KM3NeT

a next generation neutrino telescope

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NIKHEF

What is KM3NeT?

- A future deep sea Research Infrastructure
- A next generation water Cherenkov neutrino telescope
- EC FP6 Design Study for a

  Deep Sea Facility in the Mediterranean for Neutrino Astronomy and Associated Sciences

which started February 2006

KM3NeT consortium

38 institutes from:

Cyprus, France, Germany, Greece, Ireland
Italy, Malta, The Netherlands, Spain, UK

+

+

+..

KM3NeT DS objectives

- Effective volume ≥ 1 km^3
- Angular resolution for muons: 0.1^0 (for neutrino energies ≥ 10 TeV)
- Energy threshold: few 100 GeV (~100 GeV when pointing)
- Sensitivity to all neutrino flavours, CC/NC reactions
- Field of view: close to 4π for high energies

Targeted budget:
M€220-250 (ESFRI roadmap)

KM3NeT DS deliverables

- Conceptual Design Report: autumn 2007 (workshop in Amsterdam, November 2007)

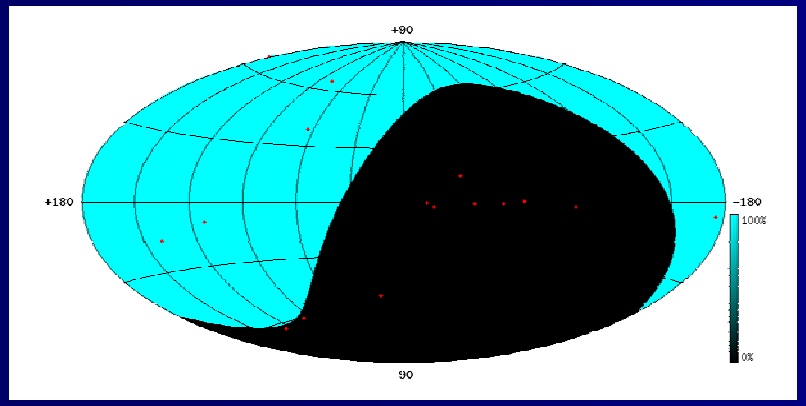
- Technical Design Report: spring 2009

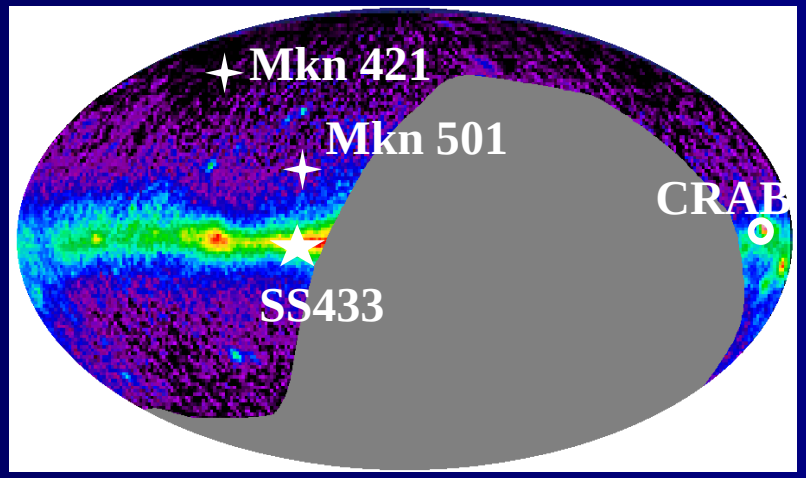
  a.o.

  – Technical description of major parts
  – QA/QC procedures
  – Optimal site-detector combinations
  – Inventory of resource opportunities

