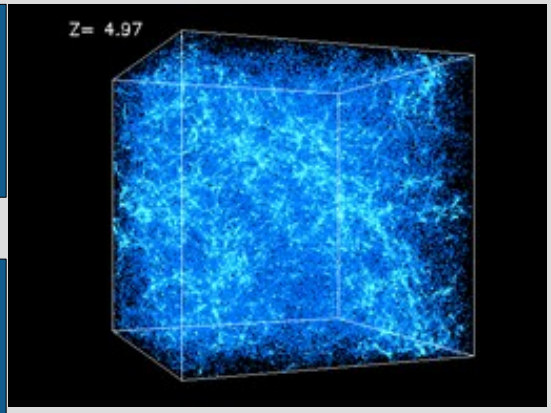
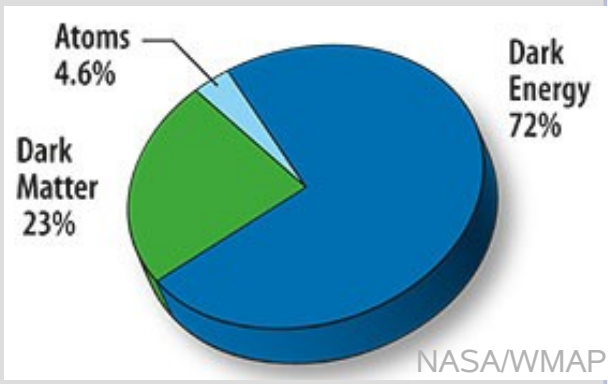
Status of XENON100

Marc Schumann *Rice University, Houston*
for the XENON100 collaboration

4th Patras Workshop on Axions, WIMPs and WISPs, Hamburg 2008

Direct WIMP Detection





COUPP
PICASSO

Phonons

CDMS
EDELWEISS

CRESST
ROSEBUD

Charge

Light

DRIFT
GERDA

XENON
LUX, ZEPLIN
WARP, ArDM

DEAP/CLEAN
DAMA, KIMS
XMASS

Reminder: XENON10 Results

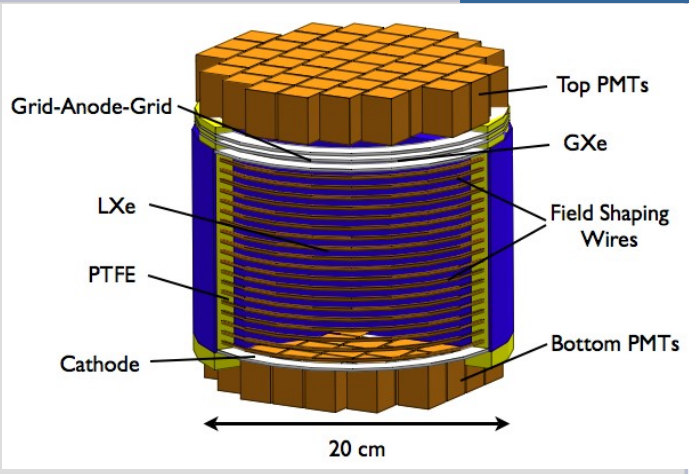
- successful operation at LNGS 2006/2007
- 15 kg dual phase detector,
  5.4kg in fiducial volume
- **Results:**

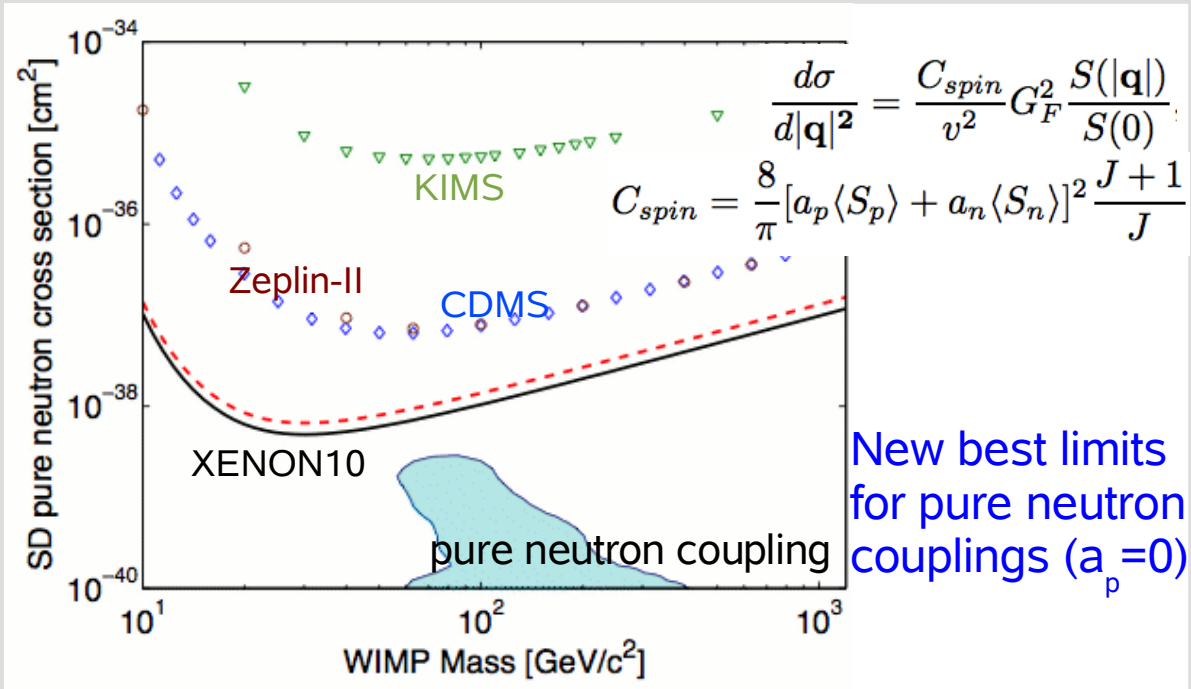
  Spin Independent:

  PRL 100, 021303 (2008)

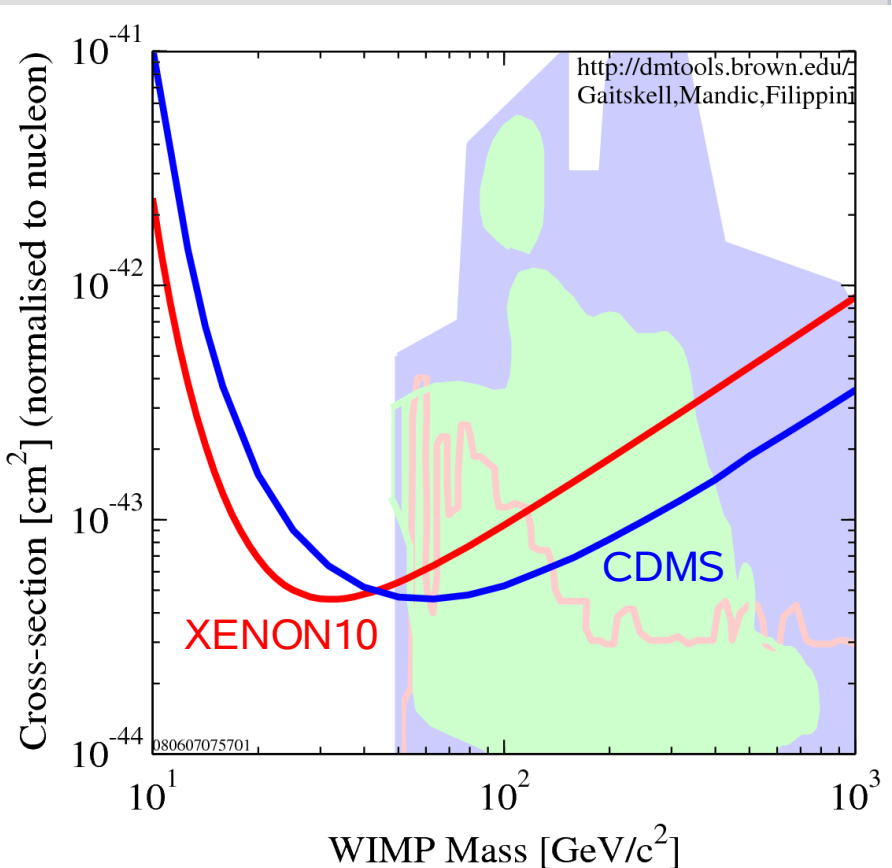
  Spin Dependent:

  arXiv:0805.2939 (submitted to PRL)





