Dark Matter Programs at UCLA

Katsushi Arisaka

University of California, Los Angeles
Department of Physics and Astronomy

arisaka@physics.ucla.edu

UCLA Dark Matter Programs

- **Direct Search**
  - *David Cline, Katsushi Arisaka, Hanguo Wang*

    Xe : ZEPLIN-II → XENON100 → XENON 1Ton

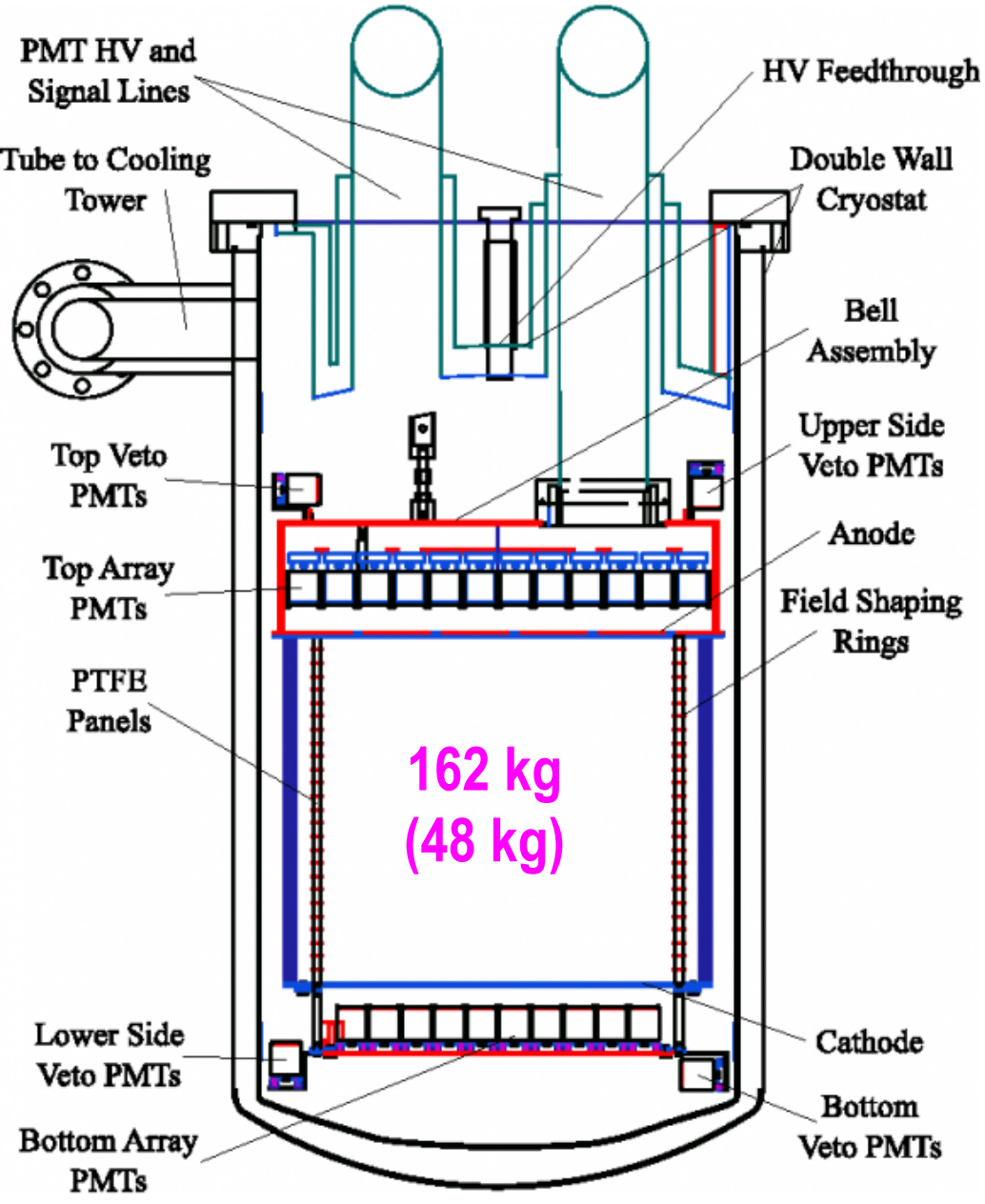
    Ar : DarkSide50 → DarkSide 5Ton

    G3 : MAX, XAX

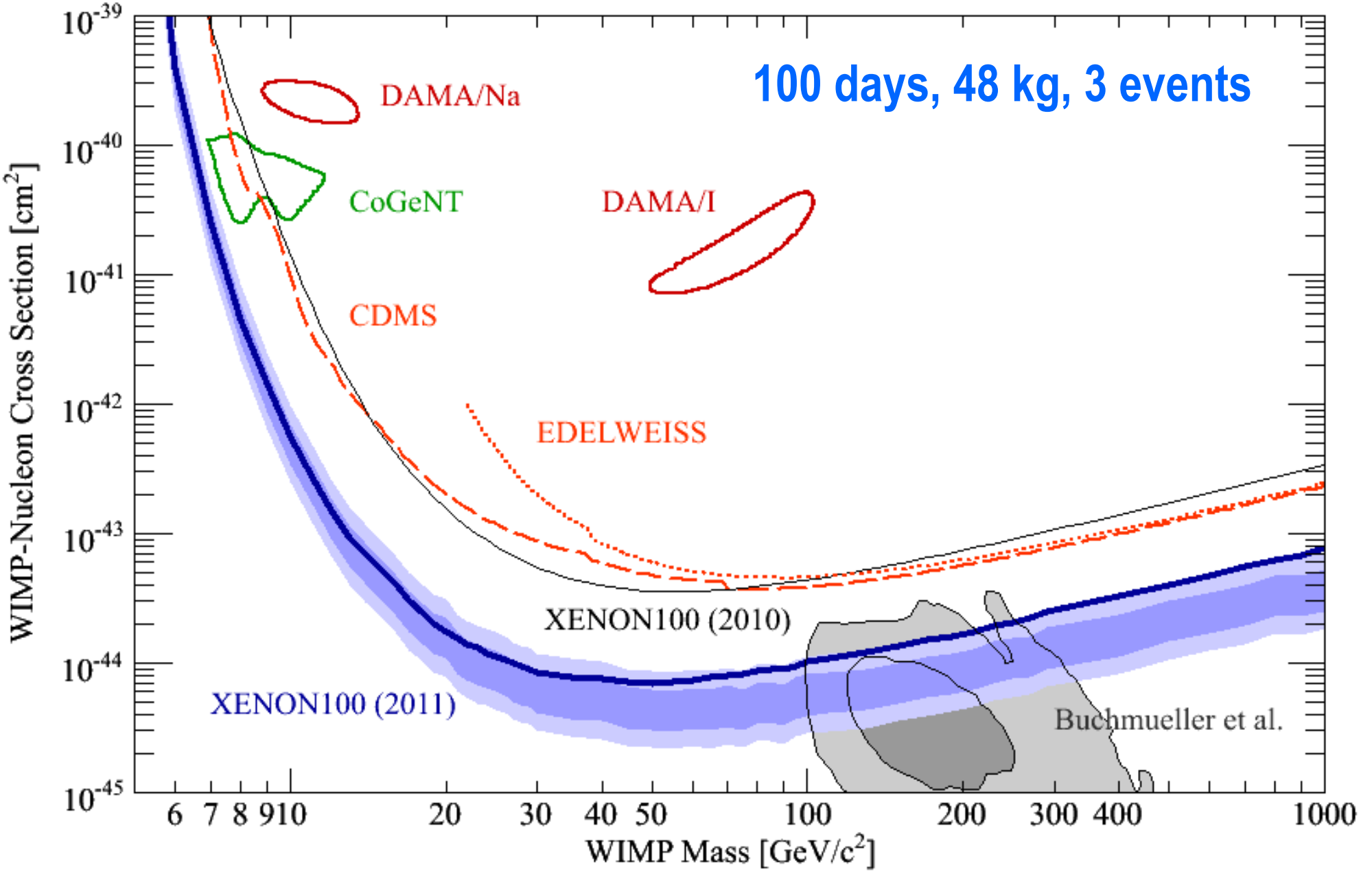
- **Indirect Search**
  - *Rene Ong* VERITAS → GAPS
  - *Vladimir Vassiliev* VERITAS → CTA
  - *David Saltzberg* ANITA

- **Theory**
  - *Graciela Gelmini* DAMA/CoGeNT
  - *Alex Kusenko* Sterile Neutrino

