My internship at LAPP

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Background

-2020/2022: Lycée Camille Julian, Bordeaux, 2 years of classe préparatoire aux grandes écoles, specialized in physics and chemistry

-2022/Today: Ecole des Mines de Saint Etienne (ingenior school), currently in my second year (equivalent M1)

-August-December 2023: Erasmus at the University of Bergen, Norway

Finding an internship

-Time of the internship: 10-14 weeks between June and September

-Position of the internship: Ingenior Assistant

-My criteria: Research field, particles physics, in France

-How I found LAPP: In2p3 institutes and ATLAS

The beginning of the internship : First Day

-No time to stop !

    -arrived 9h30 am

    -Quick overall of the idea of this internship, getting my computer
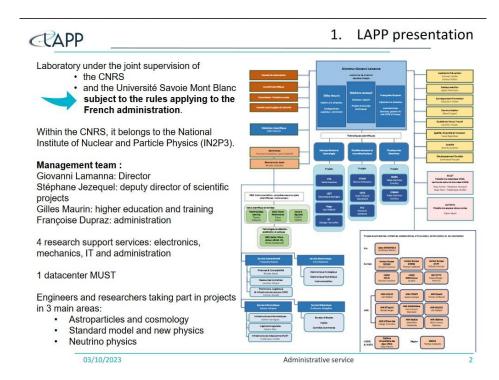
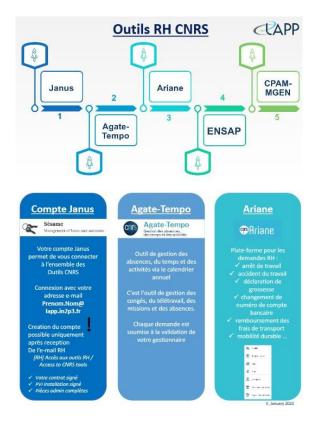   -DITTO meeting at 10h am !

In the afternoon:

    -configuring the computer
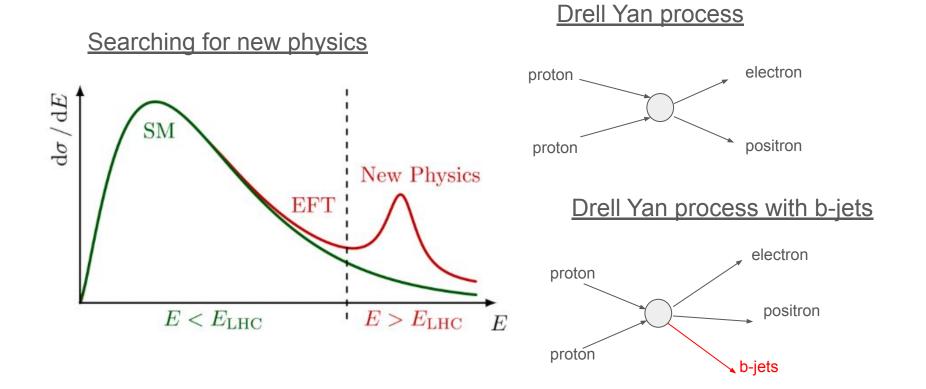
    -first contact with the work of Timoty

Learning about LAPP

Topic of the internship

Searching for new physics

Drell Yan process

proton → electron
proton → positron

Drell Yan process with b-jets

proton → electron
proton → positron
proton → b-jets

Objectives of the internship

-Defining the process in the code

-Generating Drell-Yan + b interactions on the computer

-Sorting these generated interactions depending on their characteristics

-Storing these data in histograms so that we can analyse them

-Comparing these results with the current theory (Standard Model) and with results of other studies

Discovering the setup and the code

First contact with an analysis tool: Rivet

=> allow to treat the events generated and produce plots

How do we use it ?

=> informatic language

What can it do ?

