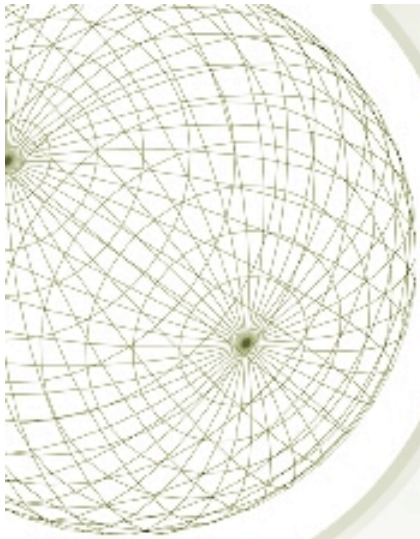

$Z \longrightarrow e^+e^-$ and PDFs
Summary of the PDF4LHC workshop

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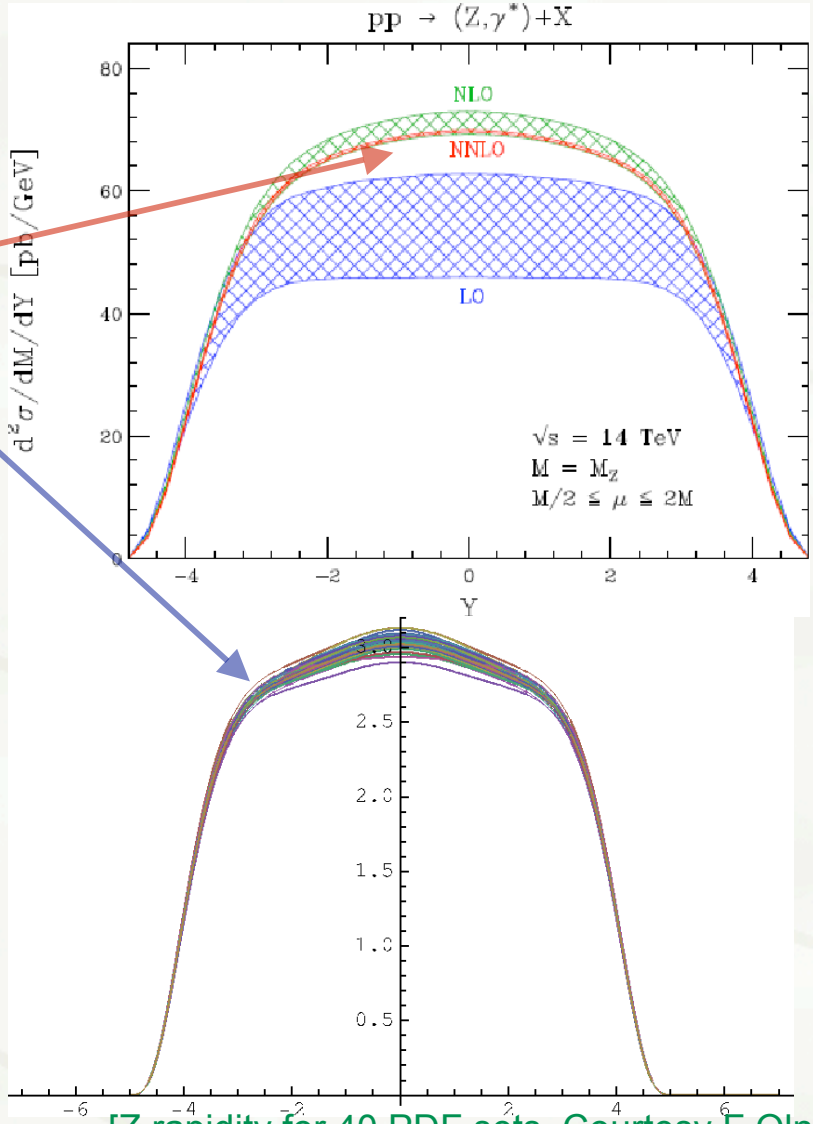
$Z \rightarrow e^+e^-$

