Re-matched tune compensation for the 90 m optics

by Thys Risselada and Helmut Burkhardt
with input from Massimo Giovannozzi, Rogelio Tomas and others

90 m optics
/afs/cern.ch/eng/lhc/optics/V6.503/HiBeta with IP1_beta90.str, IP5_beta90_2010.str
prepared to be tested with beam and to be commissioned in the machine for physics

Known challenge :
Major external tune compensation required

	beam1		beam2	
	MU_X	MU_Y	MU_X	MU_Y
IR1	0.2251	0.0569	0.2237	0.0550
IR5	0.2219	0.0546	0.2203	0.0528
total	0.4470	0.1115	0.4440	0.1078

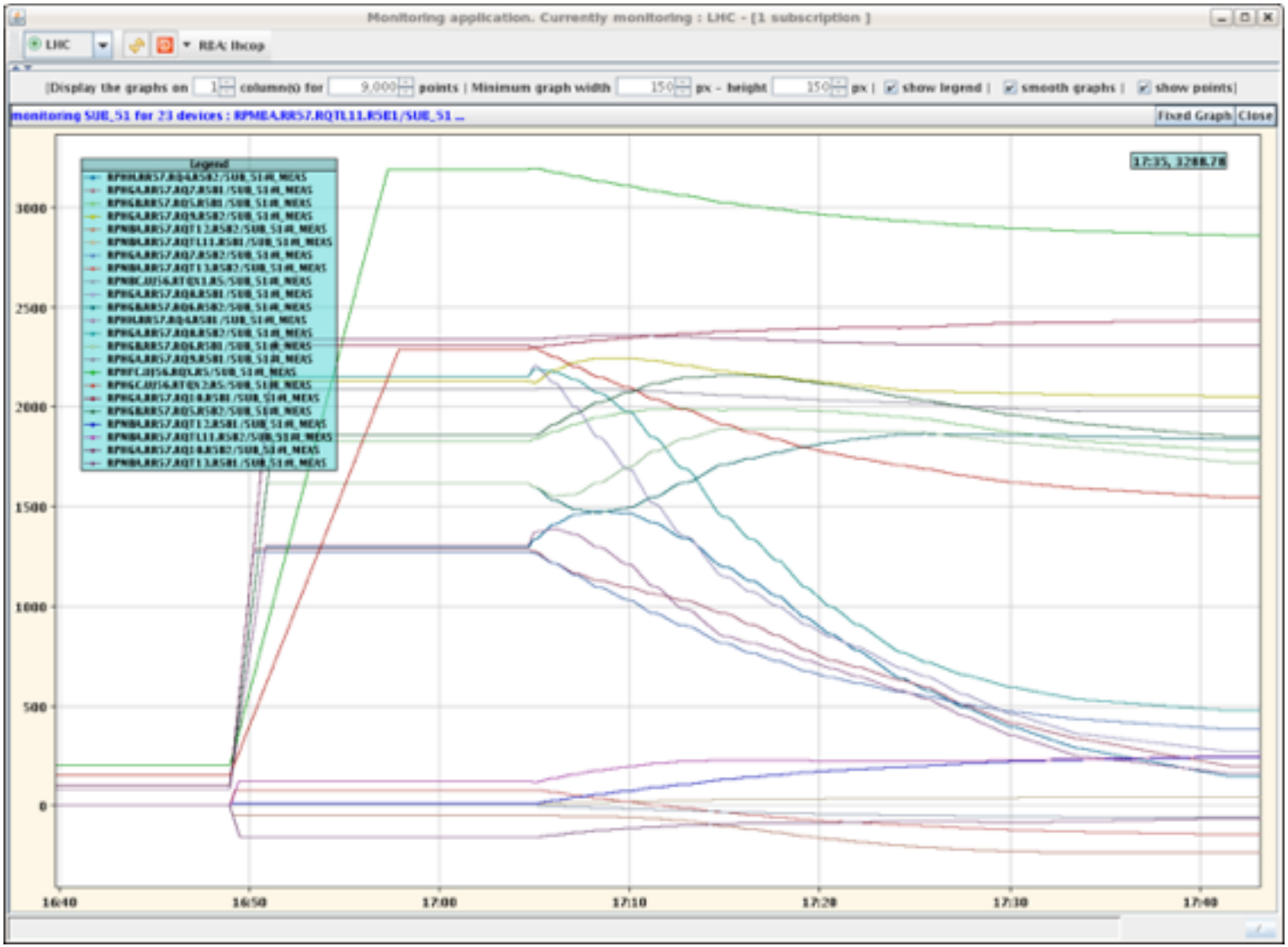
Ref :

