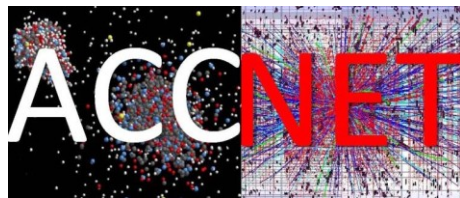


# Machine Development Plans at the LHC

Frank Zimmermann

EuCARD-AccNet-EuroLumi workshop on  
Optics Measurement, Correction and Modeling  
CERN, 22 June 2011

Thanks to Ralph Assmann & Giulia Papotti











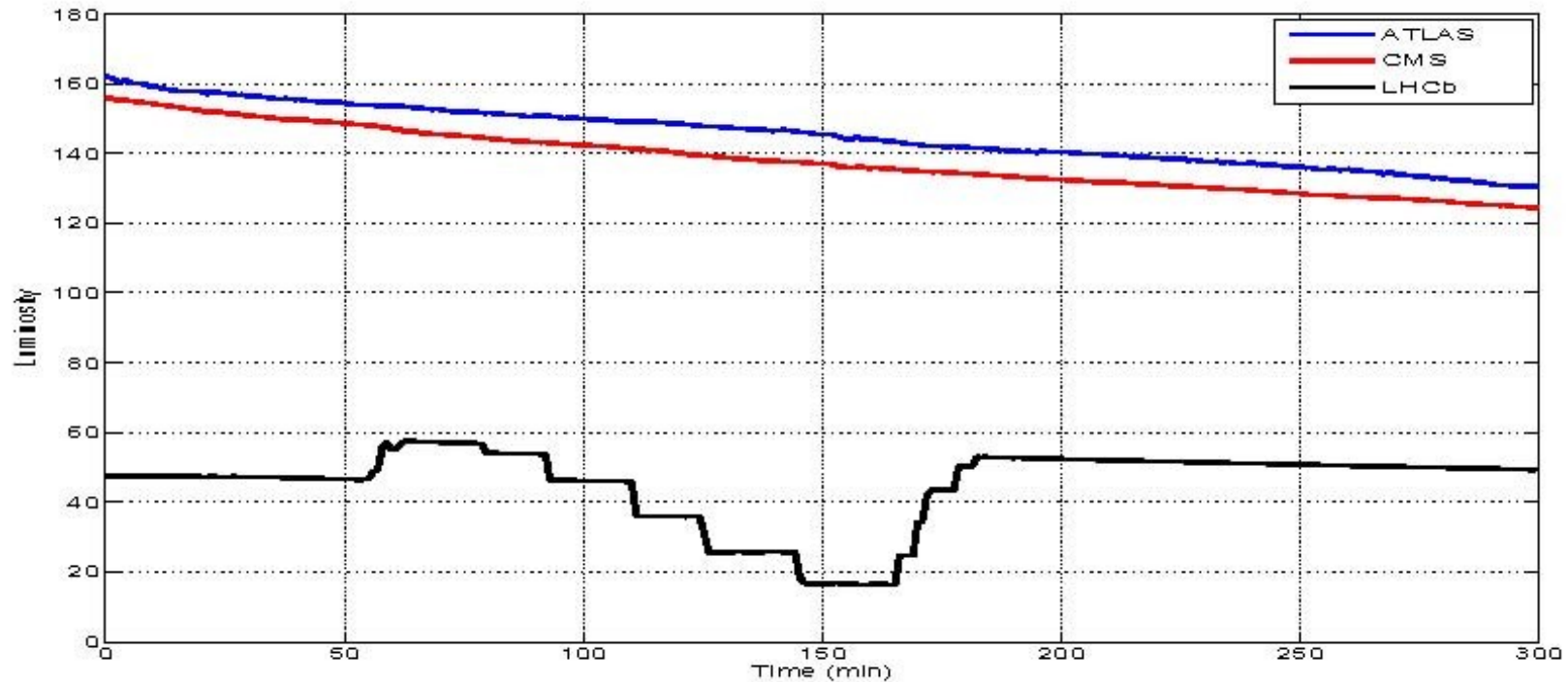
# contents

- precursor – luminosity leveling
- LHC MD organization & schedule
- studies performed so far
- highlight results
- future plan



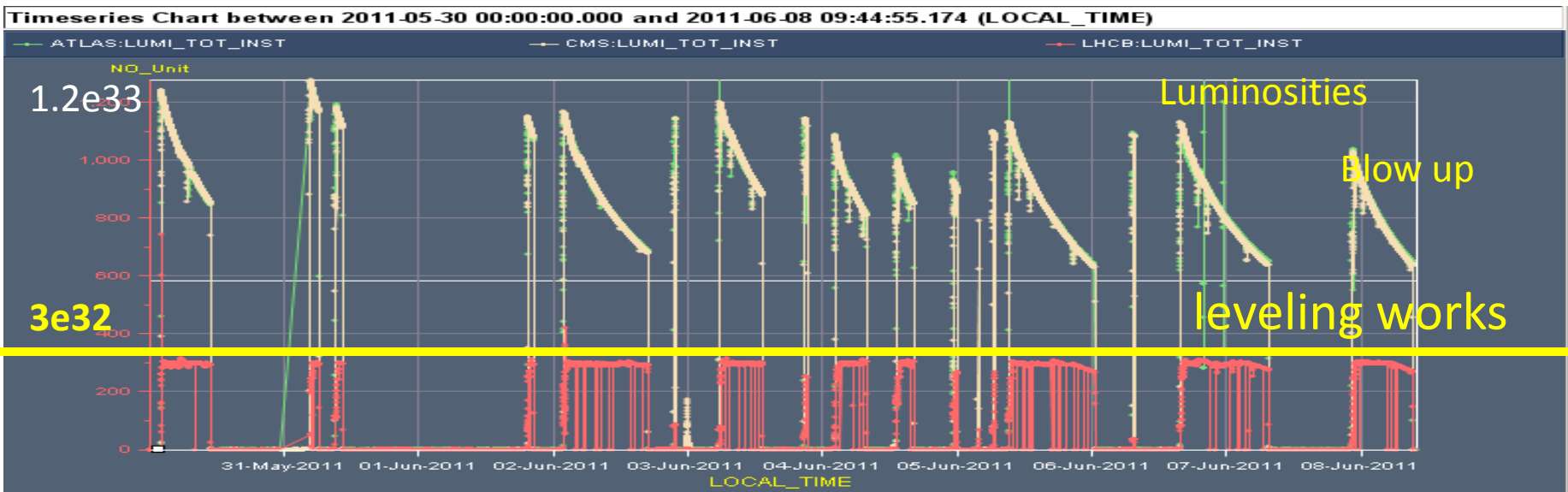
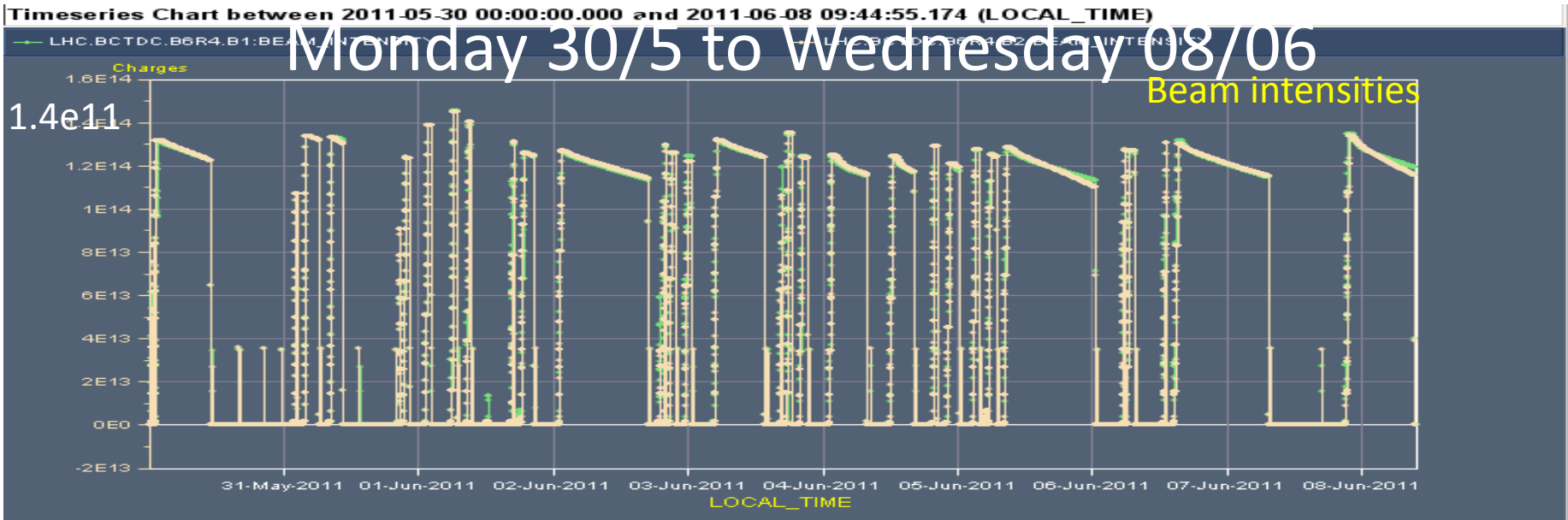
# offset leveling test

W. Herr et al,  
March 2011



conclusion: the luminosity can be successfully leveled using transverse offsets between 0 and a few  $\sigma$  (here at IP8) without significant effects on the beam or the performance of the other experiments (IP1&5)

# routine leveling in IP2 & 8!



LHC

0

Wk 3

08/06/2011

# LHC: days for physics in 2011

Phase	Days	Comment
Commissioning	21	
Scrubbing run	10	
5 MDs	22	4.5 days per slot [Now 4x5 days + 2 days floating]
6 Technical stops	30	5 days (4 days TS plus 1 day recovery with beam)
Special requests	10	TOTEM/ALPHA Intermediate energy run Luminosity scans
Intensity ramp up	~39	
<b>Total high intensity</b>	<b>~130</b>	
Ion setup	4	
Ion physics	24	
<b>TOTAL</b>	<b>290</b>	

# 2011 LHC Schedule

Approved by the Research Board, December 2010

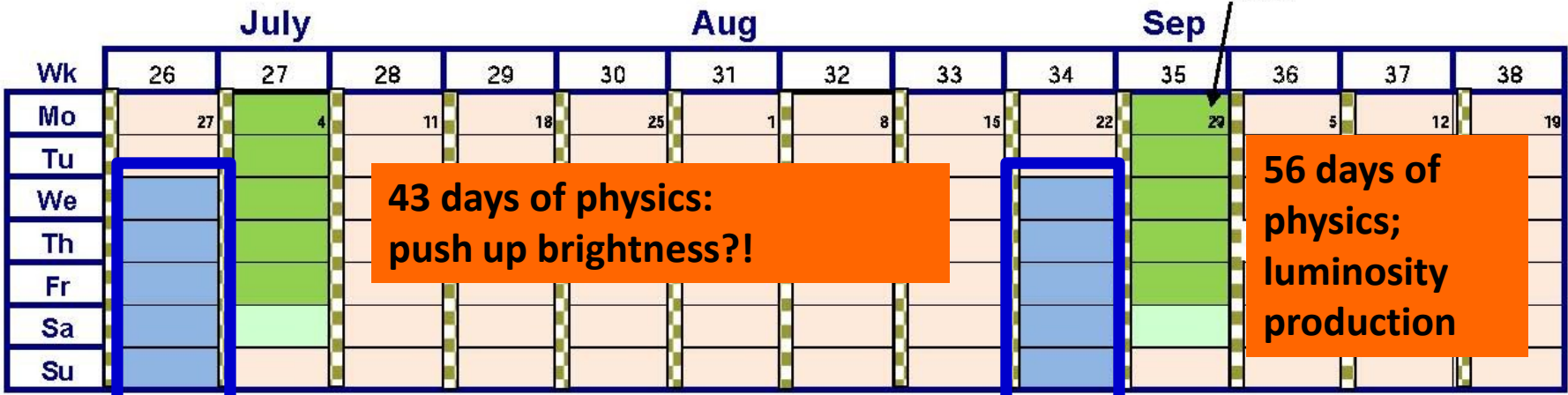
	Jan			Feb			Close ring		Re-commissioning with beam		Mar			Intermediate energy run	
Wk	52	1	2	3	4	5	6	7	8	9	10	11	12		
Mo		3	10	17	24	31	7	14	21	28	7	14	21		
Tu															
We															
Th		Technical stop			Hardware commissioning										
Fr															
Sa	1														
Su															

	Apr			May					June					
Wk	13	14	15	16	17	18	19	20	21	22	23	24	25	
Mo	28	4	11	18	Easter	2	9	16	23	30	6	Whit	13	20
Tu														
We														
Th														
Fr					G. Friday	MD				Ascension	1st May comp.			
Sa														
Su					1st May									

1<sup>st</sup> LHC MD block; bb studies, ATS optics,...

