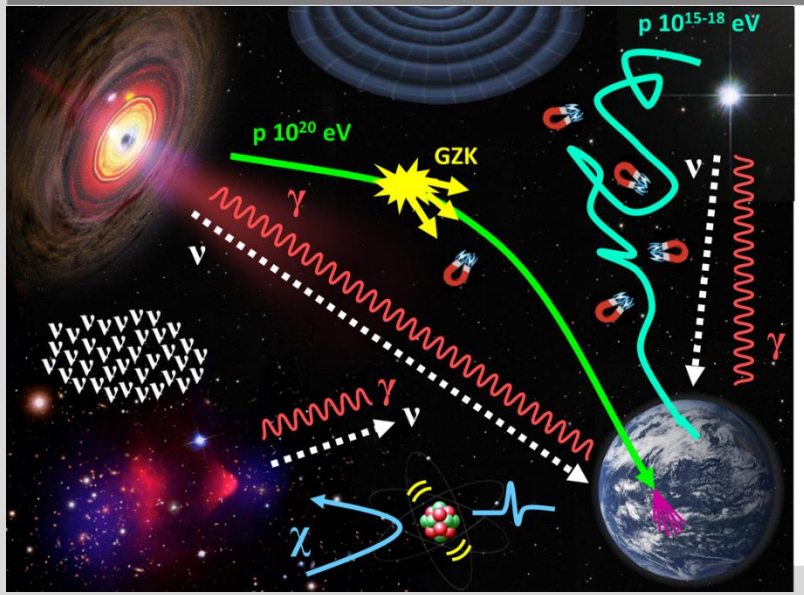
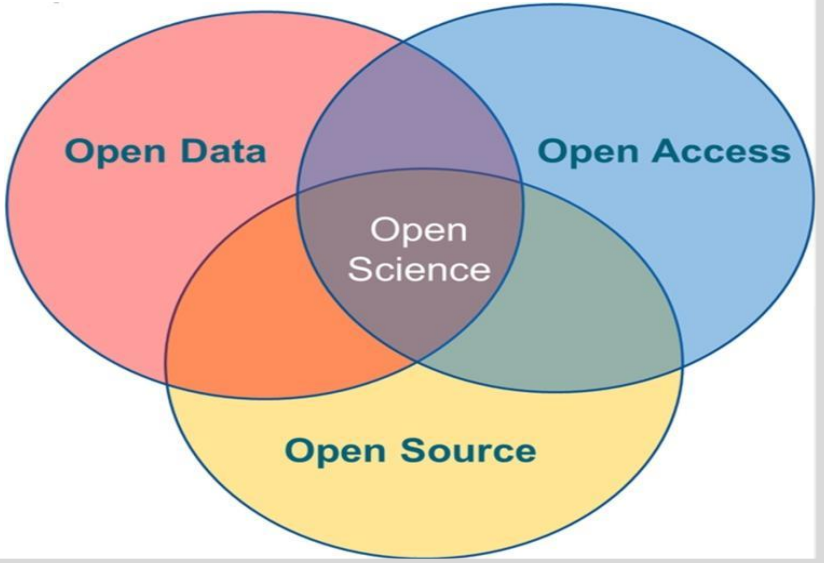
KRAD-APPDS joint meeting
KIT, October 2018

1. General slides on future of a global data centre
2. KRAD status

Andreas Haungs





Recommendations of the KAT (white paper)

„Astroparticle Physics in the Light of the „Digitale Agenda der Bundesregierung*“

Recommendations of the KAT
The KAT emphatically emphasizes the importance of setting up and developing centres for data storage, the provision of data and the necessary computing resources as a basic digital service for German scientists and, moreover, for public participation in scientific data.
The KAT supports the establishment of a structure that facilitates communication between scientists as users of scientific data and modern data analysis methods on the one hand, and continues to implement expert advice within the framework of user support.
The KAT draws attention to the central importance of externally funded and sustainably invested human resources positions, which are absolutely necessary for the support of users.

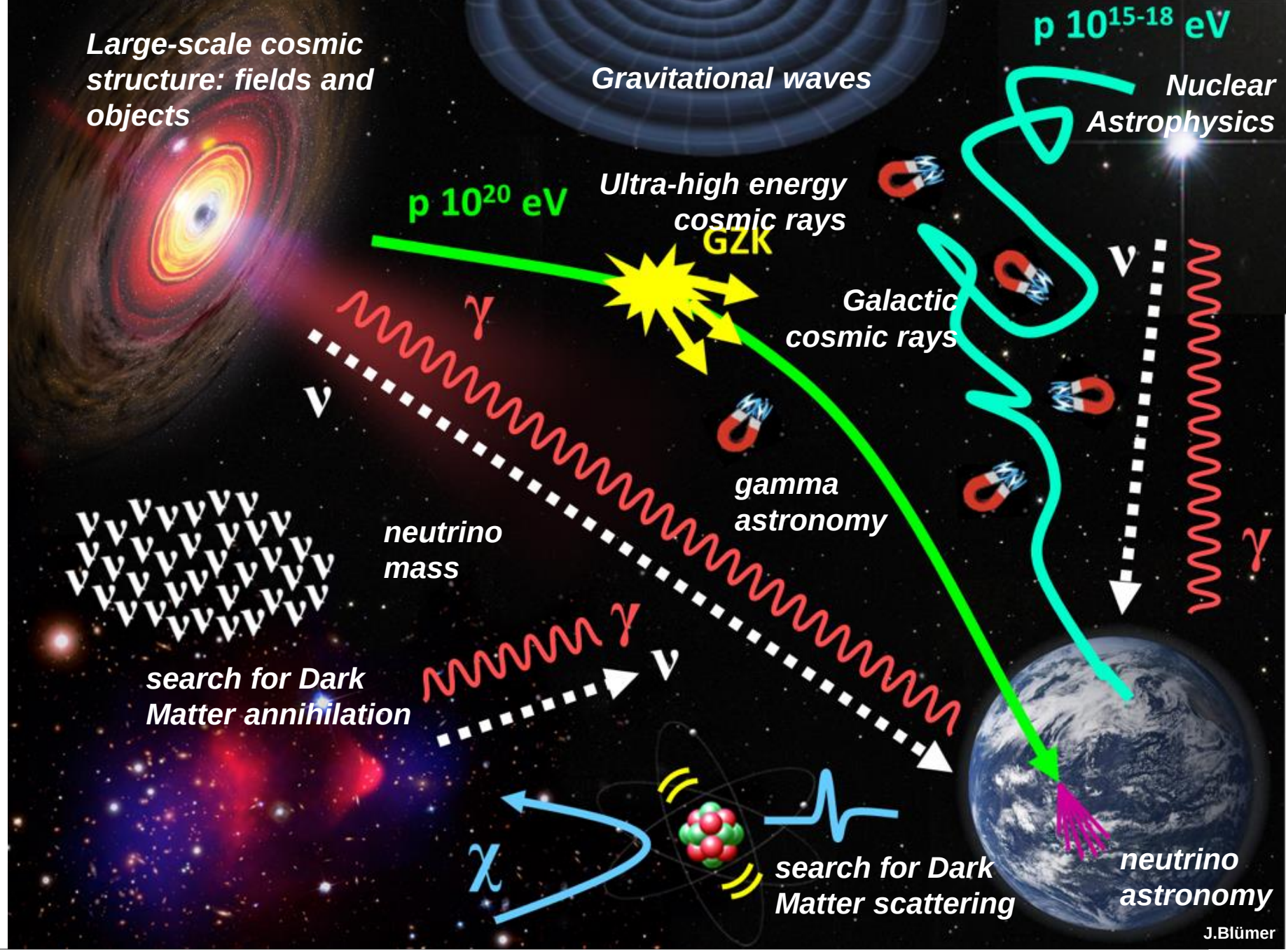
* https://www.bmbf.de/de/die-digitale-agenda-relevant-auch-fuer-bildung-wissenschaft-und-forschung-206.html

