Computing, Simulation and Software

Apostolos Tsirigotis, HOU and
Kay Graf, ECAP

KM3NeT – Phase 1
Collaboration Meeting
Marseille, Jan., 29th – 31st 2013

FRIEDRICH-ALEXANDER
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FOR ASTROPARTICLE
PHYSICS

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Project Management and Working Groups

- Spokesperson
- Deputy Spokesperson
- Technical Project Manager
  - …
- Physics and Software Manager
  - neutrino astronomy
  - ORCA studies
  - simulation
  - software and computing

} joint session to gain overview

Parallel Session

Computing, Simulation and Software	*GRAF, Kay et al.*	
En-Vau (342), CPPM	14:00 - 14:15	
Monte Carlo Simulations	*MARGIOTTA, Annarita*	
En-Vau (342), CPPM	14:15 - 14:40	
The SeaTray Software Framework	*EBERL, Thomas*	
En-Vau (342), CPPM	14:40 - 15:00	
HOU Reconstruction & Simulation (HOURS): A simulation and reconstruction package for neutrino telescopy	*TSIRIGOTIS, Apostolos*	
En-Vau (342), CPPM	15:00 - 15:20	
Muon track reconstruction for multi-PMT in KM3NeT	*TROVATO, Agata*	
En-Vau (342), CPPM	15:20 - 15:35	
Reconstruction, analysis and simulation at Nikhef	*SAMTLEBEN, Dorothea*	
En-Vau (342), CPPM	15:35 - 15:50	
aa(fit) software spin-off's	*HEIJBOER, aart*	
En-Vau (342), CPPM	15:50 - 16:00	

Simulations

- maintenance/development/availability of simulation code
- testing/cross-comparing the different simulation software modules/code
  - KM3, HOURS, SIRENE, CLSIM
- define/implement simulation input parameters and study their impact on detector performance
- benchmarking of the MC code
- simulation processing (production)
- documentation of the simulation environment and data

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testing/cross-comparing the different simulation software modules

- Pseudo-experiments to check different simulation MC codes for light propagation and production from:
  - Muons
  - All secondary particles from neutrino interaction (relevant for low energy neutrino studies – ORCA)
  - All neutrino flavors
  - Common GENIE input

define/implement simulation input parameters and study their impact on detector performance

- optical water properties
- depth
- detector layout
- DOM characteristics (QE, Angular Acceptance, ...)

