



Informed Sampling of the Plasma Hyperspace for Digital Twinning

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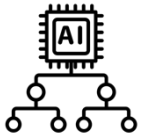
Real-time Prediction



Low Latency

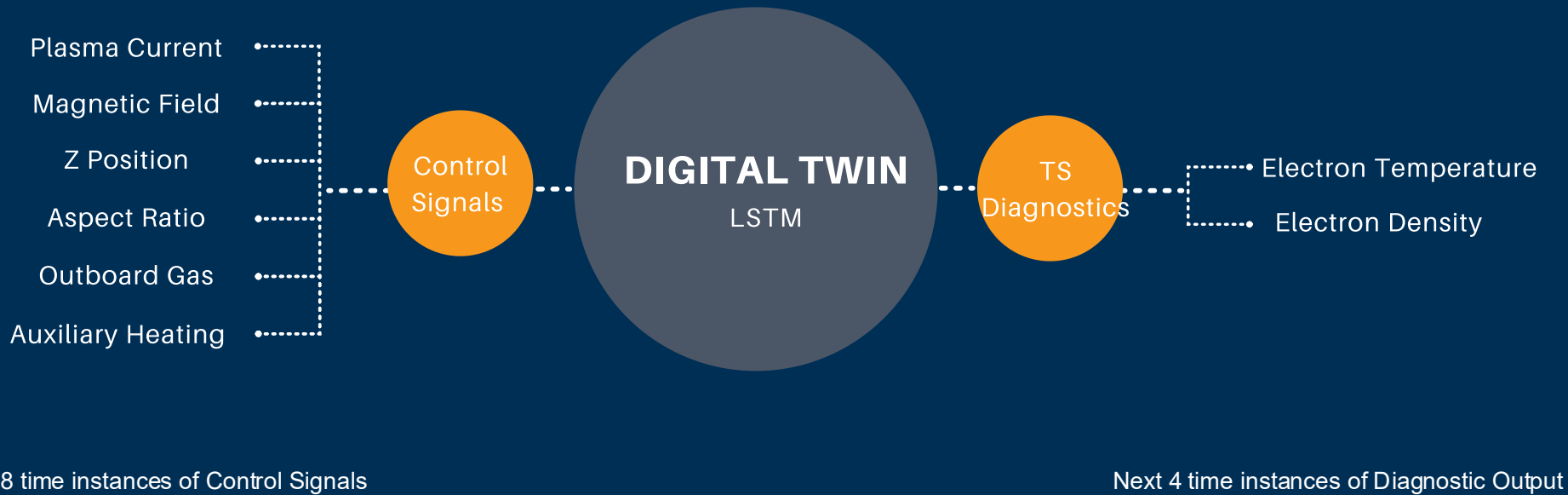


Fast and Creative Experimentation at minimal risk and cost



Precursor to building advanced automated control feedback loops.

