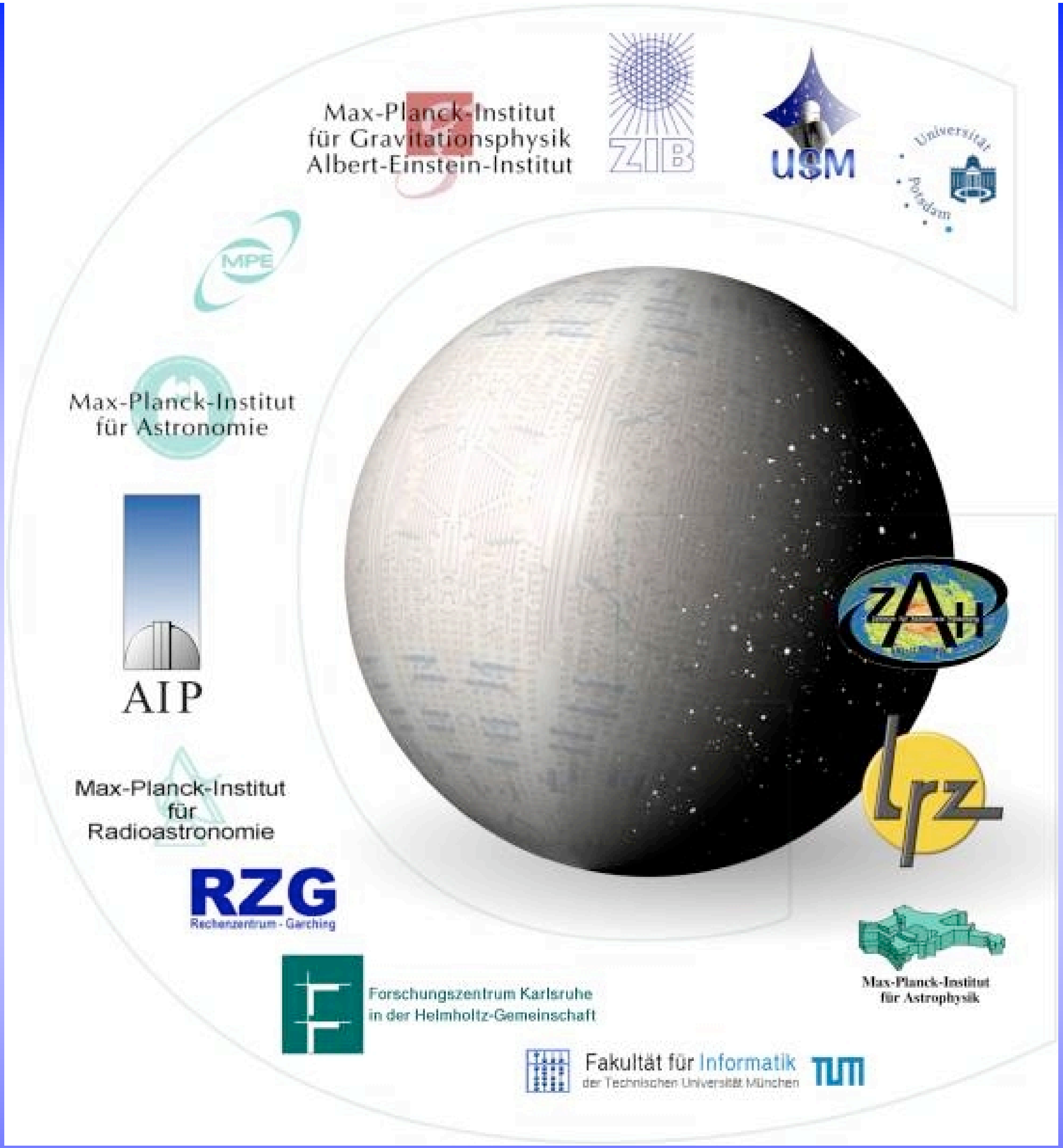


Harry Enke (AIP)

20.10.2005

German AstroGrid

German AstroGrid (GACG)

- Context
- Purpose
- Goals

E-Science call for proposals

BMBF Referat Internet

- Integration of all German GRID-efforts into the D-Grid
- Establishing community grids and integrating middleware platforms
- Communities as driver of technology development
- Making GRID-technology available to other scientific communities not yet involved
- Developping Germany into a more visible contributor within the GRID-world

AstroGrid-D Consortium

Consortium	Associated Partners	
AIP (Leader)	UP	Potsdam/Berlin
AEI		
ZIB		
	MPIA	Heidelberg
ZAH	MPIfR	
MPA	LRZ	Garching
MPE	RZG	
TUM	USM	
	FZK	

AstroGrid-D Work packages

- Integration of compute and data ressources
- Managing and providing meta data
- Distributed management of data
- Distributed query of data bases and management of data streams
- Supervision and interactive management of grid jobs
- User and application programmer interfaces

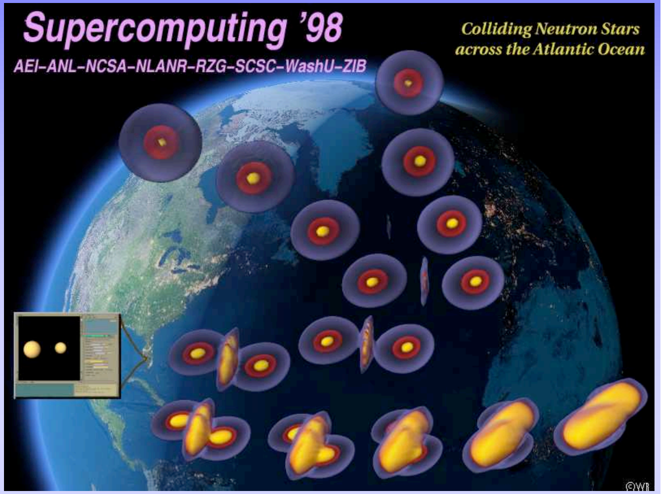
Clustercomputing in AstroGrid-D

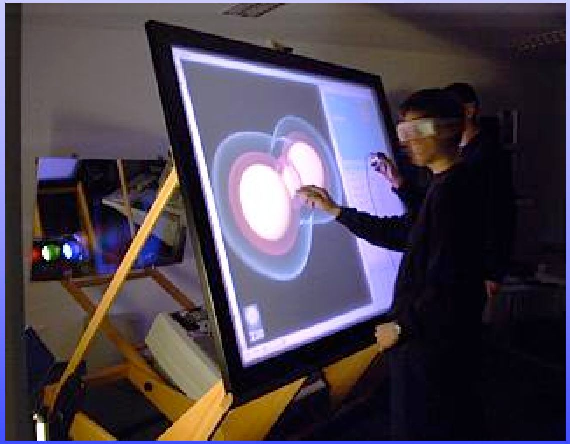
- Grid-Clustercomputing
    - History
    - Problems
    - Plans

About Cactus

- Cactus and its ancestor codes have been using Grid infrastructure since 1993
- Support for Grid computing was part of the design requirements for Cactus 4.0 (experiences with Cactus 3)
- Cactus compiles “out-of-the-box” with Globus

