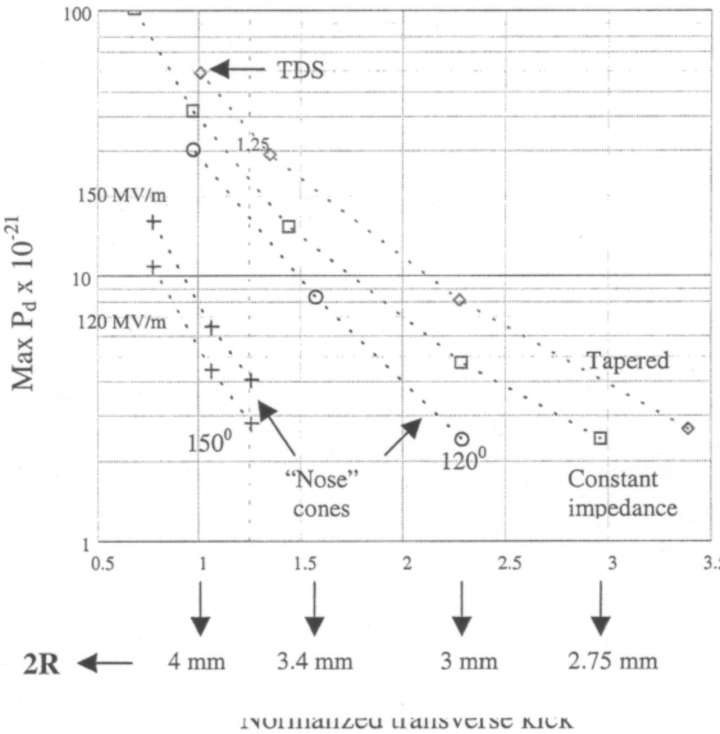
Igor Syratchev 16.08.01
Preliminary Draft

1. Minimization of the damage potential for the 30 GHz accelerating structure.



Three types of the structures are compared, to see the impact of the aperture (group velocity) reduction on the damage potential and the short-range transverse kick. The loaded gradient for all the cases was chosen 150 MV/m for the nominal CLIC current of 0.96 A. All the structures have the filling time equal to the original TDS (20 ns).

The tapered and "nose" cone structures where simulated for the equal distribution of the group velocity along the structure for each case. The normalization of the transverse kick was done as $(R/R_0)^3$, where R_0 is the average radius of the original TDS: R_0 = 2mm.

One can see that for the same growth of the transverse kick, the damage potential reduction for the "nose" cones structure is half of that for the Tapered type structure. This comes from the fact that for the same average aperture, "nose" cone structure provides lower group velocity and higher shunt impedance.

