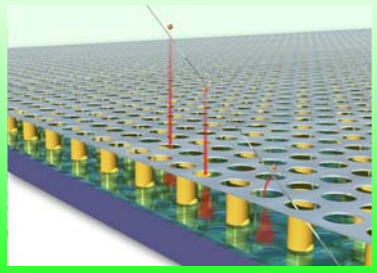
DICE
(Delft Internal Conversion Experiment)

W.J.C. Koppert (NIKHEF) H. van der Graaf (NIKHEF), F. de Boer (NIKHEF), R. Kalter (TU Delft), A. van der Kooij (TU Delft), M. Fransen (NIKHEF), A. Taal (RID-TU Delft)

DICE: An Introduction

The main component of DICE (Delft Internal Conversion Experiment) is a Time Projection Chamber based on the driftchamber principle of measuring x and y and extracting z out of the drifttime.

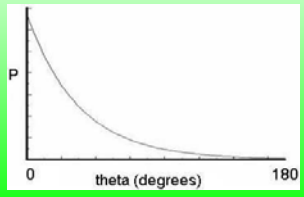
The measurements are done with a gridpix detector, a timepix chip modified with a grid. Due to an electric field electrons, that are kicked out by a passing charged particle, follow the field lines to a grid hole. After passing the hole an avalanche is created that is measured by the underlying pixel.This gridpix principle allows us to obtain 3D information of single electrons.



Application of DICE: Investigation of internal conversion and light neutral boson decays

In internal conversion of different isotopes anomalies in the predicted angular distributions are detected [F. de Boer,hep-ph/0511049]. An explanation is that those anomalies are caused by the appearance of an X-boson.

In decays with internal pair creation a virtual photon decaying in an electron positron pair. The expected distribution of the angle between the pair is shown right. The existance of a light X-boson would results in a small peak in this angelar spectrum, that has never been observed yet, mainly due to worse angular resolutions.



Characteristics:

-Drift gap: 20 mm

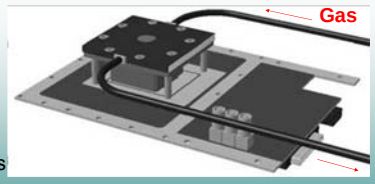
-Avalanche gap: 50 um

-Gas: Helium-Isobutane, pentane

-Pixel Pitch: 55x55um, 256x256 pixels

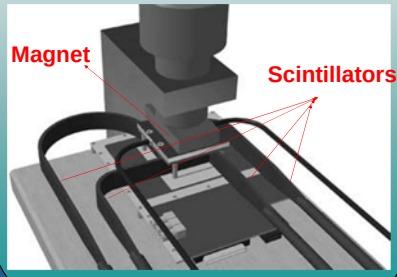
-Potentials: Kathode ~1050V, Anode ~450V, chip ground

-Chip size: 16.12x14.11 mm^2



The experimental setup:

In order to do this experiment DICE is placed in a homogenous magnetic field of ~0.3 T, this to discrimminate electrons and positrons. Furthermore the DICE has four scintilators, to detect the electrons and positrons coming directly from the decay. The scintillators are used as triggers in order to reduce the background.



Internal conversion:

Presuming light neutral X-bosons do exist there are two processes contributing to internal pair creation:

$\gamma \rightarrow e^+e^-$ and $X \rightarrow e^+e^-$

However nuclear reactions with those processes included are not clean. In all of the cases an extra electron is emitted which spoiles the measurement.There are a few possible scenarios for this experiment:

-Use a very small piece of an isotoop and place is in the centre of DICE (the fixes the origin of the track)
-Use a radiactive gas
-Find a reaction with small energy background electrons

Read out system:

-MUROS box + National Instruments card

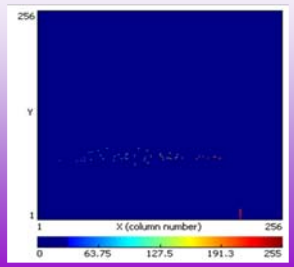
-or USB device

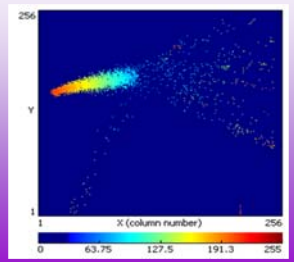
-Data aquisition software: pixelman

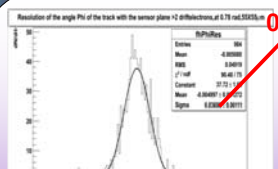
-Analysis: ROOT

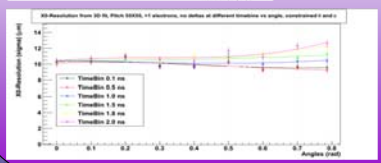
First (non analysed) results:

From SPS testbeam (may 2009) typical event (left): a 100 GeV Pion passes through Helium-Isobutane (80/20) and weird event (right): probably an interaction with the mechanics. Blue dots large drifttime electrons, red dots small drifttime electrons.







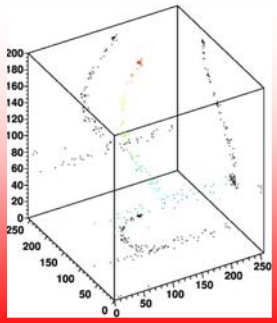


Some expectations:

From GOSSIP (1mm drift gap) straight track simulations it is known that the angular resolution is a few degrees and the x and y resolutions are ~10 um, with this gossip results good resolutions in the DICE experiments are expected. DICE has been tested in the SPS test-beam at the end of may, the analysed results from straight tracks are expected soon.

A first analysis:

A 3D picture form an event at the SPS test beam @ CERN, a pion passes through the DICE detector kicking out a delta electron in a 0.3 T field. The electrons are colored red for small drift times and blue at large driftimes. The electrons are projected on the xy, yz and xz planes in black



Summary

The angular resolution of DICE-detector is expected to be a few degrees, a factor 2-3 better than the detectors used before. The detector is small cheap, easy to produce an easy to handle.

The points of discussion are:

-What decay to study?

-What gas to use?

-Upgrade the trigger?

If these things are known, the DICE detector be operating in a few months.

W.J.C.Koppert (wkoppert@nikhef.nl), MPGD 2009, Crete