High-β* Optics for the LHC, H.B. & Simon White, **LHC-Project-Note-431**, May 2010
High beta optics, H. Burkhardt, presentation and paper at the Jan. 2011 Lumi days, link
Intermediate 90m Optics for ATLAS-ALFA, H. Burkhardt, S. Cavalier, CERN-ATS-Note-2011-027 PERF, Apr 2011

+ starting with some latest NEWS on cold checkout of the un-squeeze from 11 m to 90 m

1st dry run test of the un-squeeze from 11m to 90m

Successfully tested without beams in hardware commissioning sector 5-6 on the 15 Feb 2011 :

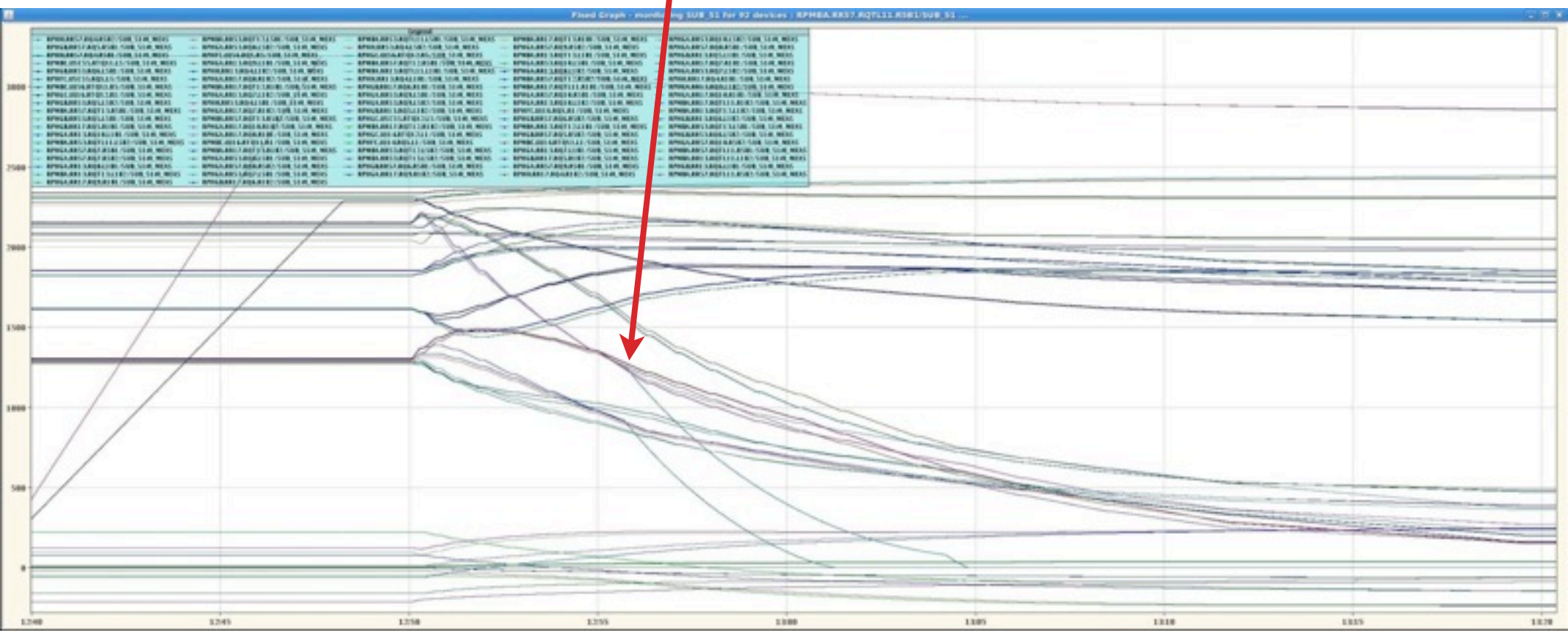


from 11m to 90 m using 19 intermediate steps - without stopping in ~ 40 min

Tests done with Stefano Redaelli and preparation of functions with Gabriel Müller / OP