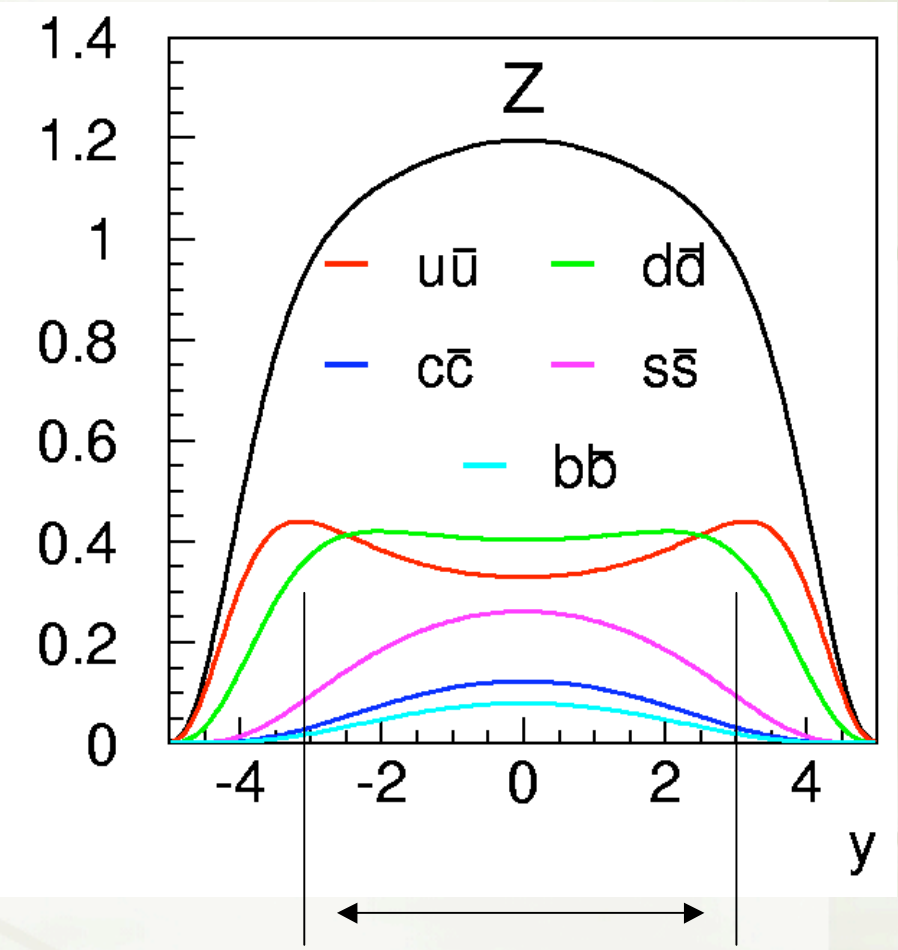
- $Z \rightarrow e^+e^-$ is very nicely predicted at the NNLO:
  - Theoretical uncertainty < 2%
  - BUT PDF uncertainty ~ 5% in the central region
- Total Z cross section constrains PDFs, but this is difficult due to the large Luminosity uncertainty
- Rapidity distributions may offer precise early information, independent of lumi, to constrain PDFs



[Z rapidity for 40 PDF sets, Courtesy F.Olness]

Flavour Decomposition of Z production

- Z decomposition in different flavours at LHC energies shows for ex:
  - At eta=0: ddbar > uubar
  - At eta=3: uubar > ddbar
- Looking at the rapidity range, different detectors are more sensitive to a specific flavour than others: EMEC, EMB, FCAL
  - Need uniform detector acceptance



