

Luminosity in 2011 and prospects for 2012

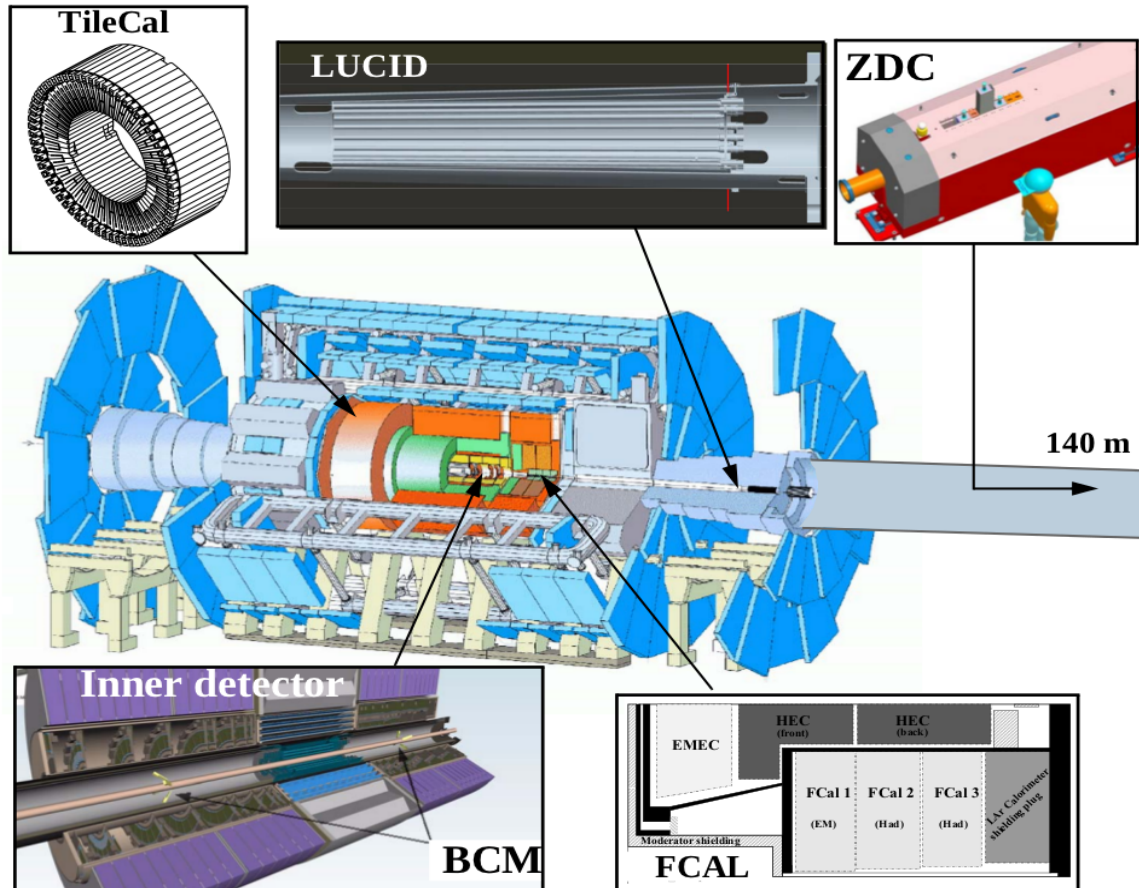
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Meeting ATLAS Italia
Rome, 17/04/2012

outline

- A review of 2011 luminosity
 - Detectors and algorithms
 - Challenges
 - calibration in VdM scan
 - Number of colliding BCIDs
 - Average number of interactions/BX: μ -dependence
 - Time stability
 - "almost-final" results
- What we foresee for 2012
 - pile-up and μ -dependence
 - first results with early data

Detectors and Algorithms in 2011

- Bunch by bunch
 - BCM
 - Evt OR,AND (H,V)
 - LUCID
 - Evt OR,AND,A,C
 - Hit OR
 - Vertex methods
 - Evt & vtx counting
- BCID-blind
 - FCal (forward LAr)
 - Gap currents
 - TILE cal
 - PMT currents



