

# Many tests in recent years

Beam test at DESY in 2015 (LCTPC, 2DLC modules)

Cosmic-ray test at Saclay in 2017 (T2K)

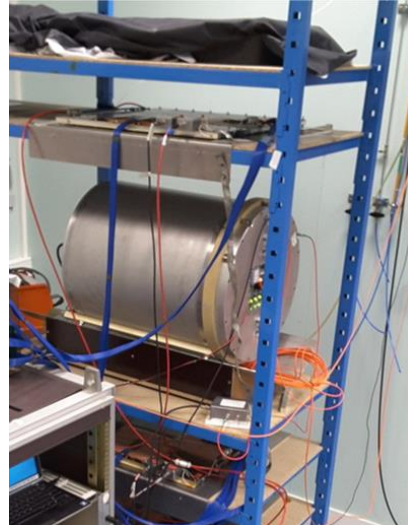
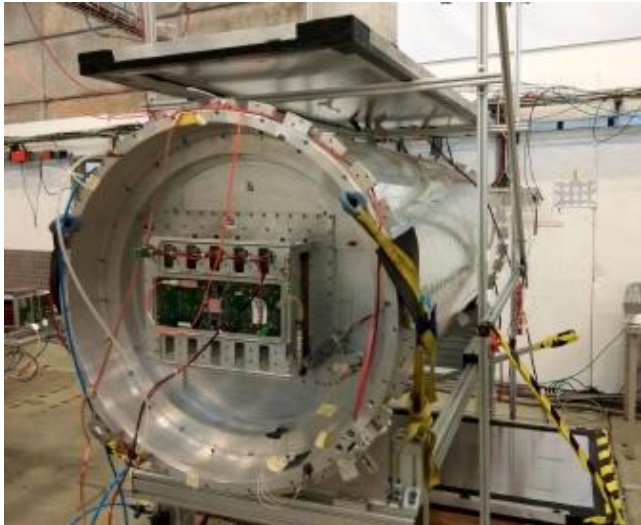
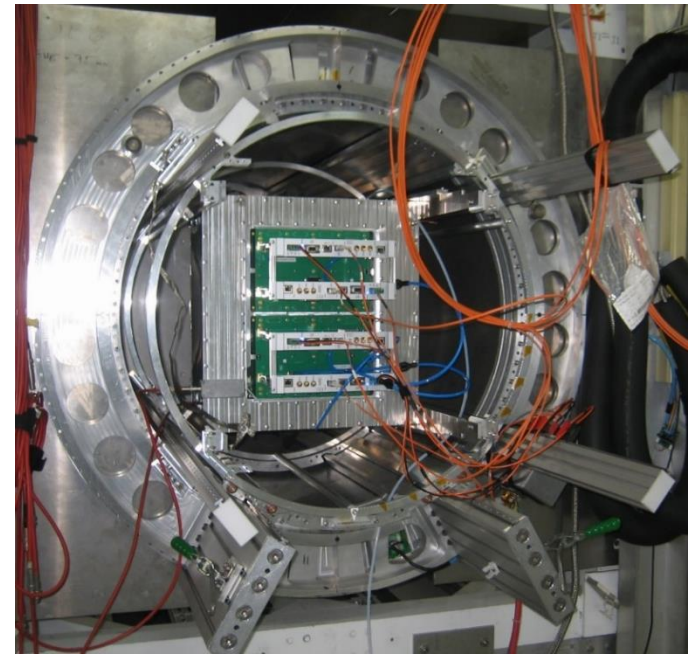
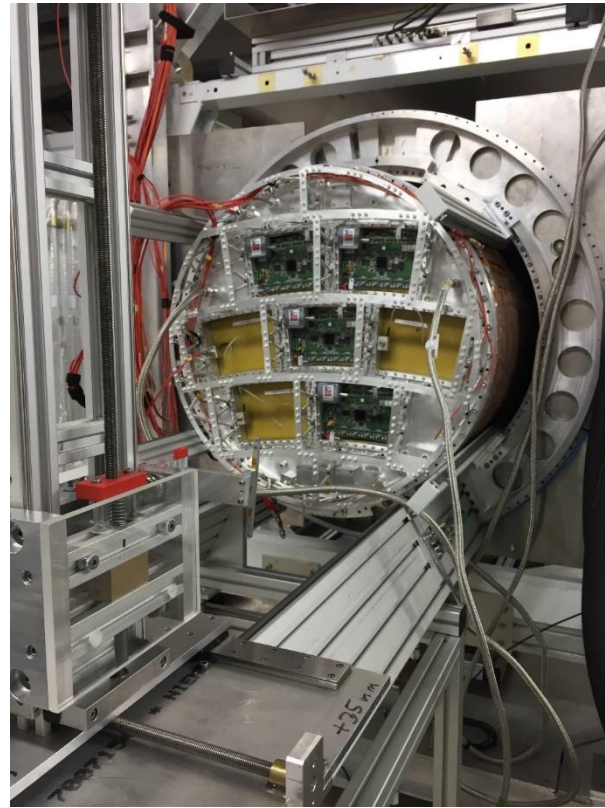
Beam test at CERN in August 2018 (T2K)

