Test of a new anode resistive coating for a Micromegas TPC

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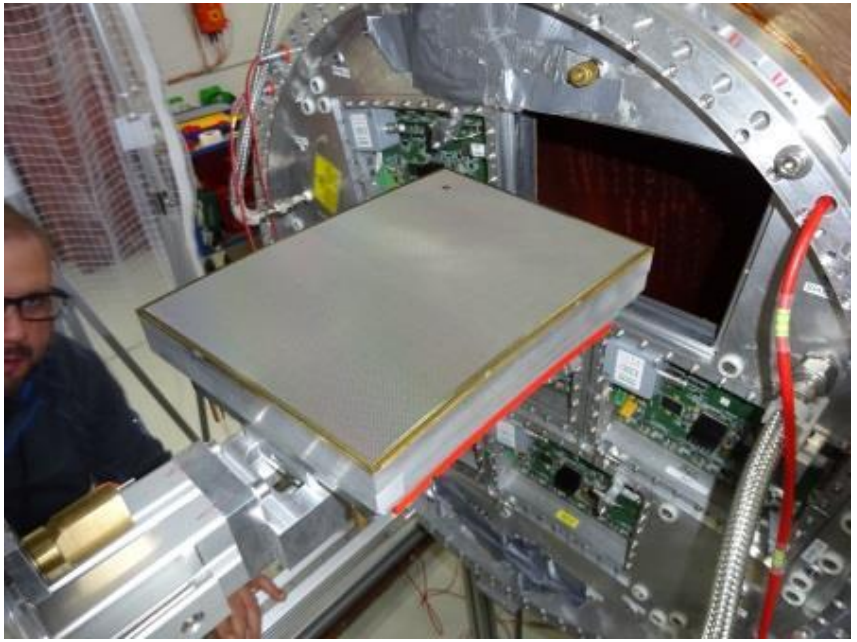
Resistive coatings for charge spreading and spark mitigation

Carlon-Loaded Polyimide and Diamond-like Carbon

Beam test

Comparaison of CLP and DLC



Part of the data used here were taken at the DESY test facility of the LCTPC collaboration.

What is a DLC?

Diamond-like Carbon

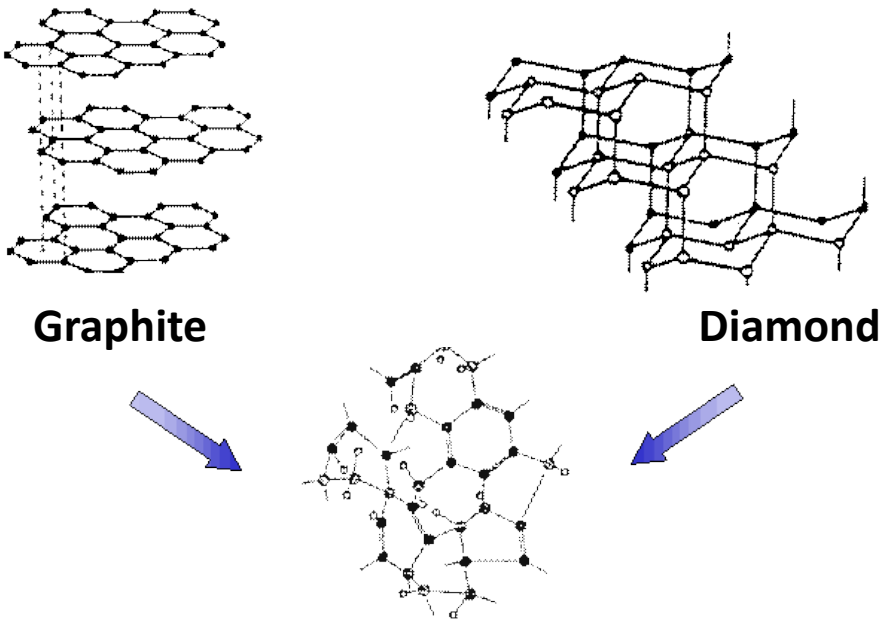
Robust, flexible, resistive with a large range of resistivity, precisely tunable, lubricant

