Tracking & Alignment news

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on behalf of the T&A group

25 January 2016

Reconstruction performance in RunII

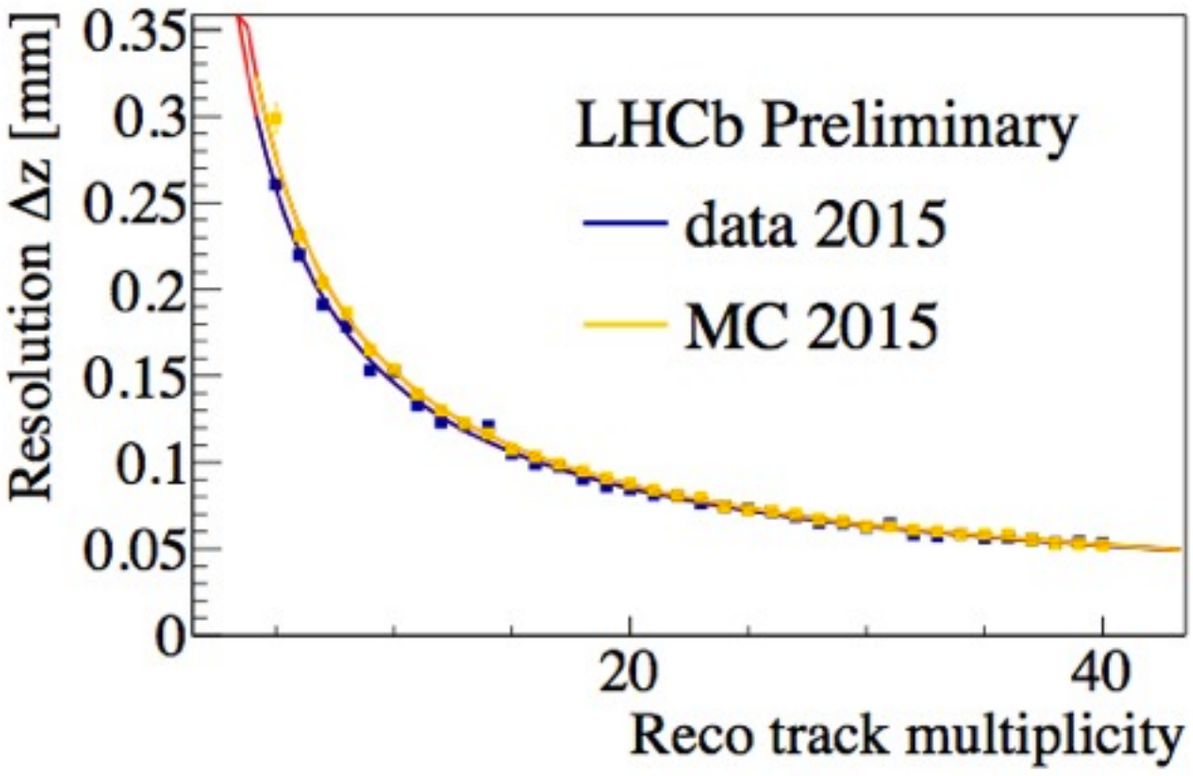
PV resolution

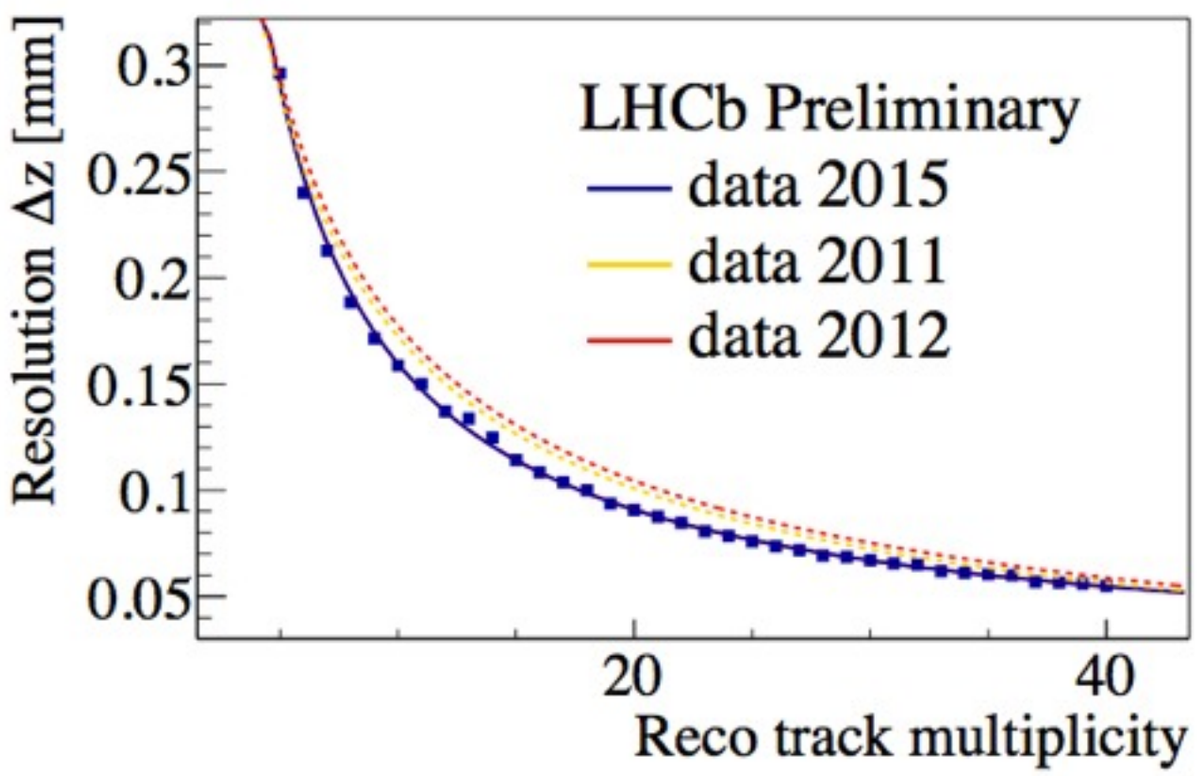
Agnieszka, Vava

Agnieszka's talk

- Data driven measurement of PV resolution
- Method:
  - split the tracks of an event randomly into 2 samples
  - perform PV reconstruction separately on each sample
  - match the PVs in the 2 samples and take the difference as resolution
- Validated on MC
- New PV finding results in a better resolution than in Run I

  The resolution for 25 tracks is better for 2015 data (~7% for x, ~20% for z)

