Mechanics parallel session

Critique Of ANTARES MECHANICS, S.CUNEO

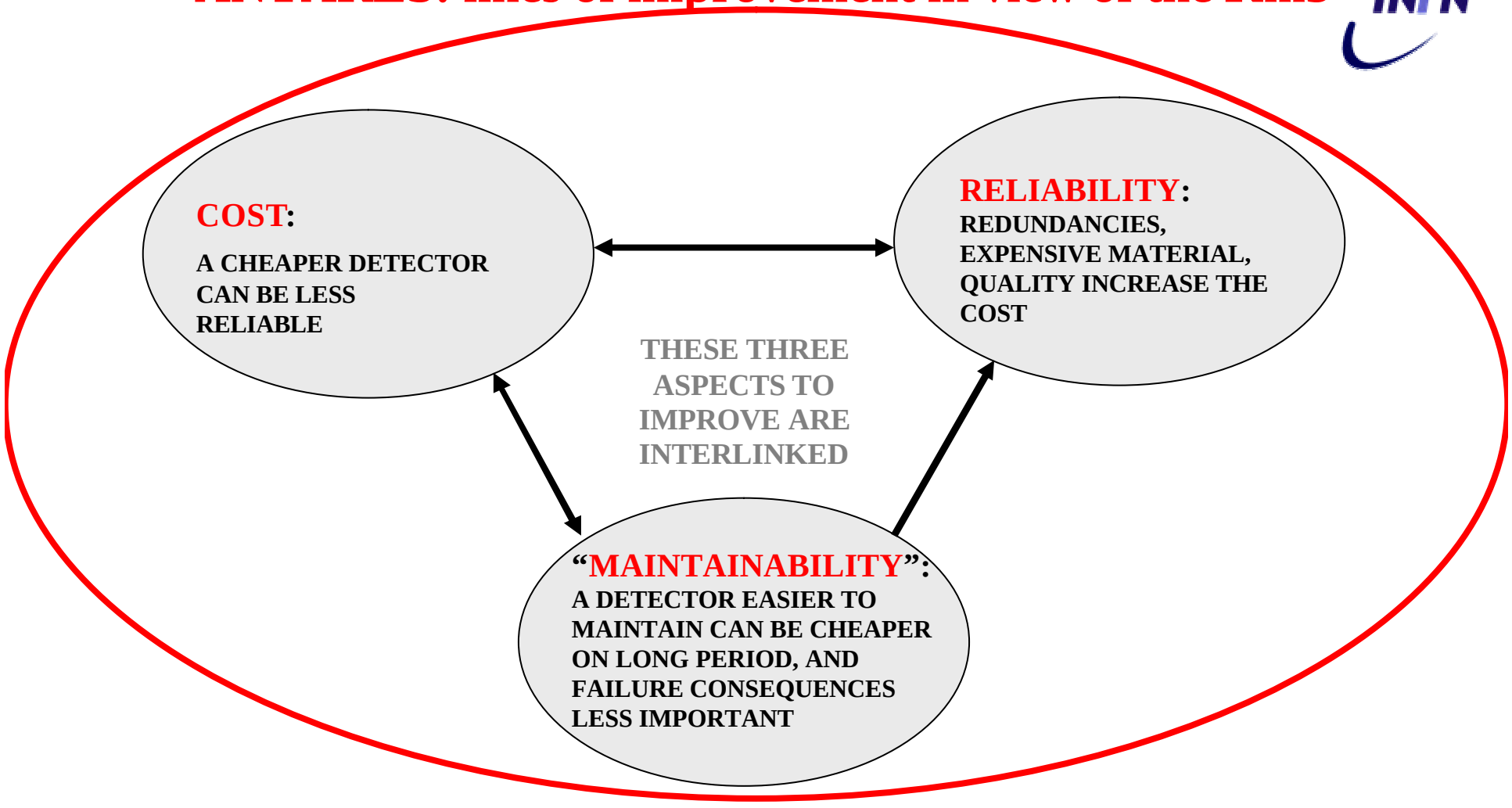
Analisys of mechanics ideas or NEMO, M.MUSUMECI R. OCCHIPINTI

Composite material for deep sea water detectors, L.GUALDESI

Presentation on NESTOR mechanics, E.ANAZONTZIS

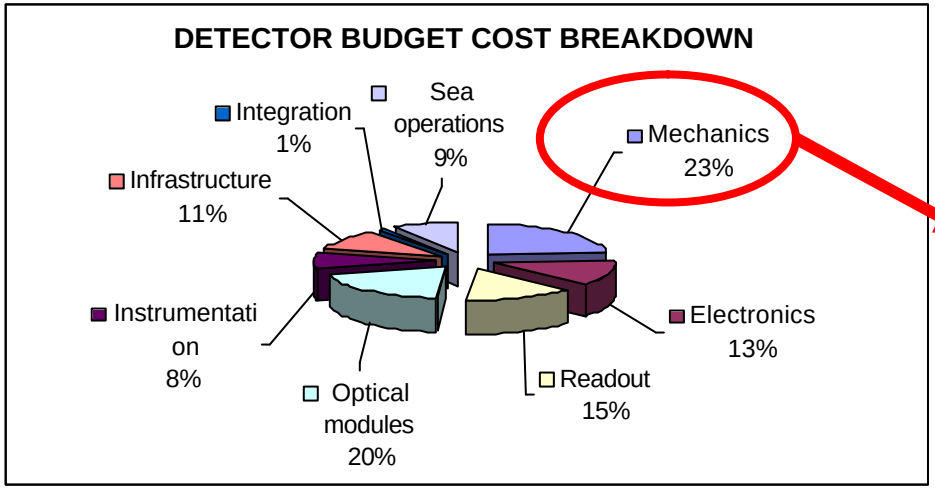
Plastic encapsulation of electronics, A.KAPPES

