Recent 30 GHz results @ CTF2

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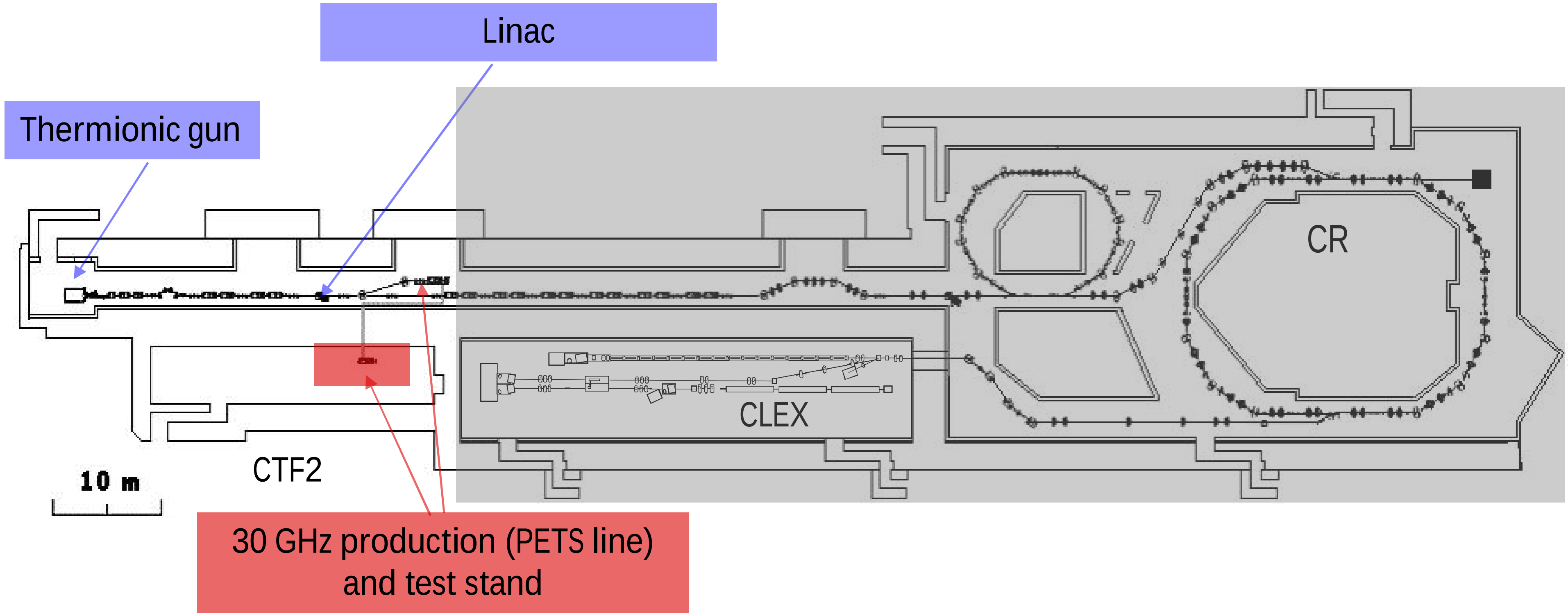
- TM_{020} 3.5 mm structure
  - ★ Motivation
    - ★ High power RF test preliminary results
- Conclusion and future plans

To set the stage...



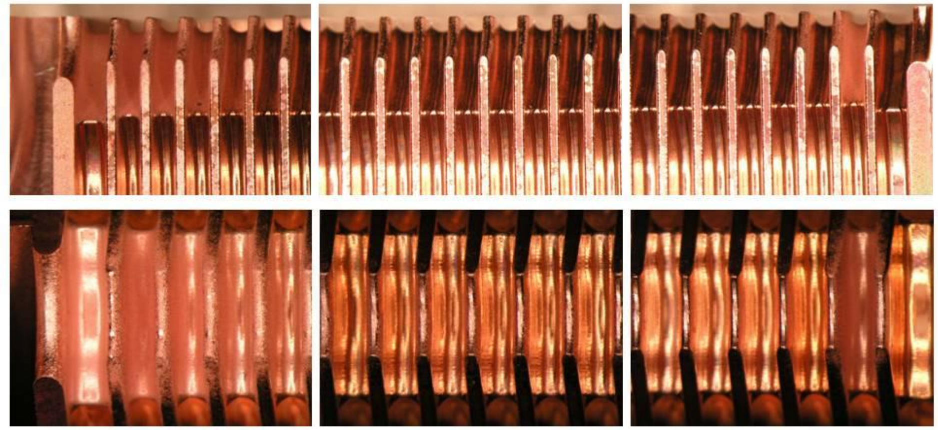
<u>30 GHz activities :</u>

- Reminiscence of the time when CLIC operating frequency was not yet 12 GHz.
- Now used to test scientific hypothesis.
- The speed bump and TM_{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.



P_{INC} → HDS 60 L

P_{INC} ← HDS 60 S

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.

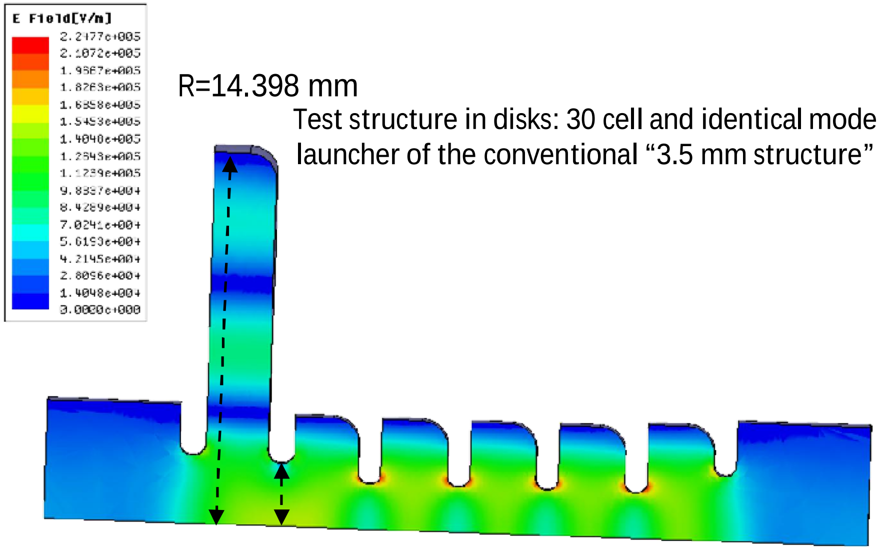
And the lower group velocity the more the difference.

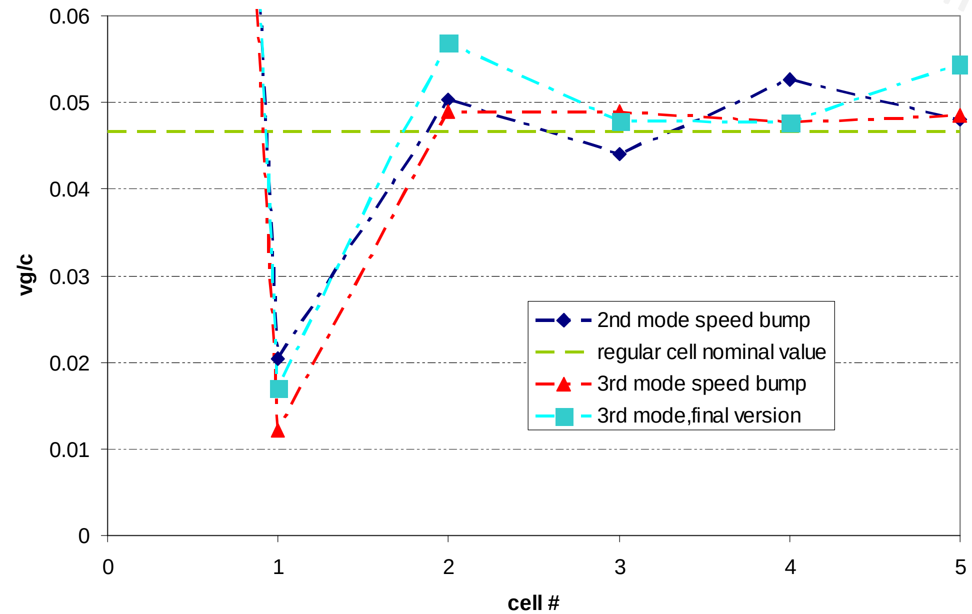
The first cell, if breakdown occurs is loaded by the input coupler/waveguide and is very specific in terms of bandwidth.