XENON100 Detector

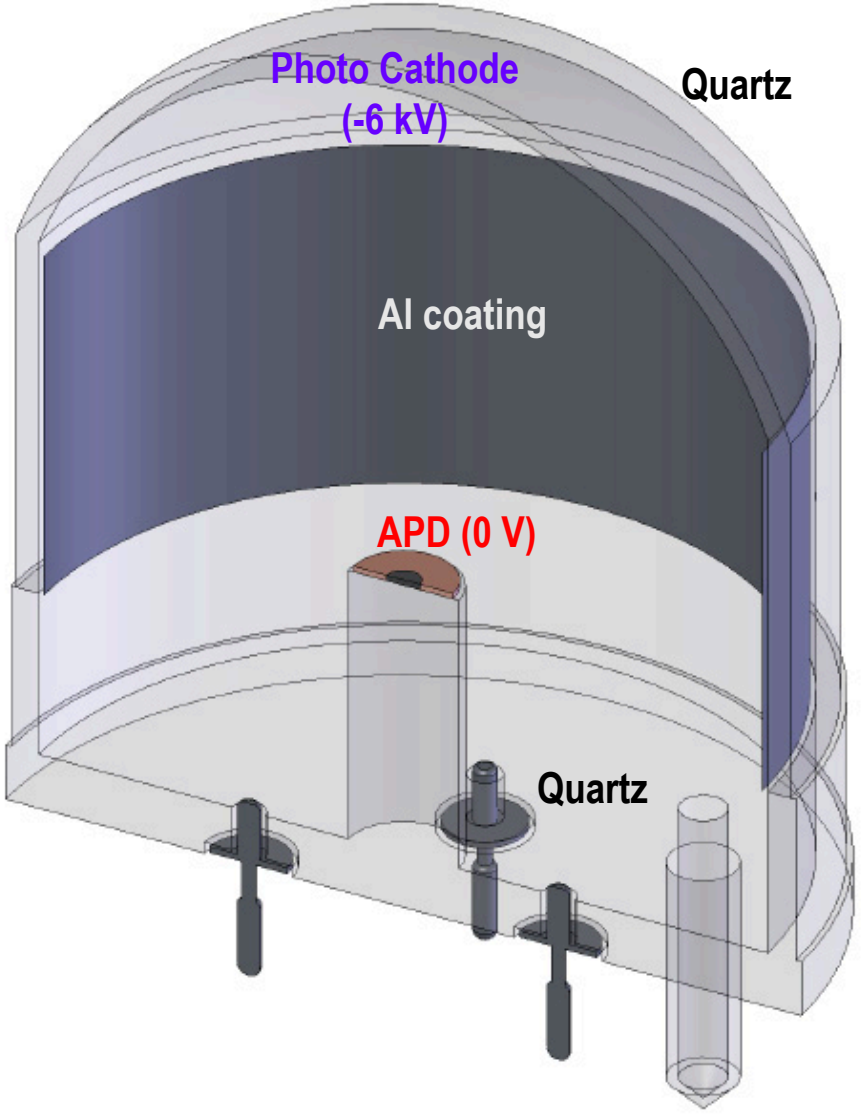


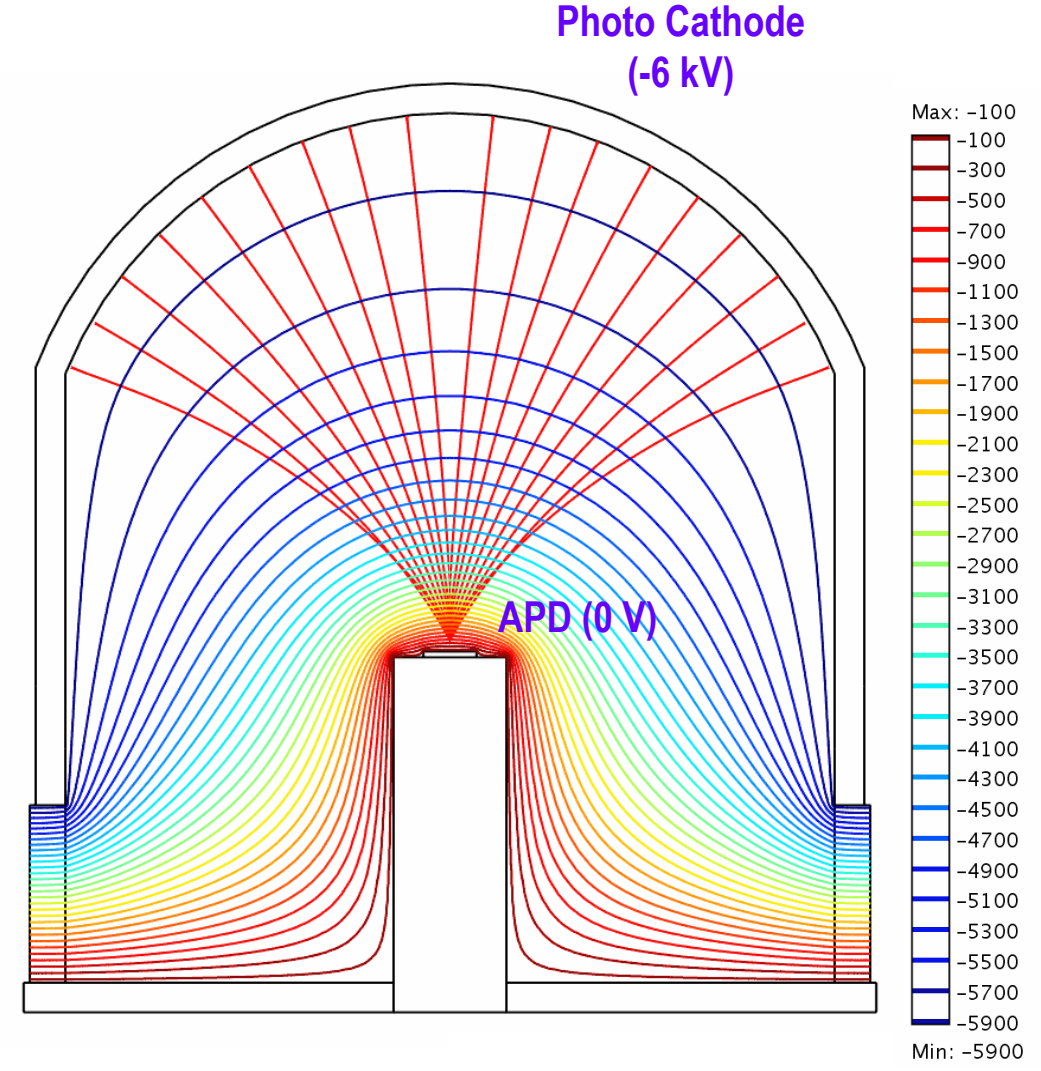
90% CL Limits of SI Cross Section

