Cluster size and position resolution for carbon-loaded kapton and diamond-like carbon

P. Colas, CEA/Irfu Saclay

The charge density function for a point charge in Cartesian coordinates is:

$$\rho\delta(x,y,t) = \frac{\tau}{4\pi t} exp\left[-\tau\left(x^2+y^2\right)/4t\right] \; where \; \tau = RC$$

Therefore: the charge seen by a given pad at a given time, Qpad(t) is:

$$Q_{pad} = \frac{Nq_e}{4}\left[erf\left(\frac{x_{high}}{\sqrt{2}\sigma_{xy}}\right) - erf\left(\frac{x_{low}}{\sqrt{2}\sigma_{xy}}\right)\right]\left[erf\left(\frac{y_{high}}{\sqrt{2}\sigma_{xy}}\right) - erf\left(\frac{y_{low}}{\sqrt{2}\sigma_{xy}}\right)\right]$$

x_{high}, x_{low}, y_{high}, y_{low} define the pad boundaries & $\sigma_{xy} = \sqrt{2t/\tau + w^2}$

Convoluting by the shaping function:

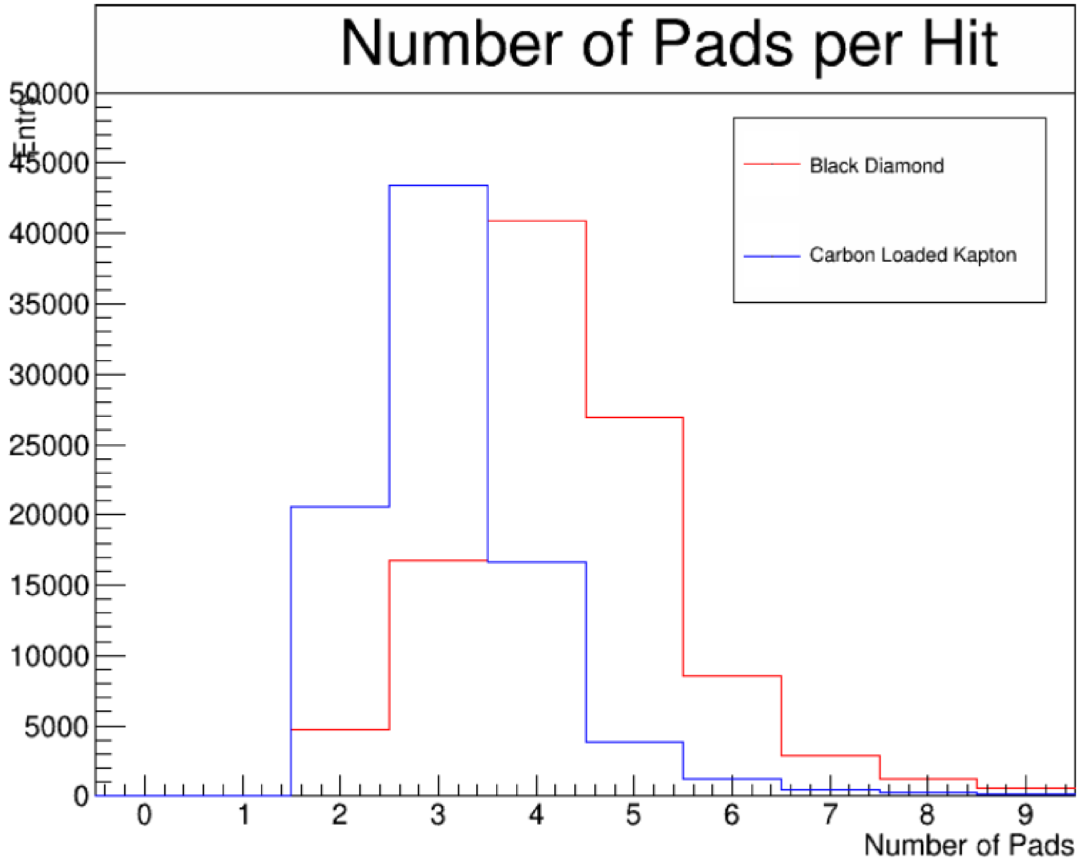
$$I(t)=\frac{1}{2T_{rise}}\left[\begin{array}{l} exp\left(\sigma^2 a^2/2-at\right)\left[erf\left(\frac{t-T_{rise}-\sigma^2 a}{\sigma\sqrt{2}}\right)+1\right]- \\ exp\left(\sigma^2 b^2/2-bt\right)\left[erf\left(\frac{t-T_{rise}-\sigma^2 b}{\sigma\sqrt{2}}\right)+1\right]- \\ exp\left(\sigma^2 a^2/2-a\left(t-T_{rise}\right)\right)\left[erf\left(\frac{t-T_{rise}-\sigma^2 a}{\sigma\sqrt{2}}\right)+1\right]+ \\ exp\left(\sigma^2 b^2/2-b\left(t-T_{rise}\right)\right)\left[erf\left(\frac{t-T_{rise}-\sigma^2 b}{\sigma\sqrt{2}}\right)+1\right]+ \\ exp\left(\sigma^2 a^2/2-at\right)\left[erf\left(\frac{t-\sigma^2 a}{\sigma\sqrt{2}}\right)+erf\left(\frac{t-T_{rise}-\sigma^2 a}{\sigma\sqrt{2}}\right)\right]- \\ exp\left(\sigma^2 b^2/2-bt\right)\left[erf\left(\frac{t-\sigma^2 b}{\sigma\sqrt{2}}\right)+erf\left(\frac{t-T_{rise}-\sigma^2 b}{\sigma\sqrt{2}}\right)\right] \end{array}\right]$$