Available from Japan (by A. Ochi). 100 nm layer deposited on kapton

Used to make lubricated mechanical parts

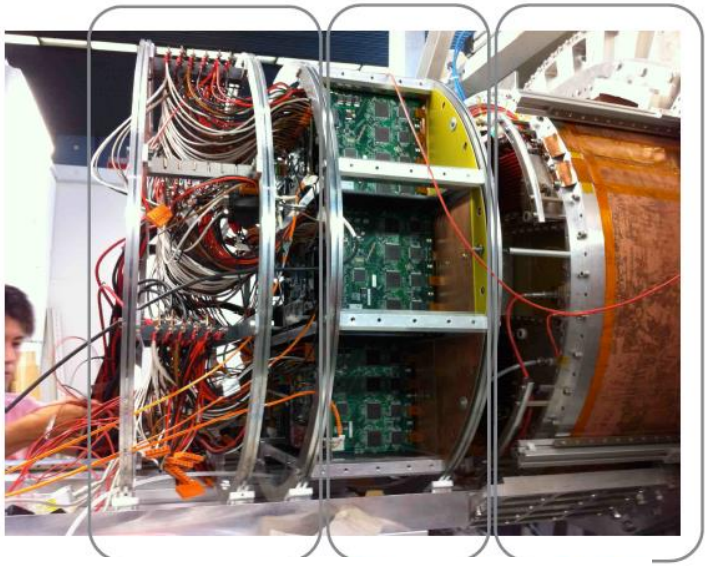
A4 foils used by Rui de Oliveira to make 2 Micromegas TPC modules

C. Donnet et al., Surface and coatings technology 120’129 (1999) 548

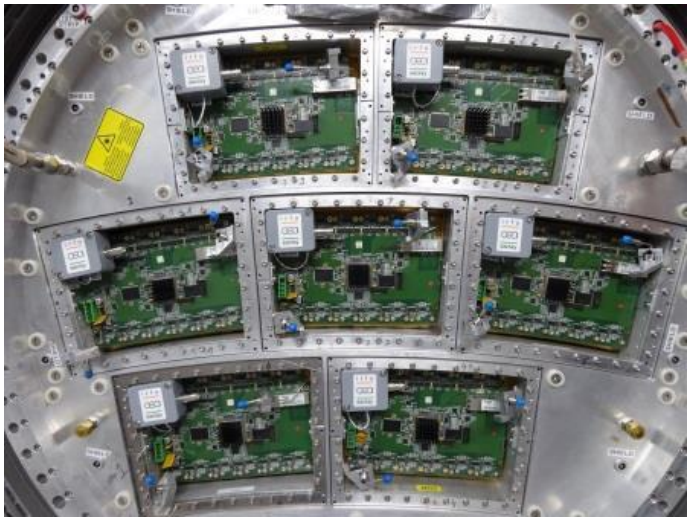


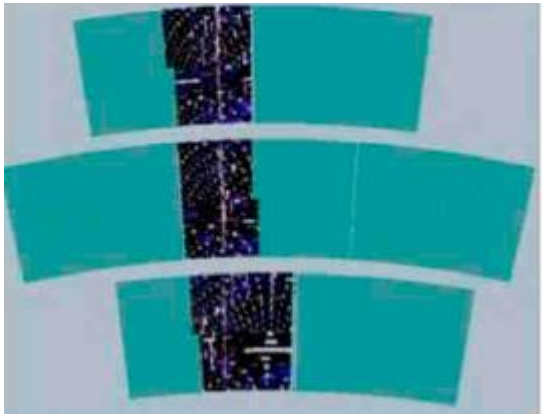
TPC Large Prototype at DESY

GEMs (see talk by D. Tsionou and A. Vauth)

