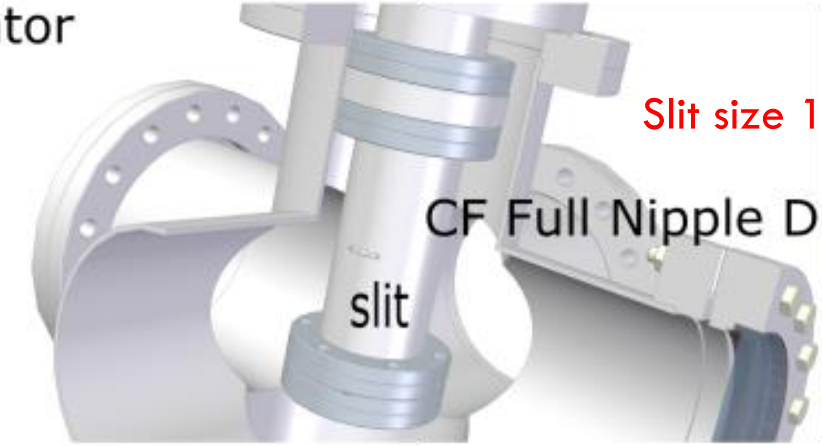
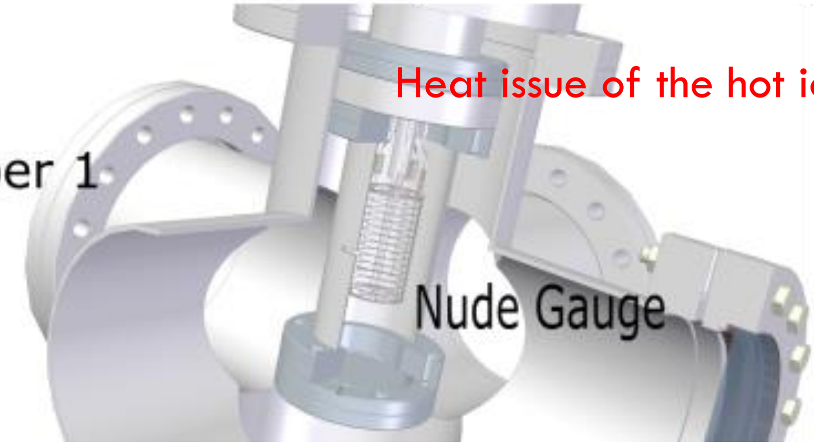
COCKCROFT UPDATE

3D moveable gauge system

Motorized and can be controlled though serial connection



Slit size 10*0.5 mm^2



Heat issue of the hot ion gauge

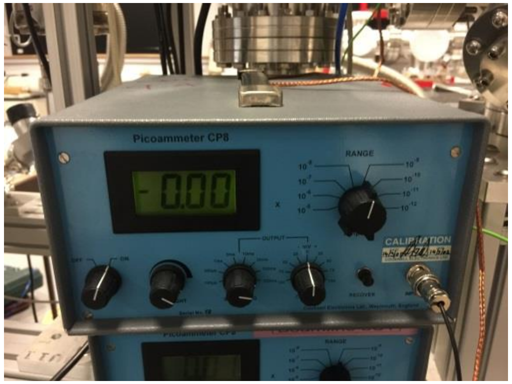
Gauge signal is amplified by pico-ampere meter and record by scope.

