# IMPROVING THE UNDERSTANDING OF PDF UNCENTAINTIES

## Mid Term Review

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DFTTO

UNIVERSITA
DEGLI STUDI
DI TORINO


# BACKGROUND

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- Expect to obtain a PhD on completion of HiggsTools (joint degree with the university of Milan).

## Main Topic

Determination of Parton Distribution Functions

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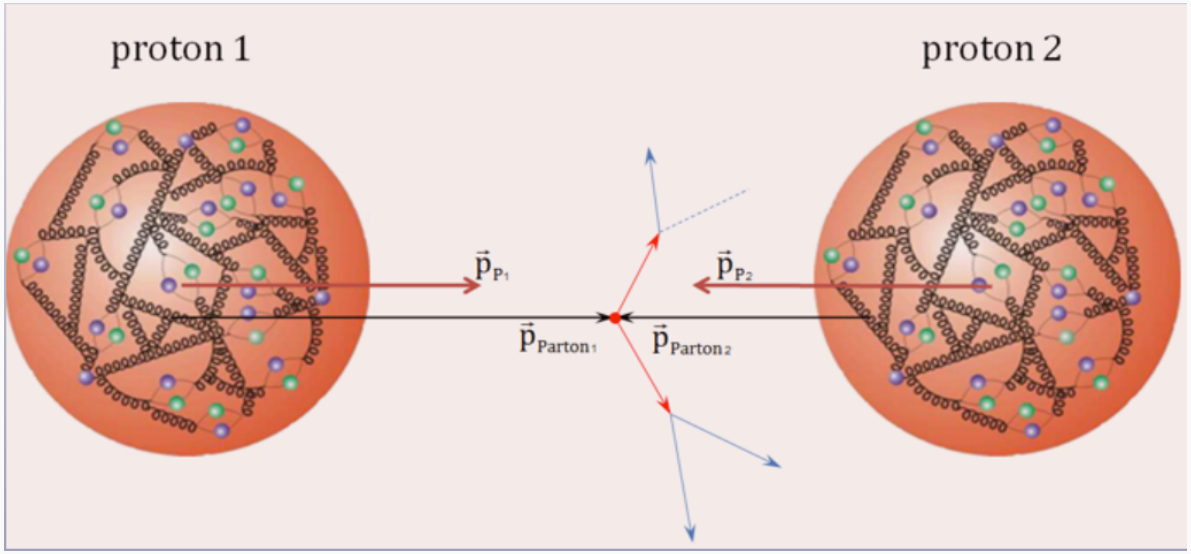
- To first approximation, they represent the *probability* of sampling a *parton* in a given event.




  - ...(but it's a little more complicated)

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# PDFS IN THE LHC

- PDFs are crucial as they enter in every calculation in LHC physics.
- Cannot be computed by theory alone. Require collaboration between theorist and experimentalists.
- As with all physical quantities, the uncertainty is as important as the value itself (Task 3.3).
- A multidisciplinary approach is needed to determine them from theoretical predictions and experimental data.
    - High Energy Physics
    - Statistics
    - Machine Learning
    - Computer science
    - Information theory


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# THE NNPDF COLLABORATION


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International collaboration, members from:

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We strive to obtain a statistically consistent and unbiased result incorporating all relevant experimental data.

# VISITS TO NNPDF NODES

I have visited several NNPDF nodes.

| | |
|---|---|
| Milan | Research work and training |
| Edinburgh | Studies on PDF uncertainties |
| Oxford | General NNPDF meeting |

# RESEARCH OUTPUT

The main achievement of so far has been the work contributing to the PDF4LHC Recommendation (arxiv:1510.03865).

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| **M3.3.2** | Methods for PDF uncertainties in shower Monte Carlos |
| **M3.3.3** | Improved PDFs using LHC data |
| **M3.3.4** | Consistent PDF fits at NNLO |
| **M2.1.2** | Better control of theoretical uncertainties for the SM-like Higgs boson scenario |
| **M1.4.1** | Review of the current state and future directions in Higgs boson physics |

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- Milan and UCL nodes directly involved.

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- Validate the strategy.
  - Develop computational tools for benchmarking.
- Derive more advanced compression methods as a follow up.

# TRAINING AND TRAVELS

- Attendance to conferences:
  - HiggsCouplings 2014 (Torino)
  - HiggsTools First Young Researchers Meeting (Durham)
  - PDF4LHC (CERN)
  - HiggsTools Anual Meeting (Freiburg)
  - Higgs Cross Section Working Group (CERN)

# TRAINING AND TRAVELS

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- Attendance to schools
  - GGI School for Theoretical Physics (Florence)
  - HiggsTools Anual School (Pré Saint-Didier)

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- Attendance to conferences:
- Attendance to schools
- Attendance to courses
  - Fundamental interactions (University of Milan)
  - Computational Physics (University of Milan)
  - QCD and Event Simulation (Pavia)
  - Monte Carlo Generators (University of Milano-Bicocca)

## Conflicting requirements

- Provide combined PDFs that match experimental precision requirements. (Task 3.3a)
- Make the PDF computations computationally affordable.