New best limits for pure neutron couplings (a_p=0)



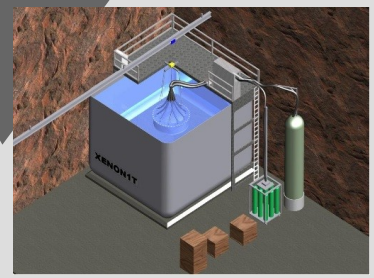
The XENON program

XENON: A phased WIMP search program

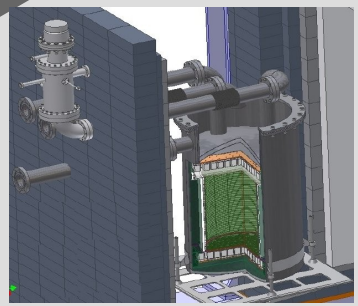
Current Members:
Columbia University
Rice University
University of Zürich
University of Coimbra
LNGS
UC Los Angeles
spokesperson: E. Aprile

?????

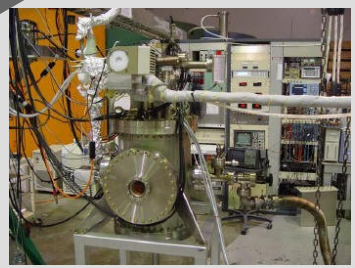
2009-2012: XENON1T



2007-2008: XENON100



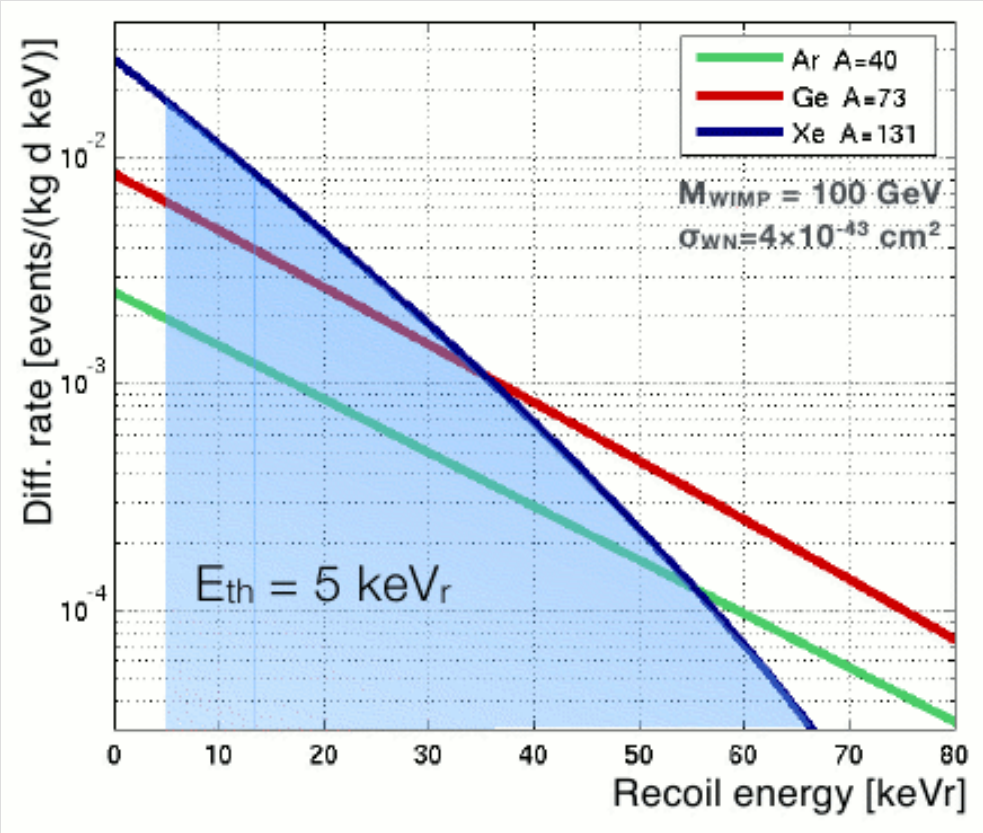
2005-2007: XENON10



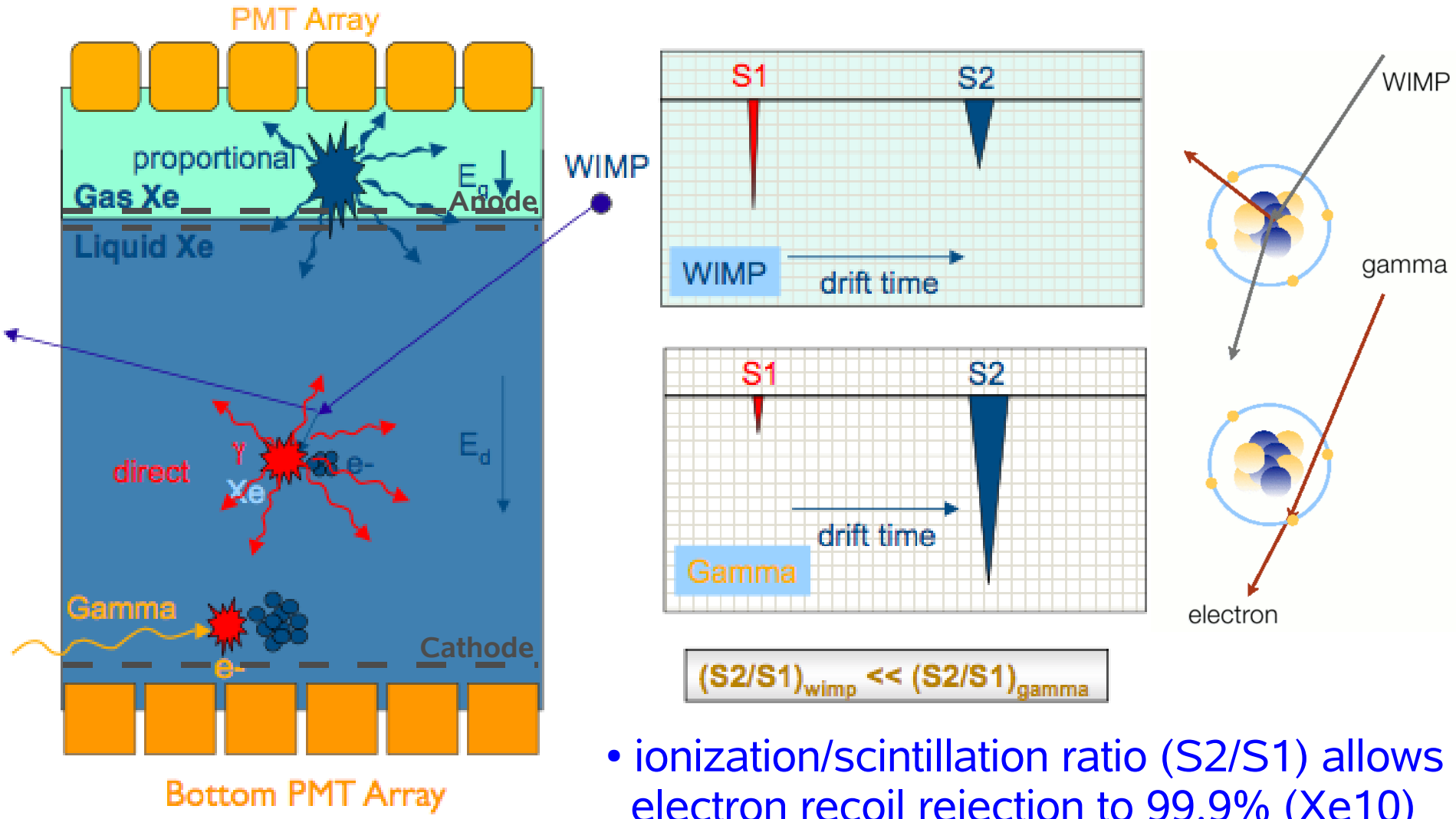
XENON R&D

Why Xenon?