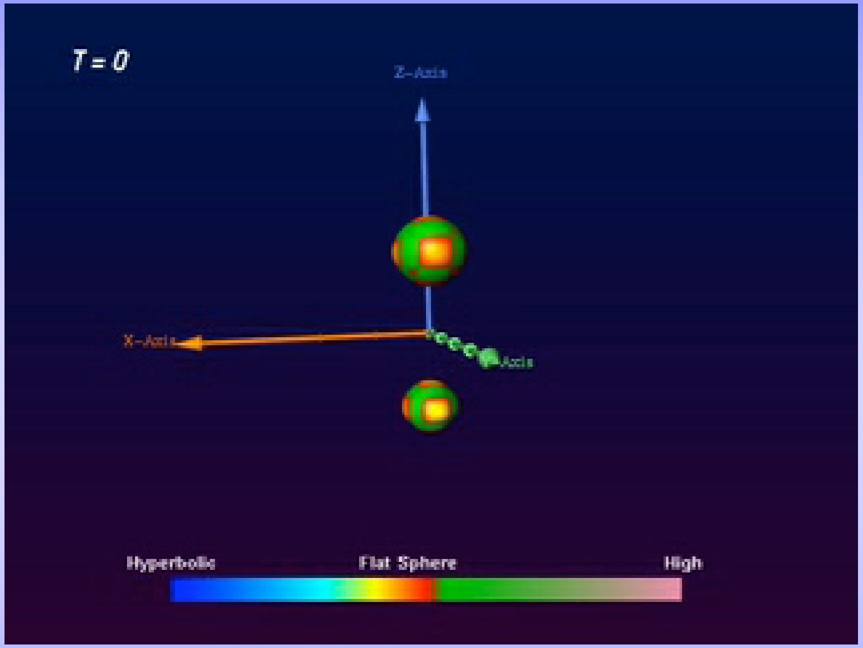
  [using globus device of MPICH-G(2)]





- Design of Cactus means that applications are unaware of the underlying machine/s that the simulation is running on … applications become trivially Grid-enabled
- Infrastructure thorns (I/O, driver layers) can be enhanced to make most effective use of the underlying Grid architecture

AstroGrid-D: Example



Numerical relativity: AEI

grazing collision of two black holes

History

- SC93
  - remote CM-5 simulation with live visualisation in CAVE
- SC95
  - Heroic I-Way experiments leads to development of Globus. Cornell SP-2, Power Challenge, with live visualisation in San Diego CAVE
- SC97
  - Garching 512 node T3E, launched, controlled, visualized in San Jose
- SC98
  - HPC Challenge. SDSC, ZIB, and Garching T3E compute collision of 2 Neutron Stars, controlled from Orlando
- SC99
  - Colliding Black Holes using Garching, ZIB T3E's, with remote collaborative interaction and visualisation at ANL and NCSA booths
- 2000
  - Single simulation LANL, NCSA, NERSC, SDSC, ZIB, Garching, …

  - **More in recent years**

Problems

- MPI applications mostly assume uniform performance of all nodes
- MPICH-G2 requires visibility (i.e. public network-adresses) of all nodes
- Nonuniform bandwidth with internet connects (i.e no SLA for bandwidth allocation)
- GRID Job manager and Job scheduler still not working with QoS sufficently
- GRID Management of distributed data products is still difficult

Plans

- Measuring current MPI-applications
  - Distribution between CPU-time and network-communication time
  - Impact of non-uniform processor-speed
  - Scaling problems

These are indicators for the GRID-fitness of the code.

The AstroGrid-Testbed, and the D-Grid-Testbed will serve to improve our knowledge.

Plans

- Tackling the visibility problem
  - Some MPI implementations were built to get around the problem of Node-to-Node communication by centralizing this to a special process, which in turn communicates with a remote process on a different cluster (e.g. PACX)
  - Using L3-Switches to get network-address-translation for the private address ranges on demand
  - Software-solutions (VPN)

Plans

- Building up network-infrastructure with guaranteed bandwidth:

Europe:

- GEANT

Country:

- DFN plans dedicated network-connections for GRID-apps

Region:

- X-Win and BRAIN

AIP Cluster Sanssouci

- 256+14CPUs AMD Opteron™ (64bit)
- 0.61 TByte main memory
- 15 TByte disk space (nodes)
- 16 TByte RAIDs
- 1 Gbit Ethernet interfaces

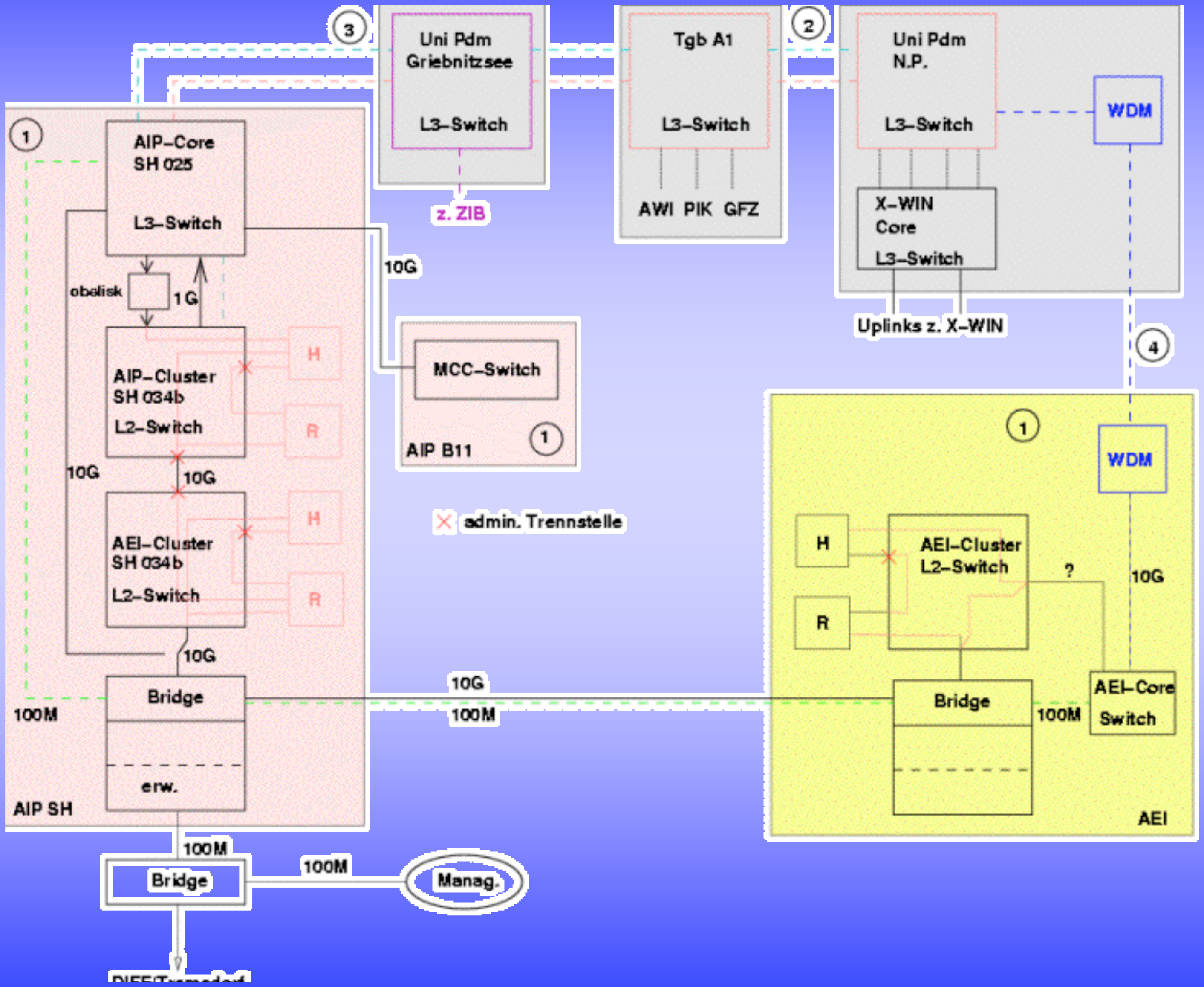
Planned enhancements 2005:
- 24 TByte disk space
- 4x8CPU Opteron with
32GB memory each

