

How to look into darkness with XENON1T

CHIPP PhD Winter School 2015

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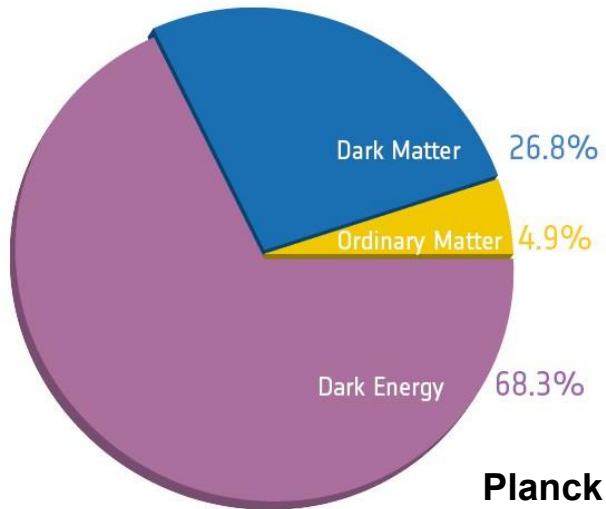
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Xe
XENON
Dark Matter Project

Dark matter is out there

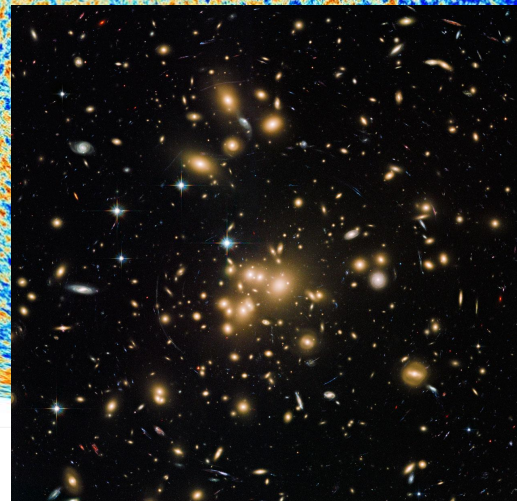
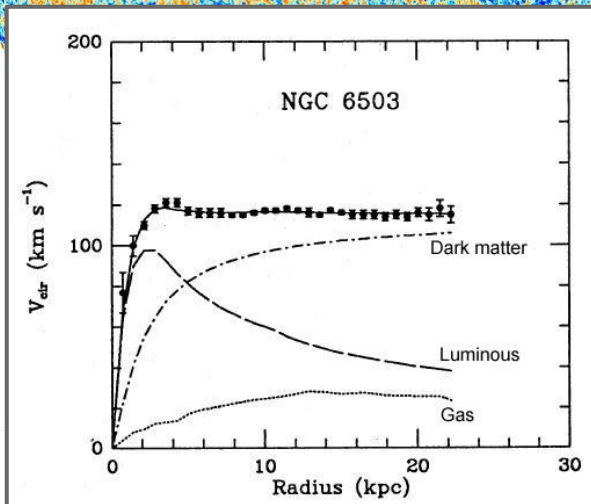
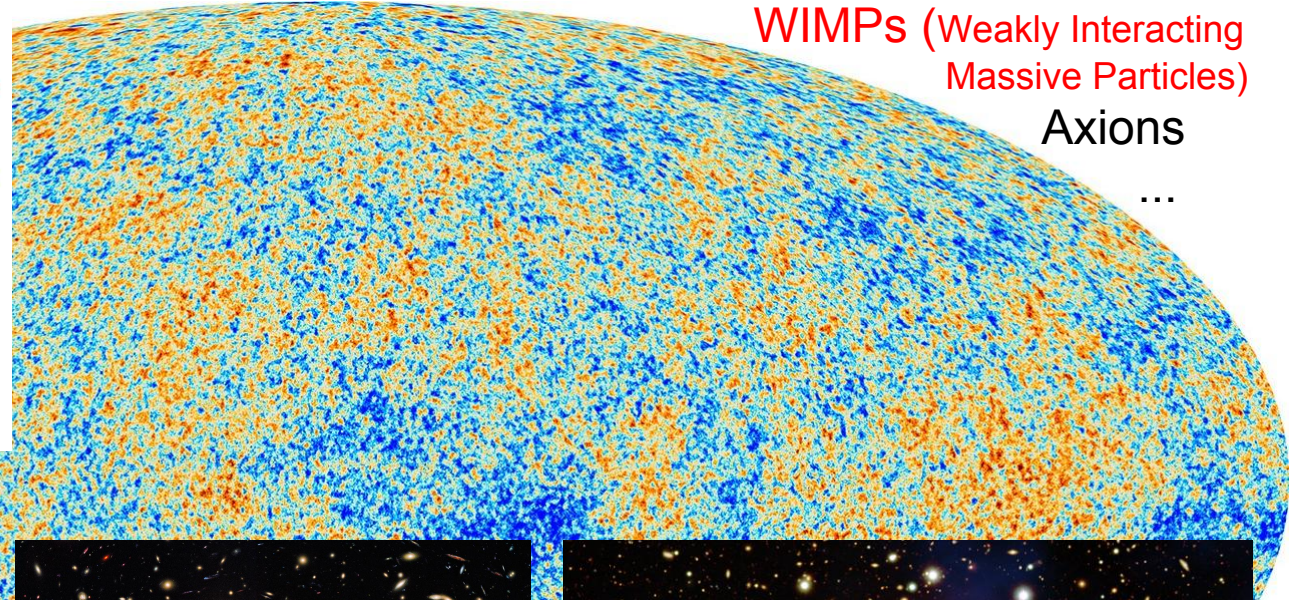