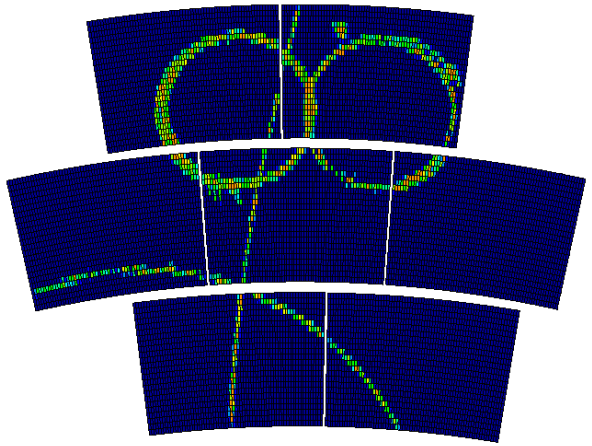


Micromegas





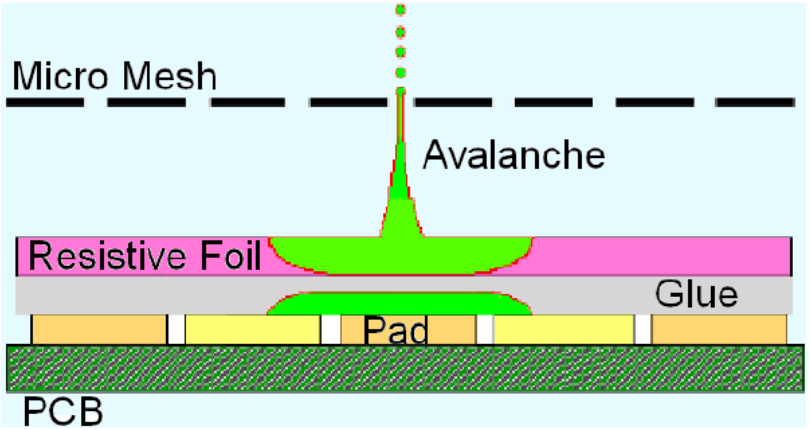
March 2015



Pad multiplicity

Need to spread the charge to improve resolution.

Insulator + resistive coverlay = resistive-capacitive continuous network. (M. Dixit et al.)



$$\frac{\partial \rho}{\partial t} = h\left(\frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2}\right), \quad (1)$$

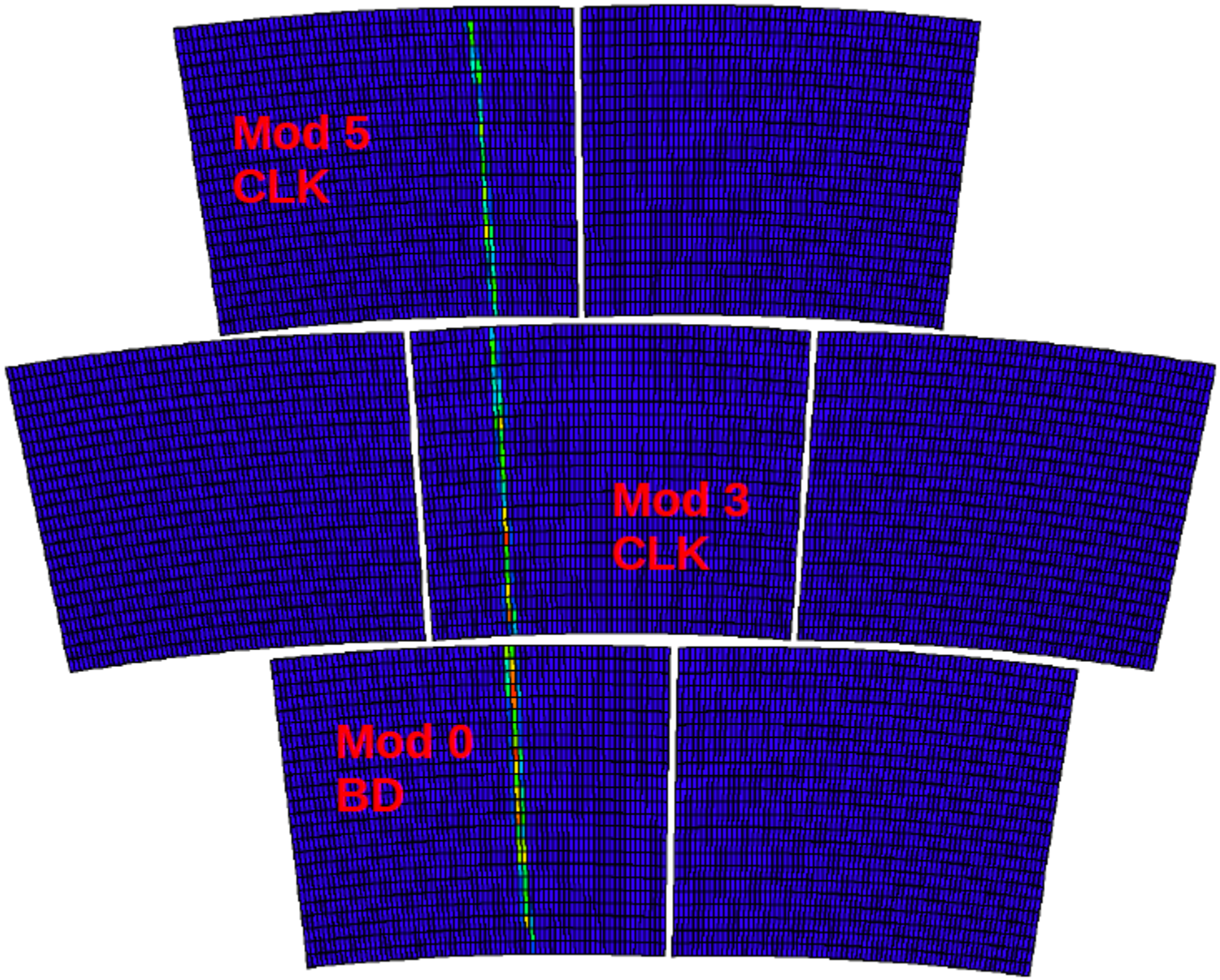
where $h = 1/RC$.

