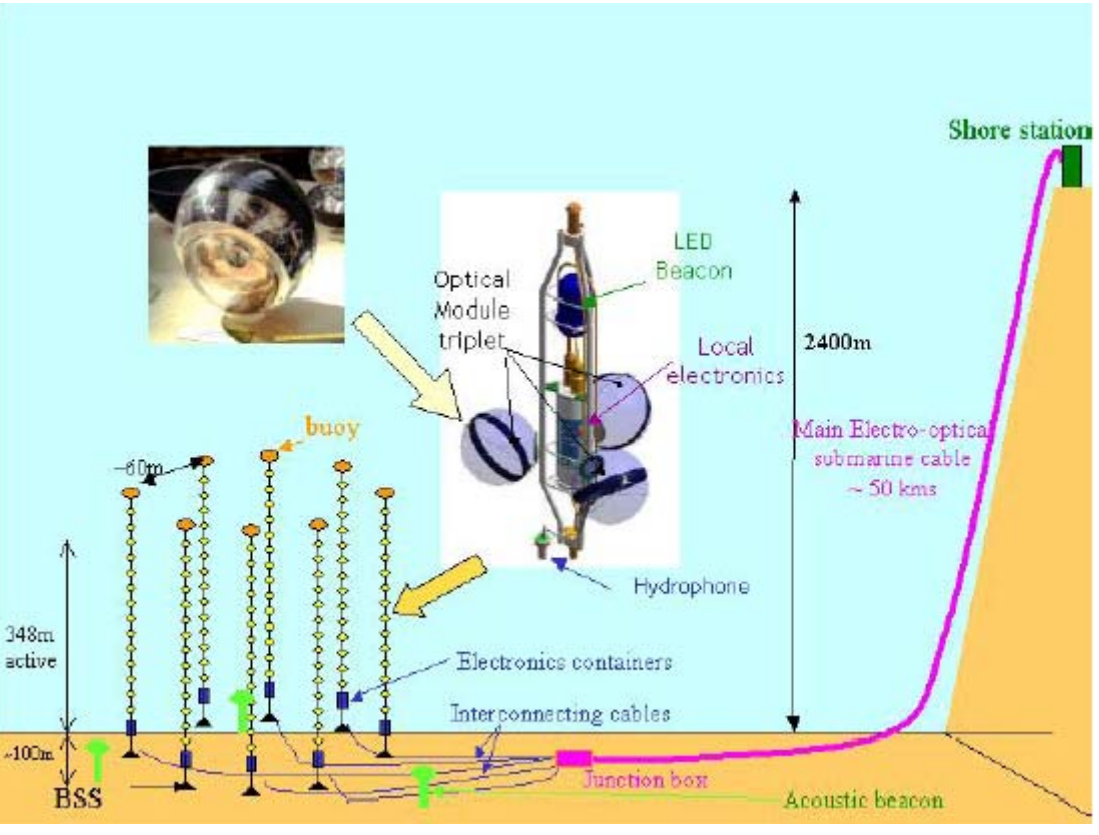
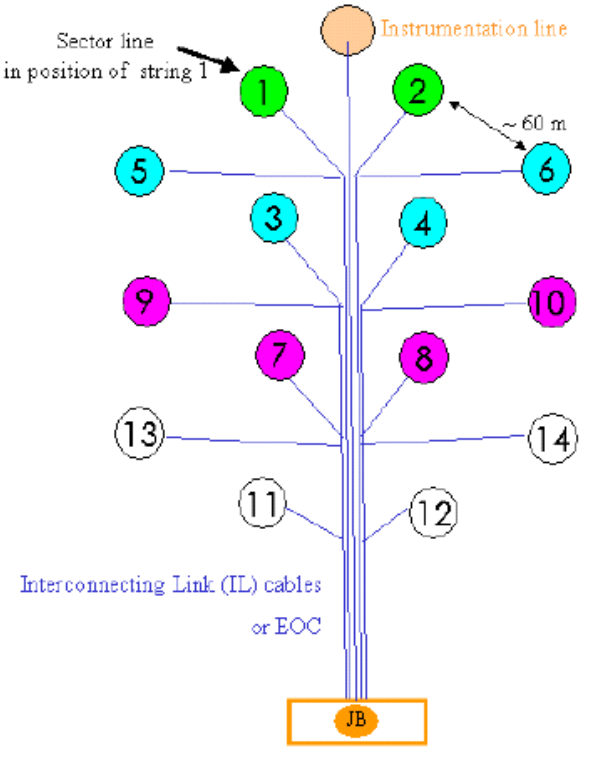
ANTARES MECHANICS: A CRITICAL ANALYSIS IN VIEW OF A LARGE SCALE DETECTOR

(thanks to M. Anghinolfi, M. Jaquet, P. Lagier, P. Lamare, M. Musumeci, P. Vernin)