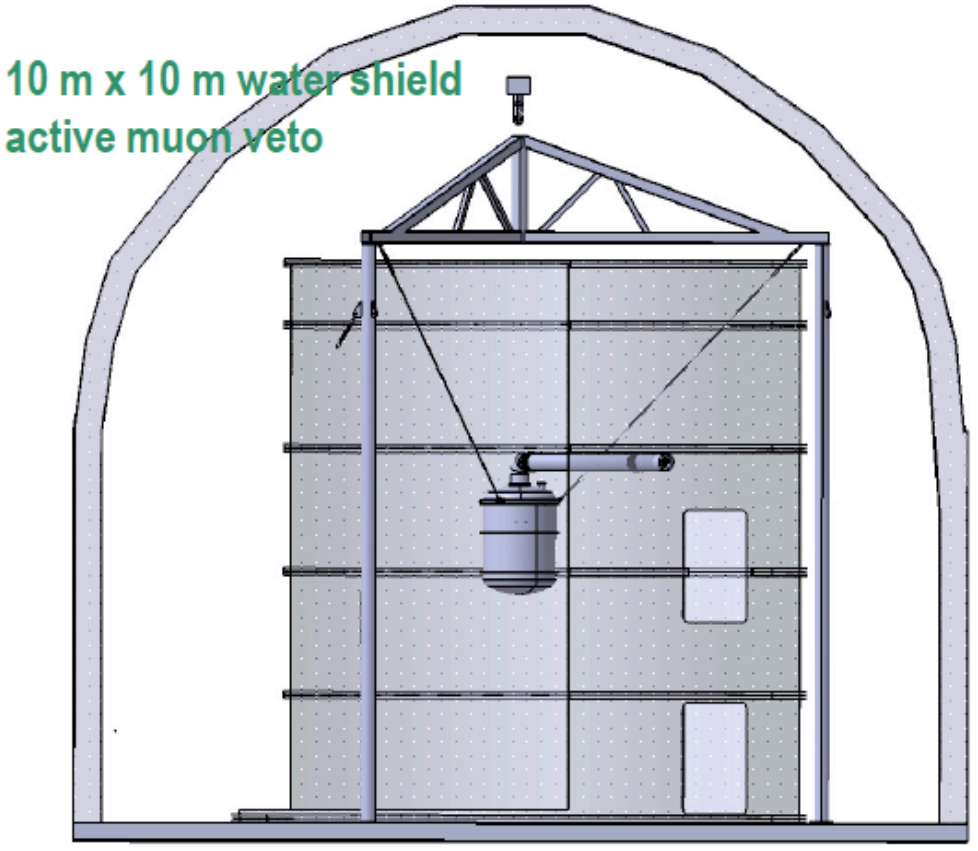


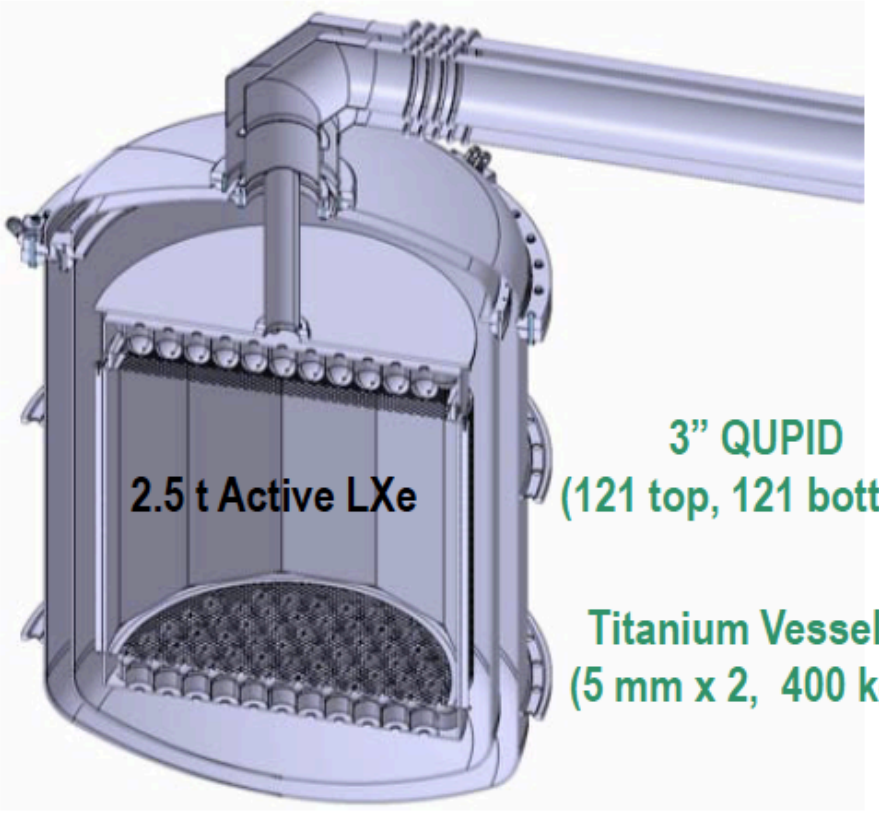
QUPID (QUartz Photon Intensifying Detector)

