



The X-ArT's programme

Davide Franco

5/04/2023 - X-ArT kick-off meeting

X-Art deliverables

Xe-doped LAr unknown

- what is the maximum solubility of Xe in LAr?
- what about ionization? and scintillation at the maximum Xe solubility?
- which is the Xe-Ar phase diagram?



WPA Xe-Ar thermodynamics

- WPA-1** Bibliographic research
- WPA-2** Experimental study of Xe-Ar phase diagram
- WPA-3** Molecular simulation
- WPA-4** Development of the Equation of State (EoS)

Mines ParisTech
ICB - U. Bourgogne



WPB Xe-Ar scintillation and ionization

- WPB-1** TPC construction
- WPB-2** Photoelectronics and DAQ
- WPB-3** Cryogenics
- WPB-4** Operation
- WPB-5** Simulation and data analysis

France APC, LPNHE, Mines ParisTech
Italy GSSI, INFN Naples
US UC Davis, Princeton
China ICHEP

ANR grant

- 48 month projects from **01/2023 to 12/2026**
- 4 French labs (APC, LPNHE, CTP, ICB) + international labs (UCDavis, Princeton, Astrocent, GSSI, ICHEP,....)
- Budget:

	Requested	Allocated	Equipement / consumables	Personnel
APC	€ 204.853	€ 192.852	€ 51.000	2-years postdoc
LPNHE	€ 90.400	€ 87.899	€ 70.000	
CTP	€ 179.075	€ 175.073	€ 50.000	1-year postdoc
ICB	€ 148.848	€ 146.347	€ 3.000	1 PhD
	€ 623.176	€ 602.172	€ 179.000	

Equipment/consumables WPA: 50 k€

Equipment/consumables WPB: 121 k€ for the TPC setup **+ 10 k€** for 8-channel CAEN digitizer from LabEx for the neutron detector project

Preliminary structure from remote meetings

WPA.1 at CTP

- calibration methods
- solubility (solid Xe in liquid Ar) measurements
- vapor-liquid equilibrium measurements
- uncertainty calculations
- => **Xe-Ar phase diagram**



WPA.2 at ICB - CTP

- Molecular simulation
- => **Development of the Equation of State (EoS)**



WPB.1 at Princeton

- 8 MPPCs mounted in a single-phase chamber (S1 only)
- development of the read-out
- low doping of Xe in LAr (<1%)
- => **test of the Ar vs Xe scintillation light separation**



WPB.2 at ICHEP

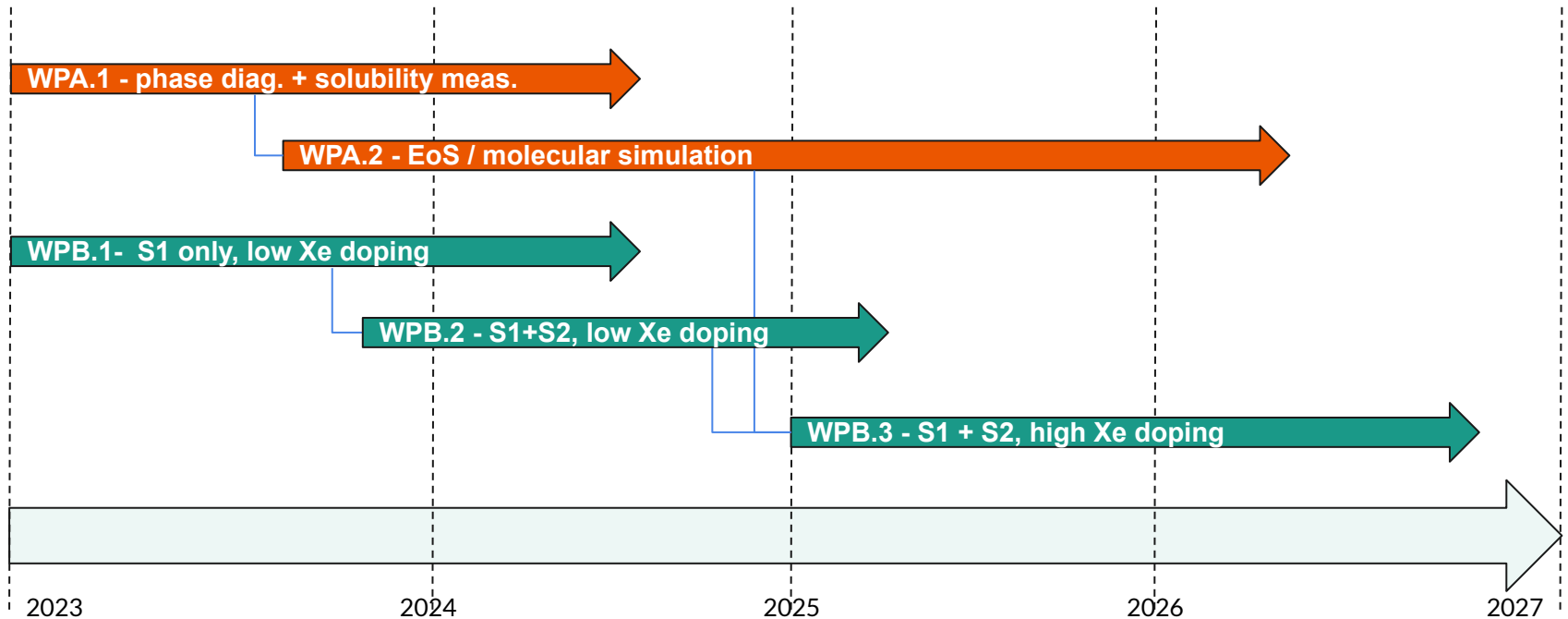
- dual-phase TPC built during phase-1
- test of the dual-phase chamber (scintillation and ionization)
- low doping of Xe in LAr (<1%)
- => **test of the TPC**
- => **characterization of Xe-Ar ionization**