Where

$$a=1/t_f$$

$$b=1/t_f+1/t_r$$

Pad multiplicity

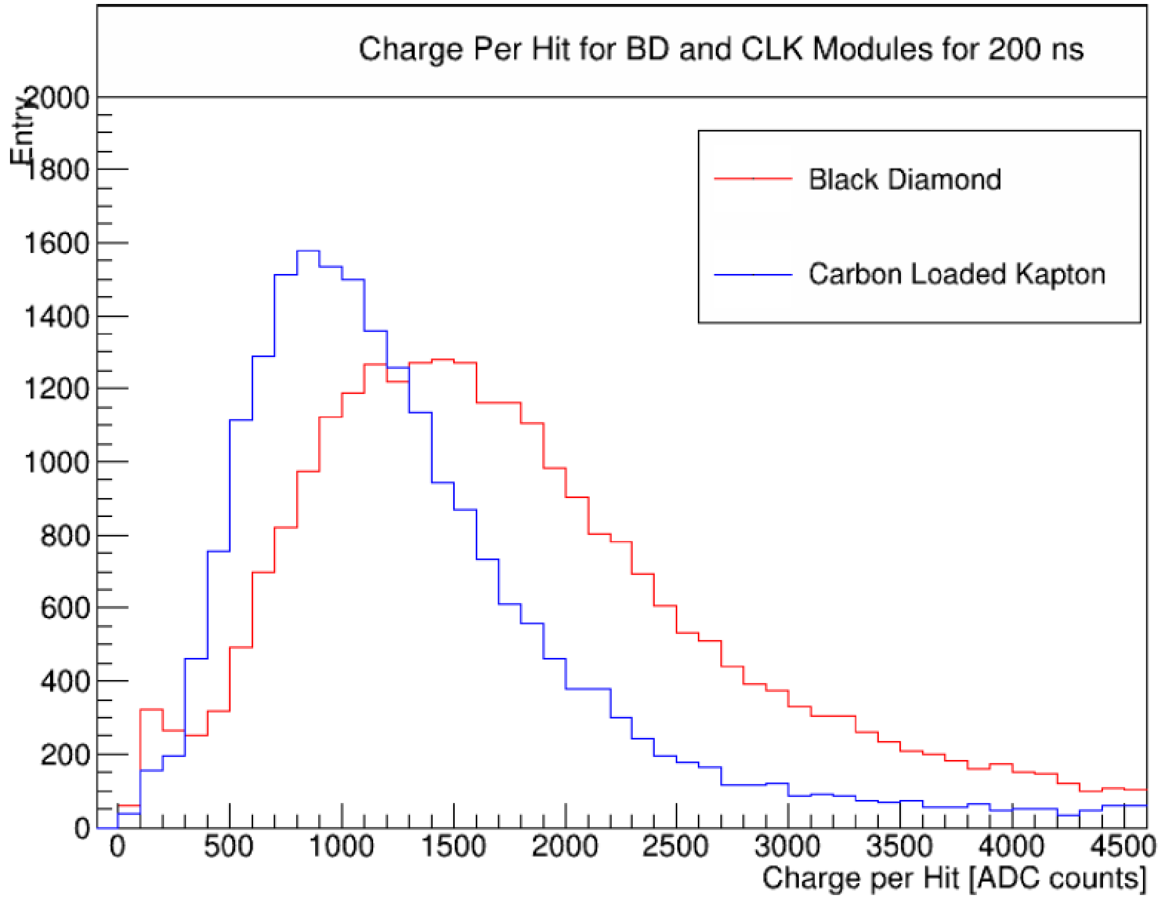


Number of pads that are fired when a charge cluster hits anode is 4.33 for BD and 3.13 for CLK.

