KM3NeT Computing and Data Management

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ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

KM3NeT and ASTERICS

Astronomy ESFRI & Research Infrastructure Cluster
ASTERICS - 653477

The KM3NeT groups

- CNRS/CPPM
- INFN/Frascati, LNS, Salerno
- FAU/ECAP
- FOM/Nikhef

are strongly involved in the ASTERICS work packages

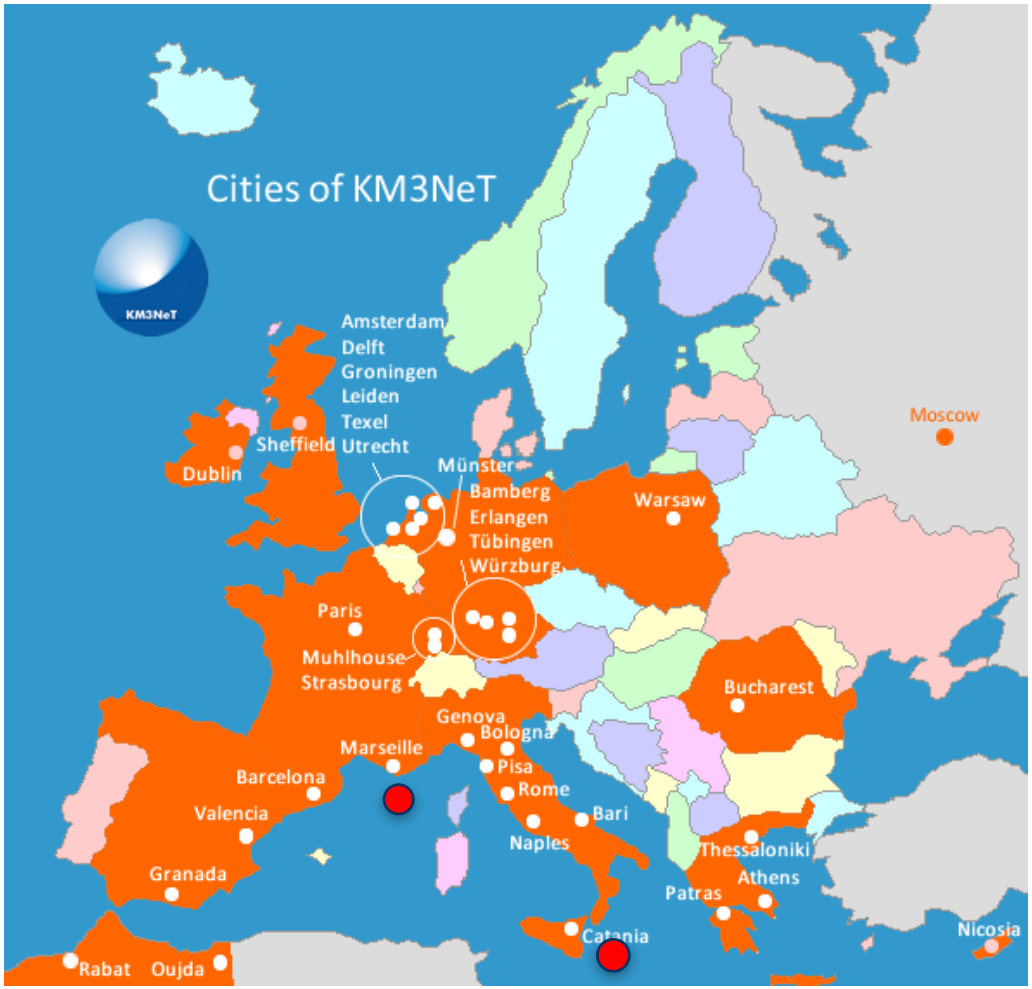
- OBELICS (WP3)
- DADI (WP4)
- CLEOPATRA (WP5)

So what is KM3NeT and what are the questions related to this session?

