Nextef results

CLIC09, Oct. 12-16

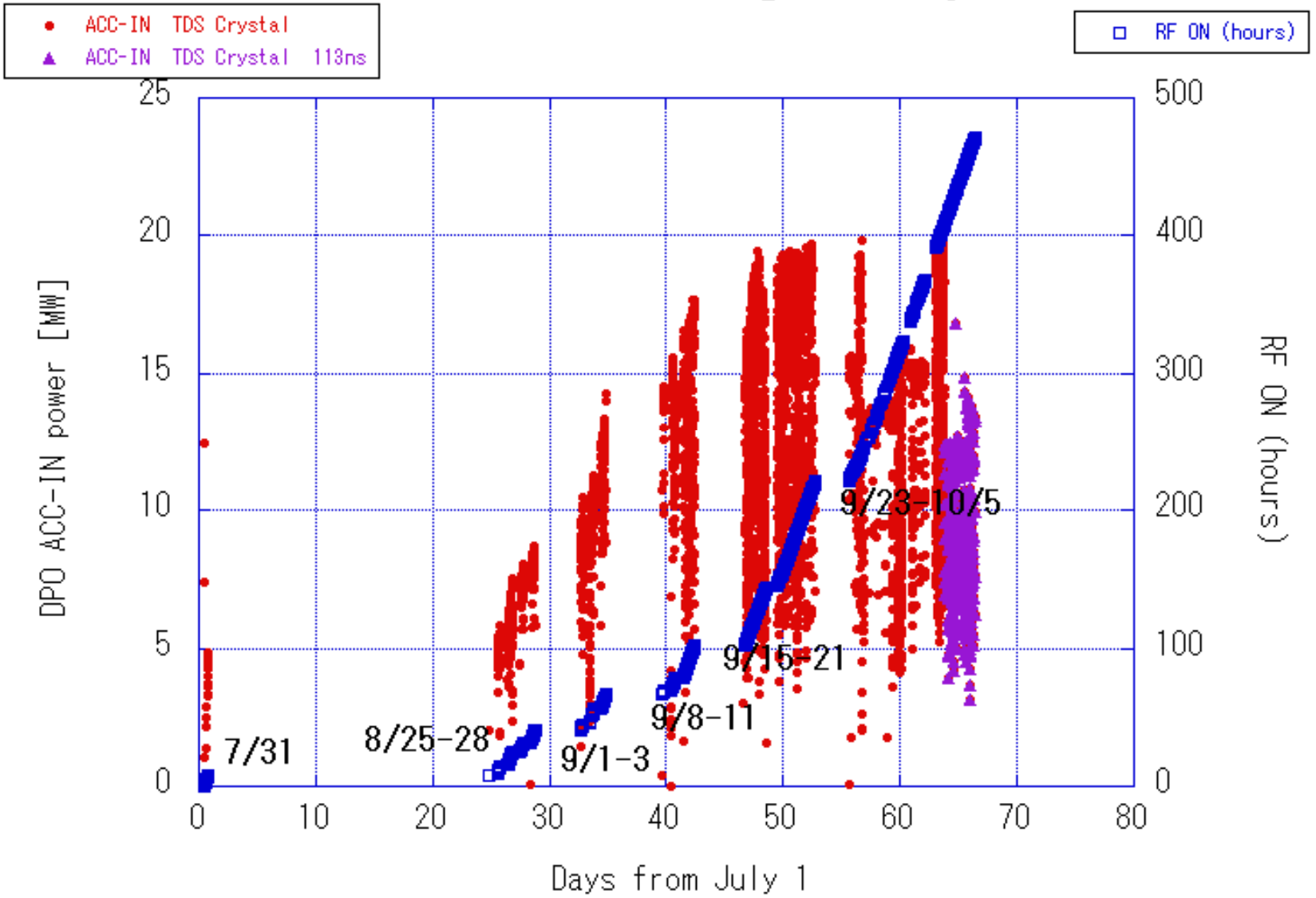
T. Higo (KEK)

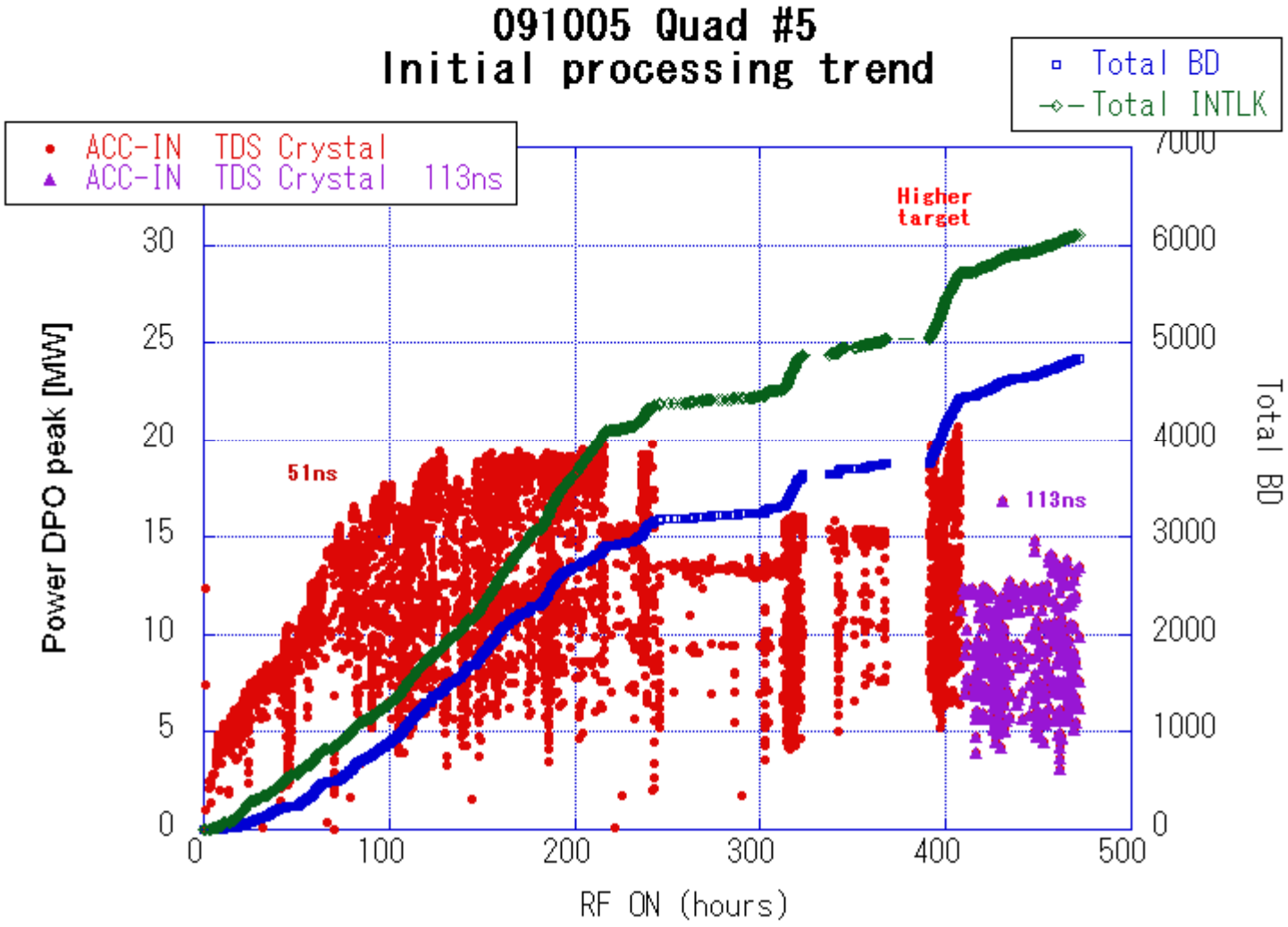
Contents

- Quadrant high gradient test status
  - Initial processing and power limit
  - VAC characteristics with Q-mass
  - Dark current
  - BD position
  - Light emission
- Change in T18 by high gradient processing
  - RF
  - Optical inspection
- Nextef plan

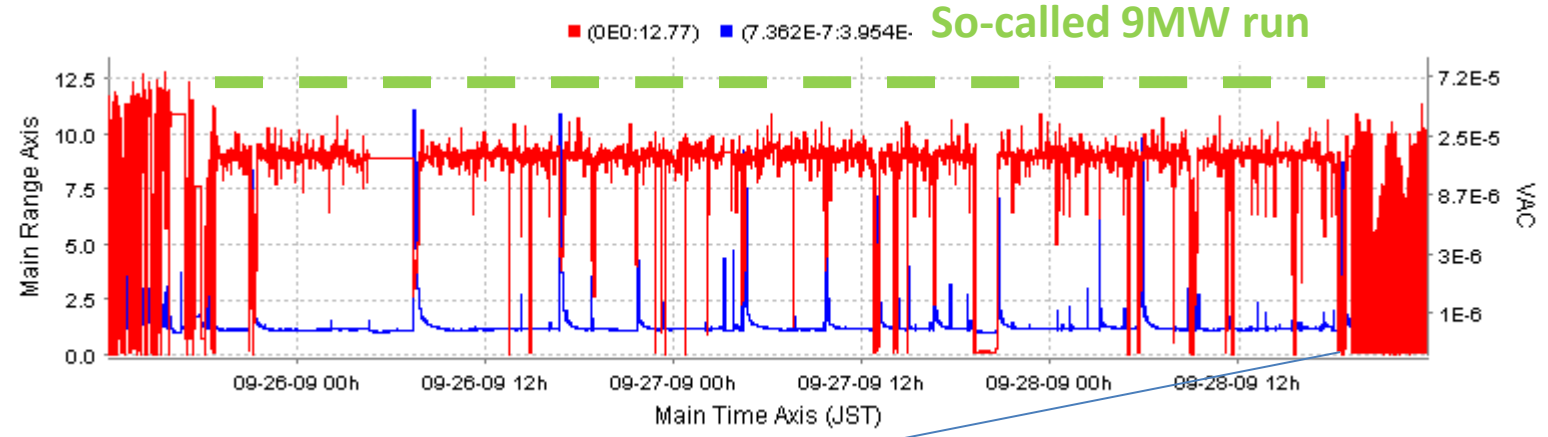
Quad #5 status
and near future plan

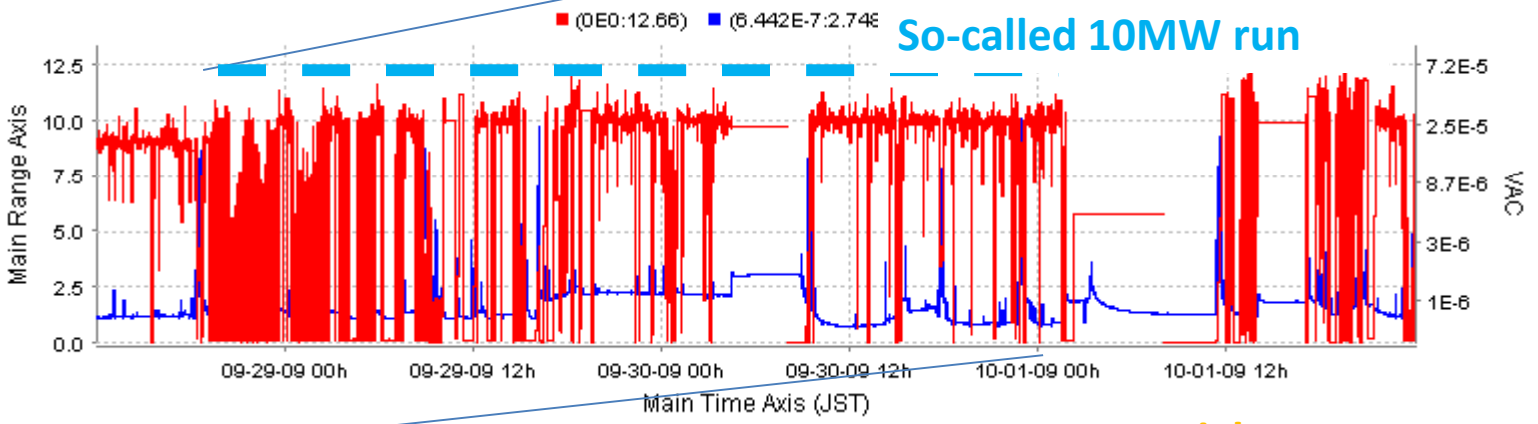
Quad #5 Processing History




091005 Quad #5
Initial processing trend
Total BD
Total INTLK
ACC-IN TDS Crystal
ACC-IN TDS Crystal 113ns
Higher target
51ns
113ns
Power DPO peak [MW]
Total BD
RF ON (hours)
0
5
10
15
20
25
30
0
1000
2000
3000
4000
5000
6000
7000
0
100
200
300
400
500

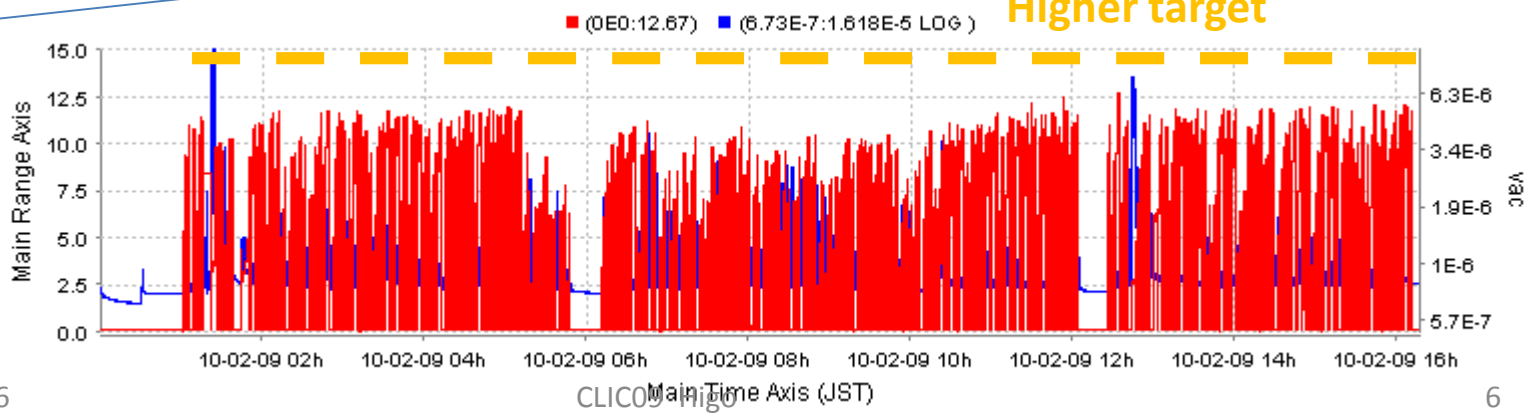
Red=power (arbitrary unit)



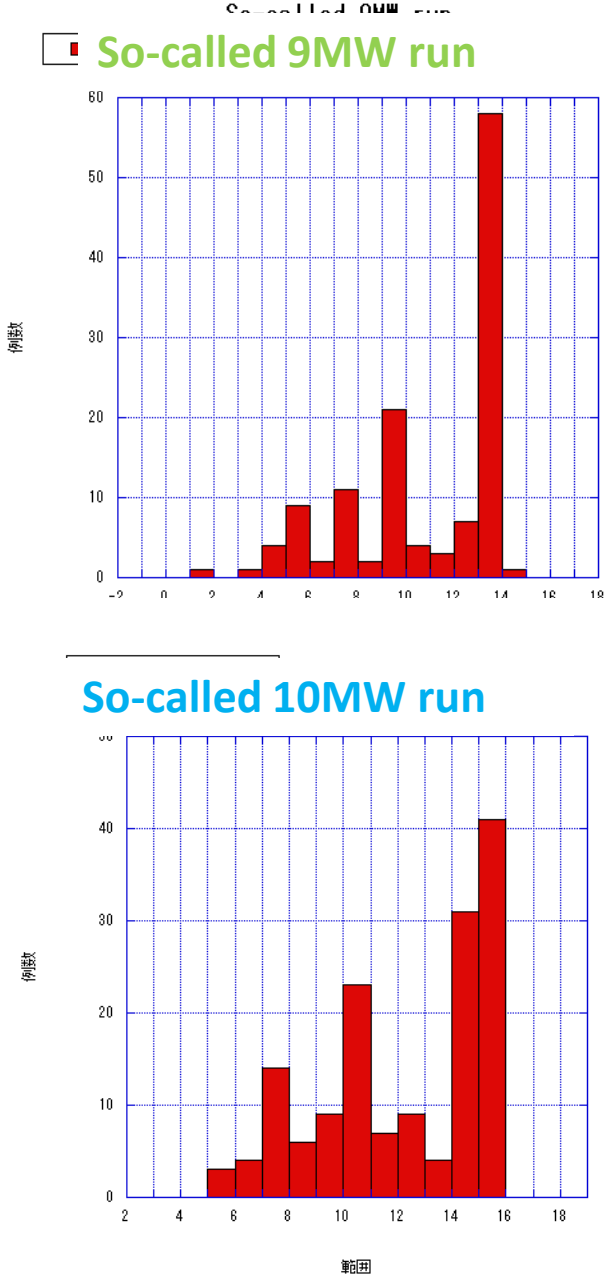


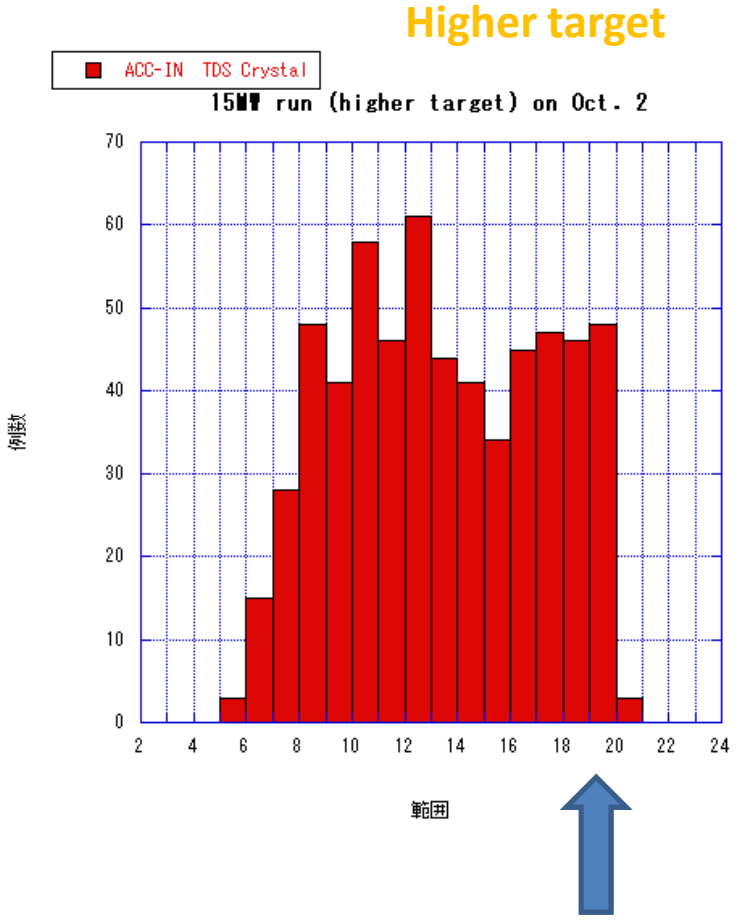
Blue = Chamber vacuum [Pa]