Thomson Scattering Digital Twin

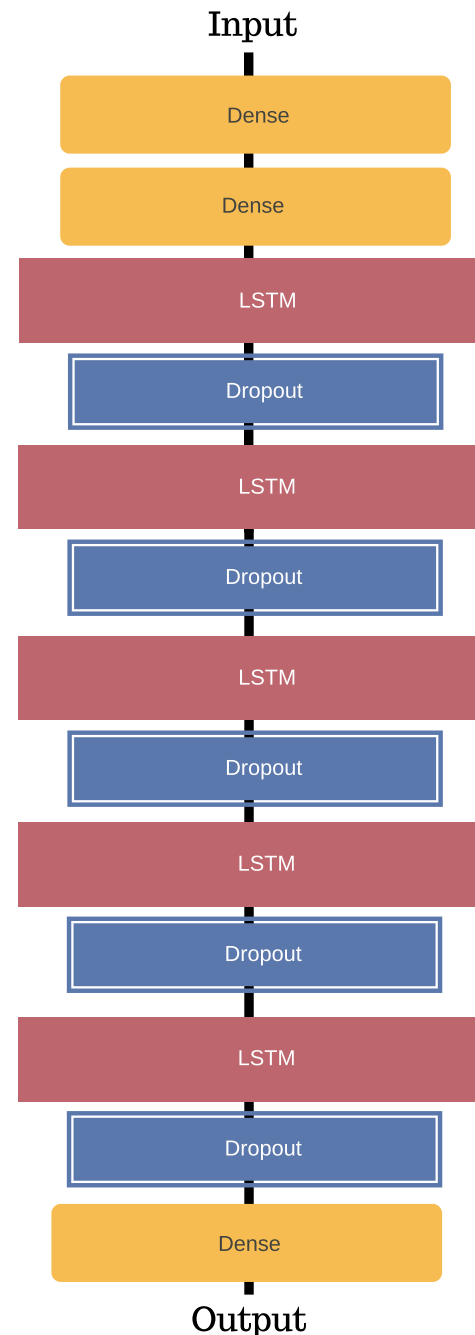


Model Architecture

Dense – Fully Connected Layer:
Extract Dependencies across Signals

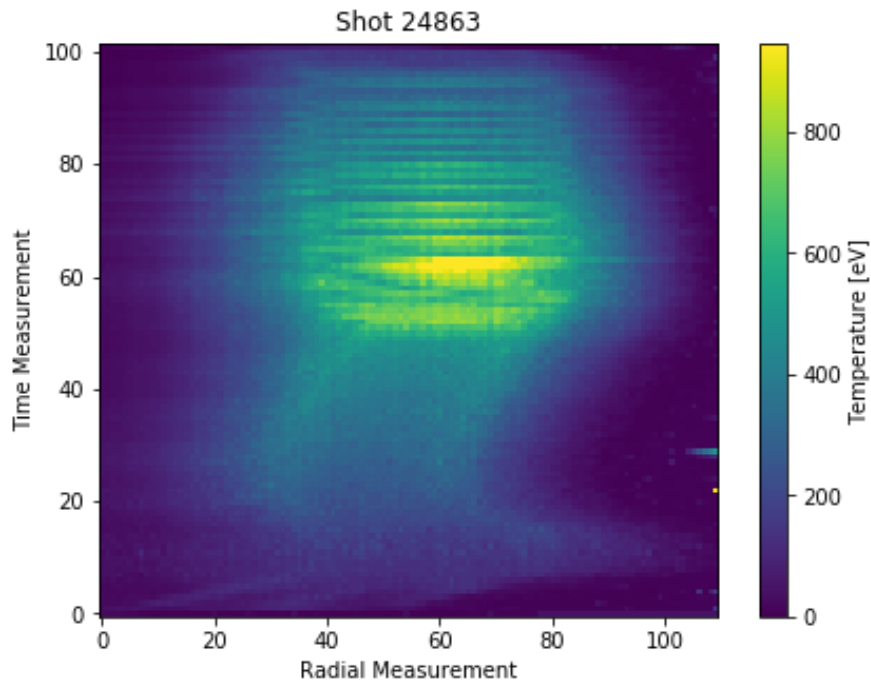
LSTM – Long Short Term Memory:
Extract Temporal Dependencies for each signal

