# KM3NeT Knowledge and Technology Transfer

E. Tzamariudaki, K. Pikounis

## KM3NeT

A Large Infrastructure in the Mediterranean sea housing the next generation neutrino detectors

**SCIENCE**

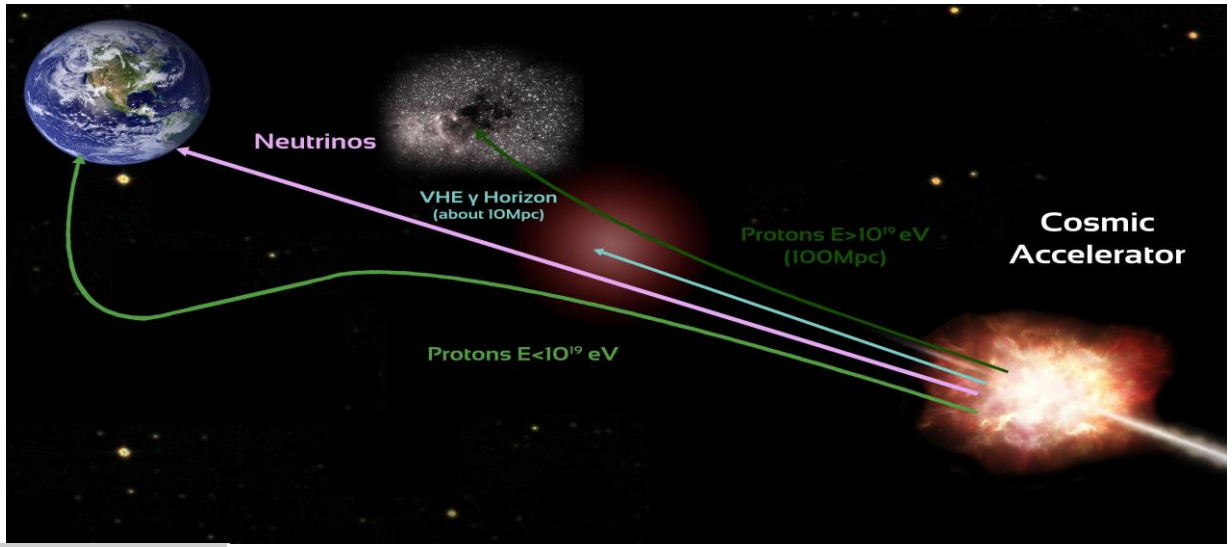
**TECHNOLOGY**

**INDUSTRY**

VLVnT – 2018
Very Large Volume Neutrino Telescopes

# SCIENCE OBJECTIVES

## ARCA : Astroparticle Research with Cosmics in the Abyss



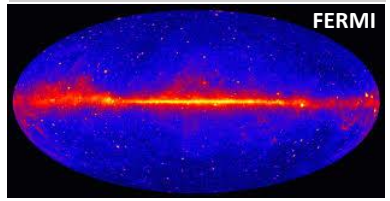

**Neutrinos** as messengers to explore the High Energy Universe

signature of production and acceleration sites of high energy cosmic rays

