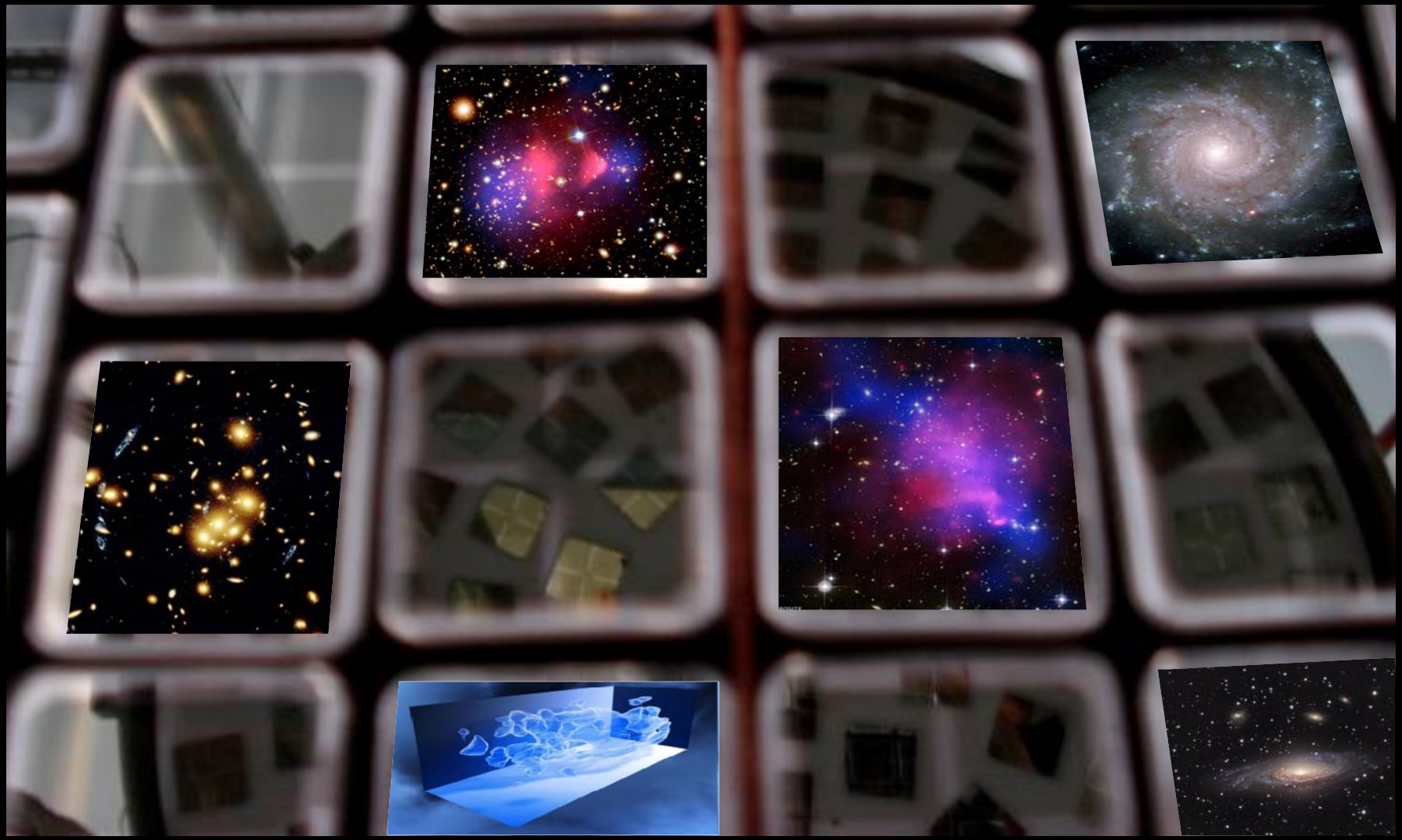
Dark matter results from 100 Live Days of XENON100 Data



