High Electric Field R&D in LUX-ZEPLIN

TEST BENCH TO STUDY HIGH ELECTRIC FIELD PHENOMENOLOGY ON CATHODE WIRES

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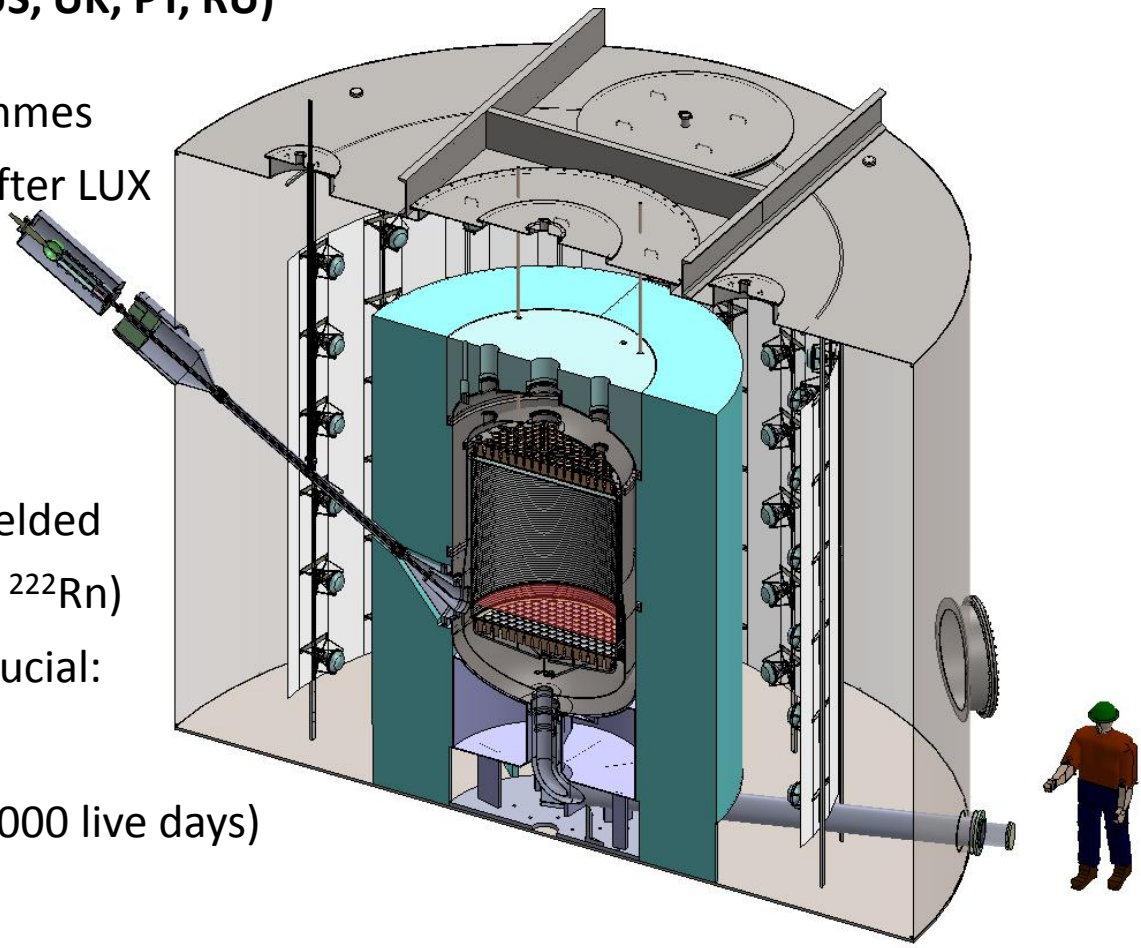
LUX-ZEPLIN (LZ)

See Ethan Bernard talk

Target: 7,000 kg LXe TPC
(two-phase xenon)

