The PANCAKE Detector Development Platform for multi-ton LXe Detectors

25.05.2022
XeSAT 2022, Coimbra

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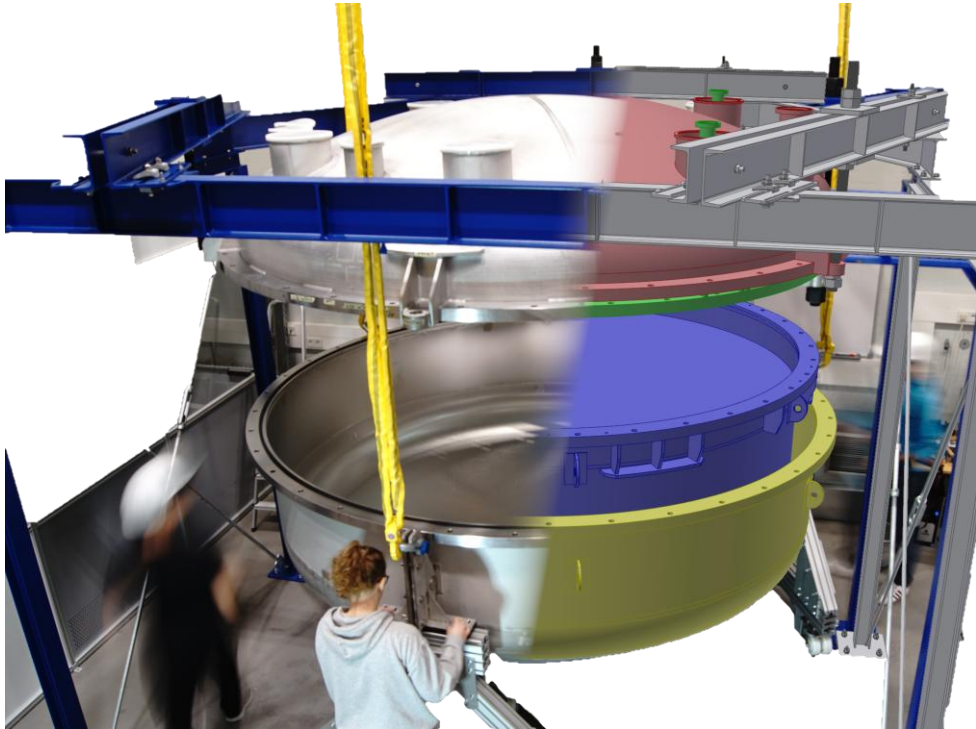


DARWIN

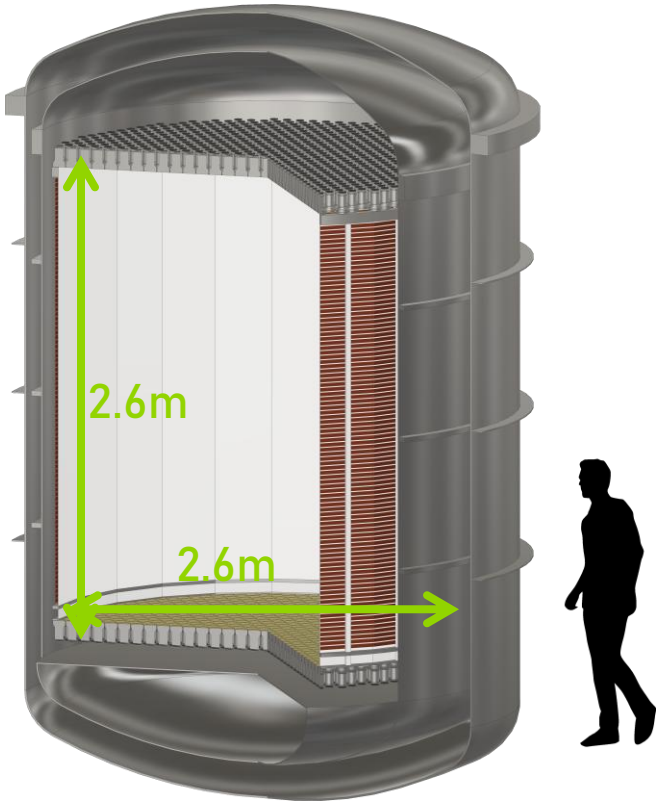
→ **next generation LXe TPC**
→ **dark matter detector**
→ **sensitivity to the neutrino floor**