Dropout: Allows for regularisation

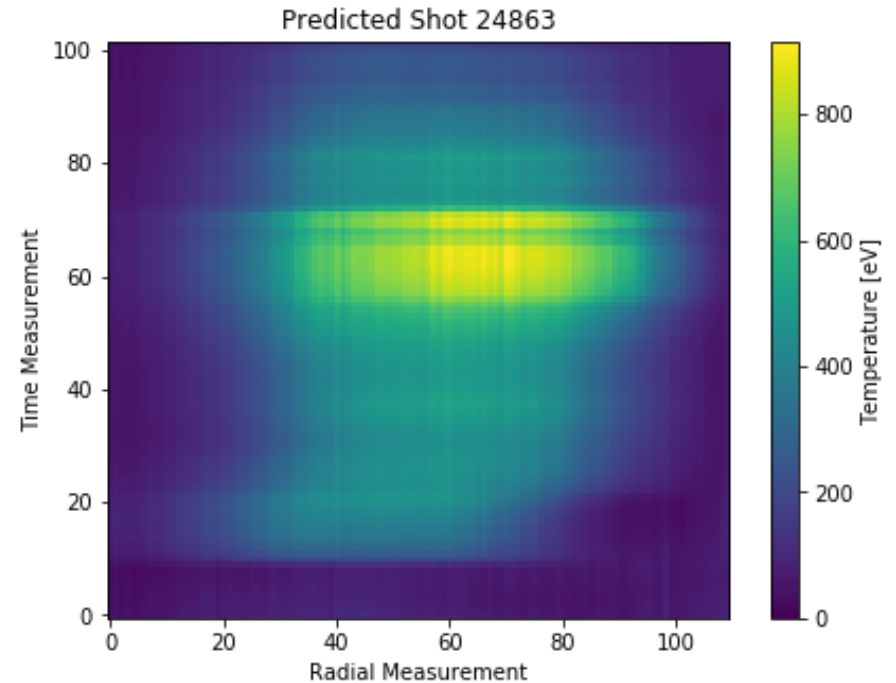


Prediction Comparison

