

DRD2 @ IN2P3

Liquid Detectors : vue d'ensemble, activités concernées

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au nom des équipes DRD2 IN2P3

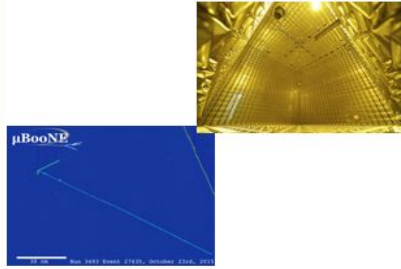
4 mars 2025



Le DRD2 et ses missions scientifiques

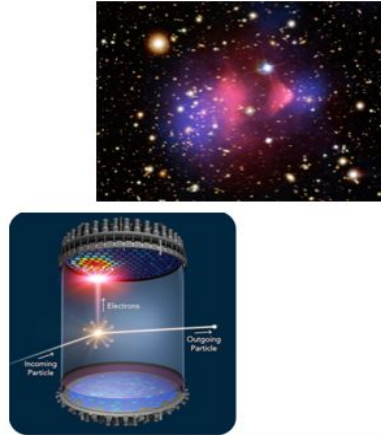
Neutrinos

- Oscillation precision measurements (δ_{CP} , mass ordering, θ_{23} octant, sterile vs)
- Neutrino interactions (from CEvNS to DIS)
- Astro neutrinos



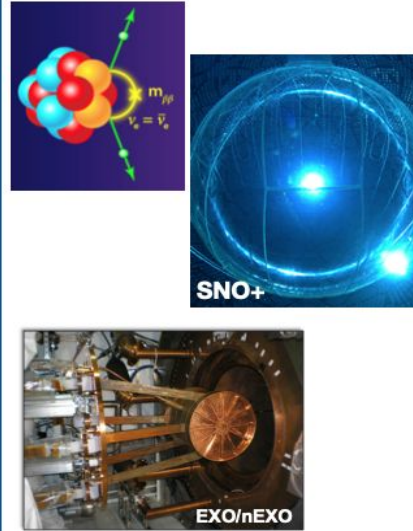
Dark Matter

- Direct detection (WIMPs, ...)



$0\nu\beta\beta$

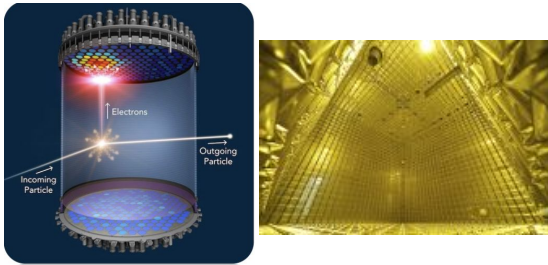
- Search for Majorana neutrinos



Le DRD2 et ses missions techniques

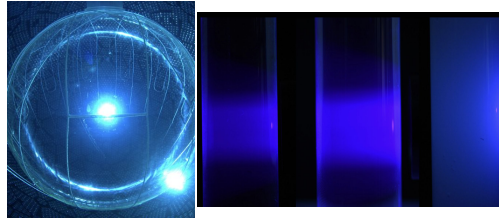
Noble Elements

- Argon & Xenon
- Ionisation charge & transport
- VUV Scintillation, light propagation & detection



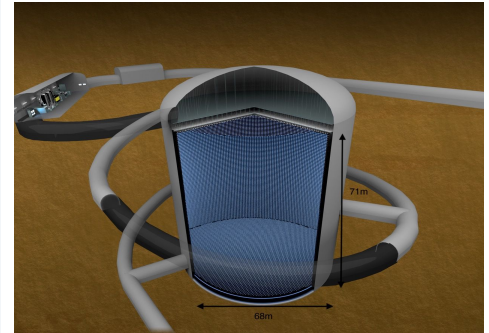
Liquid Scintillators

- Visible Scintillation, light propagation
- Scintillator properties
- Isotope loading



Water Cherenkov

- Cherenkov light, light propagation
- Doping for n-capture



Le DRD2 et l'impacte de l'R&D sur les projets scientifiques

Liquides Nobles (Argon/Xenon)