DARWIN goals:

- **WIMP dark matter** arXiv:1606.07001 arXiv:2203.02309
- axions, ALPs
- neutrinoless double-beta decay arXiv:2003.13407
- neutrinos arXiv:2006.03114

DARWIN baseline design:

TPC : 2.6m	**enormous size**
LXe : 50t @-100°C	**low temperature**
ultra-low background	**radiopurity level**

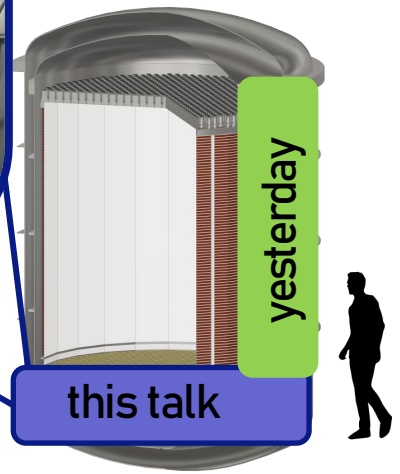


minimal material budget, size and temperature range technical
→ realization will be challenging!

PANCAKE

- full diameter test platform
- test full-scale components and new concepts
- under ‚real' conditions:
  - submerged in liquid xenon
  - cold xenon gas
  - under HV

Talk by Laura Baudis
arXiv:2105.13829



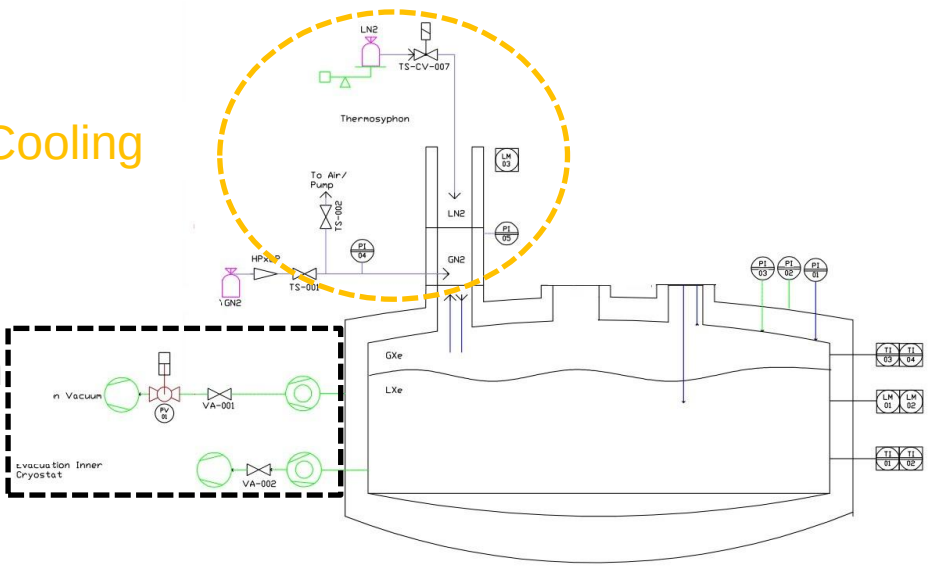
Talk by Vera Hiu-Sze Wu