- high mass number A~131:
  SI: expect high WIMP rate @ low theshold
- high atomic number Z=54,
  high density (~3kg/l):
  self shielding, compact detector
- SD: 50% odd isotopes
  allows further characterization after detection by testing only SI or SD
- efficient, fast scintillator (178nm)
- no long lived Xe isotopes,
  Kr-85 can be removed to ppt
- "easy" cryogenics @ -100°C
- scalability to larger detectors:
  Xe3 → Xe10 → Xe100 → Xe1T
- in 2-phase TPC: good background discrimination



How does it work?



- ionization/scintillation ratio (S2/S1) allows electron recoil rejection to 99.9% (Xe10)
- 3d position reconstruction in TPC

XENON100

Goal:

reduce gamma background 100 x
→ material selection & screening
→ detector design

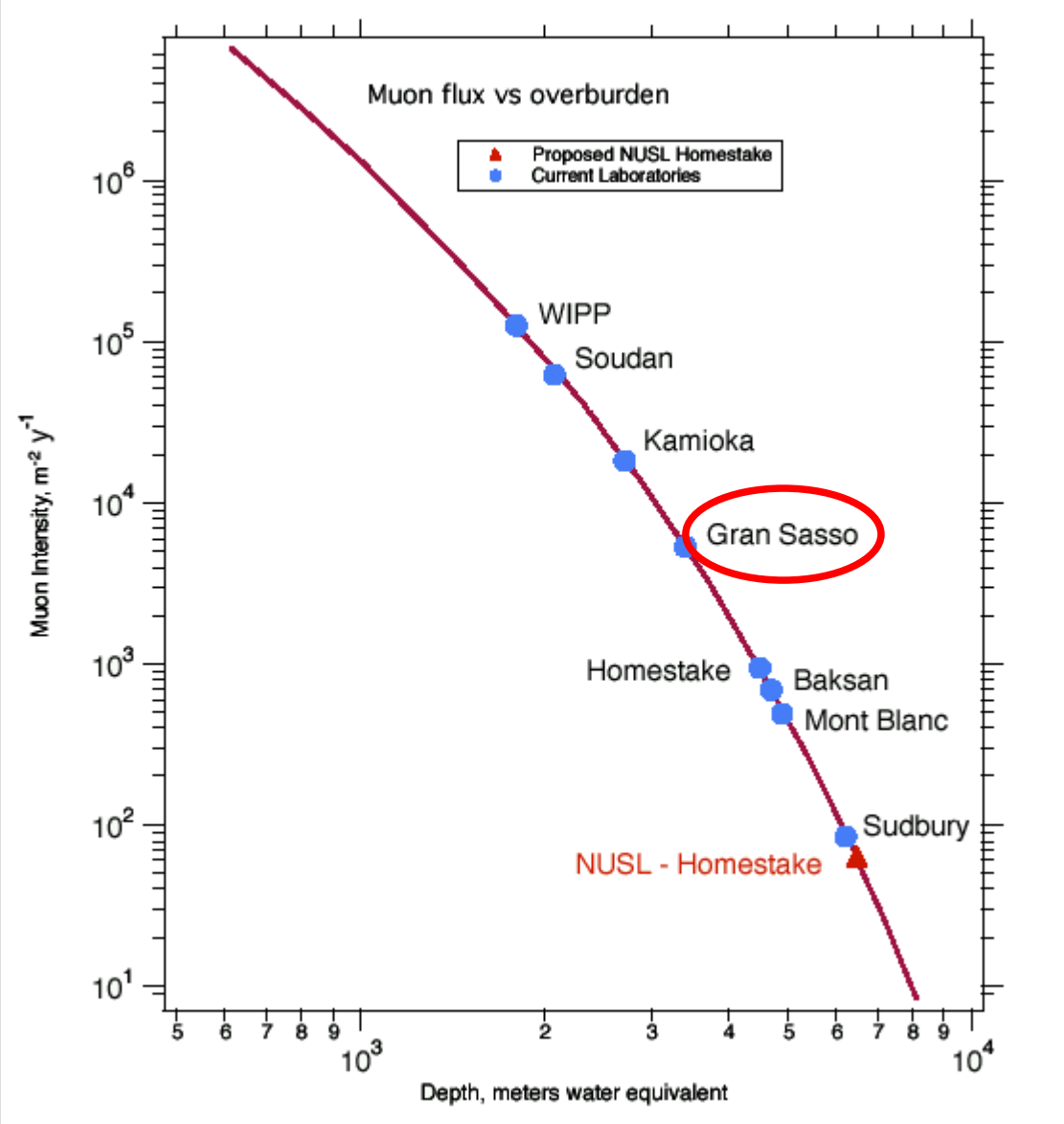
Quick Facts:

- 170 kg LXe TPC (mass: 10 x Xe10)
- ~50 kg in fiducial volume
- active LXe veto
- 242 PMTs
- new cryostat design:
  PTR, feedthroughs outside shield
- improved Xe10 shield (Pb, Poly, Cu)
- 6 institutions, ~30 people

Backgrounds

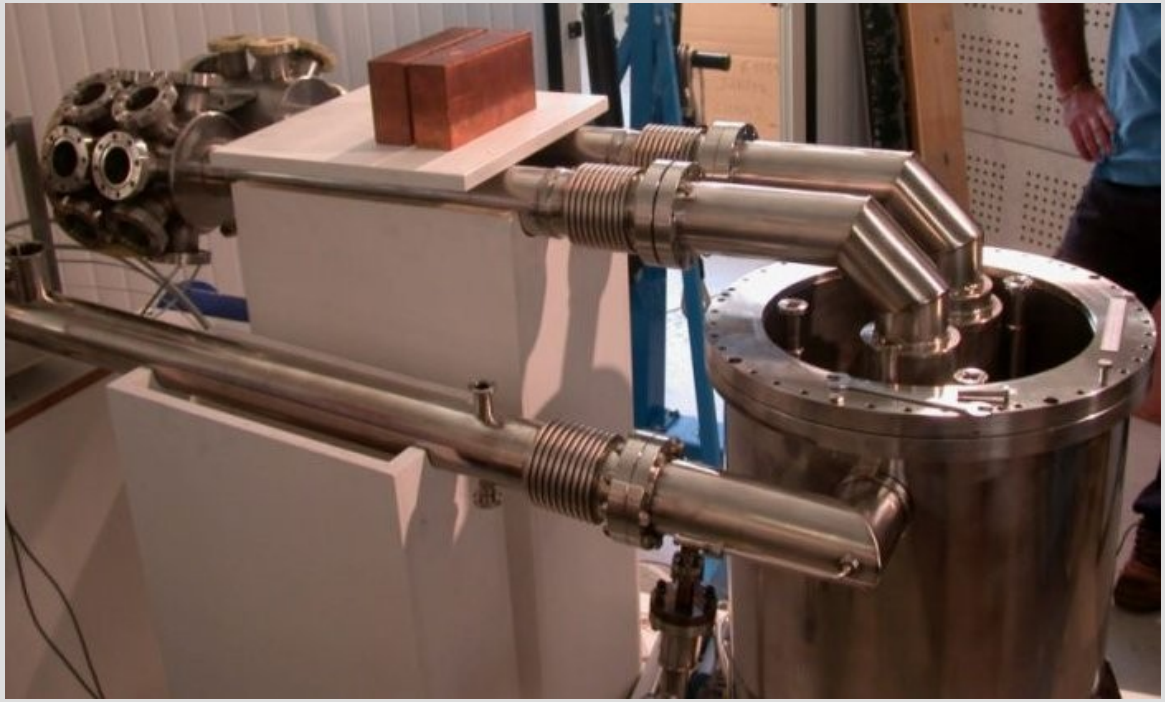
Background reduction and background estimates are very important for any Dark Matter Experiment

