Overview of Muon PRS Activities

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CMS Physics TDR

CMS Physics TDR planned for late 2005

- Focus of work for all PRS groups for next year

Vol. 1: Detailed description of how data is reconstructed

- Detector response, physics object definitions, calibration and alignment procedures

Vol. 2: Feasibility studies of Higgs, SUSY, etc.

- Part I: Small number of full analyses
  - Complete analyses including backgrounds, misalignment, and miscalibration
  - Detailed study $H \to 4\mu$, 2μ and $Z' \to 2\mu$ by Muon PRS group
- Part II: Demonstration of the physics capability of CMS
  - General physics topics done with full simulation or detector parameterization
  - Studies coordinated by Analysis PRS groups

Vol. 2: Full Analyses

$H \rightarrow ZZ \rightarrow 4\mu$ (Madrid, UF)

- **Z / Higgs mass fit optimization**
- **Alignment & magnetic field impact**
- **Selection optimization**
  - Different for low and high masses
- **Understanding of all backgrounds in detail**
  - tt, Zbb, ZZ
- **Realistic detector configuration/environment (neutrons)**

$H \rightarrow WW \rightarrow 2\mu 2\nu$ (Bari, Padova)

- **Optimize selection**
  - No mass peak
- **Understand detector issues**
  - μ isolation, jet vetoes, MET
- **Understand backgrounds (tt, single t, VV, Zbb)**

Vol. 2: Full Analyses, Cont'd

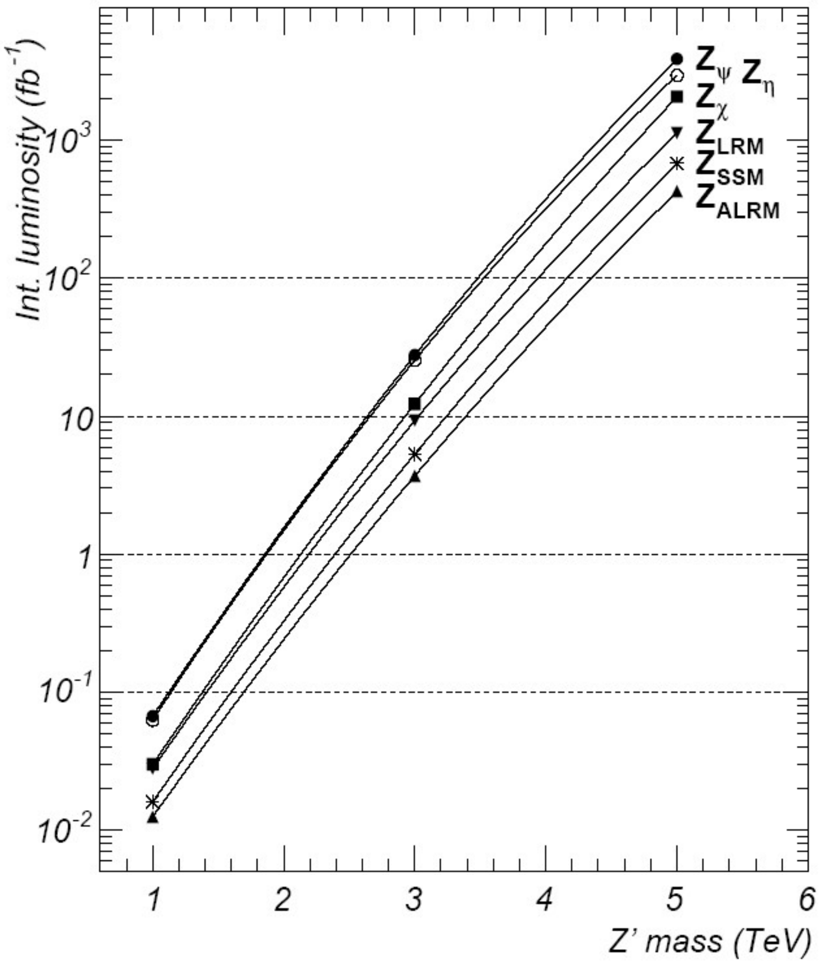
Z' **(Dubna, UCLA)**

- **Very high p_T muon reconstruction optimization**
  - Some improvements incorporated already
  - Small working group formed to study and standardize TeV muon reconstruction issues
- **Bremsstrahlung recovery**
  - Essentially part of above
  - Possibility of adding HE?
- **Alignment requirements / impact**
  - Work on misalignment effects starting
  - Alignment procedures and software still needs help