wires at electrodes do sag
→ impacts signal

unique system worldwide

PANCAKE

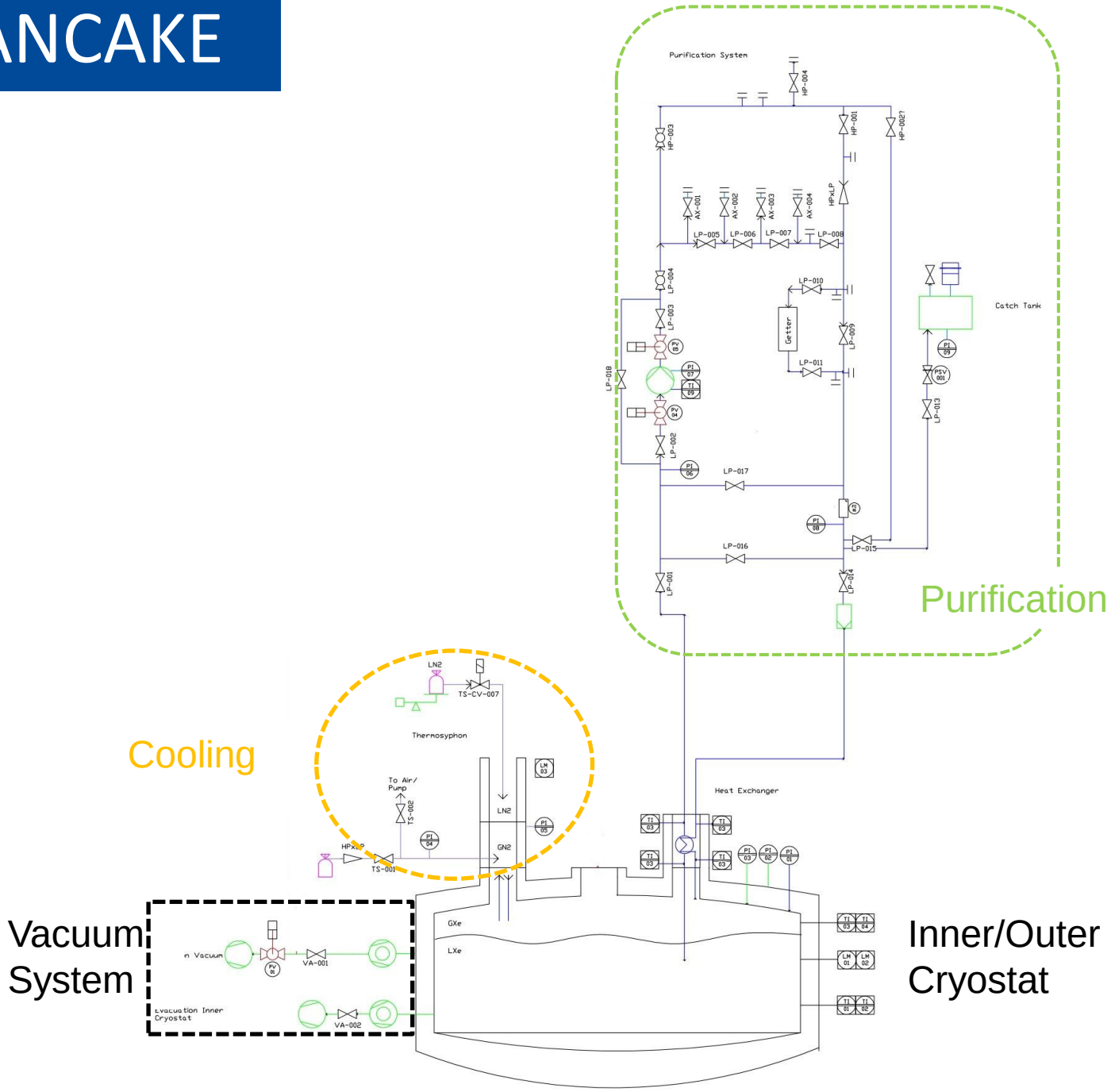
Cooling



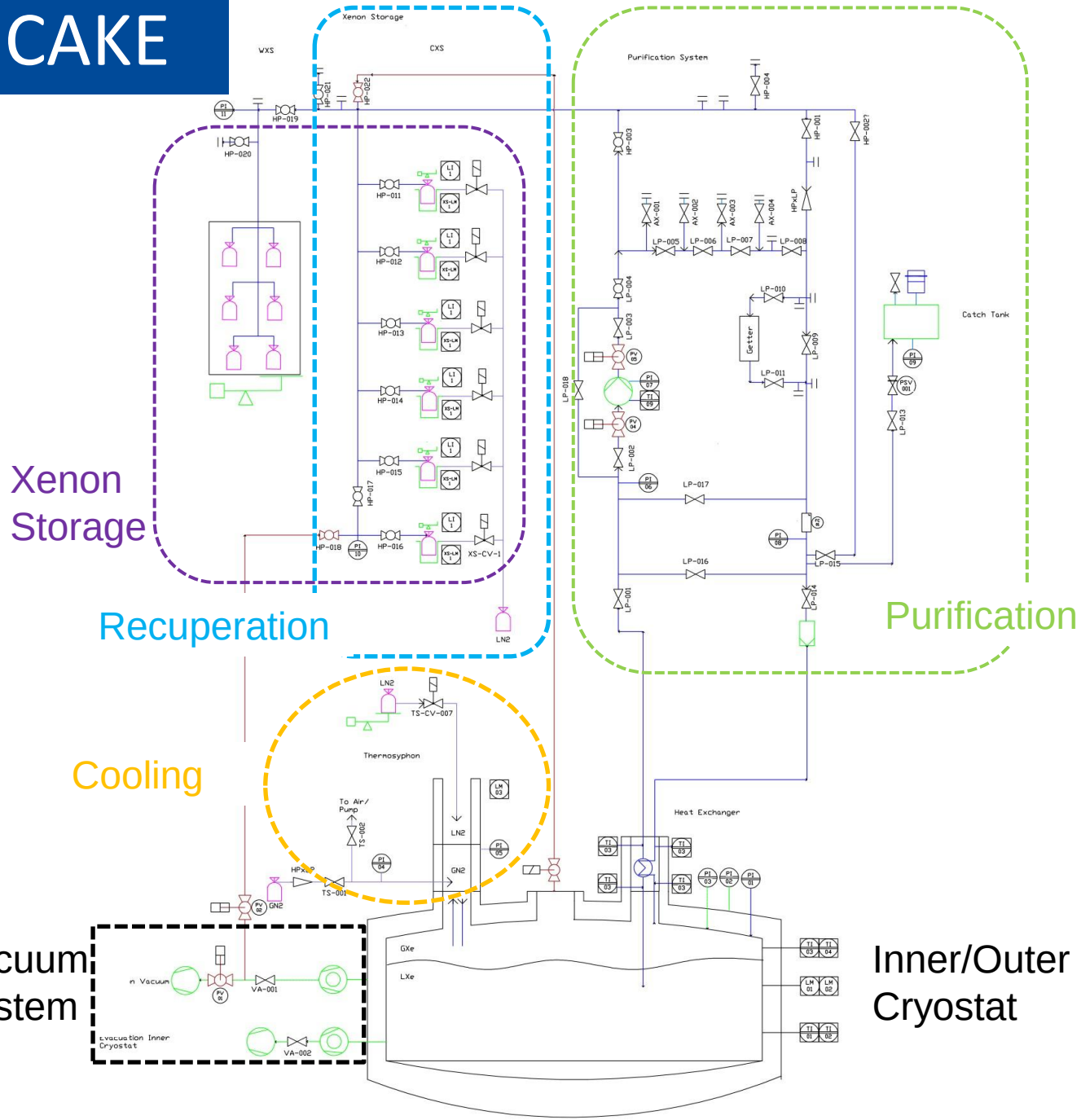
Vacuum System

Inner/Outer Cryostat

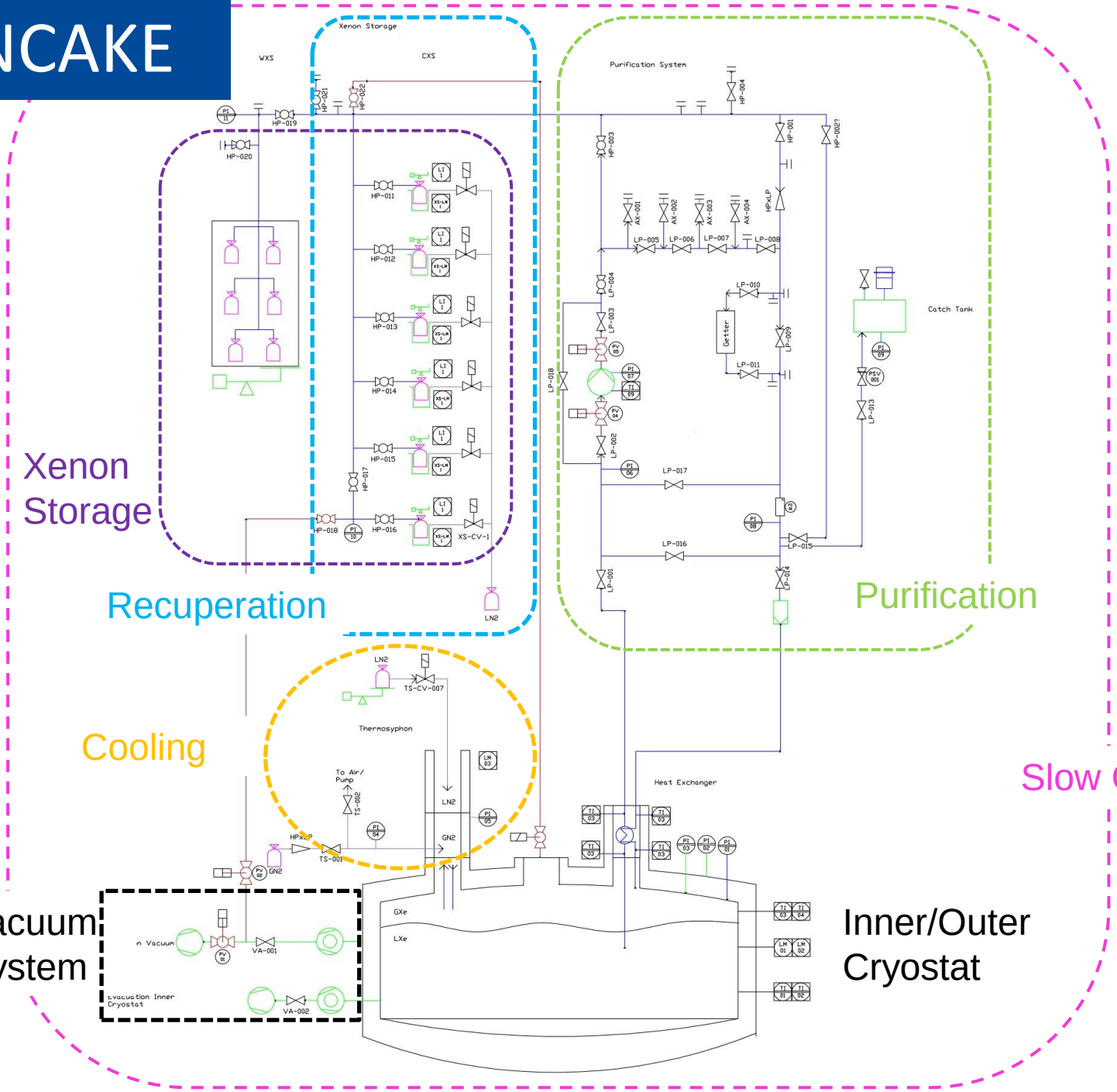
PANCAKE


Purification System
Purification
Catch Tank
Getter
Cooling
Thermosyphon
To Air/ Pump
Heat Exchanger
LN2
GN2
GXe
LXe
Vacuum System
Evacuation Inner Cryostat
Inner/Outer Cryostat

PANCAKE


Xenon Storage
WXS
CXS
Purification System
Catch Tank
Getter
Thermosyphon
To Air/ Pump
Heat Exchanger
LN2
GN2
GXe
LXe
n Vacuum
Evacuation Inner Cryostat
XS-CV-1
TS-CV-007
TS-001
TS-002
VA-001
VA-002
Xenon Storage
Recuperation
Purification
Cooling
Vacuum System
Inner/Outer Cryostat