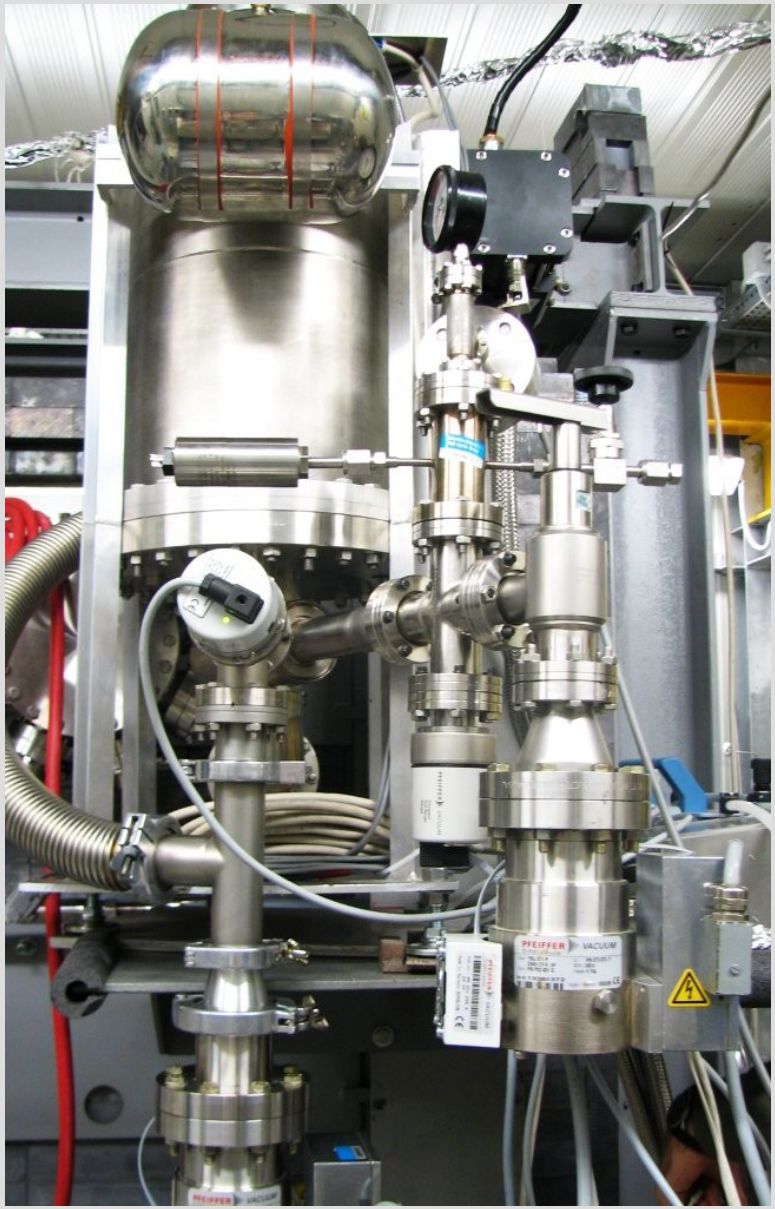
⇒ see next talk (E. Tziaferi)



Cryostat, Cooling, Purification

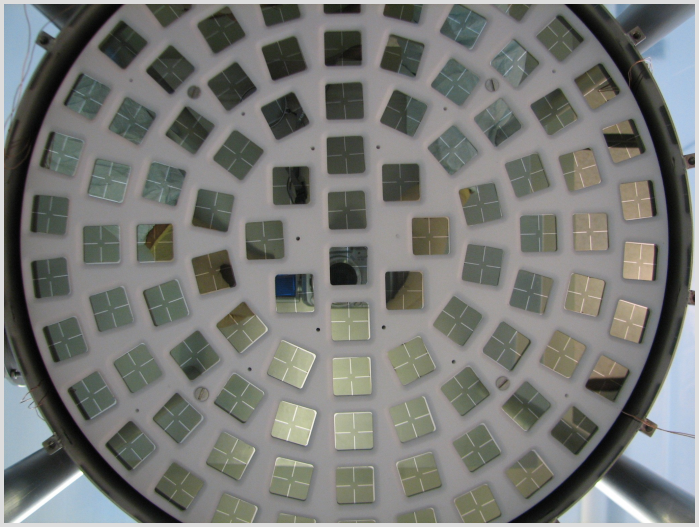
- double wall SS cryostat
  (low radioactivity steel, GERDA type)
- 170 W PTR cryocooler
  gas gets liquified outside the shield
- continuous Xe purification (Getter)
- dedicated Kr-85 removal (July08)

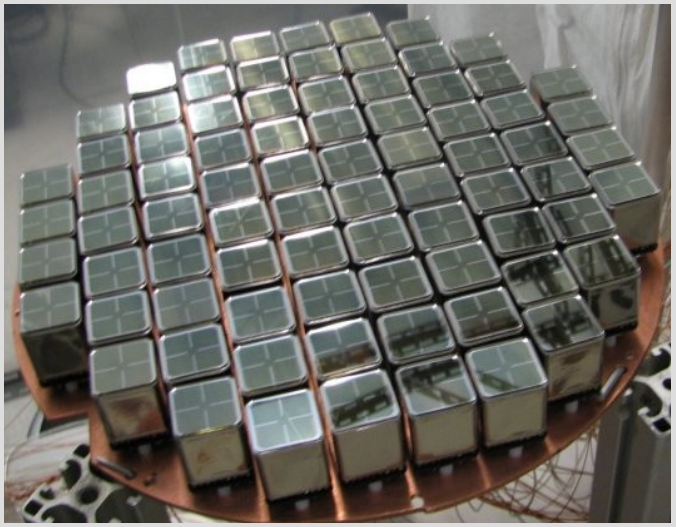




PMTs & Calibration

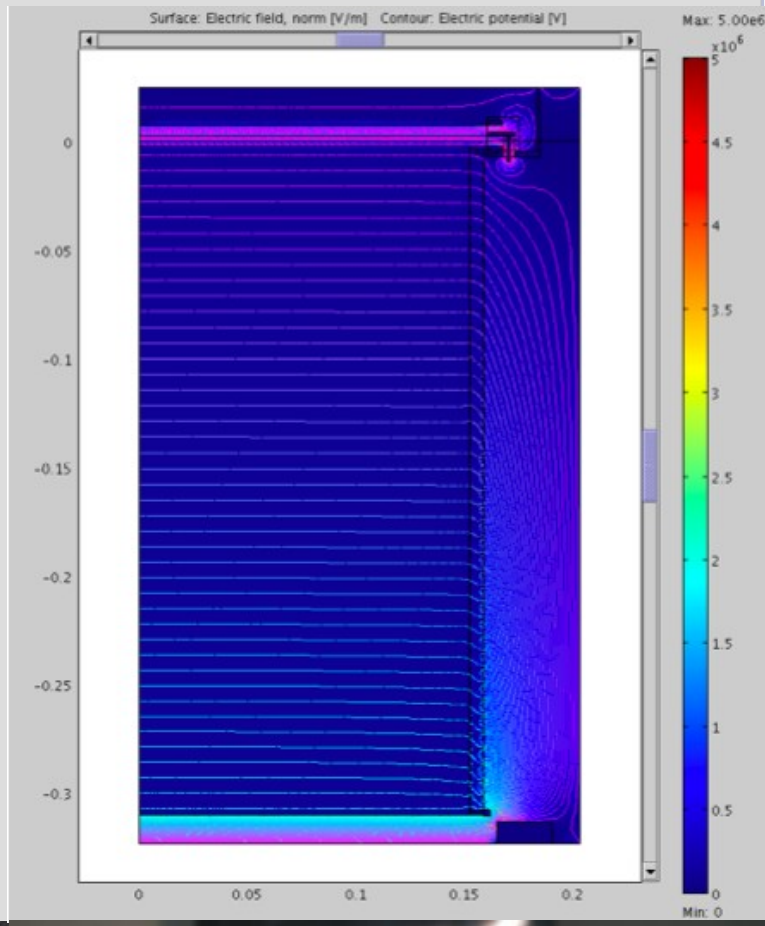
- Hamamatsu R8520 PMTs:
  1"x1", low radioactivity, 80 with high QE ~33%
- 98 in top array: arranged for good fiducial cut efficiency
- 80 in bottom array: optimized for S1 collection → low threshold
- 64 in active veto: gain factor 3-4 compared to passive veto
- gain calibration with LEDs, measure SPE response

