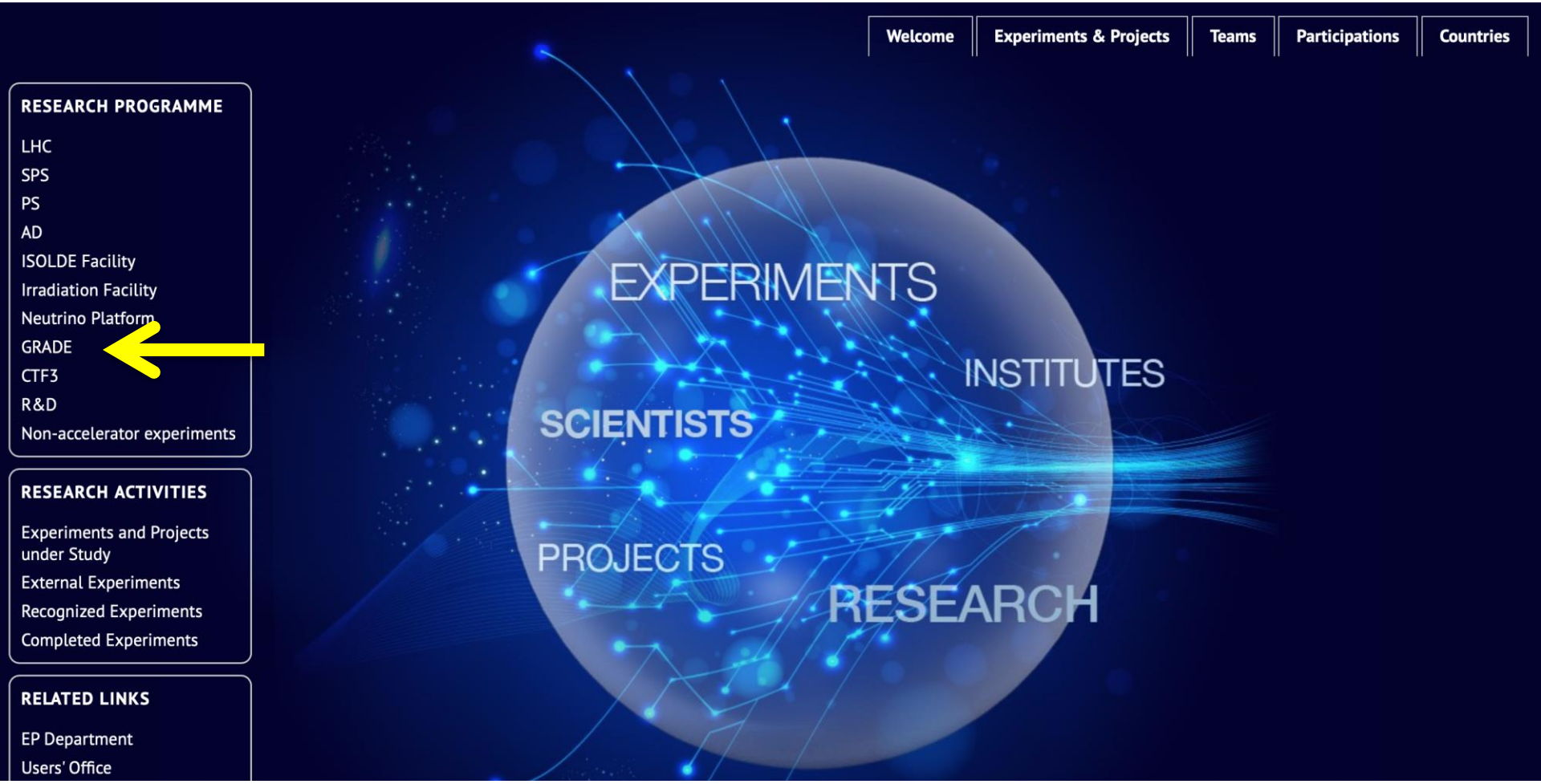
Ideasquare projects summary

M.Nessi

22-02-2019

In CERN grey book (GRADE)