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.

Speed bump (TM_{03})





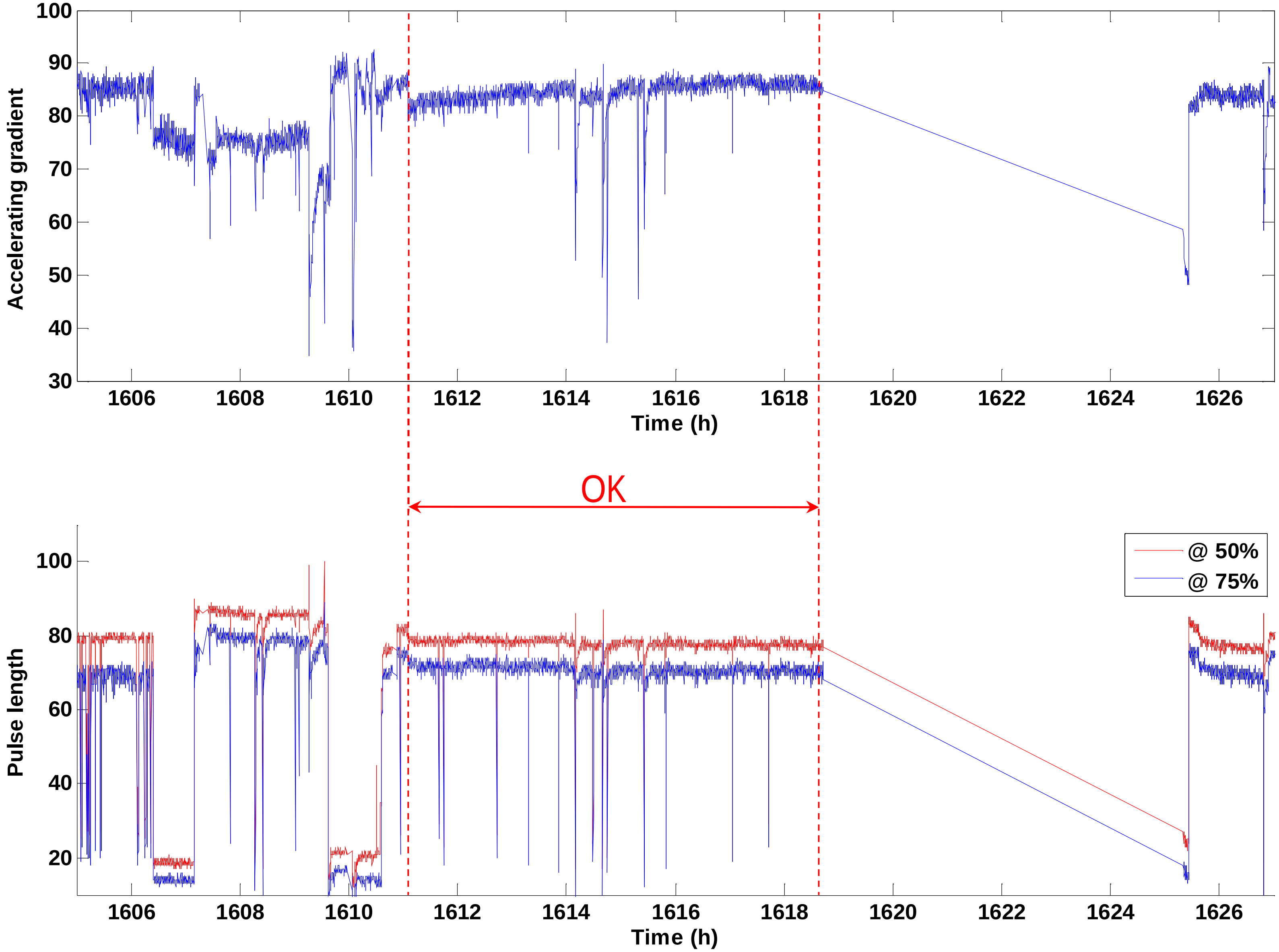
Goal : « protect » the structure by lowering V_g in the first cell (usually the most damaged).

Tested in both direction :

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

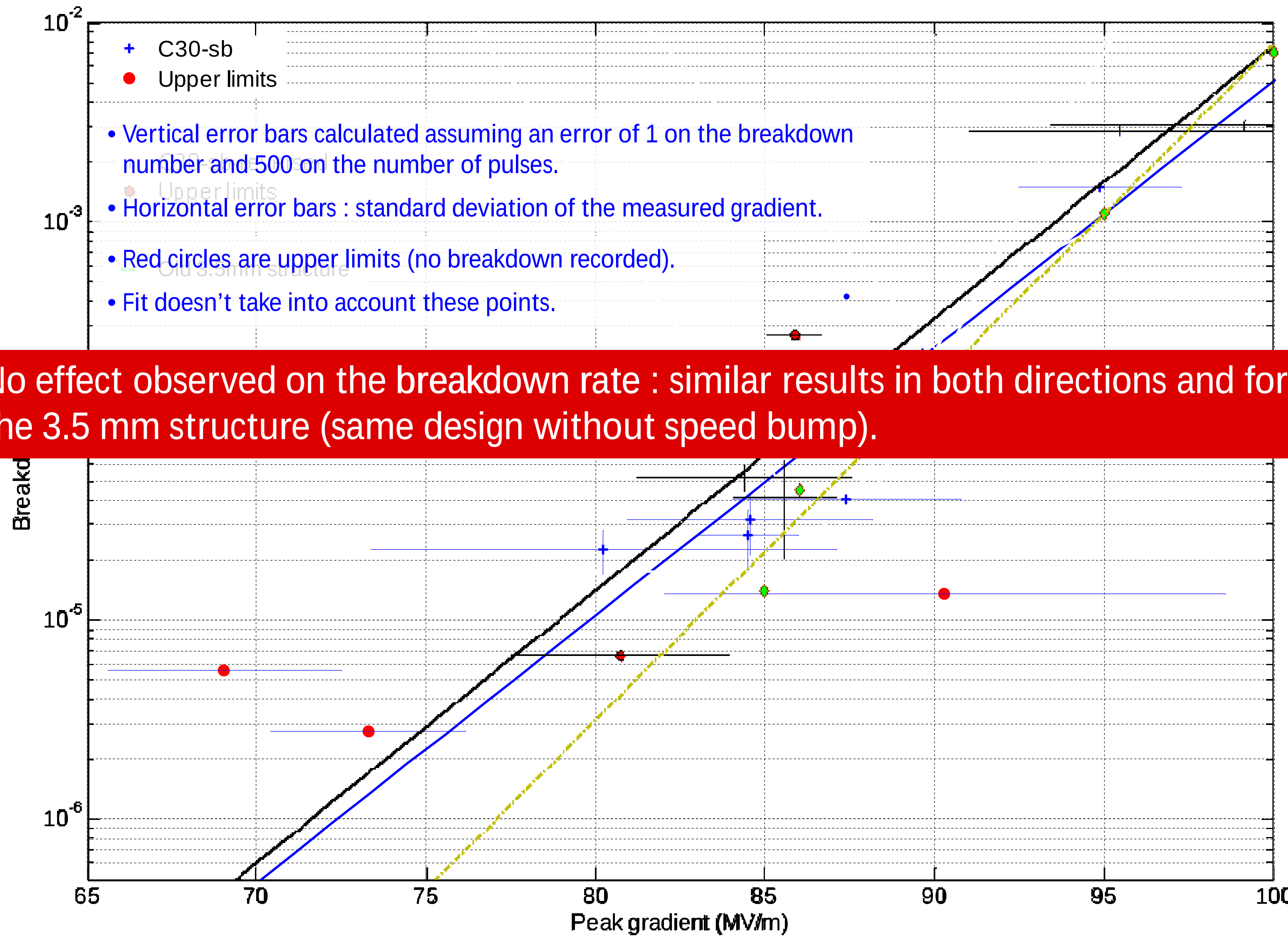
→ Equivalent to 19 + 8 « SLAC hours » @ 60 Hz...