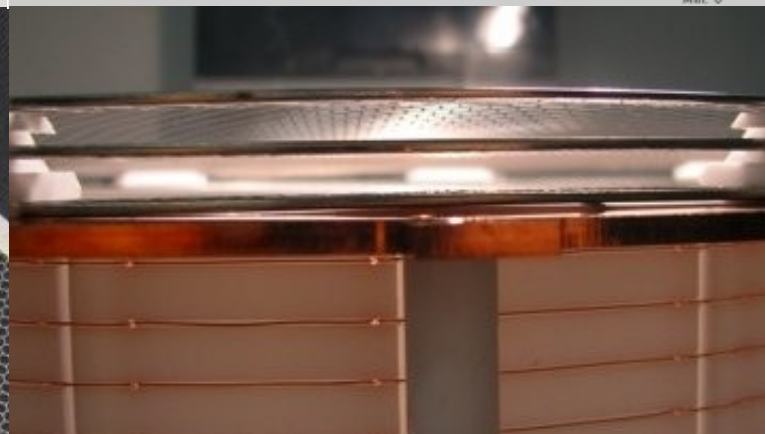




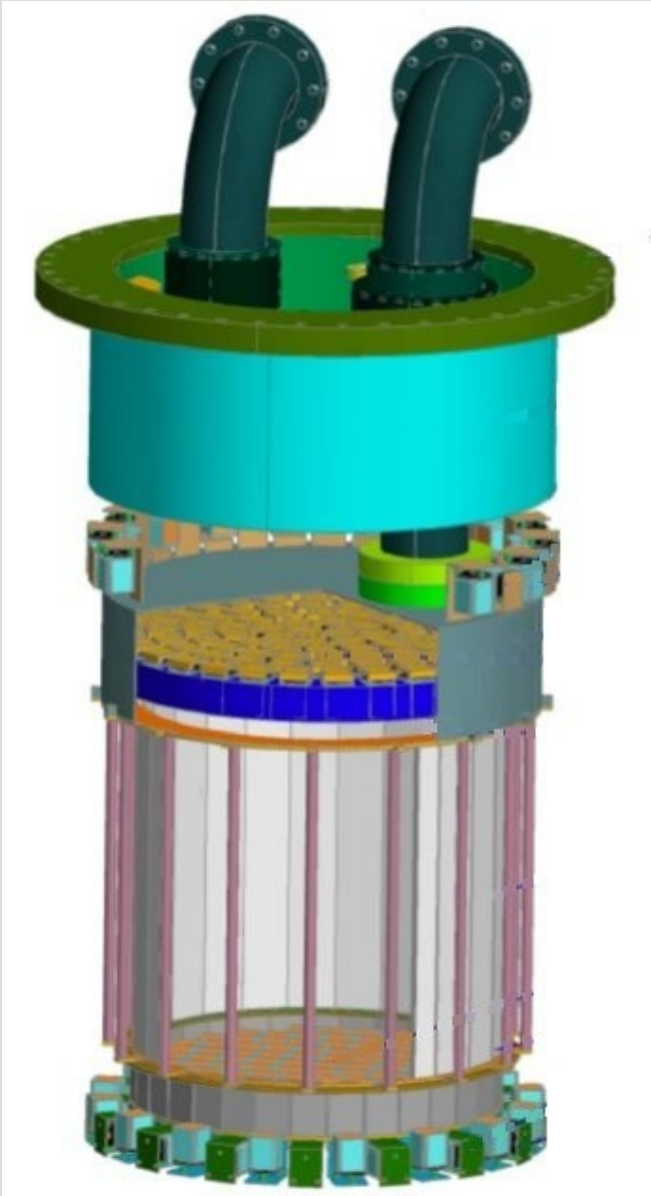
Electric Field & Grids

- cathode: -30kV → drift field 1kV/cm
- anode: extraction field ~5kV
- field inside TPC was optimized in simulations for field homogeneity
  → 40 double field shaping rings
- anode stack optimized for
  - optical transparancy
  - S2 energy resolution (+4%)
- hexagonal mesh structures,
  pitch cathode 5mm, anode 2.5mm





XENON100 Detector



XENON100 @ LNGS

- installed underground since end of February
- filled with 140 kg xenon since mid May

LNGS: 1.4km rock (3100 mwe)

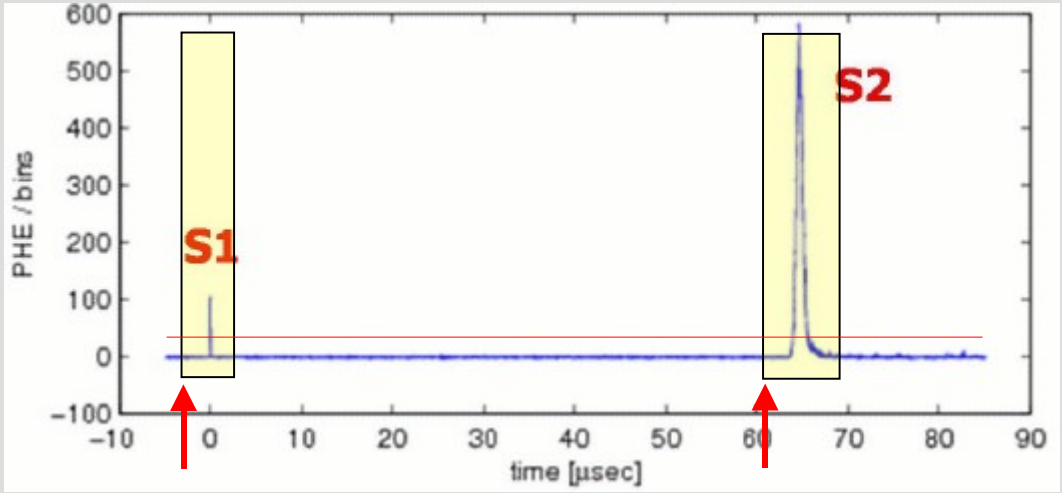
Data Acquisition

Requirements:

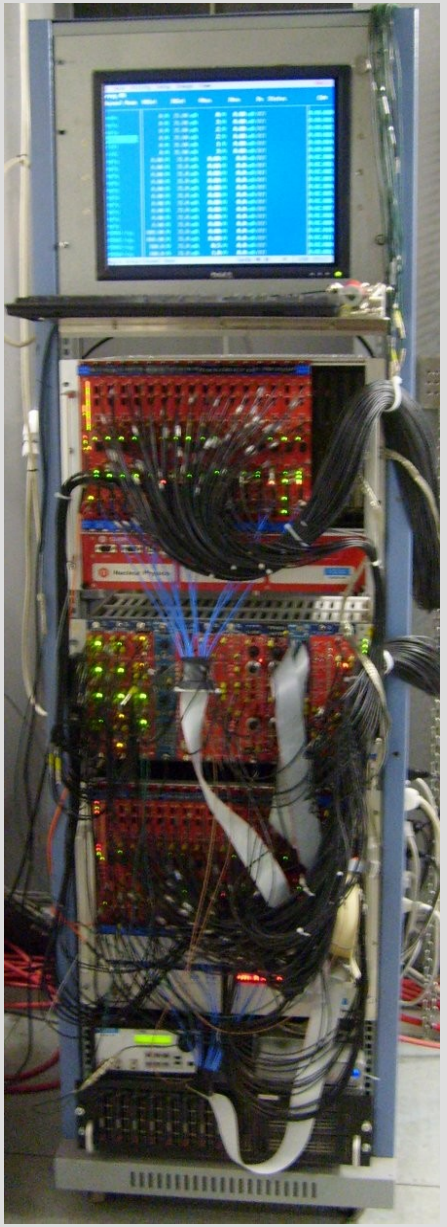
- digitize full waveform (320µs) of 242 PMTs
- no deadtime
- high rate capability for calibration

