

# Liquid Detectors

## TF2 – Symposium Summary

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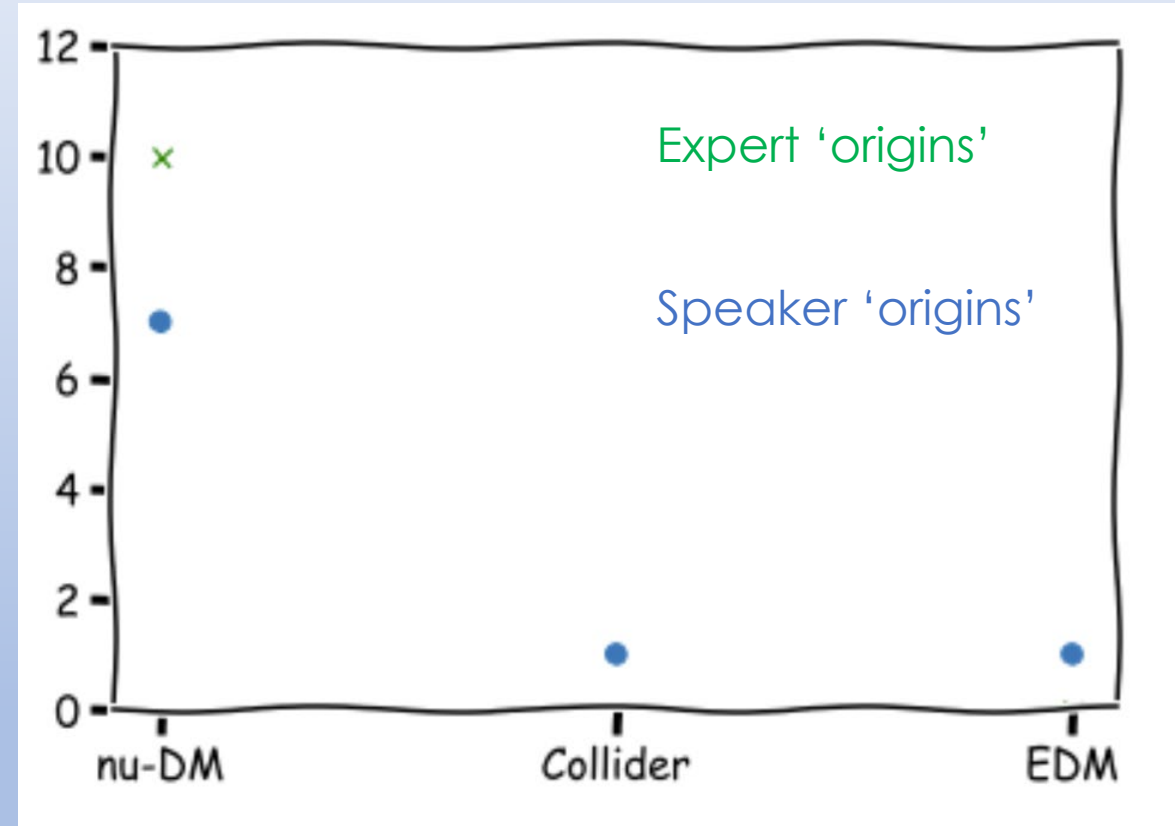
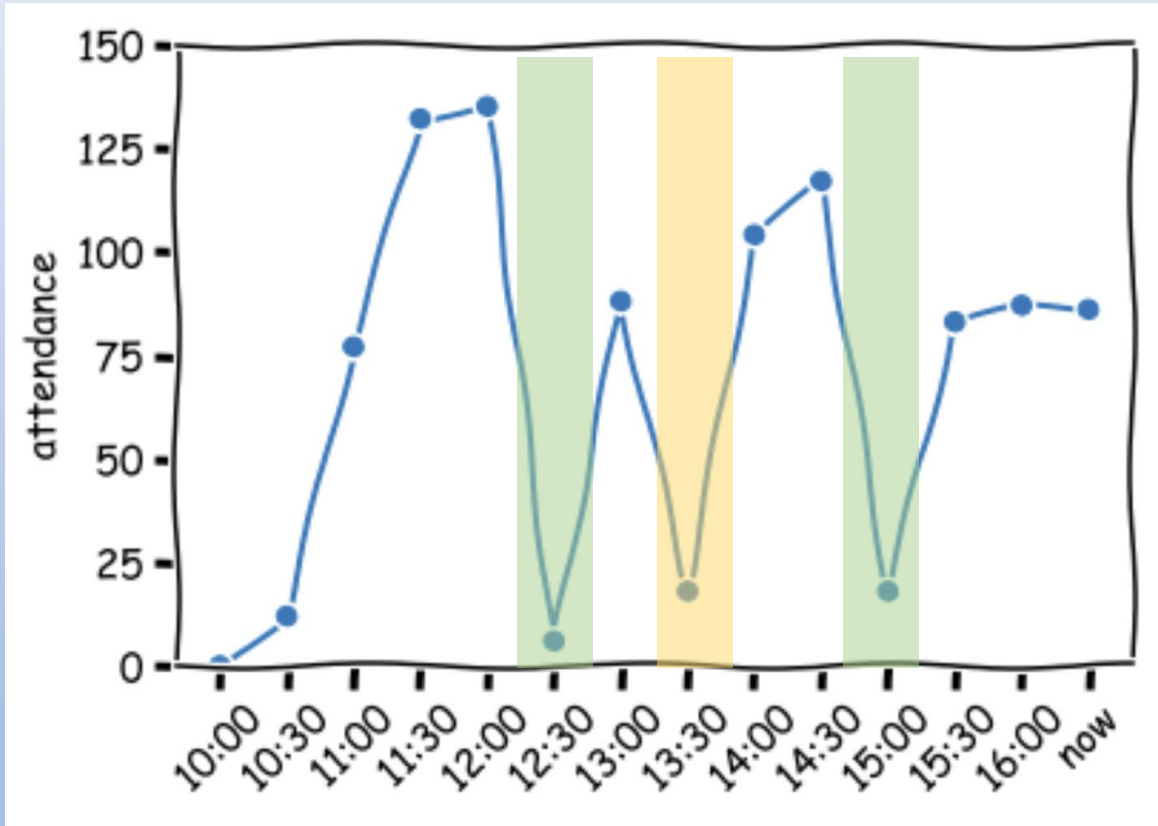
Teresa Marrodan