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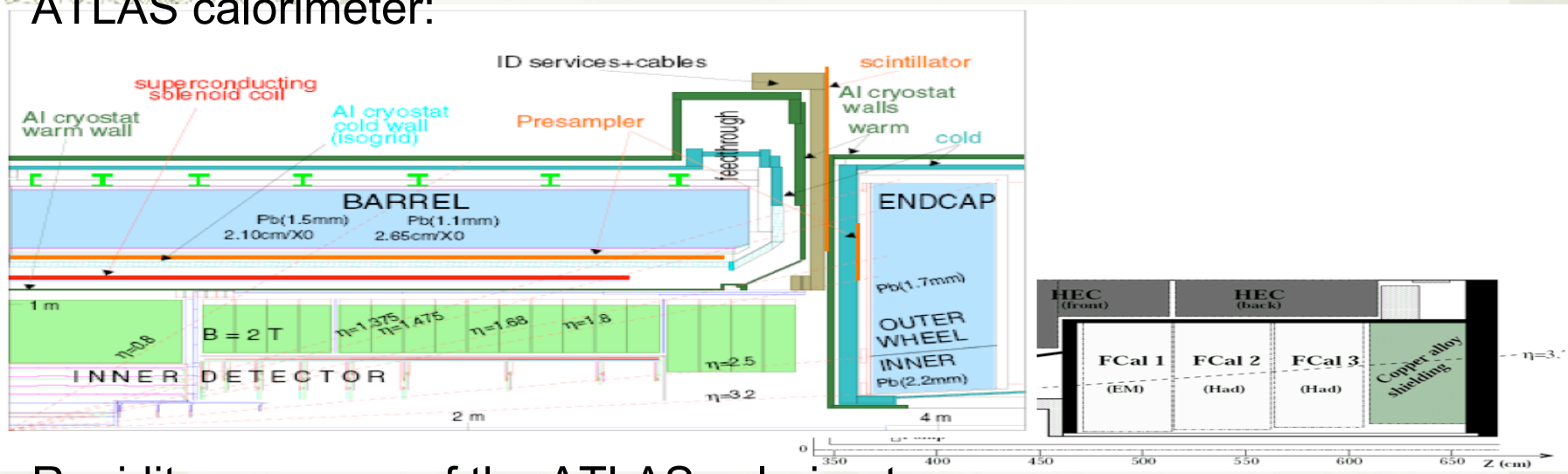
ATLAS Detector and calorimeter

ATLAS calorimeter:



Rapidity coverage of the ATLAS calorimeter:

EM Calo	Barrel $\|\eta\|<1.475$	End-Cap $1.375<\|\eta\|<3.2$
Presempler	Barrel $\|\eta\|<1.52$	End-Cap $1.5<\|\eta\|<1.8$
Hadronic Tile	Barrel $\|\eta\|<1.0$	Extended Barrel $0.8<\|\eta\|<1.7$
Hadronic LAr		End-Cap $1.5<\|\eta\|<3.2$
Forward Calo		End-Cap $3.1<\|\eta\|<4.9$

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Statistics

- Rapidity distributions may offer precise early information on PDFs if we accumulate enough statistics:
  - 10,000 per 0.1 bin in eta -> 600,000 Z events
    (a week of data taking, assuming 1Hz :))
- Cross section measurement to 2% differentially in eta requires large MC simulation (a factor of 3 data statistics) => USE FROZEN SHOWER MC as much as possible:
  - Need uniform description for EMEC, EMB, FCAL

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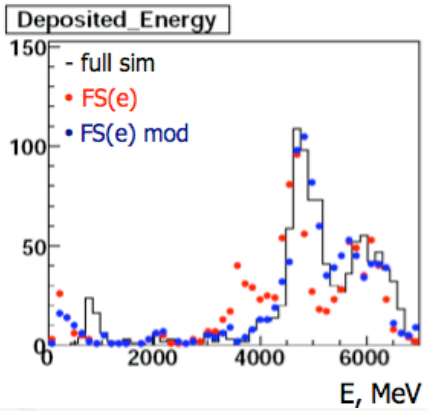
Frozen Showers for EMEC

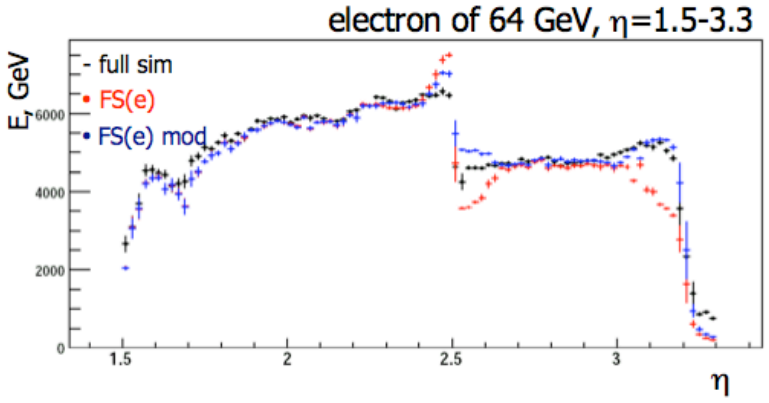
- Previously shown (Ringaile):

Frozen Showers for EMEC

Possible to improve FS response generating library with the eta bins more far from the crack/edge region

e.g. generate FS lib bin at eta=2.8 while read the same bin as it was generated at eta=3.15





We understand that part of variation is due to frozen shower simulation containment check. Work in progress.