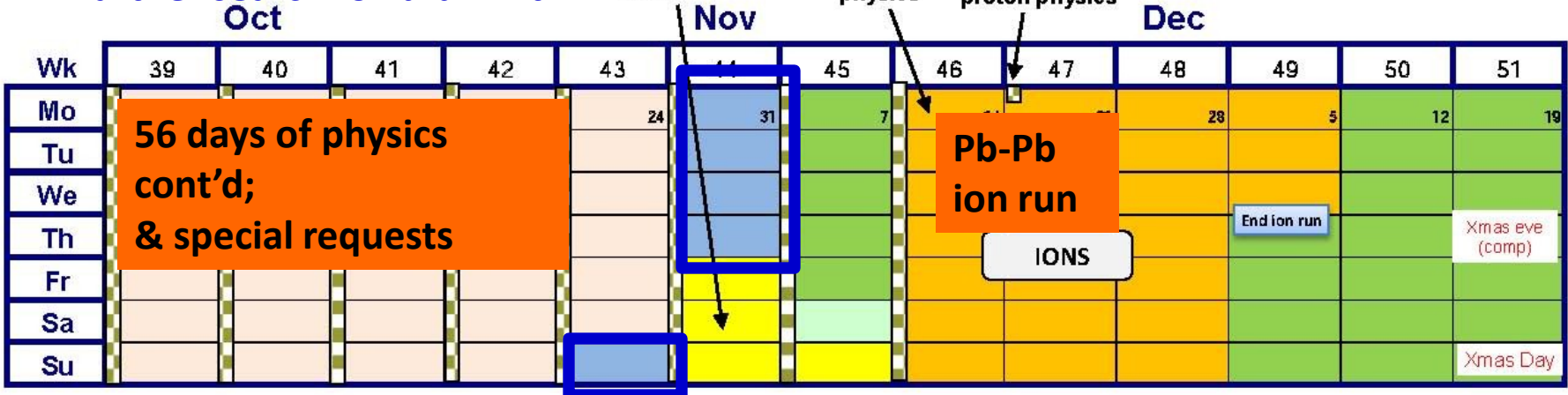


# LHC MD blocks



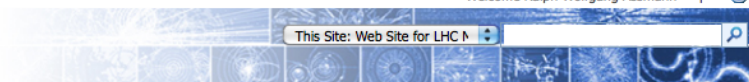
1<sup>st</sup> injection of 25-ns beam;  
further search for b-b limit  
Oct

quality 25-ns beam  
in terms of e-cloud  
Dec



- Technical Stop
- Recommissioning with beam
- Machine development
- Ion run
- Ion setup

- Injectors - proton physics
- Special runs (TOTEM etc.) to be scheduled



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### Announcements

**5th LSWG on 2011.06.07** ↑ NEW 31/05/2011 02:57 PM  
by Giulia Papotti

The 5th meeting of the LHC Studies Working Group will take place in 874-1-011 on Tuesday 7th June at 15:30.  
The meeting will be devoted to the preliminary schedule of the second MD block, together with finishing the discussion on the results of the...

**4th LSWG on 2011.05.24** 18/05/2011 10:00 AM  
by Giulia Papotti

The 4th meeting of the LHC Studies Working Group will take place in 874-1-011 on Tuesday 24th May at 15:30.  
The meeting will be devoted to discussing the results of the first MD block and the preliminary schedule of the second MD block.

**3rd LSWG on 2011.04.19** 16/05/2011 10:31 AM  
by Giulia Papotti

The 3rd meeting of the LHC Studies Working Group (LSWG) took place on Tuesday 19th April at 15:30.  
The meeting was devoted to discussing the schedule of the 1st LHC MD (May 5th-8th).

**schedule for 1st LHC MD** 04/05/2011 05:36 PM  
by Giulia Papotti

The schedule for the 1st LHC MD block was presented at the LMC (2011.04.20) and approved.  
The presentation can be found in Shared Documents, 2011 Presentations, FOM\_20110503\_MD1.pptx

(link: [https://espace.cern.ch/lhc-md/Shared%20Documents/2011%20Presentations/FOM\\_20110503\\_MD1.pptx](https://espace.cern.ch/lhc-md/Shared%20Documents/2011%20Presentations/FOM_20110503_MD1.pptx))...

**2nd LSWG on 2011.04.05** 01/04/2011 07:31 PM  
by Giulia Papotti

The next meeting of the LHC Studies Working Group (LSWG) will take place in 874-1-011 on Tuesday 5th April at 15:30.

#### Agenda:

- Riccardo overview of ATS MDs;
- Werner overview of beam-beam MDs;
- Philippe + Elena overview of RF MDs;
- Chiara overview...



### Contacts

Last Name	First Name	Business Phone	E-mail Address
Assmann	Ralph		ralph.assmann@cern.ch
Papotti	Giulia		giulia.papotti@cern.ch
Zimmermann	Frank		frank.zimmermann@cern.ch

[Add new item](#)

### Links

- [LMC Committee](#)

# LHC MDs coordinated by Ralph Assmann, Giulia Papotti, Frank Zimmermann

05/11/2011 12:00 AM LHC MD #3

[Add new event](#)

- [LHC Page 1](#)
- [LHC Coordination](#)
- [elogbook](#)
- [LHC Beam Operation Committee](#)

[Add new link](#)





# MD Requests Per Category (after combining and cutting)

	Time [h]
Beam-beam MD's	144
RF MD's	110
Optics MD's	114
IR MD's	32
e-cloud MD's	72
Injection and injection protection	58
Collimation	64
Passive Protection Stored Beam	16
Impedance	48
R2E	8
Instrumentation MD's	23
Ion MD's	26
Magnet MD's	8
Total	723



### MPS class A : MDs with **setup beams**

- Probe bunch ( $<2e10$ ) – automatically approved.
  - But people should be aware that at 3.5 TeV such beams can quench. EiC's should be able to set some limits.
  - **For quench tests – OK needed from MP3.**
- Setup beam – automatically approved.
  - But people should be aware that a quench could occur at any energy. EiC's should be able to set some limits.
  - **For quench tests – OK needed from MP3.**





# Unsafe beams

---

## General guidelines - **MD request with unsafe beams** :

- MD request should reconsider if the MD could not be done with safe beams.
  - Quite a number of MDs require intensities within factor 2-3 of SBF limit.
  - Some require beams within the 'Relaxed' and 'Very relaxed' SBF reach (3.5 TeV) . Note this is often related to the need for a nominal bunch.



# MDs : MPS class B

---

MPS class B

**MPS class B : MD request with unsafe beams at end-of-fill or with physics conditions (no changes of optics or orbit) – any energy.**

- To be approved on a case by case by MPP (or rMPP ?).





### MPS class C : MD request with unsafe beams involving changes of orbit or optics.

- Safe and controlled machine conditions must first be established with Setup Beams.
  - Orbit interlocks may have to be adapted for injection of unsafe beam.
  - Collimators may have to be moved in some/all phases.
- If orbit/optics changes at 3.5 TeV:
  - (Orbit expert must define the reference orbit for OFB).
  - Test ramp with probe.
  - (Orbit interlocks must be adapted for ramp & squeeze).
  - Test ramp with 1-2 nominal bunches (for collimator setup). Loss maps and asynch dump test.
  - Once qualified, intensity to be approved by MPP (or rMPP?).



# MDs : MPS class D

MPS class D

MPS class D : MD request with unsafe beams involving new 'machine territory' – drastic changes of the optics, WP...

- Such MDs will be **downgraded** to Setup Beam unless full failure analysis is performed.
  - If failure analysis → to class C.

# MDs vs MPS

Time	MD	Requester	Energy [GeV]	Max Intensity	Theme	MPP Class	EIC / Support
06:00	3.5 TeV: <u>Tune scan</u> – beam-beam optimization, lifetime and losses	W.Herr, T.Pieloni, R.Assmann, R.Steinhausen	450, 3500	1.00E+13	LHC nominal + HL-LHC	B	Walter / Giulia
12:00	Ramp down, cycle, test ATS optics w/o beam	S.Fartoukh					
16:00	0.45 TeV: <u>BPM offset</u> determination for triplet BPMs	J.Wenninger	450	1.00E+11	LHC nominal	A	Alick / Jorg
00:00	0.45 TeV: <u>Alignment TCDO/TDI</u> and injection losses (other beam)	W.Bartmann, C.Bracco	450	1.20E+11	Commissioning Leftover	A	Mirko
08:00	0.45 à 3.5 TeV: <u>RF single-bunch instabilities</u>	E.Shaposhnikova	450, 3500	9x1E11	LHC nominal	A+	Walter / Giulia
14:00	Ramp down, cycle.						
16:00	0.45 à 3.5 TeV: <u>90 m optics</u> unsqueeze.	H.Burkhardt	3500	1.00E+10	Commissioning Leftover	A	Alick / Stefano + Jorg
00:00	Ramp down, cycle						
02:00	0.45 à 3.5 TeV: <u>Cross calibration</u> of BSRT/WS/BGI	F.Roncarolo	450, 3500	2 x 24 x 1E11	LHC nominal	B	Reyes / Verena
10:00	Ramp down, cycle						
12:00	Injection and ramp with collision tunes + ramp down, cycle	R. Steinhausen, R. Calaga, R.Tomas	450, 3500	1.00E+11	LHC nominal	A	Stefano
20:00	0.45 TeV: <u>Beam-beam limit</u>	W.Herr, T.Pieloni	450	4x1.7E11	LHC nominal	A+	Alick / Giulia + Reyes
04:00	Ramp down, cycle						
06:00	0.45 TeV (maybe 3.5 TeV): Investigation on <u>CODs</u>	N.Catalan	450	1.00E+11	LHC nominal	A	Alick
12:00	0.45 à 3.5 TeV: <u>ATS</u> + rampdown	S. Fartoukh	450, 3500	1.00E+10	LHC nominal + HL-LHC	A	Reyes / Jorg + Stefano
20:00	0.45 – 3.5 TeV: <u>Nominal collimation</u> , single bunch tune shift	R.Assmann, B.Salvant, N.Mounet, E.Metral	3500	3.00E+11	LHC nominal + HL-LHC	B	Stefano
04:00	Ramp down, cycle						
06:00	0.45 TeV: <u>RF multi-bunch instabilities</u>	E.Shaposhnikova	450	4 x 36 x 1E11	LHC nominal	B	Alick / Giulia
10:00	0.45 : <u>Coupled-bunch instability</u> rise times	N.Mounet, E.Metral, COLL team	3500	2-3 x 36 x 1E11	LHC nominal + HL-LHC	C	Reyes / Jorg
18:00	Ramp down, cycle						
20:00	0.45 à 3.5 TeV: <u>Quench test</u> in the DS of IR7	S.Redaeli, R.Assmann	3500	1.00E+13	LHC nominal	C	Stefano / Mirko

G.Papotti: 88th LMC Meeting held on 20 April 2011

MPS classification of MDs useful -> Triggers discussion and follow-up work  
**Detailed program for class C/D requests** (unsafe beam + non-nominal machine),  
including **necessary MPS modifications** very useful to guarantee a smooth and  
successful MD (**short EDMS note, approval tbd before MD**)



# 1<sup>st</sup> LHC MD Period Started 4 May 2011

LHC Page1      Fill: 1757      E: 0 GeV      04-05-2011 17:26:50

## MACHINE DEVELOPMENT: CYCLING

Energy: 0 GeV

### Post Mortem Information

PM event ID: Tue May 03 14:03:36 CEST 2011  
 PM event category: PROTECTION\_DUMP  
 PM event classification: MULTIPLE\_SYSTEM\_DUMP  
 PM BIS Analysis result: First USR\_PERMIT change: Ch 12-PIC\_MSK: A T -> F on CIB.USC55.L5.B1  
 PM comment:

### Comments 04-05-2011 16:47:48 :

Precycling ...  
 Will change to Accelerator mode =  
 Machine Development at 5pm

### BIS status and SMP flags

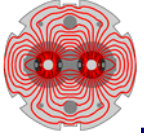
B1      B2

Link Status of Beam Permits	true	true
Global Beam Permit	false	false
Setup Beam	true	true
Beam Presence	false	false
Moveable Devices Allowed In	false	false
Stable Beams	false	false

