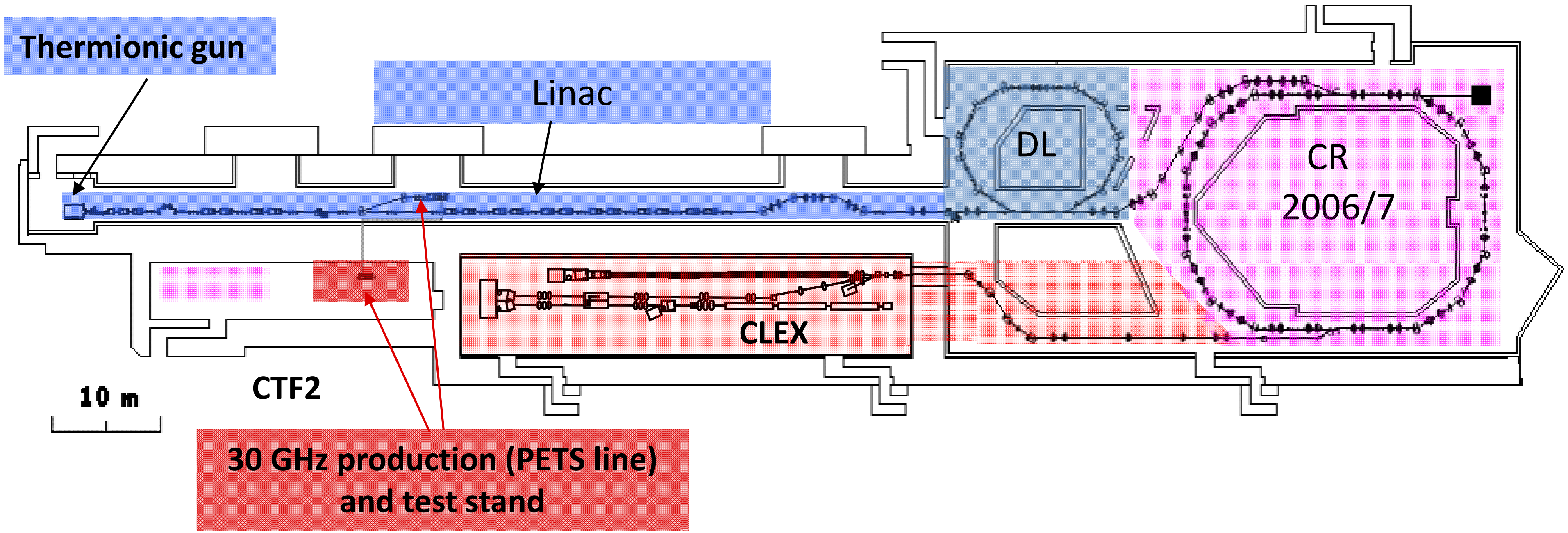
30 GHz results from 2008

Mathias Gerbaux

CTF3 Collaboration Technical meeting
27/01/2009

To set the stage…



Structures tested in 2008

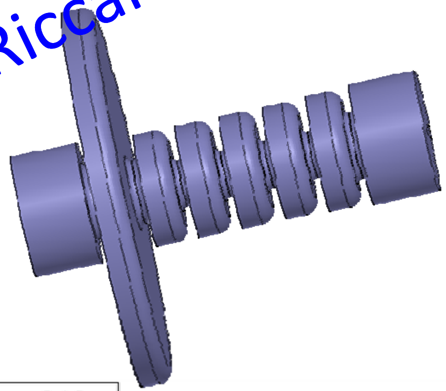
Only two…

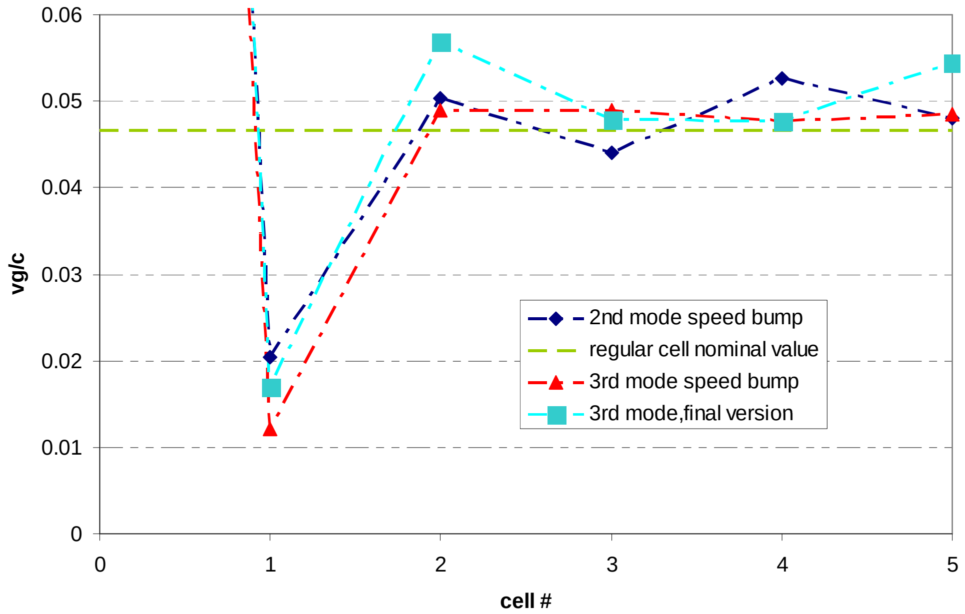
- HDS4_thick : re-test, bad results. Didn't reach an accelerating gradient much higher than 60 $MV.m^{-1}$.
- C30_speed_bump_ : same geometry as the older 3.5 mm structure except for a « speed bump » lowering the group velocity at the input.

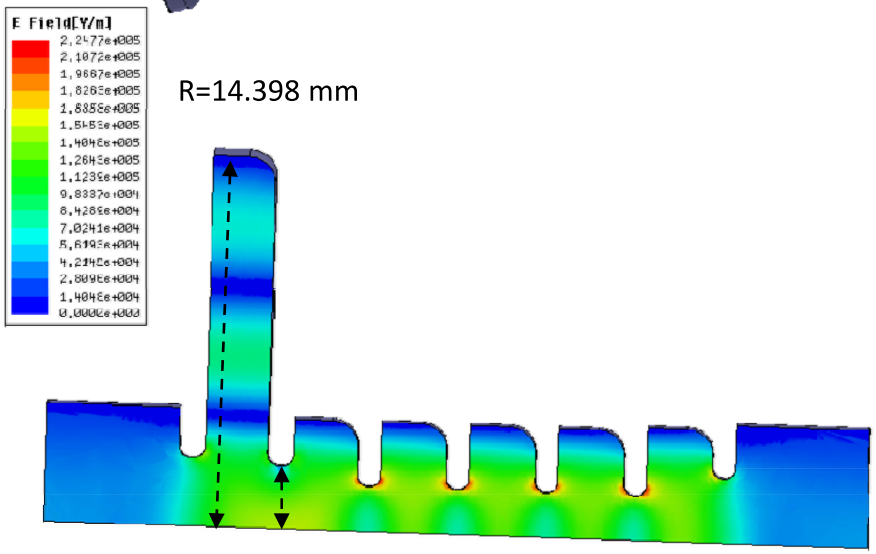
  Two measurements : fed by the input and by output.

Speed bump (TM_{03})

