Università di Roma Tor Vergata

nast
Nanoscience
Nanotechnology
Innovative Instrumentation

Tecnomuse
TECNOlogia MUonica per la SicurEzza nei porti

Dott. Alessandro Cianchi

On behalf of Tecnomuse collaboration

Genesis

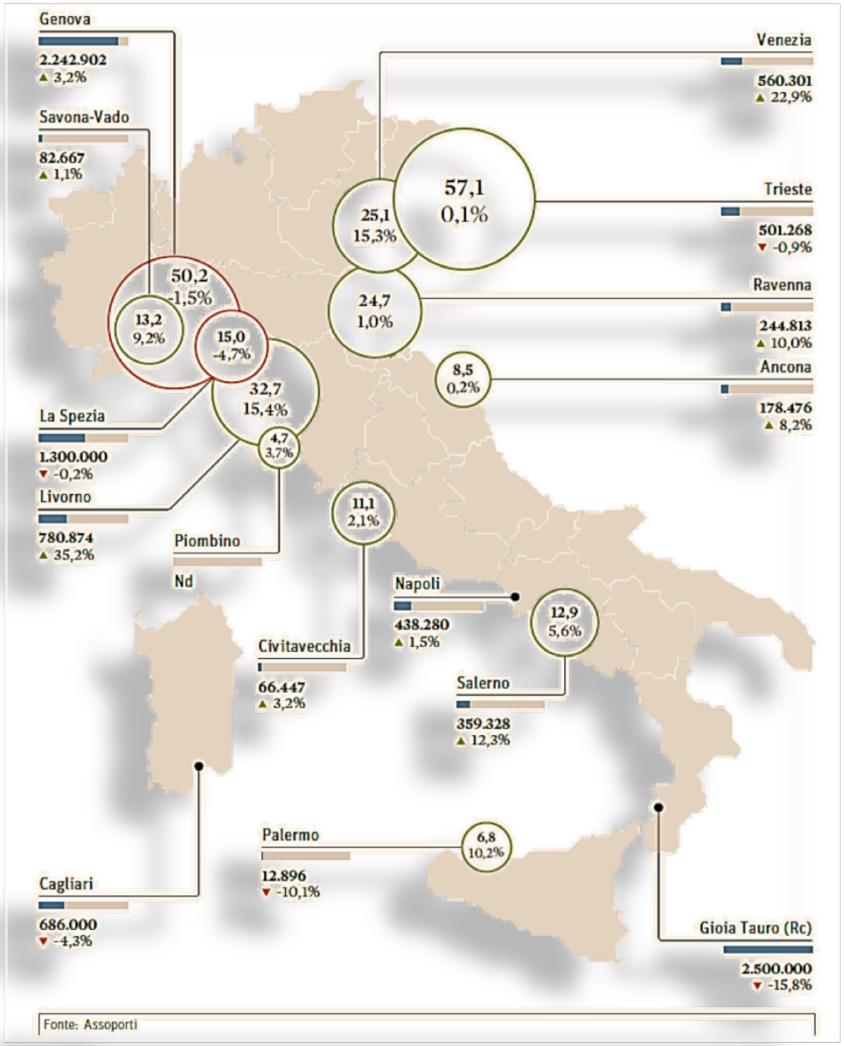
THALES

AGENZIA DELLE DOGANE

PORTI di ROMA e del LAZIO

INUIT
Università di Roma Tor Vergata

Maritime traffic



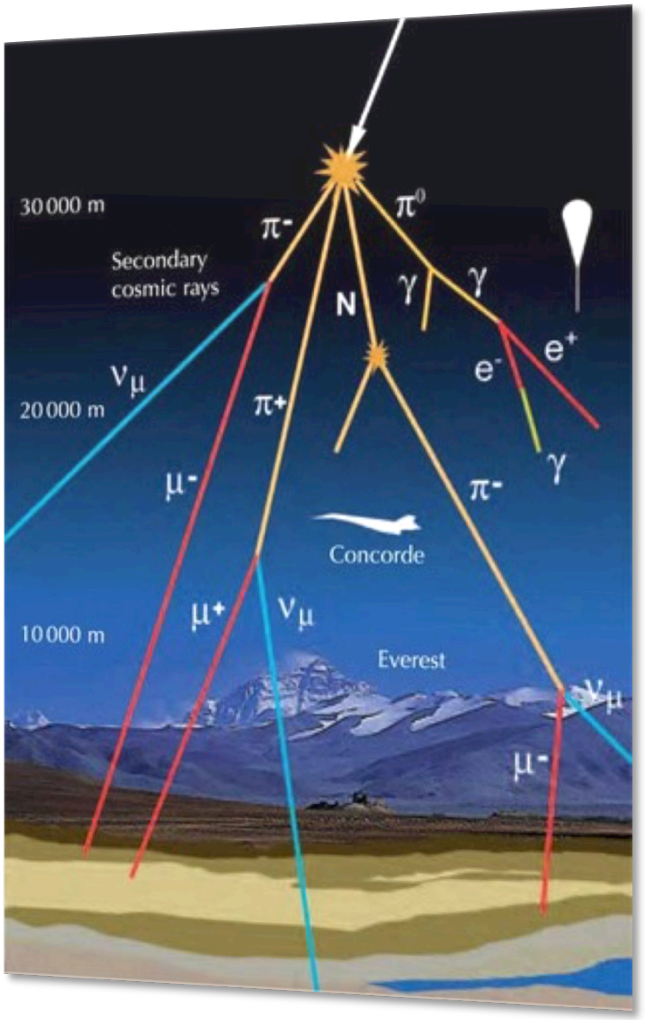
- Over 70 %of global trade by value are carried by sea
- World merchandise trade +2.3% yearly
