Approach to Virtual Observatory link in KM3NeT

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The detector, physics and data format

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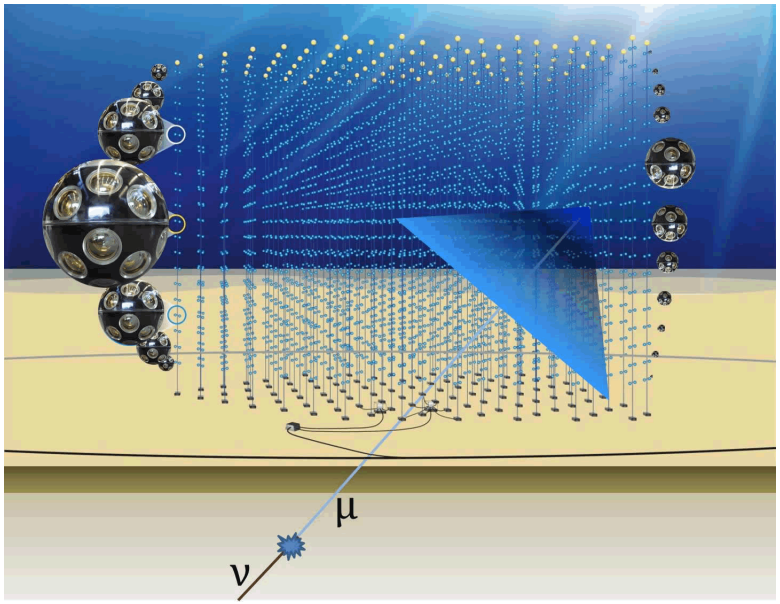
KM3NeT scientific target

Main detection channel: identification of ν through Cherenkov radiation of secondaries

- ARCA: cosmic neutrinos in TeV range and above
- ORCA: wider neutrino physics with atmospheric neutrinos
- add-on: acoustic signals, sea science
- main data format: event-based (describing single ν, μ)

