

# Highlights from the 1<sup>st</sup> JENNIFER Summer School

**Sören Lange, Klemens Lautenbach, Dennis Getzkow**  
Justus–Liebig–Universität Giessen

**Jennifer Consortium General Meeting**  
September 21–23, 2016, Queen Mary University of London

# JENNIFER Summer School 2016

**When?** July 25–29, 2016

**Who?** 40 participants (lecturers and students)

**Where?** At Grünberg (village close to Giessen)

Sporthotel Grünberg (\*\*\*\*)

training camp of german national soccer team

and other teams such as Borussia Dortmund, Schalke 04, ...

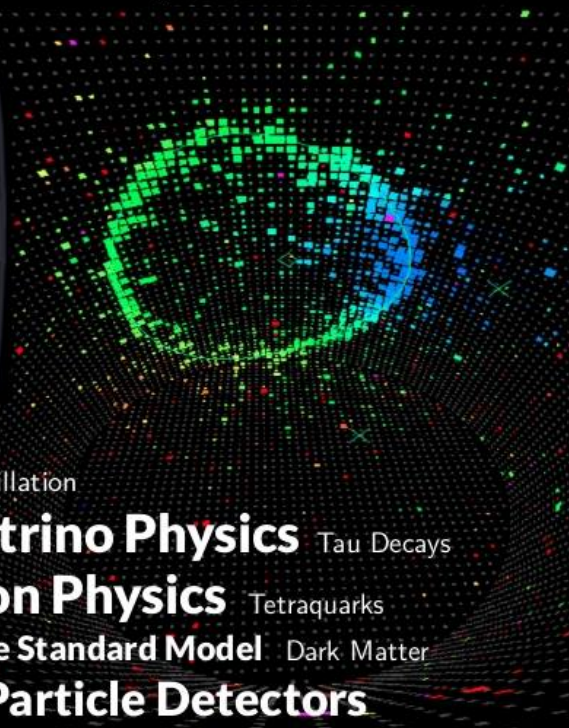
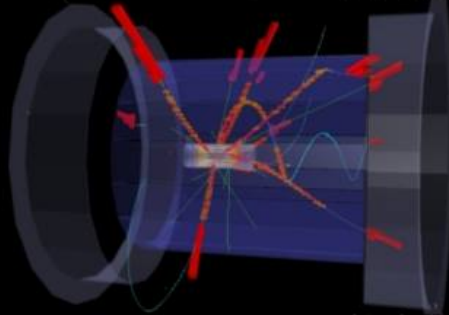
Warm weather (20–25<sup>0</sup> C) → social dinner: barbecue (outside)

Some groups had more than one eligible students:  
we offered participation, and some students from Bonn, Giessen,  
Göttingen received financial support from other sources.

We appreciate very much.

# JENNIFER SUMMER SCHOOL ON PARTICLE PHYSICS AND DETECTORS

Japan and Europe Network for Neutrino and Intensity Frontier Experimental Research



Mixing & Oscillation

Penguin Diagrams **Neutrino Physics** Tau Decays

CP Violation **B Meson Physics** Tetraquarks

**Physics beyond the Standard Model** Dark Matter

**Modern Particle Detectors**



An MSCA-RISE project funded by European Union under grant n.644294

July 25–29, 2016, Sporthotel Grünberg

[http://belle.uni-giessen.de/jennifer\\_school.html](http://belle.uni-giessen.de/jennifer_school.html)