Dark matter candidates:

WIMPs (Weakly Interacting
Massive Particles)

Axions

...

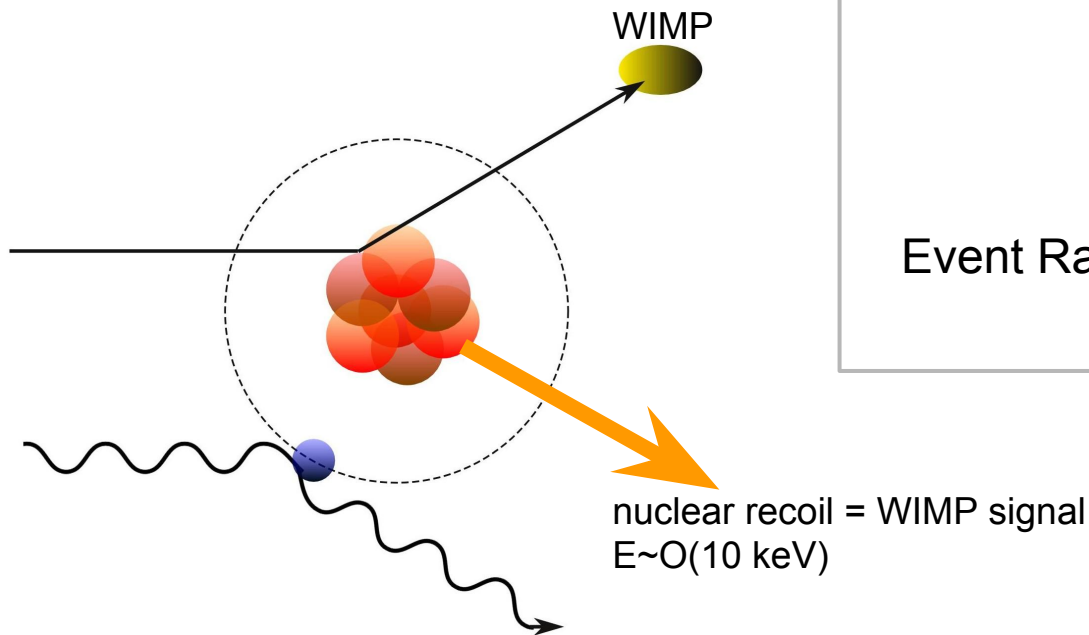


Galaxy rotation curves

Lensing

Cluster lensing + x-ray

XENON looking for WIMPs



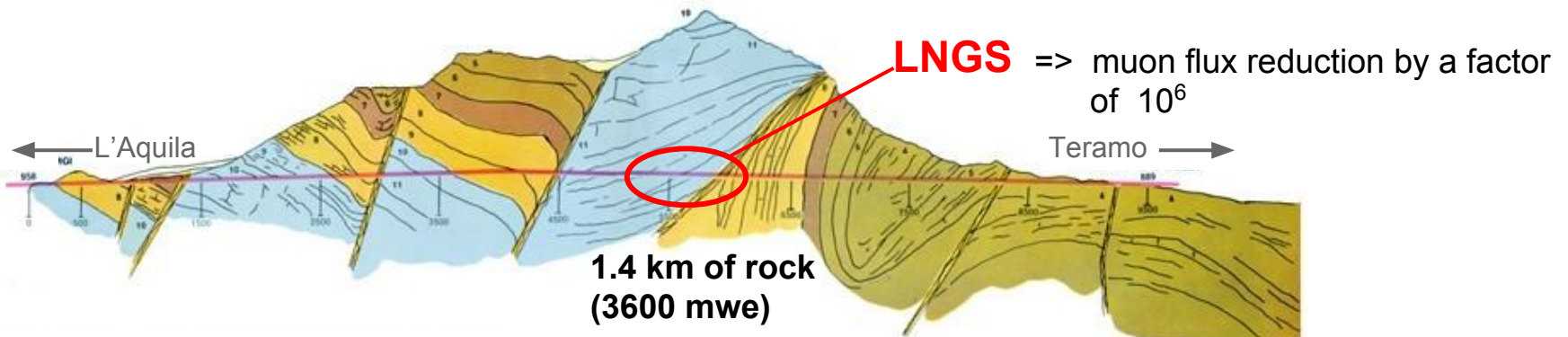
