

**Bonn Physikshow**  
**Herbert Dreiner, Michael Kortmann**  
**and over 300 Bonn University physics students**

## 1 Awards

**2006** Alumni Preis der Universität Bonn

**2009** European Physical Society High Energy Physics Outreach Prize

**2012** Within the framework of the SFB TR-110 we were awarded a large four year grant (k€60) by the DFG to travel with our Physikshow at least once per year in Europe and also once to China. This was renewed in 2016.

**2015** EU-Cost Award (4 yrs). Physics-show and outreach training for European particle physicists.

**2018** ESERO. In 2018, a consortium of institutes at Bochum, Bonn and Köln Universities won the competition to host the ESA (European Space Agency) national education and outreach center for Germany. The Bonn Physikshow is a founding member.

## 2 Highlights

- **2004** Video ‘*Ship Floating on air*’ receives over 5 million viewings on YouTube.
- **2006 – 2017** Deutsches Museum, München. Visited four times, with three performances each visit.
- **Nov. 2008** Performed the 2nd Particle Physics Show at the U-Bahn Station “Bundestag” in Berlin upon invitation from BMBF for the national exhibit “Weltmaschine” for the start of the LHC.
- **Sept. 2010** Performed the 2nd Particle Physics Show at the Globe at CERN, Geneva, Switzerland in French.
- **3.10.2011** Performed at the main stage of the Deutschlandfest at the Bonn Münsterplatz in front of over 10,000 people (central festivities in honor of the German national holiday).
- **2014 - 2018** 3rd Particle Physics Show invited to perform in: Oxford and London, UK (2014); Padua and Trieste, Italy (2015); Copenhagen and Odense, Denmark (2016), Valencia and Barcelona, Spain (2017); Lisbon (Portugal) and Madrid (Spain) (2018); Amsterdam (Netherlands) (2019).
- **Dec. 2015** Special physics show for refugees in Bonn in English and Arabic.
- **March 2016** Travelled to Beijing China with 7 physics show students. Trained Chinese students from Peking University (PKU) in physics show activities and performed a show with them in Chinese for Chinese high-school students.

- **March 2018** Staatstheater, Mainz. Performed Particle Physics Show in German in a fully professional theater.
- **March 2019** Compagnie Theater, Amsterdam. Performed in a professional theater in Amsterdam, upon invitation of Nikhef and the University of Amsterdam. theater.
- **March 2019** - Developed the first ever Physics Show Musical: Planetamos, about the habitability of planets. Performances in Bonn (3/2019; 7/2019; 2/2020) and in Bochum (6/2020).
- **2016, 2018** Bonn Physikshow students took part in ScienceMe!, the international science slam competition in Geneva Switzerland. In 2016 Laura Weber and Christoph Schürmann finished 3rd and in 2018 Steffi Moll and Florin Hemmann won.
- **2002-** Have “sold out” over 80 performances in the Wolfgang-Paul Lecture Hall at Bonn University, with a capacity of 520 people, reaching over 40,000 people.
- **2001-** Over 300 Bonn physics students trained in science outreach in the Bonn Physikshow.

### 3 Publications

1. *It's Physikshow time in Germany*  
Herbert K. Dreiner  
**CERN Courier 9 (2007) 30.**
2. *A Physics Show Performed by Students for Kids: From Mechanics to Elementary Particle Physics*  
Herbert K. Dreiner,  
**Physics Teacher 46 (2008) 358** (refereed journal); e-Print: physics/0701344.
3. *Fun physics in school: students perform for students*  
Herbert K. Dreiner, and Tobias Strehlau  
**Science in School 9 (2008) 46.**
4. *Physique? C'est tout le Français à moi*  
Herbi Dreiner  
**Guardian Newspaper, Life and Physics Blog, Sept. 22nd, 2010.**
5. *Slam Pow Bang: On Tour in England with the Bonn Physics Show*  
Herbi Dreiner  
**Guardian Newspaper, Life and Physics Blog, March 13th, 2014.**
6. *Can physics help communication between refugees in Germany and their hosts?*  
Herbi Dreiner  
**Guardian Newspaper, Life and Physics Blog, Jan. 19th, 2016.**
7. *What's (the) Matter?*  
Herbi Dreiner *et al.* (together with 25 physics students).  
**arXiv:1607.07478 [physics]**  
(Manuscript of the third particle physics show, including extensive description of 25 live experiments.)

8. *Cross Cultural Science: the Bonn Physics Show goes to China*  
Herbi Dreiner  
**Guardian Newspaper, Life and Physics Blog: Oct. 15th, 2016.**
9. *Inside Story: On the road with the Bonn Show*  
Herbert K. Dreiner  
**CERN Courier 3 (2017) 49.**

## 4 Physikshow

The Bonn Physikshow was founded in Dec. 2001 by Prof. Herbert Dreiner, Ph.D. and Michael Kortmann. Prof. Dr. Ewald Paul joined in 2004, specifically specifically to take part in the particle physics shows, and retired in 2018. Sascha Heinz joined from 2011 until 2017. All are members of the Physikalisches Institut, Universität Bonn. The typical feature of the Bonn physics shows is that they are developed and performed by the university physics students. Also, most shows feature a storyline to hold the attention of the audience and put the experiments in a context. The students are thus highly involved and have on their own developed many of the activities described below, such as the *Weihnachtsshow*, the *Mondshow*, and the *Physix Factor*. No entrance fee is charged for the shows.

