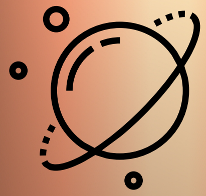
DZA science strategy

Answer 1:

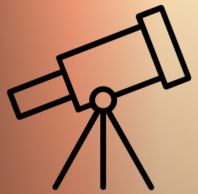
DZA science strategy



Astronomy

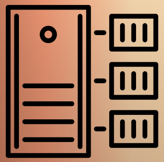
Radio:
SKA

GW:
ET



Technology

- Receivers
- Optical & IR Sensors
- Si mirror technology



Computing

- Processing large data volumes
- Innovative AI
- Smart archive

DZA science strategy

Answer 2:

The DZA science strategy will be developed during the project phase 23-25

- **interation with communities (RdS & KAT)**
- **international developments (Astronet & APPEC)**
- **promising science themes**
- **interlocking astronomy, instrumentation, data science**
- **unique opportunities (key point in setting up new national centre)**
- **returns to Saxony (industry, society)**
- **synergetic**

DZA science strategy

Both ‘answers’ are correct:

DZA has been proposed to facilitate Germany’s engagement in projects that could hardly be realized otherwise. Key examples are SKA and ET.
We were chosen – now we will deliver.
This will be a major effort in the next 20 years - we need to get started now.

...but DZA will be much more than SKA + ET

This ‘much more’ is not yet defined. This will be a continuous process.
During the ‘project phase’ options will be studied. Decisions will be >2026.

Key Project SKA

SKA will build and operate two arrays in the southern hemisphere:
SKA-low in Australia, SKA-mid in SA
Start of construction: now
Germany will become a partner soon

So far a 1.6% share secured via MPG
Germany added 30% to science case

DZA is committed to increase the role of the German community in SKA .
Too late for HW contributions, but just in time for contributions in SW

Key Project ET

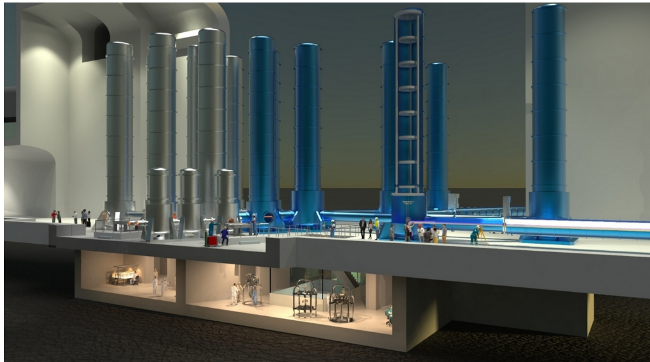
German contributions to development of GW astrophysics (Geo 600).
Next generation GW interferometry project in Europe: ET

Germany is not a formal partner in ESFRI - ET project

DZA is committed to assure Germany’s participation in ET
and in enabling ET (specifications & costs).

ET is in its early phases (design, site, costs, partnerships all tbd)
→ broader opportunities for optimized German contributions.

DZA aims for technology contributions →
Low Seismic Lab



Key Projects Technology

Receivers, Backends
Telescopes, Green Power
Correlators, Radio cameras
} Radio Astronomy needs

Gravitational Wave Astronomy needs {
Silicon mirrors
Cryogenic coatings
Suspensions

(curved) CMOS- and IR- sensors
Telescopes
FPGAs
Robotics

Key Projects Data Science

Prompt triggers of high-volume data trains
Imaging with Pb data sets
Radio Cameras (Interferometry with 1000s of antennas)
→ Engaging in SKA Computing → Exploring DSRC → Really big data
(MeerKAT+, SKA, DSA2000 are interferometers, as are GW instruments)
AI developments
Methods (multi-dimensional statistics, IFT, end-to-end simulations, …)
FAIR data centers and catalogs (MeerKAT, SKA, LSSR, …, LISA)

Robotics, predictive maintenance, digital twins, …)
Smart sensors, FPGAs,
Green IT

Quantum computing

Key Project Astrophysics Synergies

This is closely connected to this workshop: MM & MWL astrophysics

Radio studies → Neutron stars (and Black Holes)
Populations, Glitches → NS EOS → GW signals
FRB, Magnetars → B Field (topologies) → EM signatures of mergers
Pulsars in Binaries: Mass functions, dynamical evolution, mergers
Binary systems: steady GW sources, GW propagation, lensing, tests of GR
Pulsars as GW interferometers → Pulsar Timing Array
Extending GW spectrum: PTA – LISA – ET

Vice versa: GW studies → NS EOS, mass spectrum, binarity, evolution
Radio-silent NS, magnetars ↔ X-ray/ γ-ray pulsars → GRBs → instruments

Embedding Radio Astrophysics

DZA contributions to MeerKAT+ (MPG), German entry ticket to SKA
+ additional antenna in Botswana → AVN (DZA/MPG/BIUST)
Largely Interferometry → compact sources (NS&Blazars are truly M-M/WL)