Local dark matter density
WIMP mass

Detector

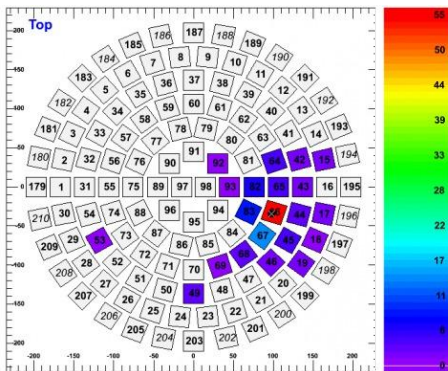
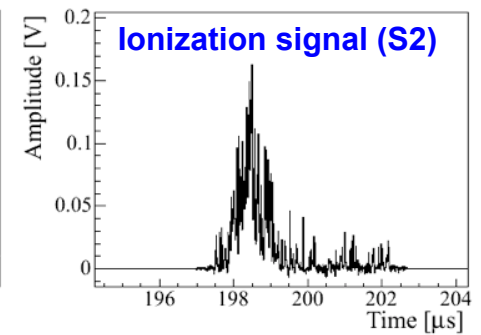
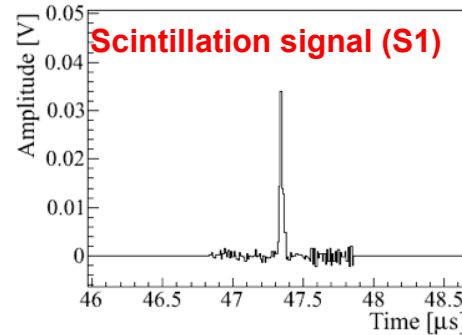
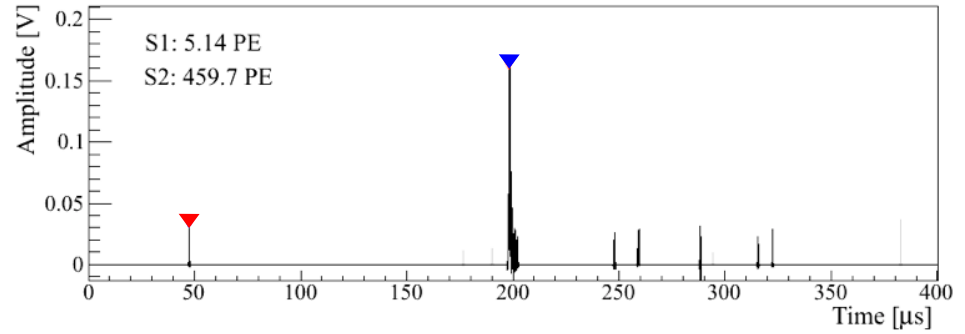
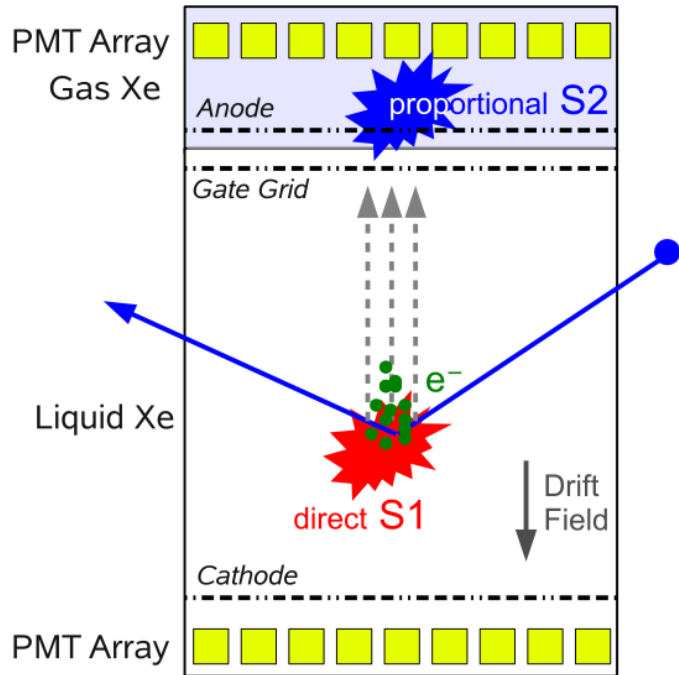
Particle Physics

