

# Jets and their substructure from LHC data

A faint, light gray background diagram of a particle jet. It features a central vertex from which several lines radiate outwards. Some lines are straight with arrowheads pointing away from the vertex, representing particles. One line is a thick, wavy curve, representing a gluon. The entire diagram is enclosed within a large, light gray triangle.

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31 May 2021 to 4 June 2021

CERN

Europe/Zurich timezone



### Overview

Registration

Call for Abstracts

Timetable

Participant List

Videoconference Rooms

This CERN-TH workshop will be held virtually on ZOOM between 31 May - 4 Jun. We invite you to register through the menu item on the left. The workshop will involve a mixed audience of experimentalists and theorists, with a particular emphasis on phenomenology and the open challenges in jet physics at the LHC. The main programme will take place in the early afternoon and topical discussion sessions will be organised both in the morning and in the late afternoon. In order to foster lively discussions, we wish to accommodate 2-3 short talks (10-15mins) in each discussion session. We encourage participants, especially young researchers, to submit their abstract using the form via the "Call for Abstracts" menu on the left.

List of confirmed speakers:

- **Bugra Bilin** (Univ. Bruxelles)
- **Andy Buckley** (Univ. of Glasgow)
- **Trisha Farooque** (MSU)
- **Rhorry Gauld** (Nikhef)
- **Thomas Gehrmann** (UZH)
- **Tommaso Giani** (Univ. of Edinburgh)
- **Lucian Harland-Lang** (Univ. of Oxford)
- **Andreas Hinzmann** (Univ. Hamburg)
- **Michael Kagan** (SLAC)
- **Gregor Kasieczka** (Univ. Hamburg)
- **Andrew Larkoski** (Reed College)
- **Ezra Lesser** (ALICE, Berkeley)
- **Kara Mattioli** (LHCb, Univ. of Michigan)
- **Ben Nachman** (LBNL)
- **Duong Hai Nguyen** (SUNY)
- **Gregory Soyez** (IPhT, Saclay)
- **Jesse Thaler** (MIT)
- **Pavel Starovoitov** (Univ. Heidelberg)
- **Benedikt Maier** (CERN)

# Some logistics

- ▶ All sessions will take place in this Zoom room
- ▶ Typical schedule involves:
  - ▶ Discussion session between 11:00 - 12:30 CEST with 2 talks/session + discussions
  - ▶ Main session between 13:30-17:00 CEST
  - ▶ Discussion session between 17:30 - 19:00 CEST with 2 talks/session + discussions
- ▶ We encourage all participants to take actively part in the discussions, and to suggest or initiate extra discussions by contacting the organisers either by email or via the Zoom chat
- ▶ Whenever possible, please keep your cameras on during the workshop

# The programme

**Monday: light-jet & V+jets  
observables in QCD  
and their uncertainty;  
impact on  $\alpha_s$  and PDFs**

|       |         | MONDAY, 31 MAY  |       |   |
|-------|---------|---|-------|---|
| 13:15 | → 13:30 | <b>Welcome</b>  | 🕒 15m | ✎ |
| 13:30 | → 17:00 | <b>Jets and V+jets: Uncertainties &amp; correlations</b>  |       | ✎ |
| 13:30 |         | <b>ATLAS+CMS: Experimental overview on jets and V+jets</b><br>Speakers: Bugra Bilin (Universite Libre de Bruxelles (BE)), Pavel Starovoitov (Ruprecht Karls Universitaet Heidelberg (DE))<br><a href="#">VJtalk_JetsatLHC_...</a> | 🕒 50m | ✎ |
| 14:50 |         | <b>Precision QCD for jets and V+jets</b><br>Speaker: Thomas Kurt Gehrman (Universitaet Zuerich (CH))  | 🕒 30m | ✎ |
| 15:35 |         | <b>break</b>  | 🕒 10m |   |
| 15:45 |         | <b>Impact of jet data on PDFs and <math>\alpha_s</math></b><br>Speakers: Dr Lucian Harland-Lang (University of Oxford), Tommaso Giani<br><a href="#">giani.pdf</a> <a href="#">lhl_jets.pdf</a>                                   | 🕒 50m | ✎ |
| 17:30 | → 19:00 | <b>Discussions</b>  |       | ✎ |
| 17:30 |         | <b>Precision predictions for jet rates</b><br>Speaker: Rene Poncelet (Cambridge University)   | 🕒 15m | ✎ |
| 17:50 |         | <b>PDF fits using 3D dijet data</b><br>Speakers: Jakob Karl Stark (KIT - Karlsruhe Institute of Technology (DE)), Klaus Rabbertz (KIT - Karlsruhe Institute of Technology (DE))   | 🕒 15m | ✎ |
| 18:10 |         | <b>additional discussions</b>   | 🕒 50m |   |

