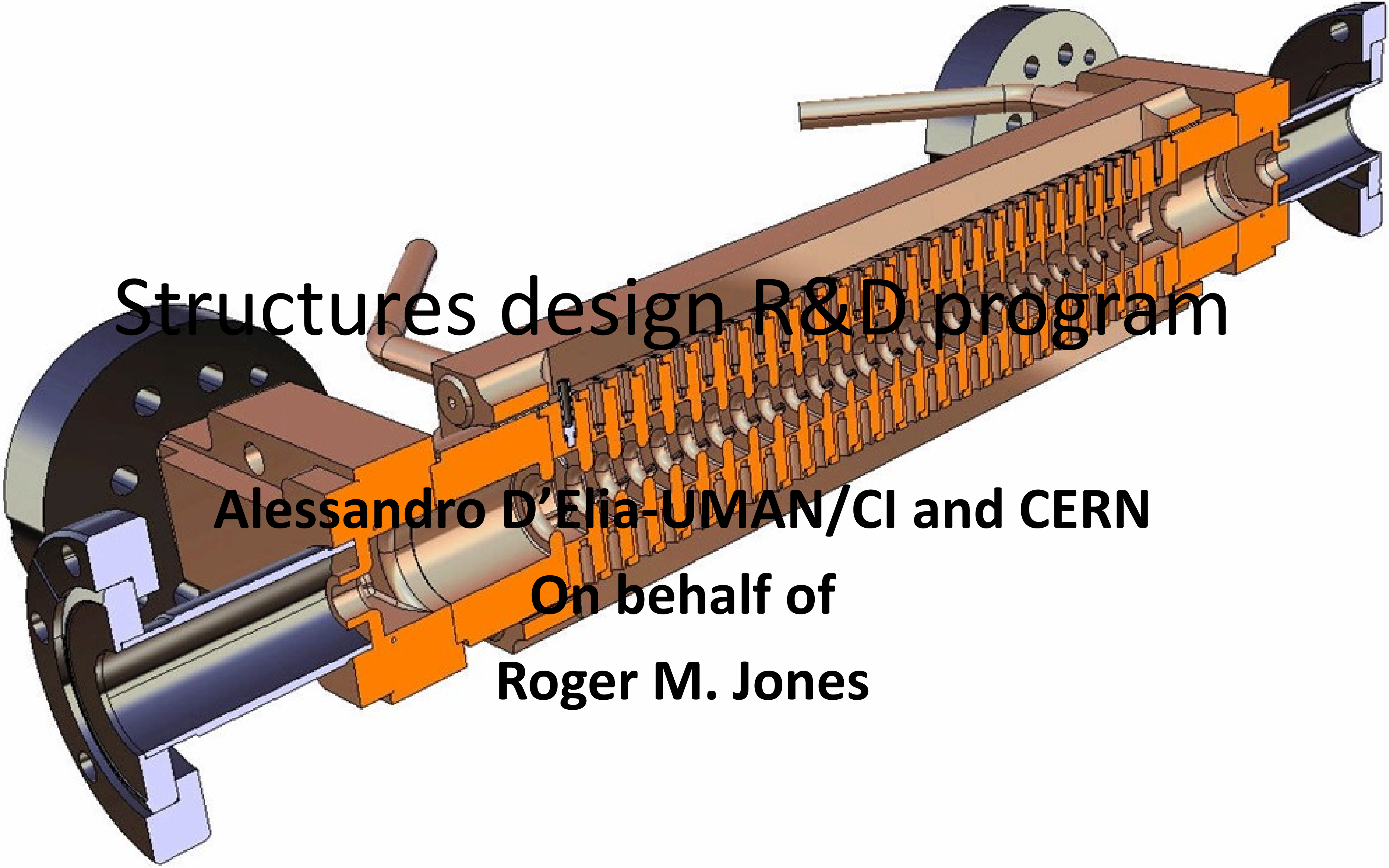


Structures design R&D program

Alessandro D'Elia-UMAN/CI and CERN

On behalf of

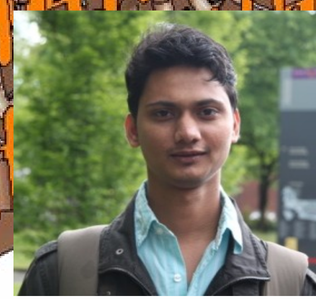
Roger M. Jones

Wake Function Suppression for CLIC-Staff

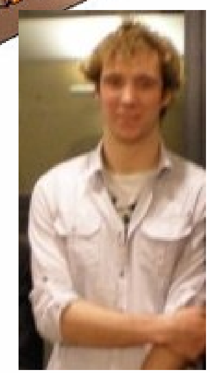
- Roger M. Jones (Univ. of Manchester faculty)
- Alessandro D’Elia (Dec 2008, Univ. of Manchester PDRA based at CERN)
- Vasim Khan (PhD student, Sept 2007)
- Nick Shipman (PhD student Sept 2010, largely focused on breakdown studies)
- Part of EuCARD (European Coordination for Accelerator Research and Development) FP7 NCLinac Task 9.2

R. M. Jones, CI/Univ. of Manchester, Accelerator Group Leader

A. D’Elia, CI/Univ. of Manchester PDRA based at CERN (former CERN Fellow).



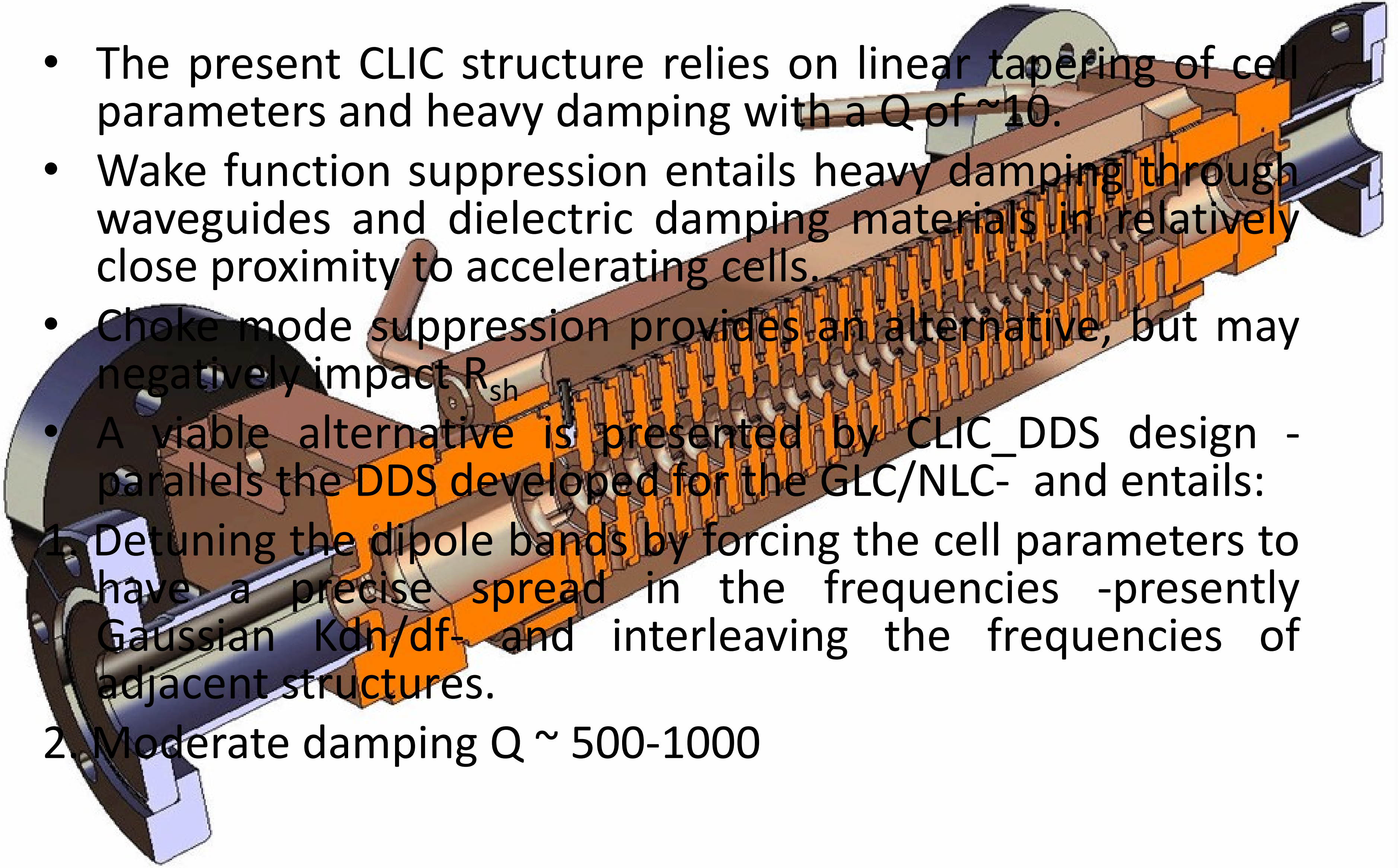
V. Khan, CI/Univ. of Manchester Ph.D. student graduated April 2011 (now CERN Fellow)



N. Shipman, CERN/CI/Univ. of Manchester Ph.D. student

- Major Collaborators: W. Wuensch, A. Grudiev, I. Syrachev, R. Zennaro, G. Riddone (CERN)