AEI Cluster Peyote

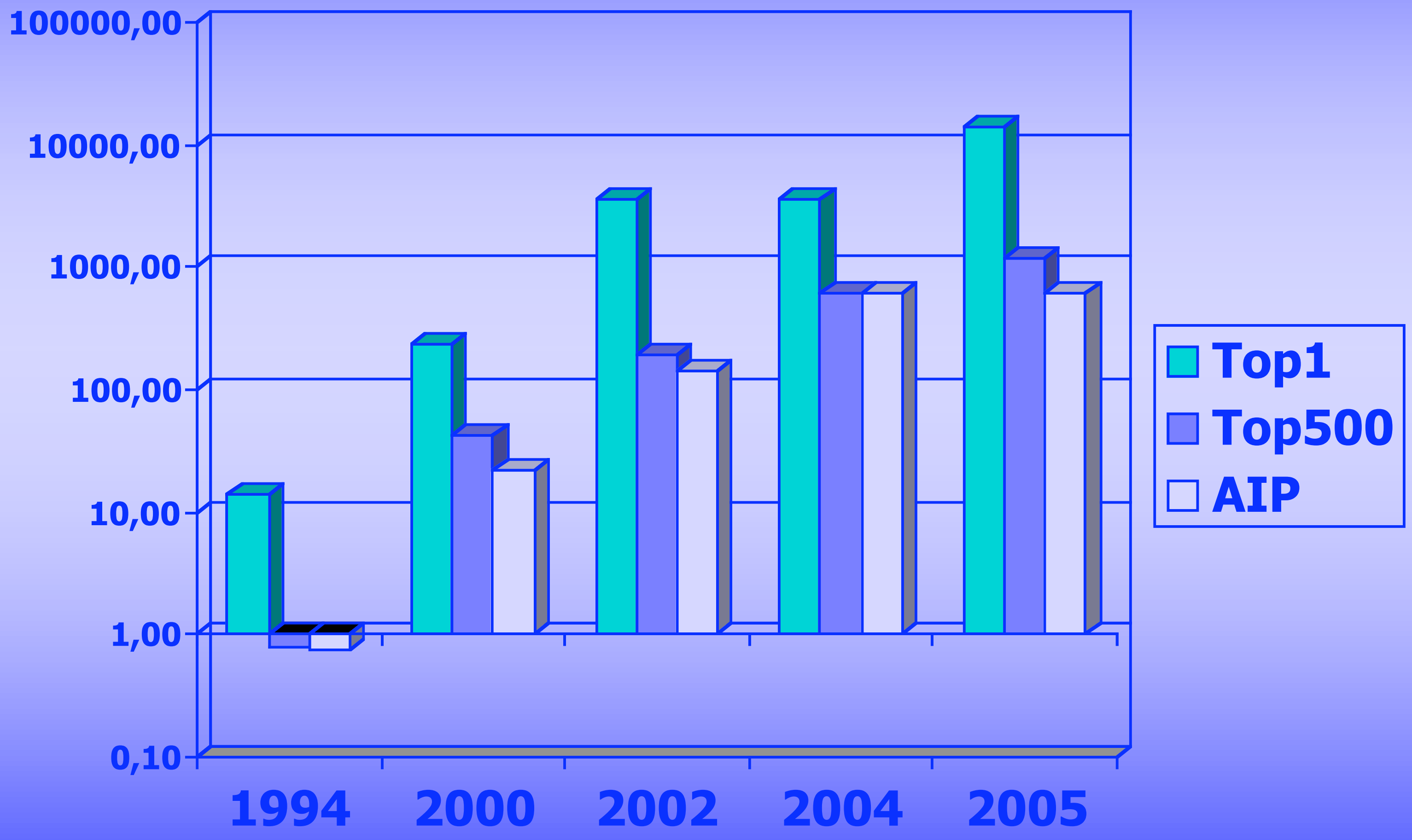
- 272 CPUs
  Intel Xeon (32bit)
  64 at 3.01MHz
- 0.55 TByte
  main memory
- 9 TByte disk space on nodes
- 12 TByte RAIDs
- 1Gbit-Ethernet interfaces
- 8 Infiniband-Nodes (Lagavulin)