23rd Rencontres de Blois

Jacob Lamblin, SUBATECH
on behalf of the XENON100 collaboration

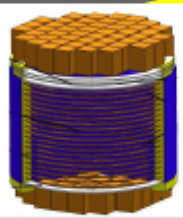
XENON program

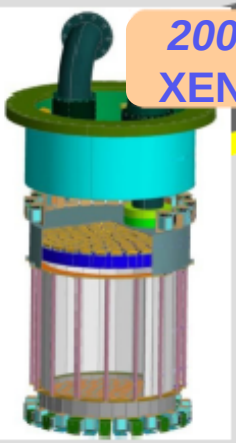
Xe XENON Dark Matter Project

XENON: A phased WIMP search program

XENON R&D

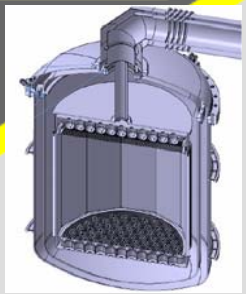
2005-2007: XENON10





2007-2012 XENON100

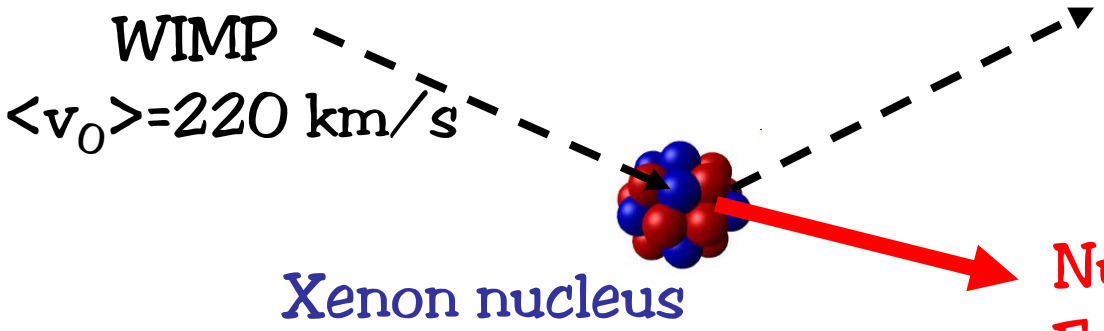
2010-2015: XENON1T

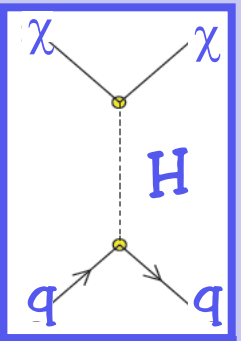


Columbia, Rice, UCLA, Zürich, Coimbra, LNGS, SJTU

Mainz, Bologna, Subatech, Münster, Nikhef, Heidelberg, Weizman

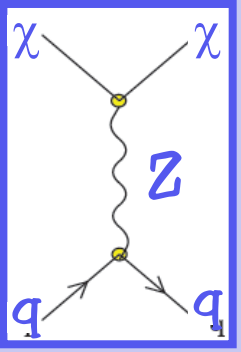
Direct detection





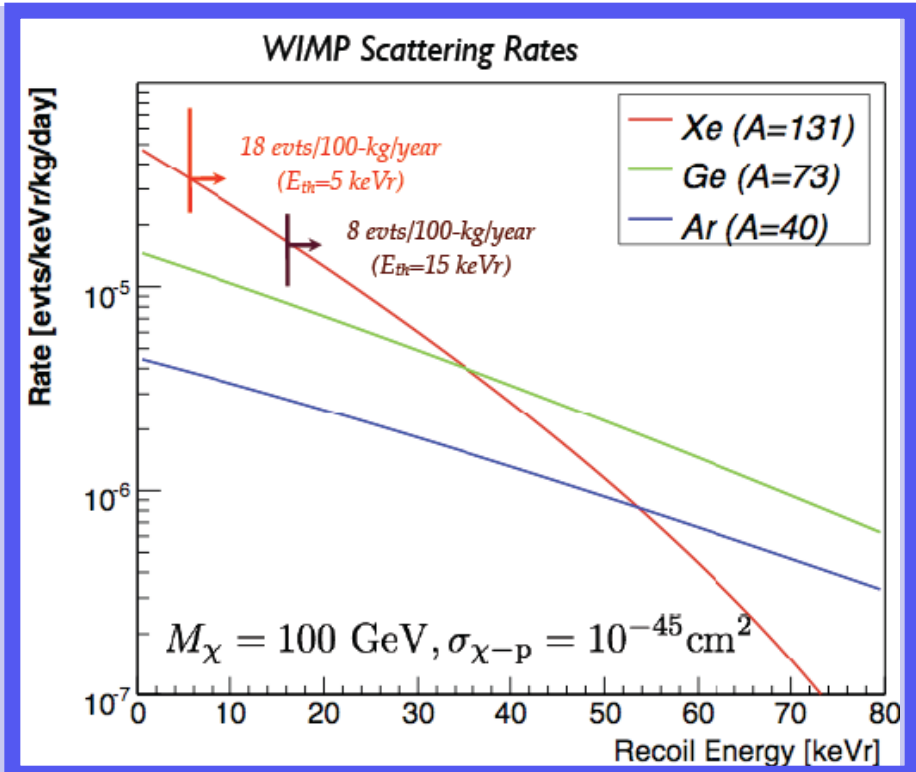
Spin independent (SI)

Interaction with all nucleons inside the nucleus
→ all nucleus are concerned

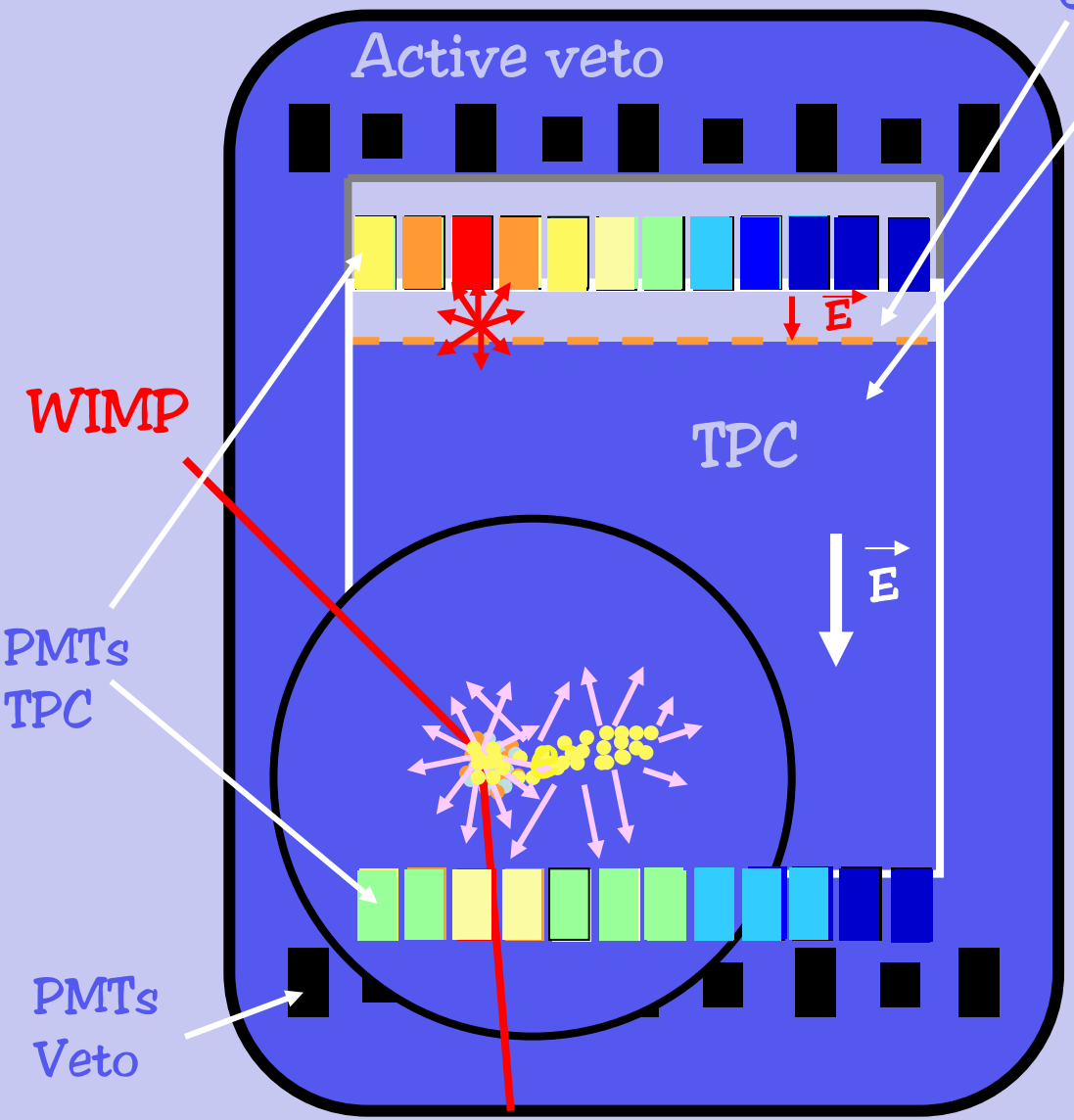


Spin dependent (SD)