Gauge and controller

Granville-phillips 274
Bayard-Alpert type
Ionization gauge

Sensitivity = 10/Torr
Typical accuracy = 20%

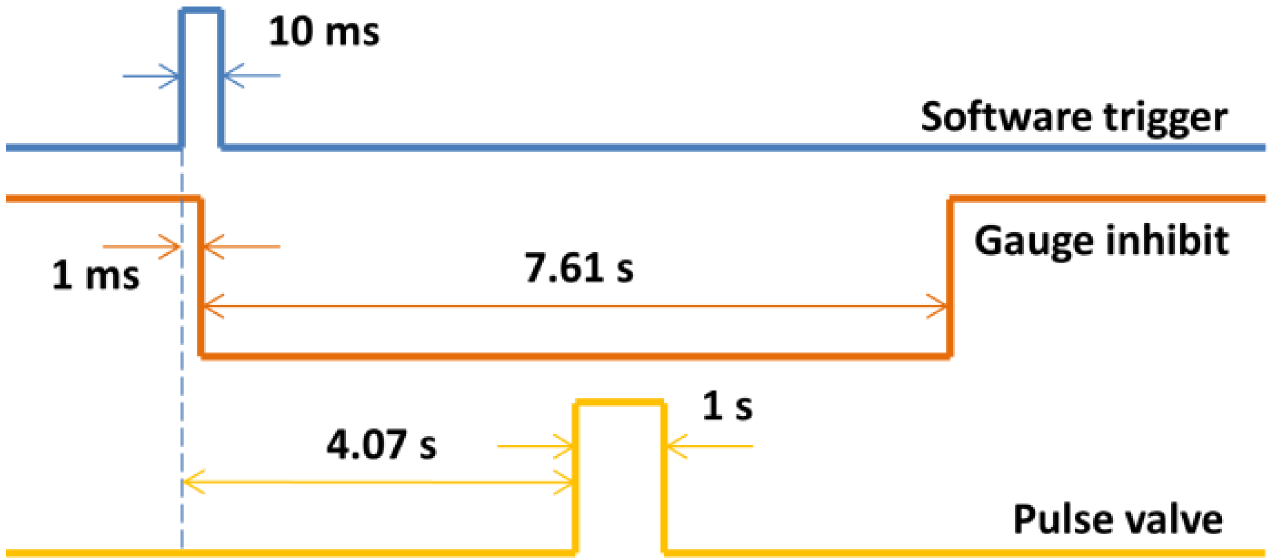
IGC 26 Ion gauge
controller

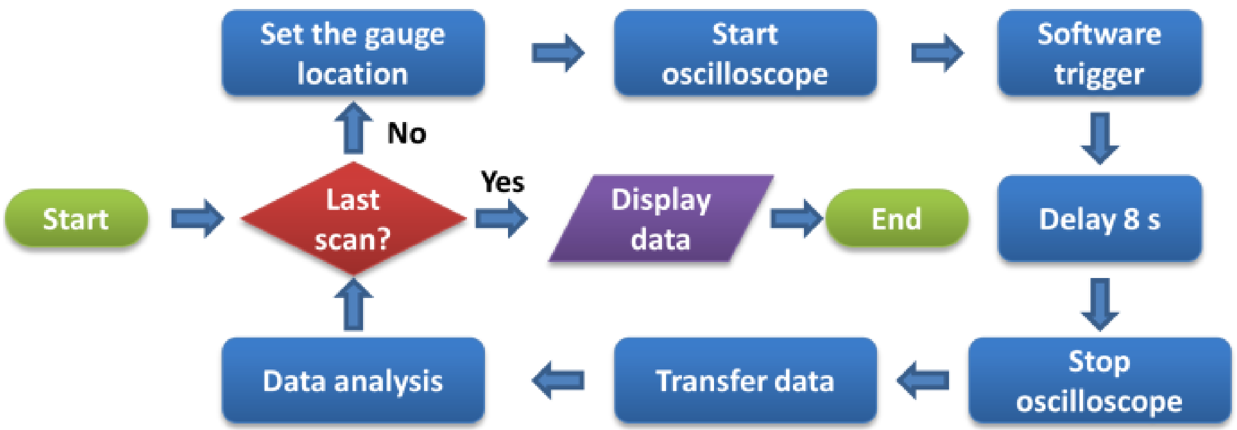


Picoammeter from
Cockneil Electronics
Ltd.

