DEFINING THE ROLE OF PHENOMENOLOGY IN THE US LHC PROGRAM

A CALL FOR DETAILED ANALYSIS AND RECOMMENDATIONS
Europe has invested heavily in Particle Phenomenology with 12-13 new Postdocs in each of two Networks

Particle Physics Phenomenology
at High Energy Colliders

Physics at Colliders is a Research Training Network funded through the European Commission’s 5-th Framework Improving Human Potential programme. The network contract (HPRN-CT-2000-00149) was concluded between the European Commission and network participants on 1st August 2000 with duration of 54 months (see Annex I of the contract for more information).

Network objectives: Our main objective is to provide precise theoretical predictions for direct production of all kinds of particles within and beyond the Standard Model up to TeV energies, as well as for other quantities (observables) sensitive to small, indirect contributions from new particles and interactions, to obtain the maximum benefit from the European high energy physics experimental programmes at CERN and DESY.

Areas of interest: (i) Precision Electroweak Physics, (ii) Higgs Physics, (iii) Top Physics, (iv) SUSY Particle Physics, (v) Alternative New Physics Scenarios.

Training objectives: Our network combines research groups with expertise in perturbative field theory and Monte Carlo techniques. This together with the meeting and exchange programme must allow our young trainees to experience at first hand the most recent methods and developments in the field.
THE 13 TEAMS OF THE NETWORK AND THEIR ASSOCIATED PARTNERS

(Click on the team names to obtain more information about each team)

WORK PLAN SUMMARY

YOUNG RESEARCHERS POSITIONS Ten teams of the network have "young researchers" positions. This page contains a list of current appointments and available positions. Note that certain conditions apply to these appointments.
Network teams divide the calculations that need to be Done.
There also have been several Summer Institutes that have discussed the Physics Issues:

THE PHYSICS OF LHC: THEORETICAL TOOLS & EXPERIMENTAL CHALLENGES

to be held from June 9-14, 2005 in Martignano (Lecce, Italy).

The aim of the school is to bring together young experimentalists and theorists and help them learn the tools for physics at the LHC.

It is addressed to Ph.D. students or post-docs, in both experimental and theoretical high-energy physics, from Italy, Greece and other European and Mediterranean countries.

The theory lectures will be aimed mainly towards experimentalists and the experimental lectures to theorists. A total of approximately 32 hours of lectures will be delivered, evenly split between theoretical and experimental topics.

Tuesday, 13 July
Welcome, status of LHC, Higgs review talks

Higgs: review and contributed talks (Standard Model and SUSY)

Status of ATLAS and CMS, SUSY review talks
Poster Session

Beyond the Standard Model physics
Second Graduate School in Physics at Colliders  Turin, Villa Gualino June 30-July 5, 2003
Detailed review of all the issues! Higgs, SUSY, Higher Dimensions etc.

ADVANCED STUDIES INSTITUTE

PHYSICS AT LHC

(LHC-Praha-2003)

Prague, July 6 - July 12, 2003

CMS Review (35') (35')  (more information)
   Tejinder Virdee
   (CERN/Imperial College)

2. Higgs Physics, theoretical overview (40') (40')  (more information)
   George Weiglein
   (Durham)

3. Higgs results from LEP (35') (35')  (more information)
   Vanina Ruhlmann-Kleider
   (Saclay)

4. Prospects for Higgs searches at the Tevatron Run II
5. Higgs searches, review of LHC potential
   (Rutgers)
   (more information)

   John Conway
   (Rutgers)

   Alexander Nikitenko
   (Imperial College/ITEP)

   A/H to tau-tau, H+- to taunu, full trigger selection chains
   (more information)

   Ritva Kinnunen
   (Helsinki Institute of Physics)

   Updated scan of MSSM parameter space
   (Helsinki Institute of Physics)

   Markus Schumacher
   (University of Bonn)

   Invisible Higgs
   (transparencies)

   Borut Kersevan
   (Jozef Stefan Institute)

   H to mu-mu in SM and MSSM
   (transparencies)

   Marcel Vos
   (IFIC Valencia)

   WW scattering
   (transparencies)

   Nicola Amapane
   (Universita‘ di Torino)

Tuesday 08 July 2003
Supersymmetry: theoretical overview  (45') (45') ( more information )

   Antonio Masiero
   (University of Padua)

3.
SUSY searches at LEP  (40') (40') ( more information )

   Sylvie Rosier-Lees
   (LAPP Annecy)

4.
Tevatron results and physics potential  (25') (25') ( more information )

   Andrew White
   (University of Texas)

5.
LHC physics potential  (35') (35') ( transparencies )

   Salavat Abdoullin
   (University of Maryland/ ITEP)