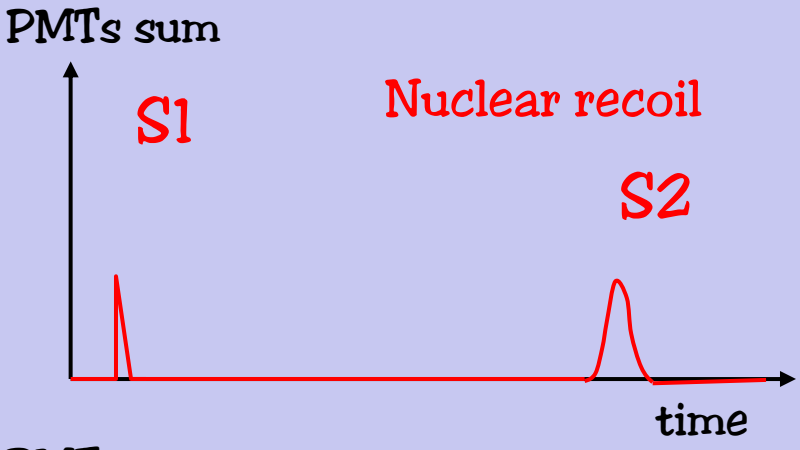
Interaction only with unpaired nucleons
→ odd number of nucleons

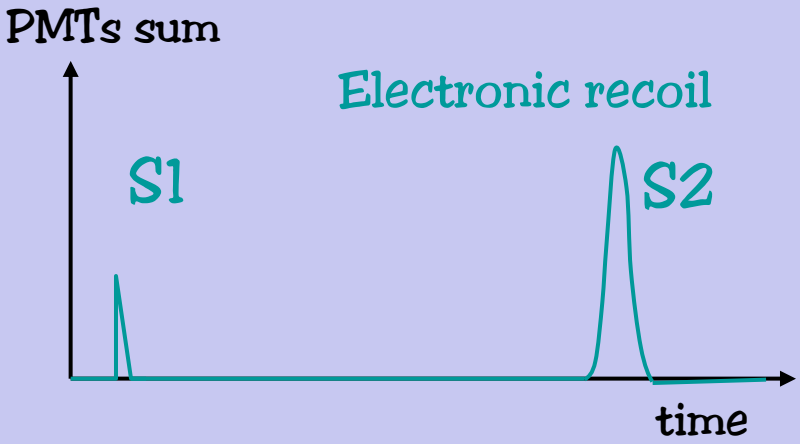


A double-phase Xenon TPC



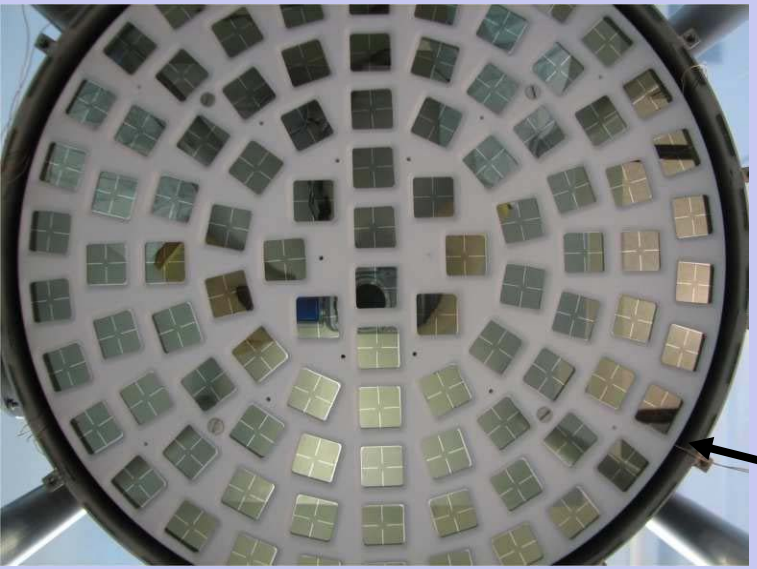
3D localization
(millimeter precision)
=> fiducial volume
and single scatters