Marie-Cecile Piro

Skyler Degenkolb

Marcin Kuzniak

# Symposium Statistics



6 keynote presentations / 30 community contributions (23 unique people) / O(20) breakout discussions



# A lively community

The Liquid Detector Task Force will primarily focus on detector technology using noble liquids, but will also include any other technologies that use liquid media such as water Cherenkov or liquid scintillators.

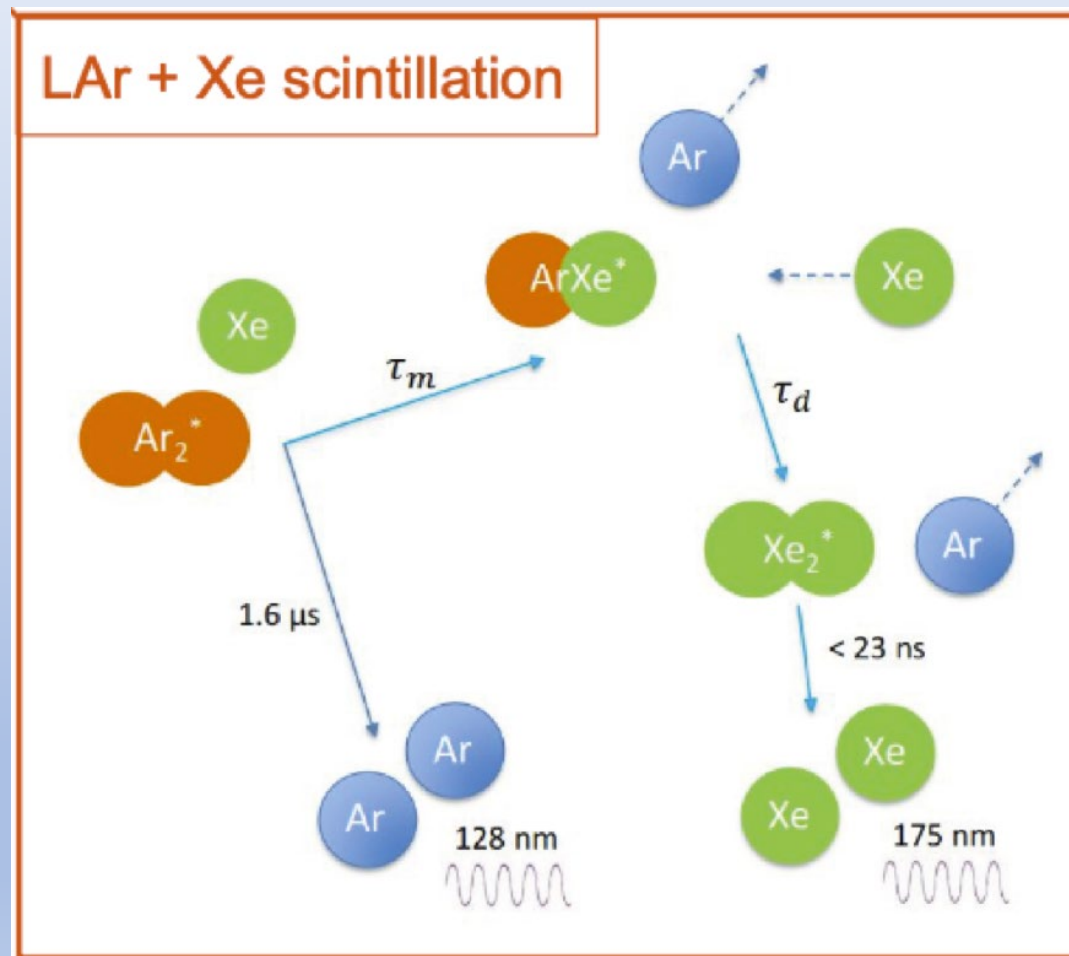
- Accelerator based – neutrino physics
- Astroparticle physics – neutrino physics, dark matter, ...
- Collider physics - calorimetry

