

# Surrogate modeling of Laser-Plasma acceleration

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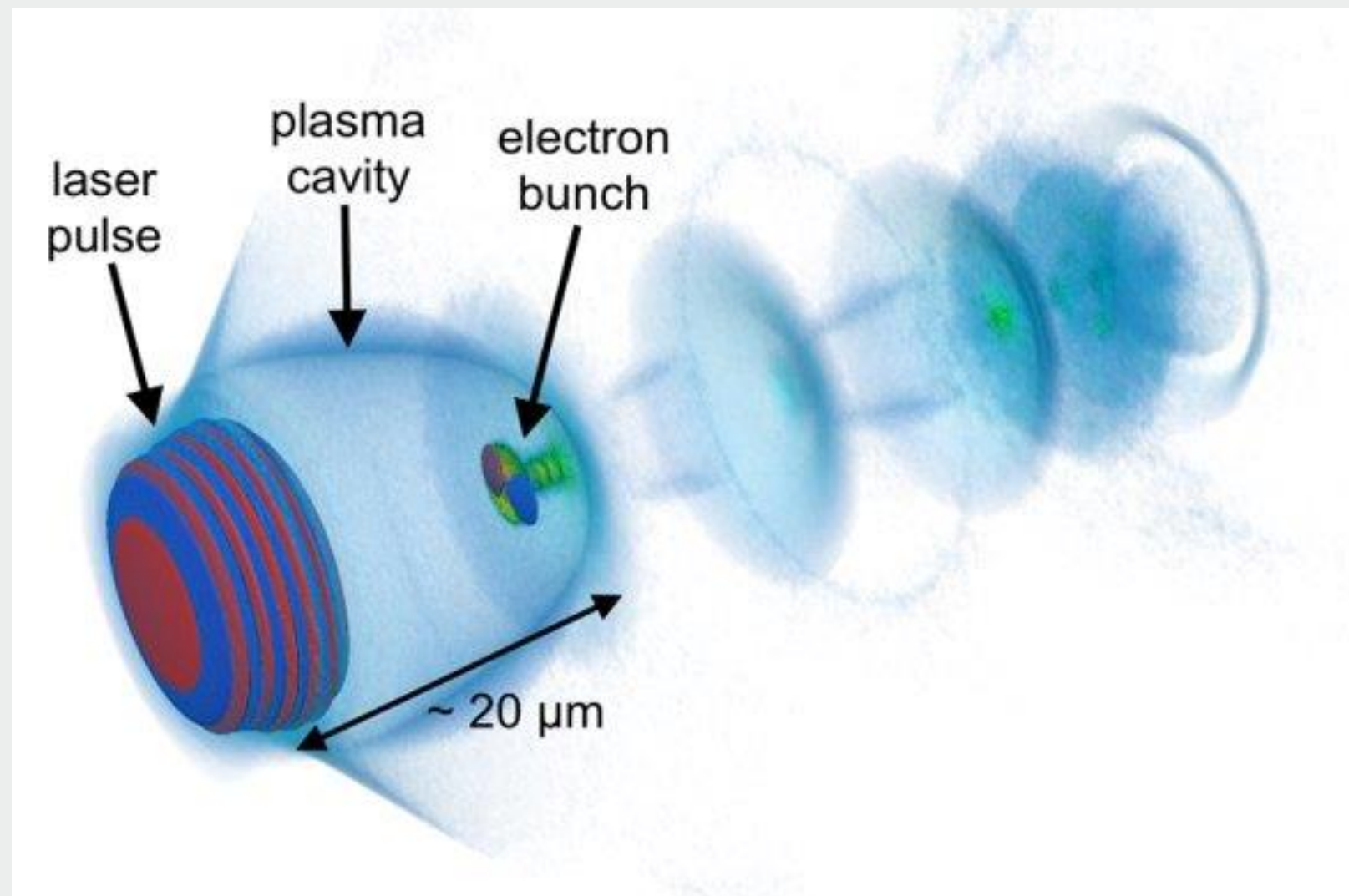
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## Experimental research of the laser plasma acceleration processes