Target = 15MW



Gradient limit at 50ns

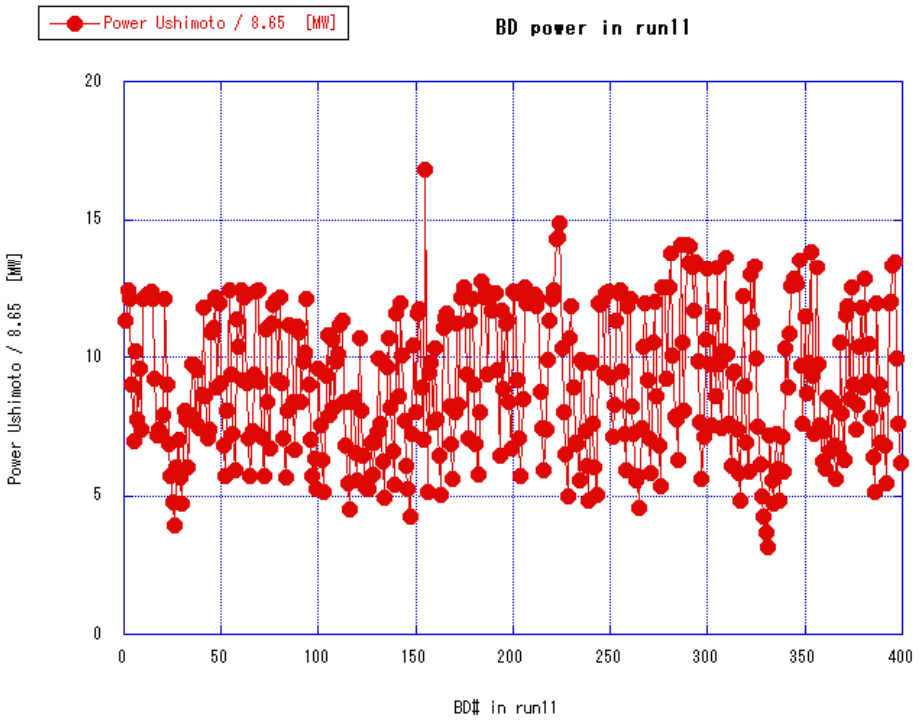


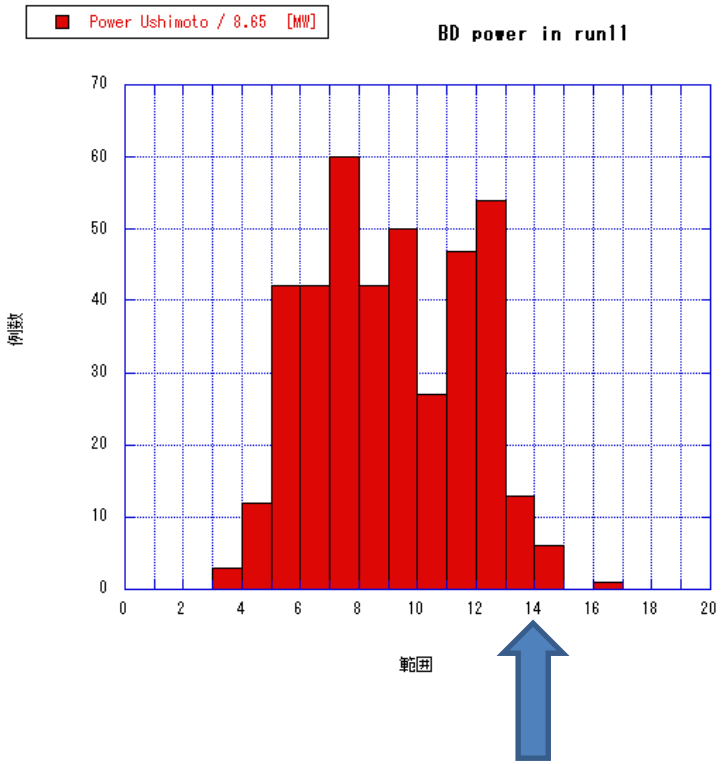


Hard limit at 19MW,
59MV/m, 50ns

Run11 with higher target at 113ns

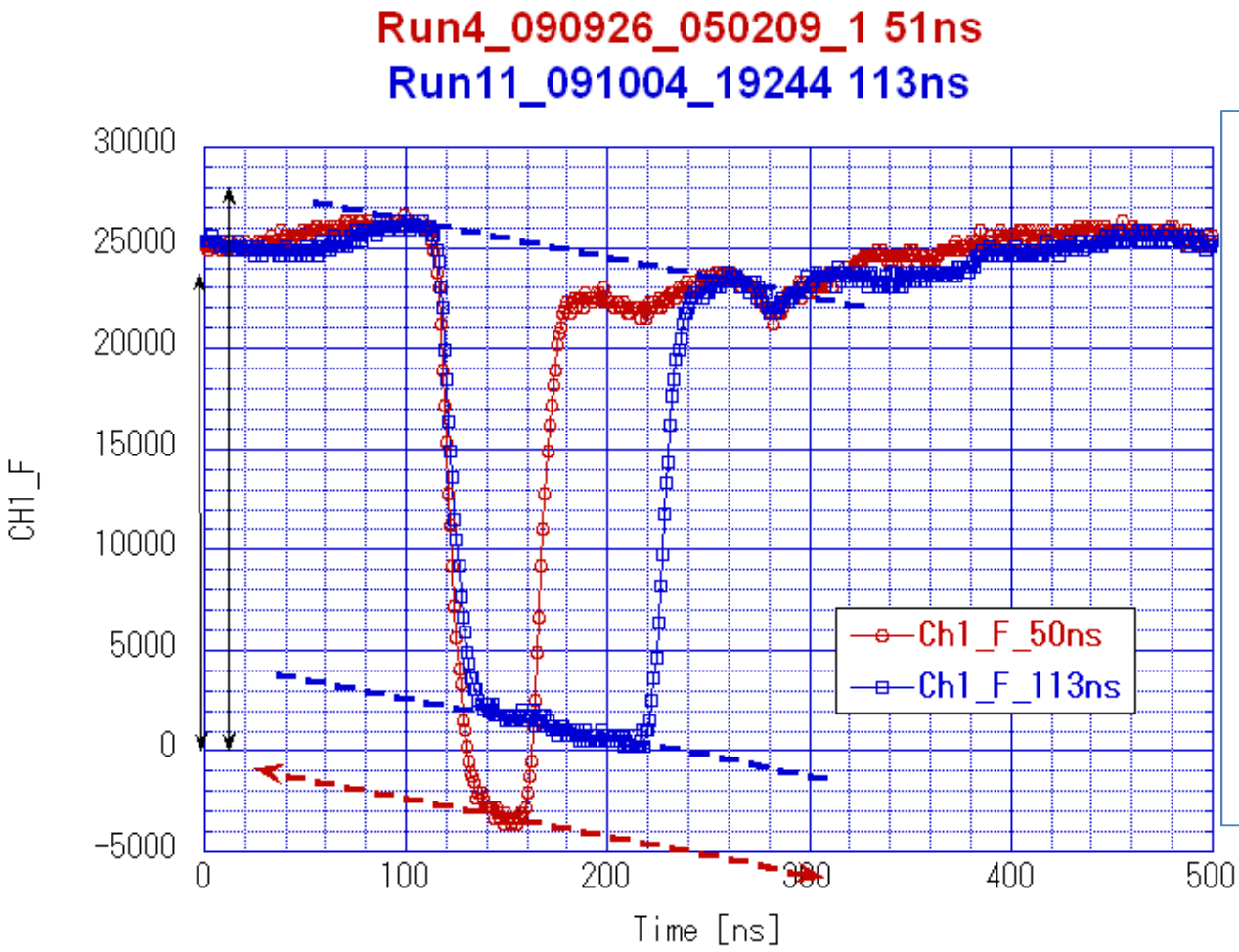
Powers at breakdown with 113ns pulse width for 60 hours





Hard limit at 14MW for 113ns pulse

ACC-IN pulse at hard limit



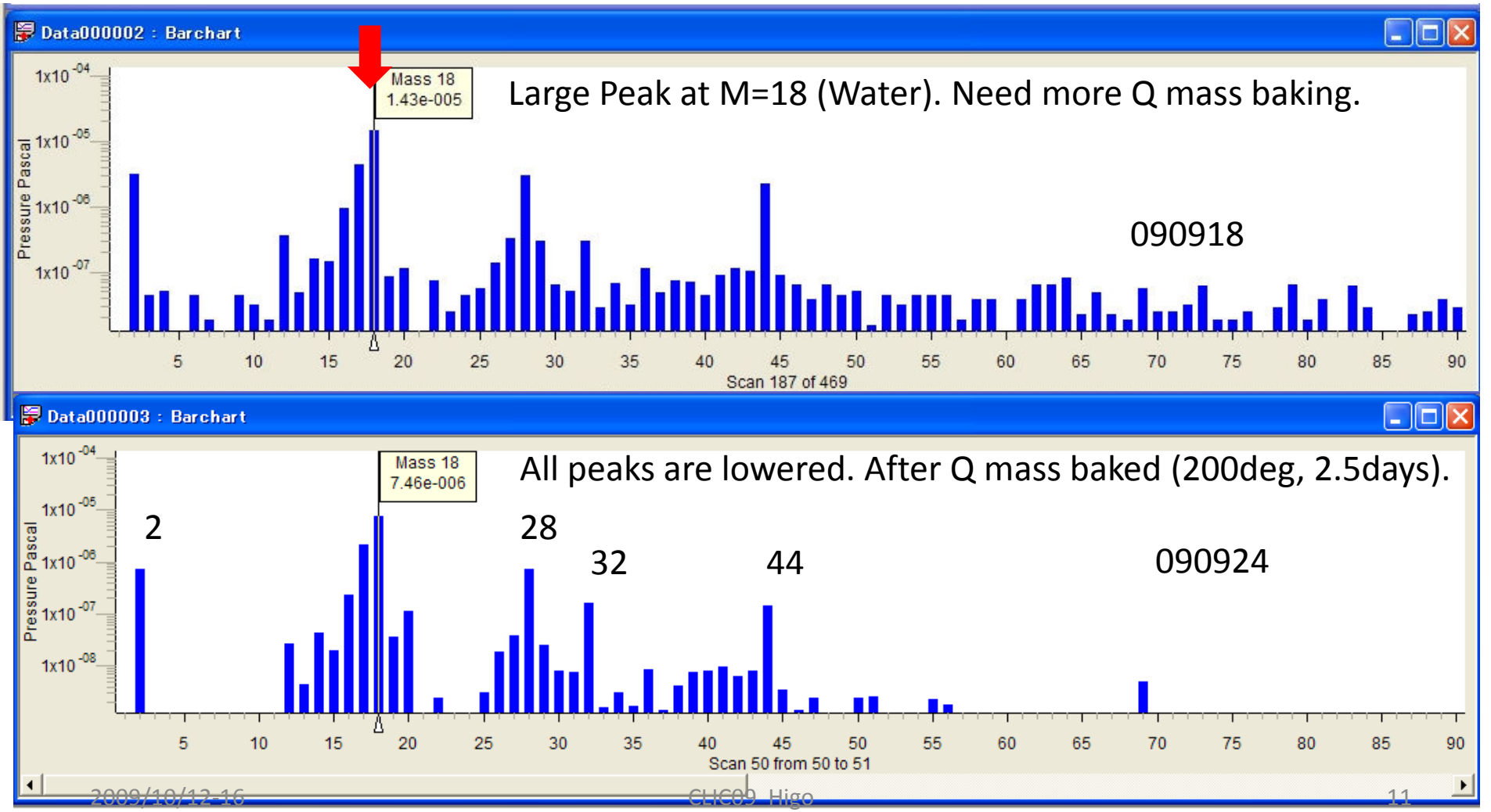
	Tp(ns)	
	51	113
Power (MW)		
	19	14
Ea (MV/m)		
	59	50
Sqrt(Tp)*Power		
	135	147

Limit at similar pulse heating temperature, but more precise comparison is needed.

Vacuum characteristics

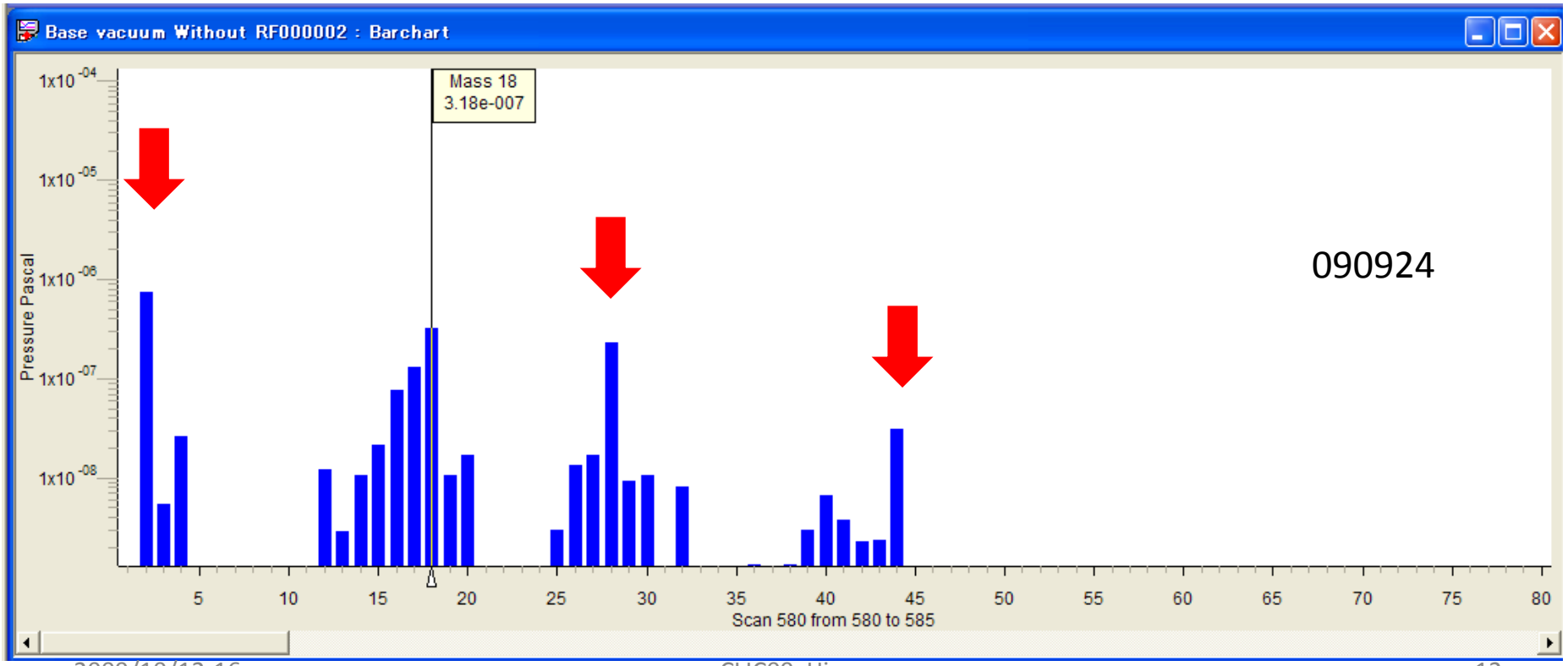
- Vacuum total pressure
  - Base pressure at $<10^{-6}$Pa
  - Typically processing below 10^{-5}Pa
  - Increases every time at few to 5MW range if after RF-OFF for more than several hours
- Mass spectrum
  - M=2, 28 and 44 increase with RF-ON, but not M=18
    - Especially when reaching power limit
  - M=2 becomes dominant residual gas after an hour or so run
  - M=27 and 28 change in a similar manner as time, indicating hydrocarbon-origin surface contamination

First and Second QMA observations. Check QMA vacuum. QMA-Acc Chamber valve closed.