AFS: 50ns\_109b\_91\_12\_90\_12bpi10inj

PM Status B1    **ENABLED**    PM Status B2    **ENABLED**





# Getting busy...





# MD1 Wed – Sat

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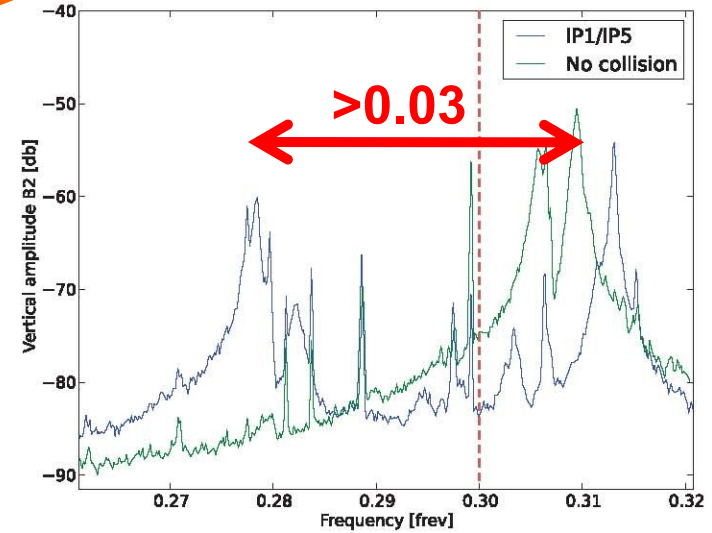
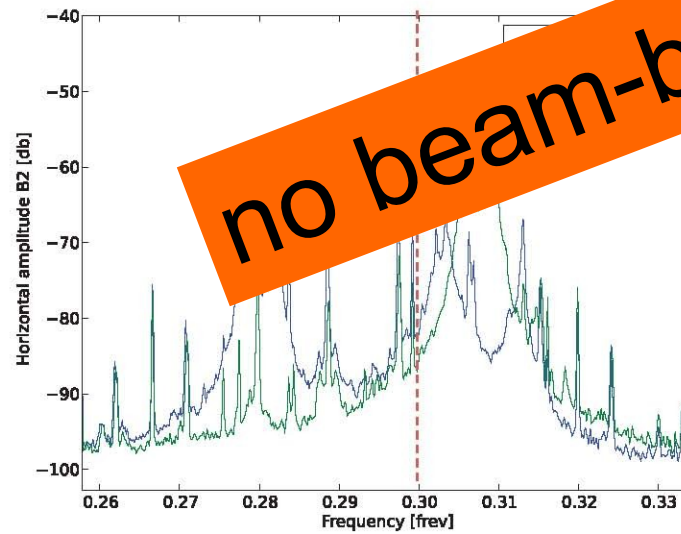
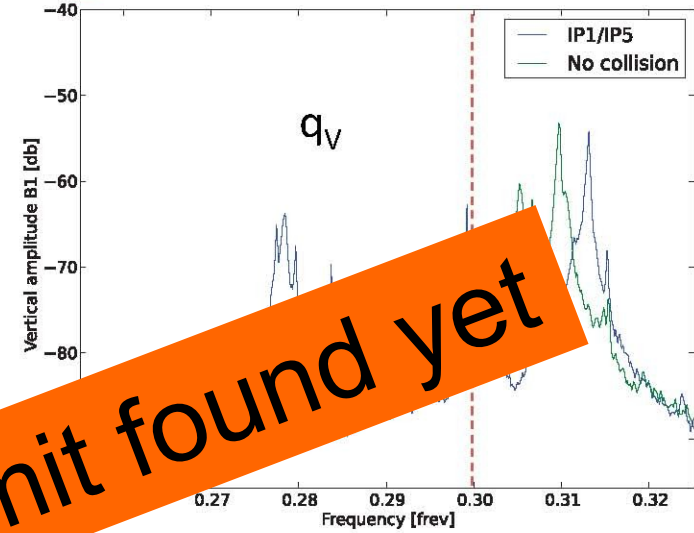
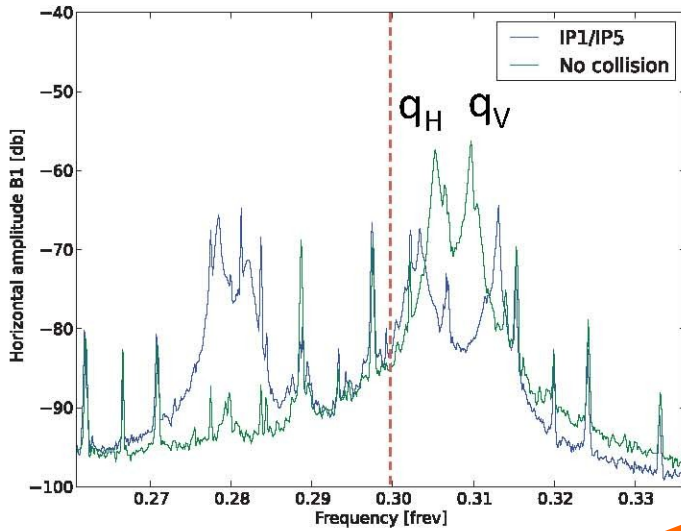
Day	Time	MD
Wed	06:00	UPS repair, ATS optics checks w/o beam
	12:00	Cycle, test ATS optics w/o beam
	16:00	0.45 TeV: <u>BPM offset</u> determination for triplet BPMs
Thu	00:00	0.45 TeV: <u>Alignment TCDQ/TDI</u> and injection losses (other beam)
	08:00	0.45 → 3.5 TeV: <u>RF single-bunch instabilities</u>
	14:00	Ramp down, cycle.
	16:00	0.45 → 3.5 TeV: <u>90 m optics</u> unsqueeze
Fri	00:00	Ramp down, cycle
	02:00	0.45 → 3.5 TeV: <u>Cross calibration</u> of BSRT/WS/BGI
	10:00	Ramp down, cycle
	12:00	0.45 TeV: Collision tunes at injection + ramp down, cycle
	20:00	0.45 TeV: <u>Beam-beam limit</u>
Sat	04:00	0.45 TeV: Investigation on <u>CODs</u>



# MD1 Sat – Mon

Day	Time	MD
Sat	10:00	<b>0.45 TeV: <u>ATS (including cycle to new injection settings)</u></b>
	20:00	<b>0.45 – 3.5 TeV: <u>Nominal collimation</u>, single bunch tune shift</b>
	04:00	<b>Ramp down, cycle</b>
Sun	06:00	<b>0.45 TeV: <u>RF multi-bunch instabilities</u></b>
	10:00	<b>0.45 → 3.5 TeV: <u>Coupled-bunch instability</u> rise times</b>
	18:00	<b>Ramp down, cycle</b>
	20:00	<b>0.45 → 3.5 TeV: <u>Quench test</u> in the DS of IR7</b>
Mon	06:00	<b>Technical Stop</b>
Lost	6h	<b>3.5 TeV: <u>Tune scan</u> – beam-beam optimization, lifetime, losses</b>

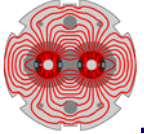
# tune spectra colliding IP1 & IP5



no beam-beam limit found yet

beam parameters investigated **beyond nominal LHC** ( $N_b = 1.8-1.95 \times 10^{11}$ ,  $\varepsilon = 1.2-1.4 \mu\text{m}$ ); no significant beam losses nor emittance effects observed with linear head-on parameter of  $\xi_{bb} = 0.02$  /IP and  $\xi_{bb} = 0.034$  (total) – **more than 3x above design!**

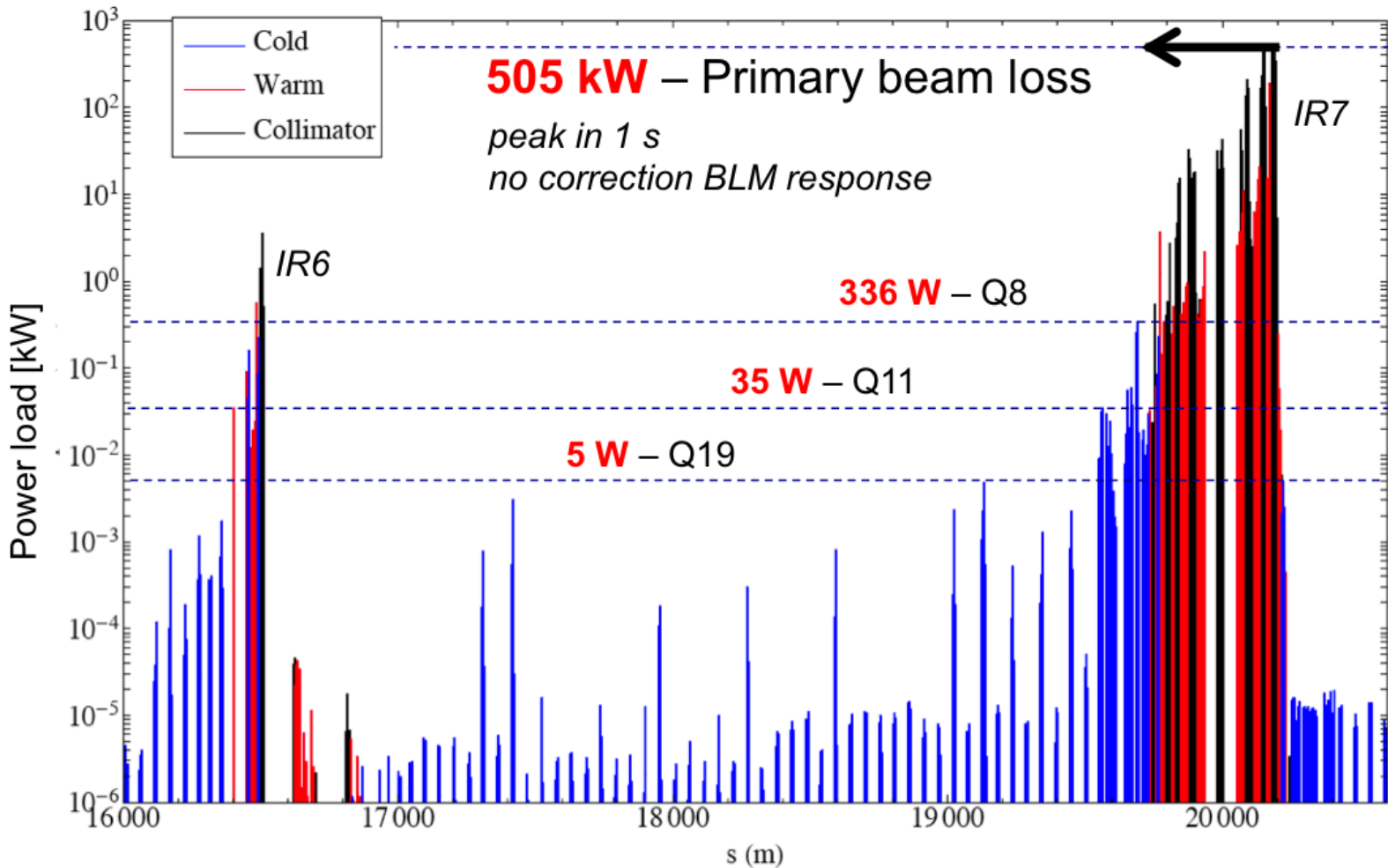




# dispersion suppressor quench



intentional large loss on primary collimator to see margins

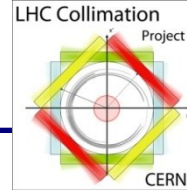


3.5 TeV operational collimator settings (not best possible)

**No quench of any magnet!**

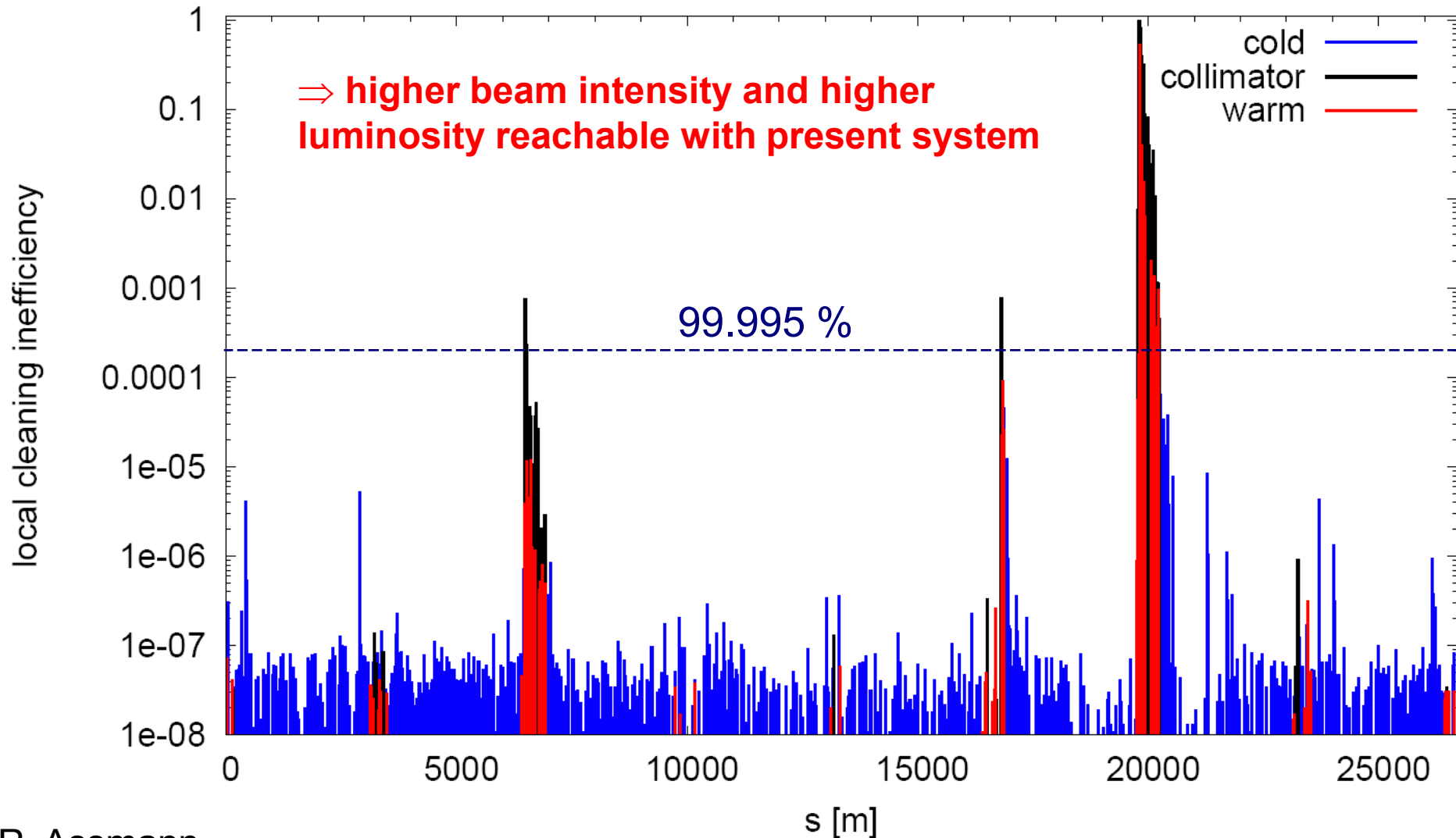


# tighter collimation settings



## cleaning efficiency

betatron losses B1 3500GeV hor norm F (2011.05.08, 01:00:47)