The solution to Eq. (1) for a resistive anode of finite size is an infinite Fourier series. A closed form solution becomes possible, however, for the case of a delta function point charge deposited at $x = y = t = 0$ and when the edges are at infinity:

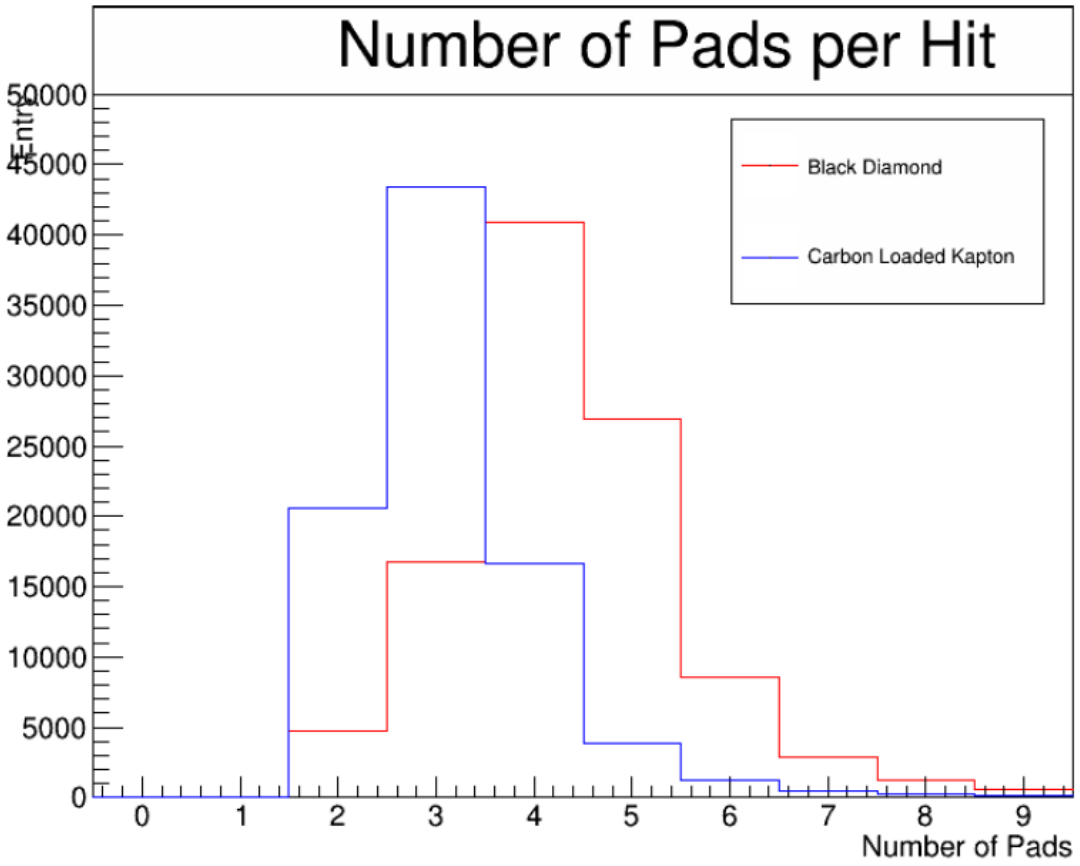
$$\rho_\delta(x, y, t) = \left(\frac{1}{2\sqrt{\pi t h}}\right)^2 \exp\left[-(x^2 + y^2)/4th\right]. \quad (2)$$

For t ~shaping time, r~sqrt(2t/RC)
Should be close to the pad size.