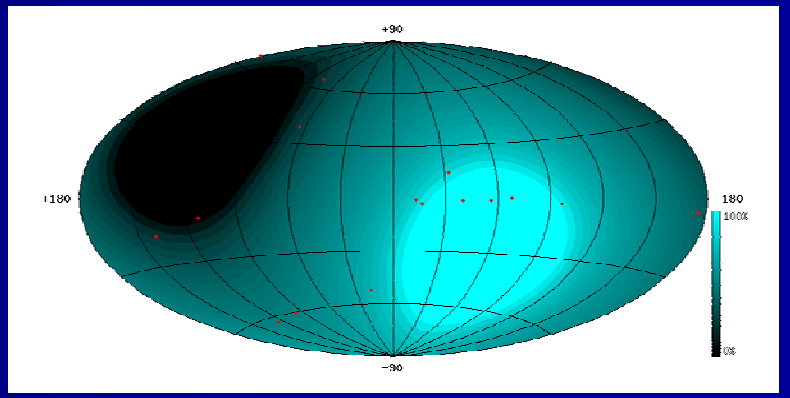
Neutrino astronomy

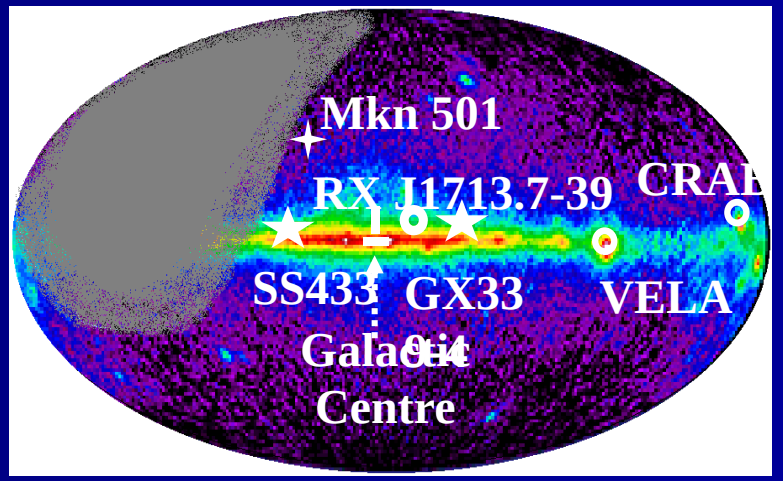
Antartica





Mediterranean Sea

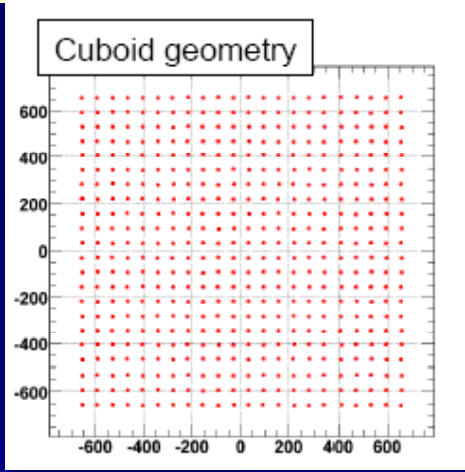


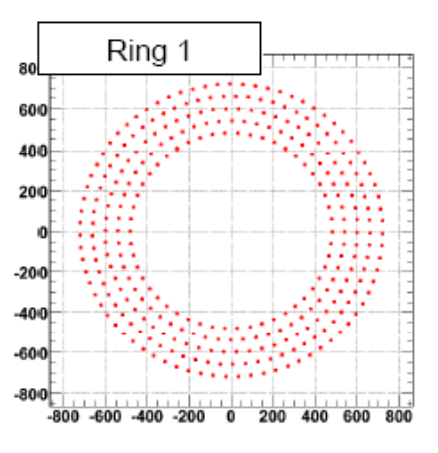


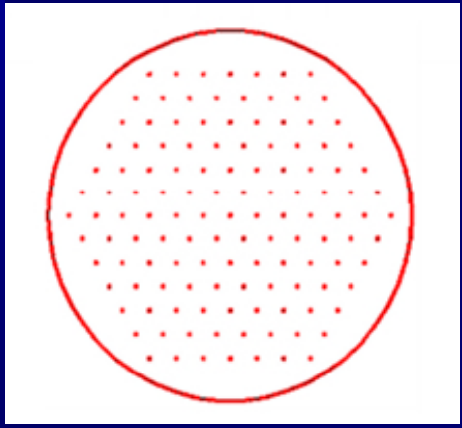
Simulations

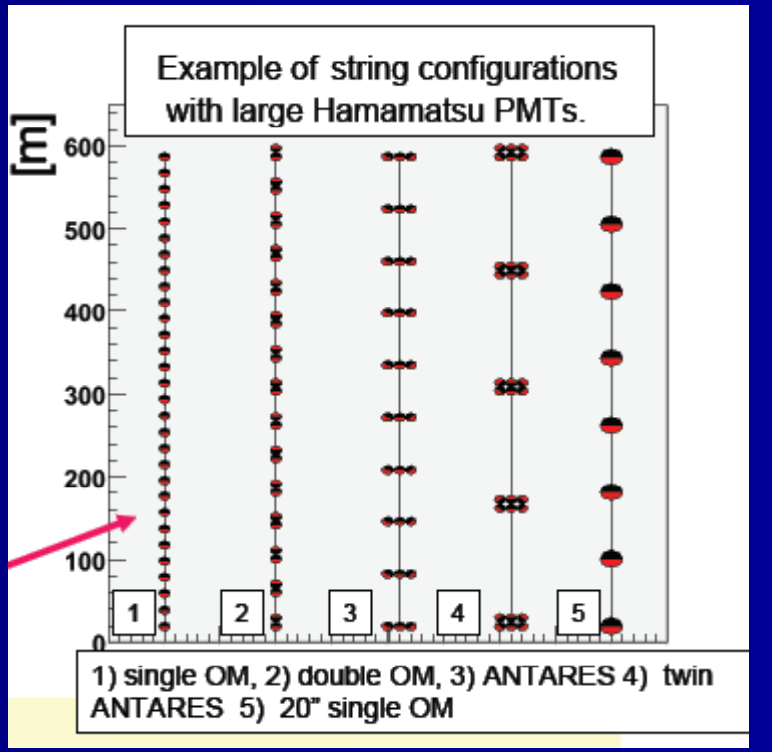
...many parameters...

Simulating various configurations









Cuboidial,
Ring,
Hexagon,
Clustered,
IceCube-like
...

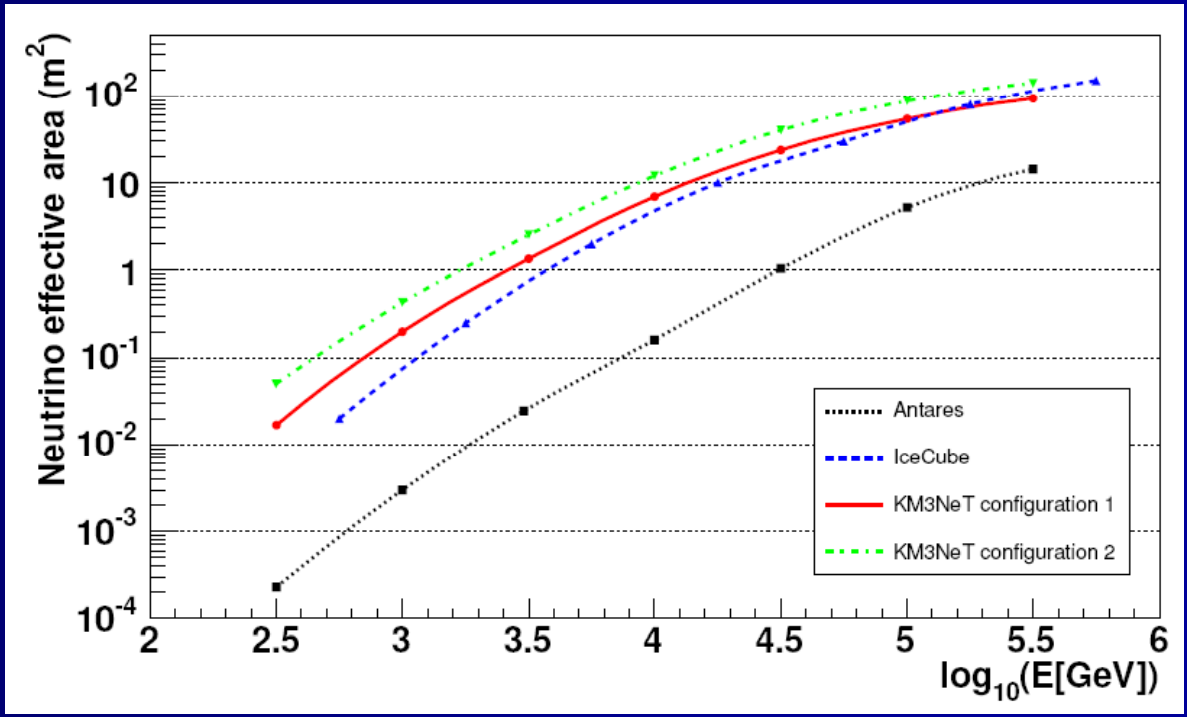
Usually with Antares environmental parameters