# Noble Properties

LAr and LXe are the elements of choice for the neutrino and DM liquid community

R&D – on multiple fronts

- Basic properties
- Spike your Ar with Xe
- Near IR instead of UV
- Superradiance
- Radiopurity
- HV

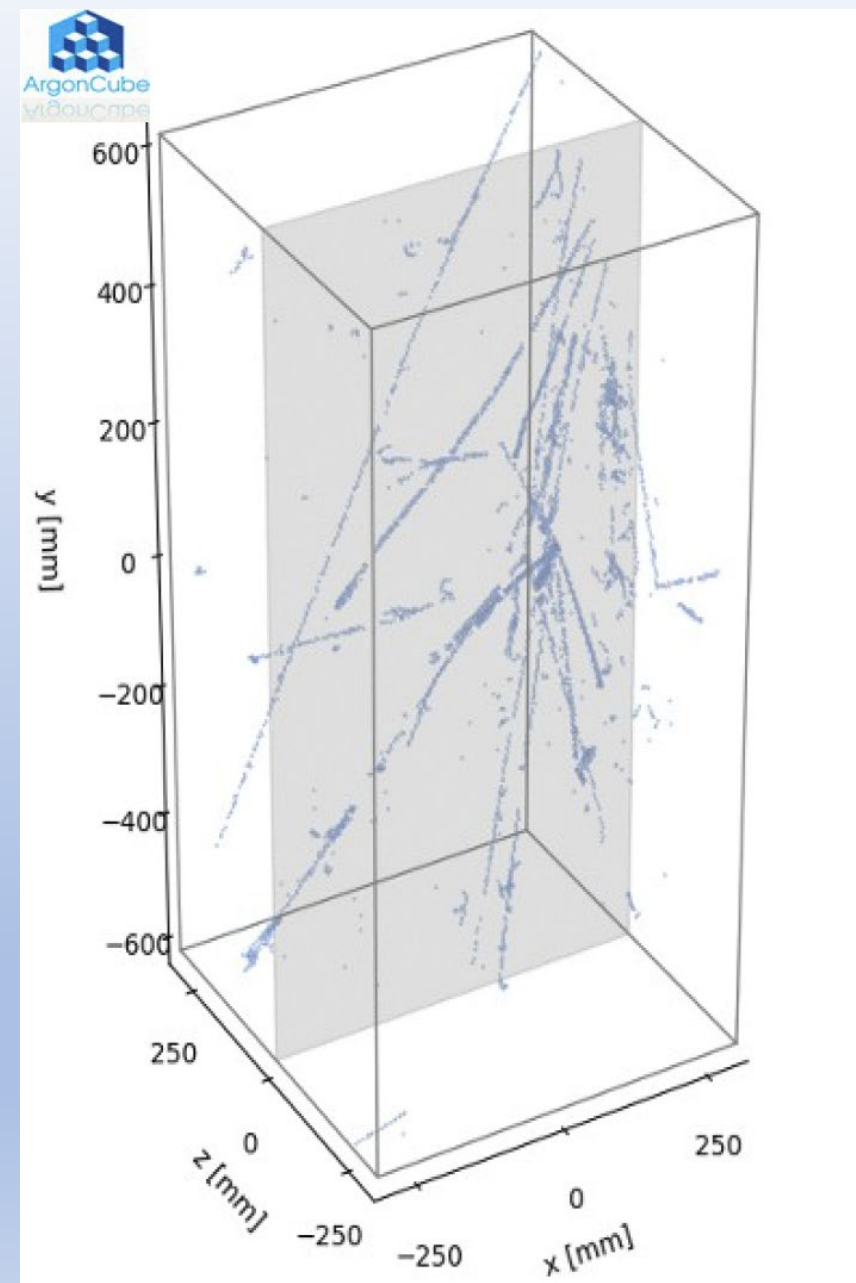
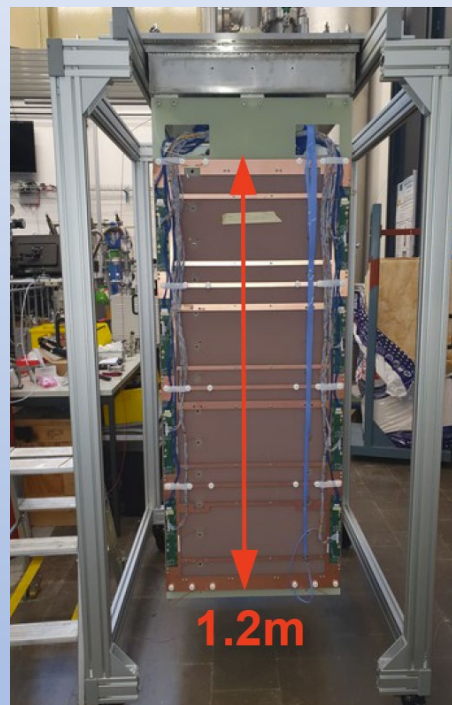