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Summary for Z->ee analysis

- Z->ee rapidity distribution is sensitive to PDF flavour decomposition
- 2% differential measurement provides interesting PDF constraints
- Z->ee is a good channel due to large rapidity coverage by the calorimeters
  - Requires detailed large statistics simulation => use of frozen showers

Summary of the PDF4LHC workshop

- The PDF4LHC workshop at CERN, 22-23 February 2008
- The key idea: a joint effort of theorists and experimentalists to get the best PDFs and their errors
  estimate before the start of LHC based on:
  - HERA/TEVATRON input data
  - Theory
  - Fitting uncertainties
  - LHC constraints

Topics covered at PDF4LHC

http://indico.cern.ch/conferenceDisplay.py?confId=27439

- Plenary session:
  - CTEQ/MRST PDF developments:
    - new PDF sets available
  - Comparisons of PDFs
  - Input data and LHC needs for PDFs
- Technical sessions:
  - PDFs at the LHC
  - Uncertainties on PDFs → our contribution
  - PDFs for MC generators

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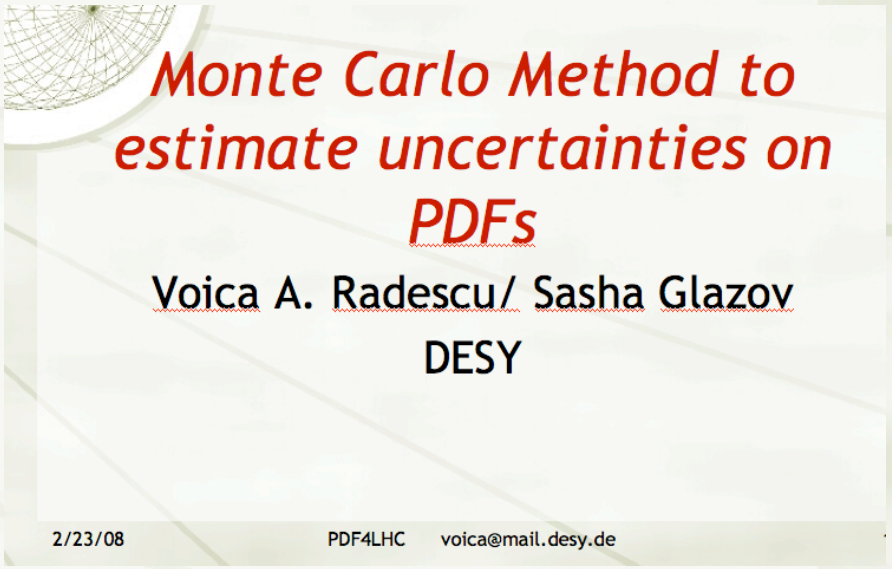
Our contribution for PDF4LHC

- We proposed a new method to evaluate the PDF uncertainties Monte Carlo Method:
  - It provides an independent cross check of the standard estimation of the errors.
  - It is simple and more general (i.e. doesn't have to rely on the Gaussian distribution assumption for the norm. uncertainty)



- Study was performed on H1- HERA I data - NC and CC e±p scattering cross sections using H1 QCDNUM implementation (NLO):
  - Fits performed in MSbar renormalization scheme using DGLAP evolution at NLO, massless quarks, a la H1PDF2000, using polinomial form to parametrise PDFs [ref: Eur. Phys. J. C 30, 1-32 (2003)]

Method

- Notations:
  - Data point → σ_i
  - Uncorrelated Uncertainty → δ_i^{uncorr}
  - Correlated systematic sources → α_j
    - Their effect on the data points → δ_{ij}^{corr}
- Prepare a shifted data set:
  - Shift the central value by taking into account the uncorrelated and correlated uncertainties:
    - For only uncorrelated uncertainties: $\sigma_i = \sigma_i(1 + \delta_i^{uncorr} RAND_i)$
    - For correlated uncertainties:
      - Generate shifts for α_j → $RAND_j$

$$\sigma_i = \sigma_i(1 + \delta_i^{uncorr} RAND_i + \sum_{j}^{N_{sys}} \delta_{ij}^{corr} RAND_j)$$

- RAND is generated random number in a Gauss Distribution

•Repeat the preparation and fit N times (N=100)
  •Extract PDFs (100 times)
•Estimate RMS of the spread => PDFs uncertainties

Not necessarily!