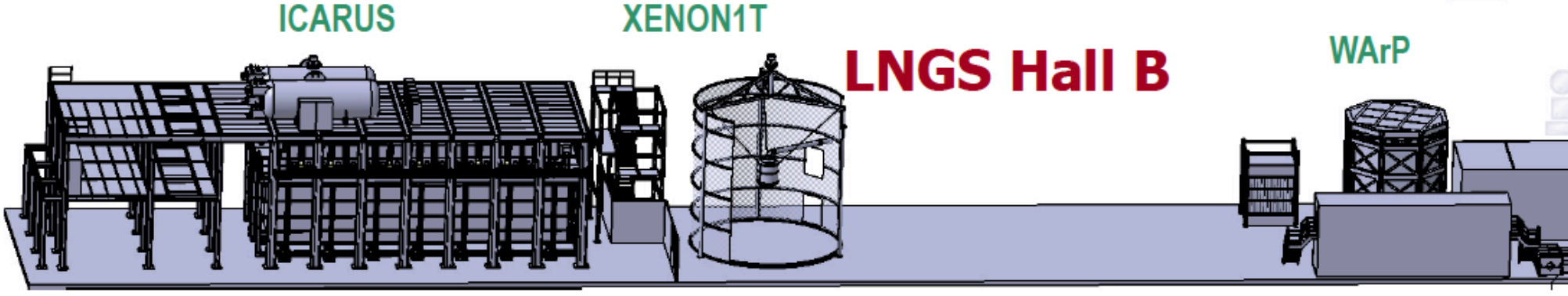
Katsushi Arisaka, Hanguo Wang





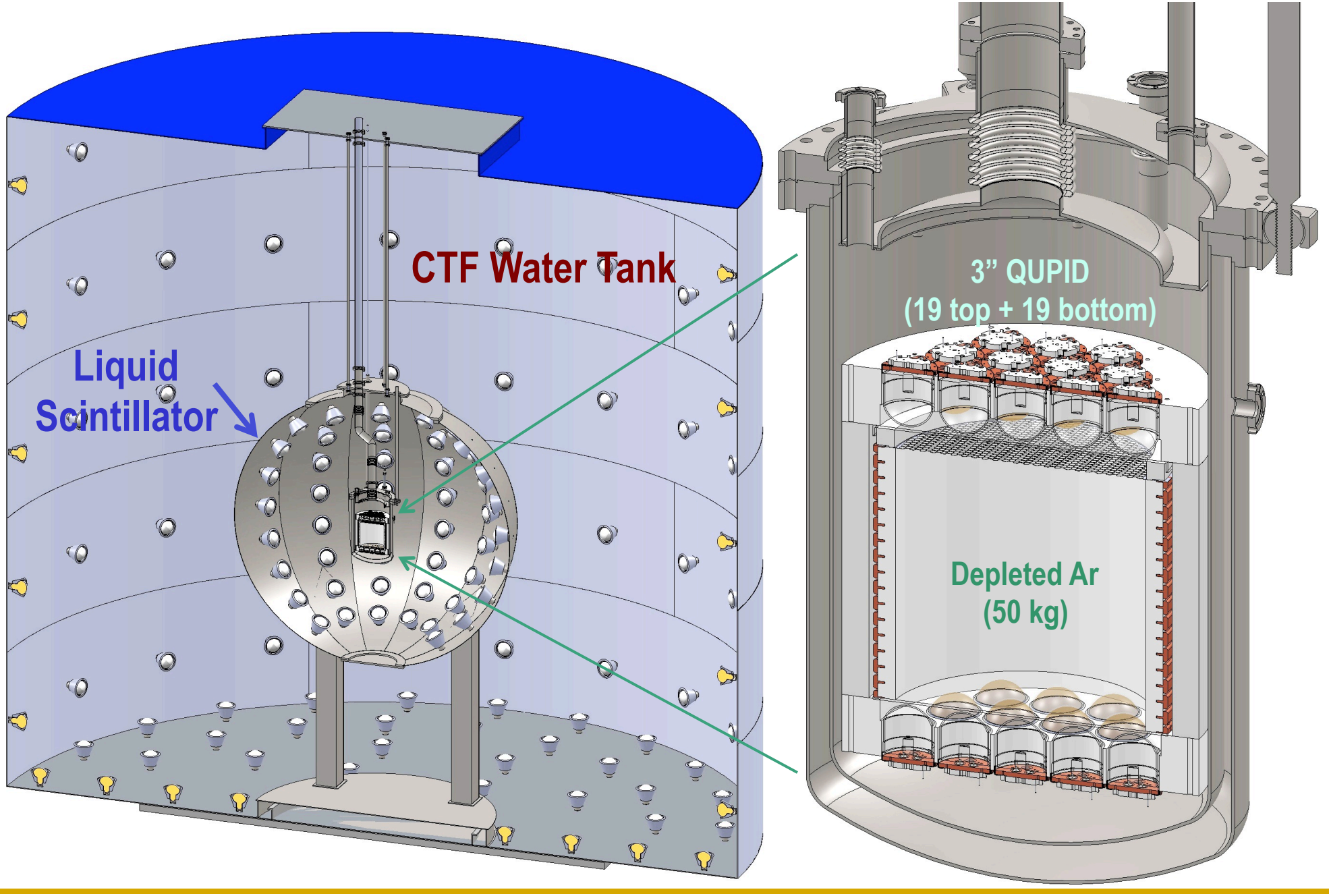

10 m x 10 m water shield
active muon veto


2.5 t Active LXe
3" QUPID
(121 top, 121 bottom)
Titanium Vessels
(5 mm x 2, 400 kg)