Breakdown rate calculation



Breakdown rates vs gradient – speed bump structure

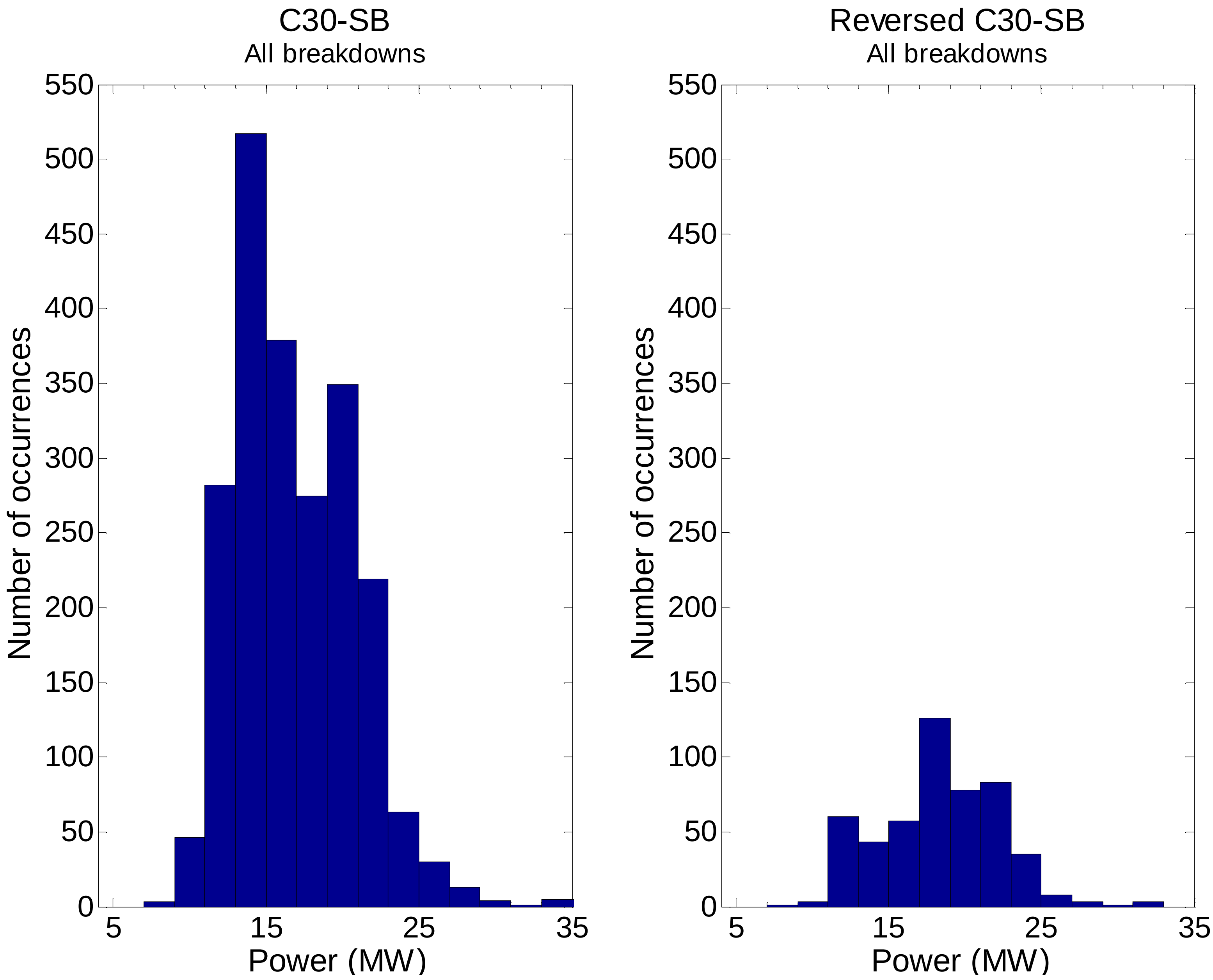
3.5 mm structure – comparison



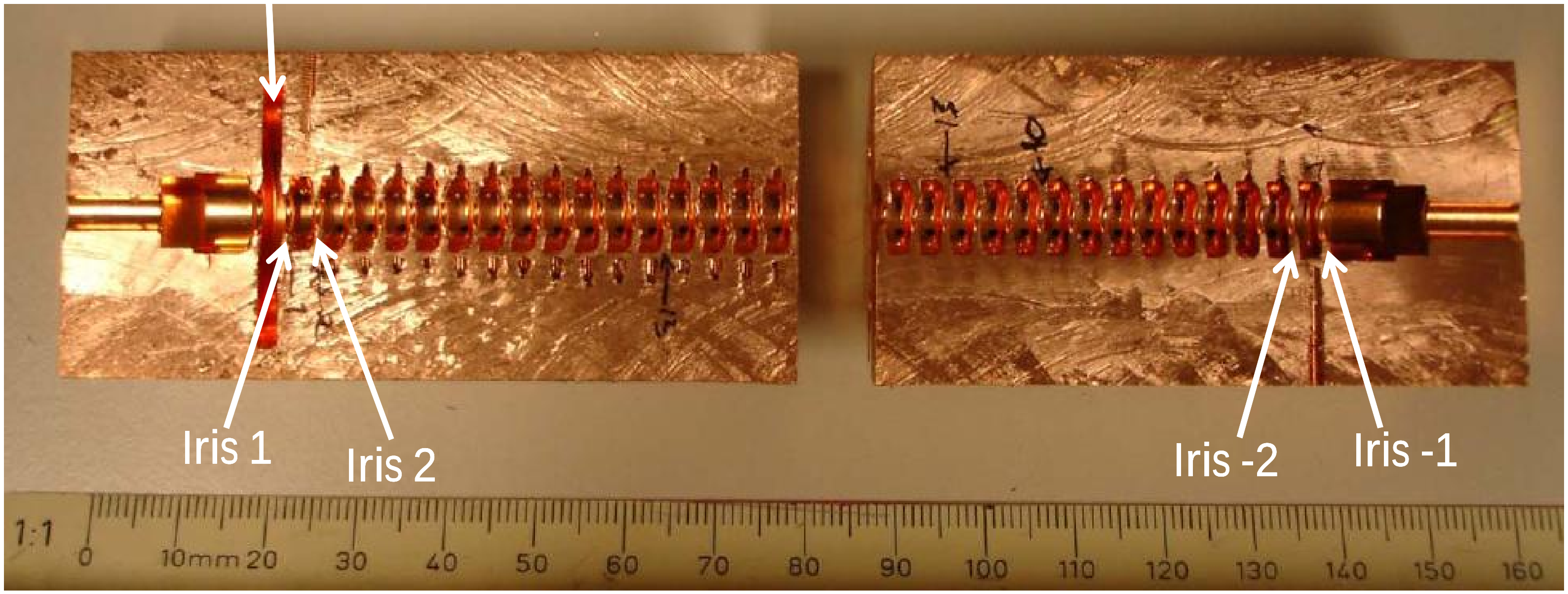
- Vertical error bars calculated assuming an error of 1 on the breakdown number and 500 on the number of pulses.
- Horizontal error bars : standard deviation of the measured gradient.
- Red circles are upper limits (no breakdown recorded).
- Fit doesn't take into account these points.

