Summary - Standard Model Electroweak Processes at LHC

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12.03.2010

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Outline

1. Summary of the Lecture
   - The Standard Model
   - W/Z production
   - The ATLAS detector
   - Tag 'n' Probe
   - Detector calibration
   - Weak Mixing Angle at the LHC
   - Also mentioned

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2. Suggestions

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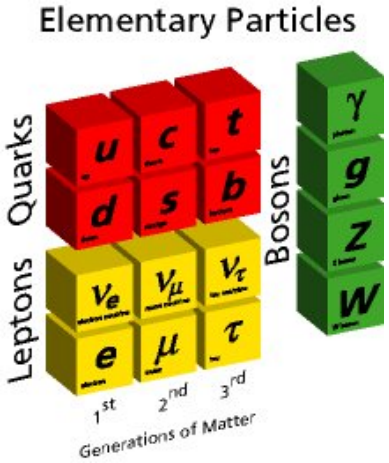
The Standard Model

The standard model of particle physics

The standard model of particle physics describes three of the four fundamental interactions.
The electroweak interaction is the unified description of the electromagnetic and the weak interaction. The gauge bosons are γ, W and Z.



Mixing angle

$$\begin{pmatrix} A \\ Z \end{pmatrix} = \begin{pmatrix} \cos\Theta_W & \sin\Theta_W \\ -\sin\Theta_W & \cos\Theta_W \end{pmatrix} \begin{pmatrix} B \\ W_3 \end{pmatrix}$$

$$\frac{M_W}{M_Z} = \cos\Theta_W + \text{ corrections (NLO,NNLO...)}$$

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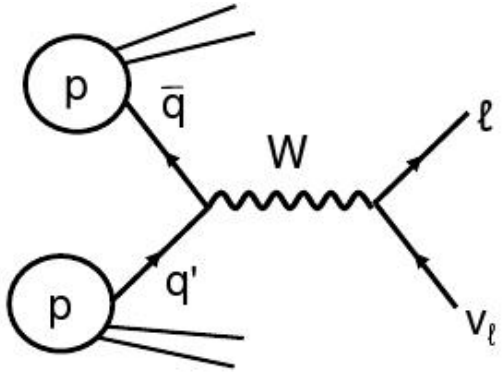
W/Z production

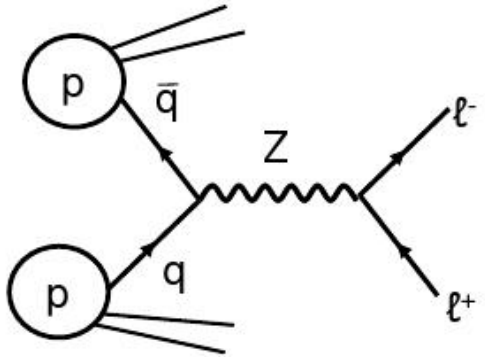
W-Boson-Production

- measurement of the W boson mass
- background to search channels (W+jets)



Z-Boson-Production

- calibration of the detector
- $\sin^2 \Theta_W$ from forw.-backw. asymmetry in $Z \longrightarrow ee$ events