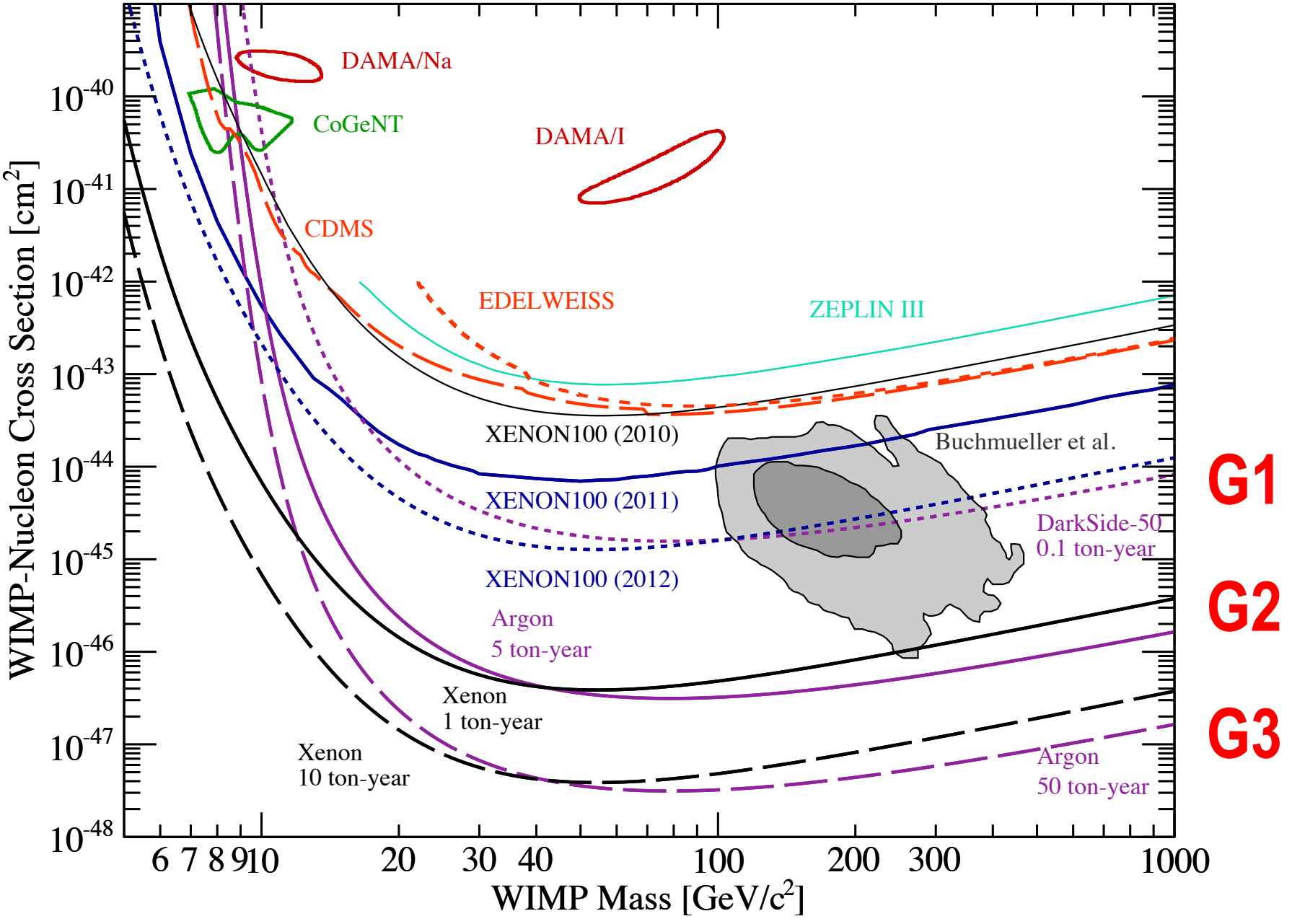

ICARUS
XENON1T
LNGS Hall B
WArP

DarkSide 50 kg → 5 Ton

Hanguo Wang

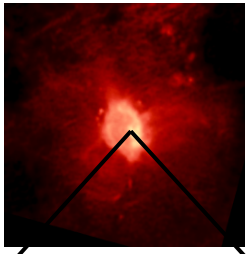


90% CL Limits of SI Cross Section

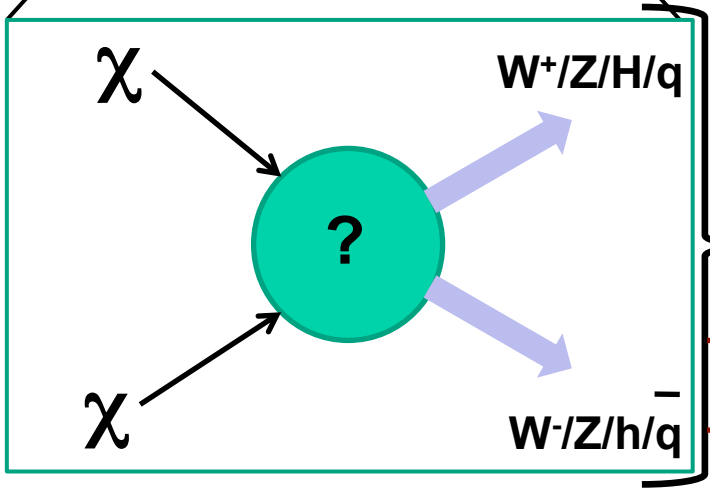


Indirect WIMP Detection

Rene Ong, Vladimir Vassiliev



WIMP
Annihilation
(e.g. GC)



Telescopes

- γ — VERITAS, HESS, Fermi …
- ν — IceCube

Cosmic Ray Expts

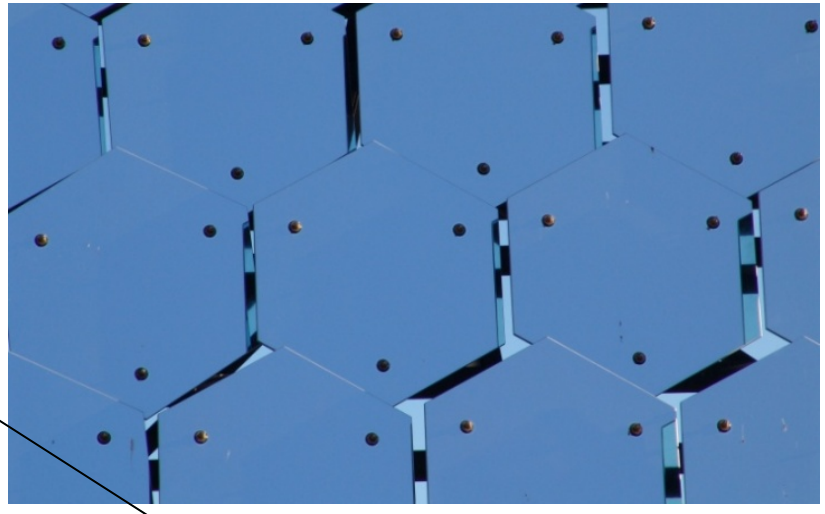
- e^- — ATIC, Fermi …
- e^+ — Pamela, AMS
- $\bar{p}$ — HEAT, Pamela, AMS
- $\bar{d}$ — GAPS