A Detuning Damping Structure (DDS) for CLIC

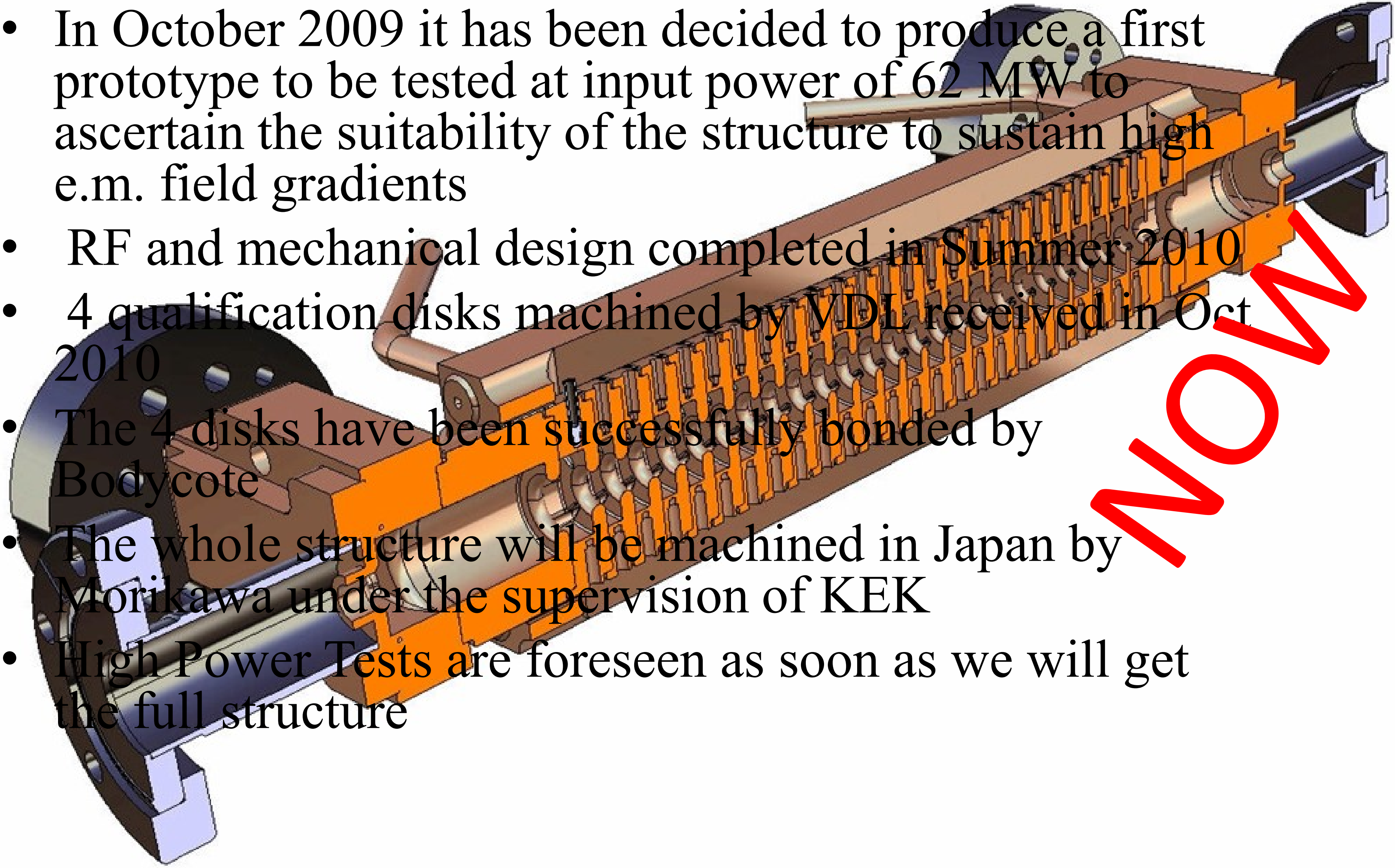


- The present CLIC structure relies on linear tapering of cell parameters and heavy damping with a Q of ~10.
- Wake function suppression entails heavy damping through waveguides and dielectric damping materials in relatively close proximity to accelerating cells.
- Choke mode suppression provides an alternative, but may negatively impact R_{sh}
- A viable alternative is presented by CLIC_DDS design - parallels the DDS developed for the GLC/NLC- and entails:

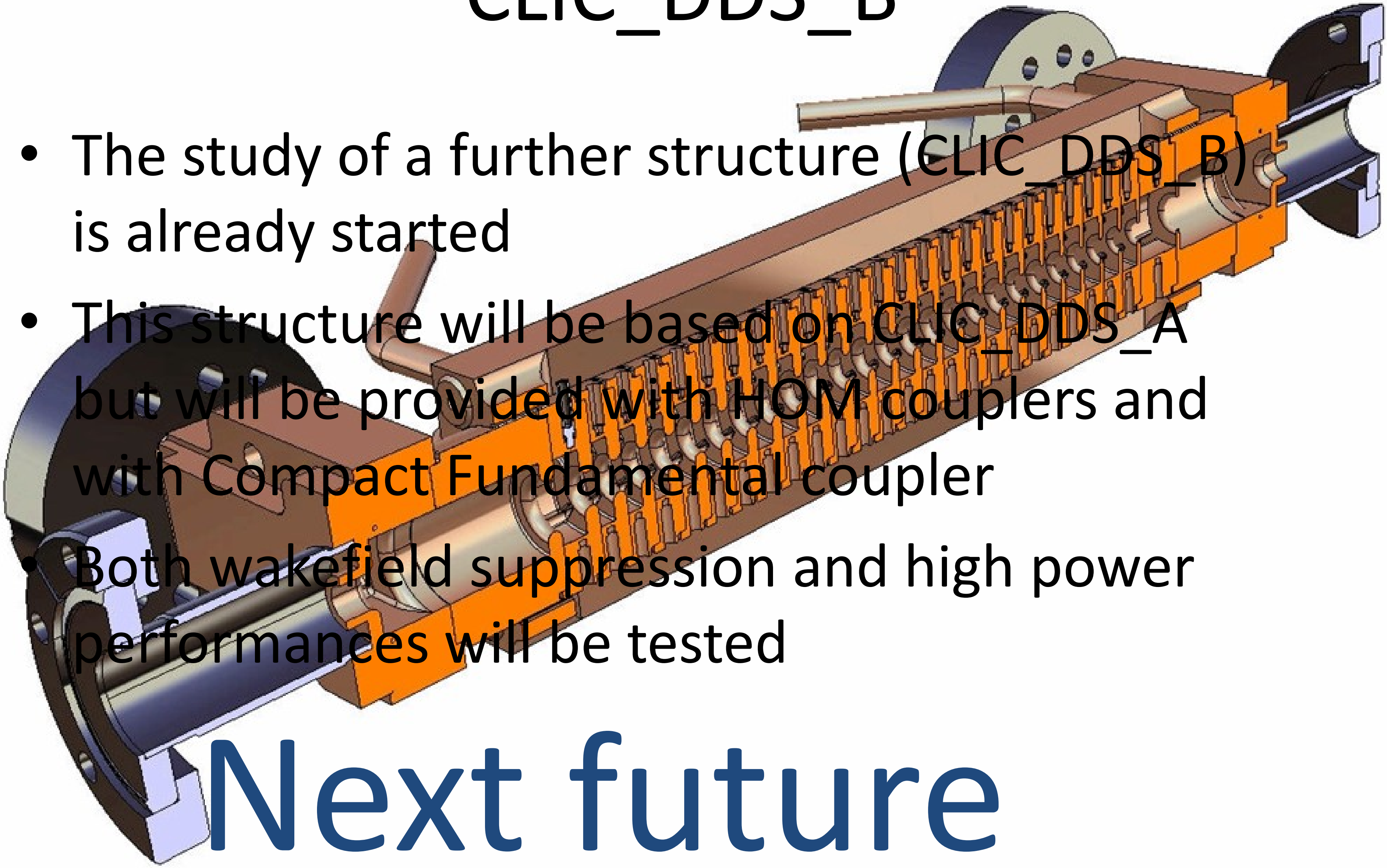
1. Detuning the dipole bands by forcing the cell parameters to have a precise spread in the frequencies -presently Gaussian Kdn/df- and interleaving the frequencies of adjacent structures.
2. Moderate damping Q ~ 500-1000

CLIC_DDS_A

- In October 2009 it has been decided to produce a first prototype to be tested at input power of 62 MW to ascertain the suitability of the structure to sustain high e.m. field gradients
- RF and mechanical design completed in Summer 2010
- 4 qualification disks machined by VDL received in Oct 2010
- The 4 disks have been successfully bonded by Bodycote
- The whole structure will be machined in Japan by Morikawa under the supervision of KEK
- High Power Tests are foreseen as soon as we will get the full structure



CLIC_DDS_B



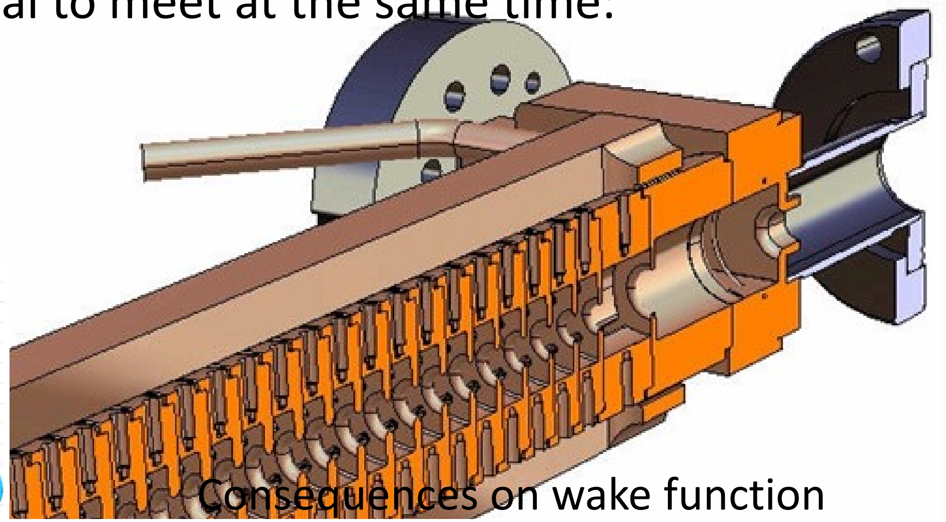
- The study of a further structure (CLIC_DDS_B) is already started
- This structure will be based on CLIC_DDS_A but will be provided with HOM couplers and with Compact Fundamental coupler
- Both wakefield suppression and high power performances will be tested