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

Charge deposition

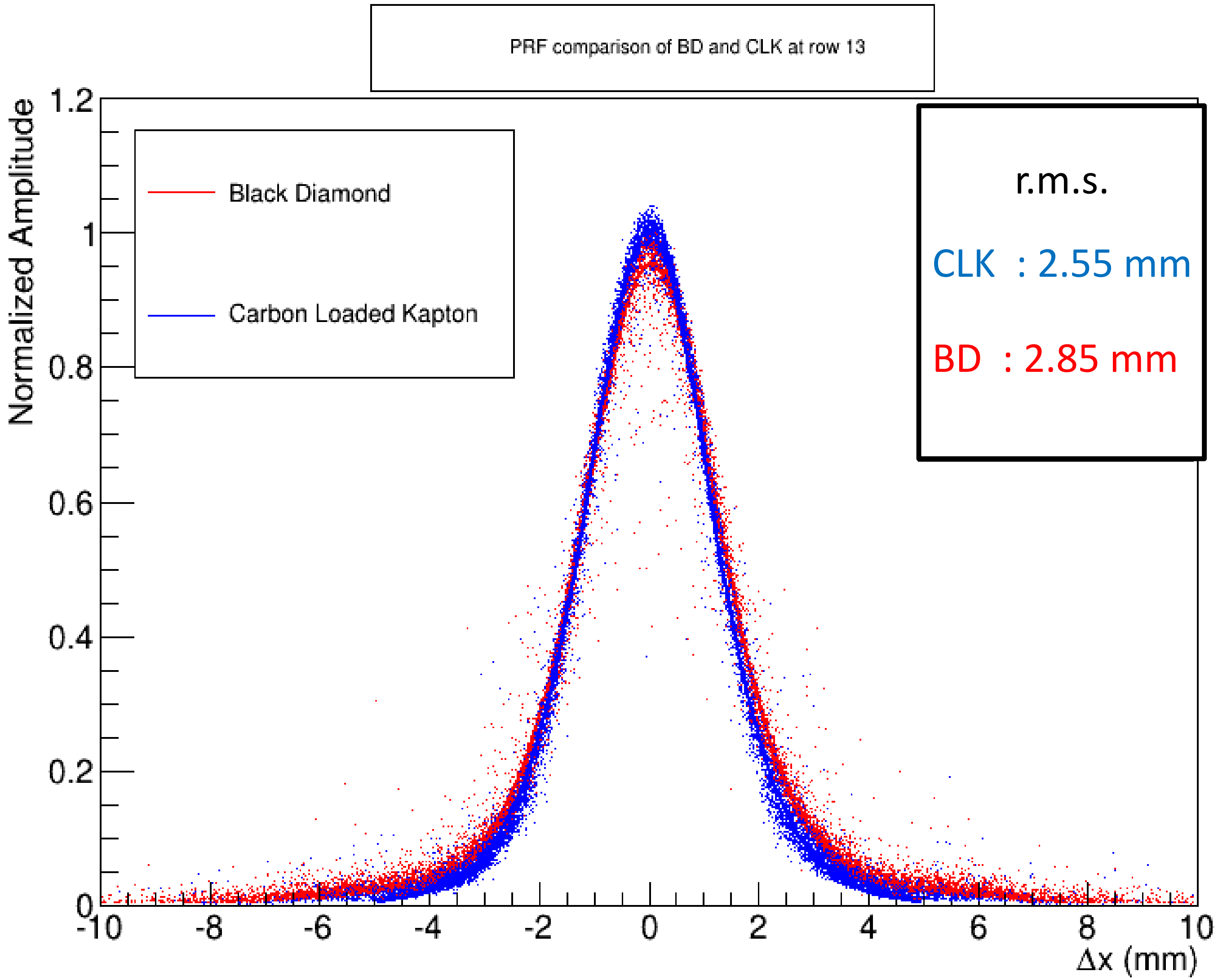
Black Diamond (DLC) modules give more charge than Carbon loaded Kapton (CLK)