### 4.1 Annual Shows

Initially every year since 2002 we have been performing a new show in autumn, typically in September. It is the core activity of the Bonn Physikshow. This consists of three performances, with two on the weekend for a general audience and one in the morning on a schoolday for school classes. The school classes mainly come from Bonn and the immediate vicinity, but we also regularly have classes from Köln and Aachen and even as far as Dortmund or Rostock (once). The show is repeated with three performances the following March. All shows have basically been fully booked from the beginning, with over 500 people per performance. Since October 2003 the shows have had a story line, which presents a significant novelty in outreach physics. The shows typically have two main protagonists, one woman, and one man. Typically 20 university physics students take part. Since 2013 we only produce a new show every two years, due to the increased travels with the various productions of the physics show, funded by the DFG CRC-110 grant, as well as EU COST Action CA15108, and since 2018 also by ESERO Germany (European Space Education Resource Office, funded by ESA).

### 4.2 Particle Physics Shows

Most physics shows involve classical physics demonstration experiments, typically for children. In 2004 in Bonn, we took on the challenge of developing the show concept to explain modern physics, in this case the physics of elementary particle physics. We believe we are the only people doing this. This concept was further developed in 2008 and 2014. Prof. Ewald Paul was involved from the beginning in 2004 and retired in 2018. The 3rd particle physics show has become the second core activity of the Bonn physics show.

**1st Particle Physics Show 2004:** In 2004 CERN celebrated its 50th anniversary. For this occasion we developed for the first time a show on elementary particle physics, entitled: *From Quarks to Quasars*. In the show we went through the topics: (i) Atomic & Nuclear Physics; (ii) Elementary particle Zoo; (iii) Forces and Symmetries, (iv) Astrophysics and

Cosmology. The show involved many demonstration experiments and had as a running theme the new particles introduced. *Performances: four times in Bonn, 2004.*

**2nd Particle Physics Show 2008-2010:** In 2008 we were invited by the BMBF (German national ministry for Education and Research) to perform a show on particle physics at the national exhibition: *Weltmaschine* (World Machine) in Berlin on the occasion of the launch of the LHC. This was a considerably modified version of the first particle physics show, but still following the same four physics topics. We initially performed it four times in the Berlin U-Bahn Station *Bundeskanzleramt*, in Nov. 2008.

*Performances:* Berlin (4x, Nov. 2008); DESY Hamburg (3x, Sept. 2009); Heidelberg University (3x, Dec. 2009); Deutsches Museum München; CERN, Geneva (3x, Sept. 2010); Bonn, Wolfgang-Paul Lecture Theater (1x, Nov. 2010) .

**3rd Particle Physics Show 2014-:** In the summer of 2013 we received the invitation to perform a physics show in Oxford and London, UK, in March 2014. For this we developed a brand new 90min Particle Physics Show. This show focused on the topics of accelerators and the Higgs boson. It involved now a story line with two proponents travelling back in time to visit famous physicists in their own laboratories and understand their contributions. The locations were Rutherford in Manchester, UK, 1910; Lawrence in Berkeley, Calif., USA, in 1950; Sau Lan Wu at DESY Hamburg, 1980 and CERN, 2014. About 18 students are involved in each performance.

*Performances:* Oxford, UK; UCL, in London, UK, 3/2014; Deutsches Museum, Bonn, 5/2014; Padua; ICTP, Trieste, Italy, 3/2015 (1x); Copenhagen; Odense Denmark, 9/2016; Bonn, Germany, 10/2016; Valencia; Barcelona, Spain, 9/2017; Bonn, Germany, 3/2018; Staatstheater Mainz, Germany, 3/2018; Lisbon, Portugal; Madrid, Spain, 9/2018; Bonn 3/2019; Amsterdam, Netherlands, 4/2019; Aachen 9/2019; Freiburg 10/2019; Helsinki 9/2020; Tartu, Estonia 9/2020; Warsaw 9/2020.

### 4.3 Christmas Physics Show

In 2007 several of the experienced students were graduating and they decided to develop a special show for Christmas as their last Show. It was centered on an advent calendar and involved one live experiment for every day up until Christmas. In 2016 this idea was revived and now embedded in a more elaborate story. A student has been studying so hard, she forgot to open her advent calendar surprises. On Dec. 23rd she then has to go through all 25 days, which also involves three visits by Santa Claus. This show has been performed in the last class of the introductory Physics I lecture and is thus also used for recruiting new physics show students. In 2019 we then included live instrumental music and 5 songs sung by the students. In Dec. 2020 we shall travel with this show to the University of Durham, UK.

*Performances:* Bonn 2007 (1x); Bonn 2016 (1x); DESY Hamburg, 2017 (2x); Bonn 2017 (1x); Bonn 2018 (2x); Bonn 2019 (2x); Durham, UK, 2020 (3x).

