

Achievements of the DK Particles & Interactions

Anton Rebhan
Speaker of the DK

VIENNA PARTICLE PHYSICS



TECHNISCHE
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WIEN



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wien

ÖAW

ÖSTERREICHISCHE
AKADEMIE DER
WISSENSCHAFTEN

$\int dk \Pi$

Doktoratskolleg
Particles and Interactions

FWF

Der Wissenschaftsfonds.

9½ years ago: INAUGURATION





Atominstitut



TU Wien



Uni Wien



HEPHY



SMI

Combining forces

of 5 institutes of TU Wien, Uni Wien, Austrian Academy of Sc. for:

Vienna-wide graduate education at highest level
in **theoretical and experimental particle physics**

1. Broad and quality scientific expertise
exposing our PhD students to full range (exp/th) of particle physics
 2. High-level student recruitment
 3. Coordinated education
 4. Intensive monitoring
 5. International cooperations
 6. Outreach and alumni culture
- ▶ Vienna centre of excellence for graduate education in fundamental physics
 - ▶ High quality and competitive research output
 - ▶ Optimal career opportunities for PhD's

DKPI Faculty Members



Hartmut ABELE

Exp

Daniel GRUMILLER

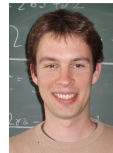
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Anton REBHAN (Speaker)

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Andreas SCHMITT (→ U. Southampton)

Th



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Walter GRIMUS

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Andre HOANG (Co-Speaker)

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Massimiliano PROCURA

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WISSENSCHAFTEN

Jochen SCHIECK (also TU Wien)

Exp

Manfred JEITLER

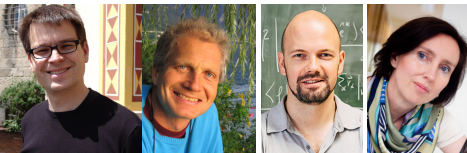
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Josef PRADLER

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Claudia WULZ

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DKPI Faculty Members



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Josef PRADLER

Th

Claudia WULZ

Exp



Gertrud KONRAD

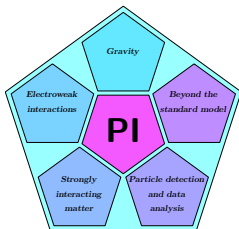
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Johann MARTON

Exp

Eberhard WIDMANN

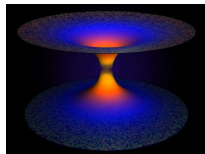
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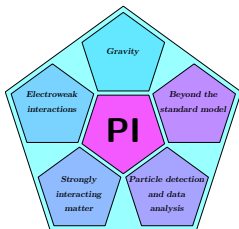


- ▶ Gravity,
- ▶ Interactions Beyond the Standard Model,
- ▶ Weak Interactions,
- ▶ Strong Interactions and Strongly Interacting Matter,
- ▶ Particle Detection and Data Analysis
CERN, ILL, ATI, BELLE, ASACUSA, CRESST, ...

Gravity

- ▶ Quantum gravity – outstanding challenge, new ideas from gauge/gravity duality
- ▶ Conversely: gauge/gravity duality as a new tool
- ▶ Connection cosmology–particle physics (dark matter!)
- ▶ Neutron interference experiments





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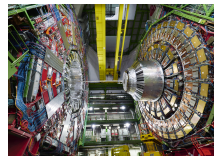
Beyond the Standard Model:

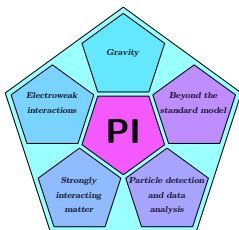
- ▶ High energy collider searches
- ▶ Dark Matter, theory and detection
- ▶ Tests of fundamental symmetries (CPT)

w/ crucial input from studies of

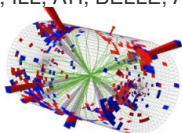
Weak Interactions:

- ▶ Neutrino physics
- ▶ Heavy flavor physics
- ▶ Neutron decay

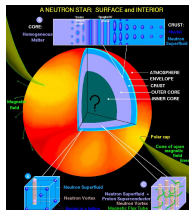




- ▶ Gravity,
 - ▶ Interactions Beyond the Standard Model,
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 - ▶ Strong Interactions and Strongly Interacting Matter,
 - ▶ Particle Detection and Data Analysis
- CERN, ILL, ATI, BELLE, ASACUSA, CRESST, ...