- In 2015 +3.2% traffic at Civitavecchia port

Increasing attention to marine port security

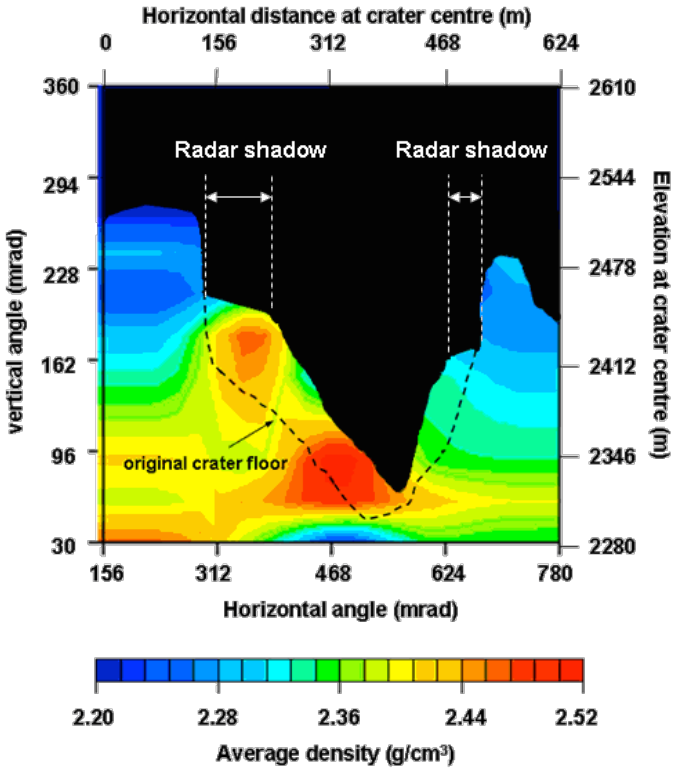
- Only few percent of containers is X-ray scanned or physical inspected
- Workers radiation safety issues
- It is needed an optimization of the logistics process of controls in ports, in line with the Smart Specialization Regional Strategy (S3)
- Synergy also with the strategies of the European Commission in the transport sector and their integration in the ICT field