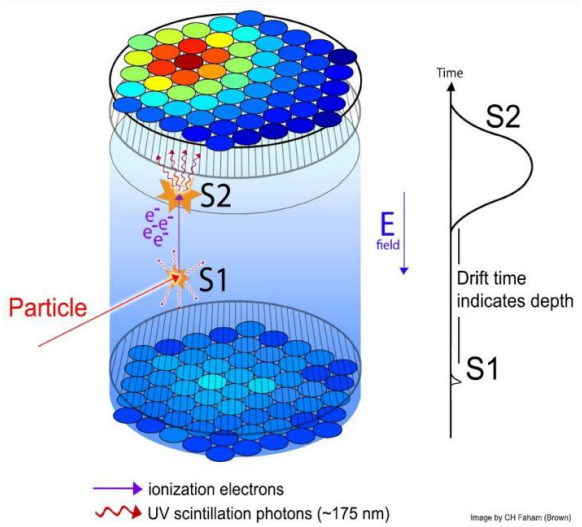
26 institutes (US, UK, PT, RU)

- Building on ZEPLIN and LUX programmes
- Construction 2014-17; installation after LUX
- Down-selection ongoing in US
- Endorsed by DMUK consortium for construction proposal to STFC



- External neutrons and γ-rays self-shielded
- Intrinsic backgrounds removed (^{85}Kr, ^{222}Rn)
- Dominant background in 6-tonne fiducial: astrophysical neutrinos (ν-e, ν-A)
- Sensitivity 2.5×10^{-12} pb at 50 GeV (1,000 live days)

CONTEXT AND MOTIVATION



Two-phase xenon emission detectors

Scintillation & ionisation both measured via optical signatures

- Absolute z position reconstruction
  TPC – *z:* S1-S2 time; (*x*,*y*): S2 'splash';
- discrimination S2/S1 ratio

HV motivation: Drift field improves S2/S1 discrimination power

Problem: difficulty to go over ~ 50 kV/cm (ZeplinIII cathode @62.5 kV/cm)
(EL threshold Lxe ~ 400 kV/cm)

TASK DEFINITION

Possible origins related with local imperfections of the electrodes (impurities, crashes, tips …) → *enhanced surface field points*

may cause

- microsparks, avalanche
- **electron emission** (*skin* effects)