Redundancy essential for assessing long term stability
& μ dependence

VdM calibration

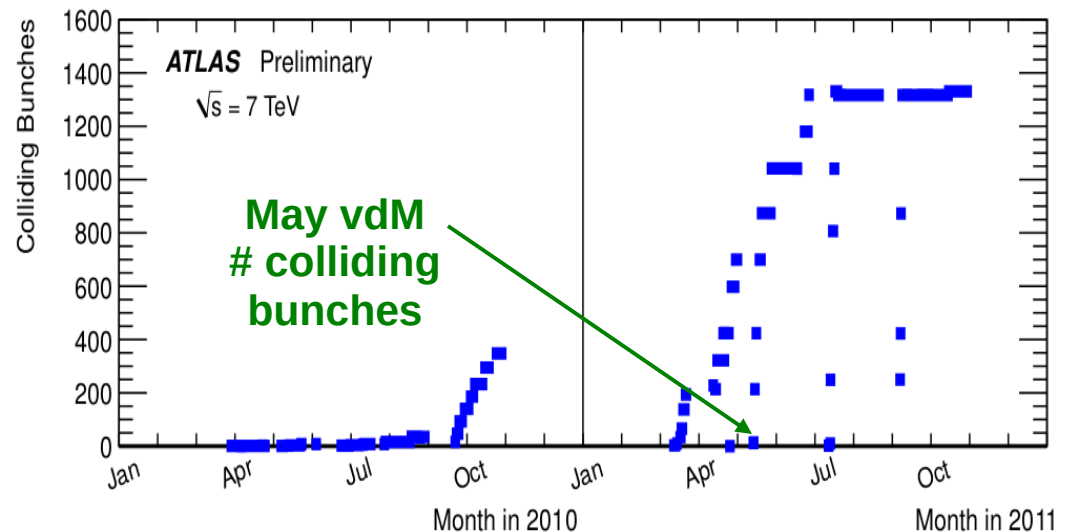
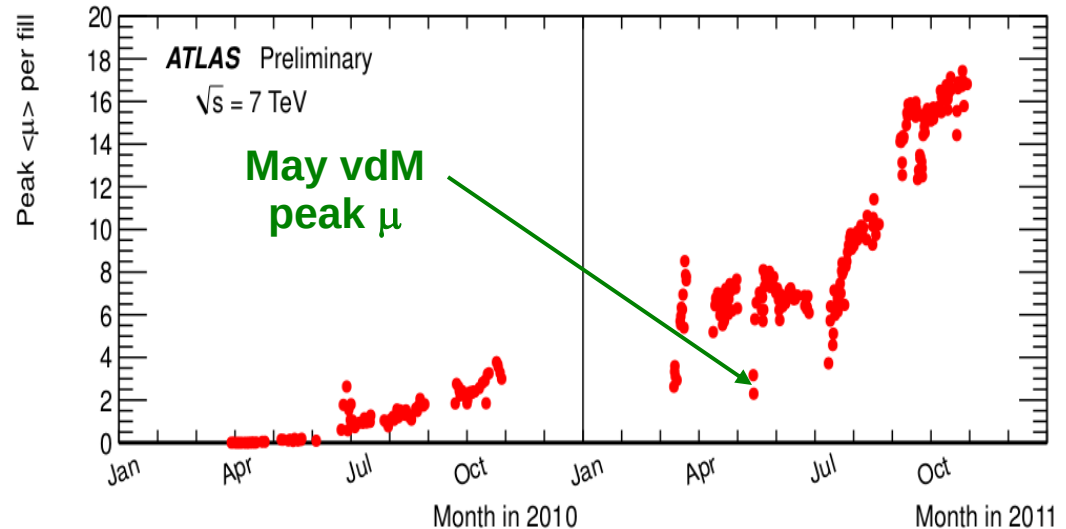
- Huge effort to evaluate systematics:
 - LHC+experiments: beam-related
 - ATLAS: specific experiment-related
- I'll not give all details: see LumiDays workshop, Cern, 1st march 2012
- Improvement wrt 2010 and early 2011 syst. evaluations dramatic on bunch-charge product
 - from 3% to 0.35%
 - No more dominant contribution

ATLAS 2011 VdM scan: sys

	2011 [%] (not final)	2012 projected	Comment
Beam centering	0.1	Measured in scan	Fill dependent
Beam jitter	0.3		
Non-reproducibility	0.8	Measured in scan	Fill dependent
Bunch consistency	0.5	Measured in scan	Fill dependent
Fit model	0.3	Measured in scan	Fill dependent
Bkgd subtraction	0.3	Measured in scan	Fill dependent
Reference L_{sp}	0.3	Measured in scan	Fill dependent
Dynamic beta	0.8		Collisions at IP1 only
Non-linear correlations	0.5	Measured in scan	Fill dependent
μ -dependence in scan	0.5	Measured in scan ~2011?	
Length scale calibration	0.3		Depends on β^*
Inner det. Length scale	0.3		
BCM H/V consistency	0.7	?	
Total vdM uncertainty	1.75	~2011?	Without beam current