- 128 CPU (64bit)
- 10 TByte RAIDs

Potsdam network



Potsdam cluster



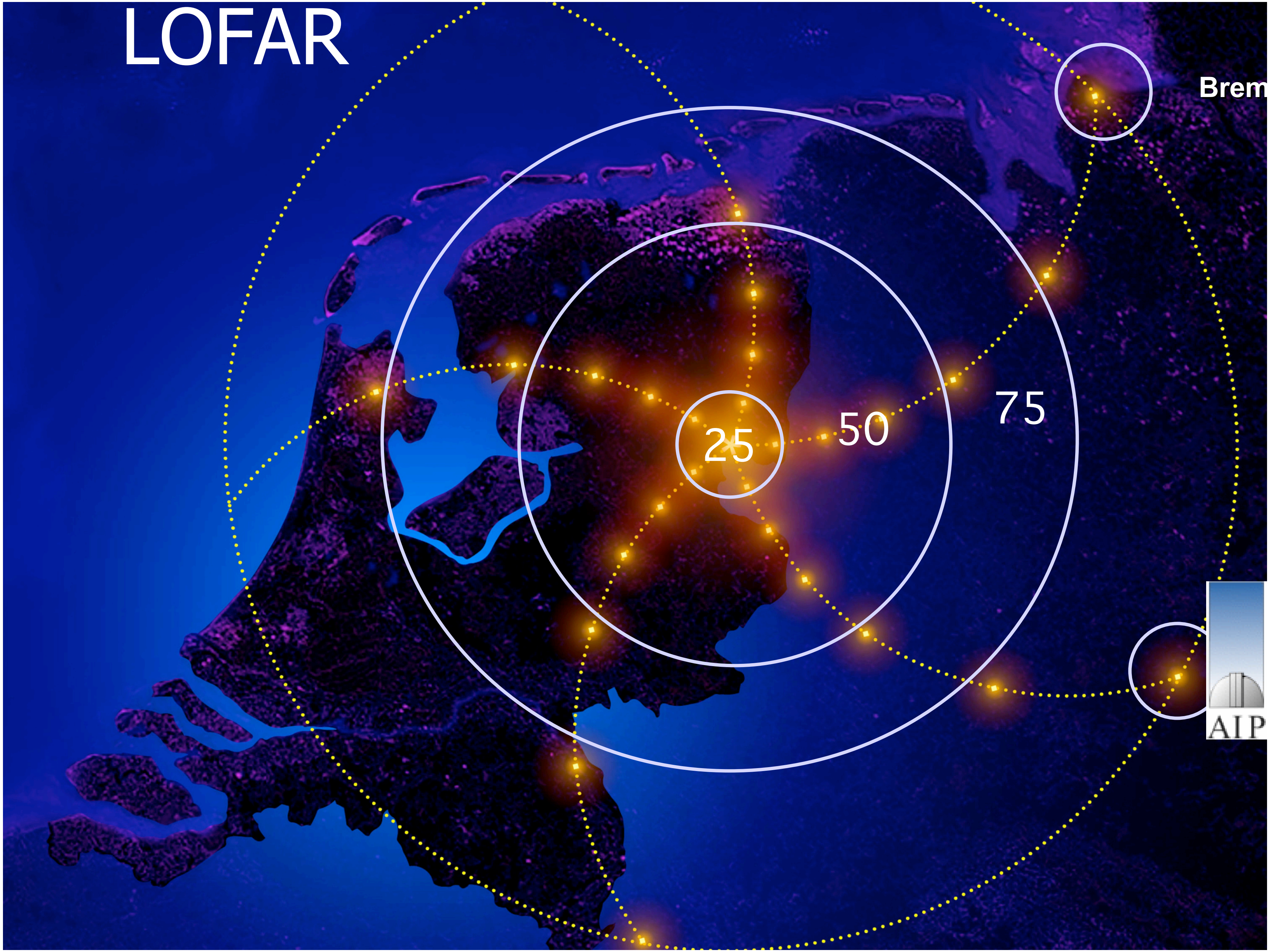
AstroGrid-D

Only a small part of the Astrogrid -Efforts are directed to Clustercomputing within the GRID

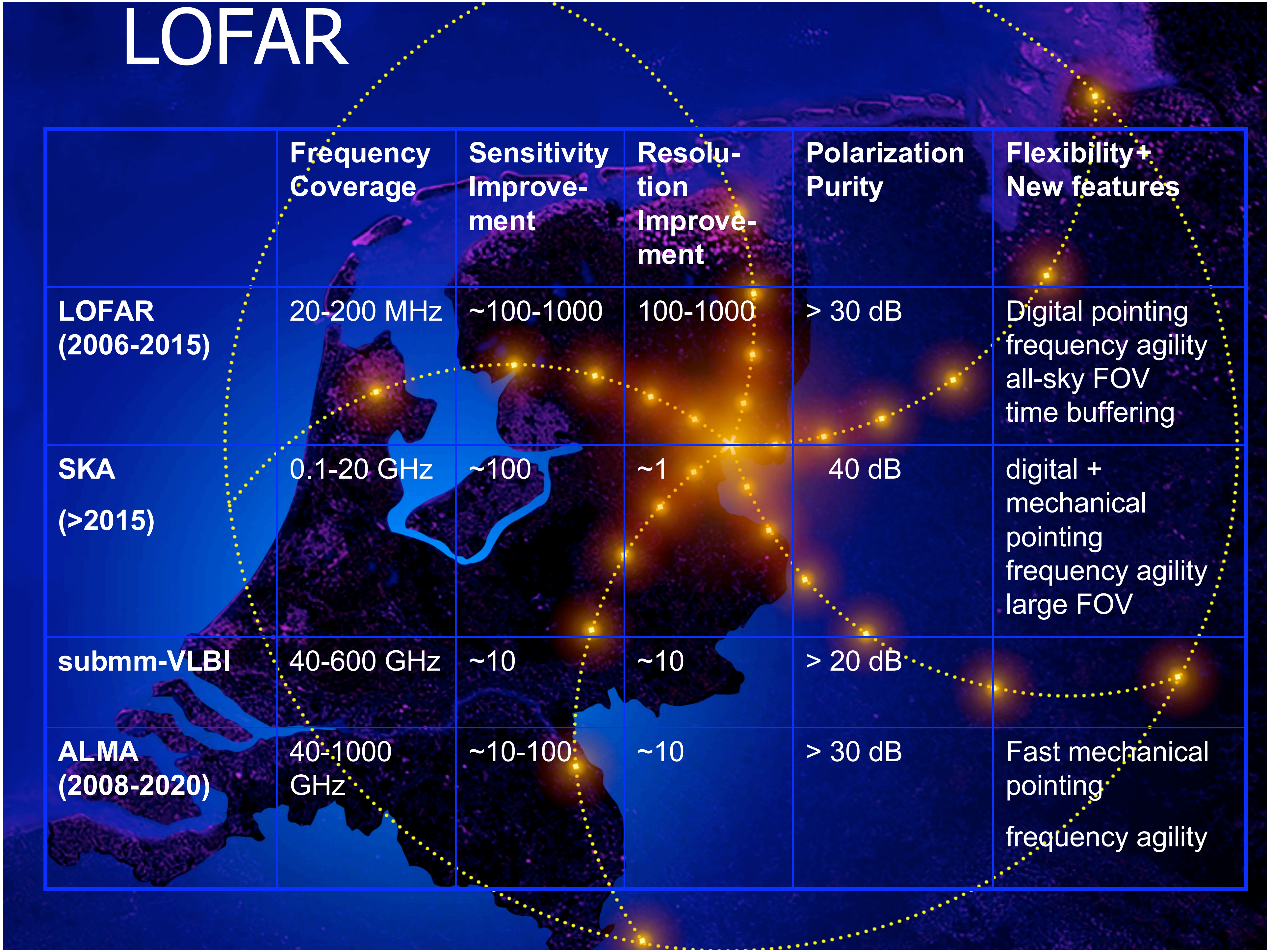
Work connected with other big astronomical projekts

