The XENON100 Dark Matter Detector

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For the XENON Collaboration

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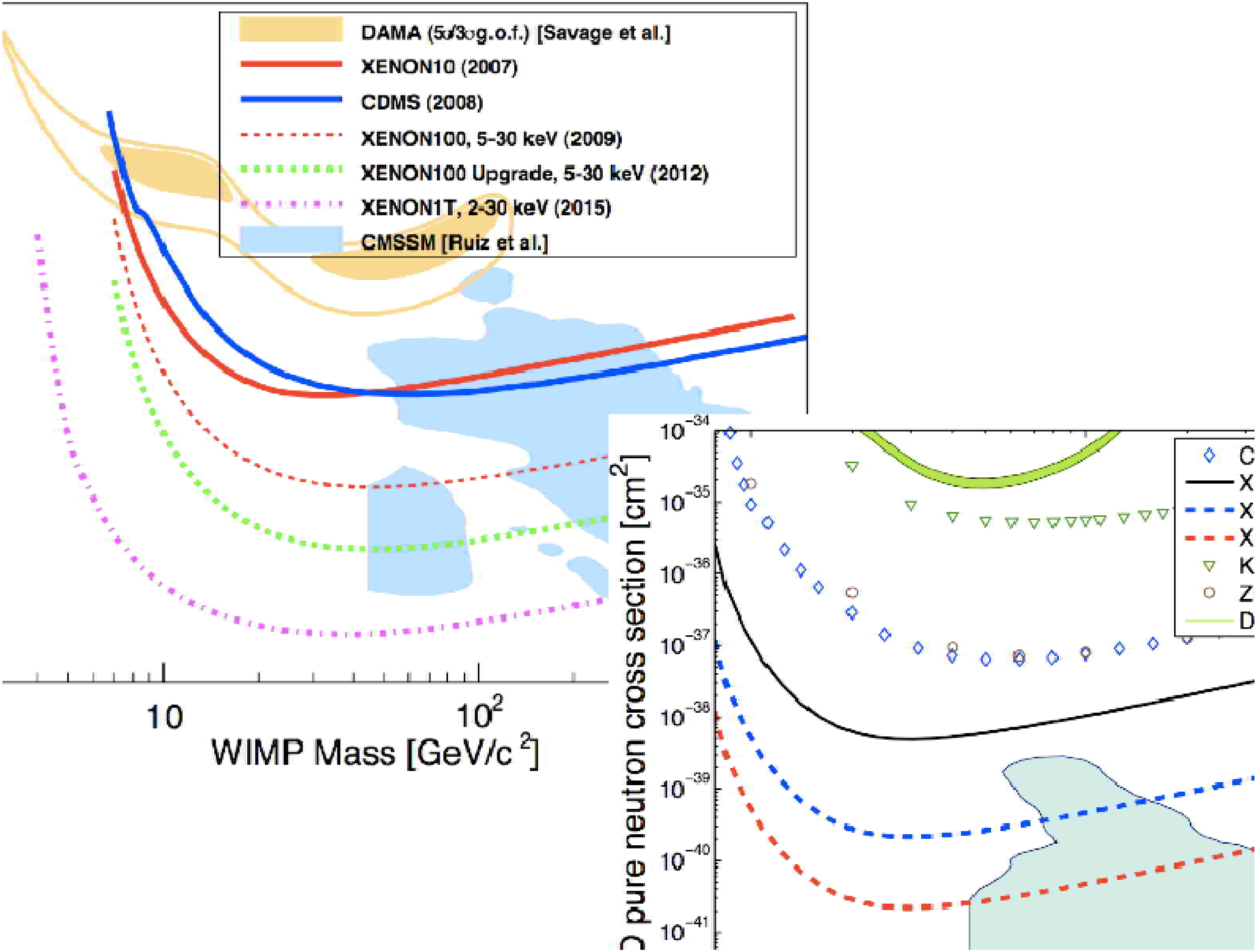
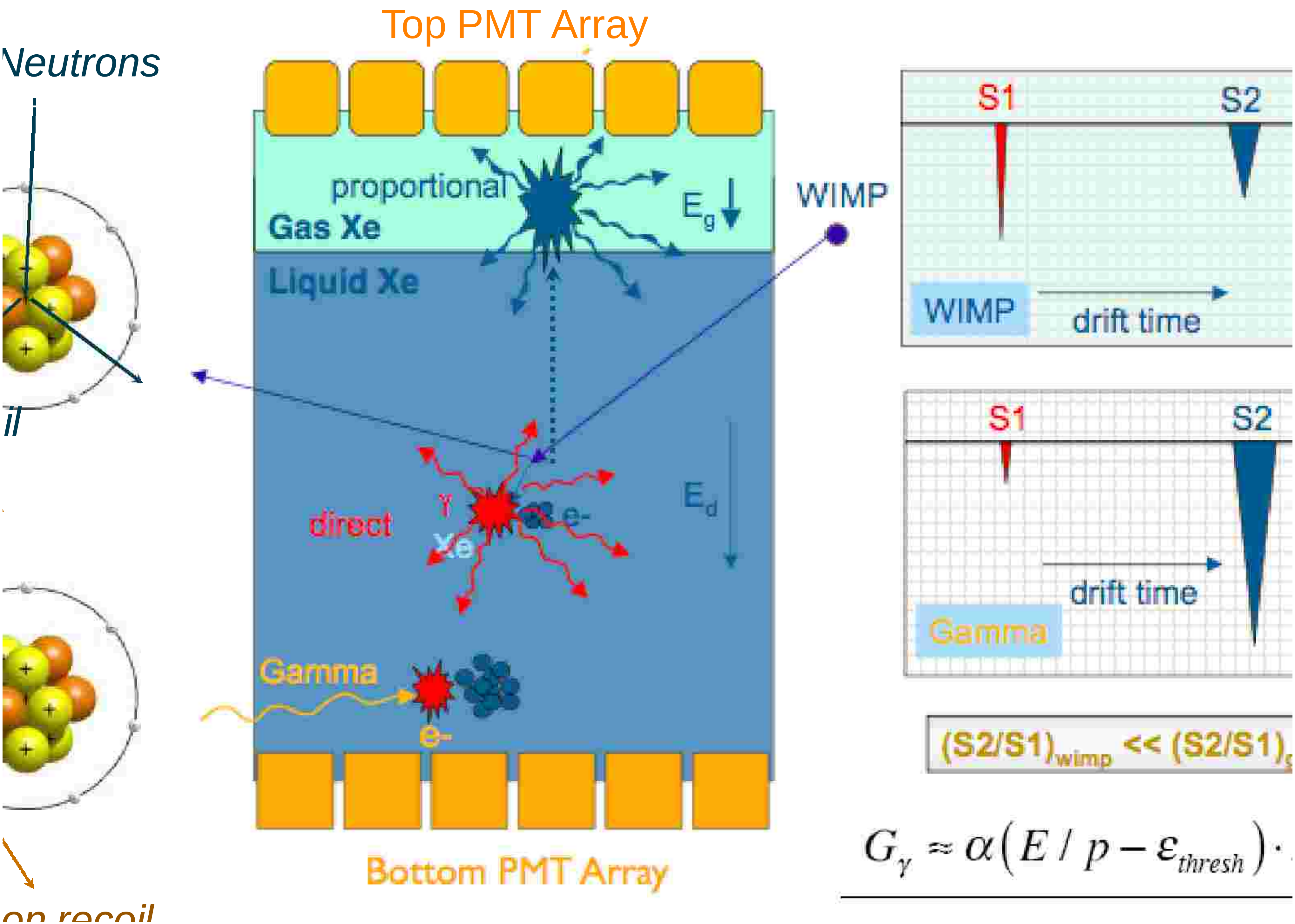