GRADE

GRADE Research Programme

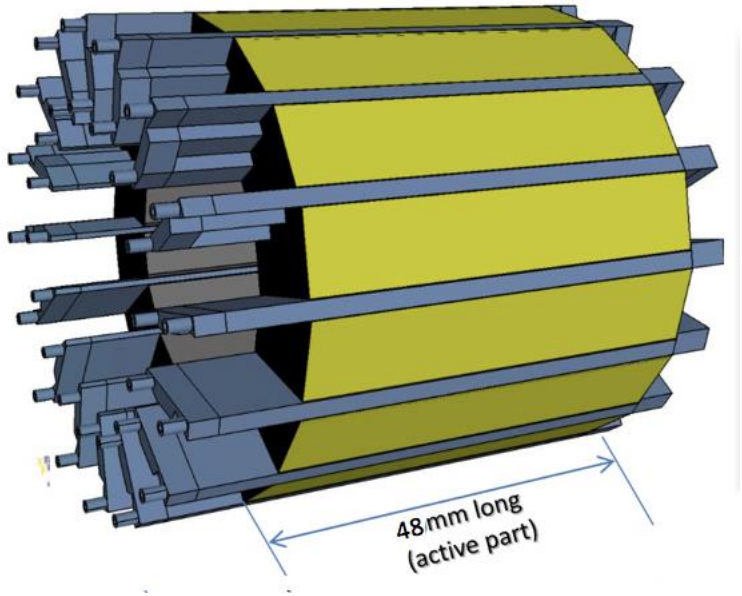
Experiments | Teams | Participations

Search criteria: Search

Name	Synonym	Title	Date of Approval
GR02	TT-PET	Thin Time-Of-Flight PET project	08-06-2016
GR03	AUGMENT	generic R&D and augmented reality techniques	08-06-2016
GR04	HEALTH	detectors for health and safety	08-06-2016
GR1	SIMPLE	Silicon Photo Multipliers for Generic Detector R&D	09-12-2015

The TT-PET project:
a 30 ps Time-of-Flight PET scanner with silicon

TT-PET Project



UNIVERSITÉ DE GENÈVE

Hôpitaux Universitaires Genève

UNIVERSITÄT BERN

AEC ALBERT EINSTEIN CENTER FOR FUNDAMENTAL PHYSICS

In collaboration with:

- Roberto Cardarelli - INFN Roma Tor Vergata
- Craig Levin - Stanford University
- Marzio Nessi - CERN IdeaSquare
- IHP microelectronics

Funded by:

FNSNF SWISS NATIONAL SCIENCE FOUNDATION

GR02/TT-PET

Thin Time-Of-Flight PET project

Overview | Teams | Participations

SPOKESPERSON: Giuseppe IACOBUCCI

DEPUTY SPOKEPERSON(S): Marzio NESSI

CONTACT PERSON: Markus Yrjo NORDBERG

TECHNICAL COORDINATOR: Frank Raphael CADOUX

RESOURCES COORDINATOR:

GROUP LEADER IN MATTERS OF SAFETY (GLIMOS):

DEPUTY GLIMOS:

DEPARTMENTAL FLAMMABLE GAS SAFETY OFFICER (FGSO):

DEPARTMENTAL CRYOGENICS OFFICER (CSO):

EXPERIMENT SECRETARIAT E-MAIL: sandy.petitfrere@cern.ch

EXPERIMENT SECRETARIAT WEB SITE:

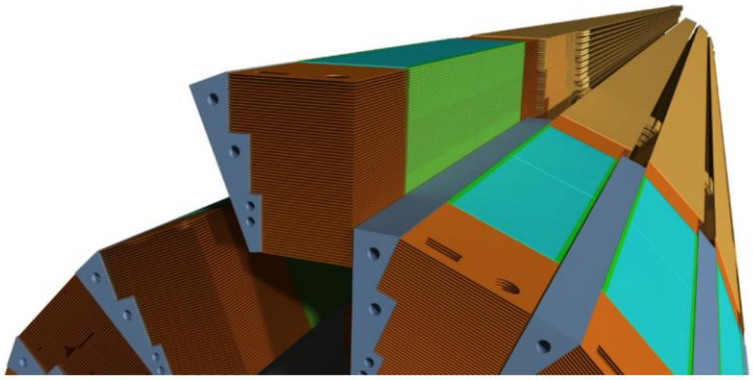
TT-PET

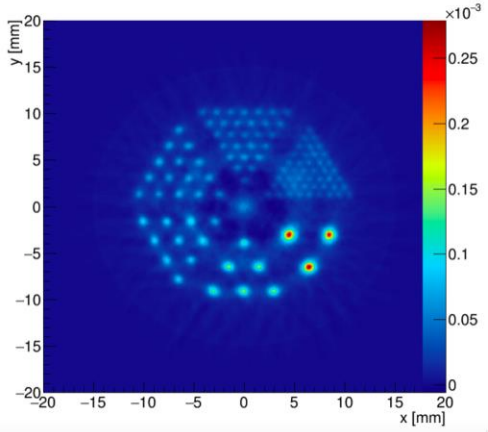
- ✓ Fully financed by a SWISS research grant (>2MCH)
- ✓ First demonstrator phase will end in spring 2019
- ✓ A new proposal for a full device construction has been submitted to the Swiss grant system
- ✓ Very interesting THz electronics technology

THE TT-PET PROJECT

The **Thin Time-Of-Flight Positron Emission Tomography** (TT-PET) project (SNSF grant CRSII2_160808) aims at developing a pre-clinical TOF-PET scanner with very precise 3D spatial reconstruction, for ultimate use in an MRI scanner. The 3D measurement will be achieved by TOF measurement with 30ps time resolution, obtained by monolithic pixel silicon sensors in a Silicon-Germanium Bi-CMOS process. The chip we are designing with the colleagues of Rome Tor Vergata will have the world best timing performance for a monolithic silicon pixel sensor and a very low power-consumption.

The scanner (a CAD design shown in the left-figure below) will be composed of 16 towers of 250µm thickness, each containing 60 layers of photon converter, monolithic pixel silicon sensor and front-end electronics. The dense layered structures and the monolithic integration of the detector provide a photon detection granularity of 500x500x250µm^3. The mechanics has been designed and is being produced by the LHEP-Bern and the DPNC. The readout system by LHEP-Bern.



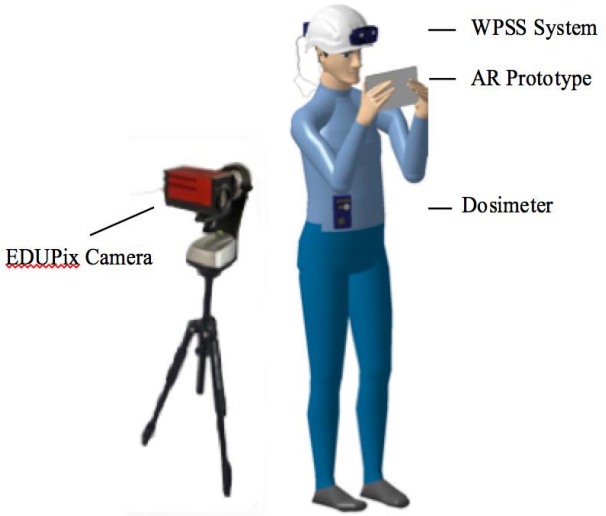


The PET scanner, comprising more than 1.5 million readout channels on 1920 chips, will be synchronised with 10 ps precision with an innovative technique, purposely developed for this project.

Augment


Overview of Personnel Safety System
Local worker
Remote Sup.
Current
Future
Step 1.
AR devices
Powered with
WRM chip
Step 1.