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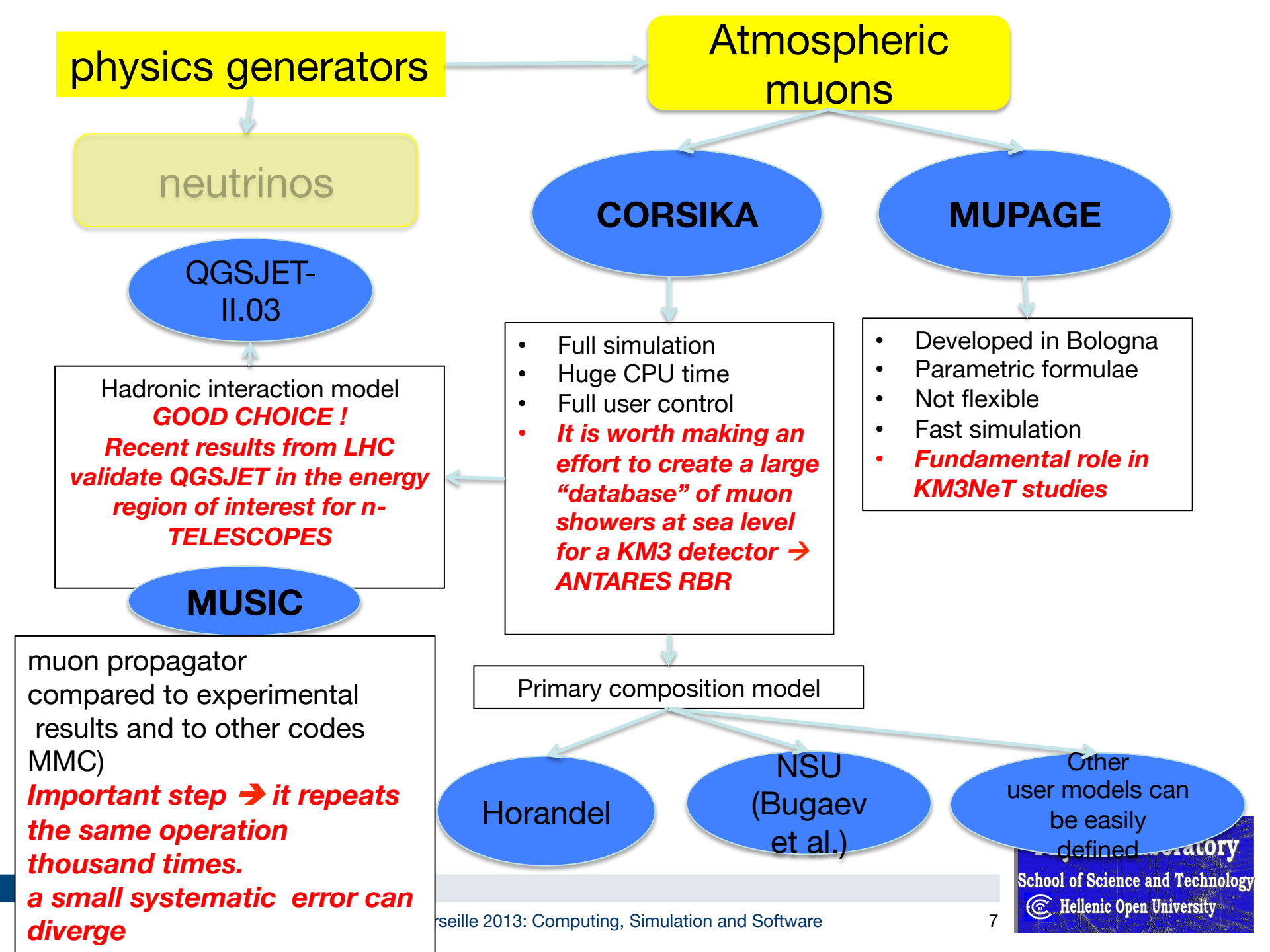
Monte Carlo Simulations (Annarita Margiotta)


