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### Summer Student Seminar 17.08.2011





## $\Longrightarrow$ CERN, the LHC and the CMS Experiment $\Leftarrow$

- Physics at DESY
  - ♦ QCD
  - Top physics
  - Higgs searches
  - SUSY searches







✤ At CERN there is not only the LHC...







• ... but the LHC is the most impressive!













# → CERN, the LHC and the CMS Experiment → Physics at DESY <</li>

- ♦ QCD
- Top physics
- Higgs searches
- SUSY searches







- Steep rise of the gluon density towards small proton momentum transfer (x)
- Not completely calculable, different schemes on the market (DGLAP, BFKL, CCFM)
- How to identify the valid one?
- Forward jets are very sensitive to this (seen at HERA, even better reach with LHC)
- DESY analyses the Forward Energy Flow in Minimum Bias and Dijet Events







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e, u

First measurement of the top quark: Fermilab! But we were lucky – we could find it now also in Europe ©

#### **DESY contribution at CMS:**

- ttbar cross-section measurement in di-lepton channels
  - $\mu + \mu$  channel: cross-check analysis for CMS PAS TOP-10-005

Novel in CM

- $e+\mu$  channel: ongoing
- e+e channel: just started
- Cross-section ratio σ(pp→tt)/σ(pp→Z+X) measurement in di-muon channel
- Study of Zbb production (within electro-weak group) (work in progress)

#### **DESY Plans for 2011:**

- Differential cross-section measurements in di-lepton channels
- Top mass determination from cross-section measurement





#### Main focus : search for neutral supersymmetric Higgs bosons

- Inclusive  $H \rightarrow \tau\tau$  searches (advanced):
  - $H \rightarrow \tau \tau \rightarrow \mu \mu + E_T^{miss}$  analysis
  - Studies of  $Z \rightarrow \tau \tau$  "standard candle"
    - $\rightarrow$  Contribution to CMS publication
- (b)bH→(b)bbb searches
  - Development of IP based trigger
  - b-tagging essential : calibration of b-tagging algorithms with top pair events
- Study of D meson production: (inclusive and associated with jets) within B-physics group







CMS and and a

- The Higgs question will be solved soon...
- By the end of next year we'll have enough statistics to either find or exclude (almost) the whole low mass range!







#### **Particle physics**

- Origin of Mass? Higgs-particle
- Gravitation in the SM?
- Different strength of the four forces?
- Unification of the four forces (Grand Unification Theories)?



#### Cosmology

- Why do we have more matter than antimatter?
- What is dark matter?



# Supersymmetry





- SUSY has solutions to (almost) all open questions:
  - Unification with gravity (Superstring theory)
  - Unification of the gauge couplings
  - Solution of the hierarchy problem
  - Candidate for dark matter particle (lightest SUSY particle supposed to be stable and could be invisible for our detector)







- Topology based searches, not optimized for any particular SUSY model
- E<sub>T</sub><sup>miss</sup> considered the basis for all the searches (missing energy due to stable lightest SUSY particle escaping the detector)
- Try to cover as much phase space as possible
- Estimate backgrounds from data (data-driven) to minimize reliance on MC
- Especially important for backgrounds due to detector (mis)reconstruction effects!

0 leptons	1 lepton	OSDL	SSDL	≥3 lep.	<b>2</b> γ	<b>1</b> γ <b>+ 1 lep.</b>
Jets + E <sub>T</sub> <sup>miss</sup>	Single lepton+ jets+E <sub>T</sub> <sup>miss</sup>	Opposite sign di- leptons+ jets+E <sub>T</sub> <sup>miss</sup>	Same-sign di-leptons + jets +E <sub>T</sub> <sup>miss</sup>	Multi- leptons	Di-photon +jets +E <sub>T</sub> <sup>miss</sup>	Photon +lepton +E <sub>T</sub> <sup>miss</sup>
DESY contributions						



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#### 10<sup>2</sup>

Some typical distributions (here opposite-sign di-lepton analysis):



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... but we can do better! Join the Upgrade!



- P.S.: If you are interested in joining our group as a PhD student, you are very welcome to contact us:
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