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



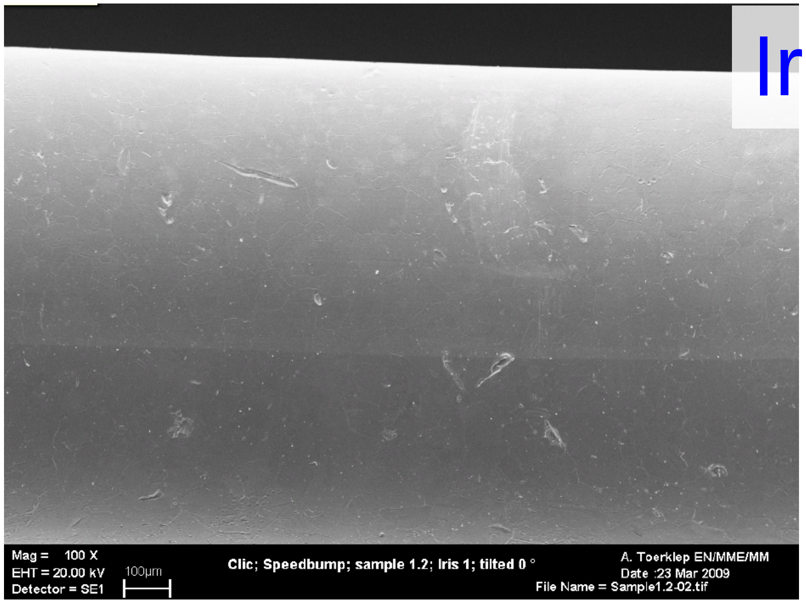
General view of the 30CNSDsbCu_speed-bump afer cutting