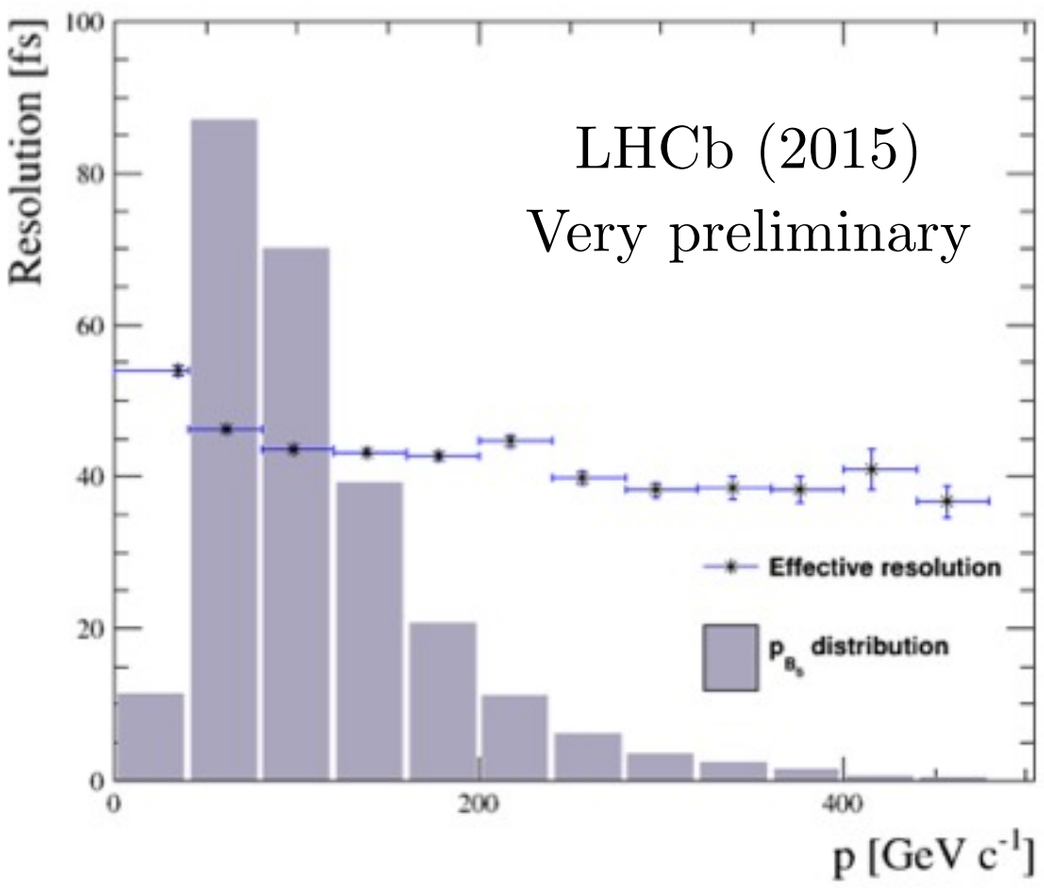




Decay time resolution

Sevda, Mengzhen, Yuehong, Liming

- Time resolution study with Run II and Run I $B_s \to J/\psi\phi$ decays — Mengzhen's talk
- Method:
  - Calibrate σ_t using prompt sample to obtain effective time resolution R as function of σ_t
    - Sweight using m(μμ) to subtract fake J/ψ
    - Fit decay time distribution in bins of σ_t
  - Use σ_t distribution from real B_s candidates to get the resolution averaged event-by-event
- The effective resolution in Run II is ~6% better than in Run I



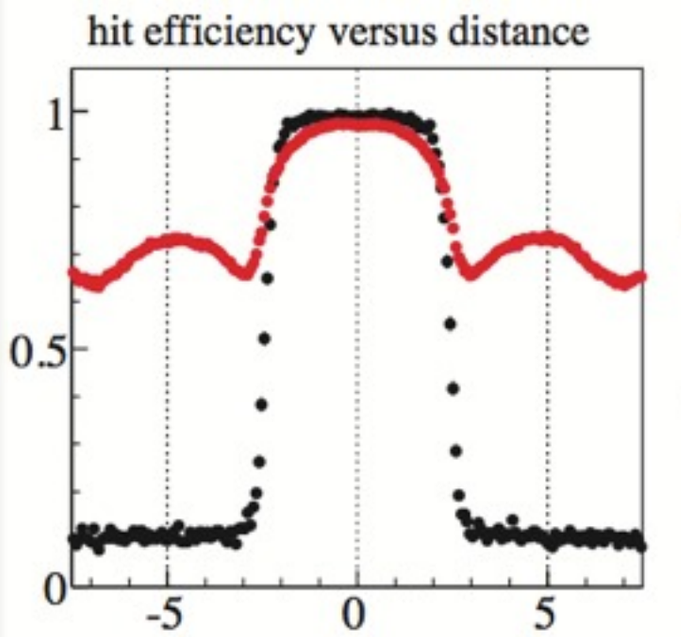
Further on going studies: Momentum resolution in Run II — Christian

A first look at Pb-Pb collisions

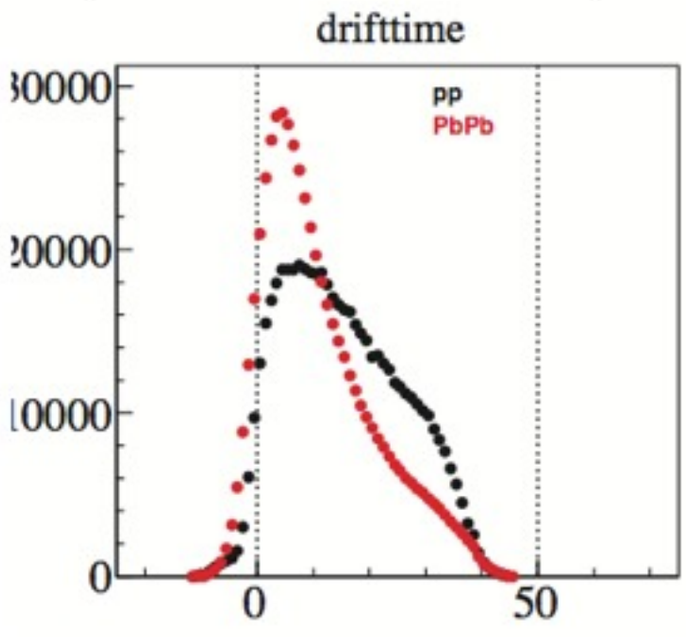
Johan, Wouter

- Pb-Pb and Pb-gas collisions — Johan's talk
- Many almost empty events (peripheral Pb-Pb collisions)
- Some very high multiplicity events: hard to reconstruct & long processing time
- Looked at sub-detector response, hit correlations, calo matching, PVs

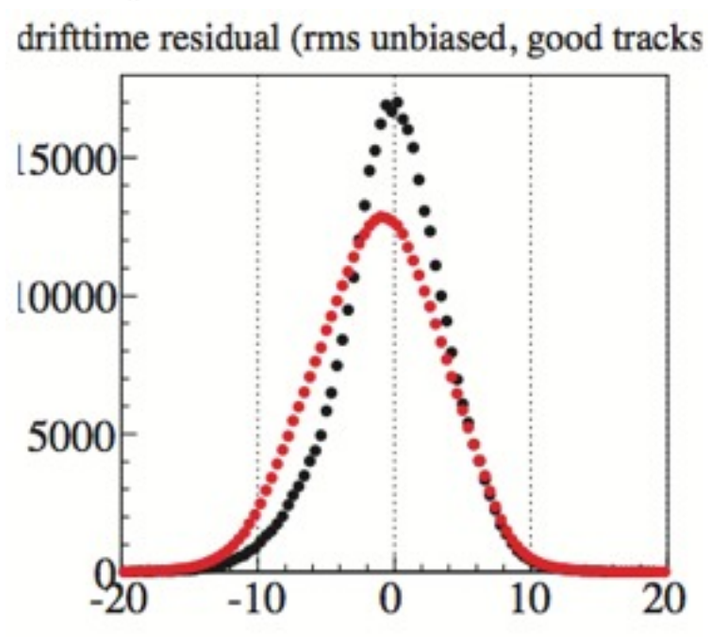
E.g. OT suffering from high occupancies



Hit efficiency *vs.* drift distance



OT drift time



Drift time residual

- Ongoing studies: evaluation of efficiency and ghost rate to define a GEC

... And lots of things still to be understood !