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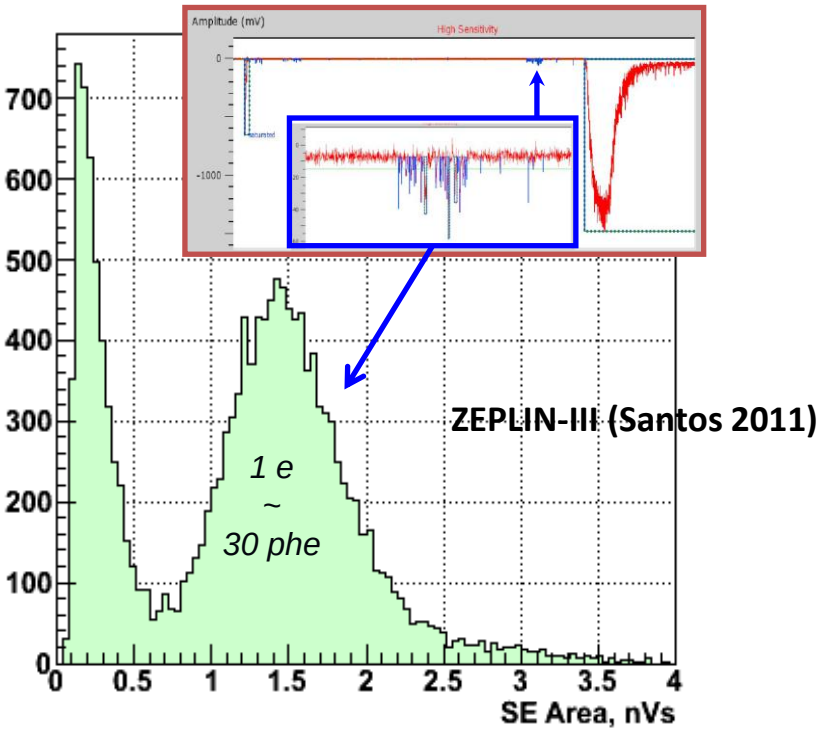
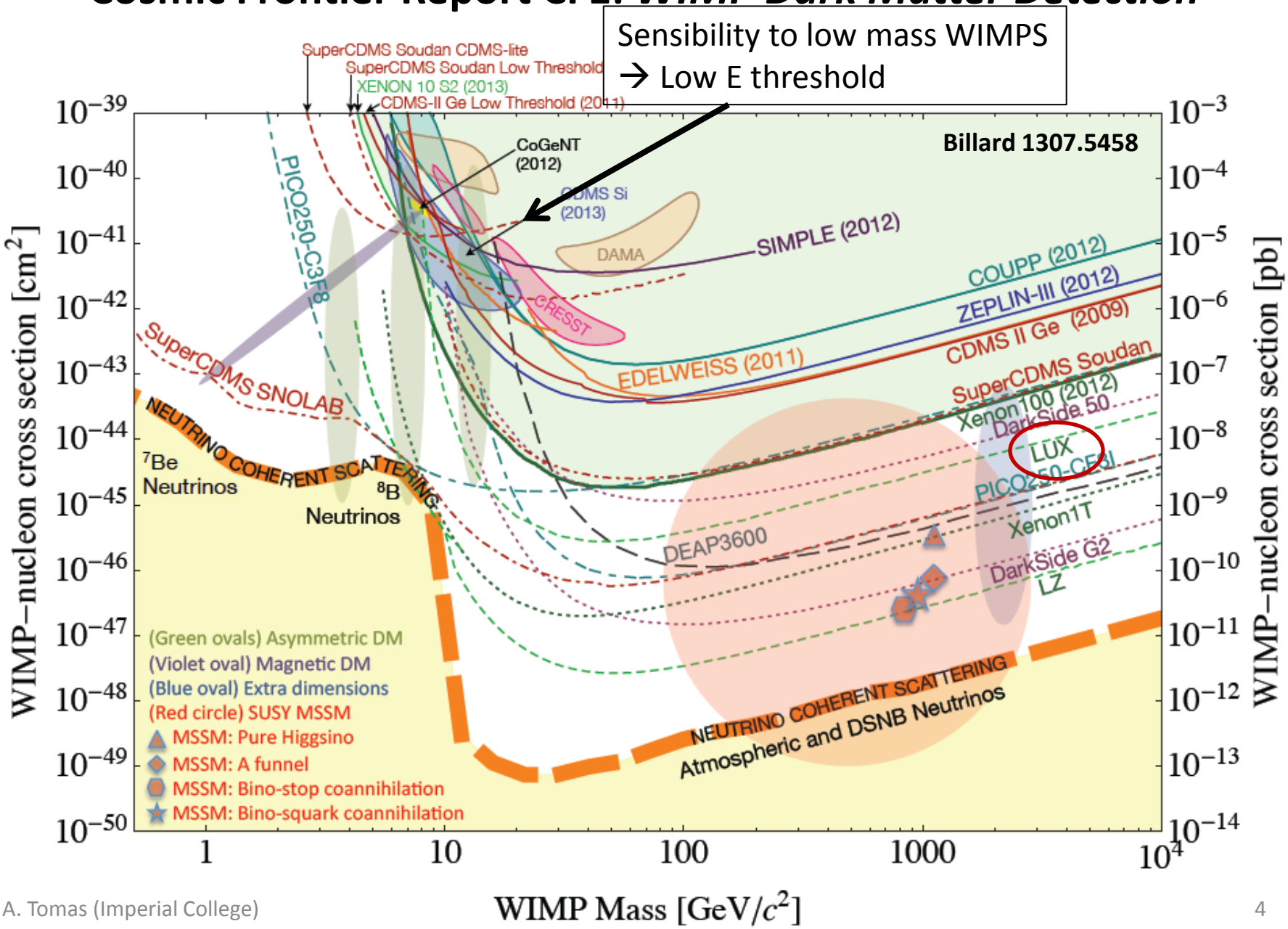