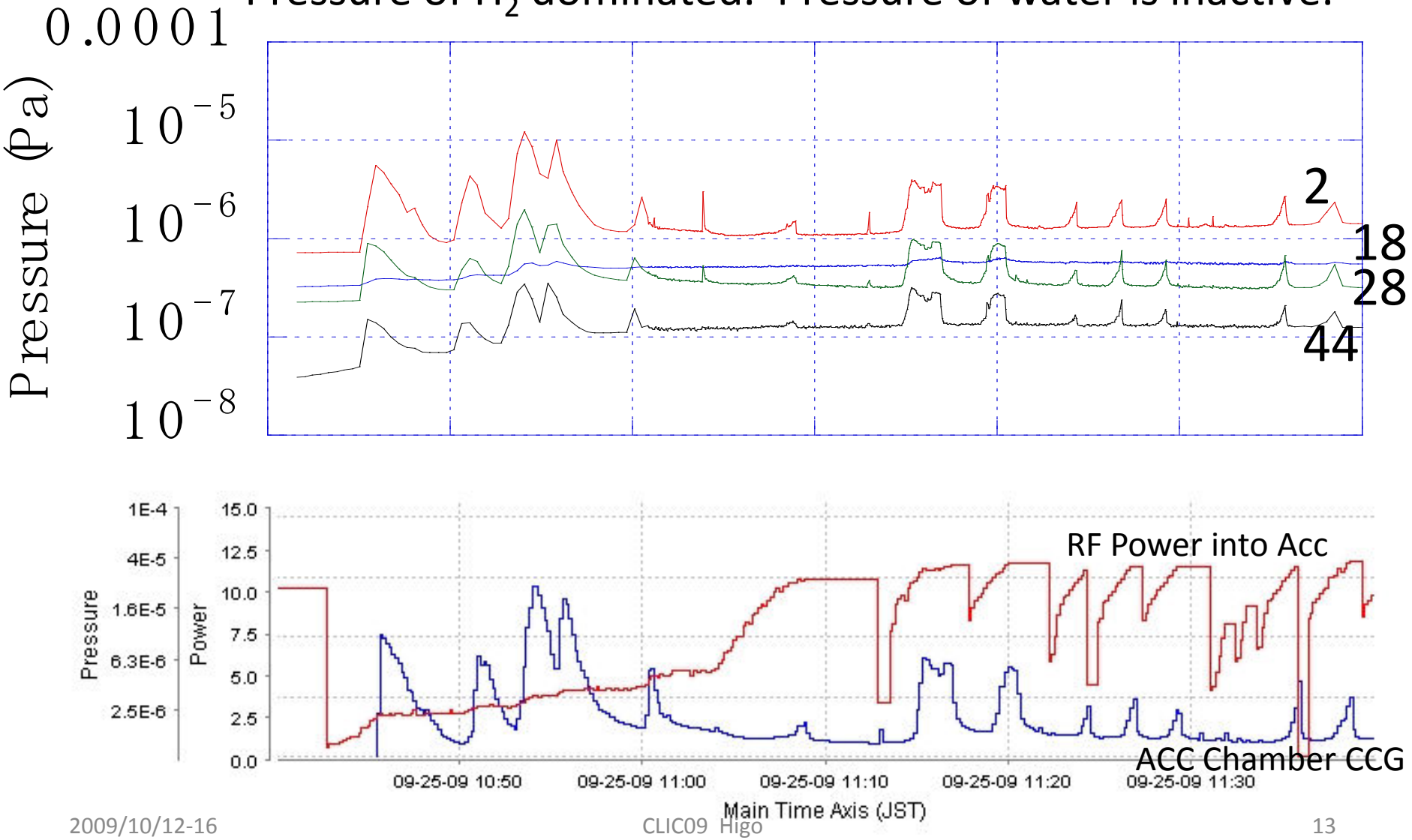
First QMA observation with RF OFF. QMA- ACC Chamber valve opened.

Peak at M=2 (H2) largest. Water (18) becomes moderate. Others are M=28 (CO) and 44(CO2).



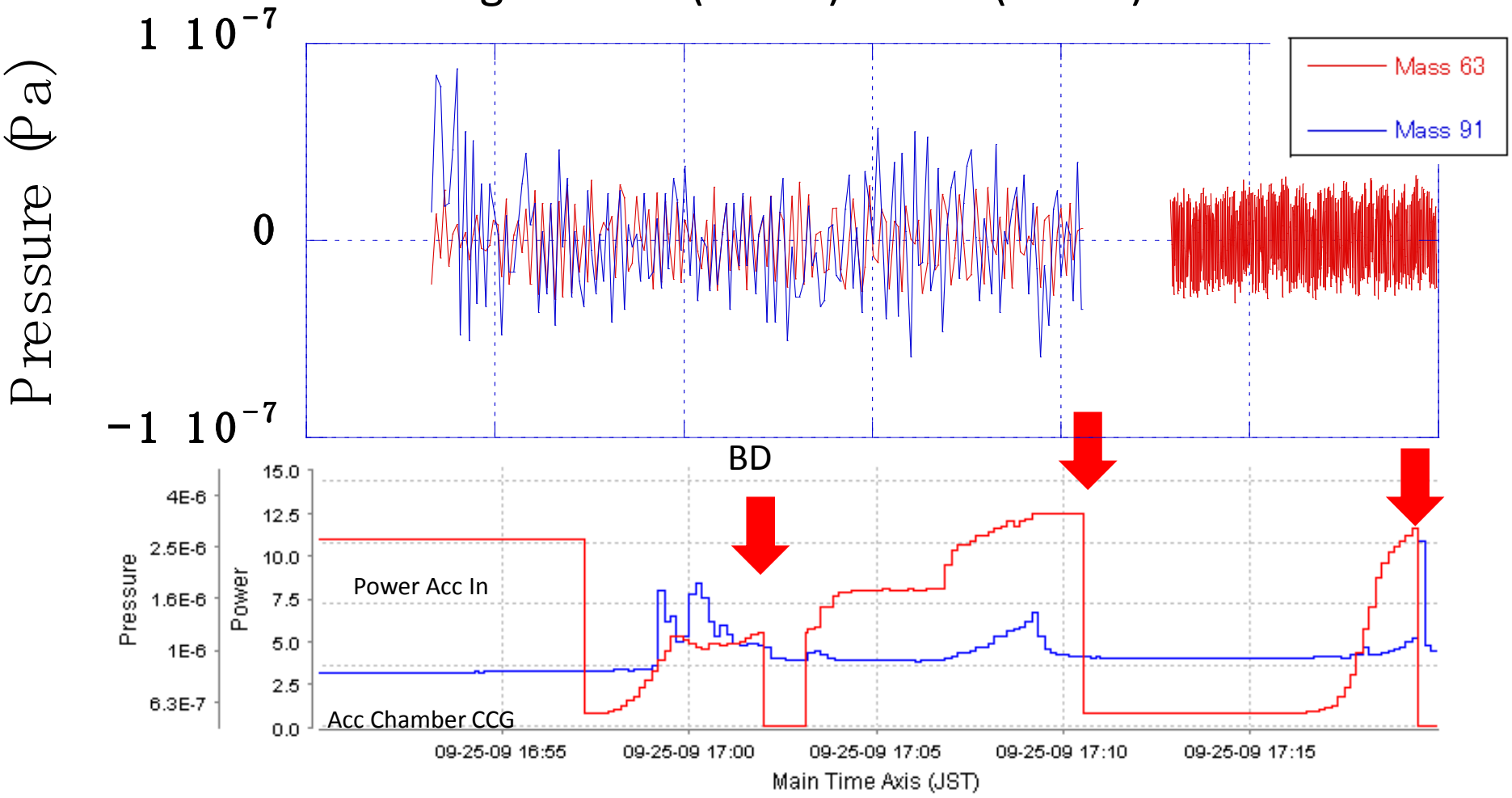
QMS (1) :RF Power and gases

Pressure of H_2 dominated. Pressure of water is inactive.

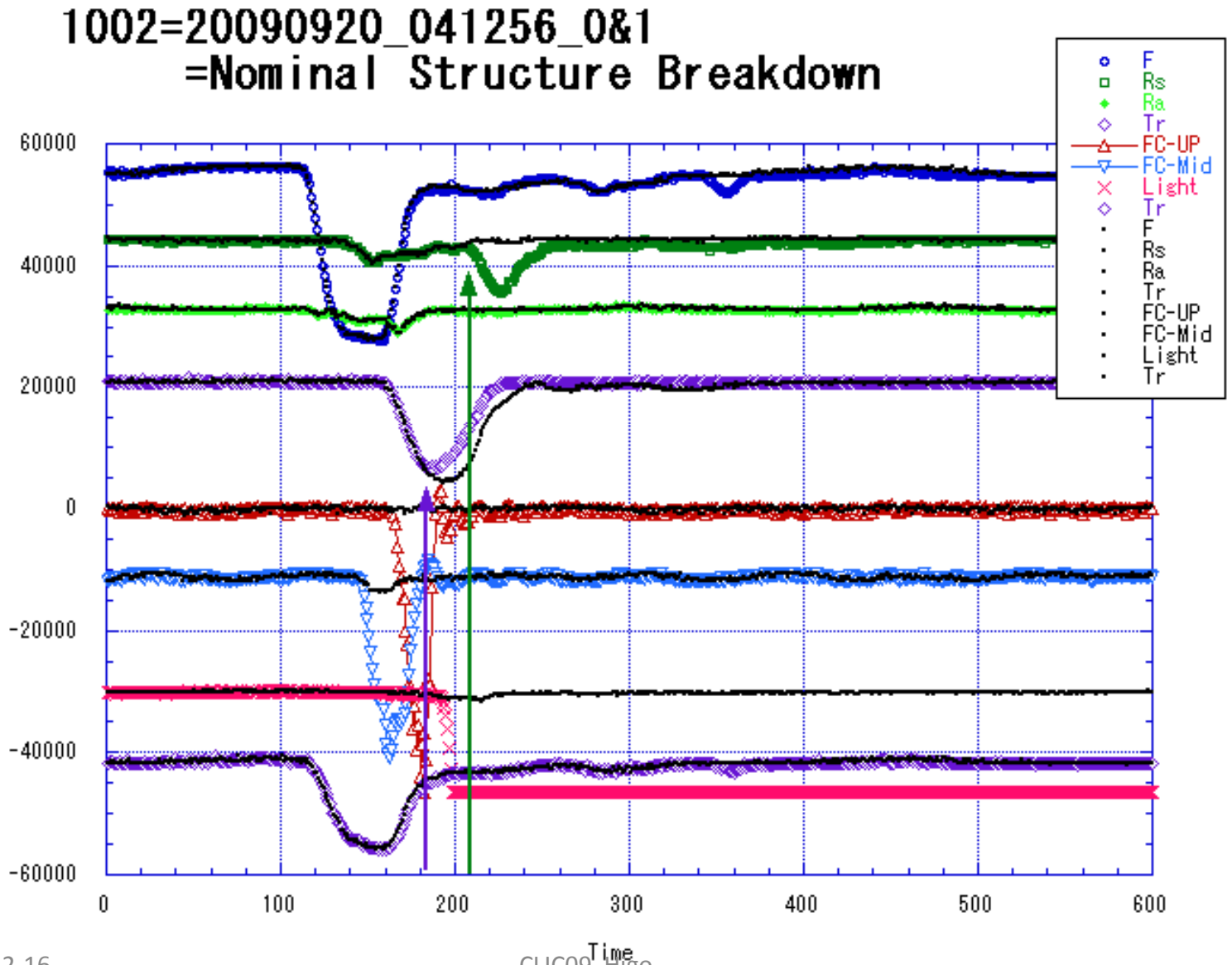


QMS (2): Cu and Zr

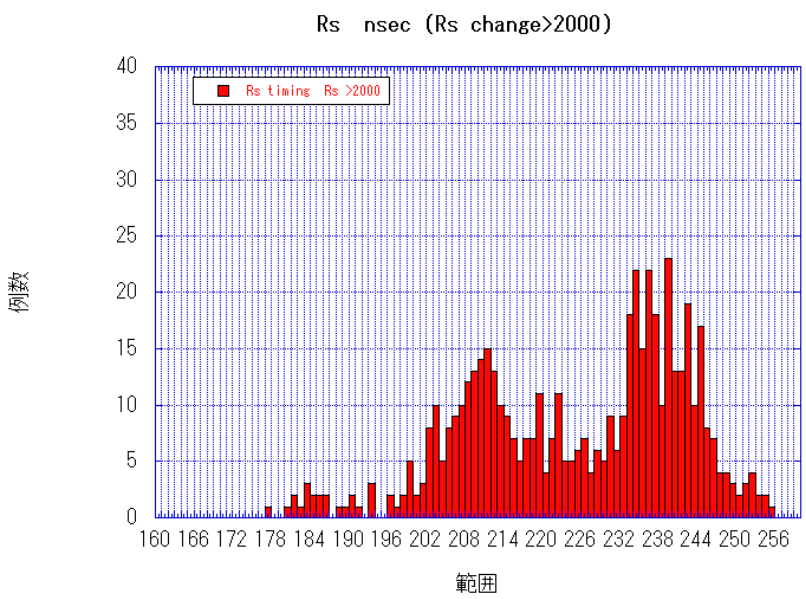
No signal of Cu(M=63) nor Zr (M=89) .

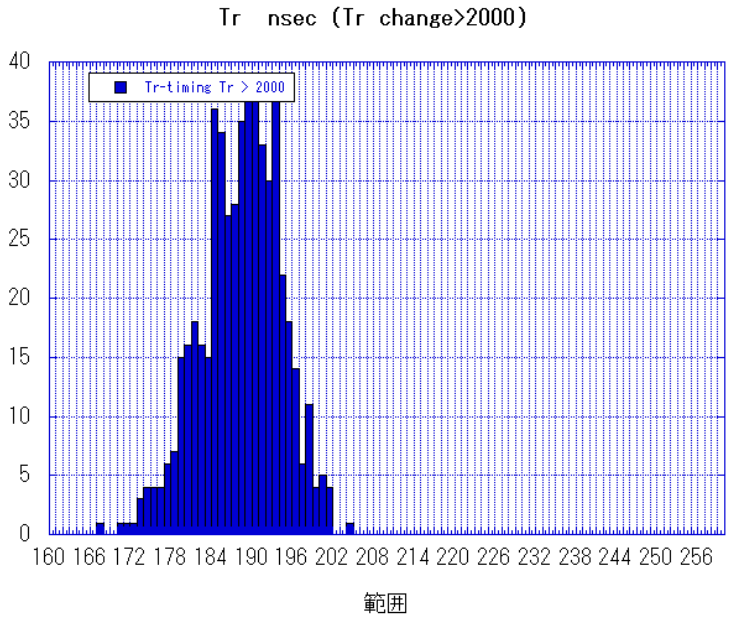


Breakdown pulse analysis

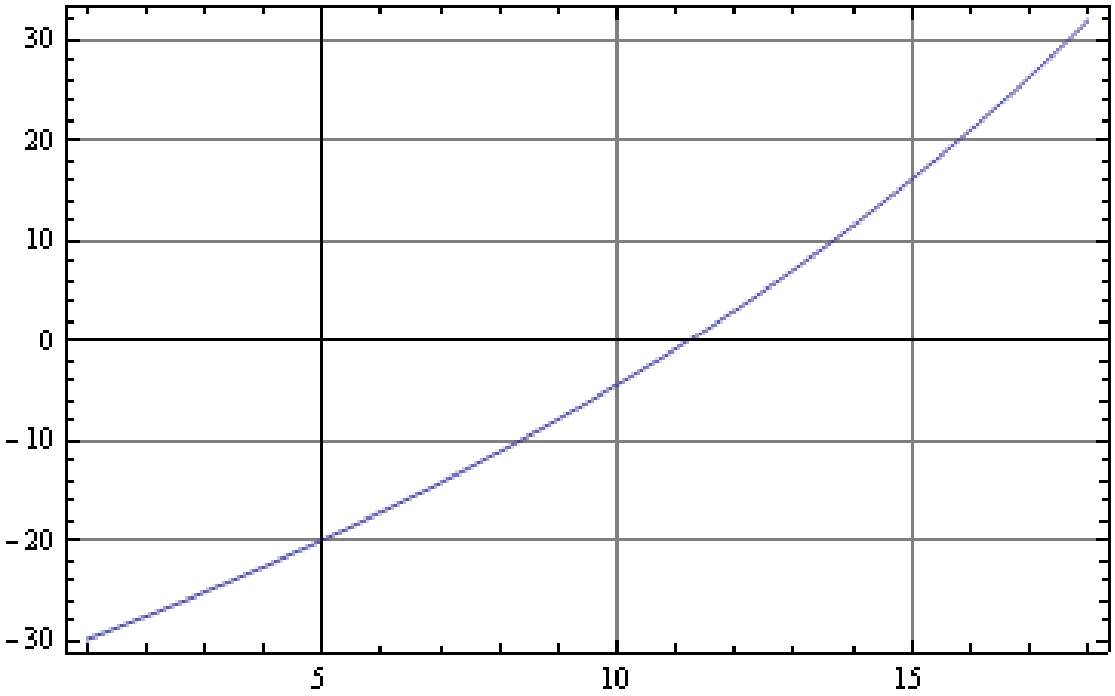


Timing distribution for change>2000



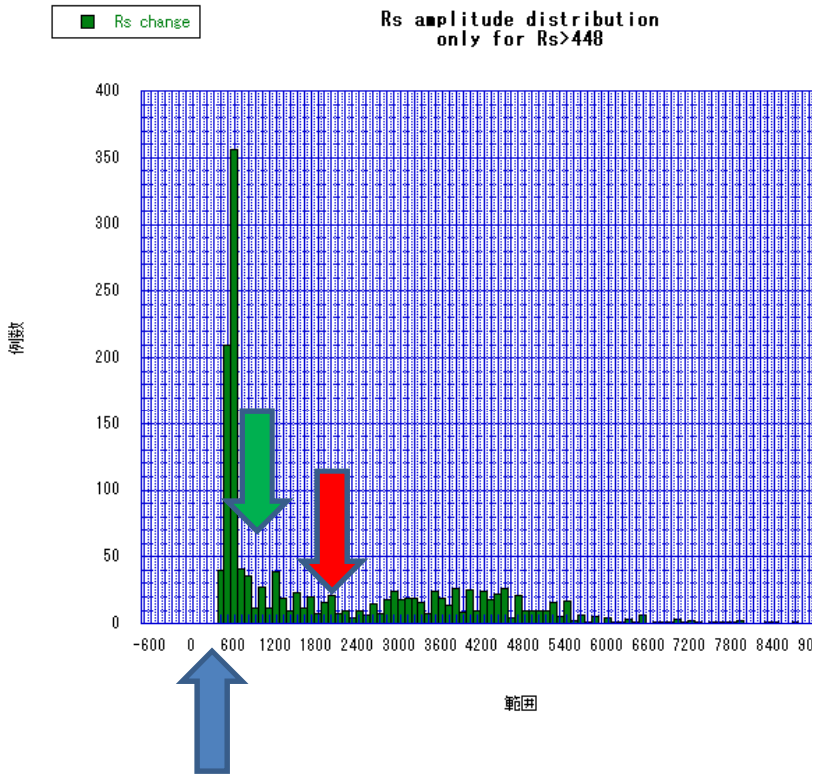


T18 structure Function F[z]