Time-domain surveys → Optimum survey strategy
All sky monitoring → nonthermal transients
→ DSA 2000 participation (Caltech/DZA)

Radio-Astronomy → Gravitational waves (S. Nissanke, M. Kramer)
→ Cosmic Rays (A. Nelles, F. Schröder), Neutrinos (Y. Kovalev)
→ γ Rays (all γ ray transients are radio sources;
time-domain interferometry)

Embedding Radio Astrophysics

14 new antennas, of ‘SKA-mid design’ (each more sensitive than MeerKAT)
Maximum baselines up to 17 km (twice as much as MeerKAT)
Populated with L- and S-band receivers (not UHF)
- SKA Band-2 receivers (0.95–1.76 GHz, close to MeerKAT L)
- MPIfR S-band receivers (1.75–3.5 GHz)

Backend to process all 80 antennas simultaneously using an independent GPU-based correlator
Initial wideband correlator mode: 8k channels
Current SKARAB-based (any) 64-antenna correlator with USE will remain fully functional and available while 80-dish correlator is being developed and installed

Embedding Radio Astrophysics

2 MK+ antennas will be bought by MPG on behalf of DZA
One of these will be implemented together with the MK+ array to join SKA.
The second antenna will be installed about 1000 km away from SKA (in Palapye, Botswana) forming the first leg of a future African VLBI Network.

DZA plans to contribute to SKA, which will significantly increase the overall value of the German investment
DZA plans to form a German SKA Regional data Center (DSRC)
This might act as a condensation hub for a European SRC and the international SRC network (but SRC network structure is in rapid evolution).

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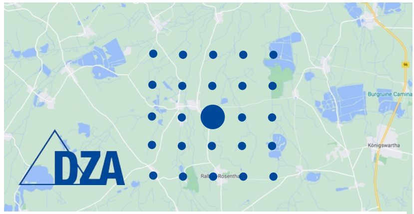
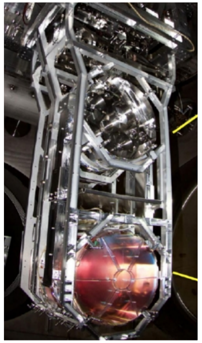
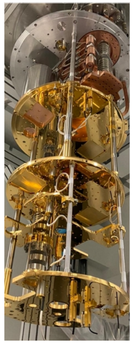
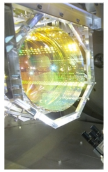
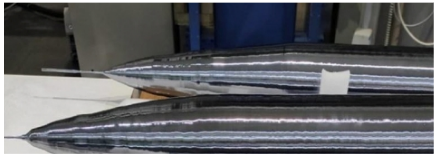
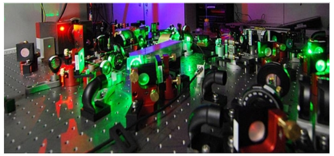
Embedding ET preparations

Low seismic lab (standalone technology centre for GWA instrumentation and a potential station for an ET interferometer in Saxony)
Underground (200m) well embedded (Lausitzer Granit) lab
along with a 3D-Seismometer-Sensor-Array (square-km array)
Validating new concepts for seismic isolation



Development of technology for gravitational wave astronomy
Adaptive seismic noise suppression
Subnanometer-microscopy and photolithography

Embedding ET preparations

Technology evolution: Advancing beyond LVO
Sensing and compensating gravitational noise
Adaptive optics/compensation towards “Seismic zero“

Michèle Heurs

Technology: silicon chips → microstructures
Seismic noise → quantum computing

LSL shall also host a ‘next generation Felsenkeller’
→ Nuclear Astrophysics → eg. NS EOS

Daniel Bemmerer

Community engagement

Time domain science has enormous potential
(but is very demanding: all-sky, all-times, all-wavelengths, all messengers)
but is largely on ’compact objects‘

Surveys detect very much more
→ opportunities in many fields of astrophysics

→ DZA will be brain-limited
→ opportunities for the entire German community

Visitor program (weeks to months, focused)
TBD: expectations (talk to us), mechanism

Broad-band is a necessity

Initially very much focused on radio waves and gravity waves
Much more additional information useful / necessary.
Rubin would have been an opportunity for DZA
(at least in TDA we might engage (under study))

→ much broader approach (optical, 4 π, all times)
→ new optics, cameras, telescopes

e.g. Mass spectrum of compact objects → astrometric/photometric lensing
→ IR Gaia → Sensor development
Multiplicity: Spectroscopic instrumentation → Matthias Steinmetz

Astrophysics is broad (exoplanets, cosmology, …) → Denkschrift process

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Particle - Astrophysics is broad (CR, γ, ν …) → strategy process

DZA is a big step but not unlimited

Particle-Astrophysics: Very strong focus on ET

Astrophysics is a somewhat broader but not competing with ESO, ESA, ...