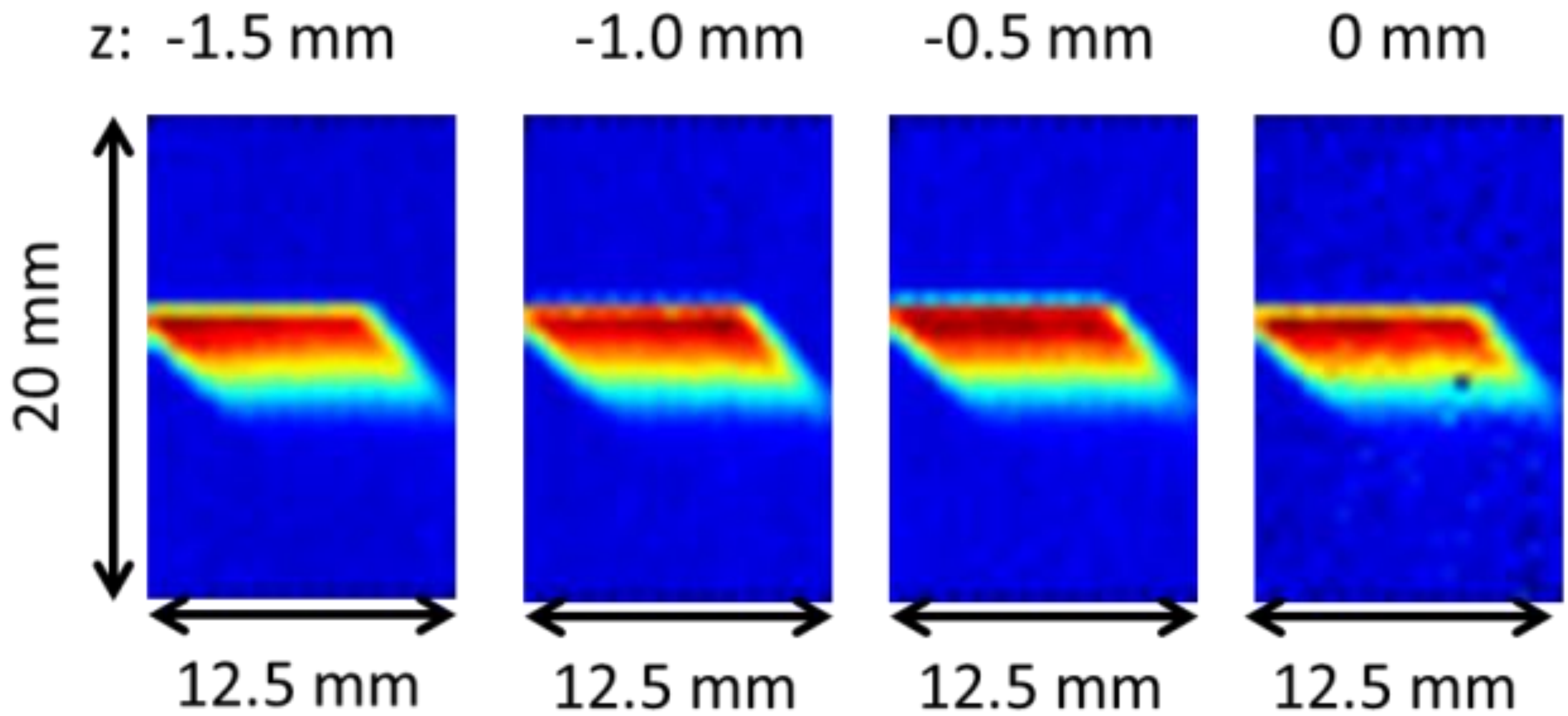
Calibration:
3.0e-8 mbar = 6.0e-10 A

Timing and automation



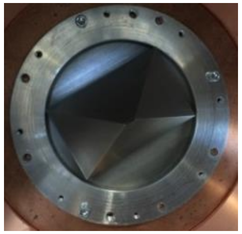


3D scan data ($I_{ion}(X,Y)$), smaller skimmer

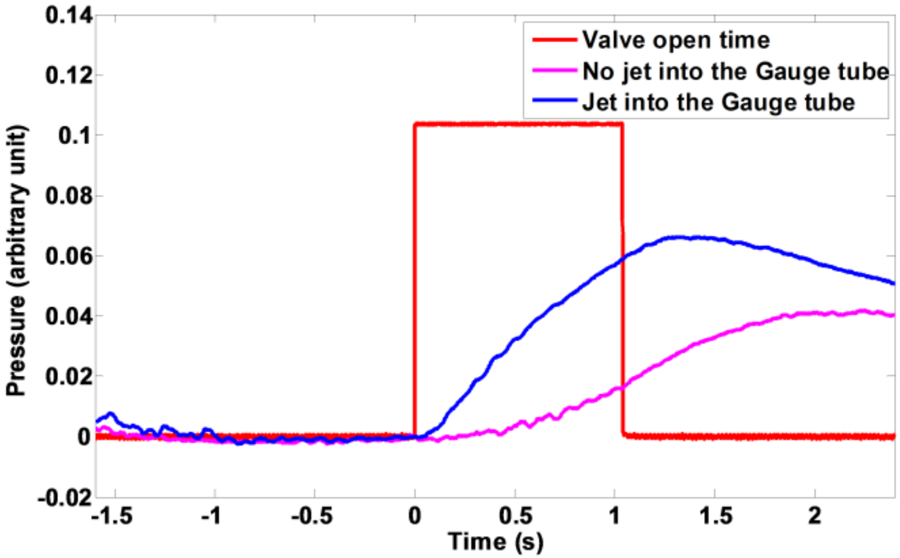


Resolution: 0.5 mm

The overall scan reflect the vertical size of the jet, but in horizontal axis, it is dominated by the slit size since the jet size is much smaller than the slit size

