ORCA – Configuration and Plans

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20/09/14

KM3NeT & ORCA

- 2 years ago
  - ORCA proposed for first phase of KM3NeT
- Now
  - ORCA is becoming an integral part of the KM3NeT physics program and planning
- Cost optimisation by
  - Phased construction
  - Complete share of technological solutions between Neutrino telescope and ORCA
  - Solutions based on published TDR of KM3NeT

Design – Optical Modules

Multi-PMT DOM

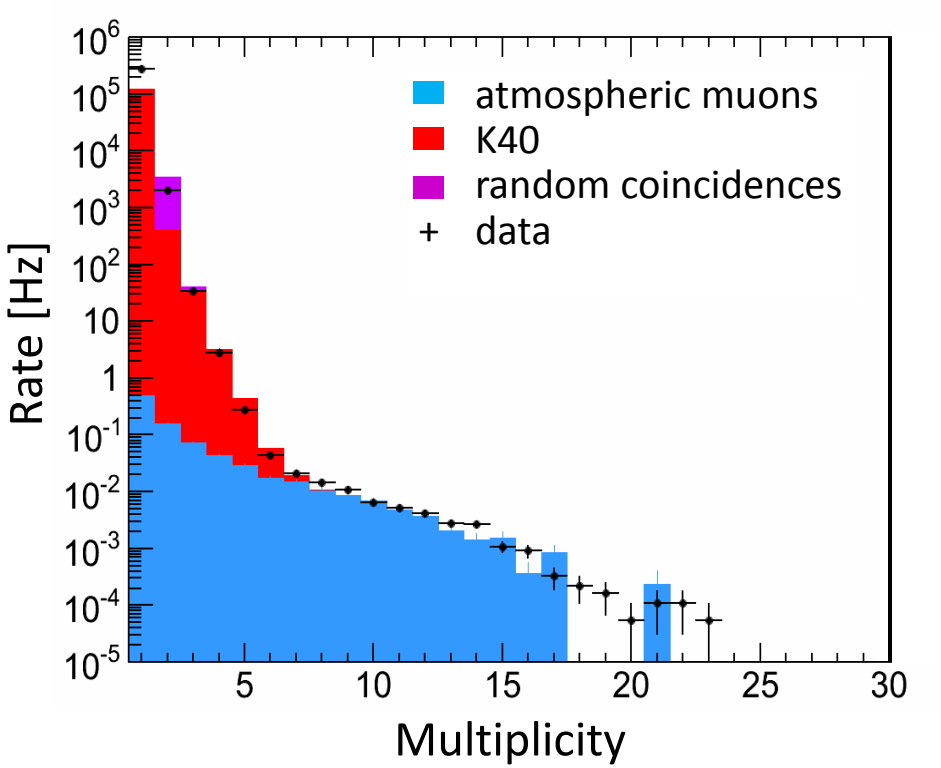
- *31 x 3” PMTs*
- *Photocathode area larger than ANTARES storey*
- *High Quantum Efficiency*
- *Photon counting & directionality*
- *Price per area lower than for large PMTs*