decreasing background

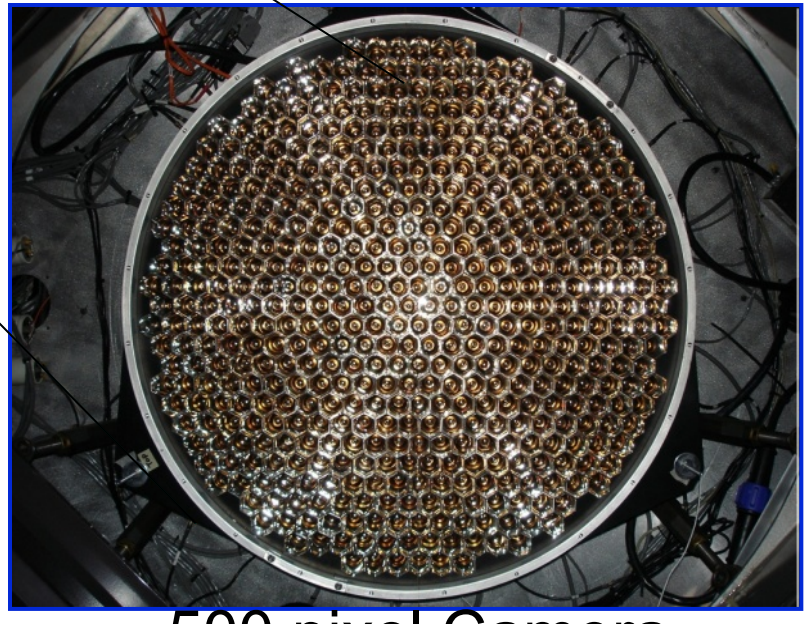
VERITAS

Rene Ong, Vladimir Vassiliev

12m reflector, f1.0 optics



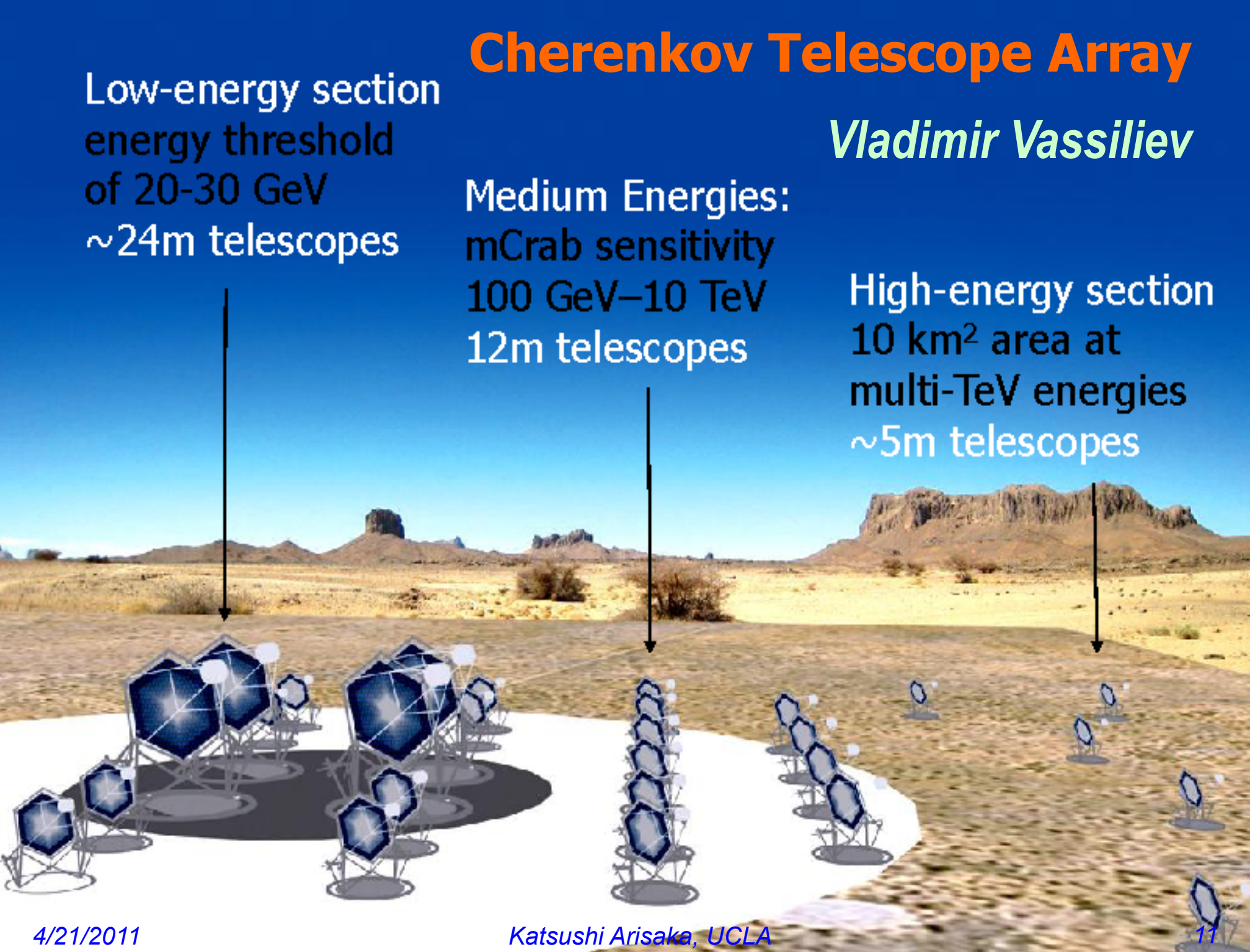
350 Mirror Facets