Z′→μ+μ−: CMS Discovery Potential

Cousins, Mumford, Valuev

Z′ → μ+ μ-: 5σ significance curves



$Z' \rightarrow \mu^+\mu^-$ mass reach:

- $>$ 1 TeV with 0.1 fb^{-1}
- 2.6 – 3.4 TeV with 10 fb^{-1}
- 3.4 – 4.3 TeV with 100 fb^{-1}

N.B.: syst. uncertainties are not taken into account

- Perfect alignment, calibration, B field, etc.;
- Background shape, functional forms of pdf's, mass resolution perfectly known.

Physics Analyses

What's missing from the work done so far is the concept of a systematic error

How does

- Energy/momentum scale uncertainties
- Alignment uncertainty
- PDF and fragmentation uncertainties

impact physics performance/reach?

For example, if I remove 99.5% of the $H \to 4\mu$ background with an isolation cut, what is the uncertainty on the 0.5% that survive?

Back to Volume 1

Detector response

Physics object definitions

Calibration and alignment procedures

First two are in good shape

- ORCA detector simulation has been in place for a while (but reconstruction software needs some detailed validation)
- Cross-check simulation with testbeam data
- First draft of DST format is available

Last two need work!

- But keep in mind that CSC's are nearly calibration-free
- Alignment methods definitely need work

Muon PRS Activities/Tasks

Simulation

- **Validate against real data, particularly beam test data**
  - Not enough analyses being done
  - Good place for new people to start and learn the detector
- **Study/calibrate neutron background simulation for EMU with expected fluence**

Reconstruction tools

- **We have a complete set, but only a first draft**
- **Moreover, there seems to be some problems/issues**

High-Level Trigger algorithms

- **Proof-of-principal algorithms developed**
- **Further optimize performance, speed, robustness**

Calibration and alignment methods

- **Some work started for DT on calib., some misalignment studies started, but not much on alignment procedures yet**

Data handling and monitoring techniques

- **Some work started on CSC data quality monitoring**

Muon PRS Activities Cont'd

Interface between online/offline software

- General framework developed to interface XDAQ with ORCA
- Still waiting for someone to interface real EMU data to ORCA (from beam tests, for example)

Conducting simulated physics analyses under realistic scenarios in order to prepare for data

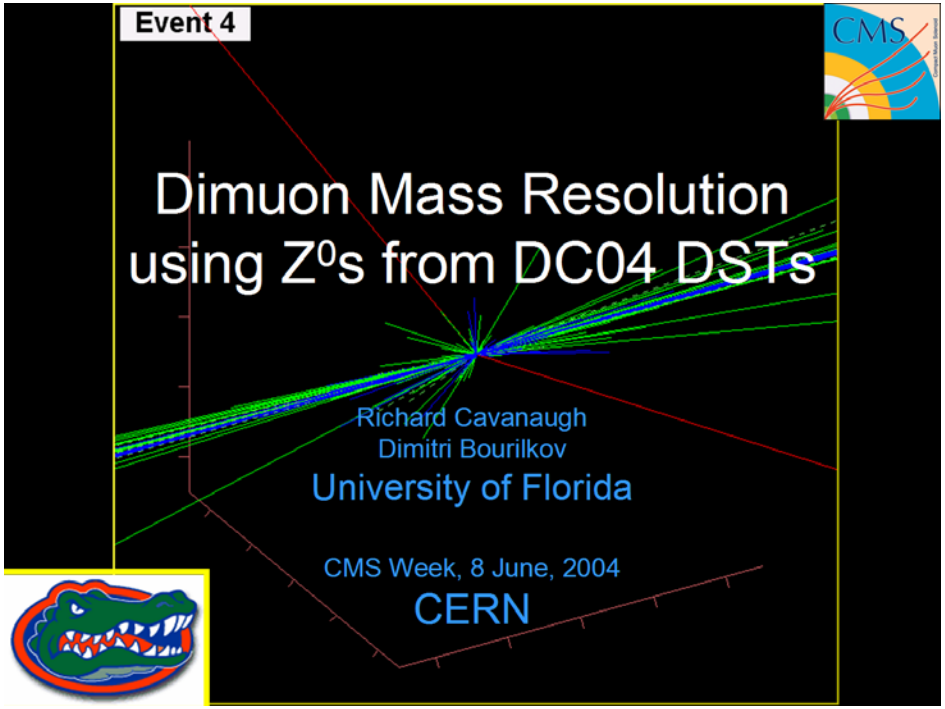
- Various groups tackling flagship analyses for Physics TDR