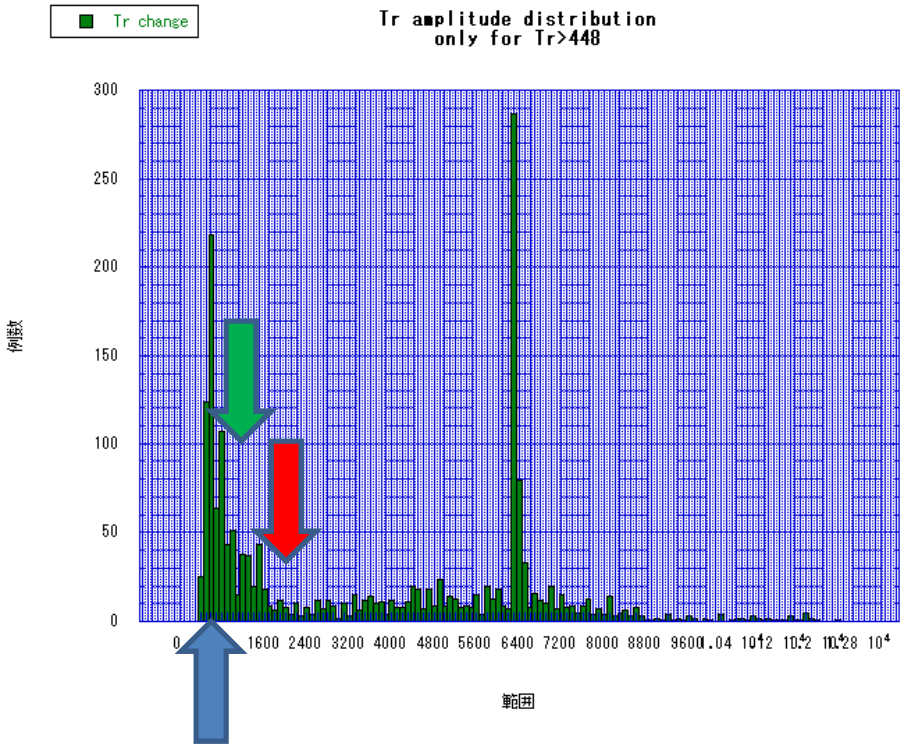


Use time difference Rs(rise)-Tr(fall) to calculate BD position.
Function F(z) is calculated from design vg(z).

Pick up large Rs, Tr change with 50ns



Sampling cut at 448

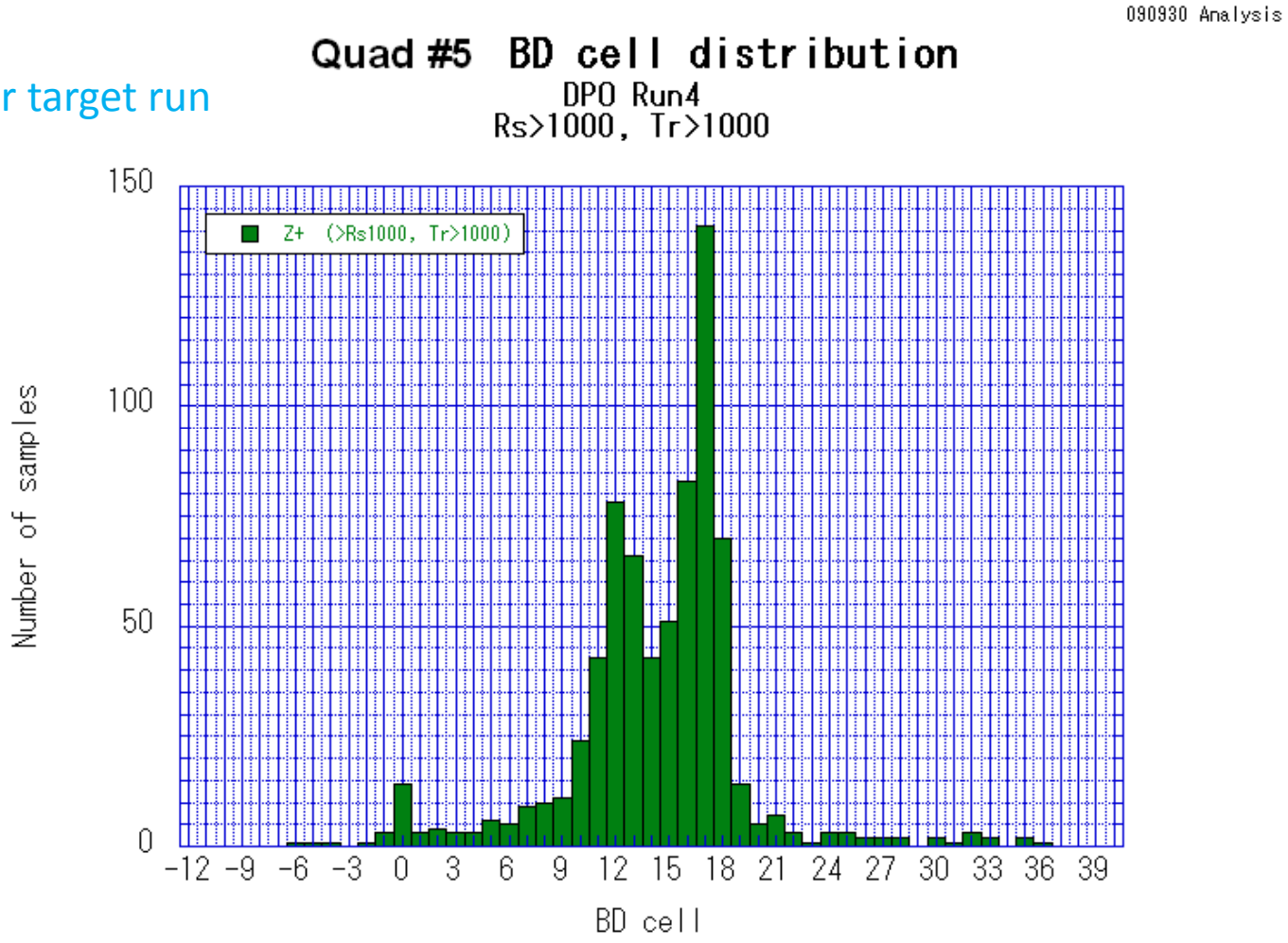


Sampling cut at 448

Cut at 1000 or 2000 for timing analysis from next page.

Breakdown cell distribution >1000

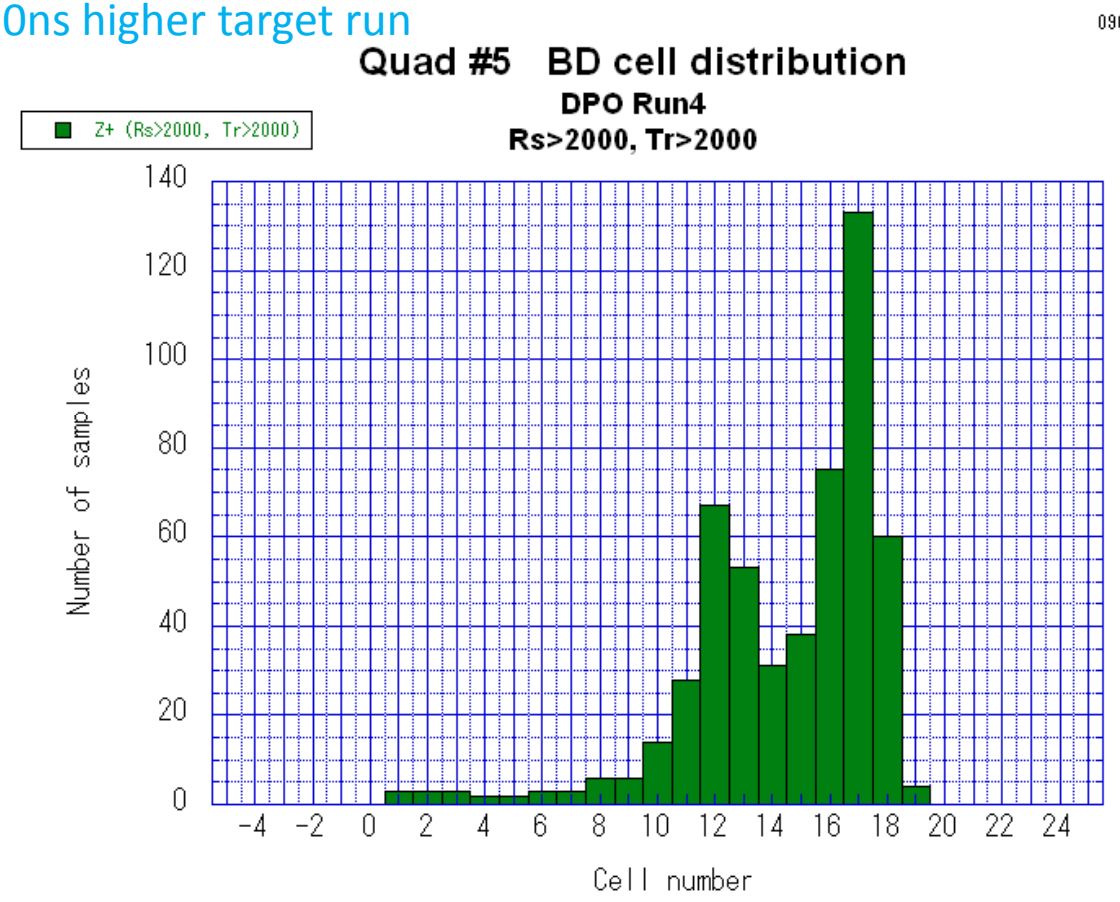
50ns higher target run



713 events were analyzed out of 1919 INTLK.

Breakdown cell distribution >2000

50ns higher target run



Mostly downstream half.

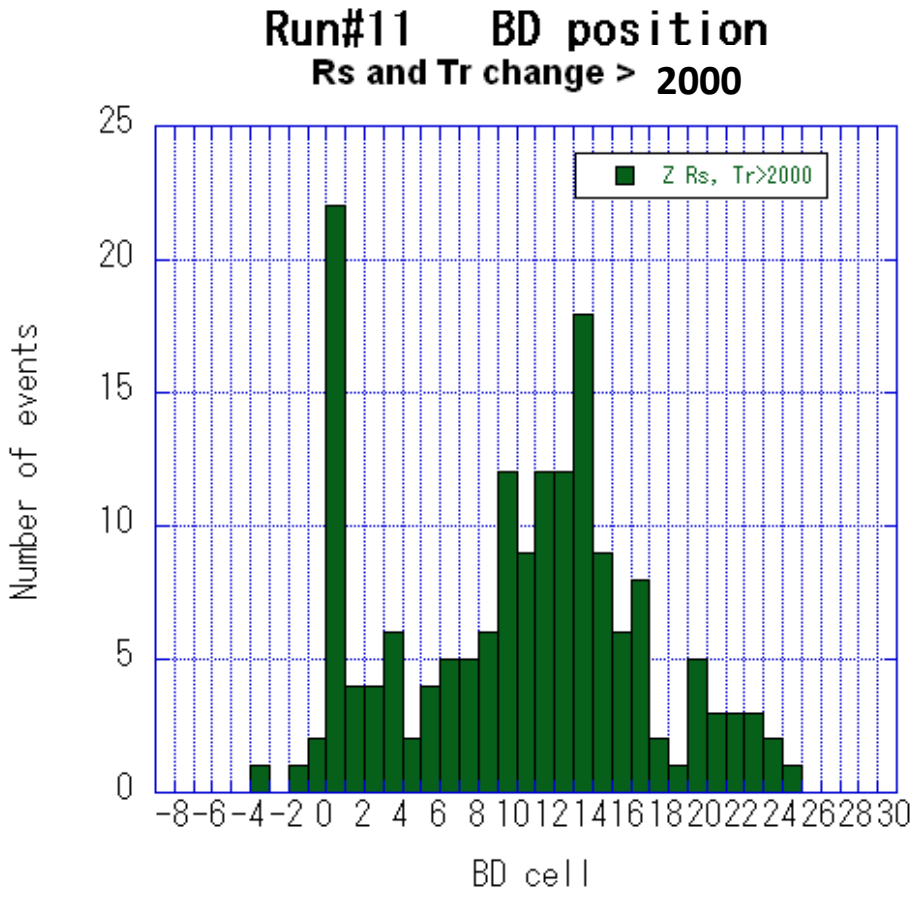
Simply increasing toward output end.

Indication of BD following some field gradient.

534 events were analyzed out of 1919 INTLK.

BD position of run11 113ns, MW

113ns higher target run



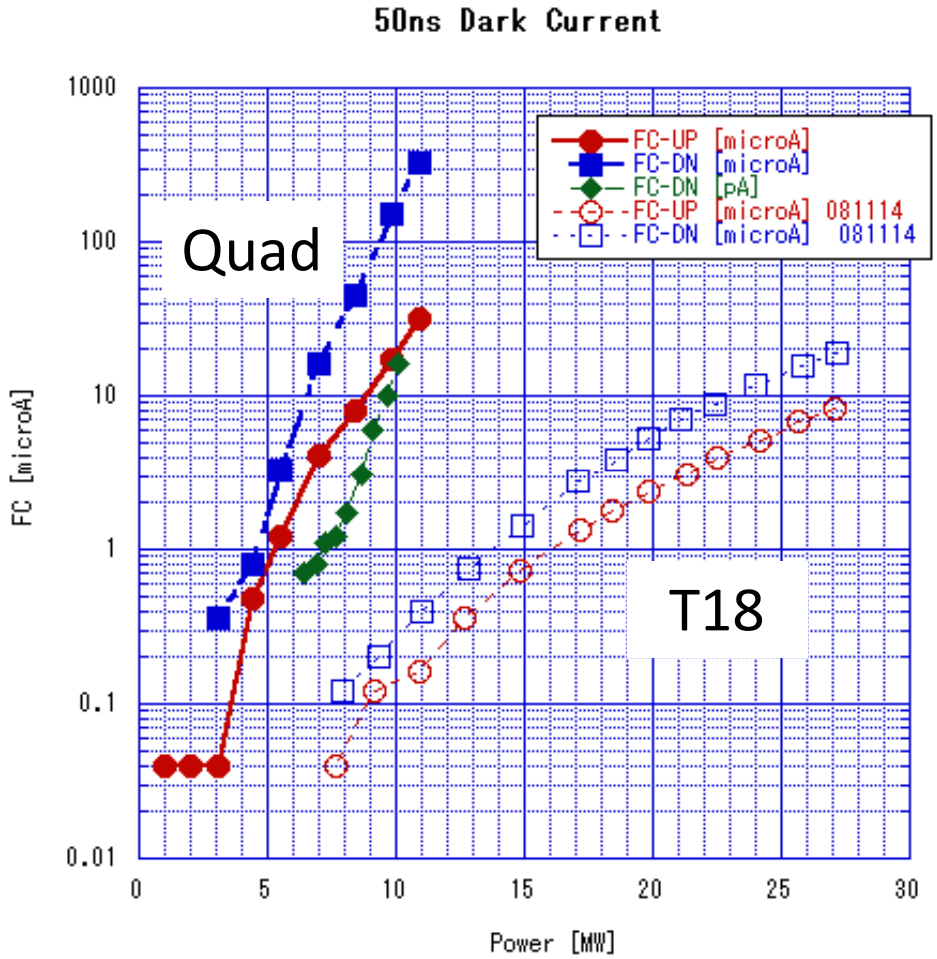
It is evident that there is difference than 50ns.

Not increasing toward output side.

Need to check the peak at cell#0.