Single electron extra motivation:

- Improve the detector energy threshold using *S2-only analysis*, but:
  - Lose discrimination by S2/S1 ratio
  - Lose *z* information (regain some from S2 pulse width)
  - Uncertainty in ionisation yield below a few keV

Snowmass Community Summer Study 2013

Cosmic Frontier Report CF1: *WIMP Dark Matter Detection*



Goals and requirements for the chamber prototype

High field in cathode → Small chamber, single wire cathode
About 15 kV enough (commercial FT)

Single e- → Completely operational 2 phases TPC
Identification and study → High Xe purity → Gas System

Practical Test bench → Easy and fast to be operated. Including the opening of the chamber any time

Research program

Stability and instability on

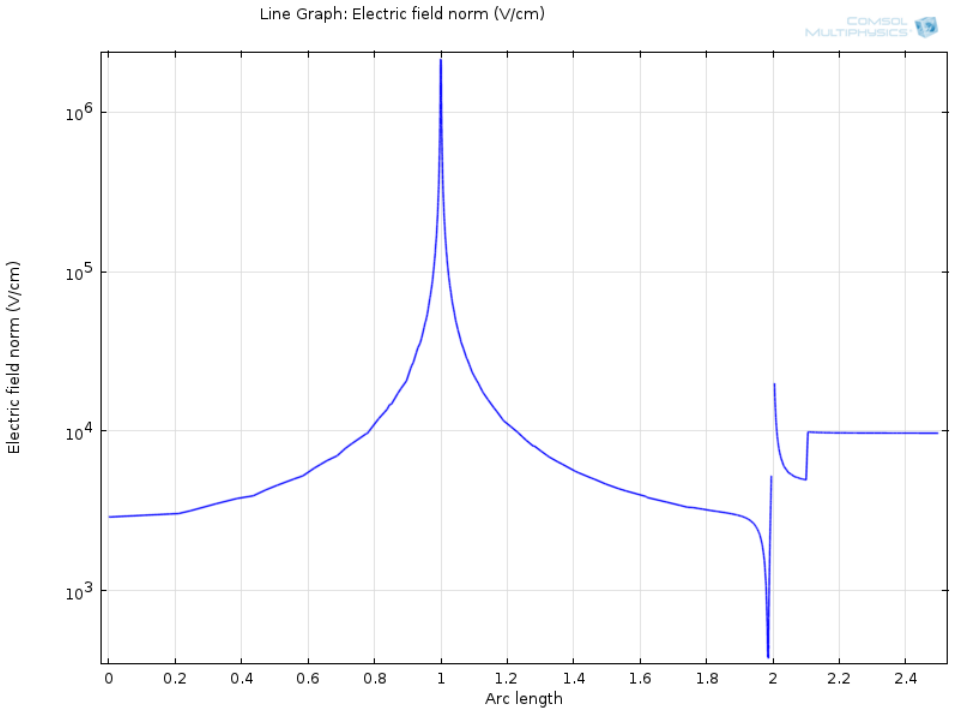
- Wire material
- Wire conditioning
- Environmental parameters