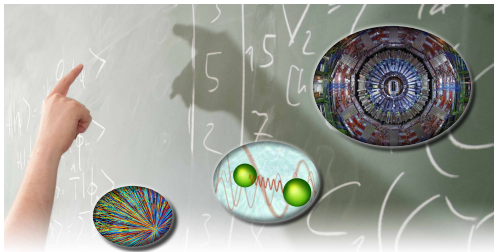


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Strong Interactions:

- ▶ Jet and top quark physics
- ▶ Hadronic light-by-light scattering
- ▶ Holographic QCD
- ▶ Strongly interacting hot and dense matter (quark-gluon plasma, neutron stars)



$\int dk \Pi$ VIENNA DOCTORAL PROGRAM Particles & Interactions

The Vienna Doctoral Program for Particles and Interactions (DK-PI) welcomes applications for **PhD fellowships in experimental and theoretical particle physics.**

The DK-PI is a graduate program that is targeted to outstanding and excellent students and offers

- research opportunities in the physics of elementary particles and hadronic matter, including theories beyond the standard model, dark matter and gravity
- three year contract with social and health benefits
- possibility for a fourth year if six months are spent at a different research institution abroad
- introductory and specialized as well as soft skill courses at TU Wien, University of Vienna, and Austrian Academy of Sciences
- support for travel to scientific workshops, schools, and international conferences
- research stays at various partner institutions around the globe



www.dkpi.at

The next **call for applications** for PhD fellowships is open.

Three selection rounds per year.
We specifically invite applications by women.

Students of 1st Funding Period



Aeikens (D)
[Grimus]



Asilar (TR)
[Wulz&Schieck]



Berger (A)
[Widmann]



Brondolin (I)
[Jeitler&Frühwirth]



Brünner (A)
[Rebhan]



Capon (AUS)
[Widmann]



Dehnadi (IR)
[Hoang]



C.Ecker (A)
[Grumiller]



Filter (D)
[Abele]



Haber (A)
[Schmitt]



Irakleidou (GR)
[Grumiller]



Klopf (A)
[Abele]



Kolbinger (A)
[Widmann]



Lehner (A)
[Widmann]



Lepenik (A)
[Hoang]



Löschner (D)
[Grimus]



Mach (A)
[Abele]



Müller (A)
[Schmitt&Ipp]



Pichler (A)
[Marton]



Preißer (A)
[Hoang]



Rad (USA)
[Wulz]



Rechberger (A)
[Abele]



Riegler (A)
[Grumiller]



Samitz (A)
[Hoang]



Sauerzopf (A)
[Widmann]



Semmelrock (A)
[Hoang&Pradler]



Soloviev (USA)
[Rebhan]



Stanzer (A)
[Grumiller]



Steinschaden (A)
[Marton]



Thalhammer (A)
[Abele]



Zarucki (PL)
[Jeitler]