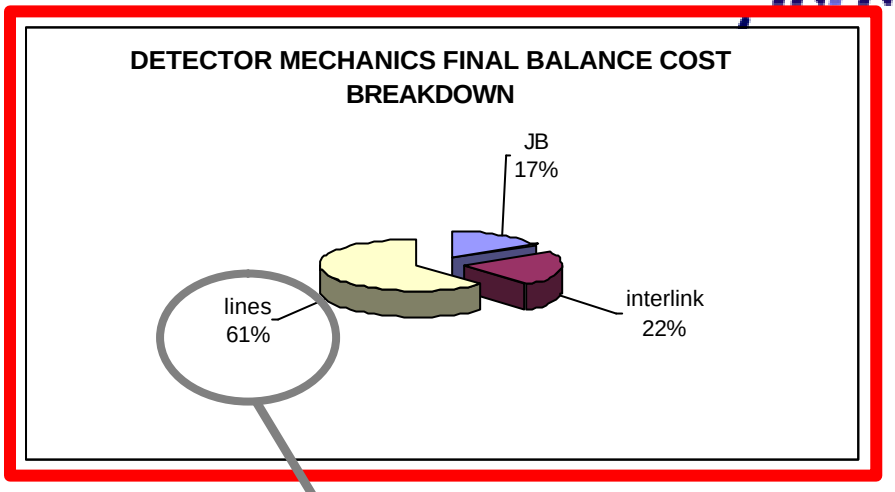
ANTARES: lines of improvement in view of the Km3

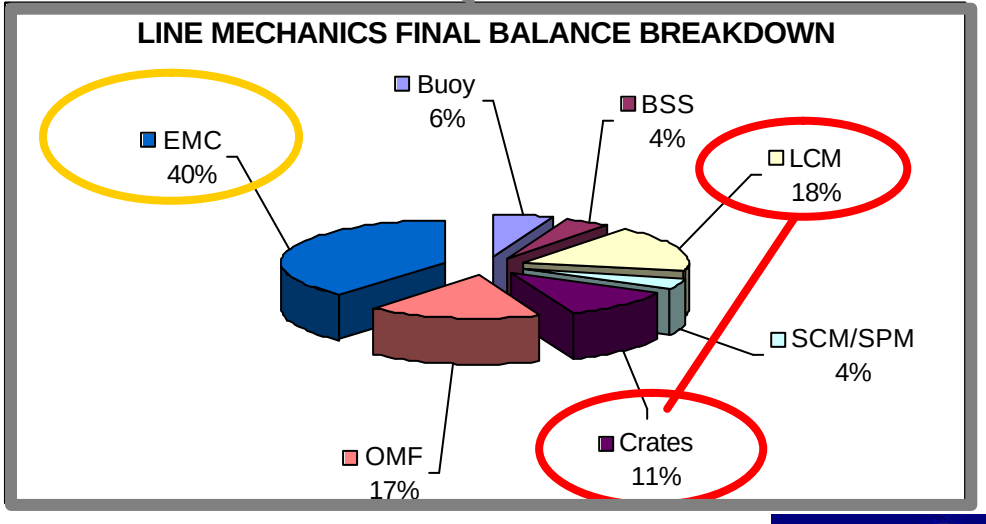


BUT, GIVEN THE QUANTITIES INVOLVED, A STRONG COMMERCIAL ATTITUDE AND AN EFFECTIVE MANAGEMENT CAN ALLOW SIGNIFICANT COST REDUCTIONS

ANTARES: costs of the mechanics







MECHANICS ENGAGE A SIGNIFICANT AMOUNT OF THE DETECTOR BUDGET

THUS, EN AFFORT ON THAT FIELD IS WORTH TO REDUCE DETECTOR OVERALL COSTS

SOME GENERAL SUGGESTIONS:

- **USE OF STD COMPONENTS/SIZES**
- **ALTERNATIVE MATERIALS (FIBREGLASS vs TITANIUM)**
- **STRONG PROJECT MANAGEMENT / COMMERCIAL ATTITUDE**
- **TAKE ADVANTAGE OF LARGE SERIES PRODUCTION COST SCALEFACTOR**
- **SIMPLIFY THE DESIGN**

ANTARES: mechanics reliability

AFTER THE EXPERIENCE, IT SEEMS THAT MECHANICS RELIABILITY COULD BE SIGNIFICANTLY INCREASED IF APPROPRIATE RESOURCES ARE DEVOTED TO QUALITY ASSURANCE

- MANUFACTURER CHANGED DESIGN WITHOUT NOTICE
- TIME PRESSURE ON THE PROJECT
- ACCEPTANCE TESTS INAPPROPRIATE

→ **EMC FIBRE FAILURE**

- ORIGINAL SUPPLIER WRONG SPECIFICATION, HOLES MACHINED TOO LARGE
- CORRECTIVE INFORMATION AVAILABLE, BUT NOT ENOUGH EMPHASIZED
- MISMATCH HOLE-CONNECTOR

- POOR EXPERIENCE ON THE CABLE
- ACCEPTANCE TESTS INAPPROPRIATE
- A CABLE/MOLDING FAILURE COULD NOT BE DETECTED

→ **WATER LEAK**

- POOR HANDLING OF MATERIAL
- POST-ASSEMBLING CONTROL HARD TO BE DONE
- CARBON STEEL NUTS WERE INTEGRATED WHERE TITANIUM WAS FORESEEN

- POOR DOCUMENTATION HANDLING
- MANUFACTURER WORKED ON PRELIMINARY DRAWINGS
- AISI304 PARTS WERE INTEGRATED WHERA TITANIUM WAS FORESEEN