The KM3NeT Collaboration

- about 240 people
- more than 45 institutes or universities
- 13 different countries

- to build, install and operate the first phase of the **KM3NeT Research Infrastructure** in the Mediterranean Sea which houses a network of **neutrino detectors** and ports for Earth and Sea science research



KM3NeT

KM3NeT is a research infrastructure in the Mediterranean Sea hosting neutrino detectors

- KM3NeT/ARCA (Astroparticle Research with Cosmics in the Abyss)
  - discovery and observation of high energy (TeV–PeV) neutrino sources
    ⇒ a telescope offshore Capo Passero (Sicily-Italy) is in construction at a depth of 3500m
- KM3NeT/ORCA (Oscillation Research with Cosmics in the Abyss)
  - neutrino oscillations physics / neutrino mass hierarchy
    ⇒ a detector offshore Toulon (France) able to detect neutrinos of a few to tens of GeV is in construction at a depth of 2500m

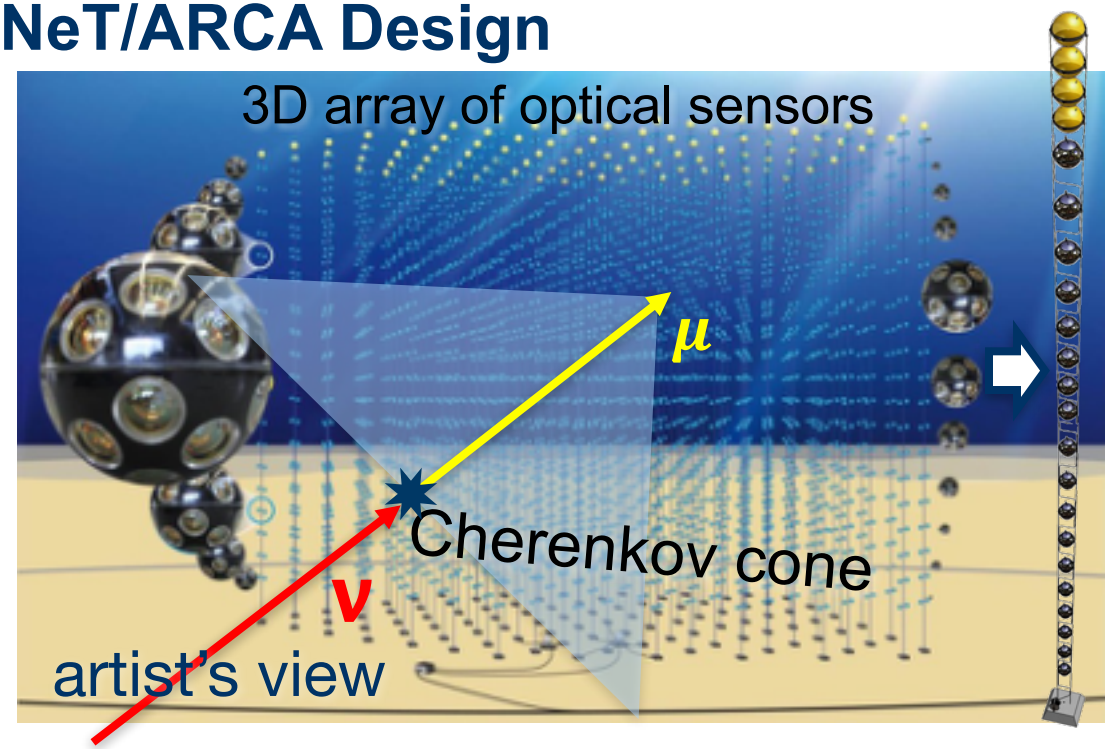
ARCA and ORCA share the same detector technology

- Details on the ARCA and ORCA physics performances and on the technical design in the recently published **Letter of Intent:**