ANTARES: overview of the layout





- **42 km-LONG MAIN ELECTRO-OPTICAL CABLE FROM SHORE STATION TO 2400 m DEPTH, GROUND RETURN THROUGH SEA ELECTRODE**
- **ONE JUNCTION BOX TO SPLIT POWER AND SIGNALS TO/FROM THE LINES**
- **UP TO 16x400m LONG MOORING LINES ANCHORED TO THE SEA BED**
- **ROV/SUBMARINE REQUIRED ONLY FOR INTERLINK CONNECTIONS / DEPLOYMENT AND RECOVERY ARE OPERATED FROM SEA SURFACE ONLY**

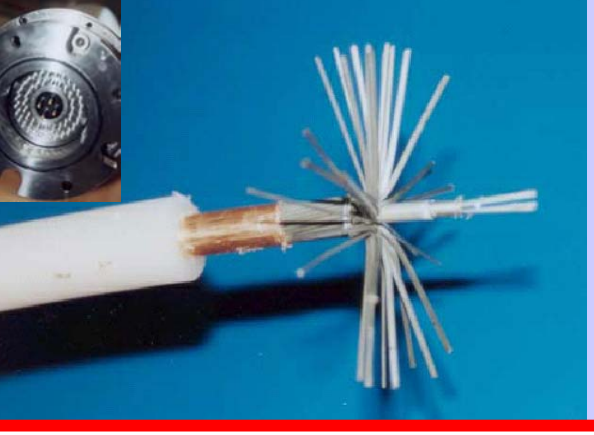
ANTARES: undersea infrastructure

THE JUNCTION BOX

- 500 dm3 TITANIUM CONTAINER (2 EMISPHERICAL CAPS + INTERMEDIATE CYLINDRICAL SPACER)
- 2 COMPARTMENTS: UPPER (DRY) WITH ELECTRONICS, LOWER (OIL-FILLED) WITH TRANSFORMER
- TITANIUM FRAME WITH FIBREGLASS PANELS TO HOLD ODI WET-MATEABLE CONNECTORS
- FEATURES TO DEPLOY AND RECOVERY WITHOUT A ROV/SUBMARINE
- 16 OIL-FILLED PRESS-BALANCED JUMPERS+WET-MATEABLE CONNECTORS

INTERLINK CABLES

- 4 OPTICAL FIBRES + 2 COPPER CONDUCTORS, WET-MATEABLE
- OPERATION UP TO 500 V / 5 A
- LENGHTS RANGING FROM 120 TO 350 m
- DRY CABLES, 100 MATING OPERATIONS WITHOUT MAINTENANCE



MAIN ELECTRO-OPTICAL CABLE (MEOC)

- STANDARD ALCATEL CABLE, 42 Km LONG
- STEEL ARMOURED, DOUBLE ARMOURED FOR 15 Km, DOWN TO 1000 m DEPTH
- 48 OPTICAL FIBRES +COPPER CONDUCTORS,
- GROUND RETURN THROUGH SEA ANODE ON JB
- RATED AT 30 KV - 50 A
- SEACON DRY-MATEABLE CONNECTOR TO JUNCTION BOX

