

# Physics Coordination Views for LS1 and Beyond

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## Outline:

- Ongoing activities for Run 1 (2009/10/11/12 data), including reprocessing and MC (details to follow from Luca !)
- Outlook for Run 2 (2015/16/17) conditions and challenges.

## Ongoing Run 1 Activities:

### Sketch of the plan - reprocessing/processing - preliminary:

- For Data12, reprocessing of the prompt streams is basically done (2B events), and we expect to continue high-priority reprocessing with Jet Calibration stream in delayed streams (only 50M events !)
- After this, we are discussing roughly 200M more events in the B-physics and Hadronic streams, using “fairshare” technology and reduced grid priorities to stretch this out over several weeks (and minimize interference with MC production on Tier1). The remaining roughly 500M events in delayed stream should be reprocessed in the first quarter of 2013 - priorities not yet clear.
- Investigating reprocessing of 2011 data. This would use Rel 17.2 (presumably very close to 17.2.7.y being used for 2012 reprocessing). It is proposed to reprocess the MC11 samples starting from HITs files. Data11 is about 1.5B events, but MC11c is already 3.7B, probably 4B by time of reprocessing (also unique samples in MC11a and MC11b ?). Note Data reco and MC digi+reco each take 50% as much time as in 2012 due to reduced  $\mu$  value. Total time would be 2-3 times what was required for Data12 reprocessing => roughly 3 months of significant Tier1 commitment !
- Many technical issues being investigated in DataPrep, Trigger, and Physics Validation communities - decided to make this investment before deciding whether we want to commit to this plan.
- Physics and Data Preservation goals under discussion. Decide early in 2013 ?

## MC Production Planning - very fluid still !

- Current count (moving target !): MC11c roughly 2.0B Fullsim, 1.7B AF-II events. MC12 roughly 2.0B Fullsim, 1.1B AF-II events.
- Do not expect large additions to MC11, but between Top, SM, and Higgs (updating MC11 samples to allow coherent 2011/2012 analyses), expect potentially another 300M events in coming months. Mixture of Fullsim and AF-II.
- For MC12, still working on plan for Winter conferences, but will probably involve about 200M Fullsim events and perhaps 600M AF-II events.
- Producing such samples (say 300M Fullsim plus 800M AF-II) would require at least 2 months of full Tier1/2 MC production capacity => along with reprocessing plans, and group production stresses, we will continue to saturate all resources !
- Plans for Summer timescale are much less clear, and will depend strongly on how successful the above campaigns are at getting out high quality full 2012 data sample analyses in preliminary form.
- Expect that very ambitious plans for Winter conferences will in the end stretch out into April and perhaps even May (interesting conferences in both months).
- Major Summer conference goal will be EPS in late July. Ideally, would like to be wrapping up the majority of high-profile Exotics and SUSY analyses, as well as first round of publications on full-sample Higgs analyses, on this timescale.
- Ideally second quarter 2013 would be filling in gaps in baseline MC samples, more extensive generation of alternate configurations for systematics (+ 2011 reproc ?)

## DPDs and Group Production:

- Updated analysis cache now available for reprocessed data, final stages of validation are underway.
- Many groups (CP and Physics) will want to produce new DPDs on full 2012 reprocessed data sample.
- In addition to the MC production, this updated DPD production is critical path for most Winter conference results.
- **Sequence is complex:** first “foundation” CP groups need to deliver results (tracking performance, jet calibrations), which is in turn required for performance evaluation of more complex objects (B-tagging and Tau performance). Finally, all of this work feeds into the high-profile analyses. Work has already started, but final CP results will most likely not be available before late Jan.
- This leaves physics groups with as little as a few weeks to update their analyses with full 2012 performance results and deliver documents to the collaboration.
- Extremely tight, and many results will not be ready for Winter conferences, but there is a string of conferences all the way through July.
- As usual, setting up for “perfect storm” at Xmas break: large number of MC requests just coming in now, large number of DPD requests just appearing as well, all will be launched into the (already very busy) grid just as everyone leaves for the holidays...
- We hope for a peaceful Xmas for ADC (and PC), but this may be wishful thinking...

## Growing Emphasis on the Future:

- Starting early in 2013, will begin MC13 development campaign involving many new generator configurations, updated simulation options like Data Overlay and ISF production activities, and optimized digitization and MC reco (truth-seeded, etc. ?)
- Already some use cases for production of very large ISF samples (examples include  $H \rightarrow \gamma\gamma$  fitting optimization,  $B \rightarrow \mu\mu$  background studies, SUSY signal grids, and no doubt others still to come like WMass). Easily get into 1B or more events each, but many open questions.
- Two-prong simulation program for upgrades needs to expand. This includes Fullsim to understand detailed performance of “physics objects” (tracking, jets, taus, b-tagging, ETMiss, etc.) using best available models of detector designs for phase-2 in particular. Second prong is to continue with detailed physics studies at 14 TeV (and some at 33 TeV ?) to continue comprehensive evaluation of future ATLAS capabilities. Initially, these studies will involve parameterized performance from physics object studies. Will transition to increasingly detailed detector models as needed. Expect to report another round of physics results for Summer 2013.
- These areas, plus increasing focus on Run 2 simulation campaigns and Data Challenges, will require an increasing fraction of computing resources later in 2013 and throughout 2014.
- Still may be some challenges to keep Tier1/2/3 adequately busy in late 2013 and early 2014, though too early to get very nervous about this yet...