# Noble Charge

Collection in LAr and LXe TPCs:  
amplification in gas, luminescence, ...

R&D – on multiple fronts

- Amplification in liquid? Dopants?
- Luminescence in liquid?
- Wires to pixels – as happened in HEP tracking?
- Cryogenic charge amplifiers – low power – more channels





# Noble Cold & Pure

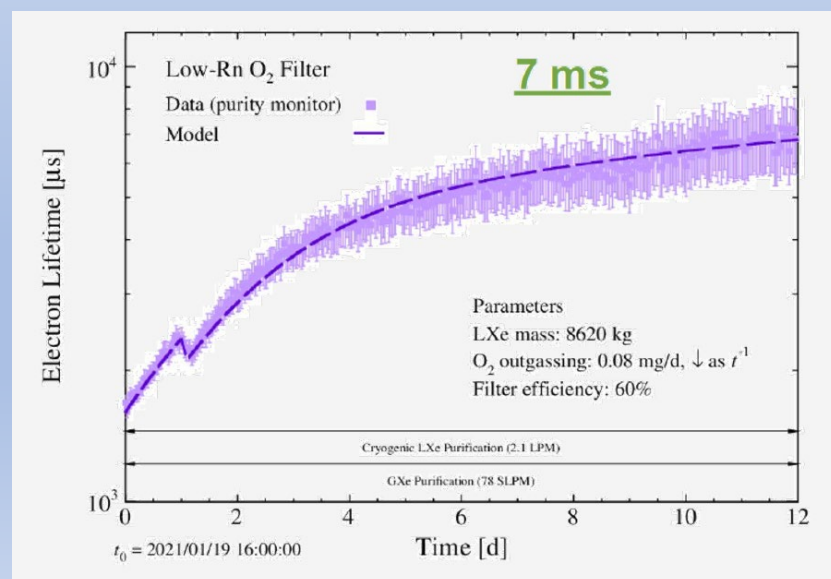


**Bigger and bigger experiments** that need to be cold and pure -> more and more complex cryogenics and Ar/Xe handling

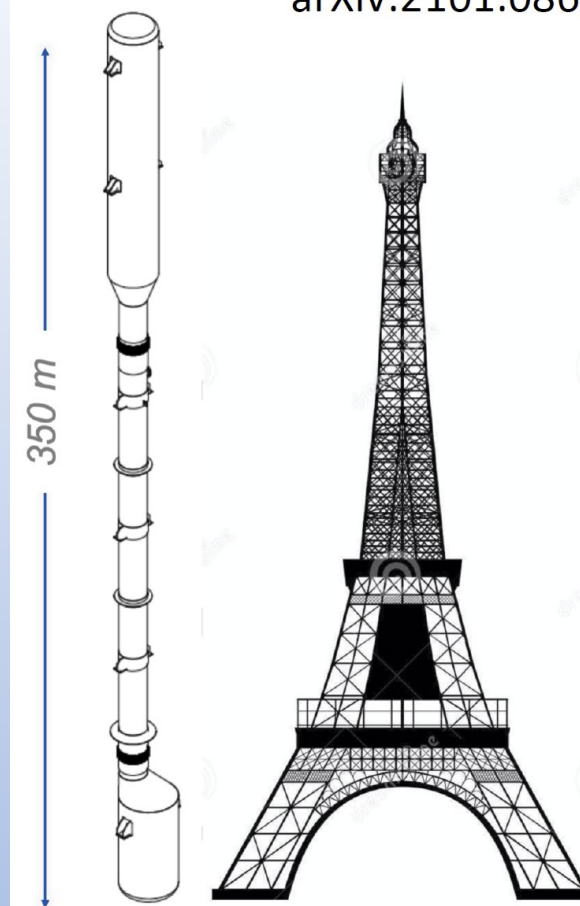