Courtesy of Riccardo Zennaro

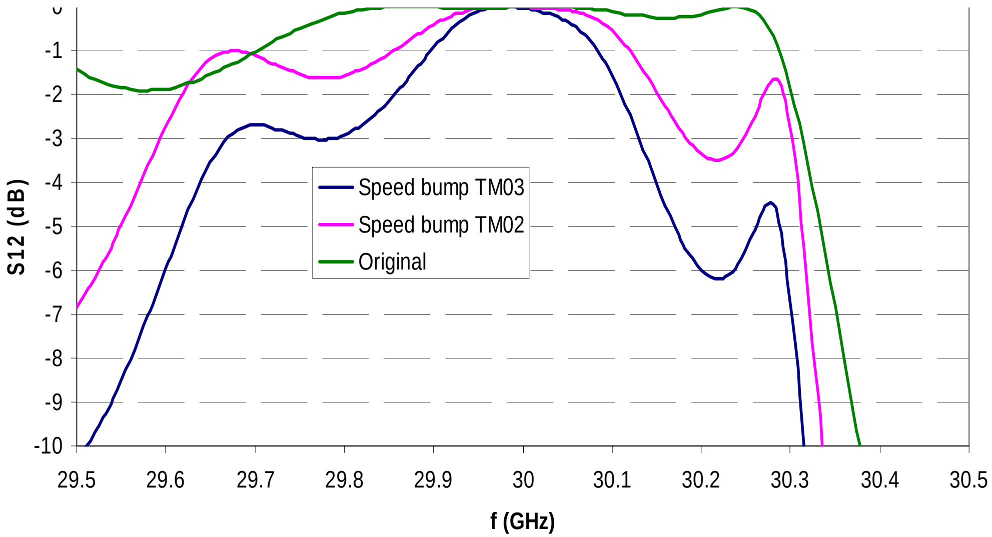






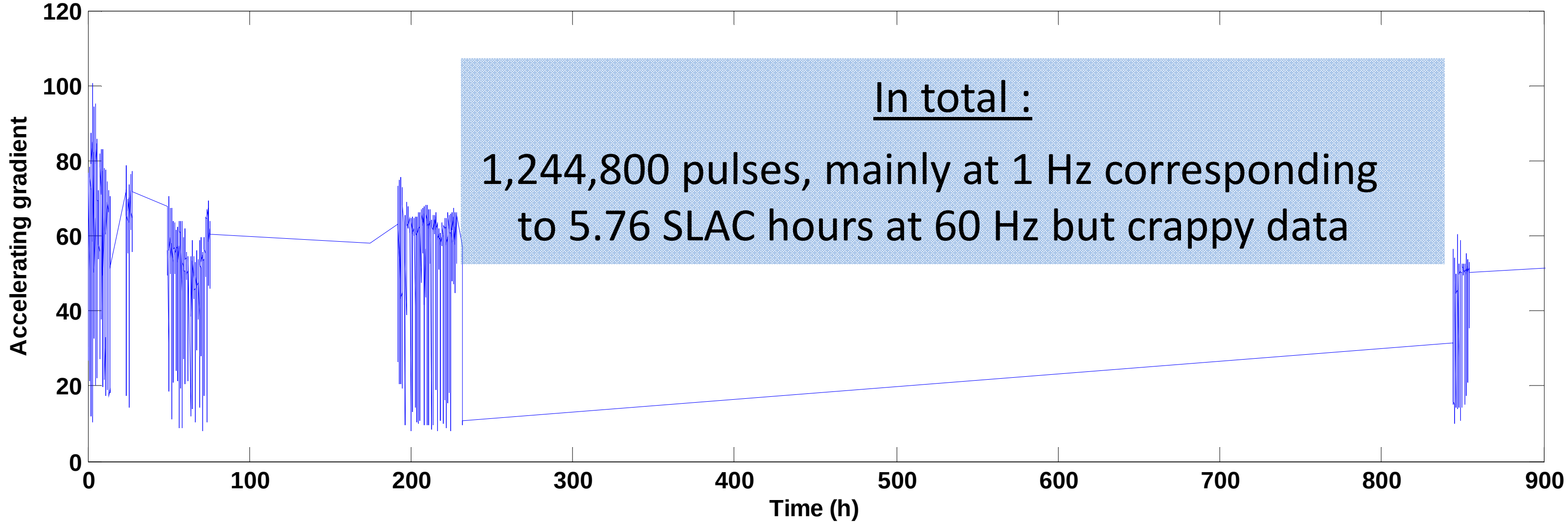
R_iris= 2.428 mm

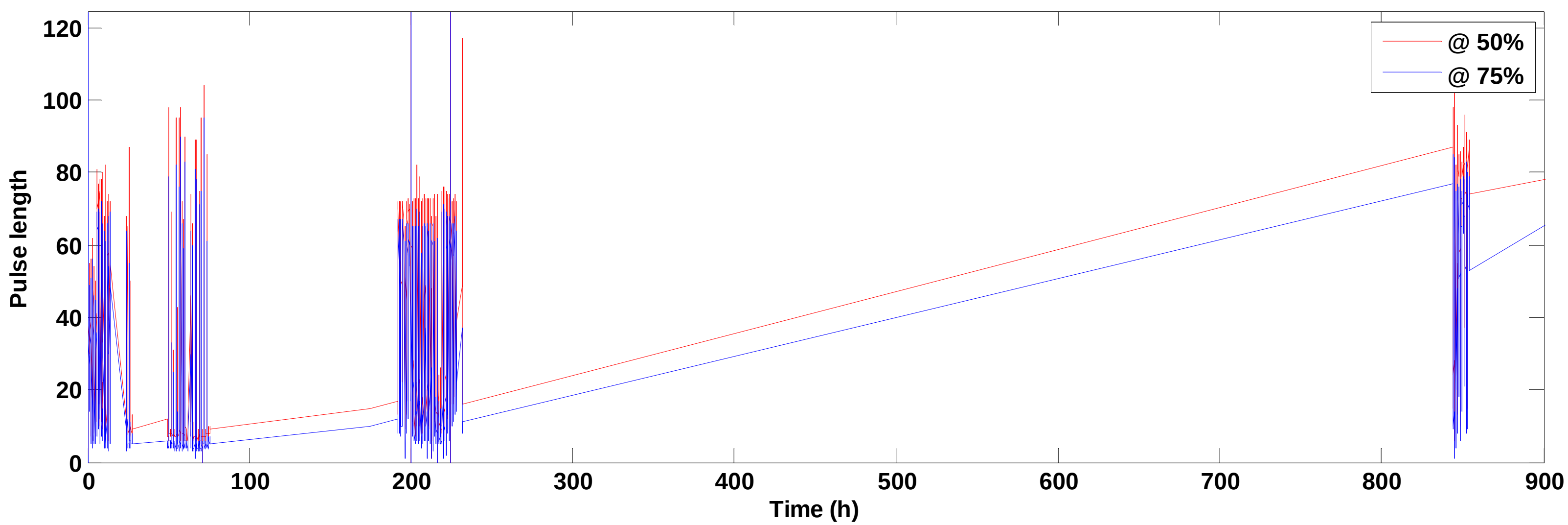
Iris_thickness= 1mm



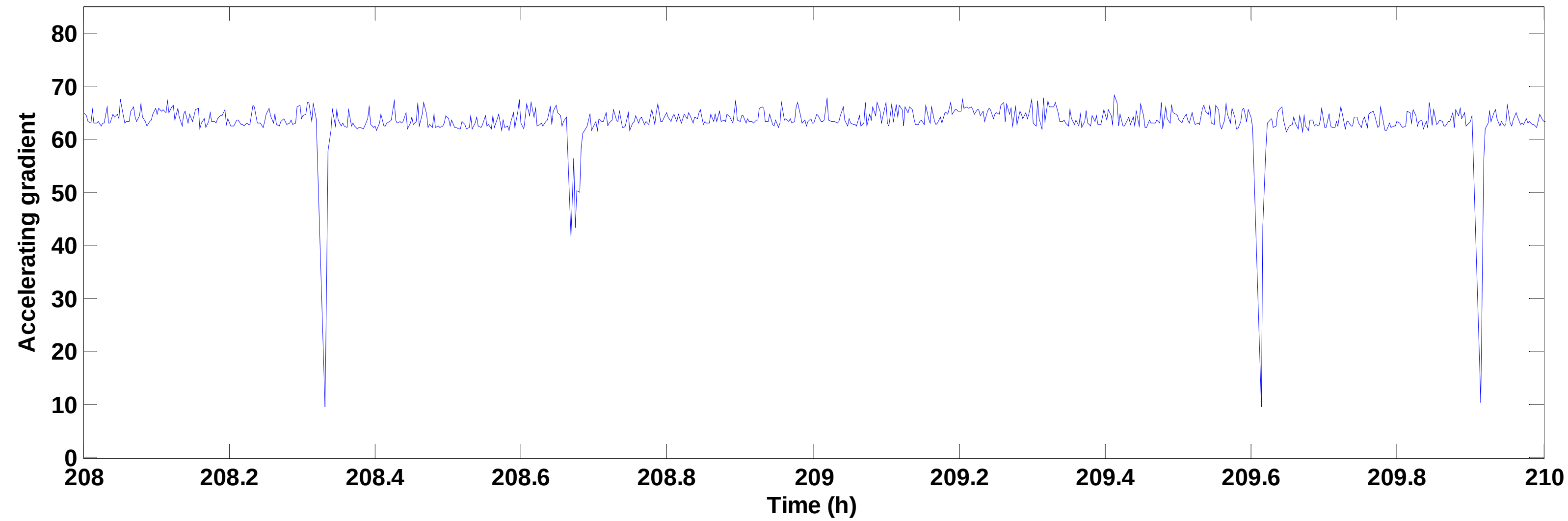
Test structure in disks: 30 cell and identical mode launcher of the "conventional" $2\pi/3$ Ø 3.5 mm