PANCAKE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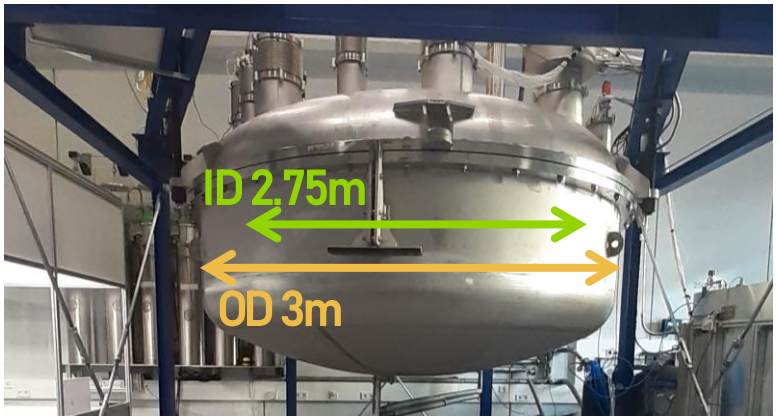
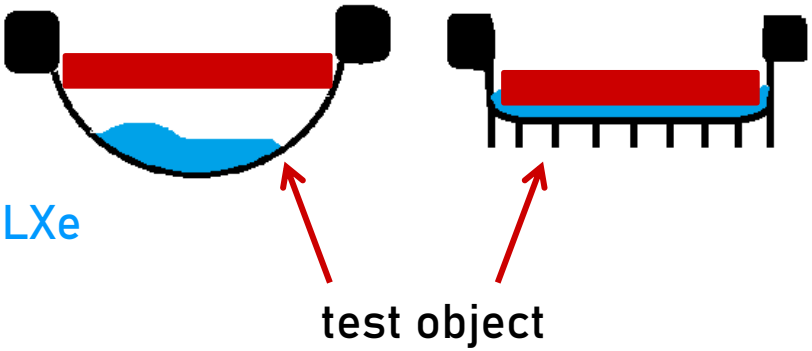
Recuperation
Purification
Cooling
Slow Control
Vacuum System
Inner/Outer Cryostat

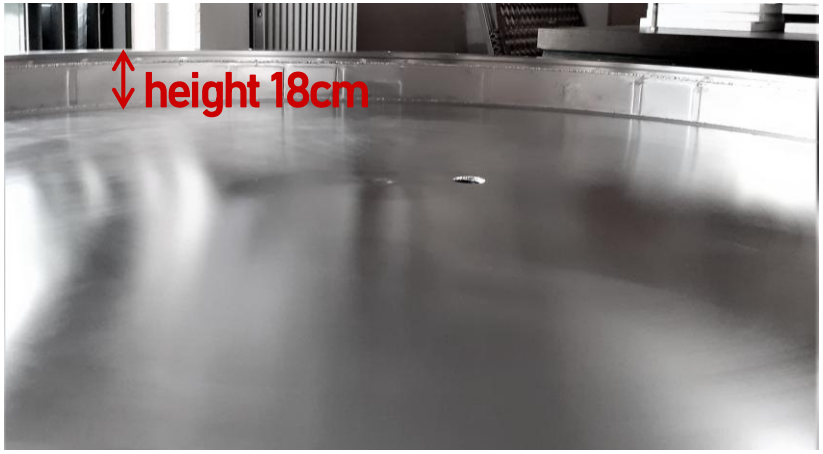
Inner and Outer Cryostat

1.) the core of the platform: **double-walled cryostat**

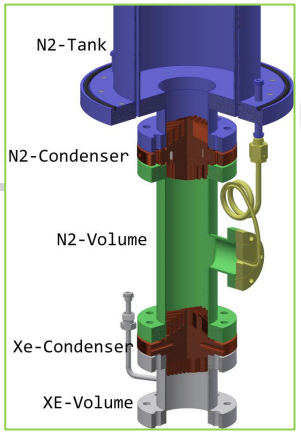
- flat floor design saves 6t xenon
- Xe-inventory 400kg ➔ 2 cm liquid level