Please no O<sub>2</sub>, H<sub>2</sub>O, Kr, Rn, <sup>39</sup>Ar in your Ar, Xe

R&D – on multiple fronts

- Scaling?
- Purification in liquid phase?
- Rn-free heat exchanges & pumps?



arXiv:2101.08686



*ARIA -distillation column*



# Noble light & not so noble light

Huge surfaces of radiopure detectors in an extreme environment with high sensitivity operated for long times.

R&D – on multiple fronts

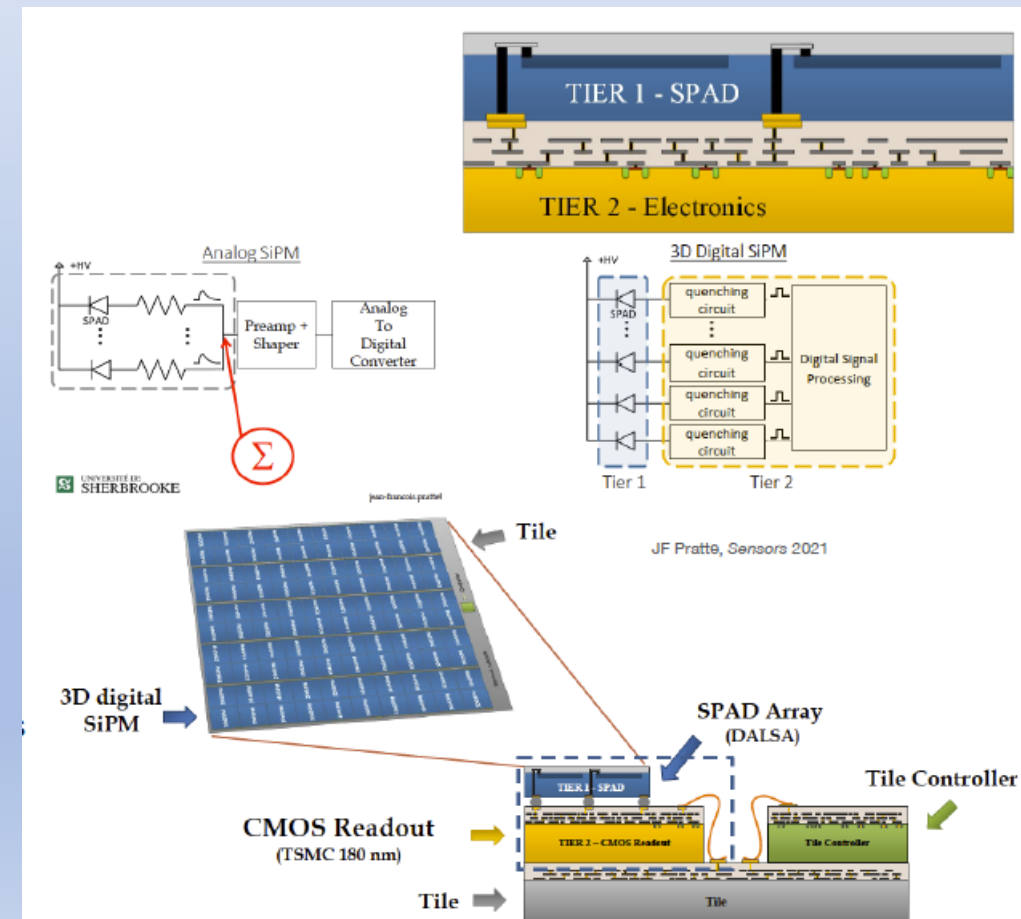
- Maximizing light collection & spectral sensitivity
- Sensor properties -> SiPM
- Integration of light/charge readout