Semi-detailed list of principal tasks and activities:

- http://cms.pd.infn.it/software/PRSmu/tasks.html

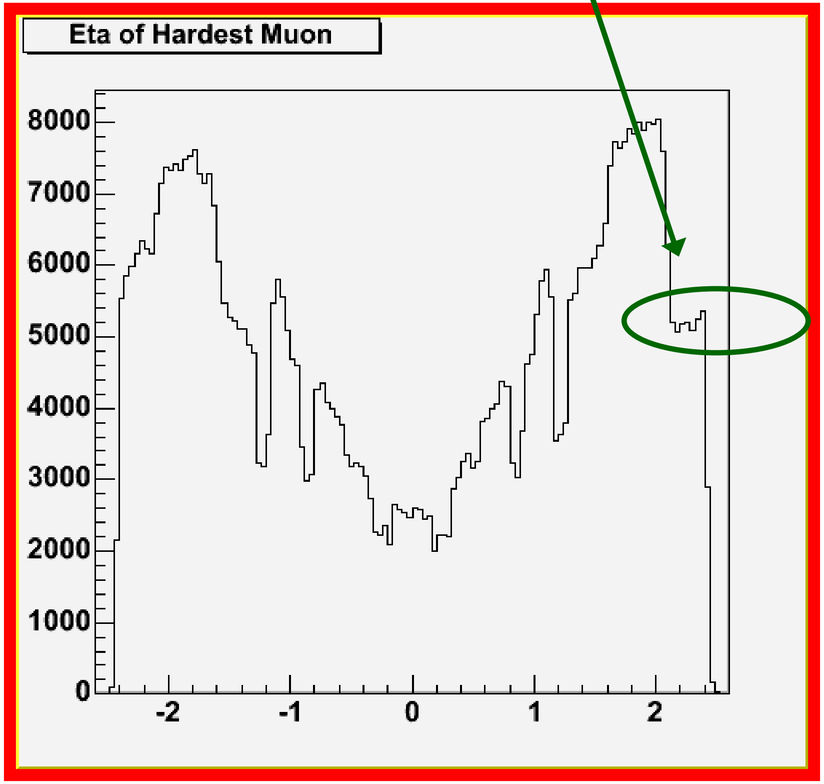
In general we need to train new muon experts to replace the overloaded few who eventually leave

