding from the Cockctoft Institute. This research has received funding from the European Commission under FP7 Research Infrastructure grant agreement no. 227579.

REFERNCES

[1] V.F. Khan and R.M. Jones, EPAC08, 2008.
[2] V.F. Khan and R.M. Jones, LINAC08, 2008.
[3] H. Braun, *et. al*, CLIC-Note764, 2008.
[4] R.M. Jones, *et. al*, PRST-AB, **9**, 102001, 2006.
[5] R.M. Jones, *et. al*, NJP, **11** 033013, 2009.
[6] A. Grudiev, *et. al,* PRST-AB, **10** 102001, 2009.