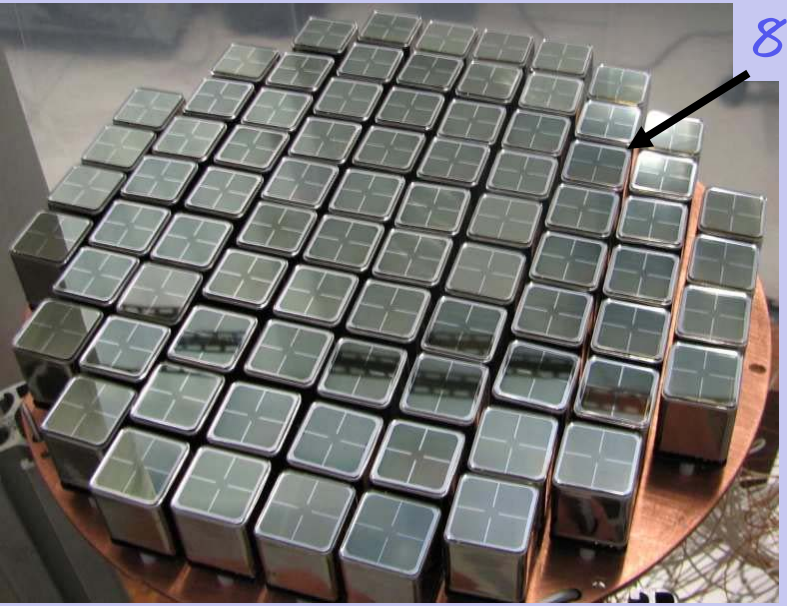
$(S2/S1)_{WIMP} << (S2/S1)_{\gamma}$

XENON100 is watching you

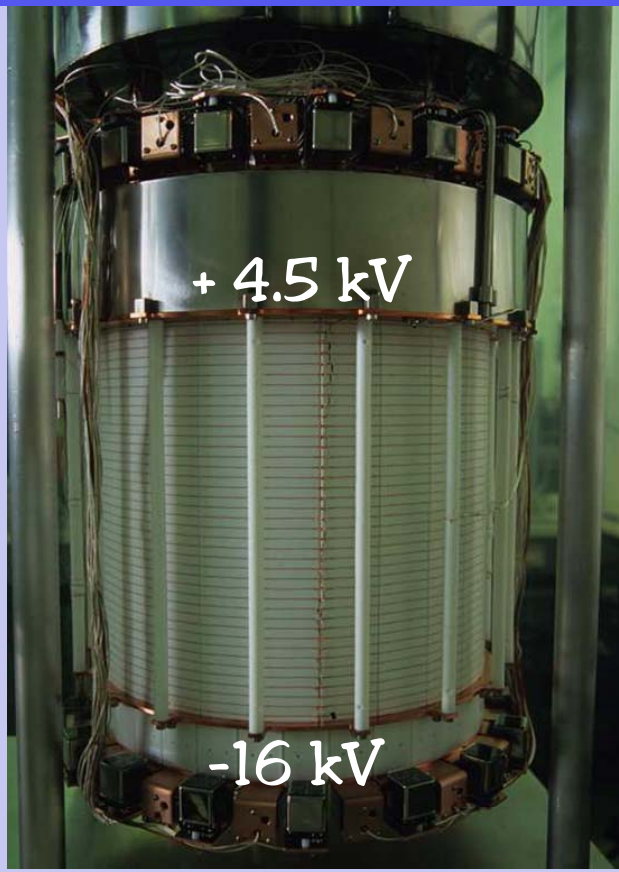


242 PMT 1"x1"
Low activity
(Hamamatsu R8520)
QE >32% @ 175nm

98 PMT top array



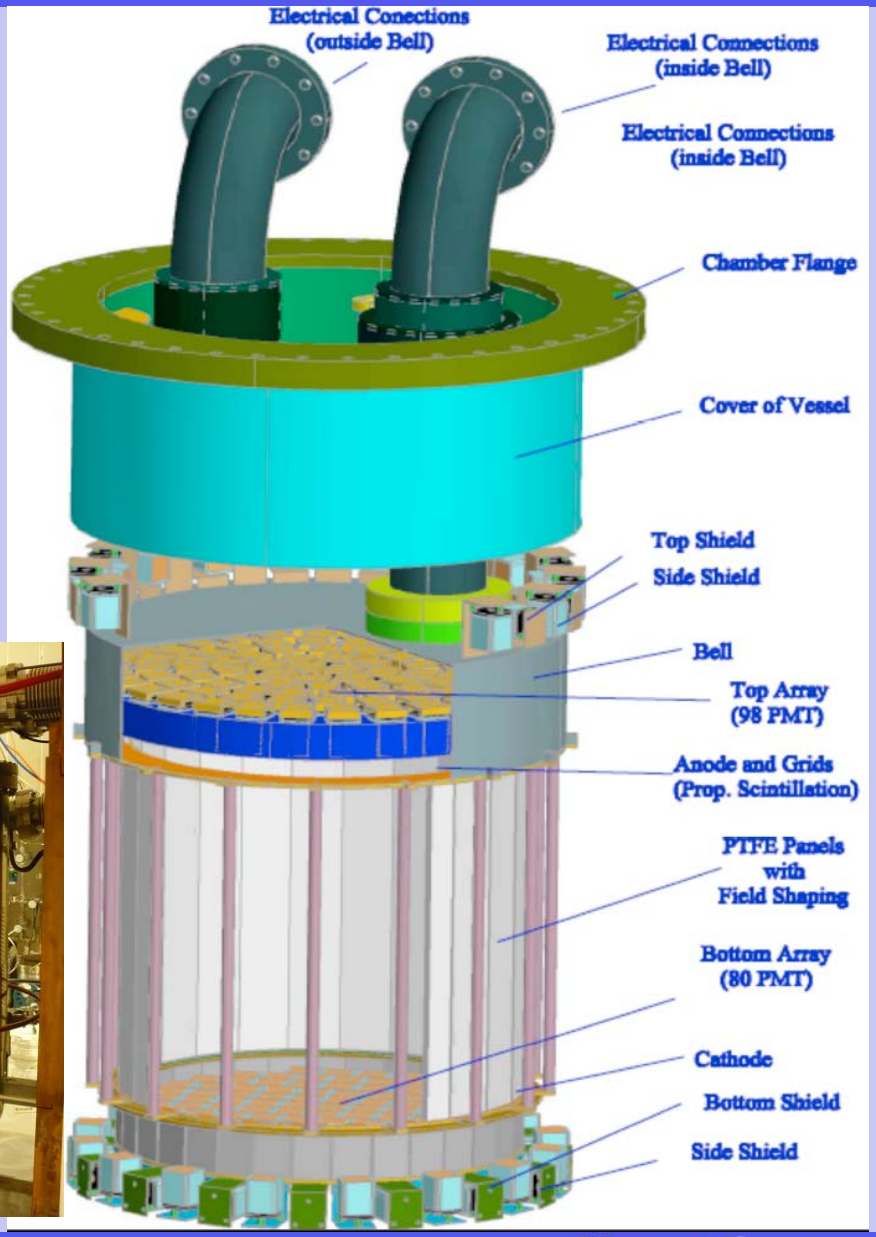
80 PMT bottom array



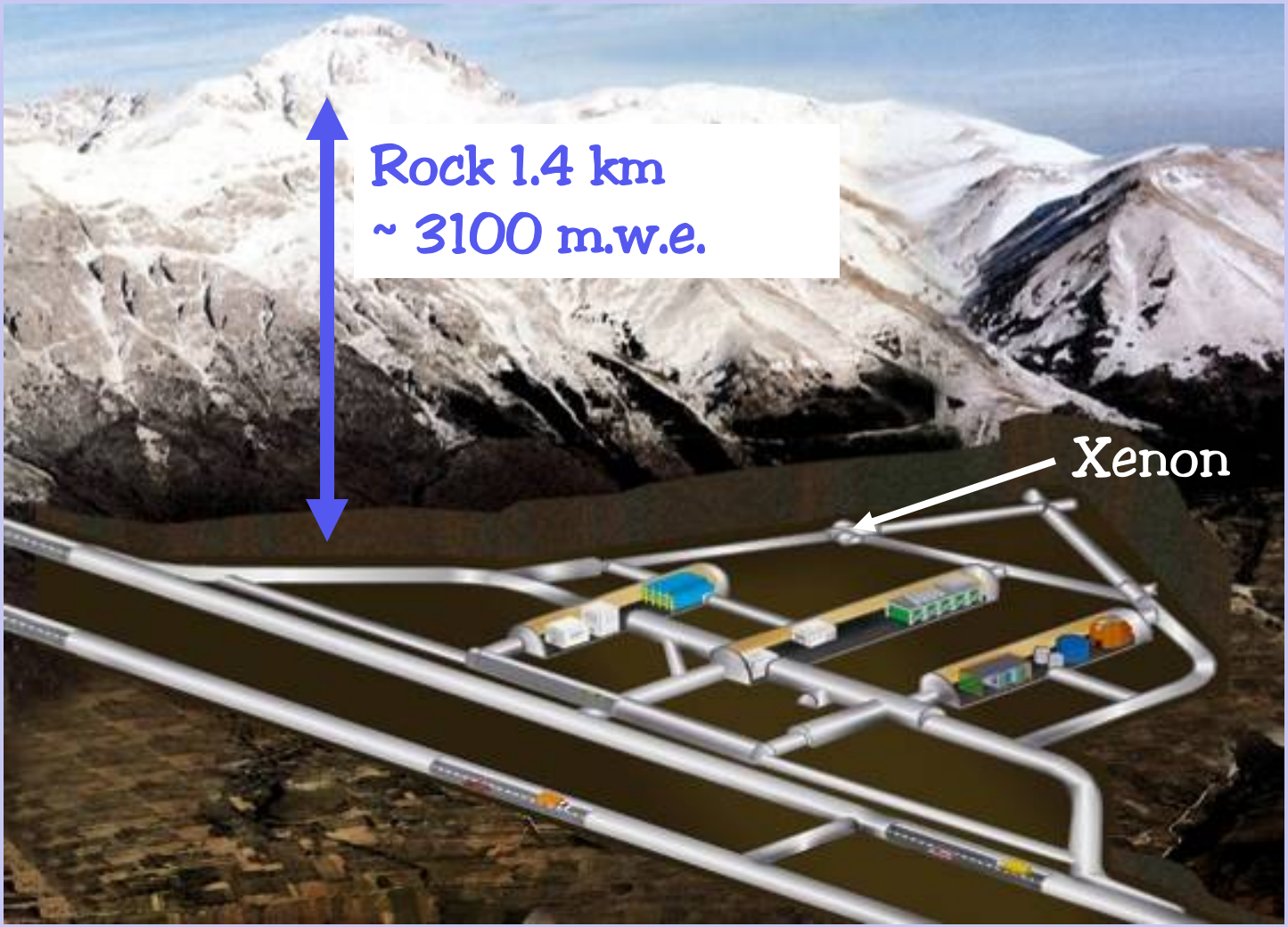
Veto PMTs

XENON100 design

- ✓161 kg Xe, 62 kg inside the TPC
- ✓ TPC : diameter 30 cm
  height 30 cm
- ✓ Drift field : 530 V/cm
- ✓ Téflon around the TPC for the light collection