Event Rate: $R \propto N \frac{\rho_\chi}{m_\chi} \langle \sigma_{\chi-N} \rangle$

=> rare event search
=> shield + go
underground

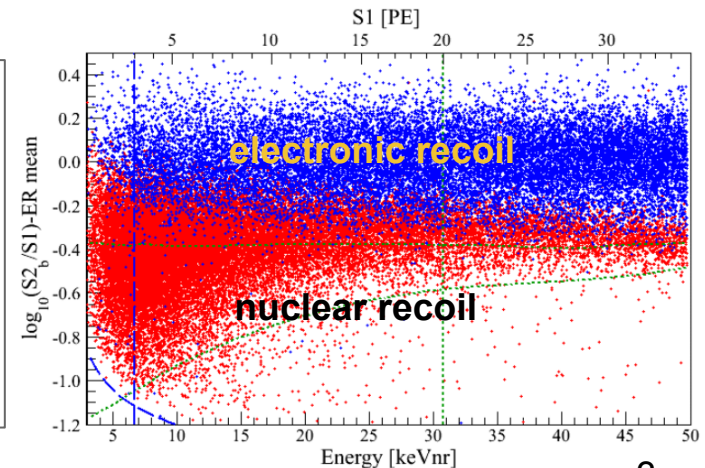


XENON detector principle



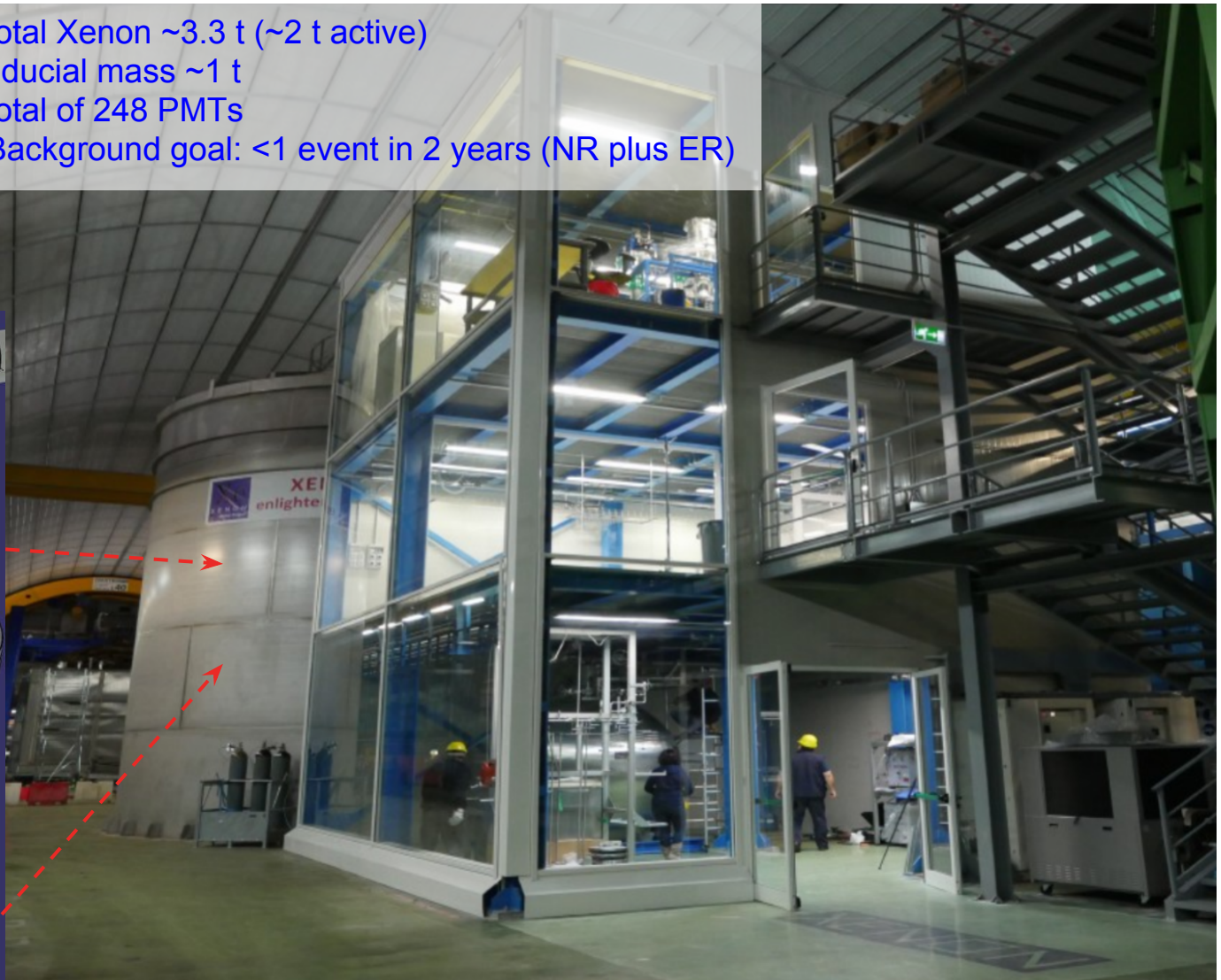
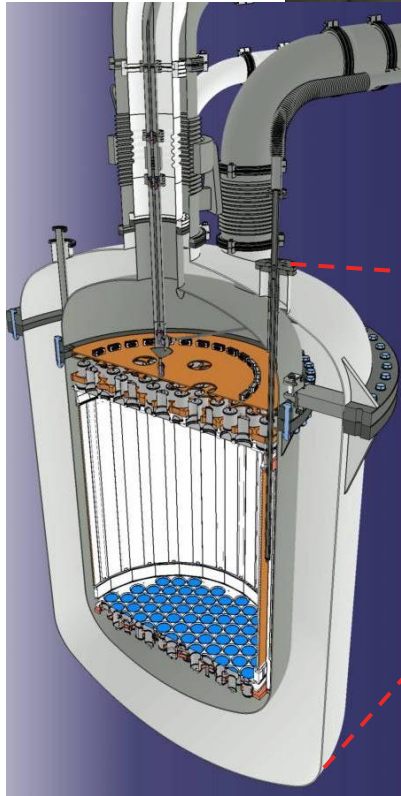
what we get:

- **X-Y position** from hit pattern
- **Z position** from drift time
- **Energy** from signal integral
- **ER/NR discrimination** from charge to light ratio