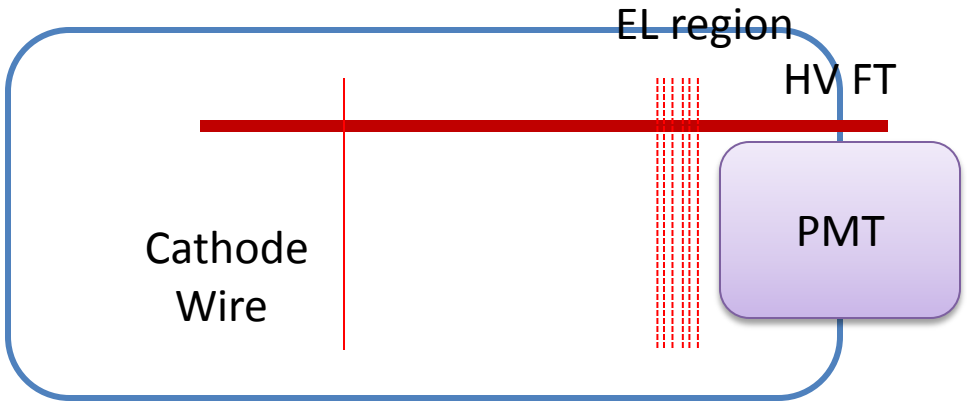
CHAMBER FEATURES

- 25 kV feedthrough into GXe
- Four viewports

- Available ID: 125 mm
- Chamber ID :150 mm
- Height (2-ph): 76 mm
- Height (PMT): 95 mm
- Capacity: 4.3 kg of Lx