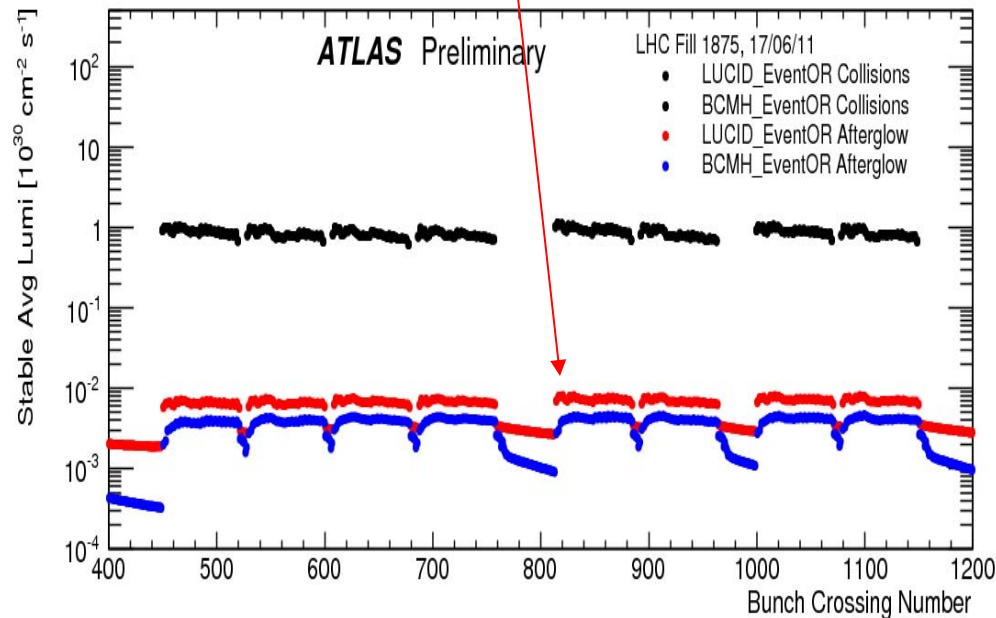
physics running: challenges

- $\langle \mu \rangle$ does not mean $\max \mu$!
- comparison with 2010 striking
- 1 year ago we were frightened about 2011 plans (remember my presentation last year?)