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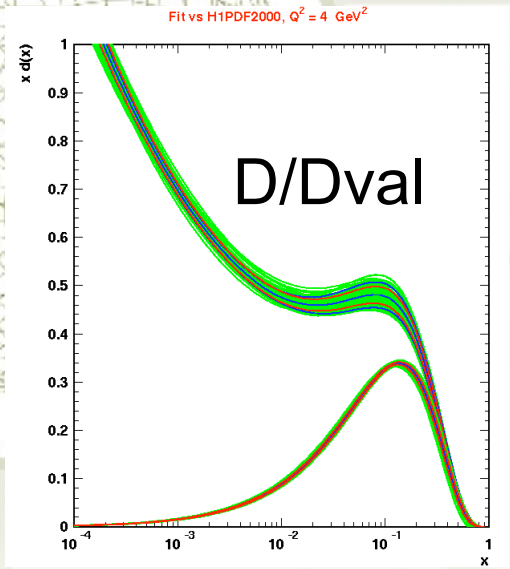
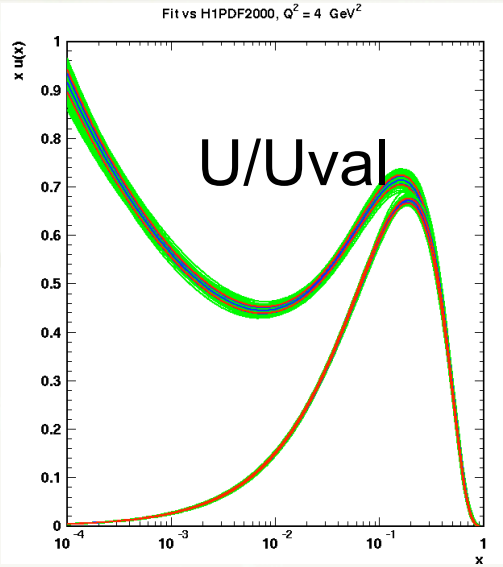
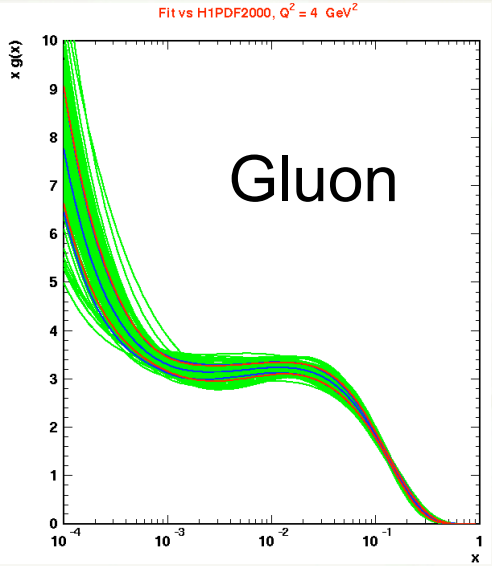
Results







- Plots shown for
  - 100 Green lines
  - Red lines: PDF uncertainties from RMS
  - Blue lines: Hessian errors
- Good agreement with the standard error propagation method

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Summary of the PDF study

- A simple method to estimate PDF uncertainties built within QCD Fit framework
- Allows to check non-gaussian distributions for the experimental uncertainties
- Simple error propagation to any observable

- Plan to study log-normal distributions of the systematic uncertainties based on combined HERA data
- Add estimation of Z->ee uncertainties

Parametrisation uncertainties for PDFs

- Experimental uncertainties for PDFs are under control using various method
- Other source of uncertainties, fixed parametrisation form of PDFs is harder to estimate
  - Use flexible PDF parametrisation based on neural networks

  [ref: R. D. Ball, L. Del Debbio, M. Ubiali (Edinburgh), S. For te, A. Piccione (Milano), J. I. Latorre (Barcelona), J. Rojo-Chacon (LPTHE - Paris), Alberto Guffanti (U. Freiburg)]
- We agreed to provide validation of their fitting program vs H1 QCDNUM Fitting code

Outlook

- Next PDF workshop will be during "HERA and the LHC" meeting at CERN, 26-30 May 2008
- Will update the PDF error estimation
- Plan to present a common analysis with NNPDF collaborators