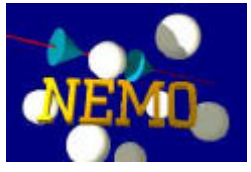
→ **CORROSION**

NEMO

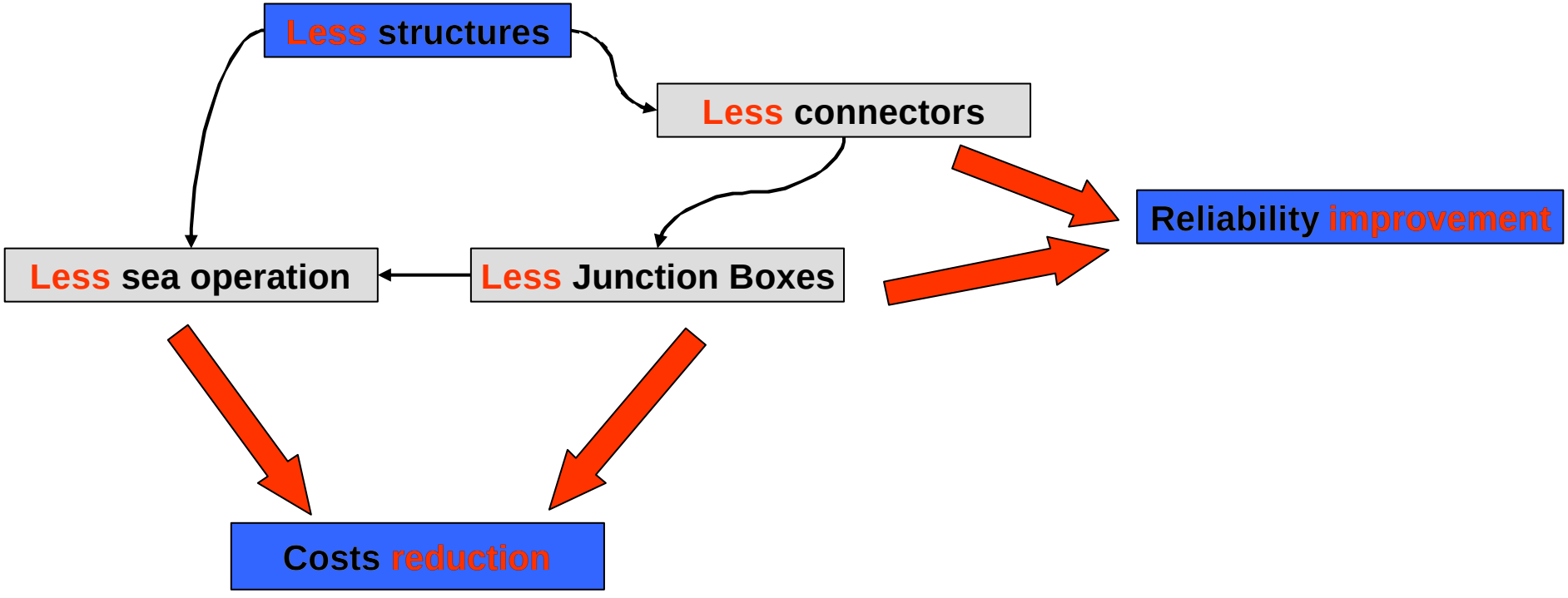
The goals of the mechanical development for the KM^3

The main goals of the work made by the NEMO collaboration to optimize the design of an ultra deep water submarine neutrino detector were the followings:

- ✓**Reduce the cost to instrument a km^3 detector by means of;**
  - ➢ **Use of towers, that permit to enlarge the spacing between the vertical structures**
  - ➢ **Realization of a modular layout for the detector;**
  - ➢ **Utilization of composite material;**
- ✓**Reduce the maintenance costs of the detector by means of:**
  - ➢ **Study of innovative connection methods;**
- ✓**Simplify the deployment operations of a 3D structure;**
- ✓**Avoid mechanical stresses on the electro-optical cables during the deployment and the lifetime of the detector;**

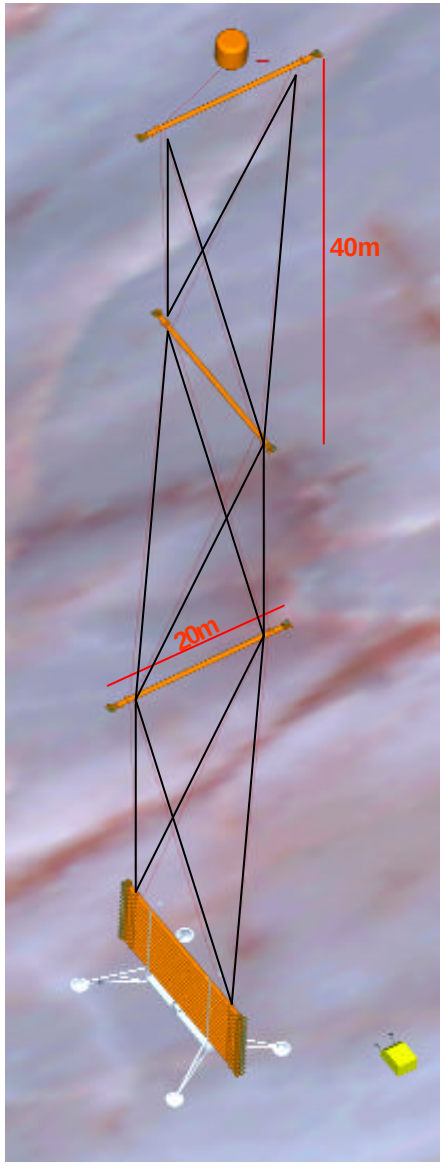


STRUCTURE REDUCTION EFFECTS



NEMO

Current configuration of the NEMO proposal for a tower



The supports for the PMT are made of pipes in Glass Reinforced Plastic (GRP) interconnected by means of synthetic fiber ropes.