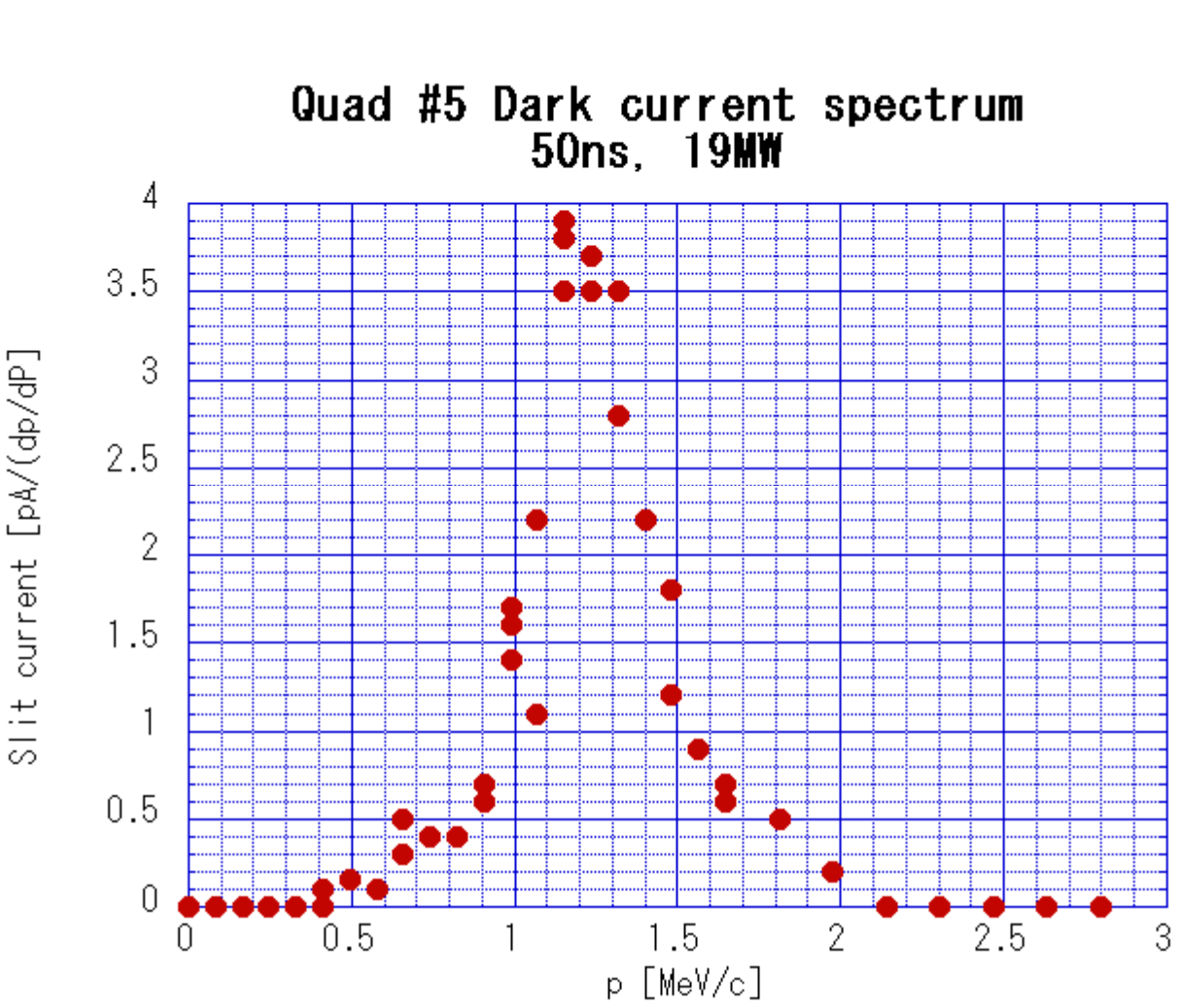
Need to check those outside structure cell region.

Quad dark current much larger than T18



(Note: Power is just the value in the control program panel. Read 12MW as 19MW, though relative comparison between quad and T18_disk is OK without this.)

Spectrum peak at very low energy

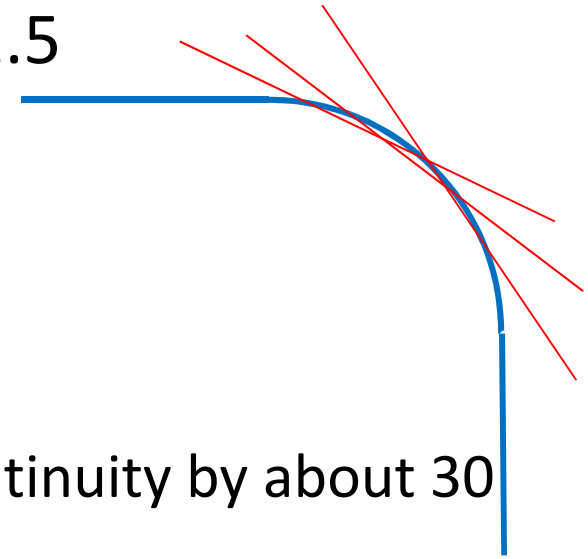


T18_Disk
Peaks at 8MeV/c and 4MeV/c with 108MV/m

Present quad
Peak at 1.2MeV/c with 19MW → 59MV/m

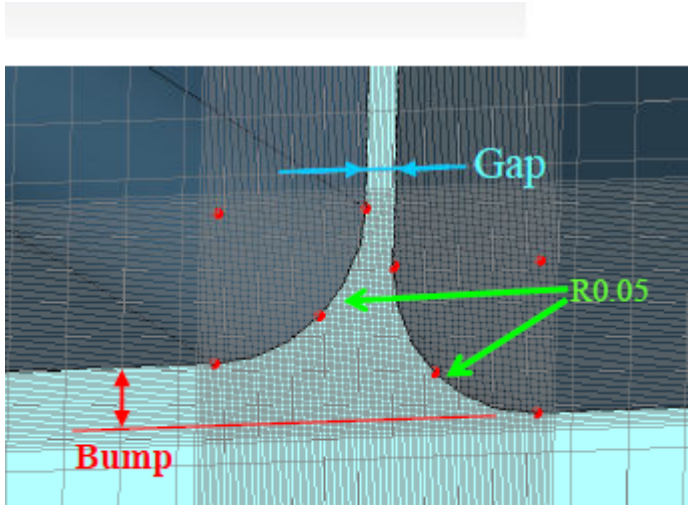
Possible cause of high dark current
Field enhancement due to round chamfer

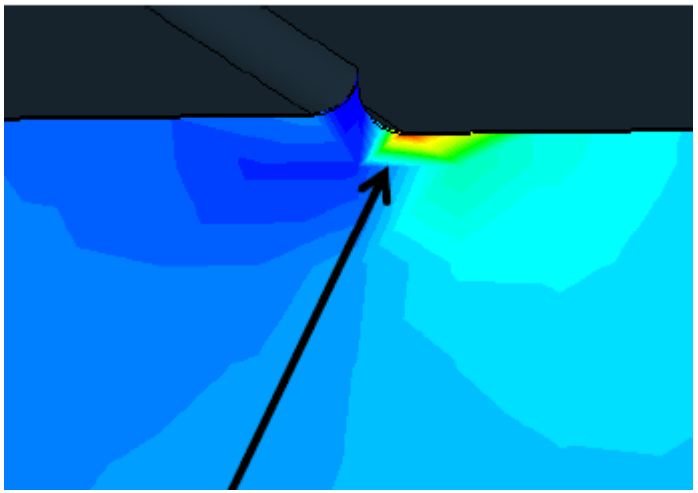
- Simulation of field enhancement
  - 1.4 ~ 1.6 at radius
  - with gap<radius/5, step<radius/2.5
- Only a few tool passes
  - to shape 50 micron radius
  - with radius tool of 2mm
    - If three passed → tangential discontinuity by about 30 degree
    - Can be relaxed by such as EP in future



Electric field enhancement in a shallow channel with round chamfer

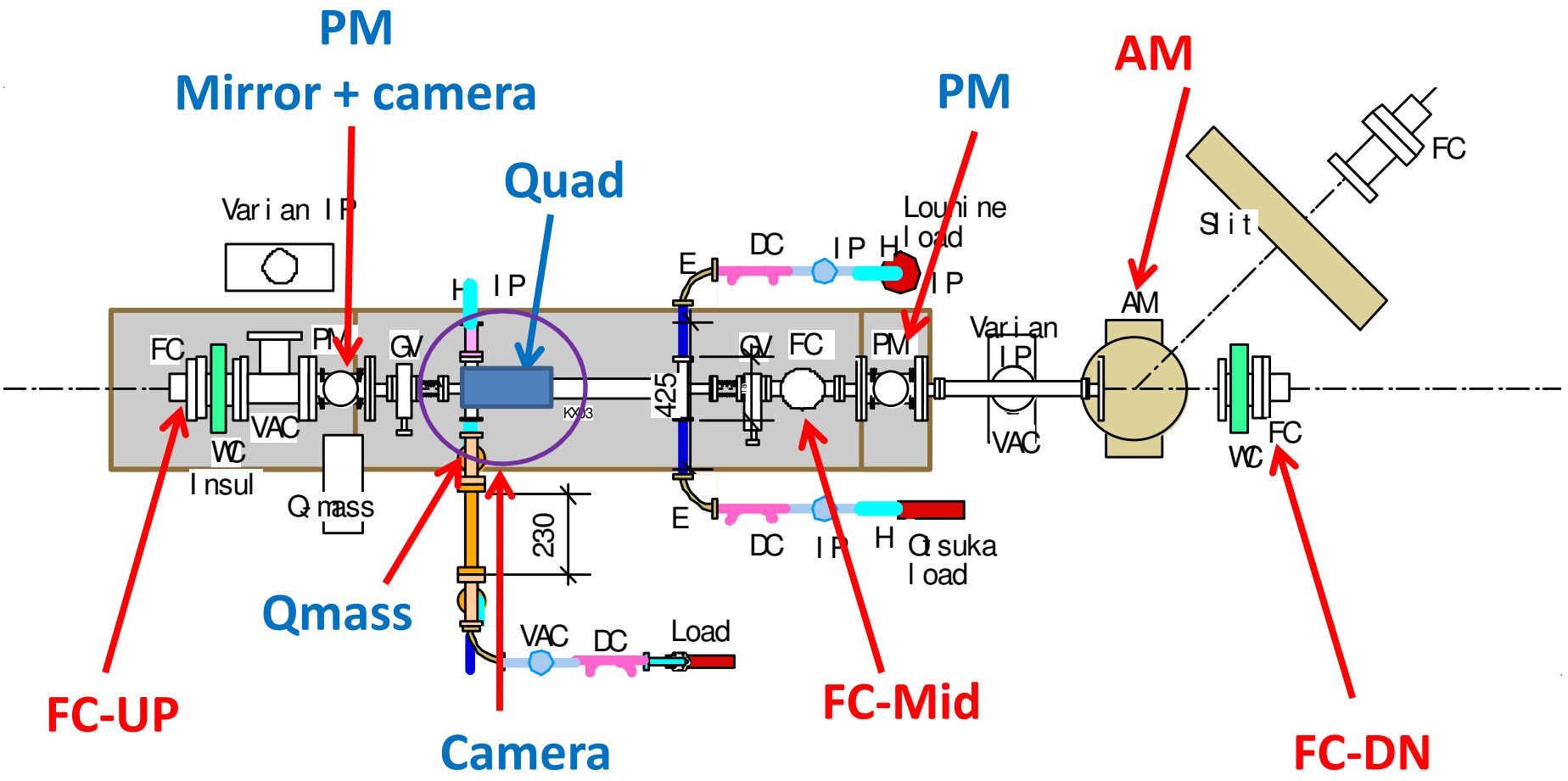
Calculation done by T. Abe by CST MS. Waveguide field.





Gap (micron)	Bump (micron)	Emax / Enominal
0	0	1.39
0	20	1.57
10	20	1.58

Other monitors for quad



Light emission observed by usual camera

- From side window
  - Can see several cells near center of structure
  - Found some BD events with a light emission from a particular cell
- View from upstream beam axis
  - Found a light emission
  - Pattern interpretation is not straightforward
  - Some event showed bright spot smaller than cell size
- Need better optical setup
  - Time gating, wider view, space resolution, etc.

Possible future program for quad #5

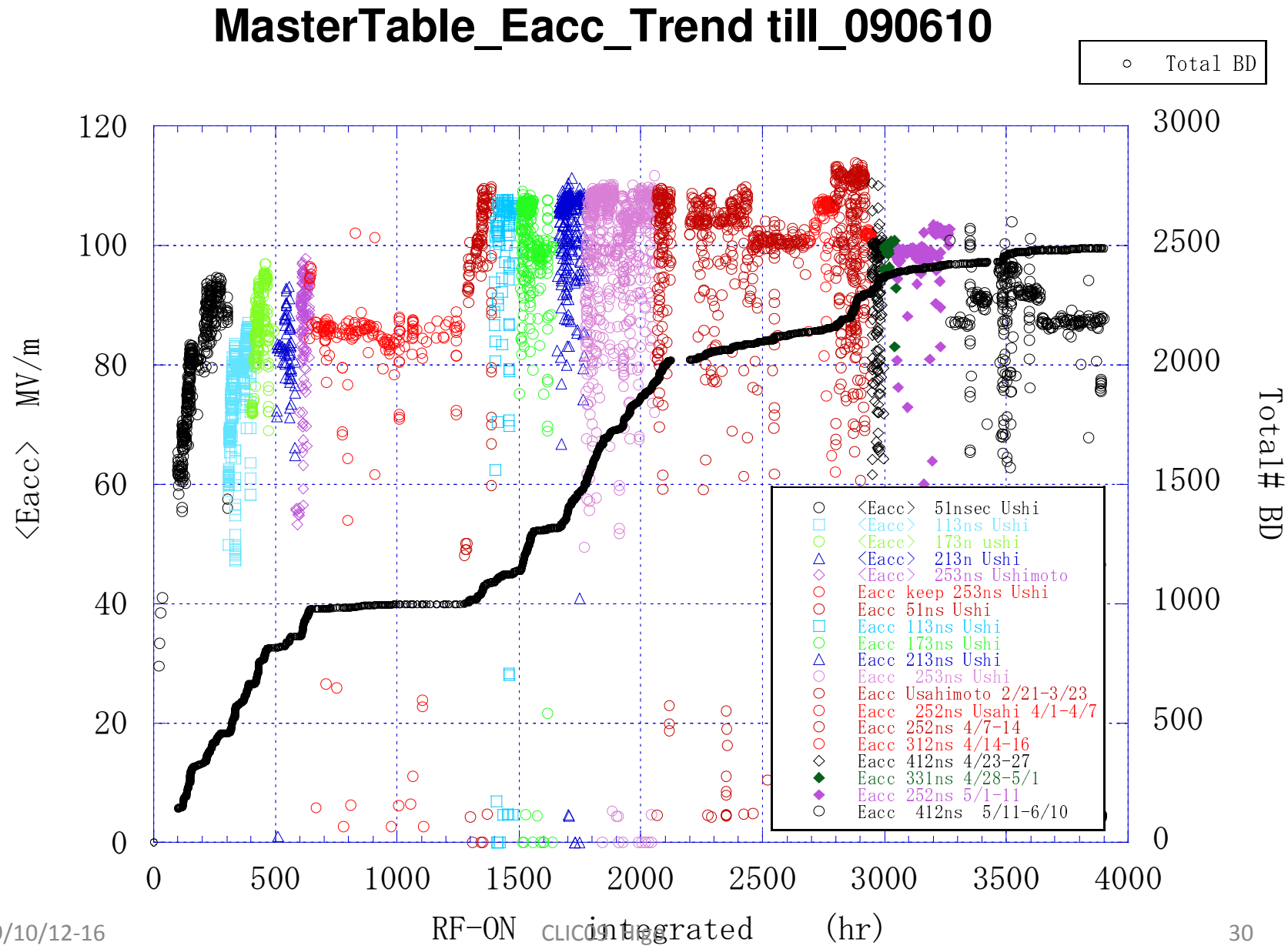
- NEG installation in progress in this week
- Further run
  - Longer pulse run at 173ns
  - Evolution of dark current
- Finish high gradient and --
  - RF check
  - Mechanical check
  - Optical inspection
  - SEM at CERN?

- Further treatment?
  - EP ?
- Further high gradient test
  - Improved optical inspection
  - Change in dark current
  - Possibly higher field?

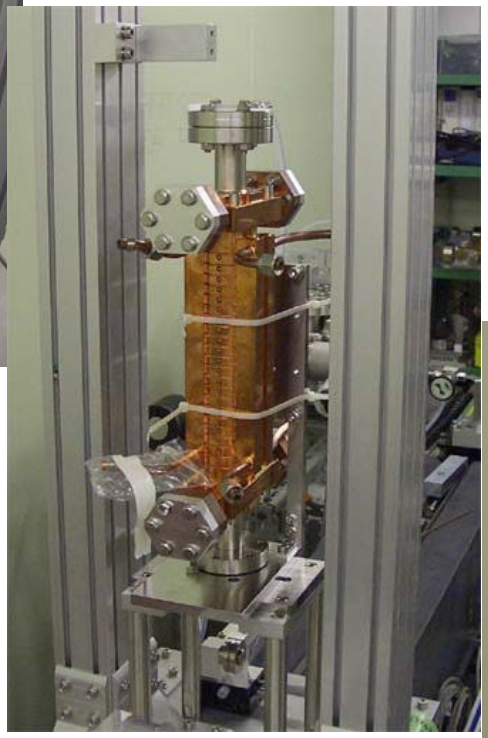
- These become good lessons for us to understand breakdown phenomena.

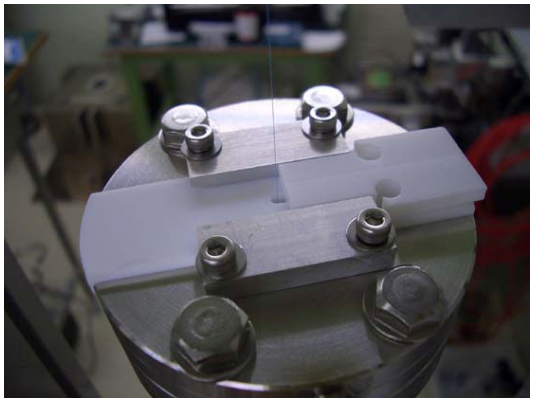
Change in T18 through high gradient test?