# TECHNICAL CHALLENGES

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**Adequate representation** Interface with experimental framework.

**Avoid bias** faithful representation of the prior.

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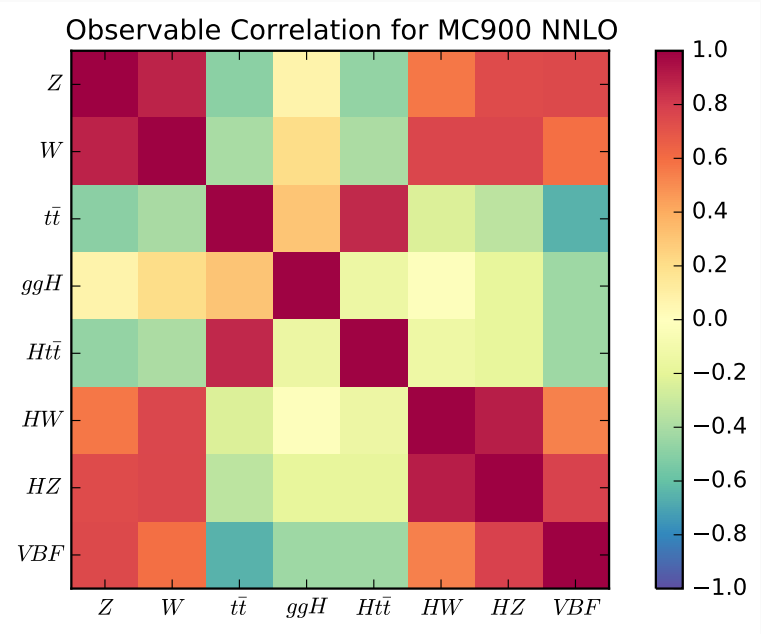
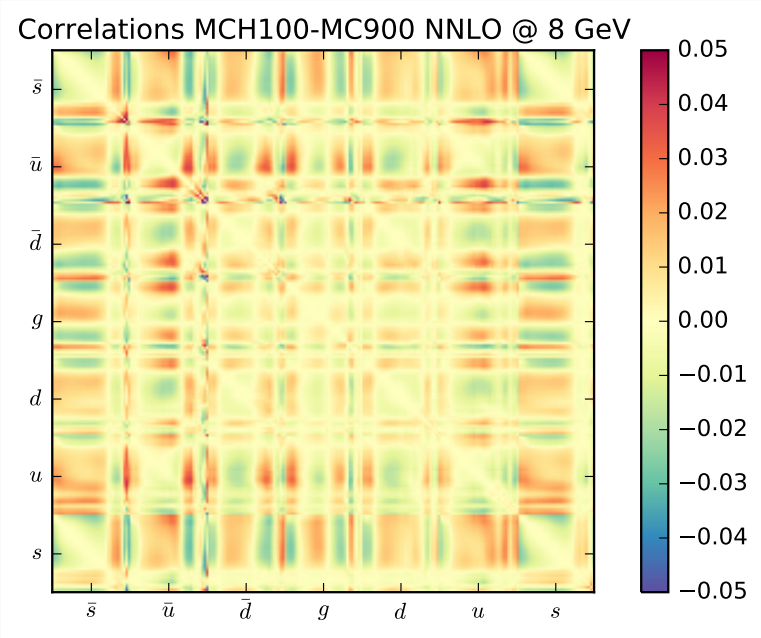
- Develop efficient code and visualization techniques that allow to iterate rapidly.



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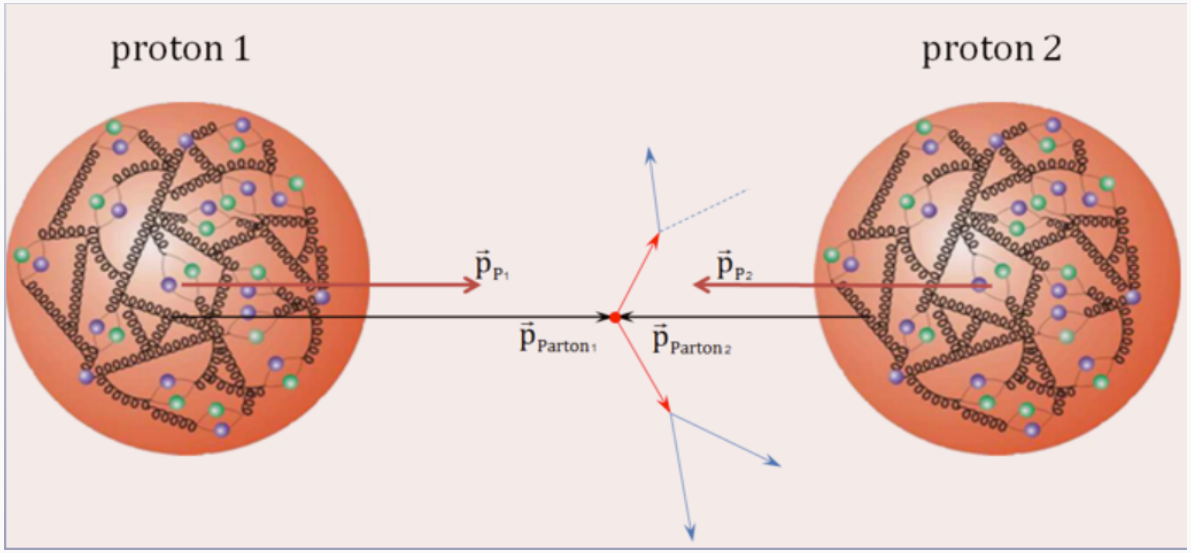