Number of colliding bunches

- In 2011 LHC filled from 1 to 1318 BCID's
- Huge impact on afterglow background

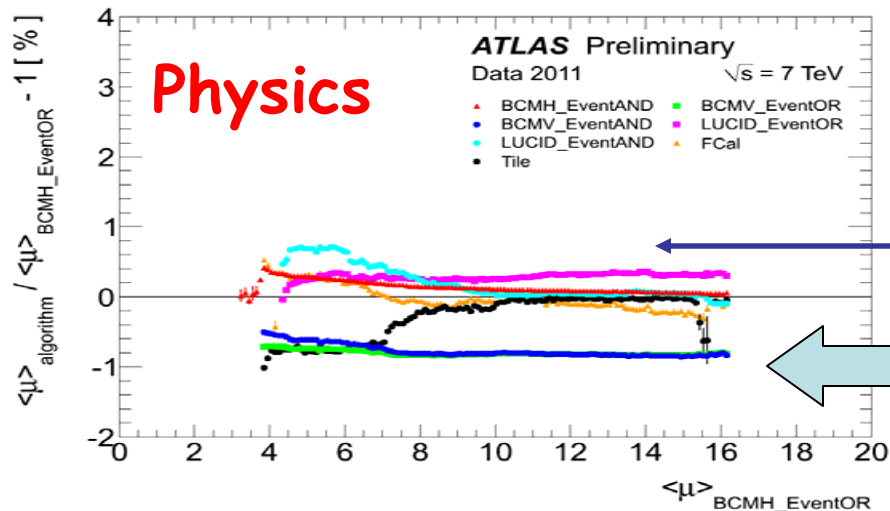
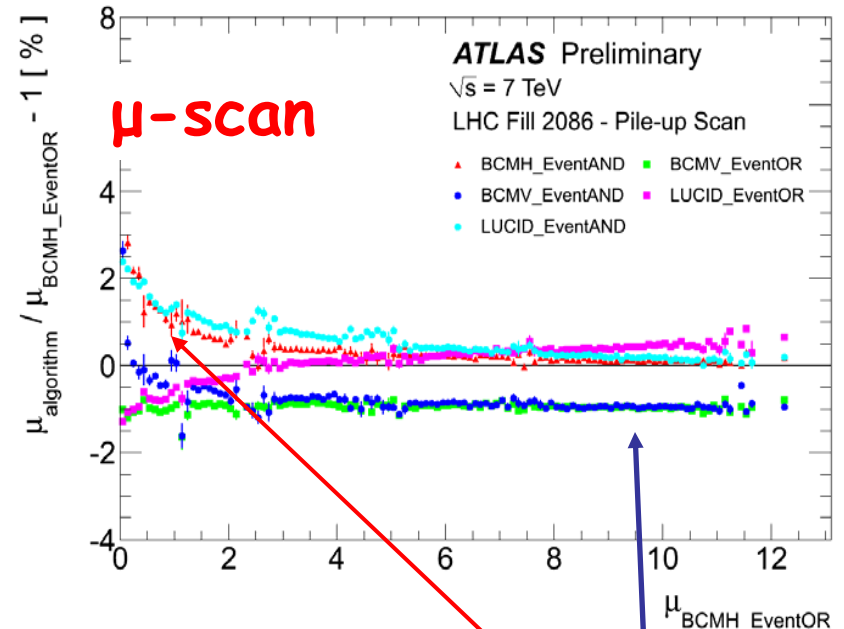
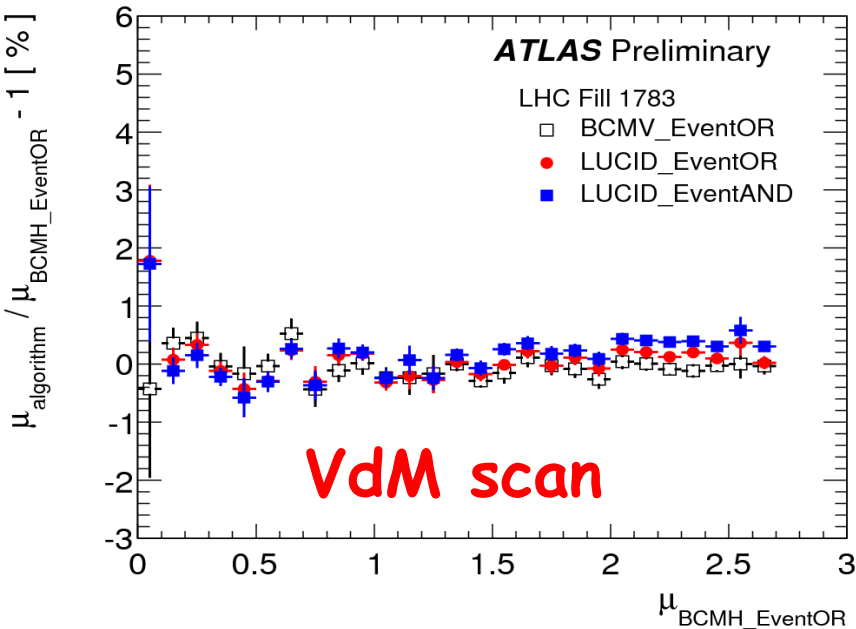


- Bkg levels 0.5% (BCM) 1% (LUCID)
- Subtracted with precision of 0.2% (sys)

μ -dependence (I)

- in 2011 we ran in a wide range of μ (average number of interactions per bunch-crossing)
 - VdM scan: $\mu < 2.5$
 - ALFA run (σ_{el} measurement): $\mu \sim 0.03$
 - Normal running conditions: μ up to ~ 25
- crucial to understand μ -dependence over 3 orders of magnitude !
 - ATLAS strategy: use different detectors and algorithms
 - perform μ -scans during physics fills

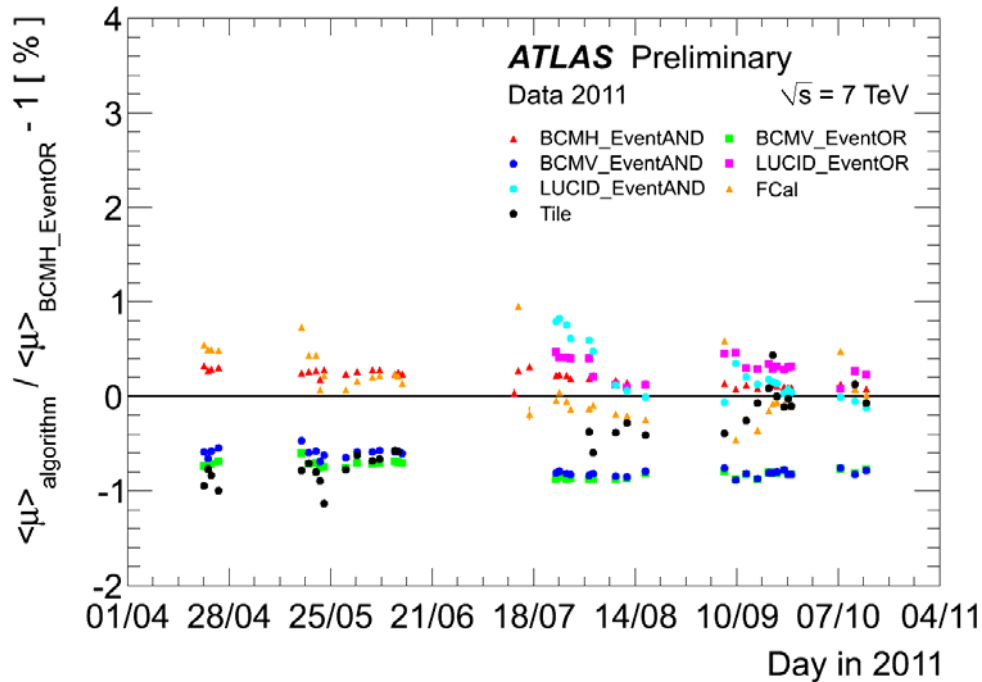
μ -dependence (II)