CERN
TECHNISCHE UNIVERSITÄT MÜNCHEN
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
TOR VERGATA
CANBERRA
NOVOCAPTIS
UNICAEN
université de Caen Basse-Normandie
Athens University of Economics and Business
ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
Prisma Electronics SA


WPSS System
AR Prototype
Dosimeter
EDUPix Camera

GR03/AUGMENT

generic R&D and augmented reality techniques

Overview | Teams | Participations

SPOKESPERSON:	Olga BELTRAMELLO
DEPUTY SPOKEPERSON(S):	Marzio NESSI
CONTACT PERSON:	Markus Yrjo NORDBERG
TECHNICAL COORDINATOR:	
RESOURCES COORDINATOR:	
GROUP LEADER IN MATTERS OF SAFETY (GLIMOS):	
DEPUTY GLIMOS:	
DEPARTMENTAL FLAMMABLE GAS SAFETY OFFICER (FGSO):	
DEPARTMENTAL CRYOGENICS OFFICER (CSO):	
EXPERIMENT SECRETARIAT E-MAIL:	sandy.petitfrere@cern.ch
EXPERIMENT SECRETARIAT WEB SITE:	

AUGMENT

- ✓ *FP7 Marie Curie ITN Project*
- ✓ *A collaboration of 13 Partners- CERN as coordinator*
- ✓ *3.2 Meuros*
- ✓ *4 years program*

EDUSAFE

Education in advanced VR/AR Safety Systems for Maintenance in Extreme Environments

Testing campaign 2015

The 1st testing campaign will take place at CERN 16 - 27 February 2015.

More Information

Technical meeting: development and integration for

EDUSAFE is a 4-year Marie Curie ITN project that provides training for 10 Early Stage Researchers and 2 Experienced Researchers. The project focuses on research into the use of Virtual Reality (VR) and Augmented Reality (AR) during planned and emergency maintenance in extreme environments (nuclear installations, space, deep sea etc).

The scientific objective of EDUSAFE is research into advanced VR and AR technologies for a personnel safety system platform, including features, methods and tools. Current technology is not acceptable because of significant time-lag in communication and data transmission, missing multi-input interfaces, and simultaneous supervision of multiple workers who are working in the extreme environment. The aim is to technically advance and combine several technologies and integrate them as integral part of a personnel safety system to improve safety, maintain availability, reduce errors and decrease the time needed for scheduled or sudden interventions.

The research challenges lie in the development of real-time (time-lags less than

GR04/HEALTH

detectors for health and safety

HEALT

Overview | Teams | Participations

SPOKESPERSON:	Marco SILARI
DEPUTY SPOKEPERSON(S):	Marco NESSI
CONTACT PERSON:	Markus Yrjo NORDBERG
TECHNICAL COORDINATOR:	
RESOURCES COORDINATOR:	
GROUP LEADER IN MATTERS OF SAFETY (GLIMOS):	
DEPUTY GLIMOS:	
DEPARTMENTAL FLAMMABLE GAS SAFETY OFFICER (FGSO):	
DEPARTMENTAL CRYOGENICS OFFICER (CSO):	
EXPERIMENT SECRETARIAT E-MAIL:	sandy.petitfrere@cern.ch
EXPERIMENT SECRETARIAT WEB SITE:	

The development of an integrated system for measurement of the 3D energy deposition in water by proton and C-ion beams has been completed. The system consist of a motorised water phantom with integrated GEMPix detector and reference PTW ion chamber, and all associated HW and SW. The system has been set-up and extensively tested at IdeaSquare before being moved to CNAO (Italy) for the measurements with clinical proton and carbon ion beams. The results are within 10% of the reference CNAO data (FLUKA simulations and Peakfinder measurements). On the other hand little progress has been made on a wider collaboration. Two institutes have signed the addendum to the MoU for the HEALTH program, CIRA (the Italian Aerospace Research Centre) and ISS (the Italian Istituto Superiore di Sanità), but no practical collaboration has been undertaken. Effort coordinated by M. Silari.

HEALT

1. W-MON

This is an on-going project to build a distributed network of radiation sensors to be installed on approximately 100 containers for conventional waste on the CERN site, with the final aim to integrate it in the global CERN radiation monitoring system. The goal is to monitor, in real time and remotely, the potential presence of radioactivity in normal waste. The development of a network of smart radiation sensors is perfectly aligned with powerful trends in the contemporary technological landscape, as the far-reaching concept of the “Internet of Things” (IoT). The project can branch out into many applications with significant societal impact, for hospitals, environmental protection, monitoring of nuclear infrastructures etc. It may as well provide a platform for monitoring elements of environmental risk beyond radiation.