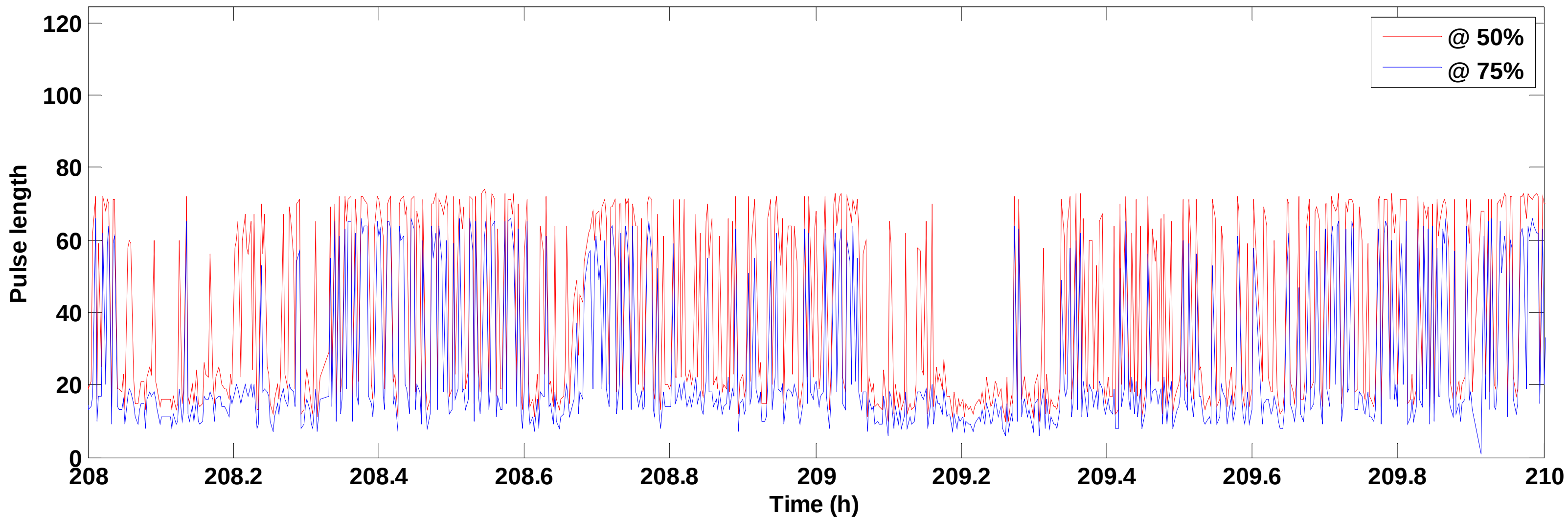
HDS4_thick re-test: whole history



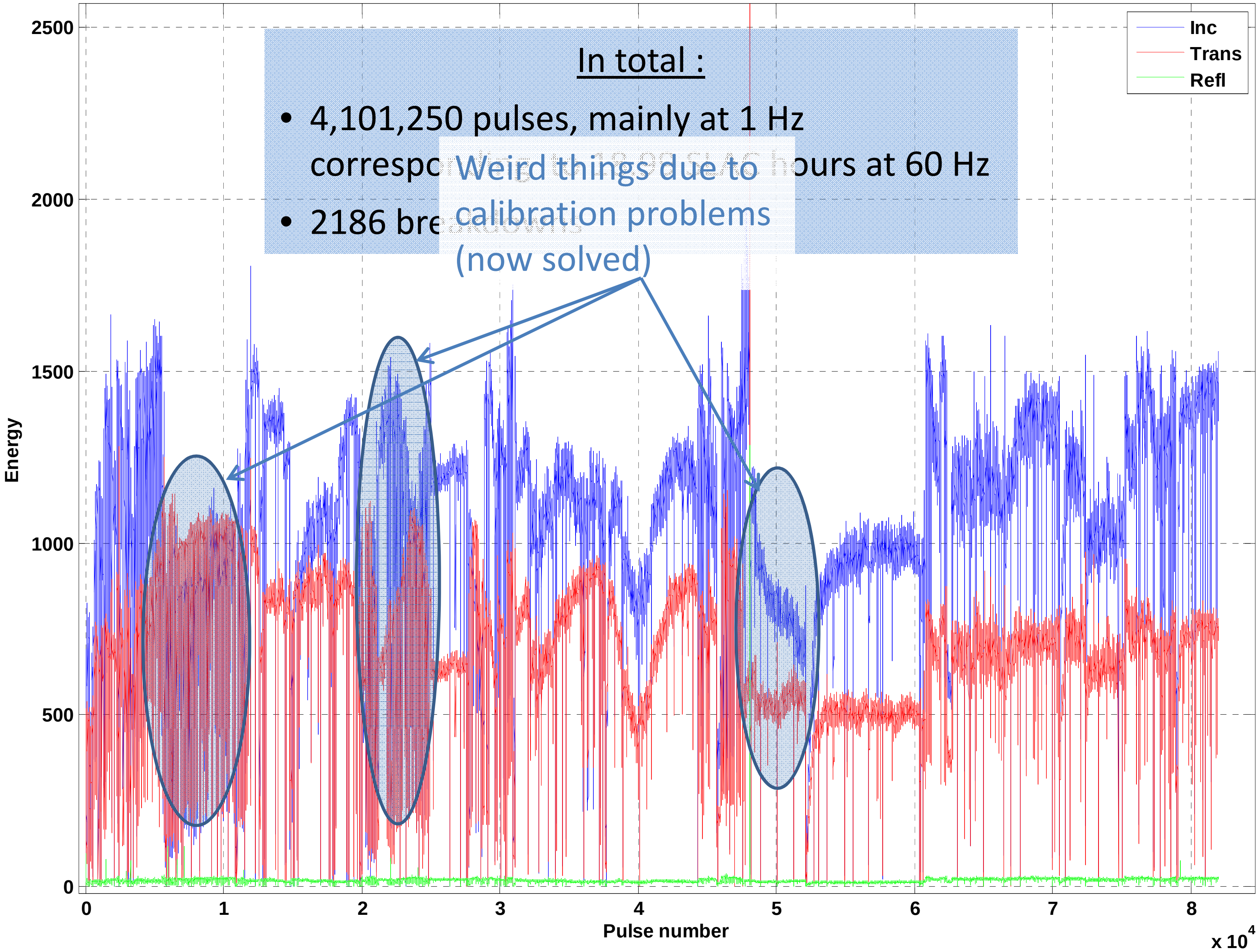


HDS4_thick re-test : typical running

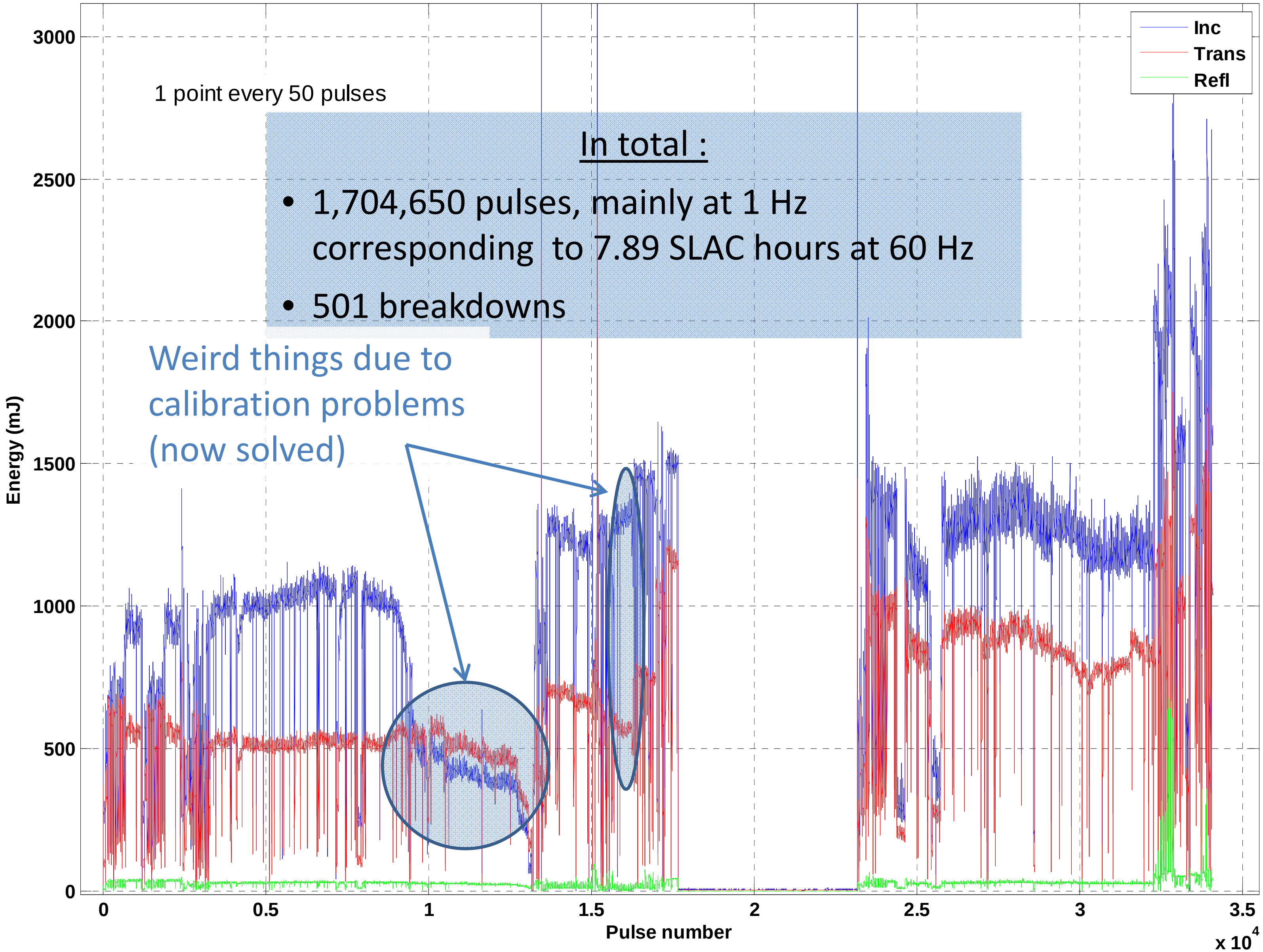




C30-sb


In total :
• 4,101,250 pulses, mainly at 1 Hz
correspo … ours at 60 Hz
• 2186 bre
Weird things due to calibration problems (now solved)
Inc
Trans
Refl
Energy
Pulse number
x 10^4
0
500
1000
1500
2000
2500
0
1
2
3
4
5
6
7
8

C30-sb-reversed



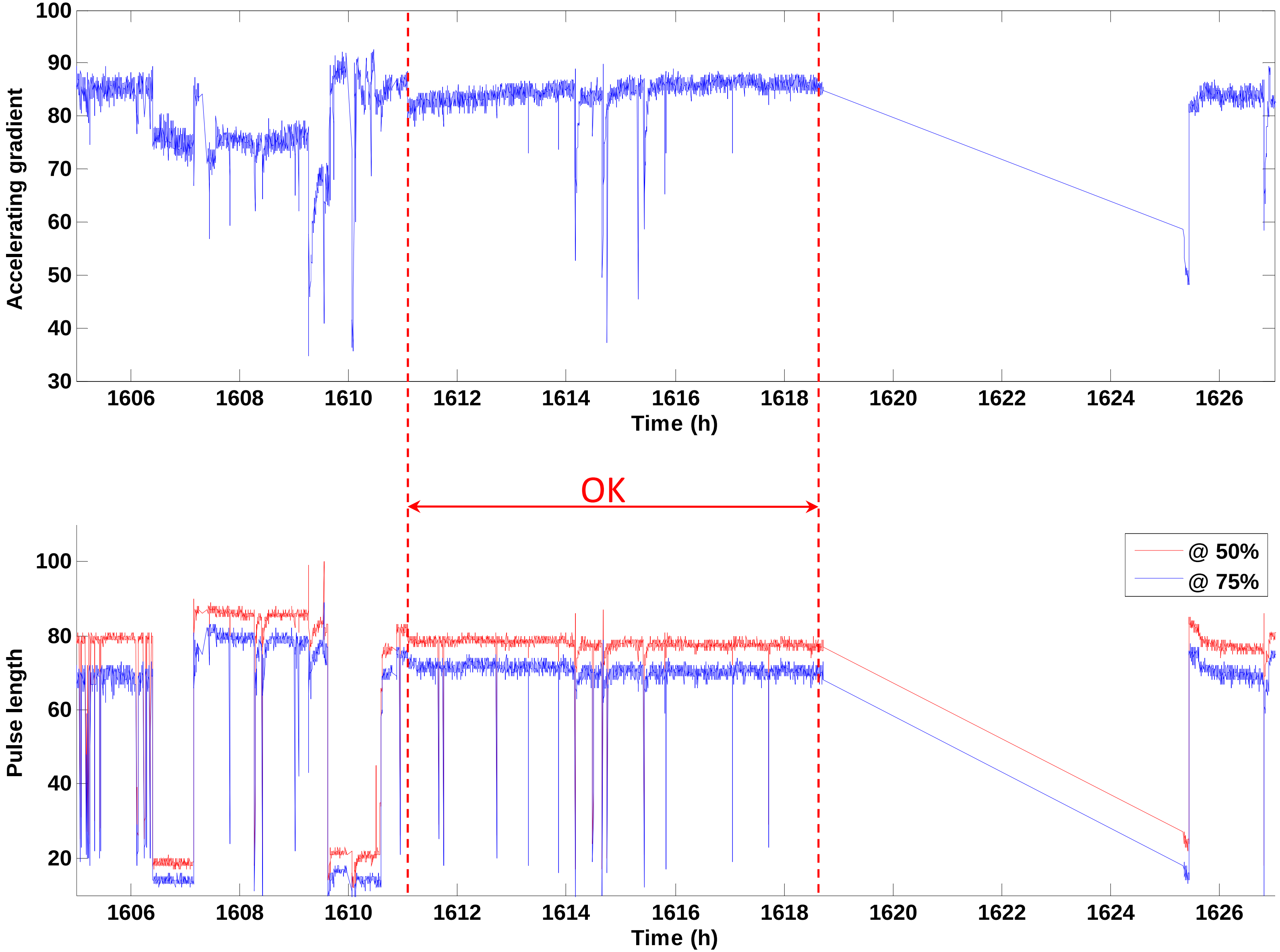
We figured out at the end of Fall 2008 that calibration was affected by various factors (drifting baselines, temperature…).

