WP8 (towards endorsement)

summary as of January

- ***How the WP covers the topics in the ECFA roadmap:***

  - *DRDTs: 1.1, 1.2, 1.3, 1.4 (specifically 1.4)*

  - *Fundamental challenges (as on DRD1 proposal):*

➢ Achieving track-reconstruction of low-energy nuclei and electrons, at granularities going from few mm down to potentially tens of um and close to the thermal diffusion limit. ECFA 1,2,3,6; task T1, T2, T4.

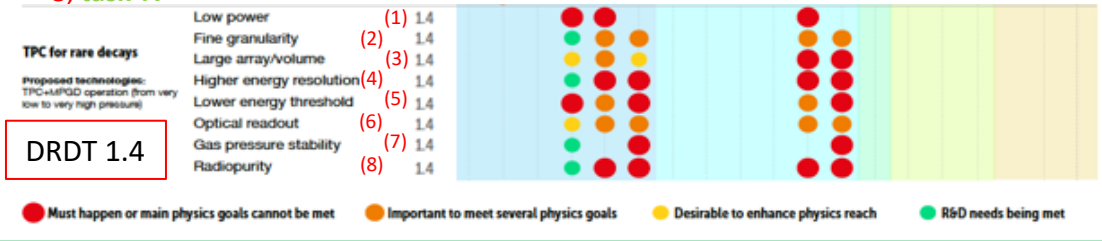
➢ Operating in a broad range of pressures going from few tens of mbar to tens of bar, with energy-reconstruction performing generally down to **~1keV threshold** if not less. ECFA 5,7; task T2, T3.

➢ Achieving high and uniform amplification in nearly pure or weakly-doped noble gases. ECFA 4,5; task T3.

➢ Increasing optical throughput (primary and secondary). ECFA 6; tasks T1, T4, T5, T6.

➢ Developing more suitably scintillating and/or eco-friendly gas mixtures as well as recuperation systems ECFA 6,7; task T1, T5, T6

➢ Enhancing the radiopurity of the amplification structure and of the TPC as a whole. ECFA 8; task T7



#	Task	Performance Goal	DRD1 WGs	ECFA DRDT	Milestones/Deliverable 12M	24M	36M	Institutes
T1	Enhanced operation of optical readout across gas densities	- O(mm)-sampling, O(MeV)-threshold, O(ns)-timing for ν-interactions. - Large-area amplification structures (≥ 50 cm × 50 cm) at optical gain ~ 10^4. - Tracking of low-energy nuclei (down to 10-100 keV) with good PID.	WG1, WG2, WG3, WG4, WG5, WG6, WG7	1.1, 1.2, 1.3, 1.4	**M1** **M1.1. Review and design**: review of TPC technologies for reaction/decay studies: status and perspectives; design/construction of small R&D chambers. [T1-T7]. **M1.2. Development and tuning of simulation tools**: design, development and/or tuning of modelling and simulation tools (IBF, ionization, optical response, Geant4). [T1-T7].	**M2** **M2.1. Construction of prototypes**: start construction of technology demonstrators for large area coverage. [T1-T7] **M2.2. Characterization of key technologies**: characterize electronics, amplification structures and overall TPC behaviour in small R&D chambers, comparison with simulations. [T1-T7]	**D** **D1. TPC commissioning and proof of principle demonstration**: characterization of mid-size technology demonstrators for reaction/decay studies, focusing on energy and tracking thresholds, energy resolution, dynamic range and IBF. [T1-T7] **D2. Analysis and definition of next steps**: establish guidelines for future developments based on requirements from future facilities and the achieved/achievable performances. [T1-T7]	ANU, AstroCeNT, CERN, DIPC, Fermilab, GANIL, CNRS-IN2P3/UGA, GSSI, HIP, IFAE, Imperial, INFN-BA, UniBA, PoliBA, U Bonn, RHUL, RWTH Aachen, STFC-RAL, U Bonn, IGFAE/USC, INFN-PD, DFA-UNIPD, INFN-RM1, IRFU/CEA, ISNAP, LIP-Coimbra, MSU, SINP Kolkata, U Aveiro, U Coimbra, U Genève, U Hamburg, UH Manoa, U Indiana, U Kobe, U Liverpool, U Bursa, U New Mexico, UPV, U Vigo, U Warwick, CAPA, IFIC
T2	Enhanced operation of charge readout across gas densities	- Large-area MPGDs (≥ 50 cm × 50 cm) at ~ 10^3 – 10^4 gain. - Large-area MPGDs (≥ 50 cm × 50 cm) with a large dynamic range. - O(1 keV) threshold across pressures (100 mbar-10 bar) in O(1000 cm^3) technology demonstrators. - IBF suppression by G*IBF≈10 or better.						
T3	Enhanced operation of pure or trace-amount doped noble gases	- EL operation at 2m (15bar) and 0.5m (>20bar) scale, with <10% deformation. - Single-electron thresholds on large areas for mixtures of noble gases. - MPGD concepts with enhanced EL-response (up to or above 1000 ph/e). - Improve light collection for large volumes. - Integrated, low-power and radiopure electronics for EL-based tracking.						
T4	Ultra-low-energy reconstruction of highly ionizing tracks (including R&D on negative-ion readout)	- Tracking of low-energy nuclei (down to 10-100 keV) with good PID. - High dynamic range for the reconstruction of low and highly ionizing particles. - Single electron counting at O(100 μm) in 3D, and diffusion at the thermal limit.						
T5	Determination of the interaction time (T_0)	- Develop new gaseous WLS and novel gaseous scintillators, comparable or better than CF_4. - Demonstration of T_0-determination for low-energy deposits with at least O(ns) resolution.						
T6	Microscopic gas properties and gas handling	- Develop the science and technology of novel eco-friendly gases. - Derive microscopic parameters for new gases.						
T7	Radiopurity	- Background levels below 10^{-6} c/keV/cm²/s for axion research and at least ×10 more radiopure cameras. - New radiopure amplification structures and techniques.						