The work at IdeaSquare will concentrate on the development of the communication protocols and infrastructure. Access is needed to the electronic workshop and the 3D printing facilities.

Collaborators: A. Curioni, M. Silari, F. Murtas, D. Celeste, S. Romano. External partners to be confirmed.

HEALT

2. RaDoM

A prototype of an active radon monitor has been built. This device has the capability of both measuring the radon concentration in air in real time and providing a direct assessment of the absorbed dose to the lung from radon decay products. We are now planning a fully engineered version of this device, and to expand its scope to generalized air contamination monitoring. This work is part of the thesis of a PhD student (Stefano Romano). At IdeaSquare, access is needed to the electronic workshop and the 3D printing facilities.

Collaborators: S. Romano. External partners to be confirmed.

3. A GEMPix-based 3D monitor for hadrontherapy

A system based on the GEMPix is being developed (an instrument developed within the ARDENT Marie Curie project in collaboration with INFN) for medical applications, for characterizing clinical beams used in hadron therapy. The GEMPix has already been tested at the Italian Centre for Oncological Hadron Therapy (CNAO) inside the CNAO water phantom, and showed to be able to reconstruct the 3D energy deposition in water by proton and carbon ion beams. At this point we intend to build our own complete system.

At IdeaSquare, we will work on building our own water phantom with support for the GEMPix and integrating an ion chamber for dose normalization. We will need access to the mechanical and electronic workshops, as well as some space to store the phantom and its ancillary equipment.

GR1/SIMPLE

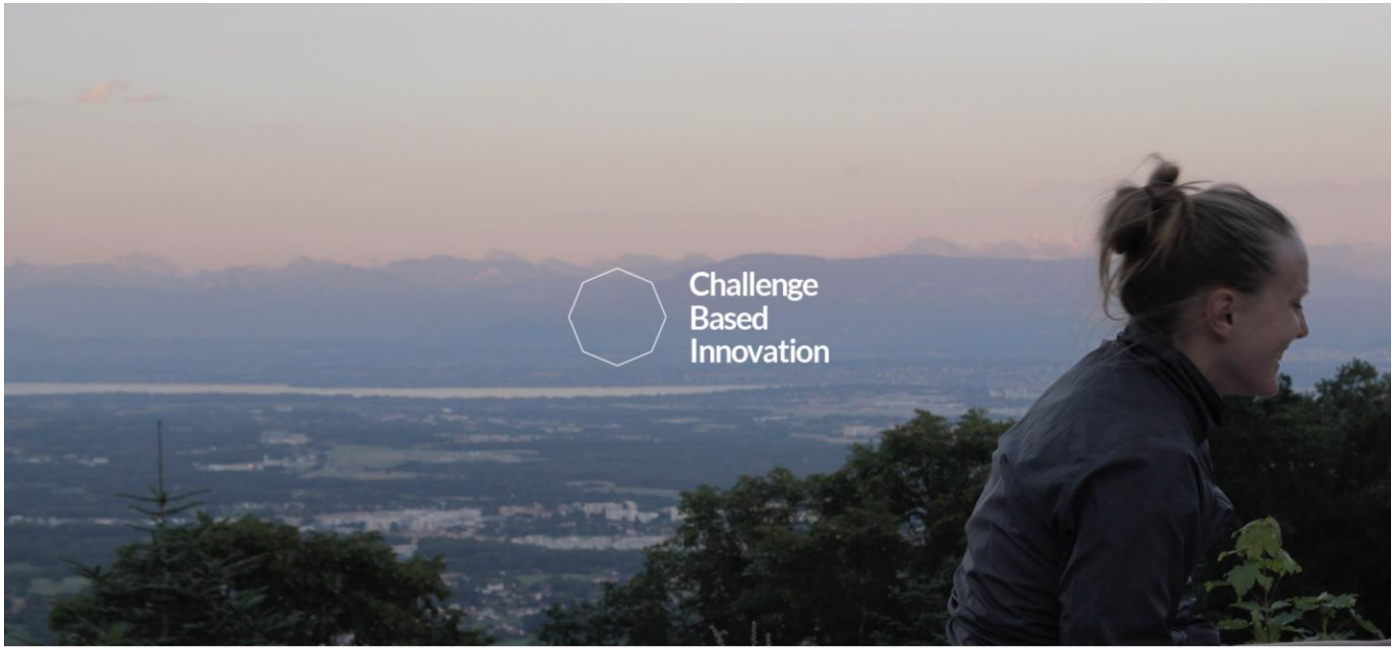
Silicon Photo Multipliers for Generic Detector R&D