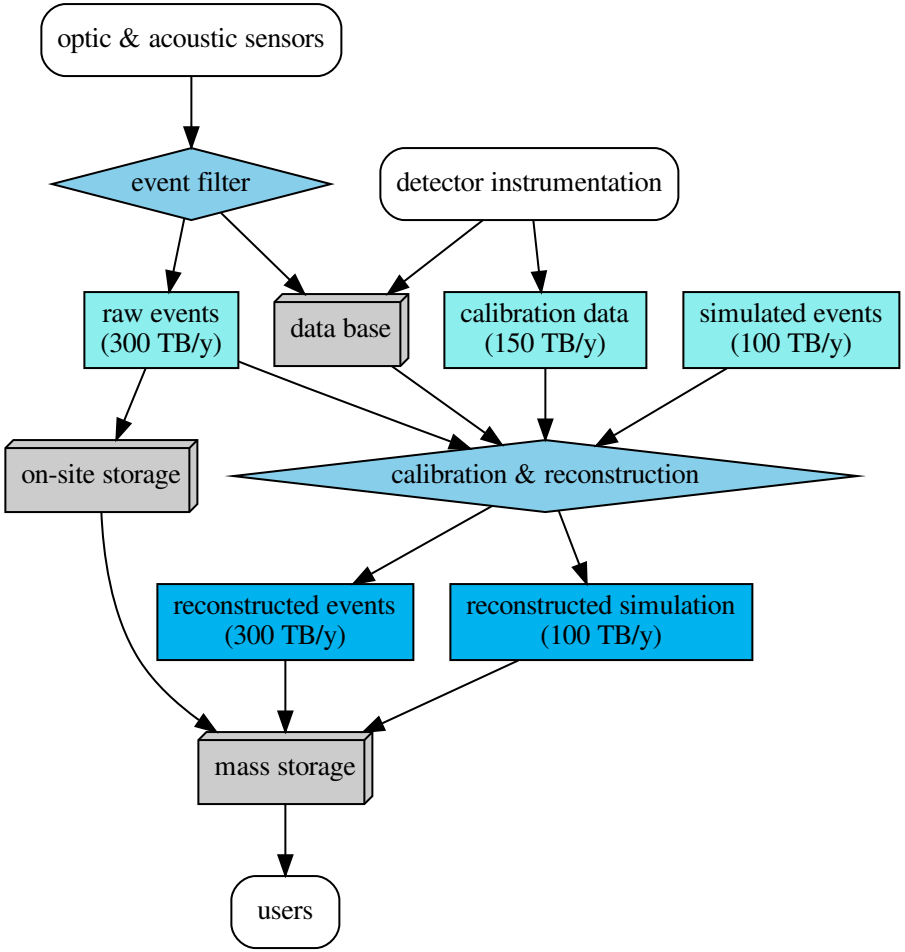


Data generation & processing

Detector construction

- Multi-PMT modules:
  31 3”-PMTs in one sphere
- 18 modules per
  string (Detection Units, DUs)
- Building
  blocks of 115 Detection Units

	ARCA	ORCA
planned DUs	$2 + 1 \times 115$	
current DUs	1	4
funded	24	6
DU distance	90 m	20 m
DOM spacing	36 m	9 m
instrumented mass	$2 \times$ 500Mton	5.7Mton



KM3NeT 2.0 LoI: arXiv: 1601.07459

KM3NeT data format

Raw data

- *Timeslice*: common header + frames
- *Frames*: All information from detector (photomultipliers, acoustic, monitoring, slow control)

Triggered events

- Filtering of raw data: JDAQEvent + JDAQSummaryslice (monitoring)
- bundled as *runs*, transfered to CCLyon

Event calibration & reconstruction

- Frameworks: JPP, AANeT & KM3Pipe
- reconstructed events in ROOT/HDF5

RECONSTRUCTED EVENT	
event info	**identifiers** run_id, event_id, group_id **data taking** detector, frame index, overlays, trigger_counter, trigger_mask, utc_nanoseconds, utc_seconds **simulation** livetime, mc_id, time Nevents, Nfiles, weights
hits	[channel, dom, time, tot, triggered]
reconstructions /mctracks	direction(local), energy, position, length, time, reconstruction parameters

KM3NeT physics environment

Full sample astrophysics analyses

- embargo time on use of events, then full access (?)
- minimum: access to publication-related processed event samples

Multimessenger analyses

- Alerts (fast processing and publication needed)
- high-level data sets of cosmic neutrino candidates
- sensible handling of event probabilities and detector sensitivity

Wider physics context

- Neutrino physics using e.g. atmospheric neutrino samples or even muon samples (large samples!)
- simulation for probabilistic interpretation can be specific to physics target
- sea science

Toy pipeline and KM3NeT VO server

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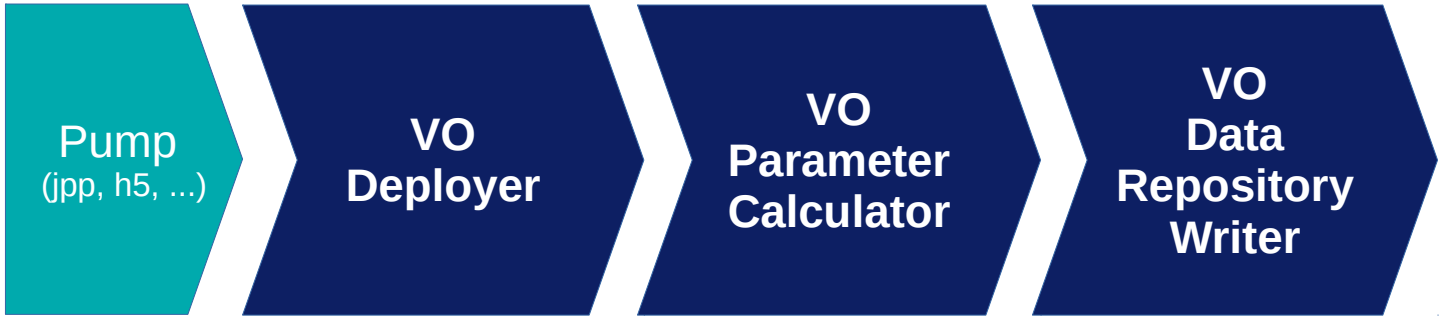
First look at requirements: VOLab + GAVO DaCHS server

VOLab: modules for km3pipe for i/o of events from different file formats



read VOConfig.cfg

- governs processing
- provides metadata on sample
- define table

→ one place for all **publishing decisions**

Standard parameters

- declination, rightascension
- (MC processing)
- (basic event selection)