### 4.4 Physical: Planetamos. The Physics Show Musical

In early 2019, a group of physics show students got together and developed a physics show musical. This involves four singing parts, and live instrumental accompaniment on stage. The songs are well-known but with modified texts. The story revolves around a store, Planetamos, where you can buy a planet specifically designed for you. A couple, Vita and Mortis come to the store and by presenting all the purchasable options for their planet the audience learns about stellar and planetary science.

*Performances:* Bonn: 3/2019 (1x), 7/2019 (1x), 2/2020 (3x); Bochum: 6/2020 (1x).

## 4.5 Shorter Shows

Over the years we have received increase demand for us to perform a show at various locations, often for a shorter time frame. Due to the relatively large number of active Bonn physics students, we have been able to develop several shorter shows 30-40min and travel to various places with them. Once we have a manuscript these shows can be quickly rehearsed by a new group of students.

### 4.5.1 Mond Show (Moon Show)

In 2009 several students developed a physics show to accompany an art exhibit at the Wallraf-Richartz Museum in Köln. The exhibition was co-organized by Ludmila Piters an art history student and former physics student and was entitled ‘*Der Mond*’ (The Moon). The show was called ‘*Odyssee im Weltraum*’ (Odyssee in outer space) and focused on topics in astronomy, astrophysics, and cosmology.

*Performances:* 4x Wallraf-Richartz Museum Köln, Aug. 2009; 2x Solingen, Feb. 2010, hosted by the Sternwarte Solingen; 2x in Bonn May, 2010.

### 4.5.2 Physiker Suchen ein Zuhause (Physicists Need a Home)

In 2005 before going to Aachen we thought it would be opportune to develop a new shorter show with which we could travel for smaller occasion events. This show is a spoof of the German TV Show: Tiere suchen ein Zuhause, where new homes are found for abandoned pets. Instead 5 physicists are presented with their quirks and each gets to do one or two experiments. The audience can then choose whom to take home with them.

*Performances:* Aachen (2015), Solingen (2016), Bad Honnef (2016), Deutsches Museum Bonn (1.4.2016), Utrecht (in English) (2017); Bonn for the ZAPF (national physics student representative organization) (9.6.2019); Bonn University Summer Fest (29.6.2019).

### 4.5.3 Frequency Show

This show is a tour through the frequency spectrum, starting with very low frequency sound waves and reaching all the way to ultra high frequency electromagnetic waves. It is about 70min long and is in part also motivated by Heinrich Hertz, who was a professor in Bonn. It does not have a story line.

*Performances:* Lions Club Düren (2013), Bonn University Alumni Association (UGB) (2014)

### 4.5.4 Further Shows

*Kochshow (Cooking Show):* We have found that it is very popular to do experiments with food. In one of our big shows we had an extended section as a cooking show, with a visiting “prominent physicist”. This is a shorter 30min show.

*Performances:* Deutsches Museum Bonn, Museumsmeilenfest (6/2015)

*AstroGastro Show:* In April 2017, two Physics Show students organized a small show, or a presentation with demonstration experiments for German physics students attending a bJDPG meeting on Astronomy and Gastronomy. Show was on the topics of gravitational waves and pulsars.

*Performances:* Bad Kreuznach (2017)

*The Physics Factor:* In 2018 the University of Bonn celebrated its 200th anniversary. The Bonn physics students contributed with 2 performances at the University Summer Fest. The show was setup as a (physics) talent show.

*Performances:* Bonn University Poppelsdorf Campus (2018)

*Quiz Show:* This was a one-off at the opening of an exhibition. We set it up as a quiz show, also asking the audience questions. We did not find it worked well.

*Performances:* Zinkfabrik, Altenberg, industry museum, Oberhausen (2015)

*Party Show:* this was a 30min shows with fun effects that you could demonstrate at a party, with things available there.

*Performances:* Deutsches Museum, Bonn (2010); Deutschlandfest, Bonn Münsterplatz Oct. 3rd, 2011 in front of 10,000 people.

## 5 List of Annual Shows performed in Bonn

This is our original core activity, where we focus most of our energy. We perform the show three times (Fri., Sat., Sun.) in September and then repeat the show with three further performances (Fri., Sat., Sun.) the following March. Since 2015 we only develop a new show every two years. In between we travel with the particle physics show, now our second core activity.

Date	Show and some details
Nov. 2002	Two 2-hr physics shows for 12-14 year old high school students; organized and performed together with 17 third year physics students. Attracted audience of 650 people per show.
Mar. 2003	Repeat of the Nov. 2002 show.
Oct. 2003	New 2-hr show entitled ' <i>Odysee durch die Physik</i> ' (Odyssey through physics).
Mar. 2004	Repeat of ' <i>Odysee durch die Physik</i> ' show.
Sept. 2004	2-hr show entitled ' <i>Wer nicht fragt bleibt dumm</i> ' (German Sesame Street theme).
Mar. 2005	Repeat of previous show.
Sept. 2005	New 2-hr show ' <i>Zeitreise durch die Physik</i> ' (Time travel through physics).
Mar. 2006	Repeat of ' <i>Zeitreise durch die Physik</i> ' show.
Sept. 2006	New 2-hr show ' <i>Episode V</i> ' (Show set up as a computer game with four levels.)
Mar. 2007	Repeat of ' <i>Episode V</i> ' show.
Sept. 2007	New 2-hr show ' <i>Physik im Alltag</i> ' (physics in everyday life).
Mar. 2008	Repeat of previous show.
Sept. 2008	New 2-hr show ' <i>Per Anhalter durch die Physik</i> ' (Hitchhiker's Guide to Physics).
Mar. 2009	No show due to refurbishing of lecture hall.
June 2009	Repeat of ' <i>Per Anhalter durch die Physik</i> ' show.