If we assume the measurement of the incident power is not too wrong…

Or at least it is only the absolute calibration that is wrong and it don’t change too quickly.

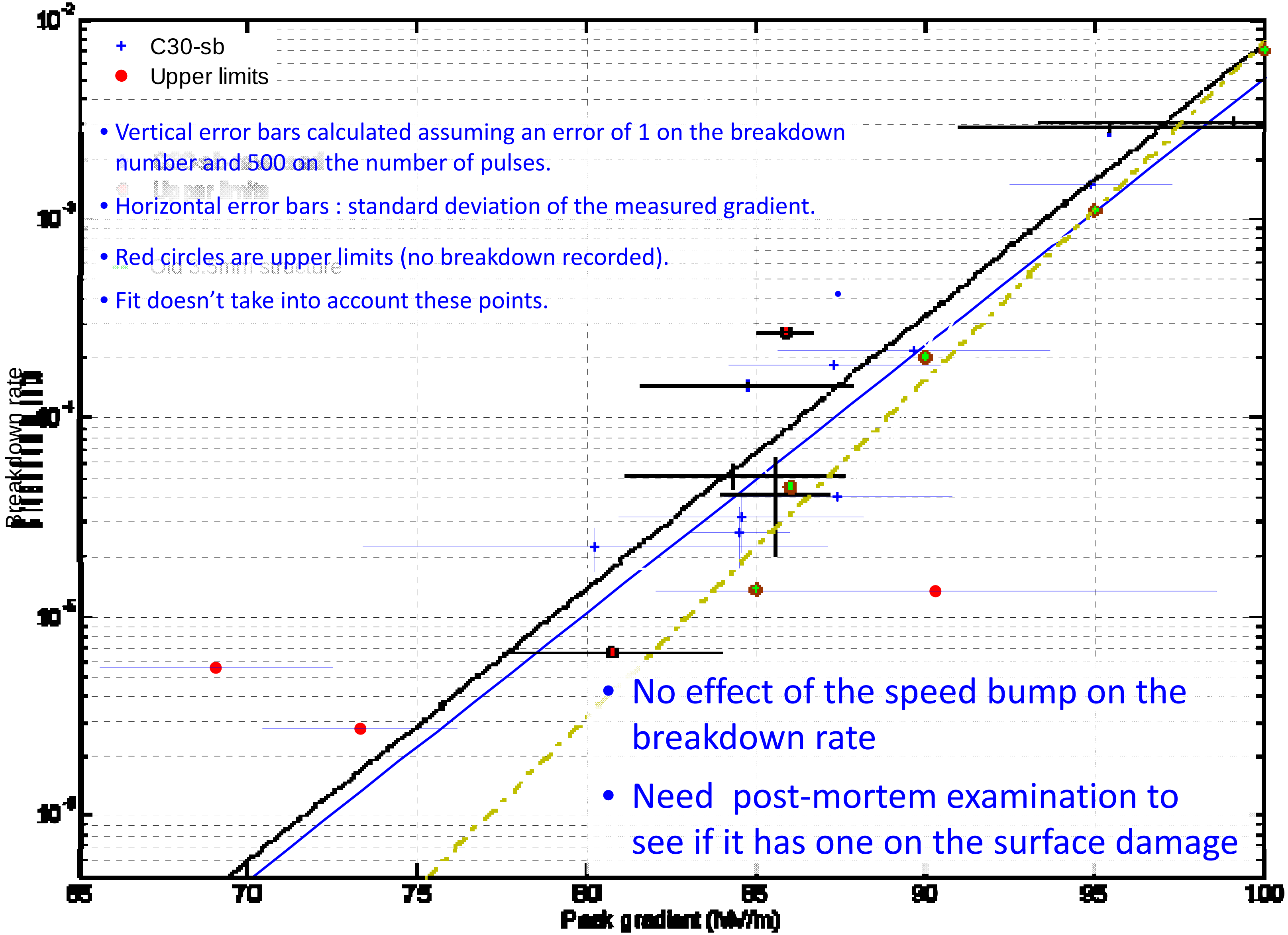
Then, we can calculate the breakdown rate as a function of the accelerating gradient .

Breakdown rate calculation



Breakdown rate vs gradient – speed bump structure

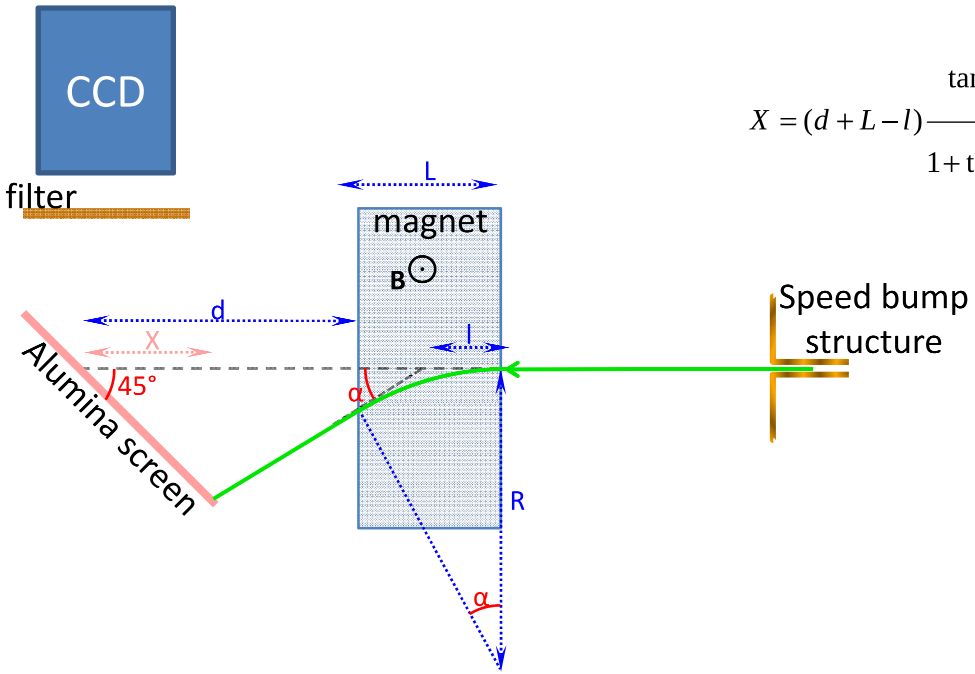
3.5 mm structures comparison



- 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 of the speed bump on the breakdown rate
- Need post-mortem examination to see if it has one on the surface damage

DIY electron spectrometer

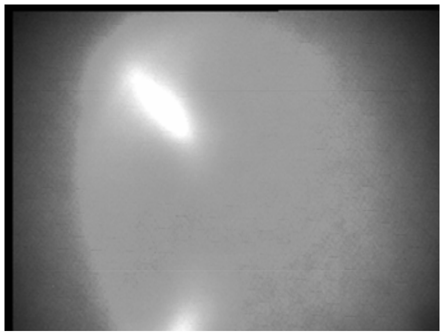
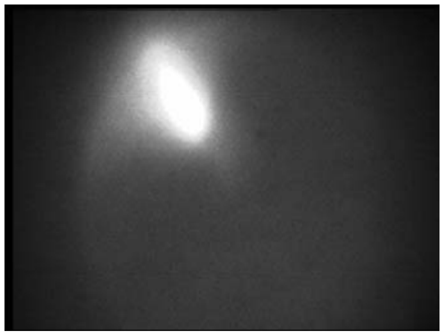


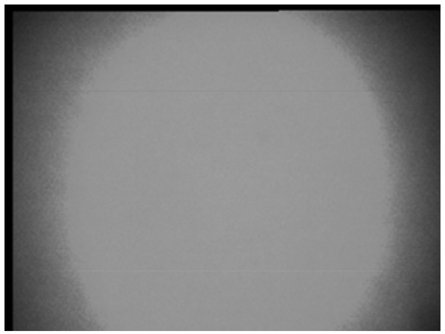
$$X = (d + L - l)\frac{\tan\left[\arcsin\left(\frac{L}{R}\right)\right]}{1+\tan\left[\arcsin\left(\frac{L}{R}\right)\right]}$$

Rough calculations :

- with B=0.15 mT (0.1 A), E(e^-) > 200 eV
- with B=0.75 mT (0.5 A), E(e^-) > 10 keV
- with B=3.0 mT (2.0 A), E(e^-) > 200 keV
- with B=7.5 mT (5.0 A), E(e^-) > 500 keV