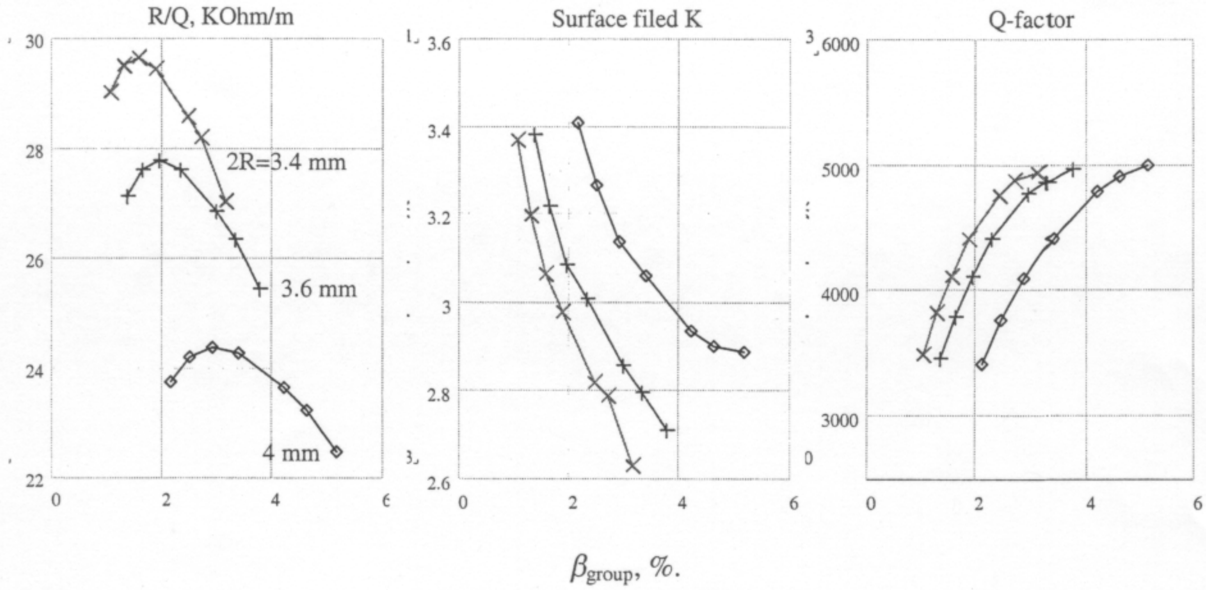
The "nose" cone structure with a higher phase advance - 150^0 was also studied. The additional drop of the P_d in this case is caused by the further reduction of the group velocity for the same aperture of the structure. From the other hand the short-range wake is just a function of the aperture and number of the cells per unit length. That is why the

reduction of the normalized kick by 25% can be foreseen in the case if the phase advance per cell is increased from 120 to 150 degree, that was confirmed with the MAFIA simulations (E. Jensen).
Nevertheless, the P_d safe limit that is less than 3 can be derived from the existing accelerators that operate for a long time (SLC).
To achieve this values it is necessary in addition to decrease the accelerating gradient. This will give the another advantage, the reduction of the surface pulsed heating.

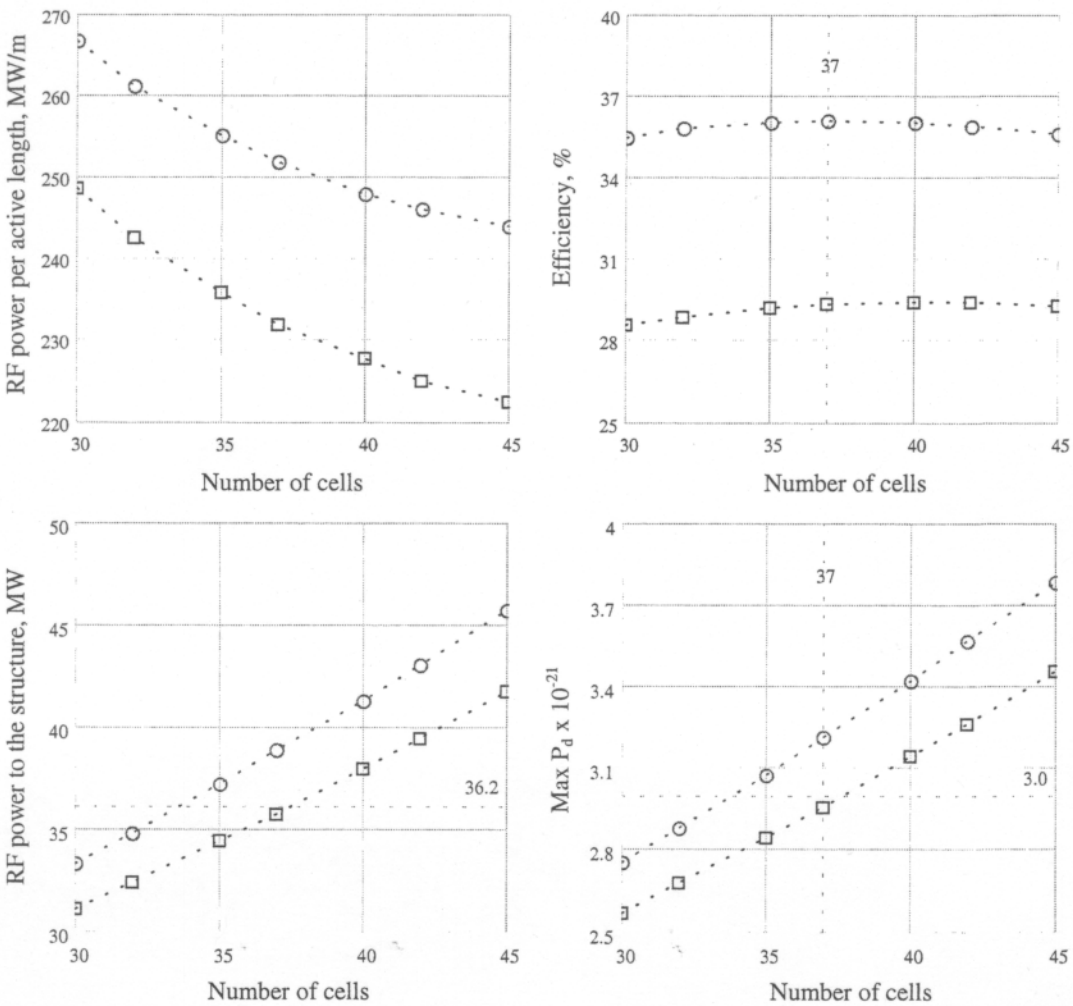
2. Optimization of the "nose" cone constant aperture structure with a 150 degrees phase advance per cell and reduced (120 MV/m) loaded accelerating gradient.