Cosmic Muons

- 1 muon per square centimeter per minute
- About 10.000 m^2/min
- Highly penetrating particles cannot be shielded by lead as X rays for instance
- Already used since several years for muon radiography



Muon Absorption radiography



H.K.M. Tanaka et al., Earth and Planetary Science Letters 263 (2007) 104

- Similar to conventional X Ray radiography but with natural and parasitic source
- Already used in different scenarios for inspection as for instance
  - Egyptian Pyramids
  - Volcanos
  - Fukushima reactor
- Major drawback is the long integrating time for reasonable signal to noise ratio

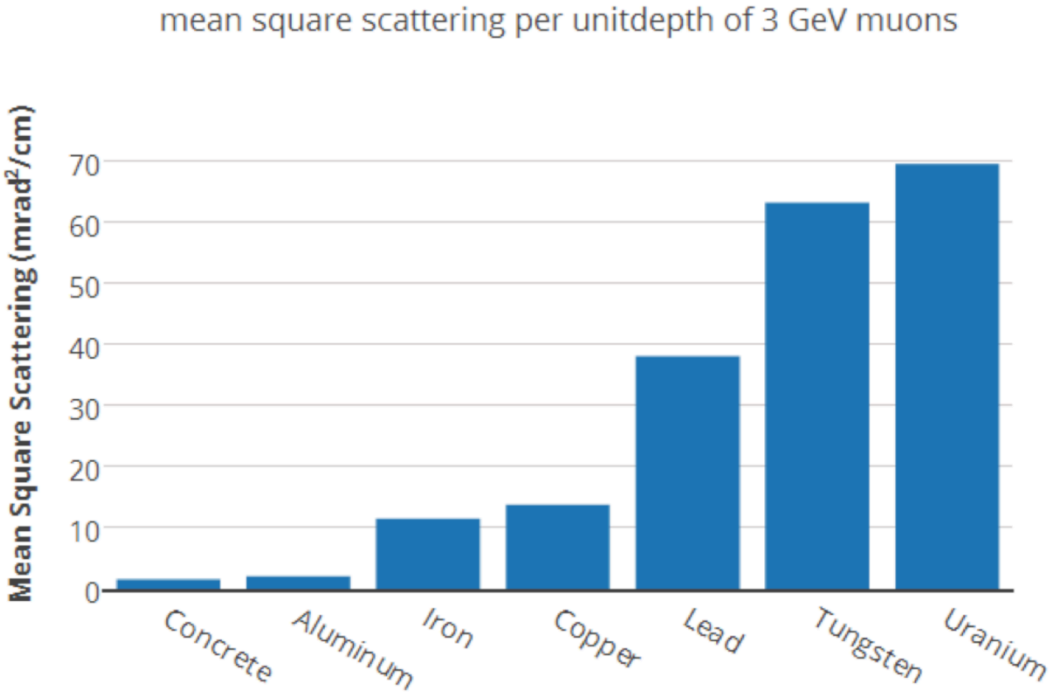
Muon scattering is the key

Incident muon