Initiative for a (global) Analysis & Data Center in Astroparticle Physics

Astroparticle Physics = Understanding the

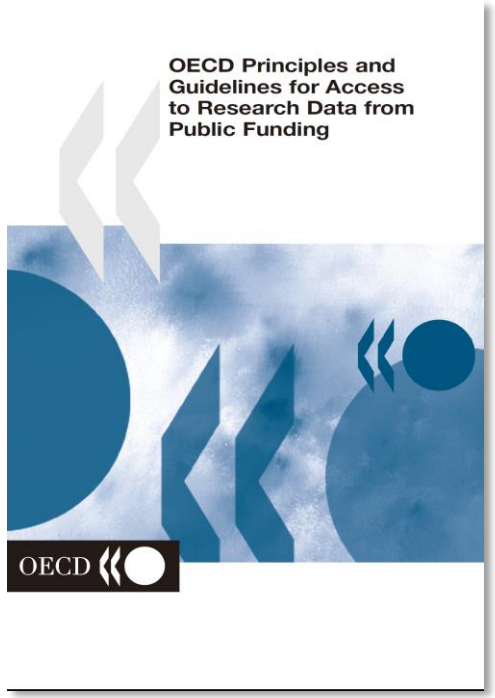
- **Multi-Messenger Universe**
- **Dark Universe**

needs an experiment-overarching platform!



Initiative for a (global) Analysis & Data Center in Astroparticle Physics

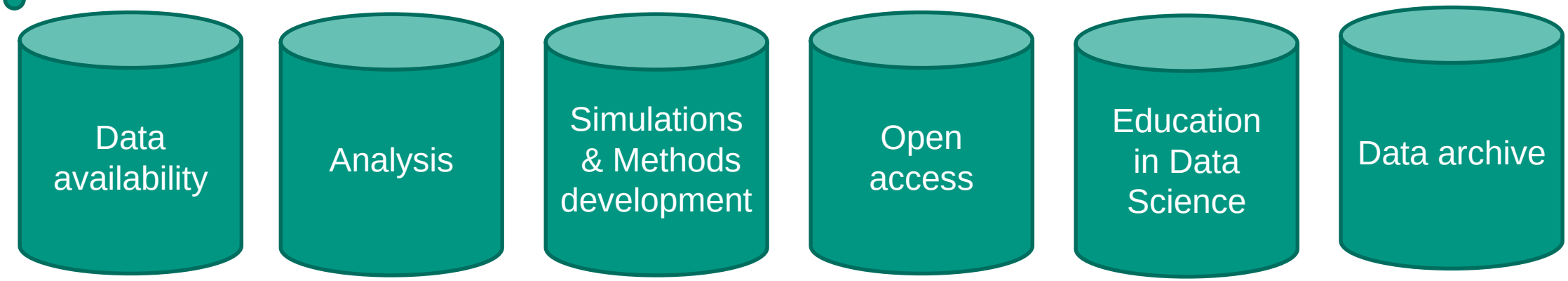
- Astroparticle Physics requests for multi-messenger analyses - this needs an **experiment-overarching** platform!



- **Tasks**
  - Provide sustainable access to scientific data
  - Archiving of Data and Meta-Data
  - Providing analysis tools
  - Education in Big Data Science
  - Development area for multi-messenger analyses (e.g. Deep Learning)
  - Platform for communication and exchange within Astroparticle Physics
- **Elements**
  - Advancement, generalization of existing structures (like KCDC and others)
  - In direction of a virtual Observatory (like in astronomy)
  - In direction of Tier-systems and DPHEP (like in particle physics)
  - „Digitale Agenda der Bundesregierung“
  - OECD Principles and Guidelines for Access to Research Data from Public Funding
  - Follow the FAIR principles of data handling

FINDABLE-ACCESSIBLE-INTEROPERABLE-REUSABLE

Analysis and Data Centre in Astroparticle Physics



- **Data availability:**

All researchers of the individual experiments or facilities require quick and easy access to the relevant data.

- **Analysis:**

Fast access to the generally distributed data from measurements and simulations is required. Corresponding computing capacities should also be available.

- **Simulations and methods development:**

The researchers need an environment for the production of relevant simulations and the development of new methods (machine learning).

- **Open access:**

More and more it is necessary to make the scientific data available not only to the internal research community, but also to the interested public: public data for public money!

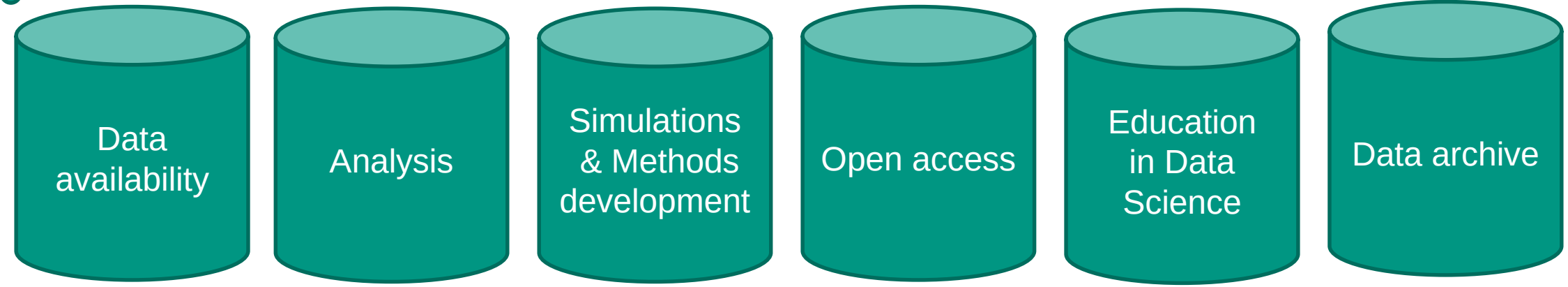
- **Education in data science:**

Not only data analysis itself, but also the efficient use of central data and computing infrastructures requires special training.

- **Data archive:**

The valuable scientific data and metadata must be preserved and remain interpretable for later use (data preservation).