Students of 2nd Funding Period



Andrejkovic



Bertemes



Bosina



Cranganore



Dobhammer



F.Ecker



Favoni



Fuß



Hechenberger



Horer



Hotzy



Hussain



Khalid



Kidambi



Killian



Kraxberger



Kuo



Lanz



Leal-Gomez



Lechner



Leutgeb



Leuthner



Lindenbauer



Lüdtke



Mager



Moser



Nanda



Nikolic



Regner



Roupec



Ruffa



Saavedra



Schmiedmayer



Schmidt



Schuh



Sonawane



Spitzbart



Tempel



Tüchler



Weiser



Widl

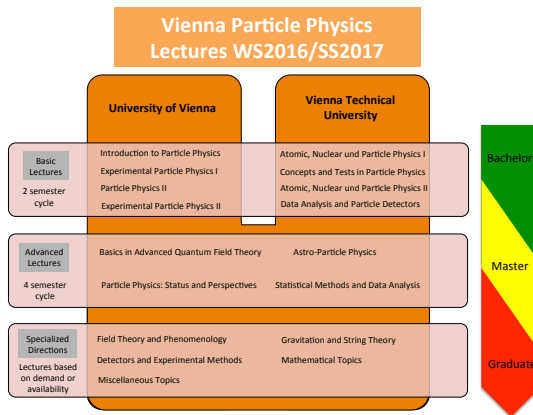


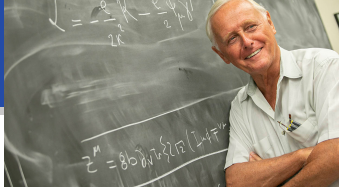
Wutte

totalling
73 PhD students

(guest lecturers financed mostly thanks to extra financial commitment of TUV and UV)
in Vienna:

- ▶ Advanced courses integrated in curricula of the two universities:
UV and TUV offering complementary introductory and advanced lectures





thanks to extra financial commitment of TUW and UV)

- ▶ Advanced courses integrated in curricula of the two universities:
UV and TUW offering complementary introductory and advanced lectures
- ▶ DK-PI Guest Professors: (block courses equivalent to 2 hours/semester)
 - ▶ Prof. Ryugo Hayano (University of Tokyo):
The Physics of Exotic atoms 8 lectures, May – June 2016
 - ▶ Prof. Claude Amsler (CERN):
The Quark Structure of Hadrons
8 lectures with graded homework exercises, Nov 2016
 - ▶ Prof. Peter van Nieuwenhuizen (Stony Brook University):
Supersymmetry and Supergravity
14 lectures with graded homework exercises, Jan – Mar 2017
 - ▶ Dr. Simon Plätzer (Durham University):
Collider Physics
10 lectures with graded homework exercises, Apr – Jun 2017
 - ▶ Prof. Jürgen Reuter (DESY Hamburg):
Physics Beyond the Standard Model
9 lectures with graded homework exercises, May – June 2017

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- ▶ DK-PI Lectures: (special lecture series w/ 4–10 hours in Vienna)
 - ▶ Prof. Laura Fabbietti (TU Munich):
Chiral Symmetry Breaking and Restauration
4 lectures, February 2015
 - ▶ Dr. Ringaile Placakyte (DESY):
Parton Distribution Functions of the Proton: from HERA to LHC
2 lectures, October 2015
 - ▶ Prof. Soo-Jong Rey (Seoul National University):
Introduction to Little String Theory
2 lectures, July 2017
 - ▶ Dr. Ralf Lehnert (ICSS Bloomington, Indiana):
CPT Symmetry and CPT Violation
5 lectures, July 2017

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- ▶ DK-PI Lectures: (special lecture series w/ 4–10 hours in Vienna)
- ▶ Erwin-Schrödinger Guest Professors
 - ▶ Prof. Aneesh Manohar (University of California, San Diego)
The standard model effective theory and dimension 6 operators
1 lecture Nov 2014, 3 lectures Mar 2015
 - ▶ Prof. John F. Donoghue (University of Massachusetts, Amherst)
Low-Energy Effective Theory of Quantum Gravity
4 lectures, Oct-Nov 2015
 - ▶ Prof. Iain W. Stewart (MIT Cambridge)
Effective Theory Methods for Collider Physics
4 lectures, June - July 2016
 - ▶

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- ▶ DK-PI Student Colloquia (~ monthly, 2 presentations by DK-PI students)

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- ▶ **Vienna Theory Lunch Seminar** (weekly, students-organized, free pizza)
in addition to regular seminars at TUW, UV, HEPHY, SMI
discontinued during pandemy, restarting this October!

