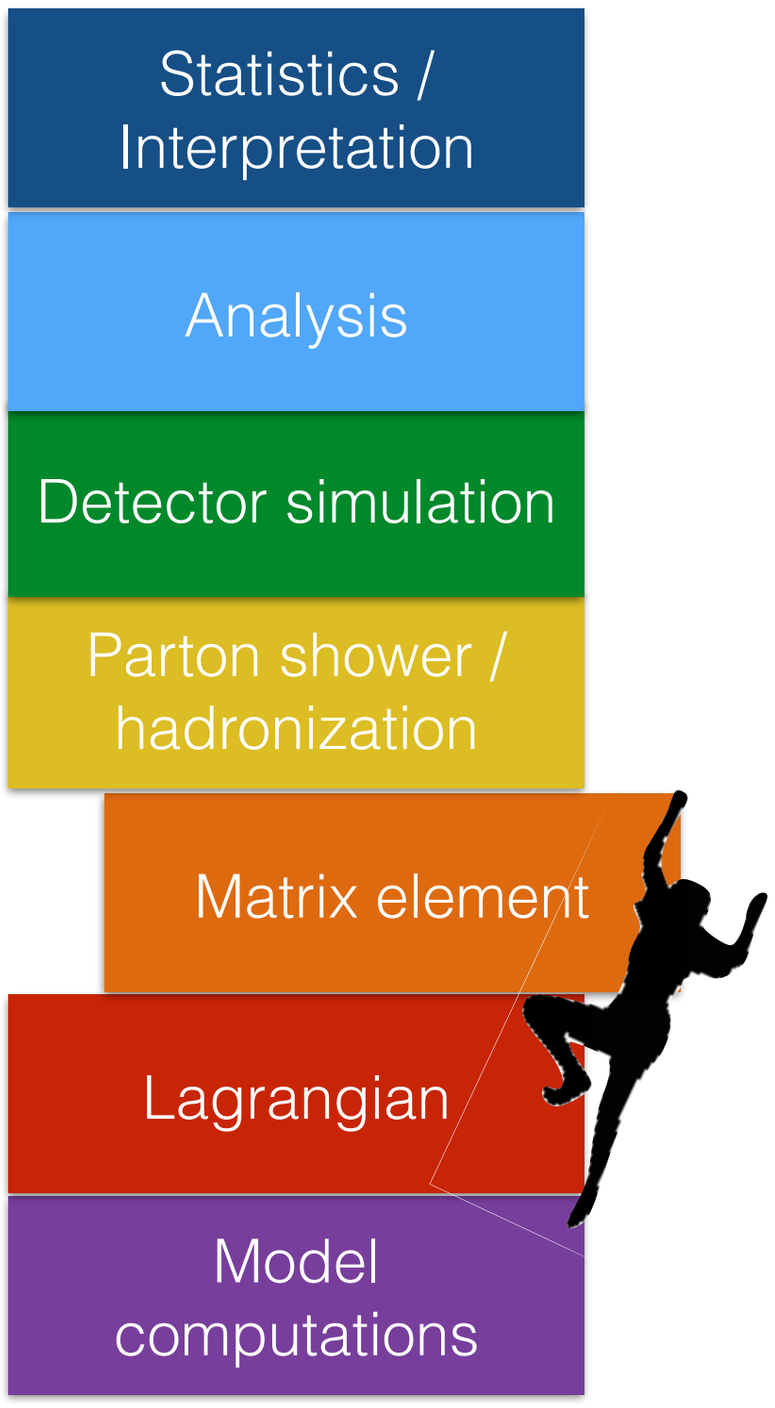
Les Houches PhysTeV 2015

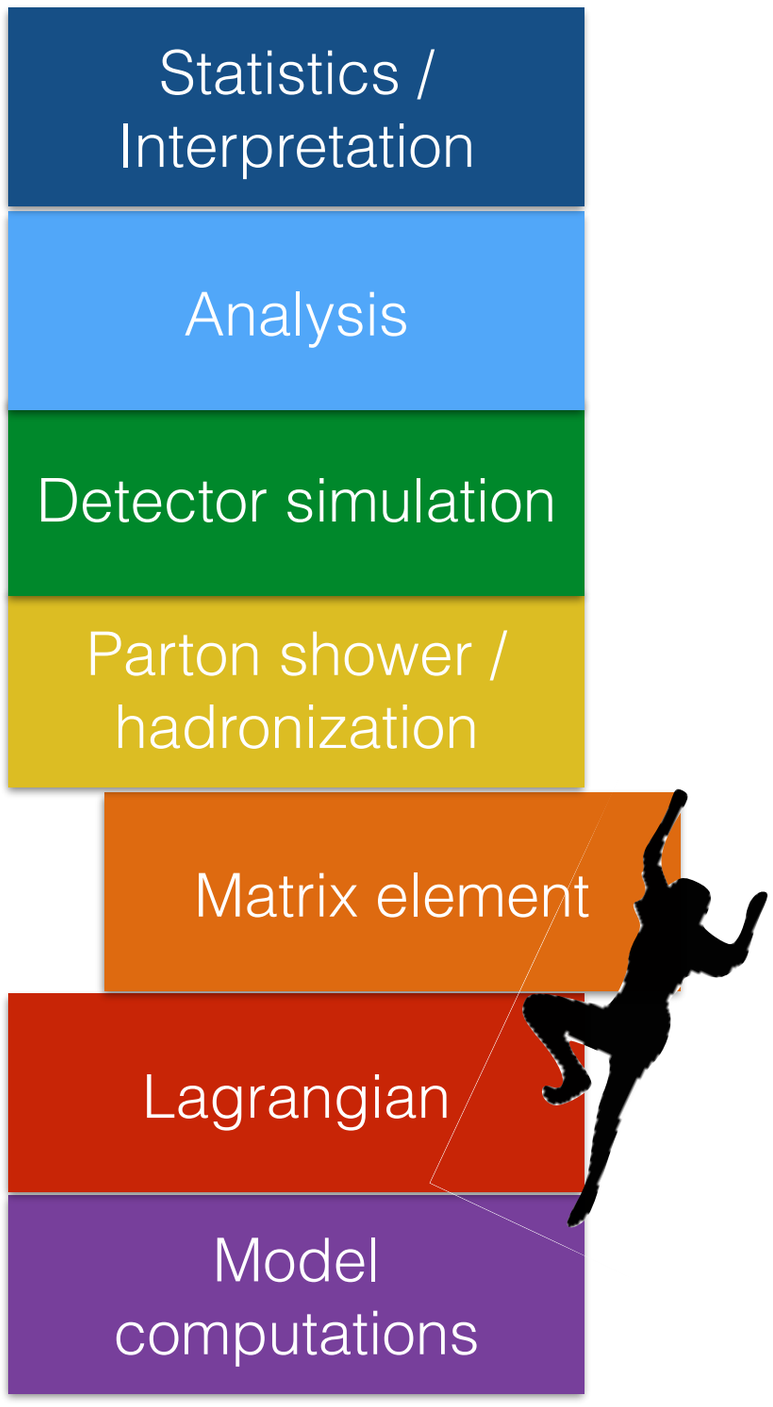
James Ferrando (U. of Glasgow)
Benjamin Fuks (IPHC Strasbourg)
Sezen Sekmen (KNU)

BSM tools & MC



- Huge diversity of tools are available to perform the lengthy computations in HEP in a large variety of areas.
- Clear and efficient communication between these tools is important.
- Run1 is over, results maturing, Run2 has just begun. Questions to consider at this moment:
  - Are our tools sufficient for the complete analysis and interpretation of the Run1 results?
  - Are our tools sufficient to address the new physics models, experimental conditions and analysis methods relevant for Run2?

BSM tools & MC



Les Houches workshops have a well-deserved reputation for developing and improving useful tools for the HEP community.

In order to maintain this legacy, we shall

- Have tutorials on existing tools
- Improve existing tools
- Design accords to help communication between tools
- And design new tools, as needed