# The programme

**Tuesday: heavy-quark jets  
(tagging, fragmentation, ...)  
& jet substructure**

| TUESDAY, 1 JUNE      |   |       |
|----------------------|---|-------|
| <b>11:00</b> → 12:30 | <b>Discussions</b>  |       |
| 11:00                | <b>A Comparative Machine Learning Study of Color Tagger Variables in VH(bb) with Fast Detector Simulation</b><br>Speaker: Alberto Rescia (University of Pavia and INFN (IT))          | 🕒 15m |
| 11:20                | <b>Recoil-free azimuthal angle for precision boson-jet correlation at the LHC</b><br>Speaker: Dingyu Shao (Fudan University (CN))   | 🕒 15m |
| 11:40                | <b>additional discussions</b>   | 🕒 50m |
| <b>13:30</b> → 17:00 | <b>Heavy quark jets</b>   |       |
| 13:30                | <b>ATLAS+CMS: Experimental overview on heavy-flavoured jets</b><br>Speakers: Andy Buckley (University of Glasgow (GB)), Duong Hai Nguyen (The State University of New York SUNY (US)) | 🕒 50m |
| 14:35                | <b>LHCb: Experimental overview on heavy-flavoured jets</b><br>Speaker: Kara Mattioli (University of Michigan (US))  | 🕒 30m |
| 15:20                | <b>break</b>  | 🕒 10m |
| 15:30                | <b>Flavour tagging in jets: theory vs. experiment</b><br>Speaker: Rhorry Gauld (Nikhef)   | 🕒 30m |
| 16:15                | <b>Machine Learning landscape of top tagging</b><br>Speaker: Gregor Kasieczka (Hamburg University (DE))   | 🕒 30m |
| <b>17:30</b> → 19:00 | <b>Discussions</b>  |       |
| 17:30                | <b>NNLO QCD predictions for W+c-jet production at the LHC</b><br>Speaker: Mathieu Pellen (University of Freiburg)   | 🕒 15m |
| 17:50                | <b>Evolution of Track functions at order <math>\alpha_s^2</math></b><br>Speaker: Solange Schrijnder van Velzen  | 🕒 15m |
| 18:10                | <b>additional discussions</b>   | 🕒 50m |

# The programme

**Wednesday: jet substructure  
(progress in TH & EXP techniques)**

| WEDNESDAY, 2 JUNE    |   |       |
|----------------------|---|-------|
| <b>11:00</b> → 12:30 | <b>Discussions</b>  |       |
| 11:00                | <b>Soft drop momentum sharing fraction zg beyond LL accuracy</b><br>Speaker: Pedro Cal (University of Amsterdam)  | 🕒 15m |
| 11:20                | <b>Investigating top tagging with N-subjettiness and prong finding</b><br>Speaker: Jack Helliwell (University of Manchester)                                | 🕒 15m |
| 11:40                | <b>additional discussions</b>   | 🕒 50m |
| <b>13:30</b> → 17:00 | <b>Jet Substructure</b>   |       |
| 13:30                | <b>ATLAS+CMS: Jet substructure measurements</b><br>Speakers: Andreas Hinzmann (Hamburg University (DE)), Ben Nachman (Lawrence Berkeley National Lab. (US)) | 🕒 50m |
| 14:35                | <b>ALICE: Jet substructure measurements</b><br>Speaker: Ezra Douglas Lesser (University of California Berkeley (US))  | 🕒 30m |
| 15:20                | <b>break</b>  | 🕒 10m |
| 15:30                | <b>New theory challenges in jet substructure</b><br>Speaker: Gregory Soyez (CEA Saclay)   | 🕒 30m |
| 16:15                | <b>Theoretical precision for jet substructure</b><br>Speaker: Andrew Larkoski (Reed Collge)   | 🕒 30m |
| <b>17:30</b> → 19:00 | <b>Discussions</b>  |       |
| 17:30                | <b>Rethinking jets</b><br>Speaker: Ian James Muilt (Massachusetts Inst. of Technology (US))   | 🕒 15m |
| 17:50                | <b>Spin-sensitive jet observables and their resummation</b><br>Speaker: Alexander Karlberg (University of Oxford)   | 🕒 15m |
| 18:10                | <b>additional discussions</b>   | 🕒 50m |

