The Southern German Node „ALU-FR" Freiburg, MPI Munich, Würzburg

Albert-Ludwigs-Universität Freiburg

Markus Schumacher

HiggsTools Kick Off Meeting

London, 2-4 April 2014

UNI FREIBURG

Outline (as given by Nigel)

For the session on **nodes**, can each node coordinator prepare a **ten slide summary** of each node. Each talk should

1) state every person involved from that node, and how they contribute to the activity of the network.

2) Summarize the expertise of the node (relating to the work packages)

3) Identify collaborations with other nodes

4) Identify links with activities outside the network

We will make a further booklet based on these slides about the network.

Disclaimer: Corrections will be added before the slides are included in booklet.

Participating People

1 Ansgar Denner   (WZ, TH)

2 <u>Stefan Dittmaier</u>   (FR, TH)   Recruitment Team

3 <u>Gudrun Heinrich</u>   (MPI, TH)   Convenor of WP2, Research Board

4 Wolfgang Hollik   (MPI, TH)

5 Harald Ita   (FR, TH)

6 <u>Karl Jakobs</u>   (FR, ATLAS)   Recruitment Team

7 Stan Lai   (FR, ATLAS)

8 Heidi Rzehak   (FR, TH)

9 <u>Markus Schumacher</u> (FR, ATLAS)

10 Jochum van der Bij   (FR, TH)

11 Christian Weiser   (FR, ATLAS)

Contributions to the Network: ESRs

WP1 Interpretation of data

- ESR6 Experimental analysis, optimisation for vector boson scattering (K. Jakobs / S. Dittmaier)

- ESR7 Investigation of jet veto efficiencies for determination of Higgs Boson properties in vector-boson fusion (M. Schumacher / K. Jakobs)

WP2 Prediction and simulations of signal and background

- ESR5 Precision calculations and analysis strategies for WW scattering at the LHC (S. Dittmaier / M. Schumacher).

WP3 Tools

- ESR8 Precision studies of Higgs-boson couplings at high energies (G. Heinrich/ F. Krauss)

see booklet on ESR projects for more details

Contributions to the Network: Secondments from other Partners

WP2 Prediction and simulations of signal background

- ESR9 Higgs Bosons in NMSSM (Ellwanger CNRS-LAL)
  → 3 months at ALU-FR for interfacing to experimental analysis

- ESR11 VV scattering an Higgs-like couplings@LHC as a probe of EWSB (Mariotti/Passarino, DFTTO)
  → 3 months at ALU-FR for evaluating performance and setting benchmarks for alternative algorithms

- ESR14 Improved predictions for Higgs boson production and decay (Grazzini, Spira,Zürich)
  → 1 month for interfacing theory with experiment

WP3 Tools

- ESR1 Higgs boson production in association with SHERPA (Krauss ,UDUR)
  → 3 months at ALU-FR for interfacing to experimental analysis

- ESR15 Matrix Element methods for Higgs physics (Dissertori/Pozzorini, Zürich)
  → 1 month at ALU-FR for interfacing with different experimental codes

- ESR20 Development of automated NLO and NNLO tools (Papadopoulos, NCSR-D)
  → 2 months at ALU-FR for training in two-loop reduction methods

Expertise of the Node:
WP1 Interpretation of Data

Task 1.1: Extraction of model-independent results from data

Limits on σxBR from ATLAS Run 1 data in

H→WW VH;H→bb   (Jakobs, Weiser)

H→$\tau\tau$ (gg→H VBF, bbH)   (Jakobs, Lai, Schumacher,Weiser)

H$^\pm$→ $\tau\nu$ (Lai, Schumacher)

Task 1.2: Measurements of Higgs boson properties

gluon fusion vs VBF production strength in ATLAS Run1 data

H→WW (Jakobs Weiser) H→$\tau\tau$ (Jakobs, Lai, Schumacher)

spin and CP properties in

H→ WW (Jakobs, Weiser) and H→$\gamma\gamma$ (Lai, Schumacher)

Task 1.3: Interpretation of experimental results in different models

MSSM interpretation of ATLAS Run 1 searches for

H→$\tau\tau$ (Jakobs, Lai, Schumacher)

H$^\pm$→$\tau\nu$ (Lai, Schumacher)

Various convenorships in ATLAS experiment in the past:
physics coordinator (Jakobs) Higgs convenor (Jakobs, Schumacher)
b-tag performance (Weiser) tau performance (Lai)   H→bb (Weiser)   H→$\tau\tau$ (Lai)