Analysis and Data Centre in Astroparticle Physics



- **Data preservation** ----
  like DPHEP, KCDC
- **Metadata preservation** ----
  like KCDC
- **Data storage (archive)** ----
  like DPHEP, GridKa
- **Computing services (Grid vs. Cloud)** ---
  like CERN Tier-centres
- **Data access (policy, technology, rate)** ---
  like GridKa, KCDC
- **Training on Data use (maintenance, tutorials)** ---
  like KCDC, VISPA, CDS

- **Data analysis, Simulation, modeling** ---
  like GridKa, advanced VISPA?
- **Data science, workflows** (tools, e.g. deep learning, tutorials) ---
  like VISPA
- **Data publication / Outreach** ---
  like KCDC, masterclasses
- **Data education** ---
  like KCDC, GridKa-school
- **Data exchange** ---
  like AMON, GAVO
- **Data catalogues** ---
  like Re3Data
- **.....**

Partly realized in individual experiments

KASCADE Cosmic ray Data Centre

- **Motivation and Idea of KCDC:**
  - public access to the data
  - data has to be preserved for future generations
- **Web portal:**
  - modern software solution
  - release the software as Open Source
  - educational courses
- **Data access:**
  - new release (Feb. 2017) with $4.3 \cdot 10^8$ EAS
  - simulation data
  - spectra
- **Pioneering work in publishing research data in astroparticle physics**

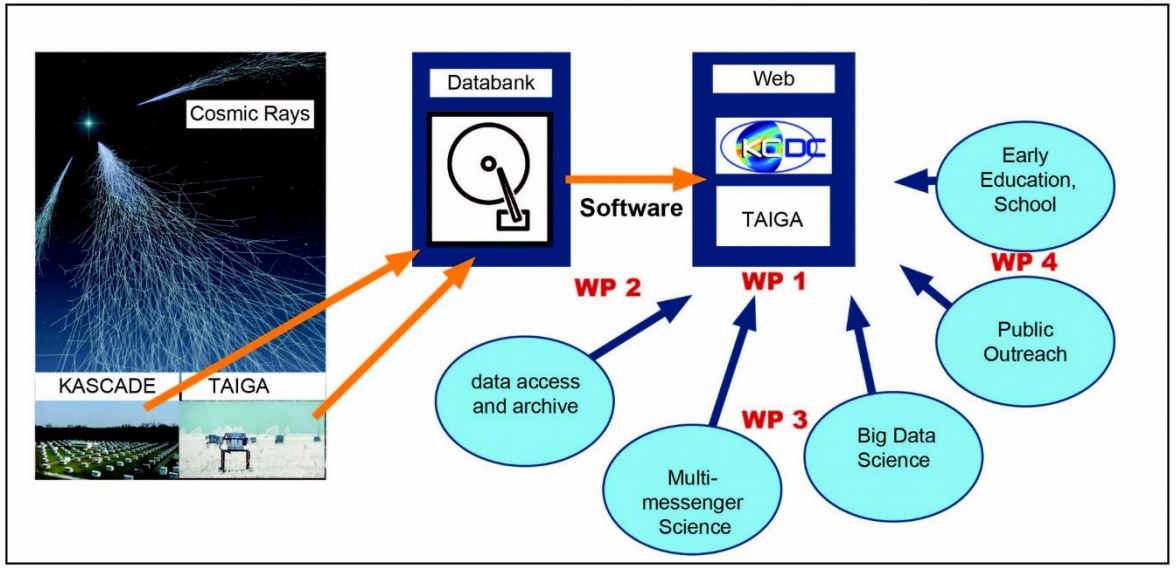
#KCDC_KIT

https://kcdc.ikp.kit.edu/

[J.Phys.Conf.Ser. 632 (2015) 012011]
[EPJ C (2018), in print]

Astroparticle Data Life Cycle Initiative

- **Basics**
  - project period 2018-2020
  - funded by Helmholtz and RSF
  - Team leaders: A. Kryukov (SINP MSU) and A. Haungs + A. Streit (KIT)



- **Main targets of the Project**
  - Extension example: data from Tunka/TAIGA and KASCADE-Grande
  - Developing solutions of distributed data storage techniques with a common meta-catalog
  - Development of appropriate machine-learning techniques
  - Perform experiment overarching multi-messenger astroparticle physics
  - Learn to use GridKa environment
  - Creation of an educational subsystem

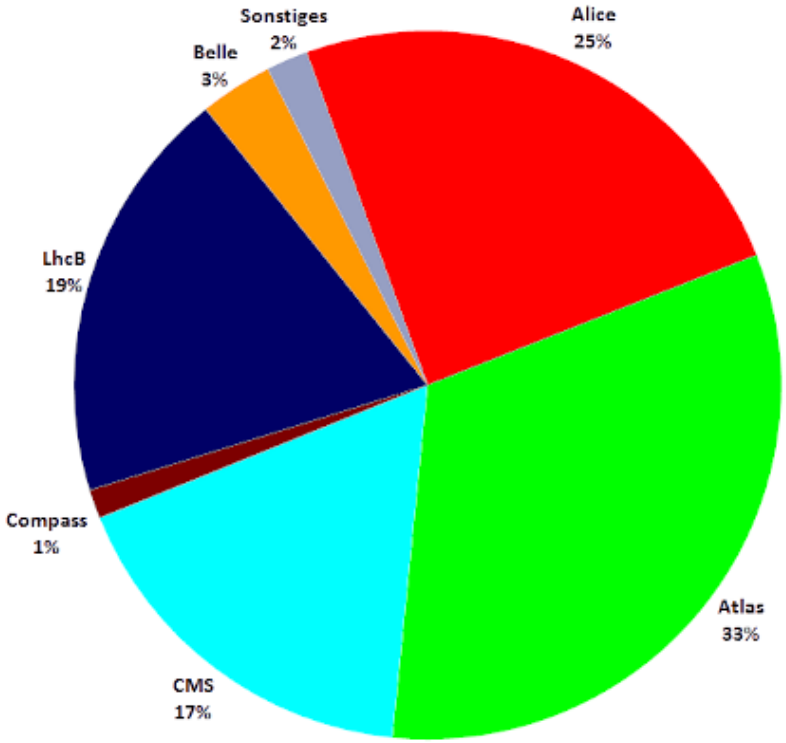
Project is a first step in extension and generalization of KCDC

