NEXT-DEMO: A PROTOTYPE FOR THE NEXT EXPERIMENT

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iWoRID 2012, Figueira da Foz, Portugal, 1-5 of July
A charged particle in gas releases energy through scintillation and ionization of the atoms of gas.
Primary scintillation: $t_0$ of the event

- UV scintillation (≈10,000 photons/MeV in gas xenon) gives the starting time of the event.
Ionization and drift

- Around 22 eV to create an ion-electron pair.
- Ionization electrons are drifted by an electric field towards the anode, with a drift velocity of ~1 mm/microsecond in a .5 kV/cm field.
• Ionization electrons enter a moderately high electric field where they produce secondary scintillation (EL), with a linear gain of $10^3$ photons per electron.

• PMTs on the cathode side give a measurement of the energy.
The distribution of light on the sensors in the anode is, at any moment, a 2D picture of the track at a given position along the axis.

Knowing $t_0$, the absolute position along the axis is also reconstructed.
NEXT-DEMO at IFIC

Demonstrating the feasibility of the NEXT concept

• To reach the target energy resolution (1% at Qbb)

• To test long drift lengths and high voltages

• To understand the MPPCs performance and their tracking capabilities

• To understand gas recirculation and resistance to leaks

• To study the chamber reflectance
NEXT-DEMO at IFIC

The PMT plane

The teflon panels

The SiPM plane

The field cage

The EL meshes
Waveforms in NEXT-DEMO

- **SI**: Primary scintillation signal: starting time of event
- **S2**: EL signal
- **Drift time**: Time interval between the primary scintillation signal and the EL signal.
XY reconstruction

First step towards tracking, which will allow for fiducial cuts and pattern recognition
Previous step: calibration of sensors (see poster by Hugo Natal da Luz)

**Barycenter** method: weight each PMT position by its charge
Find an average position of the event
Bias towards the centers of PMTs (one has a much higher gain)
No events reconstructed close to borders
Alternative method: compare the observed light distribution with a set of expected ones (generated by MC all over the XY plane) and find the minimum \( \text{chi}^2 \)

**XY reconstruction**

Good uniformity
Better uniformity for the second method, but still needs improvement and more data
NEXT-DEMO: a detector in evolution

Three different campaigns:

1) Detecting UV scintillation light of xenon: the *ultraviolet* era

2) Coating reflector panels with wavelength shifter to blue: the *blue* era

3) Placing SiPM for tracking -> also the anode plane is coated -> bluer than blue: the *ultramarine* era
NEXT-DEMO: a detector in evolution

- Na22 source, NaI scintillator to tag the 511 keV gamma
- Hot getter for higher purity
- Digital trigger
- NEXT-100 electronics already being debugged in NEXT-DEMO

**Conditions of operation**
- Pressure: 10 bar
- Cathode voltage: 32 kV
- Gate voltage: 12 kV
- Drift field: ~600 V/cm
- E/P 2.4 kV/(cm bar)

- Very stable conditions, intense data taking program, continuous operation for more than one month
- Millions of events processed
Waveforms in NEXT-DEMO

Digital trigger, very flexible, allows different configurations (external, internal (S1, S1+S2)…)

Most efficient: external (NaI source + S1)
NEXT in the ultraviolet era: Na22 analysis

CCES2Sum

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FWHM 2.18%
FWHM@Qbb $\sim$0.99%
TPB coating on reflectors in the drift region

Tetraphenyl butadiene (TPB) converts UV light to blue (peak at ~430 nm)

- Coated teflon reflects blue light more than UV
- PMTs have ~twice more QE for blue light than UV

Improves light collection in the cathode
NEXT in the **blue** era

- light collection improved from 3 to 5 times
Towards the ultramarine era...

- SiPM are not sensible to UV, need to coat them with TPB
- TPB emits isotropically, thus more light going back to the cathode
- Denser EL meshes in place: more resistant to sparks, higher E/p in the EL gap
Towards the ultramarine era...

- SiPM installed
- Data taking in progress...
Towards the ultramarine era...

First EL signal with SiPM
Conclusions

• NEXT-DEMO up and running for one year and a half
• Millions of data processed and analyzed
• Energy resolution which extrapolates to ~1% at Qbb
• Much more light collected with TPB
• Ultramarine era has started: full tracking capability
• NEXT-100 is approaching...
Thank you!
Back up slides