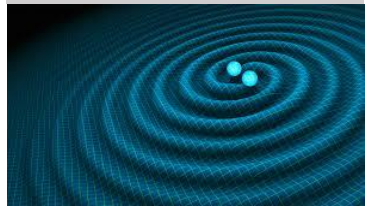
associate with

**Photons**

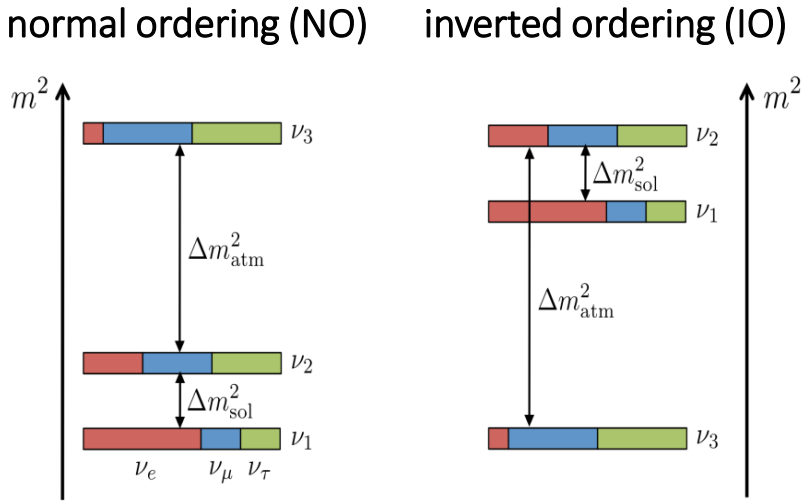

**Cosmic rays**




**Gravitational Waves**



## ORCA : Oscillation Research with Cosmics in the Abyss

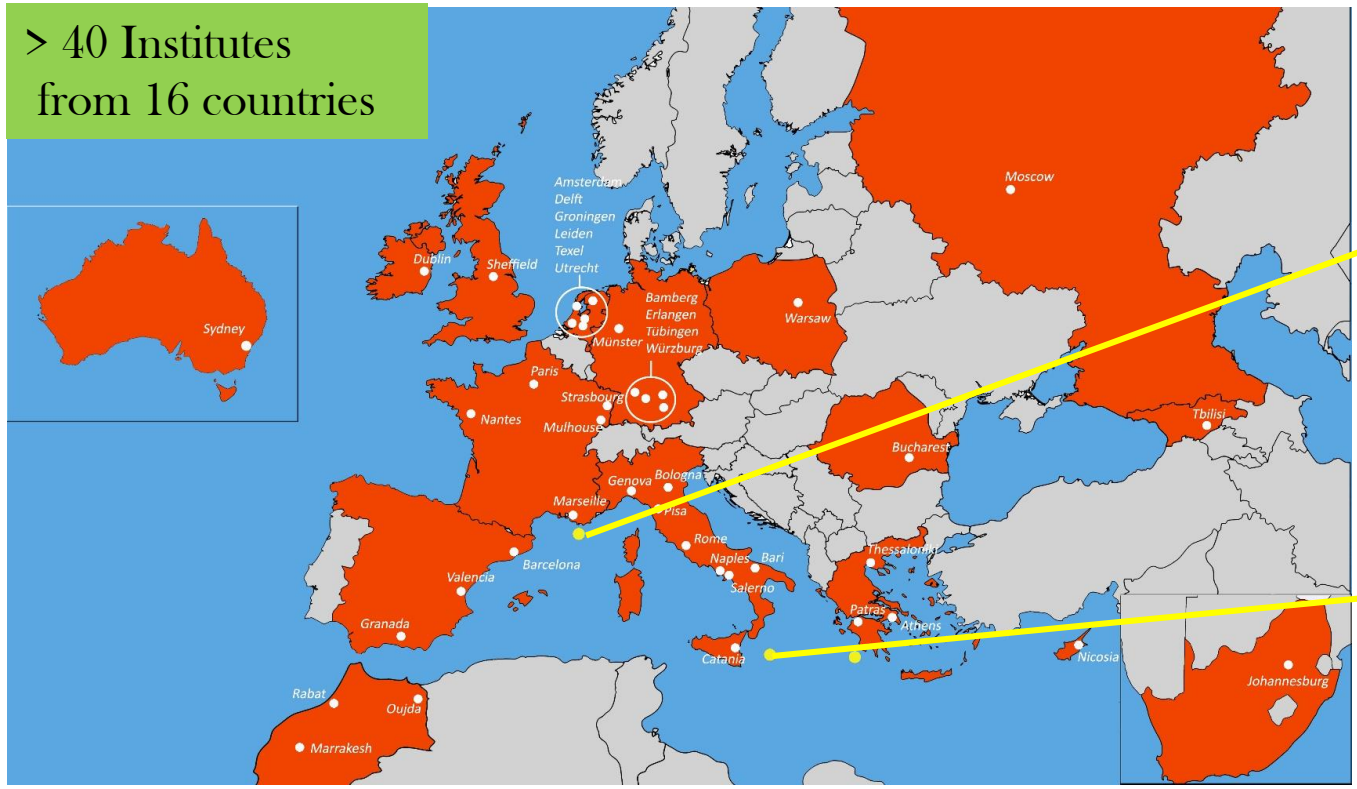



Determine the ordering of the neutrino mass eigenstates

- a measurement of fundamental importance to the theory

# KM3NeT: A Distributed research infrastructure

> 40 Institutes
from 16 countries




**O**scillation **R**esearch
with **C**osmics In the **A**byss
Low-energy studies of
atmospheric neutrinos
Depth: ~2500 m