Test IR1&5, after beam dump before recycle yesterday

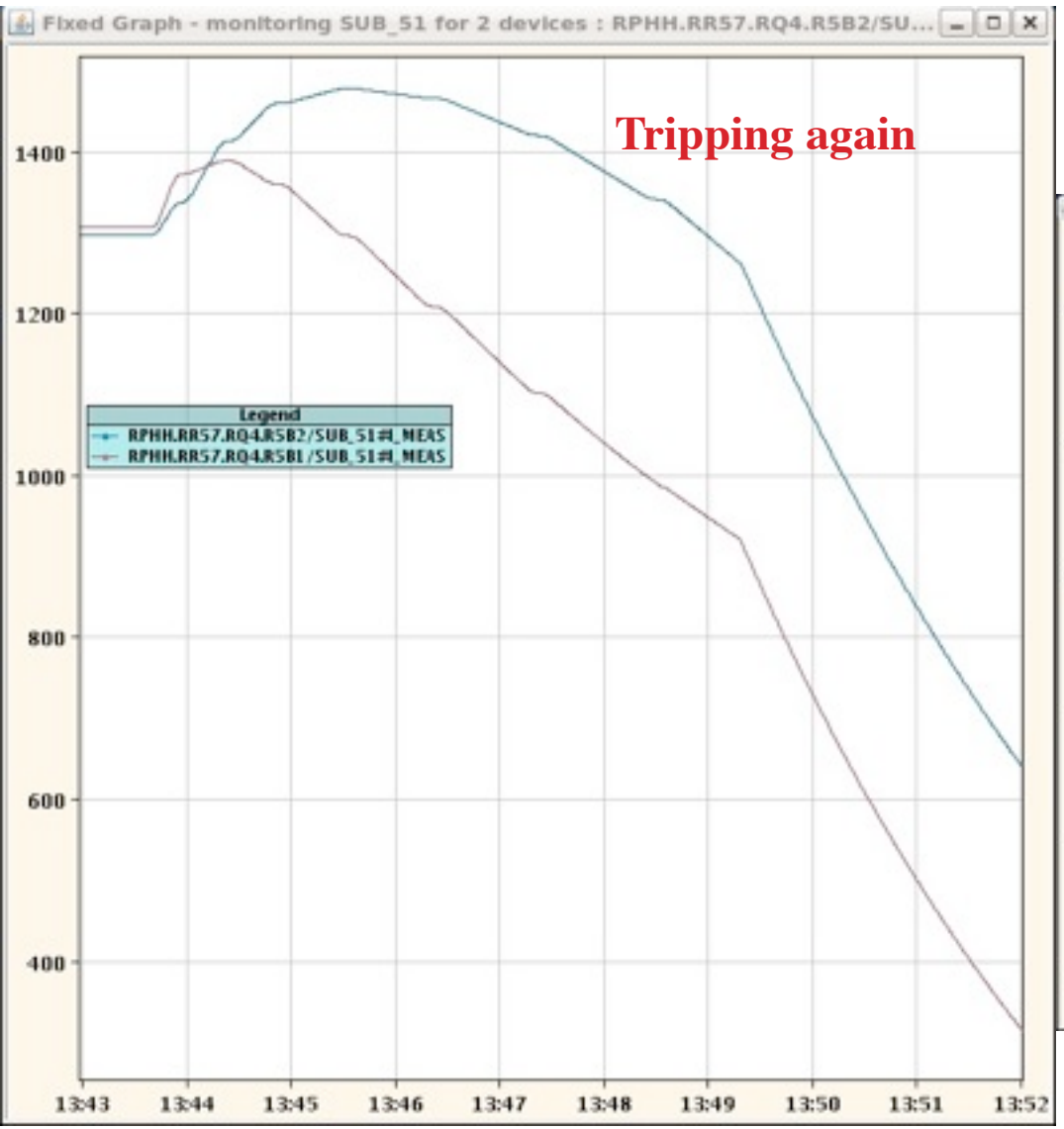
2/05/2011. Loading the dedicated beam process for 90m SQUEEZE_HIGHBETA-90M_3.5TeV_IP1+IP5_V1
Start un-squeeze at 12:50. **Trip of Q4.R5** b1 + b2 at 12:57 at 910A between 25 m and 30 m points.