- GAIA
- LOFAR
- GEO600
- Robotic Telescopes
- Planck Process Coordinator

LOFAR

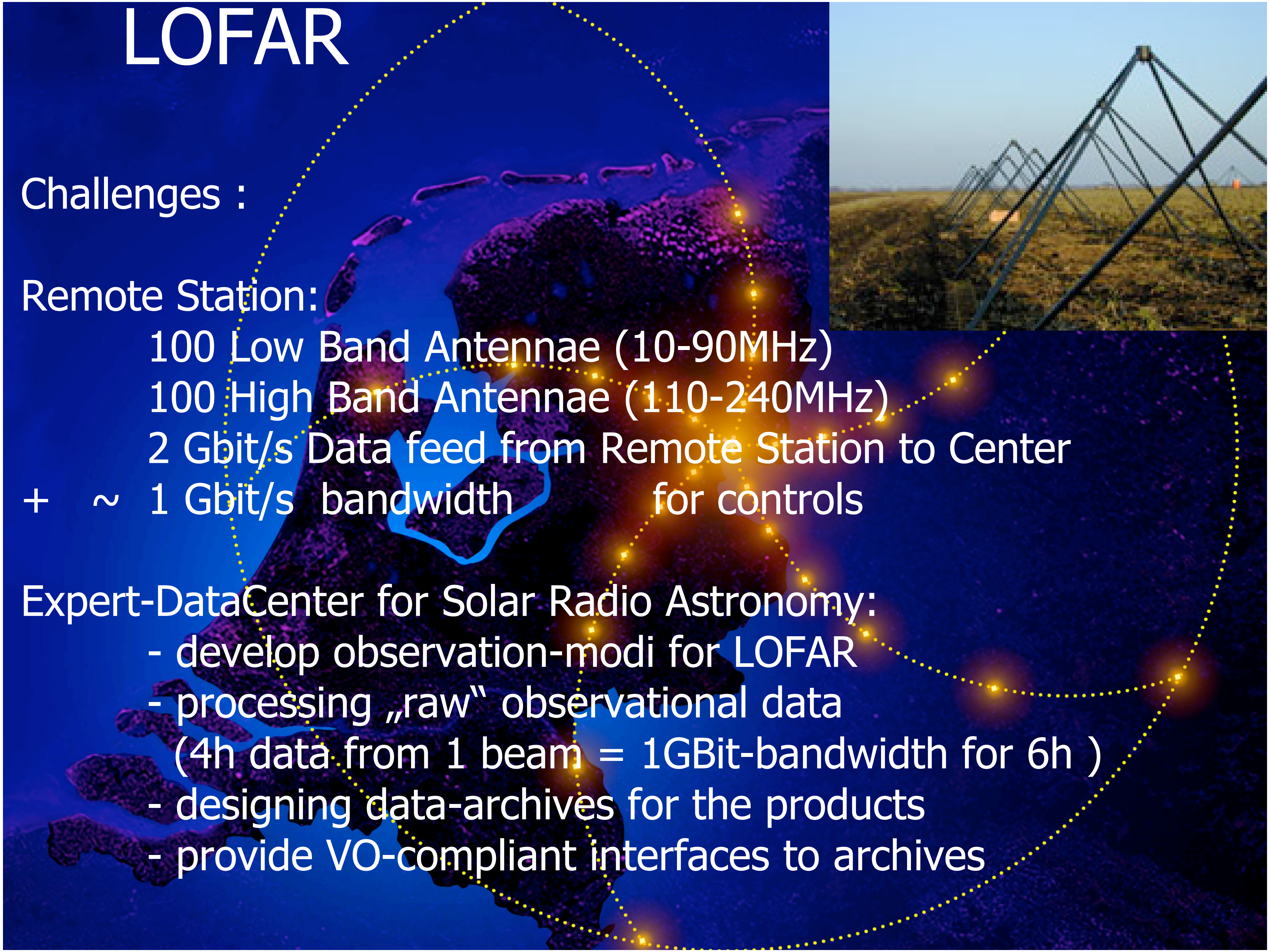


LOFAR



	Frequency Coverage	Sensitivity Improvement	Resolution Improvement	Polarization Purity	Flexibility+ New features
LOFAR (2006-2015)	20-200 MHz	~100-1000	100-1000	> 30 dB	Digital pointing frequency agility all-sky FOV time buffering
SKA (>2015)	0.1-20 GHz	~100	~1	40 dB	digital + mechanical pointing frequency agility large FOV
submm-VLBI	40-600 GHz	~10	~10	> 20 dB	
ALMA (2008-2020)	40-1000 GHz	~10-100	~10	> 30 dB	Fast mechanical pointing frequency agility

LOFAR



Challenges :

Remote Station:

100 Low Band Antennae (10-90MHz)
100 High Band Antennae (110-240MHz)
2 Gbit/s Data feed from Remote Station to Center
\+ ~ 1 Gbit/s bandwidth for controls

Expert-DataCenter for Solar Radio Astronomy:

- develop observation-modi for LOFAR
- processing „raw" observational data
  (4h data from 1 beam = 1GBit-bandwidth for 6h)
- designing data-archives for the products
- provide VO-compliant interfaces to archives

Workstation scenario

Setting:

- Application on workstation
- Interactive analysis
- Data on workstation
- Data product on workstation
- Privacy of data no issue
- Short development cycle

Workstation scenario

Problems:

- Portability to other enviroments
- Well-known libraries like IRAF not designed for distributed computing
- No clear separation of interactive and non-interactive parts (workflow

Shortcomings:

- Data-sets may not fit to workstation-size
- Limited computing power of workstation
- Network bandwidth insufficient for huge datasets

Grid scenario

Requirements (minimal):

- Clearly separated non-interactive and interactive parts of analysis
- Parallelizable runs on data-sets

Additional efforts:

- Porting to different OS-environments
- Distributing Libraries (e.g IRAF) and other resources (templates, training sets)
- Mosaicing

Grid scenario

Benefits:

- Distributed computing = more computing power available
- Moving the tool to the data is possible
- Freeing the workstation for interactive work on retrieved results
- Using idle CPUs for non-interactive work
- Scaling with huge data-sets

Grid scenario

Setting:

- Working Grid environment:
  - Gridportal
  - Job management
  - Co-Scheduling of compute- and data resources
  - Job monitoring

Clusterfinder

- Simultaneous search for X-Ray Clusters of galaxies
  - X-ray photon maps (RASS)
  - Optical galaxy maps (SDSS)

(P. Schuecker et al., 2003) , MPE

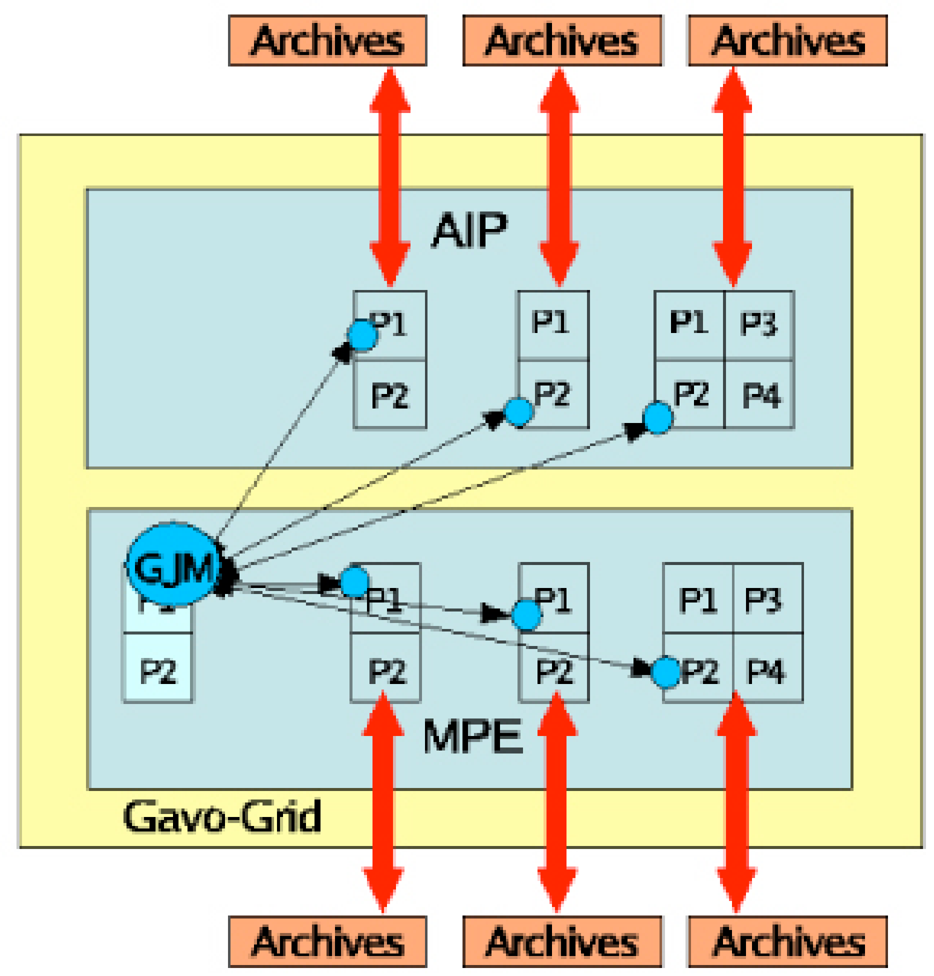
„On a test area of 140 square degrees, 75 X-ray clusters are detected down to an X-ray flux limit of 3 x 10^{-13} erg s^{-1} cm^{-2} in the ROSAT energy band 0.1-2.4 keV. The clusters have redshifts $z < 0.5$. The survey thus fills the gap between traditional large-area X-ray surveys and serendipitous X-ray cluster searches based on pointed observations, and has the potential to yield about 4,000 X-ray clusters after completion of SDSS.“