CAEN V1724 Flash ADC: 14bit, 100MHz

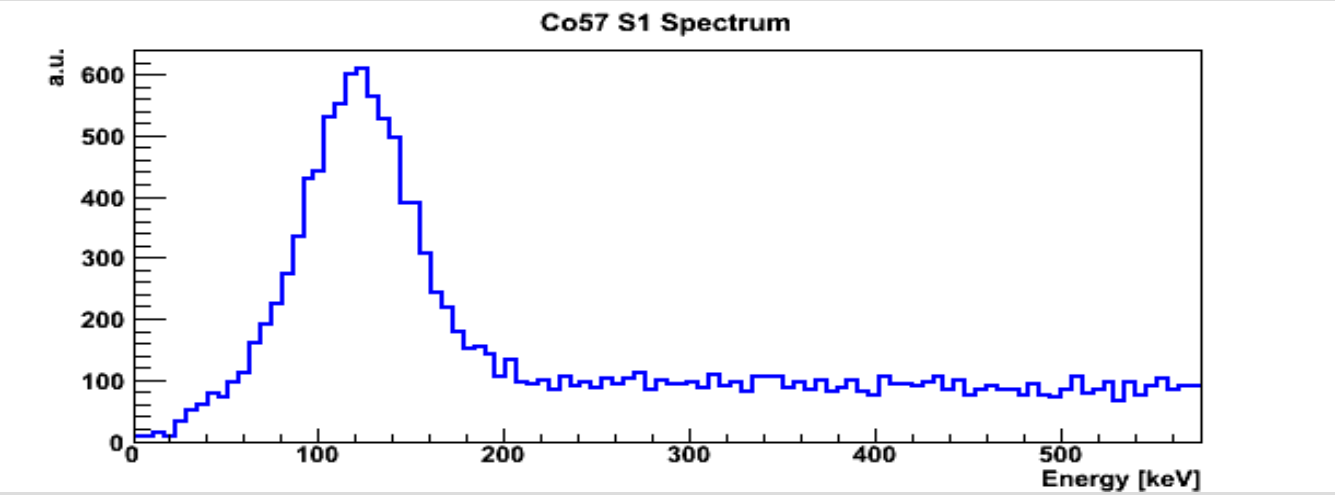
- circular buffer → no deadtime
- on board FPGA: *Zero Length Encoding*



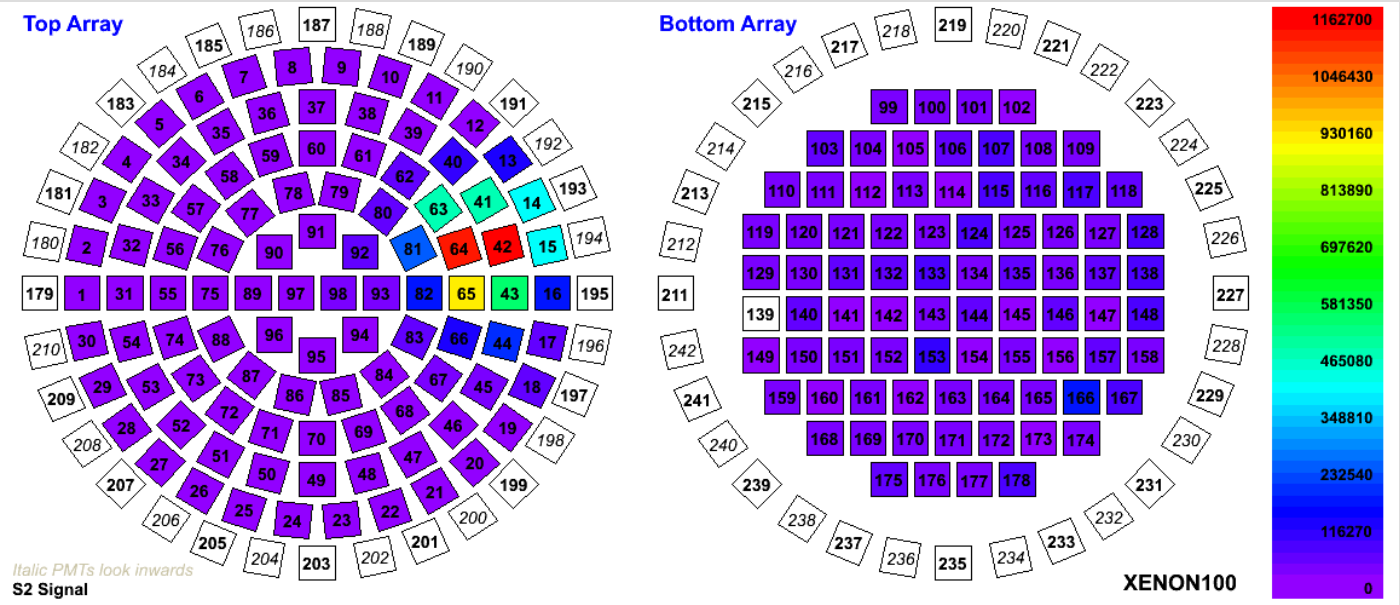
⇒ calibration rates >60 Hz possible

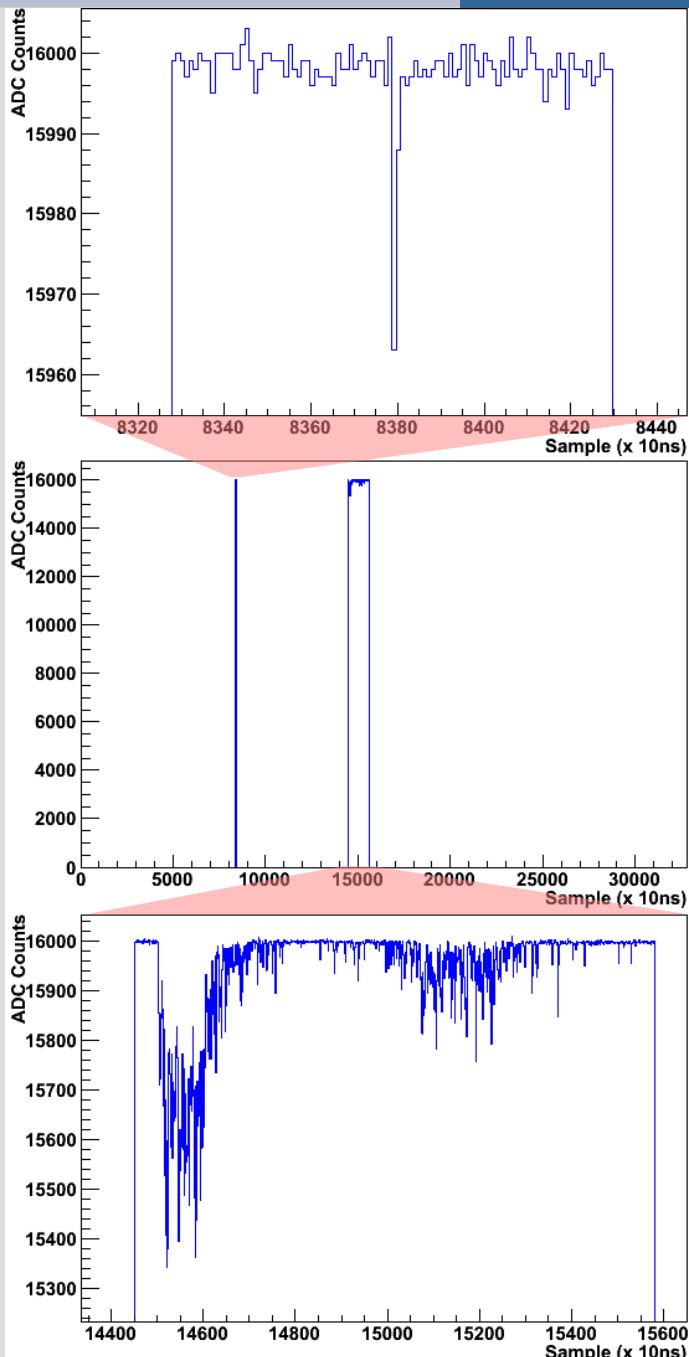


Measurements & Analysis



- Measurements to characterize detector performance are underway
- development of analysis tools



