

# NEXT with Micromegas

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5<sup>th</sup> TPC Symposium, Paris, December 2010

# Outline

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Introduction

NEXT-0-MM

NEXT-1-MM

Radiopurity Measurements

Conclusions

# NEXT

**A high-pressure, 100kg gaseous Xe TPC to look for the  $0\nu\beta\beta$  decay of  $^{136}\text{Xe}$**

## Project Baseline:

An electroluminescence TPC where the energy is measured with PMTs and the topology is given by SiPM.

## Alternatives studied:

- An electroluminescence TPC where APDs are used for both the energy and the topology measurements
- Equip the detector with Microbulk Micromegas and perform the energy and topology measurement through the charge collection

# NEXT

**A high-pressure, 100kg gaseous Xe TPC to look for the  $0\nu\beta\beta$  decay of  $^{136}\text{Xe}$**

## Project Baseline:

An electroluminescence TPC where the energy is measured with PMTs and the topology is given by SiPM.

Talk by I. Liubarsky

## Alternatives studied:

➤ An electroluminescence TPC where APDs are used for both the energy and the topology measurements

Talk by T. Lux

➤ Equip the detector with Microbulk Micromegas and perform the energy and topology measurement through the charge collection



Advances on the R&D related to this option, on behalf of the Zaragoza and Saclay groups

# NEXT-0-MM

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## The first prototype

F.J.Iguaz et al. J. Phys.: Conf Series 179 (2009) 012007

T. Dafni et al., NIM A 608 (2009) 259-266

A. Tomas et al., 2009 JINST 4 P11016

S. Cebrian et al., JCAP (2010) 010

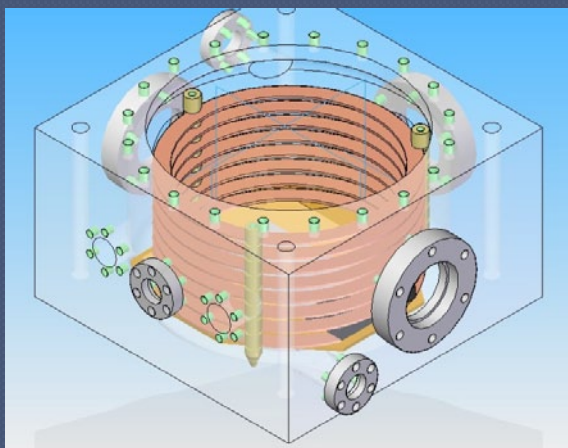
# NEXT-0-MM Setup



SS made  
Volume of 2 litres  
Vessel height: 9.5cm  
Drift height: 6cm (6 Cu rings + cathode)  
Cathode diameter: 14cm

Leak measurement:  $2.3 \times 10^{-9}$  mbar.l/s  
Max pressure: 12bar

Heaters up to 110°C  
Tested at lab up to 11 bar  
Sources used:  $^{55}\text{Fe}$ ,  $^{57}\text{Co}$ ,  $^{109}\text{Cd}$ ,  $^{241}\text{Am}$

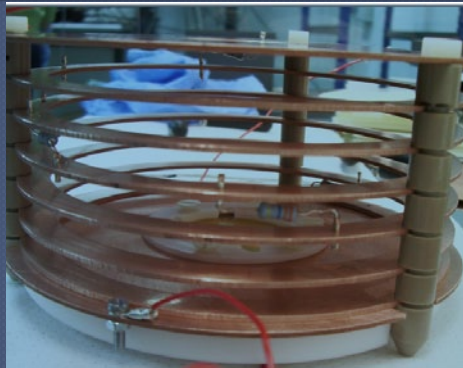


Material introduced:  
PEEK, Cu, Plastic, Perforated screws,  
Cables, Pins, mM (Cu, Kapton),  
Soldering, Resistors, Source

# Equipping NEXT-0-MM

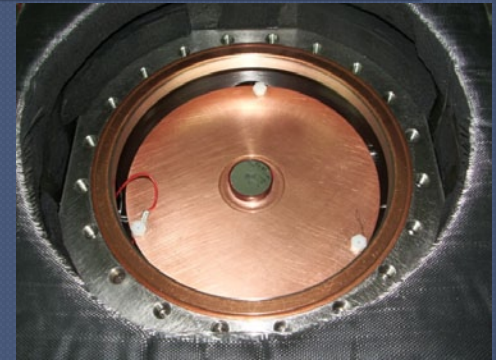
## Field Cage

6 copper rings  
3 Peek columns  
6 resistors of  $10\text{M}\Omega$



## Cathode

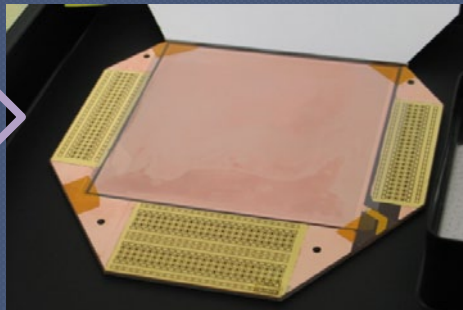
Copper disc  
Opening  
to fit the source



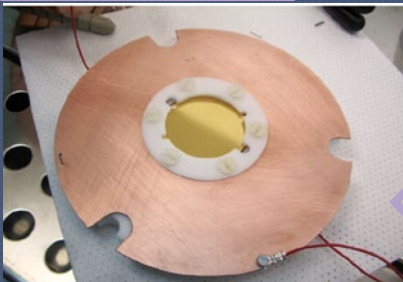
## Microbulk Micromegas

$50\text{ }\mu\text{m}$  gap

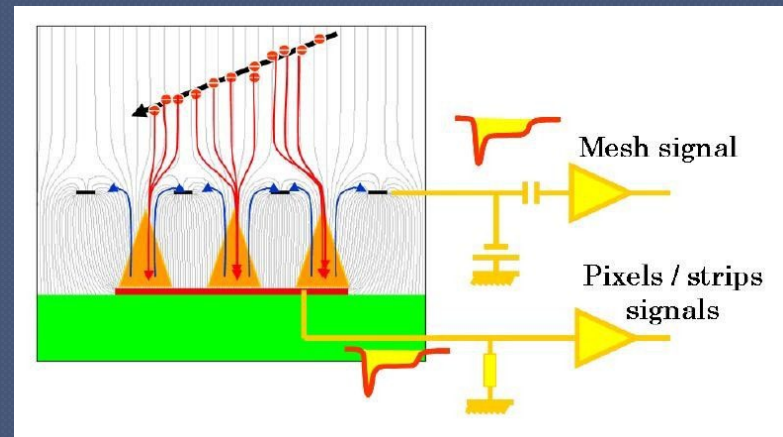
$10\times 10\text{ cm}^2$   
Pixelised anode  
 $12\times 12$  pixels



$\varnothing 35\text{ mm}$



## Two signal outputs

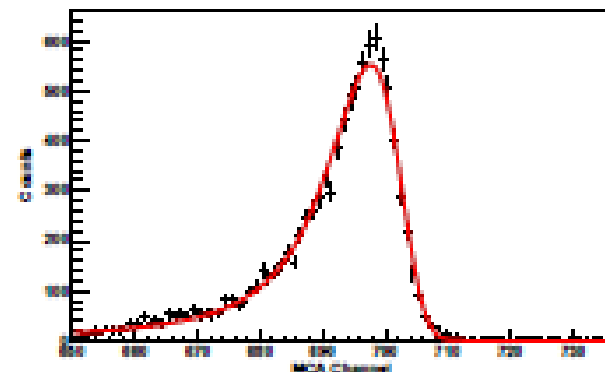
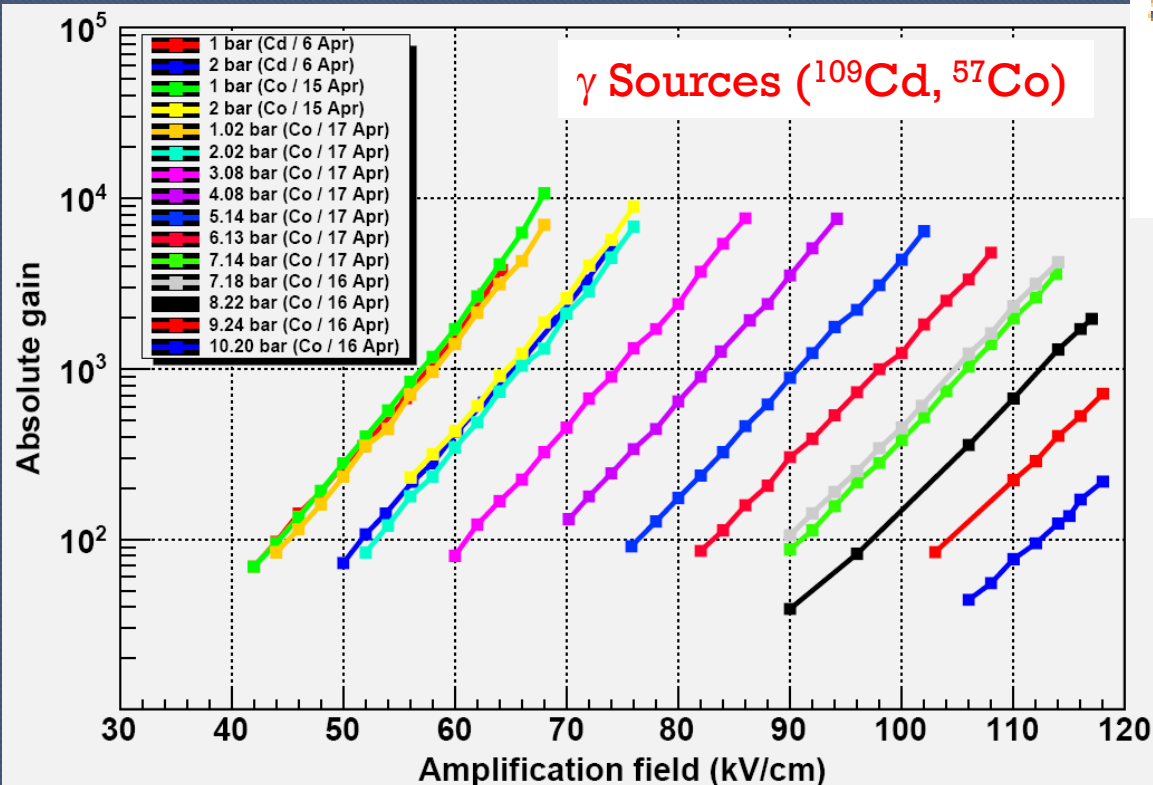




