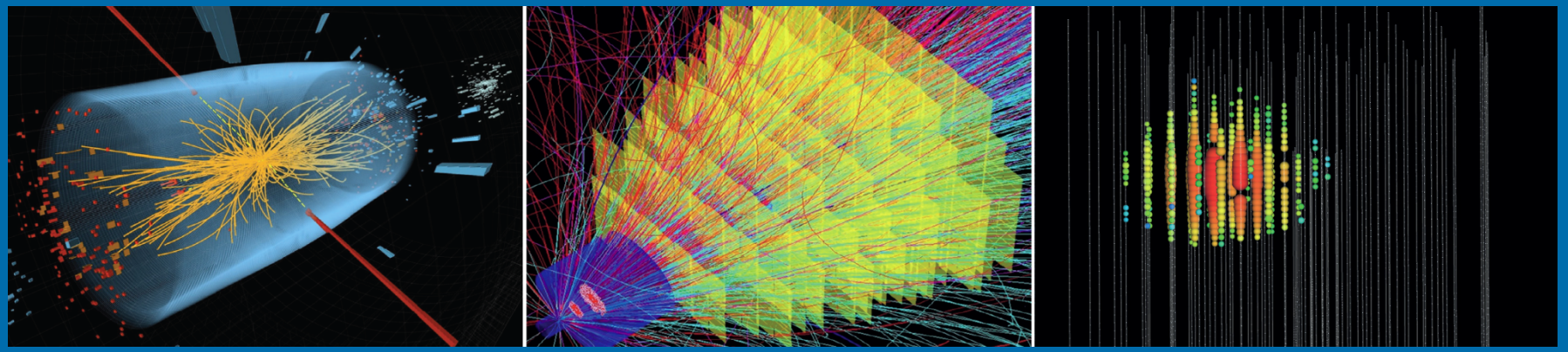
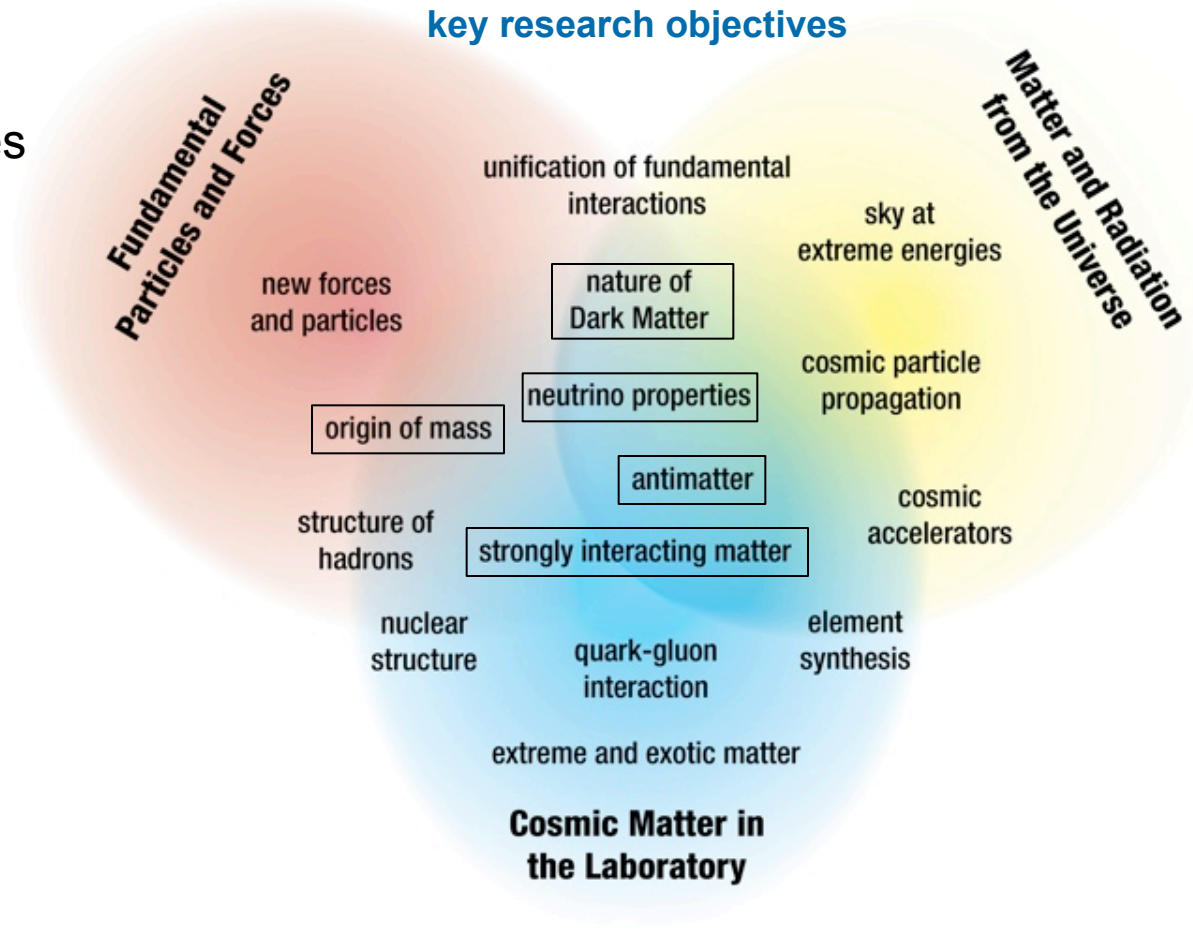
# Cross-topic interactions