- ✓Cryogenic system outside the shield
  → Pulse Tube Refrigerator (160W)
- ✓ Constant recirculation
- ✓ Shield :
  Lead 20 cm
  Polyethylene 20 cm
  Copper 5 cm
  + Water 20 cm on 4 sides



Gran Sasso underground laboratory

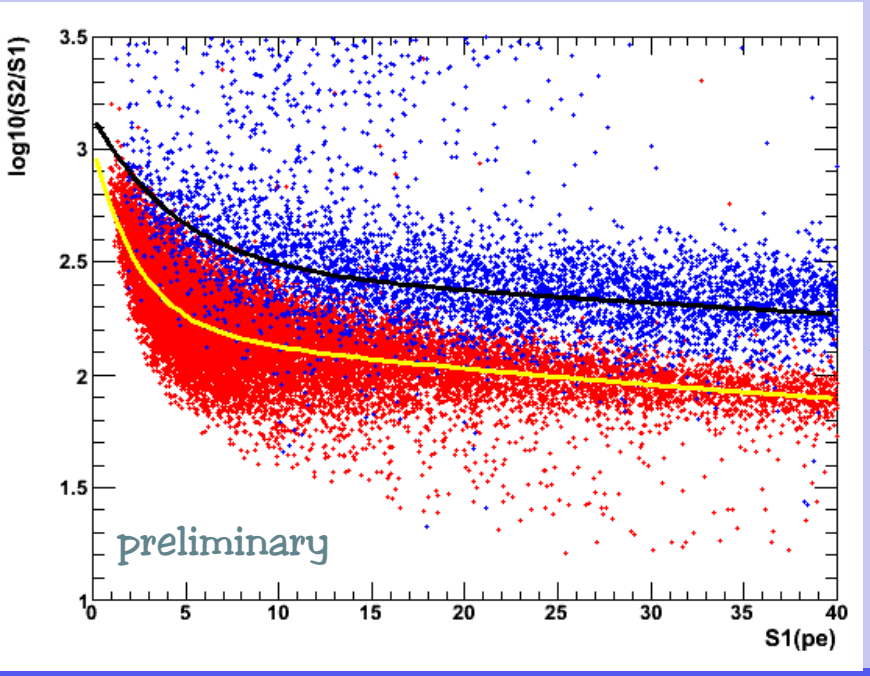


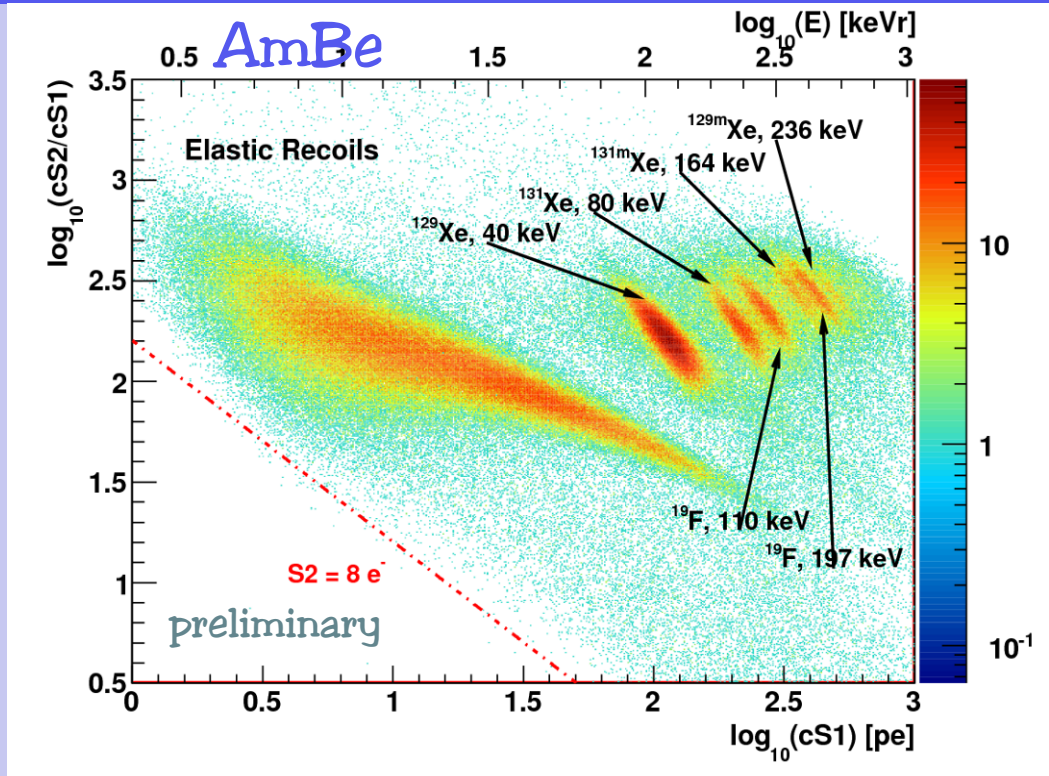
Detector Calibration

Several sources :

^{137}Cs, ^{60}Co, ^{232}Th (gammas)

AmBe (neutrons) → nuclear recoils + gammas (^{129m}Xe, ^{131m}Xe and inelastic scattering)