- Matière noire (Xe) : XLZD, DARWIN (R&D)
- Matière noire (Ar) : DarkSide, Argo
- Neutrinos (Ar) : DUNE (3e/4e modules)
- $0\nu\beta\beta$ (Ge) : LEGEND (LAr bath)
- $0\nu\beta\beta$ (Xe) : nEXO
- (Xe) Détecteurs xénon de la taille du kton:
(<https://indico.slac.stanford.edu/event/8015>)
- Mélange Xe-Ar pour physique du neutrino (incl. DUNE) et matière noire

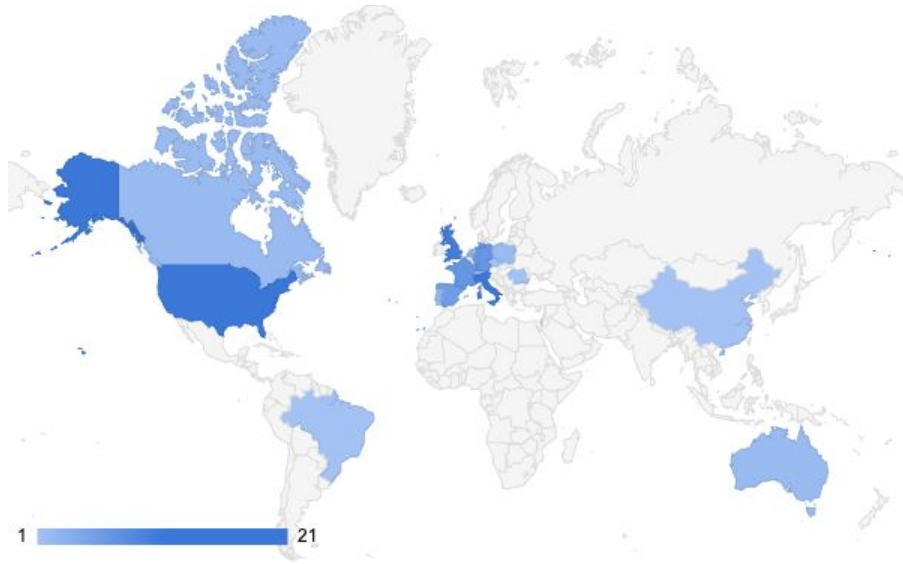
Scintillateurs liquides

- Neutrinos (WbLS) : THEIA
- $0\nu\beta\beta$ (LS) : SNO+ high Te doping, KL-Z+
- Neutrinos (MeV and GeV) & $0\nu\beta\beta$ (Opaque-LS and hybrid systems LS+crystals) : LiquidO

Water Cherenkov

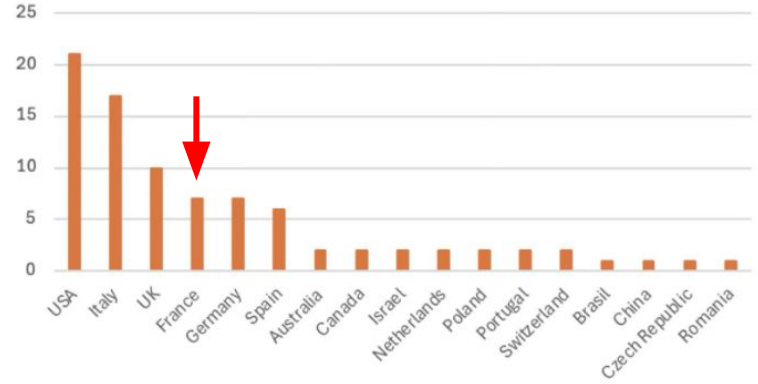
- Neutrinos : HyperK
- Futures telescopes neutrinos