HELMHOLTZ ASSOCIATION

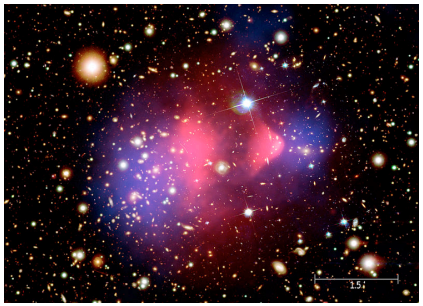
# Overlap between programme topics

- several scientific objectives shared between topics
- from complementary approaches or methods to concrete overlap and potential for collaboration
- aims
  - identify overlap
  - regularly exchange ideas and results
  - encourage common activities




- following slides: examples for specific overlap

# Dark matter



## combine all available information from

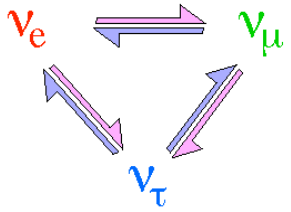
- searches in
  - direct detection → EDELWEISS, EURECA
  - dark matter annihilation or decay
    - $\gamma$ telescopes → CTA
    - cosmic rays → AMS 02
    - $\nu$ telescopes → IceCube/DeepCore, PINGU
  - production → LHC, ILC
    - missing energy, invisible Higgs decays, displaced vertices
- dark matter in models of new physics (e.g. supersymmetry)
  - implications for cosmology, connections with gravitational waves and matter-antimatter asymmetry
  - axions and axion-like particles (ALPs)
    theoretical motivation (string theory) and new detection ideas

# Dark matter

## joint topical workshop


## lectures

# Neutrino properties




- determination of mass scale and mass hierarchy

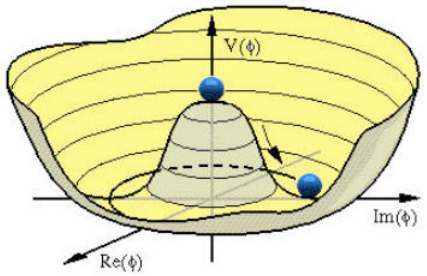
  Dirac vs. Majorana, CP violation
  - model independent results from KATRIN, PINGU
  - combine with model dependent constraints from cosmology and $\nu$-less double $\beta$ decay experiments
- models of new physics
  - mass generation:

    Higgs mechanism and Majorana mass terms
  - heavy neutrinos and unification of forces
  - heavy neutrinos and cosmology: leptogenesis
- neutrino induced nuclear reactions
  - supernova dynamics and nucleosynthesis

# The origin of mass

mass generation by
supersymmetry breaking

electroweak symmetry breaking
mass generation by Higgs mechanism

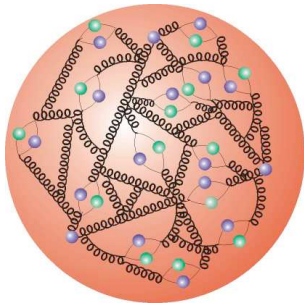



composite Higgs models:
Higgs as bound state
similar to pion in QCD

neutrino masses
Higgs mechanism and
Majorana mass terms

hadron masses
binding energy of strong interaction
broken chiral symmetry

# Strongly interacting matter



## connections in various domains

- hadron structure:

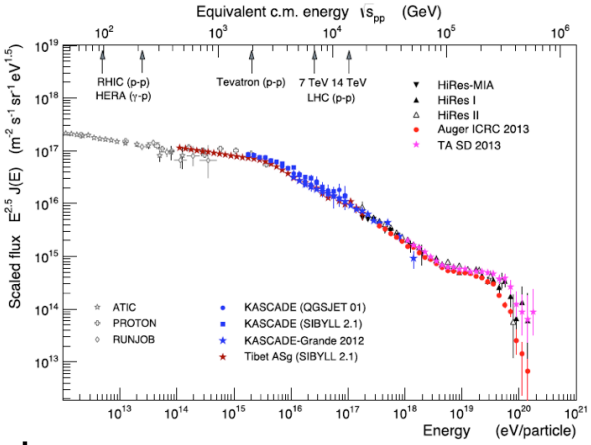
  probed in complementary ways at LHC and at PANDA
- common theoretical tools, e.g. effective field theories
- lattice gauge theory:

  collaborate on physics, methods, technology
  - generation of gauge field configurations: HIM and DESY
  - simulation lab: algorithms, community support: FZJ and DESY

**high-performance computing**

- methods from string theory applied to quark-gluon plasma

# Strongly interacting matter



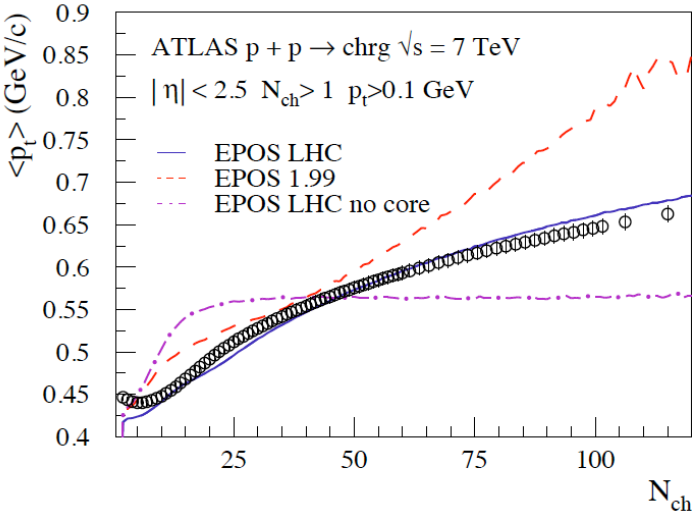

## high-energy scattering of hadrons

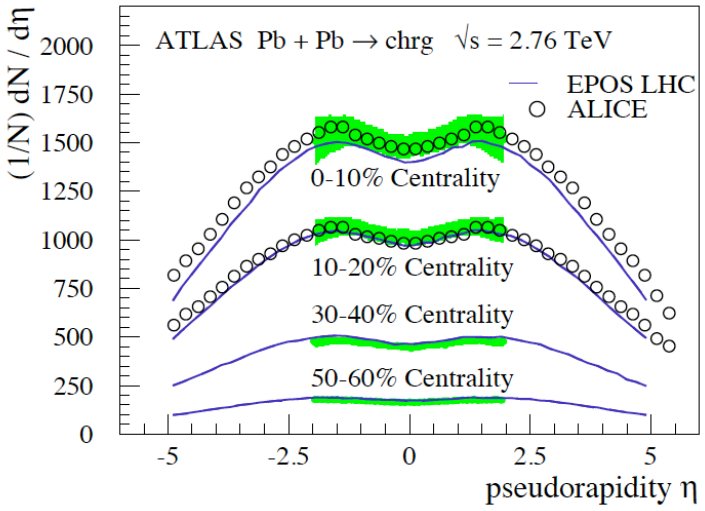
- LHC and ultrahigh energy cosmic rays

  LHC: detailed event information, cosmic rays: huge energy range

  → develop theory and models

  - KIT/DESY collaboration in tuning Monte-Carlo generators

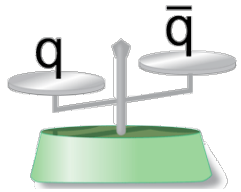



T. Pierog et al, June 2013

  - Young Investigator Group working in Auger and CMS

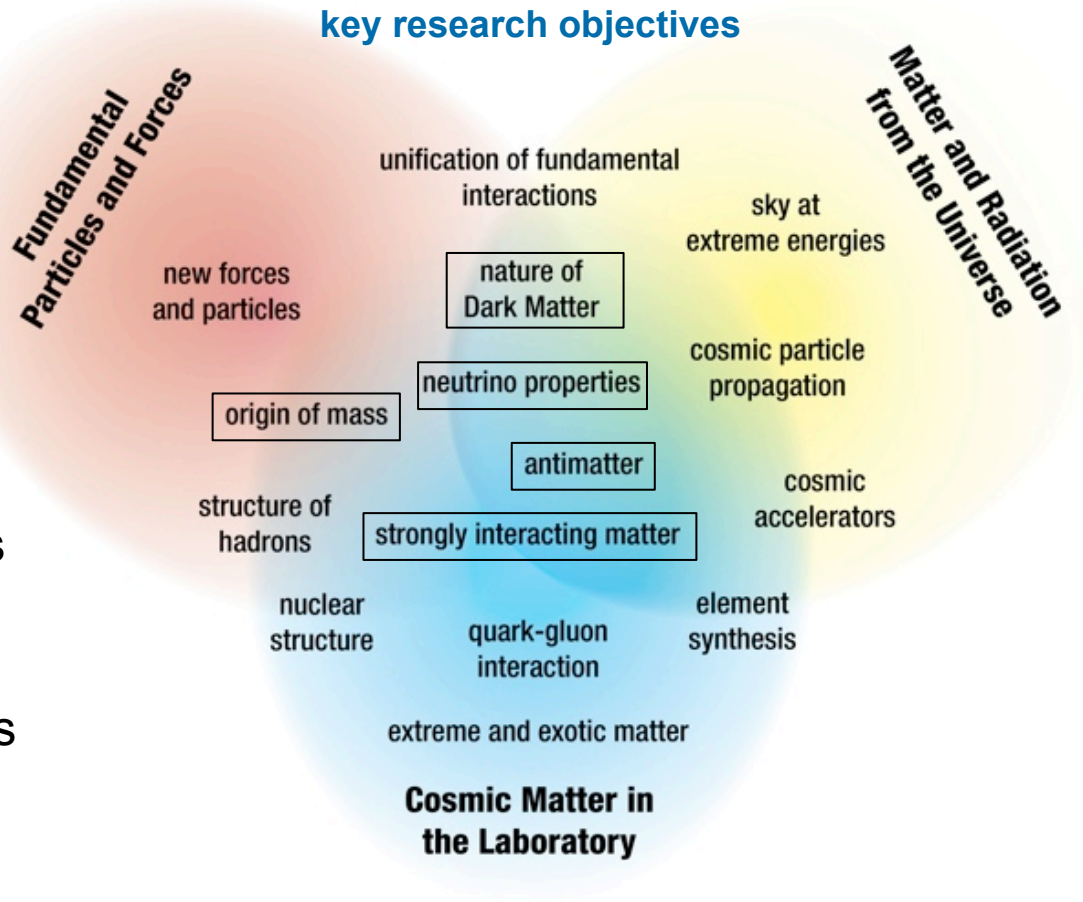