KM3NeT DOM



Experiment	Type	Photodetector	Area (m <sup>2</sup> )
nEXO	LXe	FBK, Hamamatsu, 3DdSiPM	5
DARWIN	LXe	SiPM is one option	8
TAO	LSci	FBK	10
DarkSide-20k	LAr	FBK NUV-HD triple dopant	30
ARGO	LAr	SiPM is baseline option	200
DUNE	LAr	Light guide or trap + SiPM	10-1000

Compact digital modules



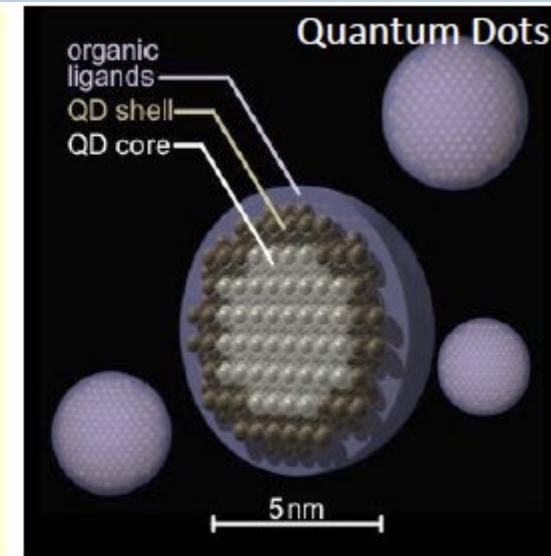
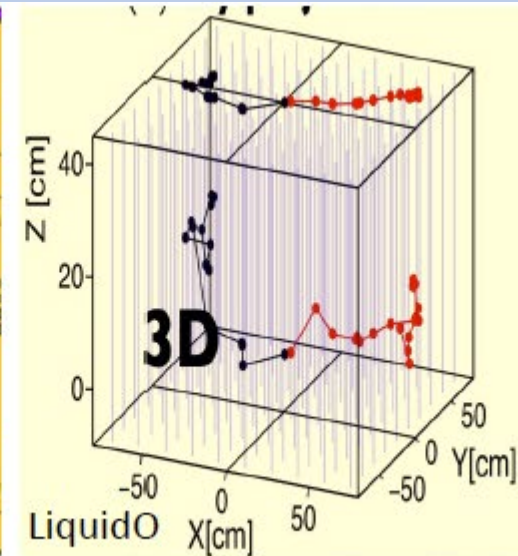
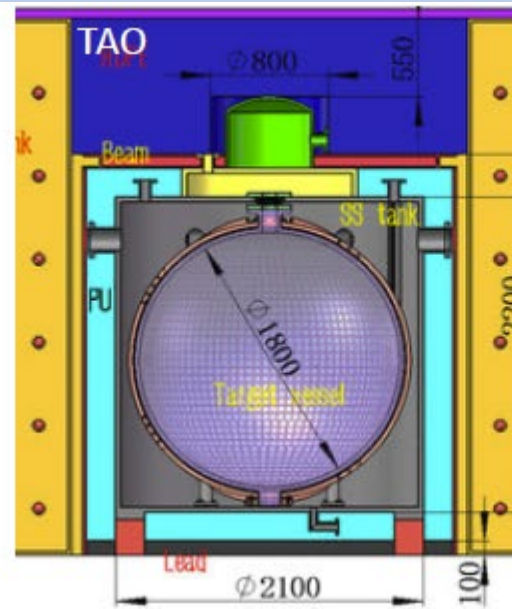
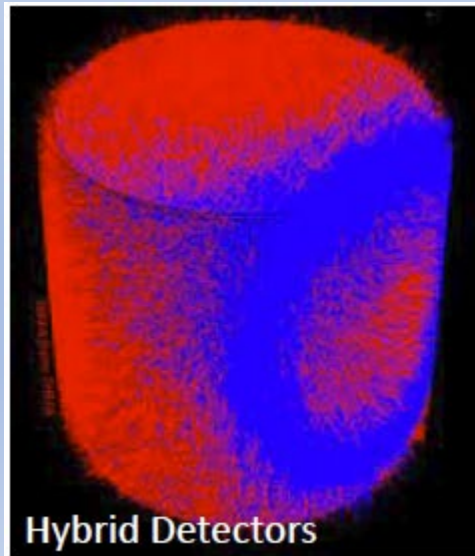
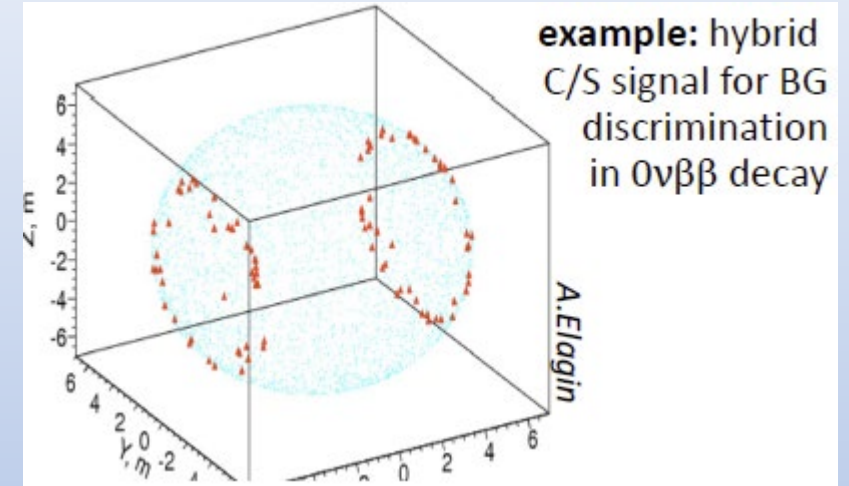
# Liquid Scintillator & Water