# NEXT-0-MM

## Tests in Argon-Isobutane

Example of results in Ar-2% Isobutane  
up to 10 bar



5.5 MV  $\alpha$  de  $^{241}\text{Am}$

0.7% (FWHM) at 4.75 bar

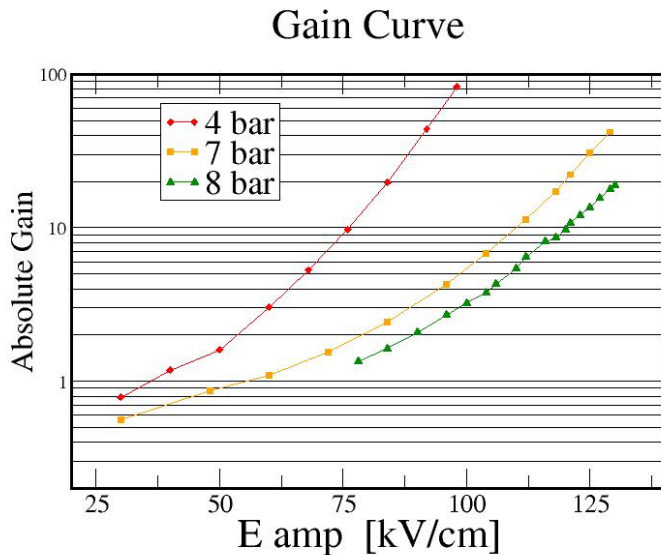
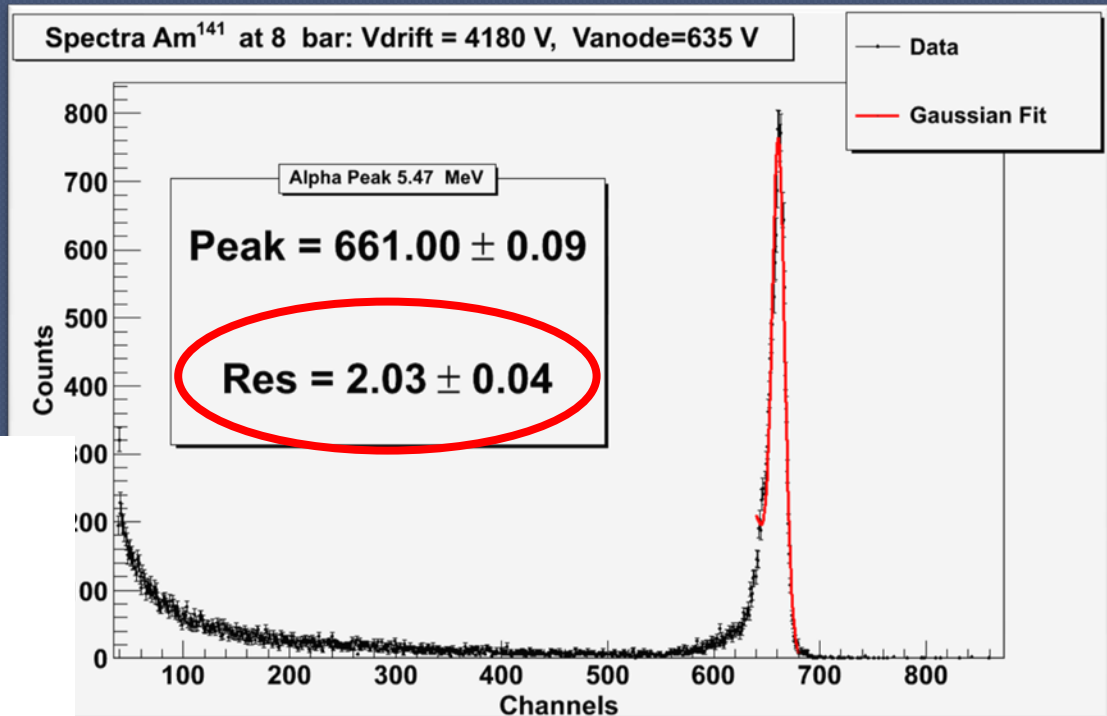


# NEXT-0-MM

## Tests with $\alpha$ in Pure Argon

Using an  $^{241}\text{Am}$  source

Tests performed in high pressures, reaching 8 bar.

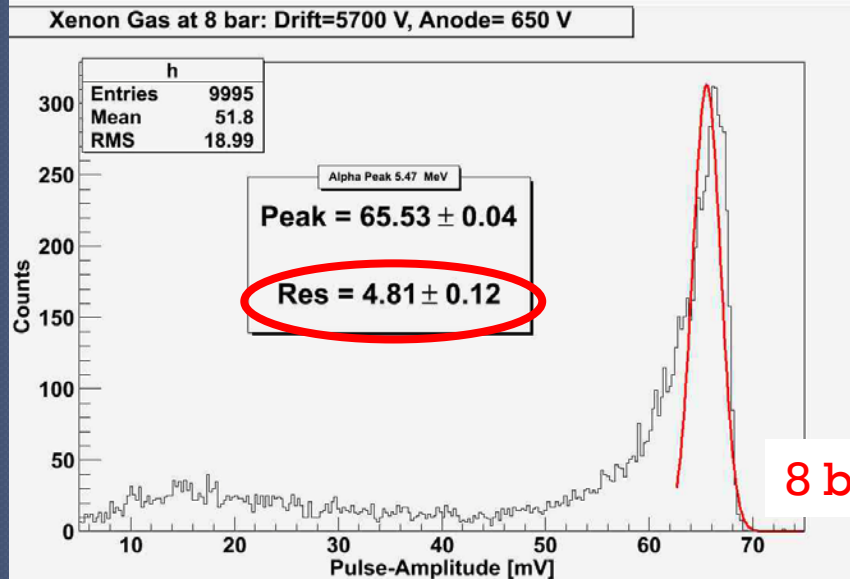
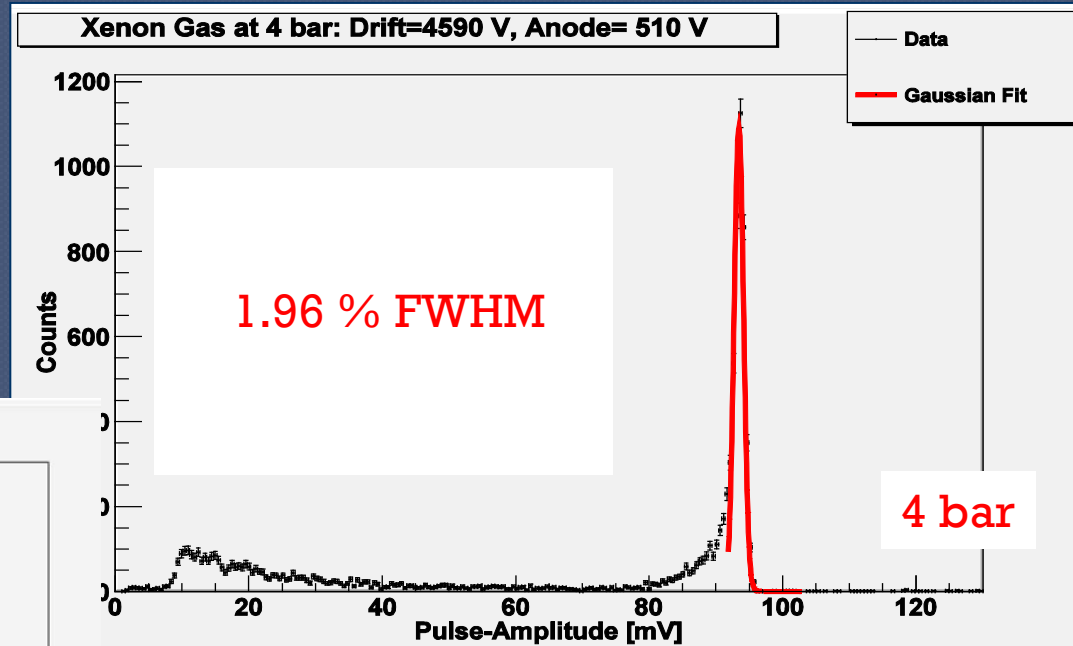