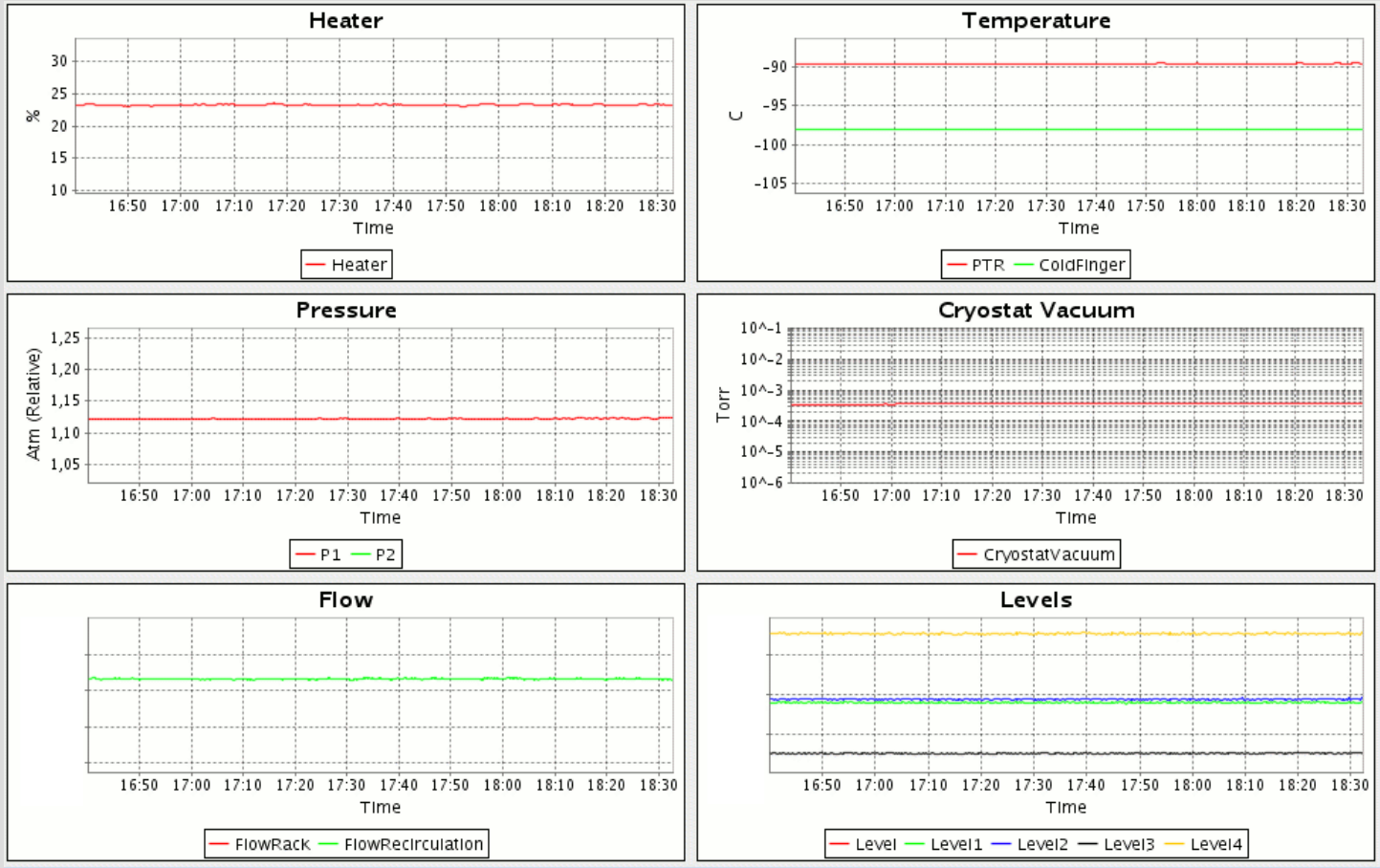


Experiment Monitor

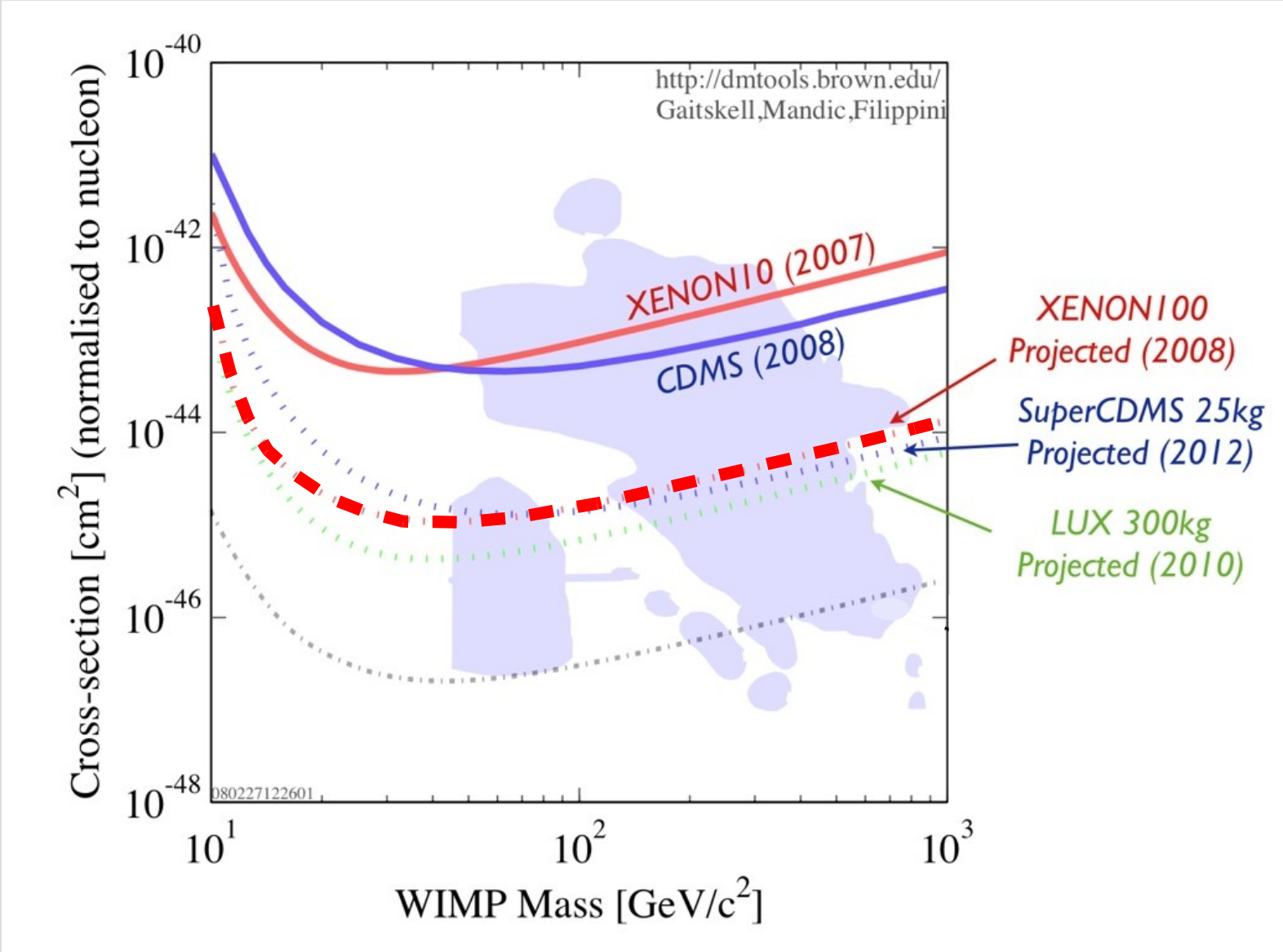
Dedicated Slow Control system monitors:

- Temperatures
- Pressures
- Flow Rates
- Recirculation
- LXe Levels
- Vacuum
- Rn Activity
- High Voltage (anode, cathode, and PMTs)
- ...