- ZEPLIN-III DAQ





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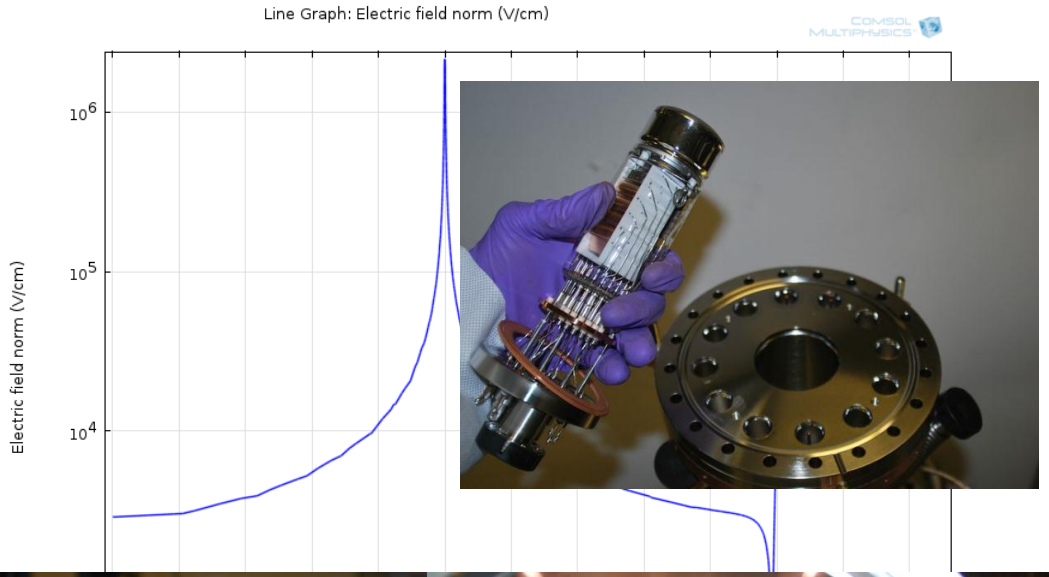
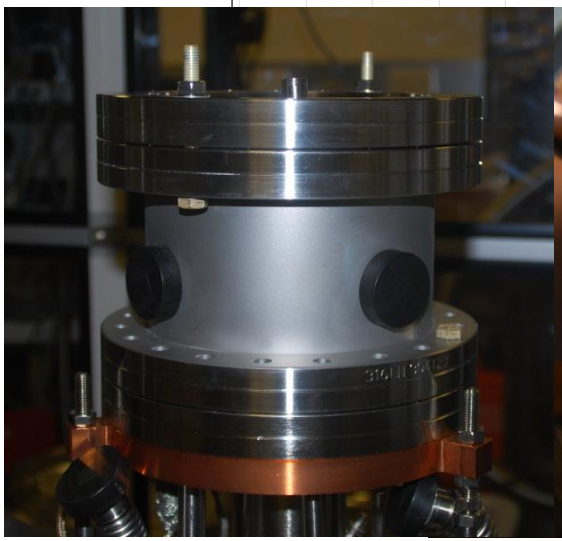
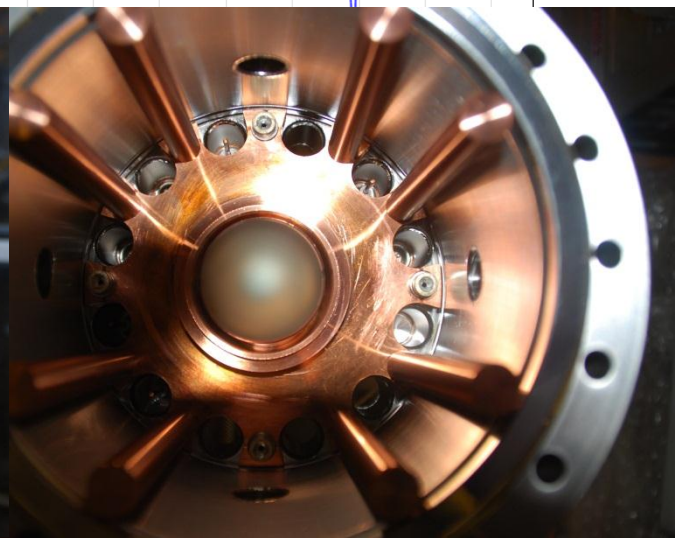
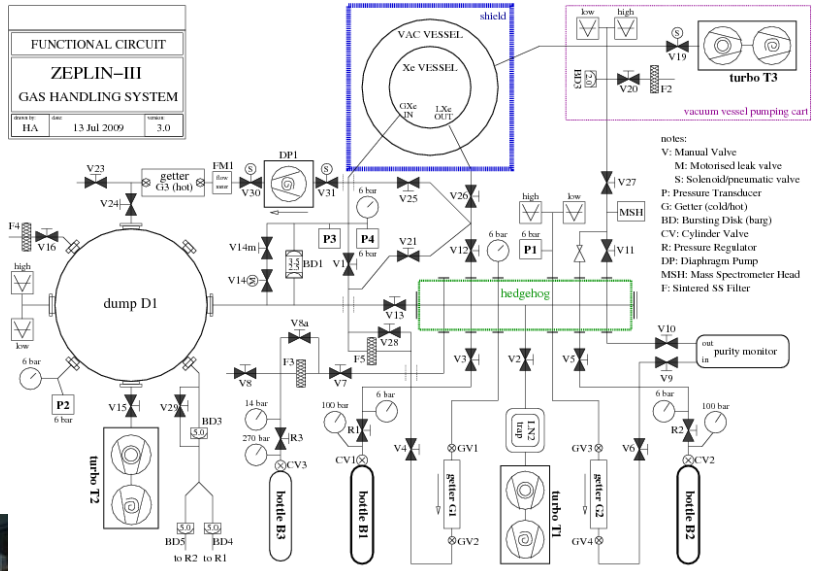