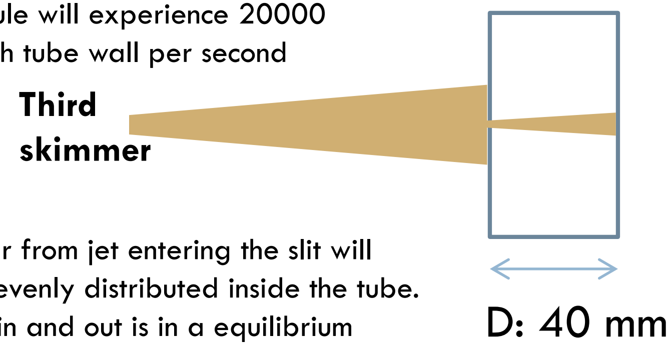


One typical measurement



Side view of the detection

Gas molecule will experience 20000 collision with tube wall per second



Assumption:

1. Gas molecular from jet entering the slit will immediately evenly distributed inside the tube.
2. Residual gas in and out is in a equilibrium state.
3. There is no molecular from the jet escaping the tube.

Gauge detection

$$Pressure:\ P = \frac{I_{ion}}{I_e * S}$$

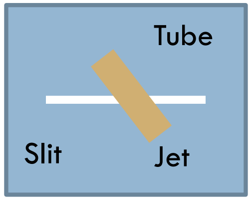
Ion current

Sensitivity

Emitting current

$$Ideal\ gas\ equation:\ P = \frac{Nk_BT}{V}$$

Front view of the detection



Slit size: L_x, L_y

Jet velocity

Gas number increase: $\frac{dN}{dt} = v\int \rho(x,y)dS$

$$\frac{dI_{ion}}{dt} = I_eSv\frac{k_BT}{V}\int \rho(x,y)dS$$

Analysis continue…

$$\frac{dI_{ion}}{dt}(X,Y) = I_e S v \frac{k_B T}{V} \int_X^{X+L_x} \int_{Y-L_y/2}^{Y+L_y/2} \rho(x,y)\,dx\,dy$$

Since the slit size is small in vertical axis, this can be simplified as:

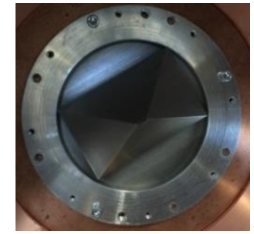
$$\frac{dI_{ion}}{dt}(X,Y) = I_e S v \frac{k_B T}{V} L_y \int_X^{X+L_x} \rho(x,Y)\,dx$$

Take derivative about X, we got: $$\rho(X+Lx,Y) - \rho(X,Y) = \frac{1}{I_e S v L_y} \frac{V}{k_B T} \frac{d}{dX} \frac{dI_{ion}}{dt}(X,Y)$$

If we scan from right to left, $$\rho(X+Lx,Y) = 0$$

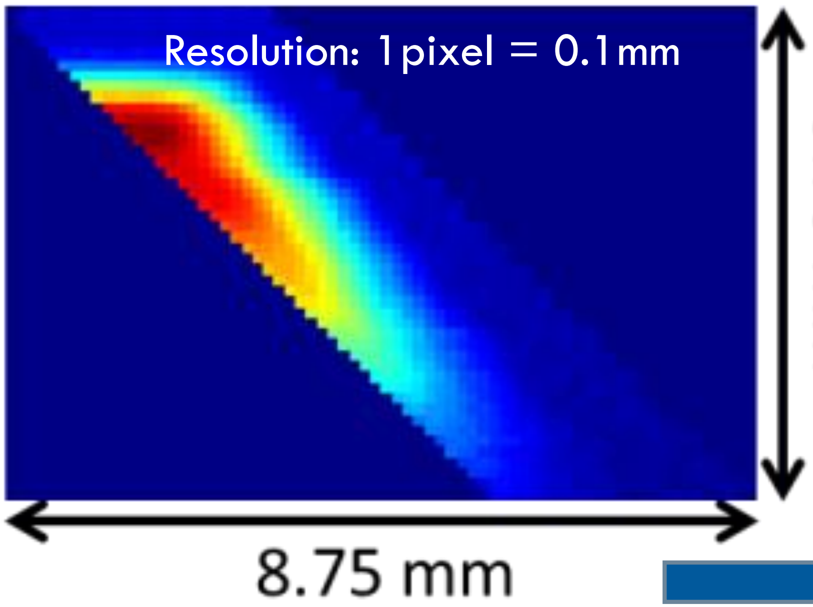
$$\rho(X,Y) = -\frac{1}{I_e S v L_y} \frac{V}{k_B T} \frac{d}{dX} \frac{dI_{ion}}{dt}(X,Y)$$