The average charge deposited per hit is shown in figure

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

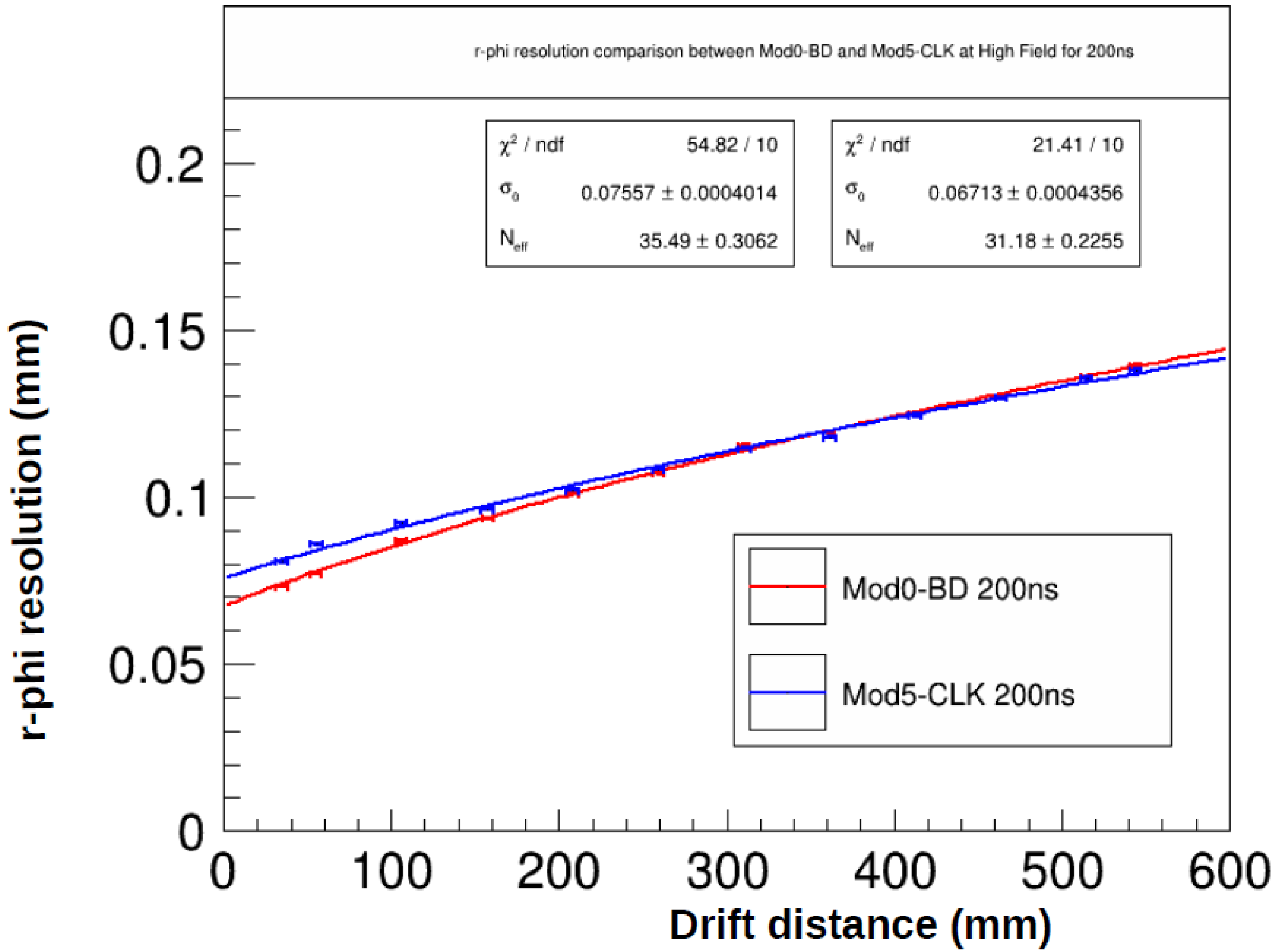
The Pad Response Function is wider for Black Diamond than for Carbon-loaded Kapton.



r.m.s.

CLK : 2.55 mm

BD : 2.85 mm



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