# Antimatter



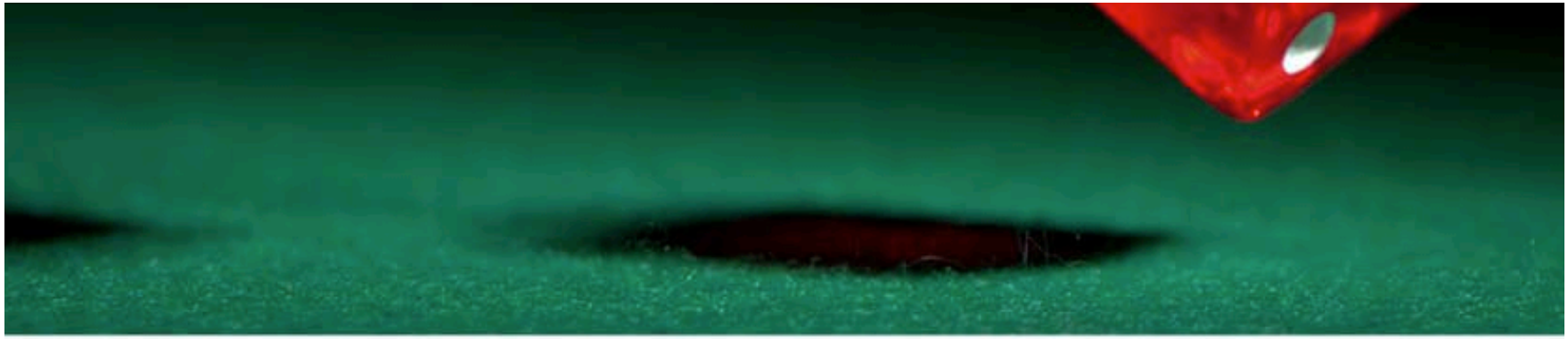

- observed matter-antimatter asymmetry of Universe requires
  **violation of CP symmetry**
  beyond amount provided by CKM mechanism in SM
- seach for CP violation
  - flavor changing: B meson decays → Belle II
  - flavor conserving: electric dipole moments → JEDI
  - complementary constraints
    much needed since generic models contain
    plethora of CP violating parameters

# Fostering common activities

- annual meeting for scientists from all three topics
- dedicated parallel sessions on overlap areas
- for each have nominated convenors from relevant topics
- will help identify potential for
  - common topical workshops and education events
  - collaboration on research projects



# Cross-topic education: an example



School on

## Monte Carlo Methods in Advanced Statistics Applications and Data Analysis

18-22 November 2013, München