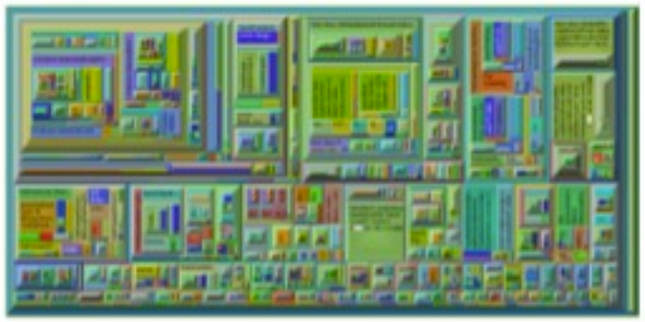
Getting ready for the data taking in 2016

Tracking

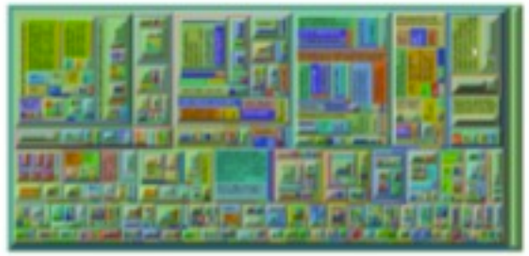
Agnieszka, Barbara, Espen, Gerhard,
Manuel, Marian, Michel, Sascha, Wouter,

Status

v45r1



v48r1



v48r1 (2015 reco)

- Many improvements since Run I
- Offline quality reconstruction in the HLT
- 34% improved timing on 2012 data using 2012 tracking sequence
- Overall 50% speed-up when using 2015 reconstruction

- **Aim for 2016: further improve tracking performance and timing**
  (critical for HLT strategy)

Tracking in 2016

Adam Dendek, Adam Davis, David, Diego, Jeysson, Manuel, Marian, Michel, Matt, Sascha, Hang, Paul, Stephen, et. al

HLT1:

Algorithm	time
FastVelo	8 %
PV reco	4 %
VeloTT	3 %
Forward HPT	20 %
Track fit	44 %
Extra muon reco	14 %

HLT2:

Algorithm	time
Forward LPT	11 %
Seeding	28 %
Track fit	14 %
Rich reco	22 %
Calo	6 %
Rerun HLT1	5 %
Combinatorics	12 %

Sascha's table

Requirements

- Need to become 1/3 faster in HLT2 and save ~10% of memory (depending on HLT1)

Plan

Tracking 2016 Twiki page

- Use MVAs already at the end of the pattern recognition (to reduce the load on the Kalman filter)
- Explore StructureOfArrays to speed up seeding
- Use ghost probability already in HLT1
- More ideas being tested in the next weeks

Working on this!

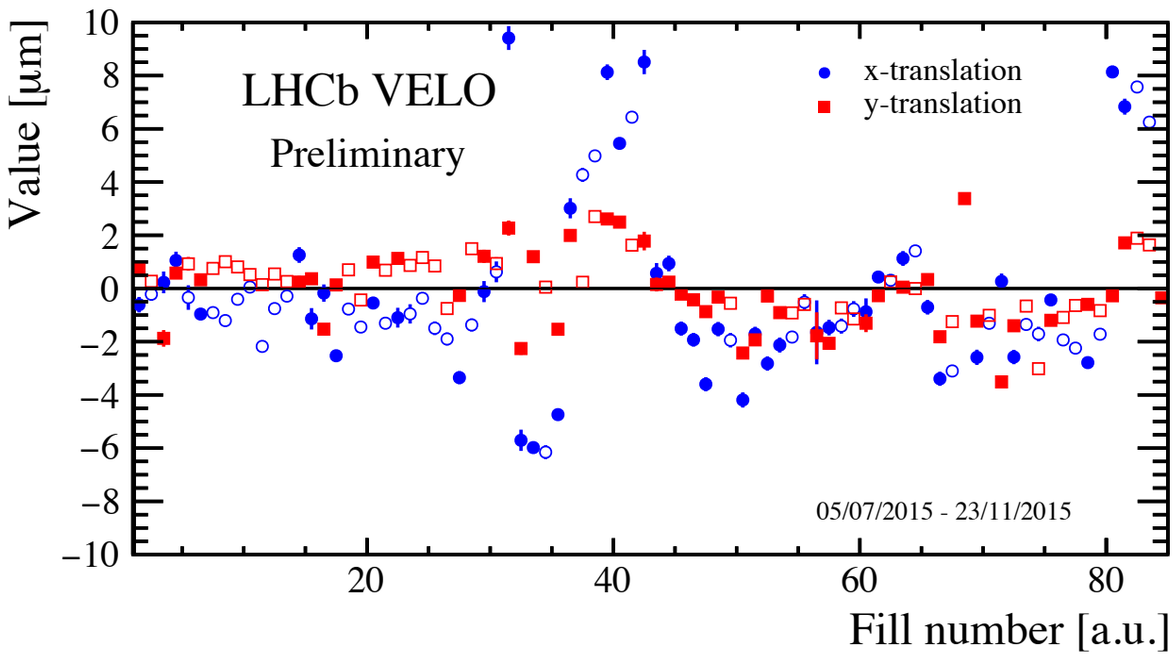
- **If you like a challenge, speed up the Runge-Kutta!**

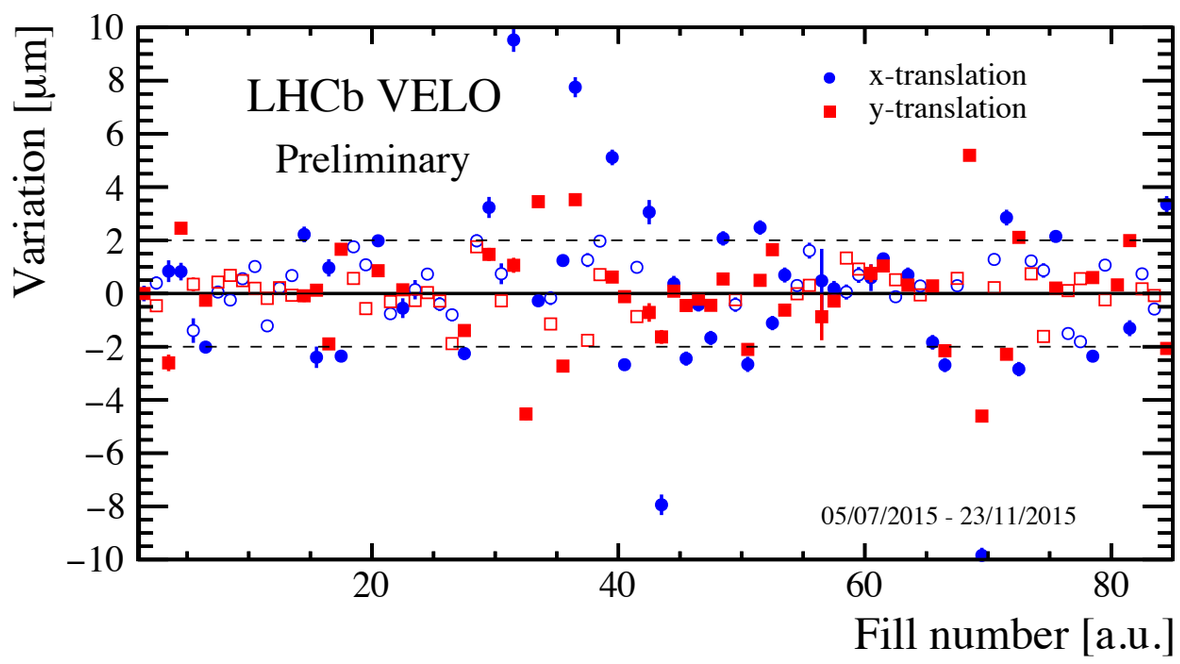
Real-time Alignment

Giulio, Silvia

Status

- VELO alignment
  - Fully automatic procedure since end October 2015
  - Variation of the constants within expectations
  - Constants updated every 2-3 fills - working well