ETEL D792

Hamamatsu R12199

HZC XP53B20

1st prototype ¶



✓ photon counting

2nd prototype : Line with 3 mDOMs
Currently operated at Capo Passero

¶ http://arxiv.org/abs/1405.0839

Design – Detection Unit

Launcher vehicle

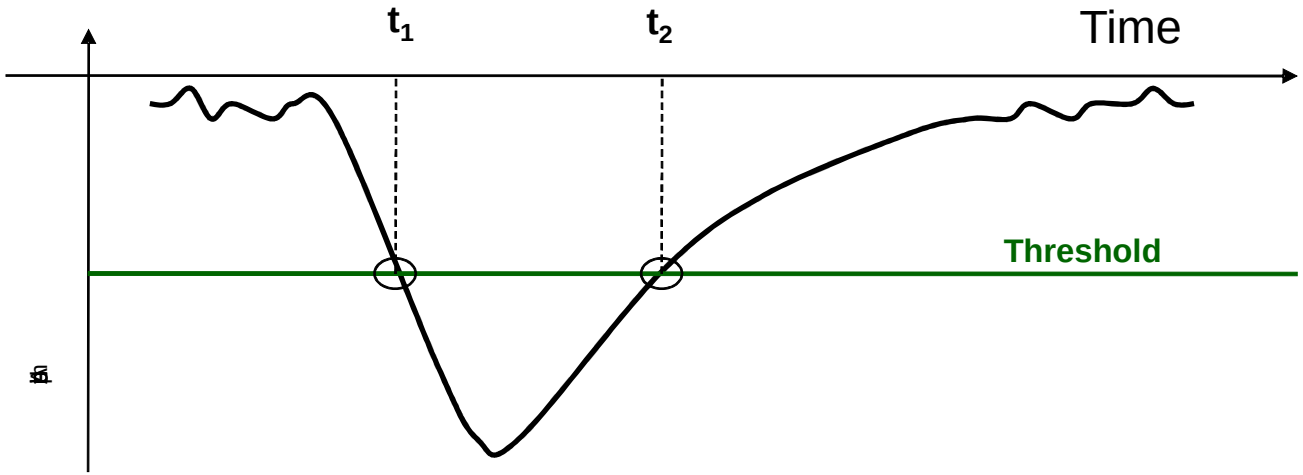
- *rapid deployment*
- *autonomous unfurling*
- *recoverable*

Each Detection Unit (Line) is composed of 18 DOMs
This number is defined by
- **DWDM system**
- **Launcher vehicle design**

Designs – Electronics & DAQ

- Time over threshold for various thresholds

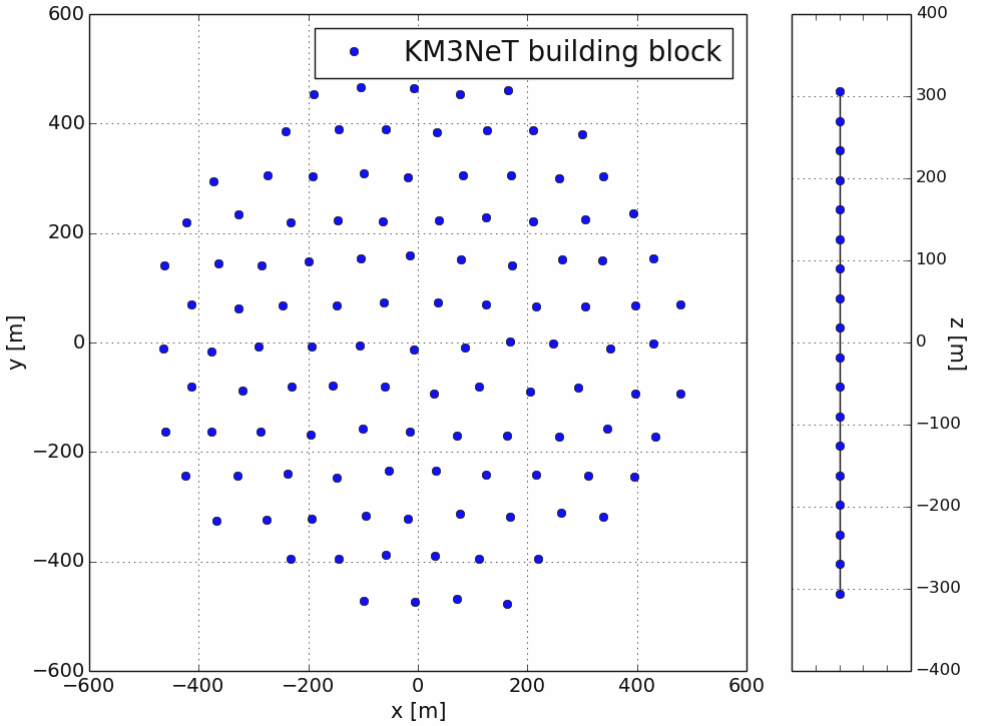
From the analogue signal to time stamped digital data:



- Implemented through FPGA & System on chip contained in optical module
- All data to shore via ethernet link
- Time synchronisation and slow control