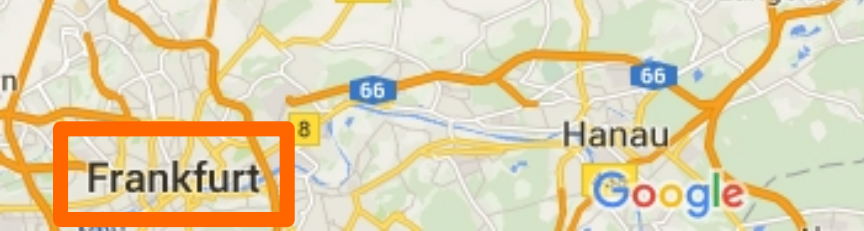
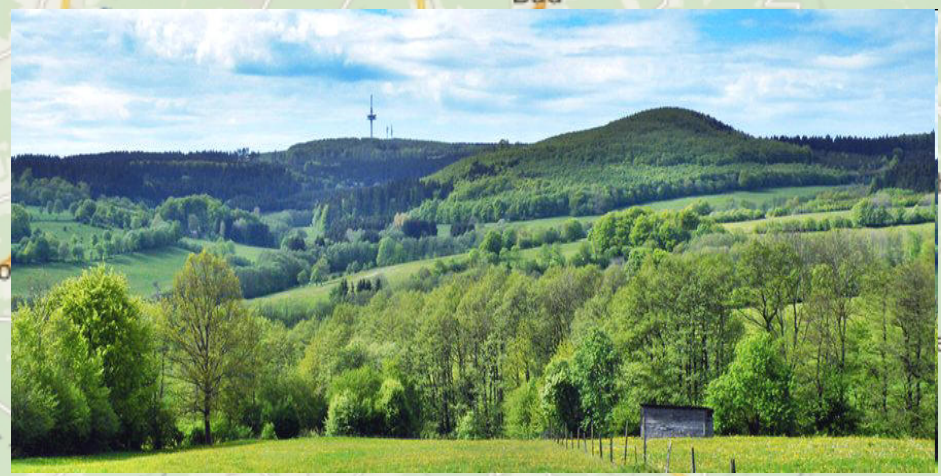
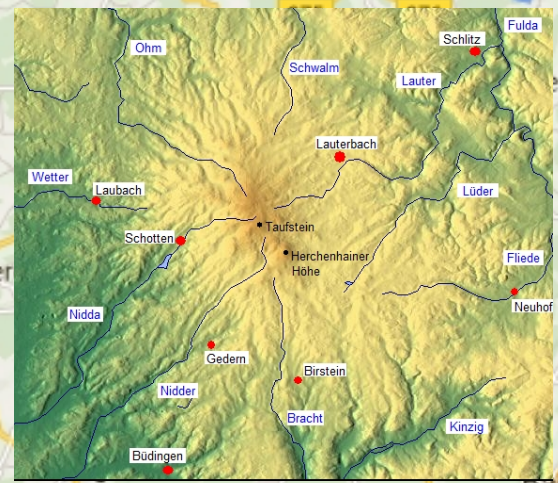