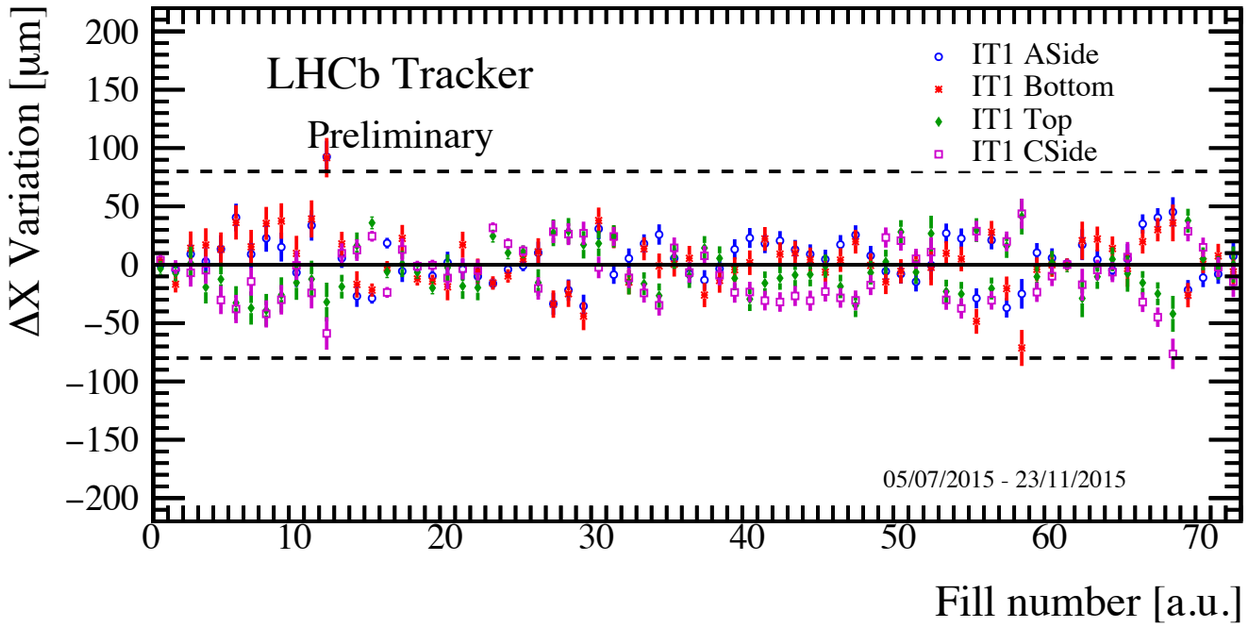


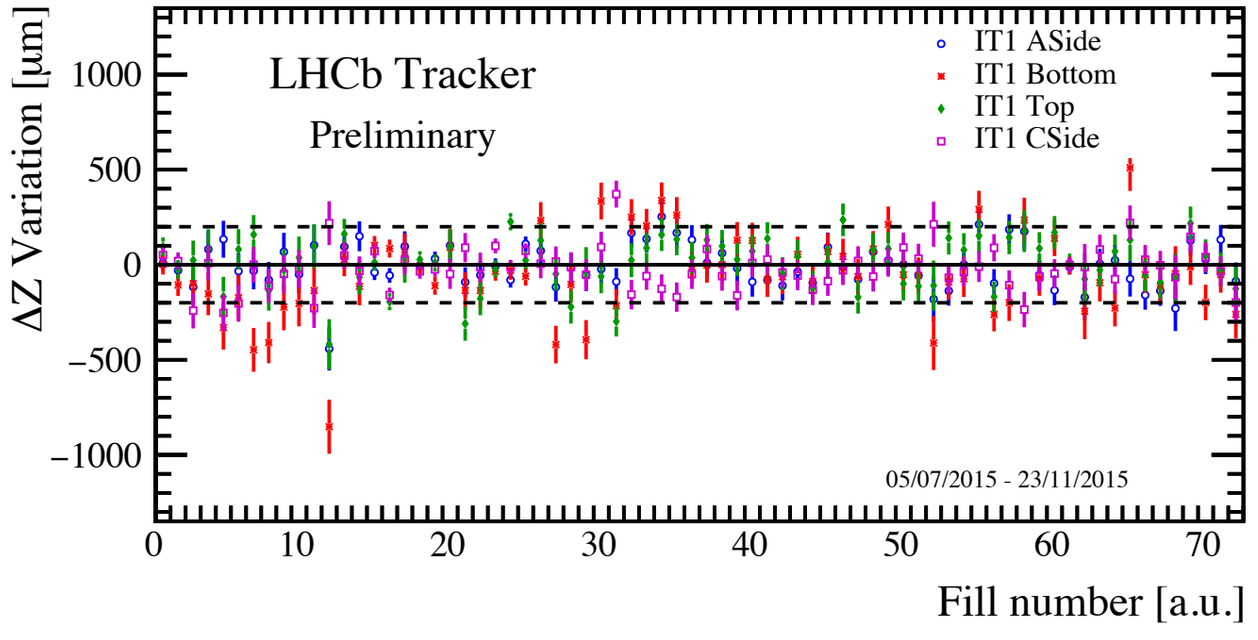
Real-time Alignment

Maurizio, Silvia, Wouter, Zhirui

Status

- Tracker alignment
  - Fully automatic procedure since November 2015
  - Variation of the constants within expectations
  - Variation observed mainly after magnet polarity switch, few updates in next consecutive fills