Gathering & writing of DaCHs files

- data table
- metadata file (resource descriptor)

Test sample on DaCHS server

DaCHS running in docker on server at ECAP: vo.km3net.de

Test sample

- Taking one file for 1 run of simulated $\overline{\nu}_{CC}$
- Select only upgoing netrinos, generate random time (one day), process 2000 events

Choices on data formats & services

- events are provided for simple cone search
- mandatory ID, rightascension, declination
- data storage in ascii file (<100 kB)
- web forms for SCS and ADQL queries
- Remote access for TAP, ADQL

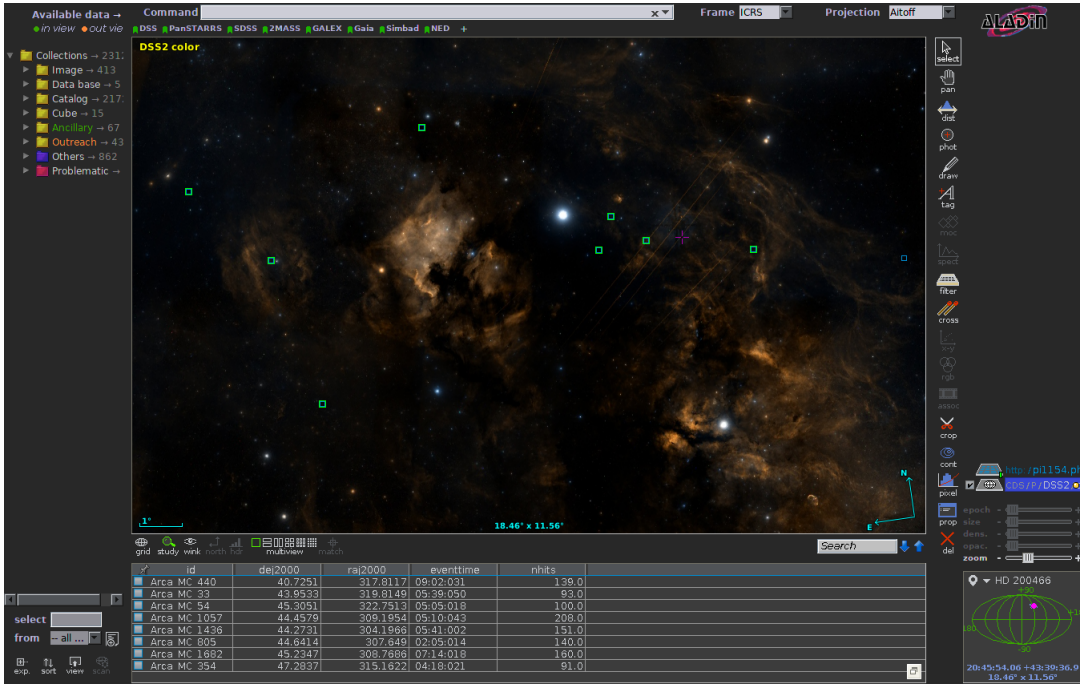
Summary

Some major questions

- scope of published data
- format,
  storage and access
- relevant meta data
- dealing with simulation

References

VOLab@Gitlab:
git.km3net.de/jschnabel/volab
KM3NeT VO: vo.km3net.de
ANTARES at GAVO: 2007-2012