Next future

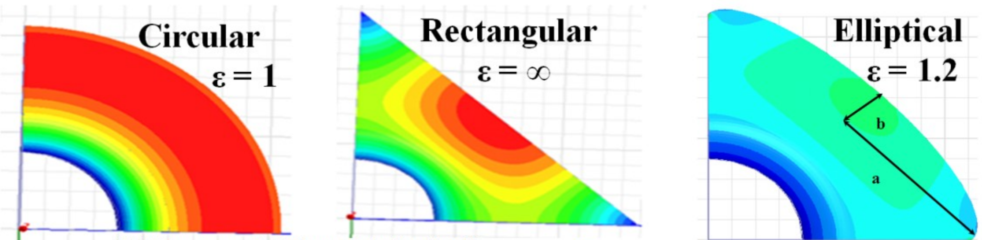
CLIC_DDS_A: regular cell optimization

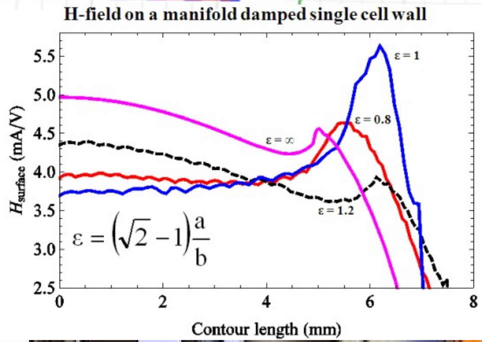
The chose of the cell geometry is crucial to meet at the same time:

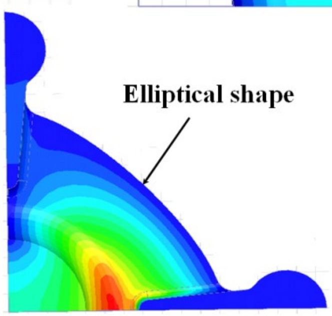
1. Wakefield suppression
2. Surface fields in the specs