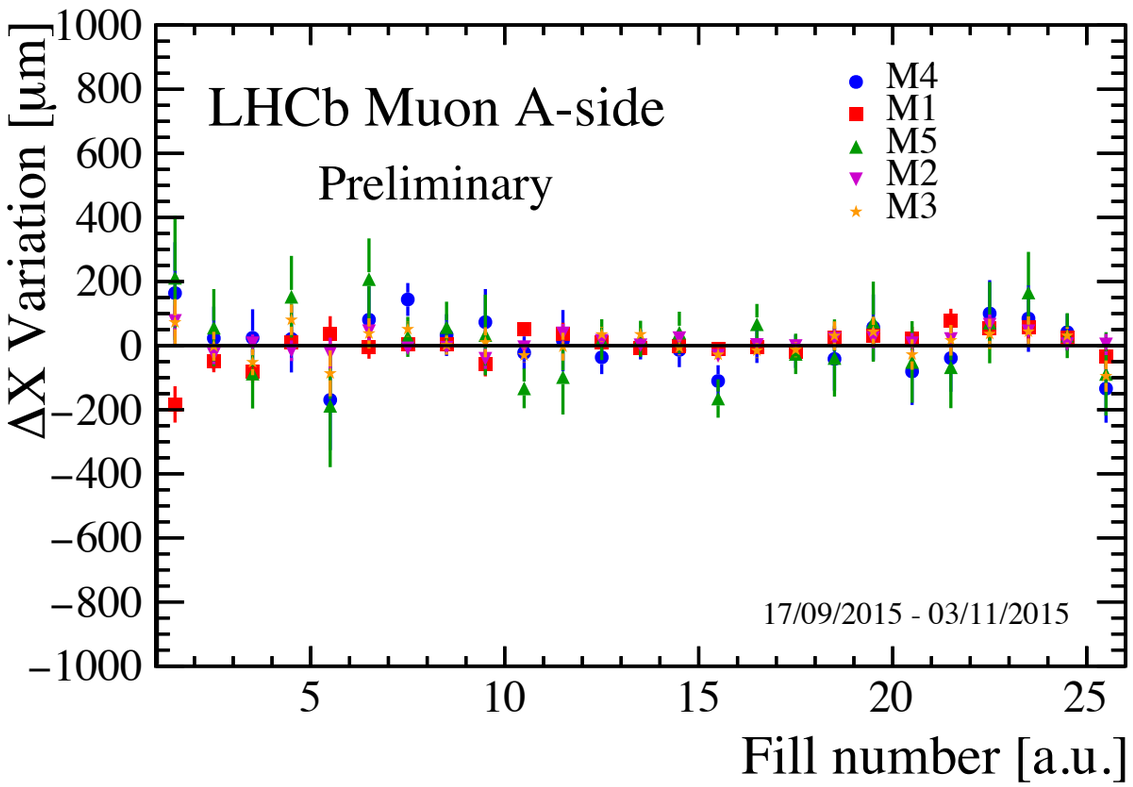


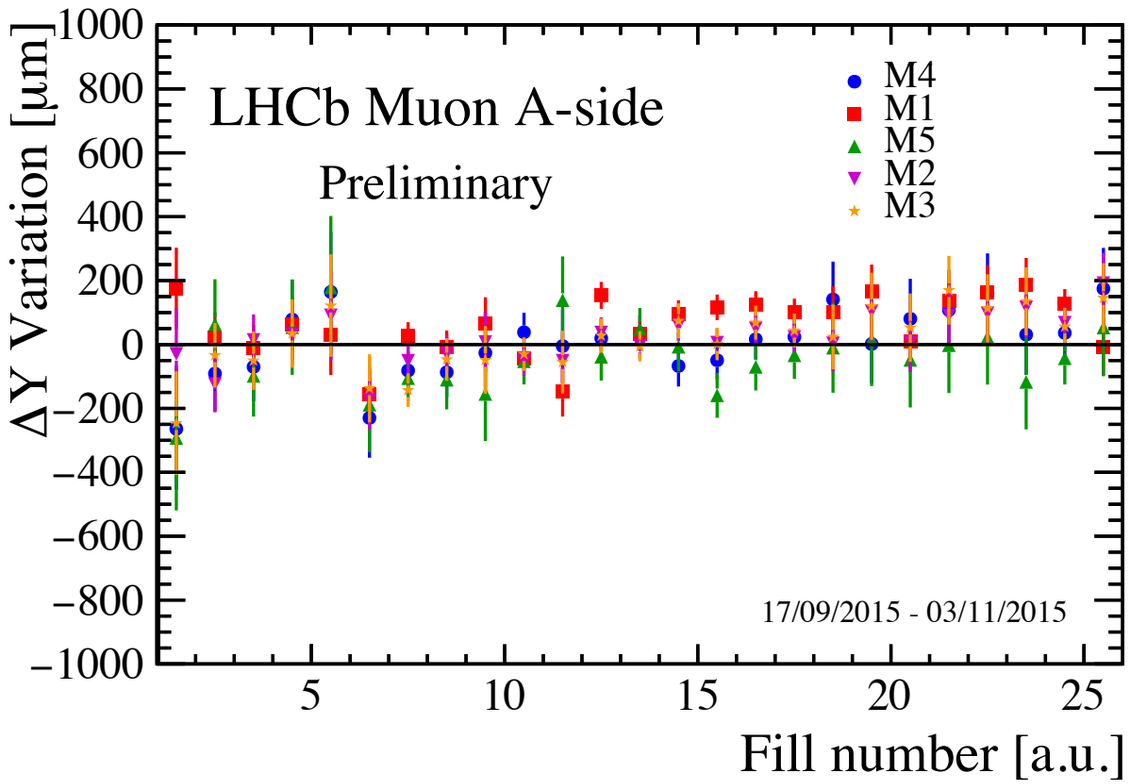
Real-time Alignment

Silvia, Stefania

Status

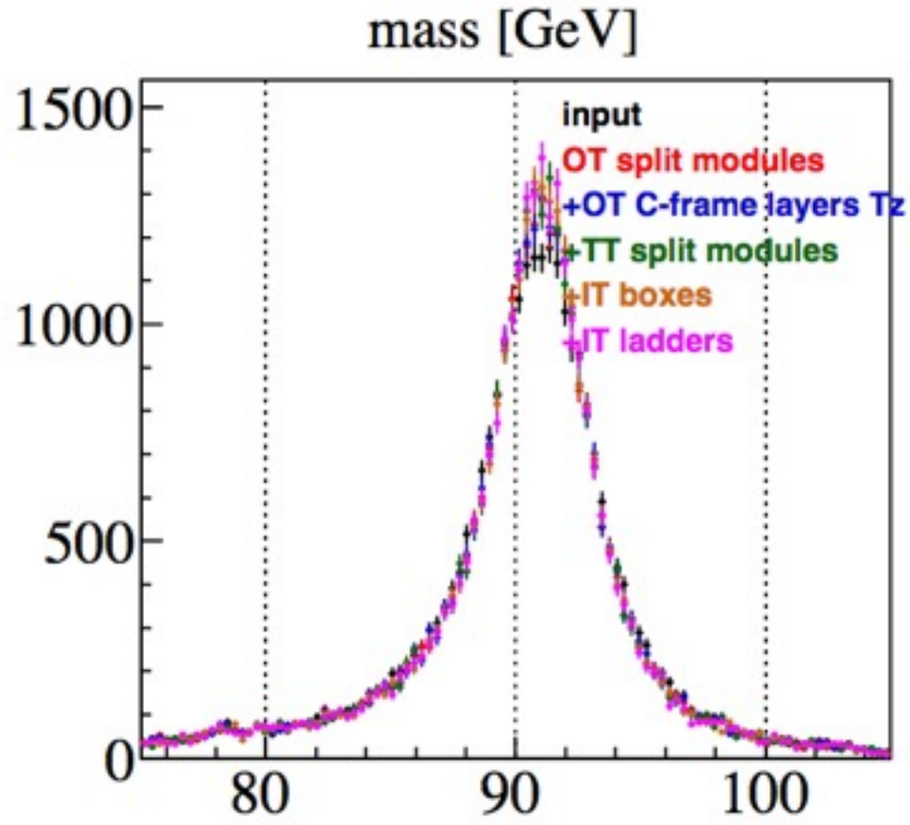
- Muon alignment
  - Stable as expected: no updates needed yet

