

R-J. Standard model and new physics

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Physics analyses and theoretical work. — We have continued the study of supersymmetric processes leading to strongly boosted top quark decays. We performed the inclusive simulation of such processes, worked out a method for background estimation, and demonstrated its sensitivity in simulation.

The group also participated in the ASACUSA experiment at the Antimatter Factory of CERN which resulted in a break-through in the test of the CPT invariance, the theorem stating the equivalence of matter and antimatter. By installing a new kind of cooling system the difference between the masses of protons and anti-protons was shown to be less than 10^{-9} . Using laser spectroscopy, 13 transitions were measured with the precision of a few times 10^{-9} on about 10^9 anti-protonic helium atoms cooled down below 1.7 K in cryogenic low-pressure helium gas. This result was reported at several conferences including the Vienna Symmetry Festival, published in Science, and mentioned in a special press announcement at CERN.

We provide also a member for the Publication Committee of the CMS Experiment at CERN and play important role in publishing CMS results of low-x QCD studies.

Work on instrumentation. — During the 2016 data-taking, we have monitored the radiation damage induced performance changes in the CMS pixel detector. We have updated the calibration data-bases used in the offline data-reconstruction in order to improve the hit resolution. We participated in the alignment of the CMS tracker, and improved the alignment technique by identifying misalignment components as residues of the calibrations in pixel local hit reconstruction. We studied the collision pile-up dependent efficiency of the pixel detector in 2016, which is a major determining factor for the CMS luminosity measurement used in all physics analyses. By identifying nuclear interactions inside the pixel detector, we participated in the position measurement of the beam-pipe and various mechanical components of the detector in order to survey the status of the envelope in which the Phase I Pixel Upgrade detector is going to be installed in the beginning of 2017. The group has manufactured the control and read-out electronics for the Phase I Pixel Upgrade detector according to the design we completed in 2015. We played a major role in the commissioning of the data acquisition system to be used for the new detector, in the construction of the Geant modeling of the new detector within the CMS software framework, and the preparation of the local reconstruction with the new geometry.

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Stable operation of the T2_HU_Budapest grid site continued in 2016. Our site is used extensively by the entire collaboration including our group for reconstructing collision data in physics analyses. The disk capacity committed to CMS has increased to 700 TB, and our computation power commitments to 933 CPU cores.

Within the framework of the SuShi (Superconducting Shield) Septum for the FCC project, the first two superconducting shield prototypes were designed, and the first one - made of MgB₂ - was constructed by an Italian company. Our detailed computer simulation studies showed that it is possible to find a wire configuration around the shield to produce a homogeneous magnetic field in a wide range of field strengths. The CERN Accelerator School (CAS) was organized in Budapest between 2-14 October.

Outreach. — The Hungarian Teachers programme at CERN (15-21 August 2016) was organized by Wigner RCP, on the initiative of our group, with the participation of 20 Hungarian physics teachers. It was followed by a general meeting on November 12 for the participants of all previous trainings taking place between 2006 and 2016 at Sapientia College of Theology, Budapest. We also participated in the organization of the annual Hands-on Particle Physics Master-classes on two occasions with 22 high-school students attending each session. In addition to conference talks and university teaching, many popular lectures were given by our group.

Grants

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International cooperation

CMS Collaboration (199 institutes), ATLAS Collaboration (182 institutes),

University of Tokyo, Japan;

RIKEN, Wako, Japan;

Max-Planck-Institut für Quantenoptik, Germany;

Università di Brescia & Istituto Nazionale di Fisica Nucleare, Italy

Publications

Articles

1. Diósi L: Nonlinear Schrödinger equation in foundations: Summary of 4 catches. **J PHYS CONF SER** 701:(1) 012019/1-5 (2016)
2. Diósi L: Structural features of sequential weak measurements. **PHYS REV A** 94:(1) 010103/1-4 (2016)
3. Horii M, Aghai-Khozani H, Soter A, Barna D, Dax A, Hayano R, Kobayashi T, Murakami Y, Todoroki K, Yamada H, Horvath D, Venturelli L: Buffer-gas cooling of antiprotonic helium to 1.5 to 1.7 K, and antiproton-to-electron mass ratio. **SCIENCE** 354:(6312) 610-

614 (2016)

4. Horváth D: Ultra-fast neutrinos: What can we learn from a false discovery? *INT J MOD PHYS A* 31:(28-29) 1645037/1-11 (2016)
5. Levy A, Diosi L, Kosloff R: Quantum flywheel. *PHYS REV A* 93:(5) 052119/1-9 (2016)
6. Tilloy A, Diosi L: Sourcing semiclassical gravity from spontaneously localized quantum matter. *PHYS REV D* 93:(2) 024026/1-12 (2016)
7. Todoroki K, Barna D, Hayano RS, Aghai-Khozani H, Soter A, Corradini M, Leali M, Lodi-Rizzini E, Mascagna V, Venturelli L, Prest V, Vallazza L, De Salvador D, Hori M: Instrumentation for measurement of in-flight annihilations of 130 keV antiprotons on thin target foils. *NUCL INSTRUM METH A* 835 110-118 (2016)