OPEN ACCESS
IOP Publishing
Journal of Physics G: Nuclear and Particle Physics
J. Phys. G: Nucl. Part. Phys. **43** (2016) 084001 (130pp)
doi:10.1088/0954-3899/43/8/084001

The KM3NeT/ARCA Design

sensitive element:
Digital Optical
Module (DOM)



vertical structure:
Detection
Unit (DU)

- detector made of 2 building blocks (BB) of 115 DUs, each.
  90 m horizontal interspacing ⇒ 0.5 km^3/block
- DU: vertical slender string equipped with 18 DOMS, 36 m vertical spacing
- power and data distributed by a single backbone cable from shore;
  seafloor network of cables and junction boxes connected
- all data sent to shore and processed there in a dedicated computing farm

The Phased Implementation of KM3NeT

Phase	Building Blocks		Number of DUs		Physics Goal		Status
	ARCA	ORCA	ARCA	ORCA	ARCA	ORCA	
1	0.2	0.06	23	7	proof of feasibility and first science results; joined analysis with ANTARES data		fully funded; first 2 DUs installed and working at Capo Passero
2.0	2	1	230	115	neutrino astronomy; study of the neutrino signal reported by IceCube.	neutrino oscillations physics	EU preparatory proposal "KM3NeT 2.0" under finalisation
3	6	-	690	-	neutrino astronomy including Galactic sources.		not yet funded

precursor

Timeline

phased implementation of the projects allows for:

- development and test of algorithms for all processing steps on a relatively small data set;
- establish processing chains and workflow with relatively low needs;
- include common e-Services and follow the development in the field (though sometimes hard due to limited HR).
- $\Rightarrow$ preparation of procedures and workflow in due time
- $\Rightarrow$ in perfect timing with the ASTERICS project.

Workflow & Preservation Considerations and Practises

- follow common practise, where possible
  - follow eCommons (as e.g. set by ASTERICS)
- use standard data formats
  - build (and enhance) existing eCommons (e.g. from precursor ANTARES) but employ new developments where advantageous
- use central services and providers (currently mostly CC-IN2P3, CNAF)
  - in addition contacts with other service providers
  - add custom designed interfaces where necessary
- quality first
  - follow internal software quality plan
  - use centralized services of standard development and deployment tools
- data storage
  - central, persistent storage of all data, software
  - essential: reproducibility and usability of all scientific results over full time of experiment (+10 years after shut-down)

Computing Model and Data Management: General Scheme

- Tier-like structure, mixed access: direct (batch) + Grid + … Cloud in the future (?)