The optimization was done with the some initial limitations for the parameters. In general it was fixed, that the maximal surface field has not to exceed 600 MV/m (that gives the limit for lowest group velocity), and the filling time of the structure has not to be more than 30 ns (that limits the structure length).
The aperture of the structure was chosen 3.4 mm, that gives 25% growth for the kick with P_d value about 2.7. If for the some reason the 25% growth of the transverse kick could not be accepted, the simulations for the 25% smaller current that of the nominal one were done.

2.1 Parameters of the "nose" cone structure with 150 degrees phase advance for the different apertures.



2.2 The choice of the structure length.

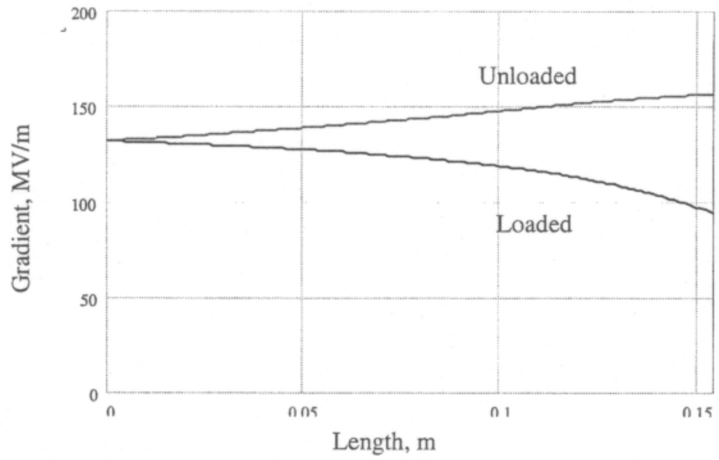


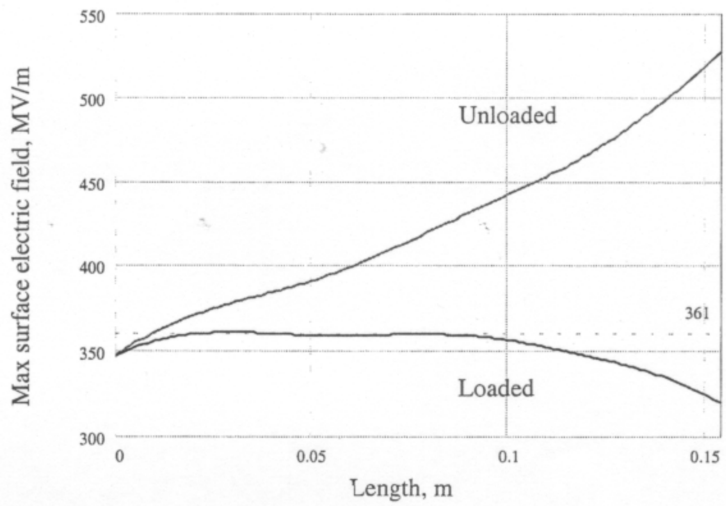
At these graphs the circles correspond to the case of the nominal CLIC current and boxes for the case of 75% of the nominal CLIC current.