-determine the types of particles:photons, electrons…, calculate characteristics of the particles : speed, mass, energy…
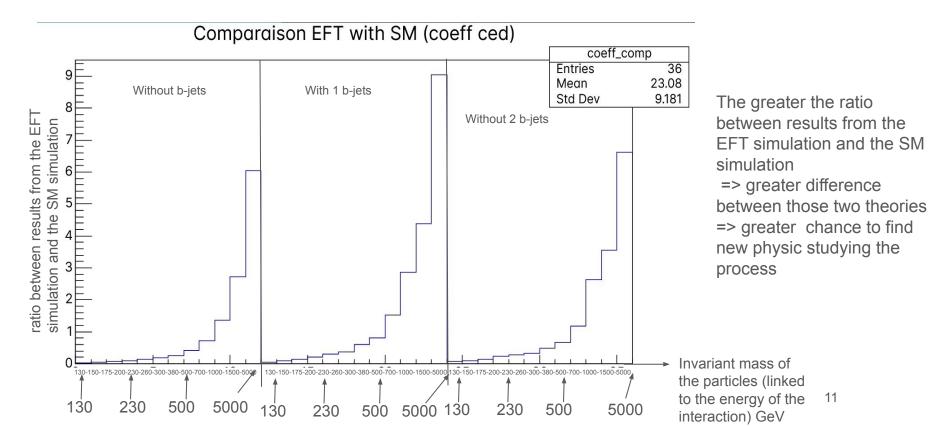
-get rid of the events that doesn't match the criteria that we can define

-sort all of these characteristics in differents plots

Rivet Analyse Example

```cpp
namespace Rivet {
  public:
    void analyze(const Event& event) {
      //both leptons with 30 Gev < pT < 40 Gev
      //both lepton with eta > 2.5
      //130 < mll
      //removing all leptons found within deltaR < 0.4 of a jet
      //removing all jets found within deltaR < 0.2 of a lepton
      if (leptons[0].pT()>leptons[1].pT() && leptons[0].pT()<40*GeV && leptons[1].pT()<30*GeV) {
          { cout << "pt_leading < 40Gev or pt_subleading < 30Gev " << endl; vetoEvent;}
      }
      After_V3 ++;
      _h_cutflow["cutflow"] -> fill(3, 1.0);

      if (leptons[1].pt()>leptons[0].pT() && leptons[1].pT()<40*GeV && leptons[0].pT()<30*GeV) {
          { cout << "pt_leading < 40Gev or pt_subleading < 30Gev " << endl; vetoEvent;}
      }
      After_V4 ++;
      _h_cutflow["cutflow"] -> fill(4, 1.0);

      if (leptons[0].eta() > 2.5 ||leptons[1].eta() >2.5 )
      { cout << "eta > 2.5" << endl; vetoEvent;}
      After_V5 ++;
      _h_cutflow["cutflow"] -> fill(5, 1.0);

      if(mll<130)
      {cout << "mll= " << mll << "< 130" << endl; vetoEvent;}
      After_V6 ++;
      _h_cutflow["cutflow"] -> fill(6, 1.0);
```

Some results

Comparaison EFT with SM (coeff ced)

Without b-jets

With 1 b-jets

Without 2 b-jets

coeff_comp	
Entries	36
Mean	23.08
Std Dev	9.181

ratio between results from the EFT simulation and the SM simulation

130-150-175-200-230-260-300-380-500-700-1000-1500-5000   130-150-175-200-230-260-300-380-500-700-1000-1500-5000 130-150-175-200-230-260-300-380-500-700-1000-1500-5000

130   230   500   5000   130   230   500   5000   130   230   500   5000

The greater the ratio between results from the EFT simulation and the SM simulation
 => greater difference between those two theories
=> greater chance to find new physic studying the process

Invariant mass of the particles (linked to the energy of the interaction) GeV

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Graspa School: Summer summer school on particles and astroparticles

-really interesting lectures, good overview of the subjects

-possible to interact with the teachers/searchers during coffee breaks or lunch

=> Learned in a formal way about the theories behind what I was doing for example about the Standard Model or the EFTS

=> Learned more about some objects I was using for my internship

Thank you for welcoming me !