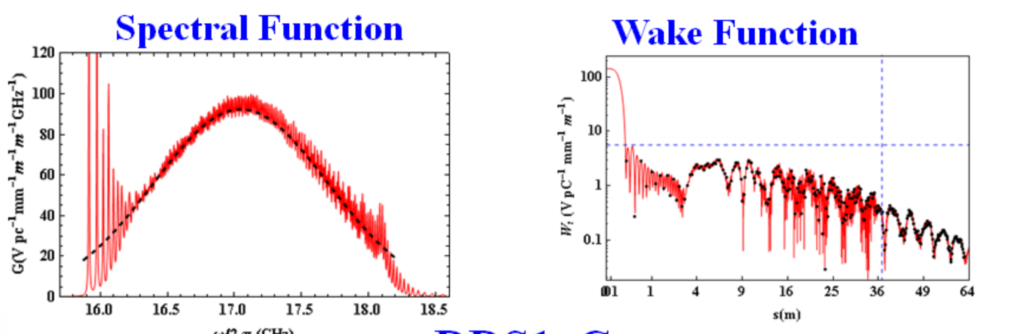
DDS1_C **DDS2_E**



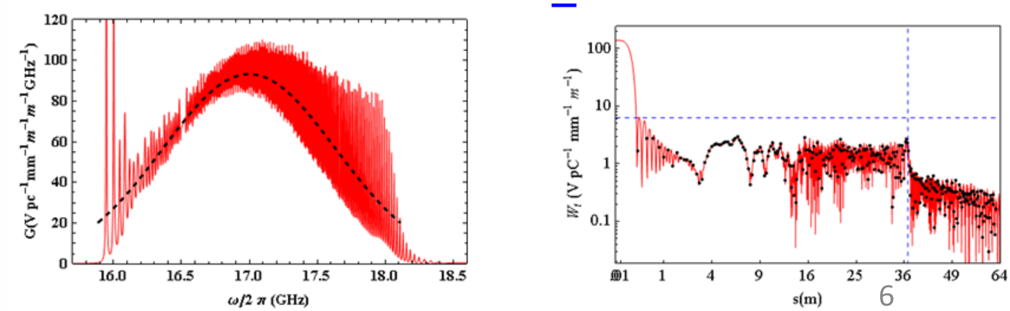




Consequences on wake function

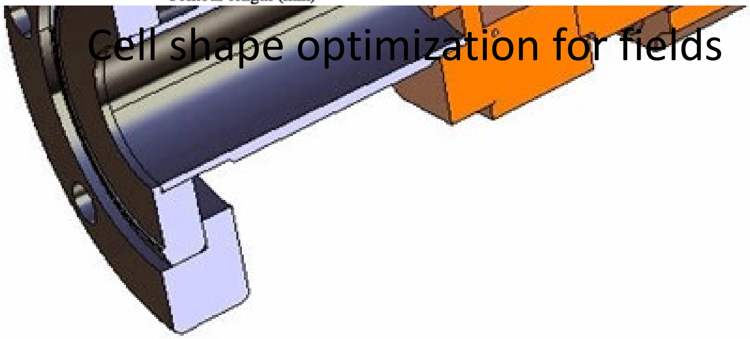


DDS1_C

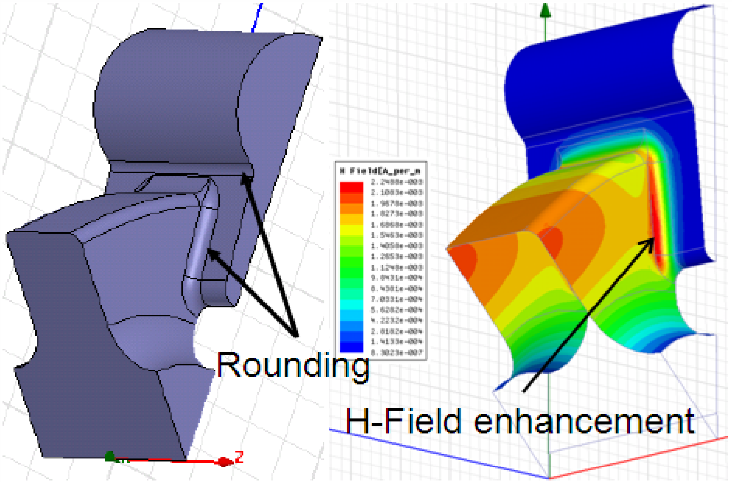


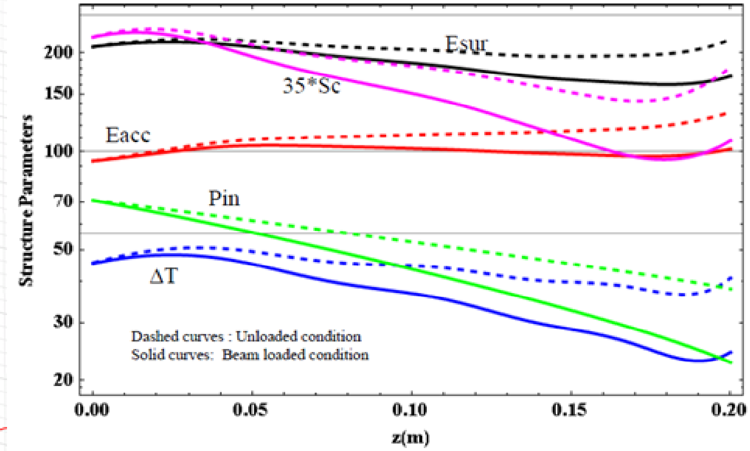
DDS2_E

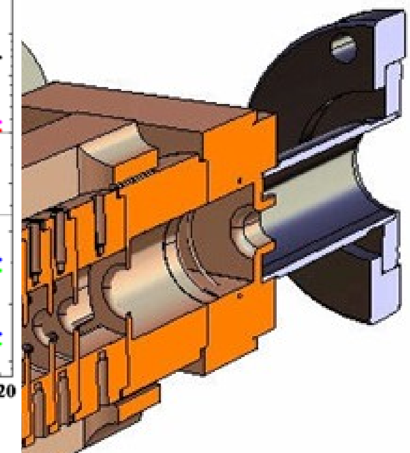
Cell shape optimization for fields

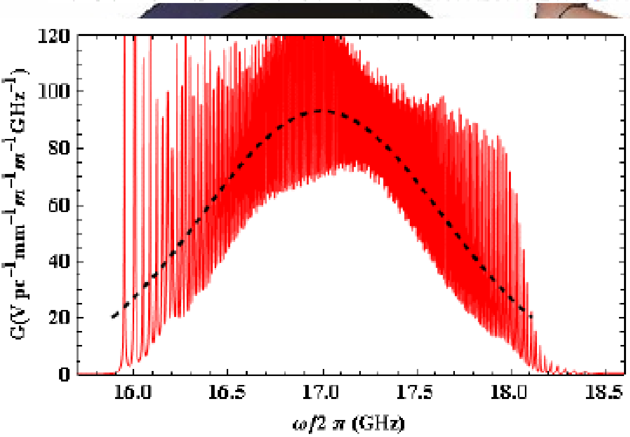


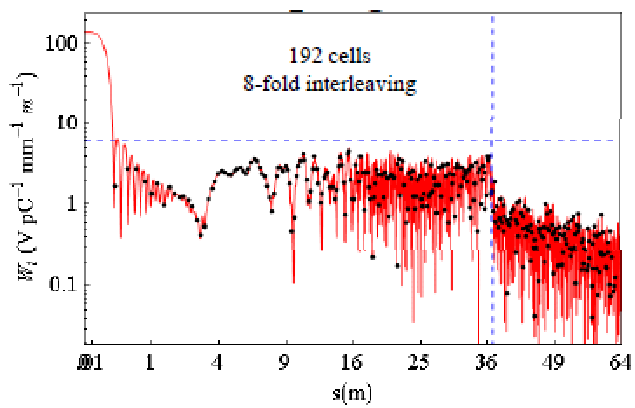
CLIC_DDS_A: regular cells, final design











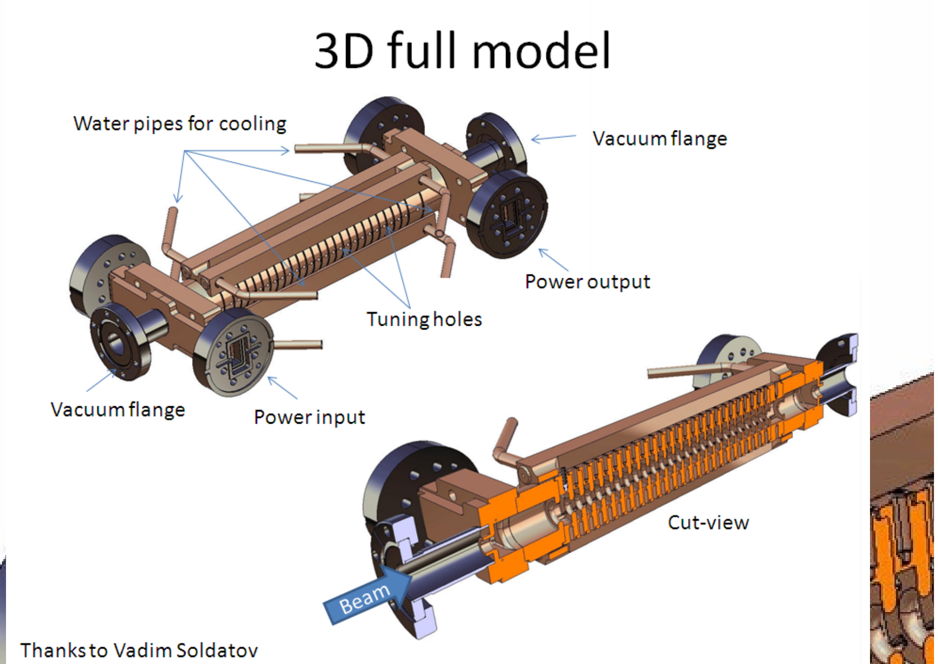
Roundings enhance the magnetic field however a reduction of the slot size mitigates this enhancement and RF parameters are back within required limits. Also the wake damping is still in the limits with margins for a further improvement.

Further information:

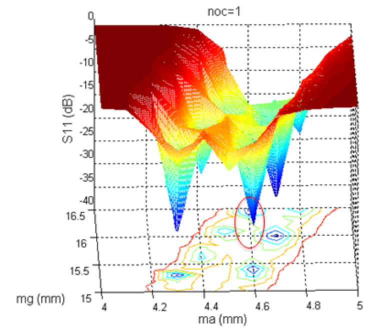
- Manifold dimensions are uniform throughout the structure
- The manifold radius is now parameterised in order to keep the lowest manifold mode above 12 GHz.

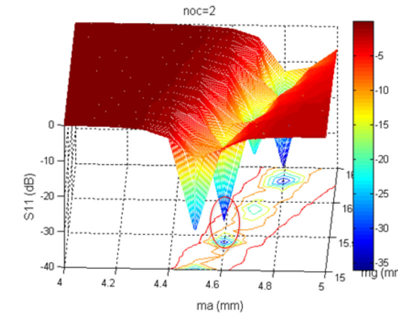
CLIC_DDS_A full structure

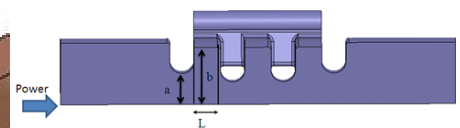
3D full model



Thanks to Vadim Soldatov

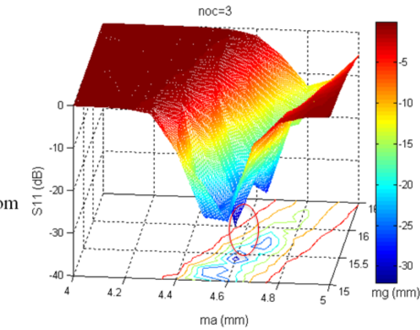


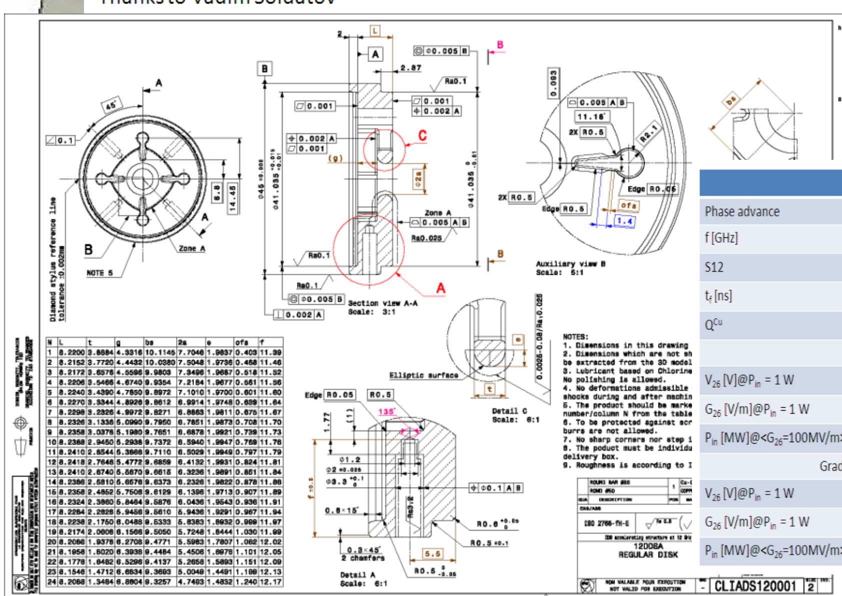




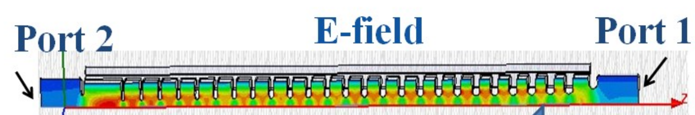
Two options
- Vary "a" and "b" : due to the manifold, very small room to vary "b"

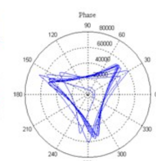
✓ vary "a" and "L"

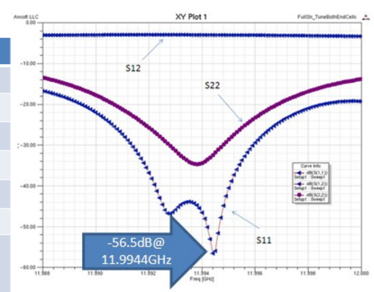


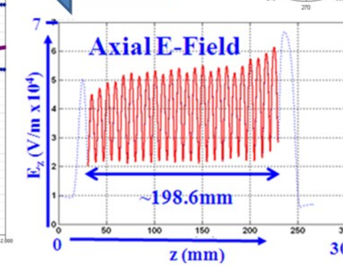


		comments
Phase advance	~120°/cell	min=114° 1st cell; max=125° cell#22
f [GHz]	11.9944	
S12	0.705	
t_f [ns]	57.15	
Q^{Cu}	6165	
Gradient averaged over all cells		
V_{26} [V]@P_{in} = 1 W	2894	2 matching +24 regular cells L_{acc} = 227.46 mm,
G_{26} [V/m]@P_{in} = 1 W	12724	
P_{in} [MW]@<G_{26}=100MV/m>	61.77	
Gradient averaged over regular cells only		
V_{26} [V]@P_{in} = 1 W	2678	24 regular cells only L_{acc} = 198.6326 mm,
G_{26} [V/m]@P_{in} = 1 W	13481	
P_{in} [MW]@<G_{26}=100MV/m>	55.03	