La Collaboration



86 équipes
 17 pays
 205 membres

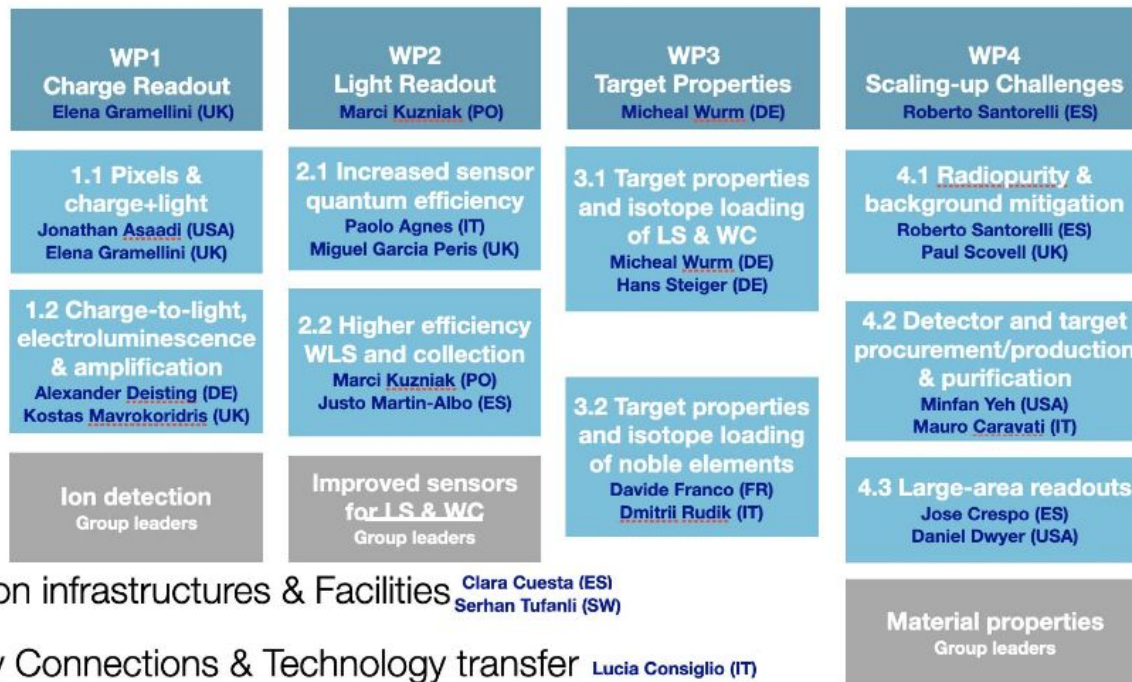
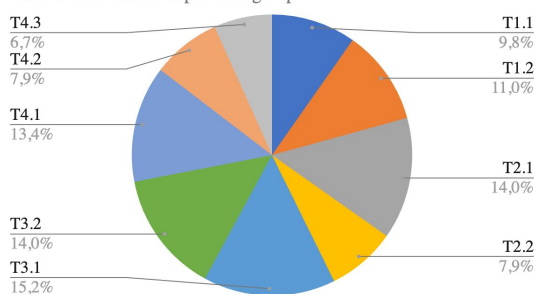
DRD2 Institutes



L'organisation en groupes de travail

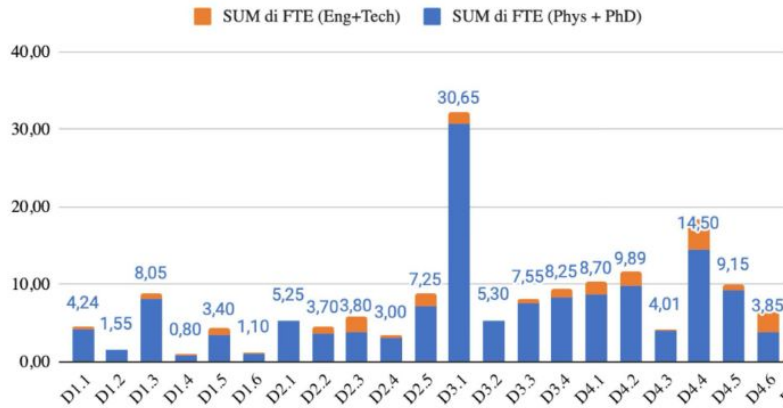
- CB Chair : Walter Bonivento (INFN Cagliari, IT)
- Co-spokespersons : Giuliana Fiorillo (Naples, IT), Roxanne Guenette (Manchester, UK)

