

**Alexander Kupco, Ph.D.**

**Excellent member**

**WP1 Deputy leader**

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## PROFESSIONAL INTERESTS / RESEARCH EXPERTISE

My main interest is physics of strong and electroweak interactions. I focus on exploration of the structure of matter and space-time at the smallest distance scales accessible in the Earth experiments. The smallest distances can be studied on most powerful hadron colliders in events induced by strong interaction – production of jets (collimated narrow sprays of particles, - a footprint of proton constituents, quarks and gluons kicked out violently from the protons). During my Ph.D. and post-doctoral years, I worked on experiment D0 at Tevatron collider at Fermilab. I contributed to many jet results of the D0 experiment, either as author of primary analyses or through my work on calibration of jet energies. This calibration is dominant experimental error for many measurements. During my convenorship of the D0 Jet Energy Scale Group, we reached 1% precision in wide kinematic domain. This directly influenced the quality of many D0 results, not only jet measurement. We developed special technique for in-situ calibration that significantly improved precision of calibration of jets induced by b-quark, this led in turn to more precise measurement of top quark mass.

With the beginning of LHC (and shutdown of Tevatron), I moved to experiment ATLAS. In addition to jet measurements, my interest was broadening towards special class of events - diffractive and photon induced events. Both have the same experimental signatures – large parts of empty detector and proton surviving the interaction. As a post-doc at CEA Saclay, I was part of the group that proposed to ATLAS to build dedicated forward proton detector AFP (installed and operating since 2016). Together with my Ph.D. student, Oldřich Kepka, we were exploring an idea how to use this type of events for studies of couplings between electroweak (EWK) vector bosons that could be done with greater sensitivity than in a conventional approach. Oldřich performer later several such ATLAS measurements. With my second PhD student, Ondřej Penc, we worked on the ATLAS measurement for production rate of di-boson Z production associated with 2 jets (ZZjj). The EWK contribution was observed for the first time in this channel and the ATLAS paper reporting on this observation was accepted in Aug 2022 for publication by Nature Physics. This EWK process receives contribution from vector boson scattering (VBS), a process that is in the Standard Model linked with Higgs mechanism.

From 2013, I started to play leading roles in the organizing of Czech particle physics community. In years 2013-2015, I led major grant that was covering the participation of Czech research institutions in the experiment ATLAS (80.4 mil CZK, about 3.2 mil EUR). From 2016, I'm principal investigator of Large Research Infrastructure for experiment at CERN (CERN-CZ), this covers and organizes contributions of Czech research institutions to all CERN experiments and projects (overall budget in 2016-2022 is 560.5 mil CZK, about 22.4 mil EUR).

## EDUCATION

1997 - 2003 Charles University, Faculty of Mathematics and Physics  
PhD in Physics (Particle physics)  
Thesis: *Measurement and QCD analysis of inclusive dijet mass cross section in  $p\bar{p}$  collisions at  $\sqrt{s}=1.96$  TeV*  
Advisor: Jiří Chýla

## Curriculum Vitae

1993 - 1997 Charles University, Faculty of Mathematics and Physics  
Master's degree in Nuclear and Subnuclear Physics  
Diploma thesis: *The study of kinetics of hadron gas and quark-gluon plasma*  
Advisor: Jiří Dolejší

### CURRENT POSITIONS

2006 - Senior Researcher (permanent)  
Institute of Physics of the Czech Academy of Sciences (FZU), Czech Republic

### PREVIOUS POSITIONS

2004 - 2006 Postdoctoral researcher, Institute of Physics of the CAS, Prague, Czech Republic  
2003 - 2004 Postdoctoral researcher, CEA Saclay, France

### PUBLICATIONS

***h*-index of 142 according to Inspire HEP database, as of 16 Oct 2022**

I (co)authored a total of 1479 journal articles and conference proceedings, most of them are papers by ATLAS and D0 Collaborations. Of them 15 are with less than 10 authors, these are either proceedings or phenomenology papers. My work has so far gained over 104283. Of these, 565 have been articles submitted or published since 2016.