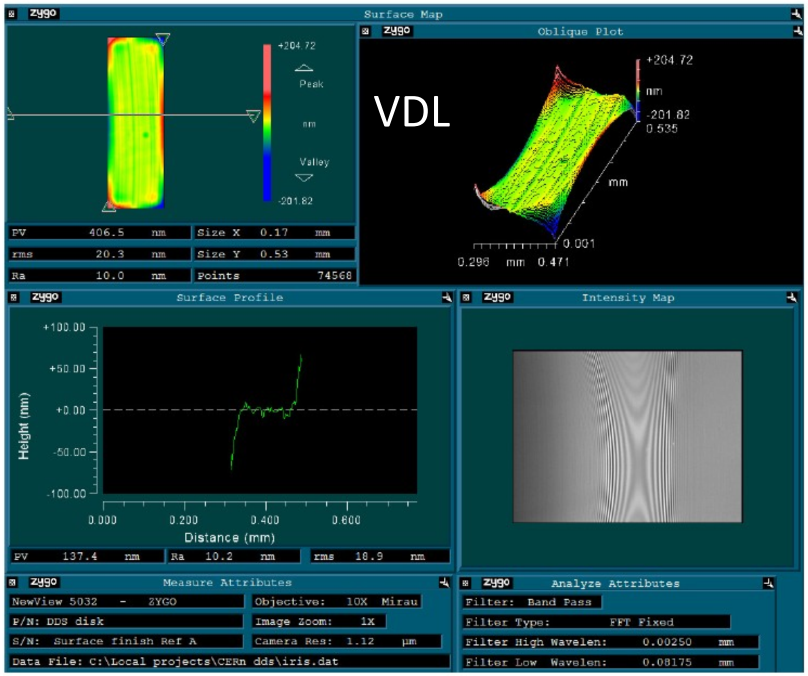


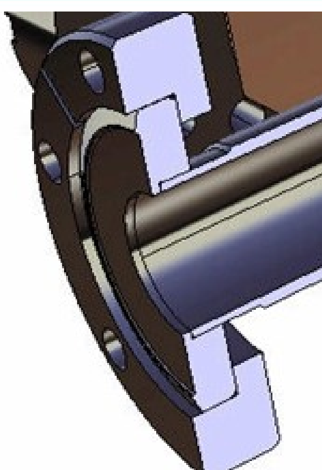


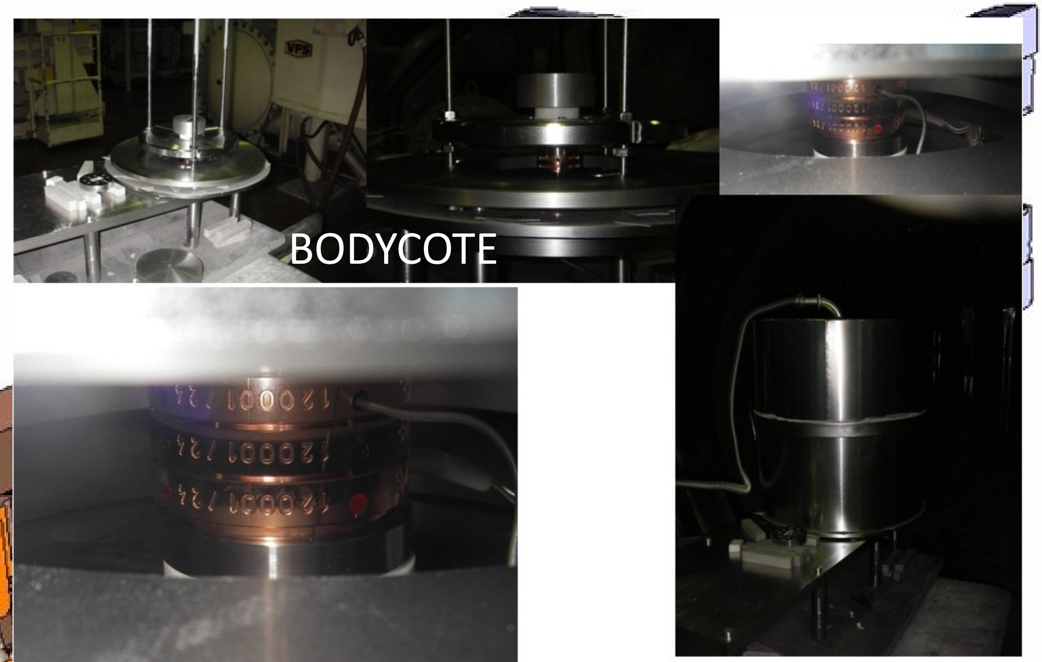


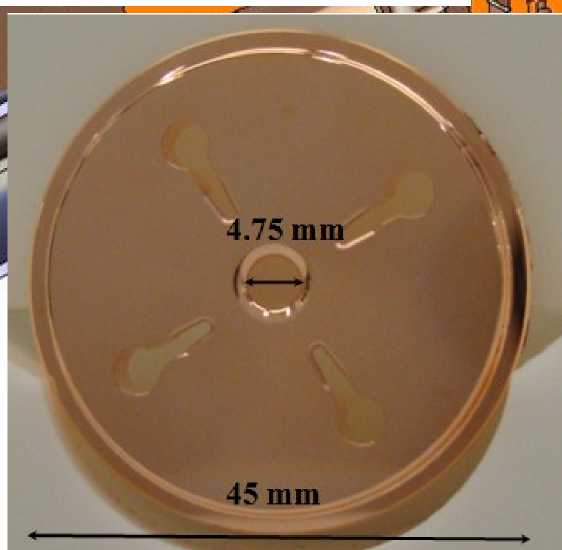


CLIC_DDS_A some further detail



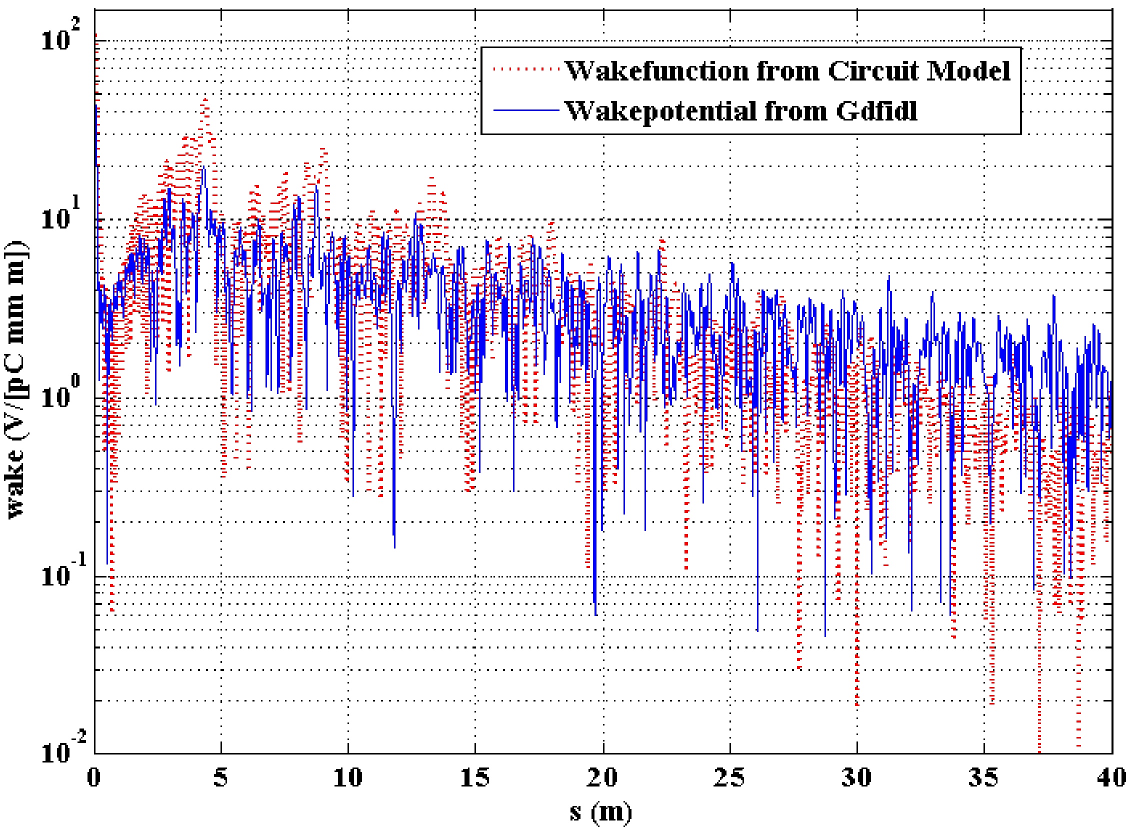




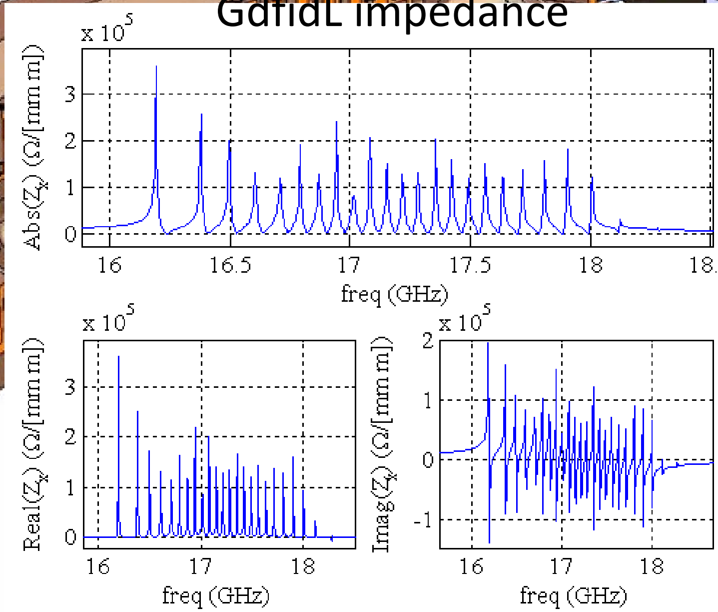


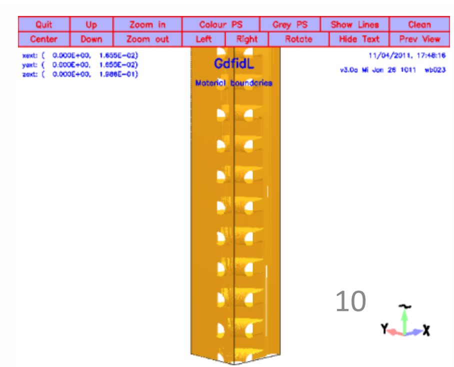
First steps toward CLIC_DDS_B

Wakefield calculations for DDS are, in the early design stage, based on single infinitely periodic cells. Though cell-to-cell interaction is taken into account to calculate the wakefields, it is important to study full structure properties using computational tools.