Model computation

Higgs computations

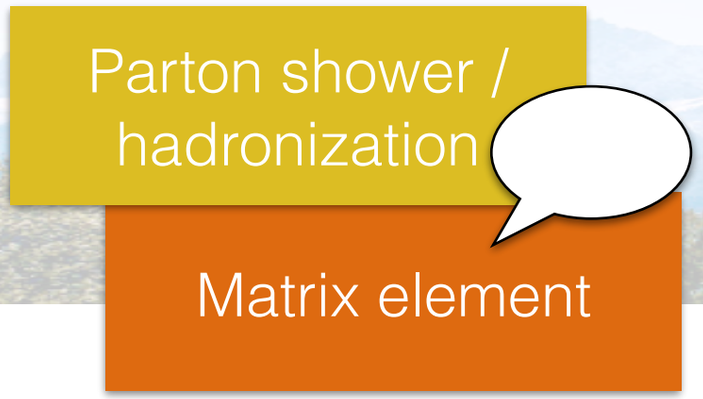
- Improvements in HDECAY, HIGLU, HPAIR, etc. (Spira)
  - Compare different codes in more detail (as has been started for the NMSSM)
  - Exercise the use of SLHA to interface different codes
  - Work to determine higher-order corrections within the MSSM for Higgs boson production and decay - and also for other BSM Higgs
- FlexibleSUSY (a SUSY spectrum generator generator): Improve Higgs boson mass prediction in mSUGRA-like NMSSM scenarios (Voigt).
- Higgs boson mass calculation in non-minimal models (Staub - also SARAH author).
- Higgs-related loop induced processes for (N)MSSM in madgraph5_aMC@NLO.
- NLO computations in the Higgs EFT framework (next slide)

Matrix element

Model computation

Automated MC sim methods at NLO in QCD for new physics

- Vector like quarks (Cacciapaglia, Deandrea, Fuks)
- Comparison of MC (LO) techniques used for Run 1 to new MC (LO and NLO) techniques that could be used for Run 2 (in the BSM context)
  - Application to SUSY
  - Application to dark matter simplified models (Falkowski, Fuks, Mimasu, Sanz)
- Higgs effective field theories: options for operator basis implementations (Chanon, Fuks, Kuttimalai, Mimasu, Sanz)



LHA for cross sections

- In LH2013, we started an effort to extend the SLHA with cross section information (Fuks, Sekmen et. al.) https://phystev.cnrs.fr/wiki/2013:groups:tools:slha
- We add new blocks with information on production cross sections. Proposed to add one XSECTION block per process:
  - Block header with general information: XSECTION SQRTS PDG_CODE1 PDG_CODE2 NF PDG_CODE3 ....
  - Cross section lines: SCALE_SCHEME QCD_ORDER EW_ORDER KAPPA_F KAPPA_R PDF_ID VALUE CODE VERSION
- Will revisit and finalize the accord.

Detector simulation

Falcon: Fast & self tuning simulator

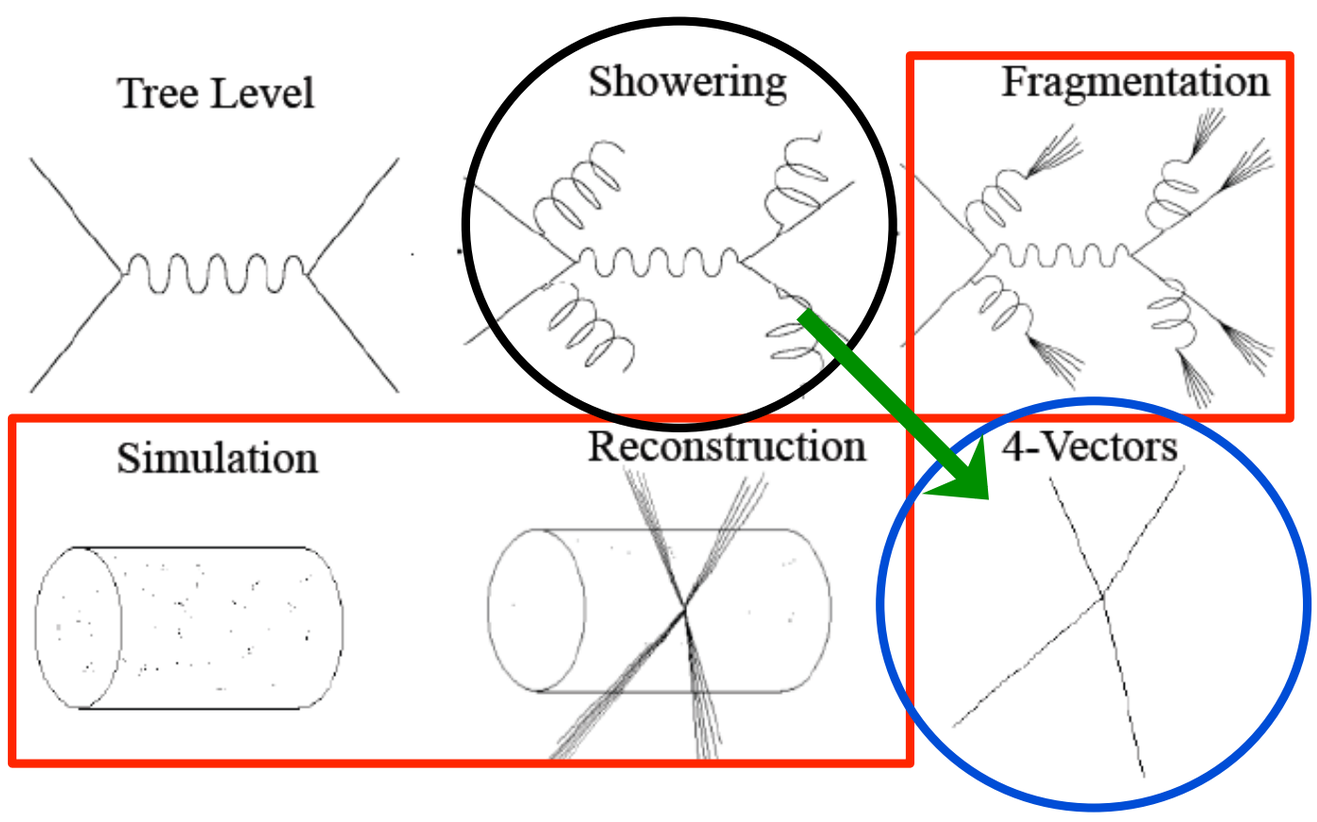
Goal: Implement a very fast, accurate, self-tuning map F from parton showered events to reconstructed events:

$$p(\vec{x} \mid M) = \int F(\vec{x} \mid \vec{y})\, p(\vec{y} \mid M)\, d\vec{y}$$

New tool being developed.
Falcon (Prosper)

Method: use a highly-optimised look-up table created from fully-simulated events.

Comparison to Delphes (Fuks)



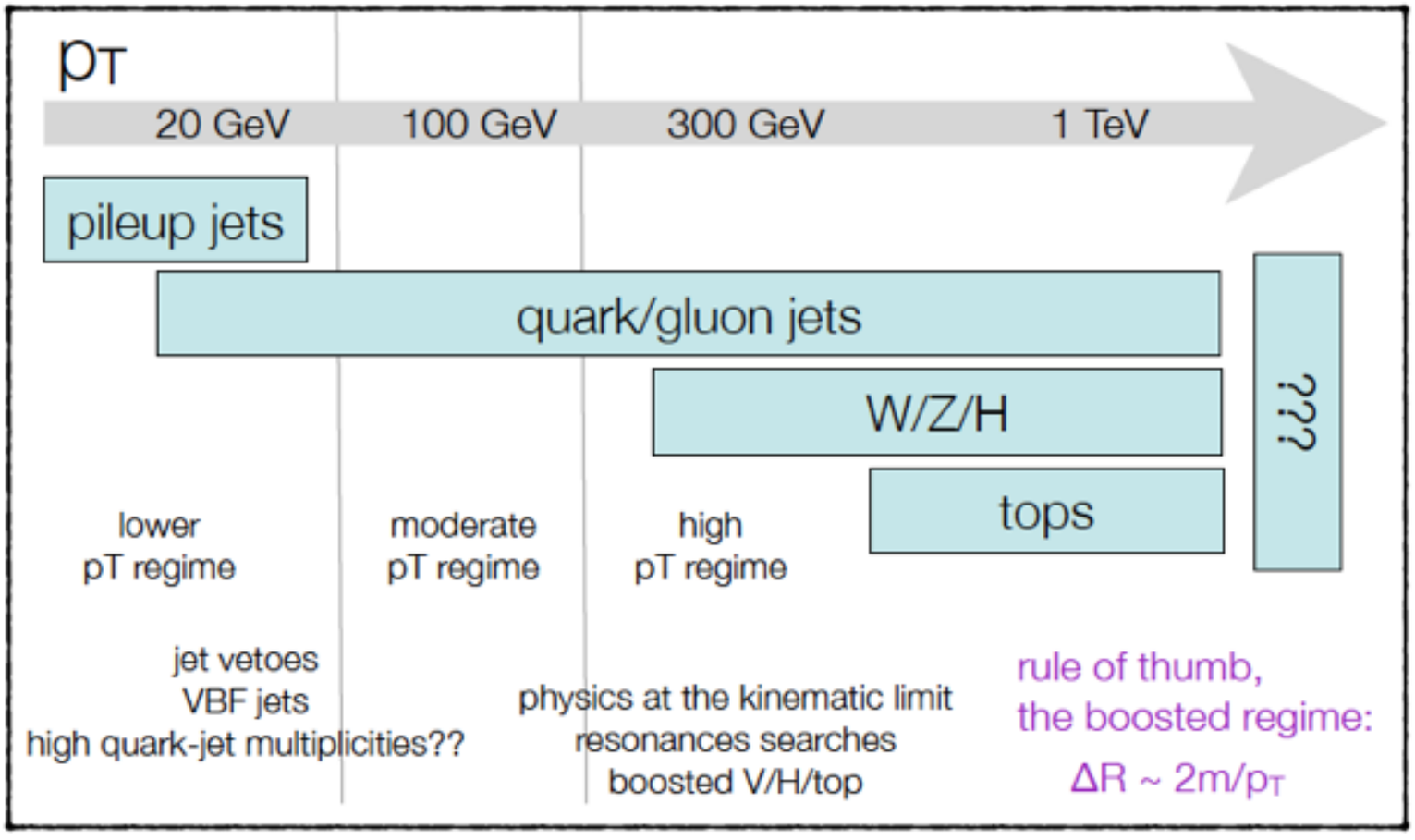
Bruce Knuteson (arXiv:hep-ex/040229v1)