Black diamond’ and Carbon-loaded kapton



Pad multiplicity

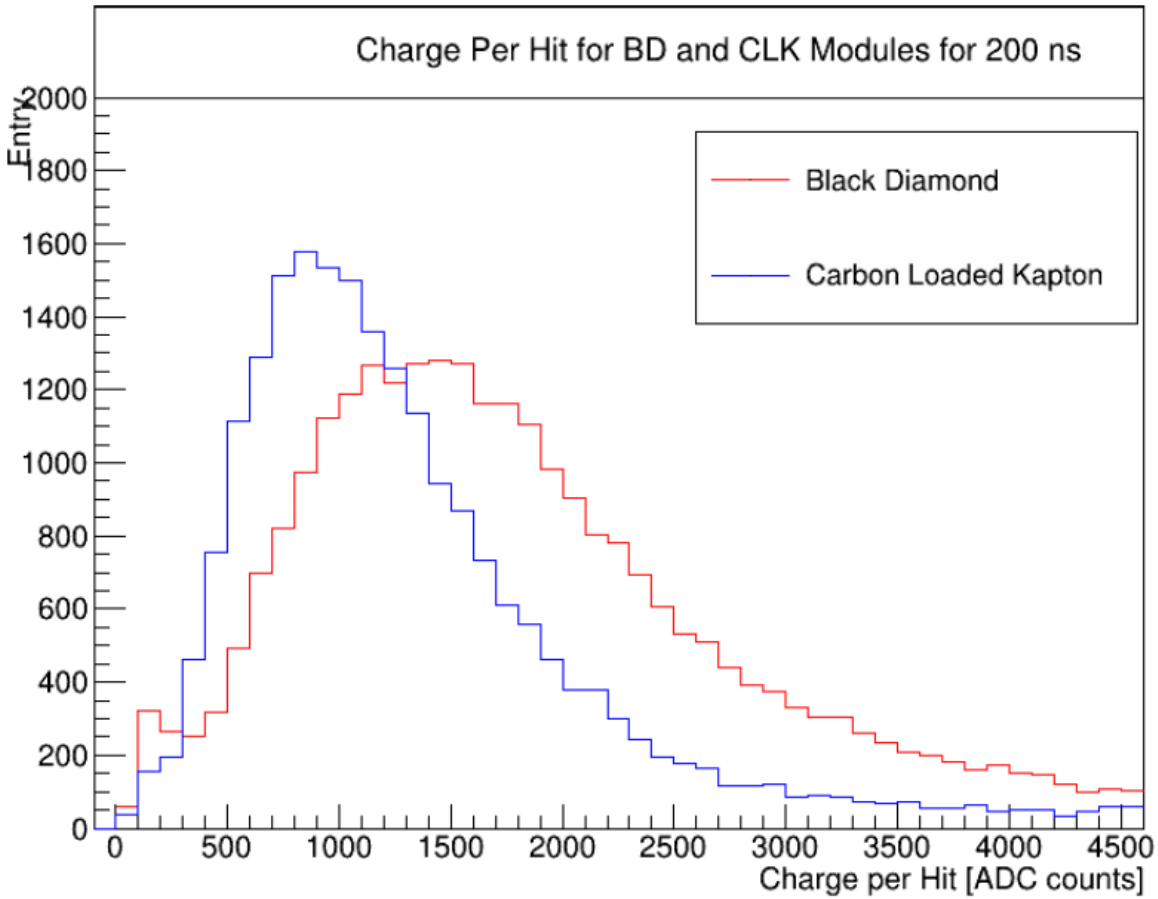


Number of pads that are fired when a charge cluster hits anode is 4.33 for BD and 3.13 for CLK.