Estimated neutrino effective area

Configuration 1 (1 km³):
127 lines in hexagon
100m line spacing
25 storeys, 15 m apart
3 Antares (10”) PMTs
per storey

Configuration 2 (1 km³):
225 lines in cuboid grid
95m line spacing
36 storeys, 16.5 m apart
21x3”PMTs per storey

Antares site parameters



Ref. ICRC0865, J. Carr et al
Thesis S. Kuch, Erlangen

Estimated sensitivity to HESS sources

Neutrino energies 1TeV – 1 PeV
Muon event rates for 5 years of data taking

	Name	configuration 2		configuration 1	
		τ_1 / bgr	τ_2 / bgr	τ_1' / bgr	τ_2' / bgr
1	Vela X	10.0 (16.0) / 13.0	23.6 (34.8) / 34.0	2.3 (3.3) / 4.2	4.2 (6.1) / 6.8
2	RXJ1713.7	6.4 (11.2) / 23.3	15.8 (25.2) / 61.0	1.6 (2.5) / 14.1	2.8 (4.4) / 22.3
3	RXJ0852.0	6.4 (12.9) / 59.0	15.8 (29.2) / 154.5	1.5 (2.8) / 30.2	2.9 (5.3) / 49.6

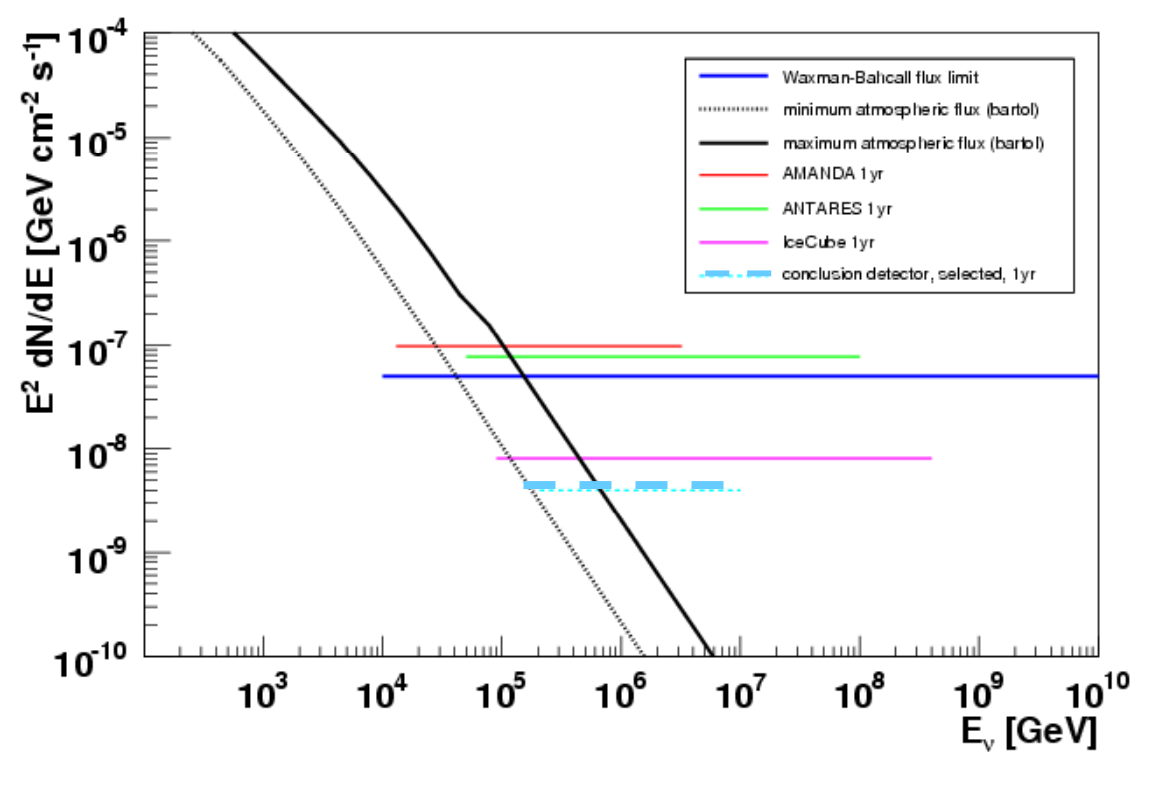
Ref. ICRC0865, J. Carr et al

Estimated diffuse flux limit

Configuration 2:
225 strings with lower half sphere multiPMTs

No atmospheric muon background taken into account

No energy reconstruction applied



Thesis S. Kuch, Erlangen

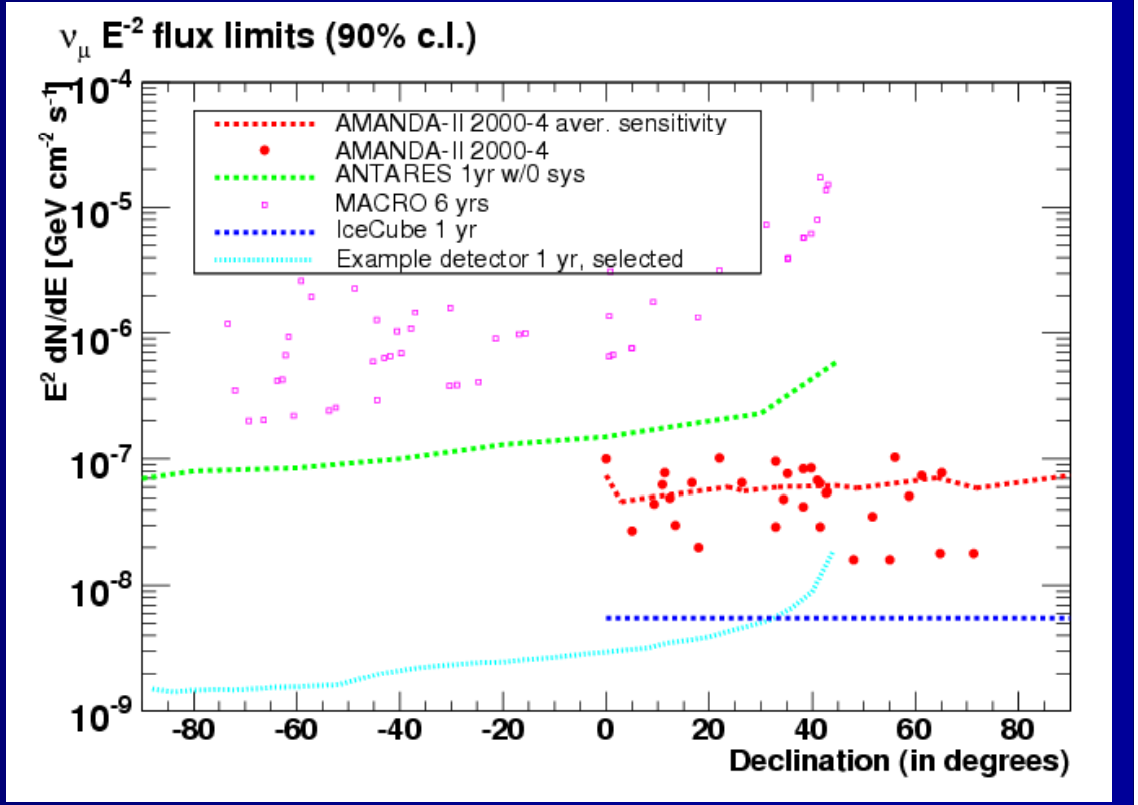
Estimated E^{-2} flux limit

Configuration 2:
225 lines with lower half sphere mulitPMTs

No atmospheric muon background taken into account

Muon energy reconstruction perfect

Neutrino energies
1 TeV – 1 PeV

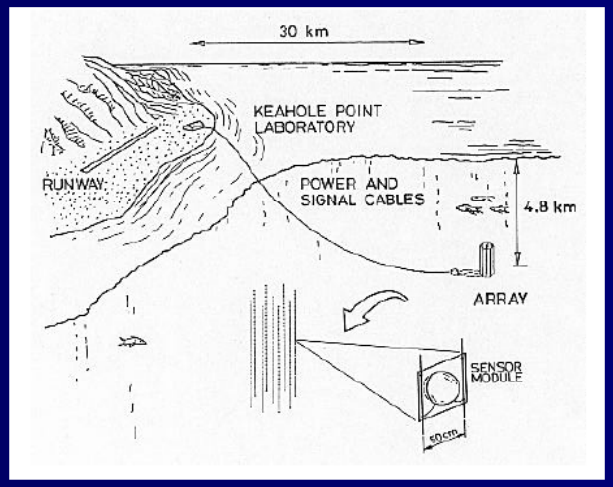


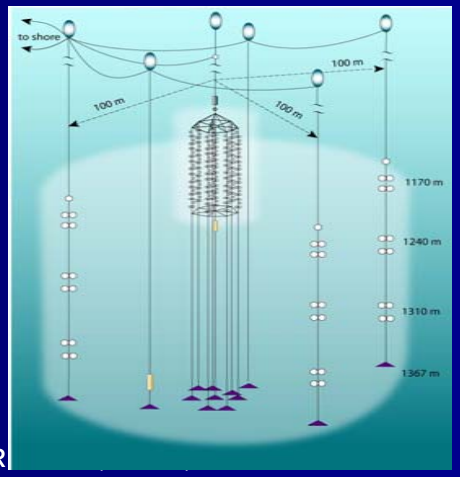
Thesis S. Kuch, Erlangen

...on the shoulders of....

DUMAND and Baikal what have we learned?

- Dumand: wet mateable connectors are weakest point -> minimize # wet mateable connectors
- Baikal: no junction box -> no wet mateable connectors





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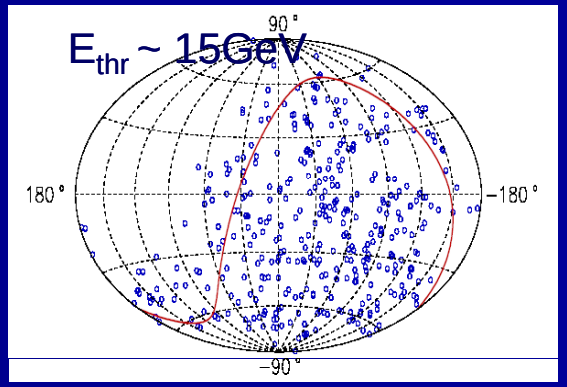


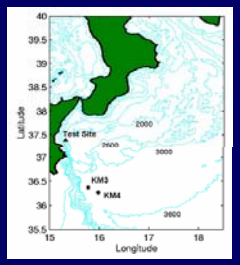
ref. astro-ph /0609711v1

AMANDA/IceCube what have we learned?