http://astroparticle.online

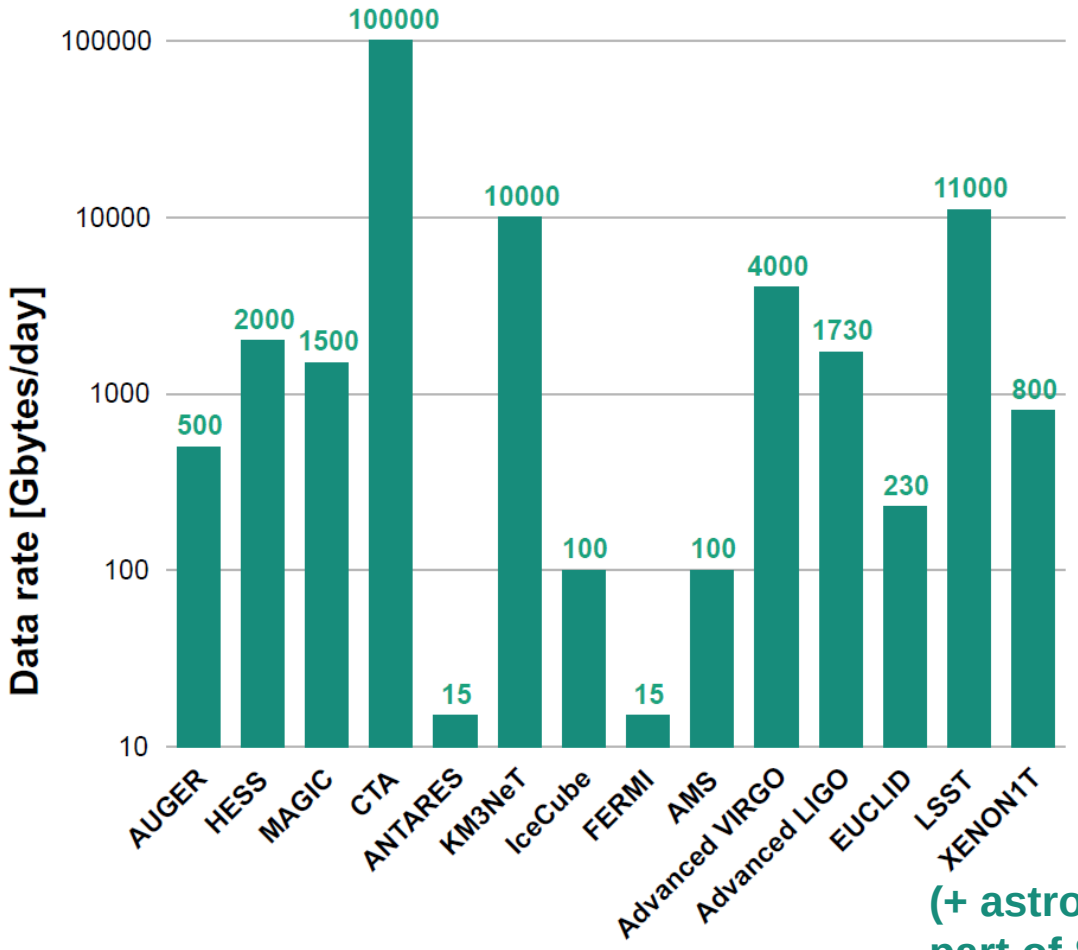
Particle Physics: GridKa (and other Tier-centres)

- Central German data and computing centre for particle (and astroparticle) physics
- Tier1-centre in the world wide LHC Computing Grid
- Provides essential part of the German contribution to the LHC-Computing
- Supports non-LHC-experiments with German participation (e.g. Belle-II, Compass and Auger).

Number of cores (405 kHS'06)	22,300
Number of compute jobs (2017)	23 million
Number of CPU-hours delivered (2017)	178 million
Disk space	23 PB
Tape space (used)	40 PB



Computing in Astroparticle Physics (Astro-Grid / Astro-Cloud)



(+ astroparticle part of SKA?)

Source: 2016 APPEC brochure on Computing: Towards a model for computing in European astroparticle physics

➔Do we need an own Astroparticle Physics computing infrastructure?

- independent of particle physics?
- Grid or Cloud or other technology?
- Use of commercial provider (amazon, google, …)?
- Is there a relation to the EOSC?

partly organized in the new facilities of astroparticle physics

CTA Science Data Management Centre

The Science Data Management Centre will coordinate science operations and make CTA's science products available to the worldwide community.

- **~20 personnel will manage CTA's science coordination including software maintenance and data processing for the Observatory.**
- **CTA will generate approximately 100 petabytes (PB) of data by the year 2030.**
- **The SDMC will be located in a new building complex at DESY in Zeuthen.**
- **Provides well-established infrastructure and a powerful computing centre.**

@ DESY in Zeuthen

Astronomy: Strasbourg astronomical Data Center

Combines many of the earlier mentioned issues:

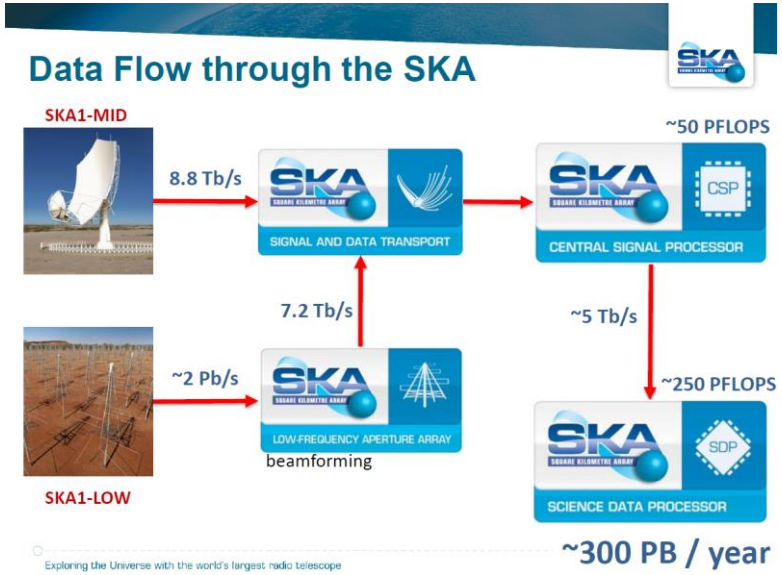
- **User Portal, Data bases, Tools, Catalogues…**
- **In Germany: GAVO in Heidelberg!**

➔ What is different in astroparticle physics?

- **Diversity of Data, calibration, format, analysis, …**

http://cds.u-strasbg.fr/

Data handling of SKA



Horizon 2020 cluster

Asterics
Astronomy ESFRI & Research Infrastructure Cluster

ESCAPE == European Science Cluster of Astronomy and Particle Physics ESFRI's

CTA	ESFRI	HL-LHC	ESFRI-Landmark
SKA	ESFRI-Landmark	FAIR	ESFRI-Landmark
KM3Net	ESFRI	EGO-Virgo	
EST	ESFRI	JIVE	ERIC
ESO/E-ELT	ESFRI-Landmark	(LSST)	"observer"