The employ of a composite material allow a great costs reduction for the raw material supply

Using commercial measures, GRP pipes can be found at very low costs.

The diameter of the pipes is 0.45m and its thickness is of 5.9 mm. The length of a storey is 20m

Each level of the tower is distanced with respect to the previous and the next one of 40m.

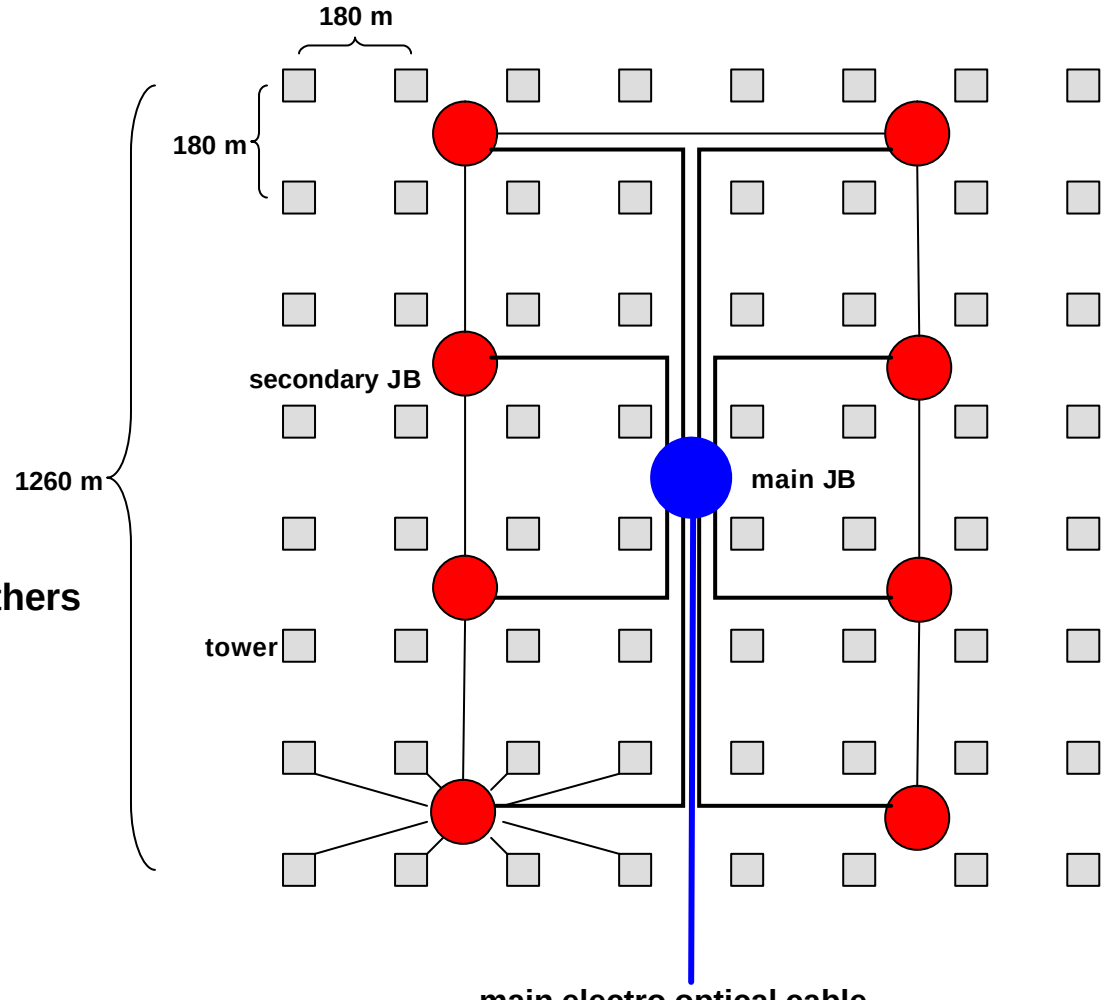
Moreover it is rotated around the vertical axis of 90 degrees.

It is possible to modify, with some boundary conditions, the specific weight of the GRP in order to make the storey neutral in water.