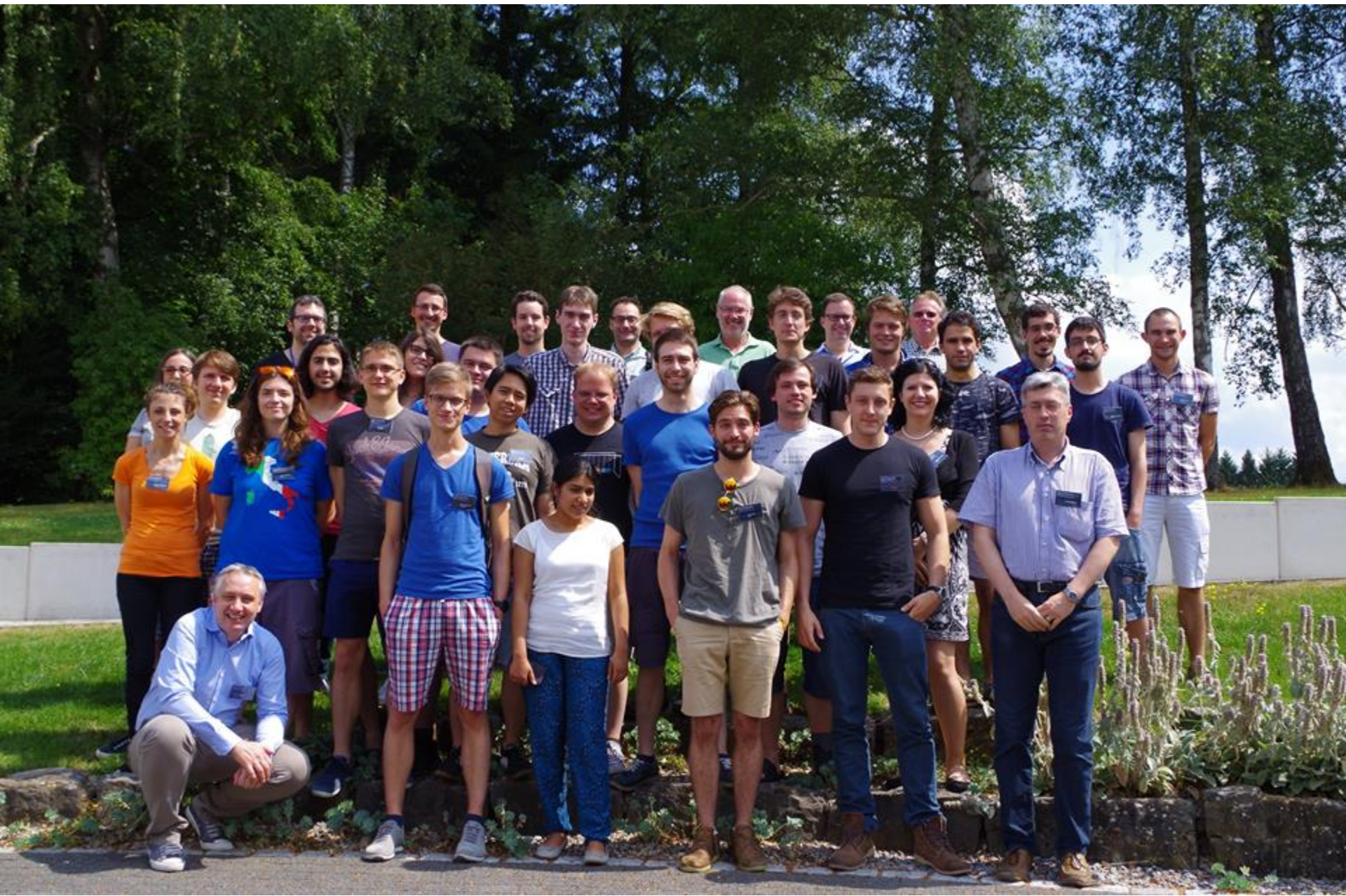
Giessen University  
Founded 1607  
~28.000 students  
where Clebsch and Gordan  
met for the 1<sup>st</sup> time



Vogelsberg  
Europe largest volcano  
(16 Mill. years ago)









Culinary support was more than „o.k.“ (reminder: 40,50 € for lunch, dinner, all softdrinks in session, 2 coffee breaks, room, beamer(s), whiteboards)