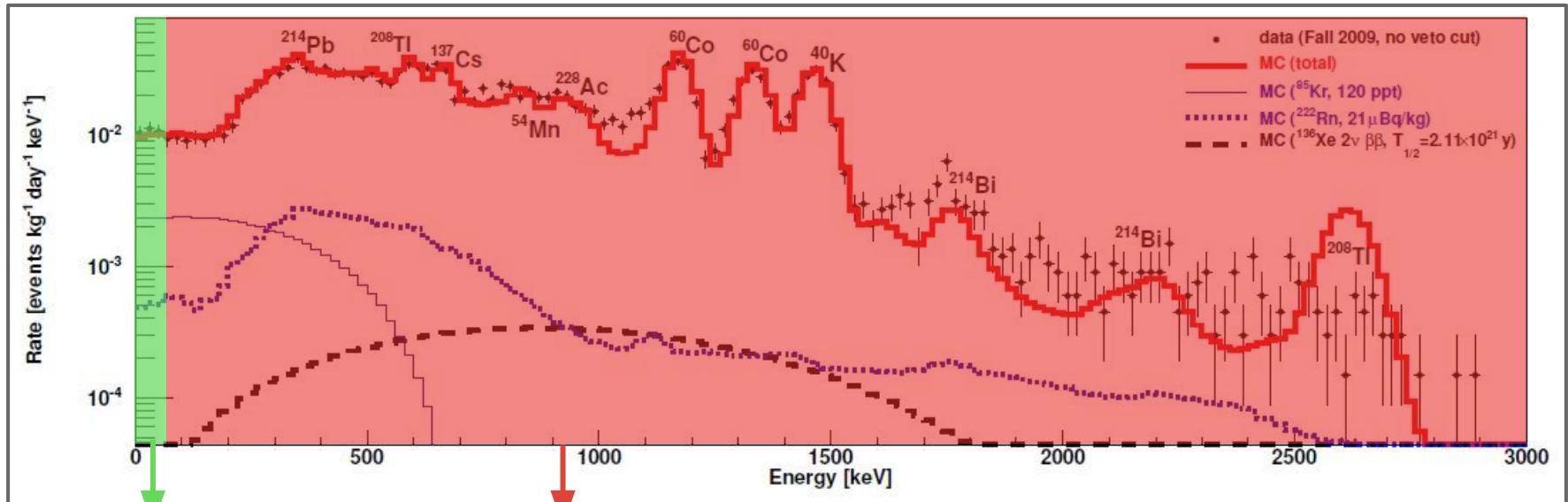
XENON1T is under construction

- total Xenon ~ 3.3 t (~ 2 t active)
- fiducial mass ~ 1 t
- total of 248 PMTs
- Background goal: <1 event in 2 years (NR plus ER)



Background calibration

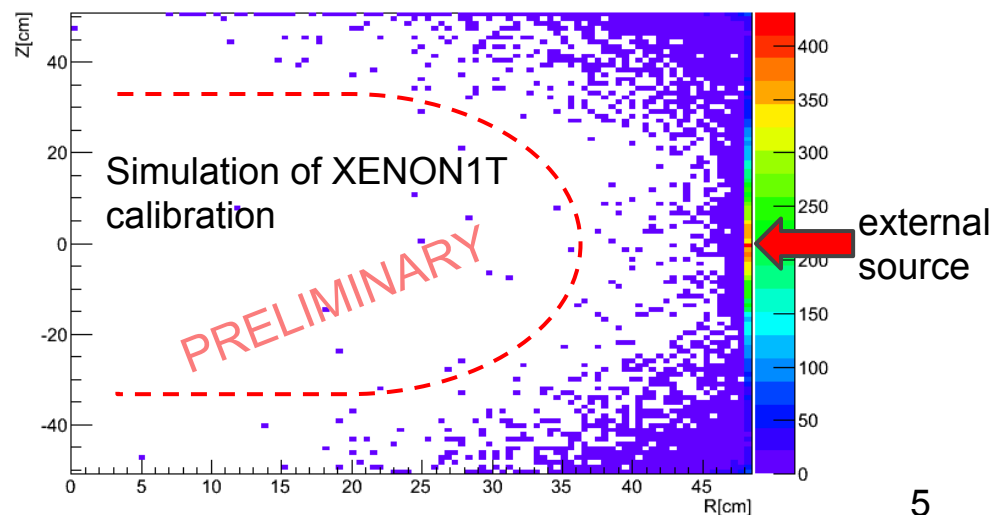
Background spectrum from XENON100



useful energy range
for DM search

out of region of
interest

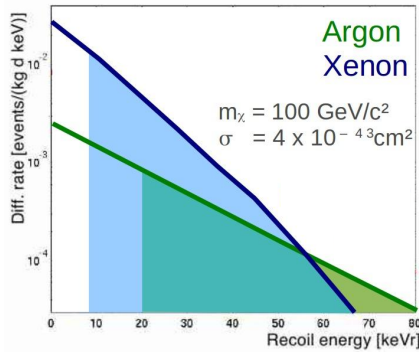
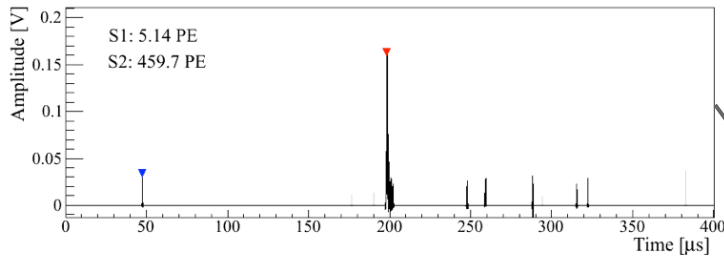
High rates are required for detector
calibration in order to get some
events in the center