Actual

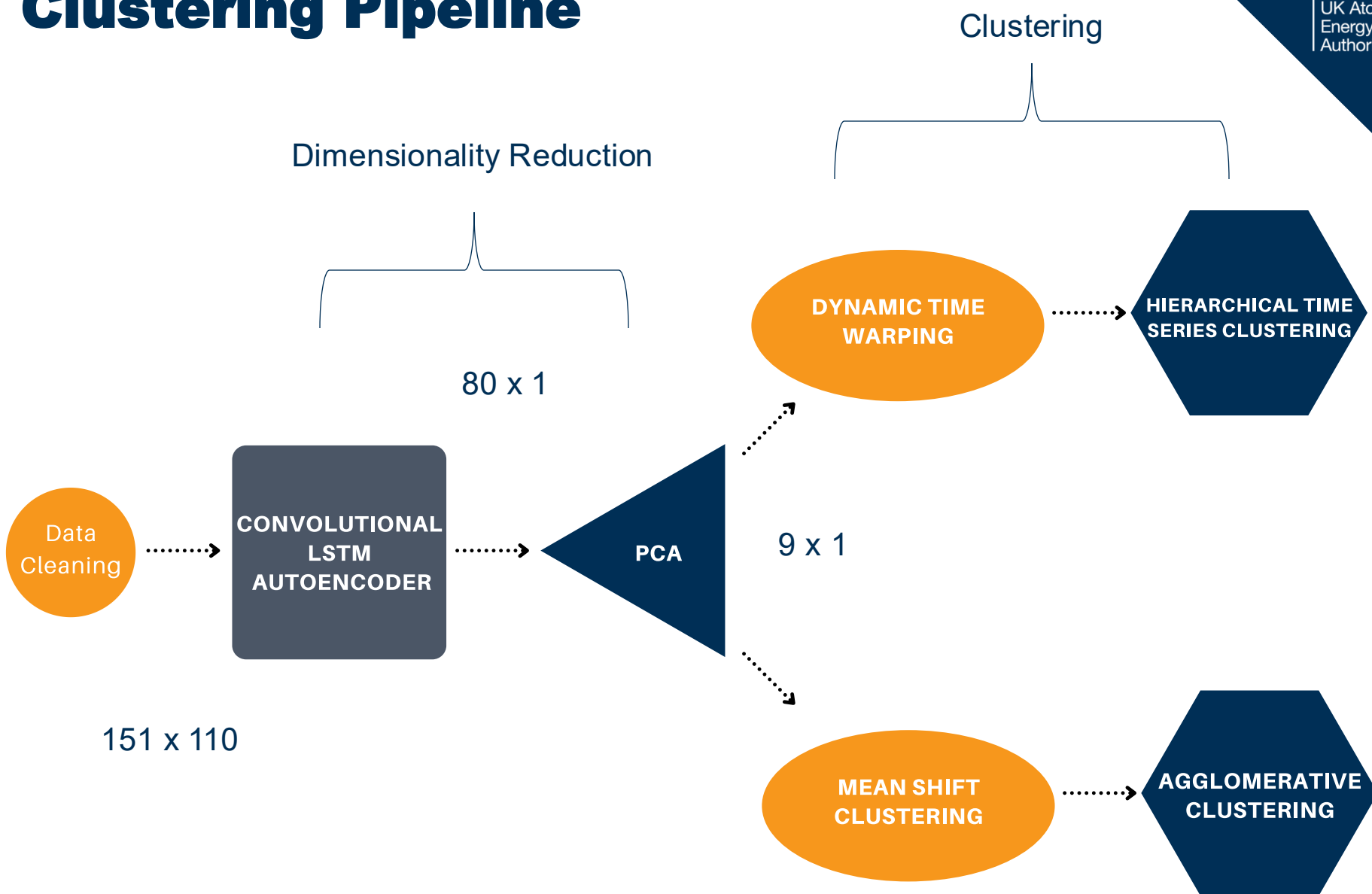


Prediction