Number of Institutions per Task group

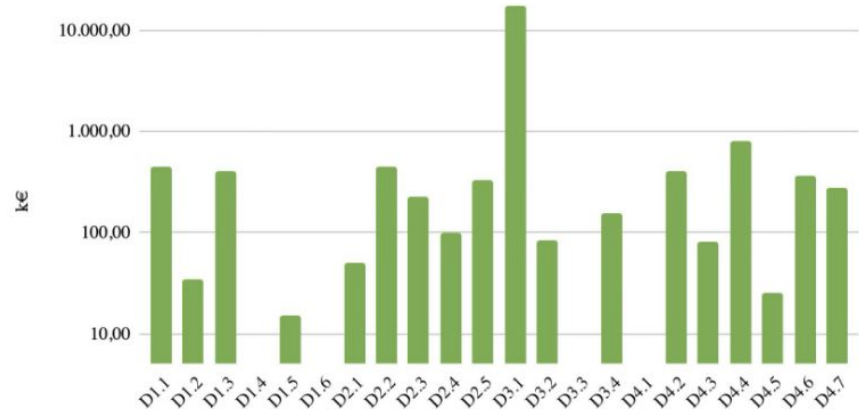
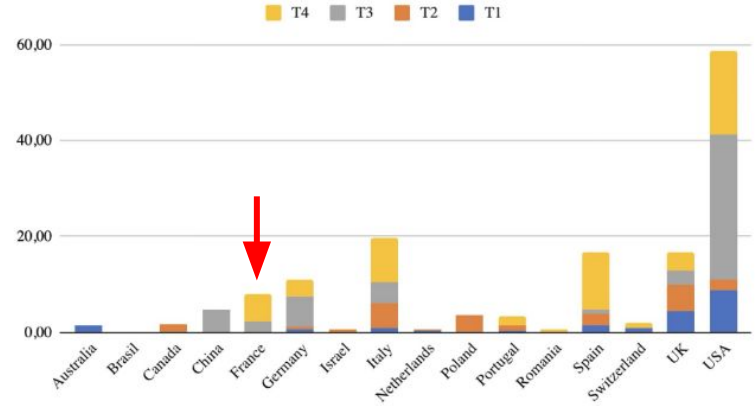


La distribution des ressources

- Distribution plutôt uniforme parmi les Working Packages
- Participation française dans la moyenne



FTE (Phys) in WPs



Équipes en France

IN2P3 :

IJCLab - A. Cabrera

APC - D. Franco (Coordinateur WP3.2)

CPPM - J. Busto

LPNHE - L. Scotto Lavina (Resource Board)

LLR - M. Buizza Avanzini

LPSC/LSM - S. Scorza

Non-IN2P3 :

Mines Paris - P. Stringari

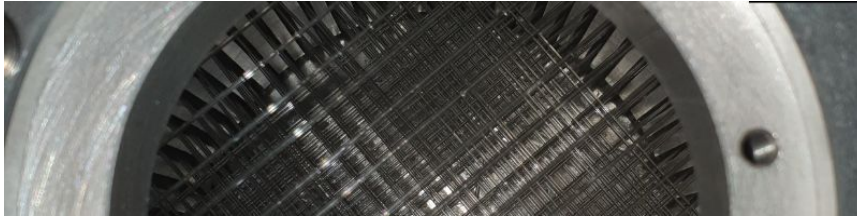
WP2.2 (Higher efficiency WLS and collection) → LiquidO

Livrables : (pas d'engagements officiels pour un livrable pour l'instant): LiquidO detection technology, new opaque scintillator technologies, etc.

Master Projects IN2P3 : LiquidO

Membres (que les PIs, pas en DRD2): A. Cabrera (IJCLab: 5 chercheurs), J. Busto (CPPM: 1 chercheur), C. Marquet (LP2iB: 3 chercheurs), F. Yermia (Subatech: 10 chercheurs)

Collaborateurs dans le DRD2 : Sussex, que le IJCLab en France



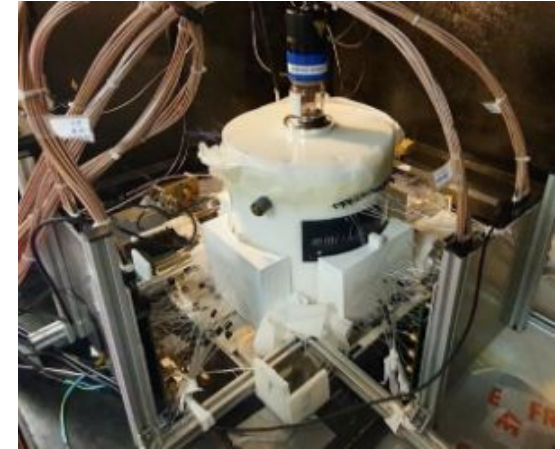
LiquidO's prototype MINI-II

Publication of Results ([arXiv tomorrow](#))

Recent Contributions @DRD2:

- New Muon-Prototype@UK (Feb. 2025)
- Novel Opaque Scintillation Technologies (Feb. 2024):

<https://doi.org/10.5281/zenodo.10629927>



WP3.2 (Target properties and isotope loading of noble elements) → X-ArT (ANR), BLEND (LabEx)

