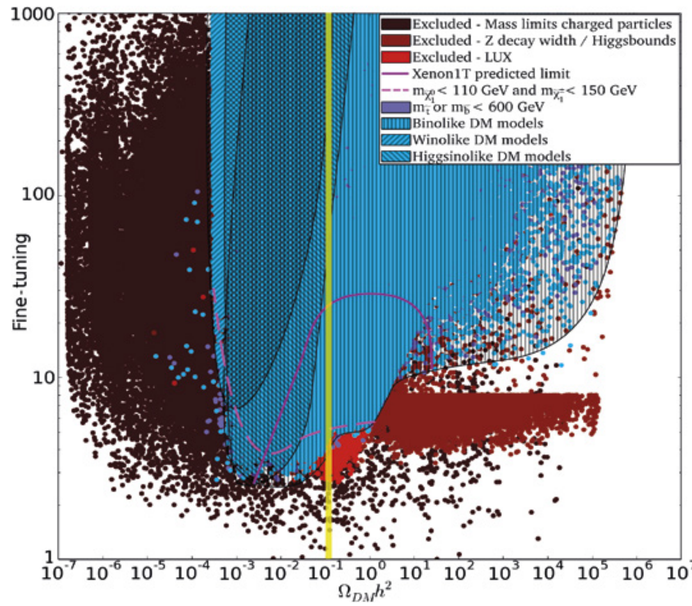
ATLAS

Technician Arnold Rietmeijer working on the ATLAS detector upgrade.

Figure 1.The impact of LHC limits and Dark Matter direct detection experiments on the viability of the Minimal SuperSymmetric extension of the Standard Model. The 19-dimensional parameter space of the model is randomly sampled: MSSM parameter configurations that are excluded by experimental constraints are shown as black/brown/red/purple points. Parameter configurations that are compatible with all experimental constraints are shown in blue. Notably, a sizeable fraction of the MSSM parameter space is not yet excluded even by Run-2 LHC data, including ample configurations that require little parameter fine tuning.



Management
prof.dr. N. de Groot
prof.dr. W. Verkerke

The year 2016 has been a fantastic year for the Large Hadron Collider, with a total luminosity of 39.6 fb^{-1} delivered with a beam energy of 13 TeV, of which 36 fb^{-1} have been recorded by the ATLAS detector. With this massive volume of data in one year of data taking, many measurements and searches now exceed the precision that was obtained in the first run of the LHC (2010–2012).

Precision testing of the Higgs sector

In 2016 the Higgs boson, which was discovered in Run-1, is now being subjected to a variety of precision tests. These tests will ultimately tell if the particle discovered in 2012 is the Standard Model Higgs boson, or (one of the) Higgs particles of larger theory that happens to have somewhat similar properties. Nikhef has played a leading role in many Higgs analyses this year: As a wrap-up of the LHC Run-1 effort, the combined measurement of the Higgs coupling properties by the ATLAS and CMS experiments was finalised into a journal publication. But the focus has been on the analysis of 2016 data: a first combined measurement of Higgs properties using this years Run-2 data from the observation of $H \rightarrow \gamma\gamma$ and $H \rightarrow ZZ$ decays was shown at the ICHEP conference in summer 2016. Another new summer result on this year's data was the search for the rare and not-yet-observed production of Higgs bosons in association with top quark decays. The programme of measurements on the discovered Higgs bosons is complemented by a search effort for hypothetical other species of heavier Higgs bosons decaying into vector bosons. These searches have significantly increased their reach in 2016, due to both the larger data volume and increased beam energy. In preparation for the ultimate future precision interpretation of all Higgs boson measurements Nikhef has also contributed to a joint experiment/theory effort, documented in CERN Yellow Report 4, to improve the theoretical modelling Higgs boson property observations: a novel method to construct probability models describing experimental Higgs observations directly from predictions of effective Lagrangian theory models, and a novel method to measure Higgs couplings in polarised vector boson decay.

Searches for new particles

The increased beam energy of 13 TeV of the LHC in Run-2 strongly increases the production rate of hypothetical new heavy particles, boosting their opportunity to be discovered, if they exist, or strengthening limits on their mass, in case they don't exist. The search in this first full year of high-energy data taking is still in the early phase: the search is focused on (comparatively) easy signatures with a large production rate that constitute the 'low hanging fruit' for such searches, and largely focus on the same signature as the searches in the Run-1 data. Nikhef has played a leading role in two of these searches: the search for strongly produced supersymmetric particles in decays without leptons and search for (miniature) quantum black holes decaying into at least two leptons.

Meanwhile, searches for new physics, *e.g.* new fundamental particles, with more challenging experimental signatures are being prepared. These new searches will gain in discovery potential as more data is collected at the LHC in the next years. One of these newly developed searches is the hunt for extremely rare decays of Z bosons and Higgs bosons where lepton flavour is not preserved. A first publication, proving the feasibility of such searches at the LHC on Run-1 data was published in 2016. Another newly developed analysis is the search for experimental decay signatures of dark matter candidates in super-symmetric extensions of the Standard Model that are not ruled out by any existing experimental observation, nor require extensive fine-tuning of the theories parameters to be viable.