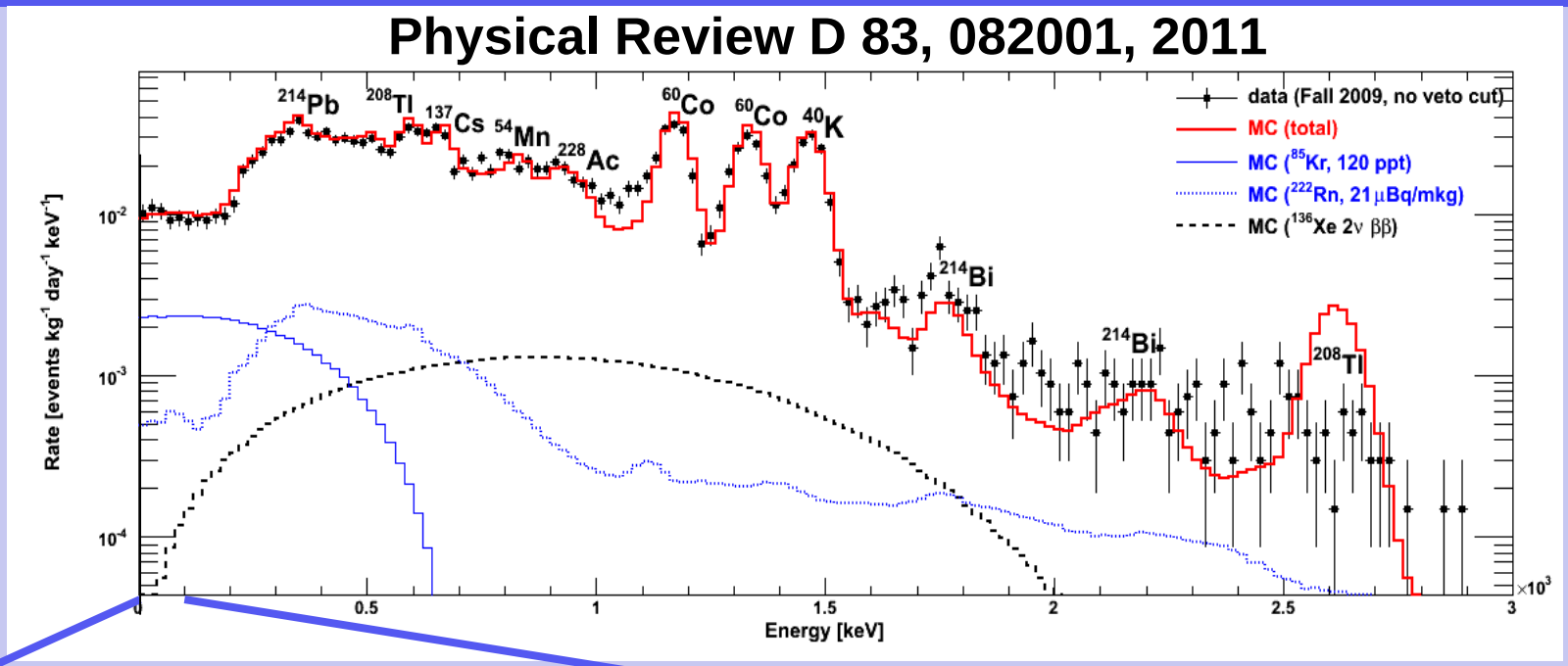


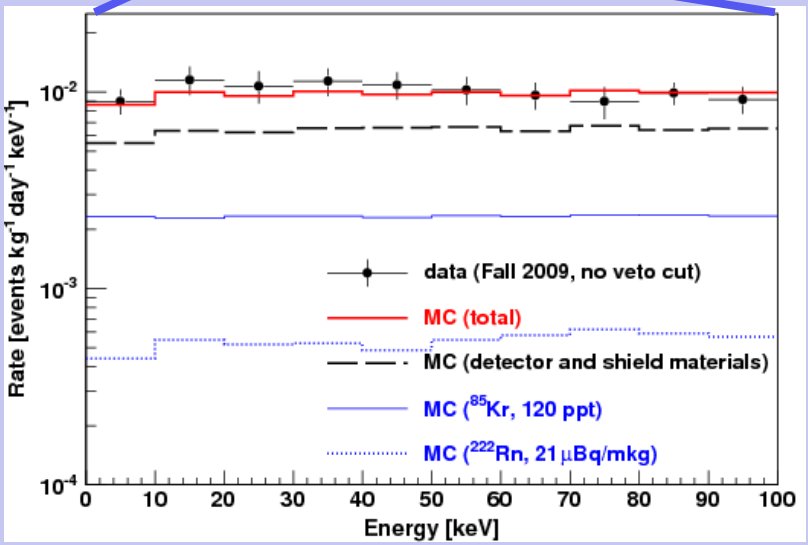


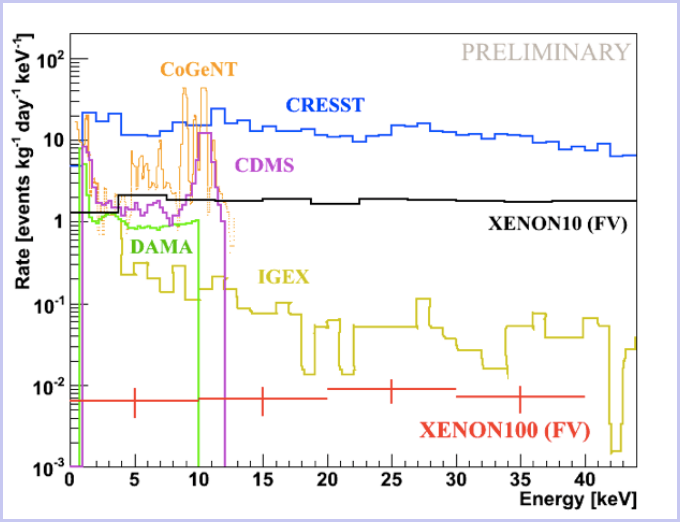
Nuclear recoils/electronic recoils discrimination

The discrimination power is ~99.5% at low energies for a 50% neutron acceptance

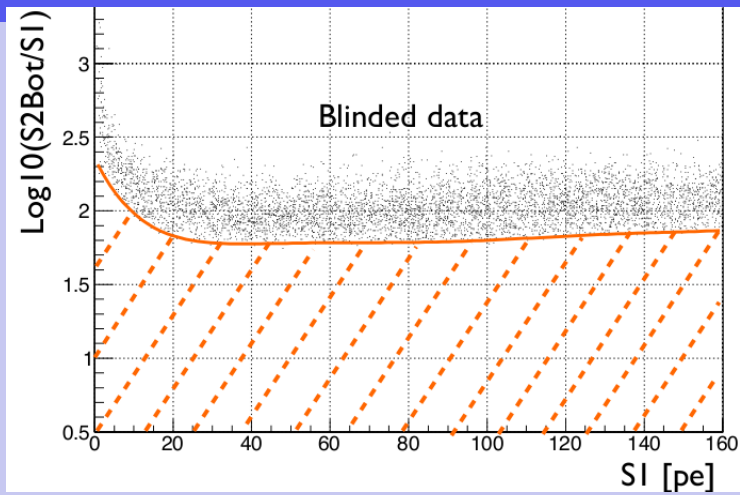
A very low and understood background







Dark matter analysis



Blind analysis = cuts are defined using only background events outside the WIMP region (below the lower 10% quantile of the electron recoil distribution) + Calibrations