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in addition to regular seminars at TUV, UV, HEPHY, SMI
discontinued during pandemy, restarting this October!

Intend to keep as much as possible after the end of the DK-PI

- for education + team formation:

- yearly Retreats (one weekend)
- yearly Summer Schools (one week)

Topics selected from theory and experiment such as to maximize interest of both theorists and experimentalists, introductory/hands-on courses with exercises

∫dkΠ
Data-revolving
Particles and Interactions

„ISS“ Indian Summer School

TRAUNKIRCHEN

SEPT. 21 - 25, 2015

Standard Model and Beyond, LHC Phenomenology, Dark Matter, Quark Gluon Plasma, Statistical Aspects of Data Analysis

SPEAKERS: Tommaso Dorigo (Padua), Greg Lanitzberg (Brown University), Guy D. Moore (McGill / Darmstadt U.), Josef Pradler (OAW)

VIENNA PARTICLE PHYSICS
universität wien TU GAW FWF
Der Wissenschaftsstand.

Please register at www.dkpi.at by July 15, 2015

LIMITED number of participants

DKPI SUMMER SCHOOL SEPT. 19 - 23, 2016

TOPICS: Neutrino and astroparticle physics, machine learning, thermal field theory, holographic aspects of relativistic hydrodynamics, standard model physics instrumentation for hadron physics

SPEAKERS: Kai BRINKMANN (JLU Gießen), Andreas SCHMITT (TAG), Thomas SCHWETZ-MANGOLD (KIT), Heige VOISS (CERN), Michael WEBER (CERN)

∫dkΠ VIENNA DOCTORAL PROGRAM
Particles & Interactions
VIENNA PARTICLE PHYSICS
universität wien TU GAW FWF
Der Wissenschaftsstand.

Please register at www.dkpi.at by July 17, 2016

Limited number of participants

Retreats, DKPI Summer Schools, VCES, ...



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VIENNA PARTICLE PHYSICS *fdkΠ* Enthusiasm for Particles and Interactions
UNIVERSITÄT WIEN TU OAW LLUF Österreichische Akademie der Wissenschaften

DKPI SUMMER SCHOOL

SEPT. 17 - 21, 2018

SPEAKERS:

- Francis Halzen (U. of Wisconsin - Madison) "Astroparticle Physics with PeV Neutrinos"
- Michal Malinský (Charles U. Prague) "Standard Model and Beyond"
- Antonio Pich (U. of Valencia) "Effective Field Theory"
- Aleksi Vuorinen (U. of Helsinki) "Cool Quark Matter & Gravitational Waves"
- Wolfgang Waltenberger (HEPHY Vienna) "Data Science for Particle Physics"

Please register at www.dkpi.at by July 15, 2018

Limited number of participants

VIENNA PARTICLE PHYSICS *fdkΠ* Enthusiasm for Particles and Interactions
UNIVERSITÄT WIEN TU OAW LLUF Österreichische Akademie der Wissenschaften

DKPI SUMMER SCHOOL

Zwettl, Austria Sept. 16 - 20, 2019

SPEAKERS:

- Phillippe Brax (University of Paris-Saclay) "Light Scalars: From Cosmology to Laboratory Experiments"
- Geoffrey Compère (University of Brussels) "Gravitational Waves in Linearized Theory"
- Christian Ecker (University of Utrecht) "Numerical Holography"
- Martin Fertl (University of Washington) "Muon g-2 - Experiment"
- Matthew McCullough (CERN) "Physics beyond the Standard Model"
- Massimo Passera (INFN) "Theory of Lepton g-2"

Please register at www.dkpi.at by July 5, 2019

Limited number of participants



2020: Summer School on-line due to pandemic

for Schools, VCES, ...



as to maximize interest of both theorists and
with exercises

PRINCE FERRARIS PHYSICS
UNIVERSITÄT TU Wien UNIVERSITÄT TU Wien UNIVERSITÄT TU Wien UNIVERSITÄT TU Wien
UNIVERSITÄT TU Wien UNIVERSITÄT TU Wien UNIVERSITÄT TU Wien UNIVERSITÄT TU Wien