Charge dispersion is higher in 'BD' => Surface resistivity is smaller in 'BD'

Charge deposition

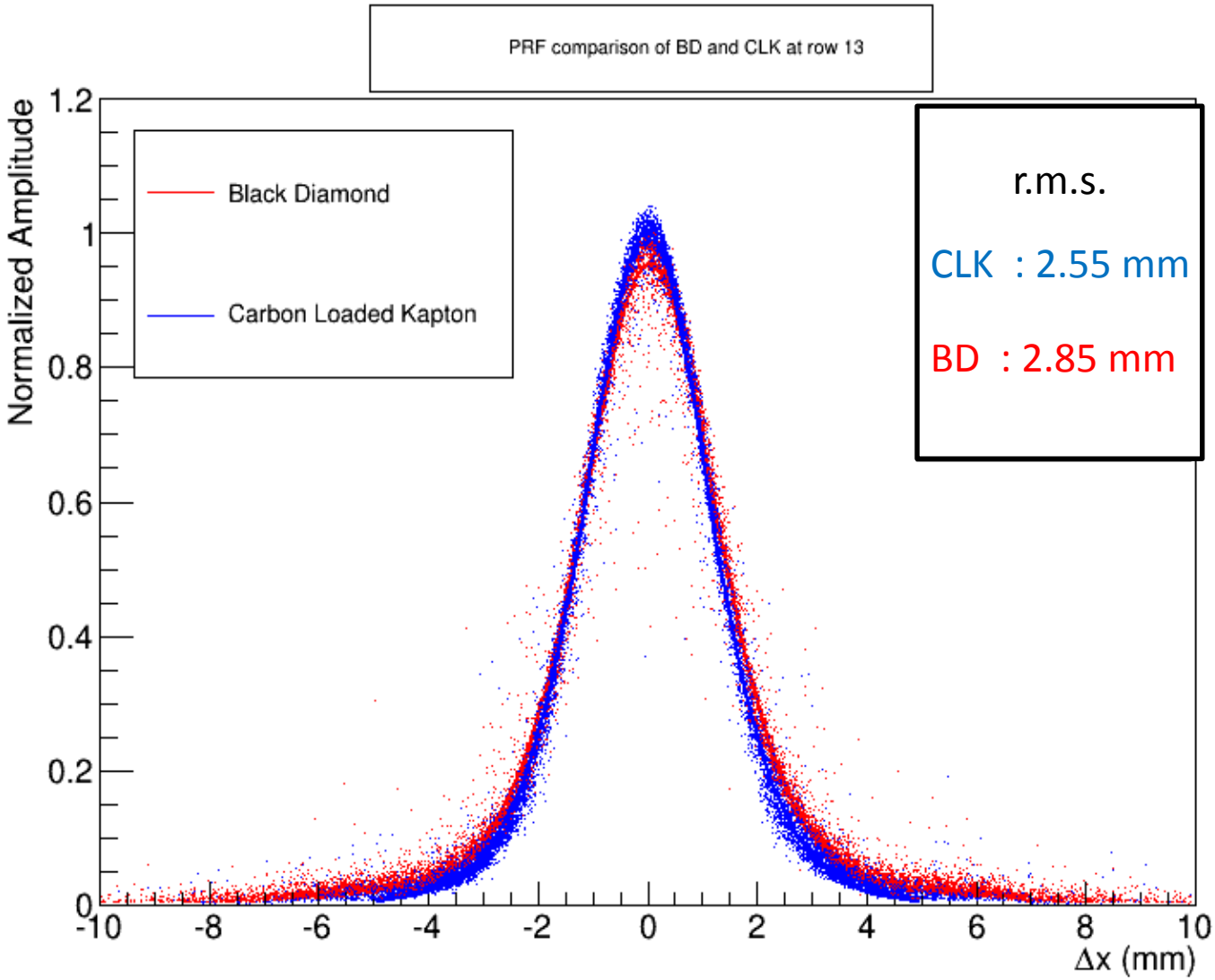
Black Diamond (DLC) modules give more charge than Carbon loaded Kapton (CLK)