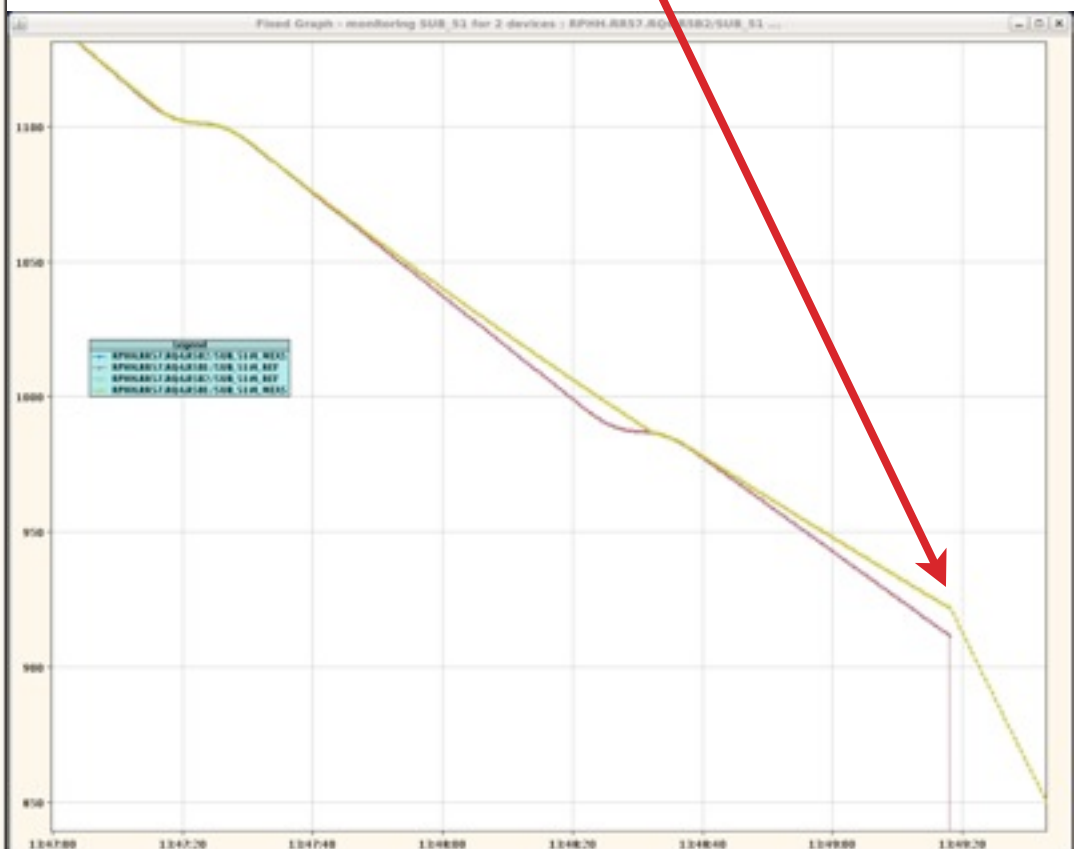
Test by Stefano Redaelli. Joined by Miriam Fitterer and myself in the CCC

Check again, just Q4.R5

Checked again by un-squeeze started at 13:43.