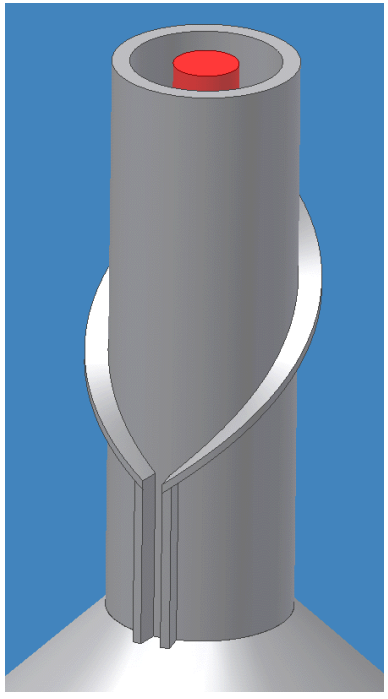
NEMO

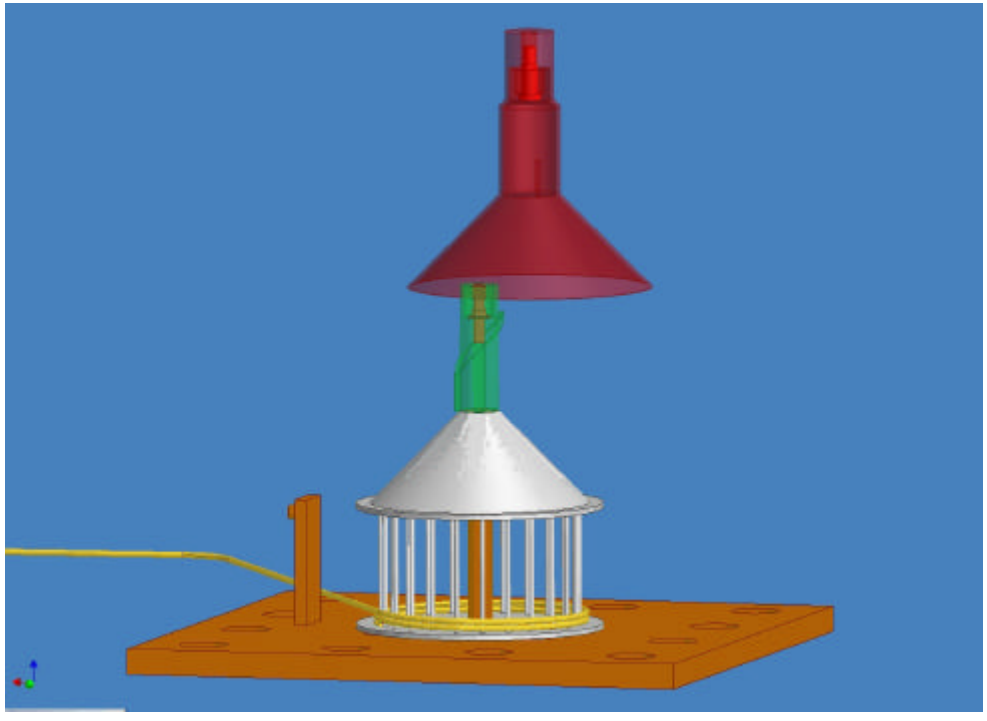
current proposal of general layout for Km^3 detector

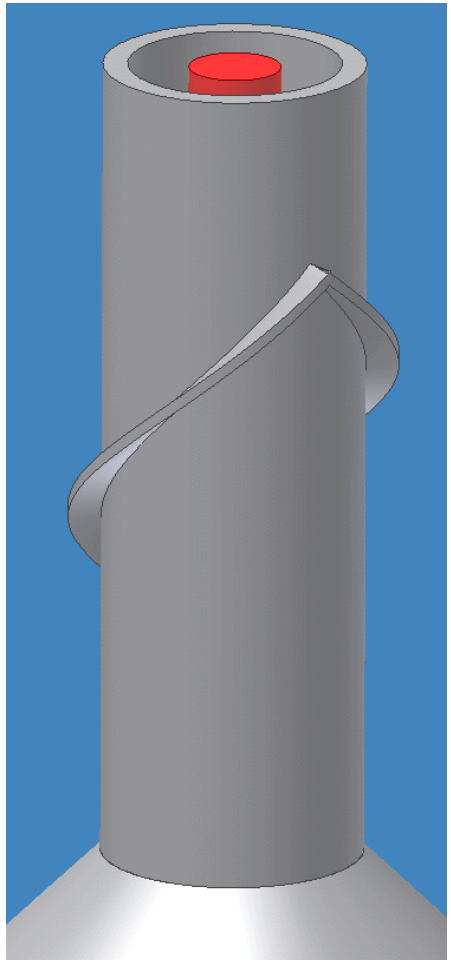
- n. 1 main Junction Box
- n. 8¸10 secondary Junction Box
- n. 64 ¸ 80 towers
- ~180 m between each row and the others
- ~180 m between each columns and the others
- 16 storeys for each tower
- 64 PMT for each tower
- > 4096 PMT