Date	Show and some details
Sept. 2011	New 2-hr show ' <i>Physiker, Wetten dass ...?</i> ' (physics show based on a German TV game show).
Mar. 2012	Repeat of previous show.
Sept. 2012	New 2-hr show ' <i>20th Century Physics Proudly presents</i> ' (Film and TV studios: cooking show, James Bond, Dinner for One, Galileo Mystery).
Mar. 2013	Repeat of previous show.
Sept. 2013	New 2-hr show ' <i>In 80 Minuten durch die Physik</i> ' (In 80 days through physics, à la Jules Verne).
Mar. 2014	Repeat of previous ' <i>In 80 Minuten durch die Physik</i> ' show.
Sept. 2015	New 2-hr show ' <i>Die Physikverschwörung</i> ' (Sherlock Holmes physics story).
March, 2016	Repeat of previous 2-hr show ' <i>Die Physikverschwörung</i> '.
Sept., 2017	New 2-hr show ' <i>Der Physiker von Oz</i> ' (Wizard of Oz story).
March, 2018	Repeat of previous 2-hr show ' <i>Der Physiker von Oz</i> '.
Sept., 2019	New 2-hr show ' <i>Nachts in der Uni</i> ' (A Night in the Museum story, but in the physics department, with Heinrich Hertz and others coming to life at night.)
March, 2019	Repeat of previous 2-hr show ' <i>Nachts in der Uni</i> '.

## 6 Additional Shows and Performances in Bonn

Over the years we have developed many smaller shows and performed on various occasions, in particular of course in Bonn.

Date	Show and some details
June 2004	Physics Show at the <i>Wissenschaftsnacht</i> (Bonn University Science Night).
Oct. 2004	3x 1st Particle Physics Show in the Wolfgang-Paul Lecture Theater.
Sept. 2005	Deutsches Museum, Bonn. 30min show on the theme of ' <i>Physics at Parties</i> ' at 10th anniversary party of the museum.
July 2006	' <i>Wassershow</i> ' (Water show) at Wissenschaftsnacht (Bonn University Science Night) at Bonn University. Afterwards joint performance with the team from the TV show <i>Kopfball</i> on the central stage.
June 2007	Science table at a family fun fair in the Rheinaue park.
Nov. 2007	Physics show at the celebration of the opening of the Bonn Cologne Graduate school of physics (BCGS).
Apr. 2010	4hr hands-on physics table at the inner courtyard of the main building of Bonn University.
Dec. 2007	The students organized on their own a special Christmas Physics Show for the Bonn University community.
June 2010	Show on <i>Energy Physics</i> and a stall at the Bonn University Science Night.
Nov. 2010	2nd Particle Physics Show in the Wolfgang-Paul lecture theater.

Date	Show and some details
Oct. 2011	30min show on the theme ‘ <i>Physics at Parties</i> ’ on the central stage at the Deutschlandfest in Bonn. There were approximately 10,000 spectators. (Immediately after us Wolfgang Niedecken performed with the WDR Big Band.)
Sept. 2013	2x 30min show <i>Party Physics</i> in the Botanical Gardens of Bonn University at the annual celebration of the administrators.
Nov., 2013	1x for the opening of the exhibition <i>Der Teilchenfänger</i> on Wolfgang Paul at the Deutsches Museum, Bonn.
Apr. 2015	30min show at the opening of the exhibit: Effekthascherei (razzmatazz), at the Deutsches Museum, Bonn.
June 2015	4x a 30 min show <i>Physics &amp; Cooking</i> in the Deutsches Museum, Bonn.
Dec. 2015	‘Aladdin and the Magic Lamp’, special 1hr physics show for refugees in English and Arabic.
June 2016	Cooking Show, Museumsmeilen Fest, Deutsches Museum Bonn
Oct. 2016	3rd Particle Physics Show, Bonn University
Dec. 2016	1x revised Christmas Show in the Wolfgang Paul Lecture Hall.
Mar. 2017	<i>Die Physikverschwörung</i> at ESF Bonn (English subtitles)
Dec. 2017	1x revised Christmas Show in the Wolfgang Paul Lecture Hall.
Mar. 2018	3rd Particle Physics Show in German
Jun. 2018	The Physix-Factor, show at University Summer Fest (in German)
Dec. 2018	2x revised Christmas Show in the Wolfgang Paul Lecture Hall.
Feb. 2019	Small physics show for Kindergarten Pustebblume in Bonn lecture hall.
March 2019	Premiere of Physics Show Musical: Planetamos.
Mar. 2019	3rd Particle Physics Show in English
Jun. 2019	Physiker Suchen ein Zuhause, ZAPF (in German)
Jun. 2019	1hr Show in Grundschule Holzlar (in German)
Jun. 2019	Physiker Suchen ein Zuhause, Uni Bonn Summer Fest (in German)
July 2019	Repeat of Physics Show Musical: Planetamos.
Dec. 2019	2x revised Christmas Show with live singing and accompaniment in the Wolfgang Paul Lecture Hall.
Feb. 2020	Repeat of Physics Show Musical: Planetamos.