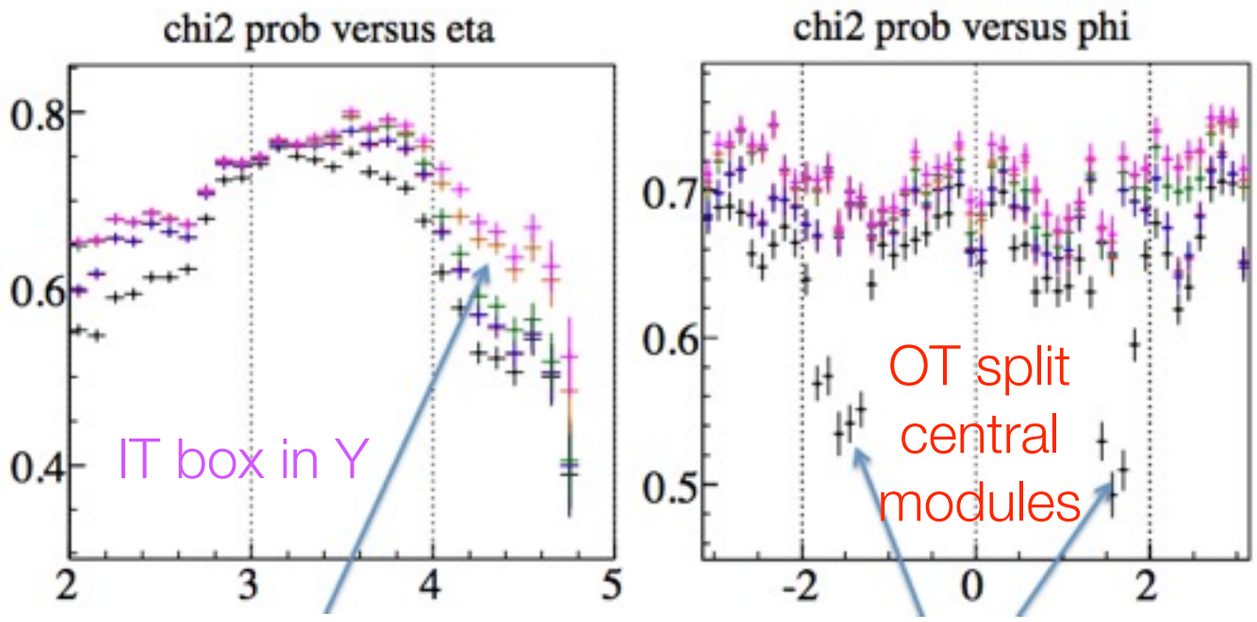




Wouter

Tracker alignment - $Z \rightarrow \mu\mu$ decays





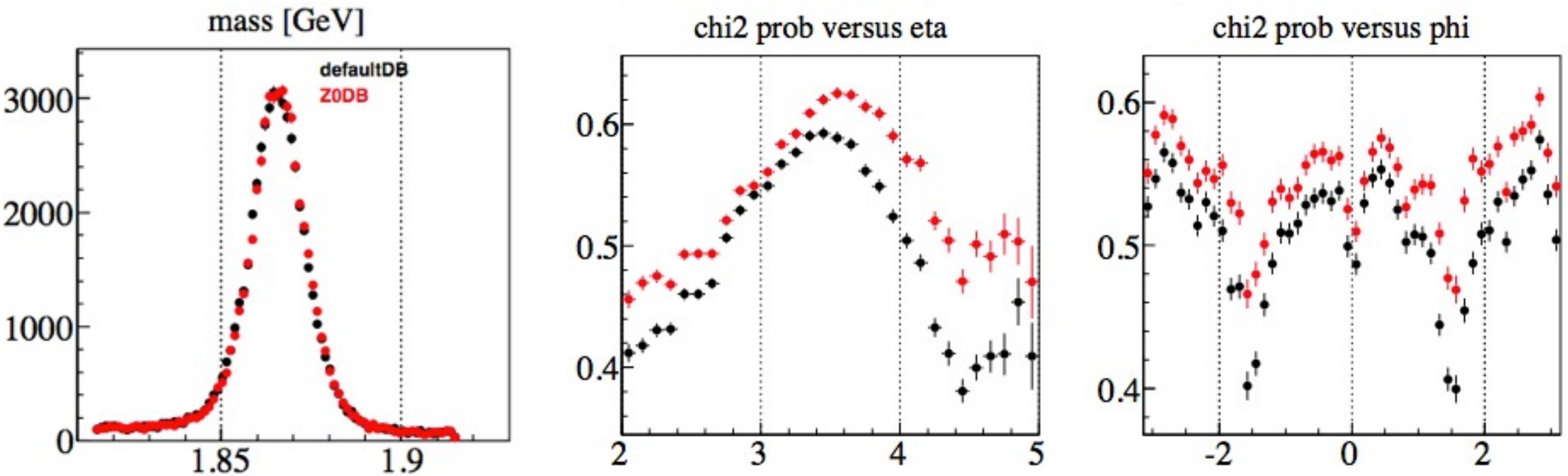
- Uses Z→μμ decays collected in 2015
- Additional D.O.F. used:
  - OT modules split above/below the beam pipe
  - OT C-frames in z
  - split TT modules
  - IT boxes
  - IT layers and ladders
- Z peak ~15% narrower, and improved track χ^2 after alignment
- Database produced recommended for W and Z analyses
  local tag of Caliboff: **CALIBOFF: ttitot-20151228**

Wouter's talk

Wouter, Maurizio

Tracker alignment - D^0 decays

- Use standard sample selection adding D.O.F.s
  - no changes in D^0 invariant mass resolution, but same improvements in track χ^2/residuals as on Z sample



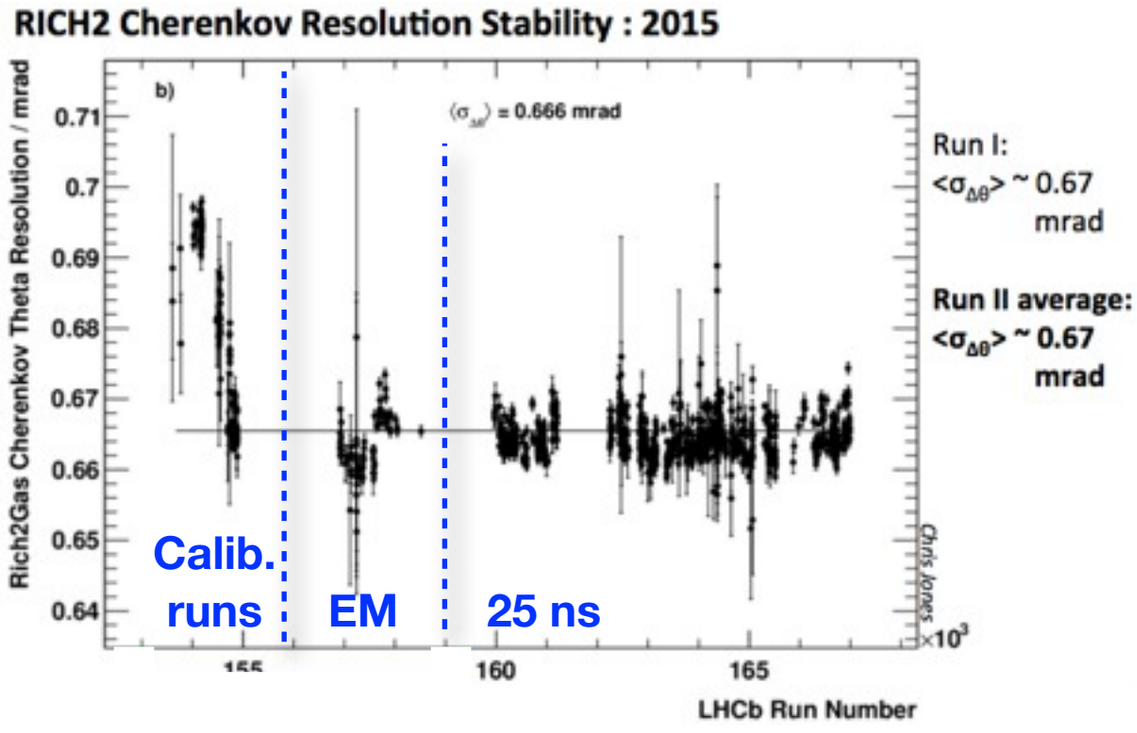
- Z decays give better resolution than D^0 decays, but low statistics: how about adding **high momentum tracks** to the D^0 default sample? - *on going*