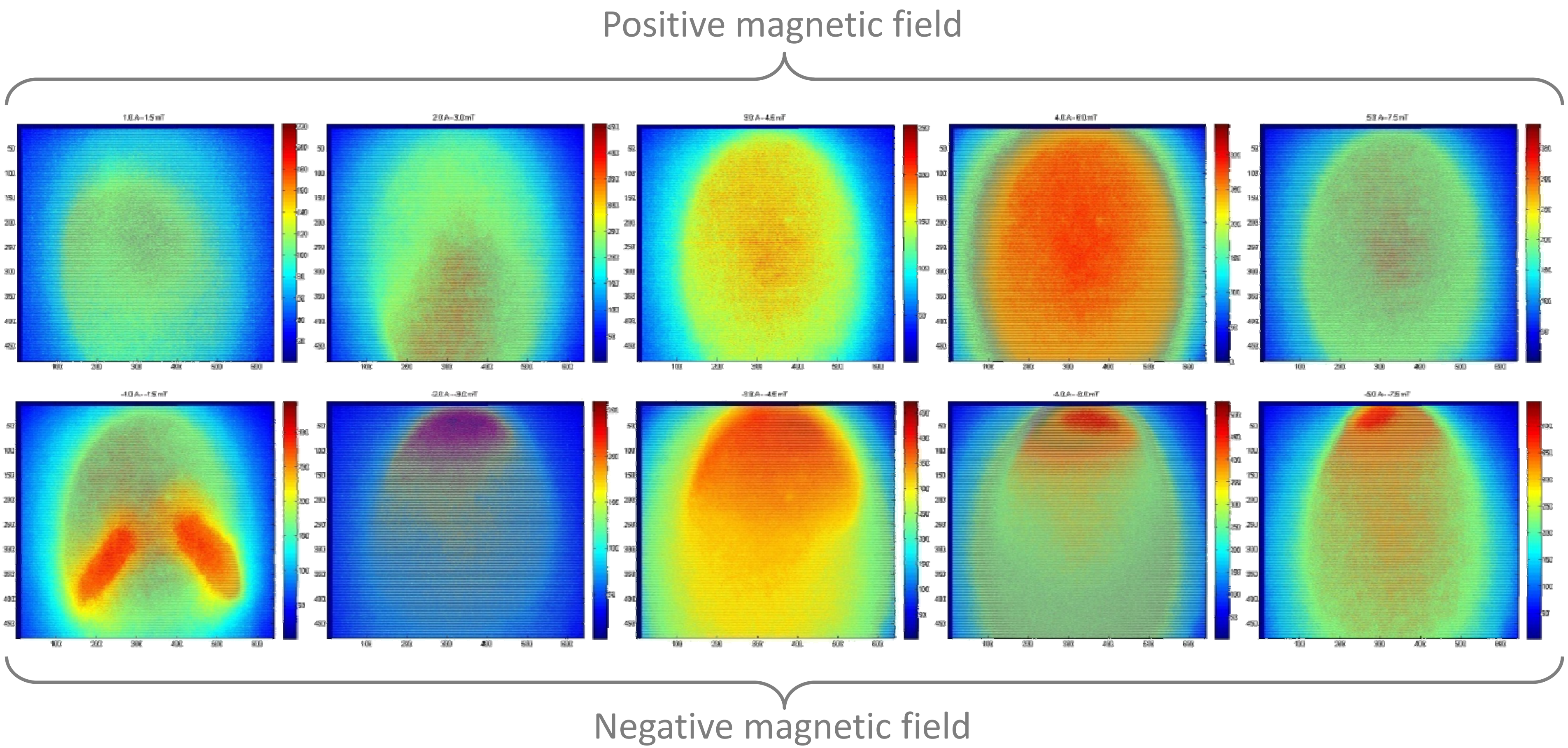
Some spots… Most of the time :



0 A | 0 A | 1 A | 3 A

DIY electron spectrometer – just a few pictures



increasing $\|B\|$

- There is an effect compatible with an electron signal (up to 500 keV)
- We haven't a real « zero » position
- Huge spread of the spot, non-reproducibility
- No calibration number of electrons – light intensity

} Needs a collimator !

Conclusion and future plans

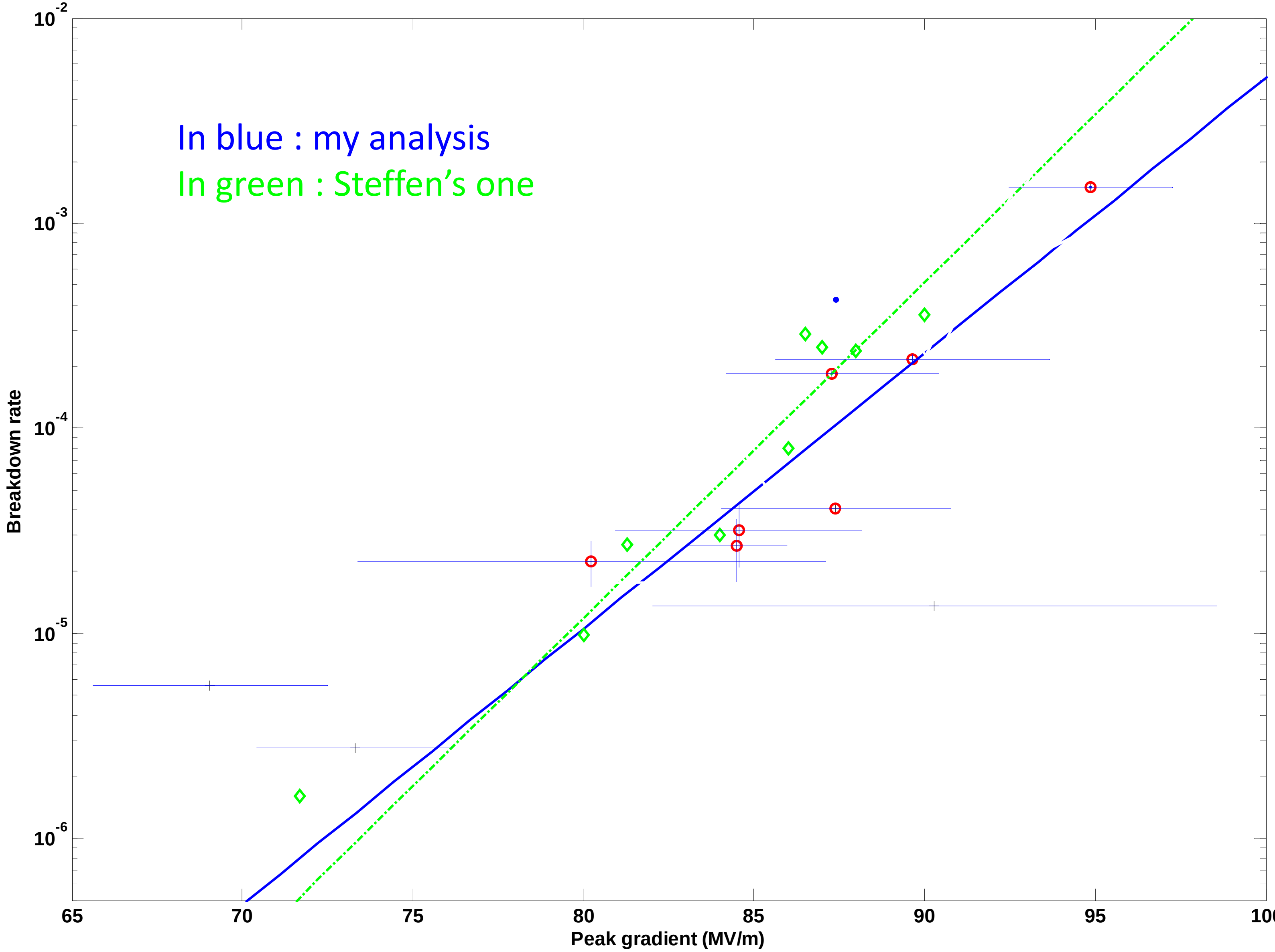
- 2 structures tested last year :
  - HDS4_thick showed poor performances
  - C30-speed bump gave better results
  - But remember the cumulative duration of the tests is still short compared to SLAC tests (less than 33 h in total for 2008).
- C30-sb manufactured following the same procedure as the T18 X-band structure currently tested at SLAC with bad results.
- Spectrometer measurement performed with what was at hand, definitely lacks a collimator !
- Poor reproducibility, we are working to see if it can be related to the position of the breakdown (structure acting as a collimator).
- Nevertheless gave indications of an e^- “beam” emmitted during the breakdown with an energy up to at least 500 keV.
- ONE last 30 GHz structure to be tested in 2009 (TM02), optical spectrometry measurement will be done (J. Kovermann).

Many thanks :

to { Alexandra Andersson
Jan Kovermann
Steffen Döbert
Riccardo Zennaro }

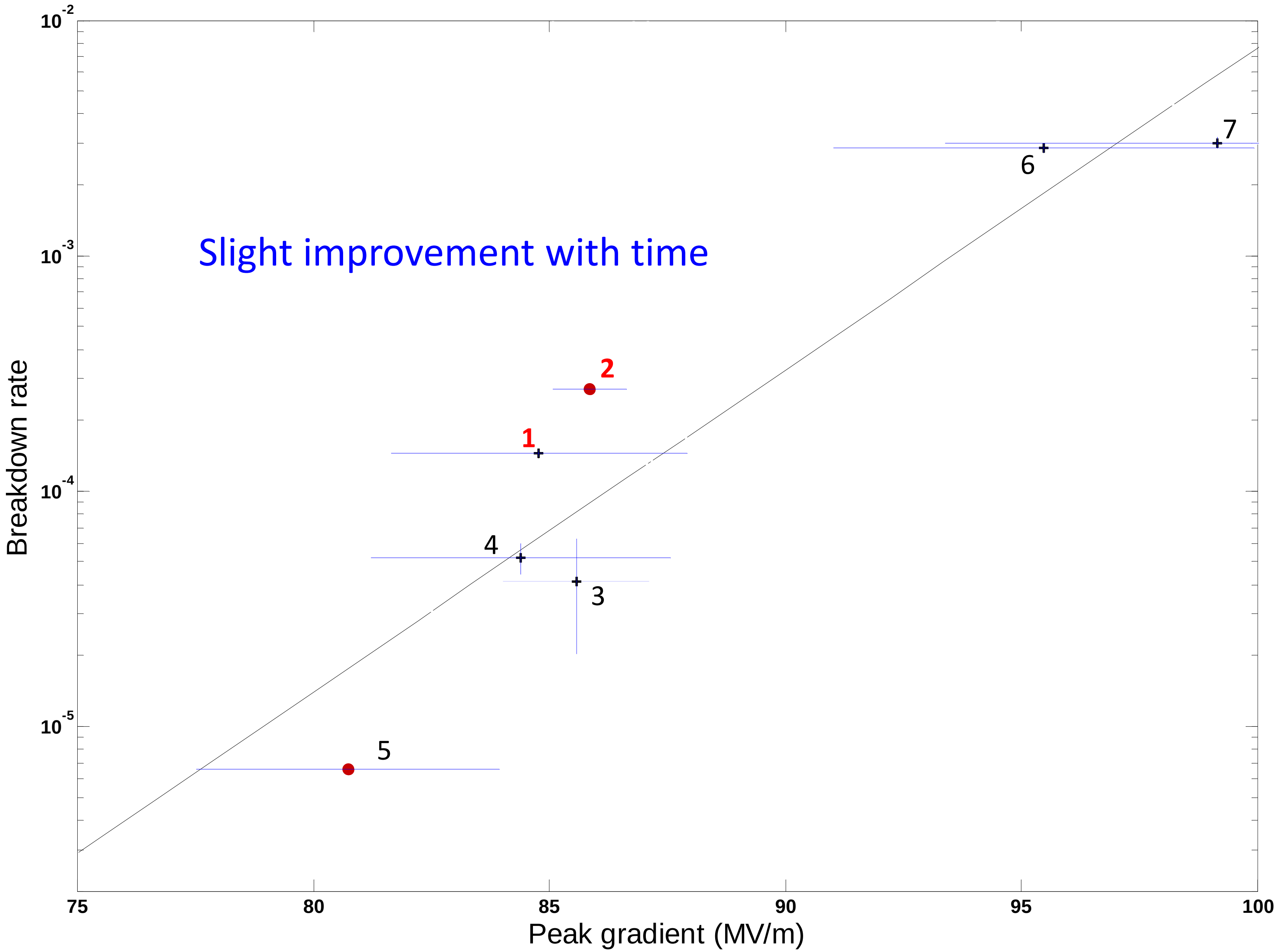
and for your attention !