## 7 Performances of Shows throughout Germany

Date	Show and Trip
Dec. 2005	Joint performance with Köln drama group c.t.201 on “Werner Heisenberg, Leben und Werk” (Werner Heisenberg, Life and Work) at the Crown Plaza Hotel in Köln.
Mar. 2006	Three performances of the show ‘ <i>Wer nicht fragt bleibt dumm</i> ’ (Sesame Street theme) at the Deutsches Museum, München.

Date	Show and Trip
May 2008	40min Show on the theme ‘ <i>Travelling the world</i> ’ at Göttingen University within the weekly colloquium; combined with a 30 min talk about the physics show.
Nov. 2008	4x the 2nd Particle Physics Show at the BMBF (German national ministry of Education and Research) funded exhibition ‘ <i>Weltmaschine</i> ’ (World machine) to mark the launch of the LHC at CERN. Location: station of the U-Bahn stop ‘ <i>Bundestag</i> ’.
Jan. 2009	45min physics show within the colloquium at the Bergische Universität Wuppertal.
Mar. 2009	Three performances of the 2nd Particle Physics Show at the Deutsches Museum, München.
Aug. 2009	4x the Show ‘ <i>Odyssee im Weltraum</i> ’ at the Wallraf-Richartz Museum in Köln, accompanying the art exhibit ‘ <i>Der Mond</i> ’.
Sept. 2009	3x 2nd Particle Physics Show at DESY, Hamburg.
Dec. 2009	3x 2nd Particle Physics Show at Heidelberg University.
Feb. 2010	2x ‘ <i>Odyssee im Weltraum</i> ’ Show in Solingen, upon invitation of the Sternwarte Solingen.
Mar. 2012	Performed the ‘ <i>Physiker Wetten, dass ...</i> ’ show at the Baykomm communication center of Bayer Leverkusen.
Feb. 2013	60 min show on the frequency range in electromagnetism at the Lions Club Düren. Ticket sales went as a donation to a local elementary school.
Mar. 2013	3x the show ‘ <i>20th Century Physics Proudly Presents</i> ’ (TV and Movies theme) at the Deutsches Museum, München.
Nov. 2013	We performed a 15min physics show on the occasion of the opening of the exhibition <i>Wolfgang Paul: Der Teilchenfänger</i> (Wolfgang Paul: the particle catcher).
May 2014	3rd particle physics show (100 min) at the Deutsches Museum, Bonn, Bad Godesberg as part of the exhibit <i>Wolfgang Paul: Der Teilchenfänger</i> (Wolfgang Paul: The Particle Catcher).
June 2014	3x the show ‘ <i>In 80 Minuten durch die Physik</i> ’ at DESY, Hamburg.
Jan. 2015	30 min show: <i>Physik Quizshow</i> , at the Industry Museum, LVR (Landschaftsverband Rheinland) Oberhausen, Zinkfabrik Altenberg.
Feb. 2015	70 min show: <i>Eine Reise mit Heinrich Hertz durch das Elektromagnetische Frequenzspektrum</i> (A Journey through the electromagnetic frequency spectrum with Heinrich Hertz) at the communications center BayKomm of Bayer Leverkusen, in Leverkusen, Germany.
Nov. 2015	45min physics show within the colloquium at the RWTH Aachen, Germany. Title: <i>Physiker suchen ein Zuhause</i> .
Apr. 2016	<i>Physiker suchen ein Zuhause</i> , LVR-Industriemuseum Gesenkschmiede Hendrichs, Solingen.
Jun. 2016	<i>Physiker suchen ein Zuhause</i> , Physikzentrum Bad, Honnef.
Mar. 2017	<i>Die Physikverschwörung</i> , Deutsches Museum, München
Apr. 2017	<i>AstroGastro Show</i> , Bad Kreuznach
Dec. 2017	<i>Weihnachtsphysikshow</i> , DESY, Hamburg

<b>Date</b>	<b>Show and Trip</b>
<b>Feb. 2018</b>	<i>GYPT</i> , Bad Honnef (national event for science interested high-school students).
<b>Mar. 2018</b>	<i>What's (the) Matter?</i> (in German), Mainz
<b>May 2018</b>	Short show for the inauguration of ESERO in Bochum.
<b>Sep. 2019</b>	<i>What's (the) Matter?</i> (in German), RWTH Aachen
<b>Oct. 2019</b>	<i>What's (the) Matter?</i> (in German), University of Freiburg

## 8 International Shows

Our first international trip to perform a show was to CERN in 2010 with the 2nd particle physics show. Since then of the particle physics shows, we have only performed the 3rd on our travels throughout Europe. This requires a large logistical effort. We travel with 15-20 people. Initially we had two vans for the equipment and two for the participants. We then switched to having the participants travel in one bus with a driver and more recently, for the longer distances, have had the participants fly. Also since Barcelona (2017) we have switched to renting one large van for all the equipment. In Valencia and Lisbon we also held workshops to train the local physics students in performing particle physics shows.