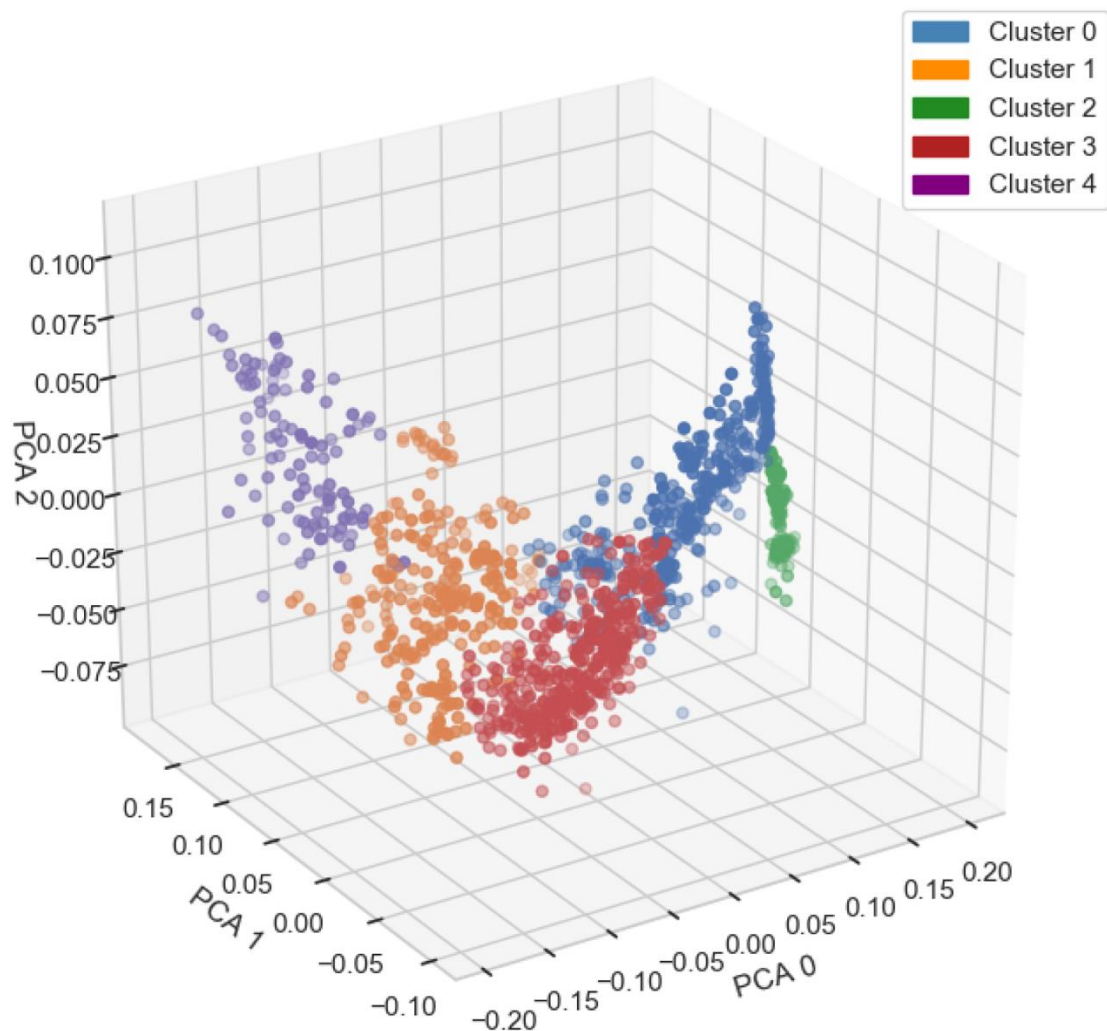


Prediction Error : 0.0285
Includes a total of 1366 shots