- Remote operation -> virtual control room
- InIce: high level of mass production of strings (currently 780 OMs on 13 strings per summer)
- IceTop: calibration, veto, CR physics

  -> SeaTop?

Mediterranean what have we learned?

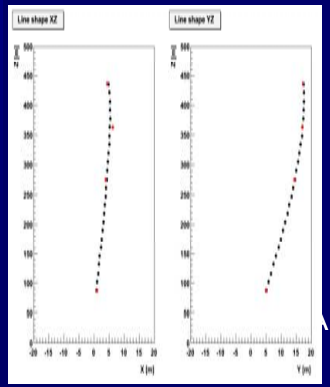


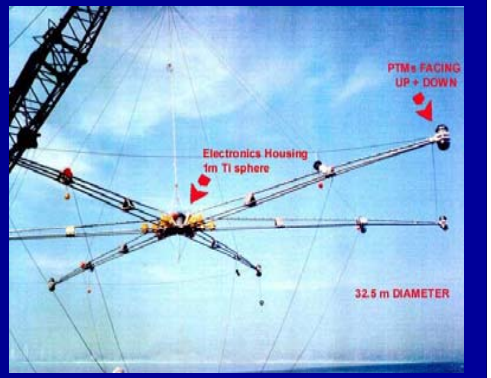
- Antares:
  - Monitoring of position flexible structures
  - All-data-to-shore

  -> minimize off-shore electronics
- Nemo:
  - Compact deployment

  -> maximize number of OMs per hour deployment
- Nestor:
  - Telescope-to-shore connection without ROV

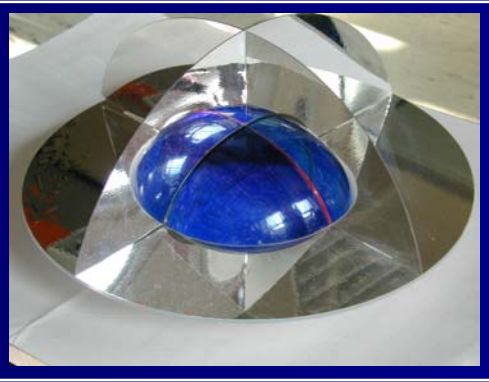
  -> minimize wet-mateable connectors





...use this experience in KM3NeT...

Optical Module



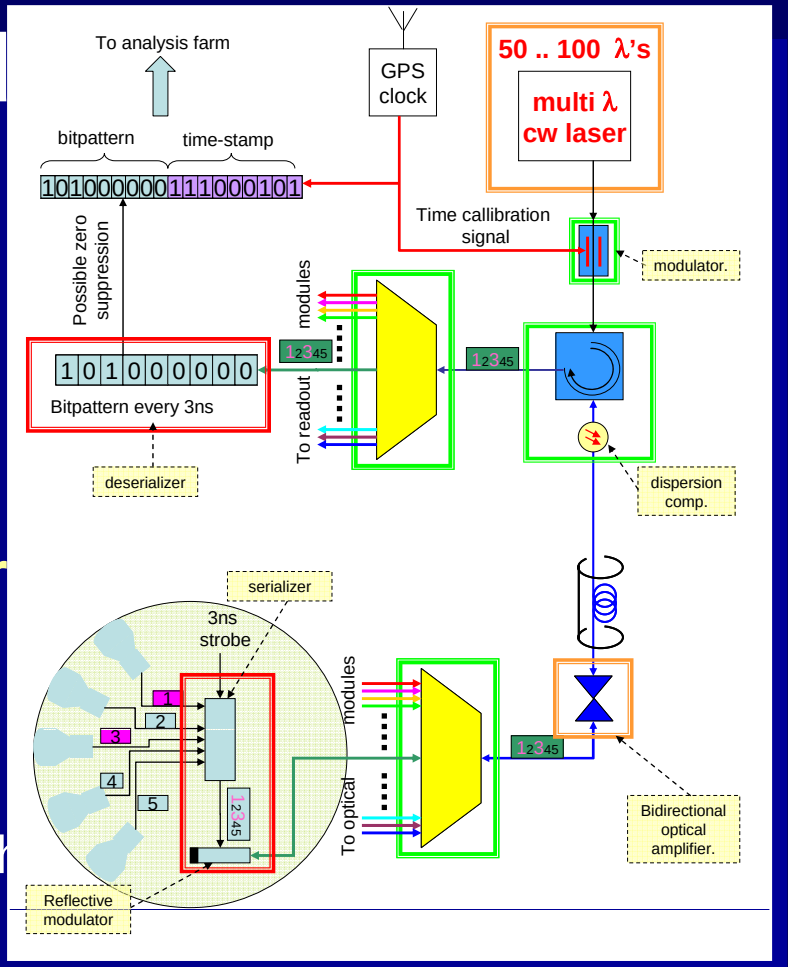
Segmentation of photo cathode of 10” PMT

-> number of connectors per photo cathode area minimized

Readout/data transmission

Three options studied

- **a la Antares**
  - Improved front-end chip
  - new FPGA/CPU
- **1-1 wire/fiber network**
  - new front end chip
  - multi-functional FPGA system
- **1-1 photonics based networ**
  - front-end chip or pic
  - on-shore timestamp
  - on-shore multi-λ laser
  - reflective optical modulator off sh