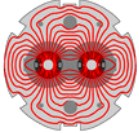




# tighter collimation settings

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	<b>TCP IR7</b>	<b>TCSG IR7</b>	<b>TCLA IR7</b>	<b>TCSG IR6</b>	<b>TCDQ IR6</b>
<b>2010 settings</b>	<i>5.7</i>	<i>8.5</i>	<i>17.7</i>	<i>9.3</i>	<i>10. - 10.6</i>
<b>Nominal</b>	<i>5.7</i>	<i>6.7</i>	<i>9.7</i>	<i>7.2</i>	<i>7.7</i>
<b>Tight B1</b>	<i>4.0</i>	<i>6.0</i>	<i>8.0</i>	<i>7.0</i>	<i>7.5</i>
<b>Tight B2</b>	<i>4.0</i>	<i>5.0</i>	<i>7.2</i>	<i>6.2</i>	<i>6.7</i>

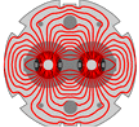


# K-Modulation (J. Wenninger, K. Fuchsberger, T. Baer)

---

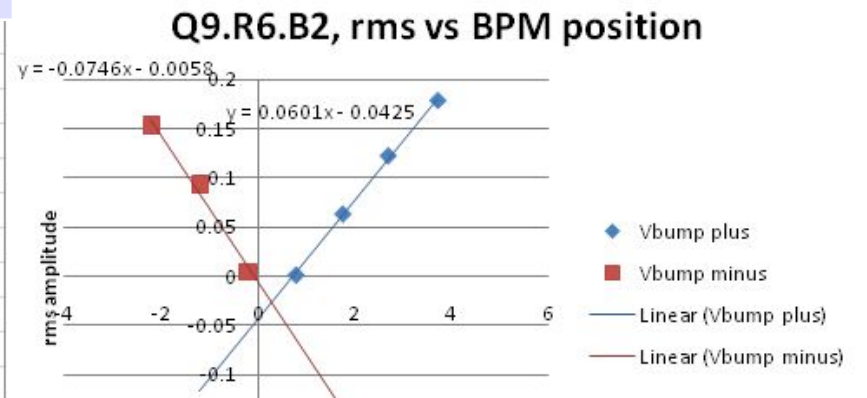
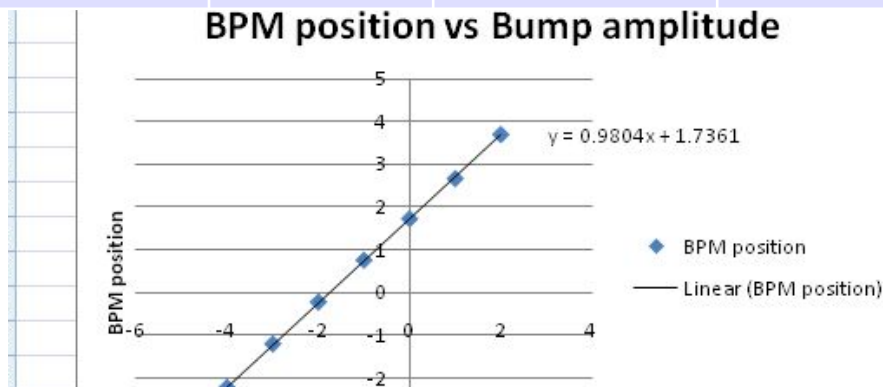
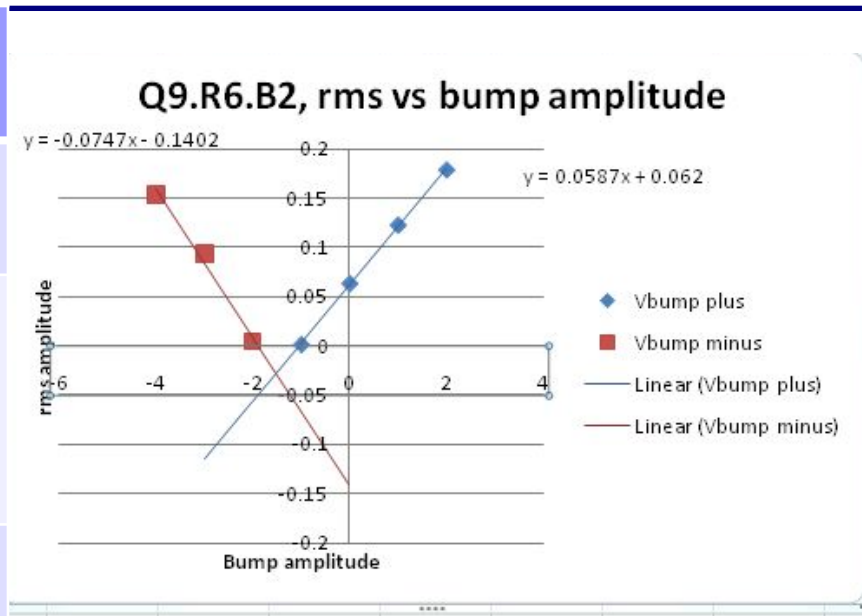
- MD was successful
  - lot's of good data was collected.
  - about 3 1/2 hours of efficient MD time.
- Took data for four quadrupoles:
  - Q6.L5B2, Q6.L7B2, Q9.R6B, QX1.L5
- Preliminary analysis was done for Q6.L5B2 and Q9.R6B2 vertical:
  - For Q6.L5B2 we found a very good alignment of the BPM with the quadrupole, while we found that the beam was off-center by -0.2mm, as indicated by the BPM.
  - The preliminary analysis for Q9.R6B2 indicates an **offset between quadrupole and BPM of 0.2mm**, while the **beam was really off-center by about 1.5 mm!**





# K-Modulation Result

Quadrupole	BPM	H Offset	V Offset
Q.6L5.B2	BPMR.6 L5.B2	$0.93 \pm 0.01$ mm	$0.024 \pm 0.000$ mm
Q.6L7.B2	BPMR.6 L7.B2 BPMWC .6L7.B2	$-1.18 \pm 0.01$ mm	---
Q.9R6.B2	BPM.9R 6.B2	$0.23 \pm 0.00$ mm	---



- Very clean rms signals
- Position can be determined at least by  $\pm 10 \mu\text{m}$ .
- Possible optimization:  
 Automatization (trim bump, start oscillation, acquire, analyse).



# 90 m Unsqueeze (Helmut Burkhardt et al)

---

- Demonstrate feasibility of simultaneous un-squeeze of IPs 1 & 5 with external tune compensation using main quads.
  - Orbit and tune feedbacks were kept ON for all the beta\* changes.
  - Coupling measurements, corrections, incorporated into functions.
  - Chromaticity & orbit adjusted (real-time trims into the LSA ).
- Everything worked as expected
- Beta-beat measurements with AC dipole carried out at flat-top, at 30m and (more extensively) at 90m.
- Primary collimators were closed to 10 sigma's as a safety measure prior to the AC dipole measurements.
- At flattop local & global coupling corrections: local jumps in IP1,IP2,IP5 and IP8 are reduced.
- Beta-beat beam1H is ~25% and ~20% for beam1V at 90m.
- Beta-beat for beam2 is ~30% at 90m.



# 90 m: Intensities and Beta\*



Beta\* IP1 [m]

87.7

Beta\* IP2 [m]

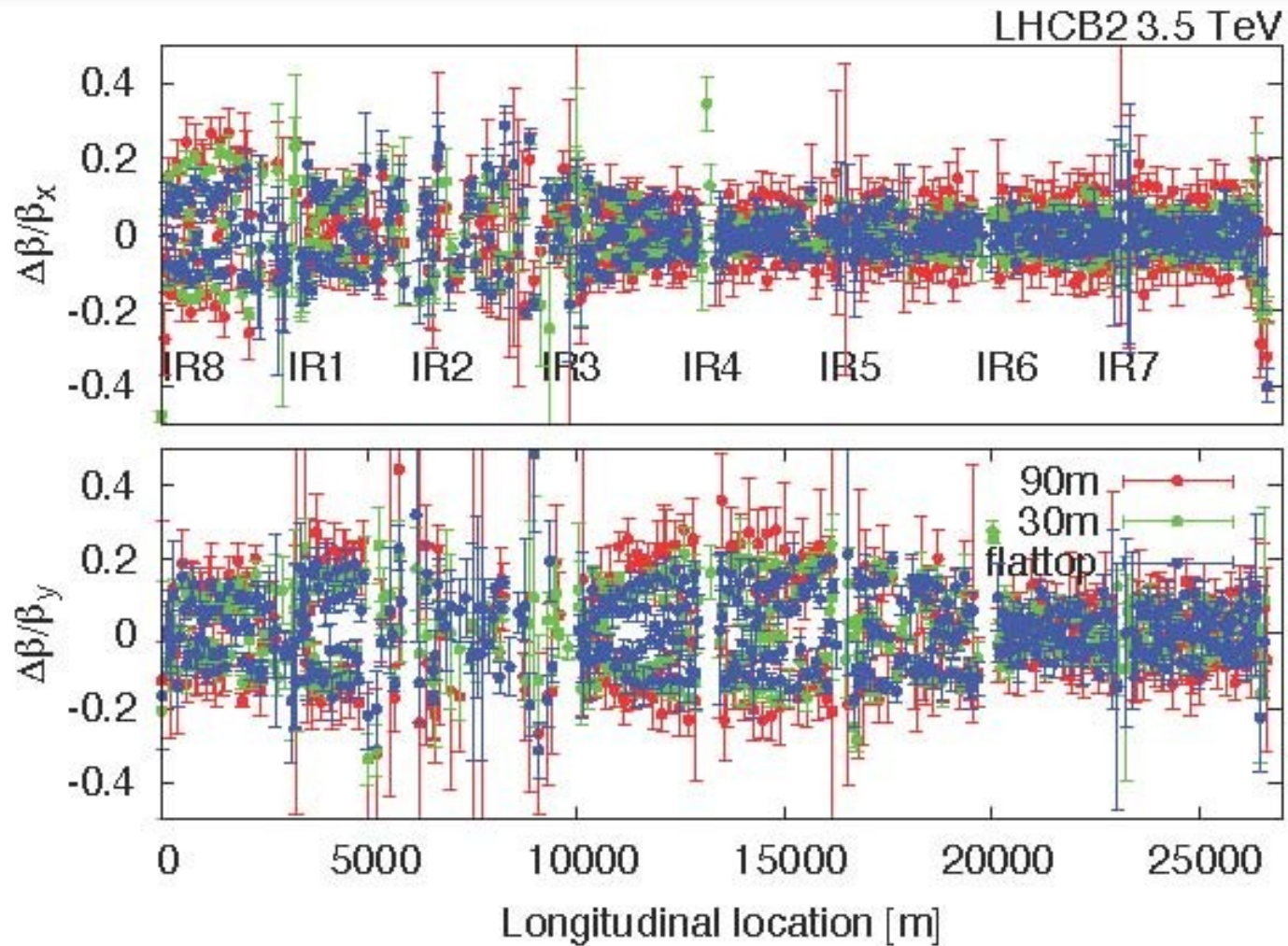
10.0

Beta\* IP5 [m]