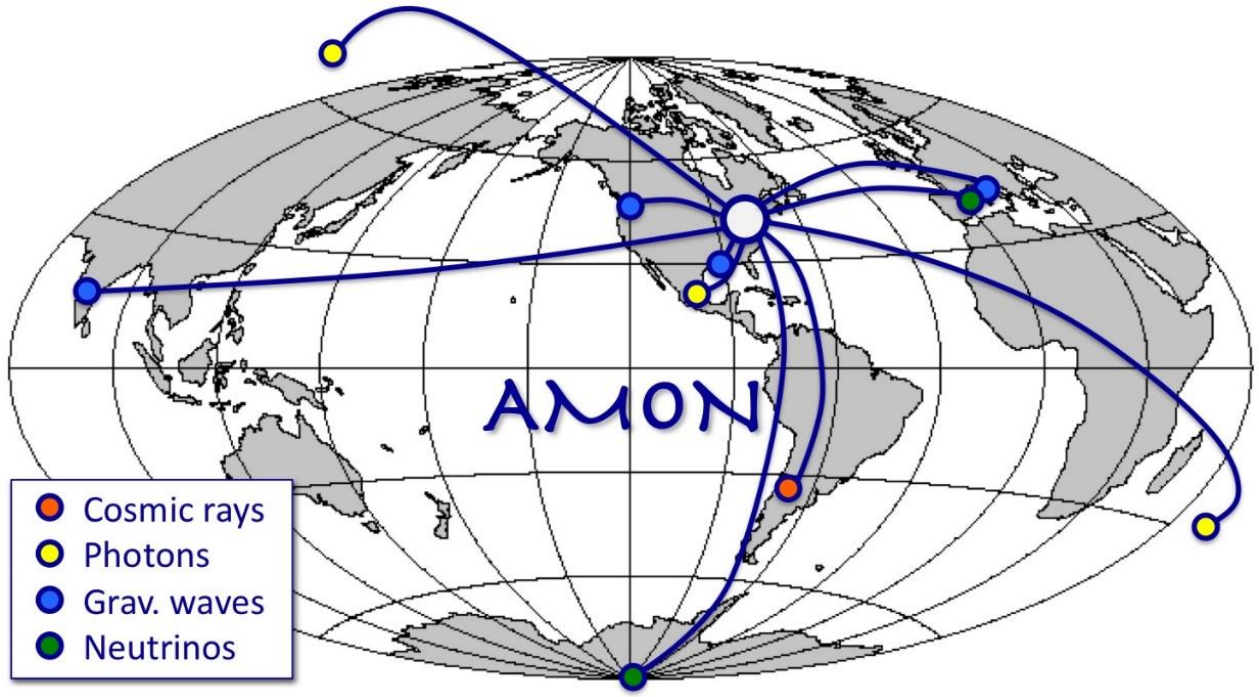
Exchange of Data / Alert systems

http://amon.gravity.psu.edu/

Members and Prospective Members

Observatory	Contact	Letter of Collaboration	MoU in Review	MoU Signed
ANTARES	Juergen Brunner	✓	✓	✓ MOU
Auger	Miguel Mostafa	✓	✓	✓ MOU
FACT	Adrian Biland			✓ MOU
Fermi	Julie McEnery	✓		
HAWC	Ignacio Taboada	✓	✓	✓ MOU
IceCube	Doug Cowen	✓	✓	✓ MOU
Las Cumbres Observatory Global Telescope (LCOGT)	Todd Boroson	✓	✓	✓ MOU
LIGO	Gabriela Gonzalez	✓		
Large Millimeter Telescope	Alberto Carramiñana	✓	✓	✓
MASTER	Vladimir Lipunov			✓ MOU
Palomar Transient Factory	Tom Prince	✓		
Swift	Scott Barthelmy	✓	✓	✓
VERITAS	Abe Falcone	✓	✓	✓

Membership to AMON is open to any relevant facility, subject to signing of the AMON MOU.



Method Development & Outreach

- **VISPA to analyze (Auger) data**
  - Learning Deep Learning ☺
  - Algorithms & data analysis in own browser
  - Example analysis
  - Writing own algorithms
  - Visualizing own results
- **Dedicated lectures at Universities**
  - Deep learning in Physics Research
  - Big Data Science
- **Masterclasses**
  - Netzwerk Teilchenwelt
  - (Auger & IceCube)
- **Cosmic Days**
- **(GridKa school)**
- **....**

VISPA Internetplattform VISPA

https://vispa.physik.rwth-aachen.de/

Data Catalogues

- **Sample and links to repositories of scientific data, mostly results, not the “data”.**

e.g., search for “Cosmic Rays”:

Found 7 result(s):

1. World Data Center for Cosmic Rays WDCCR
2. KASCADE Cosmic Ray Data Centre KCDC
3. Spitzer Science Archive SHA
4. World Data Center for Solar-Terrestrial Physics, Moscow
5. Virtual Space Science Observatory VSSO
6. LAADS Web
7. High Energy Astrophysics Science Archive Research Center

http://www.re3data.org/

Support by the BMBF (I):

Innovative Digitale Technologien für die Erforschung von Universum und Materie

Verbundforschung KAT-KET-KHuK (Pilotprojekt ErUM-Data)

Proposal (11 Universities + 6 associated partners; coordinator T. Kuhr of LMU)

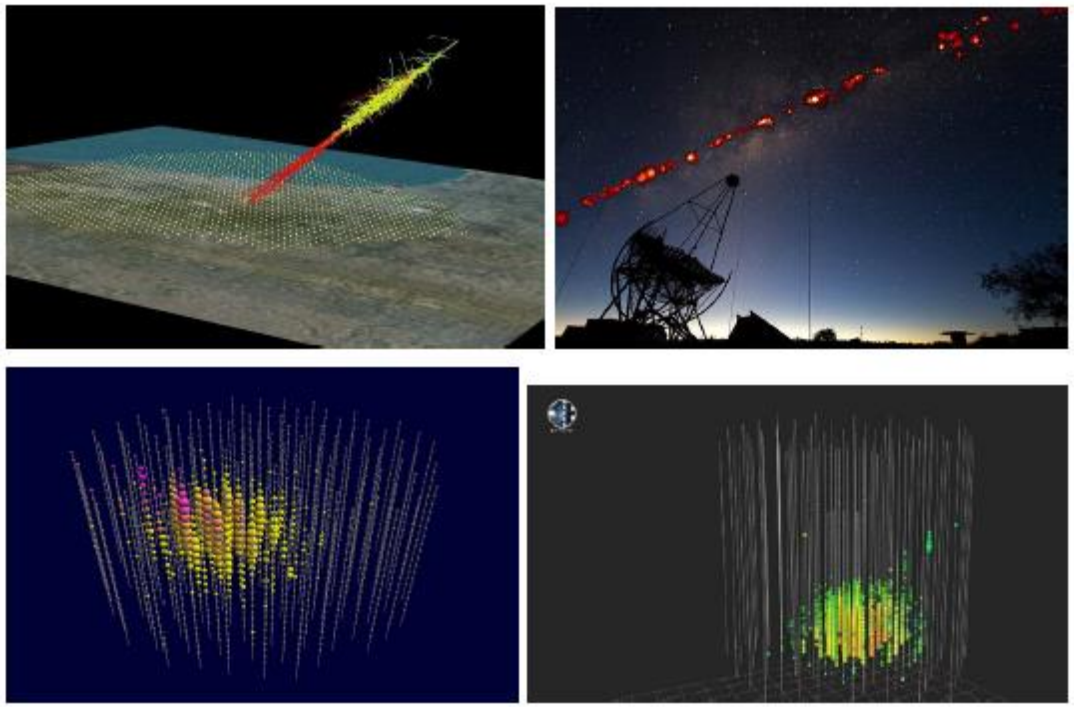
- **Topic A: Development work for the provision of technologies to leverage heterogeneous computing resources**
- **Topic B: Application and testing of virtualized software components in the environment of heterogeneous computing resources**
- **Topic C: Deep learning, gaining knowledge through well-founded data-driven methods**
- **Topic D: Event reconstruction: cost and energy efficient use of computing resources**

Approved for period 10/2018-9/2021

one plan of action:
ErUM-Data: Contributions to the digital agenda

Support by the BMBF (II):

BMBF call:
Funding measure: Digital change in education, science and research
Funding area: Kuration criteria and data quality standards



Proposal submitted (5 Institutes; coordinator A. Haungs, KIT)

FAIR Research Data from High Energy Astroparticles Physics

- **Preparation of efficient multi-messenger analyses**
- **Preparation for public access to coherent particle shower data**

➔ **Develop concept regarding data and metadata format and quality,**

➔ **Develop concept regarding the curation of combination of the data**

➔ **Including Data and Simulations**

➔ **Develop a demonstrator to validate the concept**

This also ensures that the data are prepared for free access as basis for a targeted 'Multi-Messenger Open Science' culture in astroparticle physics.