-> number of active components off-shore minimized

Ref. ICRC. 0490, P. Kooijman et al

Detection unit

- Rigid or flexible structure
- Both options can work, assess:
  - Reliability
    - #(wet mateable) connectors
  - Production model
    - Distributed versus single assembly site
    - Transport to deployment site
  - Deployment model
    - Dependence on weather conditions
    - #(sub)sea operations: #OM per hour deployment

Production model example

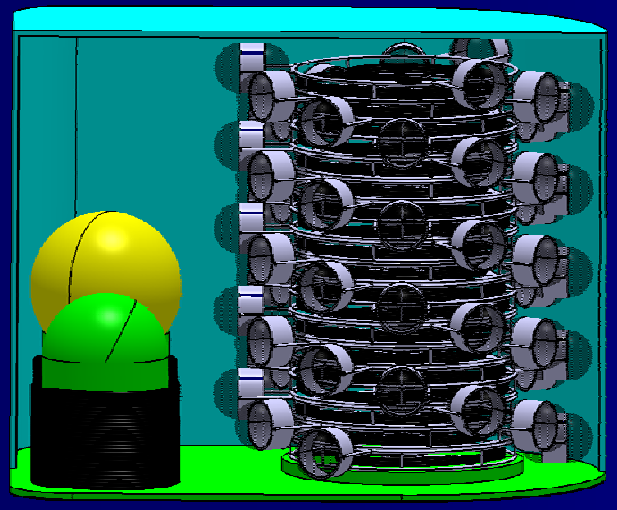
- Configuration:
  - 10000 optical modules
  - 250 detector units
  - 25 calibration units
- 3 years for construction (2010-2013)

15 / day
10 / month
1 / month

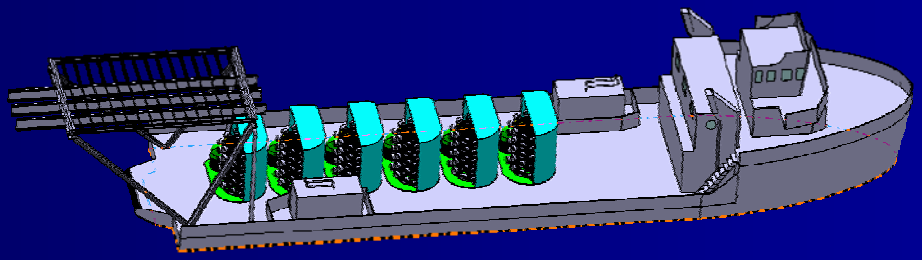
~ 5 assembly sites are needed

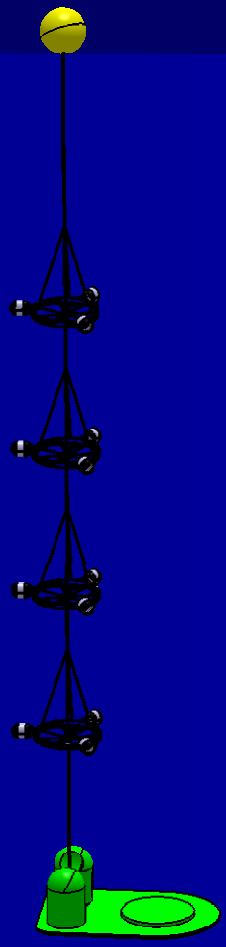
10 “lines” /400 OMs per month to be deployed