WPB.3 at CTP / LPNHE

- Design of the mixing, cryogenics and purification enabling high Xe doping (>> 1%)
- => **Full test of scintillation and ionization of Ar up to the maximum Xe solubility in LAr**

A preliminary timeline



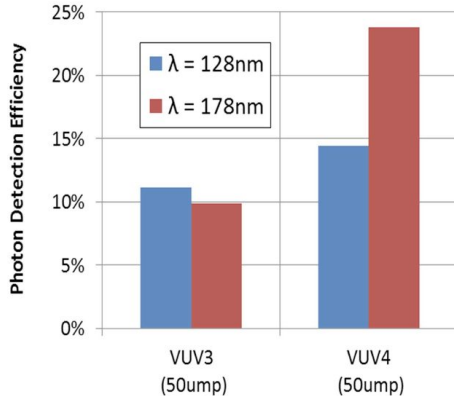
WPB: the TPC

4 x Hamamatsu S13371-6050CQ-02

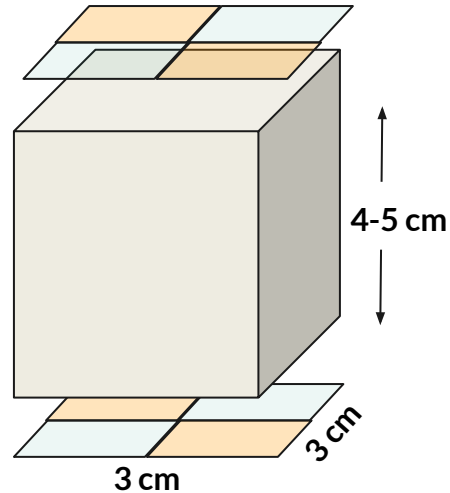
- 24% PDE at 178 nm

4 x Hamamatsu S13371-6050CN-02

- 24% PDE at 178 nm
- 14% PDE at 128 nm



128+ 178	178
178	128+ 178



No wavelength shifter

Anode, cathode and extraction with grids

Max drift field?

A Xe-doped LAr low-mass detector needs to minimize the drift time: 500? 1000 V/cm?