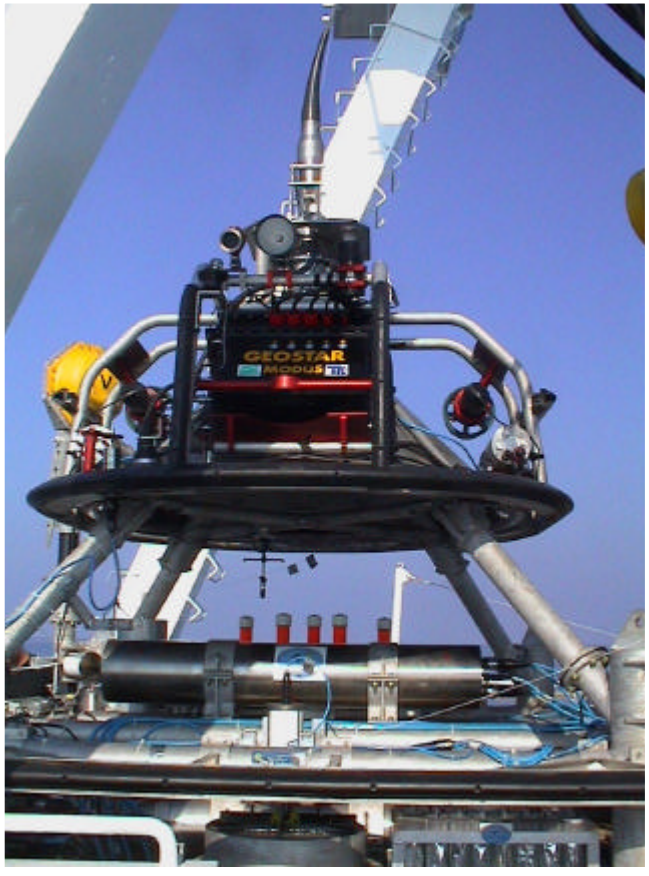
A possible self connecting system





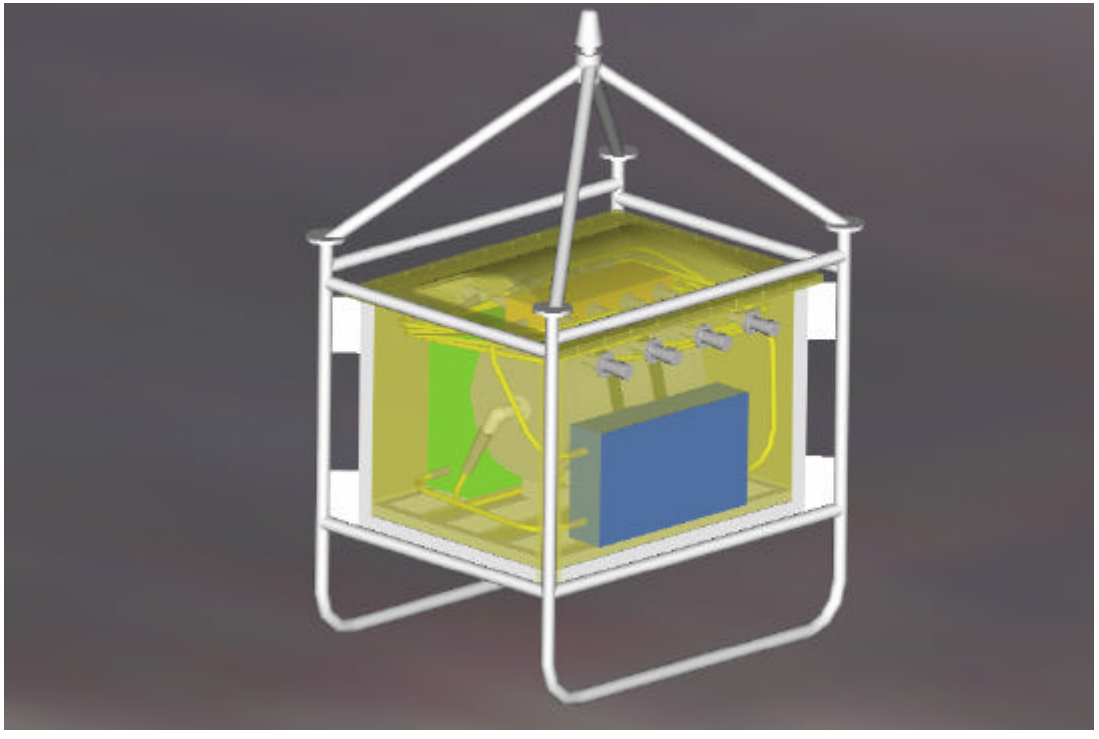


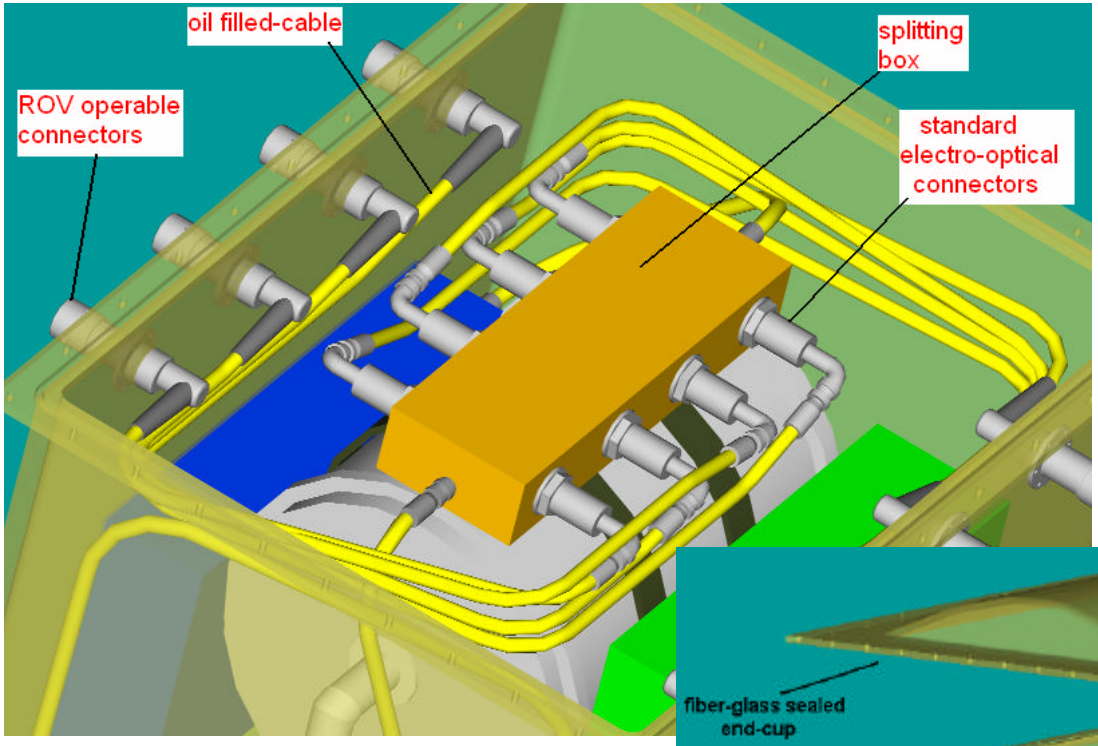
MODUS
submarine vehicle for GEOSTAR deployment/recovery

