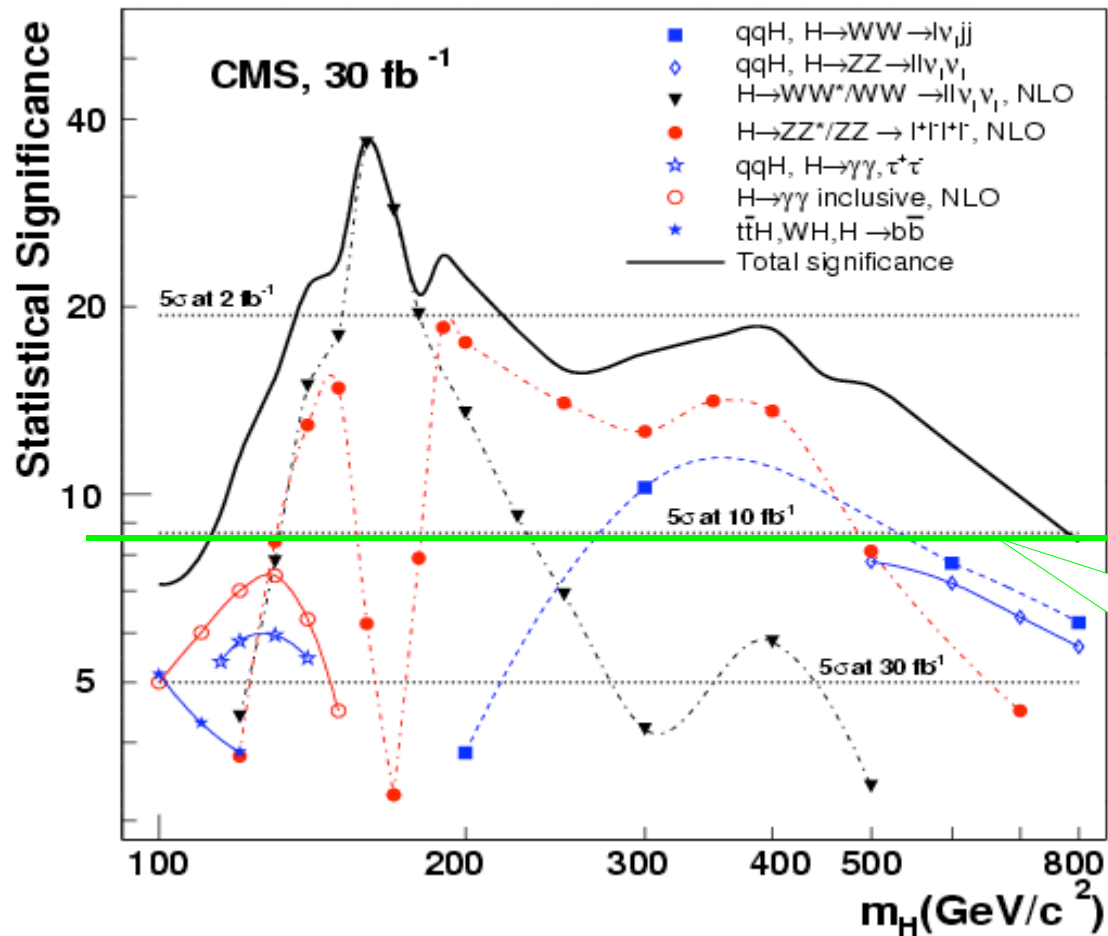


# Status of $H \rightarrow ZZ \rightarrow 4\ell$ analysis

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On behalf of the CIEMAT group

Muon Barrel Week      Aachen 29th April 2004



- $h \rightarrow ZZ(*) \rightarrow 4l$  is a discovery mode
  - true for wide  $m_H$  interval from about 130 GeV to 500 GeV
- h mass measurement
- h width measurement (for  $m_H > 200$  GeV)
- $h \rightarrow ZZ(*) \rightarrow 4l$  - "Golden" channel

Higgs may be discovered for  $10\text{fb}^{-1}$  using  $H \rightarrow WW, ZZ$  decay modes for  $M_H = 130..500$  GeV

- CMS NOTE 2003/033
  - Summary of the CMS Potential for the Higgs Boson Discovery

- Recent talks at CMS meetings in last few months by V.Bartsch (Karlsruhe), A. Drozdetski (UF) , N. Godinovic (Split), B. Mangano (SNS/INFN), A. Nikitenko (IC/ITEP), M. Sani (Firenze) - activity is very high
- Recent study for low Higgs mass: "*Observability of Higgs boson decays to four muons in the low mass range*", V.Bartsch, J.Weng, G.Quast, CMS Analysis Note 2003-007, V.Bartsch's PhD thesis
  - Attempt to make full simulation and reconstruction but not realistic yet
  - Radiation in the final state is not taken into account at the reconstruction step
  - High Level Trigger reconstruction was used instead of off line reconstruction
  - objects: muon, isolated muon were not optimally defined
  - cuts were not fully optimized
  - Signal generation needs to be improved
    - using NLO generators for producing events
    - taking into account spin correlation effects may lead to different angle distributions and a particular (different) set of kinematical cuts
  - Internal bremsstrahlung consideration
  - etc...