# NEXT-0-MM

## Tests with $\alpha$ in Pure Xenon

$^{241}\text{Am}$  source

Examples at 4 and 8 bar



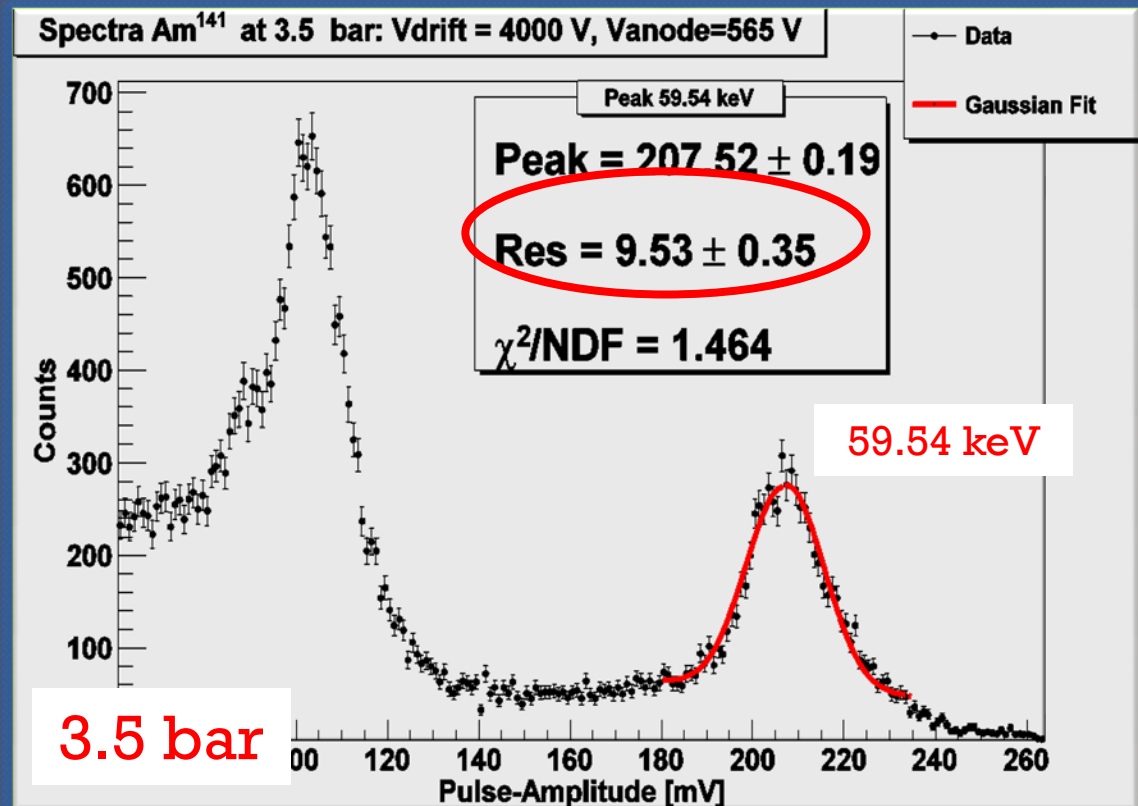
At higher pressures resolution worsens because of Attachment

# NEXT-0-MM

## Measurements with $\gamma$ in Pure Xenon

$^{241}\text{Am}$  source upside down  
blocks the  $\alpha$  allows the 59.54 keV  $\gamma$

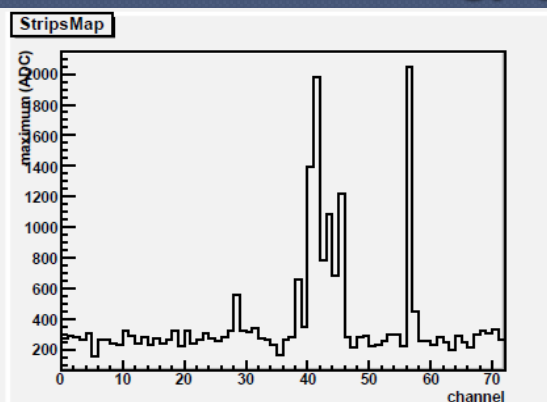
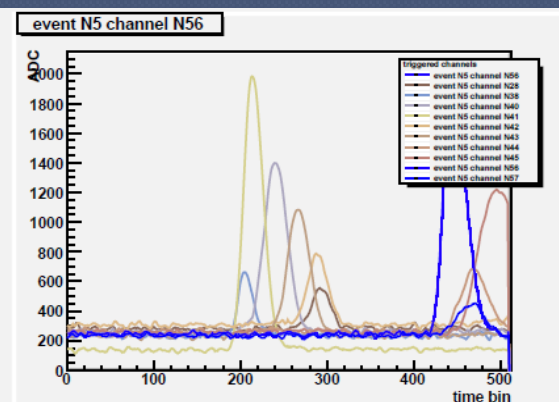
Example taken at 3.5 bar



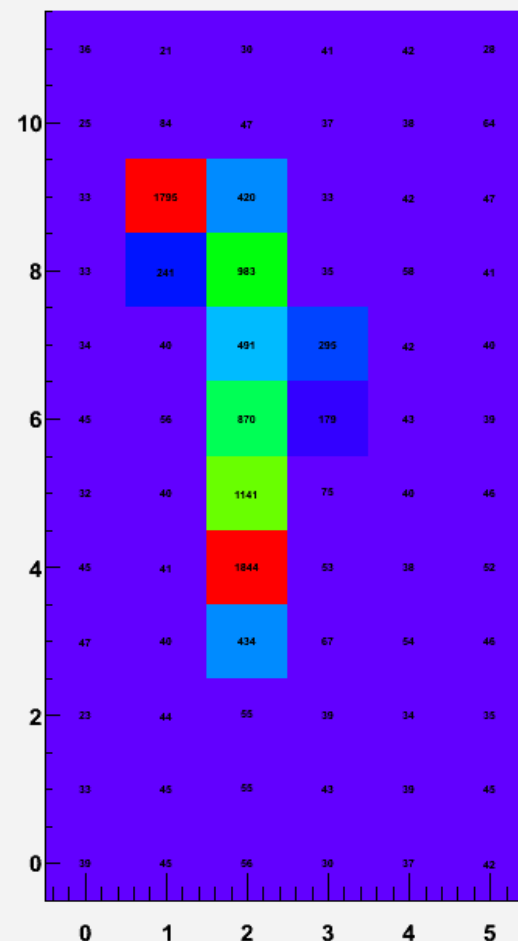
# NEXT-0-MM

## $\alpha$ tracks in Ar-Iso

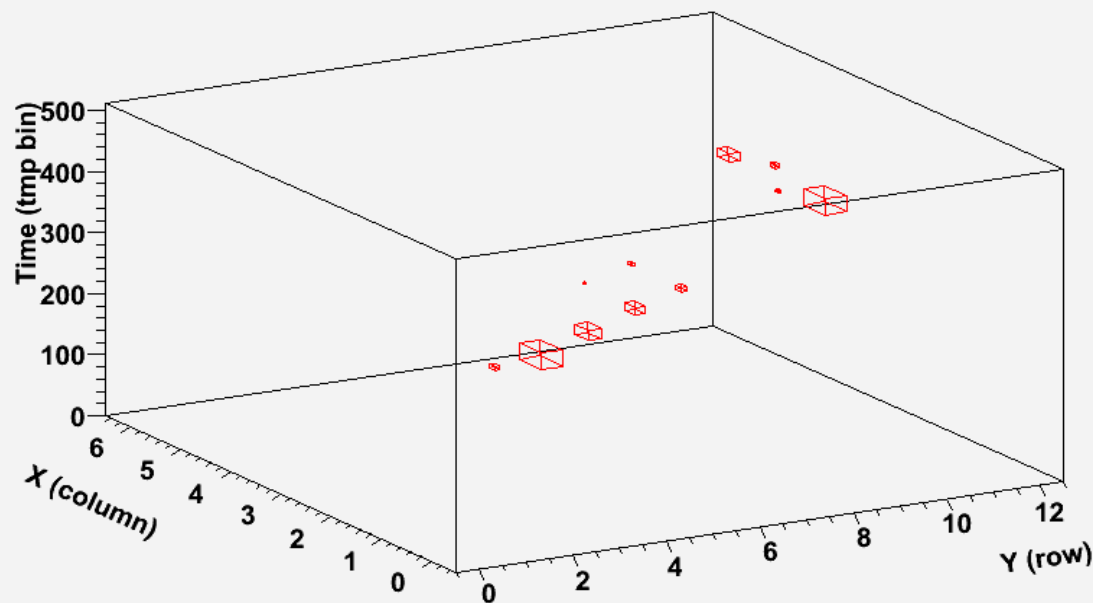
Ar- 2% Isobutane @1bar  
reduced T2K electronics version



Map for event 5



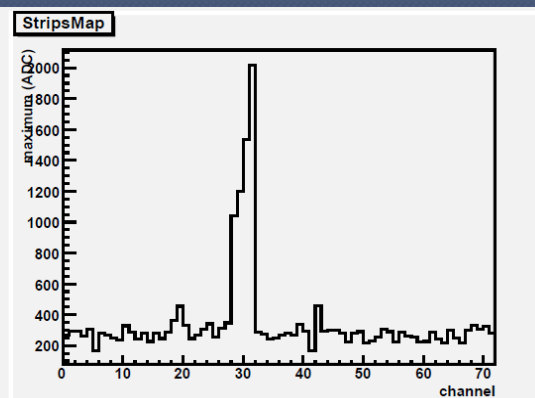
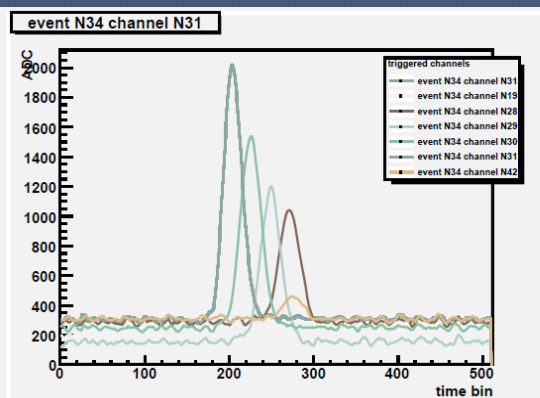
Event 5 reconstructed