Overview | Teams | Participations

SPOKESPERSON:	Markus Yrjo NORDBERG
DEPUTY SPOKEPERSON(S):	
CONTACT PERSON:	Markus Yrjo NORDBERG
TECHNICAL COORDINATOR:	
RESOURCES COORDINATOR:	
GROUP LEADER IN MATTERS OF SAFETY (GLIMOS):	
DEPUTY GLIMOS:	
DEPARTMENTAL FLAMMABLE GAS SAFETY OFFICER (FGSO):	
DEPARTMENTAL CRYOGENICS OFFICER (CSO):	
EXPERIMENT SECRETARIAT E-MAIL:	sandy.petitfrere@cern.ch
EXPERIMENT SECRETARIAT WEB SITE:	

SIMPLE

- ✓ Silicon Photo Multipliers for Generic Detector R&D
- ✓ The project was stopped a few years ago because of problems with one of the industrial partners
- ✓ SIMPLE has become CBI from that moment
- ✓ SIMPLE should be formally cancelled and CBI should appear as new organization by itself



Idsq and the Neutrino Platform

- Idsq is also hosting an important part of the Neutrino Platform activities
  - *Central design office (3 designers + 2 mechanical engineers)*
  - *Several R&D activities projected to future neutrino detectors and eventually possible spinoffs*
  - *Development of large hodoscope detectors for tagging cosmic rays to help surface neutrino detectors*

Additional R&D project present in IDsq

- ✓ precise determination of the group velocity of the 128 nm scintillation light in Liquid argon (paper is ready but not submitted yet);
- ✓ optimisation of the trigger system of ICARUS, based on scintillation light patterns and timing;
- ✓ performance studies of new plastic VUV wave shifter (PEN) in LAr using LAr-TPC equipped with PMT's and SiPM;
- ✓ performance study of reflector foils on the TPC field cage to improve the scintillation light collection in LAr (including studies of effects of space charge accumulated on insulators);
- ✓ doping of LAr with Xenon as efficient diffused wave shifter;
- ✓ doping of LAr with nano-particles (in view of a possible use as neutron moderator);
- ✓ R&D on possible charge signal amplification in LAr using sub-micron strips anodes;
- ✓ R&D on new front end electronics at cryogenic temperatures (based on new silicium-germanium junctions);
- ✓ test of new purification filter material for LAr;
- ✓ test of a dual phase TPC sensitive to keV energy depositions with SiPM readout(recording primary and proportional scintillation light);
- ✓ revamping of the R&D on resistive thick gems.

Xenon Doping of Liquid Argon

for astroparticle DETECTORS

XE-DOPING

- Two processes:

$h\nu_1$ = 9.7 eV (λ=128 nm)
$h\nu_2$ = 7 eV (λ=175 nm)

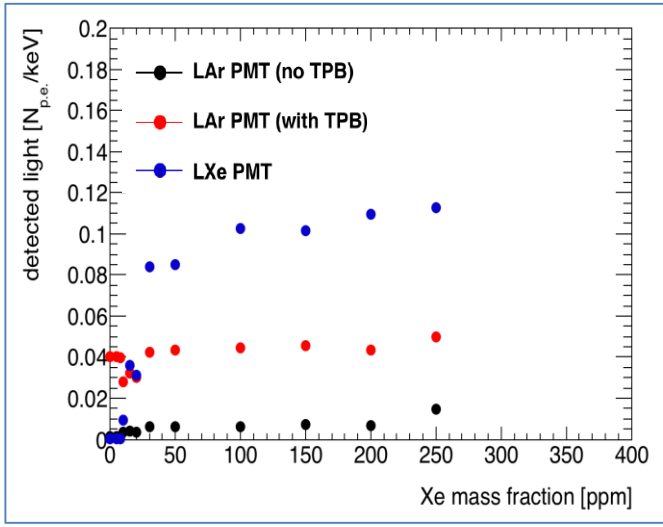
Radiative exchange (slower)