WP8 (towards endorsement)

summary as of January

- ***Projects***

A. High Pressure TPCs for precision studies of neutrino interactions. (Alan Bross)

B. TPCs for low-energy nuclear physics. (Marco Cortesi)

C. Electroluminescence-based TPCs for Rare-Event Searches and other R&D on pure noble-gas amplification. (Francesc Monrabal)

D. Radiopure TPCs for precise track imaging and/or calorimetry with avalanche-based readouts. (Giorgio Dho)

- ***Milestones and deliverables (as on DRD1 proposal)***

M1.1. Review and design: *review of TPC technologies for reaction/decay studies: status and perspectives; design/construction of small R&D chambers. [T1-T7]*
M1.2. Development and tuning of simulation tools: *design, development and/or tuning of modelling and simulation tools. [T1-T7]*

M2.1. Construction of prototypes: *start construction of technology demonstrators for large area coverage. [T1-T7]*
M2.2. Characterization of key technologies: *characterize electronics, amplification structures and TPC behaviour in small R&D chambers, comparison with simulations. [T1-T7]*

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WP8 (towards endorsement)

A. High Pressure TPCs for precision studies of neutrino interactions. (A. Bross)

- Kickoff meeting (June 3, 2024). 👍
- Good progress with groups' response & project implementation. 👍
- Current Project version not too different from original one.
- No plans for endorsement yet.

- Contributions to 1st DRD1 meeting: I
- Contributions to 2nd DRD1 meeting: -
- Contributions to 3rd DRD1 meeting: -

B. TPCs for low-energy nuclear physics. (M. Cortesi)

- Kickoff meeting (April 30, 2024) + at least another meeting. 👍
- Good progress with groups' response & project implementation. 👍
- Current Project version has strong feedback based on recent meetings. 👍
- No plans for endorsement yet.

- Contributions to 1st DRD1 meeting: I
- Contributions to 2nd DRD1 meeting: -
- Contributions to 3rd DRD1 meeting: I

C. Electroluminescence-based TPCs for Rare-Event Searches and other R&D on pure noble-gas amplification. (F. Monrabal)

- Kickoff meeting (June 3, 2024). 👍
- Good progress with groups' response & project implementation. 👍
- Current Project version not too different from original one.
- No plans for endorsement yet.