DAMA (5σ/3σ g.o.f.) [Savage et al.]
XENON10 (2007)
CDMS (2008)
XENON100, 5-30 keV (2009)
XENON100 Upgrade, 5-30 keV (2012)
XENON1T, 2-30 keV (2015)
CMSSM [Ruiz et al.]
10
10^2
WIMP Mass [GeV/c ^{2}]
10^{-34}
10^{-35}
10^{-36}
10^{-37}
10^{-38}
10^{-39}
10^{-40}
10^{-41}
pure neutron cross section [cm^2]



$$G_\gamma \approx \alpha\left(E/p - \varepsilon_{thresh}\right)\cdot$$

Top Shield PMTs

'Bell' with Top PMT Array inside

Teflon Cylinder
(Field shaping Ring Support,
Separation of Target and Shield)

Bottom Shield PMTs

Dual Phase Liquid Xenon TPC

Phased program to explore successively lower cross sections

In each phase we also establish the technologies for the next phase.

e	Size {kg of xenon) Fiducial	Total	Status
ON3		< 3	Lab tests only, completed
ON10	5	25	Experiment, Data published
ON100	50	170	Experiment, final commissioning
ON100 grade	100	350	Design, 2010 - 2012

1. Larger target mass
2. Lower background radiation in all materials
3. Lower detection threshold

ENON experiment is placed into passive shield.

20 cm lead, 20 cm Poly, 5 cm Copper

materials inside shield must be controlled for background activity

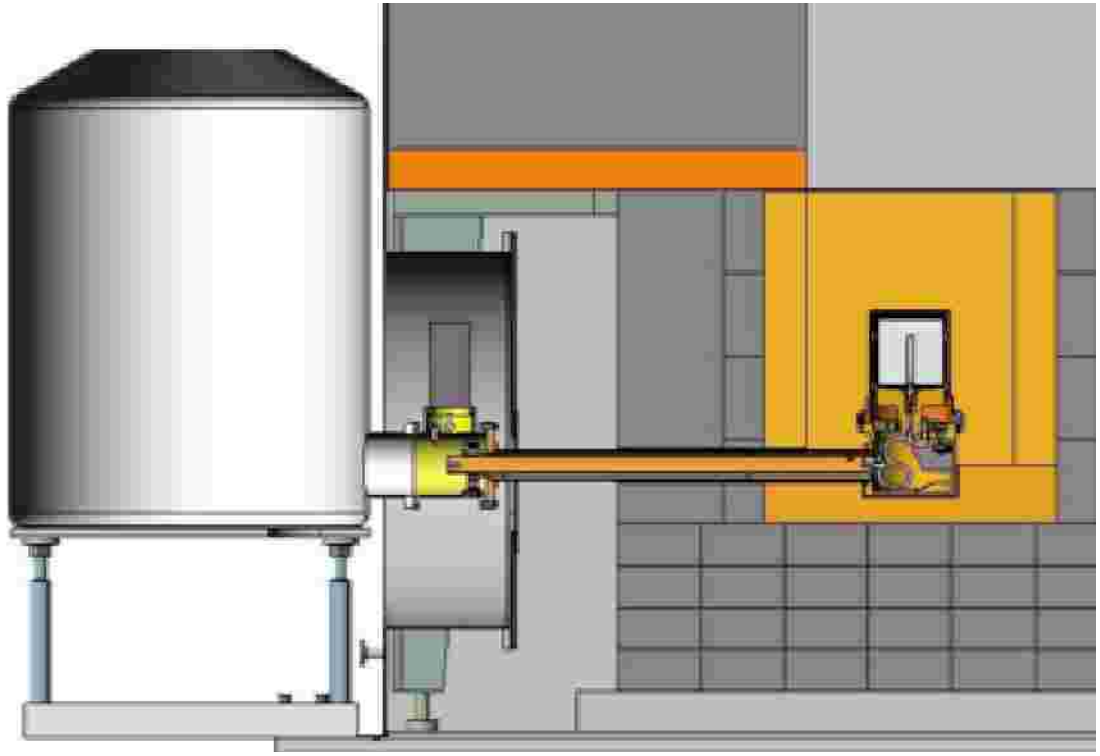
wever, some assemblies are difficult or impossible to change:

e.g. Pumps, PTR, Motor-Valve, Sensors

Place as many parts as possible outside shield.

Choose low activity materials for everything inside shield.

Compared with XENON10, the detector mass (except Xe) was



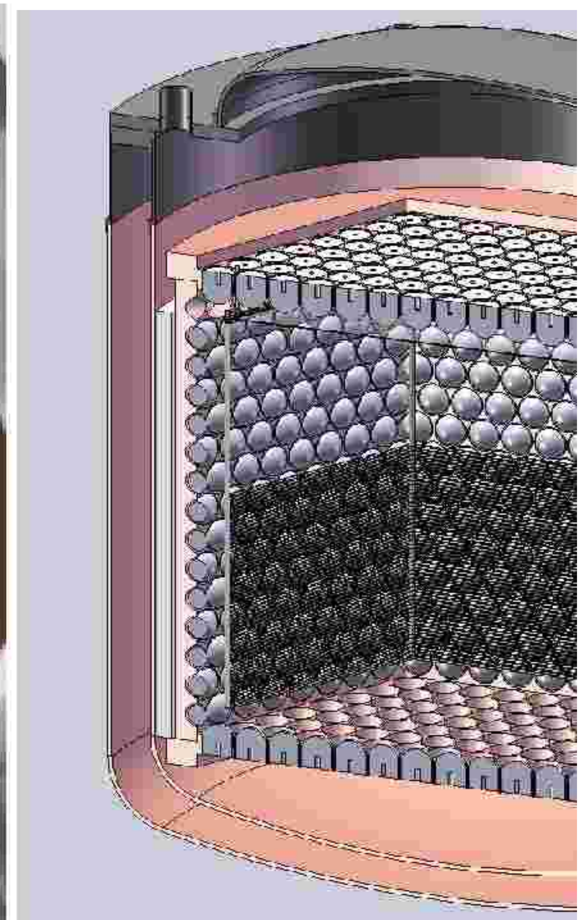
Radioactivity of all materials used in XENON100 m
with a dedicated HPGe counter at LNGS

TPC Material	Unit	Quantity used	^{238}U [mBq/unit]	^{232}Th [mBq/unit]	^{40}K [mBq/unit]	^{60} [mBc
R8520 PMTs	PMT	242	0.15±0.02	0.17±0.04	9.15±1.18	1.00:
PMT bases	base	242	0.16±0.02	0.07±0.02	< 0.16	< (
Stainless steel	kg	70	< 1.7	< 1.9	< 9.0	5.5:
PTFE	kg	10	< 0.31	< 0.16	< 2.2	< (
QUPID	QUPID	-	<0.49	<0.40	<2.4	<(
Shield Material						
Copper	kg	1600	< 0.07	< 0.03	<0.06	<0.1

ast
2007)

the current
(2007-2010)