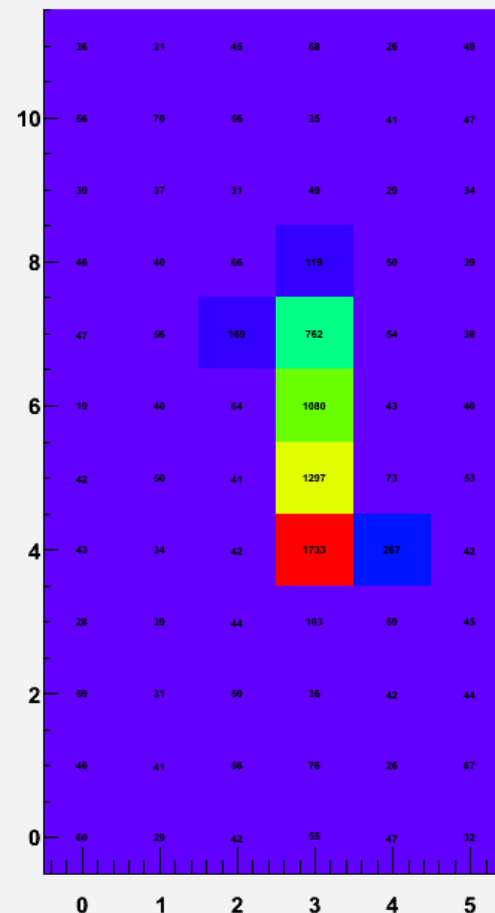
# NEXT-0-MM

Ar- 2% Isobutane @1bar  
reduced T2K electronics version

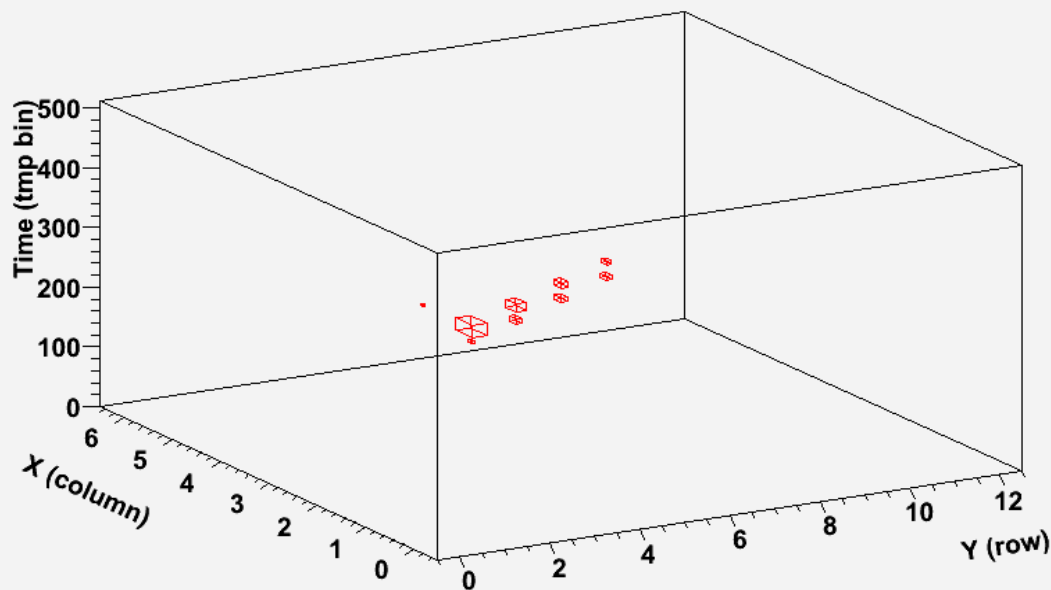
$\alpha$  tracks in Ar-Iso



Map for event 34



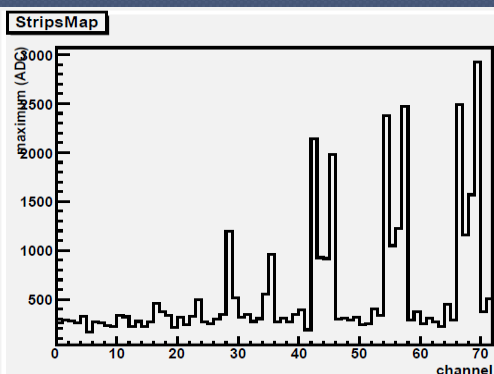
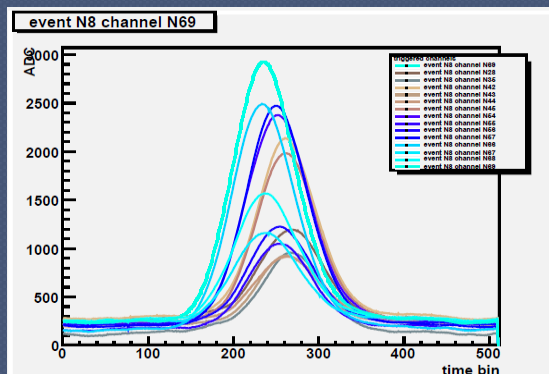
Event 34 reconstructed



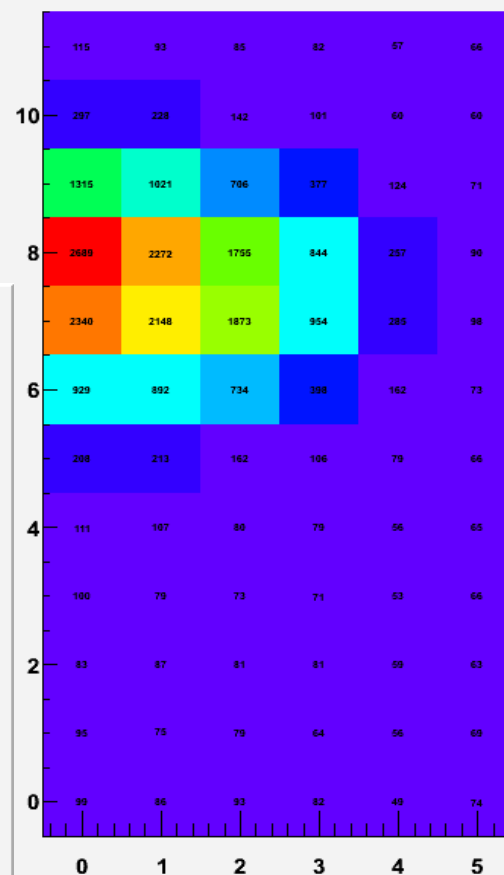
# NEXT-0-MM

Pure Ar @1.23 bar  
reduced T2K electronics version

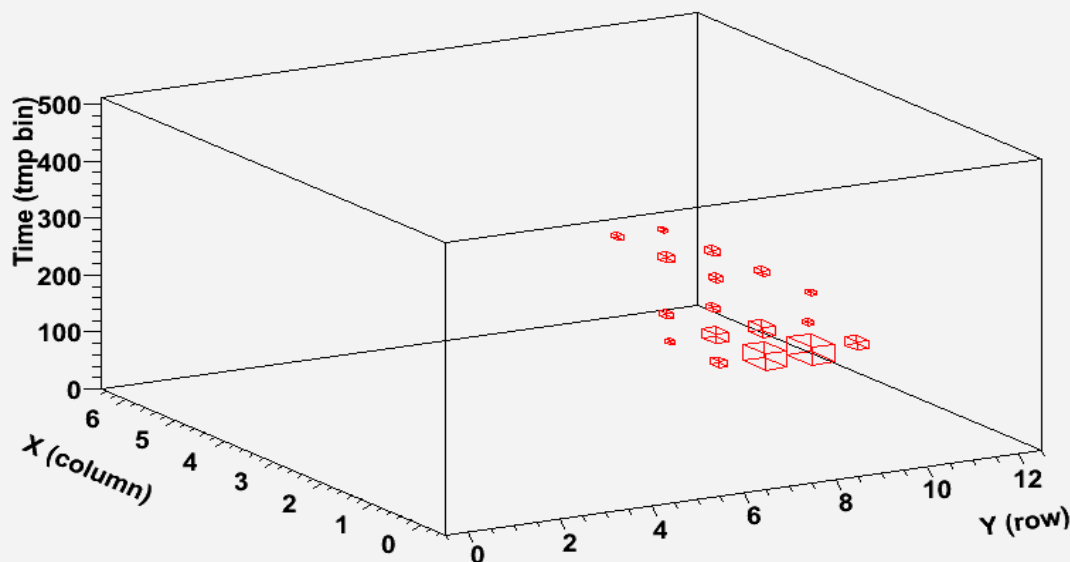
$\alpha$  tracks in pure Ar



Map for event 8



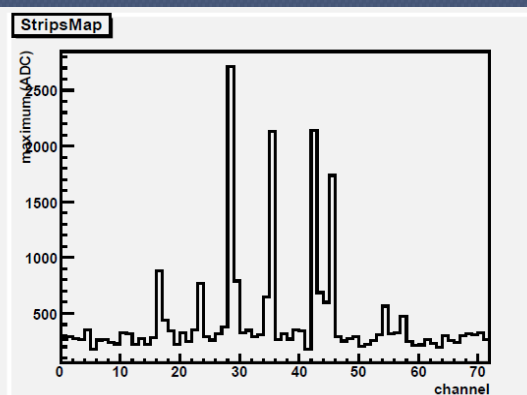
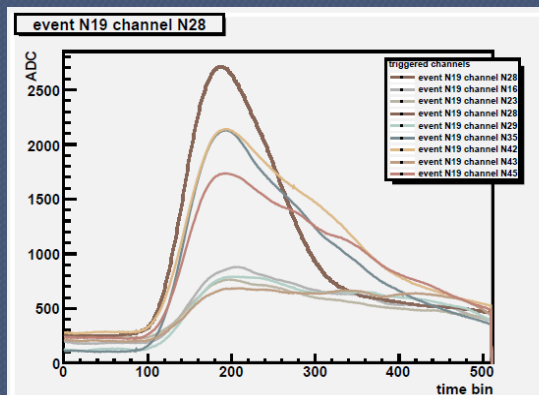
Event 8 reconstructed