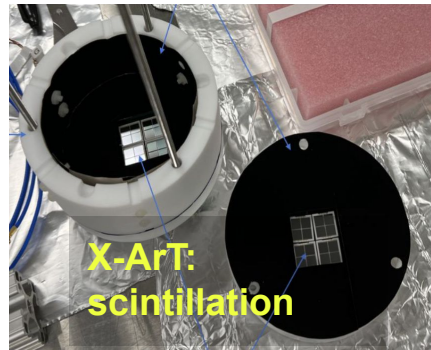
Coordination WP3.2

Livrables : (T3.2.G3.D3/D4) Measurement of LAr response to sub-keV recoils / Measurement of Xe-Ar particle detection and thermodynamic properties

Master Projects IN2P3 : DarkSide, X-ArT (R&T)

Membres : D. Franco (DR IN2P3, WP3.2 Coordinator), T. Hessel (postdoc IN2P3), E. Nikoloudaki (PhD UPC), J. Machts (PhD ANR/UPC), D. Paillot (IR IN2P3)

Collaborateurs dans le DRD2 : CPPM, CTP Mines ParisTech, LPNHE, GSSI, AstroCeNT, INFN Naples, CIEMAT, CERN, FBK, TRIUMF, LNGS, Fermilab, IHEP, UC Riverside, INFN Cagliari



WP4.1 (Radiopurity and background mitigation) → IRENE (ANR)

Livrables : pas d'engagements officiels pour un livrable pour l'instant

Master Projects IN2P3 :

Membres : J. Busto

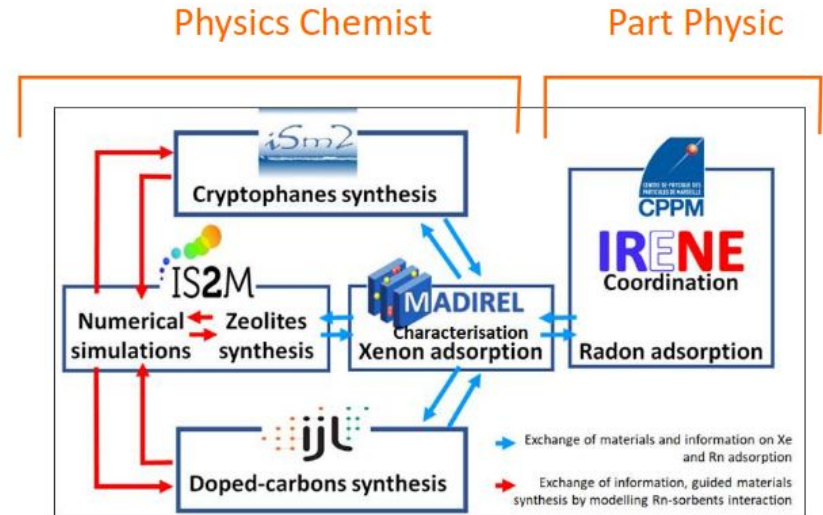
Collaborateurs dans le DRD2 : APC, LPSC, LPNHE

Projet IRENE

Innovative materials for **Extreme radon capture**
ANR > 02/2024

Collaboration avec 5 laboratoires, 15 personnes
(physiciens et chimistes):

- Feedback entre les 5 laboratoires
- Trois familles de adsorbents (Zeolites, Mol. Cages, Carbon-based)
- Xenon comme gaz de référence
- Capture du Radon en N₂, He et Xe



WP1.2 (Charge-to-light, LE & Amplification) → XLZD, XeLab (R&T IN2P3 pour XENON et XLZD)

WP3.2 (Target properties and isotope loading of noble elements) → X-ArT (ANR)

Livrables : (T3.2.G3.D3) Measurement of scintillation of Xe-LAr as a function of Xe concentration with focus on cryogenics

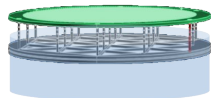
Master Projects IN2P3 : XENONnT, XeLab (R&T)

Membres : L. Scotto Lavina (DR IN2P3, Resource Board), Frederic Girard (postdoc IN2P3), Yajing Xing (McF Sorbonne), Nabil Garroum (IR IN2P3)

Collaborateurs dans le DRD2 : APC, Mines Paris, CPPM, WIS, L'Aquila, Nikhef, LIP Coimbra, TRIUMF, UZH, Mainz, Freiburg, Muenster