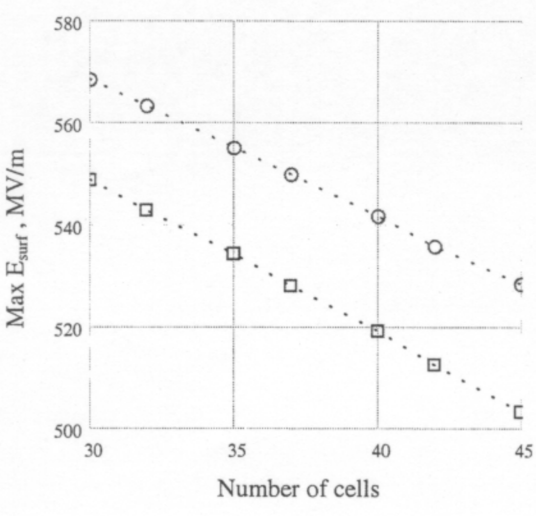
The predefined geometry of the first cells gives the limit for the maximal input RF power when the P_d does not exceed the given value. For the case when $P_d < 3$, $P_{in} < 36.2$ MW and the cells number then has to stay in between 34 - 37. From the other hand, following the efficiency curves one can see that the structure with 37 cells provides the best efficiency for both the currents.

2.3 Surface fields.

Typical envelopes of the field distributions along the structure are shown next. The simulation was done for the 37 cells structure with 120 MV/m loaded gradient and 75% current. The reference line (361 MV/m) at the down graph corresponds to the maximal surface field in the case of the original TDS with the same acceleration. Note, that during the routine operation (including beam loading and RF amplitude ramp) the field distributions will be the same as for the case of the "loded" curves. Hence in case of the "nose" cone structure it will be provided rather flat distribution of the surface filed along the structure.



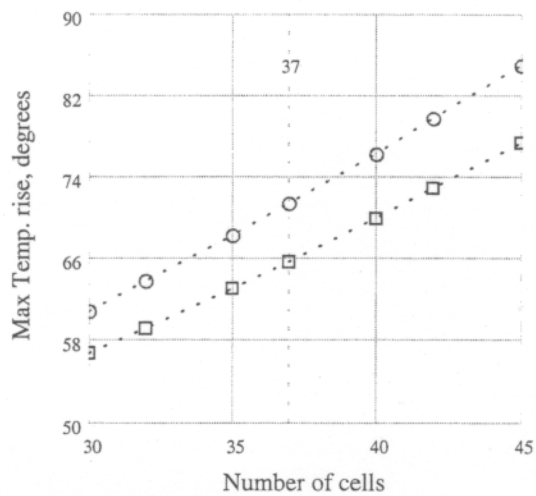




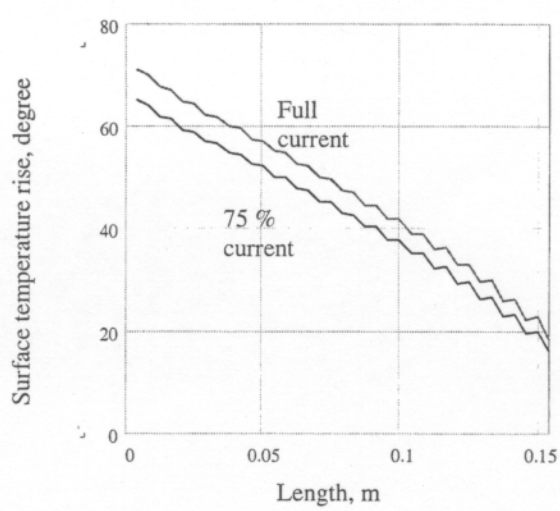
In this picture the maximal "unloaded" surface field of the "nose" cones structure as a function of the structure length is shown. Circles are the full current, boxes - 75% current.