Selected 5 most important articles:

- 1 ATLAS Collaboration, 'Observation of electroweak production of two jets and a Z-boson pair with the ATLAS detector at the LHC', accepted by *Nature Physics* (Aug 2022), preprint CERN-EP-2020-016, arXiv:2004.10612 [hep-ex]. **[41 citations]**.
- 2 TOTEM and D0 Collaborations, 'Odderon Exchange from Elastic Scattering Differences between pp and ppbar Data at 1.96 TeV and from pp Forward Scattering Measurements', *Phys. Rev. Lett.* **127** (2021) 6, 062003. **[51 citations]**
- 3 ATLAS Collaboration, 'Observation of photon-induced W+W- production in pp collisions at  $\sqrt{s}=13$  TeV using the ATLAS detector', *Phys. Lett.* **B 816** (2021) 136190. **[29 citations]**
- 4 ATLAS Collaboration, 'Observation and Measurement of Forward Proton Scattering in Association with Lepton Pairs Produced via the Photon Fusion Mechanism at ATLAS', *Phys. Rev. Lett.* **125** (2020) 261801. **[34 citations]**
- 5 ATLAS Collaboration, 'Measurement of the exclusive  $\gamma\gamma\rightarrow\mu^+\mu^-$  process in proton-proton collisions at  $\sqrt{s}=13$  TeV with the ATLAS detector' (2016). *Phys. Lett.* **B 777** (2018) 303. **[69 citations]**

### APPLICATION RESULTS AND SOFTWARE DEVELOPMENT

- 1 Contribution to FPMC, Monte Carlo generator for forward physics (author of effective opacity model used to describe rescattering corrections), <https://fpmc-hep.github.io/>
- 2 New model of cluster hadronization which was later improved and implemented to Monte Carlo generator Herwig, <https://herwig.hepforge.org/>

### RESEARCH GRANTS

Since 2016, I was primary investigator for major research grants on international cooperation of Czech research institutions with experiments and projects at CERN. The total acquired amount is about 22.4 million Euro (560.5 million CZK).

PI	10.7 mil EUR	Jan 2020 - Dec 2022	Research infrastructure for experiments at CERN (CERN-CZ), LM2018104	MEYS, Large Research Infrastructure Program	Czech
Co-PI for FZU	1.5 mil EUR	Mar 2017-Dec 2022	Getting new knowledge of the microworld using the CERN infrastructure, LTT17018	MEYS, program Inter-Excellence	Czech

## Curriculum Vitae

PI	11.7 mil EUR	Jan 2016 - Dec 2019	Research infrastructure for experiments at CERN (CERN-CZ), LM2015058	MEYS, Large Research Infrastructure Program	Czech
Co-PI for FZU	28500 0 EUR	Jan 2015 – Dec 2016	Investigation of the Microworld using the CERN Infrastructure, LG15052	MEYS, Program for International Cooperation INGO II	Czech
PI	5100 EUR	Jan 2015 – Dec 2016	Study of new states of matter at LHC	Czech-France mobility program Barrande	International
PI	3.1 mil EUR	Jan 2013 - Dec 2015	International experiment ATLAS-CERN, LG13009	MEYS, Program for International Cooperation INGO II	Czech

### INVITED TALKS AT INTERNATIONAL CONFERENCES

I have given over 27 invited talks of which 17 have been at international conferences and workshops (including talks on major conferences of our field, ICHEP, twice, Rencontres du Moriond, International Symposium on Multiparton Dynamics, International Symposium on Physics in Collision, or conference Photon). List since Jan 2016 is provided below:

- Jun 2019 *Future accelerators in Europe*, ATLAS Czech and Slovak Workshop, Prague, Czech Republic.
- Jun 2018 Inclusive jet and dijet production at 13 TeV, ATLAS Czech and Slovak Workshop, Prague, Czech Republic.
- Jun 2018 *ZZ production and vector boson scattering at ATLAS*, ATLAS Czech and Slovak Workshop, Kosice, Slovakia.
- Sept 2017 *Triple and quartic gauge boson couplings at the LHC*, International Symposium on Physics in Collision (PIC2017), Prague, Czech Republic

### AWARDS and FELLOWSHIPS

- 2005 Otto Wichterle Prize, awarded by the Czech Academy of Sciences
- Jun 2001 – Sept 2001 NATO Science Fellowship (Fermilab)

### PUBLIC OUTREACH

My activities in public outreach include occasional: lecturing high school students about particle and quantum physics, either dedicated talks or summer school lectures; invited lectures to wider public in libraries, special events (introductory lecture to movie Particle Fever), or amateur astronomical community; radio talks.

### SUPERVISION OF GRADUATE STUDENTS and POSTDOCTORAL FELLOWS

- MSc
  - Oldřich Kepka (Charles University)
  - Ondřej Hladík (Charles University)
  - Radek Podškubka (Charles University)
- PhD
  - 2006-2009 Oldřich Kepka, Charles University (cotutelle with Orsay University)  
Works at FZU as senior scientists, he is currently ATLAS Standard Model Group Convenor.
  - 2015-2021 Ondřej Penc, Czech Technical University in Prague  
Works now at CERN, where he obtained in March 2022 CERN post-doc fellow position.

### TEACHING ACTIVITIES

I'm teaching from 2009 lecture "Quark, partons, and quantum chromodynamics", this MSc and PhD introductory course on quantum chromodynamics is obligatory for master's degree subject of particle and nuclear physics at Faculty of Mathematics and Physics at Charles University. I'm also member of Subject-Area

Board of Particle and Nuclear Physics at this faculty. As this, I participated in many Ph.D. state exams and thesis defenses.

#### MAJOR COLLABORATIONS

2004 - Experiment ATLAS at CERN  
1999 - 2012 Experiment D0 at Fermilab

#### ORGANIZATION OF INTERNATIONAL SCIENTIFIC MEETINGS

2020 International conference ICHEP 2020, member of local organization committee, Prague  
2017 International symposium PIC 2017 (Particle in Collision), member of local organization committee, Prague  
2017 International conference FPCP2017 (Flavor Physics & CP Violation) workshop, Prague  
2017 ATLAS CZ+SK Workshop, main organizer, Prague, (51 participants)  
2015 'Workshop on pico-second timing detectors for physics and medical applications', chair of local organization committee, Prague  
2004 'Workshop on Low-x Physics', Prague (60 participants)

#### INSTITUTIONAL RESPONSIBILITIES

March 2022 - Elected member of Institutional Council of FZU  
Jan 2020 - Head of Division of Elementary Particle Physics, Institute of Physics (FZU) of the Czech Academy of Sciences (CAS), Czech Republic  
Dec 2014 - Dec 2019 Head of Department of Experimental Particle Physics, FZU

#### COMMISSIONS OF TRUST AND SERVING SCIENTIFIC COMMUNITY

Journal referee European Physics Journal C  
Universities Since 2019 - member of Scientific Board of Faculty of Nuclear Sciences and Physics Engineering, Czech Technical University in Prague  
Since 2013 - member of Subject-Area Board of Particle and Nuclear Physics at Charles University, Faculty of Mathematics and Physics  
Academy of Sciences From 2019 – elected member of Assembly of the Czech Academy of Sciences  
Grant Agency Member of Committee for cooperation of Czech Republic with CERN, and advisory body of minister of Education, Youth and Sports  
ATLAS experiment since 2016 – representative of FZU ATLAS group in ATLAS Collaboration Board  
since 2015 – national coordinator for ATLAS High Luminosity LHC upgrade