Recent 30 GHz results @ CTF2

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Outline

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- 30CNSDsbCu_speed-bump
  - Motivation
  - High power RF test results
  - Effect of the speed bump on the damages

- \( \text{TM}_{020} \) 3.5 mm structure
  - Motivation
  - High power RF test preliminary results

- Conclusion and future plans
30 GHz activities:

- Reminiscence of the time when CLIC operating frequency was not yet 12 GHz.
- Now used to test scientific hypothesis.
- The speed bump and TM\textsubscript{02} structures are based on the design of the older 3.5 mm diameter structure.
Why speed bump?

From Igor’s presentation at the X band workshop:

Very often we do observe, that after accelerating structure processing the most of the surface modifications take place in a few first cells. Also the number of cells involved is correlated with the group velocity, the less the Vg the fewer cells modified.

What we do certainly know, the breakdown ignition is a very fast process: 0.1 -10 ns. If so, one can propose the main difference between the “first” and “second” cell is accessible bandwidth.

And the lower group velocity the more the difference. The first cell, if breakdown occurs is loaded by the input coupler/waveguide and is very specific in terms of bandwidth.

In other words, the first cell can accept “more” energy during breakdown initiation than the following ones.

We do not know the exact transient behavior of the breakdown and the structure bandwidth could play important role.
Goal: « protect » the structure by lowering $V_g$ in the first cell (usually the most damaged).

Tested in both direction:

- RF fed from the input ($4.1 \times 10^6$ pulses, 2186 breakdown) → the speed bump plays its role
- RF from the output ($1.7 \times 10^6$ pulses, 501 breakdown) → the speed bump has no effect

→ Equivalent to 19 + 8 « SLAC hours » @ 60 Hz...
Breakdown rate calculation
No effect observed on the breakdown rate: similar results in both directions and for the 3.5 mm structure (same design without speed bump).
Number of breakdowns in the two experiments

C30-SB
All breakdowns

Reversed C30-SB
All breakdowns
General view of the 30CNSDsbCu_speed-bump after cutting

SEM inspection was performed on these irises
Damages

Iris 1

Iris -1
Damages

Iris 2

Iris -2
Is it possible to change some global parameter without changing local field distribution?

→ Only by changing the propagating mode

- Same phase advance
- Same P/c
- Same aperture and iris shape
- Same field configuration in the iris region

**but**

- Different group velocity (4.7% vs 2%)
- Different R/Q (29 kΩ/m vs 12 kΩ/m)

Test structure in disks: 30 cells, same mode launcher as the “conventional” $2\pi/3$, Ø 3.5 mm.
At the moment, equivalent to ≈26 « SLAC hours »
TM$_{020}$ structure – preliminary results

Breakdown rate vs. Peak gradient (MV/m)

- TM02 upper limits only
- TM02 last "real" points
- TM02 fit
- 3.5 mm
- C30-SB
- Reversed C30-SB

Graph showing breakdown rate as a function of peak gradient for different structures and fits.
Conclusion and future plans

- The 30CNSDsbCu_speed-bump worked well and the speed bump seems to reduce the damages due to breakdowns.

- This suggests to test a « speed bump » structure at 12 GHz.

- The TM$_{020}$ structure is still under test (still conditioning ?) but the results are not very promising.

- If $v_g$ was the key parameter, the achievable gradient at a given BD rate should be higher than for the other 3.5 mm structures.

- If it was rather surface field, the results should be more or less the same.

- The experiment confirms neither one nor the other. Is this only due to fabrication issues or is there another key parameter?

- It underlines the difficulty to draw conclusions with a single structure!
La réserve du chef
Direct comparison of $V_g$

(TM01: $2\pi/3 V_g = 4.7\%$

(TM02: $2\pi/3 V_g = 2.0\%$

$V_g$
In total:
- 4,101,250 pulses, mainly at 1 Hz corresponding to 18.99 SLAC hours at 60 Hz
- 2186 breakdowns Weird things due to calibration problems (now solved)
In total:

- 1,704,650 pulses, mainly at 1 Hz corresponding to 7.89 SLAC hours at 60 Hz
- 501 breakdowns

Weird things due to calibration problems (now solved)