# The programme

## Thursday: Machine learning applications & tagging techniques

| THURSDAY, 3 JUNE     |   |       |
|----------------------|---|-------|
| <b>11:00</b> → 12:30 | <b>Discussions</b>  |       |
| 11:00                | <b>Deep learning jet modifications in heavy-ion collisions</b><br>Speaker: Yilun Du (University of Bergen)  | 🕒 15m |
| 11:20                | <b>Measuring QCD Splittings with Invertible Networks</b><br>Speaker: Theo Heimel (Universität Heidelberg)   | 🕒 15m |
| 11:40                | <b>additional discussions</b>   | 🕒 50m |
| <b>13:30</b> → 17:00 | <b>Machine Learning for jets</b>  |       |
| 13:30                | <b>ATLAS+CMS: Measurements involving tagging techniques</b><br>Speakers: Benedikt Maier (CERN), Trisha Farooque (Michigan State University (US))            | 🕒 50m |
| 14:45                | <b>Image-Based Jet Analysis and its application to experiments</b><br>Speaker: Michael Aaron Kagan (SLAC National Accelerator Laboratory (US))              | 🕒 30m |
| 15:30                | <b>break</b>  | 🕒 15m |
| 15:45                | <b>Theory perspective on ML jet analyses and the interpretability of their results</b><br>Speaker: Jesse Thaler (MIT)                                       | 🕒 30m |
| 16:30                | <b>additional discussions</b>   | 🕒 30m |
| <b>17:30</b> → 19:00 | <b>Discussions</b>  |       |
| 17:30                | <b>Boosted Top Quark Tagging and Polarization Measurement using Machine Learning</b><br>Speaker: Soham Bhattacharya (Deutsches Elektronen-Synchrotron (DE)) | 🕒 15m |
| 17:50                | <b>Combine and Conquer: Event Reconstruction with Bayesian Ensemble Neural Networks</b><br>Speaker: Jack Araz (IPPP - Durham University)                    | 🕒 15m |
| 18:10                | <b>additional discussions</b>   | 🕒 50m |

- ▶ The 2021 edition of the [PhysTeV workshop](#) (aka “Les Houches”) was canceled.
- ▶ Some subjects related to SM phenomenology at the LHC, that are traditionally discussed in Les Houches, will be covered, in a reduced format, through a few virtual meetings.
  - [Mon. 14](#): “TH progress and open issues in SM predictions (jets, V+jets, Higgs, top)”
  - [Tue. 15](#): “SM predictions: EXP needs and wish-list update (jets, V+jets, Higgs, top)”
  - [Wed. 16](#): “Monte Carlo generators and Parton Showers (TH+EXP)”
  - [Thu. 17](#): “open discussions” + “Jet substructure and Machine Learning”
  - [ [Fri. 18](#): if needed, time for further discussions ]

- ▶ You are welcome to register and join the discussions!

Please register  
&  
use the call for abstract to propose ideas for discussions

👉 when:  [afternoons CET time]

👉 where:

👉 format: short kick-off talks followed by time for open discussion

- If you are interested (even in just one or two sessions), please register to the event.
- Everyone is welcome to suggest ideas for discussions, during or before the meetings (use “Call for Abstracts”).



**Thank you and enjoy the workshop !**