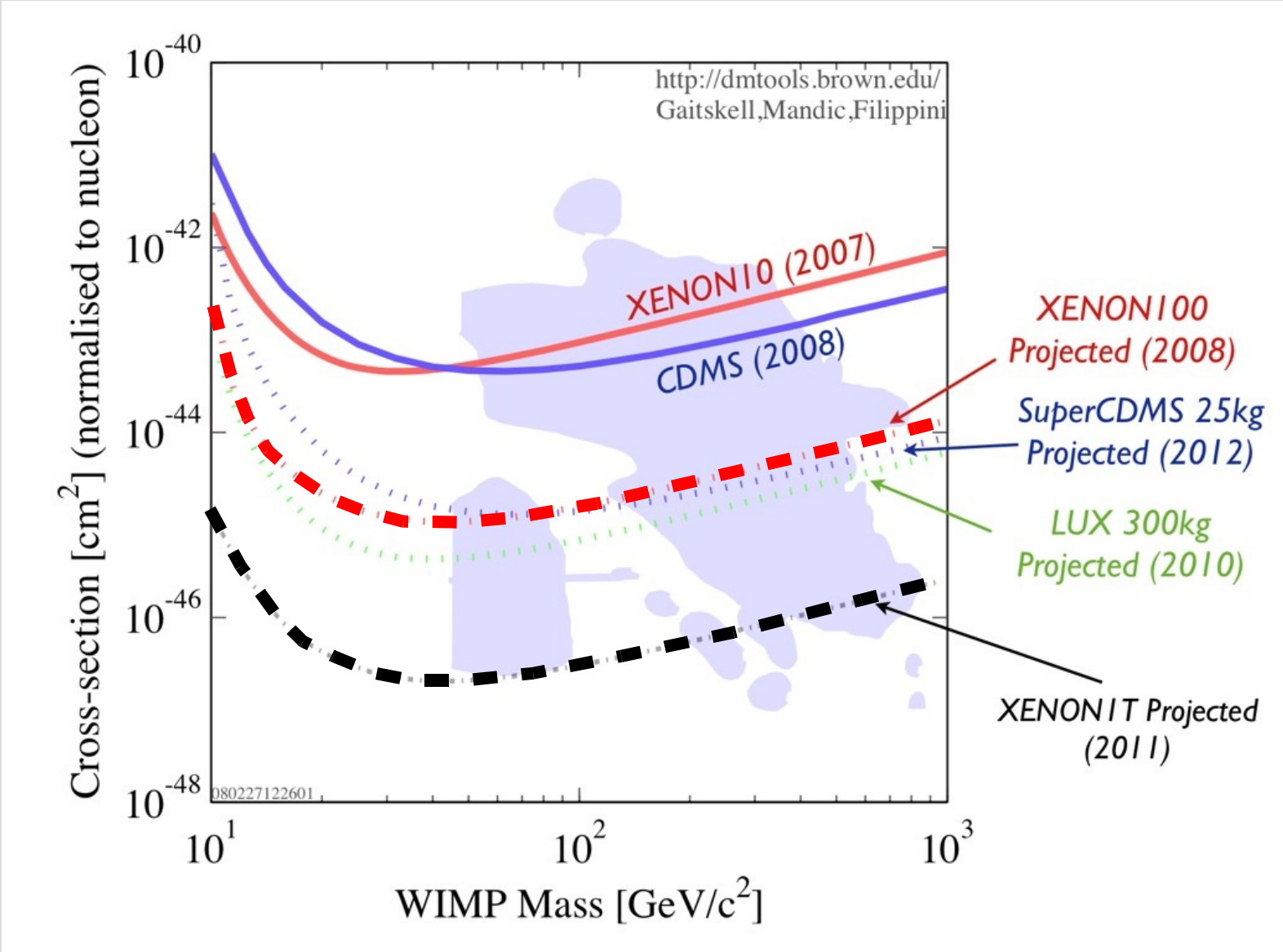
⇒ all important components of the experiment



XENON100: Sensitivity

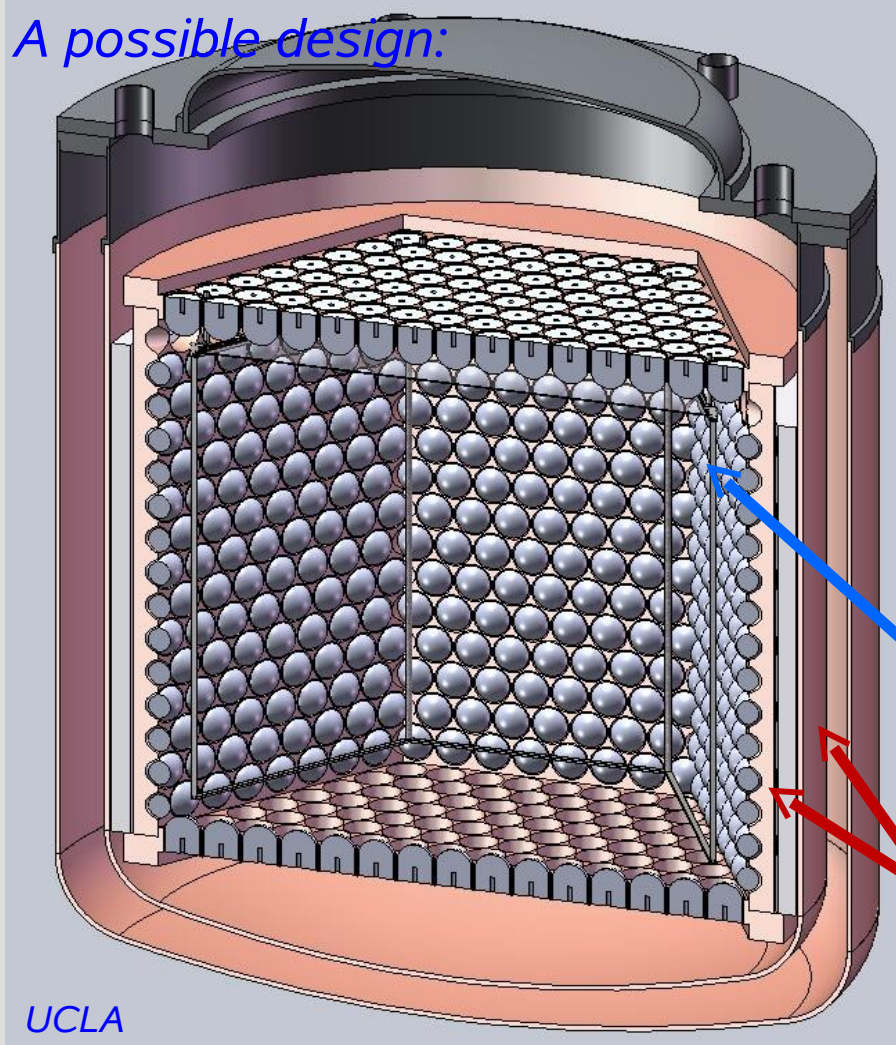


XENON100: Sensitivity



The next step: XENON1t

A possible design:



- 3t LXe ("1m³ detector")
  1t fiducial mass
- MC studies, design studies already started
- Proposal in fall 2008
- Timeline: 2009-2012

Summary

- XENON100: 170 kg dual-phase TPC
- XENON100 is underground @ LNGS
- first Dark Matter run expected fall 2008
- stay tuned...