# INDICO

	Monday, 25 July 2016	Tuesday, 26 July 2016	Wednesday, 27 July 2016	Thursday, 28 July 2016	Friday, 29 July 2016
AM	08:30 <b>Welcome &amp; Organisation Remarks</b> (until 09:00) <a href="#">slides</a>	09:00 <b>Morning #1</b> (until 10:30)	09:00 <b>Morning #1</b> (until 10:30)	09:00 <b>Morning #1</b> (until 10:30)	09:00 <b>Morning #1</b> (until 10:30)
	09:00 <b>Morning #1</b> (until 10:30)	09:00 B Mesons (Theory), Lecture, Part 2 - <a href="#">Thomas Mannel (University of Siegen)</a> <a href="#">Slides</a>	09:00 Cancer Therapy with Protons, Lecture - <a href="#">Guntram Pausch (ONCORAY Dresden)</a> <a href="#">Slides</a>	09:00 Neutrinos (Theory), Lecture, Part 1 - <a href="#">Michele Maltoni (IFIC Valencia)</a> <a href="#">Slides</a>	09:00 Neutrinos (Experiment), Lecture, Part 2 - <a href="#">Alessandro Bravar (University of Giessen)</a> <a href="#">Slides</a>
	09:00 B Mesons (Theory), Lecture, Part 1 - <a href="#">Thomas Mannel (University of Siegen)</a> <a href="#">Slides</a>	11:00 <b>Morning #2</b> (until 12:30)	11:00 <b>Morning #2</b> (until 12:30)	11:00 <b>Morning #2</b> (until 12:30)	11:00 <b>Morning #2</b> (until 12:30)
	11:00 <b>Morning #2</b> (until 12:30)	11:00 B Mesons (Experiment), Lecture, Part 2 - <a href="#">Christoph Schwanda (HEPHY Vienna)</a> <a href="#">Slides</a>	11:00 "Supercomputing" on your laptop, Tutorial - <a href="#">Sören Lange (University of Giessen)</a> <a href="#">Slides</a> <a href="#">notes</a>	11:00 Neutrinos (Experiment), Lecture, Part 1 - <a href="#">Alessandro Bravar (University of Geneva)</a> <a href="#">Slides</a>	11:00 Neutrinos (Theory), Lecture, Part 2 - <a href="#">Michele Maltoni (IFIC Valencia)</a> <a href="#">Slides</a>
11:00 B Mesons (Experiment), Lecture, Part 1 - <a href="#">Christoph Schwanda (HEPHY Vienna)</a> <a href="#">Slides</a>		12:30 <b>EXCURSION: Glaueberg celtic archeological site and museum</b> (until 15:00)			
PM	13:30 <b>Afternoon #1</b> (until 15:00)	13:30 <b>Special Young Student Presentation</b> (until 14:00)	15:30 <b>EXCURSION</b> (until 18:30)	13:30 <b>Afternoon #1</b> (until 15:30)	14:00 <b>Afternoon #1</b> (until 15:30)
	13:30 Modern Detectors, Lecture, Part 1 - <a href="#">Carlos Marinas (University of Bonn)</a> <a href="#">Slides</a>	13:30 Zero G - <a href="#">Philipp Riedl (University of Giessen)</a>		13:30 Detectors and Data Acquisition, Tutorial - <a href="#">Hans-Georg Zaunick (University of Giessen)</a> <a href="#">Paper</a> <a href="#">Slides</a>	14:00 Dark Matter (Theory and Experiment), Lecture, Part 2 - <a href="#">Gianluca Inguglia (DESY Hamburg)</a> <a href="#">Slides</a>
	16:00 <b>Afternoon #2</b> (until 18:30)	14:00 <b>Afternoon #1</b> (until 15:30)		16:00 <b>Afternoon #2</b> (until 17:30)	15:30 <b>DEPARTURE</b> (until 16:00)
	16:00 STATISTICS (Tutorial) - <a href="#">Elisabetta Prencipe (Forschungszentrum Jülich)</a> <a href="#">Slides</a>	14:00 Modern Detectors, Lecture, Part 2 - <a href="#">Carlos Marinas (University of Bonn)</a> <a href="#">Slides</a>		16:00 Dark Matter (Theory and Experiment), Lecture, Part 1 - <a href="#">Gianluca Inguglia (DESY Hamburg)</a>	
		16:00 <b>Afternoon #2</b> (until 17:30)		18:30 <b>BARBECUE</b> (until 23:00)	
		16:00 Gamma-Ray Imaging in Nuclear Medicine, Lecture - <a href="#">Guntram Pausch (ONCORAY Dresden)</a> <a href="#">Slides</a>			
	17:30 <b>POSTER SESSION</b> (until 18:30)				