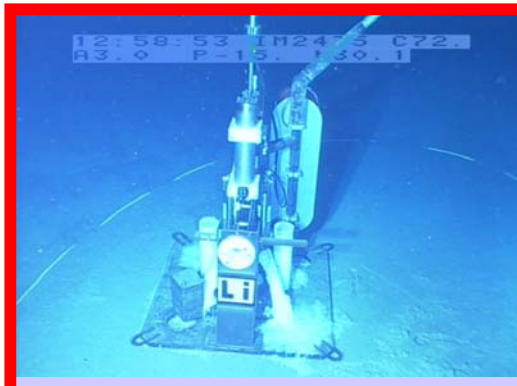
ANTARES: line mechanics

THE BUOY

- **SYNCTACTIC FOAM-MADE**
- **STANDARD MODEL**

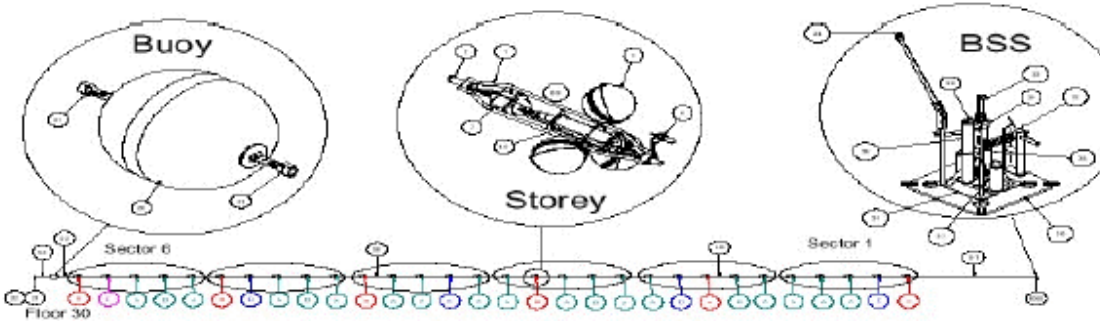
THE STOREY

- **TITANIUM GRADE 2 WELDED FRAMEWORK HOLDING LCM CONTAINER AND 3 OPTICAL MODULES**
- **LCM CONTAINER MADE OUT OF TITANIUM GRADE5, CYLINDRICAL BODY 179x157mm DIA + END FLANGES**
- **OPTICAL MODULES HOUSING PMT, ELECTRONICS, MU-METAL CAGE AND OPTICAL GEL INSIDE A GLASS SPHERE AND FASTENED TO THE OMF VIA A TITANIUM GRADE 2 WIRE STRUCTURE**

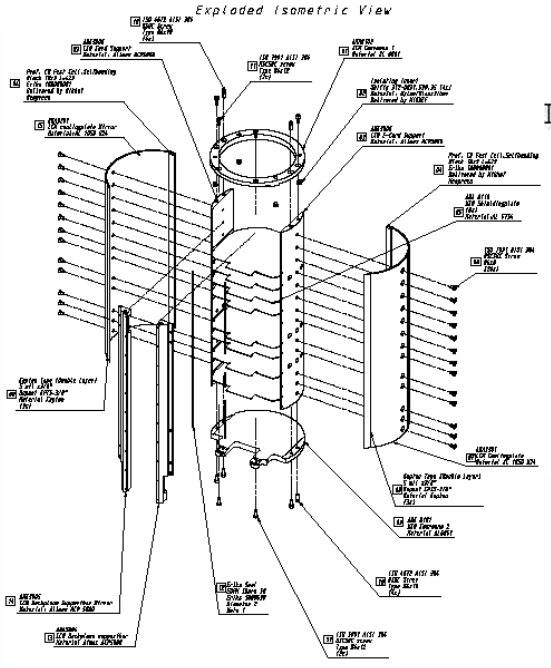


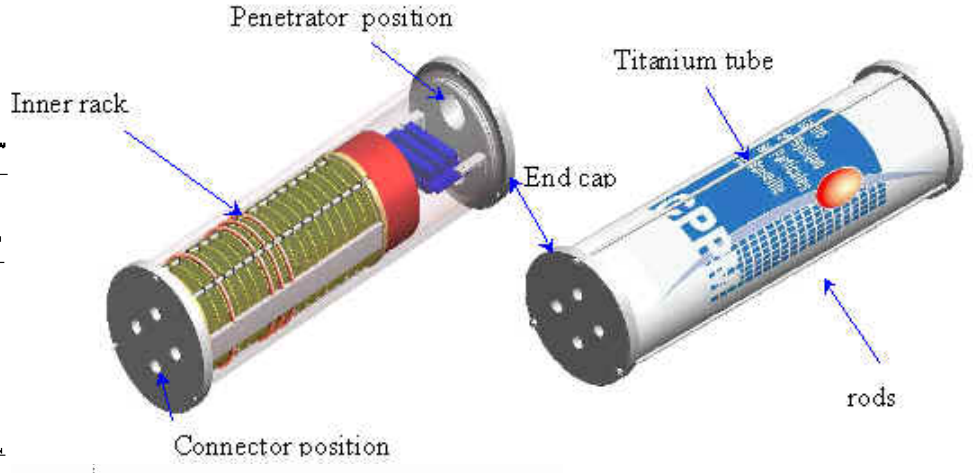
THE BSS

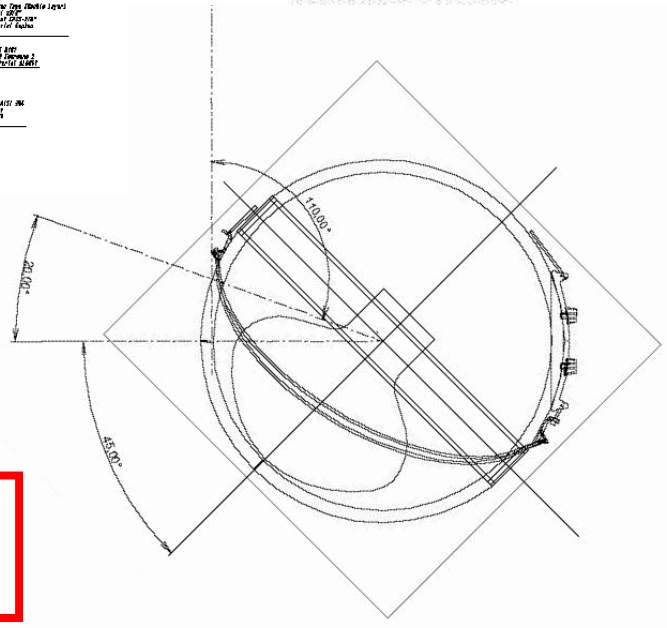
- **TITANIUM/CARBON STEEL CONSTRUCTION (CATHODIC PROTECTION)**
- **SELF-RELEASING, RELEASE SPEED LIMITED (DAMPERS)**
- **REDUNDANT ACOUSTIC RELEASE**
- **HOUSES SCM/SPM, HYDROPHONE AND PRESSURE SENSOR**