C30-sb

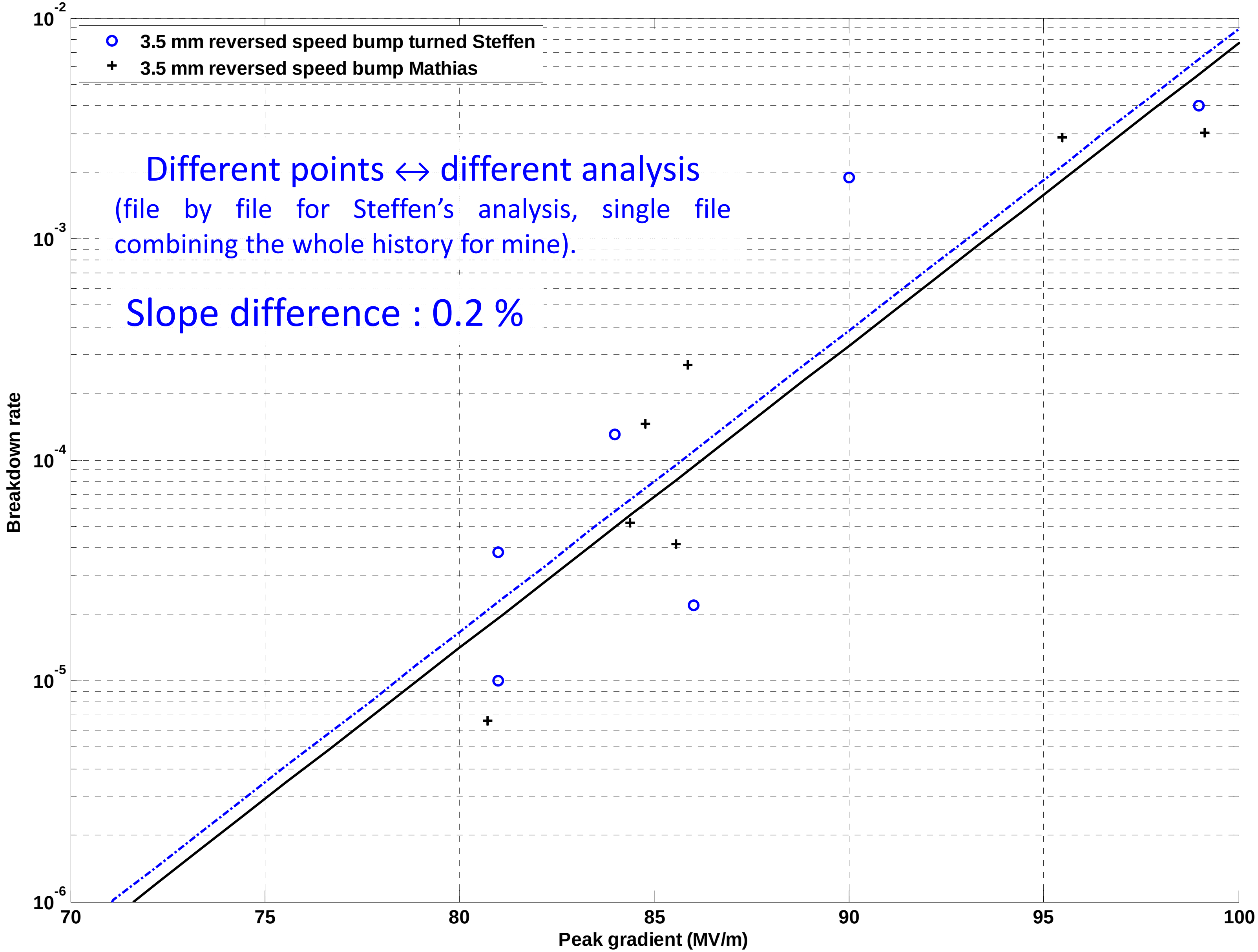


In blue : my analysis
In green : Steffen's one
Breakdown rate
Peak gradient (MV/m)
10-2
10-3
10-4
10-5
10-6
65
70
75
80
85
90
95
100