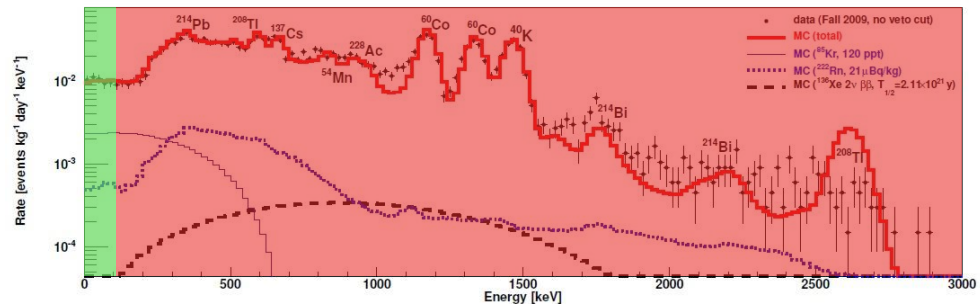
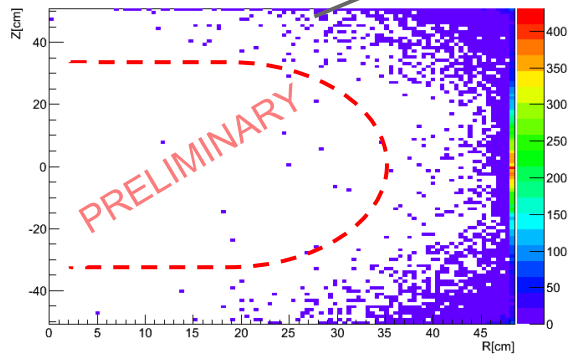