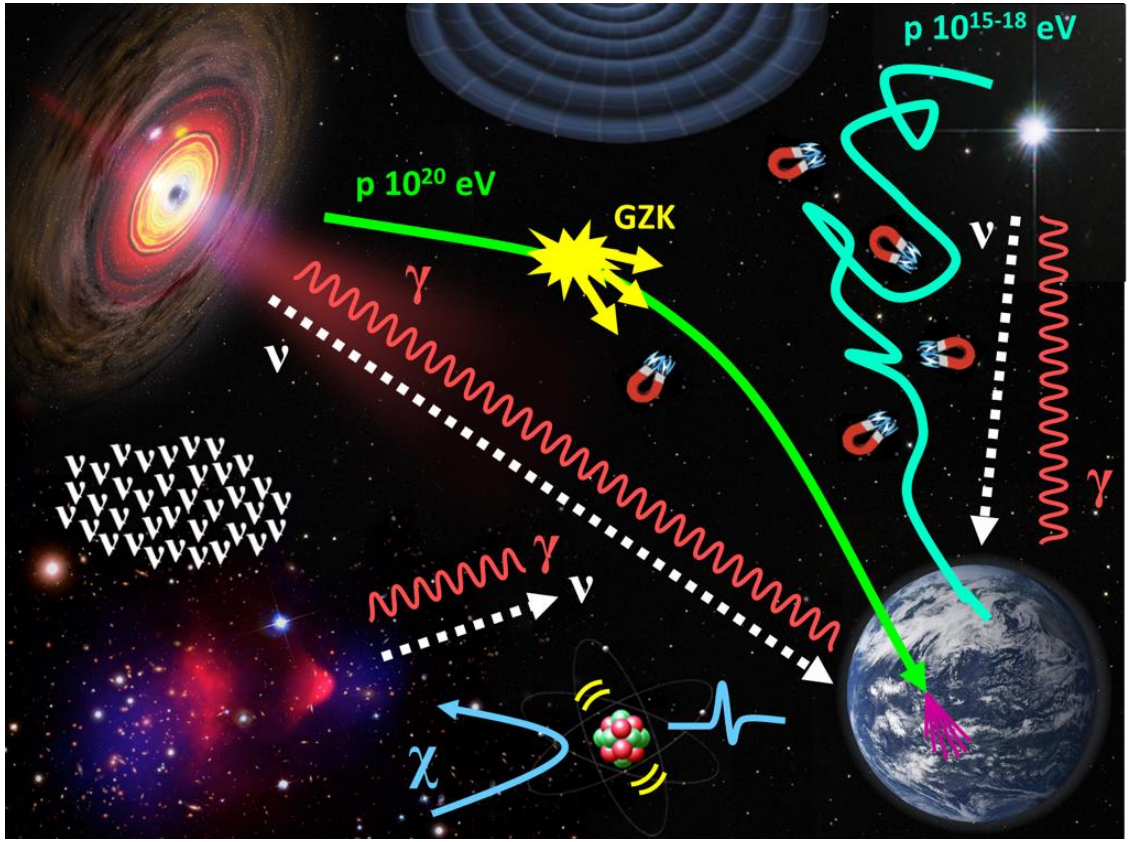
for period 1/2019-12/2021

Support by Helmholtz:

Analysis- and Data Center for Multi-messenger AstroParticle Physics

ADC-MAPP

Andreas Haungs, KIT IKP
Ralph Engel, KIT IKP
Gernot Maier and Marek Kowalski, DESY
Achim Streit and Andreas Heiss, KIT GridKa
Christian Stegmann, DESY



- Demonstrator of the data and analysis centre with all functionalities and scientific validation by specific multi-messenger analyses

- Further development of existing structures (KCDC, GridKa, DESY-Tier1, CTA Data center)
  - Synergy of the data management
  - Integration of university groups
  - Involvement in national (NDFI) and international (EOSC) initiatives

PIERRE AUGER OBSERVATORY

IceCube

cta cherenkov telescope array

Organisational: DPG-AKPIK, Arbeitskreis Physik, moderne Informationstechnologie und Künstliche Intelligenz

Broad representation of interests for the relevant topics in physics

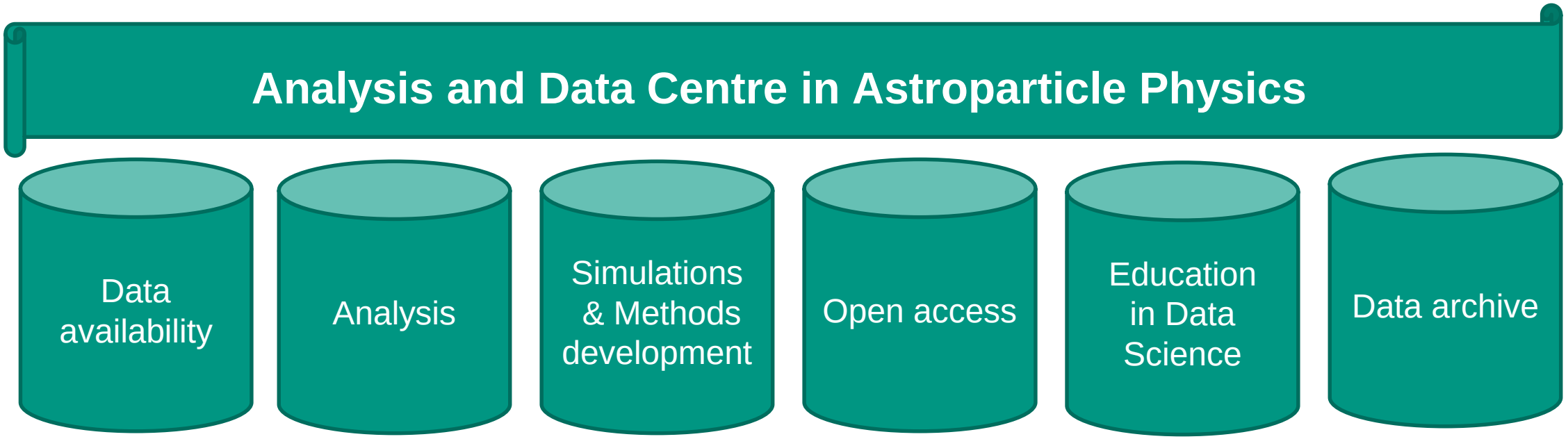
www.dpg-physik.de/dpg/gliederung/ak/akpik/index.html

Ask Karl Mannheim, Martin Erdmann, Wolfgang Rhode

Topics:

1. **BIG DATA:** archiving, processing, management, analysis and simulation of complex data streams, HPC, information theory, statistical methods
2. **IT:** high-performance data readout systems and mass storage, visualization, smart sensors, bridge technologies for the next level of big data
3. **KI & ROBOTIK:** Data Driven Algorithms & Software, Autonomous Devices, Remote Control, Innovative Applications, Algorithms for Quantum Computers
4. **UNIVERSITY:** curricula and multi-disciplinary research centres, cooperation with the GI Task Force "Data Scientist", IT infrastructure
5. **INDUSTRY and SOCIETY:** Ethics, Technology Assessment, Sustainability, Business, Law, Start-Ups, Public

Initiative for a (global) Analysis & Data Centre in Astroparticle Physics

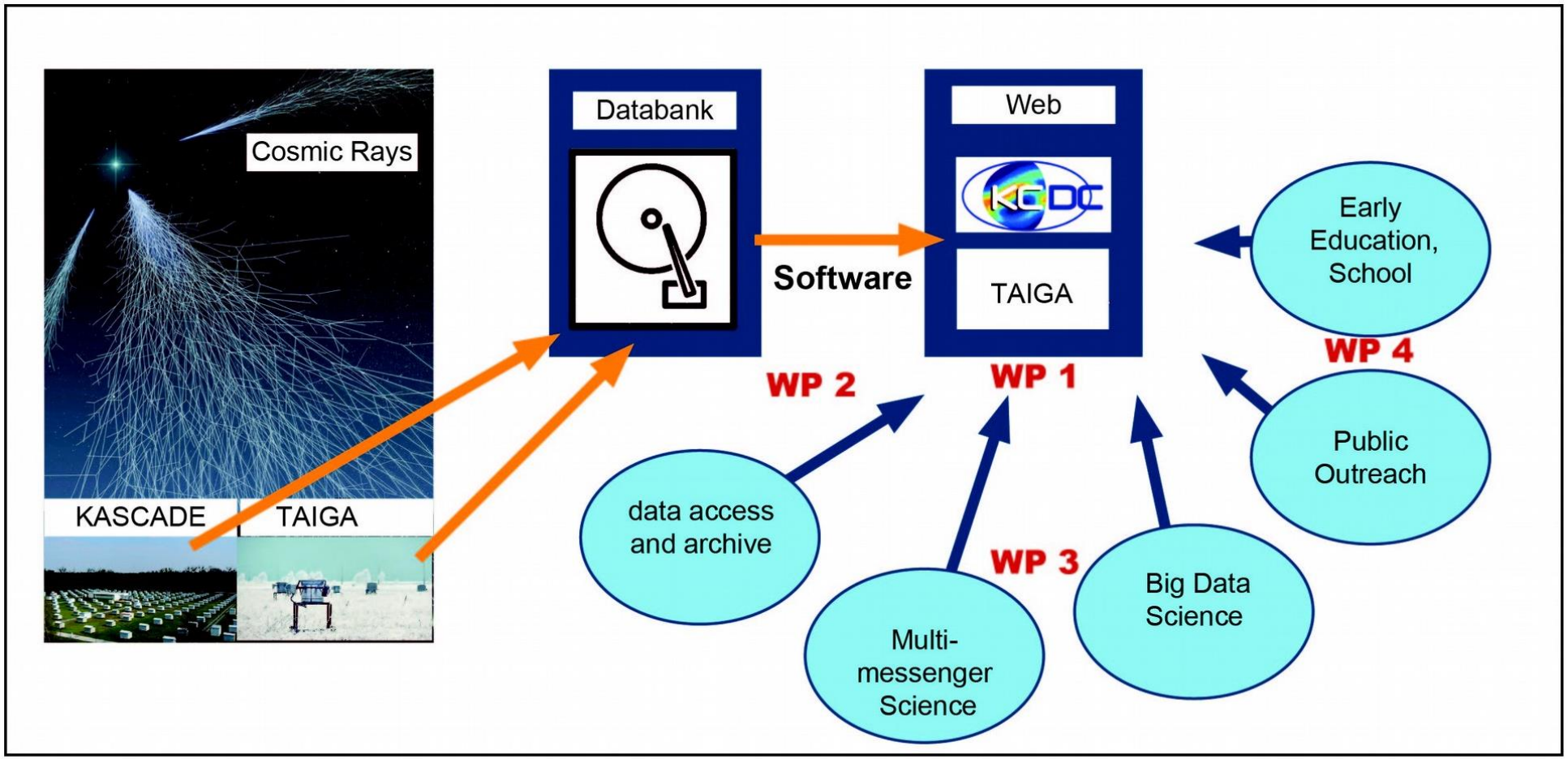


Next steps:

- **Helmholtz & MPG & Universities define the specific needs.**
- **Secure funding & 'organize' hardware**
- **Implementation and: Start ☺**

KRAD: work packages

1. WP1: KCDC extension
2. WP2: Big Data Science Software
3. WP3: Multi-Messenger Data Analysis
4. WP4: Go for the public



KRAD: work packages

1. WP1: KCDC extension

We will extend KCDC by scientific data from the TAIGA (Tunka) experiment. Further goal is to improve KCDC and make it more attractive to a broader user community.

2. WP2: Big Data Science Software

We will develop specific analysis methods and corresponding simulations in the new environment which needs a move to most modern computing, storage and data access concepts (“Data Life Cycle Lab”).