Others

8. Horváth D: A CERN nagy hadronütköztetője, 2016 (The Large Hadron Collider of CERN, in Hungarian) *FIZIKAI SZEMLE* 66:(11) 364-372 (2016)
9. Barna D: Magyar részvétel a jövő részecskegyorsítójának fejlesztésében (Hungarian participation in the development of future's particle accelerator, in Hungarian). *TERMÉSZET VILÁGA* 147:(Special edition 2) 86-89 (2016)
10. Horváth Dezső: Neutrínóoszilláció és neutrínótömeg. Fizikai Nobel-díj, 2015 (Neutrino oscillation and neutrino mass. Physical Nobel Prize, 2015, in Hungarian). *MAGYAR KÉMİKUSOK LAPJA* 71:(2) 38-40 (2016)

See also: R-I.8, R-H NA49 Collaboration, R-H NA61 collaboration (Vesztergombi G)

ATLAS collaboration

Due to the vast number of publications of the large collaborations in which the research group participated in 2016, here we list only a short selection of appearances in journals with the highest impact factor.

1. Aaboud M et al. incl. Pásztor G, Tóth J (2851 authors): Search for charged Higgs bosons produced in association with a top quark and decaying via $H^\pm \rightarrow \tau \nu$ using pp collision data recorded at $\sqrt{s} = 13$ TeV by the ATLAS detector. *PHYS LETT B* 759: 555-574 (2016)
2. Aaboud M et al. incl., Pásztor G, Tóth J (2854 authors): Search for resonances in the mass distribution of jet pairs with one or two jets identified as b-jets in proton-proton collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector. *PHYS LETT B* 759: 229-246 (2016)
3. Aaboud M et al. incl. Pásztor G, Tóth J (2863 authors): Search for TeV-scale gravity signatures in high-mass final states with leptons and jets with the ATLAS detector at $\sqrt{s}=13$ TeV. *PHYS LETT B* 760: 520-537 (2016)
4. Aaboud M et al. incl. Pásztor G, Tóth J (2857 authors): Search for heavy long-lived charged R-hadrons with the ATLAS detector in 3.2 fb⁻¹ of proton-proton collision data at $\sqrt{s}=13$ TeV. *PHYS LETT B* 760: 647-665 (2016)

5. Aaboud M et al. incl. Pásztor G, Tóth J (2859 authors): Search for Higgs and Z boson decays to phi gamma with the ATLAS detector. **PHYS REV LETT 117**:(11) 111802/1-19 (2016)
6. Aaboud M et al incl. Pásztor G, Tóth J (2864 authors): Measurement of the $W\pm Z$ boson pair-production cross section in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector. **PHYS LETT B 762**: 1-22 (2016)
7. Aaboud M et al. incl. Pásztor G, Tóth J (2862 authors): Search for high-mass new phenomena in the dilepton final state using proton-proton collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector. **PHYS LETT B 761**: 372-392 (2016)
8. Aaboud M et al. incl. Pásztor G, Tóth J (2857 authors): Measurement of the top quark mass in the $t\bar{t} \rightarrow$ dilepton channel from $\sqrt{s} = 8$ TeV ATLAS data. **PHYS LETT B 761**: 350-371 (2016)
9. Aaboud M et al. incl. Pásztor G, Tóth J (2861 authors): Measurement of the total cross section from elastic scattering in pp collisions at $\sqrt{s} = 8$ TeV with the ATLAS detector. **PHYS LETT B 761**: 158-178 (2016)
10. Aaboud M et al. incl. Pásztor G, Tóth J (2855 authors): Measurement of the $t\bar{t}$ production cross-section using $e\mu$ events with b-tagged jets in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector. **PHYS LETT B 761**: 136-157 (2016)
11. Aaboud M et al. incl. Pásztor G, Tóth J (2852 authors): Search for scalar leptoquarks in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS experiment. **NEW J PHYS 18**: 093016/1-26 (2016)
12. Aaboud M et al. incl. Pásztor G, Tóth J (2855 authors): Measurement of $W+W-$ production in association with one jet in proton-proton collisions at with the ATLAS detector. **PHYS LETT B 763**: 114-133 (2016)
13. Aaboud M et al. incl. Pásztor G, Tóth J (2858 authors): Search for dark matter produced in association with a hadronically decaying vector boson in pp collisions at with the ATLAS detector. **PHYS LETT B 763**: 251-268 (2016)
14. Aaboud M et al. incl. Pásztor G, Tóth J (2864 authors): Search for new resonances in events with one lepton and missing transverse momentum in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector. **PHYS LETT B 762**: 334-352 (2016)
15. Aaboud M et al. incl. Pásztor G, Tóth J (2858 authors): Measurement of the inelastic proton-proton cross section at $\sqrt{s}=13$ TeV with the ATLAS detector at the LHC. **PHYS REV LETT 117**:(18) 182002/1-19 (2016)
16. Aad G et al. incl. Pásztor G, Tóth J (2865 authors): Constraints on non-Standard Model Higgs boson interactions in an effective Lagrangian using differential cross sections measured in the $H \rightarrow \gamma\gamma$ decay channel at with the ATLAS detector. **PHYS LETT B 753**: 69-85 (2016)
17. Aad G et al. incl. Pásztor G, Tóth J (2864 authors): Measurements of four-lepton production in pp collisions at with the ATLAS detector. **PHYS LETT B 753**: 552-572 (2016)
18. Aad G et al. incl. Pásztor G, Tóth J (2868 authors): Dijet production in $\sqrt{s}=7$ TeV pp collisions with large rapidity gaps at the ATLAS experiment. **PHYS LETT B 754**: 214-234 (2016)
19. Aad G et al. incl. Pásztor G, Tóth J (2871 authors): Combination of searches for WW,