<b>Date</b>	<b>Show and Trip</b>
<b>Sept. 20th-24th, 2010</b>	2nd particle physics show in the Globe CERN, Geneva, CH (3 shows, in French).
<b>Mar. 16th-23rd, 2014</b>	3rd particle physics show: ‘What’s (the) Matter?’ (3rdPPS) at Oxford University and University College London (UCL), (4 and 2 shows, in English)
<b>Mar. 22nd-28th, 2015</b>	3rdPPS at Padua University and ICTP Trieste (3 and 1 shows, in English)
<b>Mar. 15th-23rd, 2016</b>	Physikshow Workshop at Peking University, Beijing, China, with show for Chinese high-school students (1 show, in Chinese)
<b>Aug. 27th- -Sept.3rd, 2016</b>	3rdPPS at Niels Bohr Institute and Copenhagen University, Copenhagen and at Syddansk University, Odense, Denmark (4 and 2 shows, in English)
<b>May 5th-7th, 2017</b>	Utrecht Physics Challenge, 30min show on Utrecht market square, 2 performances
<b>Sept. 20th-24th, 2017</b>	3rdPPS at Valencia Science Museum (hosted by Valencia University) and CosmoCaixa, Barcelona, Spain (hosted by Autonomia University Barcelona), (3 and 2 shows, in English)
<b>Sep. 17th-26th, 2018</b>	3rdPPS at Tecnico University, Lisbon, Portugal, and CaixaForum Madrid, Spain. Hosted by IFT, Madrid (2 and 3 shows, in English)
<b>Apr. 4th-7th, 2019</b>	3rdPPS at Compagnietheater, Amsterdam, Netherlands. Hosted by Nikhef and UvA (3 shows, in English)

Date	Show and Location
Sep. 20th-29th, 2020	3rdPPS at Helsinki University; Tartu University, Estonia, and Warsaw University.

## 9 Science Slams

Science Slams were started in Darmstadt in 2008, they are similar to poetry slams, except people talk about their research in an entertaining fashion, typically for 10-12min, only. This is related to the science on tap activities for example in Tel Aviv and in Hamburg.

Science slams performed by H. Dreiner: Pantheon Theater Bonn, topic: Fukushima (Oct. 2011); Bonn joint particle slam by Bonn professors (Nov. 2011); Aachen Jakobs Hof, topic: Higgs (Jan. 2013); Bonn Poppelsdorfer Schloss, topic: Fukushima (Sept. 2013); Dortmund: Higgs (May 2013); Bonn Kunstmuseum Dark Matter (Feb. 2015); Church in Dortmund, Fukushima (June 2016).

A special feature of the Bonn Physics Show is that there is ample opportunity for the students to organize activities upon their own initiative. In 2016 a new initiative was started in Geneva, CH by the people from ScienScope from the University of Genève, CH.

Science Me! Geneva 1 (2016, 3rd place: Christoph Schürmann and Laura Weber, topic: nucleosynthesis); Science Me! Geneva 2 (2018, 1st place: Florin Hemmann and Steffi Moll in French, topic: Teleshopping); Science Me! Hannover (2017 Niklas Kramer, Alexandra Wald); Science Me! Hannover (2019).

## 10 Euro Physics Fun, since 2015 Euro Science Fun

Euro Science Fun (ESF) is a European organization of science shows. It was started in Leiden, NL in 2005 just for physics shows but since 2015 it encompasses other sciences, such as chemistry, biology and mathematics, as well. ESF has annual meetings where people active in science shows meet and exchange ideas.

**March 28th - April 1st, 2017** We hosted the event in Bonn, Germany. The highlight was the joint display of hands-on experiments as well as several on-stage shows at the Deutsche Museum, Bonn, Germany on April 1st. The entire workshop was mainly organized by the two university physics students: Julia Hampel and Katharina Hortmanns.

We have furthermore attended and performed small shows at the following meetings:

- **Mar. 2007** Leiden, Nederland
- **Apr. 2010** Bad Honnef, Germany
- **Apr. 2011** Kharkiv, Ukraine
- **Apr. 2012** Bergen, Norway
- **Apr. 2013** Göttingen, Germany
- **Apr. 2014** Nordborg, Denmark
- **Apr. 2015** Liberec, Czech Republic
- **Apr. 2016** Reykjavik, Iceland
- **Apr. 2018** Ostrava, Czech Republic

- **Apr. 2019** Turku, Finland
- **June 2020** Geneva, Switzerland

## 11 Kinderuni

**June 2005:** Kinderuni Bonn, 30min show for 8 year old kids on the topic ‘*Atome – gemeinsam sind wir stark*’ (Atoms, together we are strong).