- Main backgrounds are  $ZZ$ ,  $t\bar{t}$ ,  $Zbb$
- Other potential backgrounds have not been considered in previous analysis
- Some processes are already studied by A.Drozdetski
  - the following processes give negligible contributions into 4 muon final state:  
 $WWW, ZWW, ZZW, ZZZ, WWWW, ZWWW, ZZWW, ZZZW, ZZZZ$
  - some others need further investigation  $t\bar{t}W, t\bar{t}Z, t\bar{t}+WW/WZ/ZZ$
- Several other (mainly QCD) backgrounds should be considered
  - weak bosons + jets, multi jets
    - can be easily suppressed, but have big cross sections  $\square$  careful check needed
  - QCD backgrounds with fake leptons needs to be considered
  - Correct treatment of pile-up and neutron backgrounds
- Current generator PYTHIA will be replaced by HERWIG which generates background better



- Neither signal nor background samples got in the prioritized list for DC04 □ left for post-DC04
  - We have pushed to start production asap
  - In parallel with Tier1/Tier2 activities we have started the production of these samples
- **Background tt:** 95000 events generated, (OSCAR) simulated and digitized
- **Background ZZ:** 5000 events generated, (OSCAR) simulated and digitized
- **Background Zbb:**
  - B was forced to decay to □. Other decay modes were not properly taken into account □ this background was underestimated by a factor 3
  - Taking into account off-mass shell  $Z/\_*$  may give up to 20% more events
  - New sample was generated by A.Drozdetski.
  - Production at CIEMAT will start soon

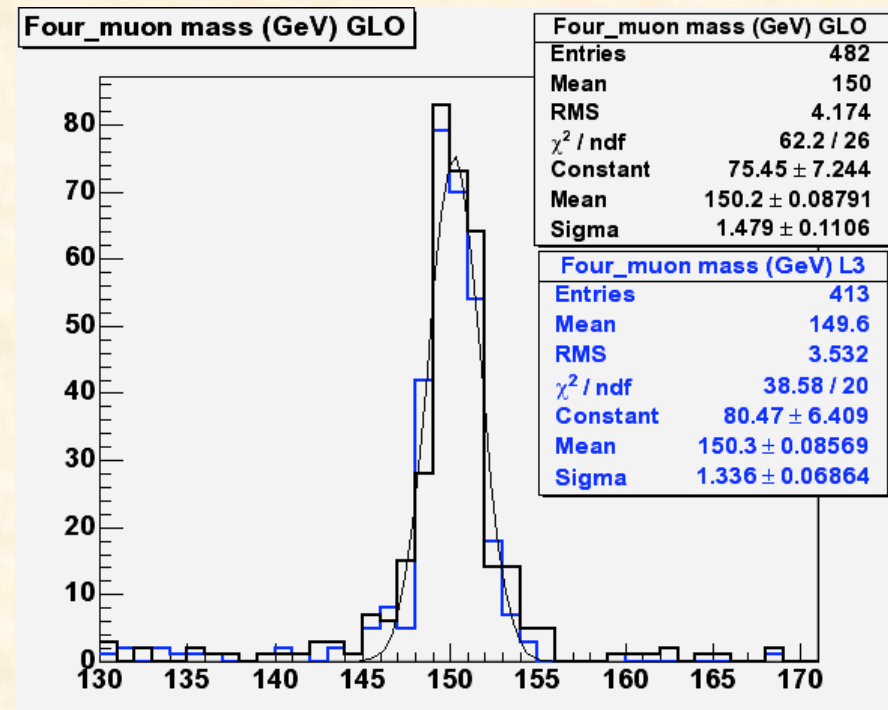
- **Signal:** requested 10k events at masses

115,120,130,140,150,160,170,180,190,200,250,300,350,400,450,500,550,  
600 GeV plus 200, 300, 400 GeV with CP odd

- PHOTOS was used to improve the spectrum of the gamma radiated by Z
- CMS adaptation had an incorrect treatment of Z→tau:
  - If gamma emitted, taus with new energy were not recorded and secondary energies were not rescaled
  - It made OSCAR crash after few events
  - Finally last friday we got a correction, we have tested it and new CMKIN release needed asap to restart the production

- New release this week of production software that permits to produce DST outside CERN
  - If this is confirmed we can get DST of background and signal in few weeks

- In the meantime we have produced 1k events at mass = 150 GeV to tune our DST-based analysis code
  - Private version of CMKIN to avoid crashing