Cuts

Data quality: - keep period with stable detector operation parameters
- remove period with high electronic noise

Physical events: - require two-fold coincident S1,
- S2>300 pe
- reject electronic noise

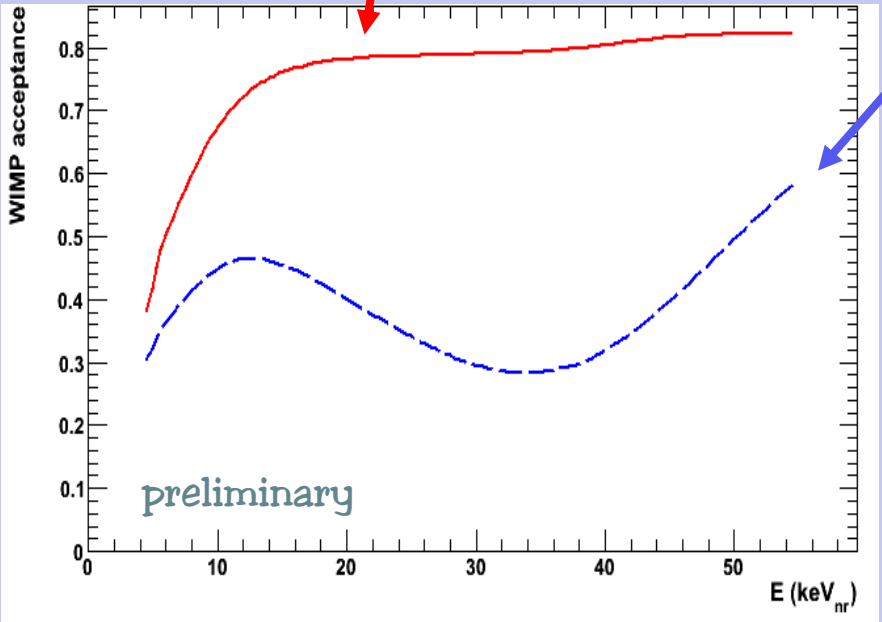
Single scatter: - only one S1 and one S2
- no veto coincidence
- S1 PMT hit pattern
- S2 PMT hit pattern (good xy reconstruction)

Fiducial volume = - event inside the inner volume (48 kg)

+ 1 post-unblinding cut to reject events which passed the two-fold S1 cut only because noise

