

**Fellini** Fellowship for Innovation at INFN

# General Meeting:

## QCD and LHC Physics Session

Nello Bruscano (Roma I), Oton Vazquez Doce (LNF), Michele Fauci Giannelli (Roma II),  
Daniel Pablos Alfonso (Torino), Leonardo Vernazza (Torino)



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Tuesday, May 31<sup>st</sup>, 2022

# QCD and LHC Physics: schedule [9:00-10:30]

## Highlights of the session 10'



**Nello Bruscano** (Roma I)

*Top properties at LHC (Yukawa coupling, QE and polarisation) [14']*



**Leonardo Vernazza** (Torino)

*Analytic tools for precision in particle physics [14']*



**Oton Vazquez Doce** (LNF)

*Femto-Strong: Hadronic interactions with  $|S|=1$  [14']*



**Daniel Pablos Alfonso** (Torino)

*Jet Quenching and the Nature of the QGP [14']*



**Michele Fauci Giannelli** (Roma II)

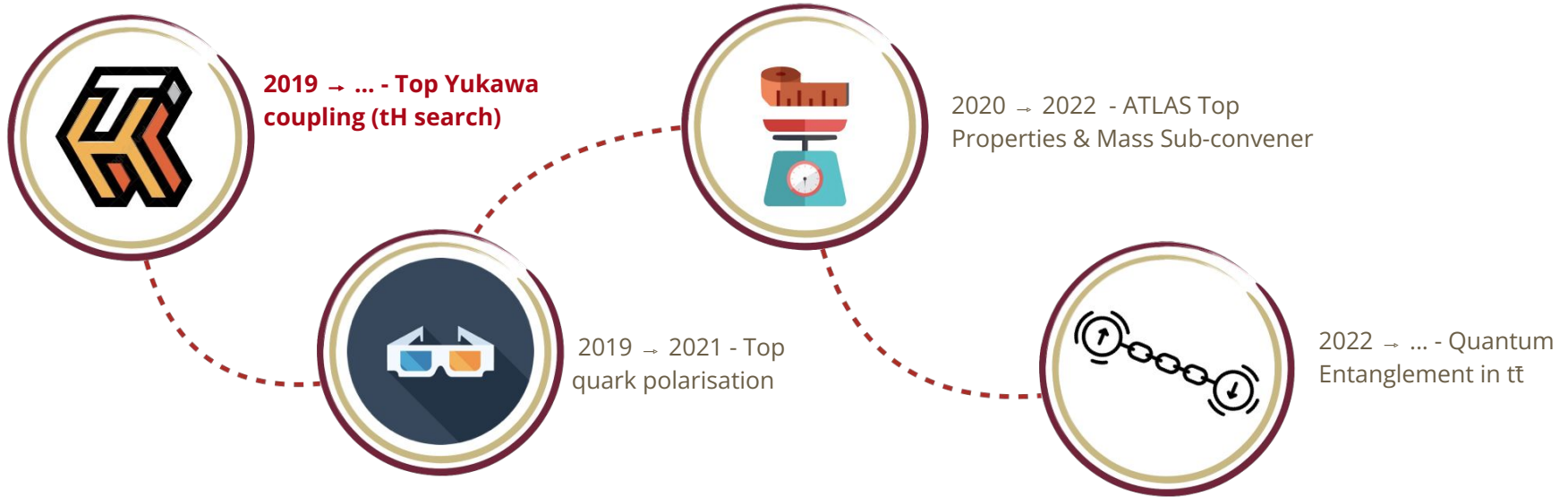
*Top physics and fast calorimeter simulation in ATLAS [14']*

## Discussion 10'

### **Keywords:**

Precision,  
complex systems,  
colliders, ...