Deployment of few hundred OMs per month



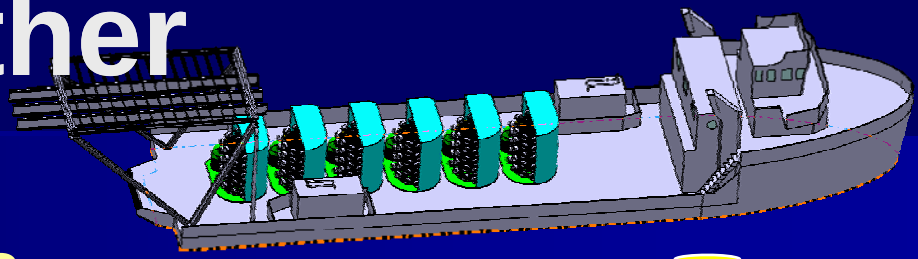
a la NEMO, but with flexible structures



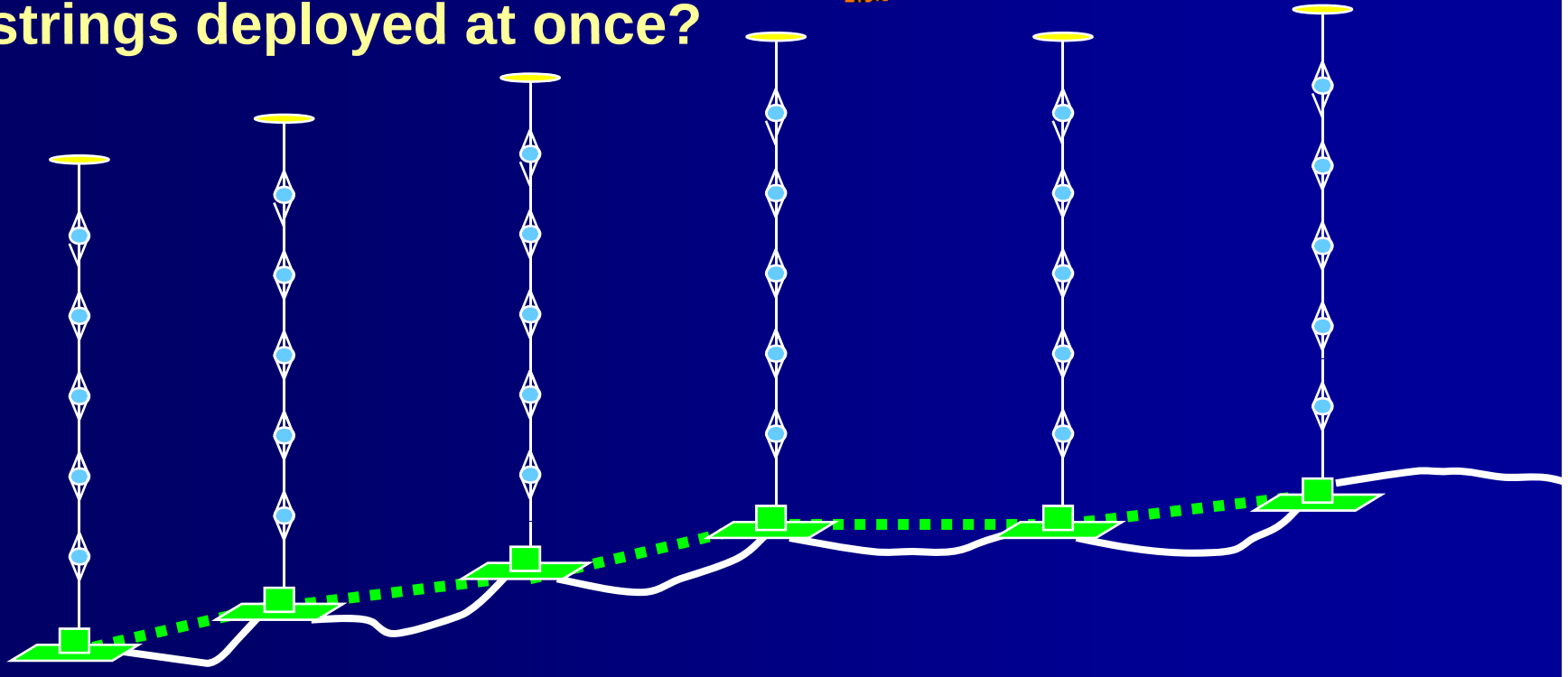


-> Large number of optical modules per hour deployment

Deployment one step further



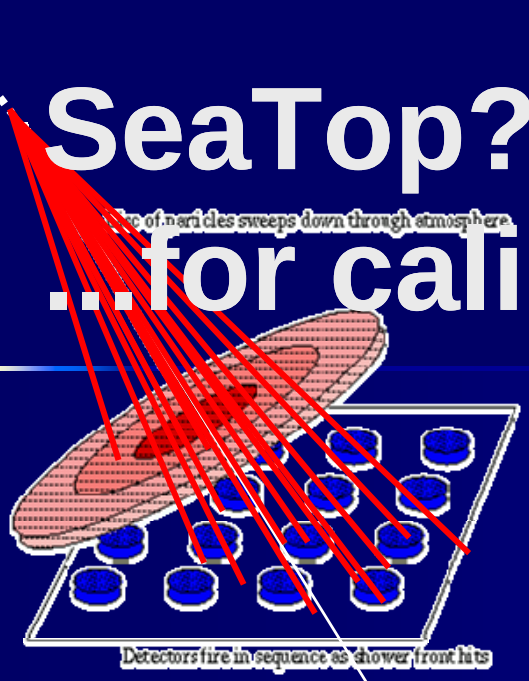
Multiple interconnected strings deployed at once?



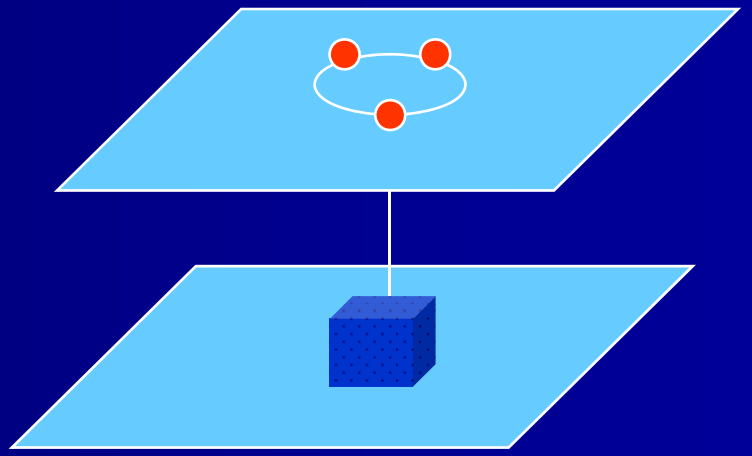
-> Less wet-mateable connectors

E. de Wolf, Nikhef/UvA

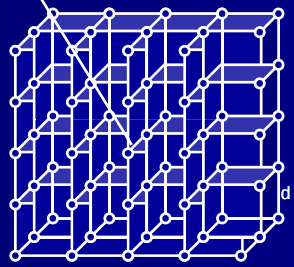
SeaTop?
...for calibration only



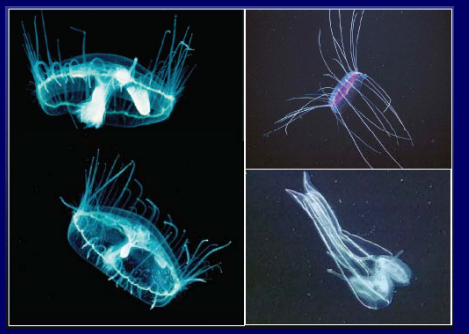
Three stations at 20 m distances
with 16 m2 scintillators each



Calibration:
- angular offset
- efficiency
- angular resolution
- absolute position



Associated sciences



- KM3NeT site in ESONET and EMSO
- KM3NeT report:

Opportunities for Long Term Cabled Observatories in the Mediterranean Sea

editors I.G. Priede and A.J. Jamieson

Site selection

- KM3NeT report input for discussion:

  Evaluation of existing water, oceanographic, biological and geological data from candidate sites

Site selection

Final choice will depend on

- Depth
- Distance from shore
- Bioluminescence rate
- Sedimentation
- Biofouling
- Sea currents
- Earth quake profile
- Access to on-shore high speed networks
- ……