**Topics:**

- Basics of statistics and probability, random numbers and the Monte Carlo method
- Bayesian reasoning
- Information field theory
- Markov chain Monte Carlos
- Sampling and clustering
- Population Monte Carlo
- Nested sampling

This school - the first one commonly organised by the three Helmholtz Alliances Terascale, HAP and EMMI and the Max Planck IMPRS EPP School - addresses physicists from particle physics, astro-particle physics and hadrons & nuclei

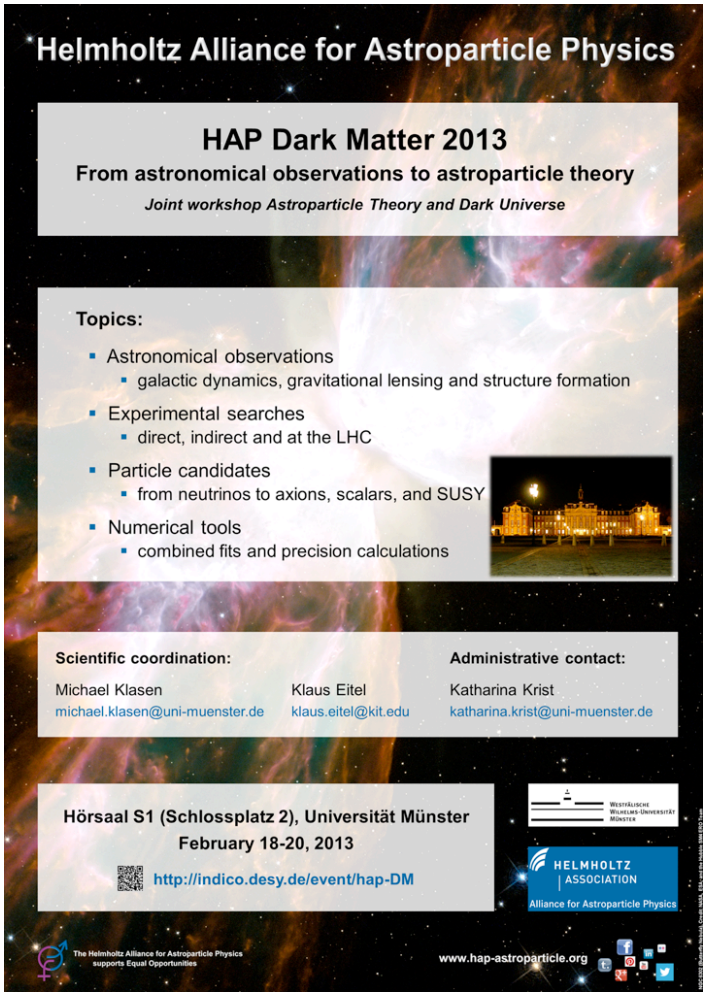
Organisers: Allen Caldwell (MPI Munich), Kevin Kröninger (U Göttingen), Kai Schweda (GSI), Ralf Ulrich (KIT), Thomas Schörner-Sadenius (DESY), Frank Steffen (MPI Munich)

**Registration deadline: 11 November 2012, Registration fee: 50 €**

Registration and more information at:

**www.terascale.de/mcstats2013**

# Cross-topic education: more examples


students from

PANDA, BES III, ..., ATLAS, CMS

students and lecturers from

astroparticle and particle physics