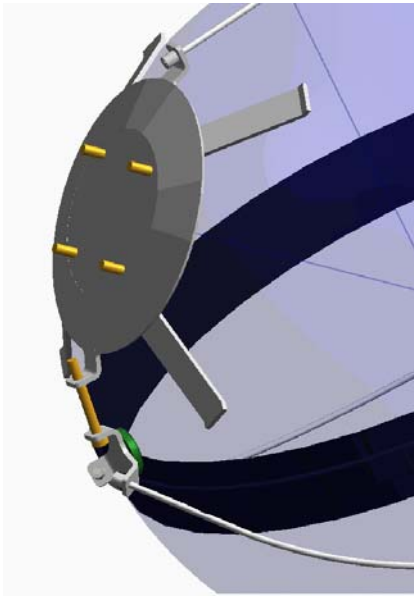
ANTARES: further line details



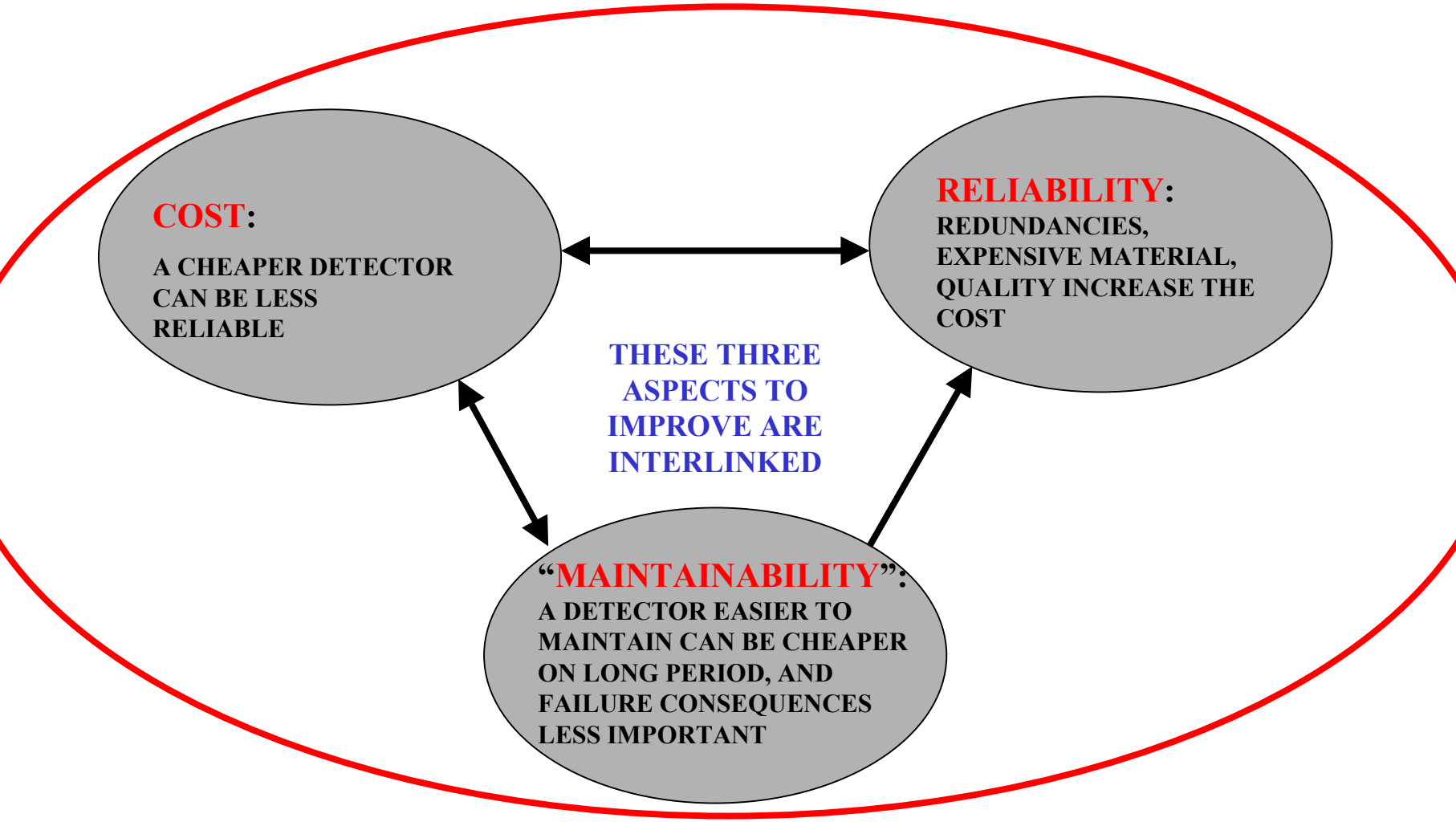




REMARK THE COMPLEXITY OF THESE ITEMS

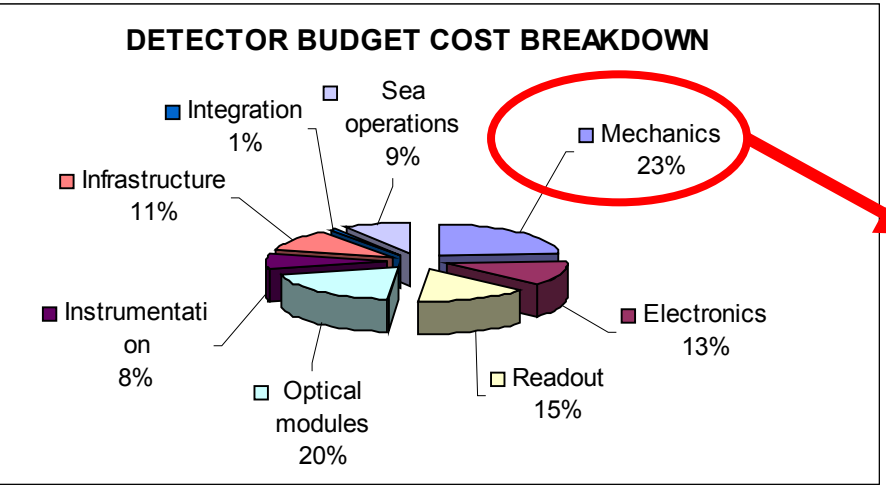


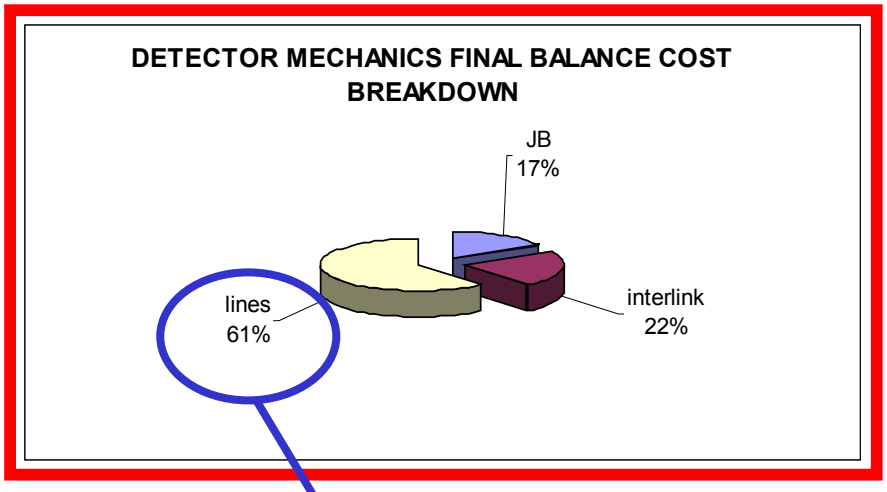
ANTARES: lines of improvement in view of the Km3