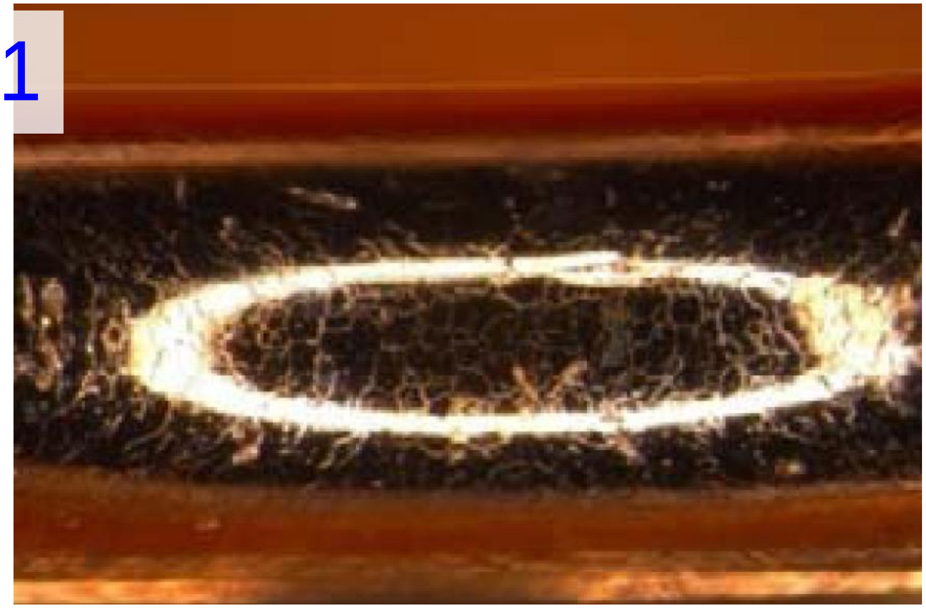


SEM inspection was performed on these irises

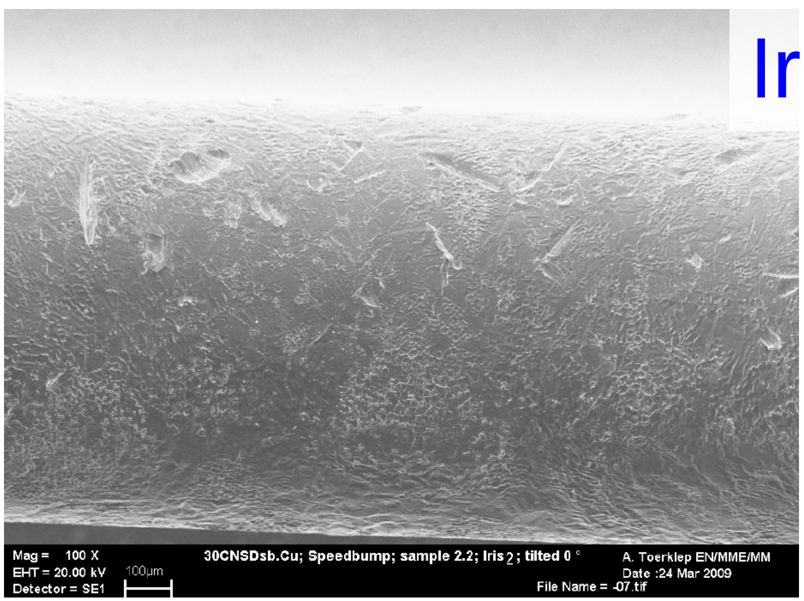
Damages

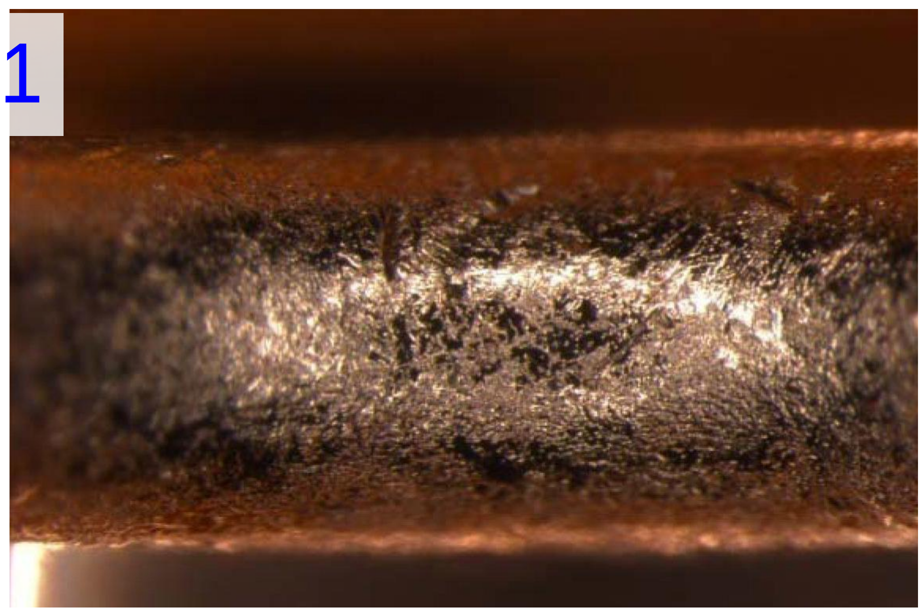
Iris 1





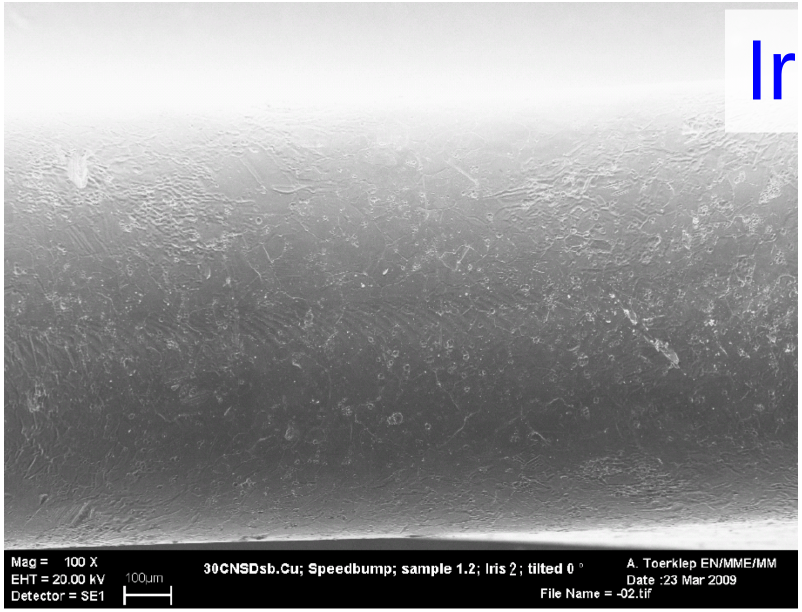
Iris -1

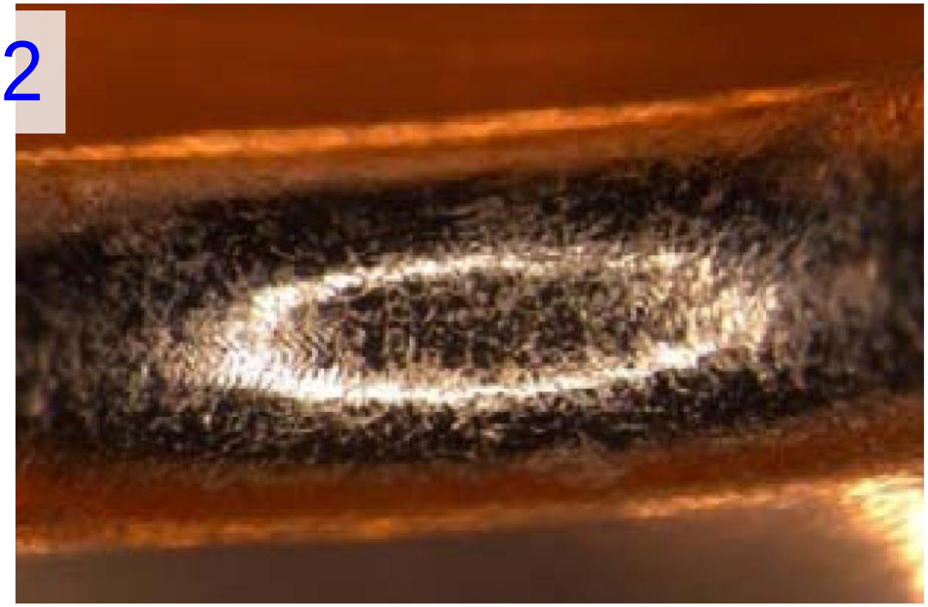




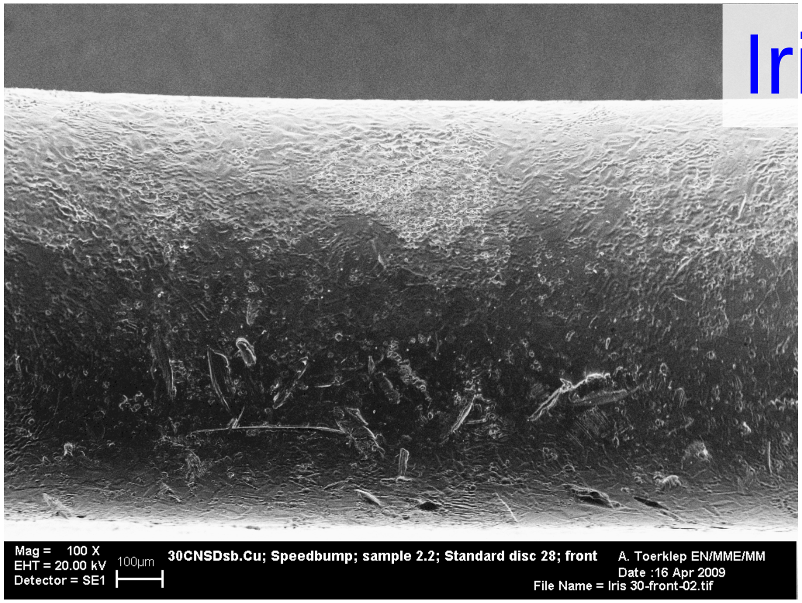
Damages

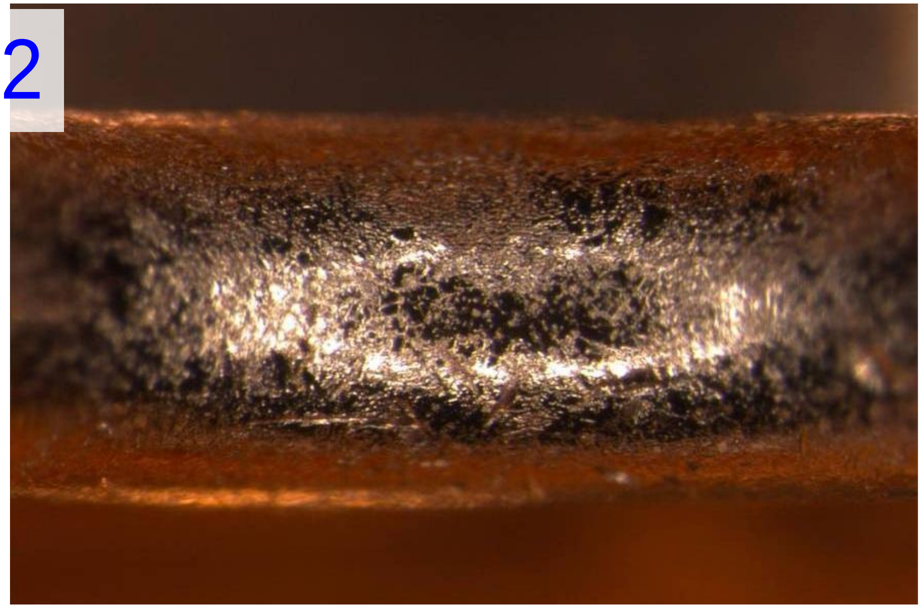
Iris 2





Iris -2



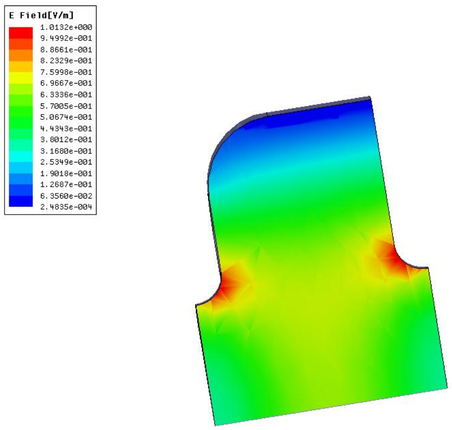


TM_{02} structure

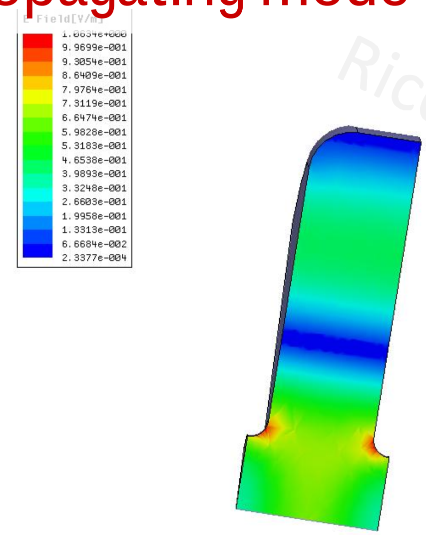
Is it possible to change some global parameter without changing local field distribution?