the future
(2010-2014



ON10

07) s_{SI}=8.8 x10^{-44}

XENON100

Projected (2009) s_{SI}~2x10^{-45} cm^2

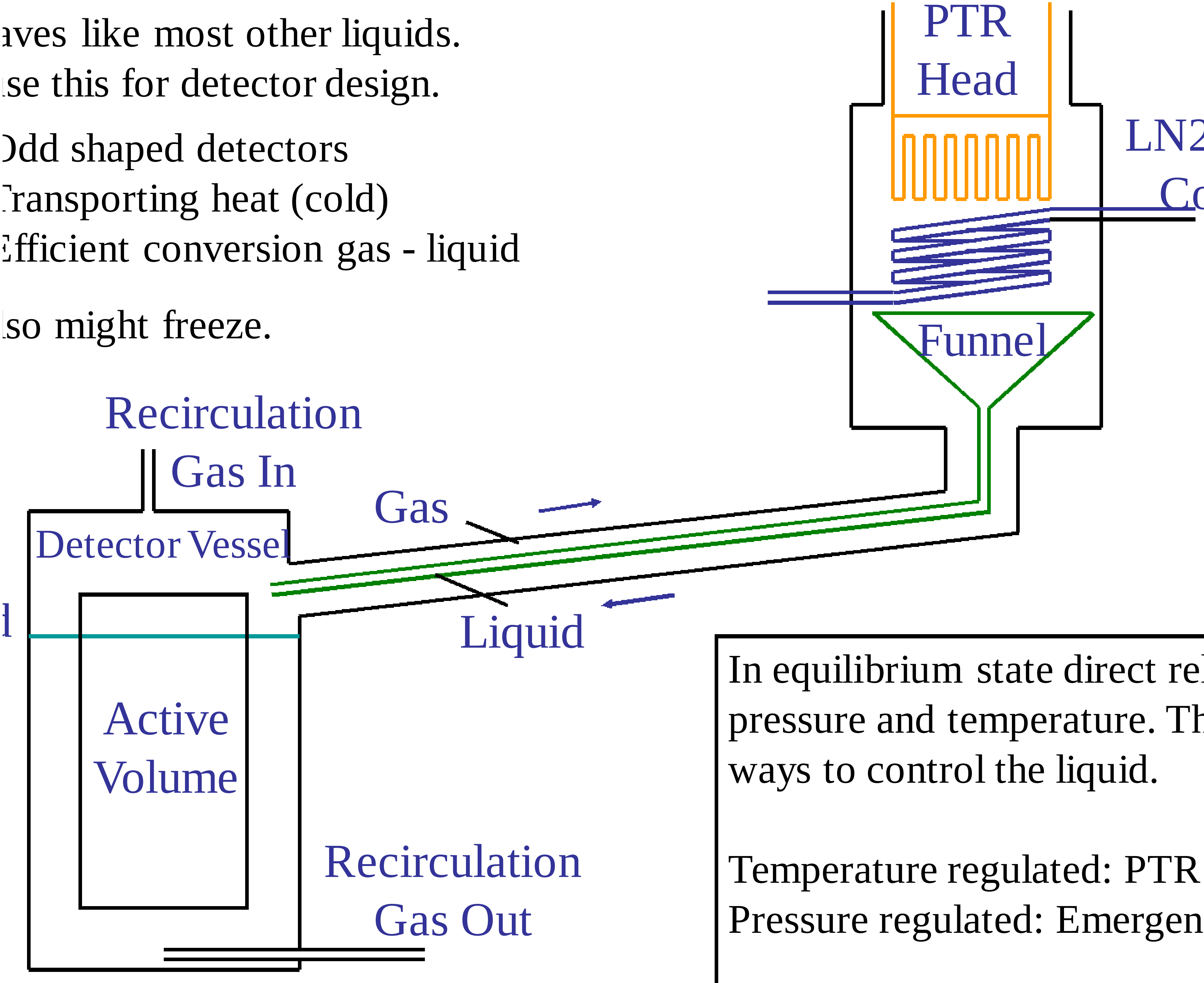
XENON

Projected (2014) s_{SI}

ıves like most other liquids.
ıse this for detector design.

-)dd shaped detectors
- Transporting heat (cold)
- Efficient conversion gas - liquid

ılso might freeze.



In equilibrium state direct relation b
pressure and temperature. Therefore
ways to control the liquid.

Temperature regulated: PTR coolinį
Pressure regulated: Emergency LN2

oling tower supports all instrumentation

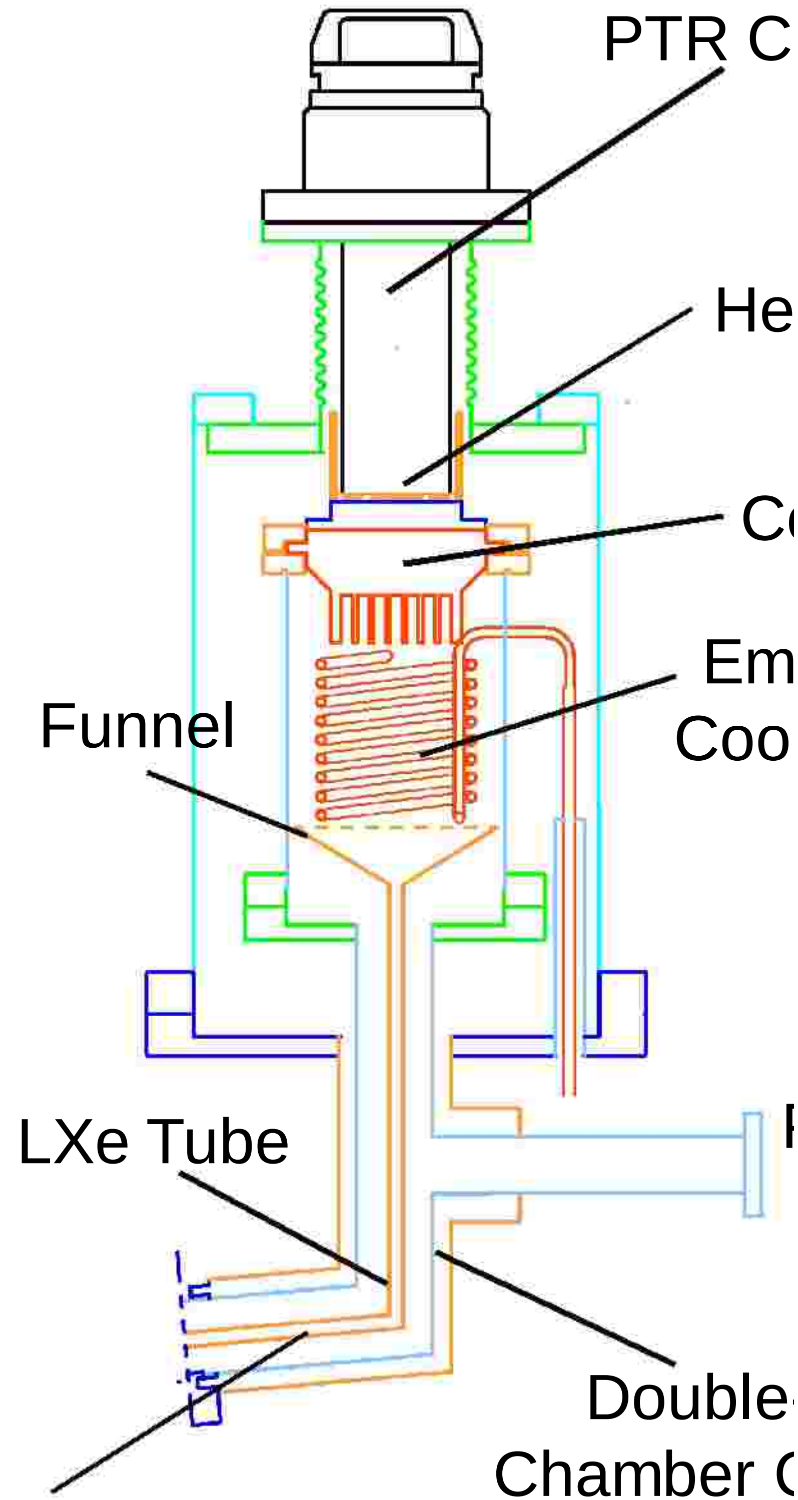
rator Head (incl. Motor Valve and Buffer Tank)
mergency Cooling Coil
n Pumps for Chamber and Cryostat
n Gauges, Pressure Gauges, Rupture Disk
oughs for Control Circuits