**A**stroparticle **R**esearch
with **C**osmics In the **A**byss
High-energy neutrino
astrophysics
Depth: ~3500 m

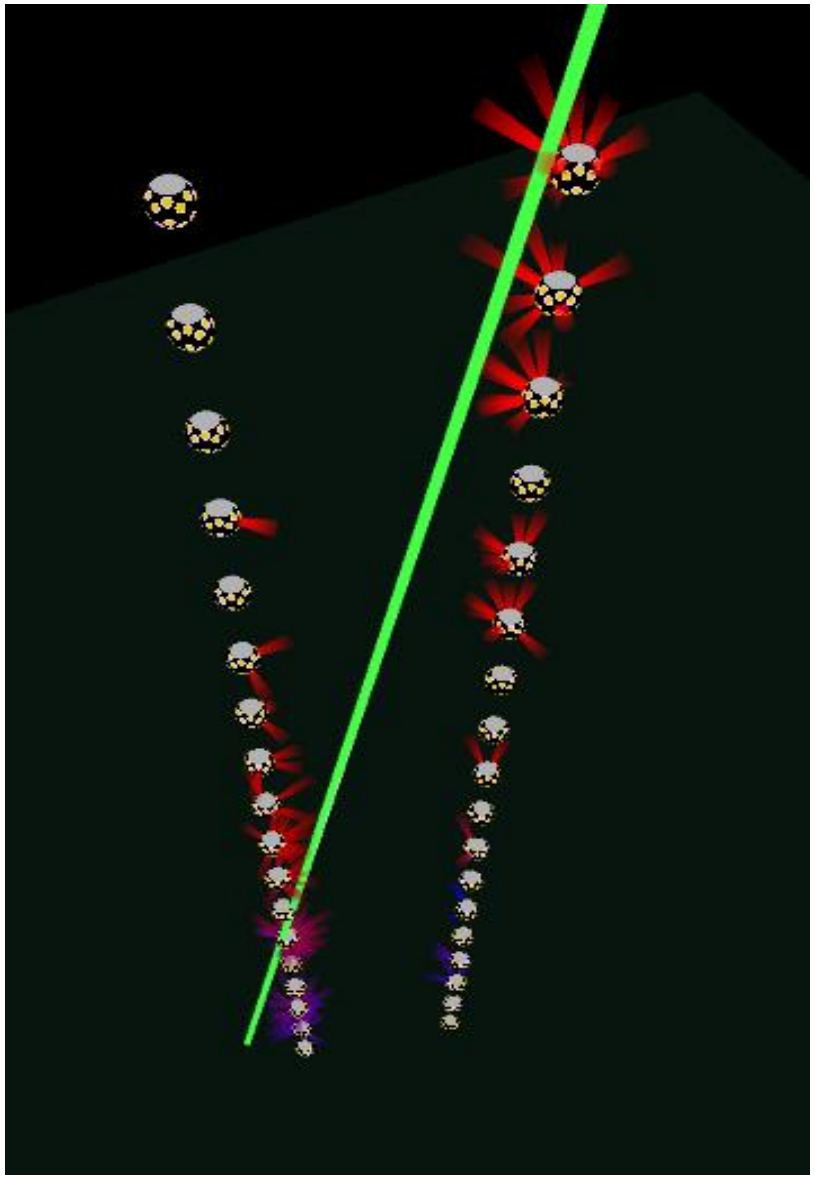
KM3NeT talk by P. Coyle

**Same collaboration, same technology**
**Distributed infrastructure, phased implementation**

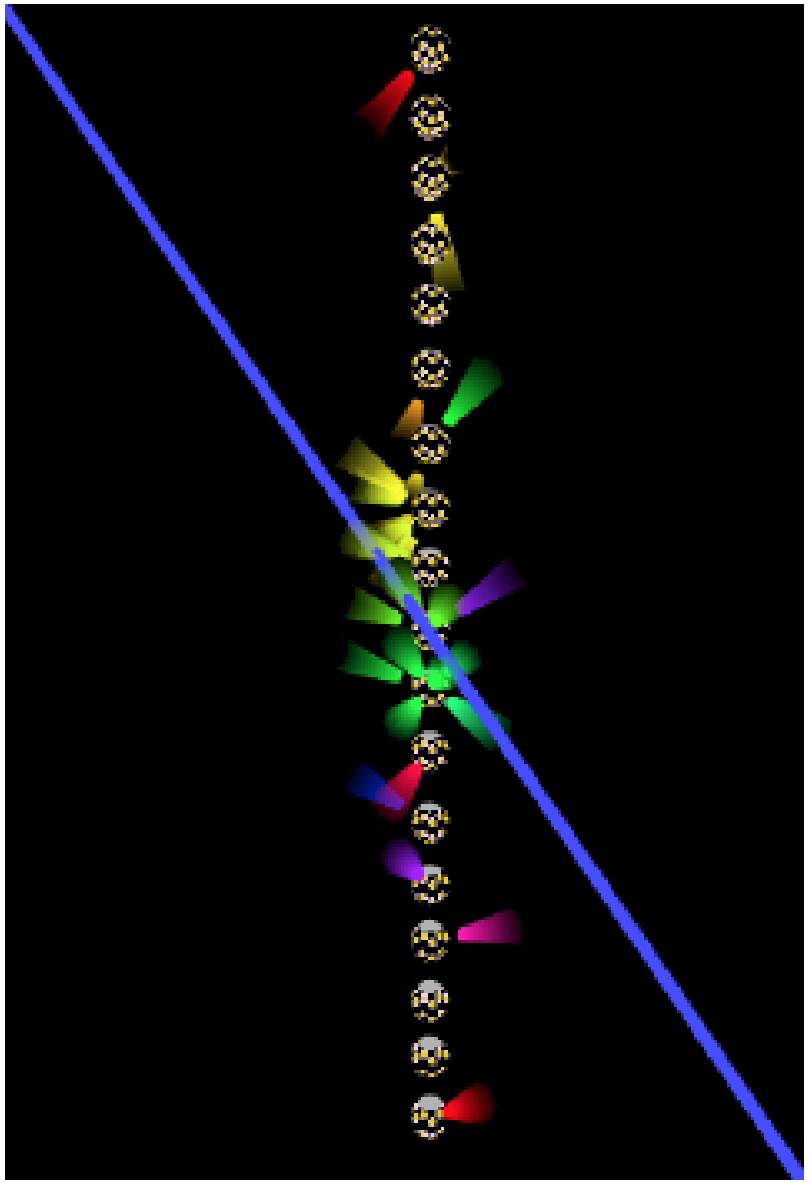
| Requirements | | Challenges |
|---|---|---|
| 15 years operation | → | Reliability, long term stability |
| high pressure 350 bar | → | Demanding operating conditions |
| 1-ns timing | → | Precision and Quality |
| 100 km optical fiber | → | Optical data |

# Event Signatures

ARCA



ORCA



# TECHNOLOGY

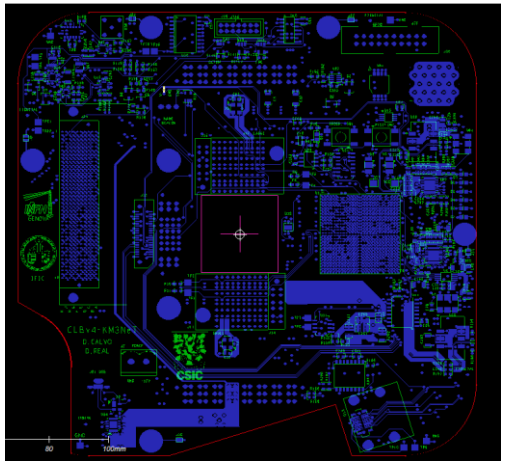

## Deep sea technology

KM3NeT-Fr: ~2500 m

KM3NeT-It: ~3500 m

## Detector technology

## Electronics



## Computing & Software

```
public static void ZeroAlgo(string A, int B){
  /* code */
}

public static void OneAlgo(string A, int B){
  /* code */
}

[WSrvPublish]
public static double GreatAlgo(string A, int B){
  /* server algorithm code */
}

public static void OtherAlgo(string A, int B){
  /* code */
}
```

# Knowledge and Technology Transfer

**Objectives**

- technology and knowledge return to society
- KM3NeT participating Institutes: centers of excellence

**how?**

- maximize the flow of information between KM3NeT and the developers of technological advances
- expose developed/adapted technological choices and innovative solutions to interested parties in other Institutions or in industry
- technology transfer of services developed by KM3NeT