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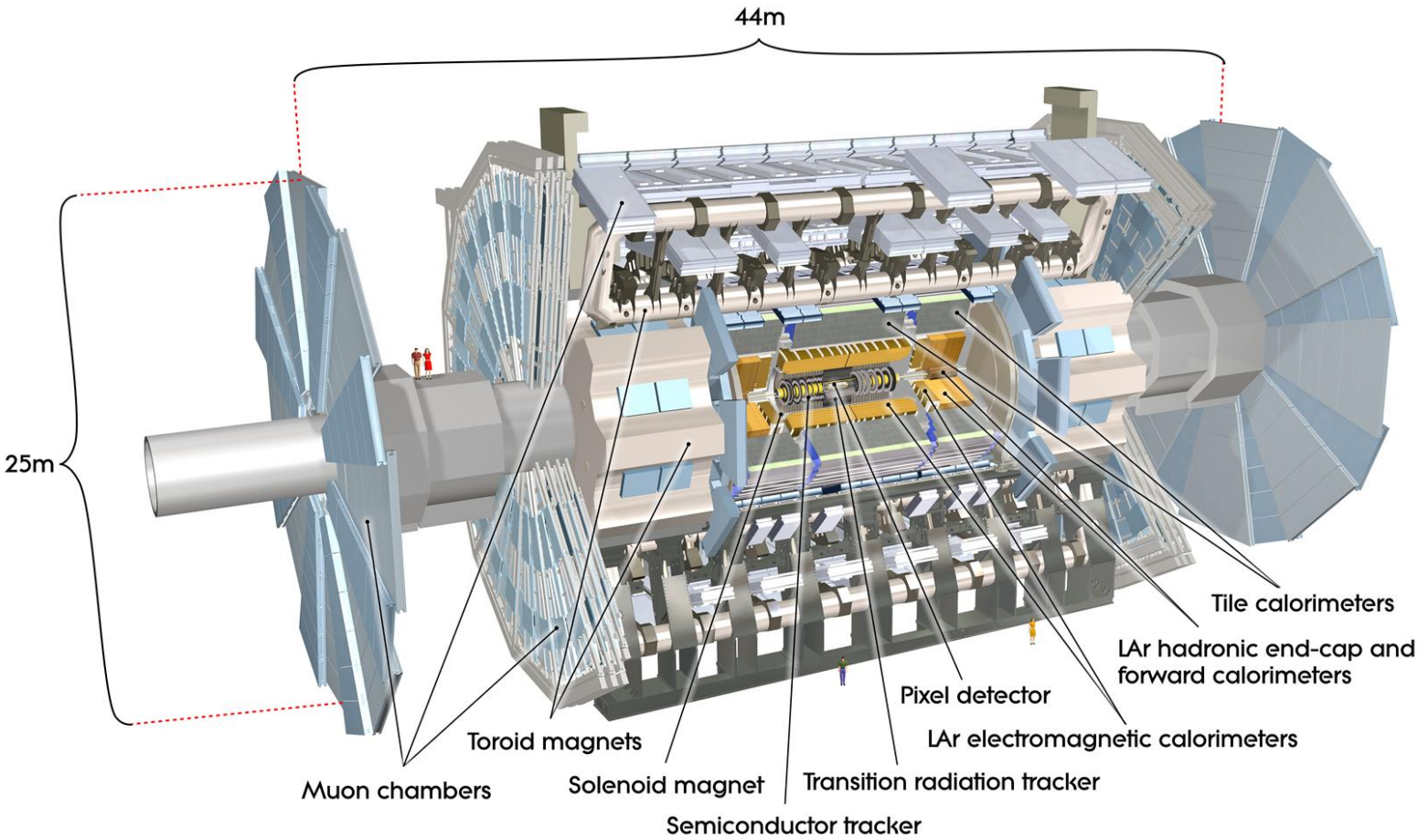
The Atlas detector



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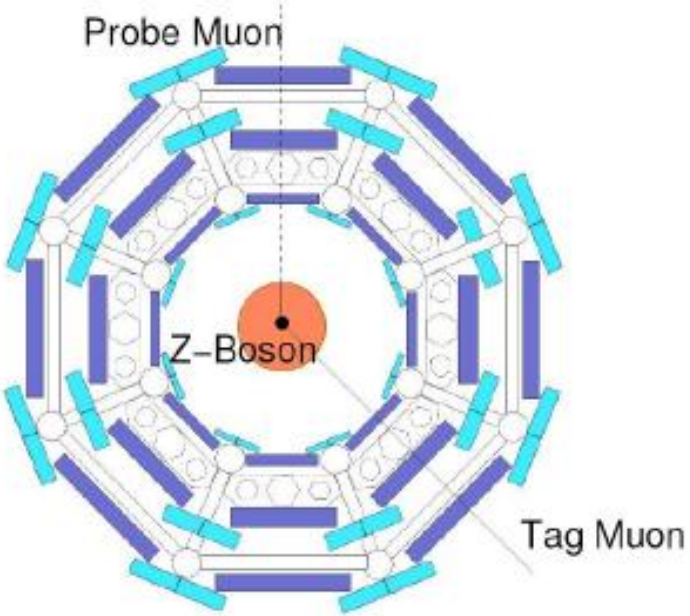
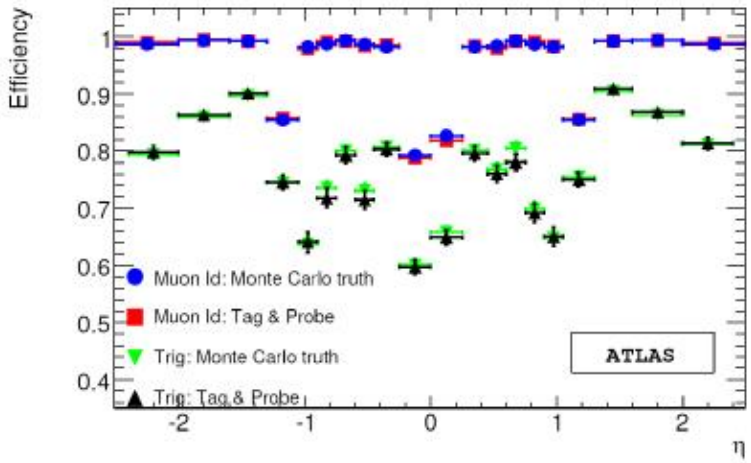
Tag 'n' Probe