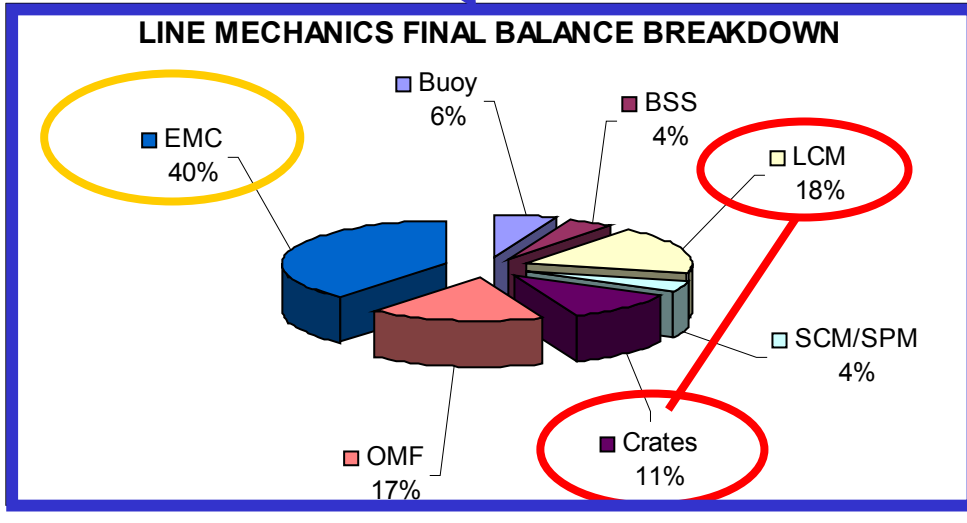


BUT, GIVEN THE QUANTITIES INVOLVED, A STRONG COMMERCIAL ATTITUDE AND AN EFFECTIVE MANAGEMENT CAN ALLOW SIGNIFICANT COST REDUCTIONS

