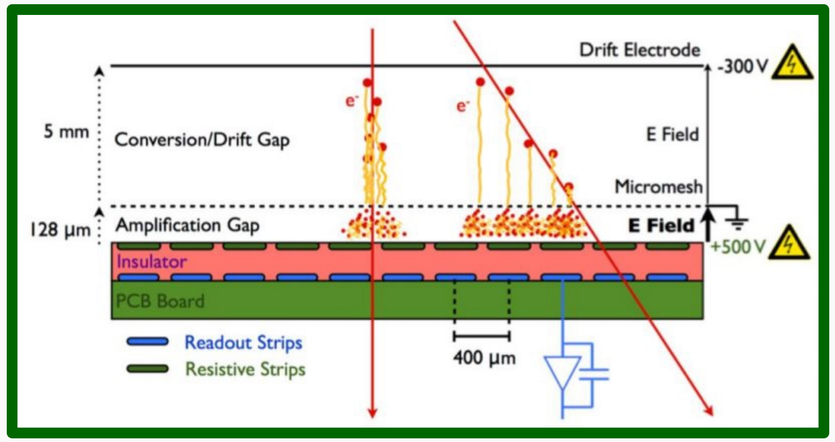
Particle Track Analysis using Neural Networks



Quick update

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NN on full unclustered events

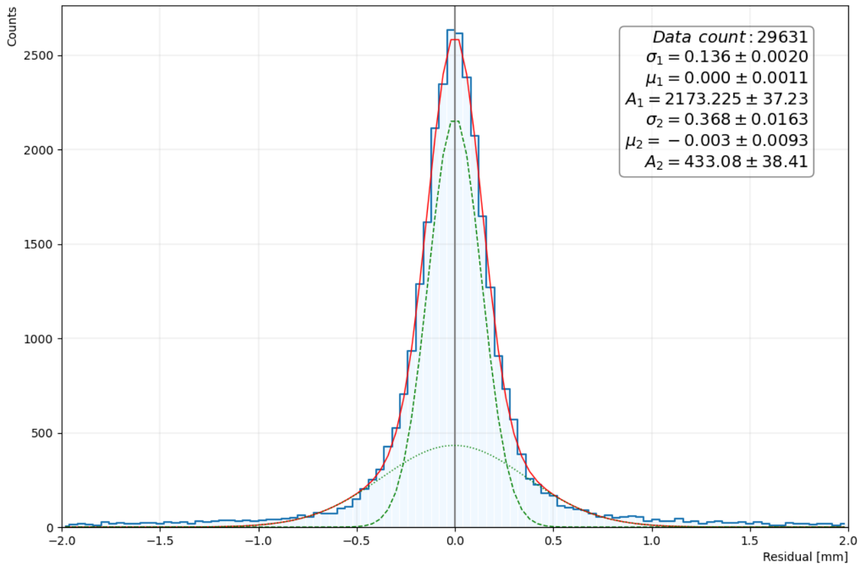
	Cluster 1					Cluster 2							Cluster 3						
Strip pos (mm)	728,2	728,6	729,0	729,3	...	741,2	741,6	742,0	742,4	742,7	743,1	...	745,3	745,7	746,1	746,4	746,8	747,2	747,6	747,9
Charge	203	260	102	116	...	252	131	76	92	83	91	...	110	187	274	388	274	283	103	109
Timing (ns)	94	86	54	37	...	25	30	39	43	71	67	...	17	-5	27	23	47	52	66	93