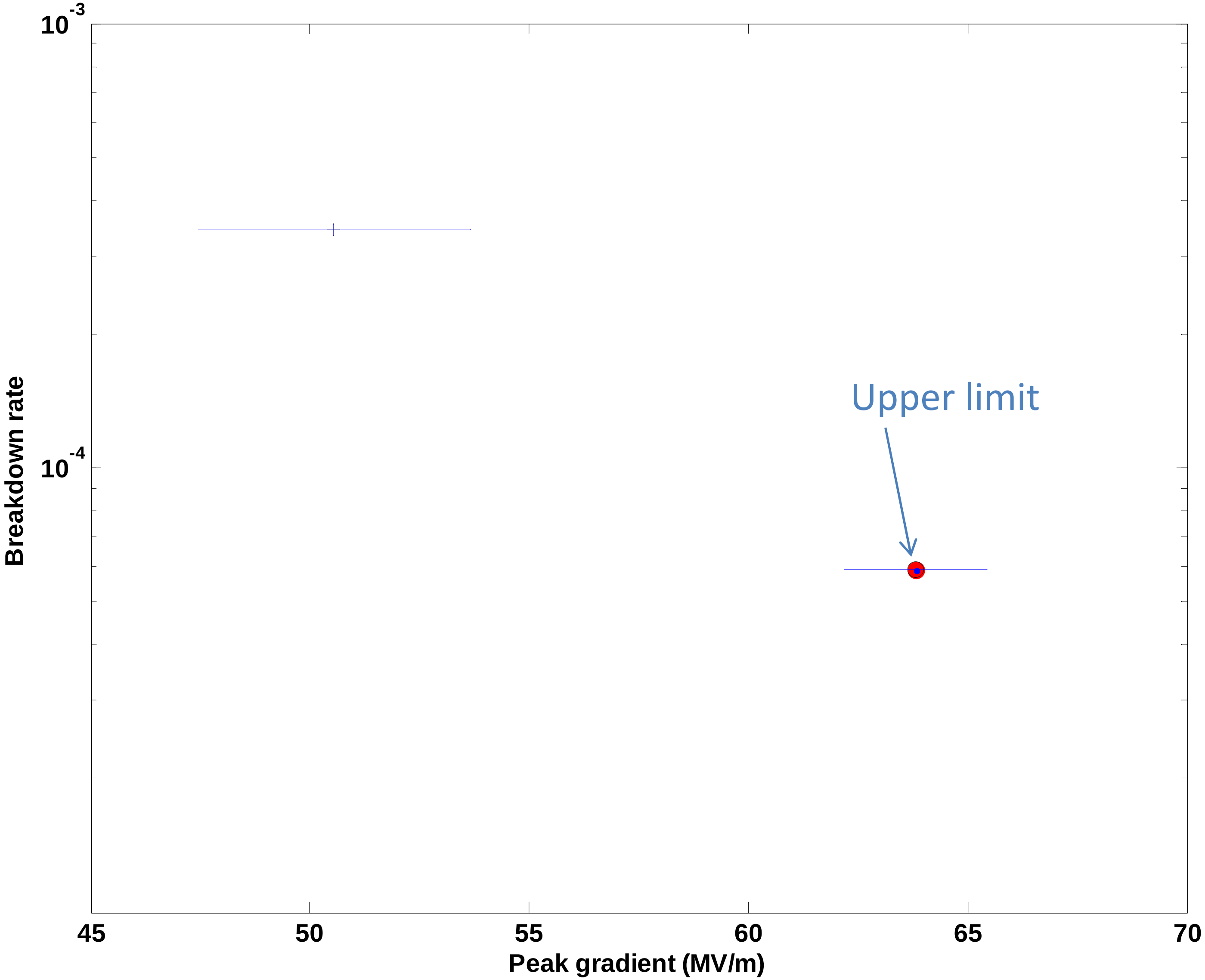
C30-sb-reversed



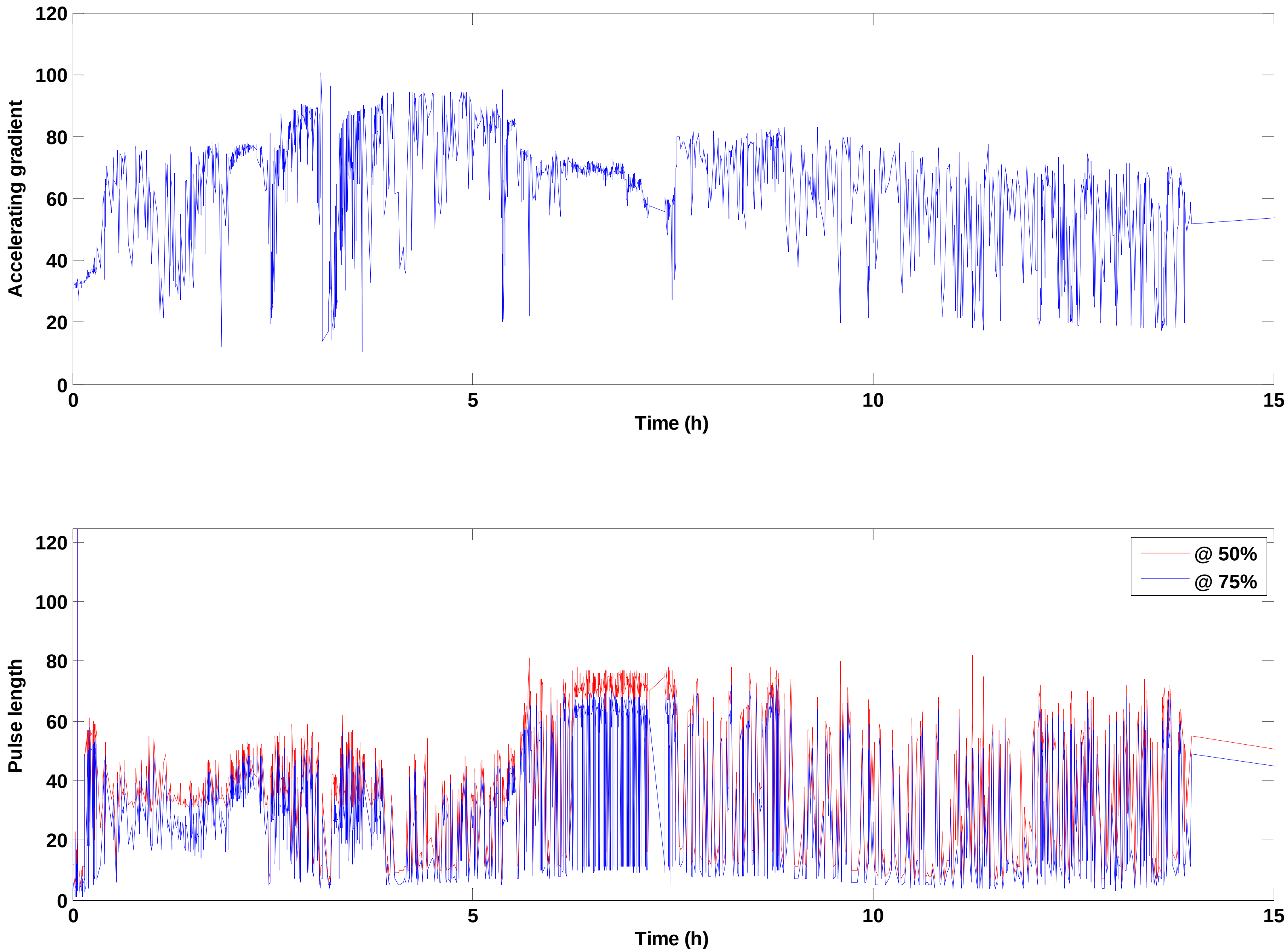
C30-sb-reversed



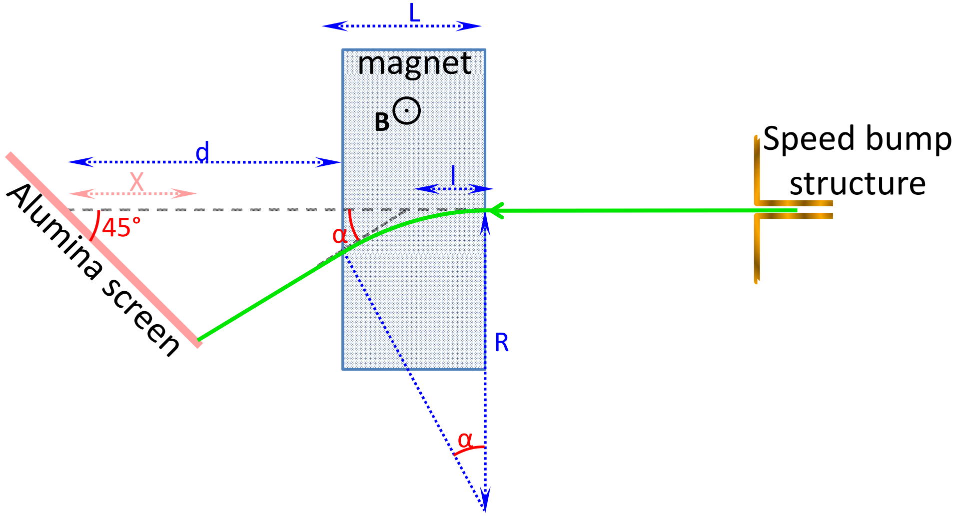
HDS4_thick re-test : ``results´´



HDS4_thick beginning of the test



Spectrometer calculations

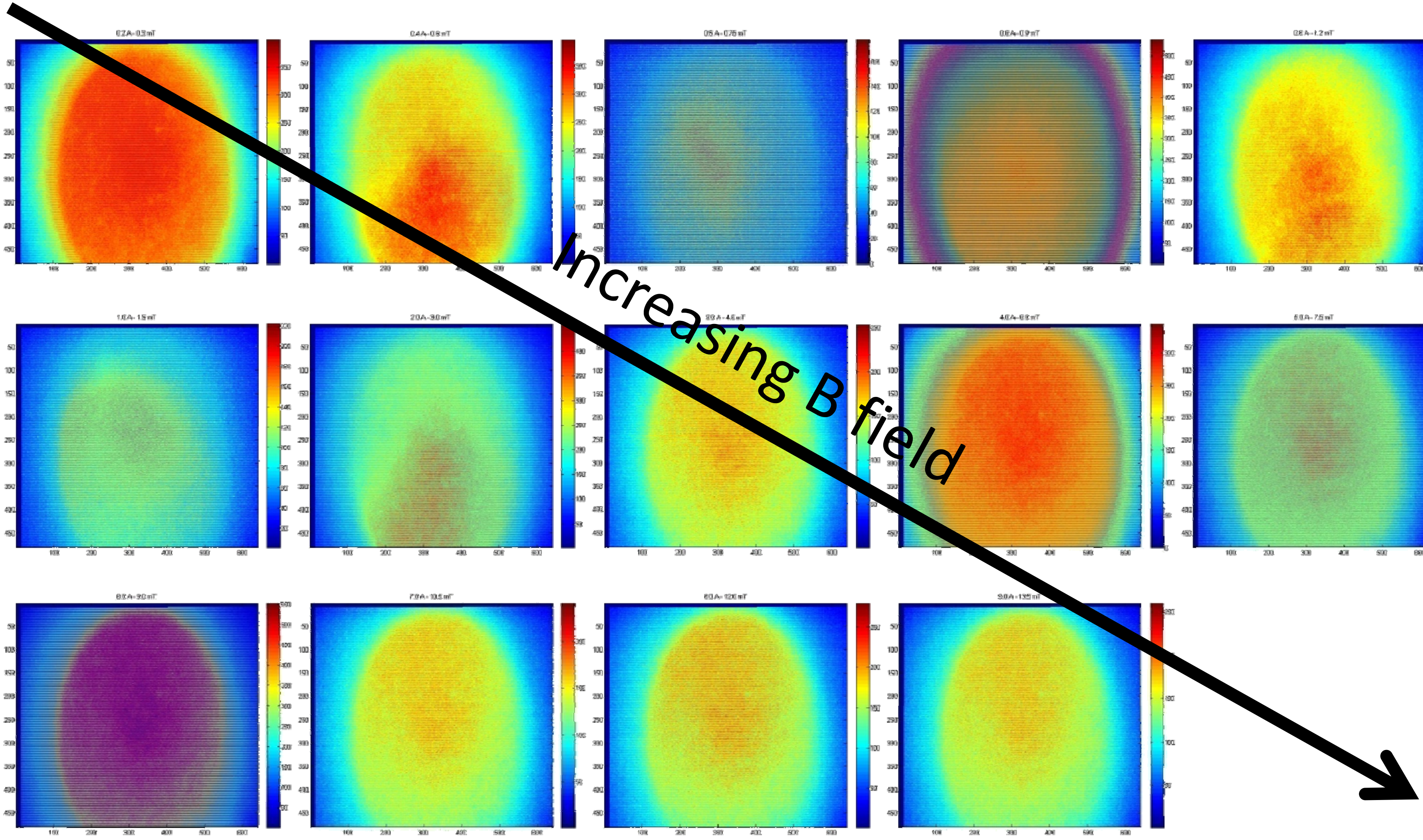


$$X = (d + L - l)\frac{\tan\left[\arcsin\left(\frac{L}{R}\right)\right]}{1+\tan\left[\arcsin\left(\frac{L}{R}\right)\right]}$$

Energie (keV)	Vitesse (m/s)	R(0.15 mT) (m) 0.1 A	R(0.75 mT) (m) 0.5 A	R(1.5 mT) (m) 1.0 A	R(4.5 mT) (m) 3.0 A	R(7.5 mT) (m) 5.0 A	R(9 mT) (m) 6.0 A	R(15 mT) (m) 10.0 A
10000	2.99E+08	1.86E+02	3.72E+01	1.86E+01	6.20E+00	3.72E+00	3.10E+00	1.86E+00
5000	2.99E+08	1.13E+02	2.27E+01	1.13E+01	3.78E+00	2.27E+00	1.89E+00	1.13E+00
3000	2.97E+08	7.49E+01	1.50E+01	7.49E+00	2.50E+00	1.50E+00	1.25E+00	7.49E-01
2000	2.94E+08	5.38E+01	1.08E+01	5.38E+00	1.79E+00	1.08E+00	8.96E-01	5.38E-01
1000	2.82E+08	3.14E+01	6.29E+00	3.14E+00	1.05E+00	6.29E-01	5.24E-01	3.14E-01
500	2.59E+08	1.94E+01	3.87E+00	1.94E+00	6.46E-01	3.87E-01	3.23E-01	1.94E-01
200	2.08E+08	1.10E+01	2.20E+00	1.10E+00	3.66E-01	2.20E-01	1.83E-01	1.10E-01
100.00	1.60E+08	7.17E+00	1.43E+00	7.17E-01	2.39E-01	1.43E-01	1.20E-01	7.17E-02
10.00	5.80E+07	2.24E+00	4.48E-01	2.24E-01	7.47E-02	4.48E-02	3.74E-02	2.24E-02
1.00	1.80E+07	6.84E-01	1.37E-01	6.84E-02	2.28E-02	1.37E-02	1.14E-02	6.84E-03
0.10	5.90E+06	2.24E-01	4.48E-02	2.24E-02	7.46E-03	4.48E-03	3.73E-03	2.24E-03