Clusterfinder

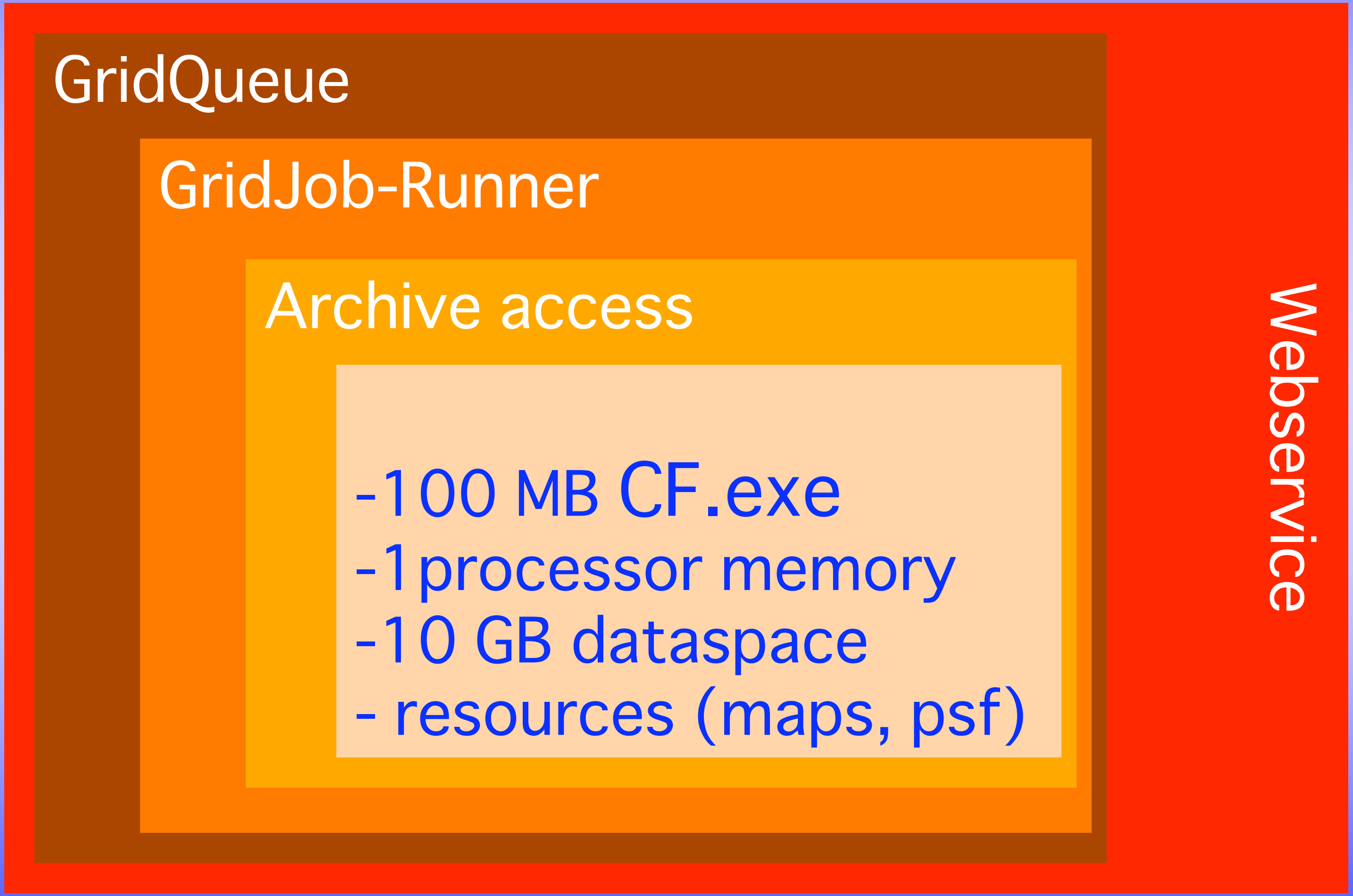
- Methods
  - VOConeSearch (HTTP-GET/SOAP)
  - Grid computing
  - Webservice
  - Archiving of results

Clusterfinder

- Grid computing
  - Dividing areas
  - Distributed jobs
    - VOArchive access
    - Processing
    - Contour plots
  - Mosaic