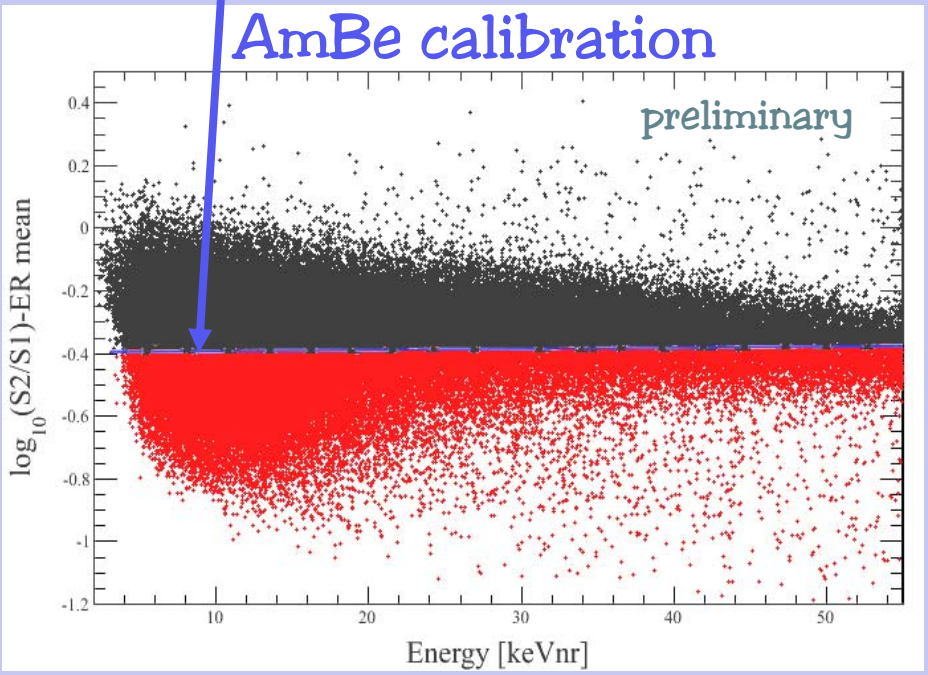
WIMP acceptance

Acceptance of all cuts except S2/S1 cut

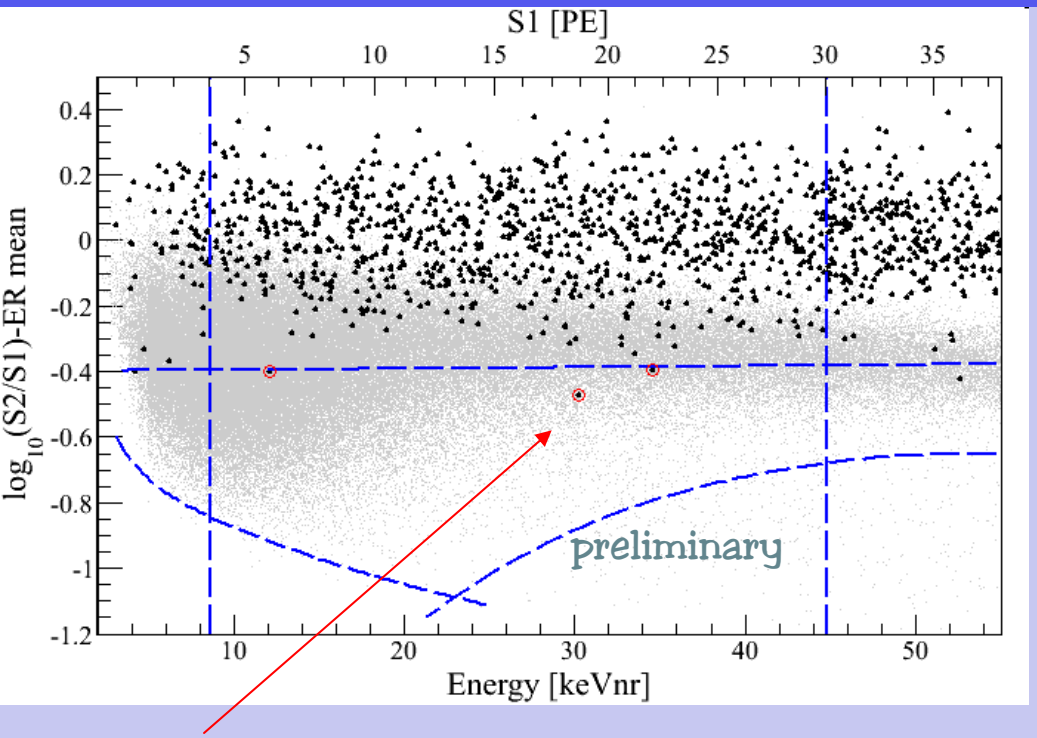


NR acceptance for an ER rejection cut of 99.75% efficiency

AmBe calibration



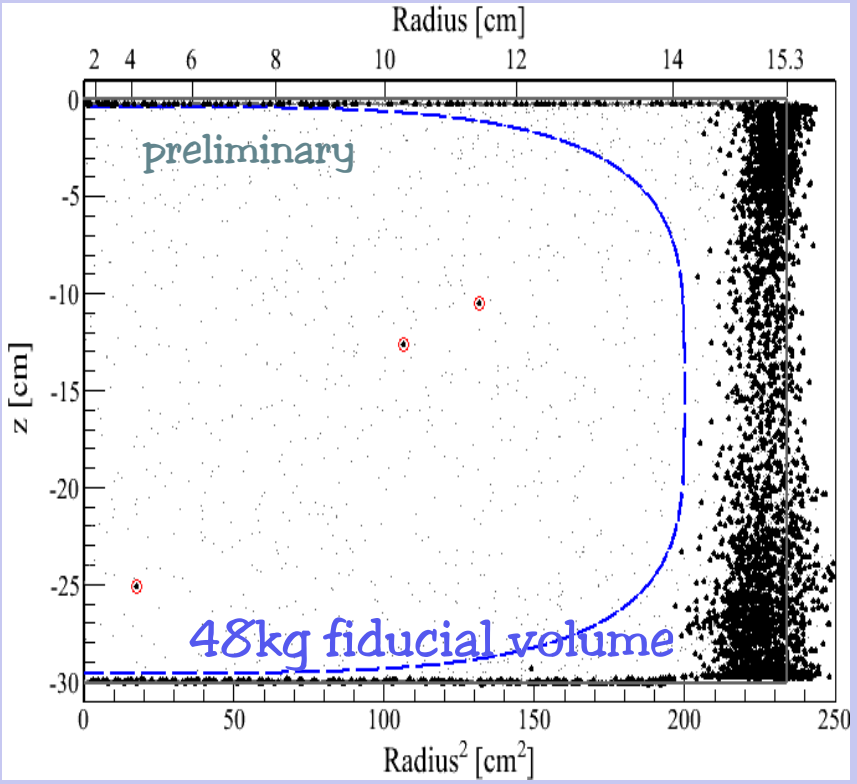
100 live days of data



arXiv:1104.2549, submitted to PRL

Background (within the fiducial volume)

Nuclear recoil calibration



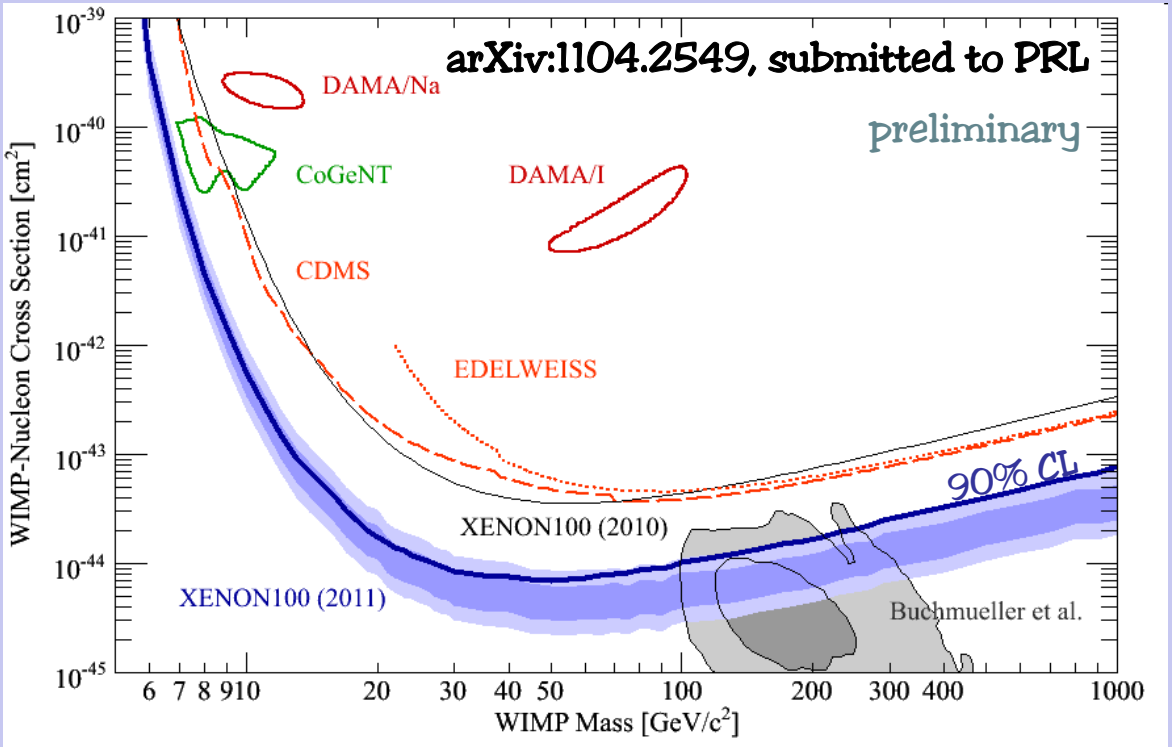
3 physical events in the WIMP search region

Bkgd prediction = 1.8+/- 0.6 events

=> No observation of a WIMP signal

New limit on the SI elastic dark matter

100.9 live days, 48 kg fiducial mass



Profile Likelihood method
arXiv:1103.0303

Using new Leff measurements
(Plante et al, 2011 arXiv:1104.2587)

WIMP velocity:
v_0 = 220 km/s
v_{esc} = 544 km/s

The best limit on spin independent dark matter to date: $7.10^{-45}cm^2$ at 50 GeV/c^2

We start to explore the predicted region for SUSY candidates

Summary and Outlook

- ✓ A very low background achieved
- ✓ The best limit on SI elastic dark matter up to date with a cross section of 7.10^{-45} cm^2 (90% CL)
- ✓ Inelastic dark matter as an explanation for DAMA is excluded
- ✓ XENON100 data taking still on going after a new krypton purification and with a lower S2 threshold
- ✓ Next step : XENON1T, at the ton scale, already in preparation