Spike or cool your scintillator, and read out multiple modalities

R&D – on multiple fronts

- Hybrid Cherenkov/scintillation
- Cold LS
- Opaque LS with fiber readout
- LS doped with q-dots

New reco algorithms



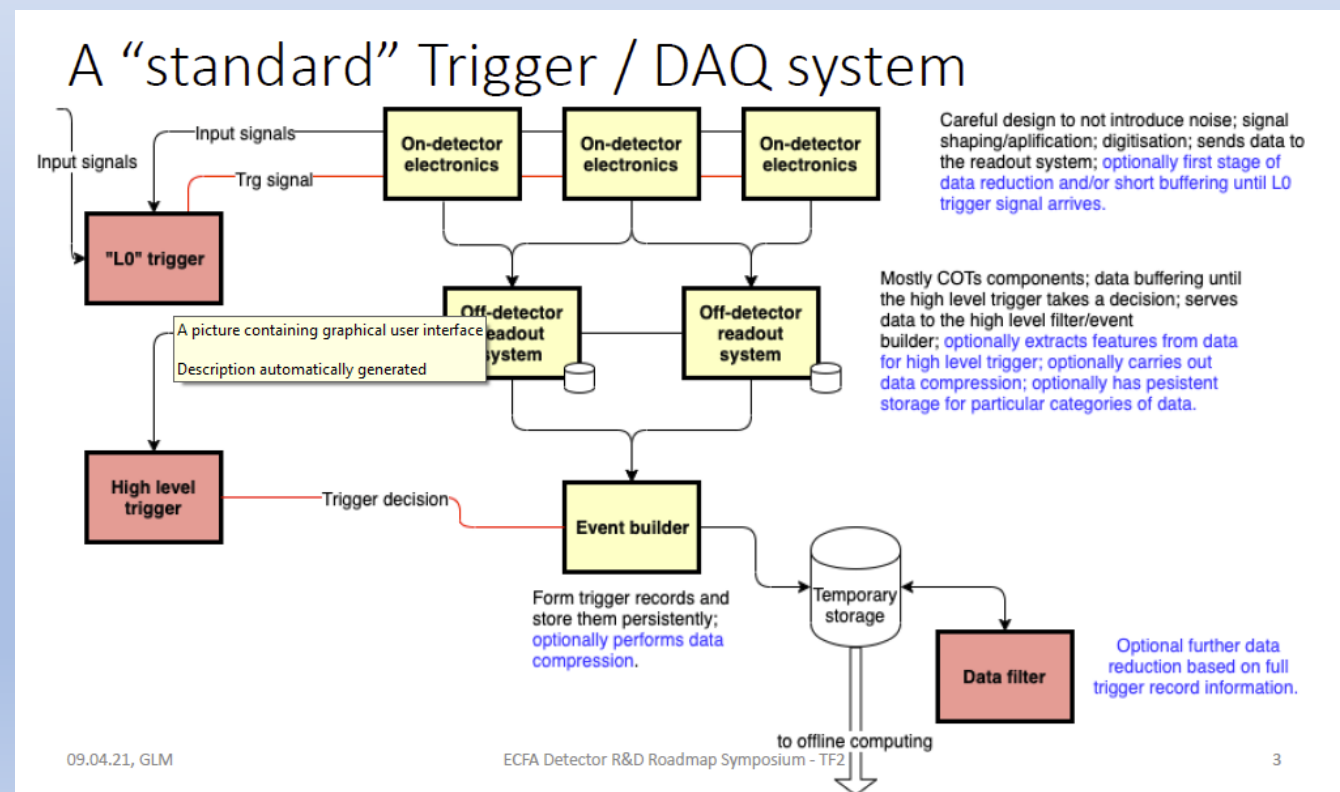
# Readout Challenges

What needs to be done outside of the liquids?