Clusterfinder on GAVO-Grid



GridQueue

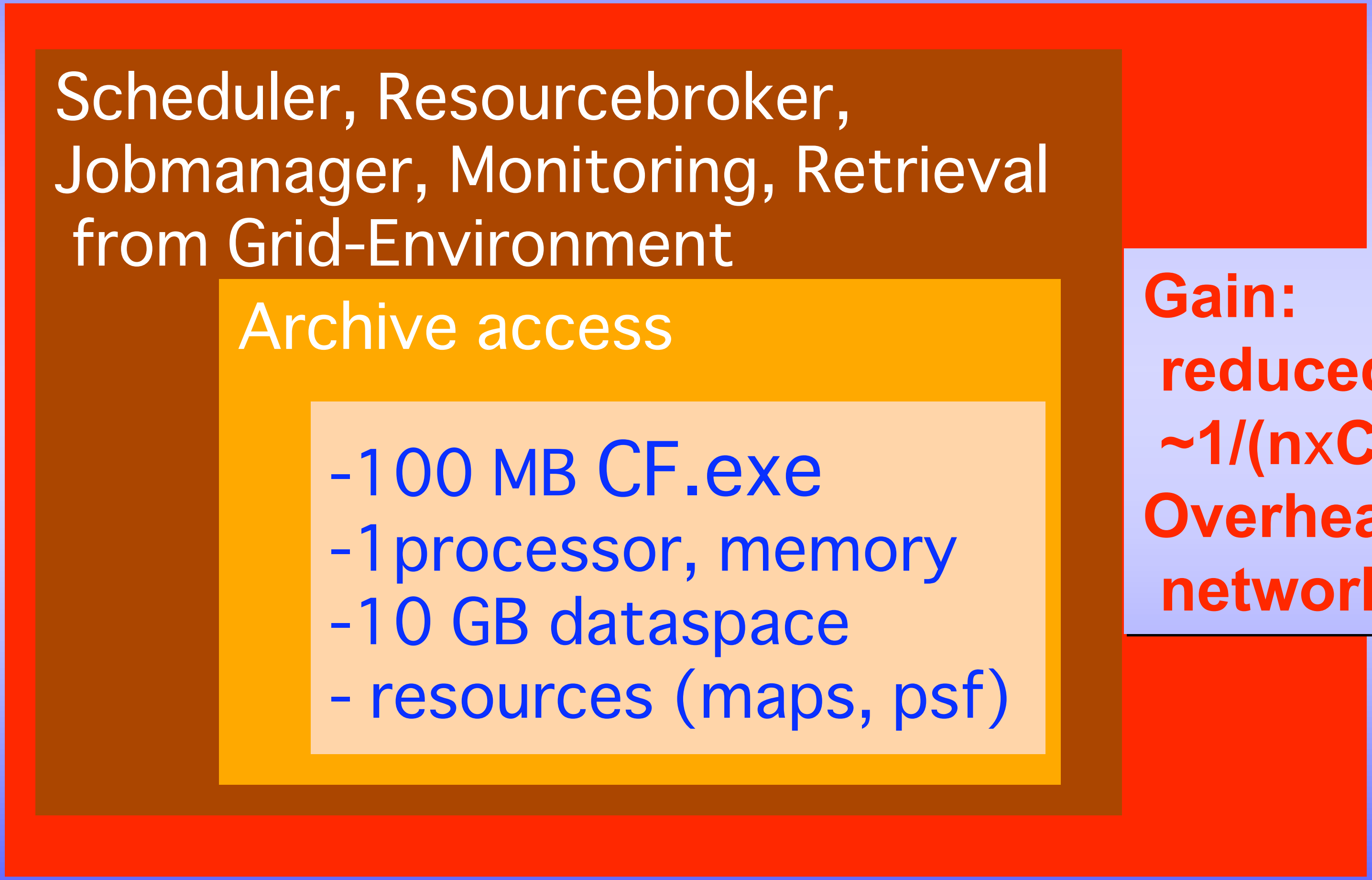
GridJob-Runner

Archive access

-100 MB CF.exe
-1processor memory
-10 GB dataspace
- resources (maps, psf)

Webservice

Clusterfinder in full Grid-Environment



Scheduler, Resourcebroker, Jobmanager, Monitoring, Retrieval from Grid-Environment

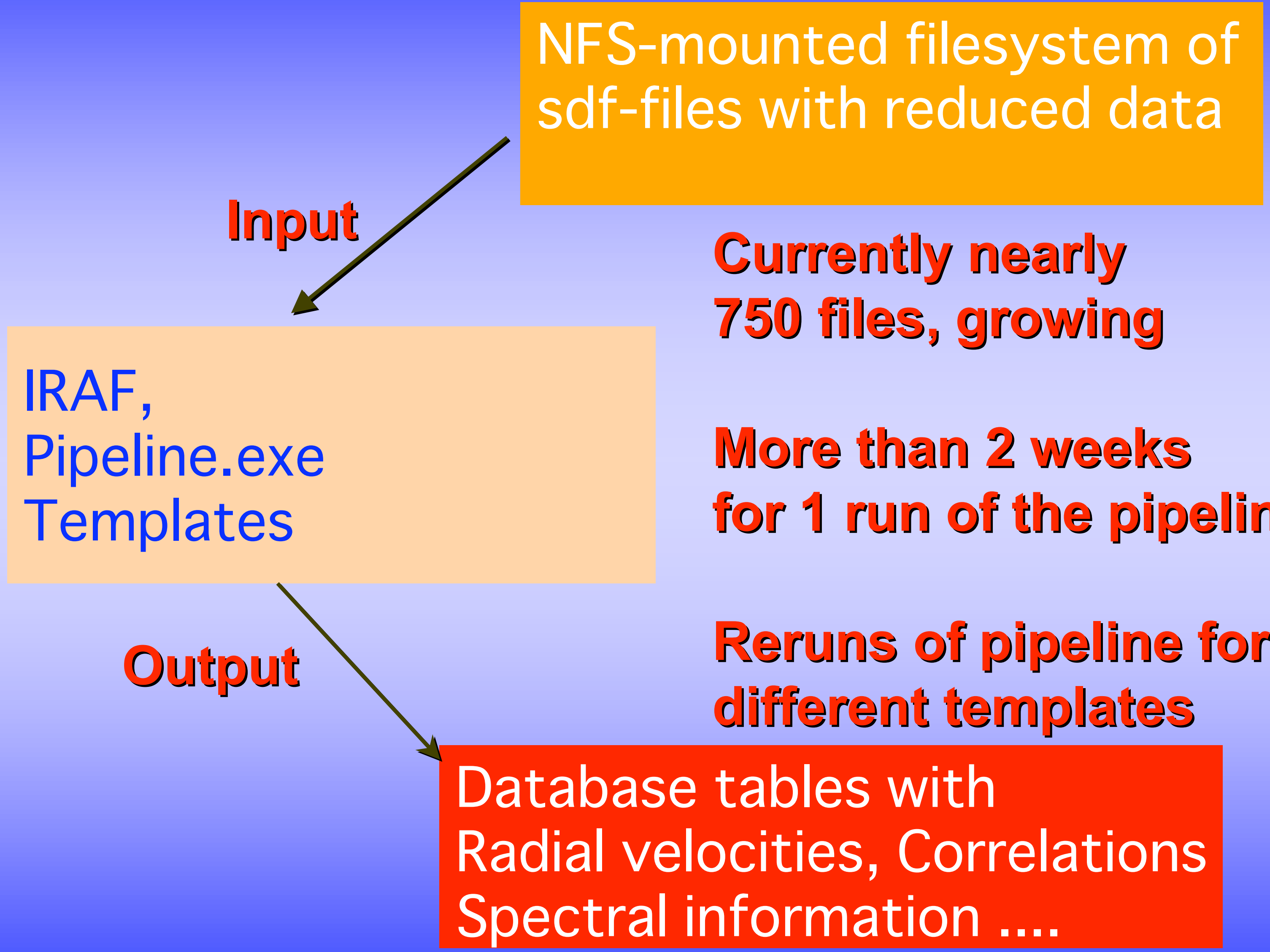
Archive access

- -100 MB CF.exe
- -1processor, memory
- -10 GB dataspace
- - resources (maps, psf)

Gain:
reduced runtime ~1/(nxCPU)