physics generators
Atmospheric muons
neutrinos
CORSIKA
MUPAGE
QGSJET-II.03
Hadronic interaction model
GOOD CHOICE !
Recent results from LHC validate QGSJET in the energy region of interest for n-TELESCOPES
MUSIC
Full simulation
Huge CPU time
Full user control
It is worth making an effort to create a large "database" of muon showers at sea level for a KM3 detector → ANTARES RBR
Developed in Bologna
Parametric formulae
Not flexible
Fast simulation
Fundamental role in KM3NeT studies
muon propagator compared to experimental results and to other codes MMC)
Important step → it repeats the same operation thousand times.
a small systematic error can diverge
Primary composition model
Horandel
NSU (Bugaev et al.)
Other user models can be easily defined
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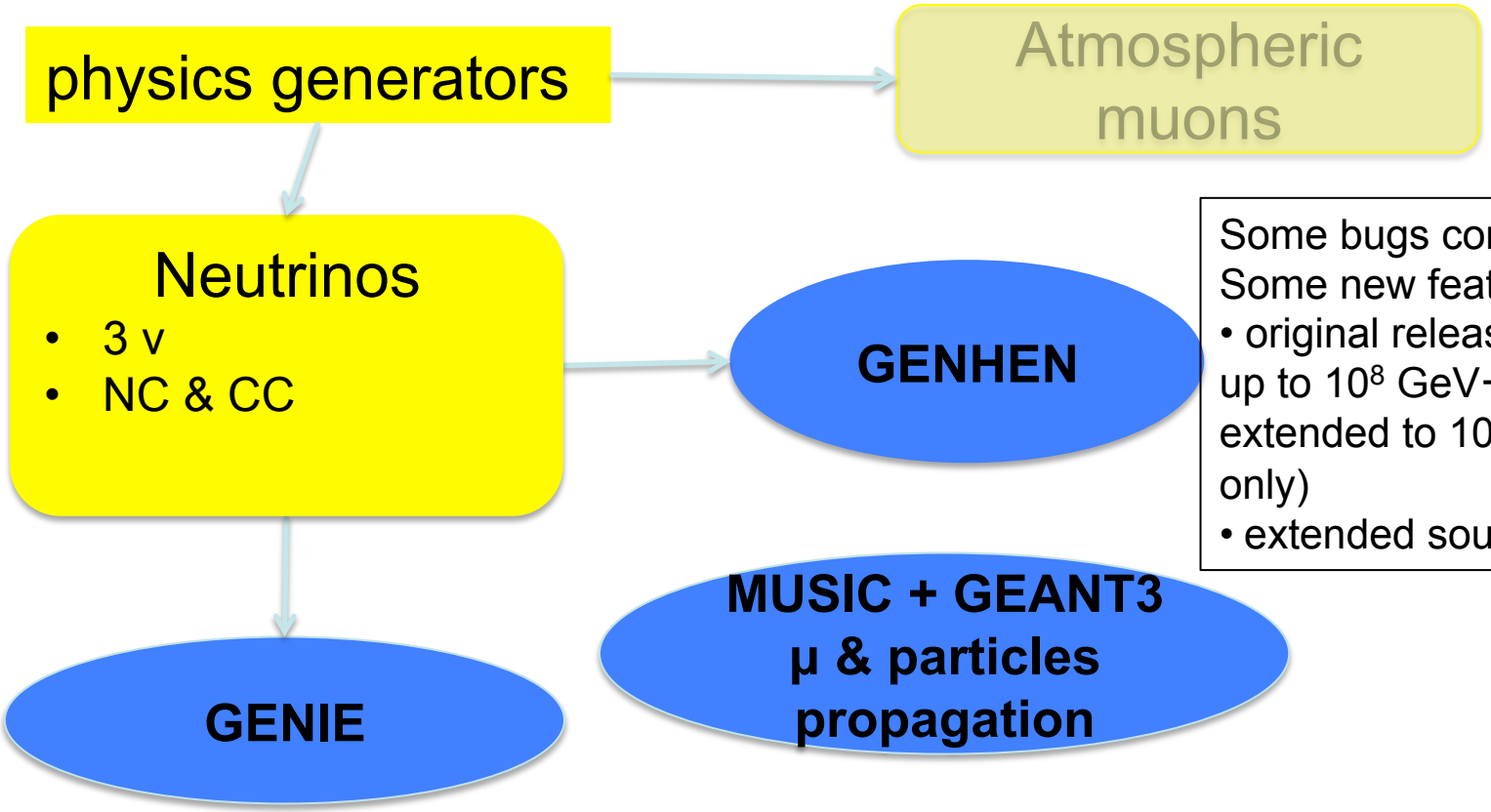

Some bugs corrected.
Some new features introduced:
• original release guaranteed up to 10^8 GeV→recently extended to 10^{10} GeV (for ν_μ only)
• extended sources considered

GENHEN : *fast simulation*
reliable between 5 GeV and $10^{8\text{-}9}$ GeV
almost orphan code

GENIE: *used by IC people for PINGU simulation*
interesting collaboration between ANTARES and IceCube
slower than GENHEN
does not cover the full energy (< 300 GeV): next vrs → 1 PeV
fully maintained and updated

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What do we have now?

several alternatives for quick (parameterized) and full simulation of atmospheric

muons and for neutrinos → It helps debugging and comparison.

What can we do with it?

more or less, all we need…..

What do we miss?

Atmospheric muons: can we make MUPAGE more flexible? Can we introduce additional parameterizations to account for the relative chemical composition of primary CRs?

Neutrinos: do we need EHE neutrino simulation ? How far should we go? $>10^{10}$ GeV ? Some contacts with the IceCube group working on JULIeT.