2.4 Pulsed heating.

The highest temperature rise will take place in the first cell of the structure. The simulation was done for the actual RF pulse shape with the ramp. The temperature dependence of the copper surface resistivity was taken into account. The RF pulse length for all the cases was chosen 130 ns. The results of the simulations for the case of the 120 MV/m loaded gradient are shown in the next picture (circles - full current, boxes -75% current).

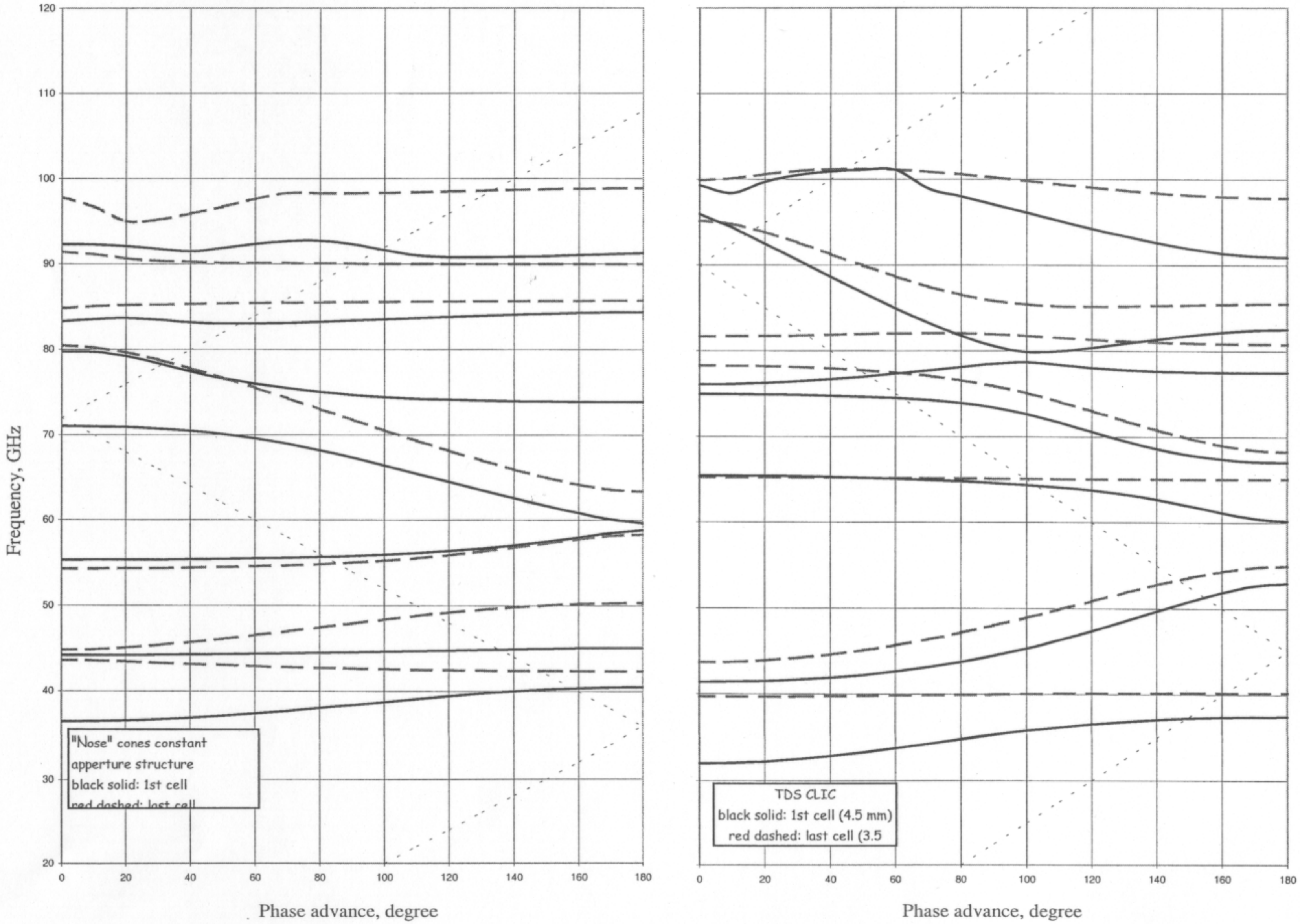


The distributions of the surface temperature rise after 130 ns in the 37-cell "nose" cone structure for the two currents and 120 MV/m gradient are shown next.



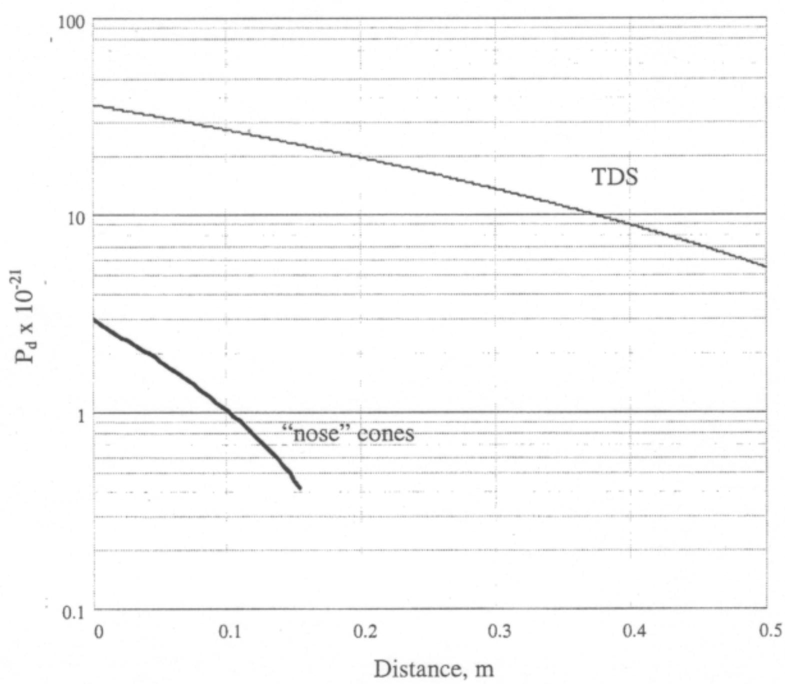
2.5 Detuinig of the HOM's.

The calculations done with MAFIA (E. Jensen) show that the "nose" cone structure provides even better detuing than the original TDS (especially for the higher modes), see the next pictures.



2.6 Damage potential

To illustrate the improvement for this criteria in the next picture P_d distribution along original TDS and 37-cell "nose" cone structure are shown. The calculation done for the gradient 120 MV/m and 75% current.



3. Discussion.

The overall parameters for the 37 cell "nose" cones constant aperture structure are gathered in the next table

Ne/ bunch, $/10^9$	3.2	4
Laded Gradient, MV/m	120	
Cell number	37	
Cell length, m	0.004167	
Total length, m	0.154	
Phase advance	$5\pi/6$ (150^0)	
β_{group} , %	3.152 -> 1.07	
R/Q, kOhm/m	28.87 (average)	
Q-factor	4470 (average)	
First dipole detuning, %	5	
Filling time, ns	26.67	
Pin, MW	35.8	38
P/active length, MW/m	232	252
Max $P_d \times 10^{-21}$	2.96	3.22
Max surface field, MV/m (unloaded/loaded)	528/361	550/373
Max ΔT, ^0C	65.1	71
Normalized transverse kick•	1	1.25
Efficiency, %	28.4	35.1

- Normalization is done on the amplitude of the transverse kick of the original TDS CLIC structure.