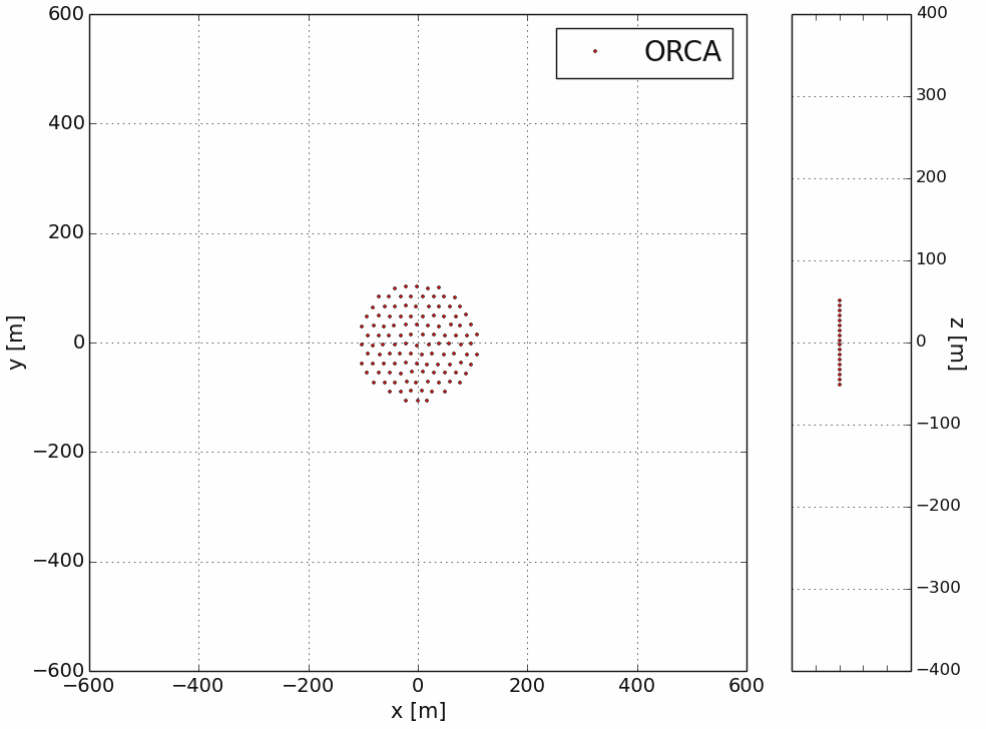
Design – Building Block

- 115 detection units (lines)
- High energy
  - 2070 DOMs
  - Footprint ~1km^2
  - 600m high



Design – Building Block

- 115 detection units (lines)
- ORCA
  - 2070 DOMs
  - Footprint ~0.036 km^2
  - 100m high
- Tunable parameters
  - Line distance
    - 20m (deployment)
  - DOM vertical distance
    - 6m, being optimised



KM3NeT - Phased implementation

Phase	Total costs [M€]	Planned Installations	Status
1	31	Shore & deepsea infrastructures at two sites, 20-30 protoype lines	Funded
1.5	80–90	2 building blocks	Letter of Intent
2	220–250	Many building blocks	ESFRI road map

¶Total costs ≡ Total cumulative costs.