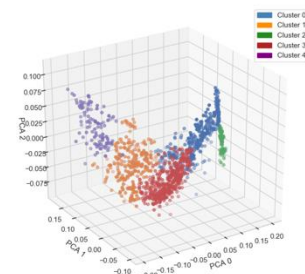
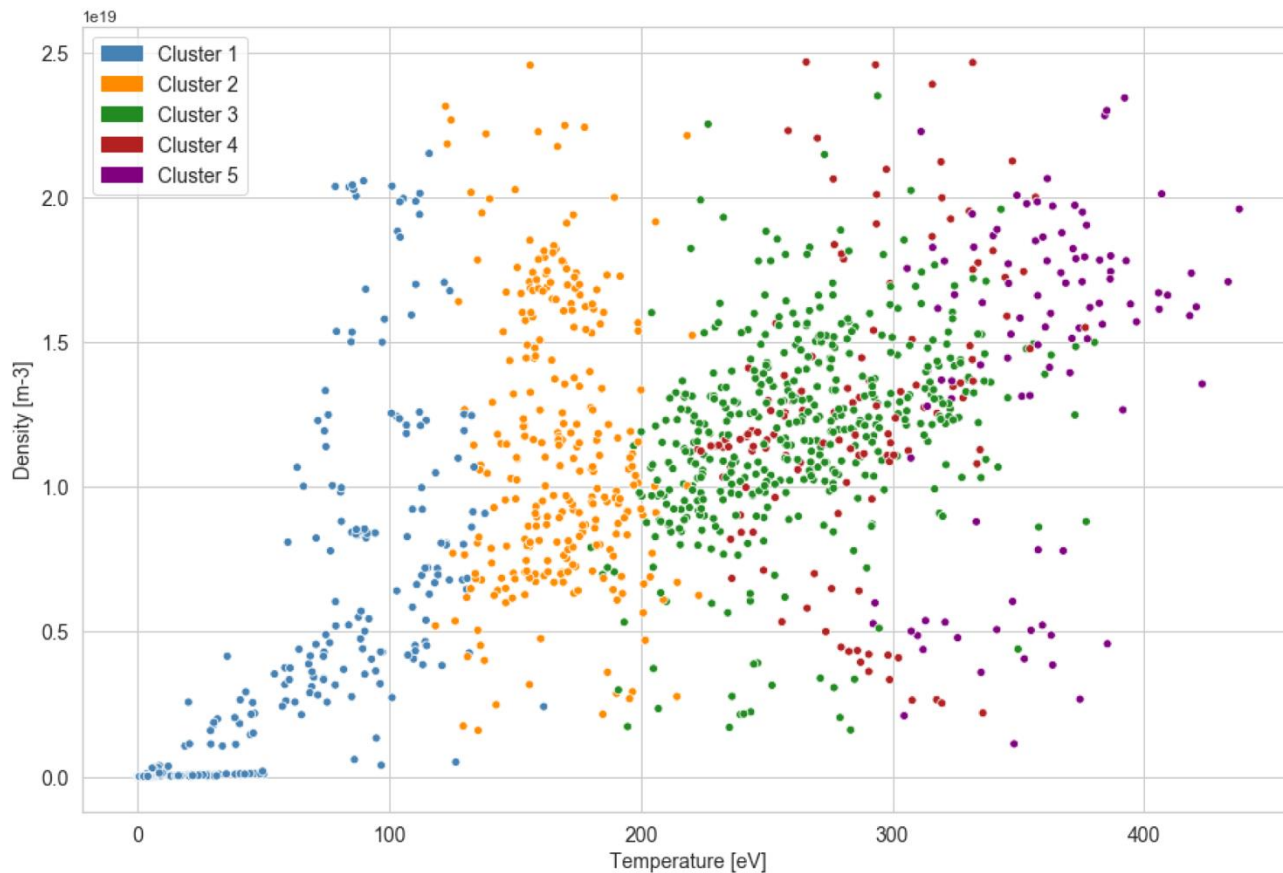
Clustering Pipeline