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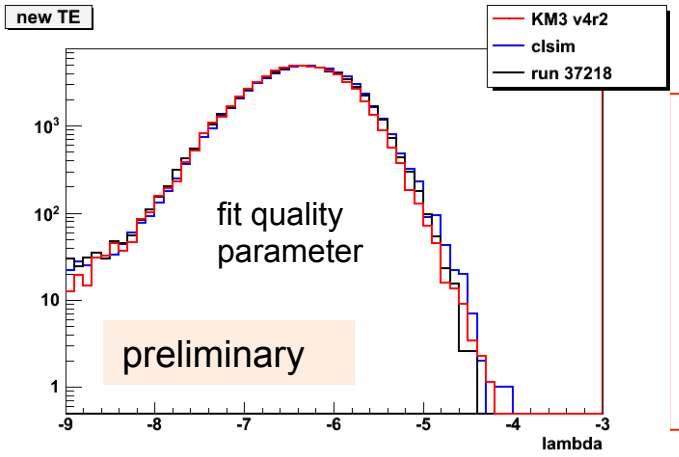
Cherenkov light emission and propagation

different approaches are possible

- individual photon propagation
  - clsim
- photon tables
  - KM3
    - GEASIM (Geant3)
  - Sirene (under test)
- parameterization/ analytical approach

- ***Do we really need for mass production?***
- ***Sea water is a homogeneus medium (not true for SouthPole ice)***
- ***ESSENTIAL FOR TEST PURPOSES***

- each photon is tracked individually
- water & ice models
- OMs description
- huge CPU time request - GPU cards necessary



- Cherenkov light from muons (track and em showers
- individual photons tracked to create "photon fields" around the emission points
- convolution with OMs to fill hit probability tables
- water models and OMs description
- quick simulation

Shower simulation (up to 100 GeV for ν_μ CC events)
No light scattering

Dramatic improvements during last year:

- ***corrected several bugs/incoherences***
- ***much better description of light scattering***
- ***One Particle Approximation for shower-like events (NC & ν_e) → GEASIM not required → much faster simulation + light scattering***
- ***OPA NOT good for ORCA***

What do we have now?

several alternatives for quick and full simulation of light production and propagation. possibility of comparing different approaches →
level of approximation/detail can be fixed.

What can we do with it?

more or less, all we need…..
KM3Net MC software has been taken from the ANTARES software.
Some modifications required to adapt the original code to the new situation → geometry, optical properties…
Some bugs found and corrected during this revision work
Some new features added (extended source simulation, …)

What do we miss?

Common repository and common releases are desirable and already under construction.

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Software and Computing Working Group

Subtasks:

- Offline software (reconstruction and analysis)
- Data handling
- Computing Strategy and Hardware
- IT Services