<https://indico.uni-giessen.de/indico/conferenceDisplay.py?confId=193>

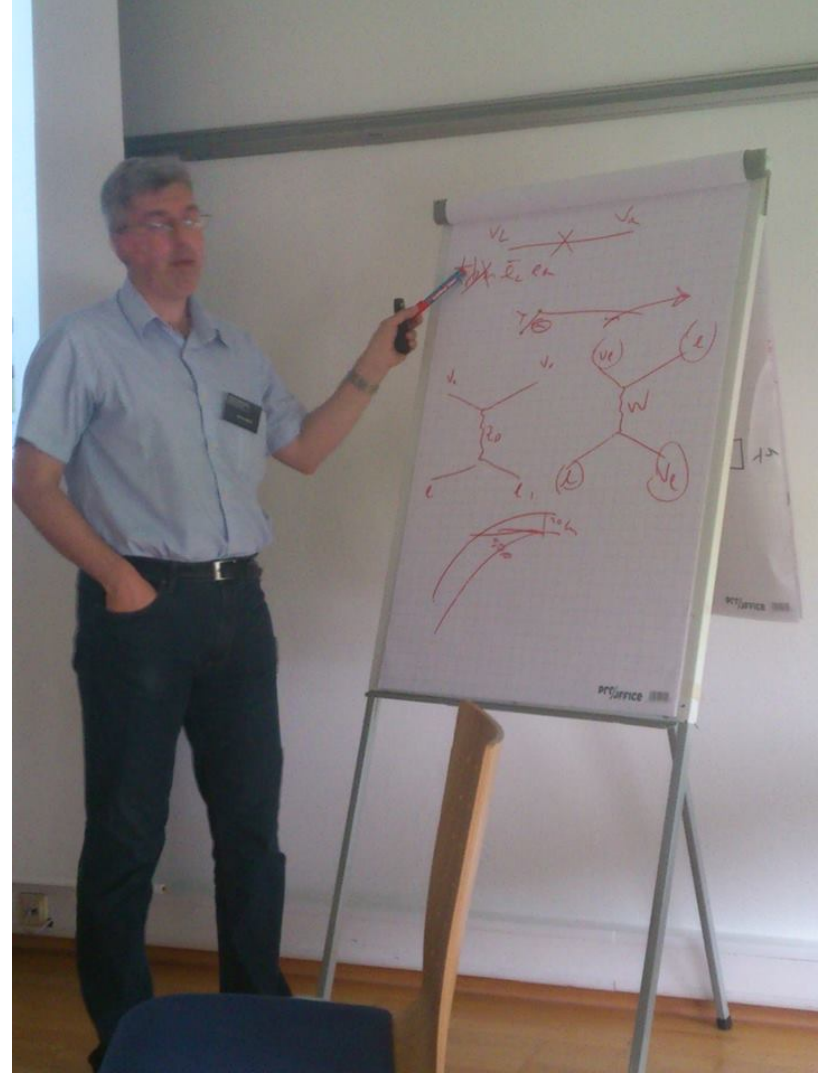
please don't worry about the certificate warning  
and click [ADVANCED] and [PROCEED]

(we are using self-certificate, which is even more secure than a certificate from some unknown server somewhere in the world)





Thomas Mannel (Siegen)  
 B mesons (theory)  
 (here: penguin diagrams)



Michele Maltoni (Madrid)  
 Neutrinos (theory)  
 (here: neutrino oscillation)

## Implications for $\nu$ Scattering

weak interactions couple to  
left-handed ( $\lambda = -1$ ) particles and  
right-handed ( $\lambda = +1$ ) anti-particles



same handedness  
no net spin along  
→ isotropic distribution

$$J_z = 0$$

$$\frac{d\sigma(\nu e)}{dy} = \frac{G_F^2 s}{\pi}$$

$$\frac{d\sigma(\bar{\nu} e)}{dy} = \frac{G_F^2 s(1-y)^2}{\pi}$$

$$\frac{\sigma(\bar{\nu})}{\sigma(\nu)} = \frac{1}{3}$$

Recall  $e\mu \rightarrow e\mu$  scattering

$$\frac{d\sigma(e\mu \rightarrow e\mu)}{dQ^2} = \frac{2\pi\alpha^2}{Q^4} s [1 + (1-y)^2]$$

$$J_z = -1$$

opposite  
net spin  
→ scattering

isotropic, parallel helicities  
antiparallel helicities  
possibility out of 3)  
 $1 - y = \frac{E' - E}{E} = \frac{1 - \cos\theta}{2}$