Many cross links with other TF

R&D – on multiple fronts

- Large detectors-> handle large amount of data
- Mixture of fast (light) & slow signals (charge)
- Data-bursts for rare event triggers



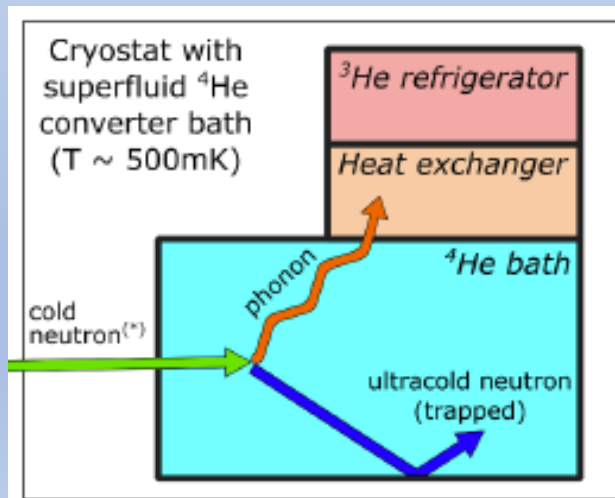
# Breakout sessions

- Nice break from the talk listening..... Nice to discuss in smaller forum
- Large variety of topics discussed..... Tried to keep track during the summaries. Stressed by many: ***“Need to collaborate, instead of compete”***
- Even breaking the rules by suggesting to freeze the liquids
- The executive summaries / answers & comments in spreadsheet will be very welcome

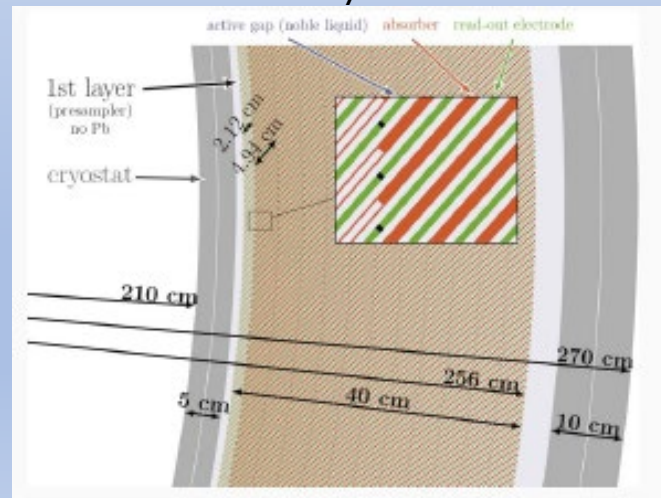
# Community contributions

- 30 different ideas from 23 unique people
- Slides available.... 1 slide / contribution

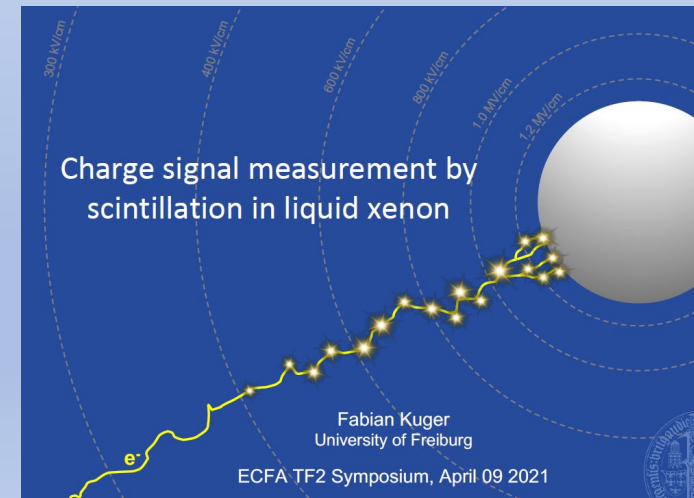
EDMn – neutron in He bath



LAr calorimetry - **colliders**



Scintillation in LXe



# Future for the taskforce

- See slides from Ines.....
- Thank you all again
- Have a good trip back home