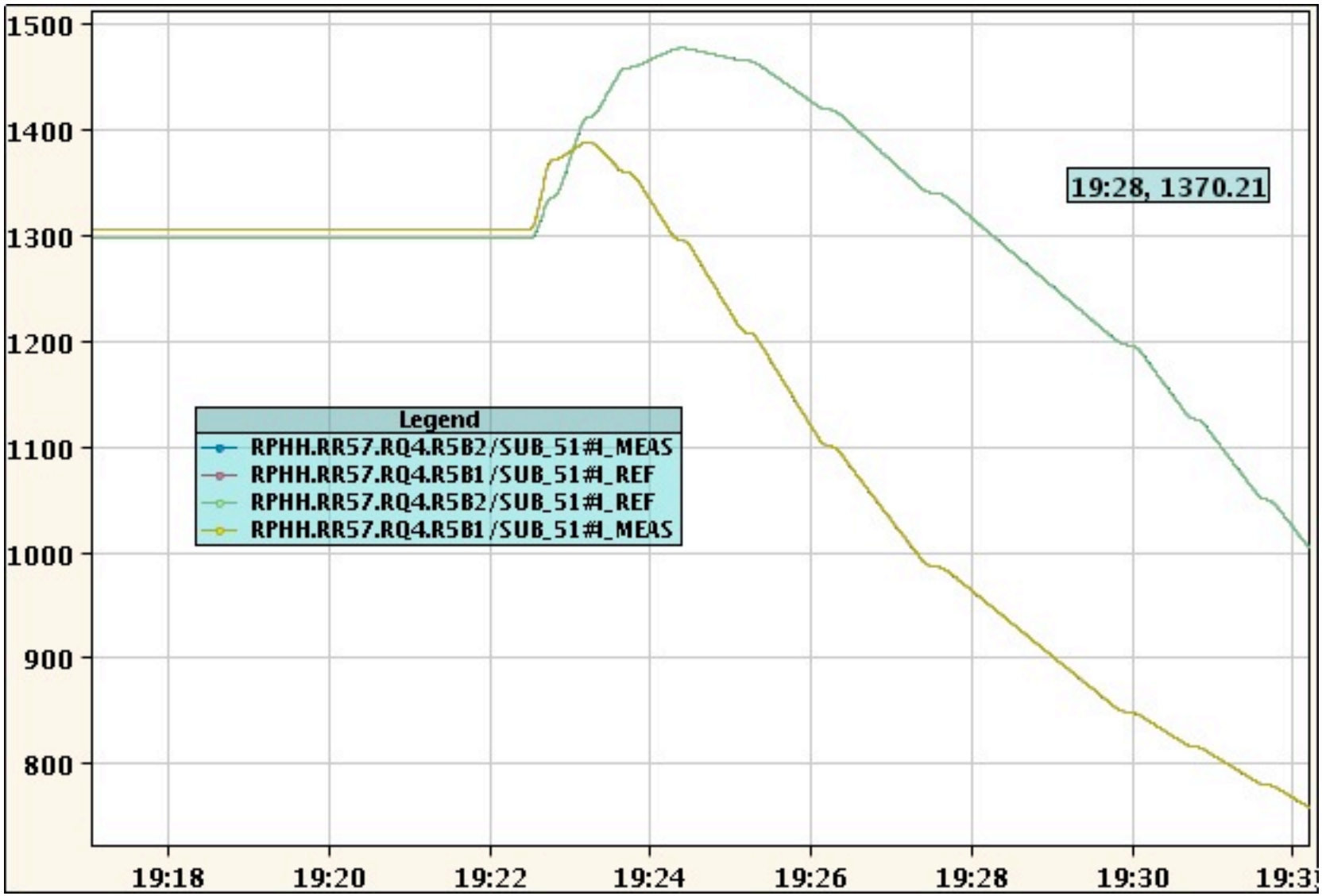


Zoom shows :
Q4 going down slower than demanded, resulting in power converter trip and discharge when Δ > 10 A



Using a slower ramp-down

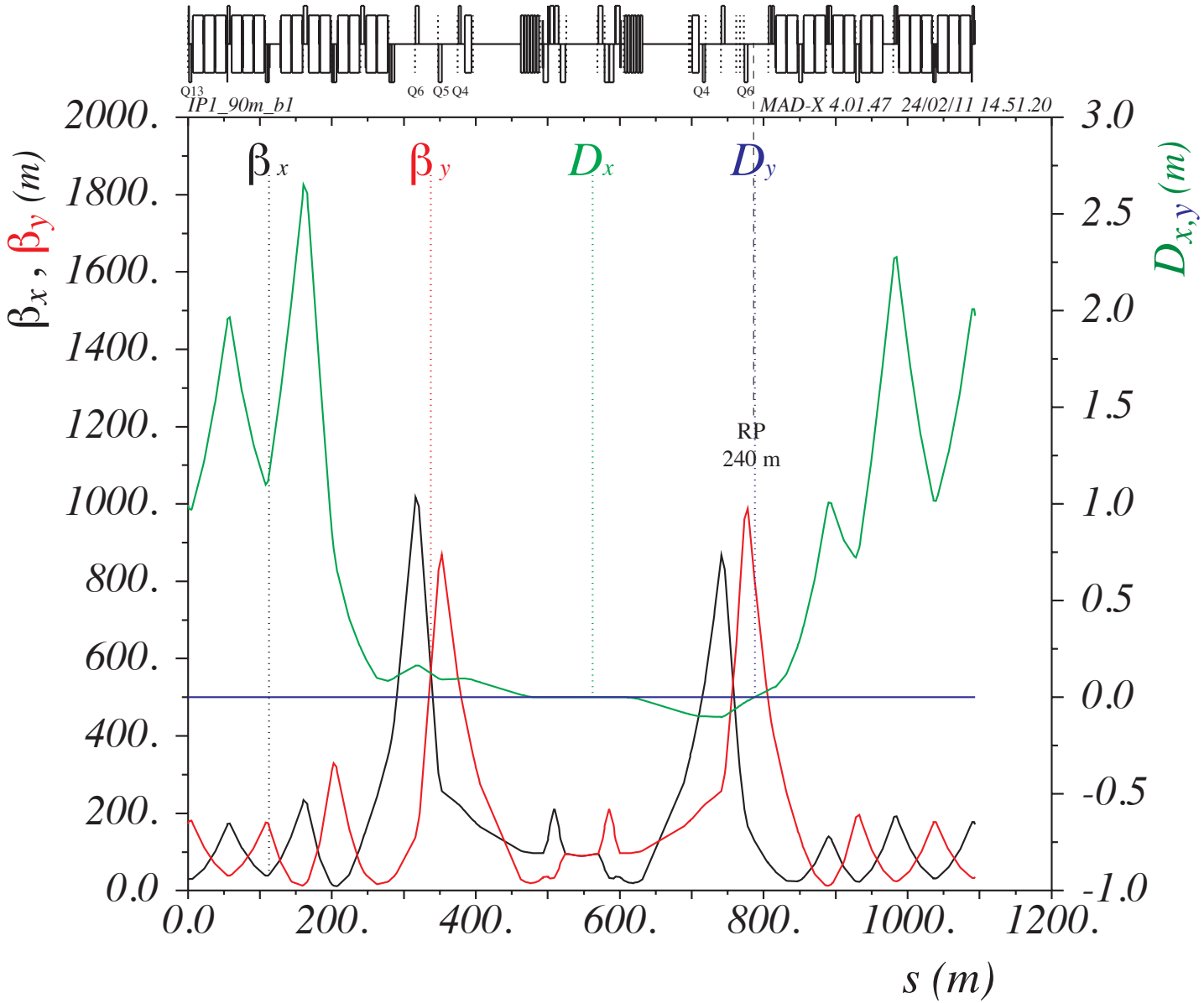
Stefano + Gabriel : updating the beam process, length of function segments with problem stretched by 70 sec. Total time (no stops) 1772 s -> 1842 s