Software

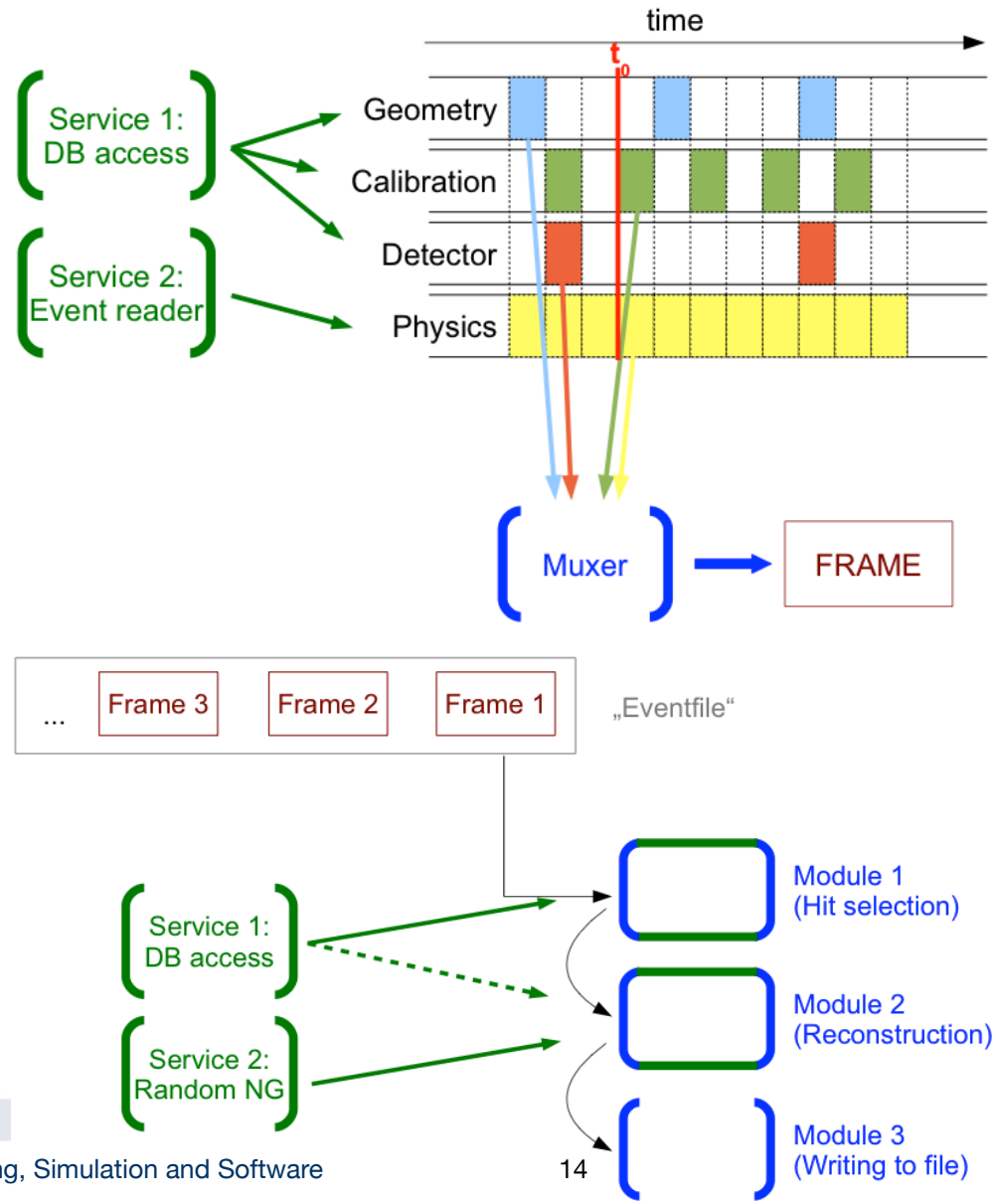
- Offline software (reconstruction and analysis)

⇒ (complete) overview in this session, talks by Annarita, Thomas, Apostolos, Agata and Dorothea

- tasks:
  - maintenance and development of reconstruction code
  - define standard software framework/packages
  - benchmarks, comparisons
  - documentation
  - data processing strategy (stages, delay times) …