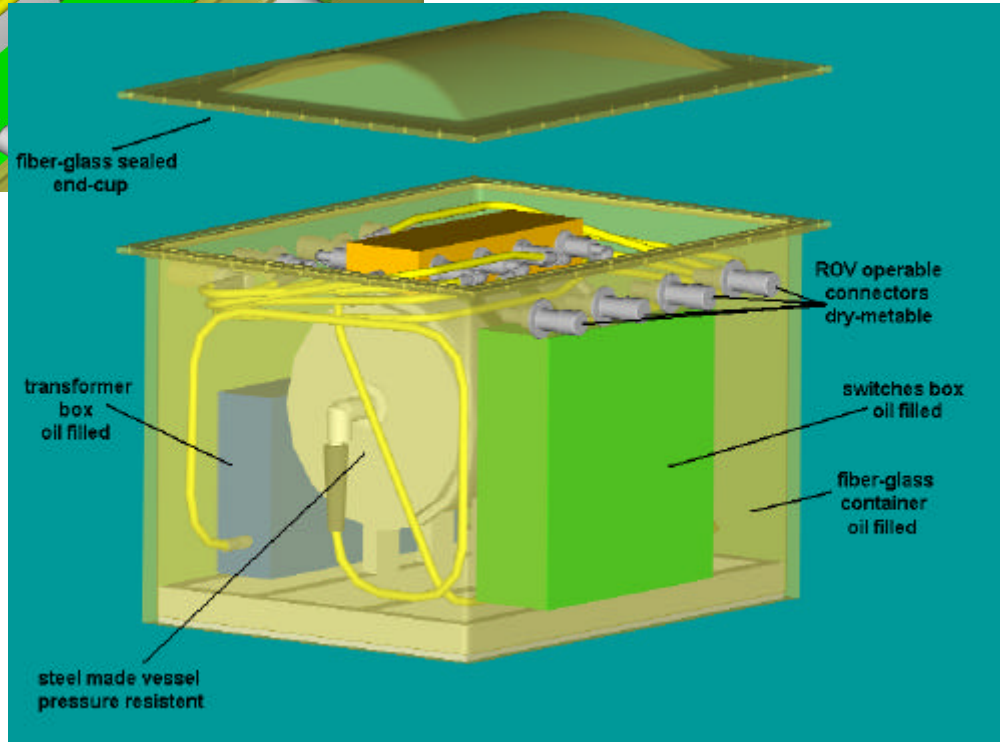


JB oil filled, pressure compensate:

1. *internal lay-out*
2. *steel pressure vessel*
3. *step-down transformer*
4. *fiberglass container, with internal steel frame*




oil filled-cable
splitting box
ROV operable connectors
standard electro-optical connectors


fiber-glass sealed end-cup
ROV operable connectors dry-metable
transformer box oil filled
switches box oil filled
fiber-glass container oil filled
steel made vessel pressure resistent

Objectives

- Develop a measuring range at 3500 meters depth
- Maximize corrosion free endurance time (time between overhauls)
- Minimize maintenance time
- Minimize failure risk
- Respect budget constraints

Two Main Options

- Use market available products and design to improve system reliability
- Invest in material performance research aimed to design and develop a system as a complete prototype
- A cost effective compromise of above is to integrate market products into a customized system

Targets

- Withstand depth pressure with an acceptable flexural deformation
- Preserve the relative motion between moving parts without an excess of friction
- Preserve for long time the surface integrity avoiding corrosion
- Privilege non magnetic or even non conductive materials to avoid galvanic effects and influence compass related instrumentation

Titanium Alloys

- Excellent response to corrosion and fouling
- Non magnetic
- High mechanical strength
- Medium availability
- Its higher cost is largely compensated by the use of less material weight to obtain the same strength and by savings in maintenance cost

Design Policy

- It is important to establish a design policy:

  - if the reference is Titanium alloy, any compulsory deviation from it must be considered as a case study

  - only Composite Technology may be associated to it with careful design of the joints due to the different elastic properties.

Composites Advantages

- Corrosion free
- Non magnetic
- Damage propagation very low
- Creative design due to the fact that the designer make its own production:

  - it is virtually possible to change material density and composition at any section

Design consideration

- Modular system with built in redundancy
- "All" connections to be made in air
- Use ships of opportunity and non highly specialized surface vessels for deployment
- Use locally available transport vessels
- No use of bathyscaphs or ROVs
- Retrieval and expandable
- Inoxidable material