Beam test at DESY in November 2018 (LCTPC)

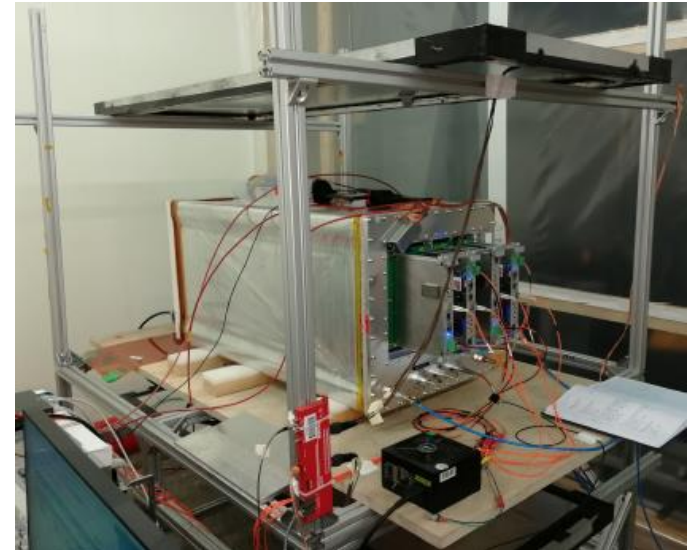
Cosmic-ray test in Saclay since January 2019 (LCTPC/FCC)

Beam test at DESY in June 2019 (T2K)

Cosmic test at CERN since December 2019 (T2K)



5 TPC of 15, 58, 60, 100  
and 150 cm length with  
1000 to 2000 channels  
All with DLC charge  
spreading



**Overall conclusion : extremely reliable and stable operation**

# Issues with DLC

Streaks of chemicals in one of the DLC foils and micro-scratches on another.



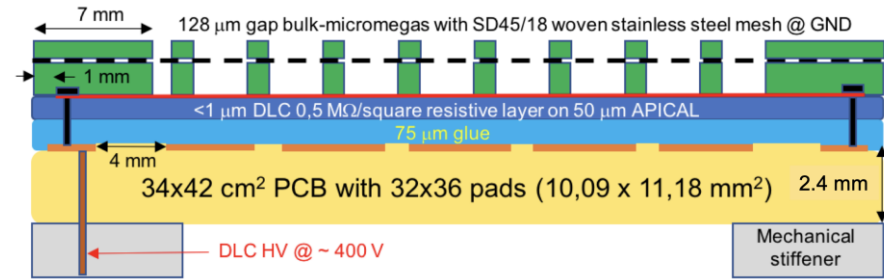
# • TPCs for ILC and T2K

Charge spreads according to a diffusion equation, parameter RC of the resistive-capacitive continuous network. R surface resistivity per unit of surface, and C capacitance per unit of surface

$$C = \frac{\epsilon_0 \epsilon_r}{d}$$

$$\frac{\partial \rho}{\partial t} = \frac{1}{RC} \left[ \frac{\partial^2 \rho}{\partial r^2} + \frac{1}{r} \frac{\partial \rho}{\partial r} \right]$$