## Extracting a B signal

Using special  $\Upsilon(4S)$  kinematics, two nearly  
independent variables  $M_B$  and  $\Delta E$  can be  
used to select B meson signal:

$$M_B = \sqrt{E_{\text{beam}}^2 - (\Sigma P_x)^2}$$

$$\Delta E = \Sigma E_i - E_{\text{beam}}$$



Methods to extract B signal

- 1) Cut on  $M_B$  and fit to  $\Delta E$
- 2) Cut on  $\Delta E$  and fit to  $M_B$
- 3) Double dimensional fit to  $M_B$  and  $\Delta E$  distribution

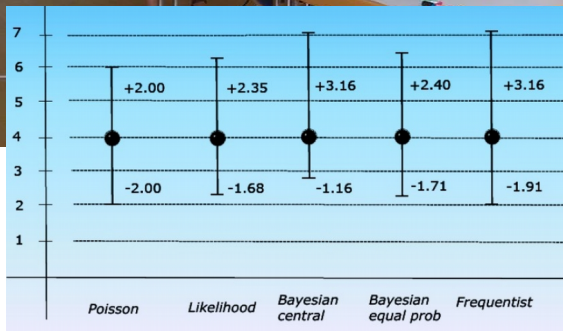
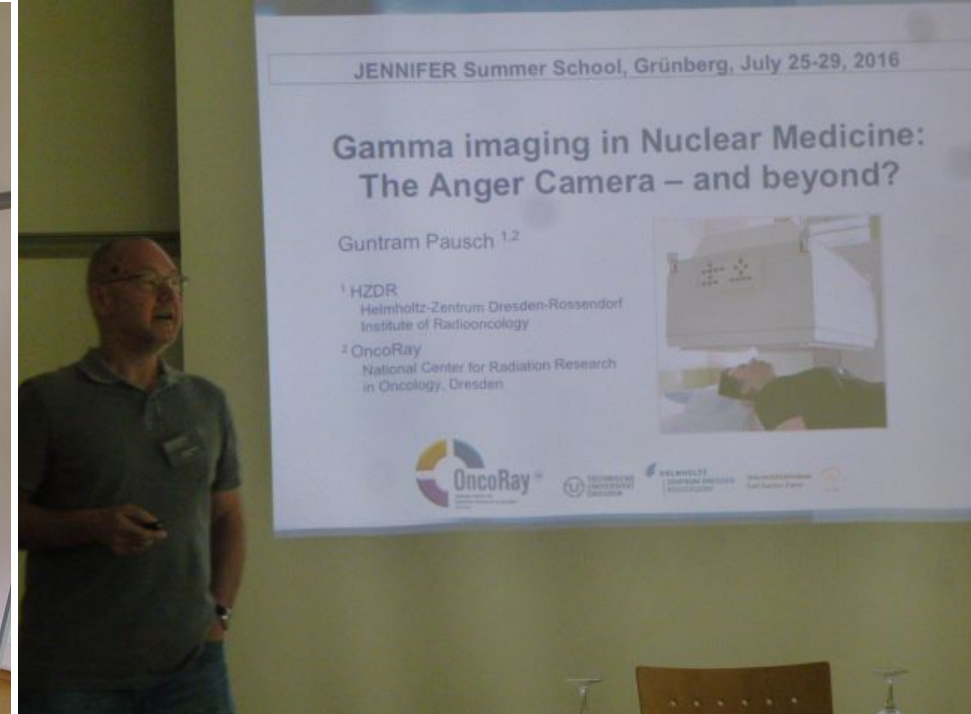
- 4) if  $B \rightarrow P, P, P_s$  cut  $\Delta E$  and look at resonant  $\pi$  in  $M(P, P_s)$  mass

Alessandro Bravar (Geneva)  
Neutrinos (Experiment)  
(here: scattering)

Christoph Schwanda (Vienna)  
B Mesons (Experiment)  
(here: signal reconstruction)

Elisabetta Prencipe (FZ Jülich)

Guntram Pausch  
(FZ Rossendorf and ONCORAY)