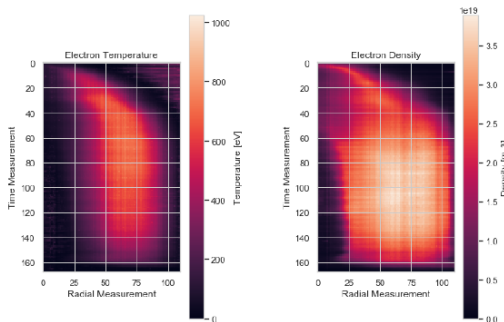


Mapping the Hyperspace of Plasma shots

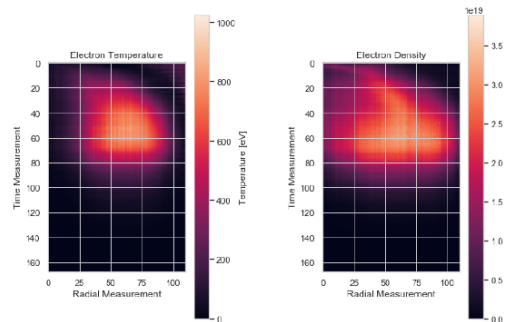


Mapping the Hyperspace

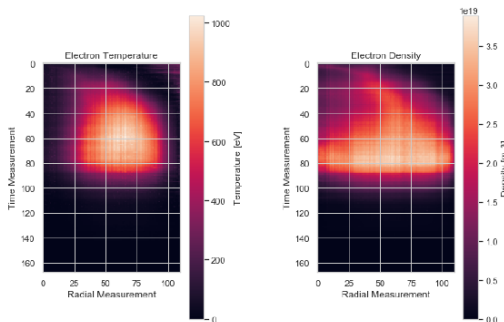




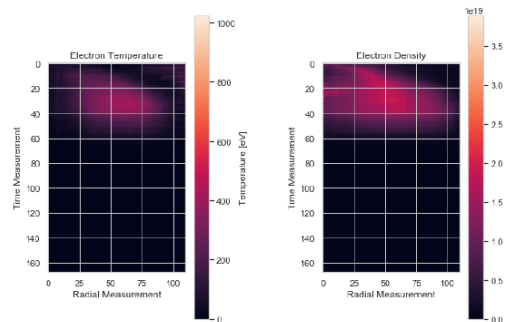
(a) Cluster 0: 204 shots



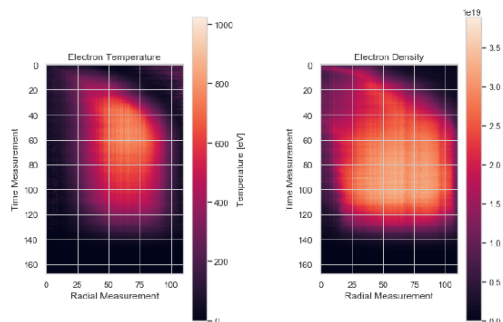
(b) Cluster 1: 394 shots



(c) Cluster 2: 205 shots



(d) Cluster 3: 130 shots



(e) Cluster 4: 184 shots

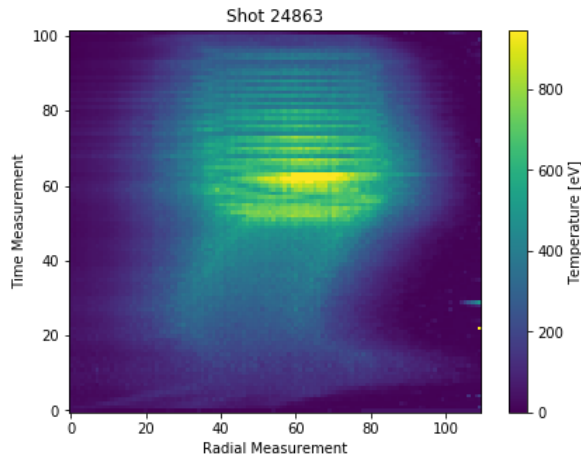
Plots of average density and average temperature taken across shots within a cluster.

Cluster based sampling for building surrogate dataset – M7 and M9

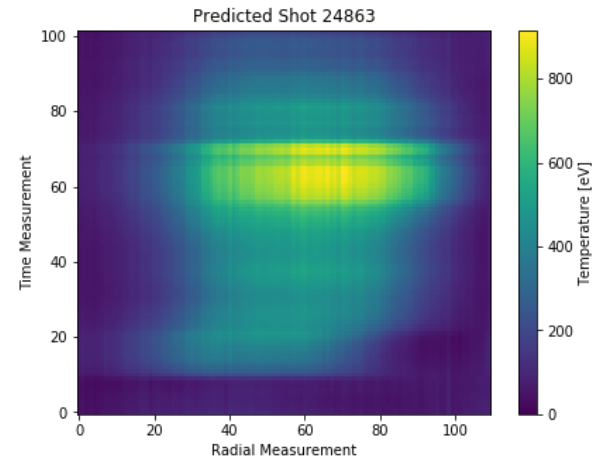
Campaign	Percentage Data	MSE
M7	100	0.0285
M7 (Sampling Technique)	10	0.0293
M9	100	0.0265
M9 (Sampling Technique)	10	0.0302
M7 + M9	100	0.0279
M7 + M9 (Sampling Technique)	10	0.0282

