

Overview of HIG contributions to upgrade TDR

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GEM Upgrade workshop III
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“Future Higgs Analyses” group

- started operating Mar 21st with first meeting
- mandate to study future, beyond 2012 data taking, Higgs physics program
 - Higgs properties (mass, spin, width, couplings)
 - add (explore) rare decays and difficult channels (self coupling)
 - untapped non-SM modes
 - VV scattering
- support CMS upgrade program
 - begin with detector-driven approach
 - later reverse strategy in order to guide upgrades based on physics needs
- studies for European Strategy group
- group is setup horizontally in the landscape of Higgs sub-groups

Upgrade TDRs

- CMS is preparing 3 TDRs for the phase 1 LHC upgrade for approval by the LHCC
- These will include physics performance motivations developed in collaboration between Physics Coordination and Upgrades
- **Pixel/HCAL TDRs**
 - first draft available before 25 April/17 May Conceptual Design Reviews
 - pre-view of physics case at LHCC session in June
 - draft for the collaboration approval by mid July
 - send final version to LHCC end of August (for September meeting)
- **L1 trigger TDR**
 - ~6 months later

Contributions to detector TDRs

- **step-by-step approach**
 - recruit people and connect them to upgrade group
 - simulate Higgs signal using upgrade detector
 - comparative studies, i.e. use 2011(12) Higgs analysis and compare performance of 2012 detector with upgrade proposal
 - background processes used to measure performance (standard candles)
 - later (maybe) simulate backgrounds to Higgs searches (difficult)
- **goal for upgrade detector TDRs**
 - quantify effects of upgrade detector on signal efficiency, resolution and background rejection
- **beyond the upgrade detector TDRs (upgrade physics TDR?)**
 - complete upgrade analyses
 - quantify effects on underlying Higgs property measurement

Samples

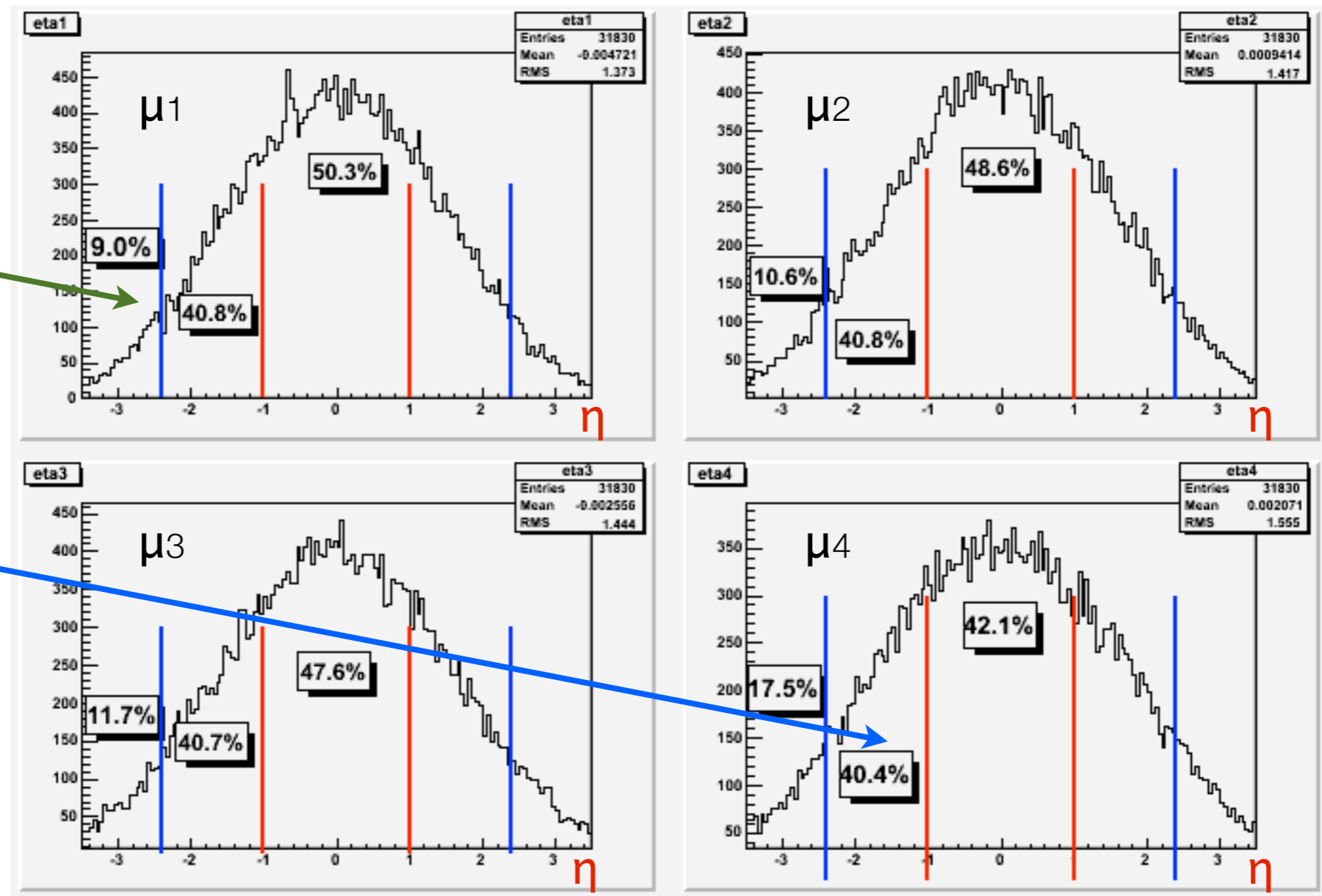
- **general**
 - use PYTHIA for background and PYTHIA/POWHEG for signal as done for 8 TeV production
 - generate at 14 TeV
 - generate with default and upgrade geometry
 - have to find agreement on PU scenario ($\langle \text{PU} \rangle = 50, 25\text{ns}$)
- **standard candles (1M events each)**
 - Z boson production to e, μ and τ
 - top-pair production
- **signal processes (200k events each)**
 - $H \rightarrow b\bar{b}$: VH, ttH
 - $H \rightarrow \tau\tau$: ggH, VBH, VH
 - $H \rightarrow \gamma\gamma$: ggH, VBF, VH
 - $H \rightarrow ZZ(4l)$: ggH, VBF
- **Higgs gen contacts (Christophe and Nicolas) will provide snippets and LHE files**