Preparing ATLAS for the long term future

In the coming years, the LHC is expected to deliver many more collisions than today. To achieve this, the number of simultaneous collisions per bunch crossing will increase: from about 40 now, to well over 200 in 2025, with a quantum jump expected in 2025 as the high-luminosity upgrade of the LHC is completed. To cope with these future highly complex collisions and with the increased radiation pressure both the inner part of the detector and the readout electronics must be replaced. Nikhef participates in the design and construction of several of these components: We will assemble one of the end-caps of the all-silicon new inner tracker (ITk) at Nikhef. The first phase of the effort, the mechanical design of the end-cap structure was finalised in 2016, with a very significant contribution from Nikhef designers, engineers and physicists. We are also contributing to the design of the new radiation hard readout chip of the ITk pixel sensors, realised in 65 nm technology, through the RD53 collaboration. Nikhef contributes also to the core design of the system of the new FELIX system. FELIX will provide the interfacing of the data acquisition, detector control and timing and control systems to the new muon detectors and first level trigger systems to be installed during the the 2019–2020 LHC shutdown. Deployment of FELIX for all other detectors and trigger systems should follow in the 2023-2025 shutdown. The FELIX system went through an important design review in 2016; and its progress was positively acknowledged. In the first deployment phase, the FELIX system will be rolled as the readout system for the Muon system in 2019–2020 LHC shutdown, with the other detector systems following in the 2023–2025 shutdown. Finally, Nikhef also assisted in the procurement of B-field and temperature sensors for the Muon New Small System that will be installed in 2019.

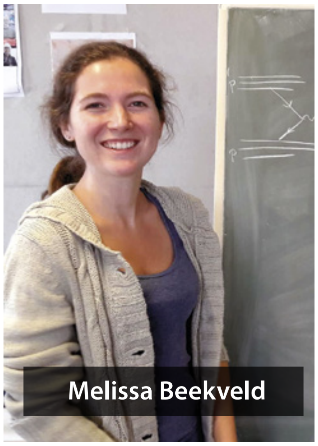
Figure 3. Participants of the FELIX development workshop of October 2016 at Nikhef.

Convenerships and management positions in the ATLAS experiments

Paul de Jong was chair of the publications committee. Pamela Ferrari and Frank Filthaut were convener of the H→WW physics subgroup. Further coordination positions held by Nikhef members were in the Luminosity Group (David Salek), B-Trigger (Olga Ignonkina), Muon Software (Jochen Meyer), Tracker Alignment (Pierfrancesco Butti) and Data Quality (Pamela Ferrari).

‘Shell Afstudeerprijs voor Natuurkunde’

Melissa Beekveld received a *‘Shell Afstudeerprijs voor Natuurkunde’* (Shell Graduation Prize for Physics) of the *Koninklijke Hollandsche Maatschappij der Wetenschappen* (KHMW, Royal Holland Society of Sciences) for her master thesis research project on dark matter with ATLAS.

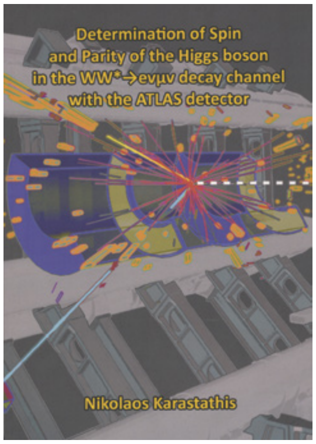


Melissa Beekveld

Wouter Verkerke appointed professor

Wouter Verkerke (see photo on p. 13) was appointed special professor of ‘Data Analysis in the field of particle physics and astroparticle physics’ at the Faculty of Science of the University of Amsterdam. The focus of Wouter Verkerke’s research will be on advanced data analysis in particle physics and astroparticle physics, and his teaching activities will also focus on data analysis and computing.

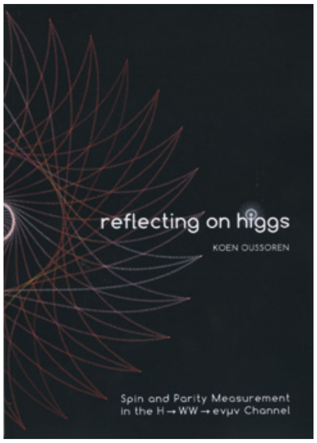
Jörn Mahlstedt
21 January 2016



Nikolaos Karastathis
25 February 2016

Pieter van der Deijl
16 March 2016

Hartger Weits
21 September 2016



Koen Oussoren
27 September 2016

N. Axel Naumann
24 October 2016

Ingrid Deigaard
30 November 2016

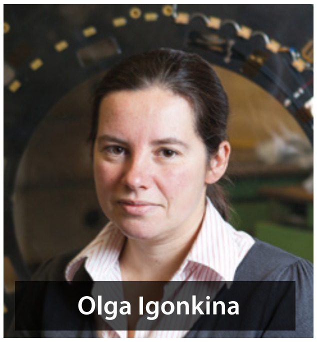
Vidi grant Tristan du Pree

Tristan du Pree was awarded a Vidi grant for his proposal "Higgs from Z to A". The Vidi grants are aimed at young excellent researchers with several years of successful postdoctoral research experience to start their own research groups.
"The Higgs boson was discovered in 2012 by CERN's Large Hadron Collider. The physicist conducting this research will use the Higgs bosons to make precision measurements to study their characteristics, to search for scalar particles, and to attempt to shed light on dark matter – a new step in particle physics."


Tristan du Pree

Vici grant Olga Igonkina

NWO granted Olga Igonkina a Vici grant for her proposal "How leptons make the world". This form of grant is for senior researchers who have shown that they have the ability to successfully develop their own innovative lines of research and to act as coaches for young researchers.
"During the Big Bang matter and antimatter were 'made' in equal quantities. So why is it that 13.8 billion years later we see a vast excess of matter and scarcely any antimatter? Particle physicists think that the elementary lepton particle can provide an answer to this fundamental question about the evolution of our universe."


Olga Igonkina

A few times a year Nikhef director Stan Bentvelsen presents a 'Spiegelmoment' with topical information about the institute.