→ Only by changing the propagating mode

Courtesy of Riccardo Zennaro



TM_{01} regular cell "reference"



TM_{02} regular cell

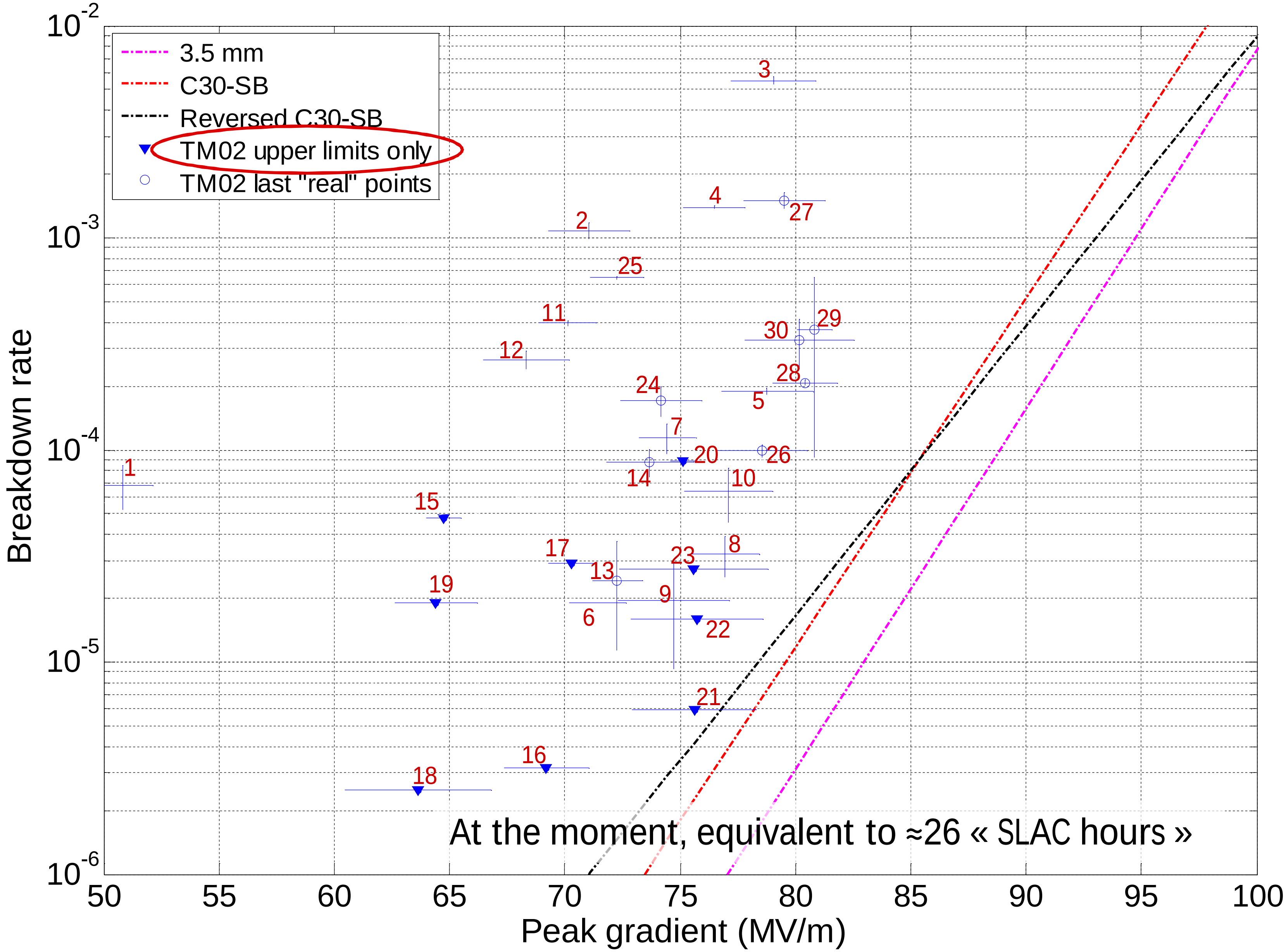
- Same phase advance
- Same P/c
- Same aperture and iris shape
- Same field configuration in the iris region

but

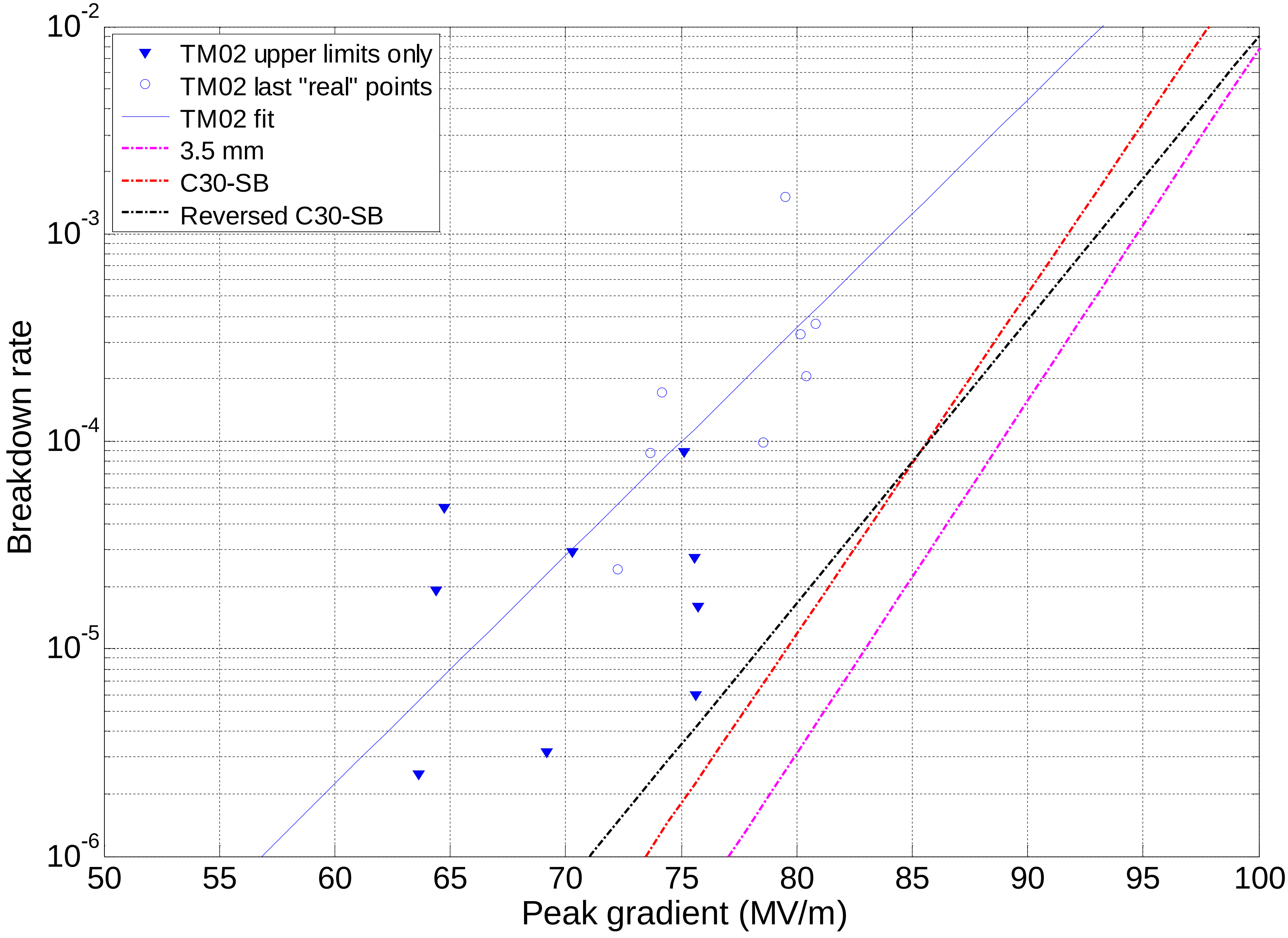
- Different group velocity (4.7% *vs* 2%)
- Different R/Q (29 kΩ/m *vs* 12 kΩ/m)

Test structure in disks : 30 cells, same mode launcher as the "conventional" 2π/3, Ø 3.5 mm.