No more trip ! **Next test planned with beam in MD on Thu afternoon.**

90 m optics

shown here for b1 and IP1



Very similar in IP1 and IP5 - only difference from optimization of the phase advance to the roman pots at 220 m in TOTEM and 240 m in ATLAS-ALFA

Global tune compensation with ring quads

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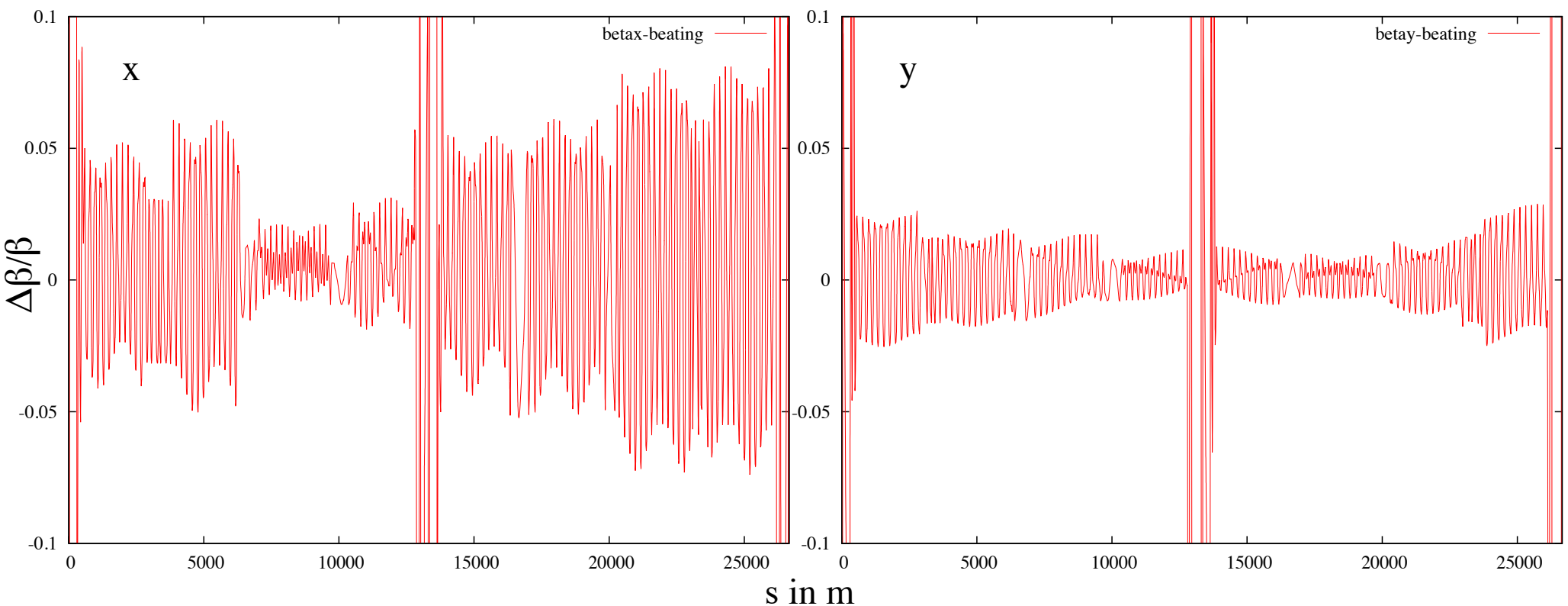
Tune adjust needed:
dqx1=0.447046 dqy1=0.111483
dqx2=0.444032 dqy2=0.107835