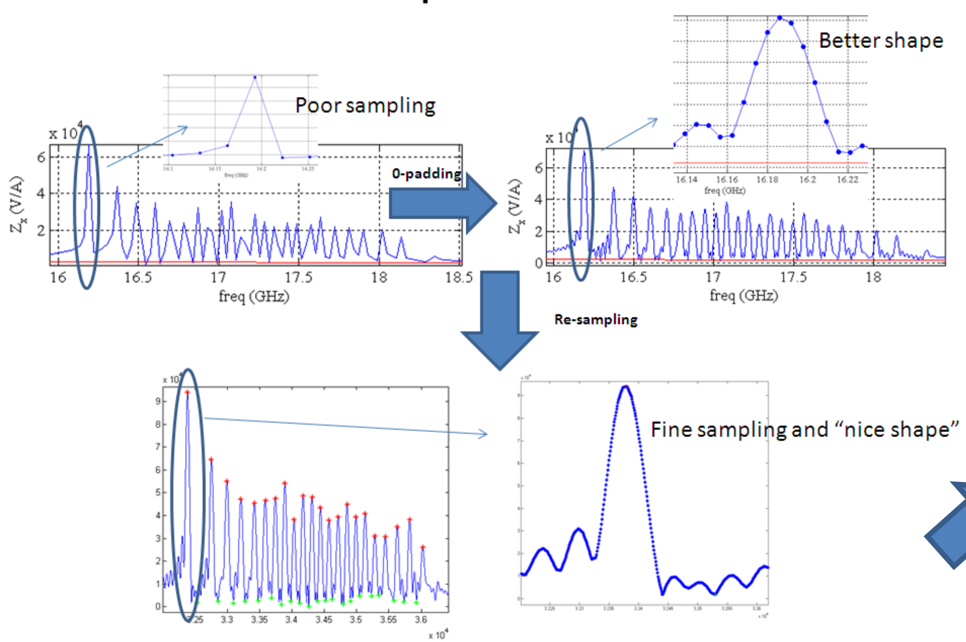
GdfidL impedance

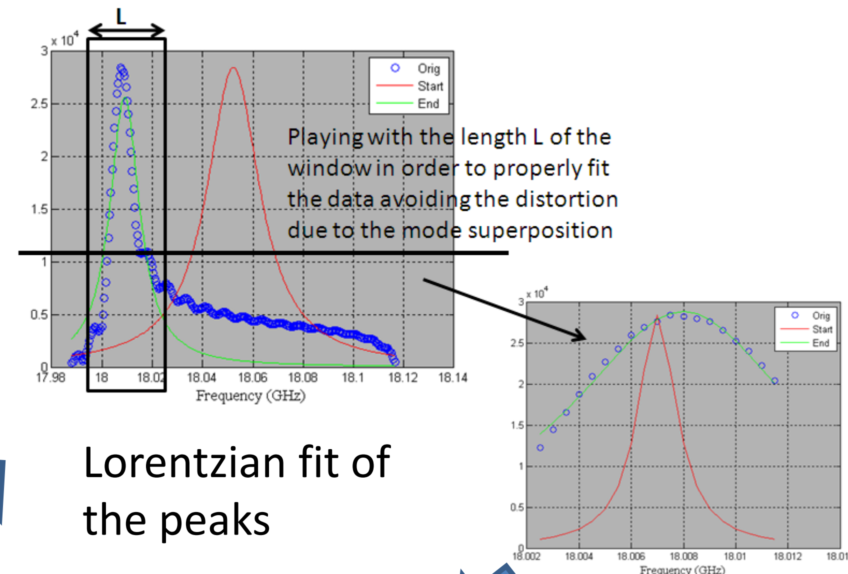




Recalculation of Kicks and Q's from the impedance

"Make-up" of the data



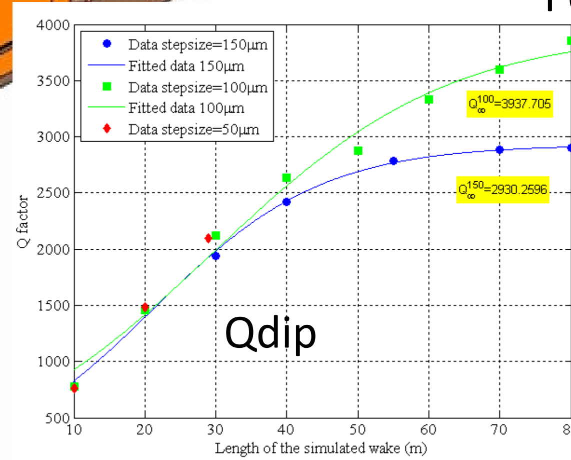


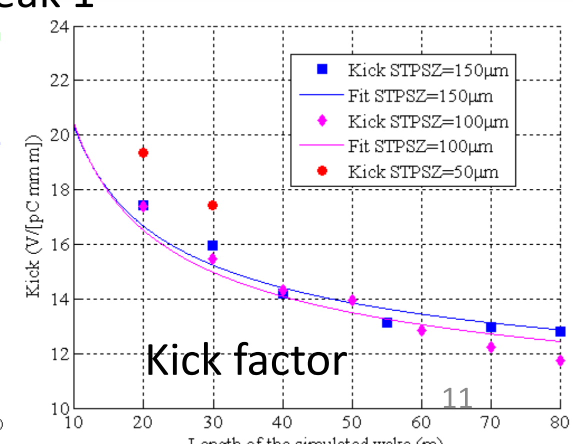
Lorentzian fit of the peaks

Peak 1

Procedure

- Simulation of a pretty long wake (up to 80m)
- For different lengths of the wake, extract wakes and impedances
- Zero padding of the results and re-sampling in order to improve the quality of the FFT signal
- Lorentzian fit of the peaks of the impedances to evaluate frequencies, Q's and kick factors
- Plot for each peak the value of Q as a function of the length and fit them with the opportune function