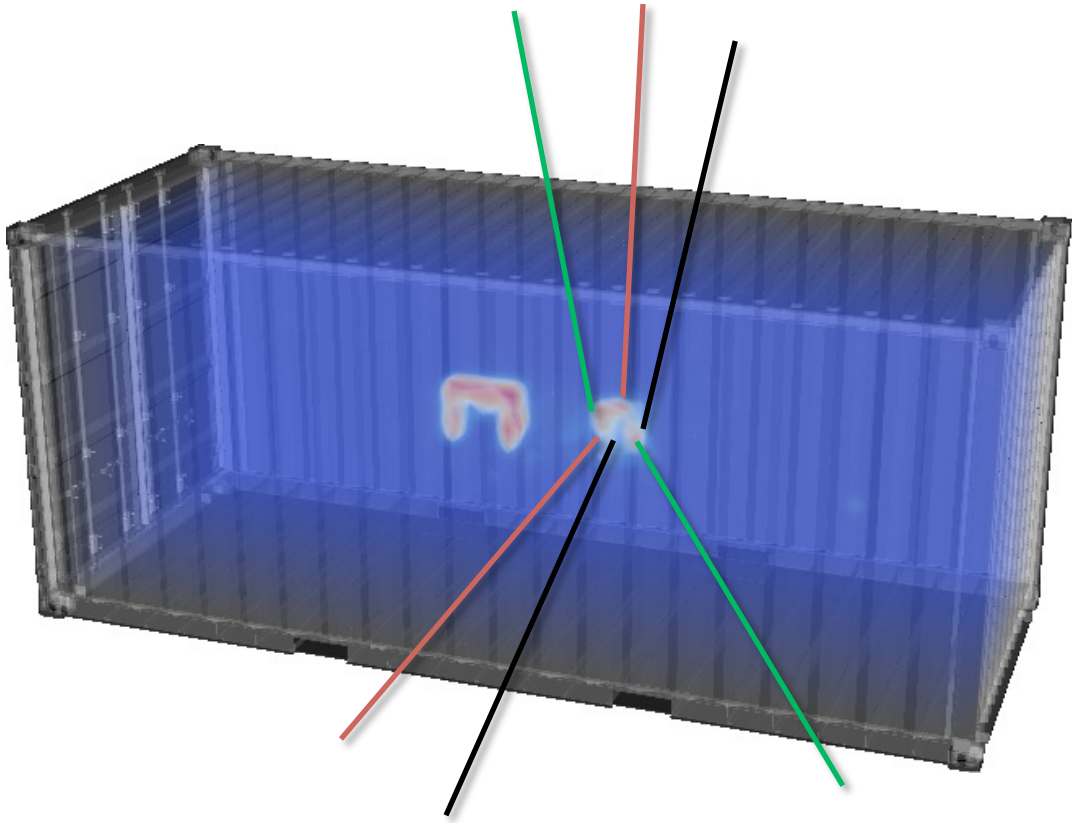
High Z material

Scattered muon

$$\theta_{plane}^{rms} \simeq \frac{13.6MeV}{\beta cp}\sqrt{\frac{x}{X_0}}$$

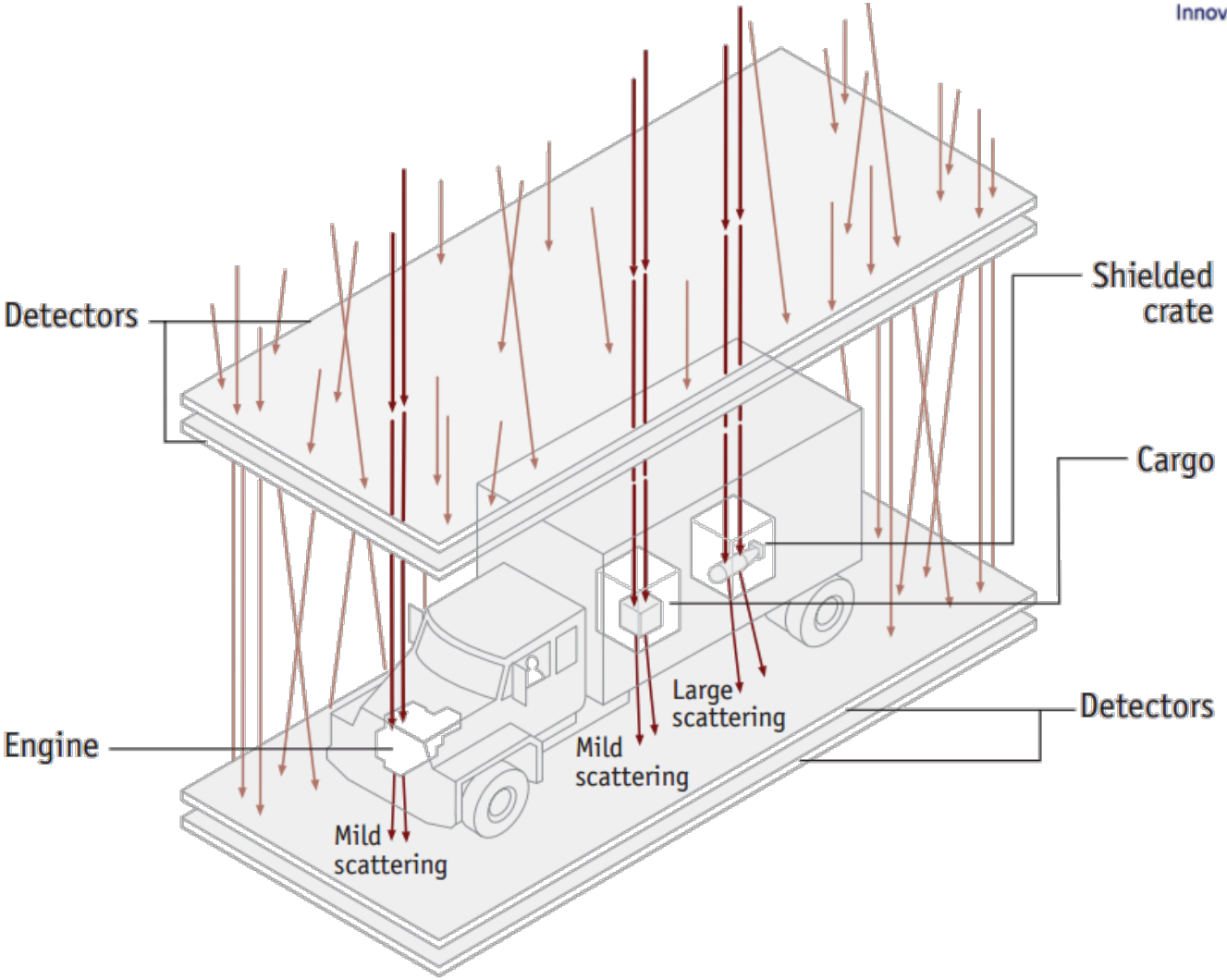


Tomography



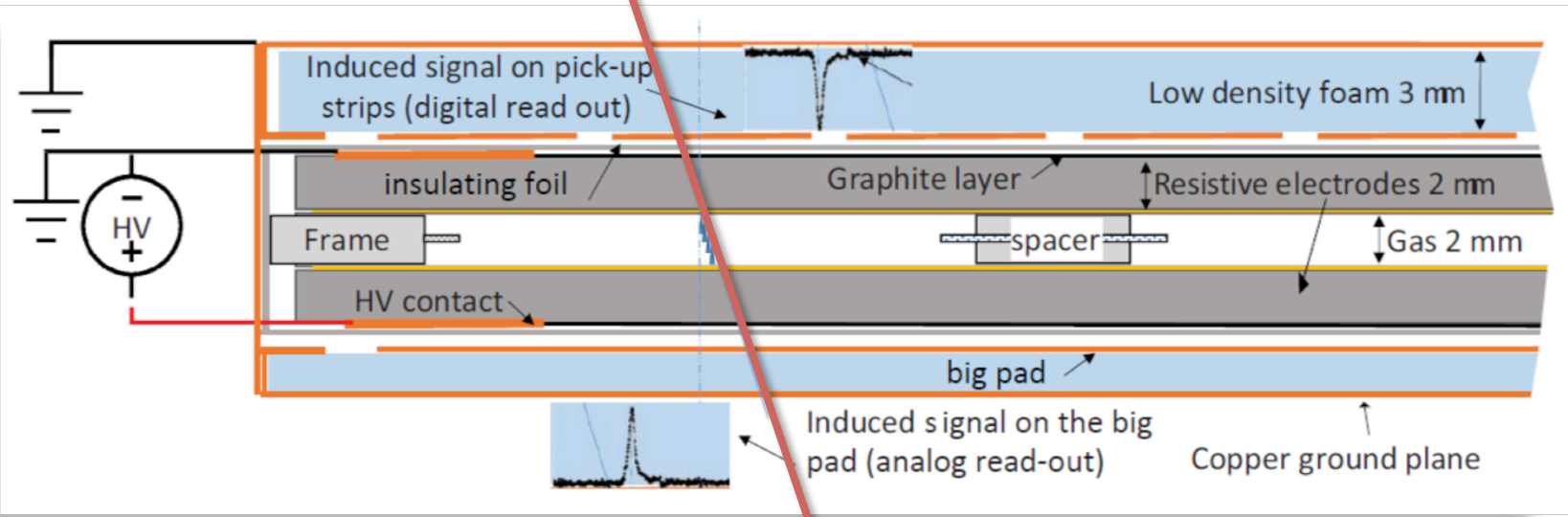
- Tomography allows trace reconstruction even with multiple scattering in the trajectory