# Top properties at LHC - Nello Bruscano (Roma I)



- Top quark, the heaviest SM particle → key role in EWSB and vacuum stability?
- Several top properties worth being investigated, like:
  - Top Yukawa coupling  $y_t$  ( tH search - main objective of FELLINI Project)
  - Top-quark polarisation measurement published in 2021
  - Top quark-antiquark Quantum Entanglement (Quantum Tomography)

# All orders in gauge theories - Leonardo Vernazza (To)

- **Develop analytic tools for precision in particle physics**

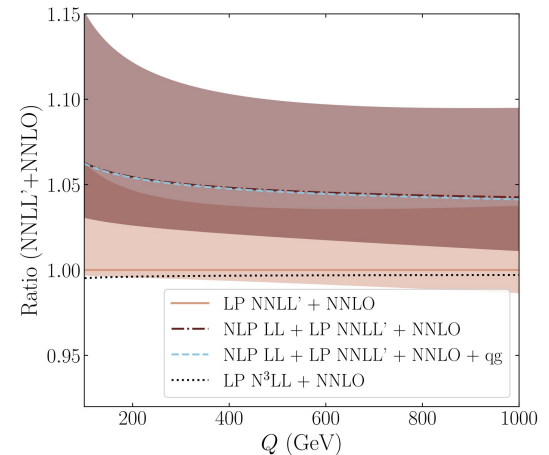
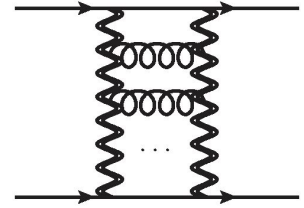
- Particle physics phenomenology
- Formal aspects of quantum field theories

- **High-energy limit**

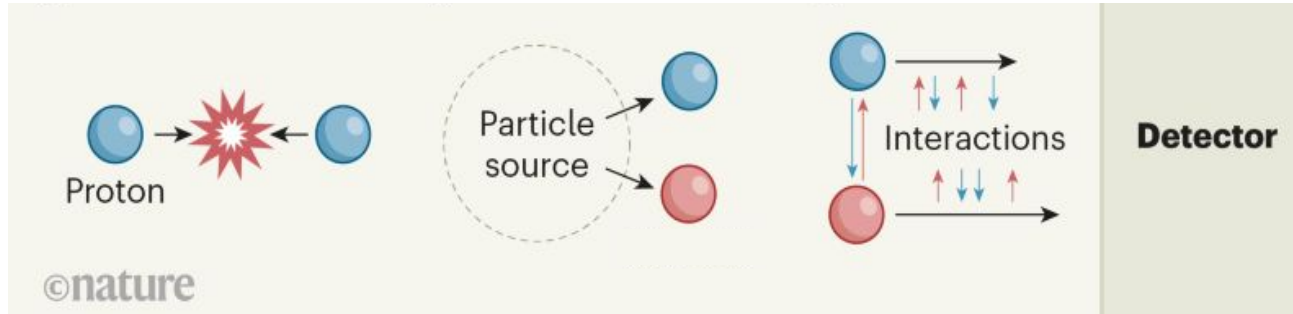
- Develop theory for the calculation of scattering amplitudes as iterated integrals
- Investigate properties of scattering amplitudes in this limit - bootstrap to general kinematic (Infrared divergences, etc.)

- **Threshold limit**

- Develop frameworks for the resummation of large logarithms at next-to-leading power
- Diagrammatic approach
- Soft-collinear effective field theory
- Phenomenology

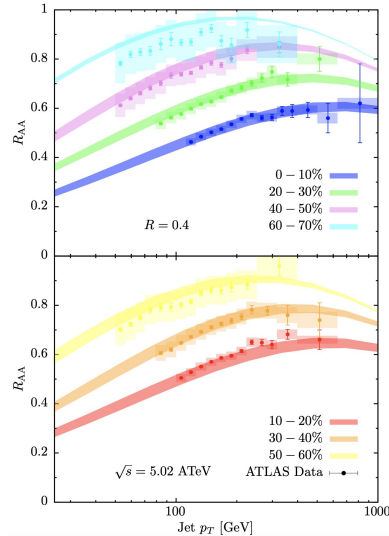


# Hadronic interactions with $|S| = 1$ - O. Vázquez Doce



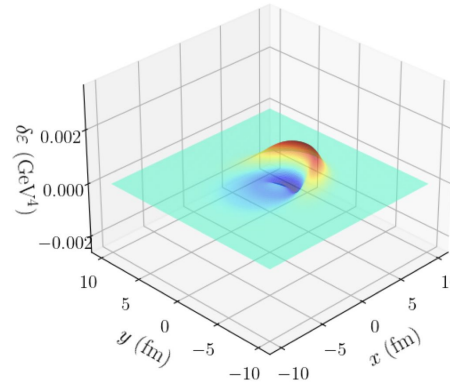
- **Measurement of the  $K^-d$  strong interaction at low energy**
  - (anti)KN interaction building block for the non perturbative Low-E QCD.
- **Femtoscropy technique in small systems ( $\sim 1\text{fm}$ )**
  - Study of two-particle correlation function at low relative momentum
  - A new method to measure interaction between hadrons with strangeness content
- **Complement Kaonic deuterium measurement**
  - Access strong interaction with strangeness at low-Energy (DAΦNE) and High-Energy (LHC) facilities