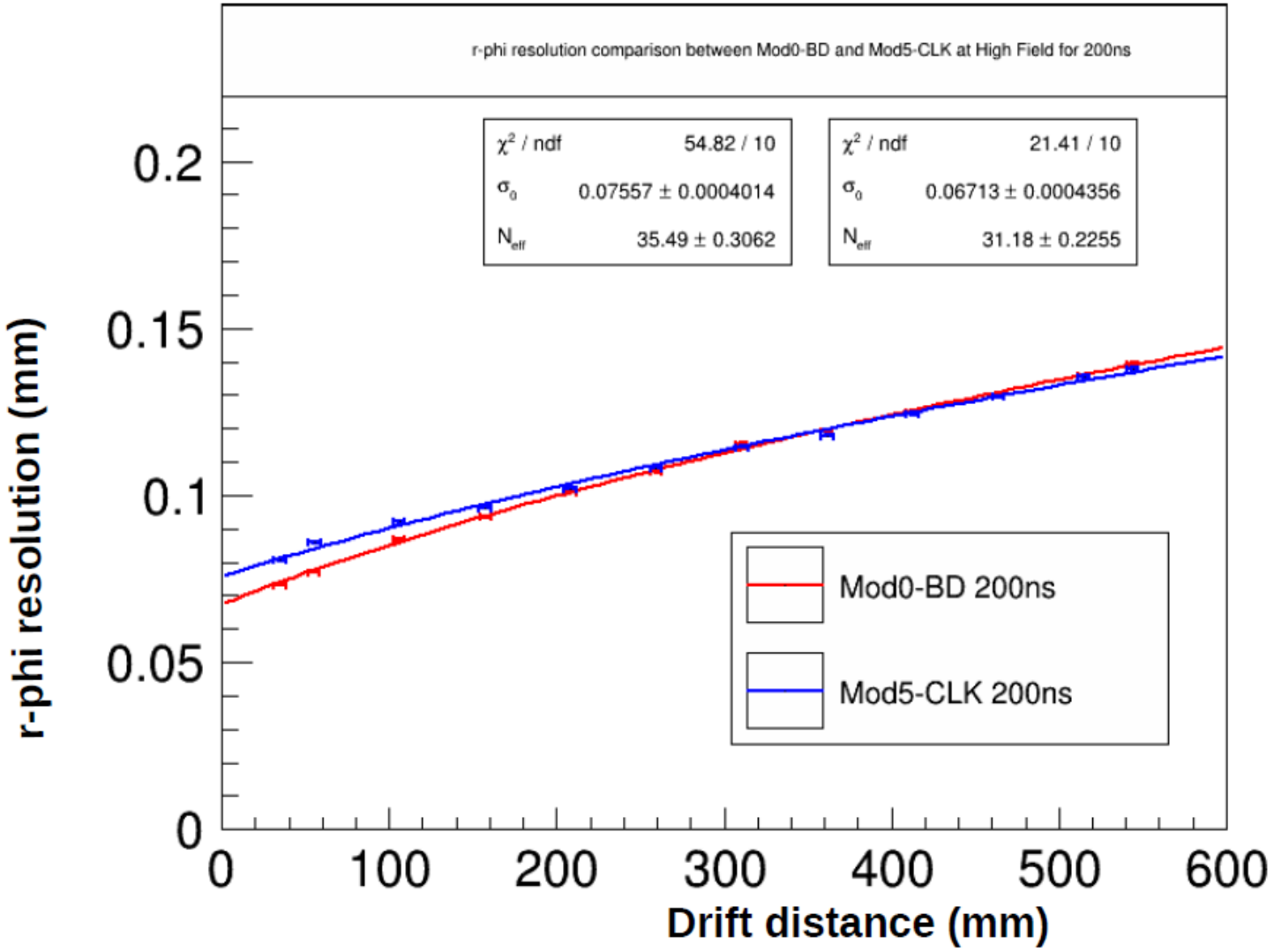


The average charge deposited per hit is shown in figure

Capacitance per unit area is higher in 'BD' than in 'CLK'

The Pad Response Function is wider for Black Diamond than for Carbon-loaded Kapton.





r-phi resolution comparison between a BD and a CLK (mod5) is shown. The two are very comparable.

Robustness

- Note that both modules underwent a short (one after 10 days, the second at the very end of the 2-week period)
- However apparently not connected to the layer (but a free wire of the mesh touching the ground; rather frequent in present design)

Conclusion

- In conclusion, a very nice material is now available to make resistive anodes
- It is robust and performant
- We will explore the industry to find more providers

- Thanks to Rui de Oliveira and Atsuhiki Ochi!

The new context of the ILD TPC

- Triggered by H(125) discovery in 2012
- Detailed site studies are going on in Japan
- The XFEL is being assembled at DESY (March 2015)
- This calls for realism in the design

En route for one of the possible locations of the Interaction Region (Sept. 2014)

CLK and DLC give same resolution