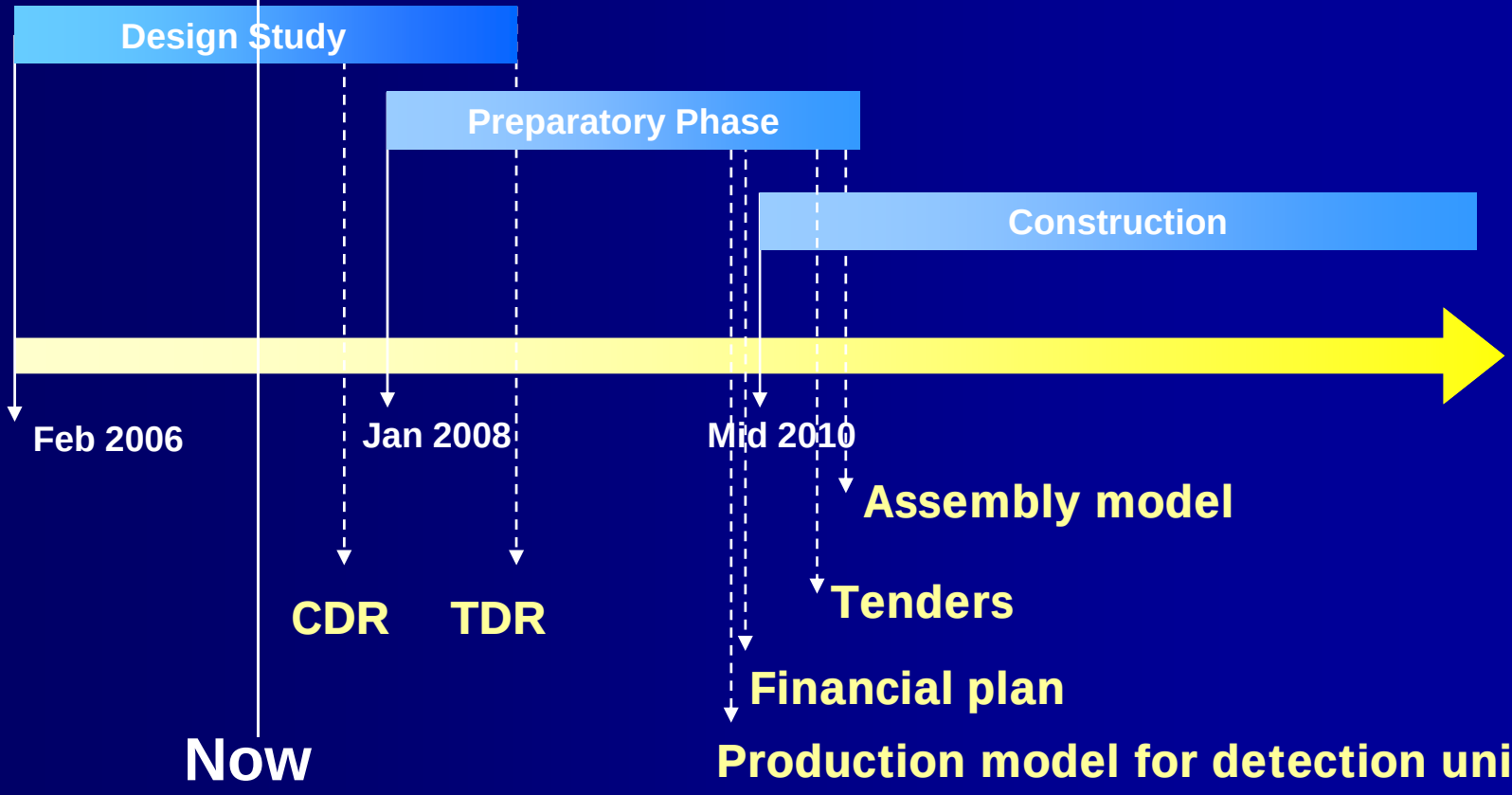
- **Socio-political/regional considerations**

KM3NeT phases

- **Design study: 2006-2009**
  - Technical Design Report
- **Preparatory phase: 2008-2011**

  (proposal submitted)
  - Political convergence (site)
  - Commitment for construction of funding agencies/ministries
  - Governance and legal structure
  - System prototype
  - Tendering procedures
- **Construction phase: 2010-2013**
  - Build ≥1 km3 detector

Foreseen KM3NeT profile



ECRI 2007

european conference on research infrastructures

Robert-Jan Smits

Director, Research DG, European Commission

ECRI 2007, Hamburg, June 6, 2007

Life-cycle of a Research Infrastructure

Preparatory Phase	Construction Phase	Operational Phase	Upgrade
▪FP7 ▪Member States ▪Research centres	▪Member States ▪Structural funds ▪EIB ▪Industry ▪FP7	▪Member States ▪Users ▪Industry ▪FP7 ▪EIB	▪Member States ▪Structural funds ▪EIB ▪Industry ▪FP7

Conclusions of ECRI 2007

5) To allow for the realization of the 35 projects of the ESFRI roadmap, the conference underlines in particular the importance of the following issues:

a) availability of top talents and researchers

b) creation of a dedicated legal structure at European level which includes efficient governance models.

c) effective financial management by combining different sources of funding, notably national, EU framework programme, structural funds, EIB, charities etc.

d) effective use of e-infrastructures to allow for optimum connections

e) appropriate arrangements for data storage, security and preservation

6) The conference felt that special attention should be paid to the international dimension of research infrastructures and called for increased cooperation with Europe's main partners around the world.

Summary

- KM3NeT DS is well on its way
  - Building on experience of existing telescopes
  - CDR workshop in November 2007
- Waiting for a decision on FP7-PP proposal
  - Commitments for construction
  - Governance
  - Site selection
  - System prototype


New groups are welcome!
KM3NeT