X-ArT



Electrodes flottants



ReStoX



XeLab



LXe TPC



Cryogenie

LLR - M. Buizza Avanzini



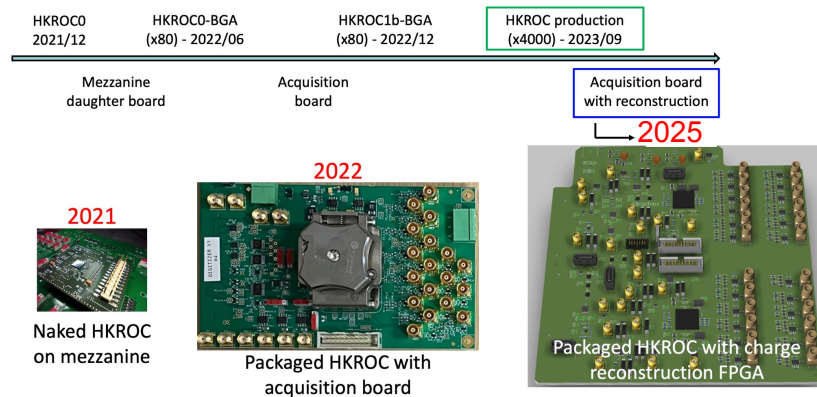
WG1 (Common Infrastructure and Facilities) → HKROC based readout development. Originally intended as electronic readout for the Hyper-Kamiokande far detector, could be used for other water cherenkov detector or HK near detector

Livrables : pas d'engagements officiels pour un livrable pour l'instant

Master Projects IN2P3 : Hyper-Kamiokande

Membres : M. Buizza Avanzini (CR IN2P3), Olivier Drapier (DR IN2P3), Thomas Mueller (CR IN2P3), Pascal Paganini (DR IN2P3), Benjamin Quilain (CR IN2P3)

Collaborateurs dans le DRD2 : aucun pour l'instant (potentiellement OMEGA et CEA)



WP4.1 (Radiopurity and background mitigation) → LSM

Livrables :

(T4.1.G2.D2) with the alpha screening activities with the XIA UltraL0@1800 under commissioning at the surface, and going underground at LSM in late 2025

(T4.1.G3.D2) with the ongoing efforts at LSM for the anti-radon factory and consequently improving performances

(T4.1.G3) Radon emanation in detection liquids

(T4.1.G2) HPGe screening

Master Projects IN2P3 : -

Membres : S. Scorza (DR IN2P3)

Collaborateurs dans le DRD2 : LPSC/LSM, CPPM, Boulby, LNGS

Radon emanation in detection liquids (CPPM and LPSC/LSM)

Measurements and characterization of radon emanation in the main detection liquids (water, scintillator, Ar and Xe)

HPGe screening (LPSC/LSM, Boulby, LNGS)

Delivery and report on a comprehensive cross-calibration for low background screening and assay across EU.

Report on identification of suitably radio pure materials that may be used for future HPGe detector systems, along with further developments of the [radiopurity.org](https://www.radiopurity.org) database for sharing material and screening assay results (<https://www.radiopurity.org/>).

Collaboration Meetings, MoU et la suite

- Deux reunions de collaboration au CERN (Fev 2024, Fev 2025) et un Virtual Meeting (Oct 2024)
- Indico des reunions et groupes de travail : <https://indico.cern.ch/category/17386/>
- Avancements sur la préparation du MoU (identifier les agences de financement, Resource Board)
- Préparation des tableaux avec les FTEs et engagements sur les ressources
- Préparation d'un document pour la Stratégie Européenne



CM 12/02/2025 @ CERN

Merci



Backup



WP1.1 Pixels & charge+light

(J. Asaadi & E. Gramellini)

- Consolidated the scientific programme to 3 Deliverables: TPC pixelation, Pixel scalability, Charge + Light readouts

	Title	Description	Institutions
D1.1	Pixel readout prototype	Prototype of lower power and lower pixel thresholds to the limit of CMOS capabilities	5
D1.2	Large-scale pixel readout design	Design of a pixel readout with O(100 million) channels	4
D1.3	Light-sensitive pixel readout design	Design (simulation and prototype) of maximal photocathode coverage and QE in an integrated fC charge and VUV light sensing scheme for pixel TPCs	7