Detection system



C. L. Morris et al. “Tomographic Imaging with Cosmic Ray Muons”, Science and Global Security, 16:37–53, 2008

Resistive Plate Chamber



- A RPC is just a gas filled plane capacitor with high resistivity electrodes
- External signal pick up electrodes can be easily tailored with any shape
- Mixture of 94.7% $C_2H_2F_4$ + 5% C_4H_{10} + 0.3% SF_6
- No flammable mixture
- Time of flight (TOF)

Large area RPC detectors

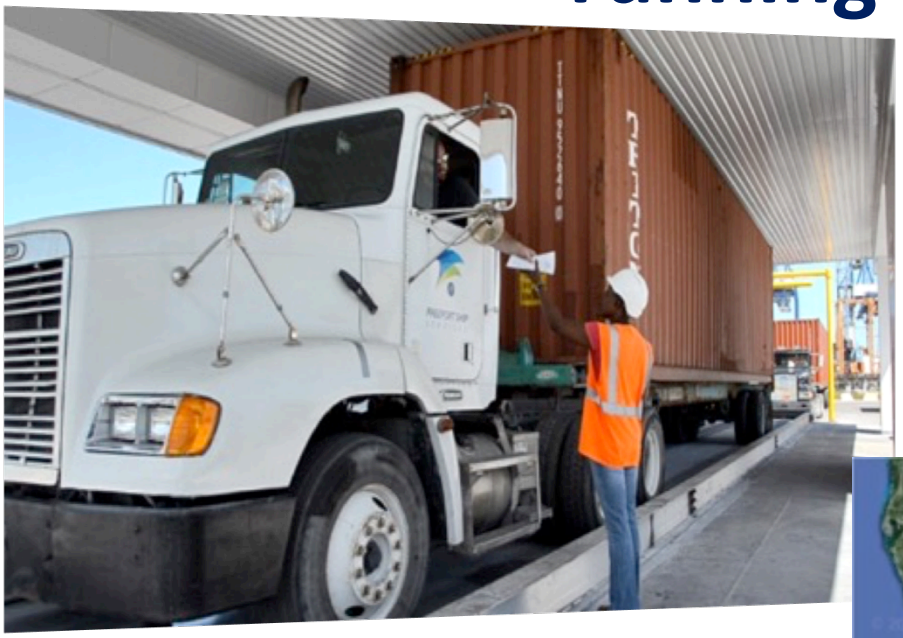
7000 m^2 ATLAS

7000 m^2 ARGO

6000 m^2 OPERA & CMS

All these devices have been produced by NAST people in collaboration with local industries

Only one device is actually running



- Freeport (Grand Bahama)