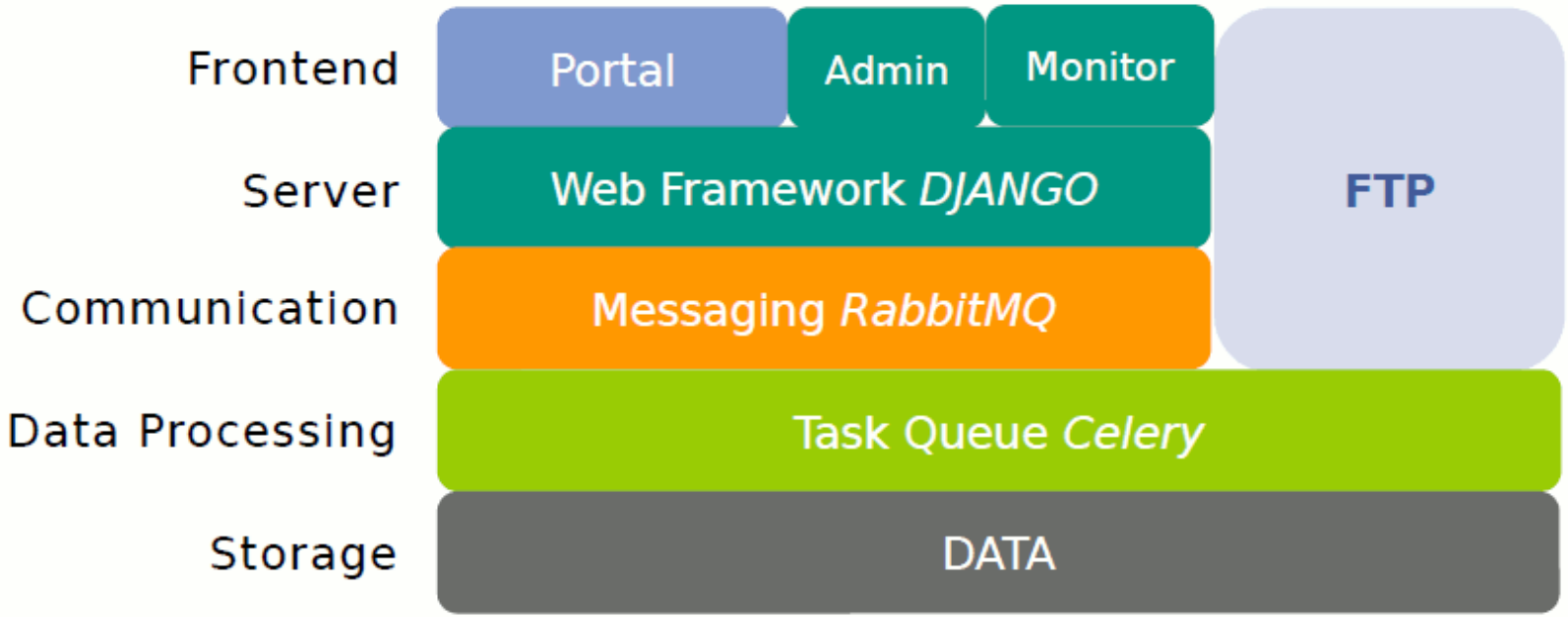
3. WP3: Multi-Messenger Data Analysis

We will perform specific analyses using the new data centre to test the concept. This will give confidence to the facility as a valuable scientific tool.

4. WP4: Go for the public

A comprehensive outreach is part of the project for all level of users - from pupils to the directly involved scientists to theoreticians.

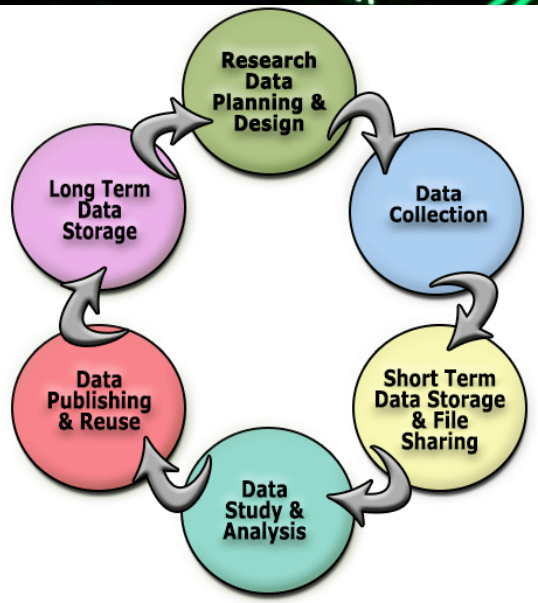
WP1: KCDC extension



- Software extension of KCDC to allow for a new databank and data shop (KIT-IKP, KIT-SCC, ISDCT)
- Preparing and providing the TAIGA data for inclusion into KCDC (ISU, MSU)
- Putting the new data into KCDC (KIT-IKP)

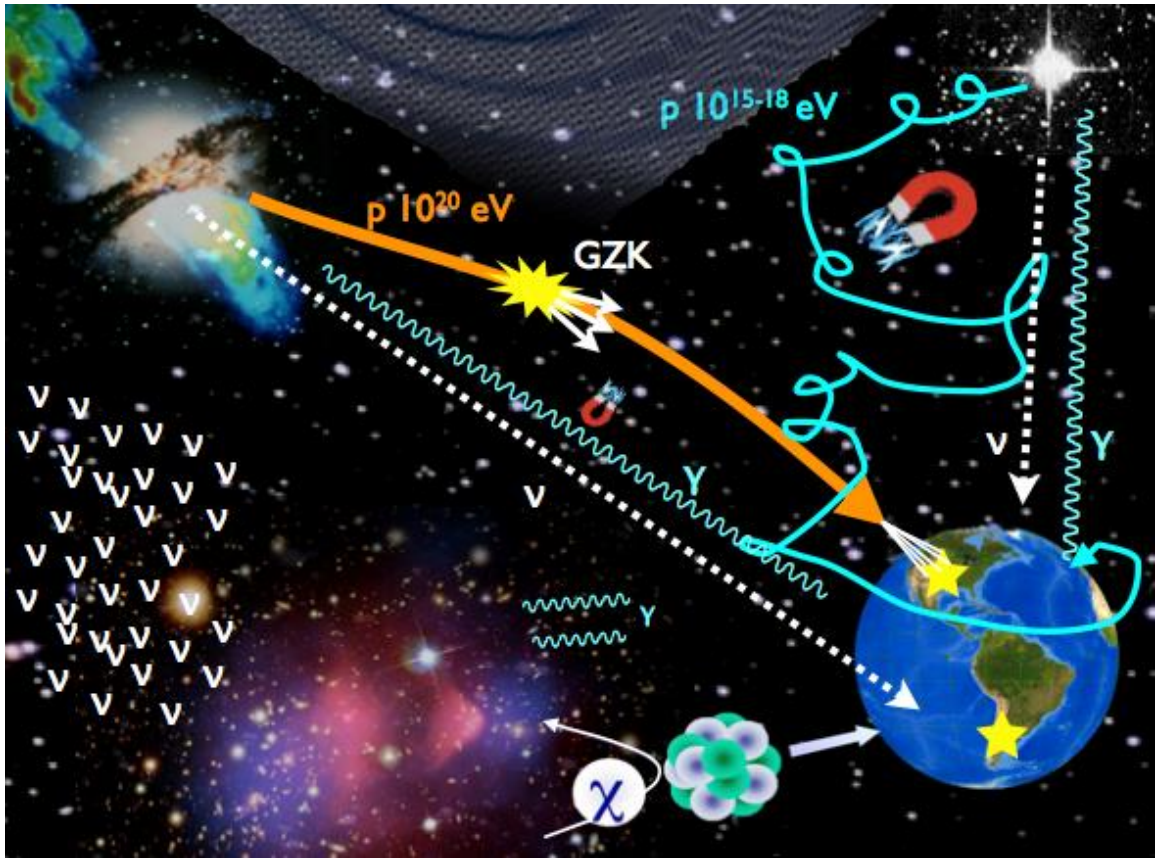
WP2: Big Data Science Software

- Movement of KCDC to large-scale computing facility and adapting the new environment (KIT-SCC, KIT-IKP, MSU-SINP)
- Optimizing data bank and access interfaces (MSU-SINP, ISDCT, KIT-SCC)
- A distributed system of storage and archiving the data is developed (MSU-SINP, KIT-SCC)
- Installation of appropriate hardware (KIT-SCC)
- Installing the Data Life Cycle Lab" (KIT-SCC)



WP3: Multi-Messenger Analysis

- Defining appropriate physics questions, where the data centre is used (KIT-IKP, MSU-SINP, ISU)
- Cross-checks of the reliability of all the specific user functions (KIT-IKP, MSU-SINP, ISU)
- Performing the combined TAIGA – KASCADE data analysis (KIT-IKP, ISU)
- Performing the multi-messenger data analysis (ISU, MSU-SINP)



- Examples:
  - Gamma-ray search
  - Hadronic interaction models
  - Radio cross-calibration

This Meeting:

- Status of present and near future activities
- Alignement of activities
- Organisationals
- Next steps