Westfälische
Wilhelms-Universität
Münster

Design of a 2-phase Xenon TPC

for electron drift length measurements

Johannes Schulz

8. Oktober 2011

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XENON project - A **T**ime **P**rojection **C**hamber -
Münster's TPC setup - Outlook

XENON
Dark Matter Project

wissen.leben
WWU Münster

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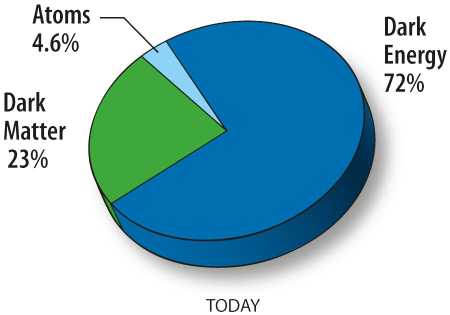
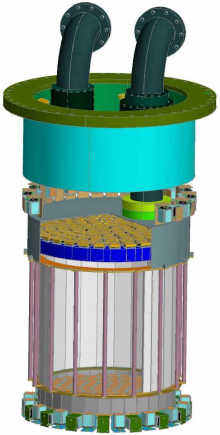
Matter distribution in the universe:



|NASA

One candidate: **W**eakly **I**nteracting **M**assive **P**article

The XENON Dark Matter Project:



The XENON100 detector

XENON100:

- 65 kg active Xenon in the detector
- instrumented with 178 PMTs
- located at Grand Sasso National Laboratory (3200 mwe)
- successor XENON1T - assembling next year

|E. Aprile et al.

Münster's contribution to XENON1T:

Design of a distillation column for Kr removal

Design of a purification system including a TPC to test for electronegative impurities.

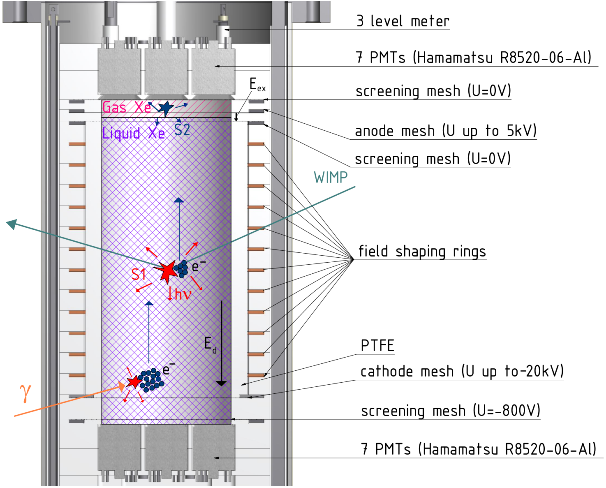
(also see presentation of Hans Kettling)

Xenon as detector material:

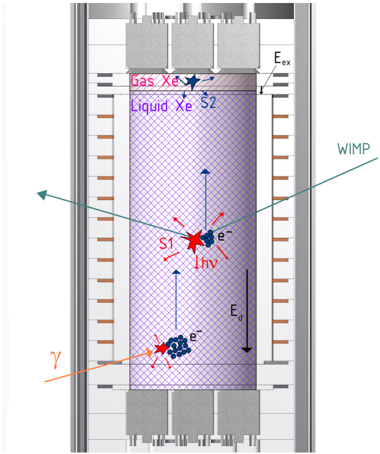
|Pslawinski

- high atomic number ($Z = 54$) and high liquid density ($\rho = 3\,\mathrm{g/cm^3}$)
- no radioactive isotopes in commercial xenon
- fast and efficient scintillator emitting light at 178 nm
- opportunity to purify the detector material at run time

General design of a 2-phase xenon TPC:

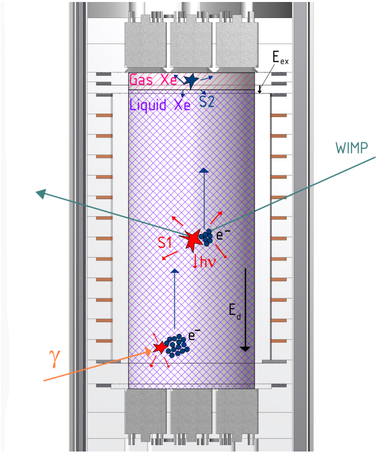


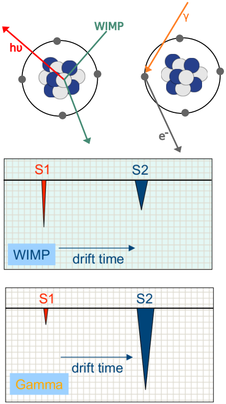
Functional principle of a TPC:



- WIMPs/neutron/γ-quanta $\Rightarrow$ electrons and scintillation light (S1).
- electrons drift (indicates the level of purity) and excite scintillation light (S2) in the gas
- light signals are detected by the PMT arrays
- 3D-position reconstruction
- different signals from electron/nuclear recoil