Analysis

Detector simulation

New reconstruction methods

- Boosted objects and substructure methods bring a new dimension to BSM searches. More important for 13TeV (and at 100TeV)
- Lots of work in the first session. Further ideas on improving boosted object identification? Semi-leptonic decays, quark-gluon jet discrimination, BSM-specific RECO and analyses, etc.?



- Interpretation of analyses with boosted objects - implement in RIVET context (Pollard)

Statistics / Interpretation

Analysis

Frameworks & comparisons

- Phenomenologists are interested in interpreting ATLAS & CMS experimental results in many different ways.
- Analysis implementation tools: Atom, Delphes, CheckMATE , MadAnalysis, TNMAnalysis, etc.
- Interpretation/recasting tools:
  - Generic tools (analysis+interpretation): Atom, CheckMATE (Desal, Schmeier, Tattersall), MadAnalysis PAD (Fuks, Kraml, Sengupta)
    - Make detailed comparisons between the codes.
    - CheckMATE: interface with Pythia8; tests with MadGraph to enable testing arbitrary physics models.
    - Embedding of MadAnalysis into MadGraph.
  - Interpretation using simplified model results: SModelS (Kraml, Kulkarni, Laa), XQCUT (Barducci)

Analysis

LHAAD / CutLang

LH recommendations for presentation of new physics results, 2012:

> Recommendation 1b: *The community should identify, develop and adopt a common platform to store analysis databases, collecting object definitions, cuts, and all other information, including well-encapsulated functions, necessary to reproduce or use the results of the analyses, and as required by other recommendations*

- Huge efforts are underway to implement LHC analyses in the existing analysis frameworks.
- However, the recommendation calls for a "framework-independent" analysis description, useable by both theorists and experimentalists - an accord akin to LHE or SLHA. Such an accord would encourage the habit of publishing complete and rigorous description of analyses.
- We propose initiating the "Les Houches Accord on Analysis Description" (Sekmen, Prosper).
  - A first rough attempt: CutLang (Ünel)

Statistics / Interpretation

LHC results and interpretation

- A long standing LH topic (Kraml, Prosper, Sekmen, Fuks, etc…). Run1 is over, Run2 has started. Interesting results will soon be flooding in. How can we use them efficiently?
- What additional information do we need from the experiments?
- How to improve the combination of results of analyses with multiple signal regions in order to make stronger conclusions about BSM?
- Everlasting question: What of statistical modelling and likelihoods?
- How to improve the interpretation/recasting frameworks mentioned earlier?
- What about a full model-simplified model interface?
- New developments on RIVET? To unfold or not to unfold for new physics?
- Fitting tools? GAMBIT (Global fitting code for generic BSM theories, fast and easy definition of new models, observables, likelihoods, scanners and backend physics codes (Scott). More?