Energie (keV)	Vitesse (m/s)	X(0.15 mT) (m) 0.1 A	X(0.75 mT) (m) 0.5 A	X(1.5 mT) (m) 1.0 A	X(4.5 mT) (m) 3.0 A	X(7.5 mT) (m) 5.0 A	X(9 mT) (m) 6.0 A	X(15 mT) (m) 10.0 A
10000	2.99E+08	7.52E-05	3.76E-04	7.50E-04	2.23E-03	3.70E-03	4.43E-03	7.28E-03
5000	2.99E+08	1.23E-04	6.16E-04	1.23E-03	3.64E-03	6.01E-03	7.17E-03	1.17E-02
3000	2.97E+08	1.87E-04	9.30E-04	1.85E-03	5.47E-03	8.97E-03	1.07E-02	1.74E-02
2000	2.94E+08	2.60E-04	1.29E-03	2.57E-03	7.55E-03	1.23E-02	1.47E-02	2.38E-02
1000	2.82E+08	4.44E-04	2.20E-03	4.36E-03	1.26E-02	2.05E-02	2.44E-02	3.98E-02
500	2.59E+08	7.20E-04	3.55E-03	7.00E-03	2.00E-02	3.24E-02	3.88E-02	6.96E-02
200	2.08E+08	1.27E-03	6.19E-03	1.21E-02	3.43E-02	5.88E-02	7.60E-02	#NUM!
100.00	1.60E+08	1.93E-03	9.36E-03	1.81E-02	5.32E-02	1.51E-01	#NUM!	#NUM!
10.00	5.80E+07	6.07E-03	2.82E-02	5.73E-02	#NUM!	#NUM!	#NUM!	#NUM!
1.00	1.80E+07	1.90E-02	2.30E-01	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
0.10	5.90E+06	5.75E-02	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

DIY electron spectrometer – ``statistical´´ analysis



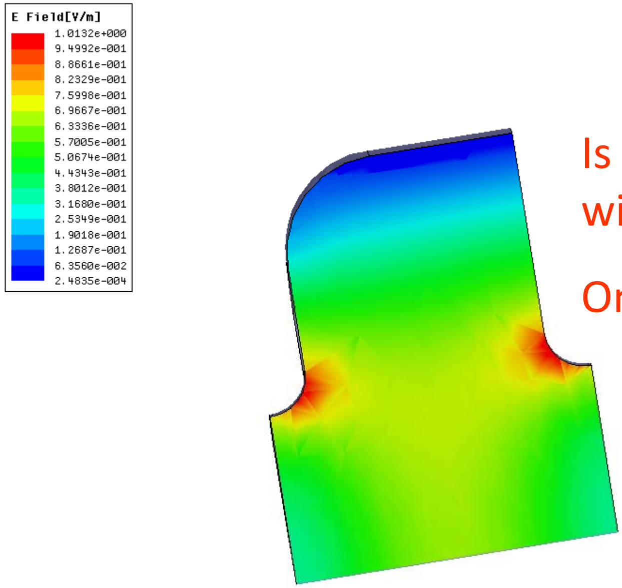
See Jan's presentation on February, 18th

TM_{02} structure

Courtesy of Riccardo

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

Only by changing the propagating mode



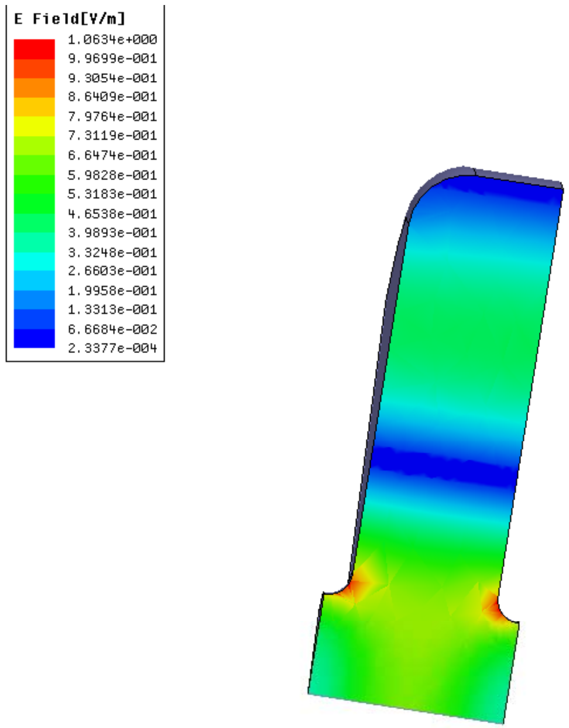
TM_{01} regular cell "reference"

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

but

Different group velocity: 4.7% & 2%

Different R/Q: 29 kΩ/m & 12 kΩ/m

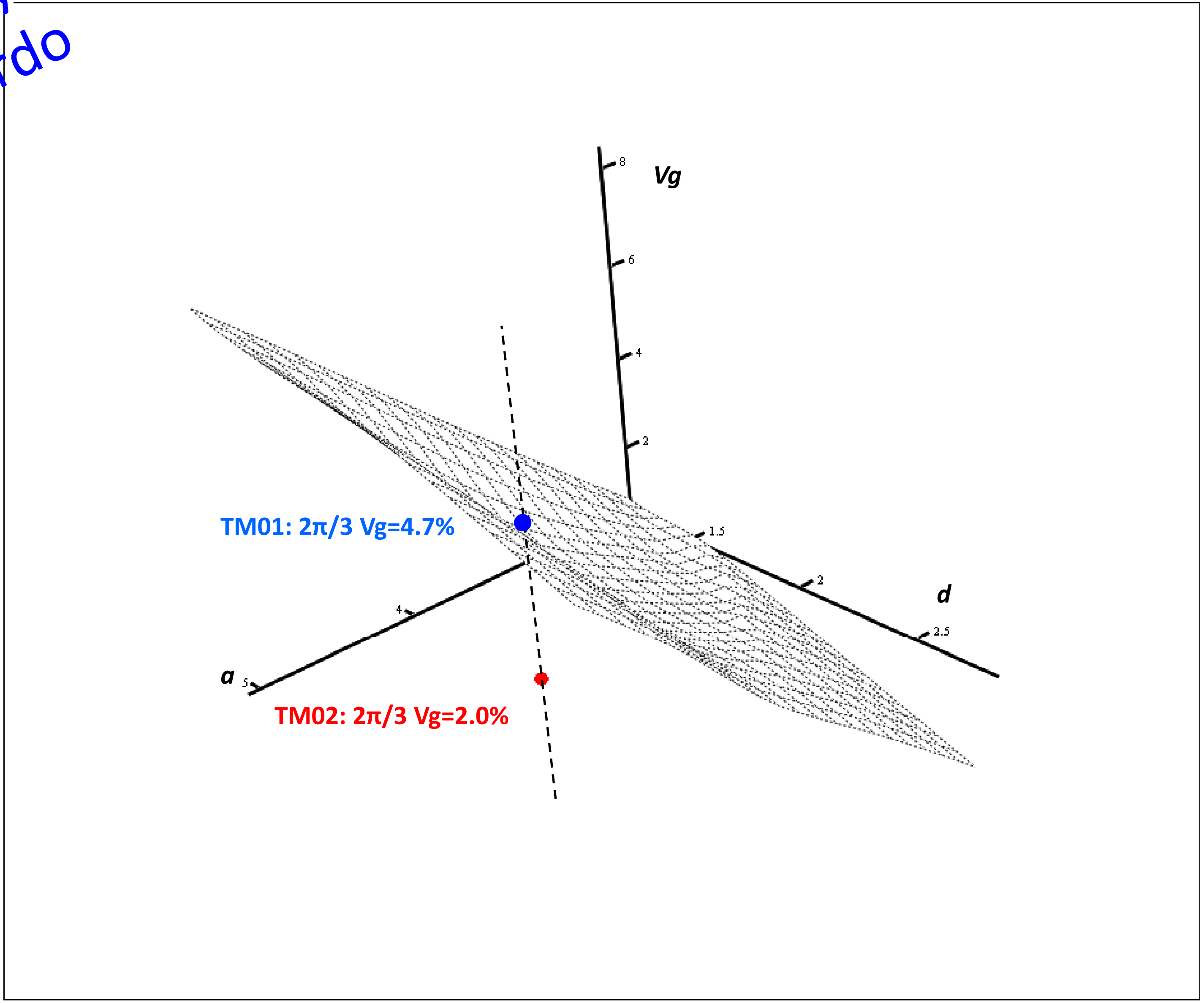


TM_{02} regular cell

Test structure in disks: 30 cell and identical mode launcher of the "conventional" 2π/3 Ø 3.5 mm

Direct comparison of Vg

Courtesy of Riccardo



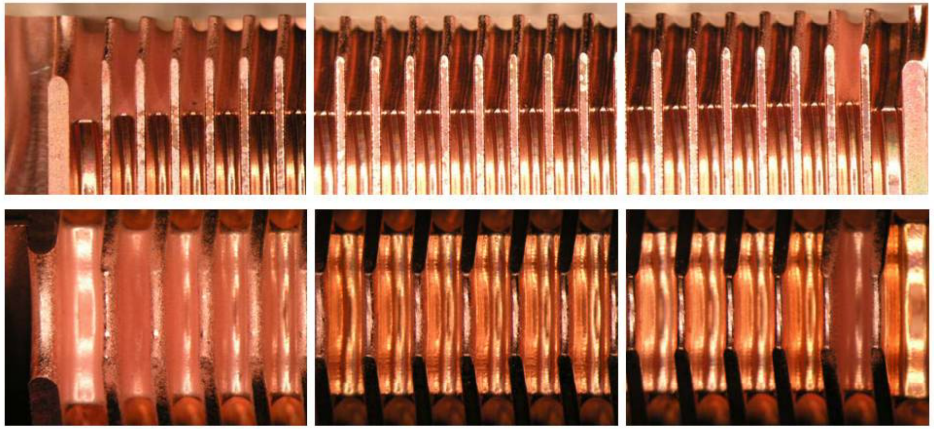
(as, ds, vgs), (a1, d1, vg1)

Je ne sais pas si la vidéo restera longtemps à cette adresse mais pour le moment, vous pouvez écouter l'intégralité du « discours à l'occasion du la
http://www.elysee.fr/accueil/
Bonne journée quand même…

Courtesy of Riccardo

Why speed bump?

From Igor's presentation at the X band workshop:



P_{INC} → HDS 60 L

← P_{INC} HDS 60 S

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 do we 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.
Other words, the first cell can accept "more" energy during breakdown initiation then consequent ones.
Worse to mention that we do not know the exact transient behavior of the breakdown and the structure bandwidth could play important role.

→ *We can tray by reducing vg in the matching cell*