Could be done using the ring quads
kqd :=    -0.008623542277 ;
kqf :=     0.009045598147 ;
  + trim quads for difference
kqtd.b1 :=    -0.000007503934 ;
kqtf.b1 :=     0.000006560747 ;
kqtd.b2 :=     0.000008362728 ;
kqtf.b2 :=    -0.000008461922 ;
```

results in beta beat of
b1: <x>= 2.65% max= 8.10% at MS.21R8.B1
<y>= 0.822% max= 2.88% at MQ.20L1.B1
b2: <x>= 2.89% max= 8.31% at DRIFT_67
<y>= 1.08% max= 2.77% at MQ.12R3.B2
It also results in a change of beta*, a slope and dispersion at he IP :
like at IP1 betx = 85.179 m , alfx = 0.00349 , Dx = -0.0484 m

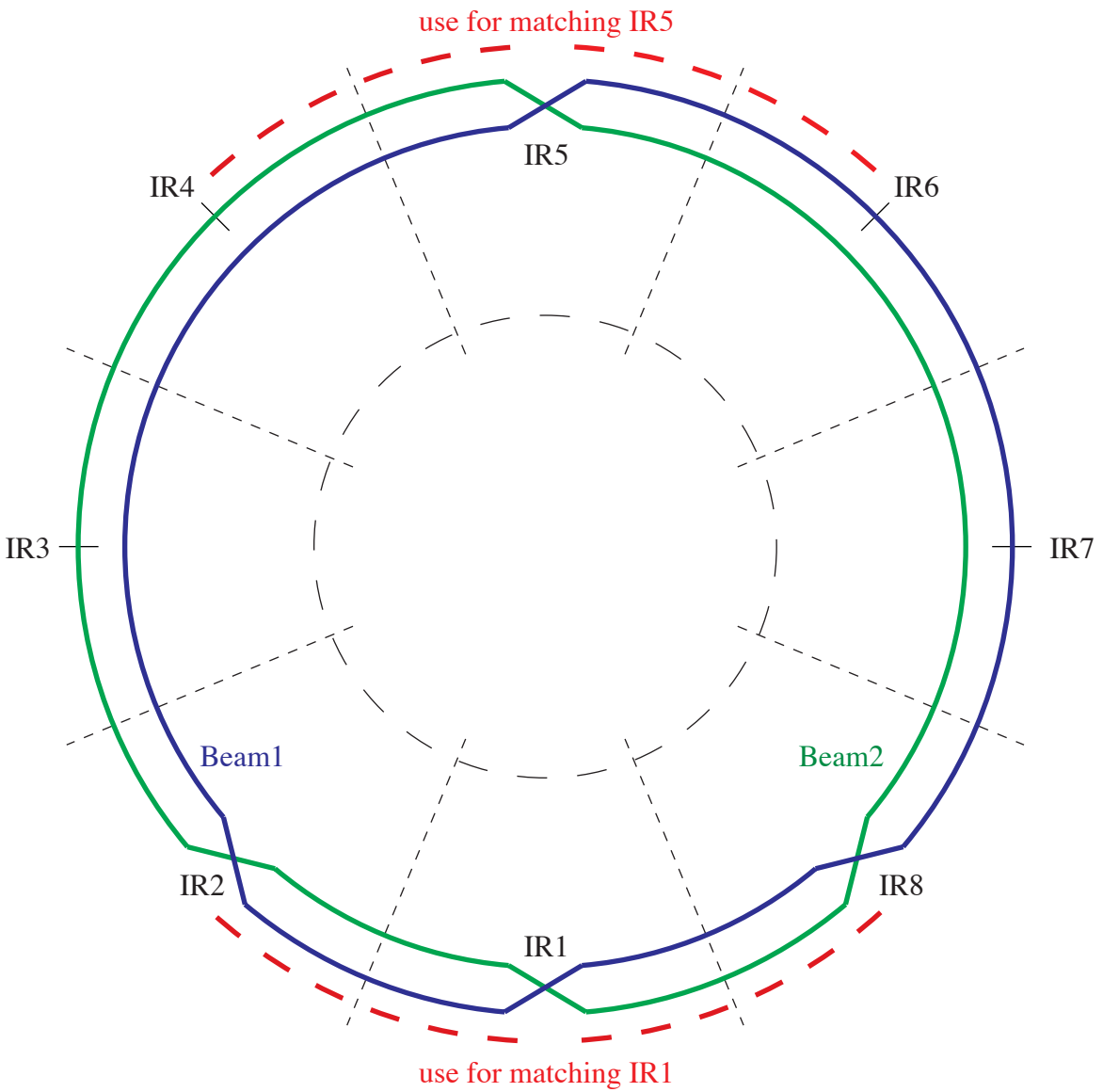


New : tune re-match using adjacent octants

Idea : correct the β-beat in a more local rematching using the adjacent octants

the main quads and trims
can be powered by octant

Just use
IP1 : kqd.a81 kqd.a12,
IP5 : kqd.a45, kqd.a56



Current status

One trial (H.B.) looking at IP5 alone :