# Jet Quenching and the Nature of the QGP - D. Pablos

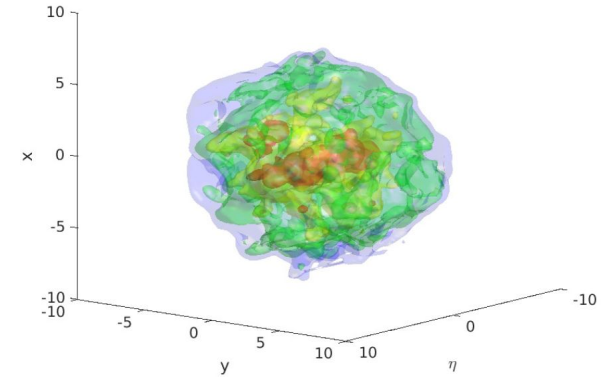


**Analytic  
Jet Suppression**

*Jets are modified by  
the QGP...*



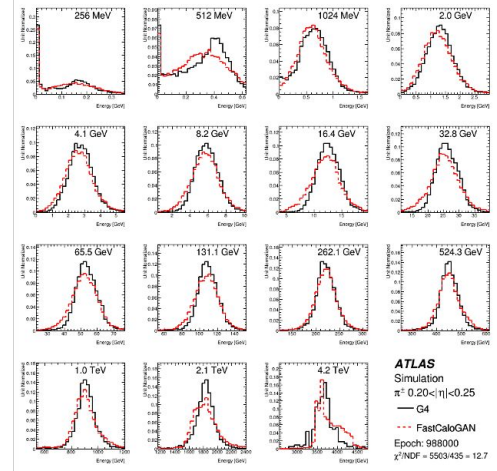
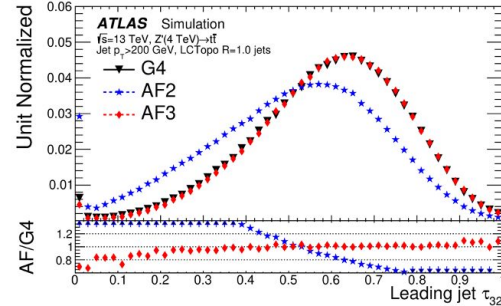
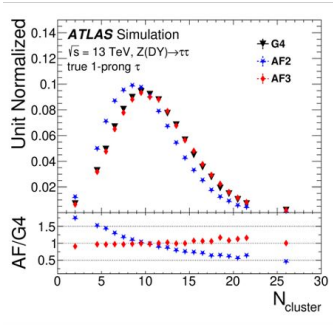
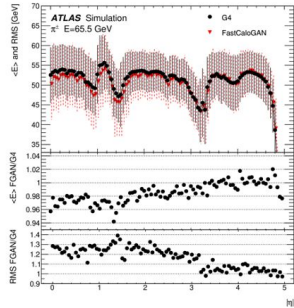
*... and jets modify the  
QGP in their turn.*



**QGP Response to  
Jet Passage**

- Quark-Gluon Plasma (QGP), a new phase of QCD matter in colliders.
- Many-body, strongly coupled system - stems from QCD Lagrangian, but “more is different”.
- Very well described by relativistic hydrodynamics with the QCD equation of state.
- Project: understand deconfined QCD medium via interaction with pQCD probes - jets.

# Top physics and fast calorimeter simulation in ATLAS - Michele Fauci Giannelli (Roma II)



- FastCaloGAN included in the new fast simulation package of ATLAS (AtFast3)

- full system calorimeter fast simulation using Generative Adversarial Networks
- it reproduces the G4 distribution within a few % and outperform the current fast simulation (AF2) in the boosted regime