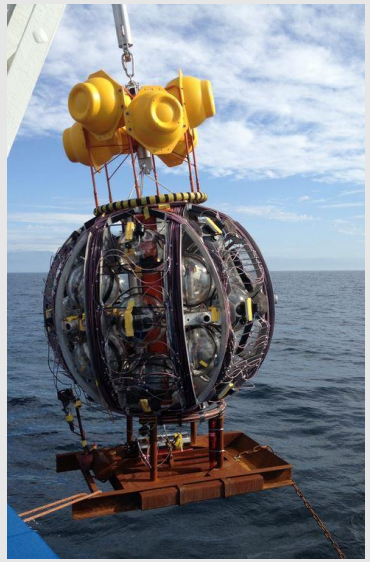
# Deep Sea Technology

**Deployment and precise underwater positioning**

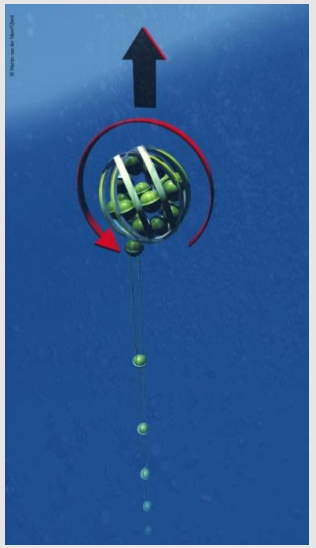
KM3NeT-Fr: ~2500 m

KM3NeT-It: ~3500 m

## The LOM (Launcher of Optical Modules)




NIOZ (Royal Netherlands Institute for Sea Research)



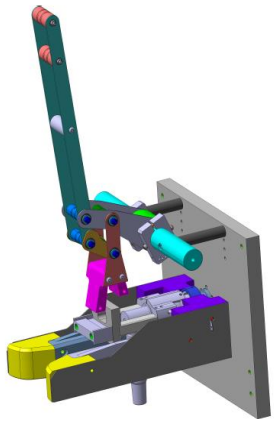
# Deep Sea Technology

**Deployment and precise underwater positioning**

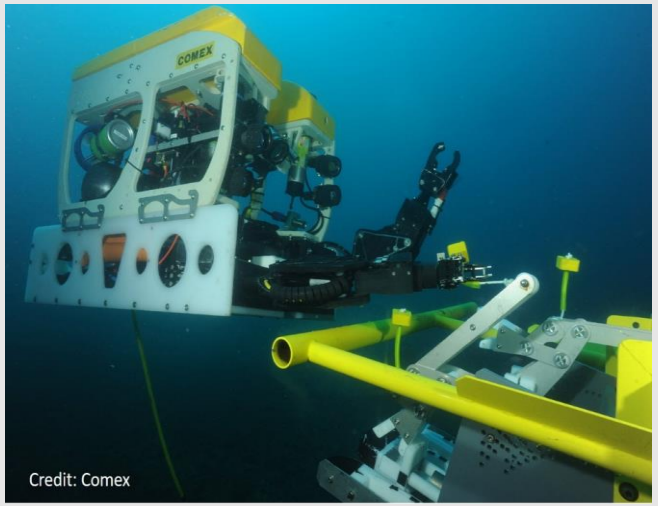
KM3NeT-Fr: ~2500 m

KM3NeT-It: ~3500 m

## Tool for (dis)connecting wet-mateable connectors with lightweight ROVs



**CPPM**
**(Centre de Physique des Particules de Marseille)**



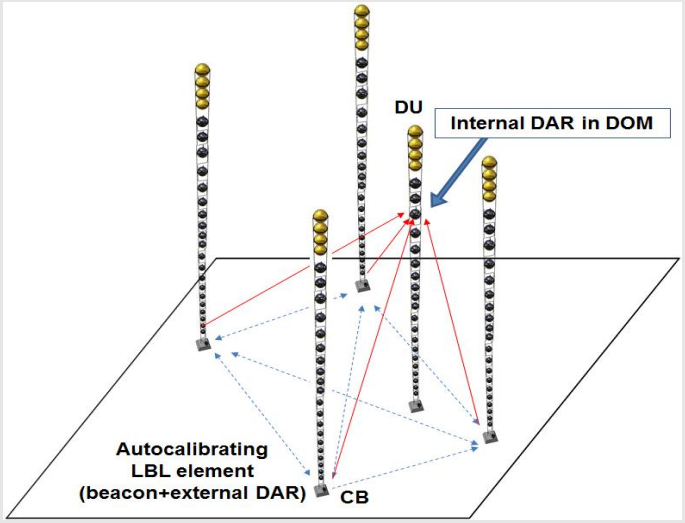

# Deep Sea Technology

**Deployment and precise underwater positioning**

KM3NeT-Fr: ~2500 m

KM3NeT-It: ~3500 m

## Precision in-water positioning




During deployment: precision ~2 m

RAPS precise acoustic positioning system:

precision ~10 cm on the position of the detector elements

INFN (Laboratori Nazionali del Sud)

talk by G. Riccobene

# Detector Technology

Detector: 3-D array of optical modules

tens of thousands of optical sensors to be tested

KM3NeT-Fr: ~2500 m

KM3NeT-It: ~3500 m

## Multiple photomultiplier testing facility

- easy, fast and safe loading and unloading of PMTs
- measure PMT dark rate, equalize gain, determine spurious pulses and timing characteristics
- simultaneous multiple PMT characterization

# Electronics

Detector: 3-D array of optical modules

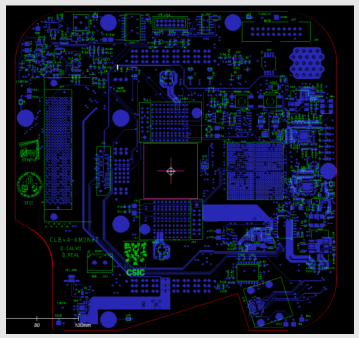
Synchronization of the optical modules

KM3NeT-Fr: ~2500 m

KM3NeT-It: ~3500 m

## Central Logic Board (CLB)

CLBv3

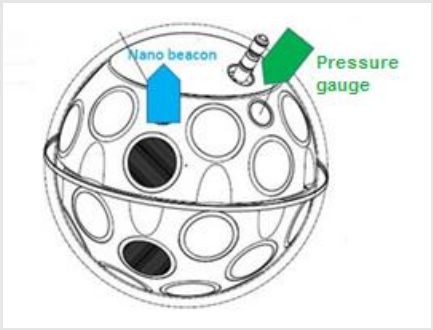


CLBv4

talk by D. Calvo

## Nanobeacon board

Relative time calibration between the optical sensors




talk by D. Calvo

# Computing

Data transmission to and from the detector

KM3NeT-Fr: ~2500 m

KM3NeT-It: ~3500 m

## Lightweight web server library

Web server libraries made to simplify the development of Graphical User Interfaces for the Detector and Acquisition Control system and for the central Data Base Web Application Server.


talk by C. Bozza

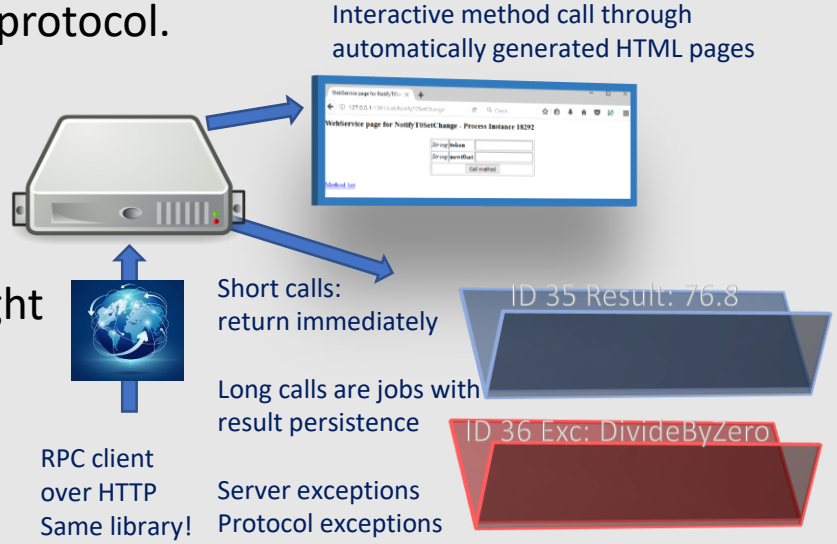
University of Salerno and INFN

SAWI library:

- extremely lightweight
- suitable for Linux, Windows, MacOS

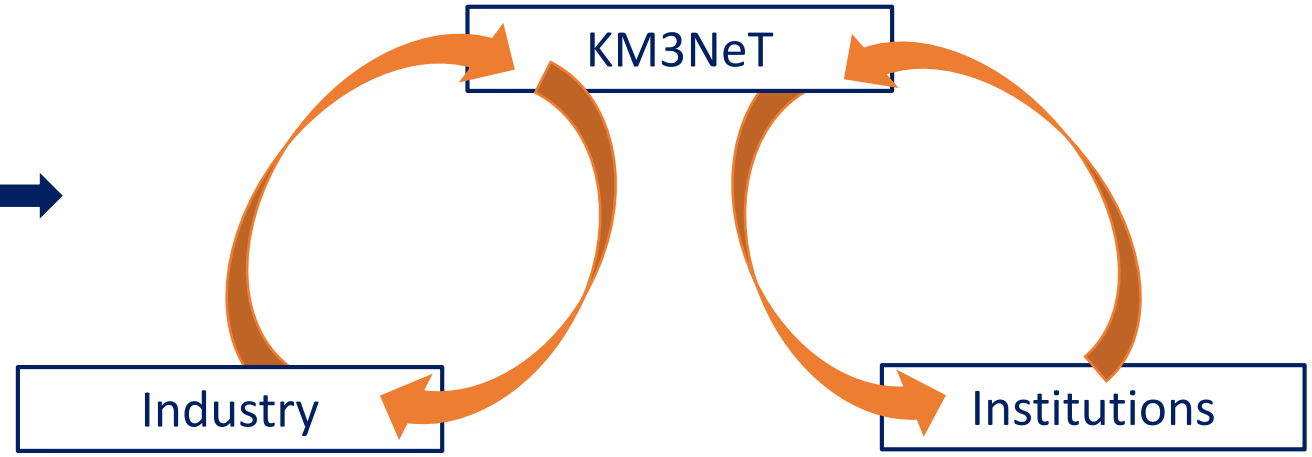
## Library for Remote Procedure Call over HTTP

**Server Application with Web Interface (SAWI):** remote procedure call technique using HTTP(S) as transport protocol.

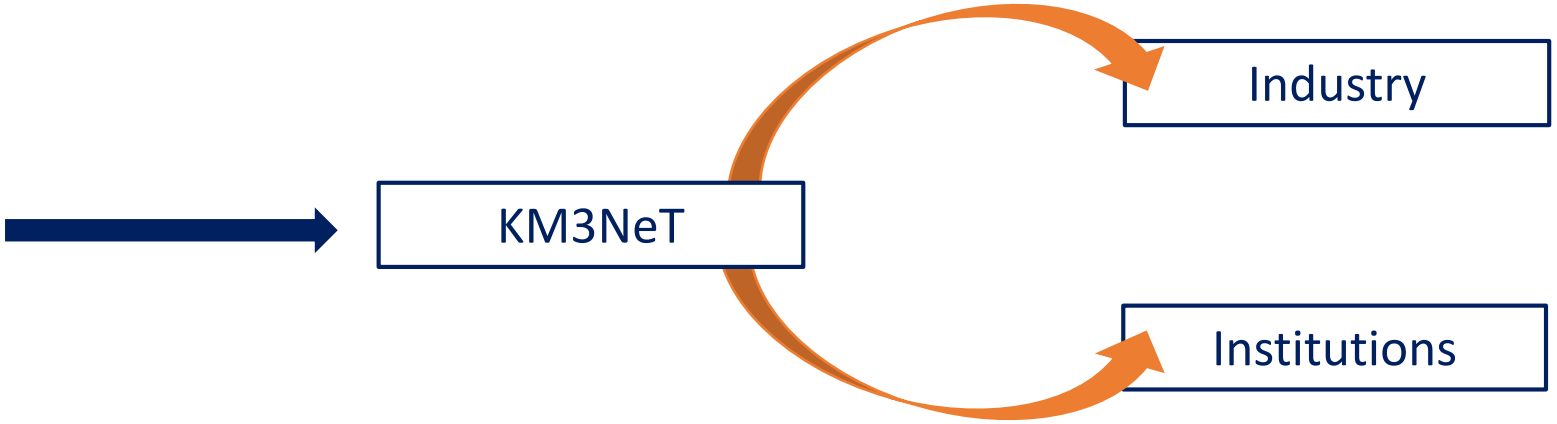


# Knowledge and Technology Transfer

Technology advancement




Technology transfer of services



# KM3NeT Knowledge and Technology Transfer

More information on

**Deployment and precise underwater positioning**

**Multiple photomultiplier testing facility**

**Computing**

to be found in the KM3NeT leaflets

KM3NeT page: www.km3net.org

Contact: kt@km3net.de