TM_{020} structure – preliminary results



TM_{020} structure – preliminary results

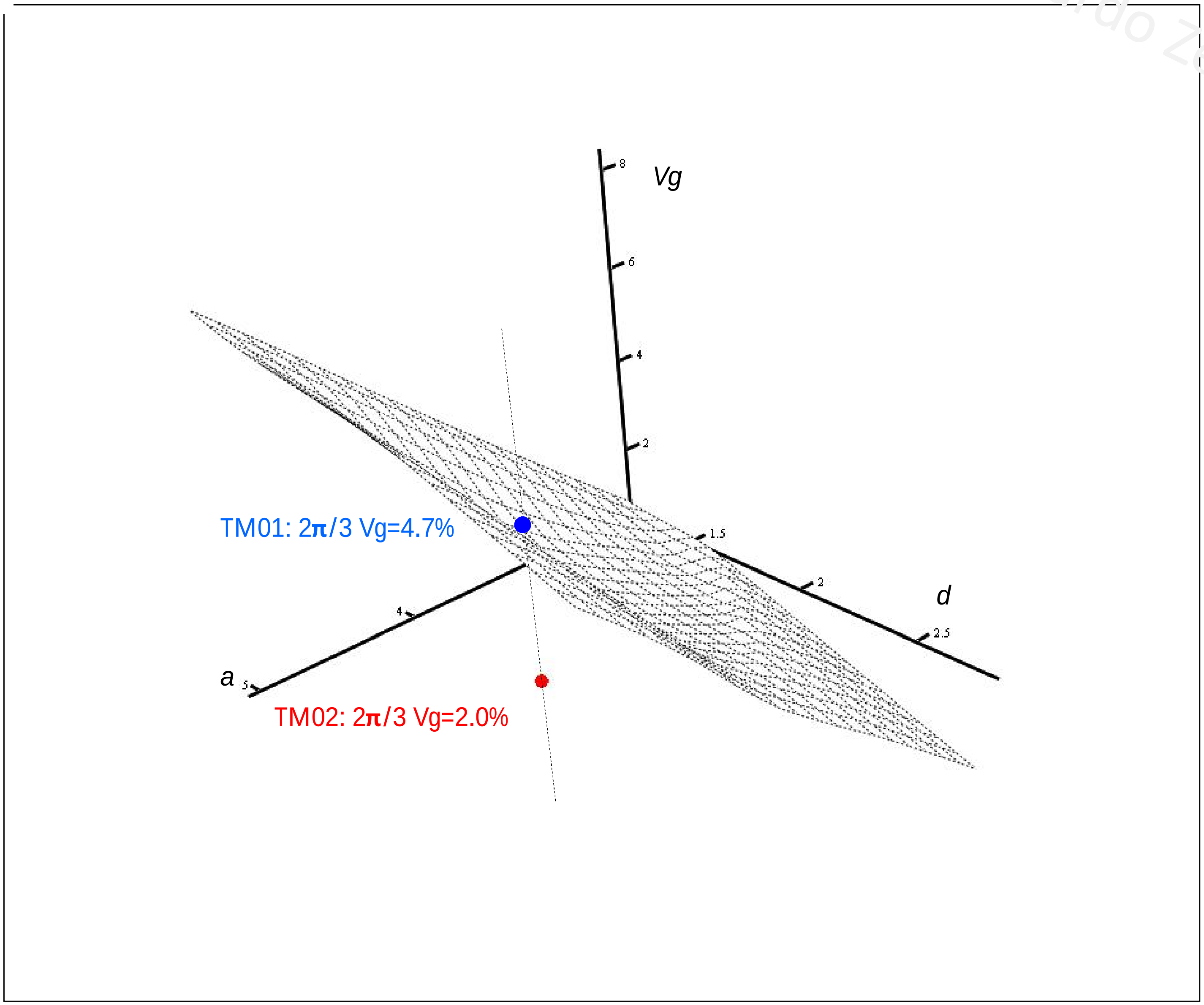


Conclusion and future plans

- 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 !

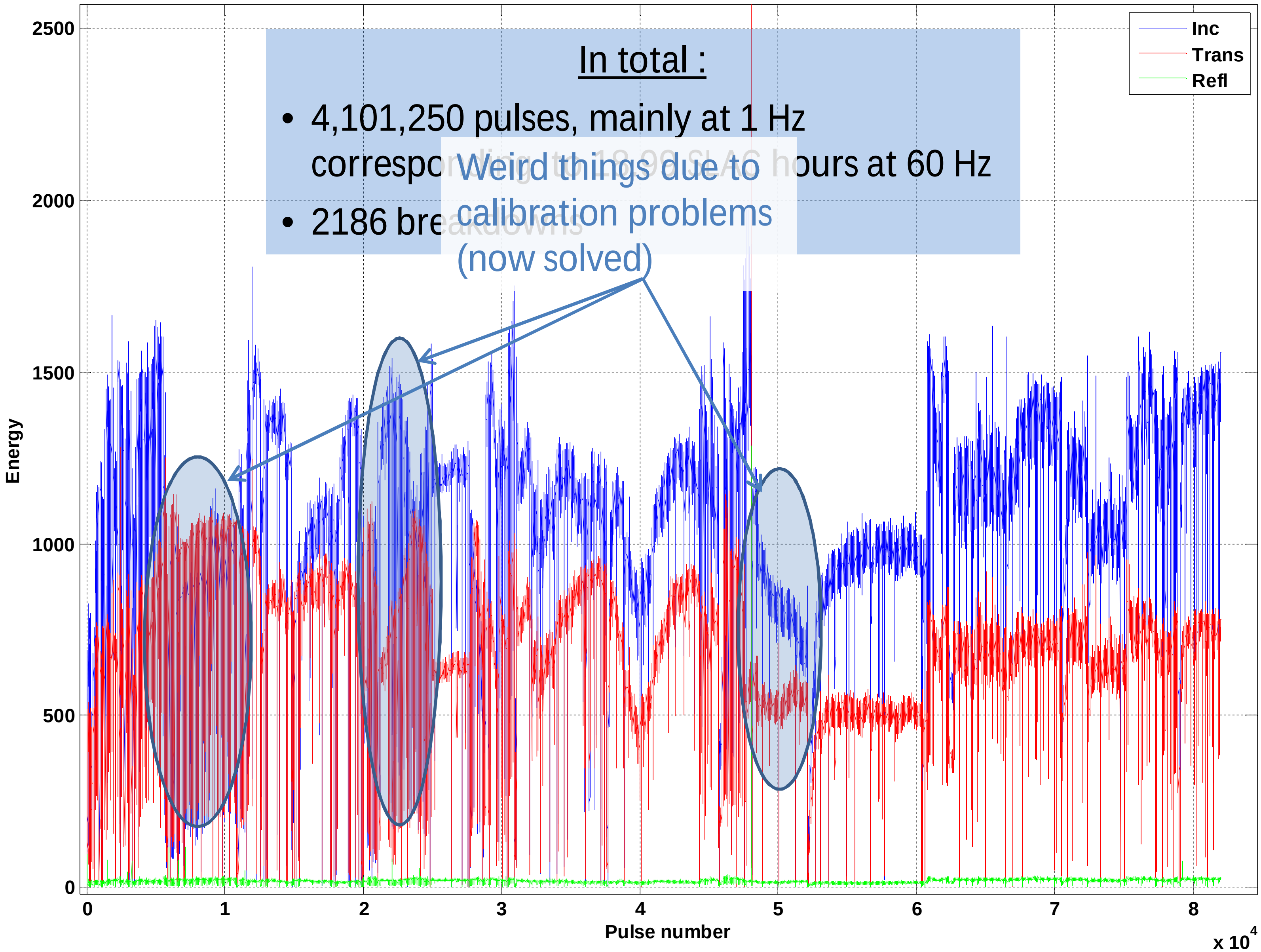
La réserve du chef

Direct comparison of V_g



(as, ds, vgs), (a1, d1, vg1)