89.6

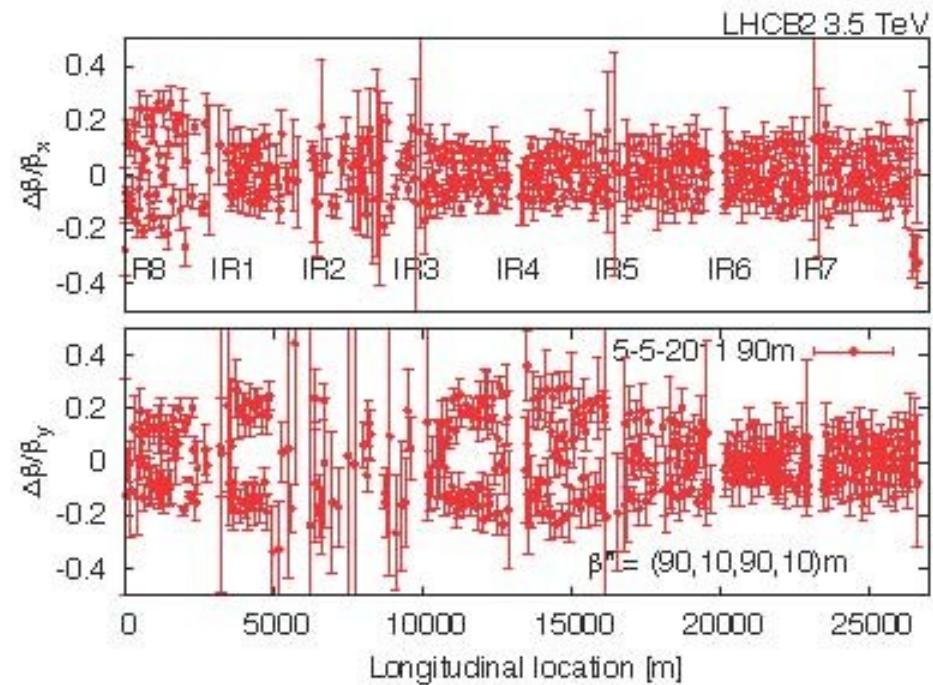
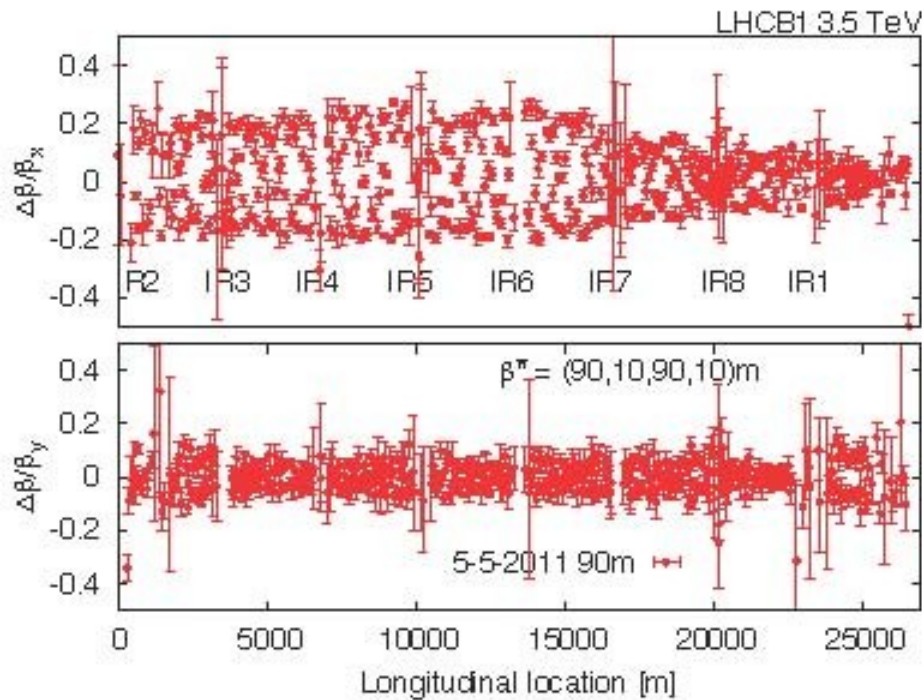
Beta\* IP8 [m]

10.0



Similar at 11, 30 and 90 m. The increase in  $\beta$ -beat by the un-squeeze is small





**b1 : 25% in x , 20 % in y**

**b2 : 30% in x , 30 % in y** (poor BPM resolution in 2-3)

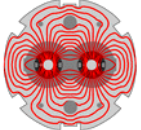
**further measurements : coupling + dispersion -- see MD Note**



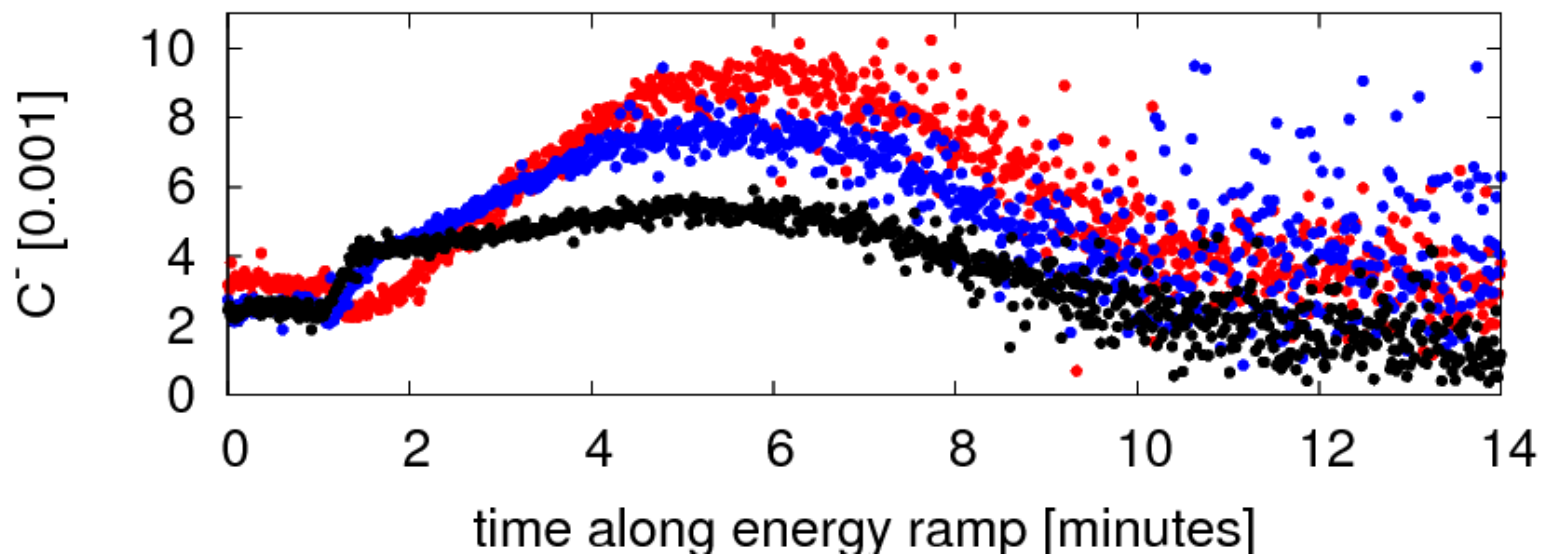
# Collision tunes at injection (R. Tomas et al)

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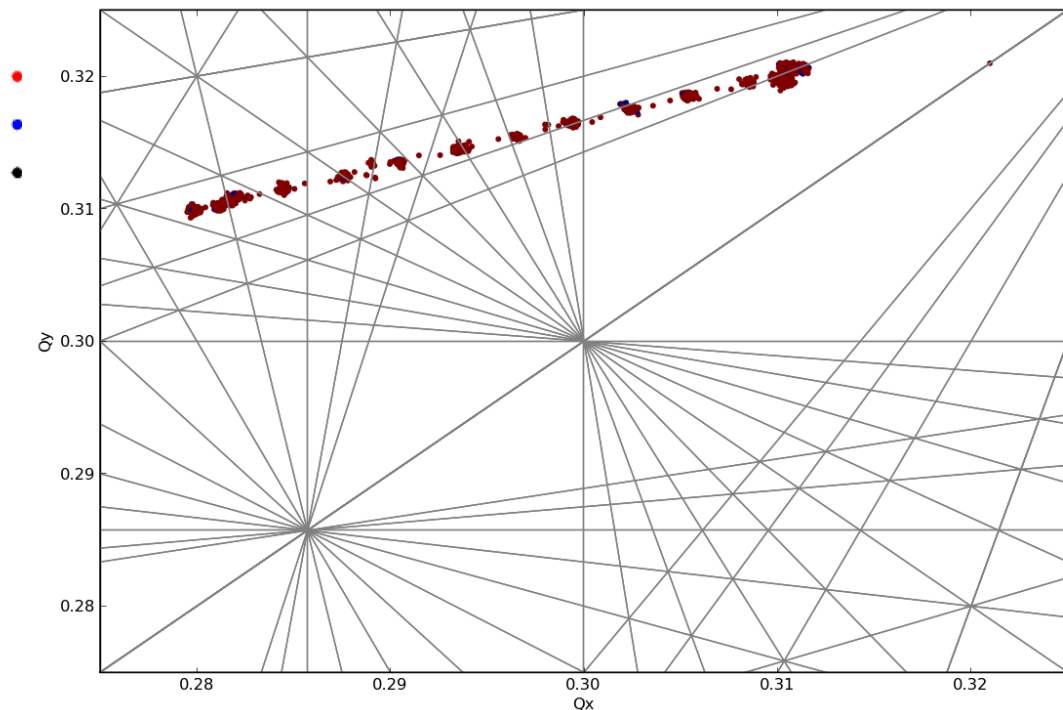
- **Local coupling** corrections implemented.
- **Nominal tunes (0.28, 0.31) ramp** for further coupling measurement and correction along the ramp with pilot bunch. Fine.
- **Tune scan from nominal to collision tunes (0.31, 0.32) at injection.** No effect on lifetime. Ramped with collision tunes.
- A second ramp: coupling corrections from ramp 1. **Improvement of about factor 2 observed in C-.** Coupling correction is valid for nominal injection tunes too.
- **3rd ramp nominal bunch**, lost half intensity at start of the ramp: **chromaticity could be negative.** Vertical oscillations 1 minute after start of ramp. Transverse dampers were off.
- **No difference in beta-beat for collision and injection tunes.**
- Small difference observed in the beta-beat for injection compared with 4-4-2011 (for both beams).



# Coupling correction & Tune Scan

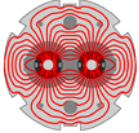


Injection tunes  
Injection tunes + coupling correction  
Collision tunes + coupling correction





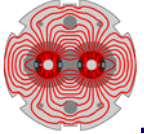
- New injection optics (ATS optics) tested and ramped successfully up to 3.5 TeV
  - crossing scheme off (TCT, TDI, TCLI opened with probe beam)
  - successfull inject and dump test
  - damper new settings OK (with new phases of the ATS optics)
  - no emittance blow up during the ramp
  - **new integer tunes measured at injection 62/60 (instead of 64/59)**
  - CO, tune, coupling, chromaticity measured and corrected at injection and flat top
    - new tune, chroma and coupling knobs operational
    - orbit and tune feed-back successfull during the ramp.
  - beta-beat measurement
    - 30% at injection, 10-15% at flat top w/o any specific correction
  - H and V dispersion measured
    - H: +/- 50 cm (compared to 2 m) for Dx at injection, +/- 20 cm at flat top.
    - V: 15-20 cm peak at injection, about 10 cm at flat top.



## ■ Next steps:

- inject and ramp with crossing scheme (170  $\mu$ rad, 2 mm in all IP's kept constant during the ramp).
- pre-squeeze to  $b_{\text{star}}=1.2$  m w/o crossing scheme.
- measure/correct the off-momentum beta-beating, and non-linear chromaticity.
- switch on the crossing scheme at  $b_{\text{star}}=1.2$  m and measure/correct the spurious dispersion.



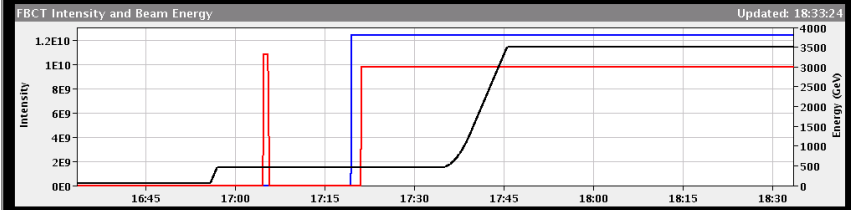


# ATS New Injection Orbit – Ramp, Dispersion

LHC Page1      Fill: 1769      E: 3500 GeV      07-05-2011 18:33:24

## MACHINE DEVELOPMENT: FLAT TOP

Energy: 3500 GeV    I(B1): 1.22e+10    I(B2): 7.82e+09



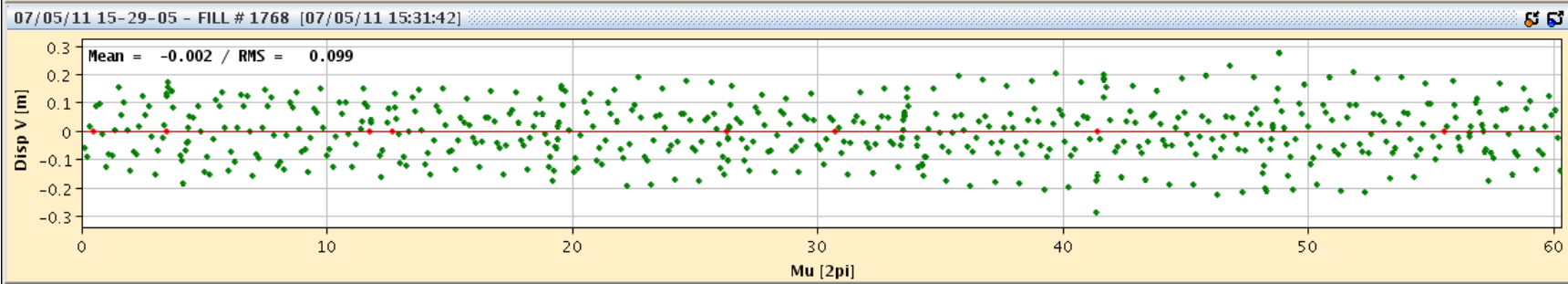
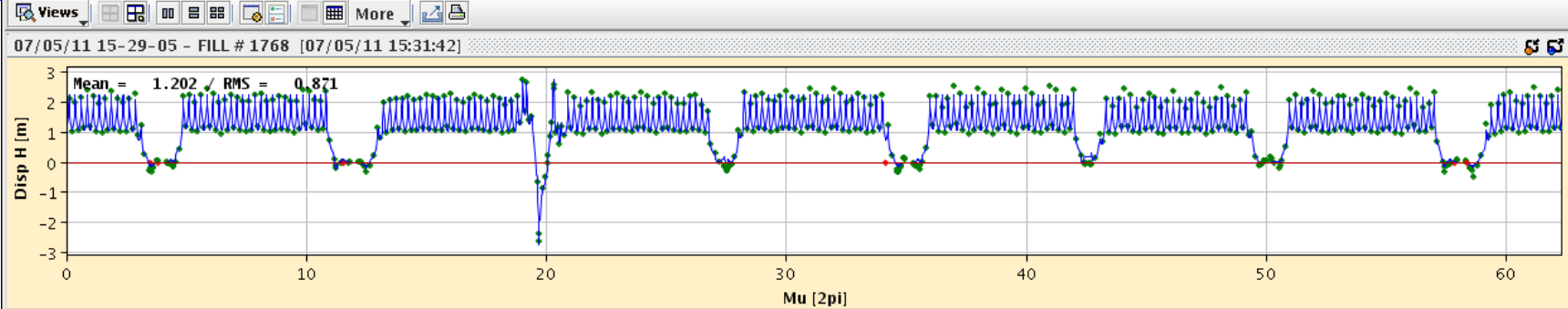
Excellent transmission of intensity through the ramp.