Sparticle reconstruction at SUSY benchmark points
B,G,I  (20') (20') ( more information )

   Massimiliano Chiorboli
   (Universita)

2.
A Detailed Study of Third Generation Squaks at LHC
(25') (25') ( transparencies )

   Junichi Kanzaki
   (KEK)

3.
Searches for direct slepton production  (20') (20') ( more information )

   Else Lytken
   (Niels Bohr Institute)

4.
Reconstruction of LSP mass  (15') (15') ( transparencies )


Dan Tovey  
(University of Sheffield)  
5.  
Taus in SUSY events  (20')  (transparencies)  

Michael Heldmann  
(Universita degli Studi di Milano)  
6.  
Higgs to sparticle and sparticle to Higgs decays  (35')  
(35')  (transparencies)  

Filip Moortgat  
(University of Antwerpen)  

Thursday 10 July 2003  
Beyond SUSY and Standard MODEL  

1.  
Physics beyond Supersymmetry  (40')  (40')  (more information)  

Pierre Binetruy  
(LAL Orsay)  
2.  
Beyond the Standard Model: review of LHC potential  
(40')  (40')  (more information)  

Luc Poggioli  
(LAPP Annecy)  
3.  
Beyond the Standard Model: Tevatron results and potential  (30')  (30')  (more information)  

Greg Landsberg  
(Brown University)  
1.  
Lepton flavor violation  (20')  (20')  (more information)  

Kajari Mazumdar  
(Tata Institute)  
2.  
Black holes at the LHC  (20')  (20')  (more information)
Christopher Lester  
(*University of Cambridge*)

3.  
**Little Higgs Task Force**  
*20'  20'  (transparencies)*  

Matthieu Lechowski  
(*LAL Orsay*)

4.  
**Randall-Sundrum gravitons to ee,mumu, gamma-gamma**  
*15'  15'  (transparencies)*  

Piotr Traczyk  
(*Soltan Institute, Warsaw*)

5.  
**Search for TeV-scale bosons on the + - decay channel with CMS**  
*15'  15'  (more information)*  

Sergei Shmatov  
(*Dubna*)

6.  
**Kaluza-Klein modes for W,Z**  
*15'  15'  (transparencies)*  

Marc Escalier  
(*LPNHE Paris*)

**Physics potential of LHCb**  
*45'  45'  (transparencies)*  

Andreas Schopper  
(*CERN*)
There are Detailed Studies of the Need for NNLO calculations so that theory errors are smaller than experimental errors. For Example Lance Dixon’s lectures

Lecture 1: Multi-loop Techniques in Field Theory and Collider Applications

Lance Dixon

Stanford Linear Accelerator Center
For the future (LHC):

\[ \delta \sigma_{\text{CDF}}^{\text{exp}} = 2\% (\text{stat}) + 10\% (\text{syst}) \Rightarrow \delta \sigma_{\text{ATLAS}}^{\text{exp}} = 1\% (\text{stat}) + 5\% (\text{syst}) \]

\( \text{\texttt{NNLO}} \) required to match this precision theoretically

\[ \delta \sigma_{\text{NLO}}^{\text{th}} = 15\% (\text{intrinsic}) \Rightarrow \delta \sigma_{\text{NNLO}}^{\text{exp}} = (3 - 4)\% (\text{intrinsic}) \]

Many collider cross sections are now known at next-to-leading order (NLO) in perturbation theory.

However, \( \text{LO} \rightarrow \text{NLO} \) corrections can be 30–100%.

\( \Rightarrow \) Precise predictions demand calculation at next-to-next-to-leading order (NNLO).
ROADMAP NEEDED FROM TASK FORCE:

1) What Theoretical Calculations Are Needed (Given The Accuracy Of Experimental Uncertainties) to Improve Our Understanding of Standard Model Physics and Beyond.

2) What level accuracy of experiments + theory is needed to pin down the parameters of non-standard model physics approaches.

3) How should the US effort in Phenomenology complement (or compete) with the European effort?

4) How Does One Ensure Training Of Next Generation Of Phenomenologists? WHAT ARE SUSTAINABLE MANPOWER NEEDS? What is the best mix of graduate students Post-Docs and Senior People at Universities and Government Labs.

4) What is the best approach to accomplish the above goals? Virtual Phenomenology Institute? Increase to Existing Grants?

5) What is the best way to have the data archived so that it is in the most useful form for future use?
Finally…

What can be realistically accomplished by various new moneys from DOE + NSF in $500K increments

PRESENTATION TO AGENCIES SHOULD BE BEFORE NEXT FISCAL YEAR

SEPTEMBER 2005!!!

What topics have I left out that the phenomenology community wants to address??