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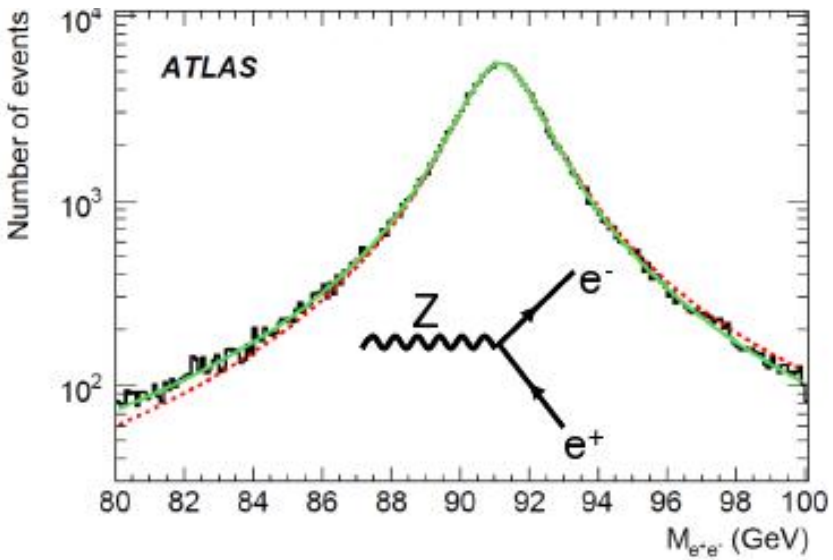
Detector calibration with Z-bosons

- look at $Z \longrightarrow ee$
- use Z-mass from LEP ($m_Z = 91.1875\ \mathrm{GeV}$)
- fit with Breit-Wigner: $BW(M) \sim \frac{M^2}{\left(M^2 - M_Z^2\right)^2 + \Gamma_Z^2 M^4 / M_Z^2}$



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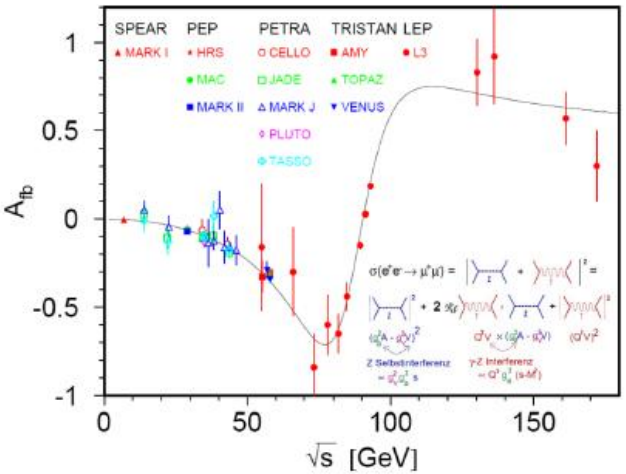
Weak Mixing Angle at the LHC

The *Weak Mixing Angle*

could be extracted from forward-backward-asymmetrie-measurements to test the Standard Model. LHC and LEP produce "inverse" events:
LHC: $q\bar{q} \mapsto Z/\gamma* \mapsto e^+e^-$ LEP: $e^+e^- \mapsto Z/\gamma* \mapsto q\bar{q}$

$$A_{FB}(\sin\Theta_W) = \frac{N_F - N_B}{N_F + N_B}$$



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Also mentioned...

...in the lecture, but not in our short talk

- Detector properties
- Di-boson production
- Particle identification
- W production kinematics and differential cross-sections
- Measurement of M_W (more in the tutorials)
- Gauge boson coupling
- Beyond LHC: ILC

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Suggestions for further schools

We We think it would have been better...

- to make a short break after 45min. Concentration drops significantly without a break

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- to make a short break after 45min. Concentration drops significantly without a break
- to outsource the detector part of the lecture
- to expain the motivation for the electroweak unification

All in all, we enjoyed the lecture and thought it to be very well balanced. For diploma students, one could skip the detector part and provide some more details on other topics.

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