Comments 07-05-2011 18:33:05 :  
 ATS MD  
 ATS measurements at 3.5 TeV completed!

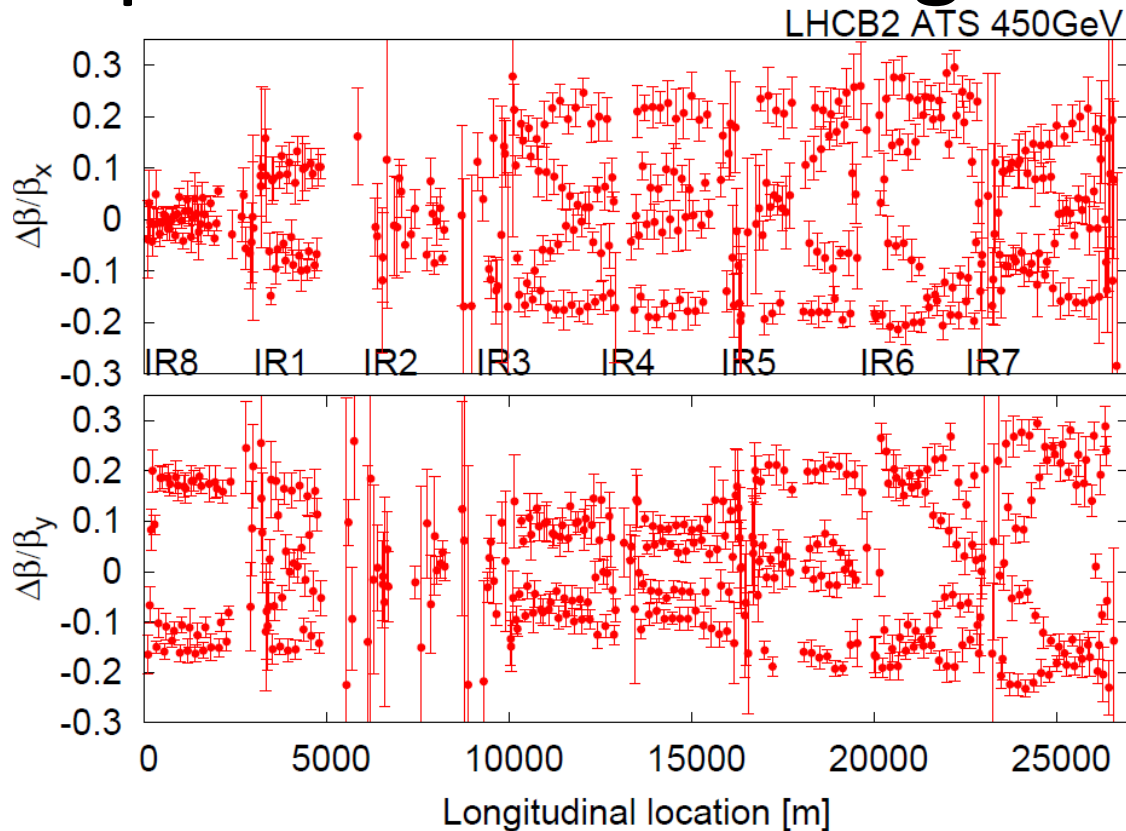
BIS status and SMP flags		B1	B2
Link Status of Beam Permits		false	false
Global Beam Permit		true	true
Setup Beam		true	true
Beam Presence		true	true
Moveable Devices Allowed In		false	false
Stable Beams		false	false

Dispersion B2.

AFS: alt      YASP DV LHC RING / RAMP\_ATS\_3.5TeV\_2011\_V1@0\_[START] / beam 2



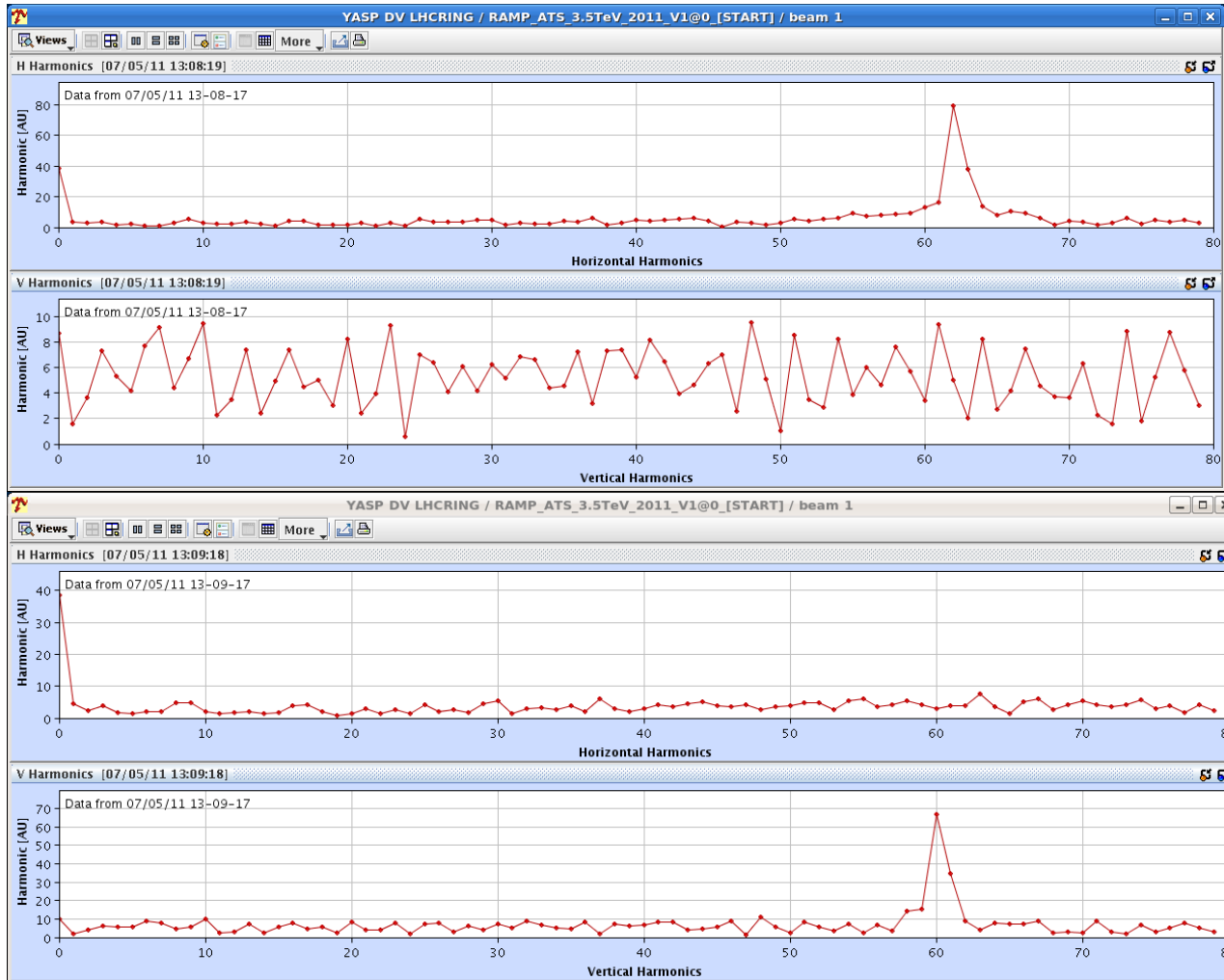
# ATS optics – beta beating at injection



## Beta-beating:

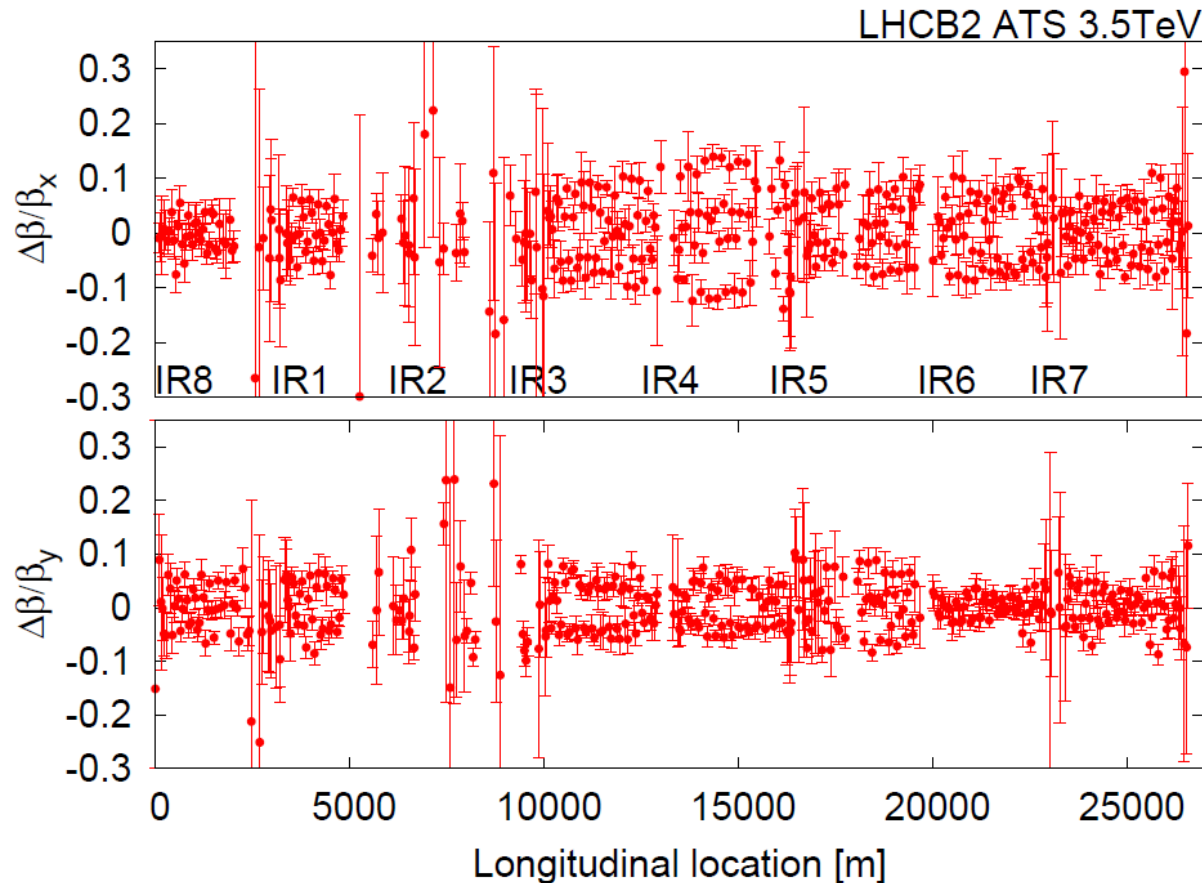
- **No correction applied** (but the right polarity of the 600A trims ... and the 3% MQW ITF).
- **25-30% beta-beating**, obviously dominated by the settings of the IR standalone quads.
- Can IR3/7 (MQW) be re-optimized and the triplet ITF be redefined by combining these results with the ones of the nominal optics?.. Do not forget that up to 20 units ITF discrepancy were observed on the KEK Q2s when re-measured in the US?
- While very small beta-beat is induced in the arcs (sorting of the SSS) why do we have a source of random  $b_2$  in the arcs creating a sizeable dispersion (see later)?