- non linearities appear only at very low μ
- in physics runs: **0.5% sys**

• note: many runs over 6 months cumulated: include time stability (see next)

long-term stability



- checked in a 6 month time-scale
- compare detectors/algorithms
- no deviations more than **1% (sys)** observed
- Note: conservative to quote both stability and μ -dependence 1%

semi-final systematics [%]

	ATLAS-CONF-2011-117 (2/fb Aug 2011)	5/fb projected	2012 projection	Comment
DCCT	2.73	0.23		
FBCT	1.30	0.20		
Ghost charge	0.18	0.18		
Total BCP	3.0	0.35	~2011?	Thanks to BCNWG!
Total vdM	1.5	1.75	~2011?	
Total σ_{vis} uncertainty	3.4	1.75	~2011?	
Long term stability	1.0	1.0	~2011	Detector aging in 2012?
μ -dependence in physics running	1.0	0.5	~2011	Larger μ range for 2012
Afterglow subtraction	0.2	0.2		
Total monitoring	1.4	1.1	~2011	Unchanged from summer despite more data & higher μ values
Total 2011 7TeV pp	3.7	2.0	~2011?	

ATLAS-CMS discrepancy

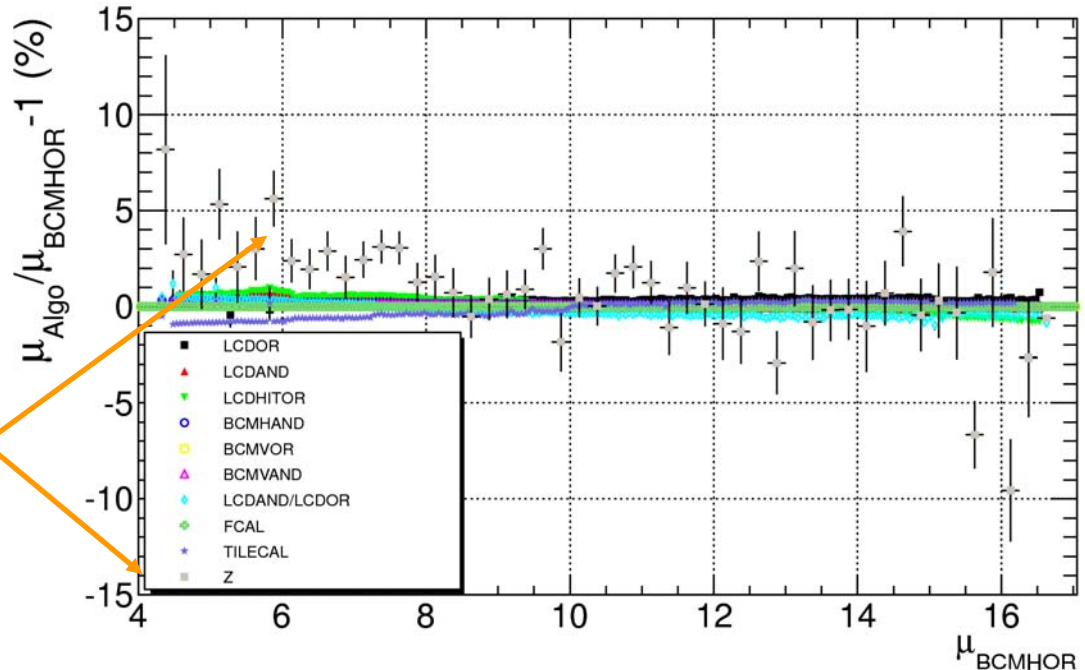
- CMS reported a difference by 6-8% with ATLAS
- Luminosity determination using Z can resolve problem

$$L_Z = (N_Z - bkg) / (C_Z \times \sigma_Z)$$

where:

$$\sigma_Z = \sigma_Z(2010)$$

N_Z, bkg, C_Z evaluated by SM group.