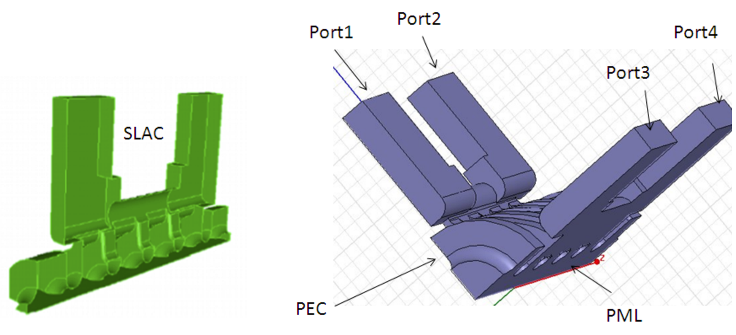


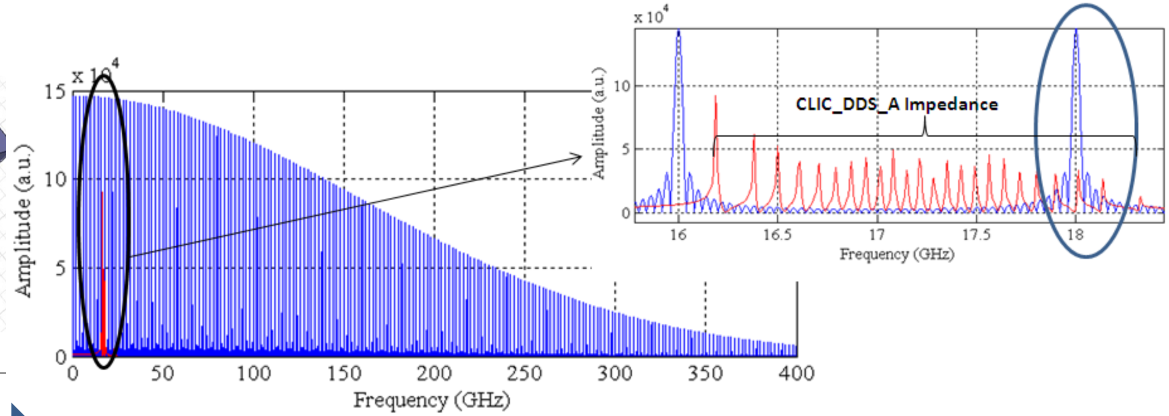


Preliminary HOM coupler thoughts

A possible structure

J. W. Wang and al. "Progress toward NLC/JLC prototype accelerator structure", LINAC04

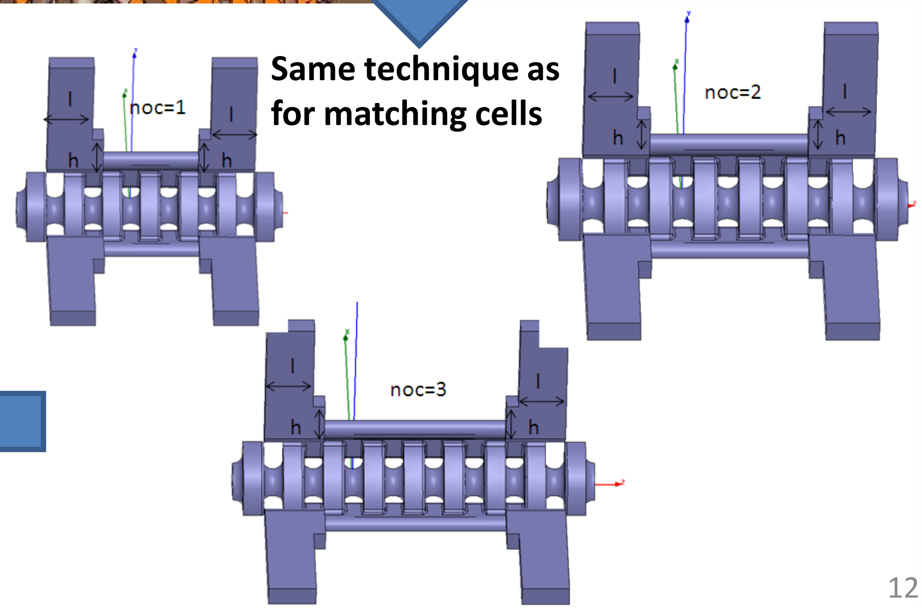


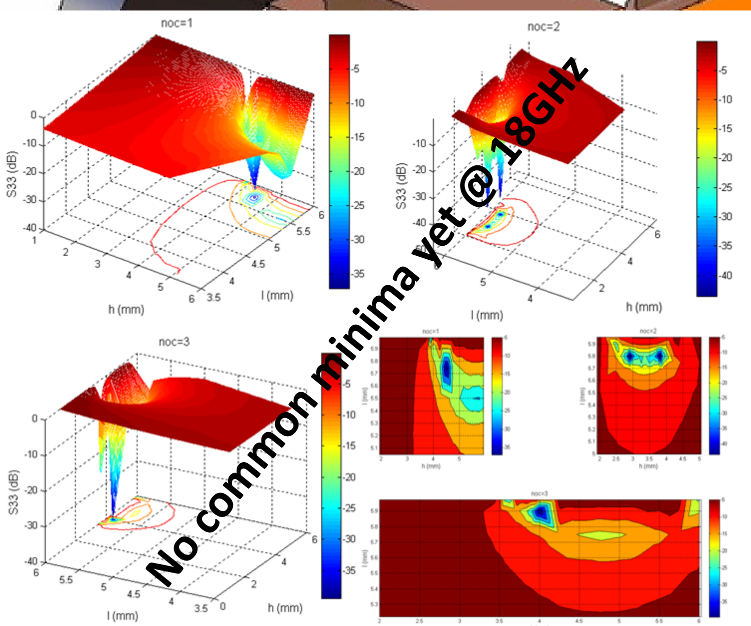


As a first approach we decided to reproduce the same as done at for NLC/JLC:
1) HOM coupler attached at the first regular cell
2) Only Matching cells uncoupled
3) HOM Coupler goes to WR62 load (Ku band=14-18GHz)
4) How much is the bandwidth?

Who is chatting with the beam? Only frequencies around 18GHz!!!

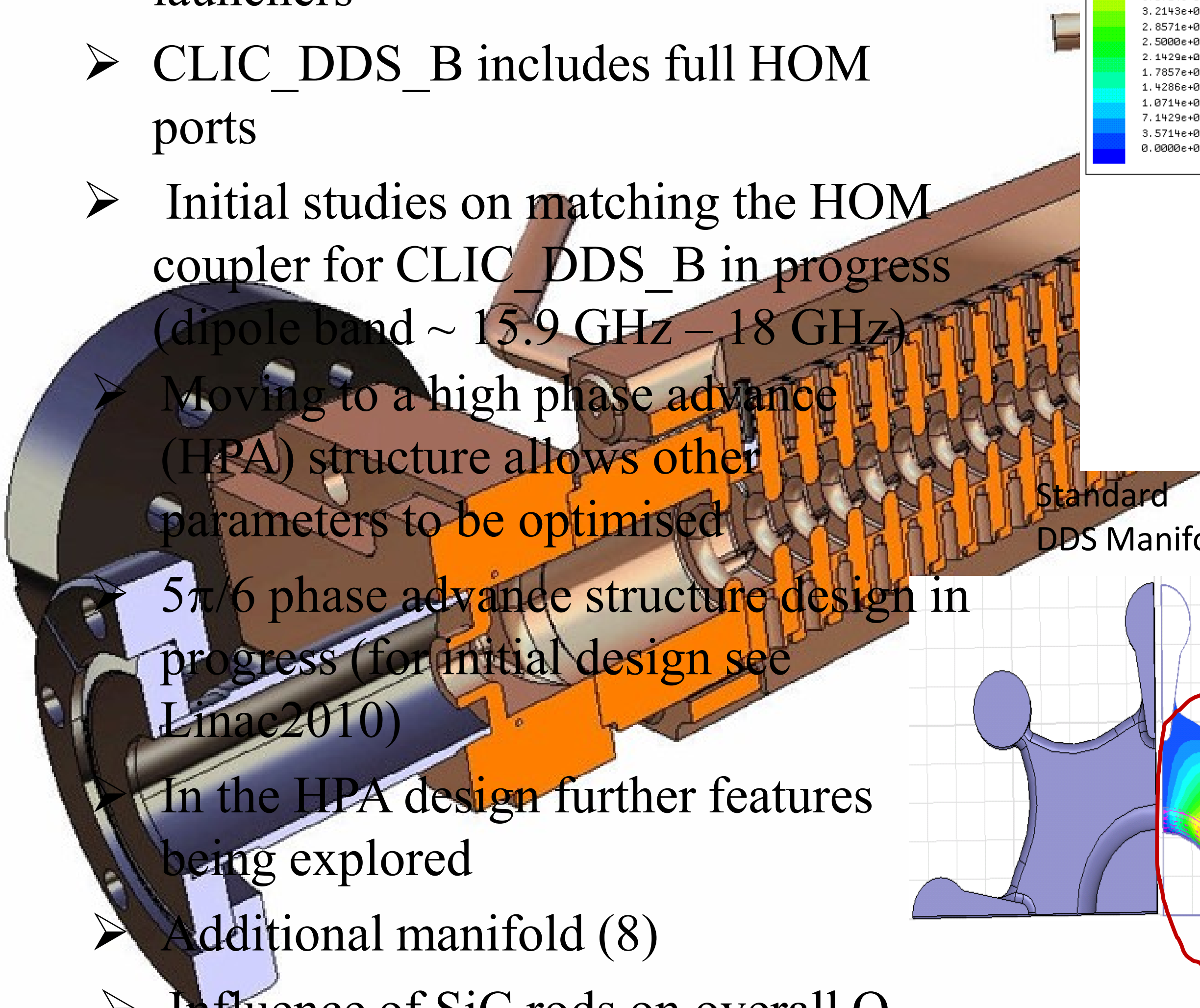
Same technique as for matching cells

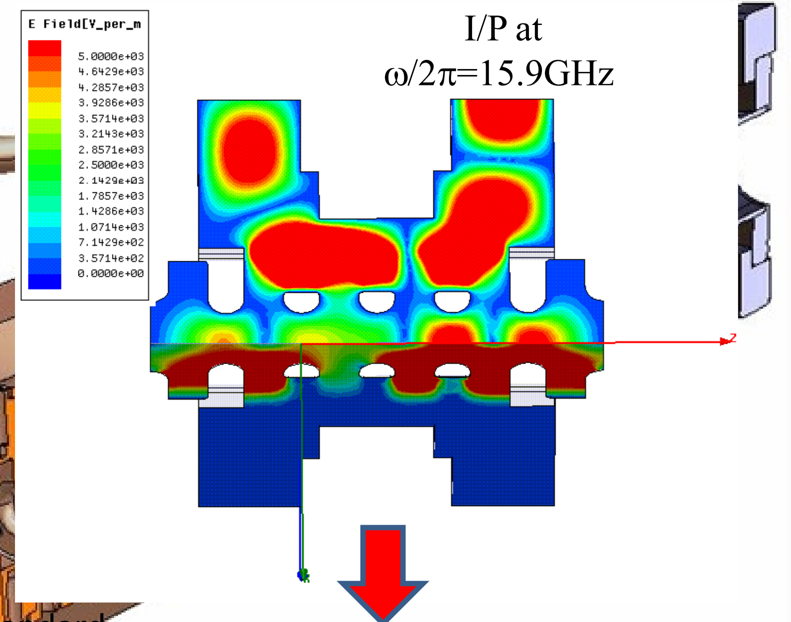


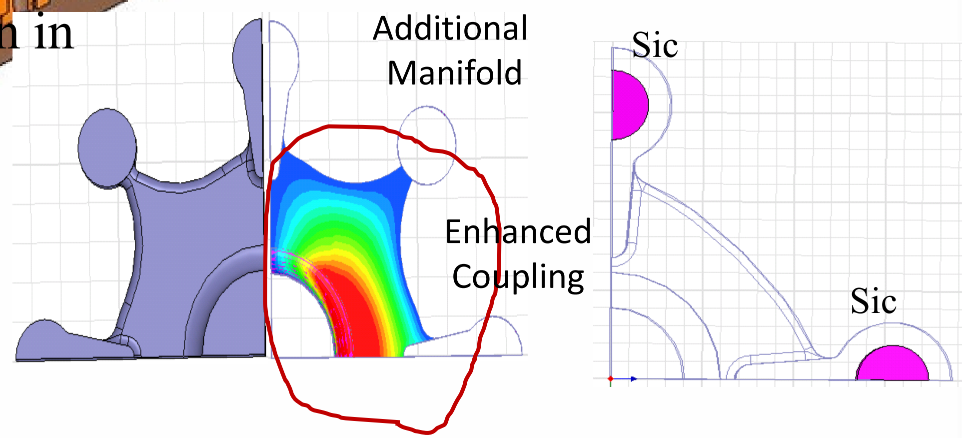


Work in Progress/R&D Opportunities

- CLIC_DDS_A is equipped with mode launchers
- CLIC_DDS_B includes full HOM ports
- Initial studies on matching the HOM coupler for CLIC_DDS_B in progress (dipole band ~ 15.9 GHz – 18 GHz)
- Moving to a high phase advance (HPA) structure allows other parameters to be optimised
- 5π/6 phase advance structure design in progress (for initial design see Linac2010)
- In the HPA design further features being explored
- Additional manifold (8)
- Influence of SiC rods on overall Q