- WZ, and ZZ resonances in pp collisions at with the ATLAS detector. *PHYS LETT B 755*: 285-305 (2016)
20. Aad G et al. incl. Pásztor G, Tóth J (2836 authors): Search for new phenomena in dijet mass and angular distributions from pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector. *PHYS LETT B 754*: 302-322 (2016)
 21. Aad G et al. incl. Pásztor G, Tóth J (2853 authors): Measurement of the charge asymmetry in highly boosted top-quark pair production in $\sqrt{s}=8$ TeV pp collision data collected by the ATLAS experiment. *PHYS LETT B 756*: 52-71 (2016)
 22. Aad G et al. incl. Pásztor G, Tóth J (2865 authors): Measurement of the dependence of transverse energy production at large pseudorapidity on the hard-scattering kinematics of proton-proton collisions at $\sqrt{s}=2.76$ TeV with ATLAS. *PHYS LETT B 756*: 10-28 (2016)
 23. Aad G et al. incl. Pásztor G, Tóth J (2872 authors): Evidence for single top-quark production in the s-channel in proton-proton collisions at $\sqrt{s}=8$ TeV with the ATLAS detector using the Matrix Element Method. *PHYS LETT B 756*: 228-246 (2016)
 24. Aad G et al. incl. Pásztor G, Tóth J (2850 authors): Measurement of the ZZ production cross section in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector. *PHYS REV LETT 116*:(10) 101801/1-19 (2016)
 25. Aad G et al. incl. Pásztor G, Tóth J (2856 authors): Search for new phenomena in final states with large jet multiplicities and missing transverse momentum with ATLAS using $\sqrt{s}=13$ TeV proton-proton collisions. *PHYS LETT B 757*: 334-355 (2016)
 26. Aad G et al. incl. Pásztor G, Tóth J (2870 authors): Charged-particle distributions in $\sqrt{s}=13$ TeV pp interactions measured with the ATLAS detector at the LHC. *PHYS LETT B 758*: 67-88 (2016)
 27. Aad G et al. incl. Pásztor G, Tóth J (2845 authors): Search for single production of a vector-like quark via a heavy gluon in the 4b final state with the ATLAS detector in pp collisions at $\sqrt{s}=8$ TeV. *PHYS LETT B 758*: 249-268 (2016)
 28. Aad G et al. incl. Pásztor G, Tóth J (2870 authors): Observation of long-range elliptic azimuthal anisotropies in $\sqrt{s}=13$ and 2.76 TeV pp collisions with the ATLAS detector. *PHYS REV LETT 116*:(17) 172301/1-20 (2016)
 29. Aad G et al. incl. Pásztor G, Tóth J (2850 authors): Measurement of W^\pm and Z-boson production cross sections in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector. *PHYS LETT B 759*: 601-621 (2016)
 30. Aad G et al. incl. Pásztor G, Tóth J (2827 authors): A search for an excited muon decaying to a muon and two jets in pp collisions at $\sqrt{s} = 8$ TeV with the ATLAS detector. *NEW J PHYS 18*:(7) 073021/1-21 (2016)
 31. Aad G et al. incl. Pásztor G, Tóth J (2849 authors): Transverse momentum, rapidity, and centrality dependence of inclusive charged-particle production in p + Pb collisions measured by the ATLAS experiment.. *PHYS LETT B 763*: 313-336 (2016)