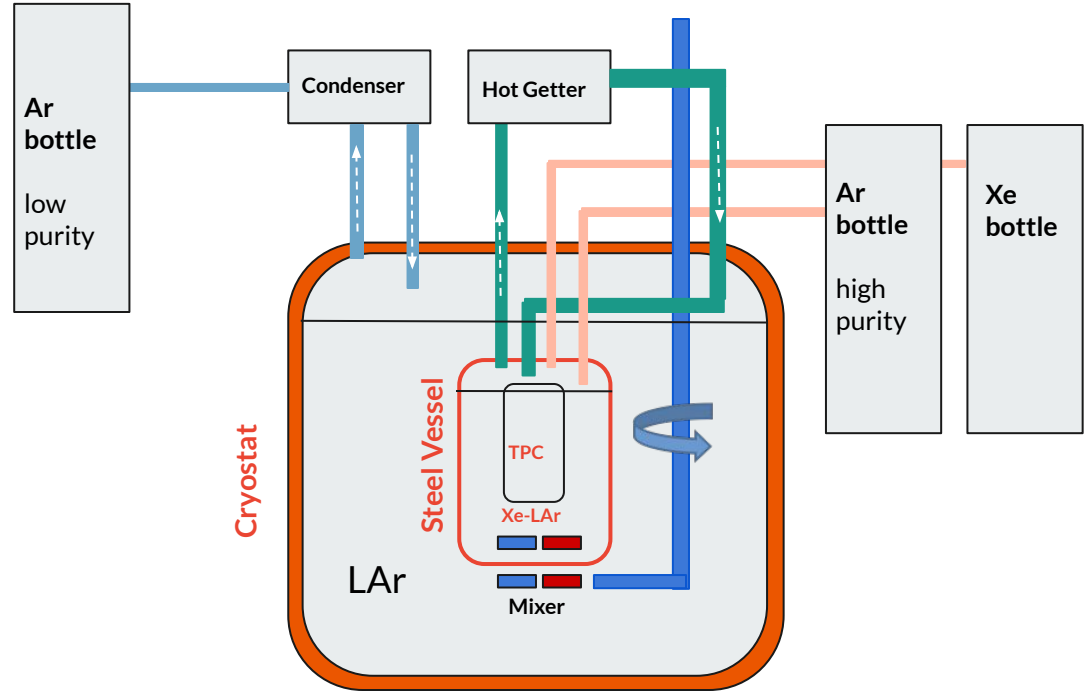
DAQ

CAEN desktop digitizer 8 channels, 5.4 MS/ch, 500 MS/sec

WPB The cryogenics baseline design

Main principles

- fill first Xe in the steel vessel, then add LAr and mix
- no need of a condenser for the Xe-Ar mixture
- condenser for the outer buffer can be avoided



WPB The cryogenics option B design

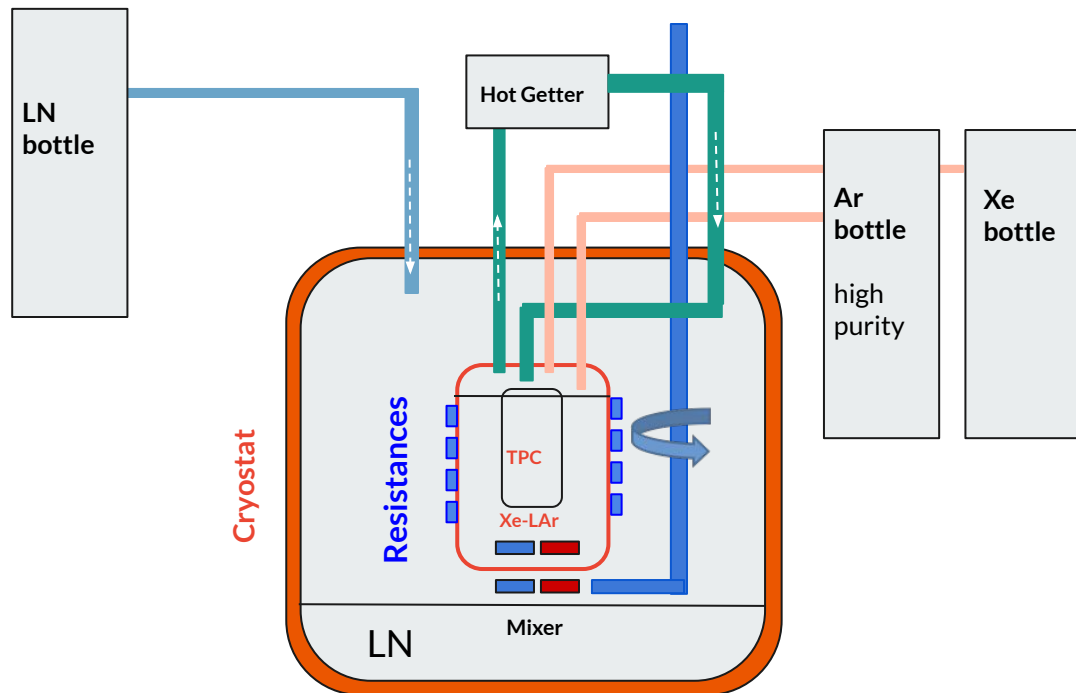
Replace LAr bath with a LN atmosphere and add resistances around the Xe-LAr vessel

Advantages:

- better control of the temperature in case of Xe precipitation
- no need of a condenser
- save budget on external LAr
- simpler design
- CTP used to work this way

Disadvantage

- can resistances induce distortion in the TPC electric field?



WPB: preliminary cryogenics shopping list

	Needed?	Available?	To buy?
Temperature probes (pt100)	Yes	Yes	Yes
Pressure transducers?	?	?	?
Cryostat	Yes	?	?
TPC vessel	Yes	?	?
Hot getter	Yes	Yes	No
Cryocooler	?	?	?
Condenser	?	?	?
Level sensor for condenser	?	?	?
Mass Flow Meter? or fixed volume loading cell?	?	?	?
Vacuum pump	Yes	?	?
Vacuum gauge	Yes	?	?
Cryogenics and vacuum valves	Yes	?	?
Leak checker	Yes	Yes	Yes

Open discussion

Management:

- asked for a wordpress + wiki space at IN2P3. Need help to set up the website
- bi-weekly remote meeting ?
- any candidate for the next year's postdoc to suggest (required to be a "fresh" PhD)?

The project:

- stages, responsables, and timeline
- setup design baseline
- shopping list and materials already available

Beyond X-ArT:

- are we interested in building a common broader program that takes advantage of emerging synergies?