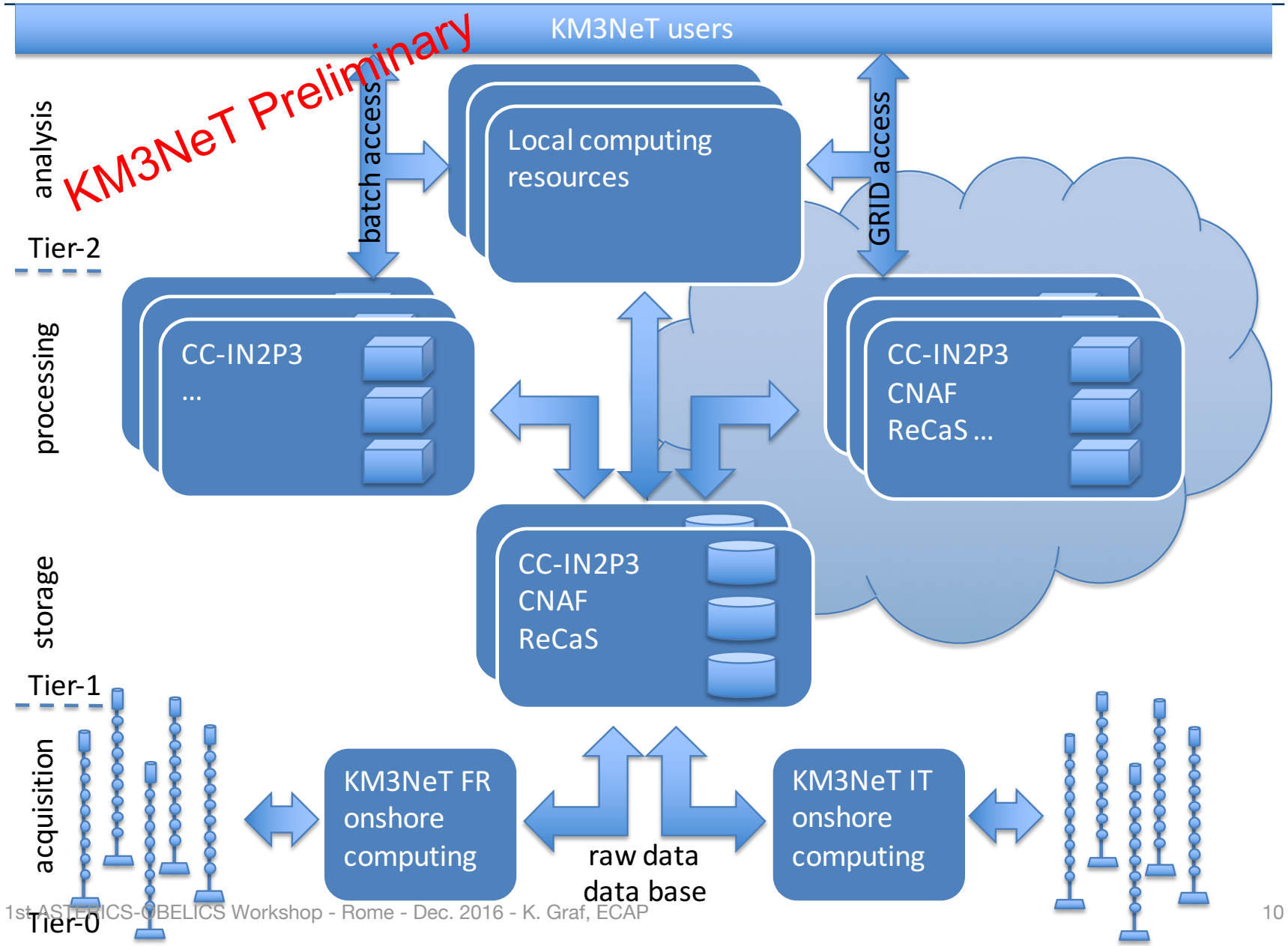
Tier	Computing Facility	Processing steps	Access
Tier-0	at detector site	triggering, online-calibration, quasi-online reconstruction	direct access, direct processing
Tier-1	computing centres	calibration and reconstruction, simulation	direct access, batch processing and/or grid access
Tier-2	local computing clusters	simulation and analysis	varying

- Resource need estimates:

Phase	Data storage per year (TB)	core hours per year (HS06.h)
Phase-1	290	60 M
one Building Block	995	353 M

KM3NeT Preliminary

- minimum processing delay (raw → high-level data) envisioned


KM3NeT users
KM3NeT Preliminary
analysis
Tier-2
batch access
GRID access
Local computing resources
processing
CC-IN2P3
...
CC-IN2P3
CNAF
ReCaS ...
storage
CC-IN2P3
CNAF
ReCaS
Tier-1
acquisition
KM3NeT FR onshore computing
raw data
data base
KM3NeT IT onshore computing
Tier-0

Special Points in the KM3NeT Data Workflow

- ”all-data-to-shore” principle: minimum trigger (PMT signal threshold) in the detector, coincidence building and triggering all on central computing farm
  - flexible, scalable environment
  - addition of triggers simple (add new servers)
    → e.g. for external alerts