DKPI SUMMER SCHOOL

Traunkirchen, Austria Sept. 20 - 24, 2021

Please register at
www.dkpi.at
 by July 18, 2021
 Limited number of participants

SPEAKERS:
 Michael Benedikt & Martin Aleksa (CERN): "Future Circular Colliders"
 Alexey Boyarsky (University of Leiden): "Sterile Neutrinos"
 Nora Brambilla (TU München): "Quarkonium Physics"
 Andreas Crivellin (PSI, CERN): "Flavour Anomalies"
 Dominik Schwarz (University of Bielefeld): "Tensions in Cosmology"

resumed 2021 in person (no comparison!)

Retreats, DKPI Summer Schools, VCES, ...



- for education + team formation:
 - yearly Retreats (one weekend)
 - yearly Summer Schools (one week)
- topical Vienna Central European Seminar (2–3 days end of November)

Nov 28 – 29, 2014

10th VIENNA CENTRAL EUROPEAN SEMINAR ON PARTICLE PHYSICS AND QUANTUM FIELD THEORY
INFLATION AND COSMOLOGY

Invited Speakers:
 Robert Brandenberger (MCEI, US)
 Alexander Miletić (MPF, Munich)
 Vasilios Michalos (ICM, Trieste, to be confirmed)
 Yin Young H. (Boston, US)
 Chao-Prateek (US), to be confirmed
 Jochem Ruhlwald (MPF, Munich)
 Mark Sredanovic (US, NY)
 Jochen Steinwand (EPFL, VS) (to be confirmed)
 Demark Vishwakarma (MCEI, VS)
 Thomas Wehner (MCEI, VS)
 Frank Wilczek (MIT, MA, USA)
 Susana Witte (Garching)

Organizers:
 Walter Glöckle (TU, Vienna)
 David Greiner (TU, Vienna)
 Andreas Igg (TU, Vienna)
 Susanna Knapp (TU, Vienna)

Please apply at www.dkpi.at

VIENNA PARTICLE PHYSICS **fdkΠ** **European Particle Physics** **LUF**

Nov 27 – 28, 2015

11th VIENNA CENTRAL EUROPEAN SEMINAR ON PARTICLE PHYSICS AND QUANTUM FIELD THEORY
QUANTUM AND GRAVITY

Invited Speakers:
 Malcolm J. Perry (US, to be confirmed)
 Michael Appleby (Vienna, US)
 Zou Feifei (Garching, Germany)
 Gidon Barkan (Vienna, US)
 Shihang Chen (Vienna, US)
 Johannes Gompf (Garching, Germany)
 Johannes G. Reuter (Garching, Germany)
 Johannes Körmann (TU, Vienna, Austria)
 Ben Lindzen (TU, Vienna, Austria)
 Sebastien Lehner (EPFL & Kavli, US)

Organizers:
 Walter Glöckle (TU, Vienna)
 David Greiner (TU, Vienna)
 Andreas Igg (TU, Vienna)
 Susanna Knapp (TU, Vienna)

Please apply at www.dkpi.at

VIENNA PARTICLE PHYSICS **fdkΠ** **European Particle Physics** **LUF**

Dec: 01-02, 2016

12th VIENNA CENTRAL EUROPEAN SEMINAR ON PARTICLE PHYSICS AND QUANTUM FIELD THEORY
PHYSICS AT LHC - RUN 2

Invited Speakers:
 Jean-François Guillemin (EPFL, Geneva)
 Gidon Barkan (EPFL, Lausanne)
 Abhishek Chakraborty (University of Zurich)
 Jorany S. Leontidis (INFN, Trieste)
 Filippos Maltoni (TU, Vienna)
 Keith M. Zurek (MIT, Cambridge)
 Susanna Knapp (EPFL, VS)
 Alan Peacock (University of Cambridge)
 Werner Rindler-Schjerve (University of Bonn)
 Maria Passera (University of Vienna)
 Christophe Schanke (University of Southampton)
 Thomas Stöckli (EPFL, Lausanne)
 Michael Sussner (EPFL, Lausanne)
 David Teague (University of Cambridge)
 Michael Wiescher (Ohio State University, Columbus, OH)
 Chuan-Prateek (Ohio State University, Columbus, OH)
 Misha Zubov (University of Cambridge)