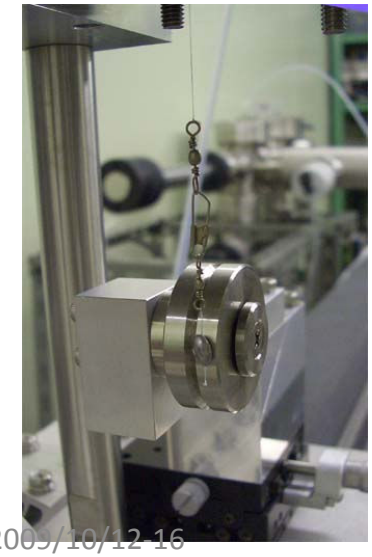
Whole history of processing of T18_VG2.4_Disk #2

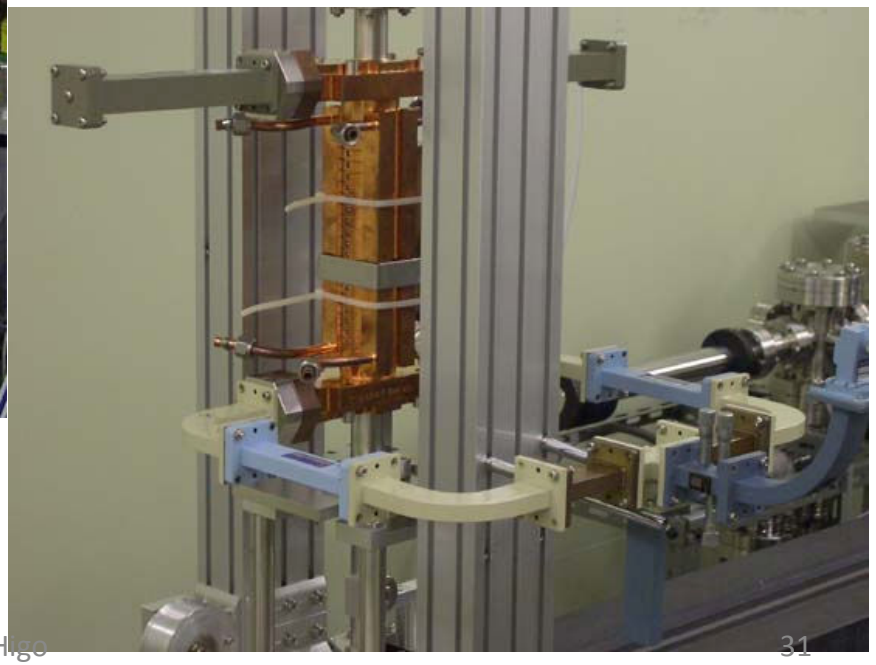


RF check setup

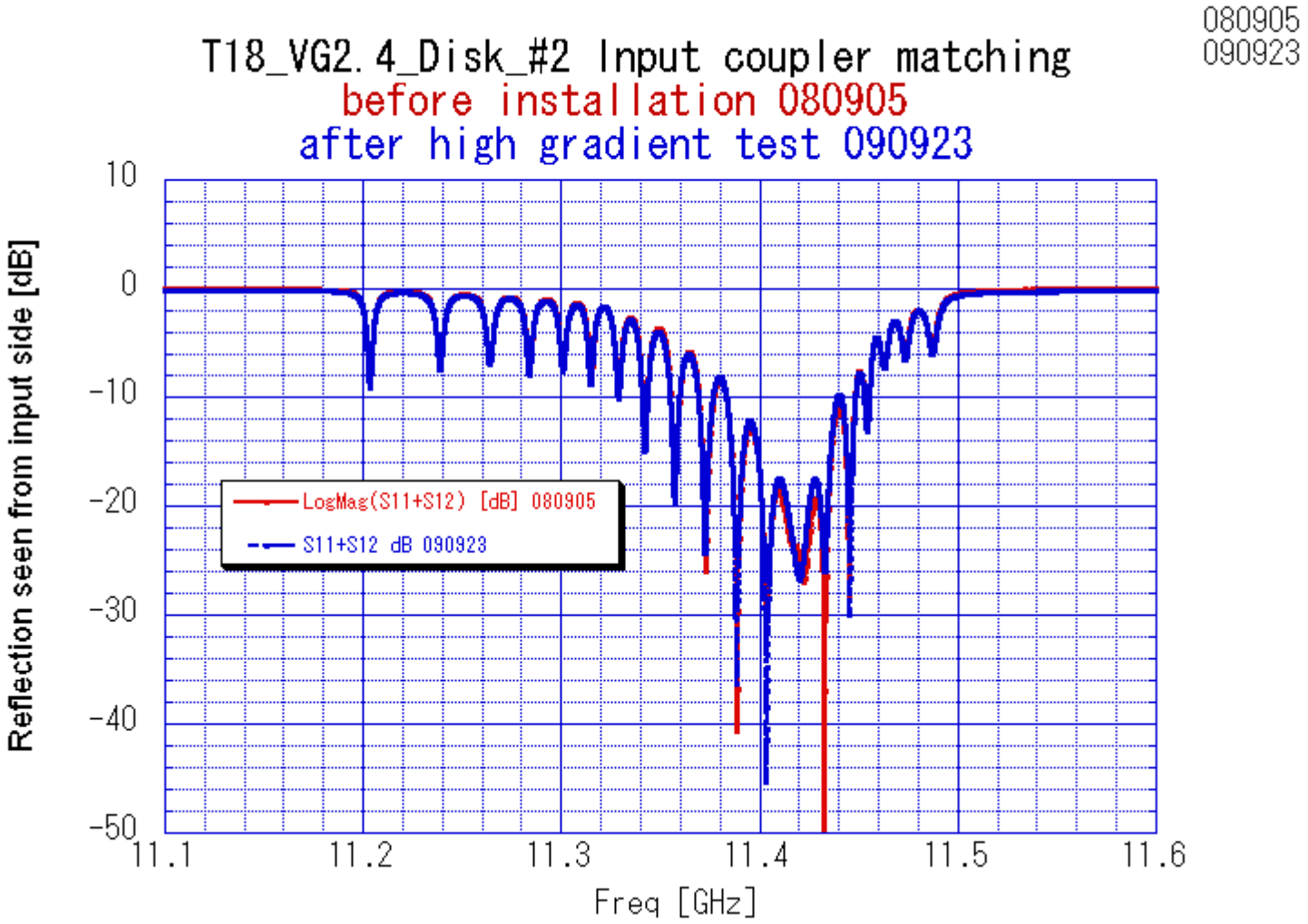




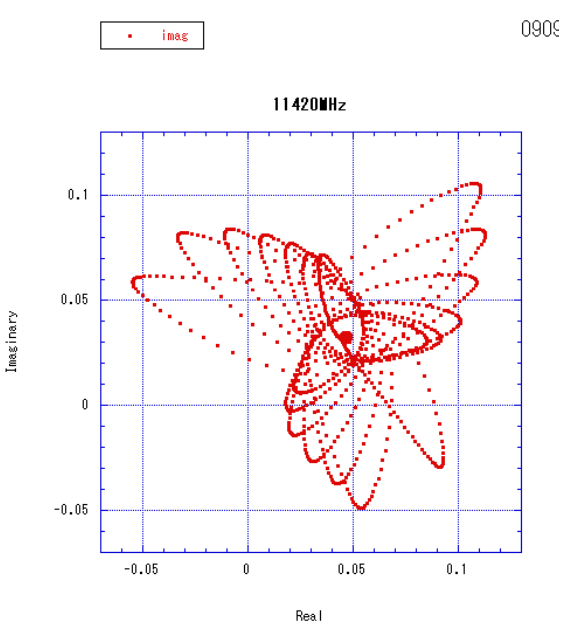


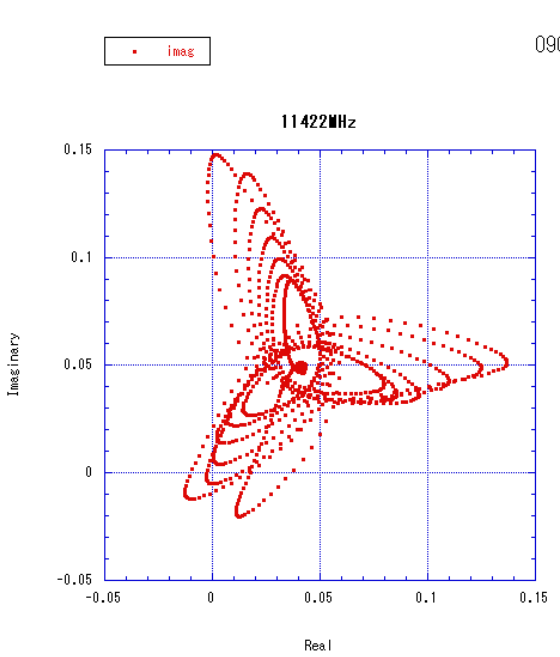


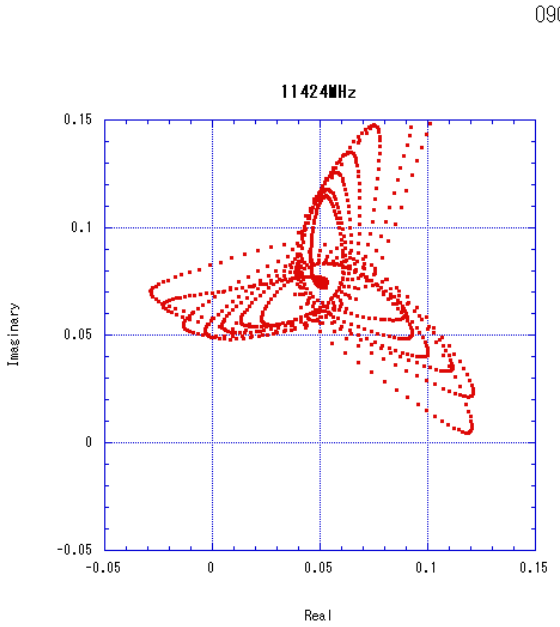
Input match not changed



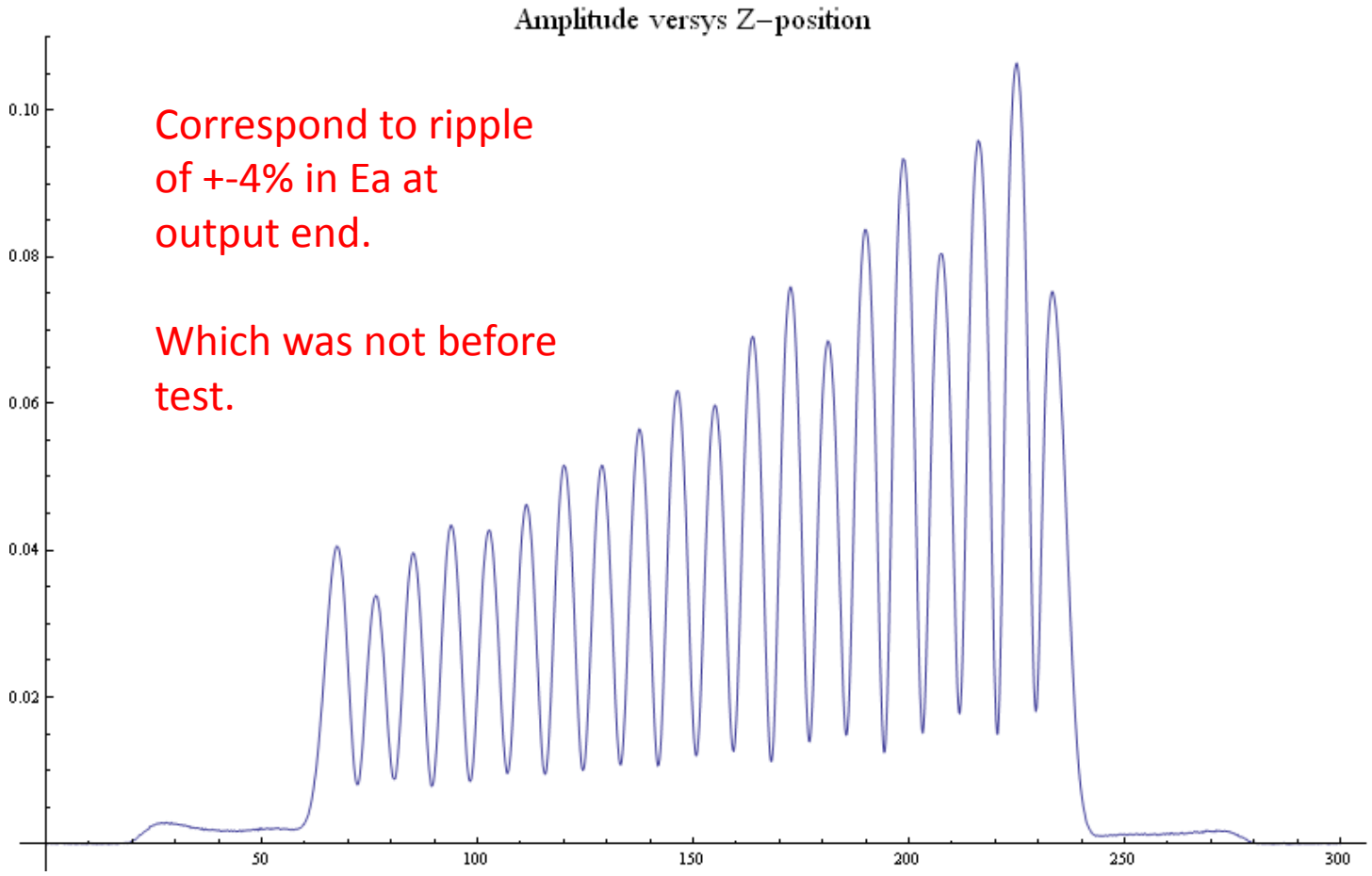
Bead pull raw data on Sep. 23







Bead pull amplitude plot 11422MHz



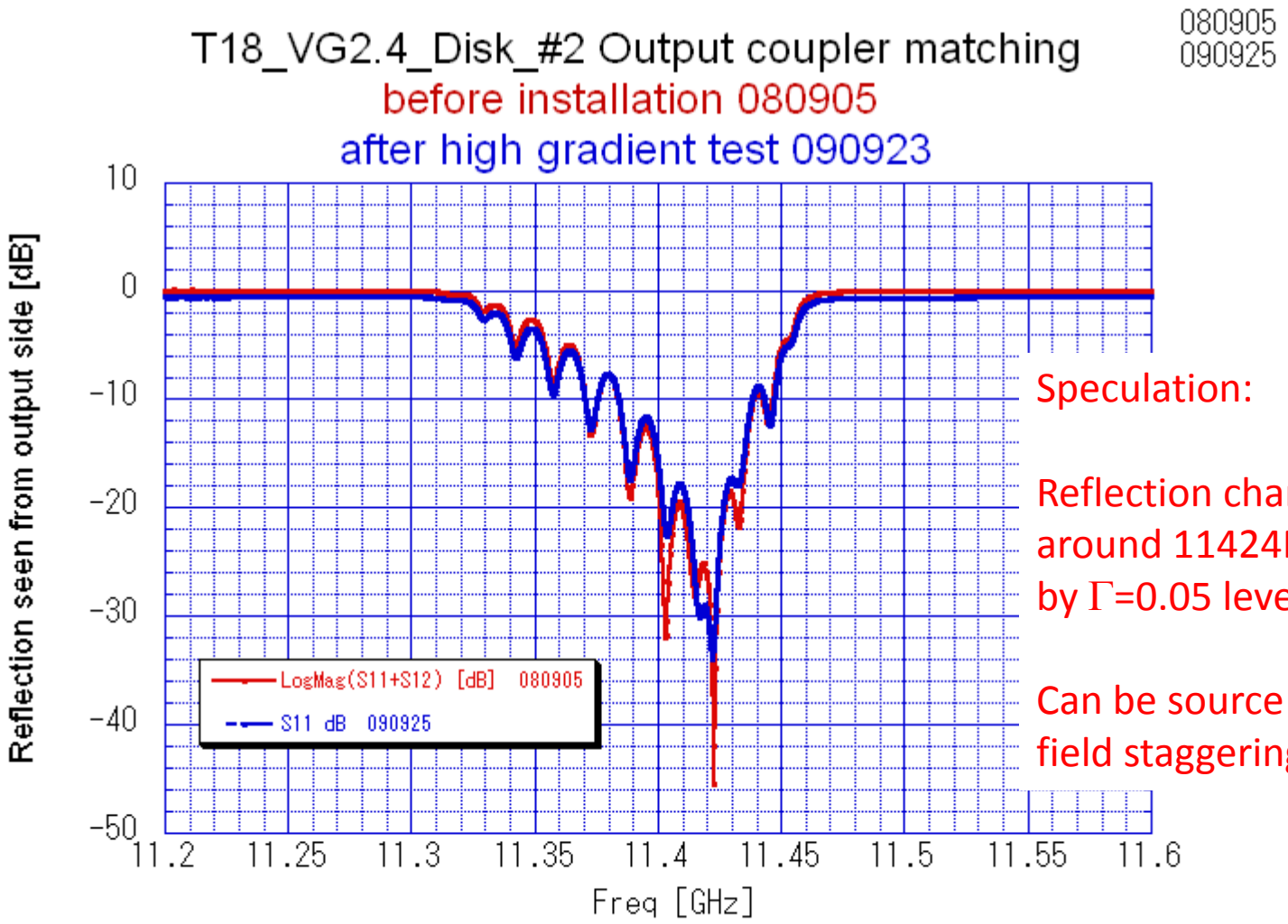
Correspond to ripple of +-4% in Ea at output end.

Which was not before test.