Project Goal

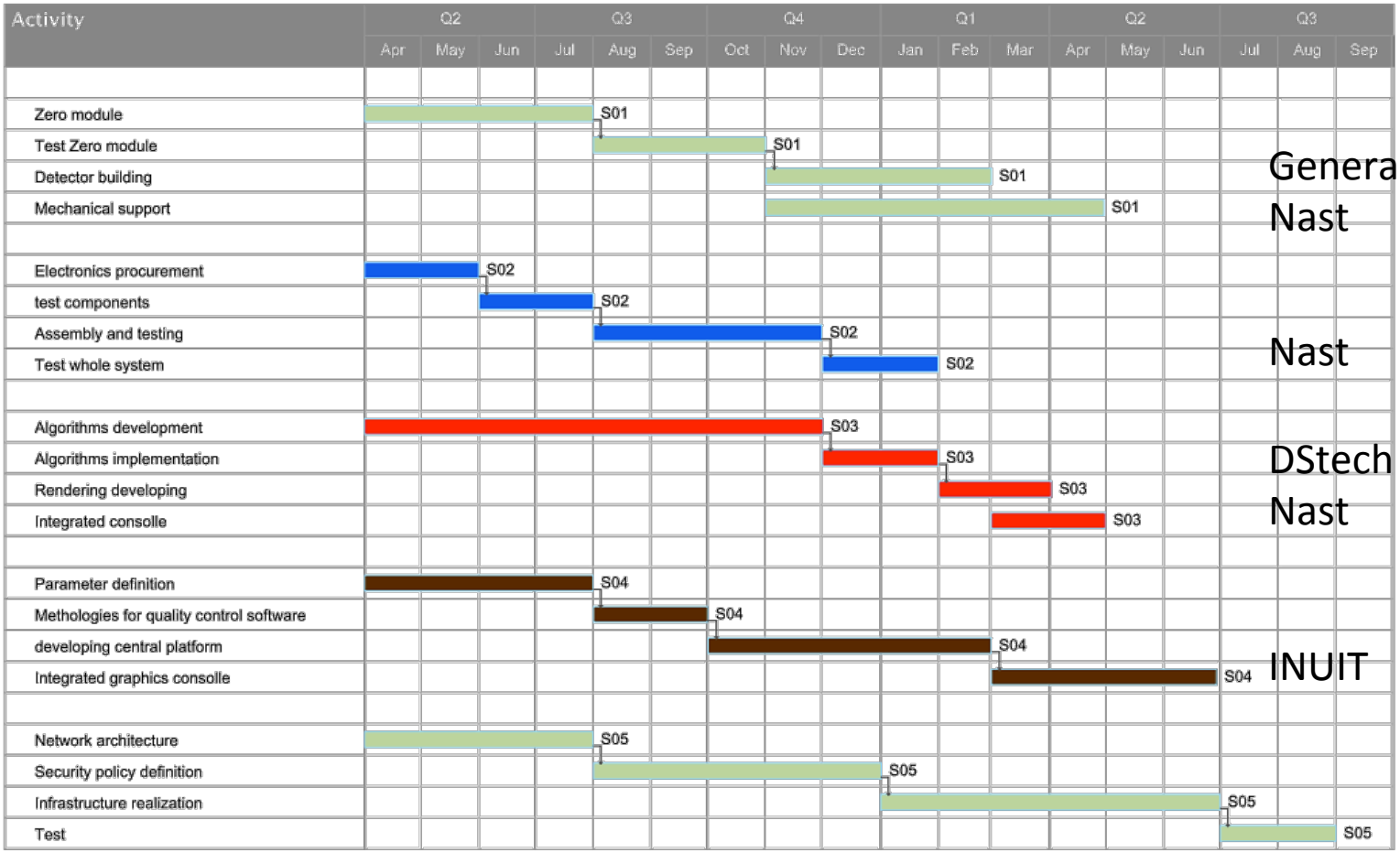
- Specific objective of the project is to create an integrated system prototype apparatus based on muon technology (TECNOMUSE) to be validated full-scale of a container.
- It responds to the needs expressed by the Customs Agency and the Port Authority to the regional government.