correct 90m tune with kqd.a45 , kqf.a45 and kqd.a56 := kqd.a45; kqf.a56 := kqf.a45;
and β-beating with

kqt12.r4, kqt13.r4
IP5 Q6-Q13 l,r
kqt13.l6, kqt12.l6b1

Result : back to 90m, ax, Dx = 0 at IP5 - and small β-beat in adjacent arcs only

Solution by Thys for IP1 + IP5 : /afs/cern.ch/user/r/riss/mad/LHC/v6.503/hibeta

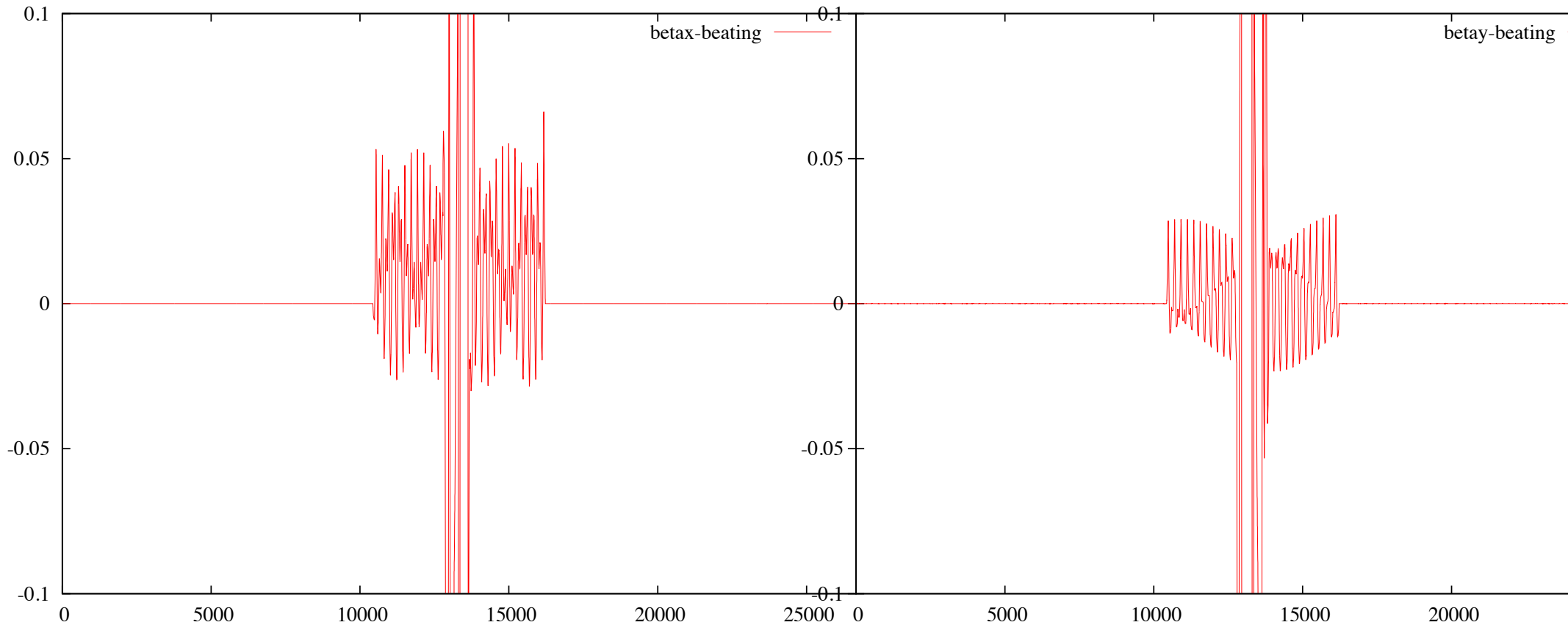
Getting betas and dispersion right at all IPs with 90m in IP1 & 5.

Preliminary conclusion :
the β-beating induced by changing the main quads can be corrected - to restore β* and cancel the beating in the rest of the machine

Plans : do some more checks and minimize the changes - then consider to use this later for the actual 90 m physics operation.

Backup Slides

β-beating using my rematch for IP5



modified around IP5, otherwise no beating

βs using Thys Risselada's solution

Solution with modified βs in IRs and around IP5, no beating in other arcs