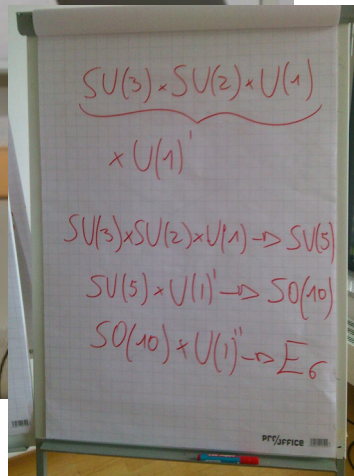
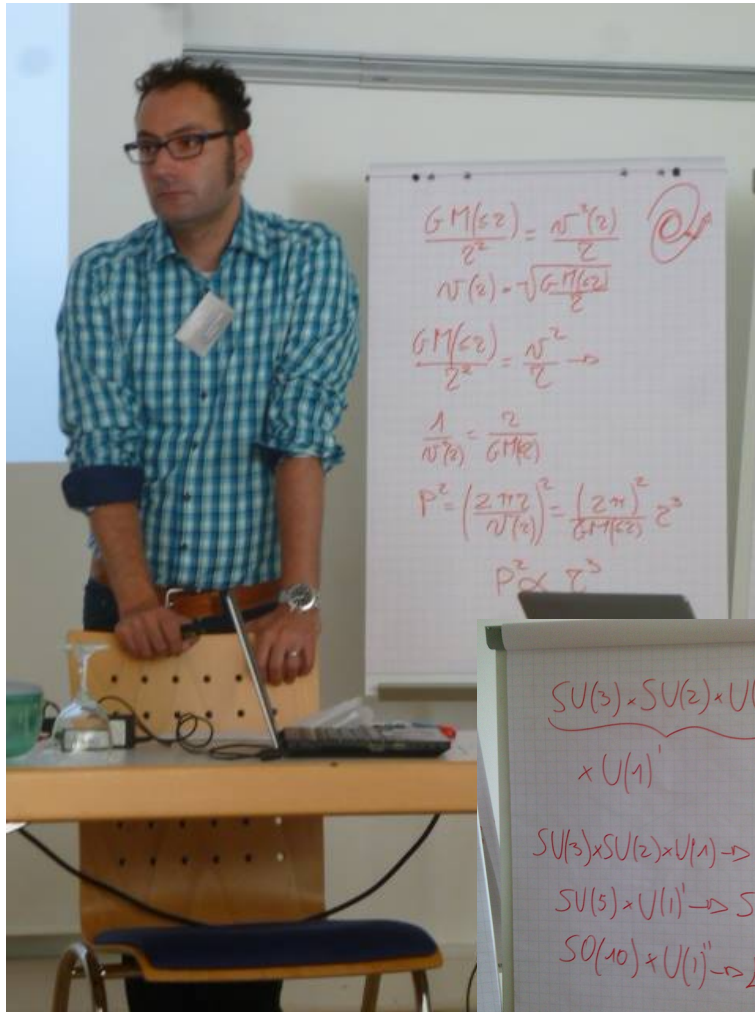


Statistics:  
why roofit has  
asymmetric error bars?

Cancer therapy with beams  
and diagnostics (tracers, PET, ...)