Input side

Output side

Output match some change

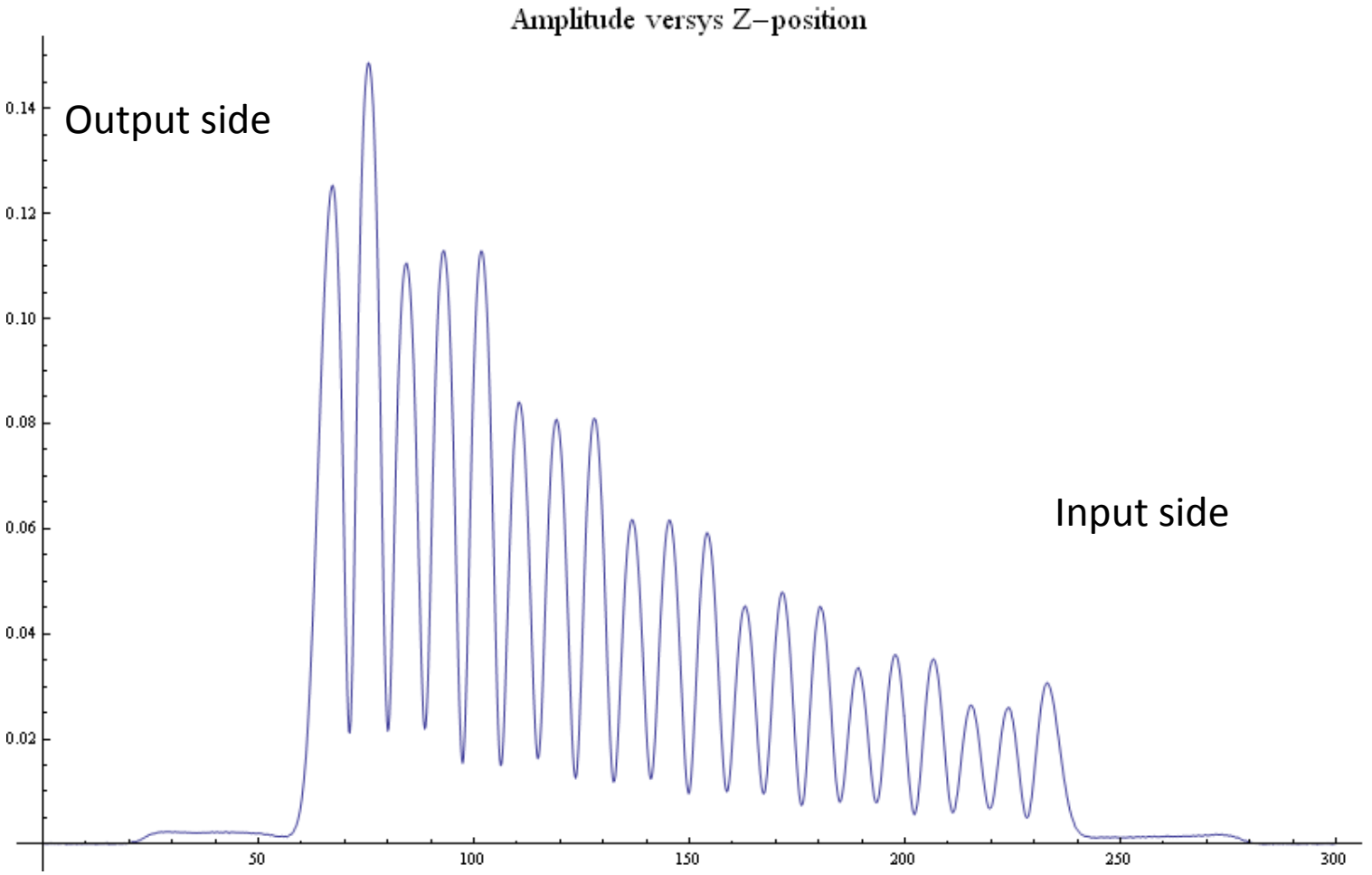


Speculation:

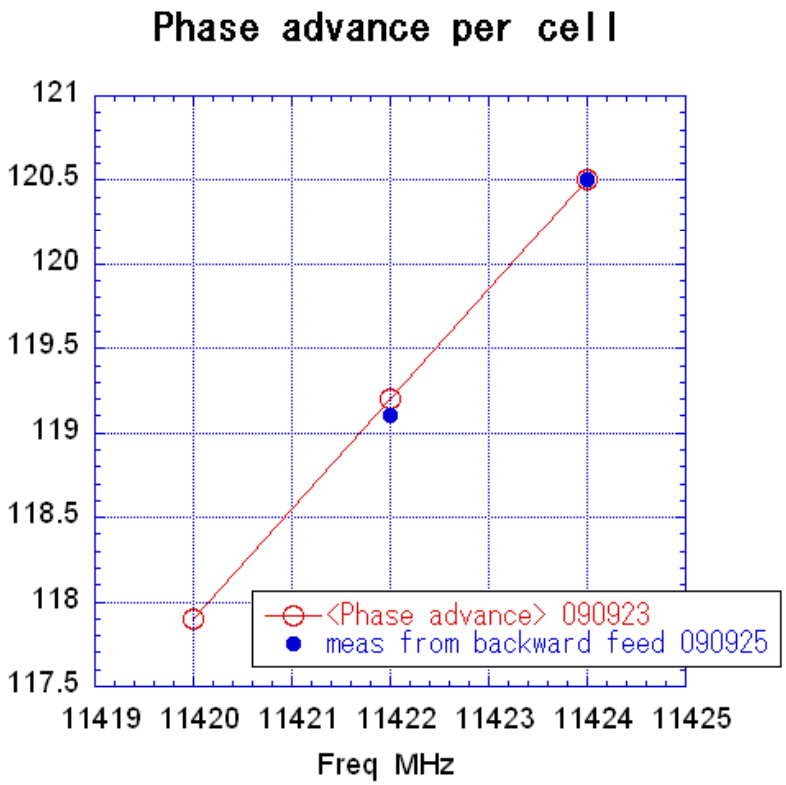
Reflection changed around 11424MHz by Γ=0.05 level??

Can be source of field staggering

Bead pull feeding from output side



Phase advance per cell

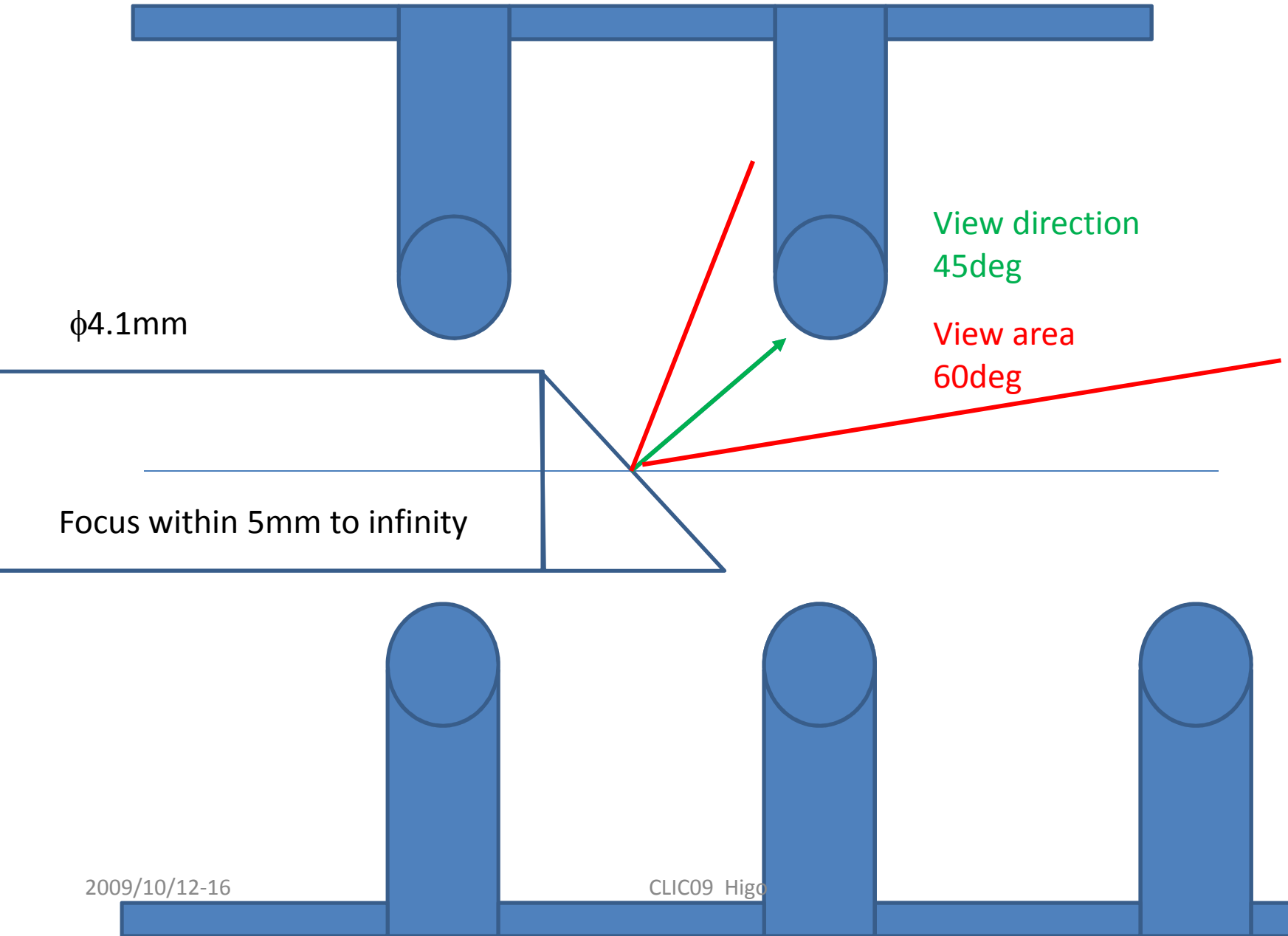


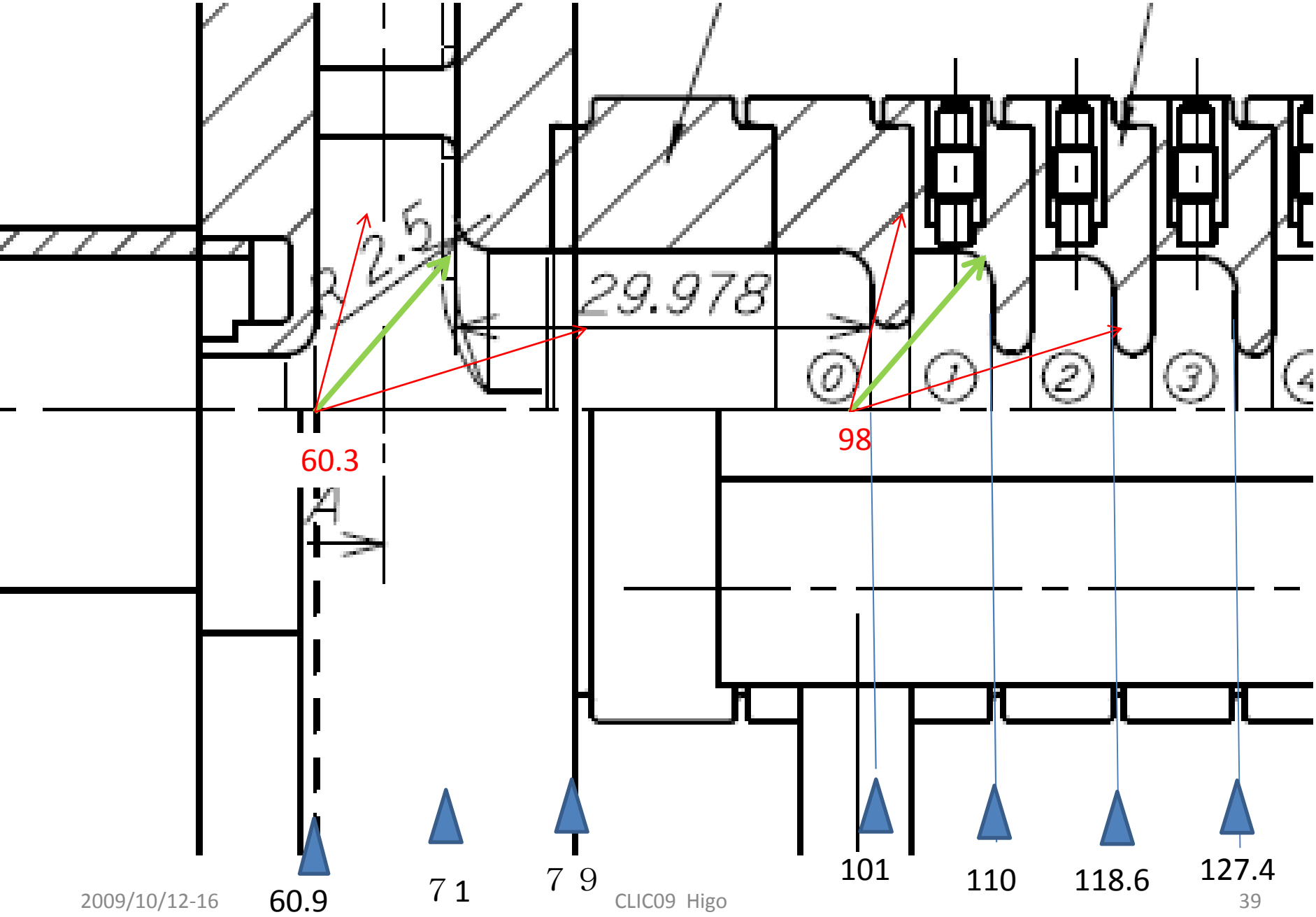
Condition
at 22.7degC in Nitrogen
Bead pull result:
11423.2MHz → 120deg/cell

delF 22.7 →30C -1.38MHz
delF N2 → VAC +3.12
delF string → no string +0.2MHz
Total delF = 1.94MHz

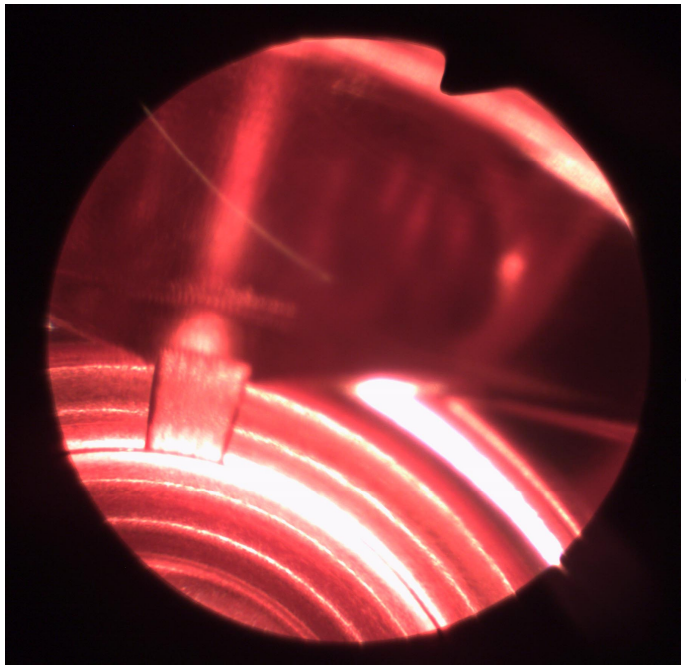
The structure now shows
120deg/cell at 11425.1MHz

Changed by 1.1MHz through high gradient test!?!?
Should confirm carefully with SLAC tuning result.

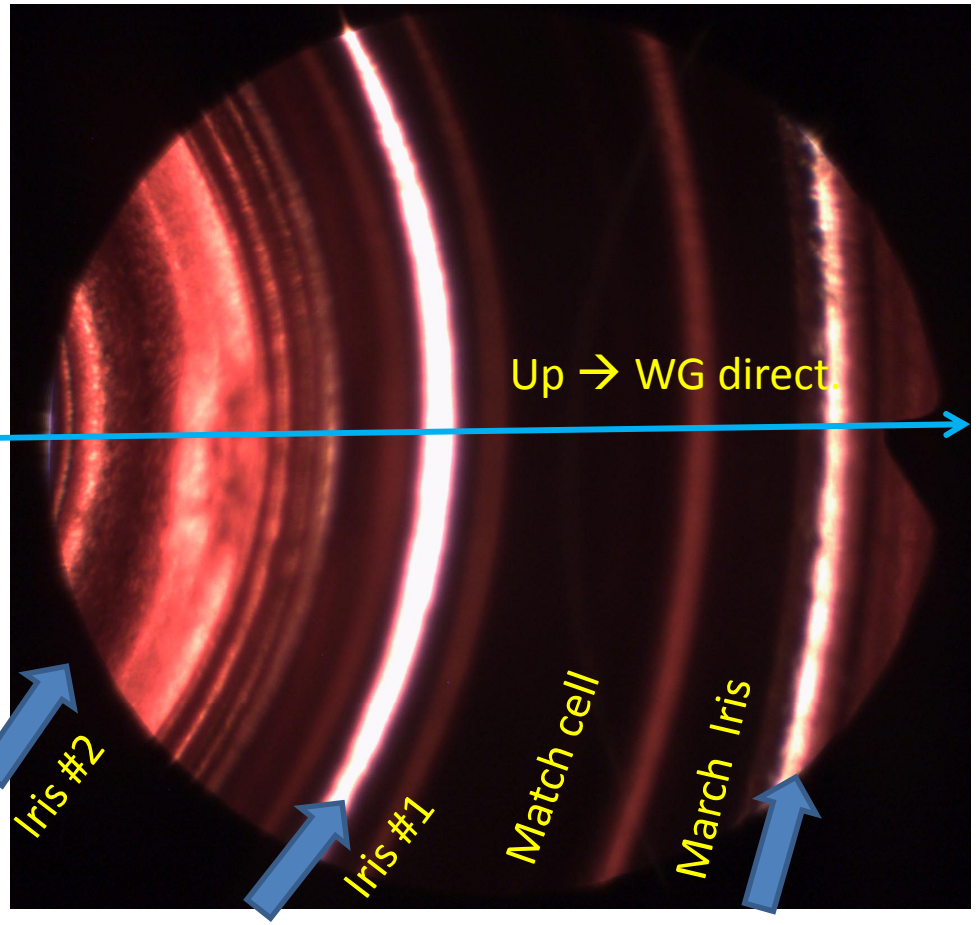

View direction
45deg
View area
60deg
ϕ4.1mm
Focus within 5mm to infinity


R 2.5
29.978
0
1
2
3
4
60.3
98
60.9
71
79
101
110
118.6
127.4

Optical inspection upstream

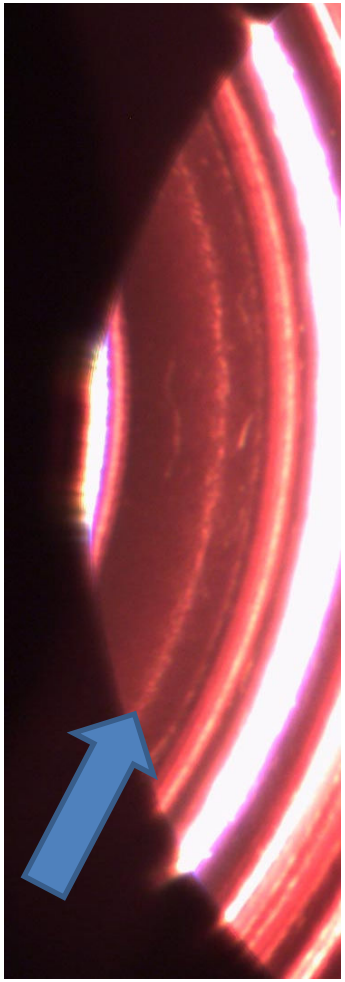


60.3mm
Input coupler to cylindrical TM01 line

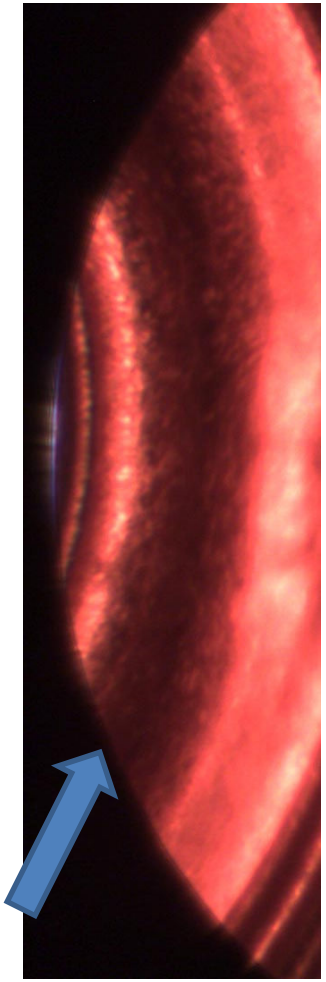


Insertion 98.0mm for observing Iris #2. This is the best we can now, only the forward iris at an enough distance.