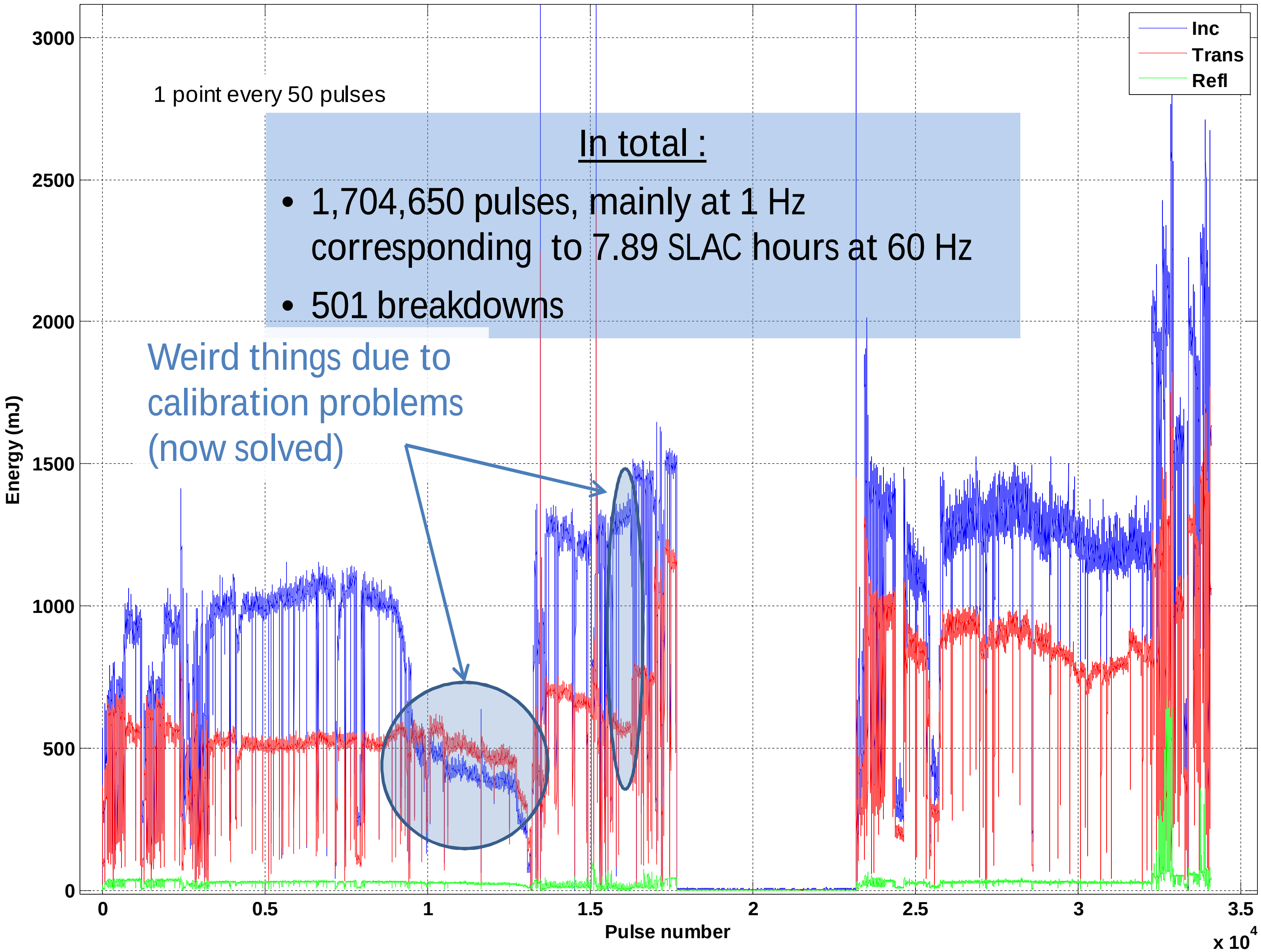
C30-sb

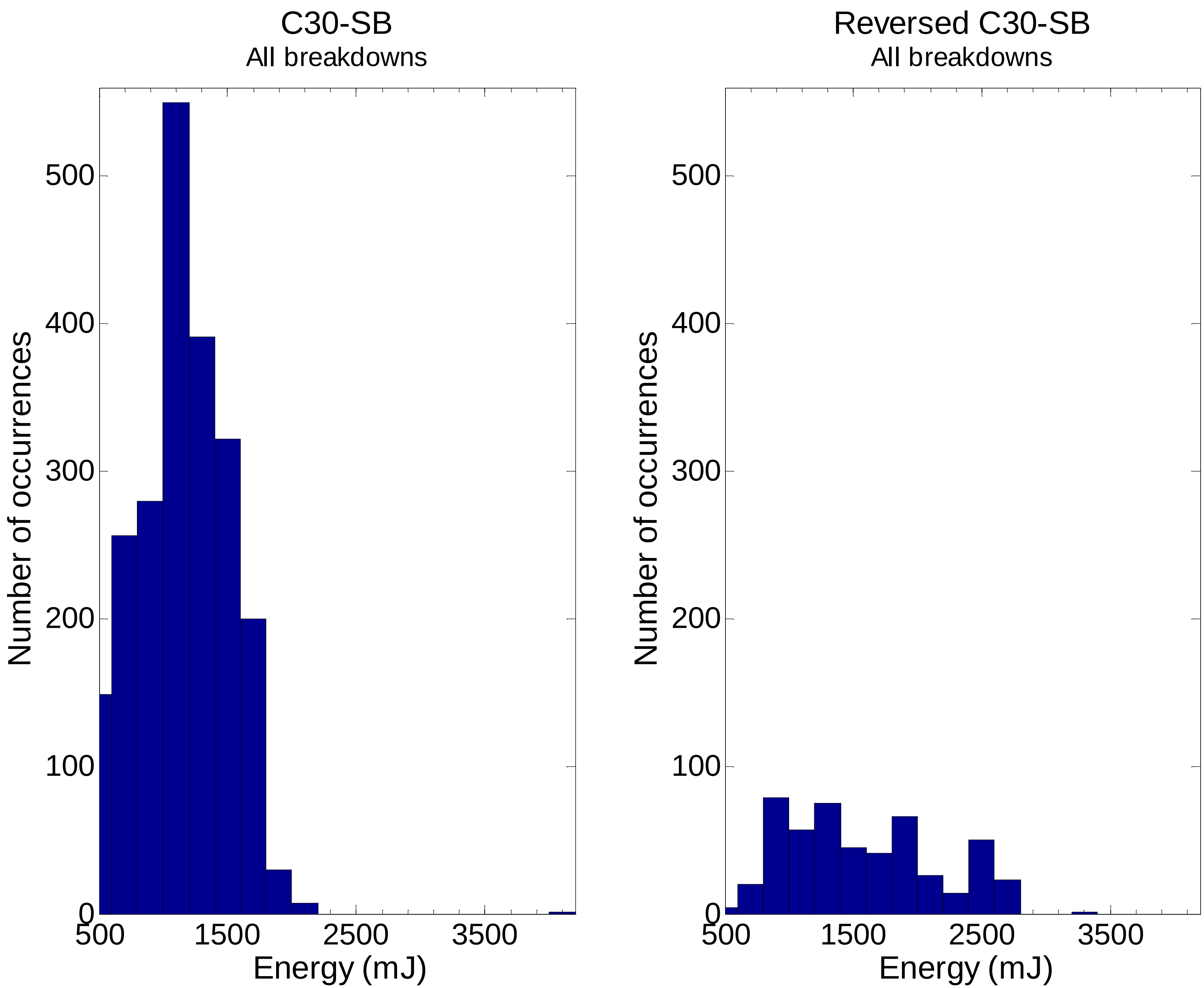


In total :

- 4,101,250 pulses, mainly at 1 Hz
  correspo… ours at 60 Hz
- 2186 breakdowns

C30-sb-reversed




C30-SB
All breakdowns
Number of occurrences
Energy (mJ)
0
100
200
300
400
500
500
1500
2500
3500
Reversed C30-SB
All breakdowns
Number of occurrences
Energy (mJ)
0
100
200
300
400
500
500
1500
2500
3500