M7 – 1366 Shots
M9 – 1117 Shots

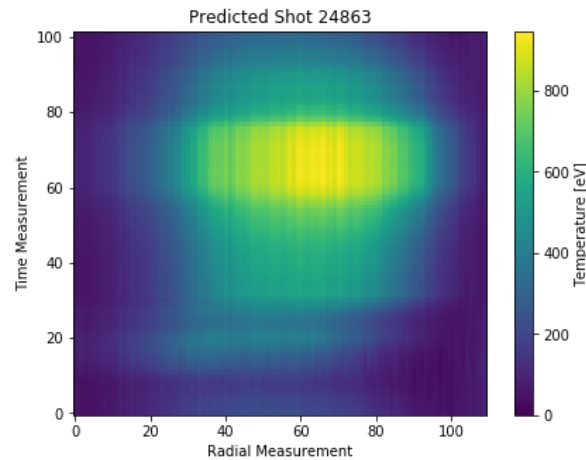
Prediction Comparison



Actual



100% Data



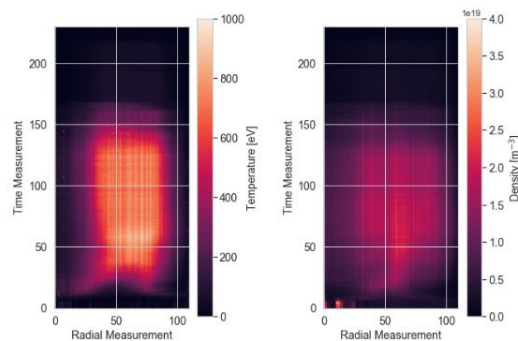
10% Data

Prediction Error (100%) : 0.0285
Prediction Error (10%) : 0.0293

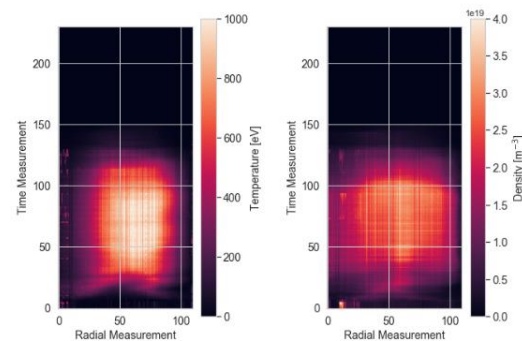
Cluster based sampling for building surrogate dataset – M8 and MU

Campaign	Percentage Data	MSE
M8	100	0.0209
M8 (Cosine Sampling)	10	0.0237
MU	100	0.0434
MU (Cosine Sampling)	10	0.0532
M8 + MU	100	0.0321
M8 + MU (Cosine Technique)	10	0.0323

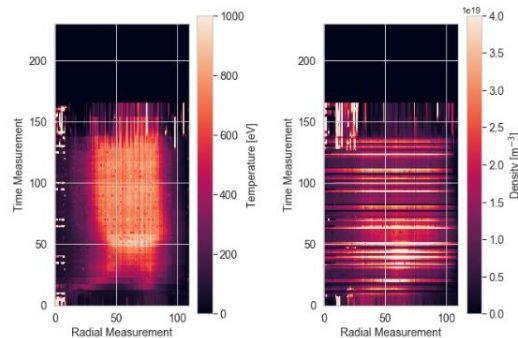
Mast-U Clusters



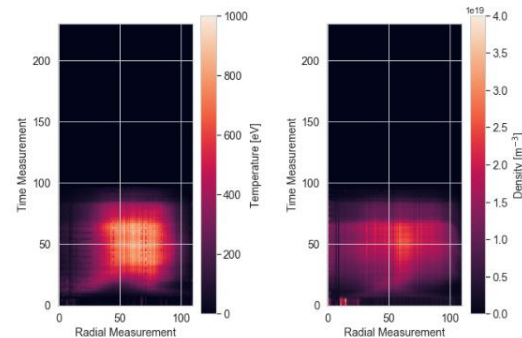
(a) Cluster 0: 44 shots



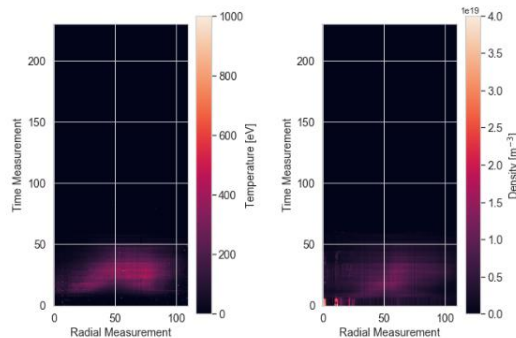
(b) Cluster 1: 34 shots



(c) Cluster 2: 4 shots



(d) Cluster 3: 20 shots



(e) Cluster 4: 14 shots