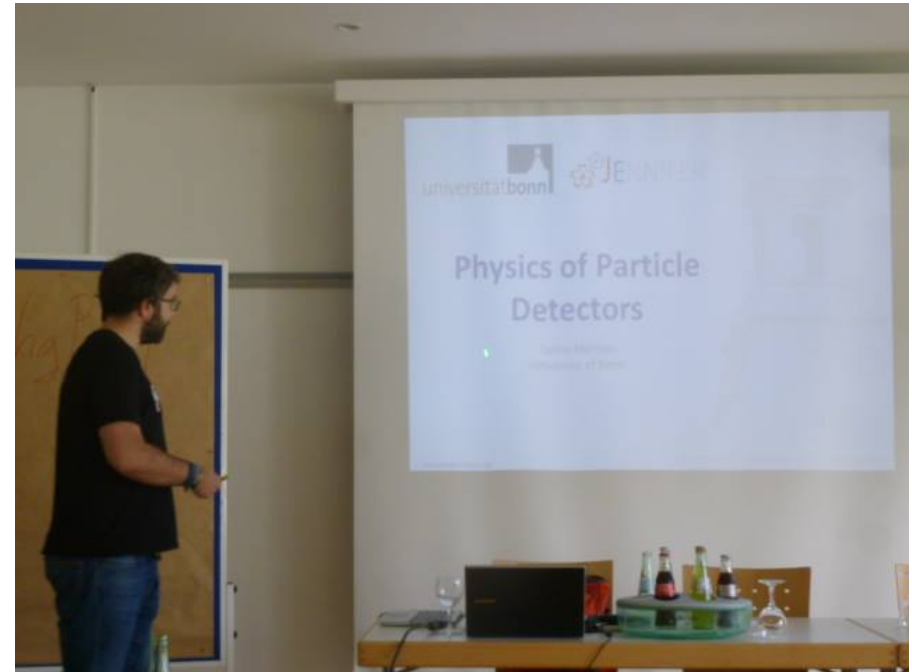


# Gianluca Inuglia (DESY)



Dark matter  
(here: virial theoreme for galaxies,  
calculation „by hand“)

# Carlos Marinas (Bonn)



Basic technologies and  
introduction to modern detectors  
(e.g. silicon pixels, etc.)

Philipp Riedl  
(guest, bachelor student  
from Giessen)



ZERO-G experiments  
(and how he did them as a hobby  
pilot over Giessen and Grünberg)

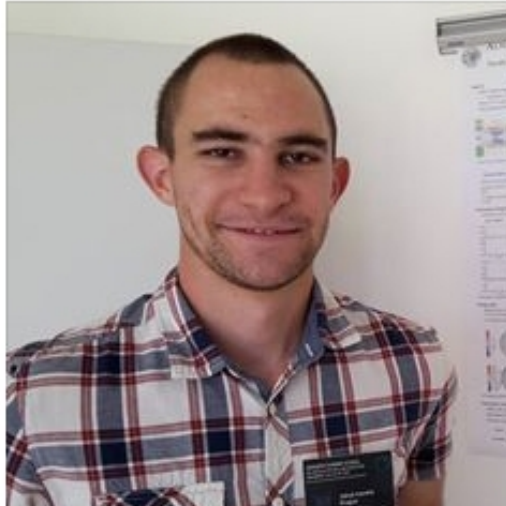
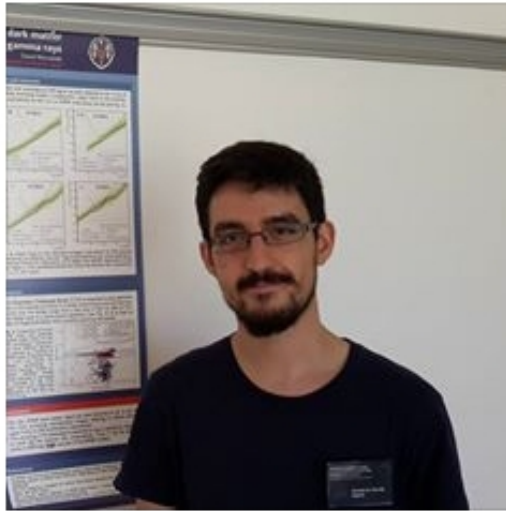
Hans-Georg Zaunick (Giessen)



Hands-on tutorial on DAQ  
for cosmics, and student  
presentation about DAQ  
For cosmic ray showers  
with satellite timing  
on a RaspBerry Pi

# Poster competition

Poster competition: 1. [Nicolas Angelides](#); 2. [Jakub Kandra](#). 3. [Dario Gatto](#).  
Congratulations to all participants: it was hard to choose the winner!







Quiz: which one is the electron neutrino?)  
Winner Christina Martellini (Roma 3)

# Excursion stop #1: Celtic museum and archeological site







Excursion stop #2: LICHER beer brewery  
(when we left, there was a fire alarm,  
but it was not our fault ...)







- **facebook** group  
many photographs available  
(closed group → please wait 1–2 days after your request)
- „Homework“ for the students:  
→ why are there 3 families of quarks and leptons?  
Answer can be submitted by email,  
at any time in the next 100+ years ...

**THANK YOU!!**

**(for making the summer school possible)**