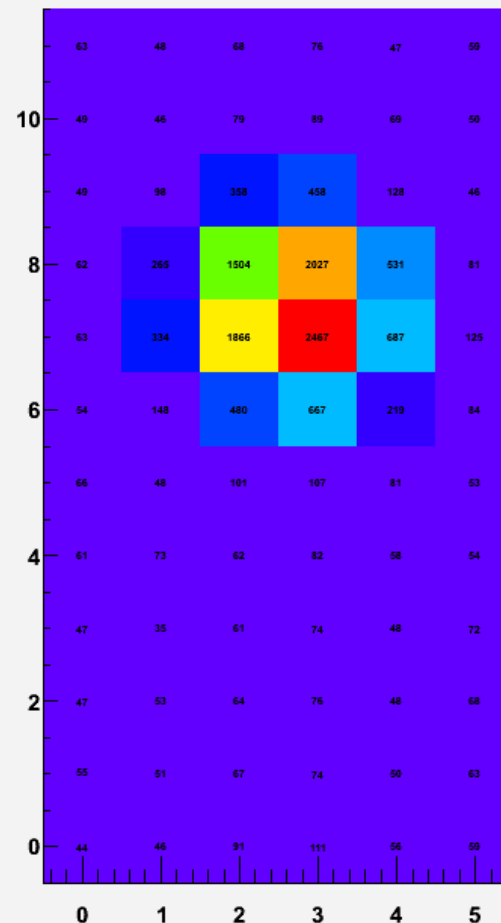
# NEXT-0-MM

Pure Ar @1.23 bar  
reduced T2K electronics version

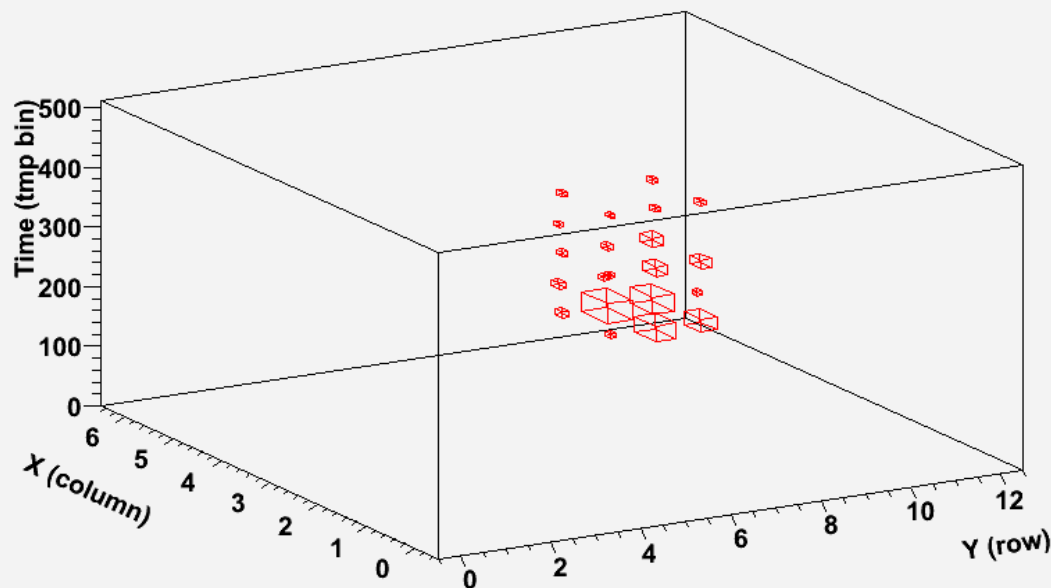
$\alpha$  tracks in pure Ar



Map for event 19



Event 19 reconstructed





# NEXT-1-MM

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The jump to a big prototype

# NEXT-1-MM

## Bigger Prototype for ~1kg of Xe (at 10 bar)

- Inner Volume of 74 litres (600mm height, Ø 396mm)
- Tested for operation at high pressure (15 bar)
- Steel structure to manipulate the parts of the vessel with a crane
- Using the same gas system as for NEXT-0
- Heating and insulation systems



# NEXT-1-MM

## Bigger Prototype for ~1kg of Xe (at 10 bar)

- Inner Volume of <80 litres (600mm height, Ø 396mm)
- Tested for operation at high pressure (15 bar)
- Steel structure to manipulate the parts of the vessel with a crane
- Using the same gas system as for NEXT-0
- Heating and insulation systems



# Equipping NEXT-1-MM

## Field Cage

35 cm drift height  
34 rings

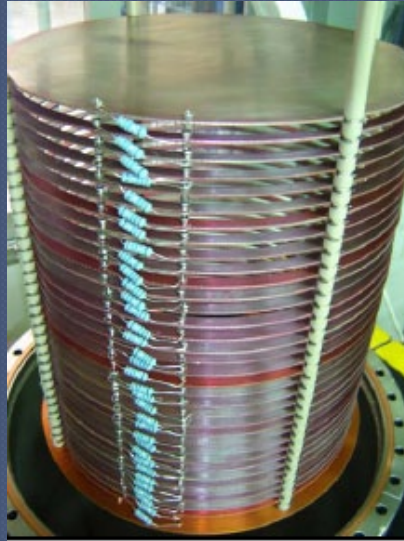
Inner ring Ø 28cm

Outer ring Ø 30cm

4 PEEK columns

35 resistors

70 PEEK screws



330 M $\Omega$  total resistivity  
For drift fields of  $\sim$  kV/cm  
need to supply 35kV

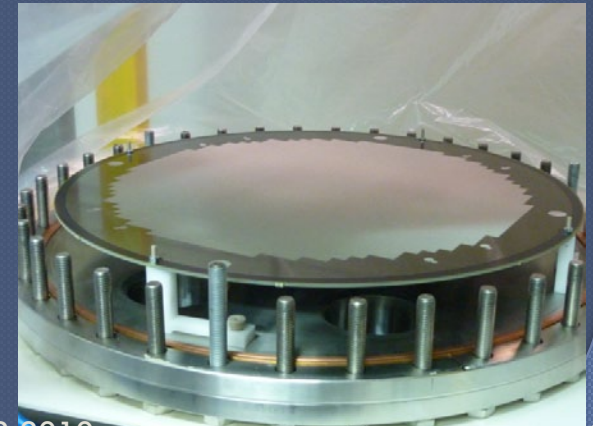
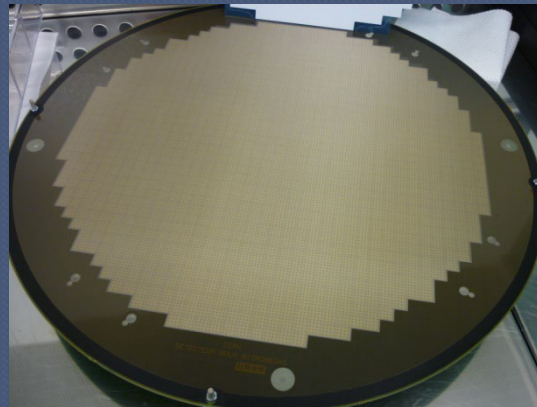
Special HHV FT  
are studied