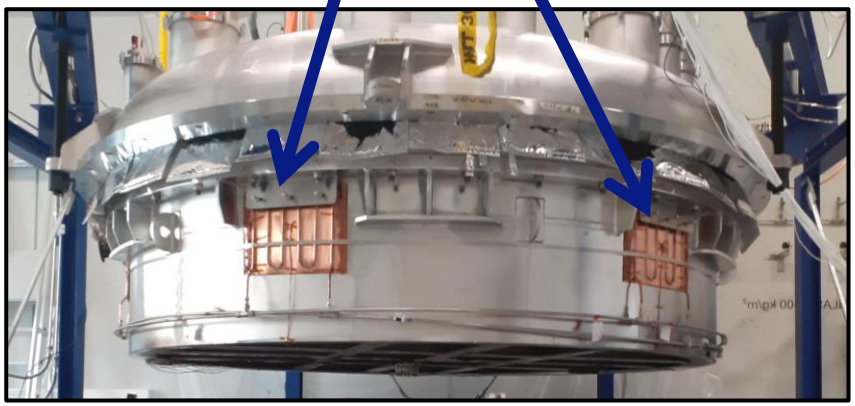


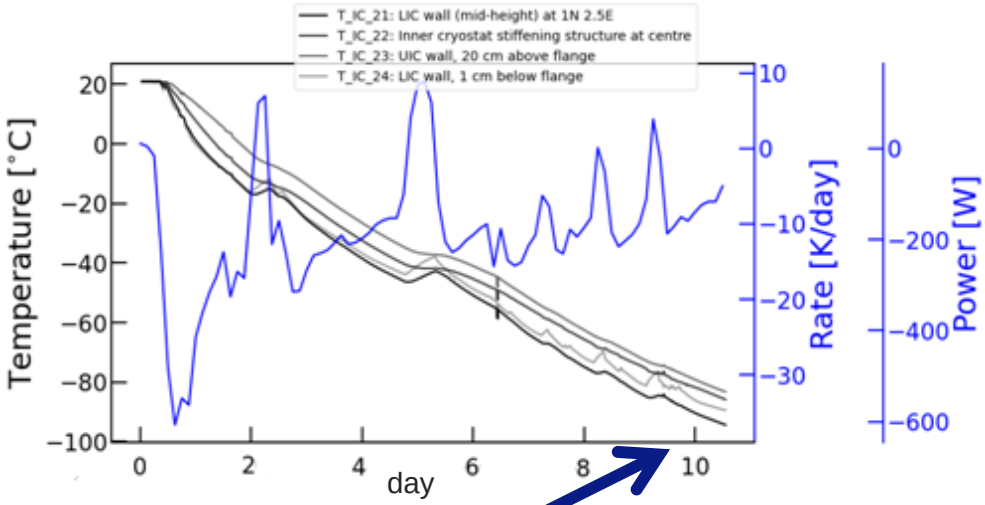
Cryogenics



2.) Cooling System

- thermosyphon: up to **200W cooling power**
- LN2 based pre-cooling system for inner cryostat up to **500W**





reached LXe temperature after 10 days

- isolation vacuum, multi-layer-insulation, heat conductance: heat influx of **65W** at -100°C

Gas System

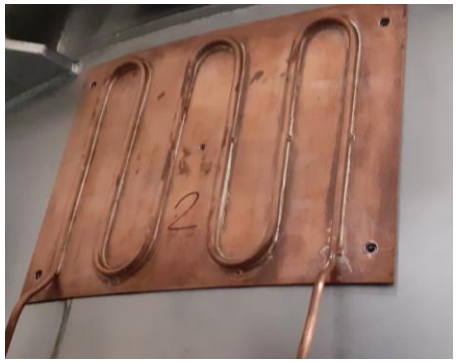
3.) Xe-purification, recuperation, and storage

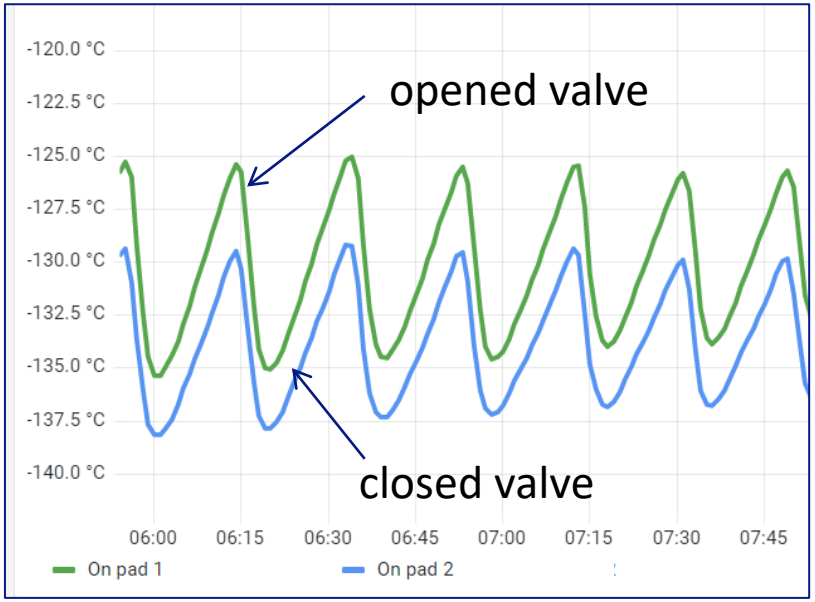
- **gas purification** with hot getter and cycling pump
- 6 freezable bottles to extract gas from inner cryostat
- **recuperation**: cryogenic pumping
- additional 6 bottles for gas-only → **gas storage**