Tecnomuse collaboration

- DsTech SRL (**primer**): Enterprise Leader - Software development, design, engineering and system integration. Testing and validation of the system
- General Tecnica SRL: Company – Sensors productions
- INUIT Foundation: Development and scientific support for the control infrastructure, security, faults and alarms
- NAST: Scientific support for the muon technique

Smartsheet

TECNOMUSE



Summary

Expected results

Full scale working prototype
Scan of a real container in a couple of minutes
Scientific publications
Know-how acquisition

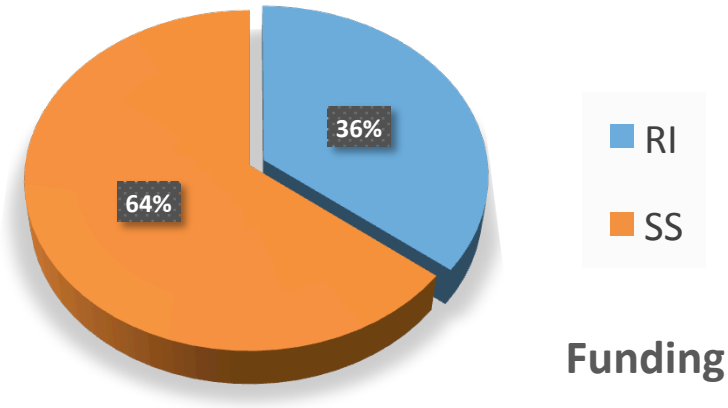
Impact of the research project

Triggering future industrial developments
Paving the way for selling the system to several customers
Increasing port security

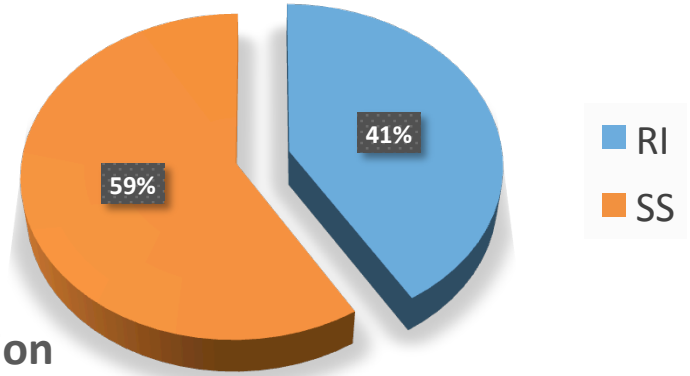
Thank you for your attention

Costs and funding

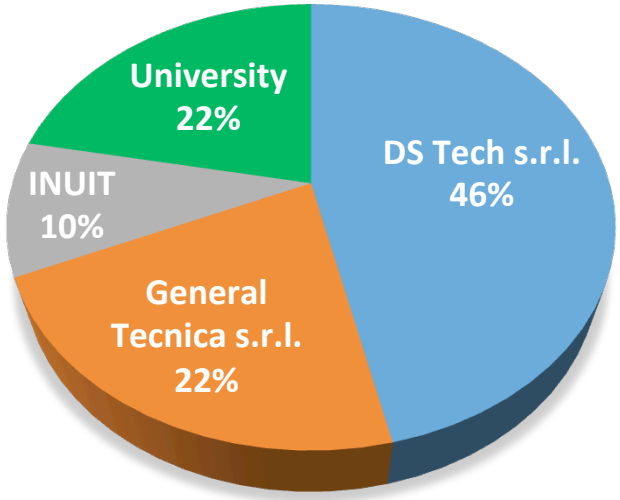
Total Cost €1.736.731,96



Funded € 1.127.656,83 (65%)



Funding Distribution



Objective and activities

SO1: Construction of the RPC detector and bracket, months 1-13 of the project; partners involved in the activity: *General Tecnica, NAST*

SO2: Development of electronics for the RPC detector, months 1-12 of the project, responsible for the partners: *NAST*

SO3: Development of software for integrated console and reconstruction capabilities and 3D imaging routines, months 1-14 of the project, partners involved in the activity: *Dstech, NAST*

S04: Development of a central platform for the integration of various elements: months 1-15 of the project, the partners involved in the activity: *DsTech*

SO5: Communication infrastructure, security, distributed control and alarms, months: 1-18, Partner responsible for the activity: *INUIT* foundation

SO6: Final Test TECNOMUSE in the harbor, months 14-18 of the project, the partners involved in the activity: *DsTech, NAST, INUIT, General Tecnica*