$$\Rightarrow \rho(r, t) = \frac{RC}{2t} e^{-\frac{r^2 RC}{4t}}$$

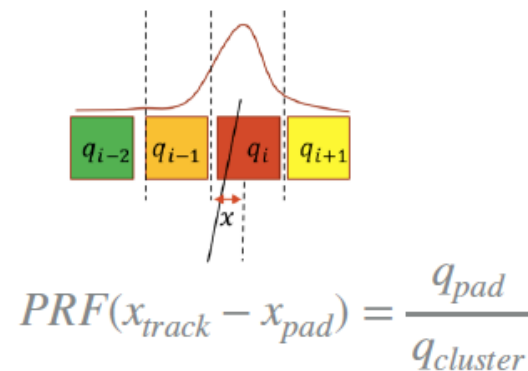
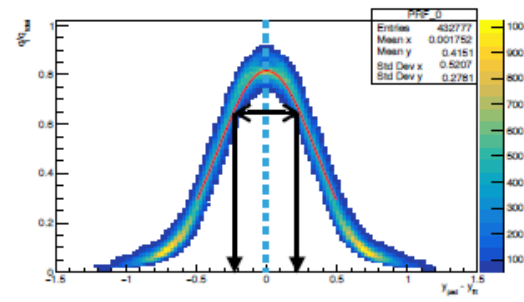
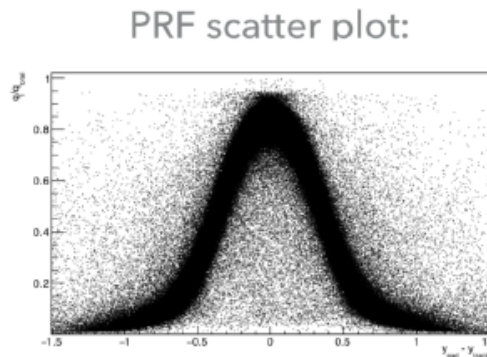
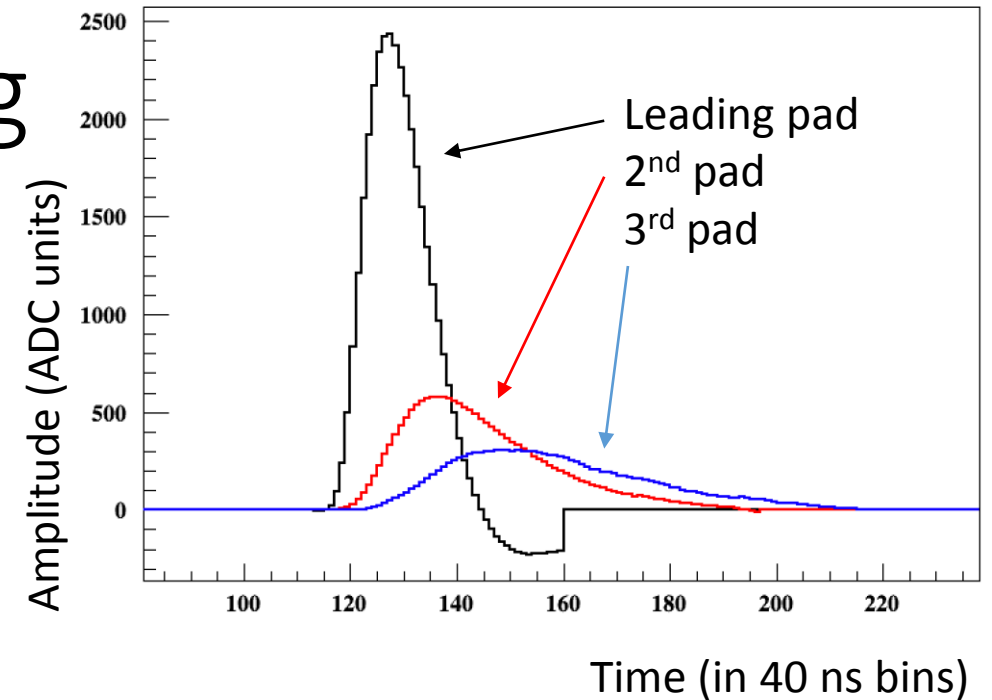


RC ~100 ns/mm<sup>2</sup> allows spreading over a few mm<sup>2</sup> in the integration time of the electronics of O(100 ns)

M.S. Dixit et.al., NIM A518, 721 (2004) , M.S. Dixit & A. Rankin, NIM A566, 281 (2006)

# Details on Charge spreading

- Wave forms
  - They carry information on RC, and can be used to assess the uniformity of RC
  - Used to get a RC map (S. Hassani, S. Emery)
  - The time of the maximum is sensitive to  $x$
- Pad Response Function (PRF)
  - Relates the pulse height fraction to the position of the track within the pad



S. Suvorov  
M. Lehuraux

# Simulation of the wave forms

Starting now a simulation in the T2K case

- Sensitivity of the ADC : 120 fC full scale (4096 channels)
- Electronic response of the amplifier-shaper (CSA) for 200 and 412 ns shaping times (a data file from Pascal Baron, fitted by Samira using a modified Gumbel function)
- AFTER input impedance scheme (from Pascal Baron)
- Thickness and permittivity of insulator
- Pad size : 9.9x11.1 mm<sup>2</sup>
- Thickness and permittivity of the kapton foil
- Surface resistivity of the DLC coating (to be varied between 200 and 400 kOhm/sq)
- Micromegas gap : 128 μm
- Avalanche size and fluctuations : Polya with theta about 1, average 2000
- Primary ionization to be obtained from HEED for 5 GeV electrons with the T2K gas mixture (Ar/CF4/Iso:95/3/2)
- We can probably start with neglecting time of ion transit in the gap (max 260 ns) and longitudinal diffusion.

# Other news

- Shivam Joshi starts studying 'ghost' tracks. 0.4% of the events have such an additional ghost track.