500 pixel Camera

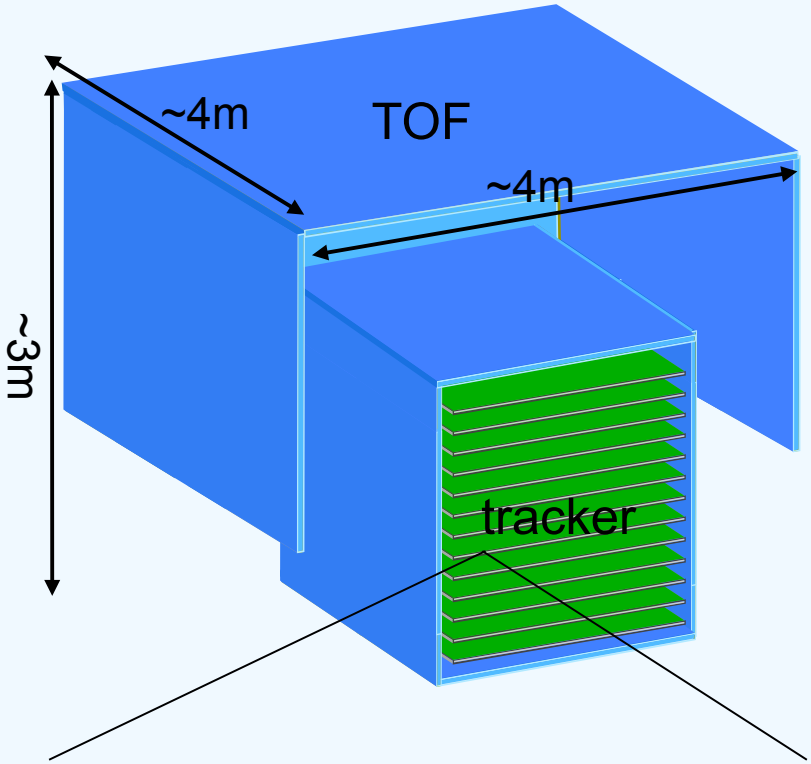
Cherenkov Telescope Array

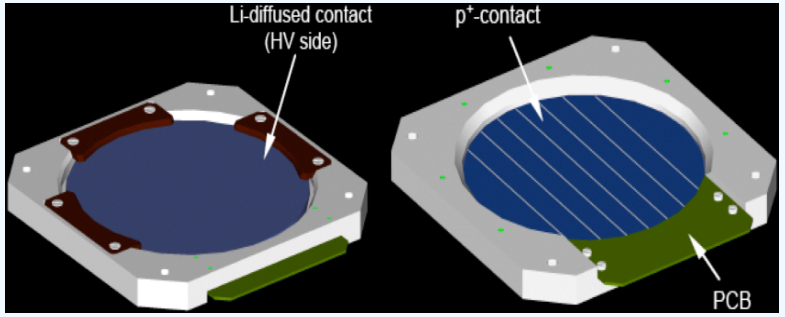
Vladimir Vassiliev



GAPS Concept

Rene Ong





LD Balloon flight in 2015 ?