ANTARES: costs of the mechanics







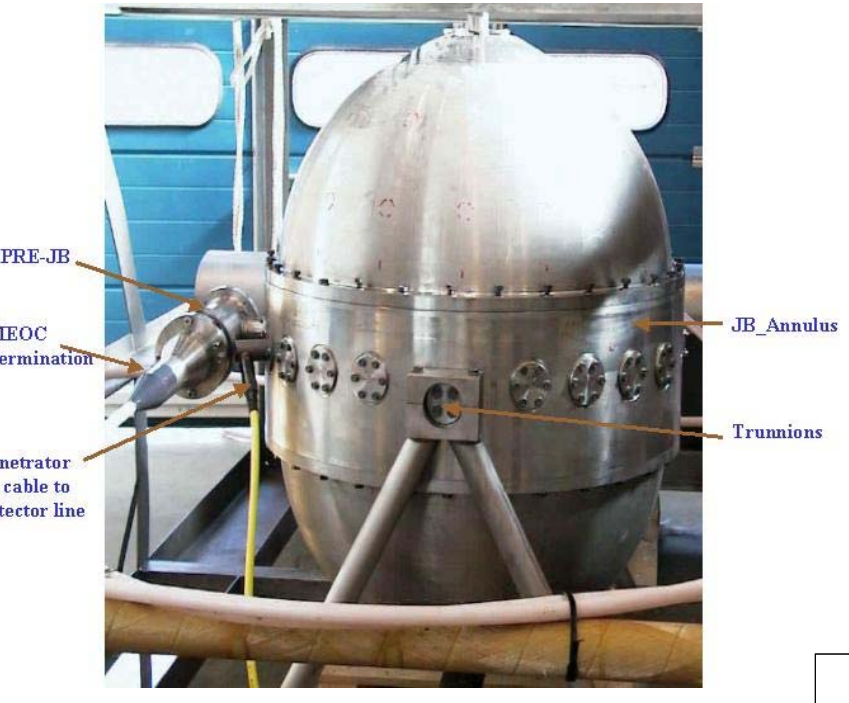
MECHANICS ENGAGE A SIGNIFICANT AMOUNT OF THE DETECTOR BUDGET

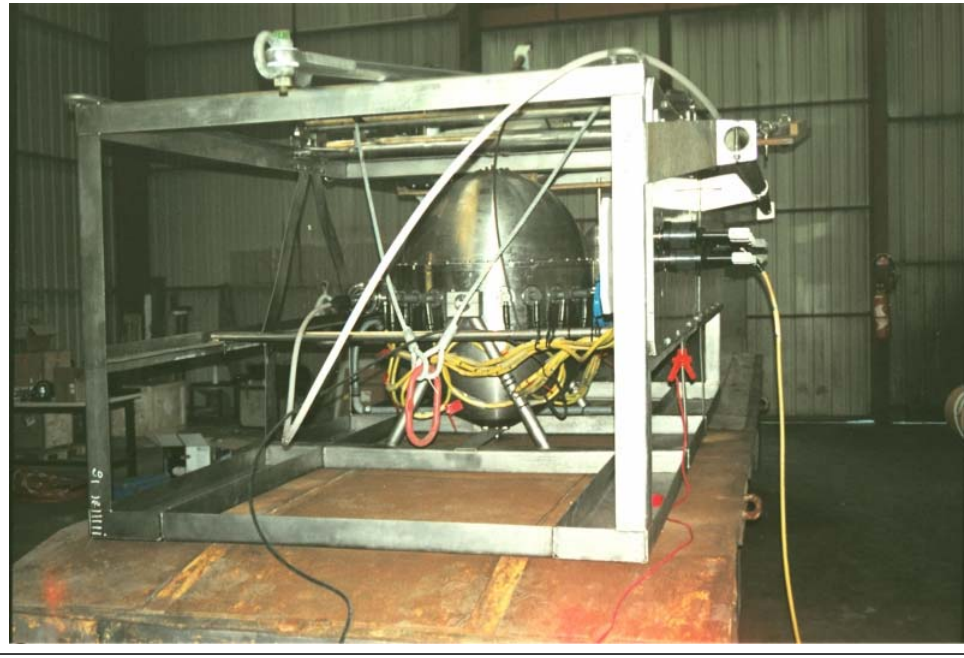
THUS, EN AFFORT ON THAT FIELD IS WORTH TO REDUCE DETECTOR OVERALL COSTS

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: junction box



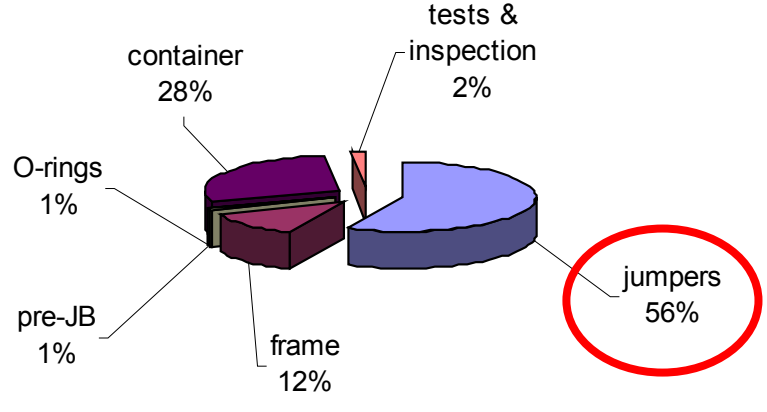


JUNCTION BOXES ARE "MINOR" ITEMS ON THE OVERALL DETECTOR BUDGET (LESS THAN 4%)