Organizers:
 Walter Glöckle (University of Vienna)
 David Greiner (EPFL, VS)
 Andreas Igg (TU, Vienna)
 Susanna Knapp (EPFL, VS)

Public Lecture:
 Physics at the Large Hadron Collider
 The Big Bang
 Misha Zubov (University of Cambridge)

Please apply at www.dkpi.at

VIENNA PARTICLE PHYSICS **fdkΠ** **European Particle Physics** **LUF**

2016 at Natural History Museum of Vienna accompanied by major public outreach activity

2020, 2021: cancelled due to lockdowns — resumed 2022 at TUtheSky

Longer-term research stays abroad

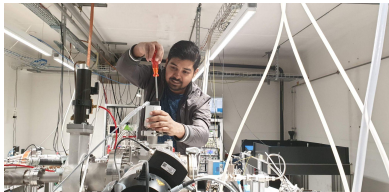
Speciality of FWF DK program

Sending PhD students abroad for 6 or 3+3 months enables 4th year in DK

- ▶ 32/73 PhD students sent abroad for such research stays
- ▶ *invaluable* preparation for future post-doc career:
 - frequently basis for post-doc positions abroad
 - boost for personal scientific development



U. Oxford



ETH Zürich



U. Jyväskylä, Finland

Speciality of FWF DK program

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	months	countries/places
EU	93	D (TUM, MPI, DESY, ...), E, NL, S, FIN, I, F, B
CH	33	CERN, ETH Zürich
USA	24	MIT, Stanford, Baltimore, Colorado, Stony Brook
UK	12	Manchester, Oxford, Southampton
Japan	12	Kyoto, Tokai, Nara Women's U.
India	3	Chennai



Victor Franz Hess Prize of Austrian Physical Society for PhD Thesis

- 2016 Max RIEGLER*
How General is Holography? Flat space and higher spin holography in 2+1 dimensions
- 2018 Erica BRONDOLIN†
Track reconstruction in the CMS experiment for the High Luminosity LHC
- 2022 Frederic BRÜNNER
Glueballs and Gauge/Gravity Duality: Unravelling the mysteries of the (strong) force
- 2023 Josef Leutgeb*
Holographic QCD and the Anomalous Magnetic Moment of the Muon
- *: also Promotio sub auspiciis praesidentis rei publicae
†: also CMS Achievement Award 2016

not to mention

several CERN and DESY fellowships, Schrödinger fellowships, DOC fellowships, ...

Thank you



Sad that the FWF discontinued its DK programme, depriving us of a 3rd funding period, :(
but:

A big thank-you to the FWF, TU Wien, Univ. Vienna, and ÖAW

Thank you



A big thank-you to the FWF, TU Wien, Univ. Vienna, and ÖAW

and also to those who carried out all the **DK-PI administration**:

Andreas IPP



Simone KRÜGER



Andrea SMITH-STACHOWSKI



associated FWF projects & graphics support:

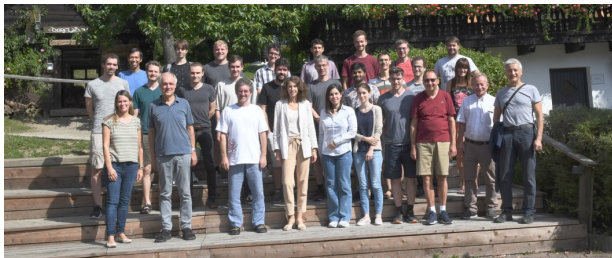


Ingrid UNGER

FARE WELL!



First DKPI Summer School 2015



Last DKPI Summer School 2023