Example of an event with multiple clusters

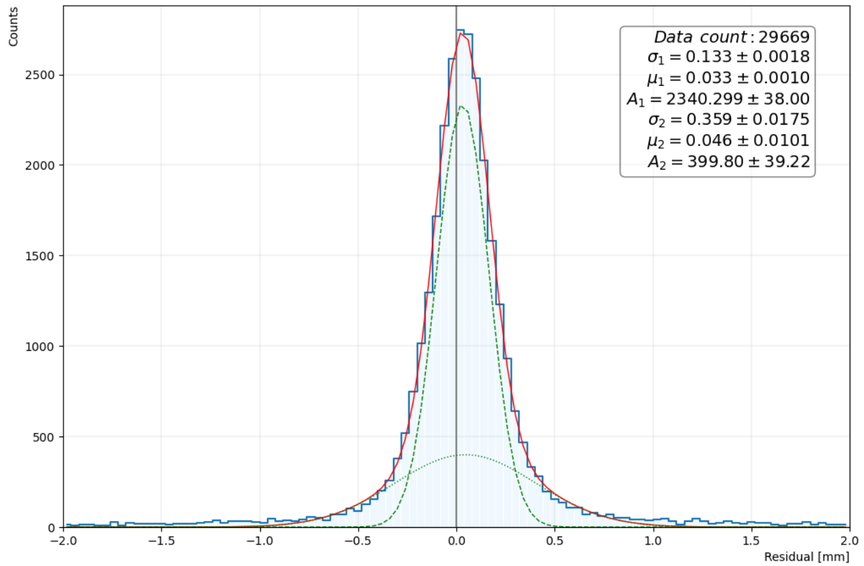
NN trained with full unclustered events of a testbeam dataset with 29 degrees inclination
« True » position of the particle is ~746.8mm (cluster 3).
Charge weighted position on the whole event : 741.6mm, charge weighted position on cluster 3 : 746.6mm.
NN manages to reconstruct the true position with a residual of 50µm à priori ignoring cluster 1 and 2.

Transformer compared to MLP

Testbeam 29 degrees 530V 100ns



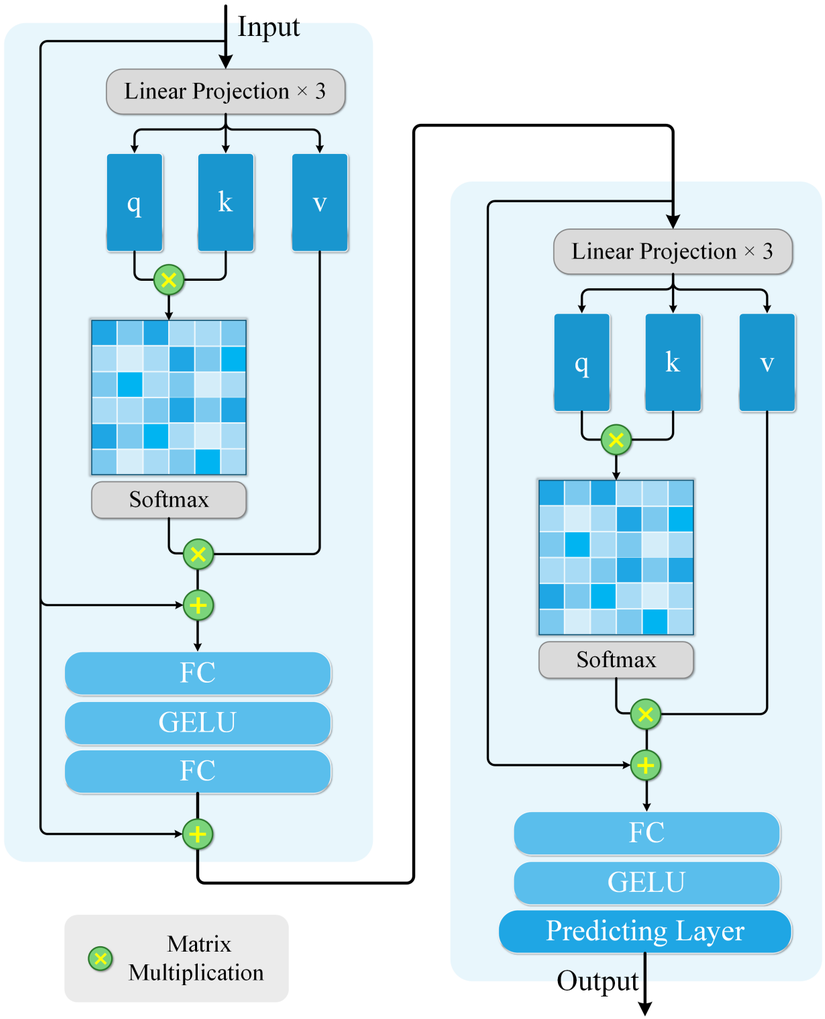
NN with ~100 000 trainable parameters (inference time on PC : ~15min)



Transformer with ~37 000 trainable parameters (inference time on PC : ~40min)

Results are minimally better. Will try transformers with more parameters.
In general we seem to hit a wall at ~130µm core resolution for 29 degree inclination.

Backup – Transformer architecture



Example of a transformer regression architecture (source)

Attention mechanism (paper)
Model assign weights to compare how each input feature stands to each other.