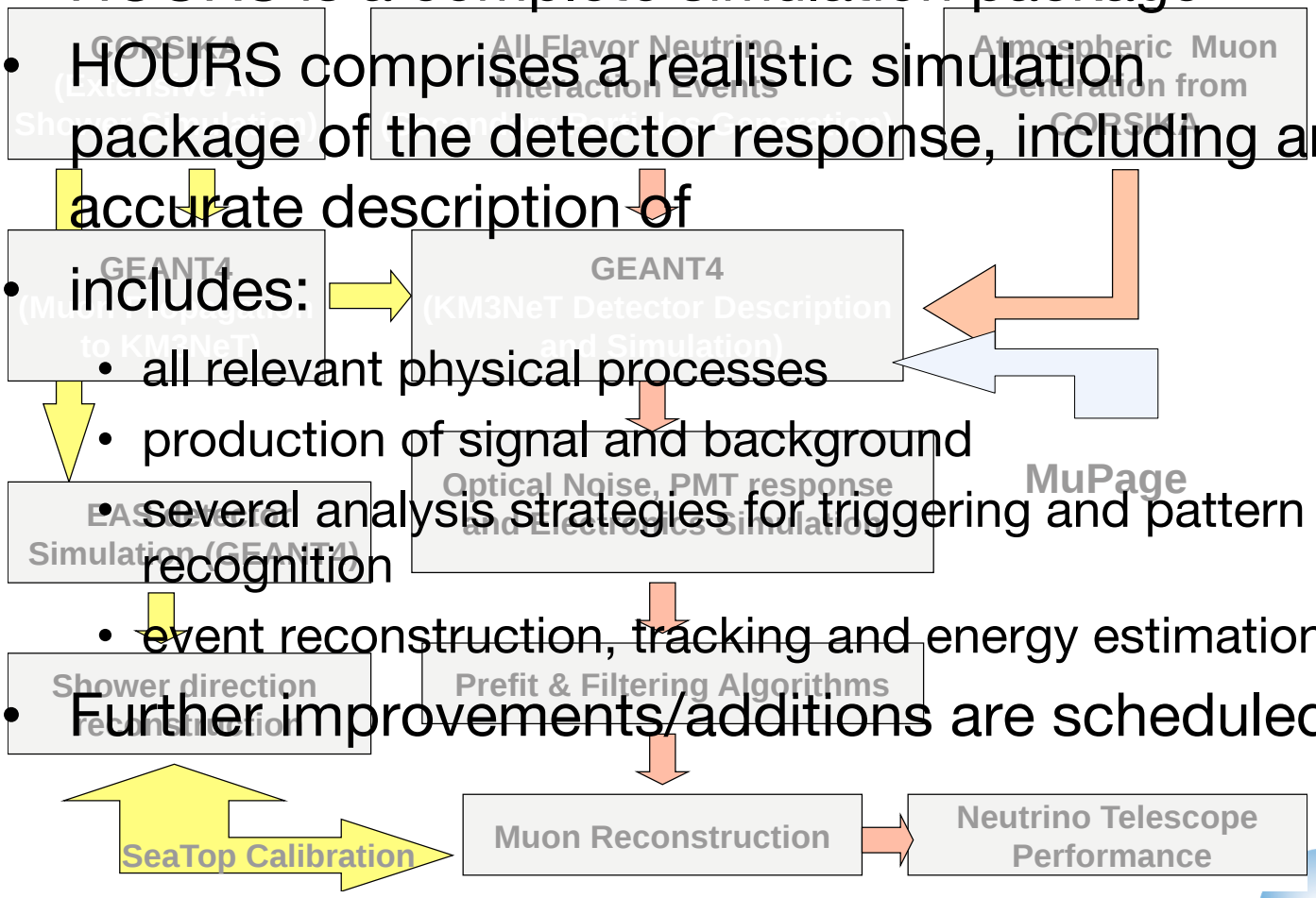
The SeaTray Software Framework (Thomas Eberl)

- SeaTray is a modular software package for reconstruction (and simulation)
- SeaTray is based on IceTray, an analysis framework developed by IceCube
- Used for event reconstruction and data mass production in ANTARES
- Many reconstruction algorithms available and documented for ANTARES
- Intended to e.g. facilitate reconstruction development
- Performance needs to be investigated



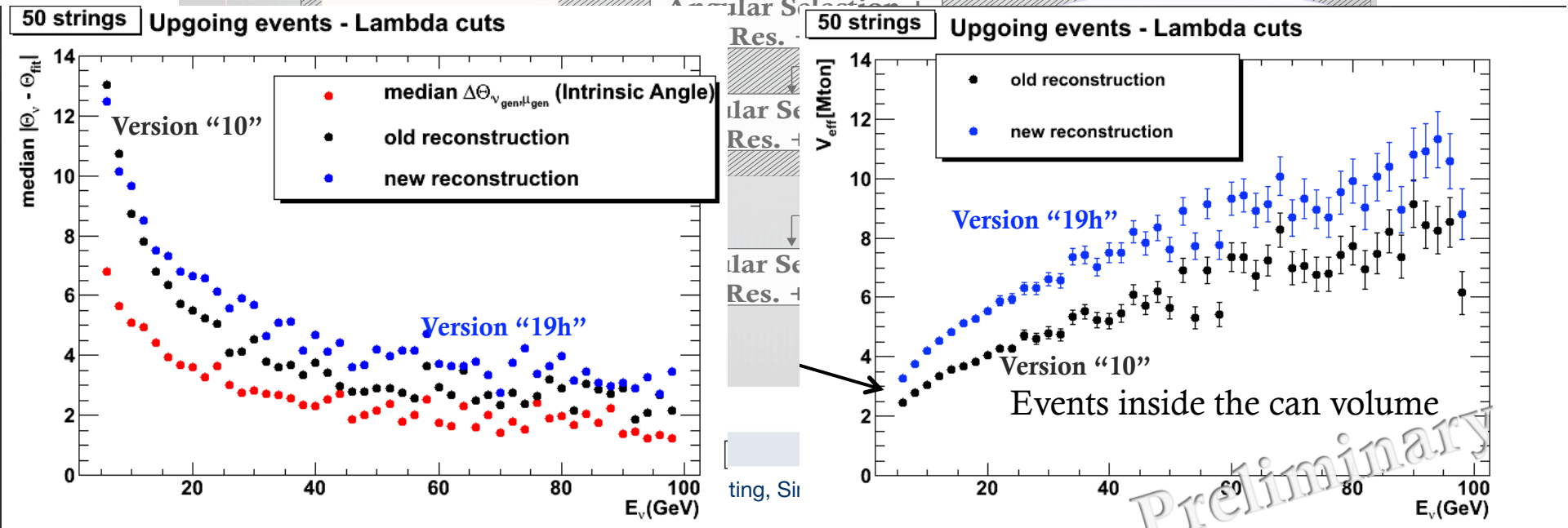
HOU Reconstruction & Simulation (HOURS) (Apostolos Tsirigotis)