final remarks about 2011

- numbers in table of systematics may still change slightly
- depending on latest studies possible shift by 1% of central value of L
- note advanced: will be available before ICHEP
- Z analysis rules-out ATLAS problem in absolute luminosity determination (the 7% ATLAS/CMS discrepancy)

what we do foresee for 2012

- There is no reason why 2012 should be worse than 2011
 - of course if nothing breaks-down and quality of the beam is ok !
- most of 2012 systematic will be uncorrelated wrt 2011
- In detail:
 - bunch-spacing will remain the same (50ns)
 - no problem foreseen if increase # BCID's
 - 8 TeV => recalibrate with dedicated VdM
 - and what about increase of μ ?

initial calibration in 2012 (8TeV)

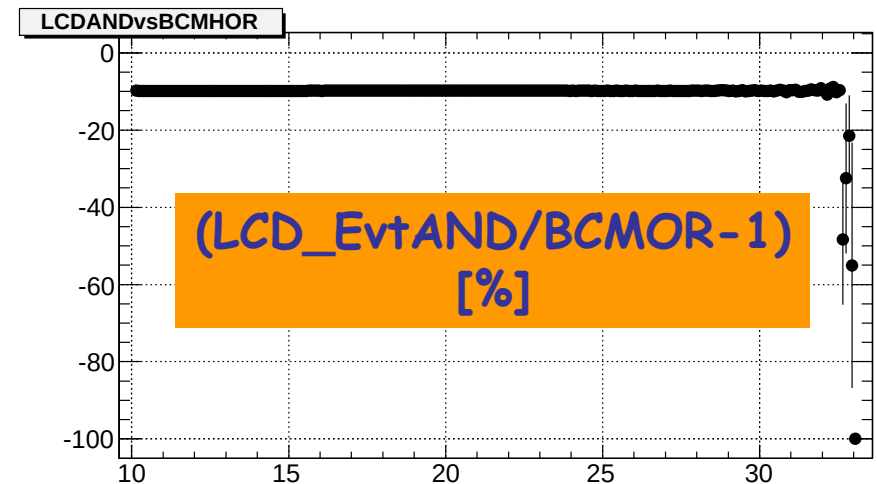
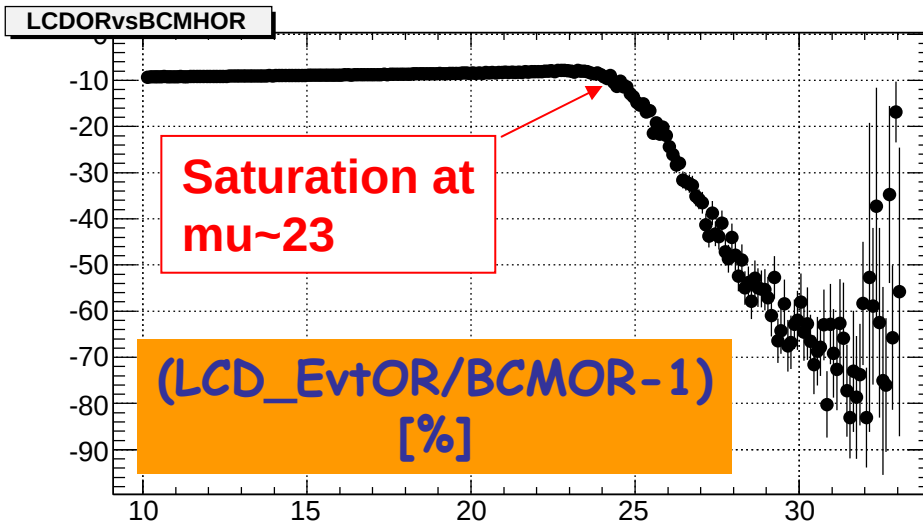
- LUCID provided MC evaluation of change of calibration constants wrt 7 TeV
 - applied and presently used
 - preferred algorithm is at present LCD_HITOR
- BCM still running with 7 TeV calibration
 - expected discrepancies up to 10%
- additional effects at the beginning:
 - detectors made HW/FW changes
 - 2011 experience: after long shutdown changes appear
- VdM scan will set new measured calibration constants (hopefully with same precision as 2011)

... adding more and more

- Calibration of still more luminosity detectors & algorithms for consistency checks
 - RPC, Medipix
 - Dedicated Inner Detector DAQ stream with prompt track & vertex reco for online lumi monitoring from these objects
 - Well advanced, cut definitions only limited by CPU constraints
 - Z counting luminosity comparisons (online monitor being developed in Bologna)

first analysis of 2012 data (I)