Overhead:
network traffic

RAVE-Pipeline : Workstation Scenario



NFS-mounted filesystem of sdf-files with reduced data

Input

IRAF,
Pipeline.exe
Templates

Output

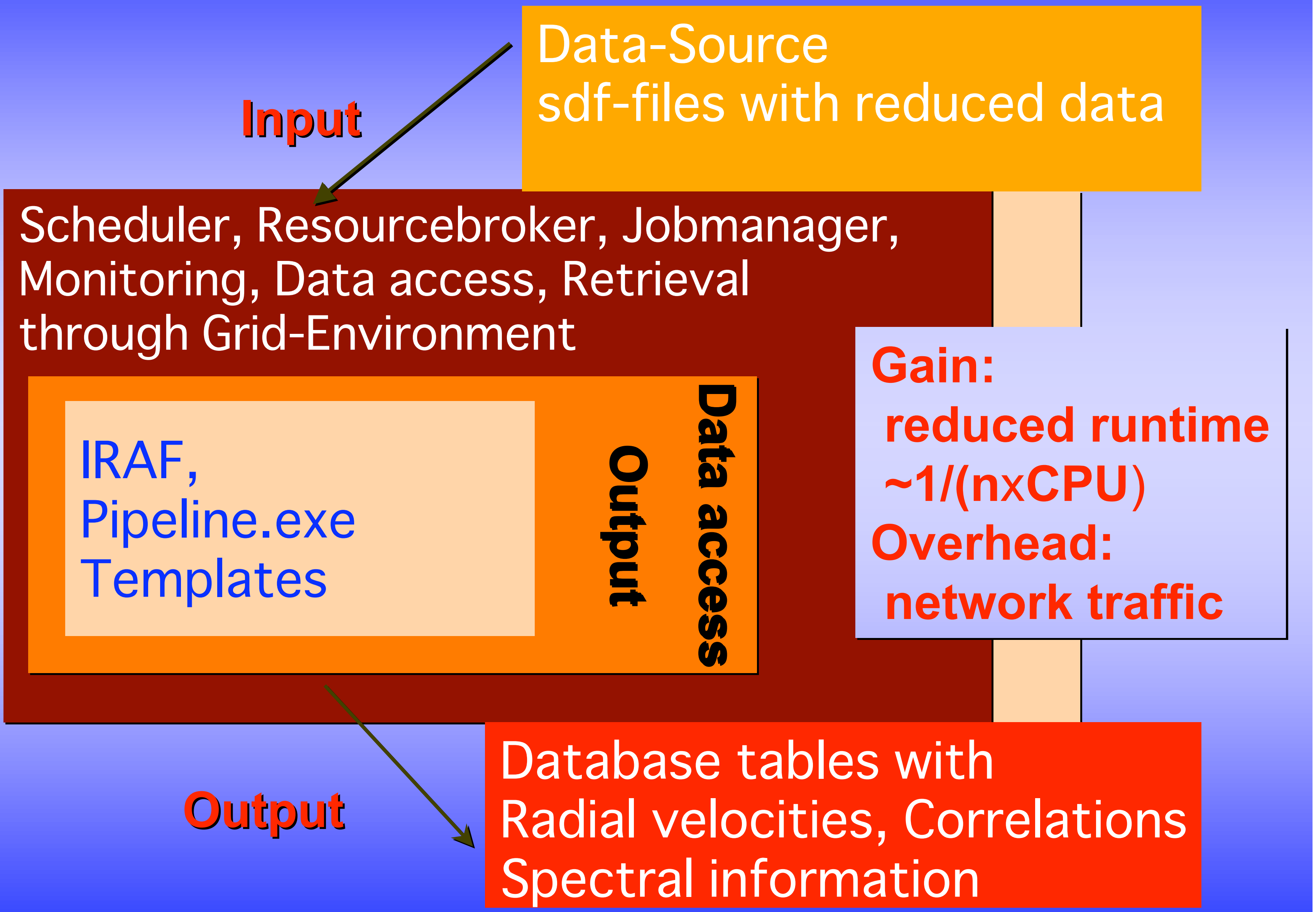
Database tables with
Radial velocities, Correlations
Spectral information ....

Currently nearly 750 files, growing

More than 2 weeks for 1 run of the pipeline

Reruns of pipeline for different templates

RAVE-Pipeline : Grid-Environment



Input

Data-Source
sdf-files with reduced data

Scheduler, Resourcebroker, Jobmanager,
Monitoring, Data access, Retrieval
through Grid-Environment

IRAF,
Pipeline.exe
Templates

Output

Data access

Gain:
reduced runtime
~1/(nxCPU)
Overhead:
network traffic

Output

Database tables with
Radial velocities, Correlations
Spectral information

AstroGrid-D: Robotic Telescopes

AIP Liverpool JMU U Göttingen

- 24h-observation, no reaction delay.
- Independent of local weather.
- Use GRID-technology in an uplifted abstraction layer for robotic telescopes

AstroGrid-D and GAVO

- AstroGrid-D:
  - Infrastructure
  - Network,
  - Computing Resources
  - Grid-Technology, Middleware
- GAVO:
  - Interoperability of archives and datasources
  - Virtual Observatoy compatible
    - Software
    - Tools
    - Database-Interfaces
    - User-Interfaces

GAVO: Context

- GAVO

  supporting efforts of the international astronomical and astrophysical Community

  - developping Standards for world wide compatibility of data-archives
  - to ensure interoperability of observational data and simulation data archives
  - building software and tools towards a „multi-wave-length“ view of the universe

International Collaboration with Grid

- One of the main isues:
  - Certficates and Policies
    - EuroPMA (Policy Management Association)
    - GGF PMA (Oct. 2005)
    - Shibboleth and VOMS
  - Registration Authorities run by Community Grids

AstroGrid-D

AstroGrid

German Astronomy Community Grid (GACG)

Startseite

Kurzbeschrei

Partner

Arbeitspakete

KickOff-Meeting

Kontakt

Impressum

Zielsetzung

Das **German Astronomy Community Grid (GACG)** ist ein Forschungsvorhaben auf dem Gebiet *e-Science und Grid-Middleware zur Unterstützung wissenschaftlichen Arbeitens* im Rahmen der deutschen D-Grid-Initiative.

Als interdisziplinäre Partner im GACG-Verbundvorhaben haben sich die größeren deutschen astronomischen Forschungsinstitute, grid-spezifische Forschungsgruppen der Informatik sowie einige Hochleistungsrechenzentren zusammengeschlossen, um gemeinsam

www.gac-grid.org

Organisationsstruktur für vertei

orschung, aufbauend auf dem
ssourcen effektiver nutzen zu

3. Integration von verteilten astronomischen Datenarchiven, sowie längerfristig auch von Instrumenten und Experimenten in eine gemeinsame GACG-Forschungs-Infrastruktur,
4. Unterstützung einzelner Forschungsinstitute bei der Einbringung eigener Ressourcen, Daten und Anwendungssoftware sowie dere Integration in die administrative Struktur des GACG, um somit auch kleineren universitären Arbeitsgruppen eine engere und fruchtbarere Zusammenarbeit mit größeren astronomischen Institutionen zu ermöglichen, sowie
5. eine stärkere Anbindung der deutschen astronomischen Wissenschaftsgemeinschaft an die sich sehr schnell entwickelnden internationalen Aktivitäten auf diesem Forschungsgebiet.

Der inhaltliche Kern dieser Zusammenarbeit besteht in der Entwicklung eines Rahmens samt zugehöriger Standards für das kollaborative Management astronomiespezifischer Grid-Ressourcen und einer dafür geeigneten Infrastruktur. Das resultierende *German Astronomy Communit Grid* wird bereits bestehende, geografisch verteilte Hochleistungsrechner-Ressourcen mit großen astronomischen Datenarchiven, ferngesteuerte Radio- und Roboterteleskopen sowie bodengebundenen Gravitationswellen-Detektoren in einem kohärenten Rechen- und Daten-Grid integriere Standardisierte Benutzerschnittstellen ermöglichen einen einheitlichen, ortsunabhängigen Zugang zu den vorhandenen Rechenressourcen, was Durchführung astrophysikalischer, numerischer Simulationen vereinfacht und effizienter gestaltet. Der transparente Zugriff sowohl auf lokale als a im Grid verteilte astronomische Datenarchive soll für die in der Community entwickelten Datenanalyse-Anwendungen eine vereinheitlichte Verwaltung, Extraktion und Verarbeitung von komplexen Datensätzen ermöglichen. Dabei werden die Standards der International Virtual Observatory Alliance (IVOA) Gemeinschaft einbezogen, um so weltweit eine Interoperabilität der verschiedenen astronomischen Datensätze und Software-Anwendungen zu gewährleisten.