## Thoughts on Transition from Run 1 to Run 2 Infrastructure:

- During first half of 2013, the use of all computing resources to produce rather comprehensive set of results for Summer 2013 (with preliminary versions for Winter 2013) looks unavoidable.
- This may make it difficult to transition in new versions of infrastructure in this period, except for very small-scale testing.
- Would expect that calendar 2013 is the year to do most development, with early deployment in the second half of 2013. Will need to complete deployment and most validation by end of first half of 2014. From then on, it will be commissioning, and the start of a large MC production campaign.
- One issue is the final collision energy in 2015. CERN management has indicated that they will target 13 TeV unless this requires too many quenches (expect less than 100 total quenches to get there, based on limited experience up to now). However, as the machine will be cold only in the second half of 2014, the final energy may not be known until rather late in 2014.
- Not clear what strategy to take in defining 2015 conditions (beam energy, and bunch structure plus  $\mu$  distribution) in time to start MC generation campaign. We will need to make a “phased” start somehow to prepare as best we can given that we don’t know exactly what we are preparing for...

## Outlook for Run 2 Conditions and Challenges

- Present LS1 schedule, as viewed from the accelerator side, does not lead to any physics in 2014, so assume physics restarts in Spring 2015.
- Conditions at that time should be 13 TeV energy, and  $\beta^*=0.5\text{m}$  or possibly slightly less. For now, accelerator team assumes no other improvements.
- Recent experiments with even more complex RF gymnastics indicate the possibility of getting even lower emittance into LHC, and it seems possible to increase the specific luminosity by roughly 1.5 (but only first preliminary results !)
- Many unknowns about 25ns operation still (e-cloud, HOM heating, increasing UFOs, etc.). Will learn more in upcoming MD period, resulting in a few stores of stable beams for physics. However, ATLAS and CMS have pushed hard to convince the accelerator team to start with 25ns and not look back.
- For now, the accelerator team assumes that  $10^{34}$  is the best they can do in 2015 (and quite possibly beyond, as it is limited by injection issues that in principle do not improve significantly until after LS2 when Linac4 is available).
- Recall the best ATLAS estimate (using our definitions of pileup, etc.) is that  $\mu=27$  for a luminosity of  $10^{34}$  and 25ns bunch spacing (double this for 50 ns).
- If higher brightness becomes a production option, this might go up by a factor 1.5.
- Careful analysis of readout performance of ID indicates a hard limit for multiple components at roughly  $\mu=80$ , so roughly  $3 \times 10^{34}$  (25 ns) or  $1.5 \times 10^{34}$  (50 ns).

- Suggests that improvements of our reconstruction and physics object definitions to retain as much of the current performance as possible up to  $\mu=80$  are quite relevant, but perhaps not incredibly time critical if we will be running at 25 ns.
- If the machine insists on running at 50 ns bunch spacing, then this will have a very significant impact on our ability to trigger well on some of the critical Higgs decay modes for a light (126 GeV !) Higgs, and will put much more pressure on high- $\mu$  operation and reconstruction, at least up to  $\mu=50$  or so.
- Machine is considering luminosity leveling in this case (reducing luminosity at the beginning of a store using partial beam separation), assuming ATLAS and CMS could digest pileup at the level of  $\mu=40-50$ .
- Trigger and TDAQ groups have proposed recording data in 2015 and beyond at 1 KHz average rate recorded, rather than the present target of 400 Hz average rate recorded. This would be allowed by TDAQ upgrades, and would allow us to largely retain the thresholds that we use today. However, it requires significant increases in computing resources (though roughly consistent with Moore's law) !
- In the case of 25 ns operation, reconstruction issues would be similar, or even slightly less demanding, than what we have seen in 2012. Therefore, major factor is increase by 2.5 in recording rate, leading to perhaps 5B Data15 events.
- For 50ns operation, higher  $\mu$  would lead to additional digi+reco and reco time, by perhaps as much as another factor of 2 (similarly for disk space if we continue to retain lower PT tracks as we do today).



## Outlook for Luminosity/Samples in 2015:

- The start-up of the machine in 2015 will be slow, and assuming most initial commissioning will take place at 25 ns bunch spacing (50 ns should be a fallback), then real luminosity accumulation might start only in May (?)
- No run extension is foreseen, so the running period would presumably end in Oct or latest Nov (I have no information on Pb-Pb or other special runs in late 2015...)
- Therefore, might expect something similar to 2012, perhaps slightly more (optimistically  $25\text{-}30\text{ fb}^{-1}$  of good data ?). Given higher recording rate of 1 KHz, assume this will translate to 5B Data15 events.
- Scaling from 2011/2012, this would imply 10-15B MC events, but we have to see how new simulation technologies and EDMs evolve over LS1. Can hope that not all MC output will be stored in full AOD format ? Perhaps too optimistic.
- Therefore, would naively assume 5B data and 15B MC events, with sizes similar to today (mean  $\mu$  for 2012 is about 25, and if improvements in injector chain brightness seen recently can be brought into production, would have something similar for a 25 ns run in 2015).