ni PTR PC150, Cooling power 200 W
with 6.5 kVA compressor

nt to fill or re-circulate with 10 SLPM

mperature Controller, Stability < 0.1 C

nergency cooling with LN2 coil.
Regulated with pressure.
completely independent systems.



Cooling Tower

ing

s

Feedthroughs

or Vessel

Simulated

Main impurities, but there are others:
Purity for light is determined by water.
Purity for charge is also determined by oxygen.

Purification of Gas with continuous re-circulation
and passage of gas through hot getter (SAES)

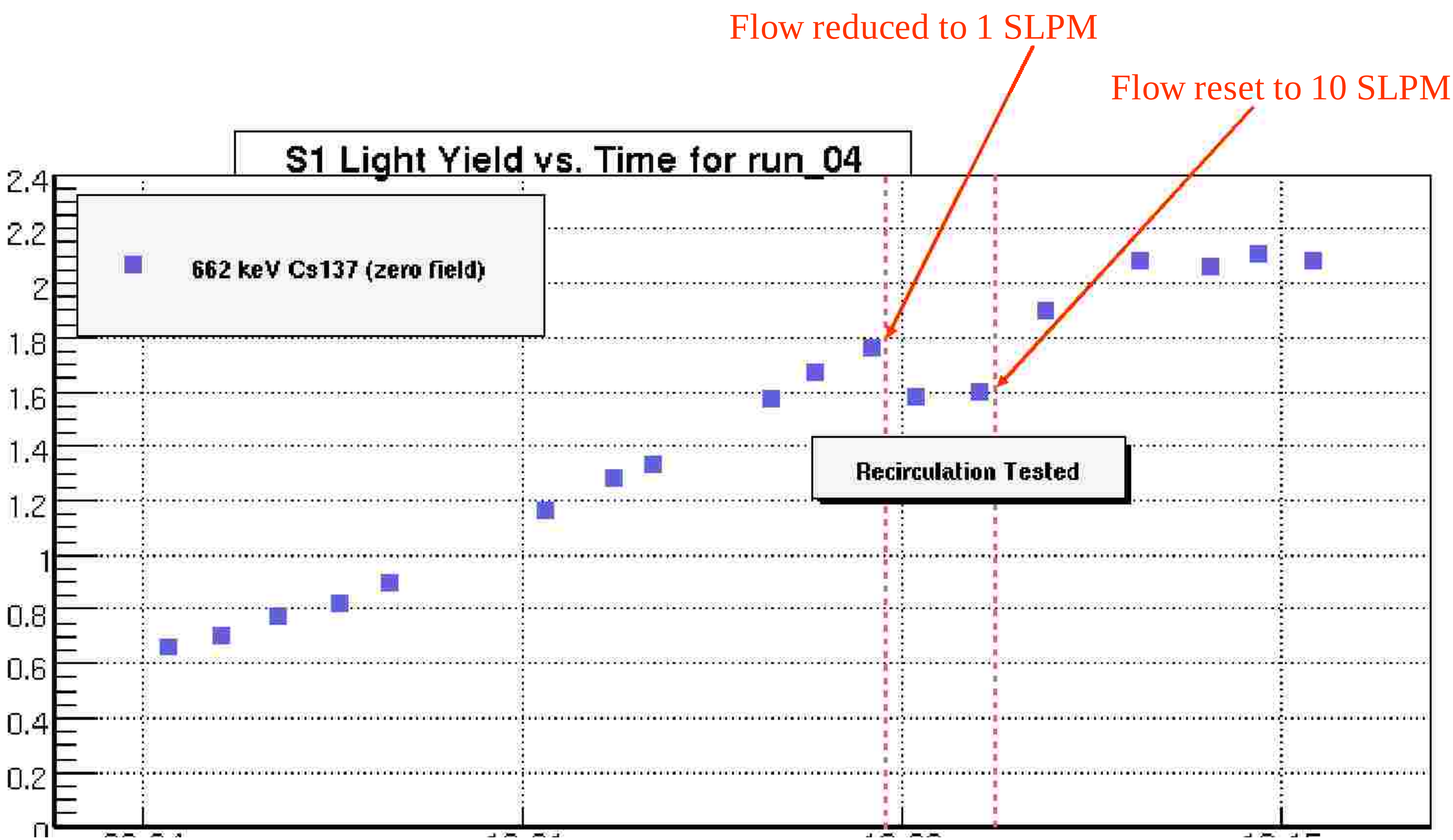
We monitor:
Water Concentration (HALO Monitor from Tiger Optics)
Initially: light yield (S1)
Then: Charge yield vs. drift time (S2)