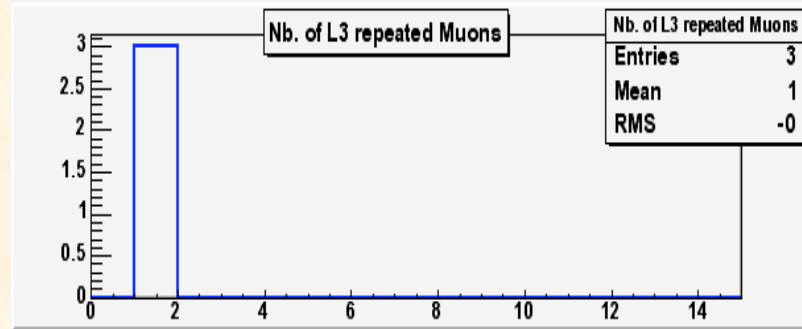
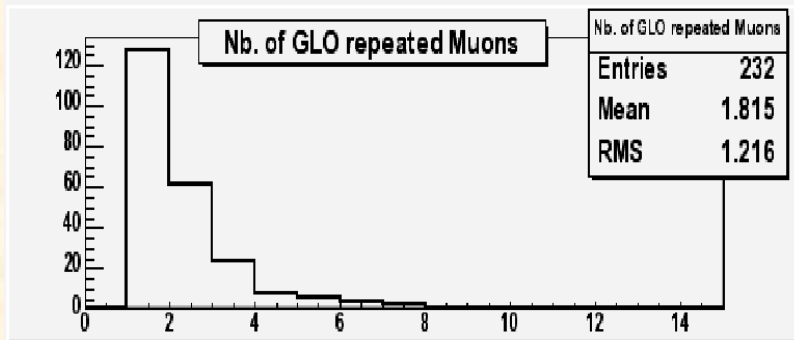


- **Too slow: 500 s to read 1000 events**

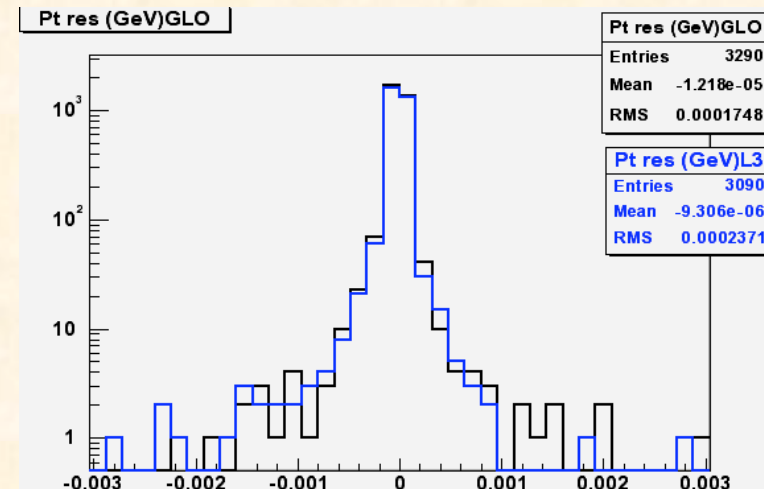
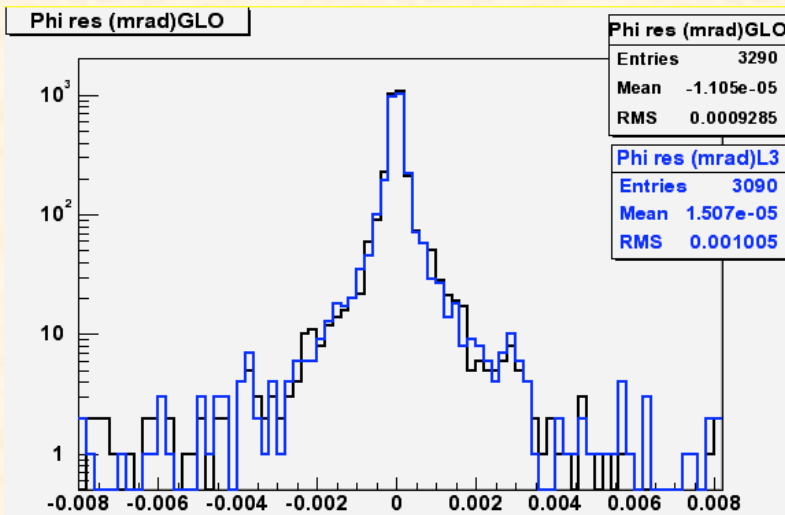
G3EventProxy::create 949 442.483 (real) 423.741 (cpu)

- We have to think in producing a Muon ROOT tree or something similar

- GlobalMuonReconstructor still have some problems (and StandAlone):
  - Many repeated muons ( $\Delta Pt < 0.3$ ,  $\Delta\phi < 0.01$ ,  $\Delta\eta < 0.01$ )



- Similar resolution





## Generalities:

- Manpower available from CIEMAT group, previously dedicated to DC04 and PCP
- CIEMAT interest is on the whole mass range.

## Production:

- Investigating generator problem with PHOTOS
- Continuing with the official production (4mu signal and background)

## Reconstruction:

- Z & H mass fit optimization: recover from internal Bremsstrahlung
- Optimization of the cuts, in particular for low luminosity:  $L \leq 10 \text{ fb}^{-1}$
- Background studies: estimation from data (and Monte Carlo)
- Systematic effects: alignment, calibration, magnetic field uncertainties
- Efficiencies from data