Edge scan (small skimmer)

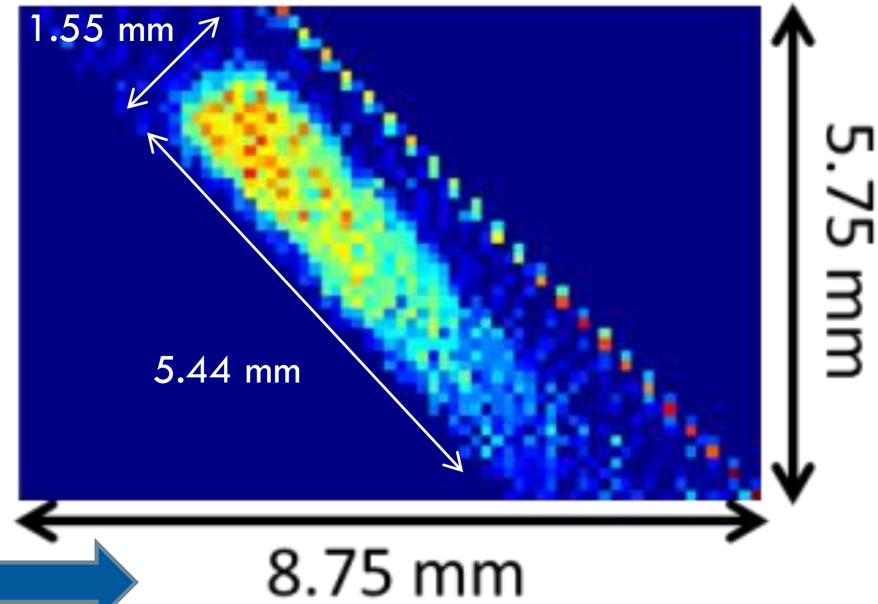


Skimmer size	4×0.4 mm^2
Oriental angle	45˚

$I_{ion}(X,Y)$



$\rho(X,Y)$



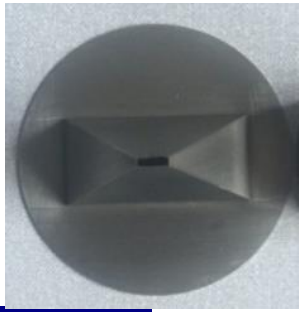
Differentiate the data in horizontal axis

Jet size in interaction point is estimated as : 4.54 mm * 0.83 mm

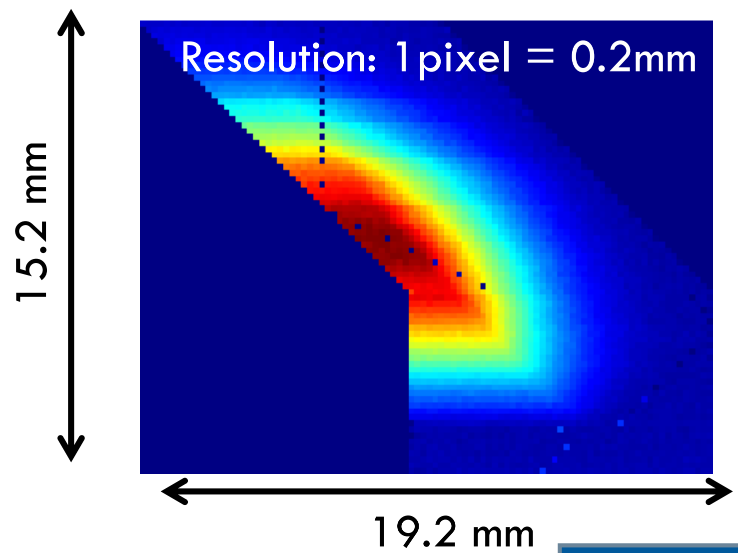
$\sigma_{jet} = 0.29$ mm

Edge scan (large skimmer)