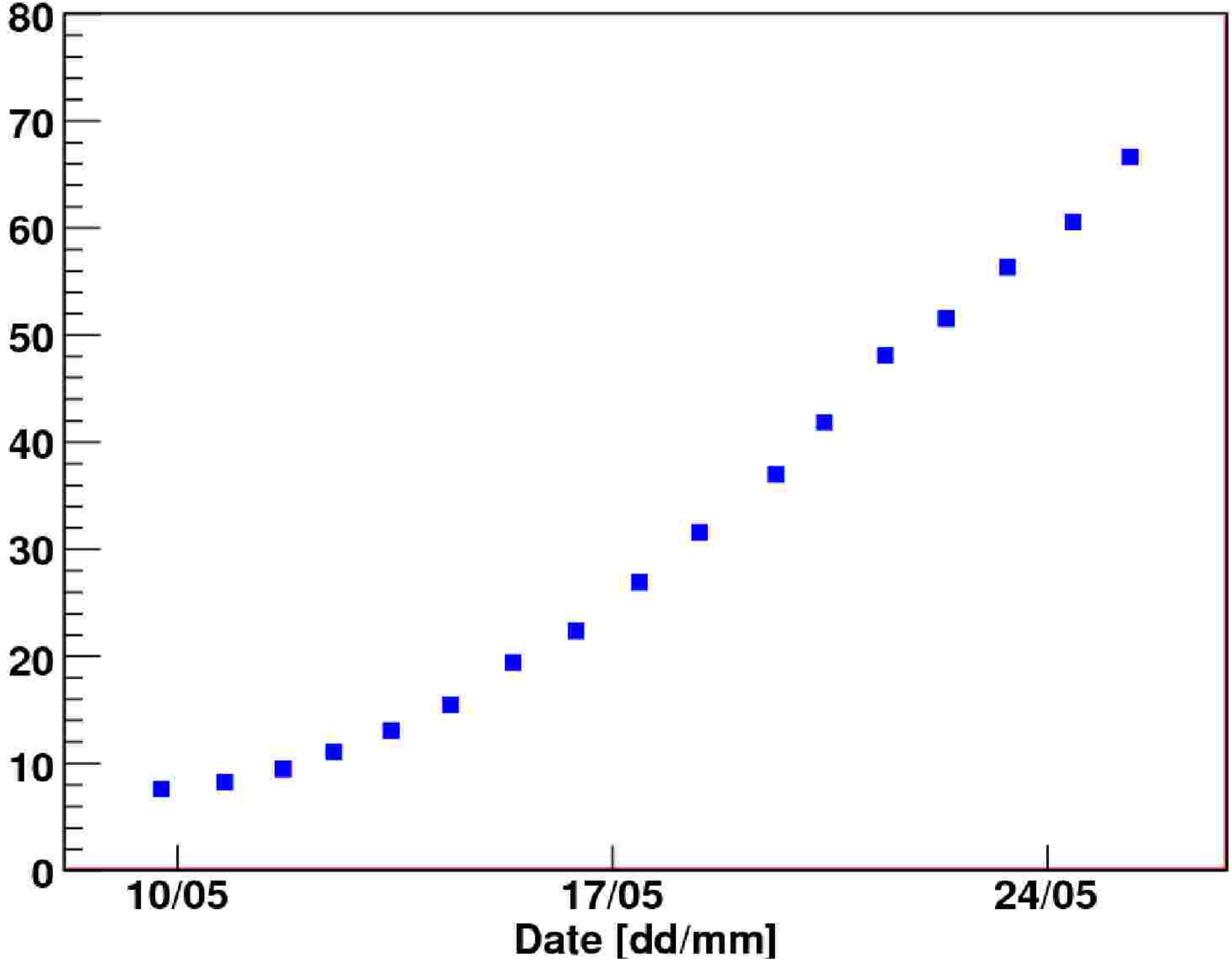
n10
culation speed 5 SLPM
mum drift time: >2msec
ion of cleaning: 2 months

Xenon100
Recirculation speed 10 SLPM
Light yield still increasing
Drift Time 70 sec or 13 cm (still inc
Cleaning since 5/9/09

Cleaning of Detector Takes Time

Time – "Driver" is Out-Gasing Rate, not Recirculation Speed.