- HOURS is a complete simulation package
- HOURS comprises a realistic simulation package of the detector response, including an accurate description of
- includes:
  - all relevant physical processes
  - production of signal and background
  - several analysis strategies for triggering and pattern recognition
  - event reconstruction, tracking and energy estimation.
- Further improvements/additions are scheduled



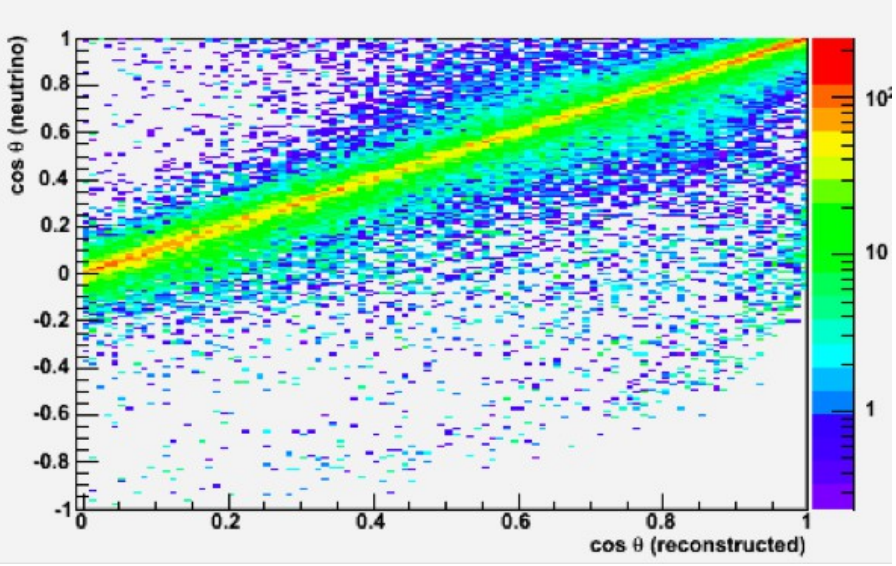
Muon track reconstruction for multi-PMT in KM3NeT (Agata Trovato)