- data processing chain from primary to high-level data based on:
  - provided by specialized service group
  - two processing and analysis chains supported (for consistency checks)
  - common data formats on all steps (root, HDF5, xml, ascii)

ASTERICS recommendation

Special Points in the KM3NeT Data Workflow

- central ORACLE database hosted by CC-IN2P3
  - dedicated web interface
    - request caching
    - secure, cross-platform access to data (https)
  - handles
    - credentials
    - detector operation
  - stores
    - detector construction information
    - calibration data
    - monitoring data
  - ideas to include also raw/processed data
- ANTARES uses similar database concept since 10+ years

Resources

- Central services funded through CNRS and INFN, additional services by the collaboration institutes and other service providers
  ⇒ long-living resources
- processing at CC-IN2P3 and via the EGI-VO km3net.org on ReCaS, INFN facilities, HellasGrid facilities and at UniNa
- data storage:
  - parallel storage of low- and high-level data at CC-Lyon and CNAF (long-term commitments, pledged resources)
  - central services like software repository, central software builds
  - additional resources available (e.g. 500TB HDD disk space at ReCaS via INFN)
- Data transfer between the computing centers based on via WAN/GRID access tools (iRODS and gridFTP) – special interface provided by CC-IN2P3

Example of Data Preservation: Open Data Policy

- central goal: prompt dissemination of scientific results, new methods and implementations; provide cross-experiment simulation data
- KM3NeT data
  - public access to summary data (event information plus quality information) after fixed latency (typically 2 years); defined in MoU
  - web-based downloads of data and software on request
    - more (detailed) data, earlier releases, etc.
  - observer in KM3NeT collaboration (free of charge)
    - access to all data, meetings, etc. (but no voting rights)
      - co-author if he/she contributed to publication
- working on publicising in virtual observatories (already for ANTARES)
- simulation data: CORSIKA production (air showers) for cross-experiment use defined and processed within ASTERICS (CORElib)
- PID discussion followed by GEDE (within RDA) → open point

Example of System Preservation: Publications

- need to preserve primary data that lead to publications for 10 years; including the processing chain
- KM3NeT is currently employing a standard environment (based on SL7 with all necessary software) for all project internal computing
  - central repository (svn, trac, repository server) and automation build service (jenkins, rpm builds)

  - working within ASTERICS on solutions to preserve that system, e.g. employing Docker to have this environment platform independent and thus future-safe for re-analysis of data
    → issue: escalation of permission
  - primary data is stored on tapes in central computing centres
    → relatively safe, still no guarantee

Example of Workflow Management: CC-IN3P3 and CNAF

- Multi-datacenter operation workflow management services and user access:
  - KM3NeT is starting to employ the usage of two large computing centres at the same time - CC-IN2P3 and CNAF;
  - currently no cross-datacentre management tools have been developed/deployed, though solutions are under finalisation; issues:
    - data synchronisation and distribution (intermediate server provided by CC-IN2P3)
    - processing job distribution
    - authorisation and authentication (worked on in ASTERICS)
  - in addition grid facilities are used (simulation data as use case) via EGI VO km3net.org and VOMS at UniNA
  - addition of cloud services: under investigation

Summary

- KM3NeT is a neutrino experiment, currently in Phase-1
- Data management plan and computing model established
  ⇒ sustainable also for the next project phases
- KM3NeT collaboration
  - actively uses eCommons
    (taken over from ANTARES and other experiments)
  - contributes to their further development within ASTERICS
- Several questions open and improvements possible with respect to *Workflow management & system preservation*
- Discussion, feedback and advice is always welcome!

- supported by:

Backup Slides

Possible Points of Discussion

- How to organise the different partners/groups?
  - from e-Infrastructure providers (computing centres and groups of those)
  - over data expert groups
  - to policy making/administrative groups
  - and to the service users (i.e. here the RIs)
- How to streamline e-Services from the service providers to the service users? Usually good services are provided but the users have to choose and implement interfaces to these services on their own.