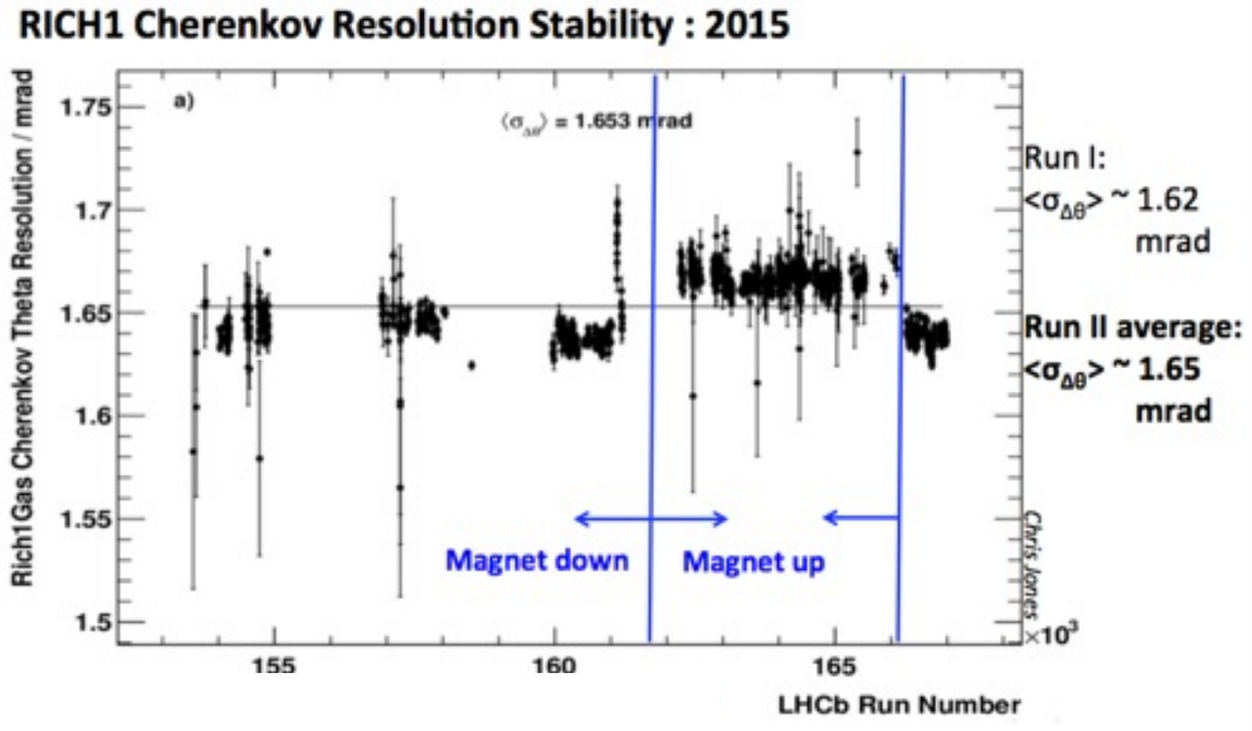
Maurizio's talk

RICH alignment & Calibration

Claire, Paras, Chris, Jibo

- Refractive index and HPD image calibration - stable and working well
- Mirror alignment: working well, several stability studies *on going*





- Monitoring in advanced status!

Thanks Claire and Roel!

Real-time Alignment&Calibration in 2016

Work in progress/to-do list

- Further stability studies ongoing for VELO, Tracker and RICH alignments
- Tracker alignment improvements:
    - Use different/combined particle samples
    - Use additional D.O.F.s to be aligned
- Ongoing improvements with Monitoring histograms/Alarms (for VELO, Tracker and RICH alignment and OT calibration tasks)
- Comparison of BCAM information with IT misalignments

Giulio, Elena, Francesca, Fred, Philippe, Pavol, Maurizio, Lucia, Silvia, Stefania, Varvara, Wouter, Zhirui et al. + RICH team + help from online team

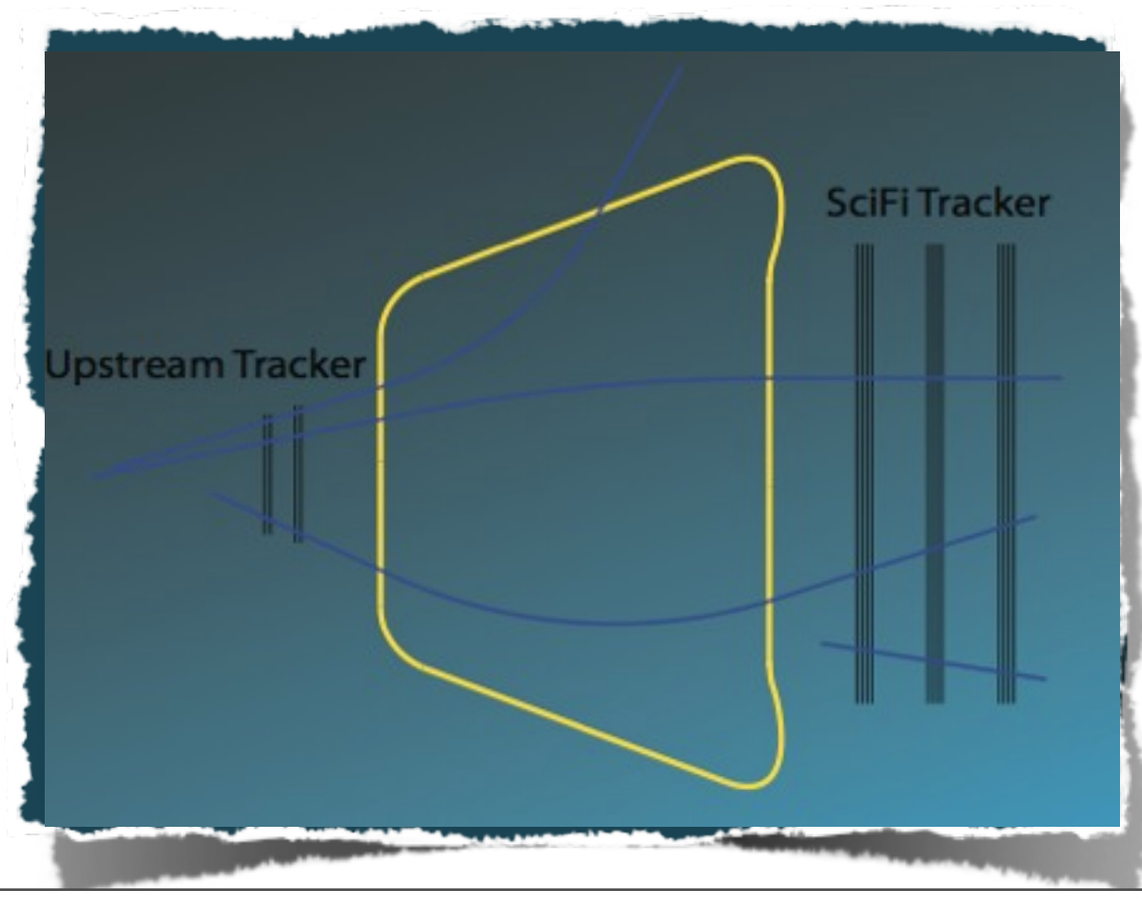
Last but not least:

Michel, Johannes and many others

Reconstruction upgrade task-force

- **Aim until June**: estimate speed of the upgrade tracking, based on CPUs

- **Need:** people working on a simplified geometry and the Kalman filter



Conclusions

- Run II performance numbers ready or being finalized
- Now priorities are:

Getting ready for the data taking in 2016

Alignment & Calibration

- Finalize stability/ optimization studies
- Implement improved sample selection and add D.O.Fs
- Monitoring/Alarms

Tracking

- Gain ~1/3 speed in HLT2
- Save ~10% memory

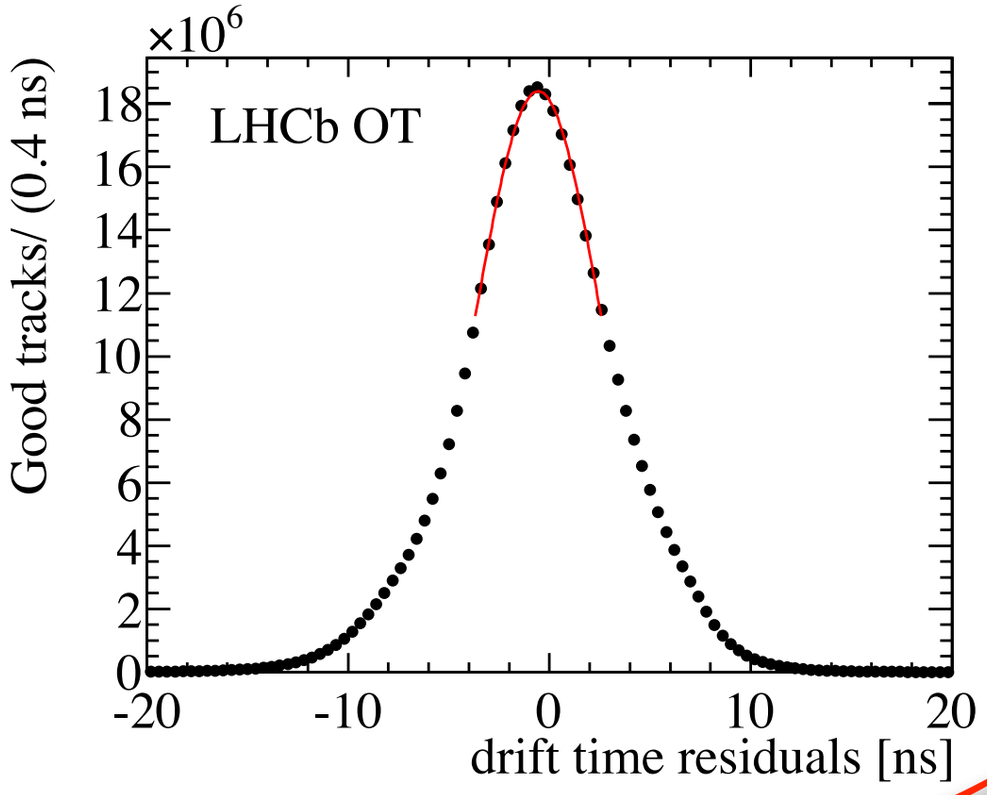
... and for the upgrade

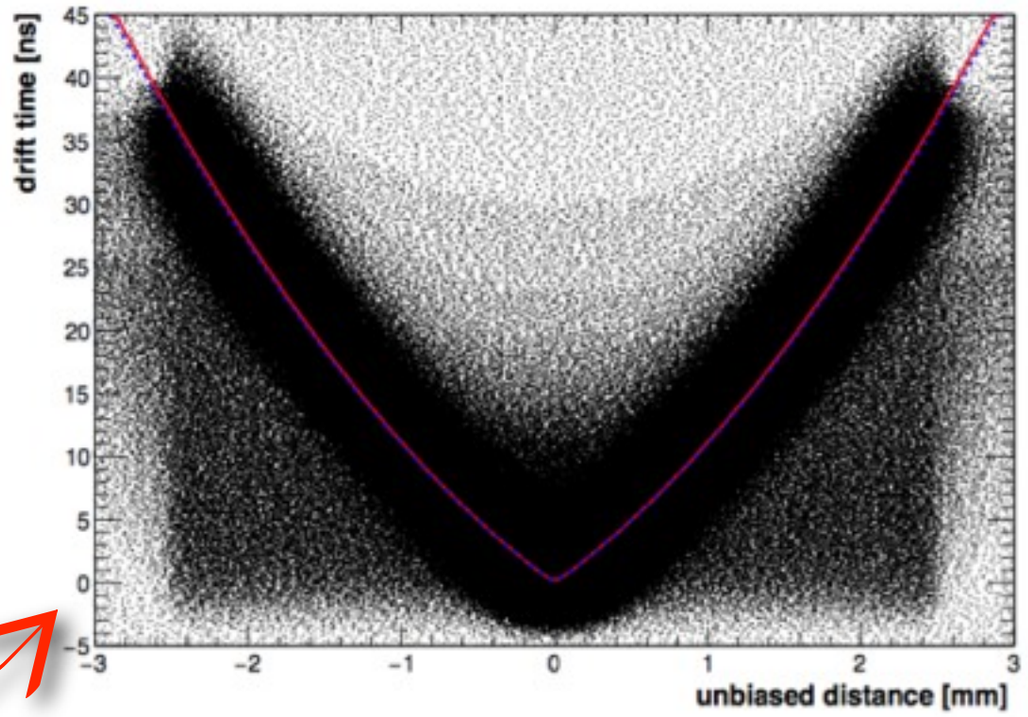
Thank you

OT calibration - Stability studies

Francesco, Lucia, Philippe

- Calibrates OT relatively to LHC clock
- Real-time global t0 offset calibration + per OTIS offsets calibrated offline
- Exploits drift time residuals $\Delta t = t_{\mathrm{meas}} - t(r)$





- TR relation in 2015 is stable wrt 2012
- Resolution evaluation and other studies *on going*

Philippe's talk

PV resolution

Agnieszka, Vava

Agnieszka's talk

Resolution for 25 tracks.

Data sample	$\sigma(x)$	$\sigma(y)$	$\sigma(z)$
Data 2011	0.0139 ± 0.0017	0.0124 ± 0.0016	0.0885 ± 0.0085
Data 2012	0.0135 ± 0.0014	0.0126 ± 0.0009	0.0926 ± 0.0054
Sim08 2011	0.0128 ± 0.0015	0.0123 ± 0.0014	0.0721 ± 0.0064
Sim08 2012	0.0137 ± 0.0016	0.0133 ± 0.0017	0.0827 ± 0.0085
MC11a	0.0119 ± 0.0062	0.0118 ± 0.0049	0.0626 ± 0.0203

from Chris Thomas talk.

	$\sigma(x)$	$\sigma(y)$	$\sigma(z)$
data	0.0129 ± 0.001	0.0123 ± 0.001	0.073 ± 0.001
MC full	0.0127 ± 0.001	0.0122 ± 0.001	0.073 ± 0.001

The resolution for 25 tracks is better for 2015 data (7% for x, even 20% for z).

Real-time Alignment

Giulio, Maurizio, Silvia,
Stefania, Wouter, Zhirui

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