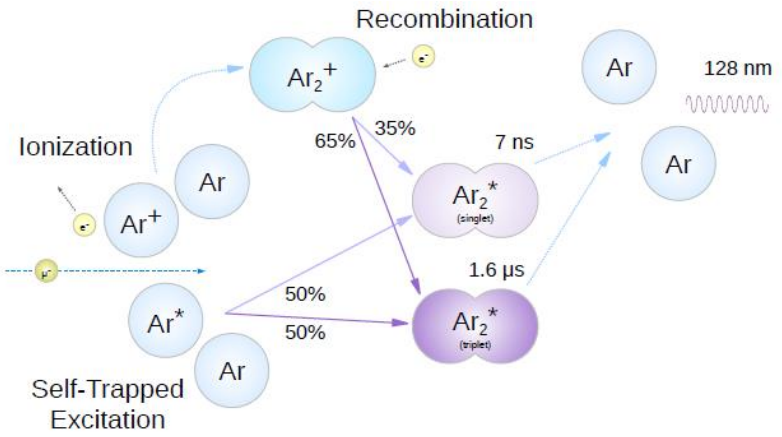
$$Ar_2^* \rightarrow Ar + Ar + h\nu_1$$
$$h\nu_1 + Xe \rightarrow Xe^*$$
$$Xe^* + Xe \rightarrow Xe_2^*$$
$$Xe_2^* \rightarrow Xe + Xe + h\nu_2$$

Collisional exchange

$$Ar_2^* + Xe \rightarrow Ar + Ar + Xe^*$$
$$Xe^* + Xe \rightarrow Xe_2^*$$
$$Xe_2^* \rightarrow Xe + Xe + h\nu_2$$