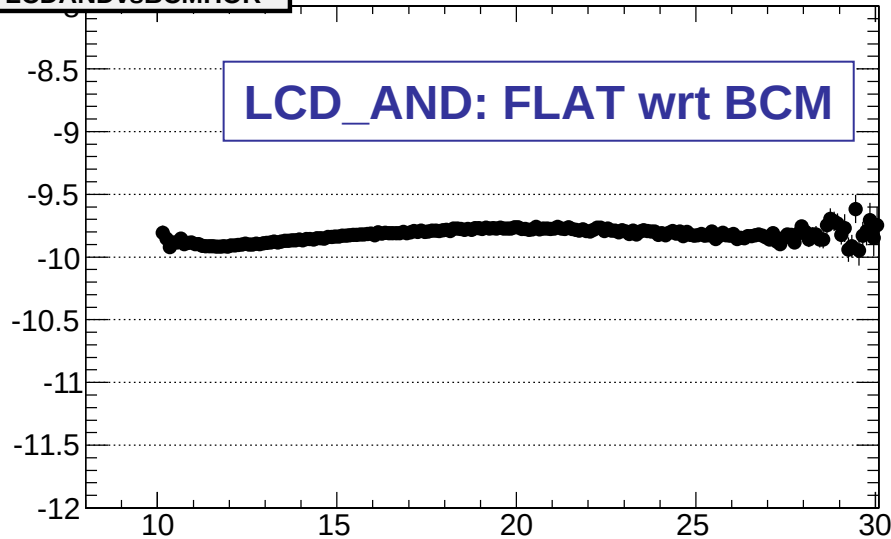
- problem: some algorithms will run into 0-starvation (saturation)
 - expected: preferred algorithm now is **LCD_HITOR** (see next)



first analysis of 2012 data (II)