Cirlex foil between field  
cage and vessel walls



## Bulk Micromegas

Active region Ø  $\sim$ 30cm  
1252 pixels  
independently read

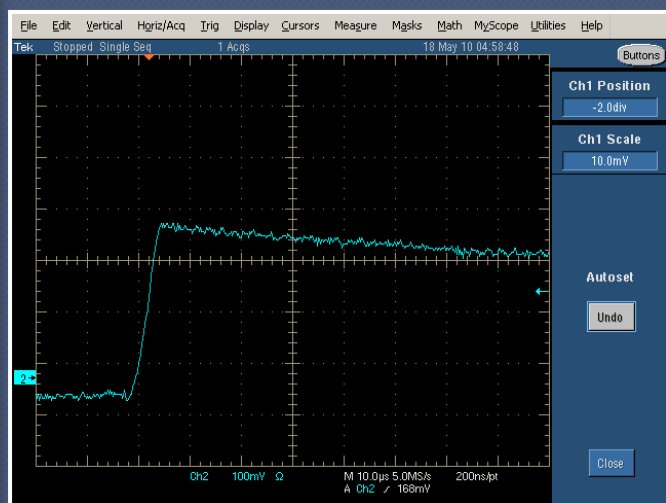


# NEXT-1-MM

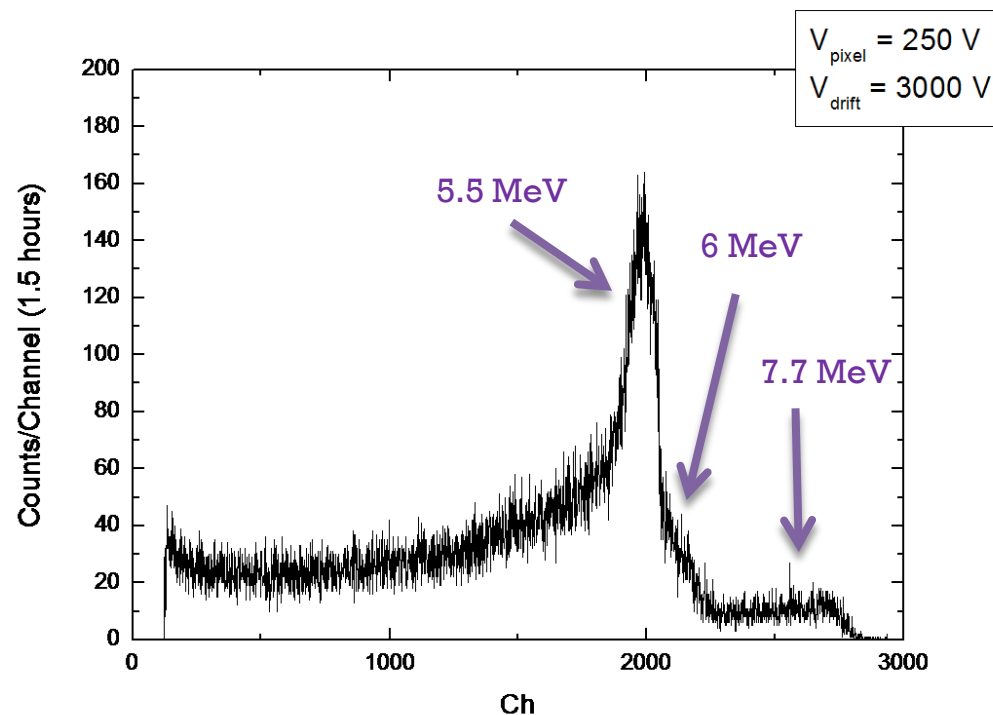
## First Tests

### Reading the mesh

First pulses  
(muons and alpha events)