80
70
60
50
40
30
20
10
0
10/05
17/05
24/05
Date [dd/mm]

a, Emax = 687 keV, t = 10.8 y, br = 99.563%) ->

a, Emax = 173 keV, t = 10.8 y, br = 0.434%)
(Gamma, E = 514 keV, t = 2.43 us) -> Rb85

0 science goal requires Kr contamination
~ 50 ppt

yogenic distillation from Taiyo Nissan Sanso to
e Kr from Xe (originally developed for XMASS):

Gas Xe < 10 ppb Kr
fied by delayed coincidences (**7+-2 ppb**)

on site
lue: Reduction by **10^3** in Single Pass at **0.6 kg/hr**

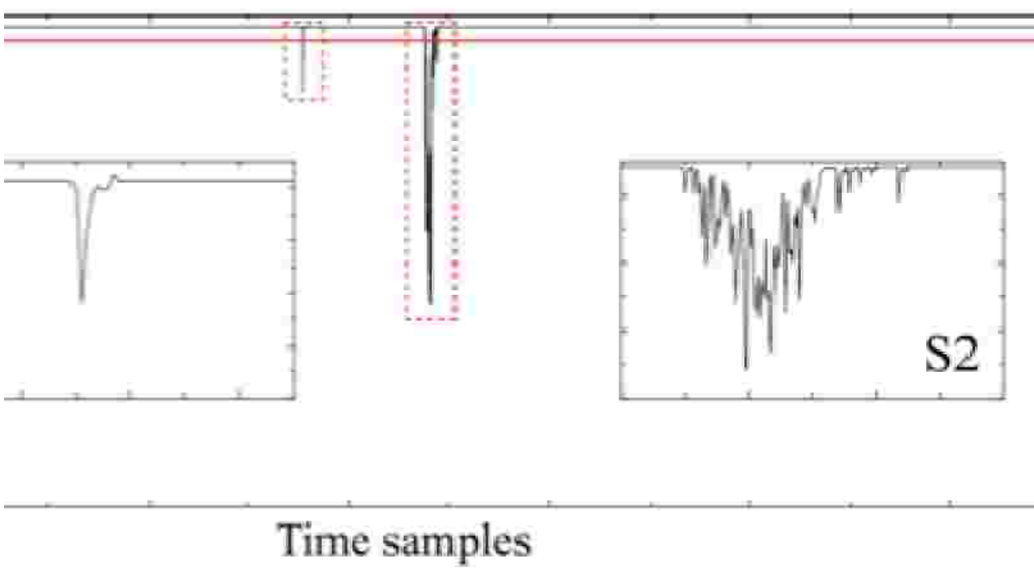
arameters have been fine tuned in first
commissioning run Sep 08.

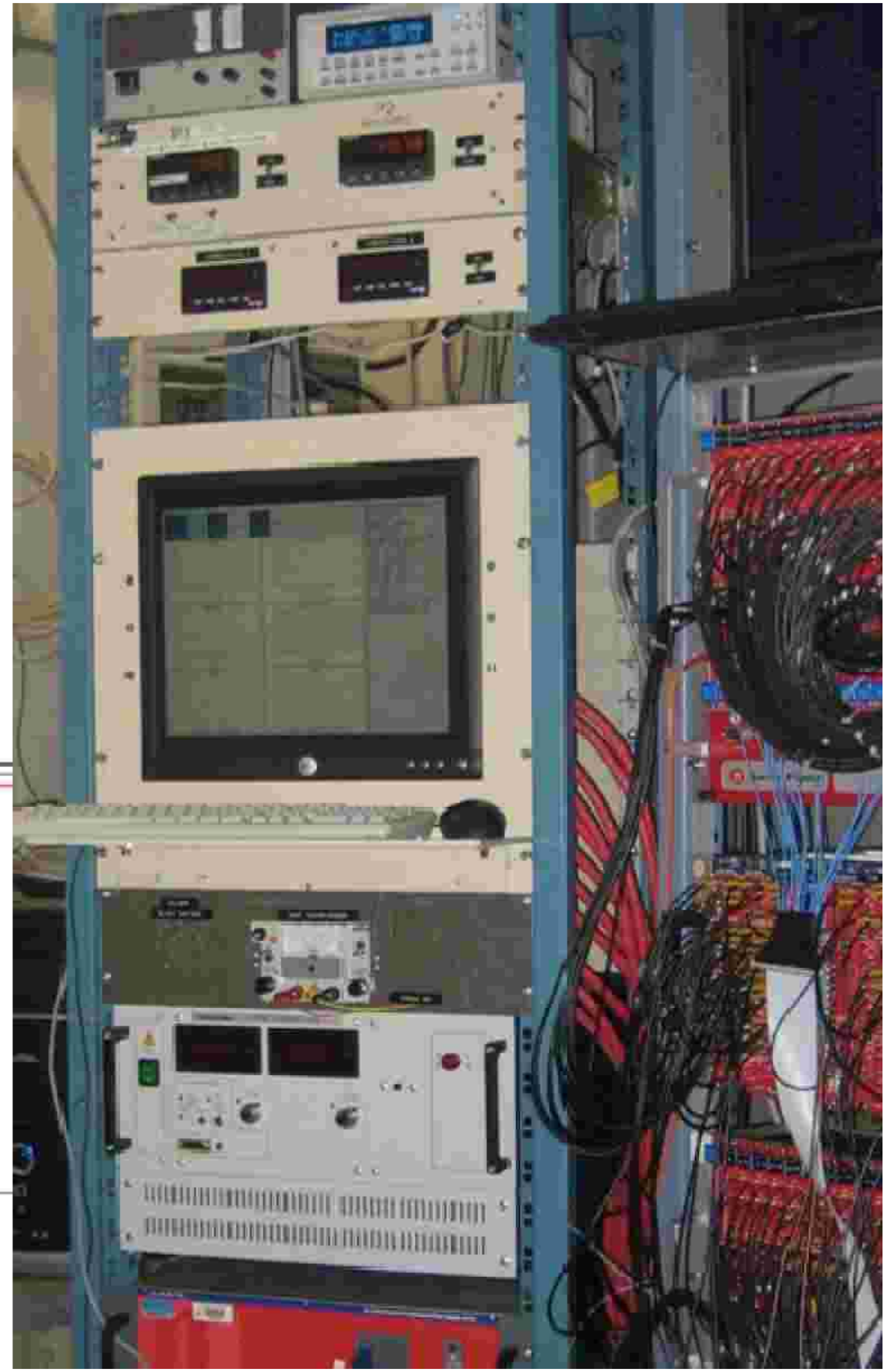
nents:

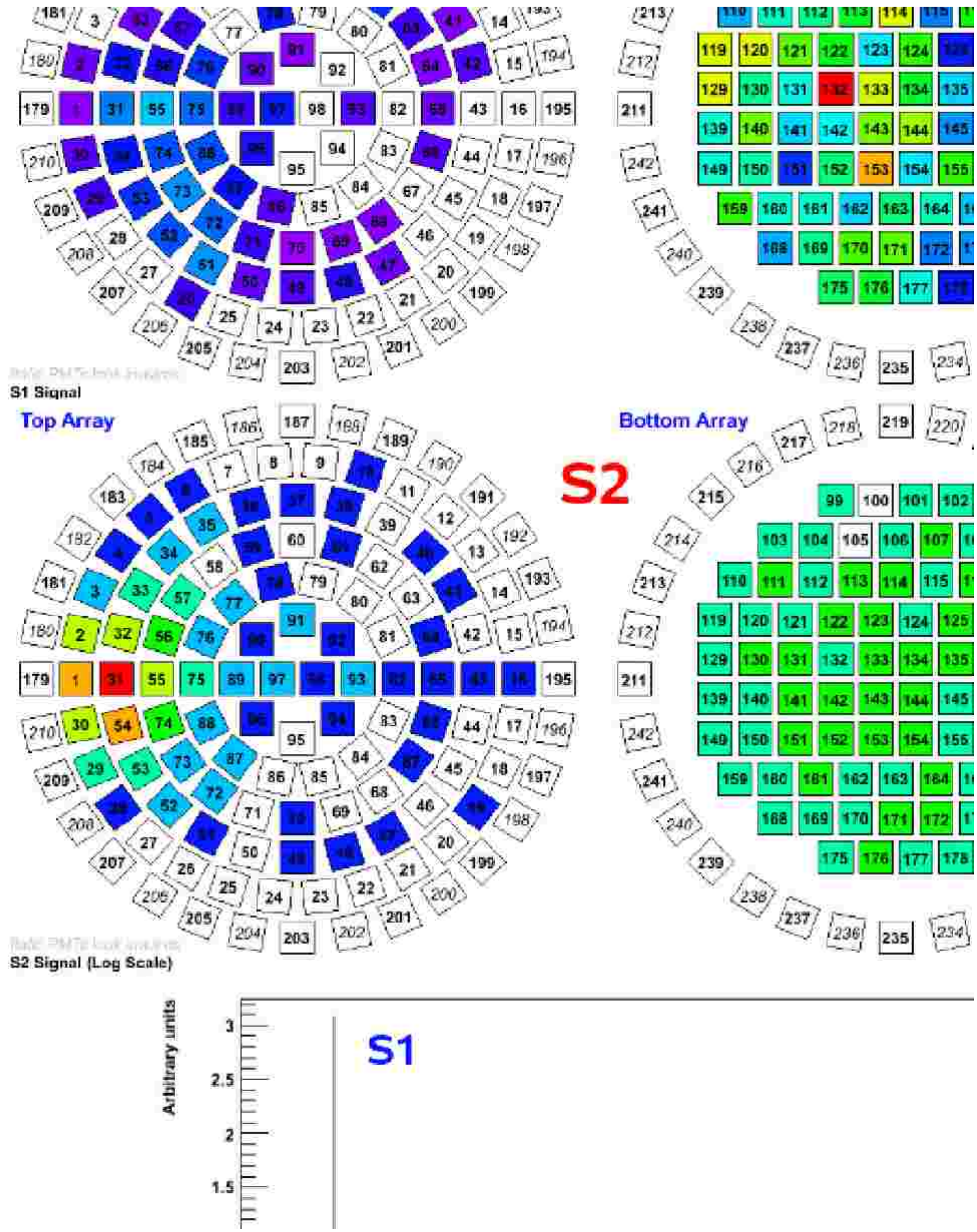
waveform (320μs) of 242 PMTs
adtime and with
apability for calibration

l724 Flash ADC: 14bit, 100MHz

ffer: no deadtime
FPGA: *Zero Length Encoding*
nt signal portion transferred from ADC
nputer to allow faster event transfer rates
alibration mode







S1 Signal
Top Array
Bottom Array
S2
S2 Signal (Log Scale)
Arbitrary units
S1

Xenon100 is part of a phased project for Dark Matter Search
Xenon3 – Xenon10 – Xenon100 – Xenon100+ – Xenon1T

Xenon100 is a Dual Phase TPC with 170 kg total (30 – 50 kg fid
In a Lead-Poly-Copper Shield

Active target surrounded by active LXe shield

Science goal is to lower detection limits by nearly 2 orders of magnitude (higher mass + lower background)

Detector filled. Presently cleaning up.

First Physics-Run expected to start end of summer 2009