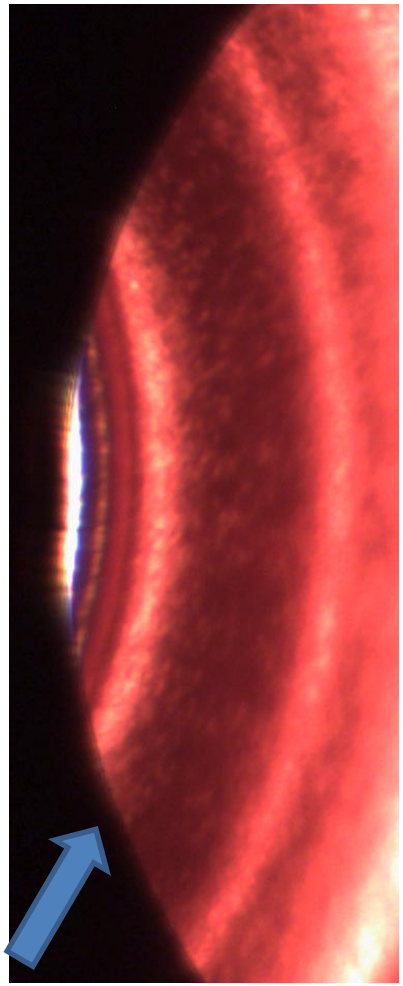
Optical inspection upstream and middle



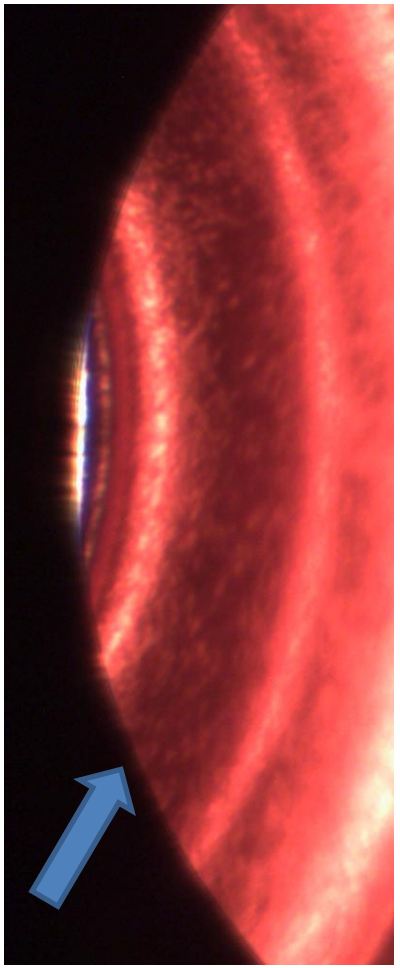
Insertion 82.7mm
Iris #1 at match cell



Insertion 98.0mm
Iris #2 at first
regular cell

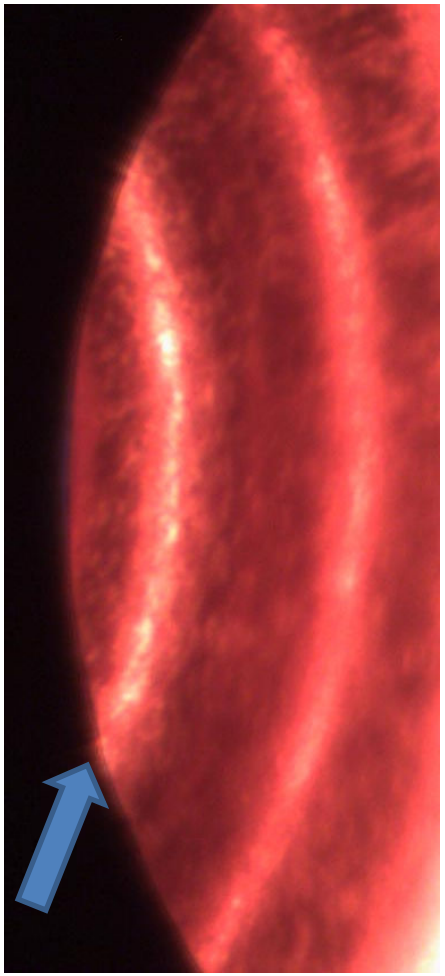


161.9mm Iris #9

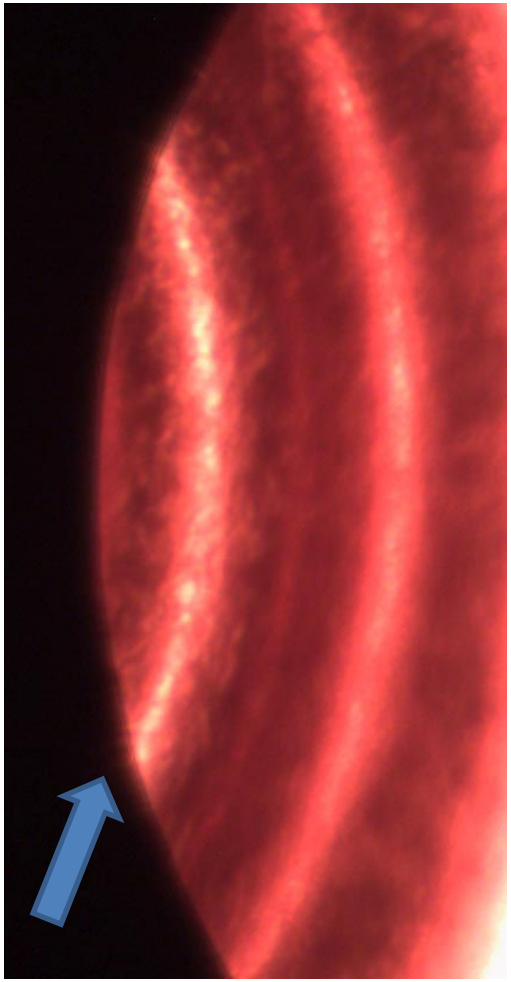


170.9mm Iris #10

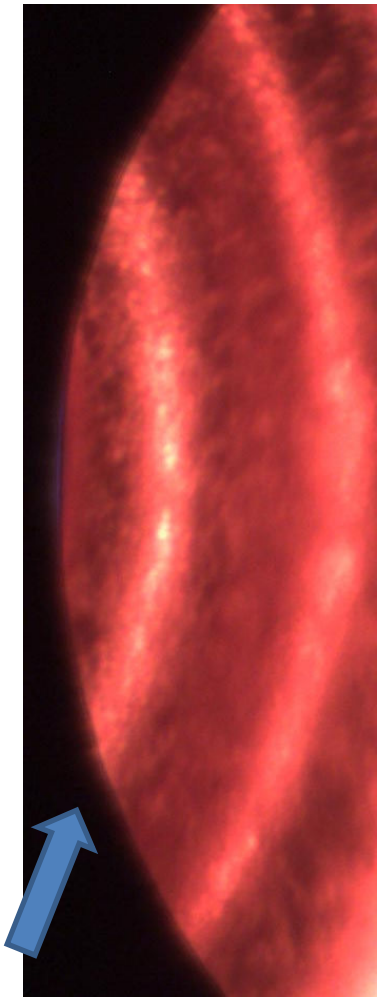
Optical inspection downstream end



243.2mm Iris #18
Upside iris of last regular cell



252.2mm Iris #19
Down side iris of last regular cell



261.3mm
Last regular cell iris #20

Optical inspection result and future

- No significant variation was observed
  - Comparing input to output but
- Need to inspect with better resolution
  - Change to straight bore scope?
  - Adjust focal plane?
  - Should be improved

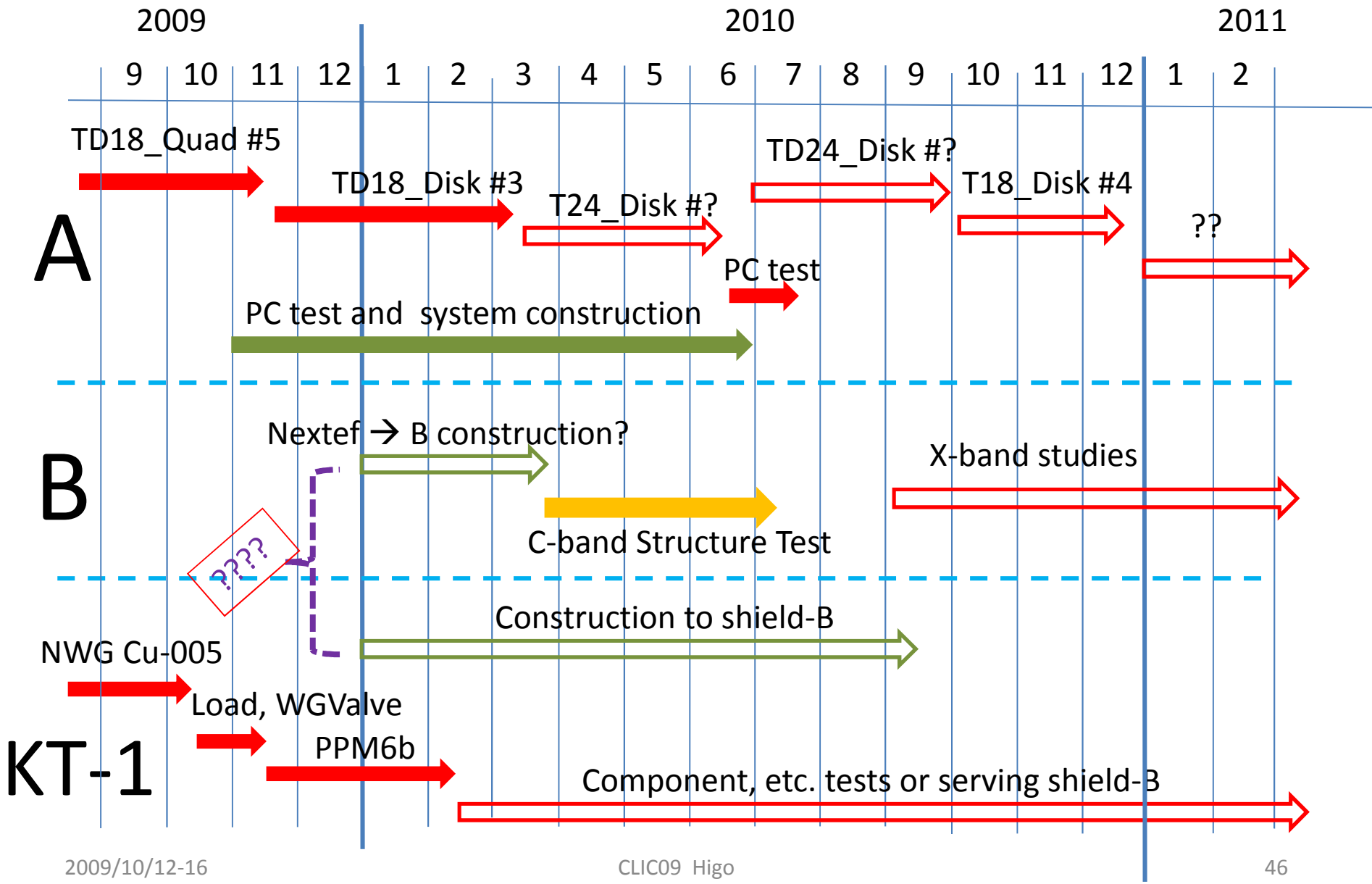
T18_Disk_#2 after high gradient test tentative conclusion

- RF evaluated after high gradient test.
  - Input matching was kept.
  - Output matching changed by Γ=0.05 level.
  - Average frequency increased by 1.1MHz.
  - Field ripple±4.4% near output end.
- Some change in RF performance was observed.
  - Need to compare carefully with SLAC data.

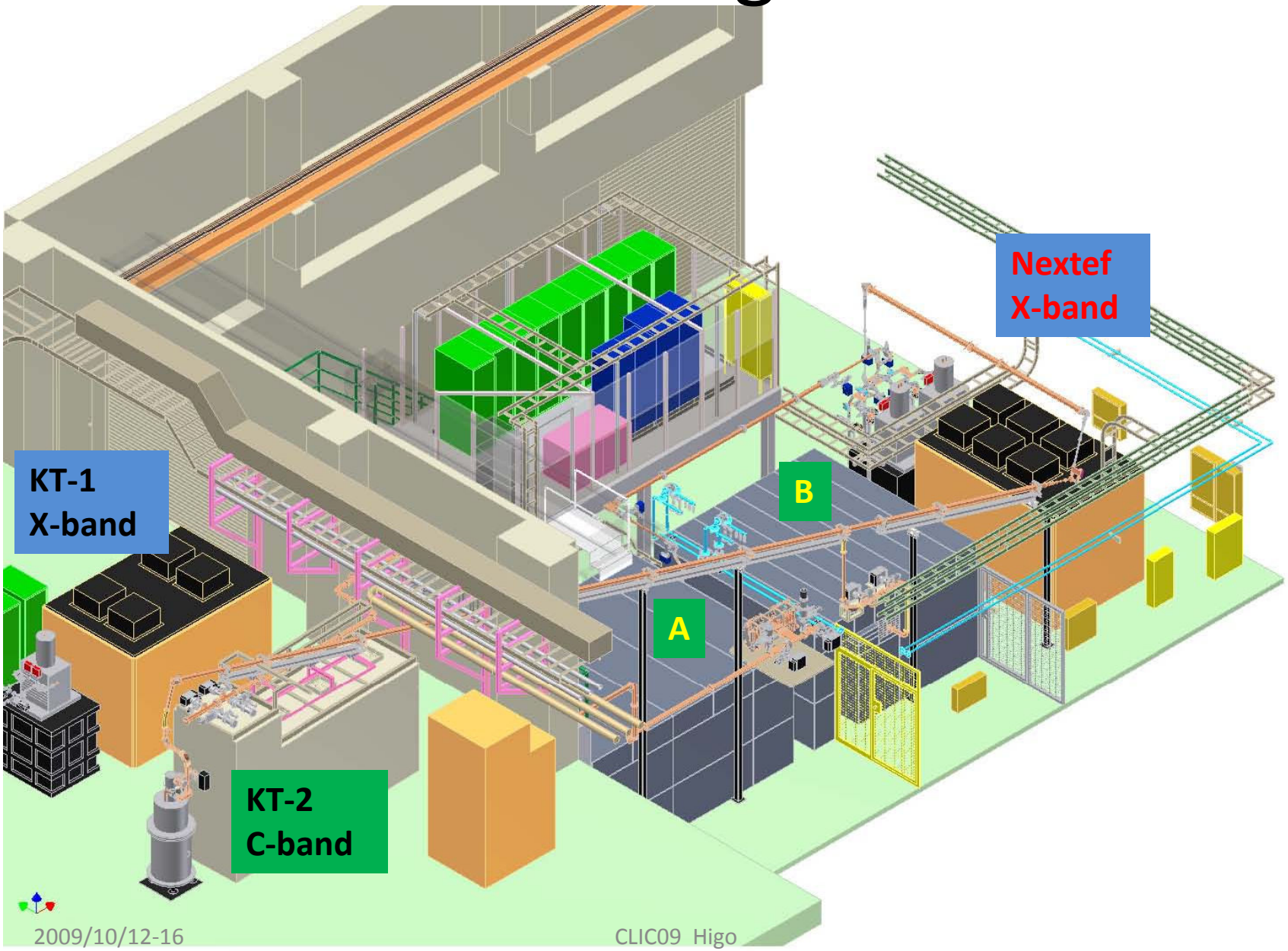
Summary and next plan

- Quad
  - Similar performance as quads tested at SLAC
  - More test in a few weeks
  - Inspection and think about the further test
- T18
  - Measurable change was observed
  - We need to remind this
- Next plan
  - TD18 is top priority
  - Then T24_Disk, TD24_Disk before CDR
  - followed by T18_Disk#4, ……

Nextef Planning revised as of CLIC09



Nextef Configuration



Conclusion

- Nextef will run fully dedicated for the feasibility study of CLIC 100MV/m
- Nextef will boost peak power and high power stability by introducing pulse compression system
- We try to construct a test area in addition to Nextef for key studies