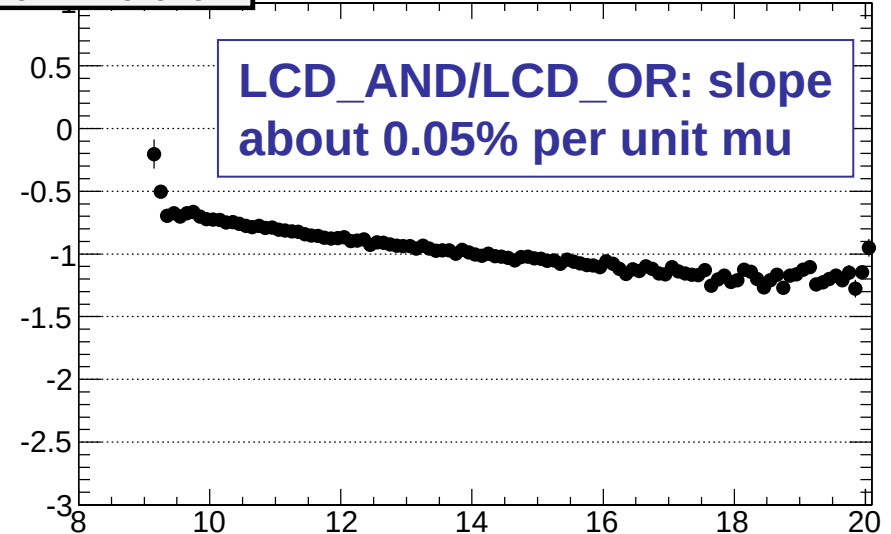
LCDANDvsBCMHOR

LCD_AND: FLAT wrt BCM



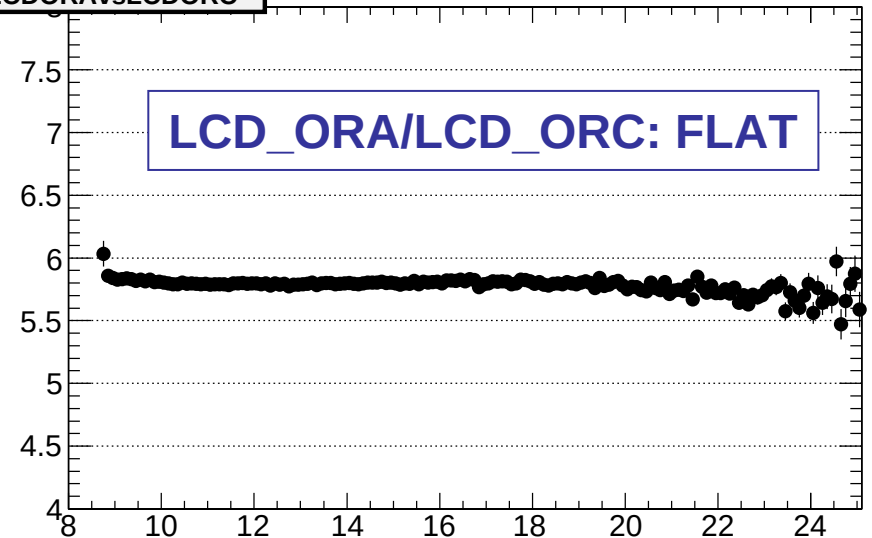
LCDANDvsLCDOR

LCD_AND/LCD_OR: slope about 0.05% per unit mu



CDORAvsLCDORC

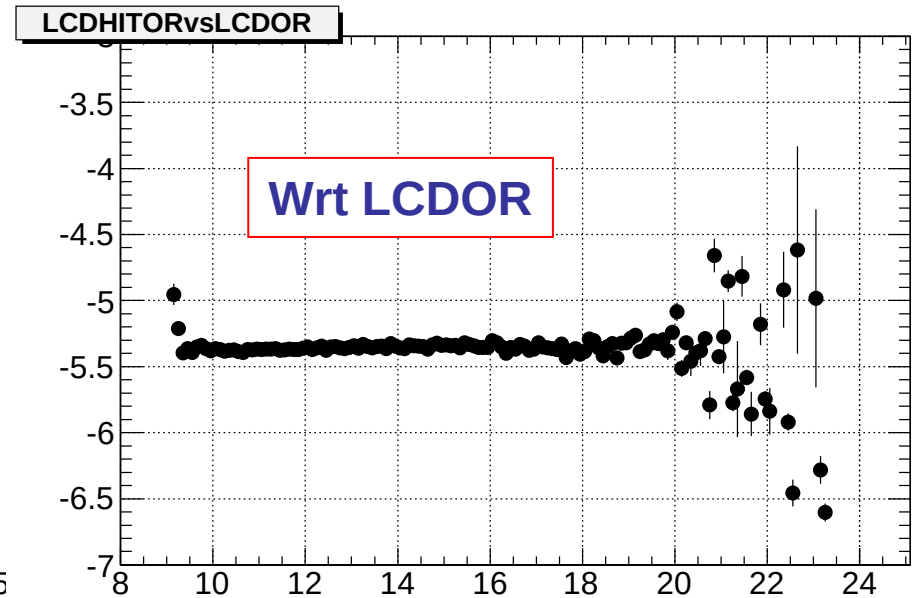
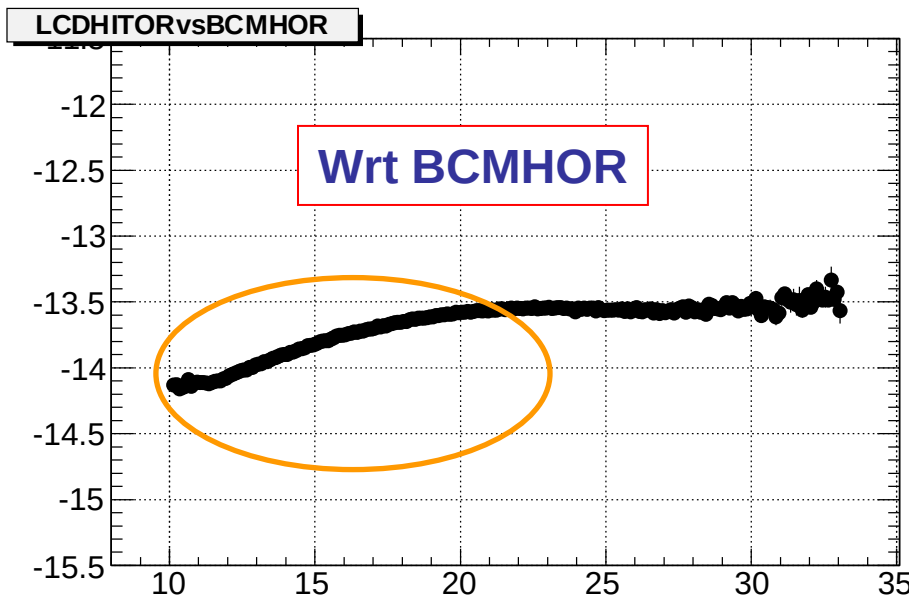
LCD_ORA/LCD_ORC: FLAT



- don't worry about offsets (we have to wait VdM scan)
just look at slopes

first analysis of 2012 data (III)

- LUCID_HITOR now preferred algorithm
 - flat up to $\mu \sim 35$ (max value reached) wrt BCM
 - behaviour $\mu < 20$ to be understood
 - flat wrt LCD_OR (until this saturates)



summary

- 2011 precision in L determination at the 2% level
 - bunch-current no more limiting: it's becoming serious !
 - all sources of measurement systematic uncertainty carefully evaluated (calibration, μ -dependence, bkg, time-stability)
- In 2012 we hope to achieve similar results
 - Prepared for challenges of higher pileup (first results encouraging)
 - 2012 uncertainty mostly uncorrelated with 2011