Material considerations

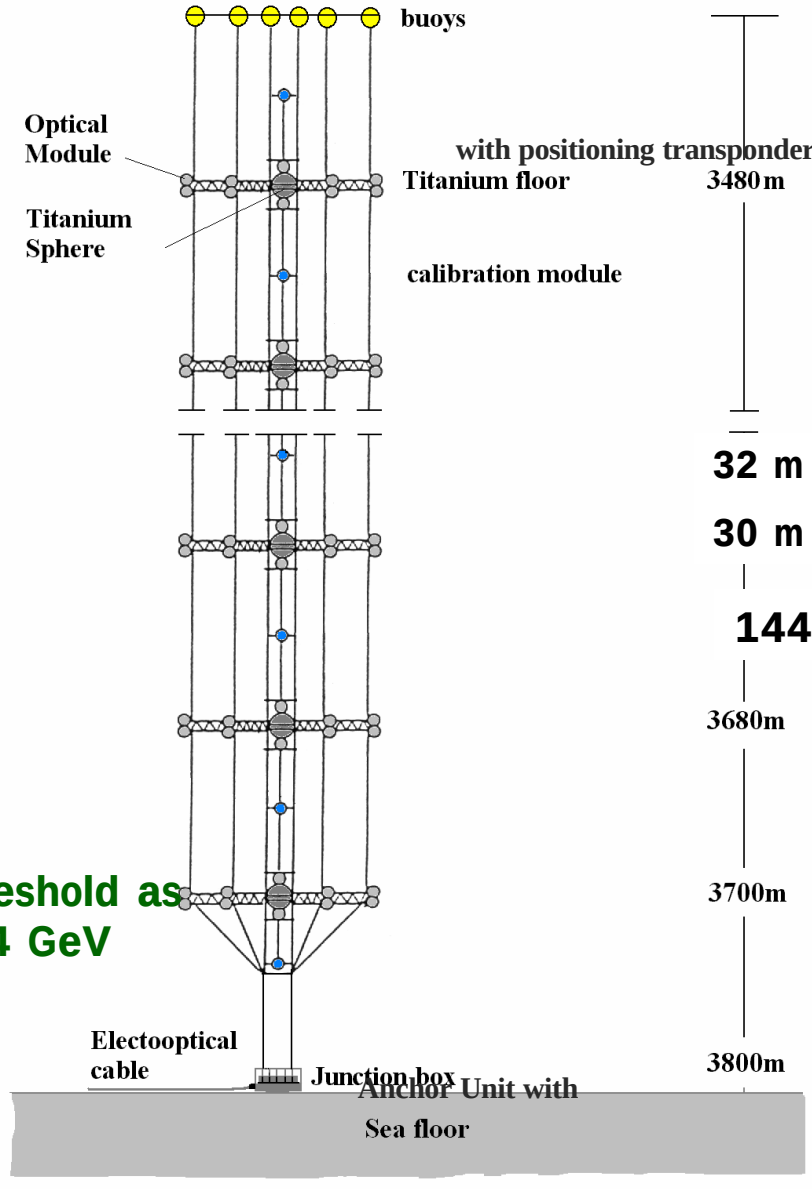
➢ Inoxidable material

- **Stainless steel > inoxidable > many alloys > sensitive in cavity corrosion > steel ropes and shackles**
- **Aluminium > special alloy > anodized**
- **Titanium**
- **Plastics > PVC, Polyethylene > ropes**
- **Glass fibers > light and strong > water ingress?**
- **Glass > PMT > housing > inoxidable**

➢ Isolation with plastic or rubber

INFN

NESTOR tower



Energy threshold as low as 4 GeV

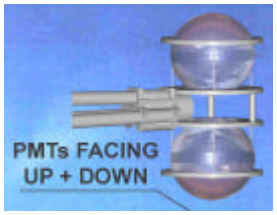
20 000 m²

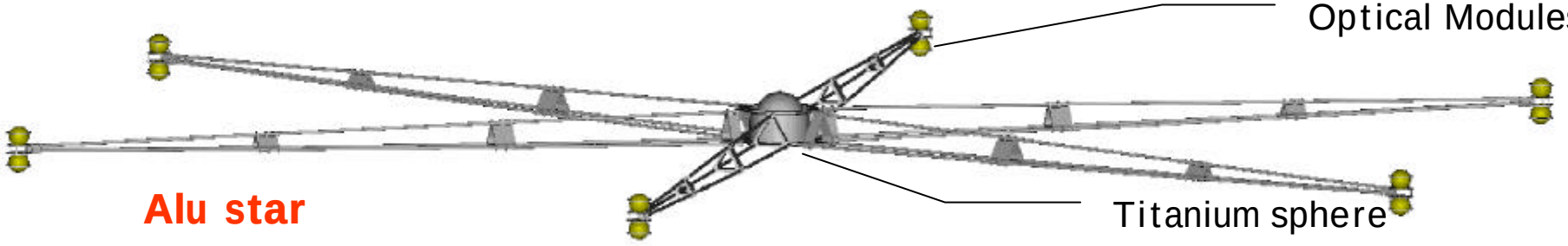
Effective Area

for E>10TeV

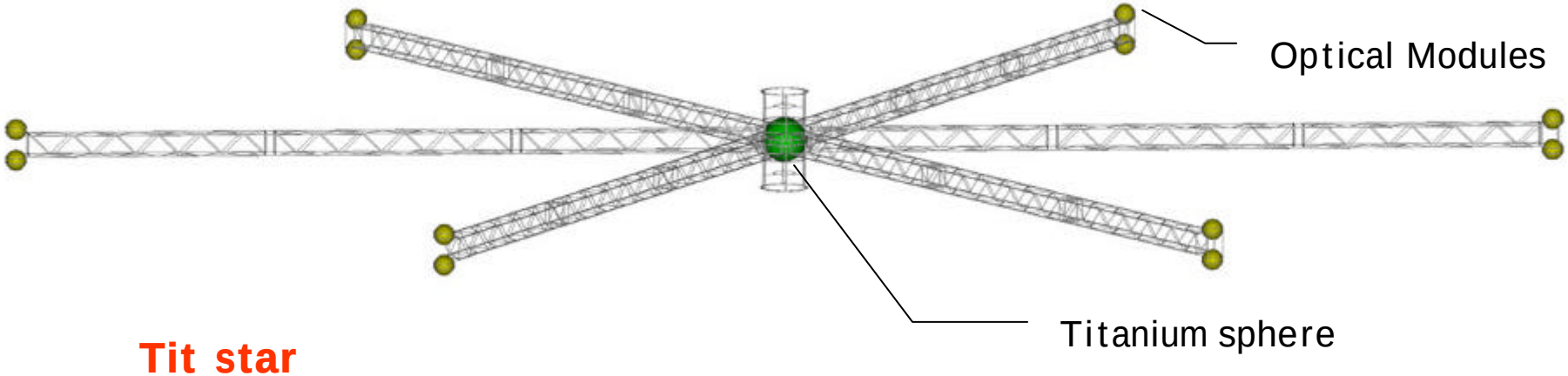
NEMO

NESTOR star





Alu star



Tit star

Titanium sphere