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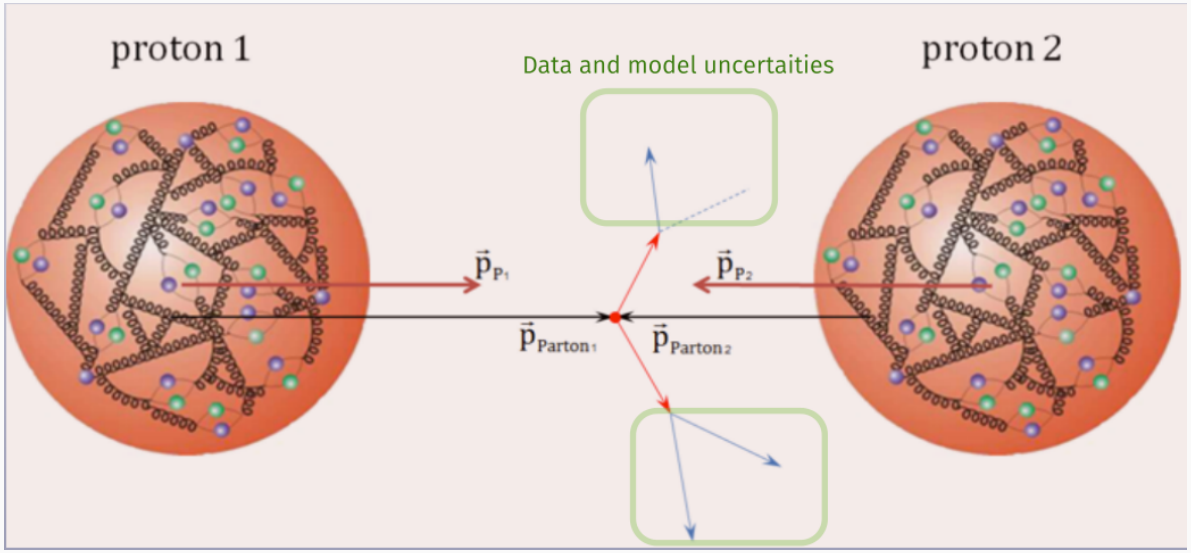

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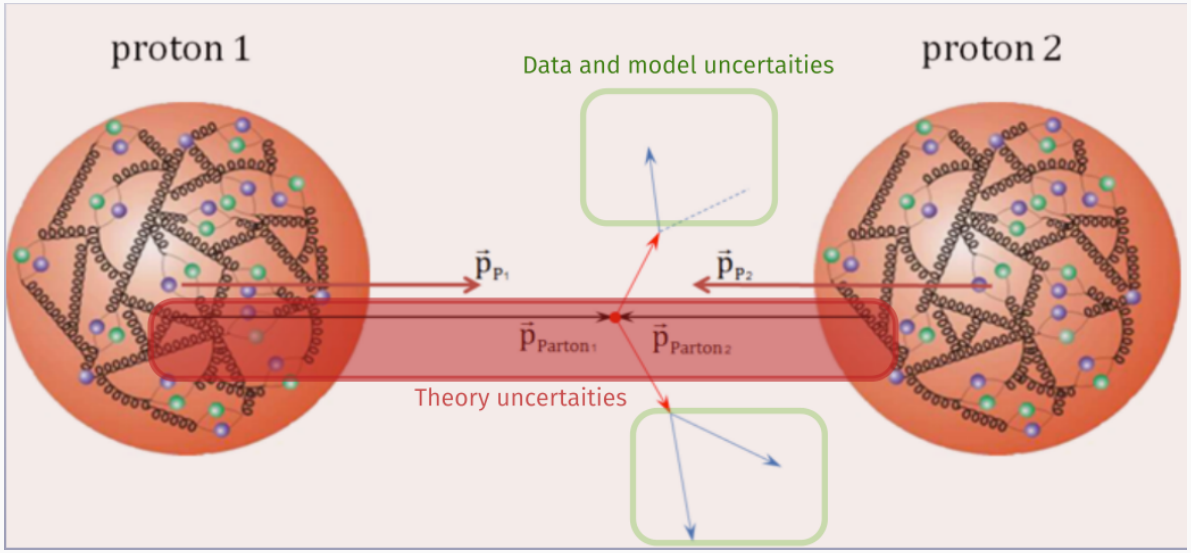

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- Develop technical skills (programming).

# OUTLOOK

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**Outreach** Design a carry on a high impact activities within the HiggsTools Network (

- Convene an *open* Journal Club
- Outreach activities for the general public.

# FUTURE CAREER

The most likely prospect is to make an application for an EU Marie Skłodowska-Curie Fellowship in 2018.

# Thank you!