Useful Studies at the Introductory Level



Analysis of recently produced DST Monte Carlo data

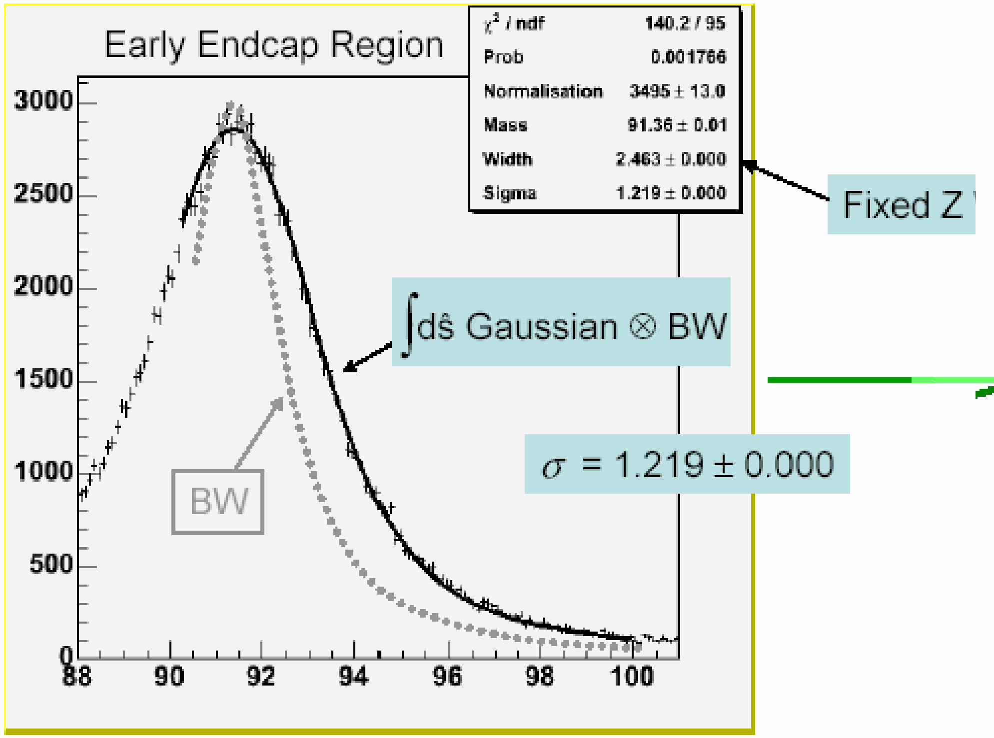
Why is μ efficiency asymmetric?

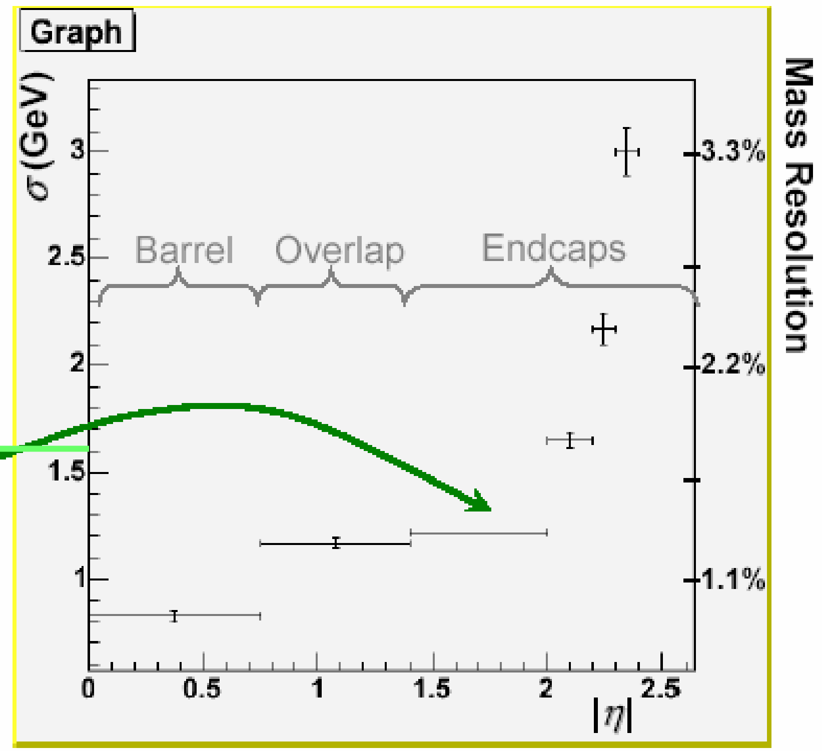


Mass Resolution

Determined from Z^0 peak:

R. Cavanaugh





Would be nice to have as a function of mass as well to provide to Phenomenologist X

Muon Workshop for Physics TDR

- **Each of the PRS groups is organizing a 1–2 day workshop on preparations for the Physics TDR**
- **For the Muon groups, DT and CSC communities will meet separately first, then have a combined meeting during Dec. CMS Week**
  - Likely first discussion: EMU meeting on Oct. 29 and 30
- **Topics:**
  - Front-end and readout issues
  - Simulation and verification
  - Calibration/alignment
  - Synchronization
  - Start-up scenarios
  - Triggers
  - Muon reconstruction and physics objects
  - Physics analyses