ORCA - Phased implementation

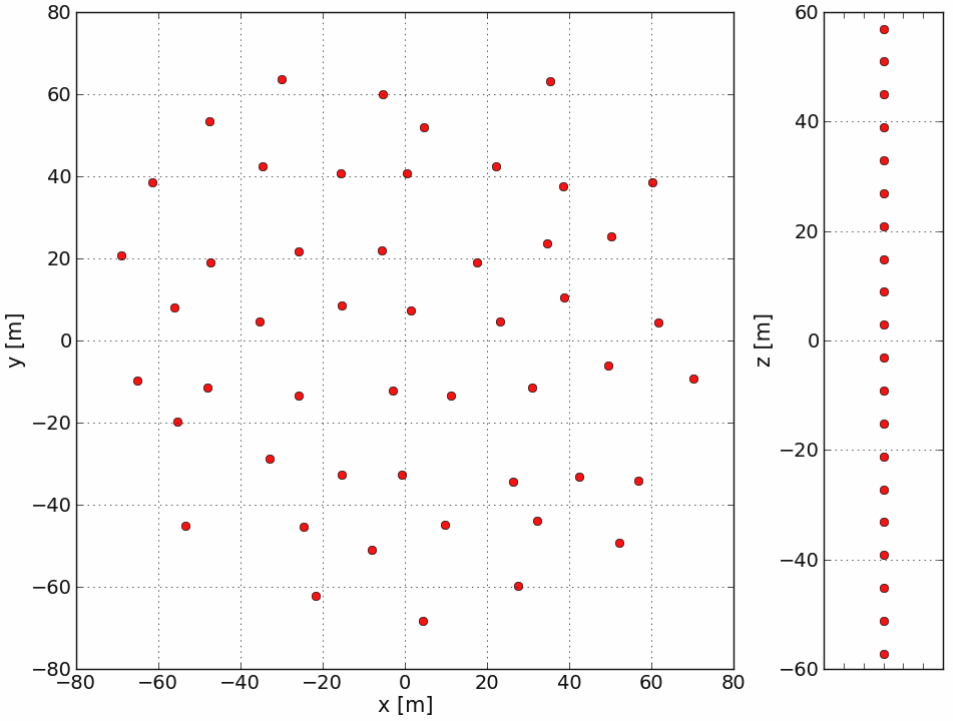
Phase	Total costs [M€]	Planned Installations	Status
a	Funds Phase 1	6-10 ORCA lines, proof of - Deployment of dense detector - Detection of low energy ν	Being discussed within KM3NeT
b	40	1 building block, parallel to HE Phase 1.5, funds permitting	Feasibility study
c	?	Beam from Protvino Extensions for CP-phase sensibility	Feasibility study

Multi-Site concept allows for parallel construction of ORCA & HE phase 1.5 detector, one candidate site for ORCA : Toulon

Simulations ~1 year ago

- Reference detector with
  - 50 lines
- Instrumented mass
  - 1.7 Mton
- Focus on track signature
- Several results obtained with this setup → scaled to new reference
- Conservative as performance improves better than linear with size

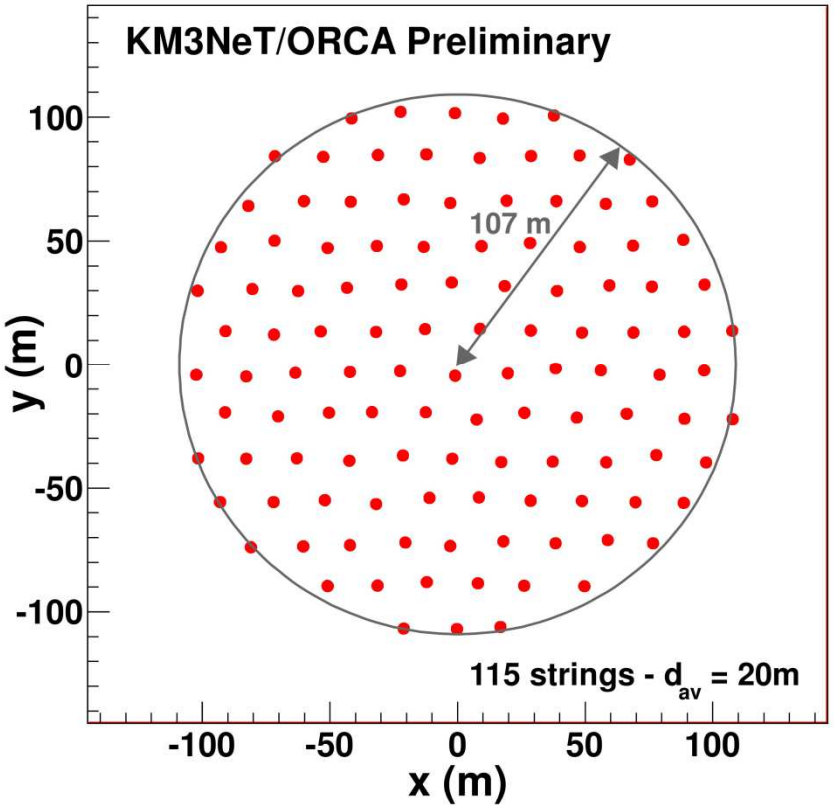
Line distance : 20m
DOM distance 6m



Simulations now

- Reference detector
  - 115 lines = building block
- Instrumented mass
  - 3.7 Mton
- Importance of cascade channel recognized
- Track & cascade considered on equal footing

