NEWS

NEw WindowS on the universe and technological advancements from trilateral EU-US-Japan collaboration

Transfer of Knowledge II

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Web site: risenews.df.unipi.it

European Commission

Transfer of Knowledge – NEWS WP10

Two of the main NEWS goals are:

- promote the collaboration among researches
- facilitate the Transfer of Knowledge (ToK) between research institutions and companies

It is important to coordinate all the activities specifically aimed to this target: direct collaborations, training courses, etc …

These are exactly the objectives of the WP10

WP10 co-leaders: R.De Rosa, *E. Pedreschi*, R.Sia

Main Objectives of WP10

Coordinate all the training activities:

- Maximize the transfer of knowledge among the participants
- Increase the research quality and competitiveness of the participants institutions

Provide trained personnel:

- Enhance personnel capabilities to be independent in the needed skills

WP10 Tasks

A list of specific tasks was identified, among the main actions of the project:

- Some tasks are more specifically related to selected activities of the project
- Some tasks are more general and involve all the participants.

A Task Leader is foreseen for each task in the work-package.

Task List and connections among WPs

- T10.1: Research-Industry ToK
- T10.2: GPD polarimeter for space applications
- T10.3: Electronics for Particle Physics and Space applications
- T10.4: Electrochemical techniques
- T10.5: High Speed Computing
- T10.6: Training courses

Task	Involved WPs
T10.1	WP2:WP8
T10.2	WP5
T10.3	WP5, WP6
T10.4	WP7
T10.5	WP2:WP8
T10.6	WP2:WP8

T10.3: Electronics for Particle Physics

Many researchers, from different research institutes and companies are involved in the development and construction of the Mu2e experiment:

- INFN, Italy, Europe
- University of Pisa, Italy, Europe
- HZDR – Gelbe, Germany, Europe
- Fermilab, Illinois,Europe
- Prisma Electronics, Greece, Europe
- Clever Operation, France, Europe

T10.1: Research – Industry ToK

Two of the companies related to NEWS (Prisma Electronics, Clever Operation) are interested in:

- Partecipate in development of electronics for Mu2e experiment (Waveform Digitizer - DIRAC board)

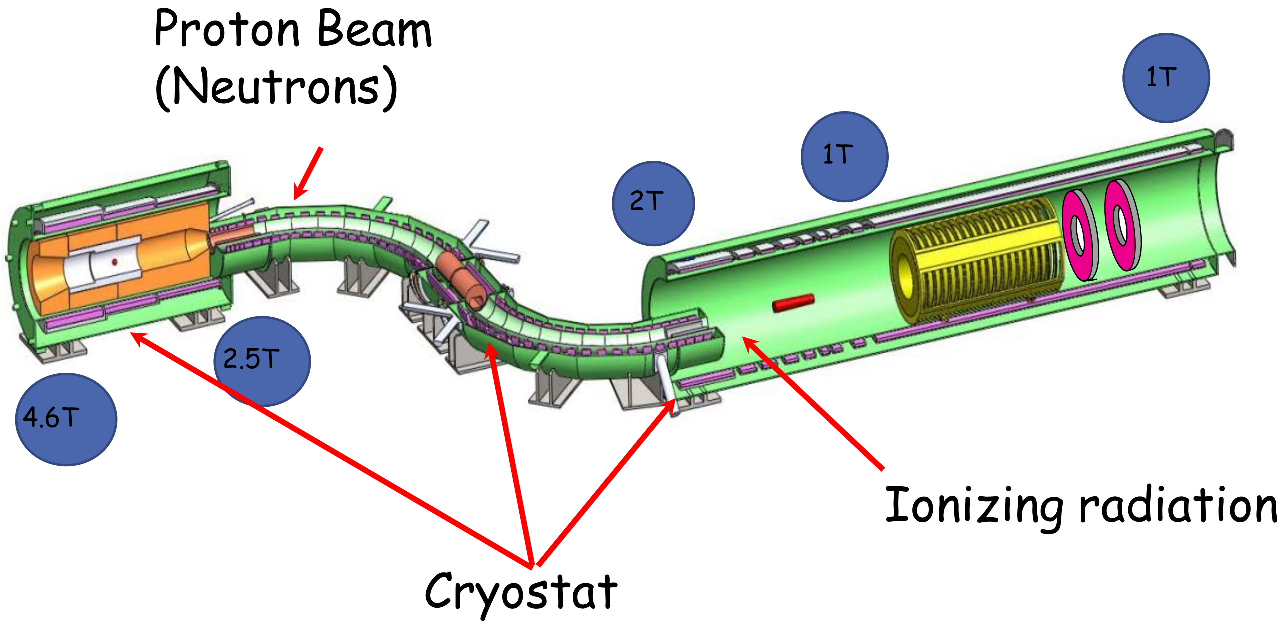
A company (CAEN) is interested in:

- To take an active part in electronic qualification tests
- Engineer and market some electronic cards (waveform digitizer – DIRAC board)

This is a real example of Transfer of Knowledge among NEWS participants

MU2E experiment @ Fermilab (1)

- Mu2e is an High Energy Physics experiment (see Simone introduction to NEWS)
- Mu2e aims to explore physics beyond the Standard Model



MU2E experiment @ Fermilab (2)

- Mu2e will operate in *harsh environment*:
  - **Radiation:** TID 0.5krad / y, NIEL 6x10^11 / cm^2 * year → rad-hard components are needed
  - **High Magnetic Field**: 1T → High → Saturation effects on ferromagnetic nuclei
  - **Vacuum** → Heat transfer and degassing problems
  - **Maintenance complicated** → cryostat will not be opened more often than once per year

Project must be realized in "*high reliability mode*", like an experiment in the space

Radiation Effects on Electronics

Long Term Effects:

- Total Inizing Dose (TID) → cumulative long term ionizing damage due to protons & electrons
- *Displacement Damage (NIEL)* → cumulative long term *non-ionizing* damage due to protons, electrons & neutrons

Transient or single particle effects (SEE) → caused by a *single charged particle* as it passes through a semiconductor (heavy ions & protons) → Soft or Hard errors

Heat Transfer in vacuum

The fundamental modes of heat transfer are:

- Conduction → transfer of energy between objects that are in physical contac
- *Convection* → transfer of energy between an object and its environment, due to fluid motion
- Radiation → transfer of energy by the emission of electromagnetic radiation

In vacuum the heat is dispersed basically by conduction (no convection)

Component choice

The presence of radiation, B field and vacuum pose stringent requirements on the components

Crucial steps for the success of the design are:

- Choose components that meet the specifications (Clever Operation & INFN)
- Qualify independently all the main components
- Test if they are compatible one to the other

Strong collaboration between NEWS partners to solve the problem

Radiation tests (1)

Several tests (component & board level) were performed

University of Pisa (Nuclear Engineering Department), HZDR, CAEN and INFN have collaborated for the success of this item:

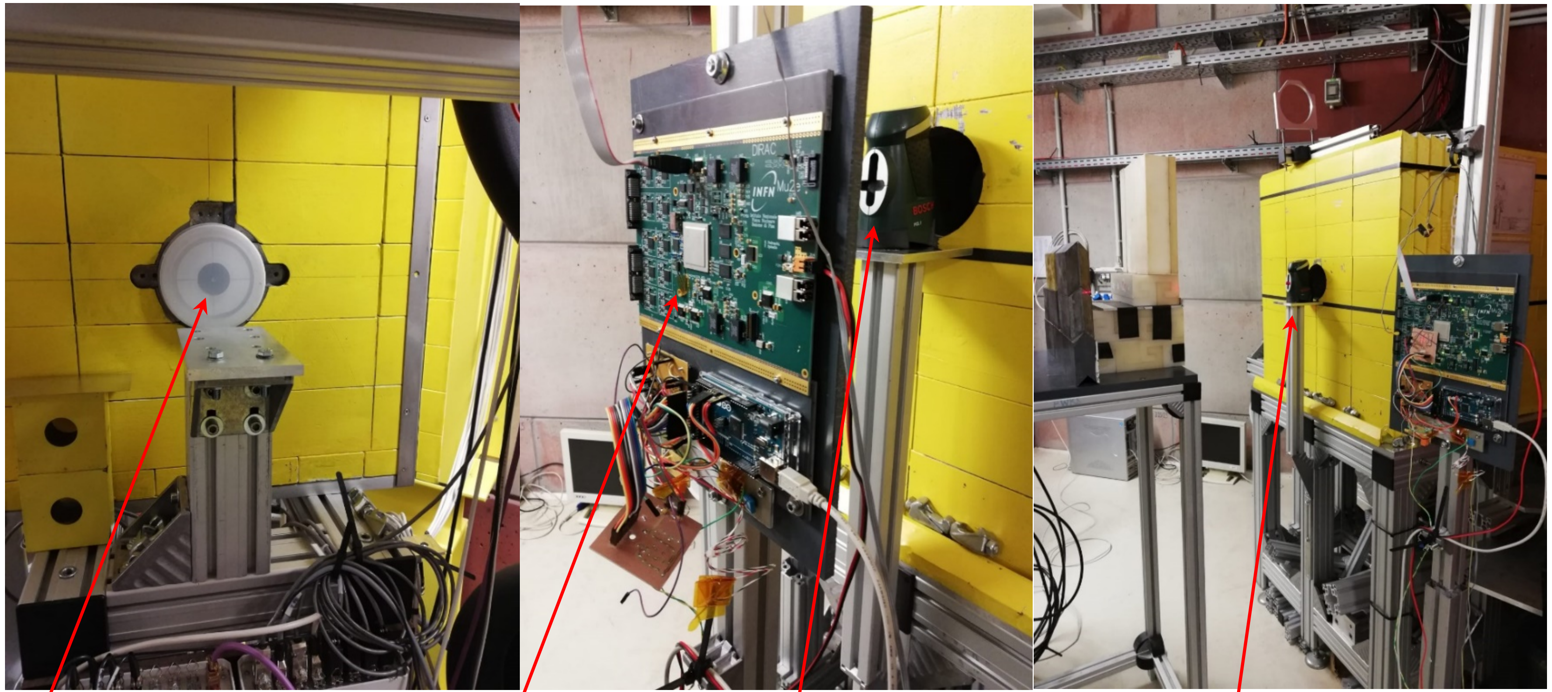
- University of Pisa and HZDR reserchers performed accurate Montecarlo simulations to define doses
- Single components tests (TID) @ HZDR gELBE facility (INFN Pisa and HZDR)
- Full board test (TID) @ ENEA Casaccia facility (INFN and CAEN)
- Neutron irradiation tests (NIEL) @FNG facility in Frascati (INFN)

Radiation tests (2)

Some test are scheduled in the next period:

- Single components tests (TID) @Brookhaven National Laboratory → April 2019 (INFN & Fermilab)
- Single component tests (SEU) @ Warrenville Hospital, Warrenville, Illinois → April 2019 (INFN & Fermilab)
- Full board test (TID) @ENEA Casaccia → May 2019 (INFN & CAEN)
- Neutron irradiation tests (NIEL) @ HZDR gELBE facility → May 2019 (INFN Pisa and HZDR)

Single Component Tests @ HZDR gELBE



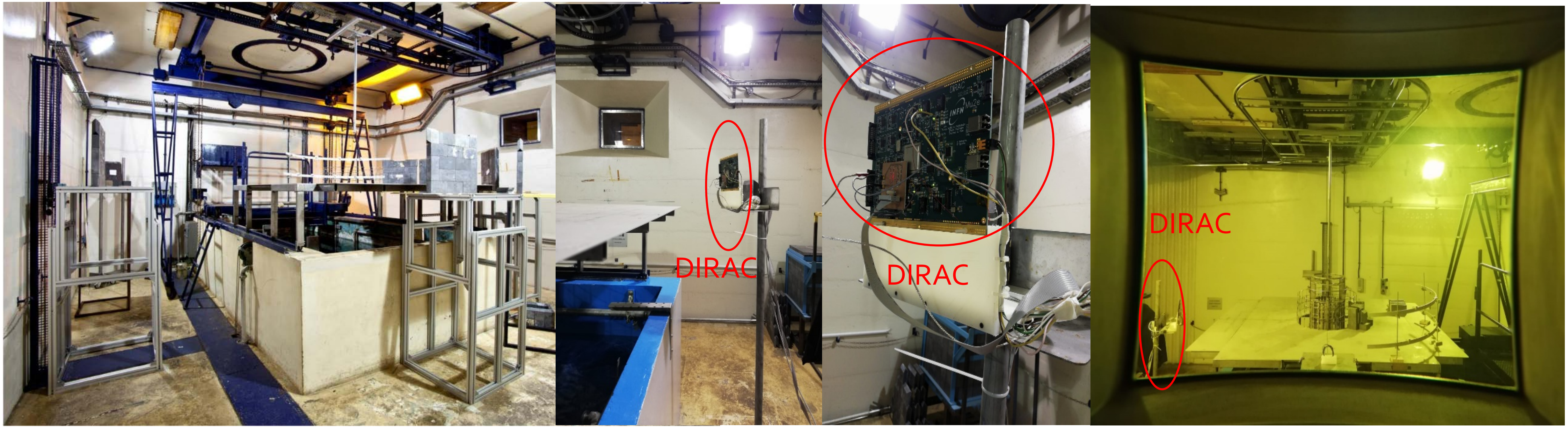
Beam DIRAC Laser Polyammide

Ø 7mm, 10mm,13mm, 16mm

- HZDR gELBE:
  - Collimated gamma beam up 15 MeV
  - Exstimated dose of 18.6 krad/h @ 600 uA