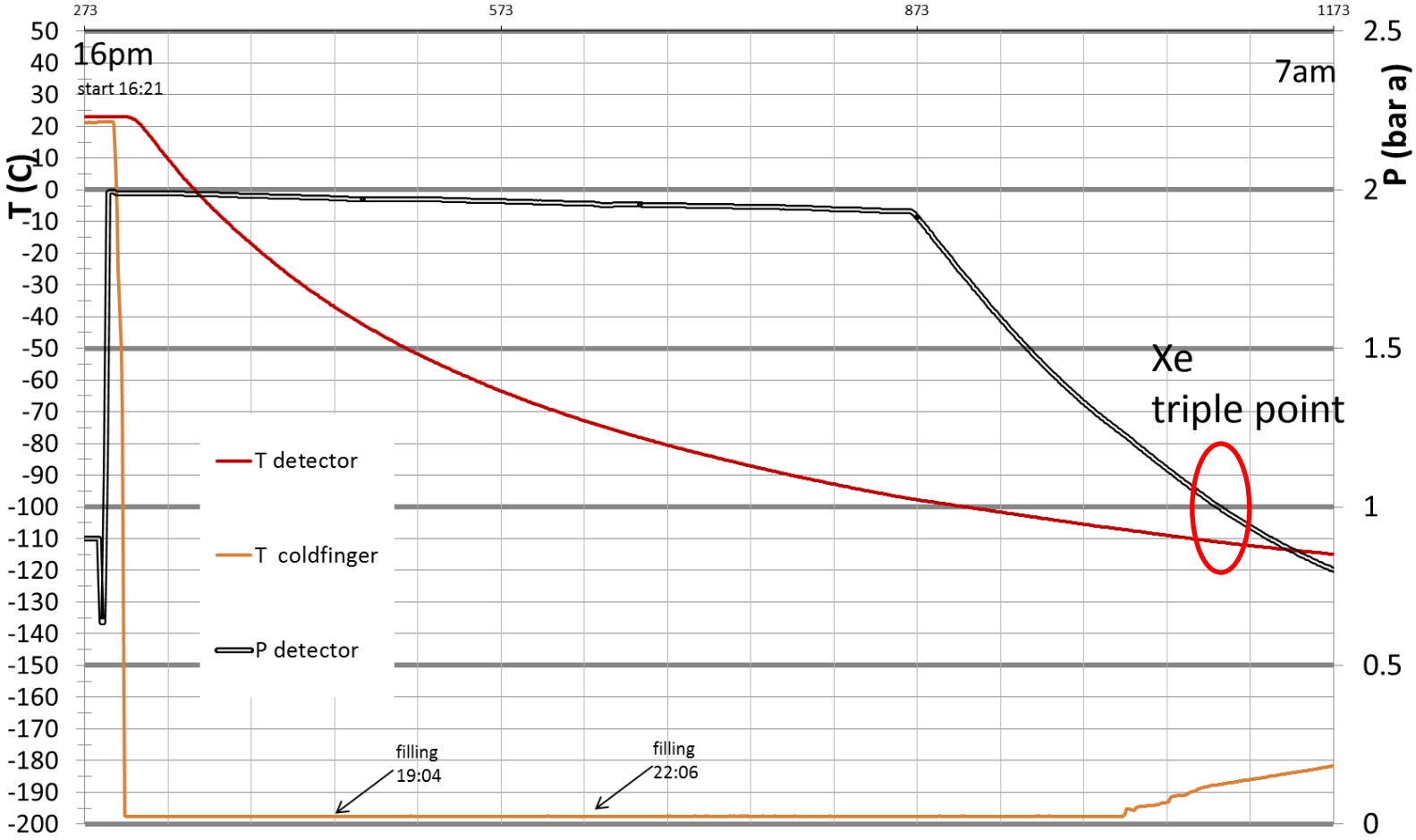
GAS HANDLE SYSTEM

- Zeplin-III GHS recommissioned
- Pressure safety inspection passed
- Slow control operational
- To be connected: hot getter (recirculation)
- and electron life time monitor



OPERATION

OPERATION. FIRST TESTS



SUMMARY

Test bench to study High Electric Field limitations and phenomenology in LXe:

(double phase detector with single e- sensibility)

- Stability on wire material and conditions
- Further study on electron emission

to be commissioned at Imperial College London for the beginning of the new year.