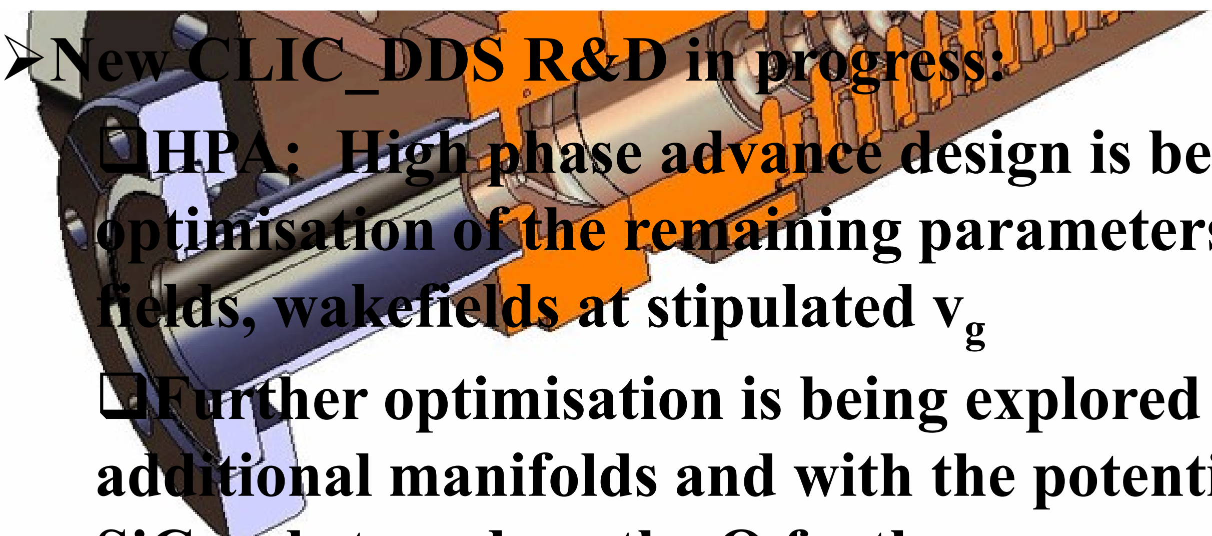




Final Remarks

- **CLIC_DDS_A : RF (including mode launcher matching cells) and mechanical design has been completed.**

- **Transfer cell fabrication to Morikawa in collaboration with KEK**
- **Cell ETA April 2011 -10 qualification cells, followed by full 24 cells**
- **Recent events in Japan have affected schedule –full structure expected during last quarter of 2011**
- **RF cold test measurements (S21) at KEK**



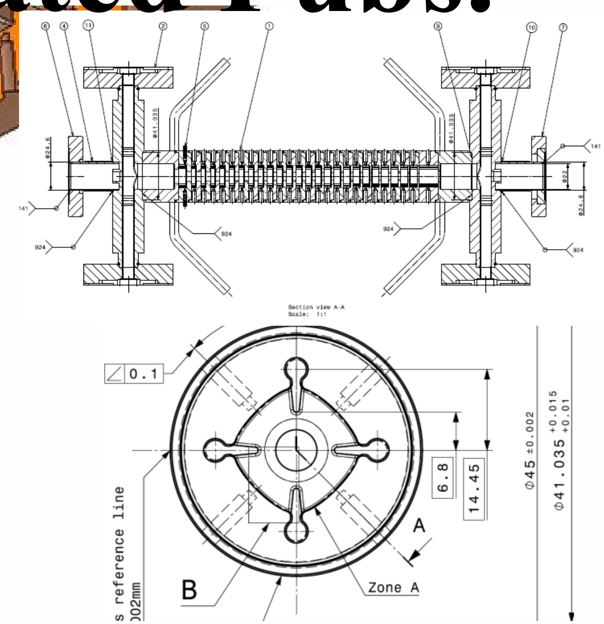
- **New CLIC_DDS R&D in progress:**
  - **HPA: High phase advance design is being studied. It Allows optimisation of the remaining parameters –minimise surface fields, wakefields at stipulated v_g**
  - **Further optimisation is being explored by implementing additional manifolds and with the potential for the insertion of SiC rods to reduce the Q further**

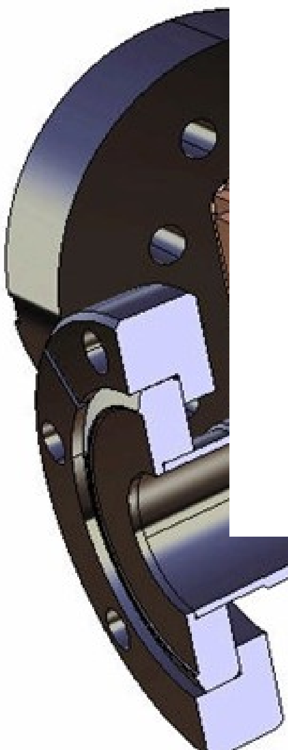
Acknowledgements

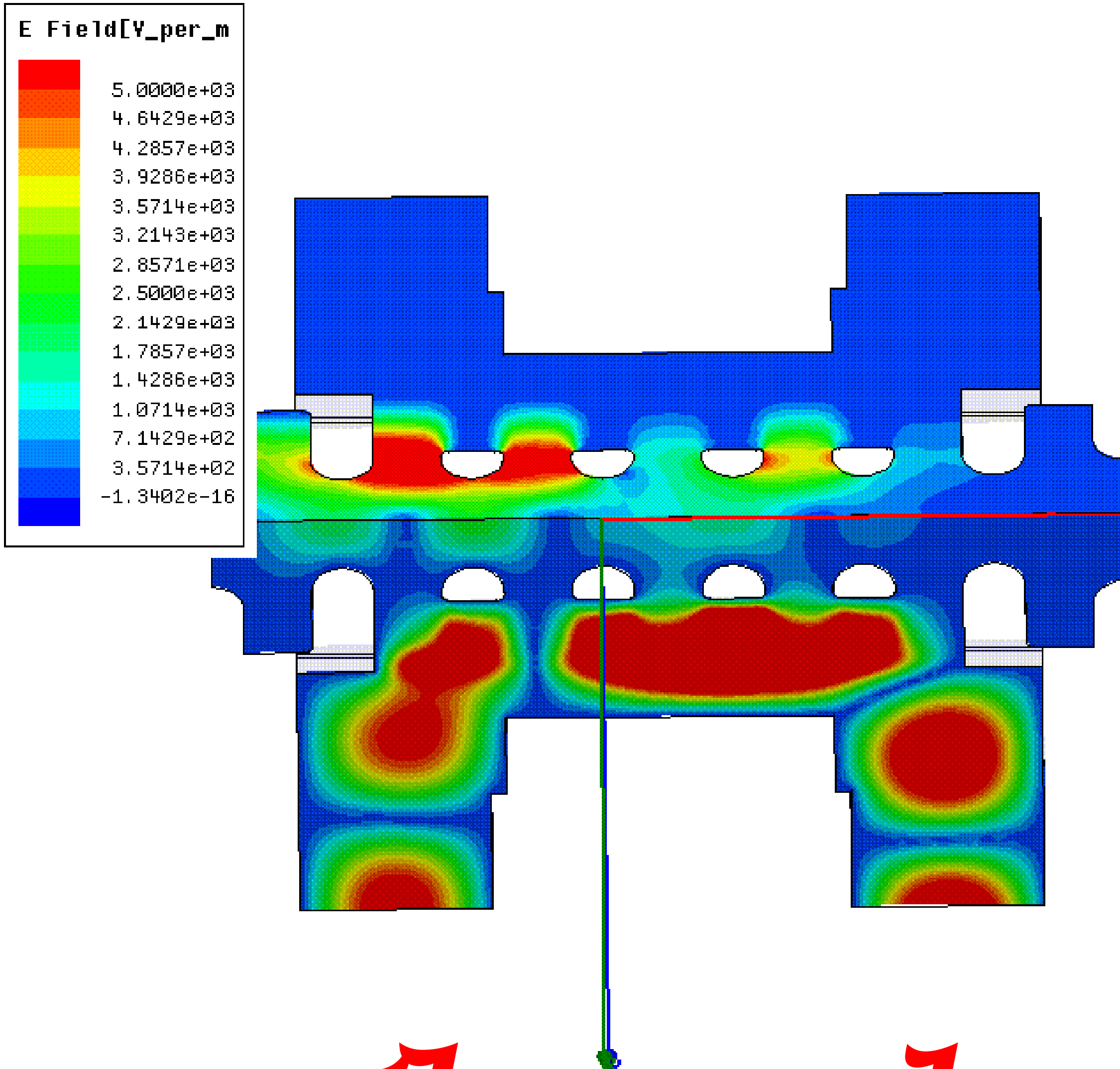
- I am pleased to acknowledge a strong and fruitful collaboration between many colleagues and in particular, from those at CERN, University of Manchester, Cockcroft Inst., SLAC and KEK.
- Several at CERN and KEK within the CLIC programme, have made critical contributions: W. Wuensch, A. Grudiev, I. Syrachev, R. Zennaro, G. Riddone (CERN), T. Higo Y. Higashi (KEK).

CLIC DDS Related Pubs.

1. R. M. Jones, *et. al*, PRST-AB, 9, 102001, 2006.
2. V. F. Khan and R.M. Jones, EPAC08, 2008.
3. V. F. Khan and R.M. Jones, LINAC08, 2008.
4. V. F. Khan and R.M. Jones, Proceedings of XB08, 2008.
5. R. M. Jones, PRST-AB, 12, 104801, 2009.
6. R. M. Jones, *et. al*, NJP, 11, 033013, 2009.
7. V. F. Khan and R.M. Jones, PAC09, 2009.
8. V. F. Khan, *et. al*, IPAC10, 2010.
9. V. F. Khan, *et. al*, LINAC10, 2010.



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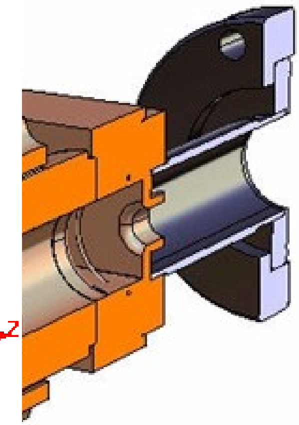

Thanks