**Apr. 2009:** Kinderuni Bonn, 30min show for 8 year old kids on the topic ‘*Was es die LHC? Über die größte Maschine der Welt*’ (What on Earth is the LHC? On the largest machine in the world).

## 12 Work in Schools and with Pupils

### 12.1 Shows

**Autumn 2007:** Under our supervision a group of high school students of the Amos-Comenius-Gymnasium, Bonn, Bad Godesberg, performed a physics show (2 shows) for their fellow high school students in their own school. We provided most of the experiments. The university students tutored the high school students on how to do a show. Article on this published in ‘Science in School’.

**Spring 2012:** Repeated the Amos-Comenius-Gymnasium effort at the Clara-Schumann Gymnasium, Bonn. Two performances by the older high school students for their fellow students. The show was organized as a talent show.

### 12.2 Hands-on

**Spring 2008:** A 10 part afternoon hands-on physics activity at the Münster Elementary school, Bonn. It was organized by 8 physics show students and involved fourth grade 15 children at the school.

**June 2008:** Project work with 3 classes of second graders on electrical currents in the Catholic Elementary School, Holzlar.

**Autumn 2008:** A 10 part afternoon hands-on physics activity at the Münster Elementary school, Bonn. It was organized by 8 physics show students and involved fourth grade 15 children at the school.

**Winter 2010:** A 10 part afternoon hands-on physics activity at the OGS Josefs Schule in Bonn, Beuel (local elementary school). It was organized by 8 physics show students and involved fourth grade 15 children at the school.

### 12.3 Schülerakademie (Academy for high-school students)

As part of the CRC-110 Christoph Hanhart and H. Dreiner have organized 3 four-day academies on theoretical particle physics for high-school students in Haus Overbach, near Jülich, Germany. At all events we have done a hands-on session with the students using the experiments from the 3rd particle physics show.

*Dates:* Oct. 2013, 2015, 2017, and 2019.

## 12.4 ESERO

In May, 2018 a consortium of Bochum University, the University of Bonn and Köln University won the right to host the German national European Space Education Resource Office (ESERO), which is based in Bochum. This is a joint project of the European Space Agency (ESA) and the Deutschen Zentrum für Luft und Raumfahrt (DLR). It is initially funded for 4 years. The physics show students David Ohse, Johann Ostmeyer, Christoph Schürmann, and Laura Weber developed a 3hr unit for teaching 10-12 yr olds about planetary science. It is called Geheimnisse im Sternenlicht (secrets in starlight). The following schools have been visited so far

1. **Jan. 25th, 2019:** Clara Schumann Gymnasium, Bonn; teacher: Dr. Marc Thormeier, 5th grade.
2. **Feb. 2nd, 2019:** Rivius-Gymnasium, Attendorn; teacher: Jan-Handrik Müller, 8th-12th grade (20 pupils, mixed) 3hrs
3. **Feb. 13th, 2019:** Kindergarten Pustebblume, Brenig. 45min Show fir young kids, performed in lecture hall in Bonn.
4. **Feb. 18th, 2019:** Clara Schumann Gymnasium, Bonn, teacher: Dr. Sebastian Grab, 5th grade, 90min.
5. **June 28th, 2019:** Katholische Grundschule Holzlar, Bonn. One hour show in the gym for the entire school. Teacher: Kathrin Gerhardy
6. **Oct. 27th, 28th 2019:** Städtischen Willibrord Gymnasium, Emmerich. 7th grade. Teacher: Michael Skibba.
7. **Dec. 11th, 12th 2019:** Winfriedschule Fulda; 7th grade students. Teacher: Christian Hartmann.
8. **Feb. 6th, 2020:** Käthe-Kollwitz Gymnasium, München. 8th grade Science Day at school. 4 workshops, 4x each. Presented particle detectors to all students of school. Teacher: Andreas Seibt.

## 13 Teacher Training

The Bonn physics show has helped organize and has participated in several training events for high school teachers. Furthermore elementary particle physics is now part of the high school curriculum in North-Rhine Westfalia.

**Teacher training in physics shows:** organized together with Olivier Gaumier (University of Geneva, CH) and Prof. Rainer Müller (TU Braunschweig) two 4.5 day events held at the DPG center Bad Honnef. 25-40 teachers learned how to perform their own physics show. Several Bonn physics show students were involved as tutors, training the teachers in smaller groups. **Oct. 2013; Oct. 2015.**

**Teacher training particle physics, using physics show experiments:** together with Christoph Hanhart, H. Dreiner organized four one day particle physics teacher training events, also using physics show experiments: 2013, 2015, 2017, and 2019. These are financed by the DFG CRC-110.

Date	Location and co-organizer
Sept 2013	Haus Overbach, near Jülich.
Nov. 2015	IAS, TU München (together with Norbert Kaiser).
Nov. 2017	Bethe Center for Theoretical Physics, Bonn.
Nov. 2019	Bochum University (together with Evgeny Epelbaum).