# ATS optics – integer tune



→ New integer tunes 62/60 (instead of 64/59)

# ATS optics – beta beating at 3.5 TeV



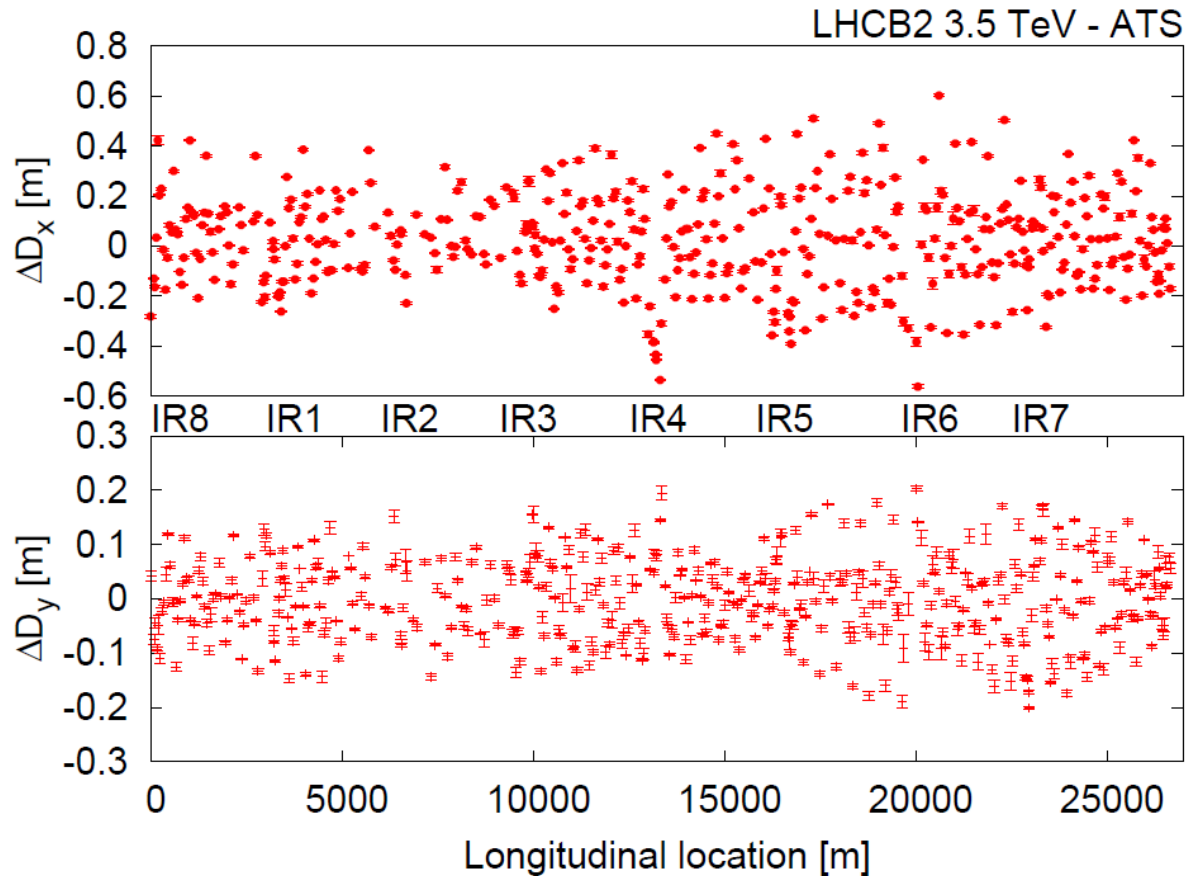
## Beta-beating:

→ **No correction applied** (3% removed for the MQWs).

→ IR contributions strongly reduced thanks to the **accurate field model at 3.5 TeV**, but the squeezed optics will require more as for the nom. optics (e.g. 1 units ITF accuracy in the triplet).

→ **Certainly less than 10% coming from the arcs** (b2 sorting of the SSSs).

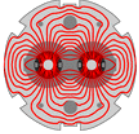
# ATS optics – spurious dispersion at 3.5 TeV



## H and V spurious dispersion:

- No correction applied (3% removed for the MQWs).
- **Dy still “perfect”** → big gain of V aperture in the existing/new IT for the squeezed optics
- **Dx not improved** (contrary to beta-beating??), looks random and not driven by the IRs:
- Most likely interpretation: SSS sorting optimized w.r.t. beta-beating ( $\pi/2$  pairs) and checking  $D_x$  a posteriori. Phasing by  $\pi$  the  $\pi/2$  pairs would have minimized  $D_x$  but was found impractical during the production (too many hardware constraints after the assembly of the MQ cold mass).





# impressions/highlights from 1<sup>st</sup> MD Block

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- We were impressed by the machine and the excellent preparation by all colleagues (success-oriented planning):
  - Availability almost perfect during MD block (only 8h out of 120h lost). Thanks to the infrastructure and hardware groups.
  - OP/CO tools were outstanding (I wished we had these in LEP times).
  - Beam instrumentation just excellent.
  - Accelerator physics understanding is impressive.
  
- Therefore:
  - A new optics could be commissioned within 8h and then the next MD again was successful with the standard cycle. Even two new optics...
  - World-record beam-beam parameter (hadron colliders) limited by maximum bunch intensity as allowed from beam instrumentation.
  - Beam instabilities were under control of experts and carefully provoked/studied (both longitudinal/transverse).
  - Cleaning efficiency in excess of 99.99% achieved.
  - 0.5 MW beam loss for a 1-2 seconds without even a single quench.



# LHC MD Notes (due 1-2 weeks after MD)

Web Site for LHC MD's

Welcome Ralph Wolfgang Assmann



## Web Site for LHC MD's

This List: Shared Documents

Home

Site Actions



View All Site Content

### Documents

Shared Documents

### Lists

Calendar

Tasks

Contacts

### Discussions

Team Discussion

### Sites

### People and Groups

Recycle Bin

Web Site for LHC MD's > Shared Documents > 2011 MD Results

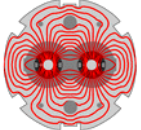
## Shared Documents

Share a document with the team by adding it to this document library.

New | Upload | Actions | Settings

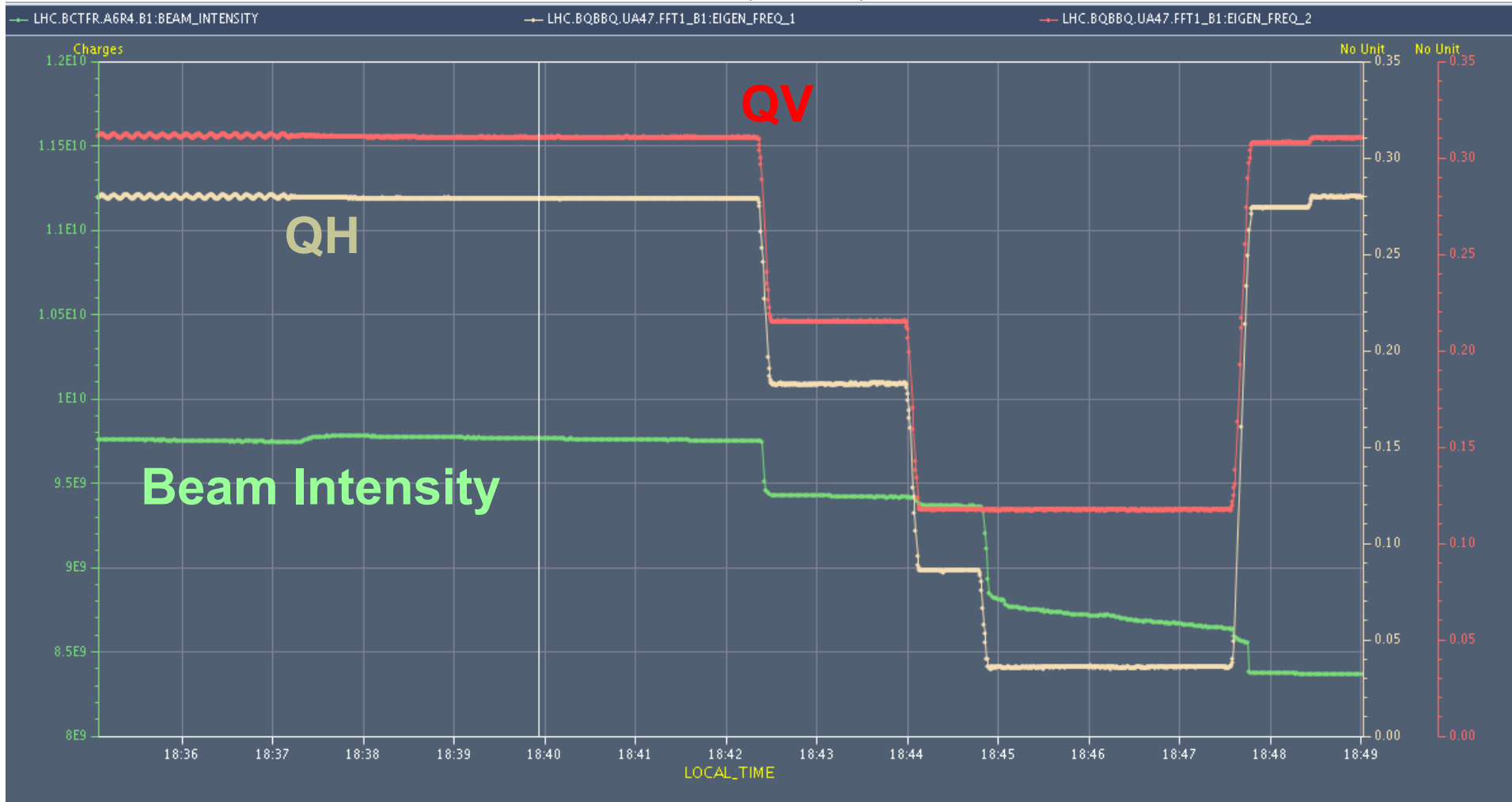
View: All Documents

Type	Name	Modified	Modified By
	ATS_RF_Multi	17/05/2011 05:41 PM	Philippe Baudrenghien
	ATSM1	23/05/2011 01:10 PM	Stephane Fartoukh
	CERN-ATS-Note-2011-028-MD	23/05/2011 01:18 PM	Werner Herr
	CERN-ATS-Note-2011-029-MD	23/05/2011 01:18 PM	Werner Herr
	CERN-ATS-Note-2011-040 MD	18/05/2011 11:35 AM	Chiara Bracco
	CollisionTunesAtInjectionAndRamp	23/05/2011 11:13 PM	Rogelio Tomas Garcia
	Draft ATS-Note-2011-041 !NEW	24/05/2011 03:08 PM	Elena Chapochnikova
	MD_nominal_collimator_settings_ATS_Note-2011-036 !NEW	24/05/2011 10:54 AM	Adriana Rossi
	MD_Note_90m_2011_05	16/05/2011 11:09 AM	Helmut Burkhardt
	MD_Note_QuenchTest !NEW	24/05/2011 02:31 PM	Stefano Redaelli

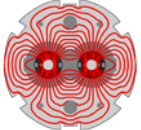


# Parasitic MD: Integer Resonance

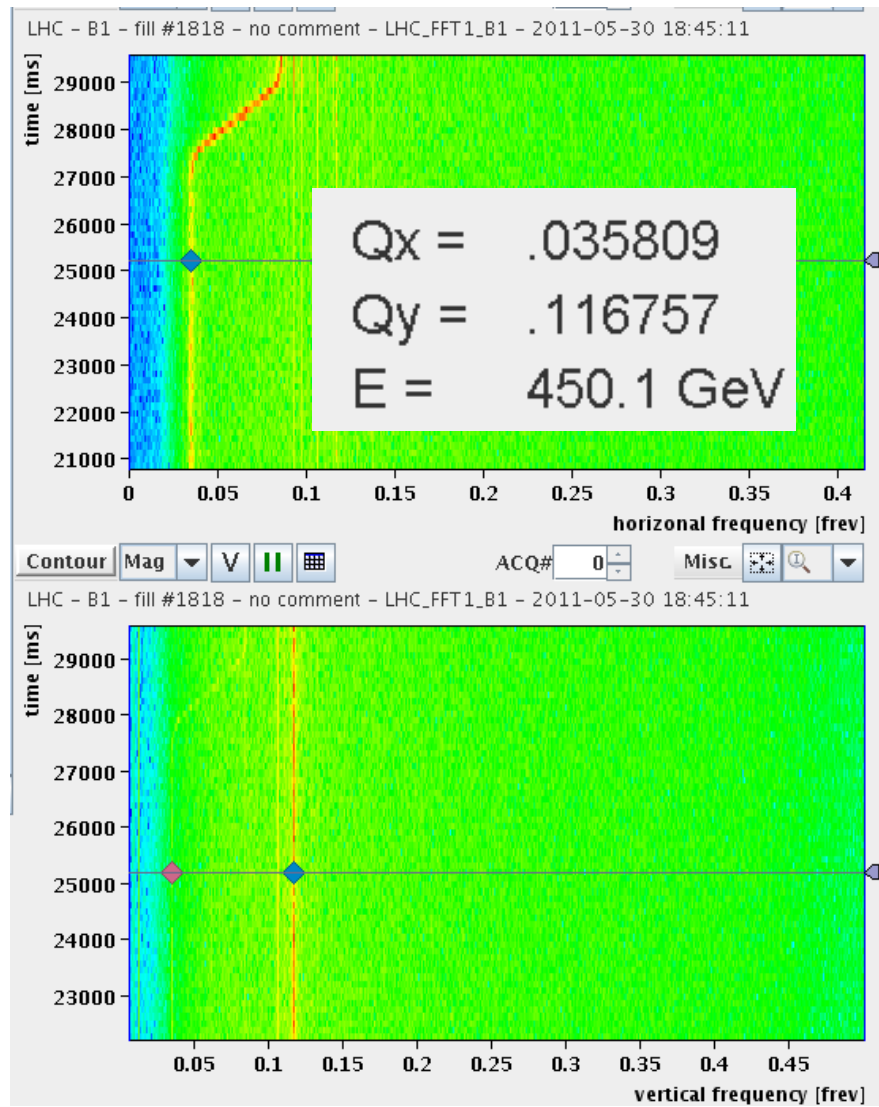
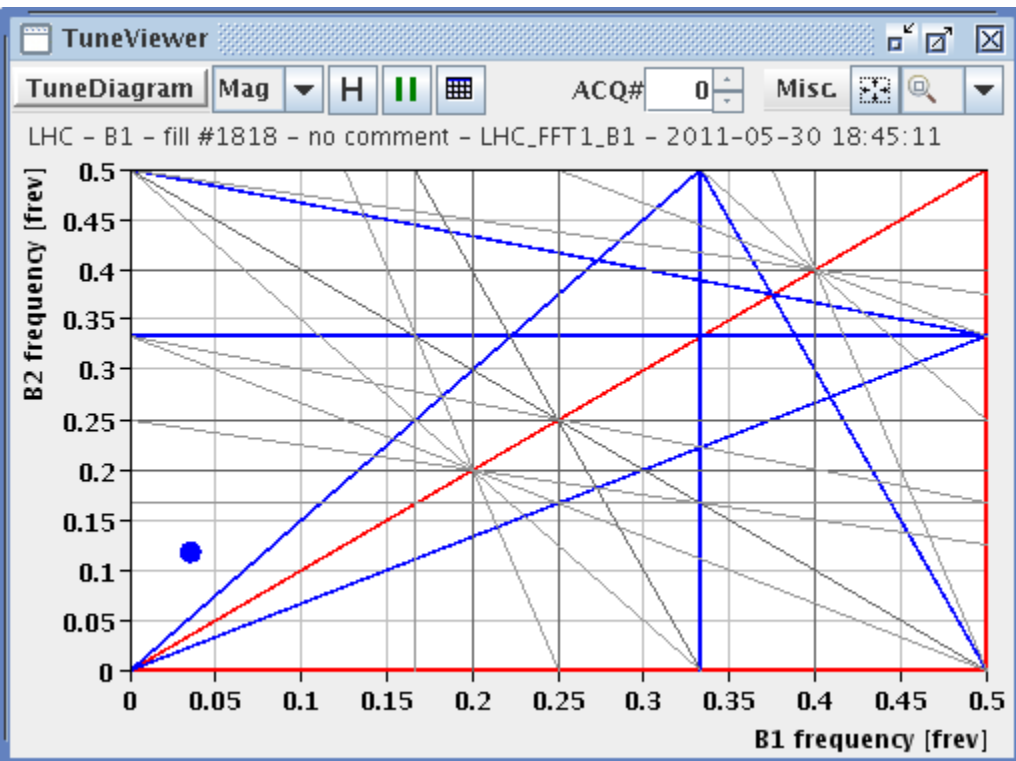
Timeseries Chart between 2011-05-30 17:56:03.491 and 2011-05-30 23:56:03.491 (LOCAL\_TIME)