Rn source diffused  
in Ar - 2%Iso at 1 bar

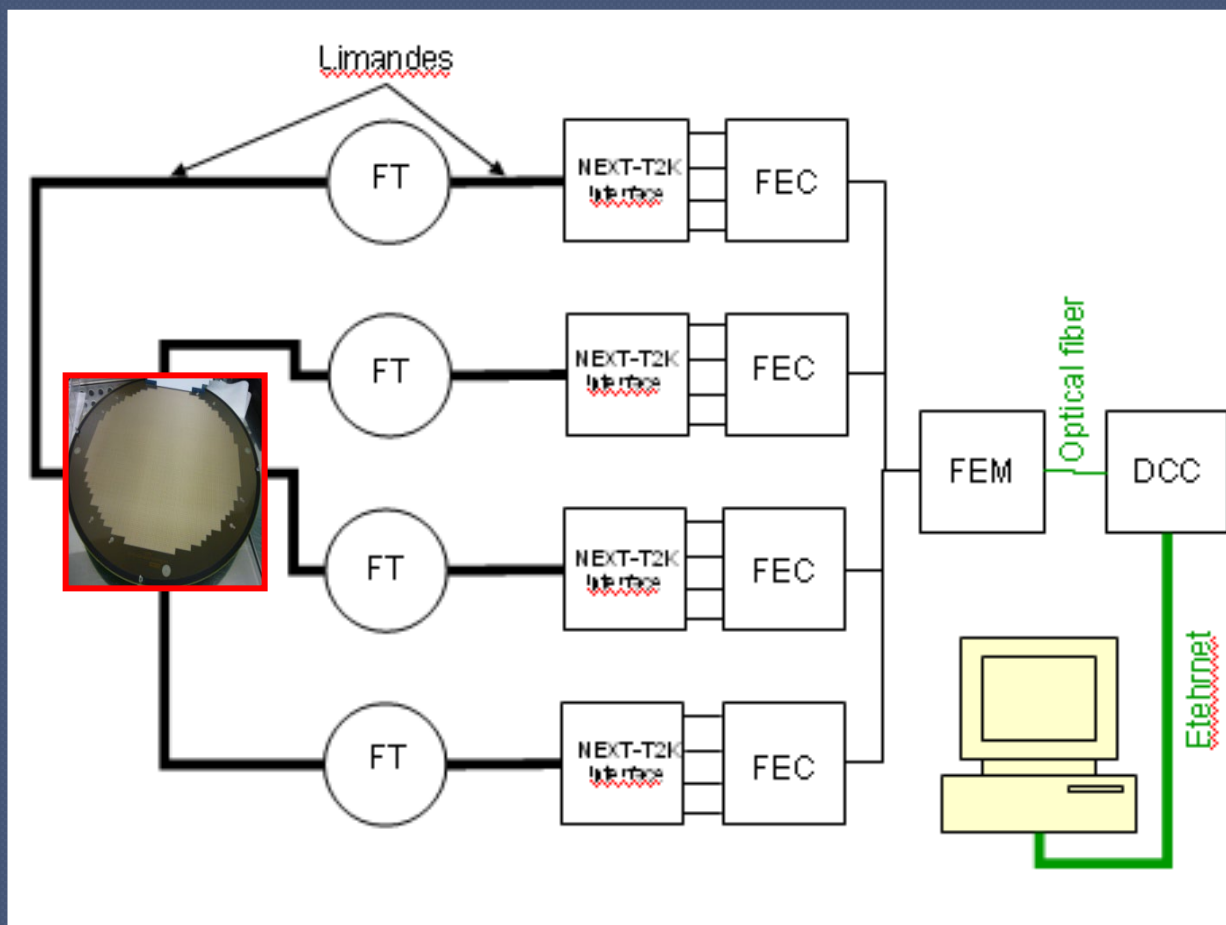




# NEXT-1-MM

## Reading the pixels

DAQ and Electronics

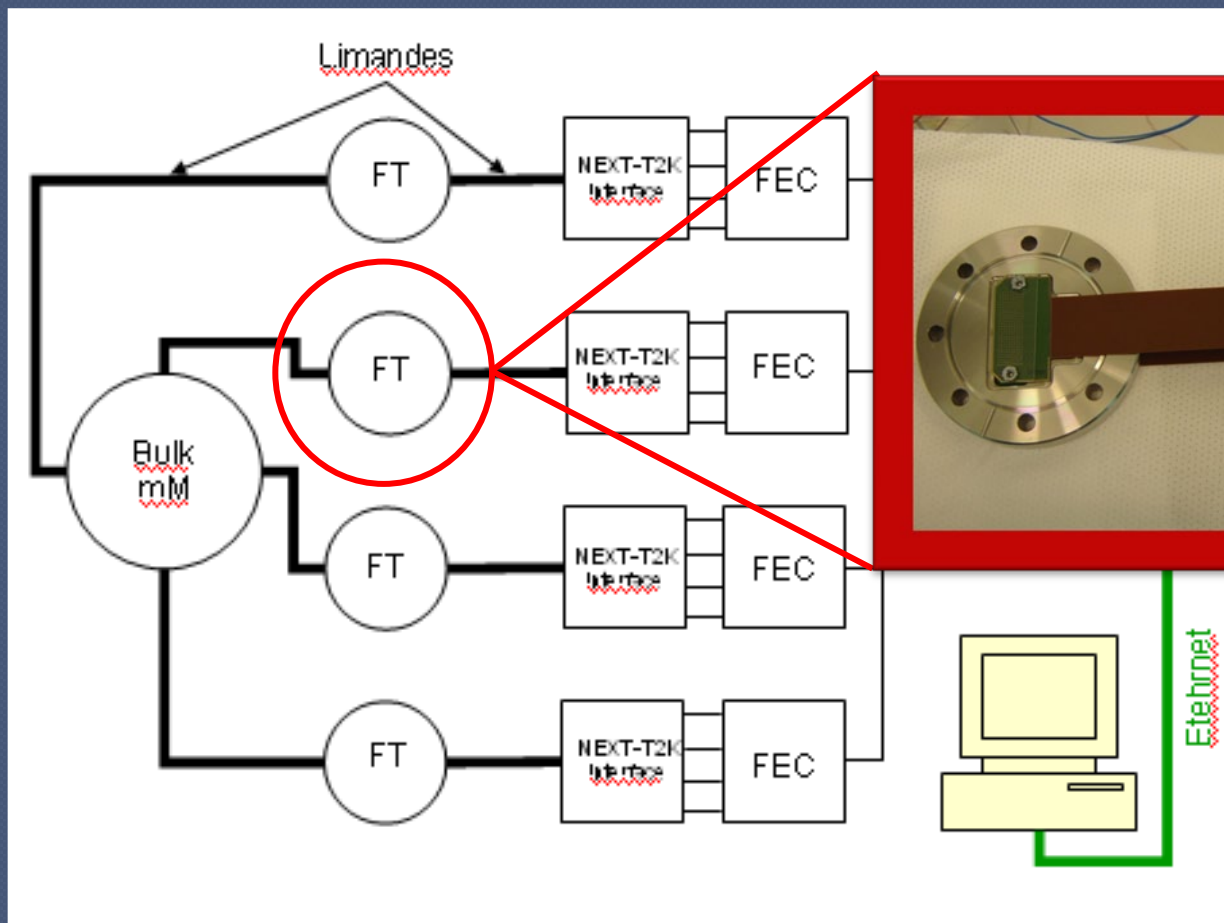


1252 channels to read

# NEXT-1-MM

## Reading the pixels

### DAQ and Electronics



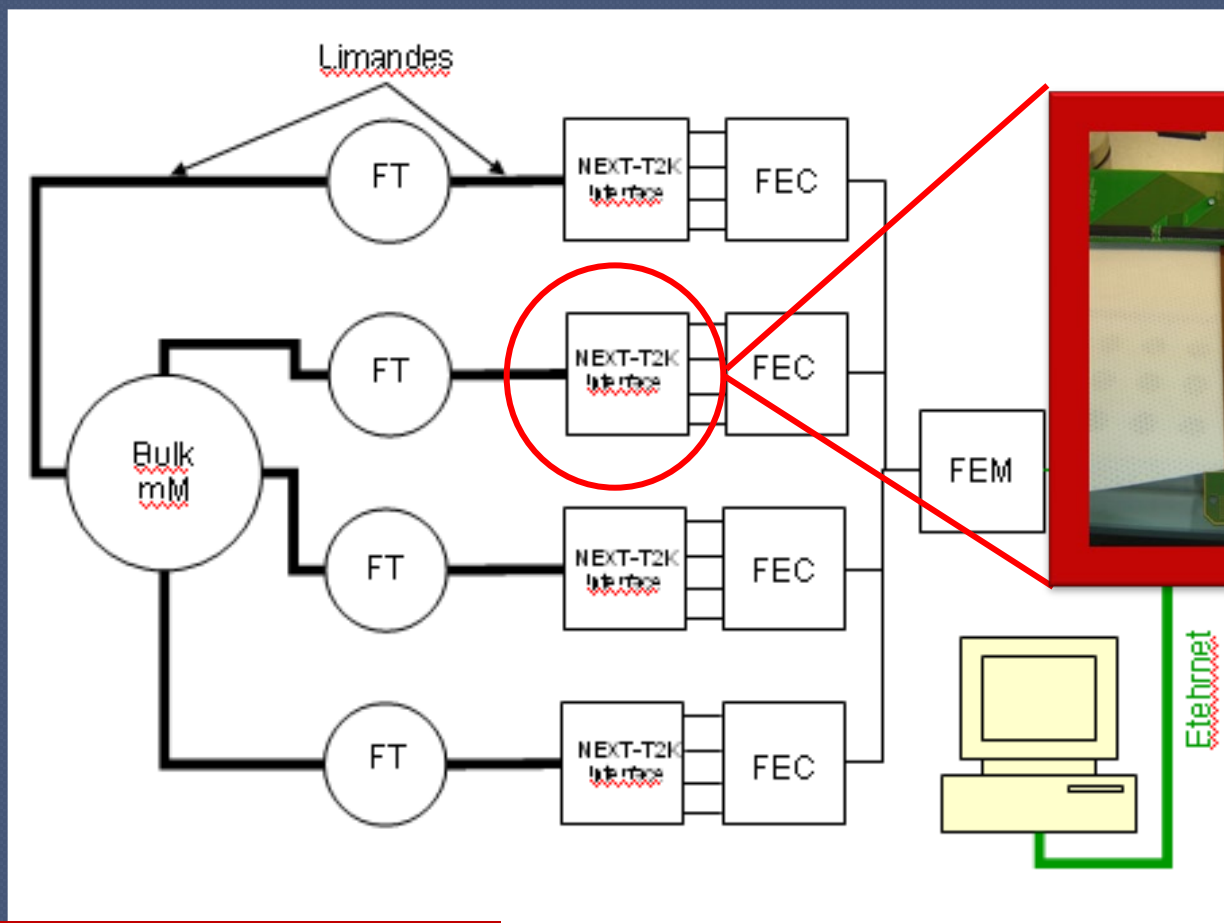
Feedthrough design by J.P. Mols (Saclay)