Tests @ HZDR gELBE - People

Full Board Test @ ENEA facility



- ENEA Casaccia:
  - Co60 source
  - Dose is function of distance (2 krad/h max)

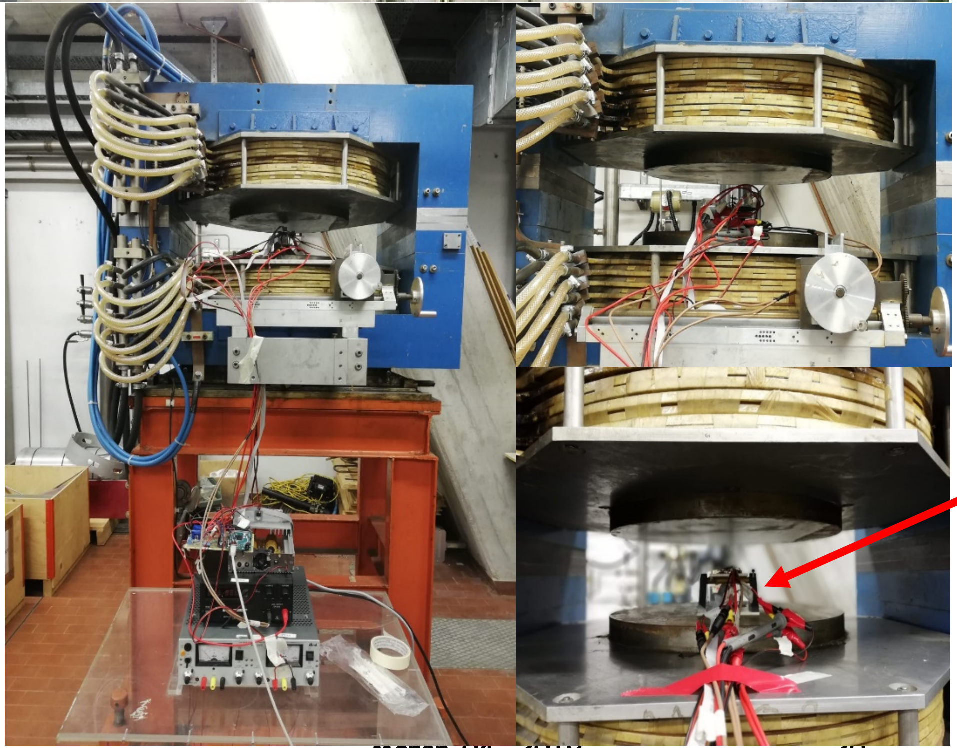
Test @ ENEA - People

NIELTest @ FNG facility

- Frascati Neutron Generator (FNG):
  - Up to 10^11 14 MeV neutrons/s
  - Isotropic Source, flux scales with r^2
  - Calibrated at 3% level using alpha particles

Magnetic Field exposure tests

- @ INFN – LASA laboratory:
  - Single component tests (DC-DC converters)
  - Up to 1.2 T of magnetic field for different spatial orientations



Training courses (T10.6)

Many tests were performed, each test was done in different laboratory with different characteristics:

- The test participants had to follow specific training courses to access and use each individual facility
- Researchers from different research institutes and Engineers from different companies gaining experience with this kind of harsh environment (rad hard, high magnetic field and vacuum)
- Increase in the level of knowledge and competitiveness for all the participants

Conclusions

- Researchers from different research institutions (INFN, University of Pisa, HZDR, Fermilab) and companies (Prisma Electronics, Clever Operation) envolved in Electronics for Particle Physics (T10.3) collaborated and shared their knowledge to design a waveform digitizer for harsh environment (T10.1)
- The research quality and competitiveness of the participants institutions was increased
- Specific training courses were attended and participants were able to increase their knowledge and enhance their personnel capabilities (T10.6)

Thank you!