WP1.2 Charge-to-light, EL & Amplification

(A. Deisting & K. Mavrokoridis)

- Consolidated the scientific programme to 3 Deliverables: camera and SiPM-based particle tracking, novel devices for charge amplification in single- and dual-phase, large-scale demonstrators

	Title	Description	Institutions
D1.4	Prototype for imaging light readout	Prototypes for light imaging of charge amplification with cameras and SiPMs	2
D1.5	Report on novel charge amplification devices	Report on novel devices for charge amplification in single- and dual-phase detectors	12
D1.6	Report on large-scale tests for amplification devices	Report on large-scale tests in single- and dual-phase LAr and LXe detectors	4

WP2.1 Increase sensor quantum efficiency

(P. Agnes & M. Garcia Peris)

- Consolidated the scientific programme to 3 Deliverables: effort targeted at efficiency in the VUV and at cryogenic temperatures, complementarity with WP1 of DRD4

	Title	Description	Institutions
D2.1	Sensor development for VUV sensitivity	Development and characterization of organic photosensors, coatings and passivation methods and of SPAD geometry for VUV detection	7
D2.2	Prototype SPAD arrays	Prototypes and characterization of new SPAD arrays for 3D-integrated FSI and BSI, analog BSI and monolithic arrays	8
D2.3	Report on VUV-optimized sensor	Report on the performance of new VUV-optimised sensors in term of PDE, noise and application to rare-event searches	8

WP2.2 Higher efficiency WLS and collection

(M. Kuzniak & J. Martin-Albo)

- Consolidated the scientific programme to 2 Deliverables: WLS and light collection optimization

	Title	Description	Institutions
D2.4	Report on optimised WLS	Report on optimised WLS (VUV to visible) and evaporation systems	3
D2.5	Design report on light collection	Design report on VUV light collection in noble elements and light readout for liquid scintillators	10

WP3.1 Target properties and isotope loading of LS & WC

(H. Steiger & M. Wurm)

- Consolidated the scientific programme to 2 Deliverables: hybrid Cherenkov/scintillator systems, opaque scintillators, and isotope loading for neutrinoless double-beta decay ($0\nu\beta\beta$) searches and neutron tagging

	Title	Description	Institutions
D3.1	Ton-scale demonstrators of novel liquid scintillators	Lab- and ton-scale demonstrators for hybrid and opaque scintillators, publication on properties and performances and improved microphysics models	16
D3.2	Demonstrators for liquid target loading	Demonstration of high Gd loading at ton-scale and of high concentration of isotope loading	9

WP3.2 Target properties and isotope loading of noble elements

(D. Franco & D. Rudik)

- Consolidated the scientific programme to 2 Deliverables: noble liquids microphysics + properties of mixtures

	Title	Description	Institutions
D3.3	Measurement of noble liquid response for low-energy recoils	Characterization of NL response to low-energy recoils and design of low-energy calibration systems	10
D3.4	Measurement of noble liquids mixtures properties	Characterization and measurement of properties of NL mixtures	13

WP4.1 Radiopurity and background mitigation

(R. Santorelli & P. Scovell)

- Consolidated the scientific programme to 3 Deliverables: radioassay techniques, low-bckgd materials, bckgd evaluation

	Title	Description	Institutions
D4.1	Report on improved radioassay techniques	Demonstration of radioassay techniques at required sensitivity for next generation of rare-event search experiments	8
D4.2	Report on low-background materials	Report on the development of novel materials, material selection, and clean treatment/manufacturing processes	8
D4.3	New tools for background evaluation	Development of new tools for background simulations and measurements of cross-section materials	6

WP4.2 Detector and target procurement/production & purification

(M. Caravati & M. Yeh)

- Consolidated the scientific programme to 2 Deliverables: production & purification facilities, radiopurity assessment and verification

	Title	Description	Institutions
D4.4	Mass production facilities	Purification and production plants for liquid targets	8
D4.5	Demonstration of UAr purification technology	Demonstration of improved purification technologies on testbeds	5

WP4.3 Large-area readouts

(J. Crespo & D. Dwyer)

- Consolidated the scientific programme to 2 Deliverables: mid-scale and large-scale facilities for integration tests

	Title	Description	Institutions
D4.6	Medium-scale integrated testing facilities	Development of mid-scale facilities for large-area readout assembly and characterization at cryogenic temperature	6
D4.7	Report on large-area readout	Report on large-scale light and charge readout systems	5