Backup

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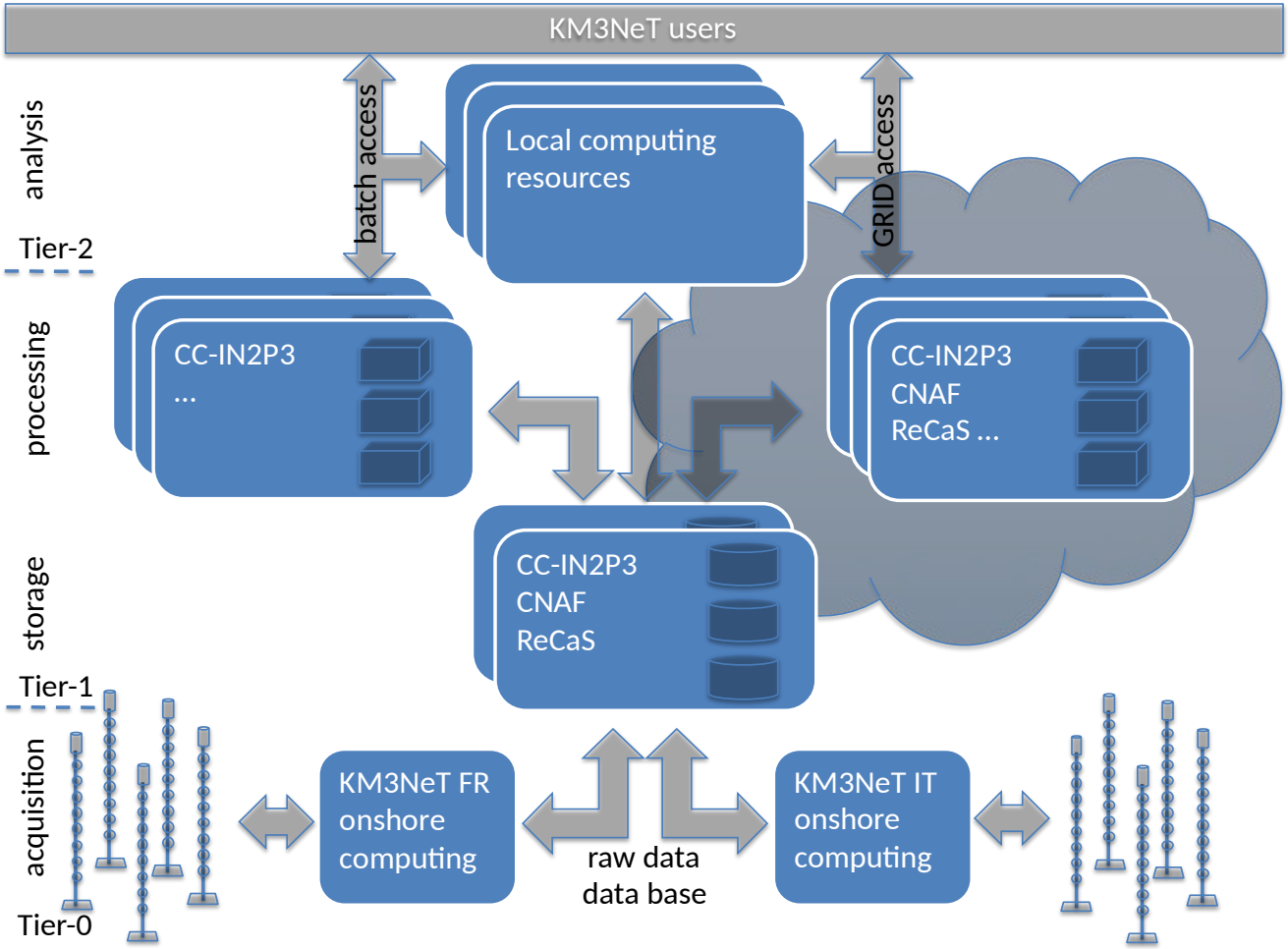
Data processing levels: Tier approach



VOLab Configuration: Resource metadata

Public information

- cataloguetitle = KM3NeT dummy catalogue
- description = Some sensible text on your sample here
- creator = The KM3NeT collaboration
- subject1/2/3 = UHE neutrinos - define keywords associated with the data, (up to 3 different ones)
- instrument = KM3NeT
- facility = ARCA - or ORCA
- source = ARCA UHE simulation - describe origin of your data, perhaps provide URL

VOLab Configuration: Calculation of mandatory parameters

Julian date and time

- eventkey = McTracks - key in km3pipe of event is stored
- resultkey = VOParticle - key in km3pipe where result will be stored
- location = orca - location of the detector

Additional tools for simulated events (optional)

- randomtime = True - generate a random time for the event. If not set, mc_time will be chosen as time.
- getonlyprimary = True -for simulation, select only the primary simulated neutrino for to store as VO particle

VOLab Configuration: Data repository content

Mandatory configuration parameters

- par0_ucd = meta.id meta.main - content descriptor for role interpretation in the VO
- parx_blobtablename = EventInfo - name of the blob DataFrame
- parx_entryname = group_id - columname of the parameter in DataFrame
- parx_vodisplayname = ID - name displayed as title of column in VO table
- parx_vocolumnname = id - internal name of column
- parx_description = Event ID -detailed parameter description