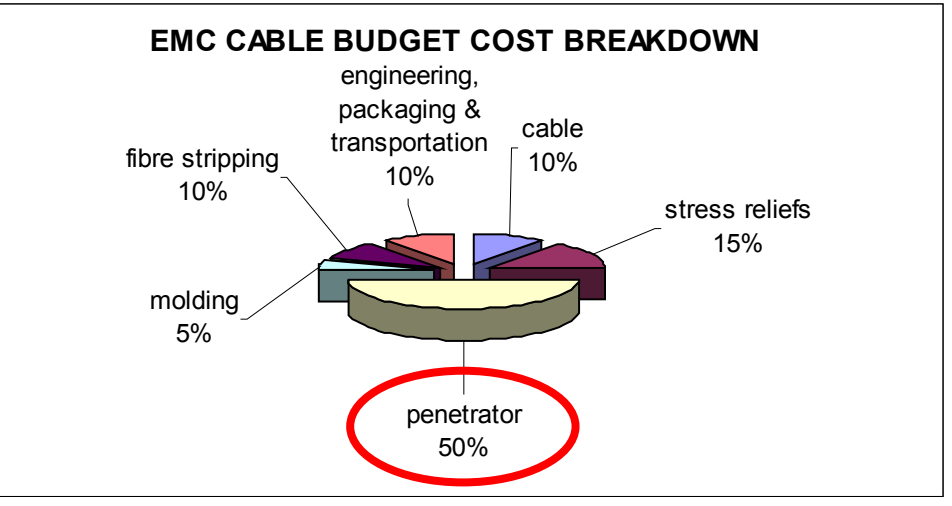
THE STRONGEST ACTION SHOULD BE MADE ON JUMPERS (SEARCH FOR COMPETITORS, COMMERCIAL AGREEMENTS AND SO ON)

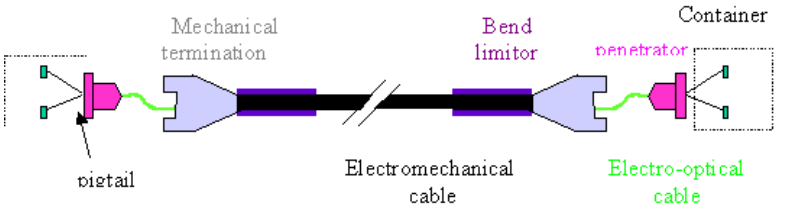
ANY IMPROVEMENT ON THE CONTAINER IS WELCOME, BUT CAN HAVE A VERY LIMITED EFFECT ON THE OVERALL DETECTOR BUDGET (LESS THAN 1%)AND SHOULD BE CAREFULLY EVALUATED - COMPLEXITY CAN AFFECT RELIABILITY