GAPS consists of two detectors (acceptance ~2.7 m^2sr):

Si(Li) Detector (target and tracker):

- Si(Li) tracker:13 layers of Si(Li) wafers
- relatively low Z material
- good X-ray resolution
- circular modules segmented into 8 strips
  → 3D particle tracking
- 270 per layer (total: ~3500)
- timing: ~50 ns
- dual channel electronics
  5-200 keV: X-rays (resolution:~2 keV)
  0.1-200 MeV: charged particle

Time of flight and anticoincidence shield:

- plastic scintillator with PMTs surrounds tracker
- track charged particles, dE/dX
- velocity measurement
- anticoincidence for charged particles

Sterile Neutrinos

Alex Kusenko

Sterile neutrinos as dark matter: production scenarios

Production **color coded** by **"warmness" vs "coldness"**:

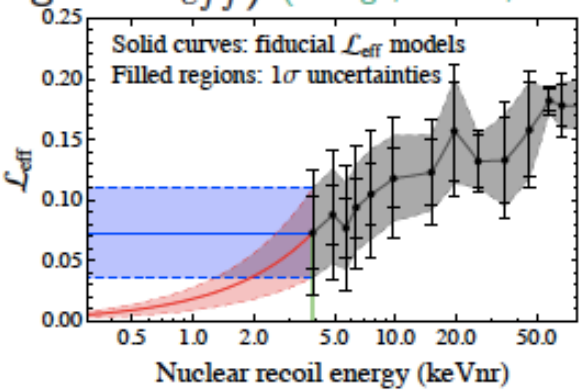
- **Neutrino oscillations off resonance** [Dodelson, Widrow] No prerequisites; production determined by the mixing angle alone; no way to turn off this channel, except for low-reheat scenarios [Gelmini et al.]
- **Resonant neutrino oscillations** [Shi, Fuller] Pre-requisite: sizable lepton asymmetry of the universe. (The latter may be generated by the decay of heavier sterile neutrinos [Laine, Shaposhnikov])
- **Higgs decays** [AK, Petraki] Assumes the Majorana mass is due to Higgs mechanism. **Sterile miracle: abundance a "natural" consequence of singlet at the electroweak scale**
- **Split seesaw**: [AK, Takahashi, Yanagida]
  Two production mechanisms, **cold** and **even colder**.

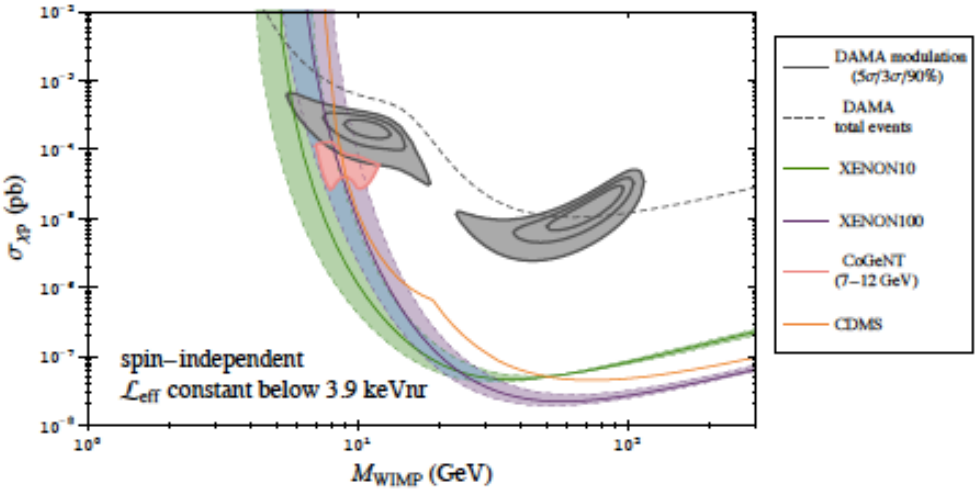
DAMA/LIBRA vs. XENON100

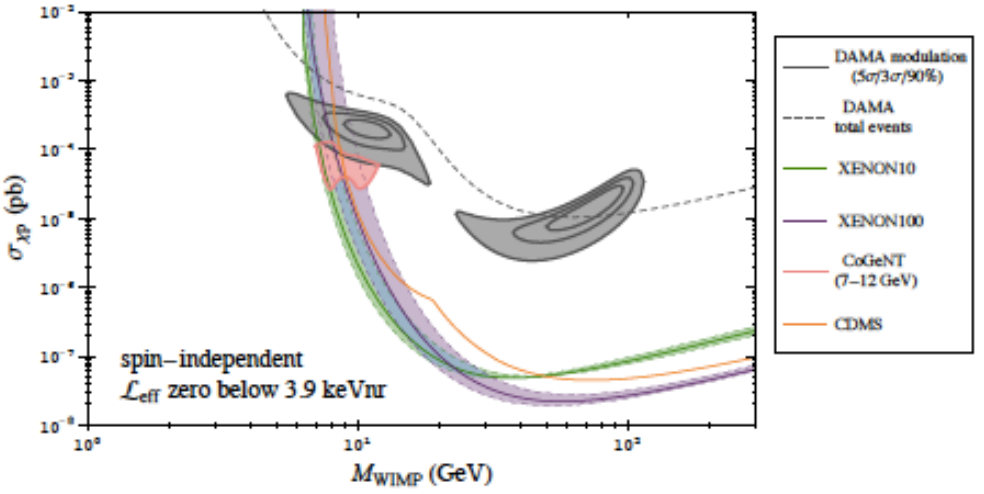
Graciela Gelmini

Compatibility of DAMA/LIBRA with Xe100 and Xe10

If L_{eff} extrapolated as a constant or zero below 4 keVnr (band: shows how the 90%CL bound changes with 1σ change in L_{eff}) (Savage,Gelmini, Gondolo, Freese 1006.0972)







UCLA Dark Matter Programs

- **Direct Search**
  - *David Cline, Katsushi Arisaka, Hanguo Wang*

    Xe : ZEPLIN-II → XENON100 → XENON 1Ton

    Ar : DarkSide50 → DarkSide 5Ton

    G3 : MAX, XAX

- **Indirect Search**
  - *Rene Ong* VERITAS → GAPS
  - *Vladimir Vassiliev* VERITAS → CTA
  - *David Saltzberg* ANITA

- **Theory**
  - *Graciela Gelmini* DAMA/CoGeNT
  - *Alex Kusenko* Sterile Neutrino