Monitoring, Control & Safety

4.) Slow Control

- 400kg of xenon expensive
  → monitoring
- read *O*(100) sensors
- based on RevPi (industry grade)
- open source
- control system (e.g. pre-cooling)
- alarms (email, sms, calls)





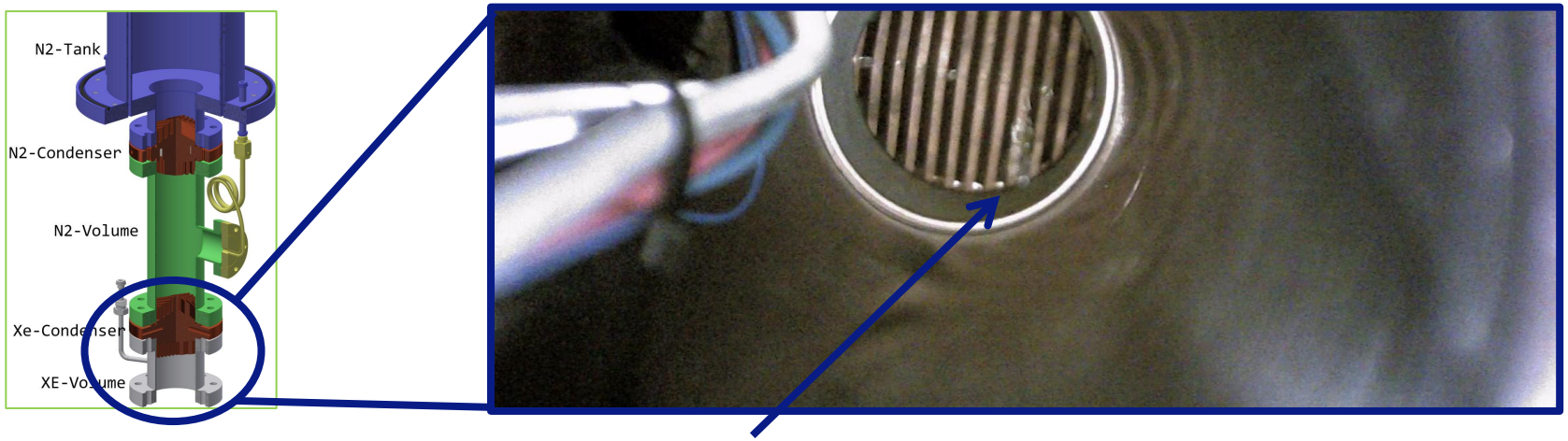
https://github.com/AG-Schumann/Doberman.git

Inside PANCAKE

5.) Cameras and Light

- several cameras and LEDs for illumination
- cameras with controlled heating for operation at -100°C

→ observe procedure, liquefaction, liquid level, HV sparks



argon droplets at cooling fin, observed with camera

Summary & Conclusion

- test facility for x-y-detector components in our lab in Freiburg
- commissioning of all sub-systems on-going
- liquefaction of argon for proof of principle

Francesco, Florian, Adam, Darryl, Julia, plus Sebastian, Jaron , and Marc

Contact:
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Thermosyphon

- N2-Tank filled with LN2
- N2 volume filled with GN2
- at top cooling fin nitrogen condenses, drops on bottom cooling fin
- there evaporates and thus cooles bottom copper block and condenses xenon on other side