The XENON1T DAQ

DAQ requirements

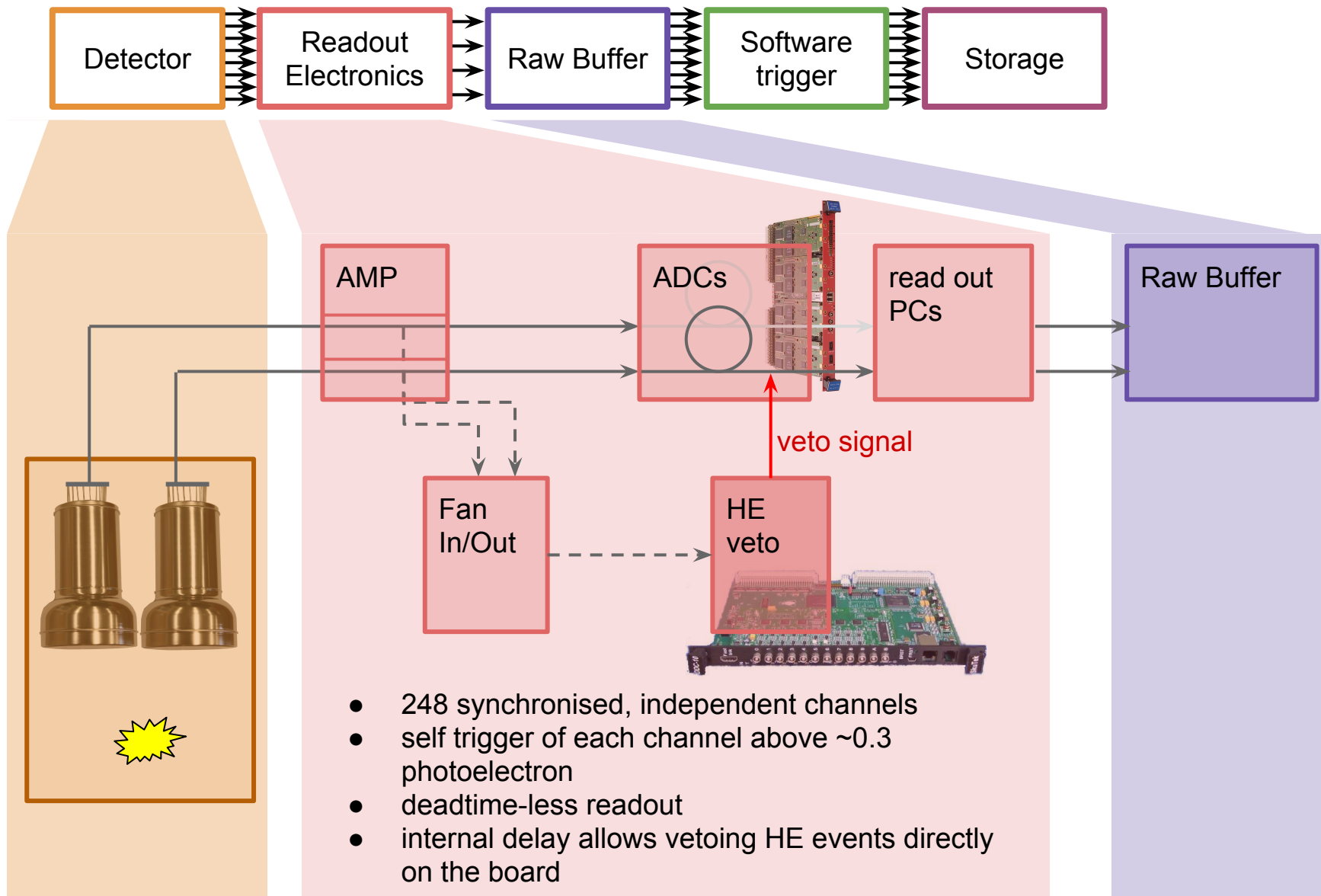


nuclear recoil
 $E \sim O(10 \text{ keV})$



- Digitize and store complete waveforms
- Low/"no" threshold
- High rates, up to 1 kHz (300 MB/s)
- High energy veto in calibration mode

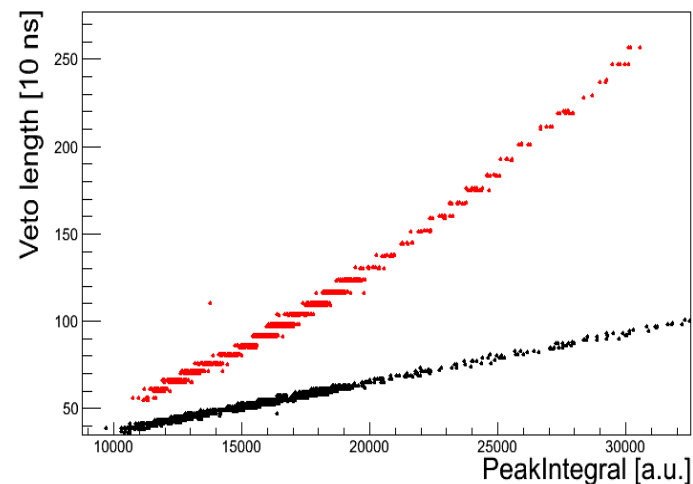
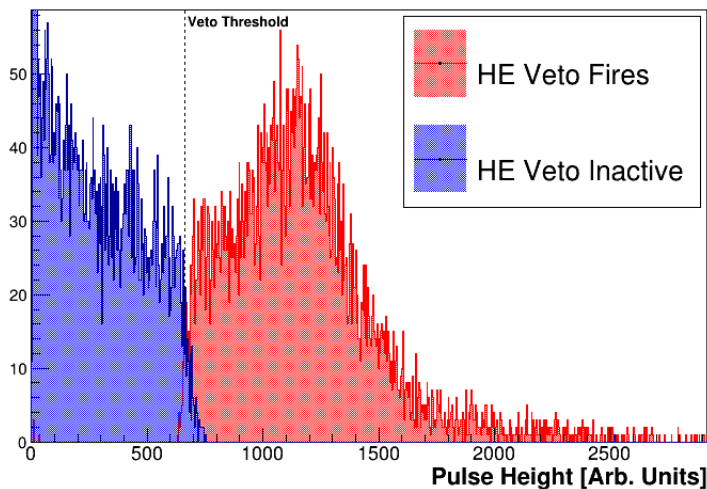
DAQ system



HE veto



- skutek DDC-10 VME board:
 - 10 channels 14 bit digitizer
 - NIM/TTL In/Out
 - embedded Linux
 - custom programmable FPGA
- custom FPGA firmware allows for:
 - online integration of sum waveform
 - flexible veto length (dependent on integral)
 - position dependent veto is possible
 - veto decision based on integral, width and risetime
 - fast (~200 ns), fully integrated into DAQ system



=> Events can be rejected directly on the ADC boards

where to go with XENON1T

- data taking starting 2015
- sensitivity $2 \cdot 10^{-47} \text{ cm}^2 \text{ 1t} \cdot 2 \text{ years}$
- XENONnT upgrade: 7t xenon in total