# NEXT-1-MM

## Reading the pixels

### DAQ and Electronics

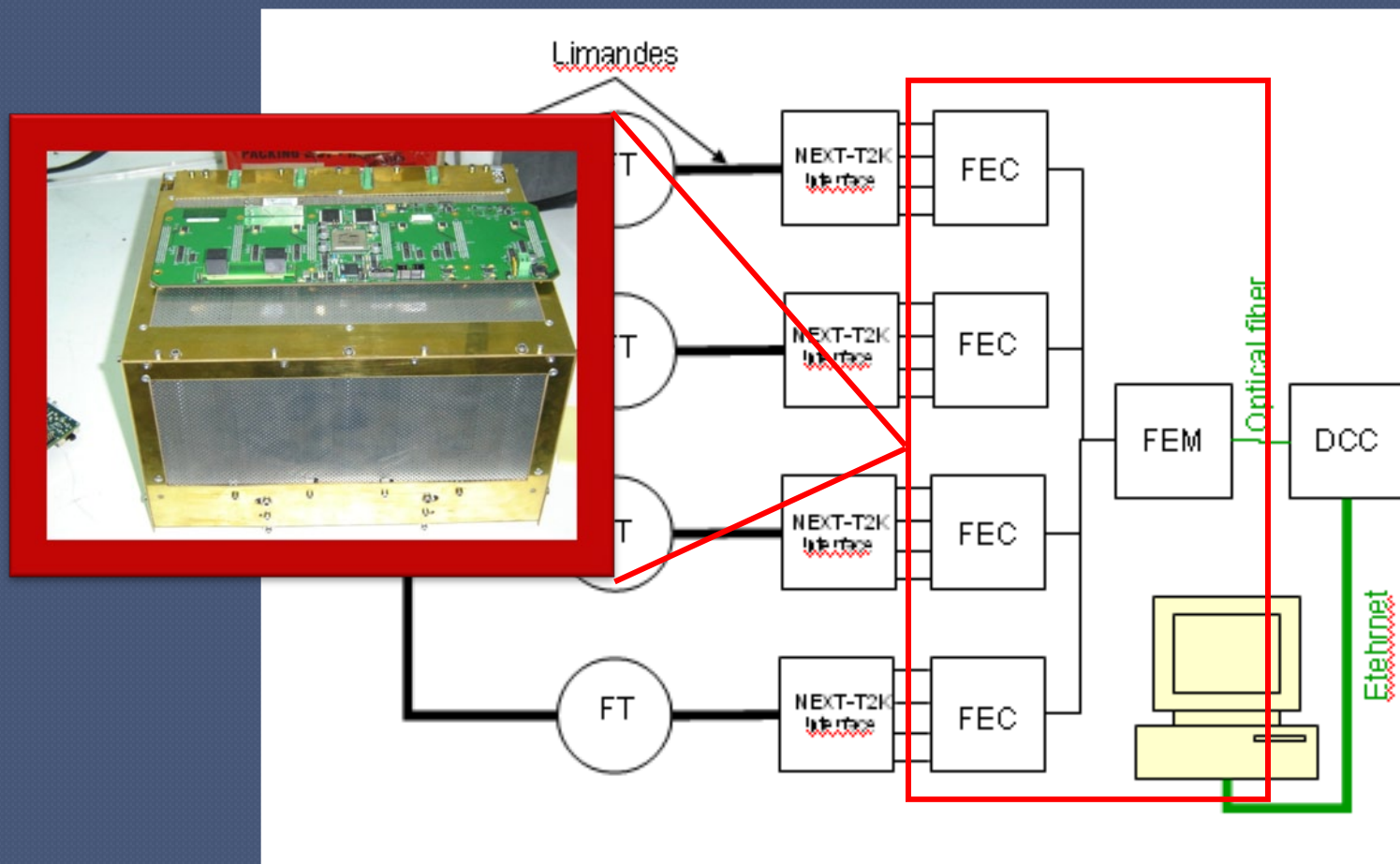


Adaptor towards T2K electronics

# NEXT-1-MM

## Reading the pixels

### DAQ and Electronics



T2K electronics, Gbyte optical link

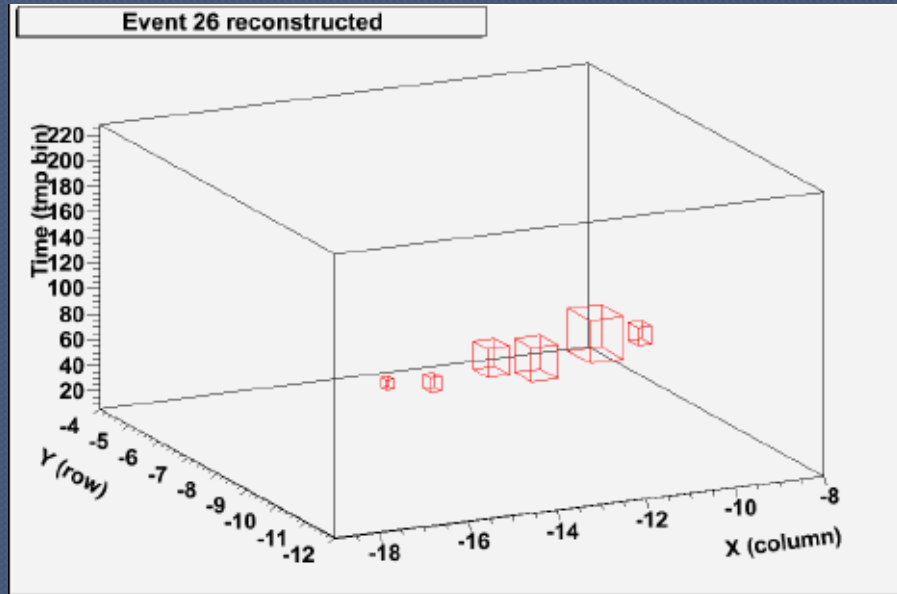
# NEXT-1-MM

## Reading the pixels

Ar-2% Isobutane

Rn source

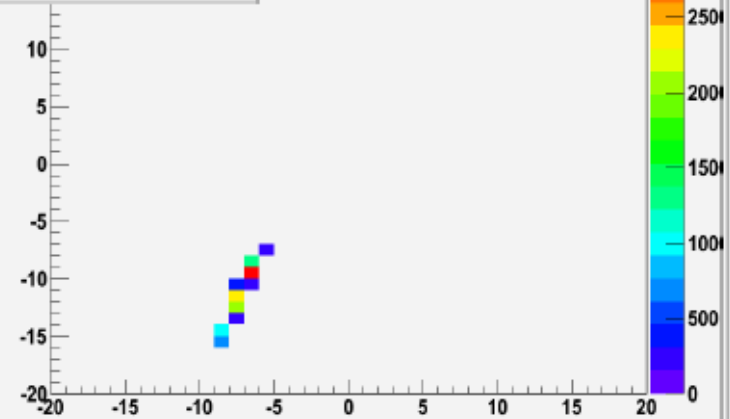
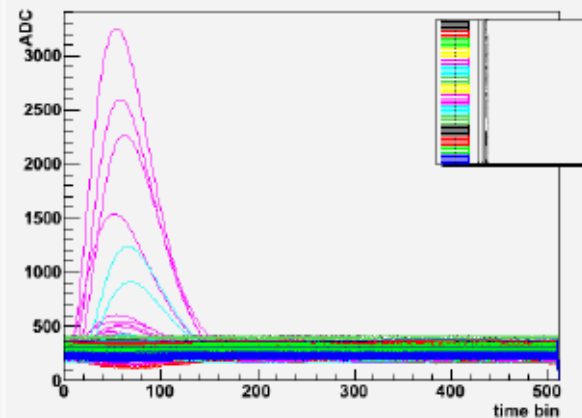
1 bar



NEXT-1-MICROMEGAS

Alpha (Rn) event!

Run68  
Zaragoza 21<sup>th</sup> October 2010

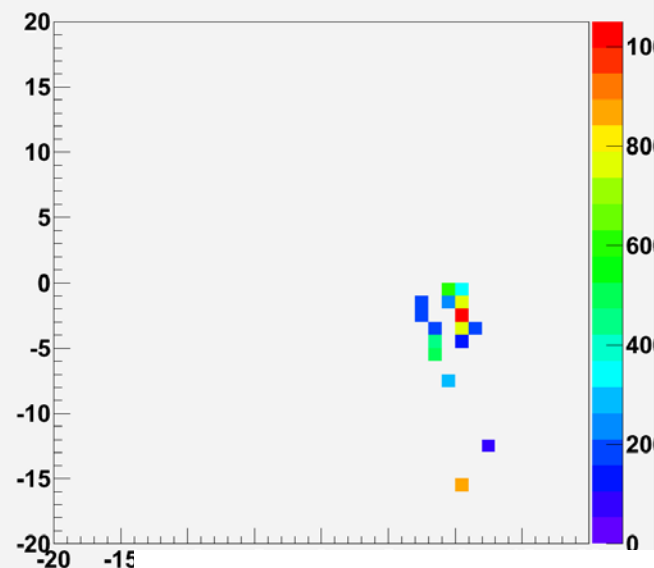


# NEXT-1-MM

## Reading the pixels

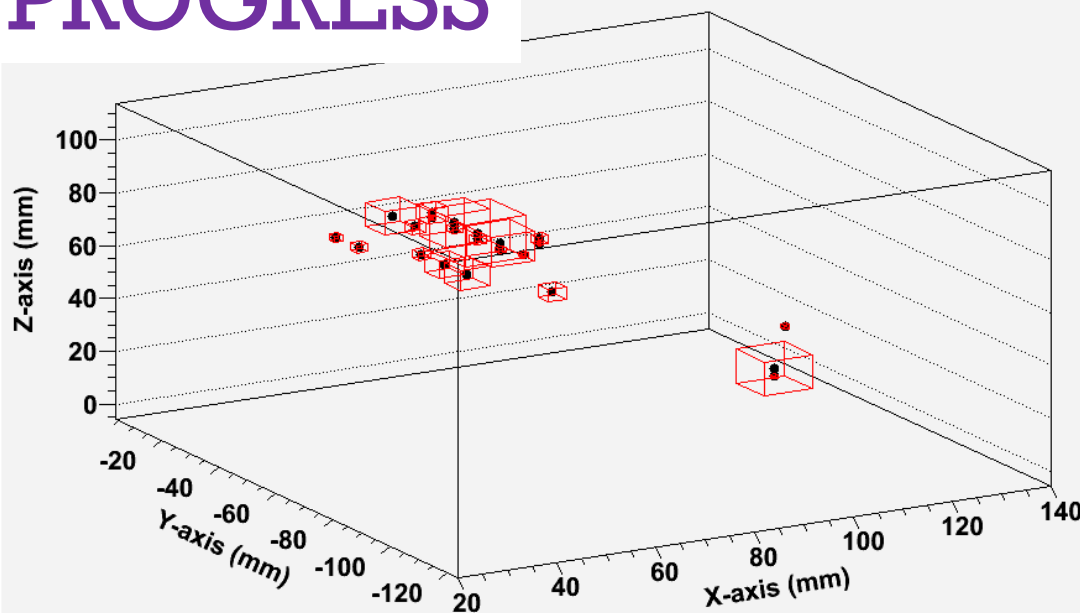
First events in Xe !

Map for event 22



WORK IN PROGRESS

from T2KrawEvent

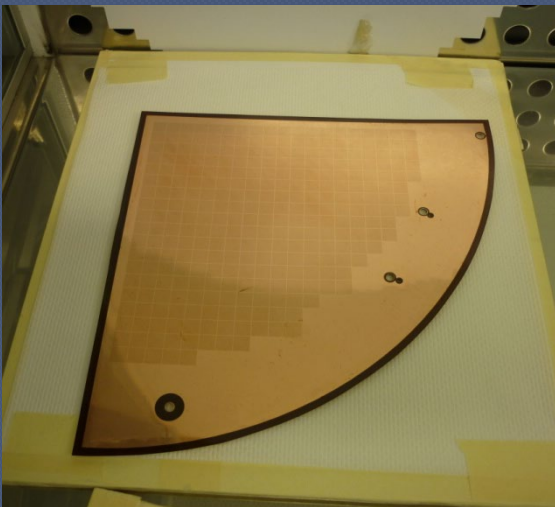


# NEXT-1-MM

## Next Steps

Study the behaviour of the bulk in different pressures

Characterize and install the new microbulks (arriving to Zgzh this week)



Explore  
tracking capability and  
energy resolution

of the microbulk in Xe

Conclude pending measurements with  $\beta$  sources  
Install a PMT plane for the  $t_0$  measurement

# Radiopurity measurements

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S. Cebrian et al., Astropart. Phys (2010) doi:10.1016/j.astropartphys.2010.09.003

# Radiopurity measurements

Rare event searches dictate the use of radiopure materials  
important parameter for the big-scale experiments  
Necessary to know the quantity, nature and origin of the contamination

## Results (in $\mu\text{Bq}/\text{cm}^2$ )

	$^{232}\text{Th}$	$^{235}\text{U}$	$^{238}\text{U}$	$^{40}\text{K}$	$^{60}\text{Co}$
<b>Microbulk mM</b>	<9.3	<13.9	$26.3 \pm 13.9$	$57.3 \pm 24.8$	<3.1*
<b>Kapton-Cu foil</b>	<4.6*	<3.1*	<10.8	<7.7*	<1.6*
<b>Cu-Kapton-Cu foil</b>	<4.6*	<3.1*	<10.8	<7.7*	<1.6*

\*Level obtained from the Minimum Detectable Activity of the detector

- ✓ Very low levels of radioactivity, especially the Raw materials
- ✓ contamination probably comes from the treatment of the materials used
- ✓ Next steps to focus on the identification of the contaminating steps and find alternatives

S. Cebrian et al., Astropart. Phys (2010) doi:10.1016/j.astropartphys.2010.09.003



# Summary

Micromegas is an **interesting** option for the NEXT-100 detector:

✓ Results in NEXT-0 -MM (6cm drift) show a good performance in energy resolution:

1.96 % (FWHM) at 4 bar of pure Xe for 5.5 MeV  $\alpha$

9.5 % (FWHM) at 3.5 bar of pure Xe for 60keV  $\gamma$

✓ NEXT-1-MM (35 cm drift) is being commissioned in Xe with a Bulk detector

✓ The microbulk planes present **very low** radioactivity levels

Work in progress

NEXT-0:-MM Tests with different Xe mixtures (e.g. Xe+Ne) underway

NEXT-1:-MM Tests with the microbulk planes to start soon

end

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Thank you for your attention

# NEXT-0

## Tests with $\alpha$ in Pure Xenon

When going to higher pressures the effect of attachment can be clearly seen