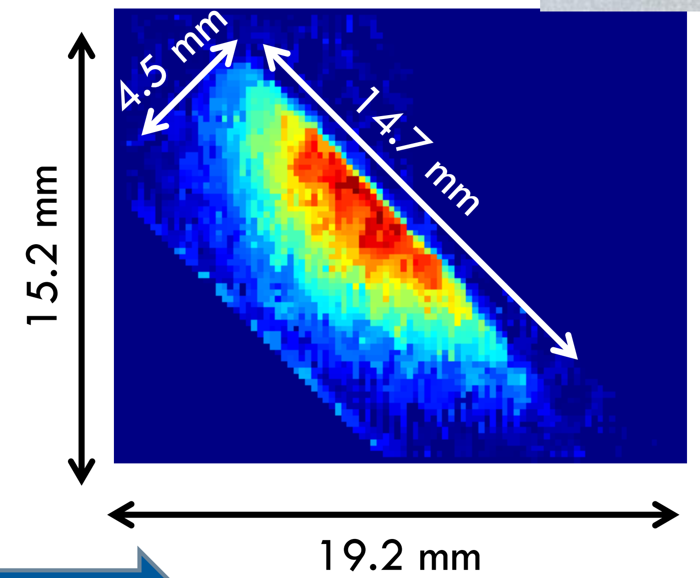
Skimmer size	7.2×1.8 mm^2
Oriental angle	45°



$I_{ion}(X,Y)$



$\rho(X,Y)$

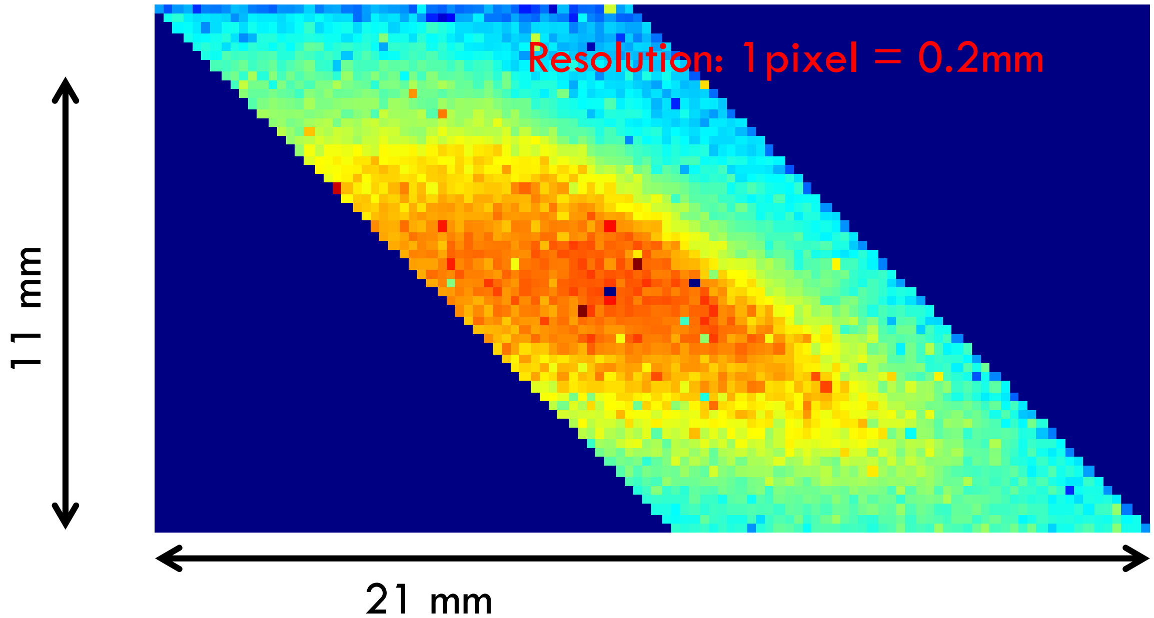


Differentiate the data in horizontal axis

Jet size in interaction point is estimated as : 10.03 mm * 2.81 mm

$\sigma_{jet} = 0.99$ mm

Recent jet density measurement



New setup progress