Line distance : 20m
DOM distance 6m

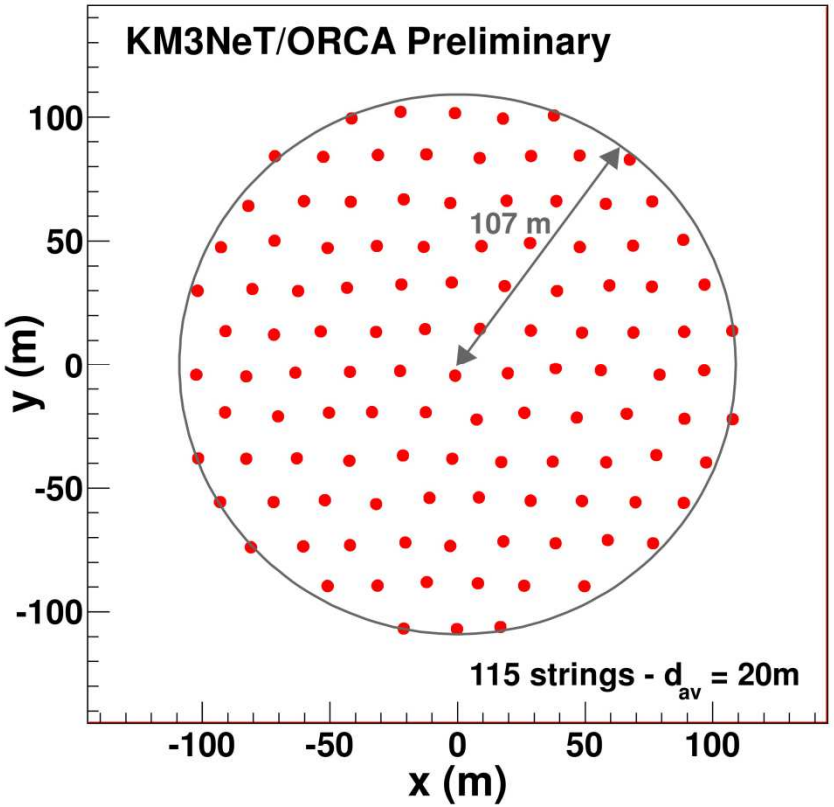


Geometry optimisation

- Reference detector
  - 115 lines = building block
- Consider larger vertical spacing by suppressing DOMs &scaling of instrumented volume →**Jannik**
- Dedicated simulation with 3x3x3 m^3 grid for finer grained optimisation →**Salvatore**
- Ongoing activities, no firm conclusion yet

Line distance : 20m

DOM distance 6,12,18m



Reconstruction

- Early focus : muon channel
  - Good results on angular resolution, E_μ and M_{eff} → **Agata**
  - Pending : Neutrino energy resolution
- From 2014 on : cascade channel
  - Encouraging results on angular, energy resolution & M_{eff} → **Jannik**
- Recent progress
  - Atmospheric muon rejection → **Luigi**
- Near future
  - E_ν and particle ID

Sensitivity & Systematics

- Development of coherent method to calculate sensitivity, including all effects and their correlations more difficult than originally thought → different approaches in PINGU & ORCA
- recent progress → **Martijn & Lukas**
- Systematic effects : ongoing activity
  - towards a list of generic nuisance parameters such as
  - Overall normalisation, shape corrections, offsets, asymmetries

Summary

- Phase 1 of KM3NeT might see few ORCA lines to
  - identify few GeV neutrinos
  - demonstrate deployment with dx = 20m
- Feasibility study : Demonstrate mass hierarchy sensitivity, benchmark : 3σ in 3 years
- So far no show stopper identified
- If both positive & supported by KM3NeT collaboration
  → obtain funding

ORCA with 1 building block
Parallel to KM3Net phase 1.5 detector