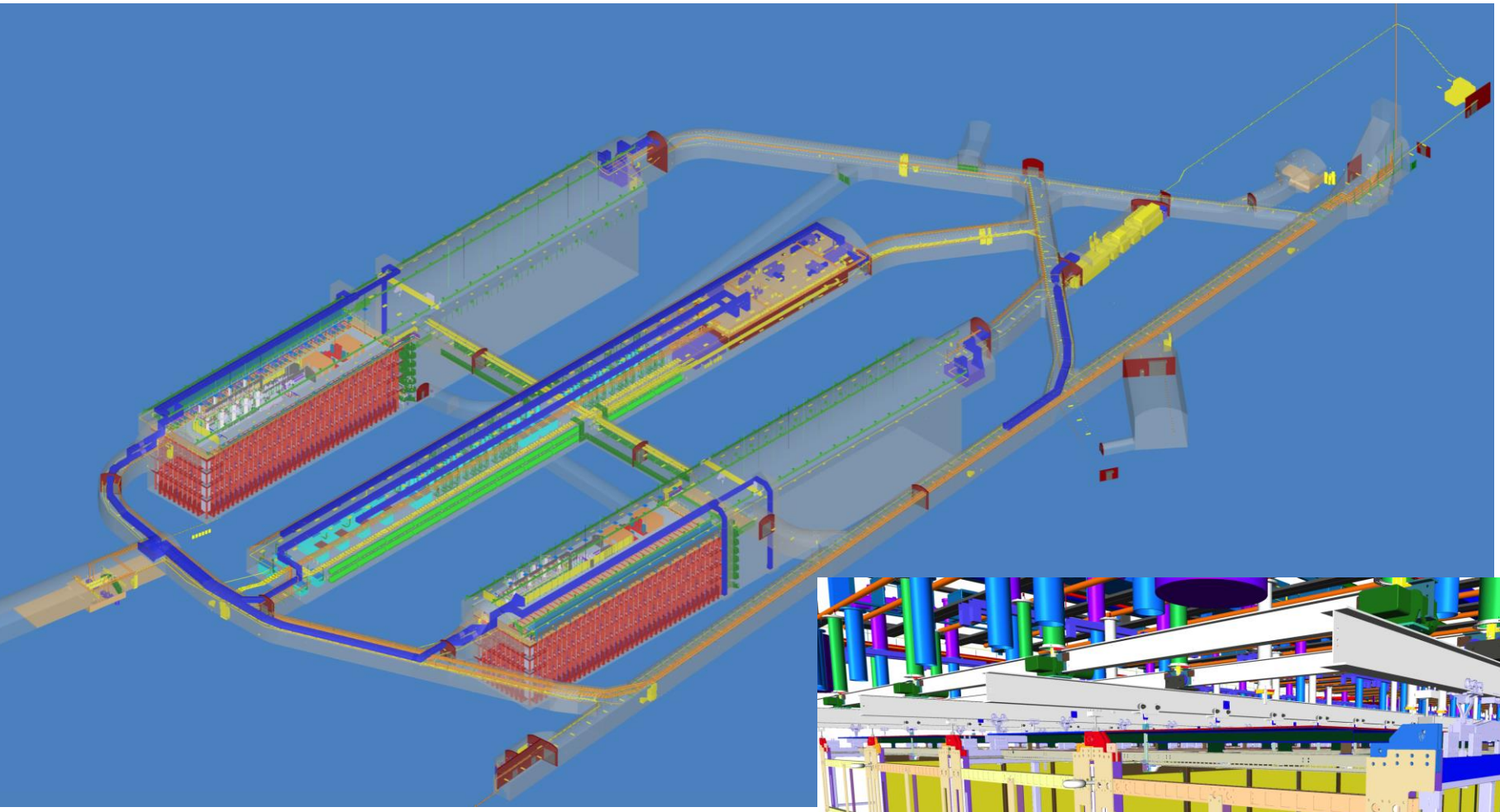
Shift is almost complete already around 10-20 ppm

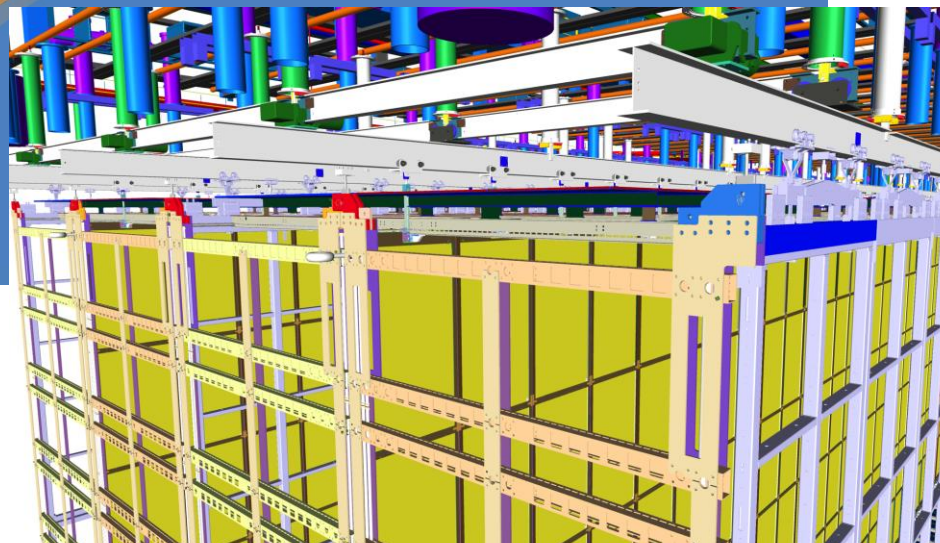




Wavelength: above 10-20 ppm, most of the Ar excitation (triplet) is passed to Xe, therefore the emission is centered on 174 nm, easier to detect. Factor 2 gain in light collection in case of wavelength shifter absence

LBNF/DUNE full mechanical integration





Idsq space

- More and more limited. Very busy environment