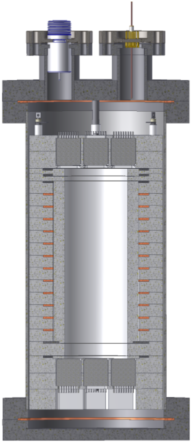
Background discrimination:

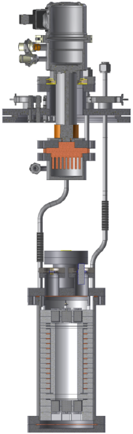


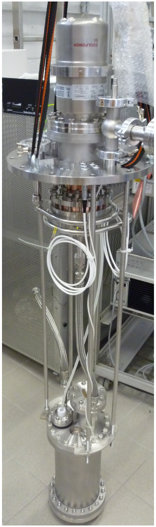


$(S2/S1)_{wimp} << (S2/S1)_{gamma}$

Münster-TPC setup:

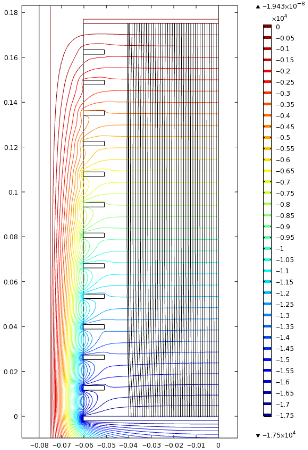


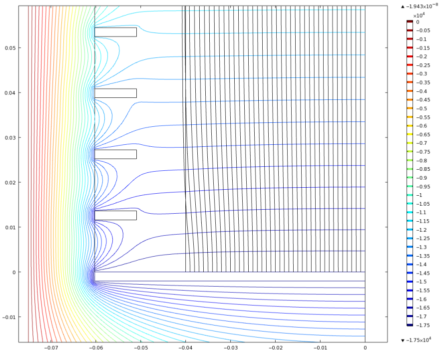




active mass ≈ 2.6 kg

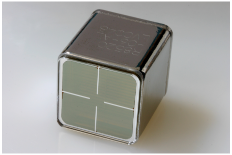
Simulations of the field shaping ring structure:





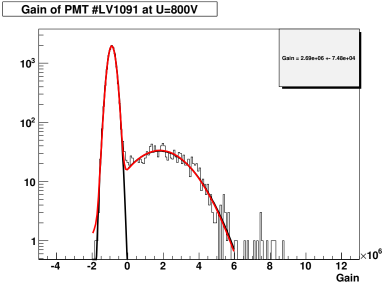
⇒ 12 rings for 170mm drift length

PMTs test and gain calibration:

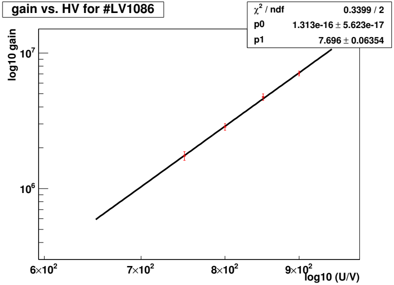


Hamamatsu R8520-06-AL

- low intensity LED pulses
- 5-10% one photoelectron
- taking >10000 waveforms

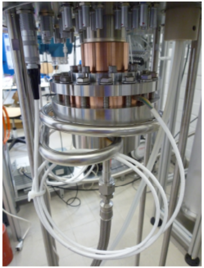


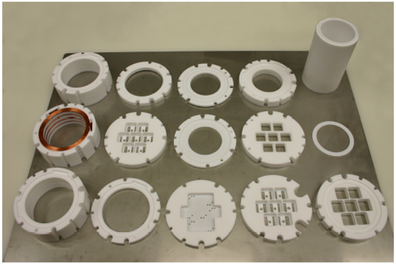
PMT calibration histogram

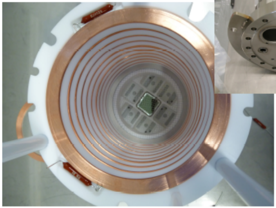


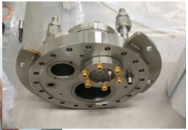
gain vs. high voltage

The TPC:









Summary and Outlook:

Done:

- designing, manufacturing, assembling, filling

Now:

- testing all general functions of the TPC
- calibration measurements (e.g. energy)
- upgrade the number of PMTs to 14

Later:

- extending the drift length stepwise up to 1000 mm or more to show a 1 ton detector will be possible
- showing the possibility of reaching the degree of purity to operate the upcoming 1 ton scale TPC

Thank you!

Columbia Rice UCLA Zürich Coimbra LNGS SJTU

Mainz Bologna Subatech Münster Nikhef Heidelberg Weizman

Deutsche
Forschungsgemeinschaft
DFG