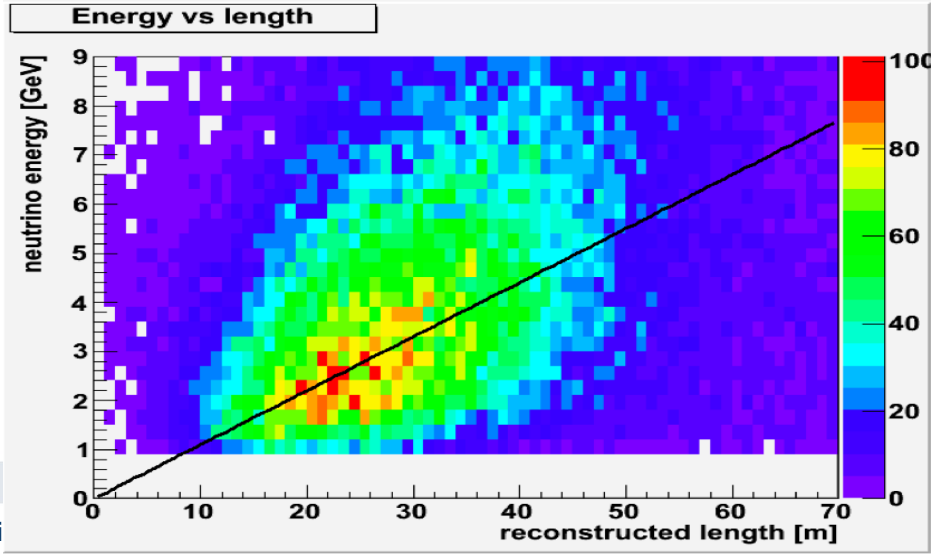
- two strategies (based on AartStrategy): version “10” (high energy) and “19h” (low energy) differ in trigger settings and pdf for fit
- after quality cuts applied to get the same angular resolution at low energy: effective volumes increase of about 25%-30% at E_ν<50 GeV



Filteringfit track reconstruction (Dorothea Samtleben)

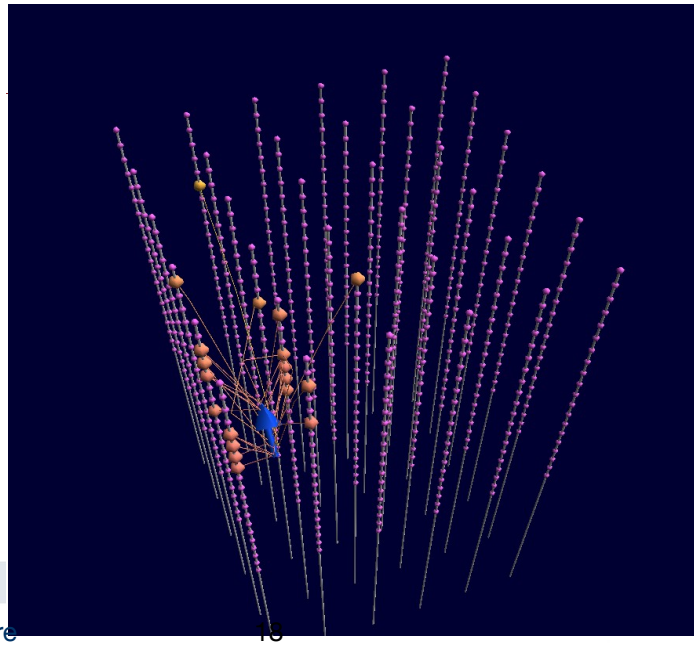
- Filteringfit provides for a flexible new scan-based track reconstruction option
- Speed is still an issue but can be improved
- Modular structure allows easy application and exploration of different reconstruction schemes
- Usage in Antares for low energy started
- promising results also for ORCA studies





aa(fit) software spin-off's (Aart Heijboer)

- Event classes for use in data-analysis
  propose to make them an official KM3NeT tool set + ntuple format (adjustments included by Aart)
- Photon tracking (+Geant 4)
  “experimental” software, useful for specialized
- Event display
  driven from user analysis script,
  useful for developers
  propose to maintain simple version
  with ntuple (GUI, etc needs manpower)



Computing

- Data handling
  - data formats: talk by Tommaso (DAQ and Readout)
  - data base:
    talks by Arnauld and Christiano (DAQ and Readout)
    → agreement on Oracle DB
  - data archive
- Computing Strategy and Hardware
  - data centres/computing hardware, networks
  - new strategies: GRID/cloud computing, parallelization
  - to start need numbers on performance
    (event size, processing time, scaling …)
- IT Services
  - central services: webpage, wiki, elog, internal portal, ICT infrastructures
  - software development: versioning system, bug tracker
  - web data portal

Next Steps

- gain overview
  (work done, work to do, interests)
- set up communication
  (mailing list, phone calls/video conferences, …)
- set up task list and work plan
  (with responsible persons)
- get going

- if you are interested: please contact me