JB FINAL BALANCE COST BREAKDOWN



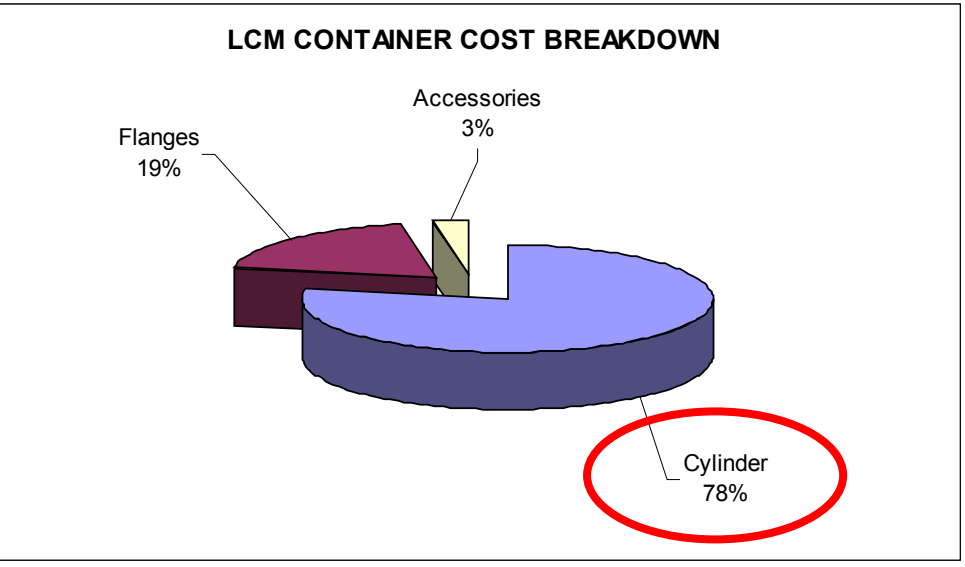
ANTARES: Electro-Mechanical Cable improvements





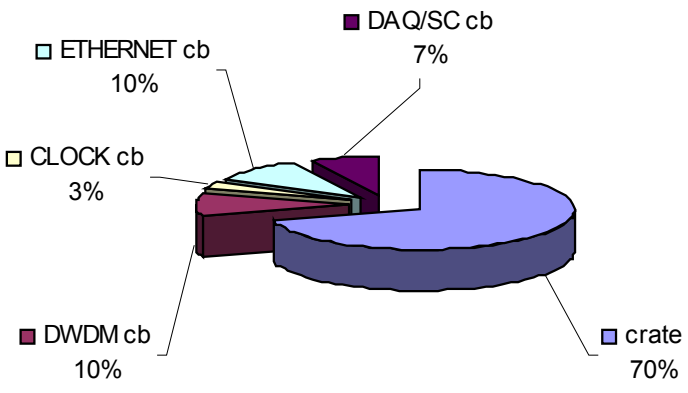
- **THE LARGEST CONTRIBUTION TO THE OVERALL COST COMES FROM THE "WATER-BLOCKED" PENETRATOR, THAT PREVENTS WATER TO ENTER INTO THE CONTAINERS THROUGH THE CABLE**
- **A "NON WATER-BLOCKED" PENETRATOR IS DEFINITELY MUCH SIMPLER AND EASIER TO INTEGRATE, AND ALLOWS EMC COST REDUCTIONS OF ABOUT 40%**
- **A GOOD COMPROMISE IS TO FORESEE SECTIONS HYDRAULICALLY ISOLATED TO THE NEIGHBORING ONES (AS IN A SHIP) SO THAT, IF SOME SECTIONS GET FLOODED, THE DETECTOR CAN KEEP OPERATIVE WITH AN ACCEPTABLE LOSS OF PERFORMANCE**
- **ANTARES SECTOR WERE THOUGHT FOR THAT, BUT THEY WILL PROBABLY BE ABANDONED. THE IMPACT OF THE LOSS OF A SECTOR IN A KM3 SIZE DETECTOR SHOULD BE BETTER ACCEPTABLE**

ANTARES: LCM/SCM container and crate improvements



- THE LARGER CONTRIBUTION TO THE OVERALL CONTAINER COST COMES FROM THE CYLINDER
- IN FACT, GIVEN ELECTRONICS REQUIREMENT, IT HAD TO BE MACHINED OUT FROM FULL BARS
- IT WOULD BE INTERESTING TO RE-SIZE AND RE-SHAPE ELECTRONICS TO FIT THEM INSIDE TITANIUM GRADE 2 STANDARD PIPES
- IF TITANIUM GRADE 2 COSTS 100, TITANIUM GRADE 5 COSTS 150

- CURRENT ELECTRONICS INSIDE LCM HAVE TO DISSIPATE 35-40 W
- IN PARTICULAR, SOME OF THEM REQUIRE A MASSIVE COOLER ("COOLING BASES")
- ALL THE COOLING BASES MAKE UP 30% OF THE TOTAL CRATE COST
- IN GENERAL, THE CRATE HAS A VERY EXPENSIVE DESIGN
- A REDUCTION OF THE HEAT LOSS BUDGET SHOULD HELP TO SIGNIFICANTLY REDUCE THE COSTS



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**