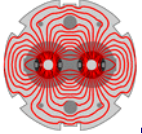


➔ Integer resonance is very narrow!

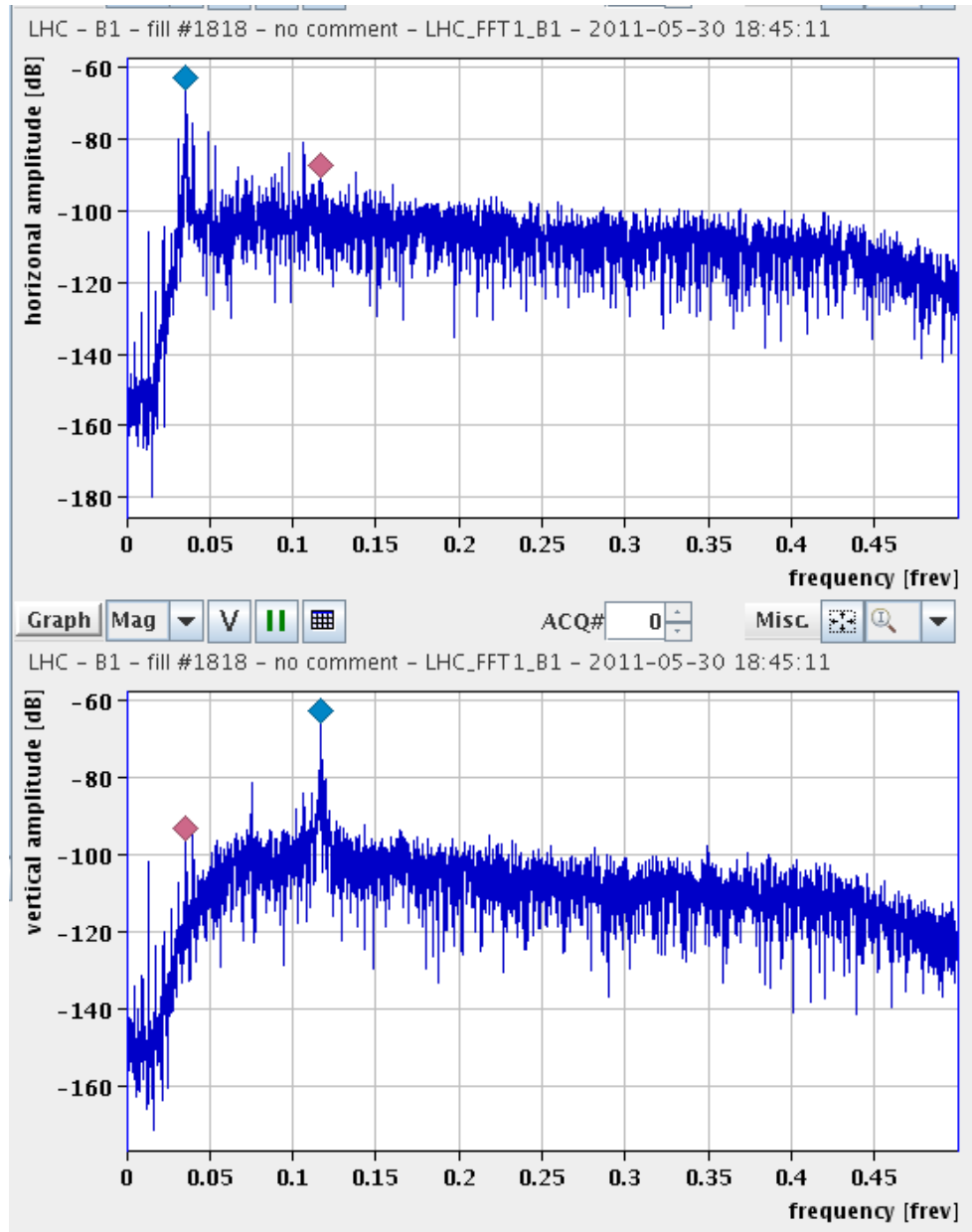


# Parasitic MD: Integer Resonance





# Parasitic MD: Integer Resonance







# Draft MD Planning Wed – Thu (29. – 30.6.)

Day	Time	MD	MP
Wed	04:00	<i>Ramp down, cycle</i>	
	06:00	No beam: <a href="#">ATS optics</a> checks w/o beam	
	08:00	<i>Ramp down, cycle.</i>	
	10:00	450 GeV: <a href="#">Injection 25ns</a> – different SPS parameters, first look, transverse damper first look (no detailed setup for 25ns)	<b>B</b>
	16:00	450 GeV: <a href="#">RF setup for high bunch intensity</a>	<b>A</b>
	22:00	450 GeV: 450 GeV → 3.5 TeV: <a href="#">Beam instrumentation</a> – high bunch intensity, ...	<b>B/C</b>
Thu	06:00	<i>Ramp down, cycle.</i>	
	08:00	450 GeV: <a href="#">Head-on beam-beam limit</a> – up to 3e11p per bunch, coherent modes. BI parasitically.	<b>A</b>
	16:00	450 GeV: <a href="#">Injecting nominal emittances, MKI &amp; UFO's</a> – 50ns, blow-up in SPS, SPS scraping and losses, injection into LHC, nominal emittance.	<b>B</b>



# Draft MD Planning Fri – Sat (1. – 2.7.)

Day	Time	MD	MP
Fri	01:00	Switch back to operational injection settings. Verification.	
	03:00	450 GeV → 3.5 TeV: <u>RF</u> – longitudinal beam stability.	<b>B</b>
	16:00	Ramp down, cycle.	
	18:00	450 GeV → 3.5 TeV: <u>Long-range beam-beam limit</u> – lifetime, emittance versus beam-beam separation. Collimation with changing crossing angle.	<b>C</b>
Sat	02:00	Ramp down, cycle.	
	04:00	450 GeV: <u>Non-linear dynamics</u> – Dynamic aperture, non-linear chromaticity and frequency map.	<b>A</b>
	12:00	If needed: Precycle.	
	14:00	3.5 TeV: <u>Collimation</u> – combined cleaning, faster setup.	<b>A</b>
	22:00	Ramp down, cycle.	



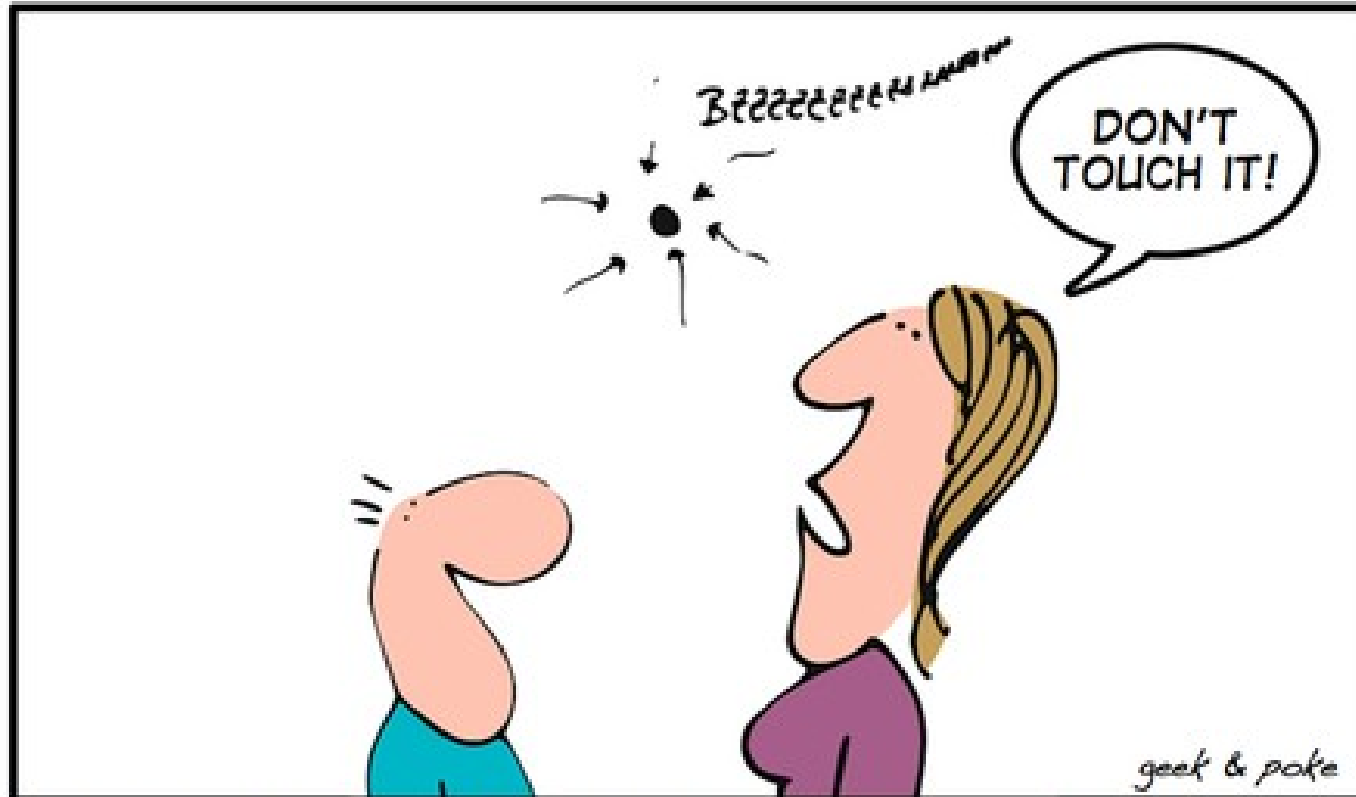
# Draft MD Planning Sun – Mon (3. – 4.7.)

Day	Time	MD	MP
Sun	00:00	3.5 TeV: <a href="#">ATS</a> – correction & pre-squeeze.	<b>A</b>
	08:00	<i>Ramp down, cycle.</i>	
	10:00	450 GeV: <a href="#">Beam distribution in LHC</a> – scraping, halo, tails, BLM limits, ... (high intensity)	<b>B</b>
	14:00	450 GeV: <a href="#">Quench margin at injection</a> – observation with special QPS instrumentation, losses from TCLIB collimator, TCDQ checks in parallel	<b>C</b>
	22:00	450 GeV: <a href="#">R2E</a> – slow controlled losses (1e13p on Q14.R2.B1).	<b>A</b>
<b>Mon</b>	<b>06:00</b>	<b>Technical Stop</b>	

## Needs from experiments:

30.6., 08:00 to 16:00 – Luminometers on in ATLAS and CMS

01.7., 18:00 to 02:00 – Luminometers on in ATLAS and CMS



**NOW THAT THE LARGE HADRON COLLIDER HAS STARTED WE CAN WATCH THE FIRST BLACK HOLES HANGING AROUND IN THE WILD**

*thank you for your attention!*