## 14 Television & Radio

- June 2004:** Provided several experimental ideas for the SAT1 show *Clever*. The experiments were used but not credited.
- June 2005:** Ten 3min films of experiments produced with professional WDR team. Broadcast over several weeks on the WDR Lokalzeit Bonn. Students moderated the films.
- Sept. 2005:** Interview in *Die Kleine Cordula Stratmann Show*.
- Oct. 2008:** Judith Wild (geb. Schindler), a member of the Physikshow team, appeared on the German science TV show *Kopfball* in a 15min segment to explain the physics of going down water slides.
- Nov. 2008:** 25min interview on WDR5 show *Redezeit* with Sabine Brandi discussing the Bonn Physikshow.
- Apr. 2011:** 20min segment on *Quarks & Caspers*, a WDR TV show, on ‘*Wie kocht man das perfekte Ei?*’ (How to boil the perfect egg).
- Apr. 2012:** Herbert Dreiner was a main guest on Horst Lichter’s (famous German TV cook) show ‘*Lichter’s Schnitzeljagd*’. 20min appearance with several Physikshow experiments as well as cooking a turkey together.
- Sept. 2012:** Report of Deutsche Welle on the Bonn Physikshow.
- Sept. 2012:** Contribution in the *ARD Buffet* TV show on the topic ‘*Warum wird der Wasserkocher kurz vorm Kochen immer ganz leise?*’ (Why does the tea kettle turn silent just before boiling?).
- Jan. 2013:** WDR complete coverage (film and radio) of a science slam in the Jakobshof in Aachen. H. Dreiner performed a slam on *The Higgs Boson* using demonstration experiments performed by the Physikshow students.
- Sept. 2012:** WDR Lokalzeit Bonn had an extensive report from ‘*20th Century Physics Proudly Presents*’ show in the Wolfgang-Paul lecture theatre.
- Sept. 2013:** WDR Lokalzeit Bonn reports live from the rehearsals for the ‘*In 80 Minuten durch die Physik*’ show in the Wolfgang-Paul lecture theatre.
- Sept. 2017:** WDR Lokalzeit Bonn had an extensive report from the ‘*Physiker von Oz*’ show in the Wolfgang-Paul lecture theatre.
- Jan. 2018:** WDR Lokalzeit Bonn report on the visit by the candidate to be the first female German astronaut and former Bonn physics show student Insa Thiele Eich with the Bonn physics show.

## 15 Talks about the Physics Show

Unless otherwise stated the talks were given by H.K. Dreiner.

1. **Mar. 27th, 2007** talk at the Euro Physics Funn conference in Leiden, NL.
2. **Jan. 26th, 2009** colloquium Wuppertal University, Germany
3. **Mar. 3rd, 2010** colloquium University of Florida, Gainesville, USA.
4. **May, 27th, 2010** colloquium University of California, Santa Cruz, USA.
5. **Apr. 5th, 2012** talk at the ESF meeting in Bergen, Norway (by Timo Heepenstrick).
6. **Apr. 5th, 2013** talk at the ESF meeting in Göttingen, Germany (by Timo Heepenstrick).
7. **March 4th, 2014** colloquium University of California, Davis, USA.
8. **Jan. 15th, 2015** colloquium Padua University, Italy.
9. **Apr. 22nd, 2015** talk at the ESF meeting in Liberec, Czech Republic (by Robert Geisselbrecht, Julia Hampel and Jana Schüller-Ruhl).
10. **Jan. 7th, 2016** colloquium Weizmann Institute, Israel
11. **Jan. 10th, 2016** colloquium Tel Aviv University, Israel
12. **Feb. 2nd, 2016** colloquium Manchester University, UK
13. **Apr. 5th, 2016** talk at the ESF meeting in Reykjavik, Iceland (by Katharina Hortmanns and Julia Hampel).
14. **May 12th, 2016** colloquium, Bonn University, Germany
15. **June 22nd, 2016** joint colloquium Niels Bohr Inst. & Copenhagen Univ., Denmark
16. **June 23rd, 2016** colloquium Syddansk Universitet, Odense, Denmark
17. **Nov. 16th, 2016** colloquium Utrecht University, Netherlands
18. **Nov. 21st, 2016** colloquium Cornell University, USA
19. **Nov. 29th, 2016** colloquium Penn State University, USA
20. **Dec. 12th, 2016** colloquium Syracuse University, USA
21. **Jan. 2nd, 2017** colloquium Ben-Gurion University of the Negev, Beersheba, Israel
22. **Feb. 1st, 2017** public talk, What is a particle?, Sankt Augustin, Menden, Germany
23. **Feb. 8th, 2017** colloquium Glasgow University, Scotland, UK
24. **April 4th, 2017** public talk combined with a classical music concert in the Laeiszhalle Concert Hall, Hamburg, Germany.
25. **May 18th, 2017** colloquium Siegen Univ., Germany (extensive set of experiments)

26. **Mar. 19th, 2018** talk at DPG Frühjahrstagung, Würzburg (talk by Steffen Schaepe)
27. **Mar.20th, 2019** colloquium at the University of Amsterdam (morning)
28. **Mar.20th, 2019** public talk at Spui25, division of University of Amsterdam (evening)