- Contributions to 1st DRD1 meeting: -
- Contributions to 2nd DRD1 meeting: -
- Contributions to 3rd DRD1 meeting: I

D. Radiopure TPCs for precise track imaging and/or calorimetry with avalanche-based readouts. (G. Dho)

- Kickoff meeting (May 3, 2024) + at least another meeting . 👍
- Good progress with groups' response & project implementation. 👍
- Current Project version has strong feedback based on recent meetings. 👍
- Aiming at endorsement by mid-2025. 👍
- Issue on how many deliverables/milestones we want to go on with.

- Contributions to 1st DRD1 meeting: I
- Contributions to 2nd DRD1 meeting: I
- Contributions to 3rd DRD1 meeting: -

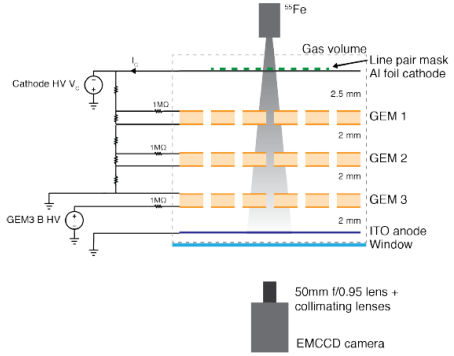
Appendix

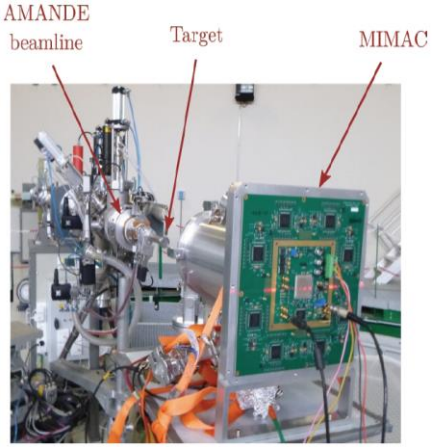
WP8 Project D:

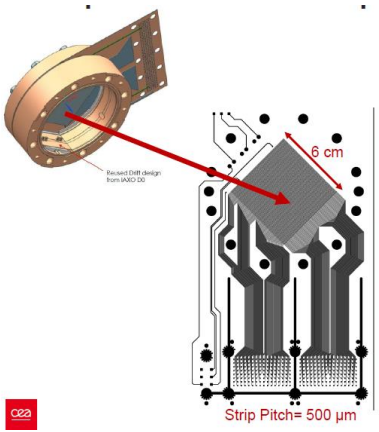
Radiopure and/or low-energy TPCs for precise track imaging and/or calorimetry with avalanche-based readouts

Focus on TPCs aimed to:

- Reconstruction of keV recoils
- Enhanced operation of charge and optical readout
- Understanding of noble and scintillating gases and negative ion operation
- Radiopurity of materials for TPCs for rare event searches







Images taken from kick-off meeting presentation

WP8 Project D:

Radiopure and/or low-energy TPCs for precise track imaging and/or calorimetry with avalanche-based readouts

- Kick-off meeting held on 3rd May 2024:
    - 10 out of 15 institution which initially expressed interest participated
- Different WG interaction possible within this project
- Milestones and FA organisation under discussion
- More meetings and activity expected with new year
- **Endorsement procedure should probably be aimed for mid next year**

7.4.15.2.D Project D

Milestones and Deliverables	Title	Description	Start Date	End Date
M8D.1.1	Demonstrate low energy threshold	1 keV threshold with optical readout over 50 L detector at atmospheric pressure(at LNGS, i.e. 900 mbar).	0	12M
M8D.1.2	Lower energy threshold and higher pressures	Try to lower the energy threshold below 1 keV. Assess performance at high pressure (up to 10 bar).	12M	24M
D8D.1	**Large volume prototypes**	**Development of technology-demonstrators operated in the range 0.1bar-1bar (in electron or negative-ion mode, with optical or charge readout), over areas of at least 10cm x 10cm, with high pixelization and close to the diffusion limit.**	**0**	**36M**
M8D.2.1			0	12M