Studies

- **perform POG-like studies in the context of Higgs searches**
 - **Jets/MET**
 - **forward jet tagging**
 - **b tagging**
 - **lepton (e, μ, τ) identification**
 - **photon identification**
- **evaluate impact on Higgs measurements by comparing with current analysis (default geometry)**
 - **VBF channels: jet tagging, (di-jet mass resolution)**
 - **Higgs strahlung (ZH): lepton id**
 - **$H \rightarrow bb$: b-tagging, (di-jet mass resolution)**
 - **$H \rightarrow \tau\tau$: MET resolution, jet tagging, tau id**
 - **$H \rightarrow \gamma\gamma$: photon id**

H \rightarrow ZZ \rightarrow 4 μ as an example

η distribution of the 4 muons, ordered by their p_T



A significant fraction of the muons lie at $\eta > 1.6$

HL-LHC Physics case

- The post LS1 ($\sim 300 \text{ fb}^{-1}$ at 14 TeV) physics case is relatively easy to state now (assuming Higgs is observed this year)
- The case for HL-LHC ($\sim 3000 \text{ fb}^{-1}$) is less easy to state now
 - Nevertheless, must have some physics goals, supported by studies, in mind already
 - Guide detector design
 - long lead-time for upgrades
- Will need HL-LHC to:
 - Improve measurements of new phenomena seen at the LHC. e.g.
 - Higgs couplings and self-couplings
 - Detect/search low-rate phenomena inaccessible at the LHC. e.g.
 - $H \rightarrow \mu^+\mu^-$, $H \rightarrow Z\gamma$

Conclusions

- Higgs group setup a sub-group to support the upgrade project and gathered people to contribute to the TDR
- we have to connect the PAG with the upgrade people
- important next step is the availability of samples
- selected a few channels to estimate the potential of the upgrade detector
- studies will not be a full evaluation of Higgs physics beyond 100/fb, but an estimation of the upgrade detector performance for specific Higgs channels