Task 2.1: Improved predictions for Standard Model-like Higgs scenarios

- NLO QCD and electroweak corrections to Higgs production processes, Monte Carlo program HAWK for VBF and WH/ZH (Denner/Dittmaier)
- NLO QCD and electroweak corrections to Higgs decays, Monte Carlo program PROPHECY4f for H$\rightarrow$WW/ZZ$\rightarrow$4f (Denner/Dittmaier)

Task 2.2: Improved predictions for non-standard EWSB scenarios

- Higgs production and decay in SUSY models (Dittmaier/Hollik/Rzehak)
- Masses and Couplings in MSSM also w/ CP violation (Hollik, Rzehak,Weiglein
- NMSSMCAL: Massses ans BRs in NMSSM (Rzehak, Spira, …)
- Effective Lagrangians in LHCHXSWG (Denner, Dittmaier, …)
- Predictions nad interpretation in Minimalistic Extensions, Singelt/Tripplet/HEIDI models (v.d. Bij)

Task 2.3: Backgrounds

- NLO QCD corrections to multi-leg background processes, W/Z+jets, WW+jets, ttbb, $\gamma\gamma$jj etc. (Denner/Dittmaier/Heinrich/Ita)
- NLO QCD electroweak corrections to SM processes, Drell-Yan, W/Z+jet, di-bosons, etc. (Denner/Dittmaier)
- WW validation from control regions, comparison with various MC event generators including SHERPA (Jakobs)

Expertise of the Node: WP3
Tools (MC tools and their automation)

Task 3.1: Improved analysis tools

- Development of b-tagging algorithms(also for boosted topology) (Weiser)
- Development of embeeding technique for estimation of backhrounds with tau-leptons (Z$\rightarrow\tau\tau$, t$\rightarrow$b$\tau\nu$, tagging algorithms (Lai/Schumacher)

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Task 3.2: Development and automatization of general next-to-leading order tools

- Unitarity-based method for NLO calculations (Ita)
- Improved Feynman-diagrammatic NLO methods (Denner/Dittmaier/Heinrich)
- Automated NLO codes, BlackHat/GoSam/Recola (Ita/Heinrich/Denner)

Task 3.3: PDFs and PDF uncertainties

- input for PDF fits: measurements of W production cross section, W charge asymmetry, differention production cross sections, W+c-production (Jakobs, Weiser)

Expertise of the Node: WP4 and WP7

WP4 Research Training

- running a DFG Research training group 2005-2014
  new training group planned for 2015-
  with annual meetings, topical lecture series
- organisation of HGF Alliance School
  "LPPP LHC Precision Predictions for Pedestrians" in 2011

WP7 Dissemination and Outreach

- several public lectures
  (e.g. "Tag der Weltmaschine" 2011, Higgs discovery 2012, Nobel Prize 2013)
- participation in bi-annual "Freiburg Science" market 2011 and 2013
- participation in International Master Classes "Hands on particle physics"
- regular visits to schools with Master Classes on site
- participation in teacher training in particle physics

Collaborations with other Nodes

current activities other than those included in ESR projects

- strange quark PDF from W+c production (Blümlein (Zeuthen) + Jakobs)

- sensitivity study for CP investigation in H$\rightarrow\tau\tau/\gamma\gamma$ using the method of Optimal Observables (Farrington (Warwick) + Schumacher)

- implementation of NLO calculations in SHERPA, e.g. WWbb production (Krauss (Durham), Pozzorini (Zurich) + Denner, Dittmaier and Ita)

- calculation of electroweak corrections to SM processes at the LHC, e.g. to di-boson production (Denner + Dittmaier)

- NLO calculations for ttH/bbH production in SUSY models (Spira (Zurich) + Dittmaier)

Links with Activies Outside Network

LHC Higgs Cross Section Working Group (current mandates):
Ansgar Denner   convenor of VBF and "Light Higgs" subgroups
Stefan Dittmaier convenor of WH/ZH subgroup

- with A.Mück (Aachen) on HAWK and PROPHECY4f (Denner/Dittmaier) with F.Siegert (Dresden) on the implementation of NLO corrections in SHERPA (Denner/Dittmaier/Pozzorini)

- with B.J"ager (Tübingen) on electroweak corrections to (off-shell) di-boson production (Dittmaier)

- with S.Borowka, T.Hahn, S.Heinemeyer on two-loop corrections to Higgs boson masses in the MSSM (Heinrich, Hollik, Rzehak)

- with T.Gehrmann, N.Greiner, N.Chanon on calculation of diphoton+1jet, diphoton +2jet production at NLO QCD (Heinrich)

- inside GoSam team NLO QCD corrections to pp -> (graviton to $\gamma\gamma$) in ADD models and H+2 (3) jet (Heinrich)