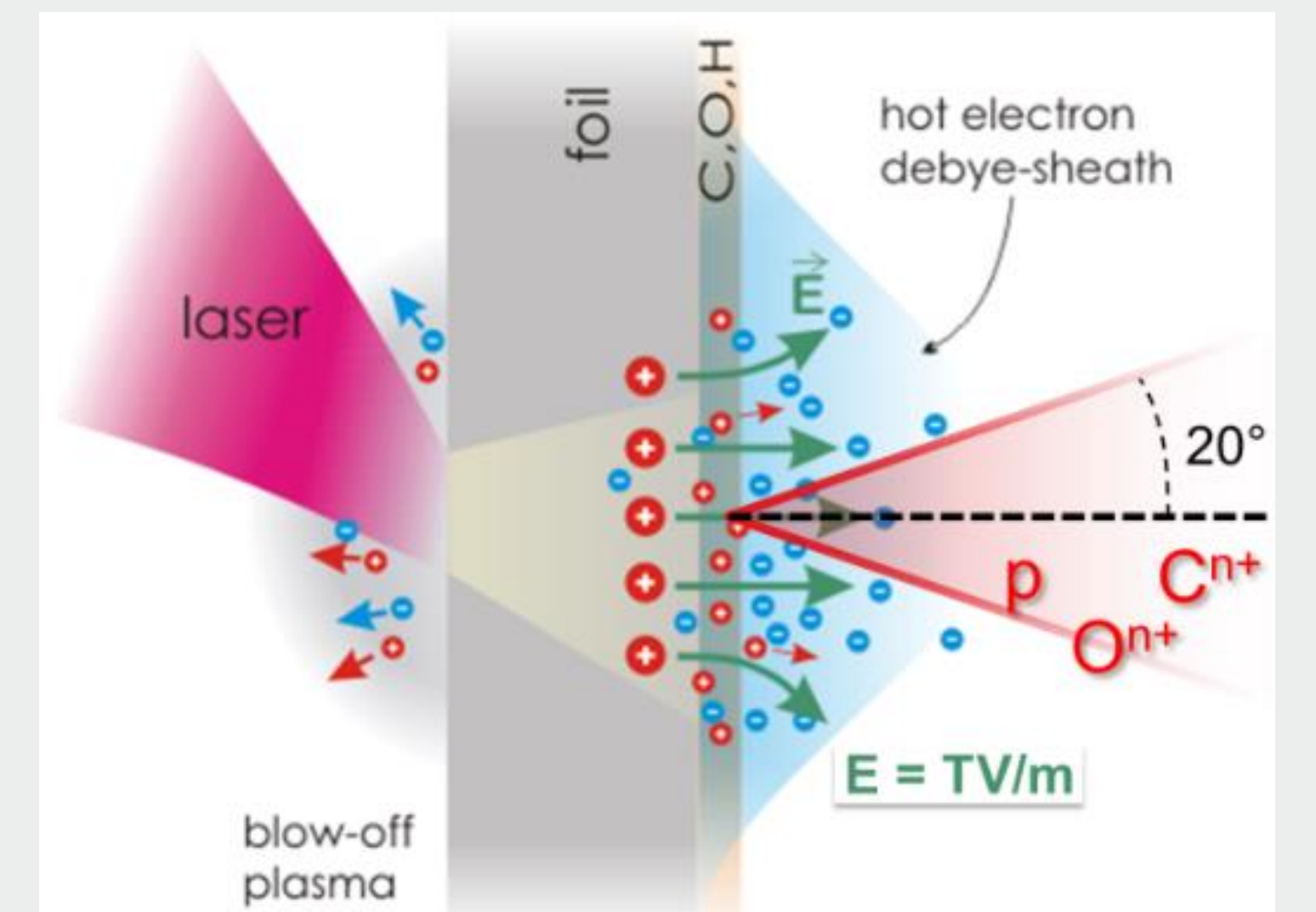
Acceleration of electrons(LWFA) or ions(TNSA) in plasma using an intense laser pulse

Highly nonlinear processes cause time consuming and difficult search for the optimal parameters

### LWFA: Laser Wakefield Acceleration



### TNSA: Target Normal Sheath Acceleration

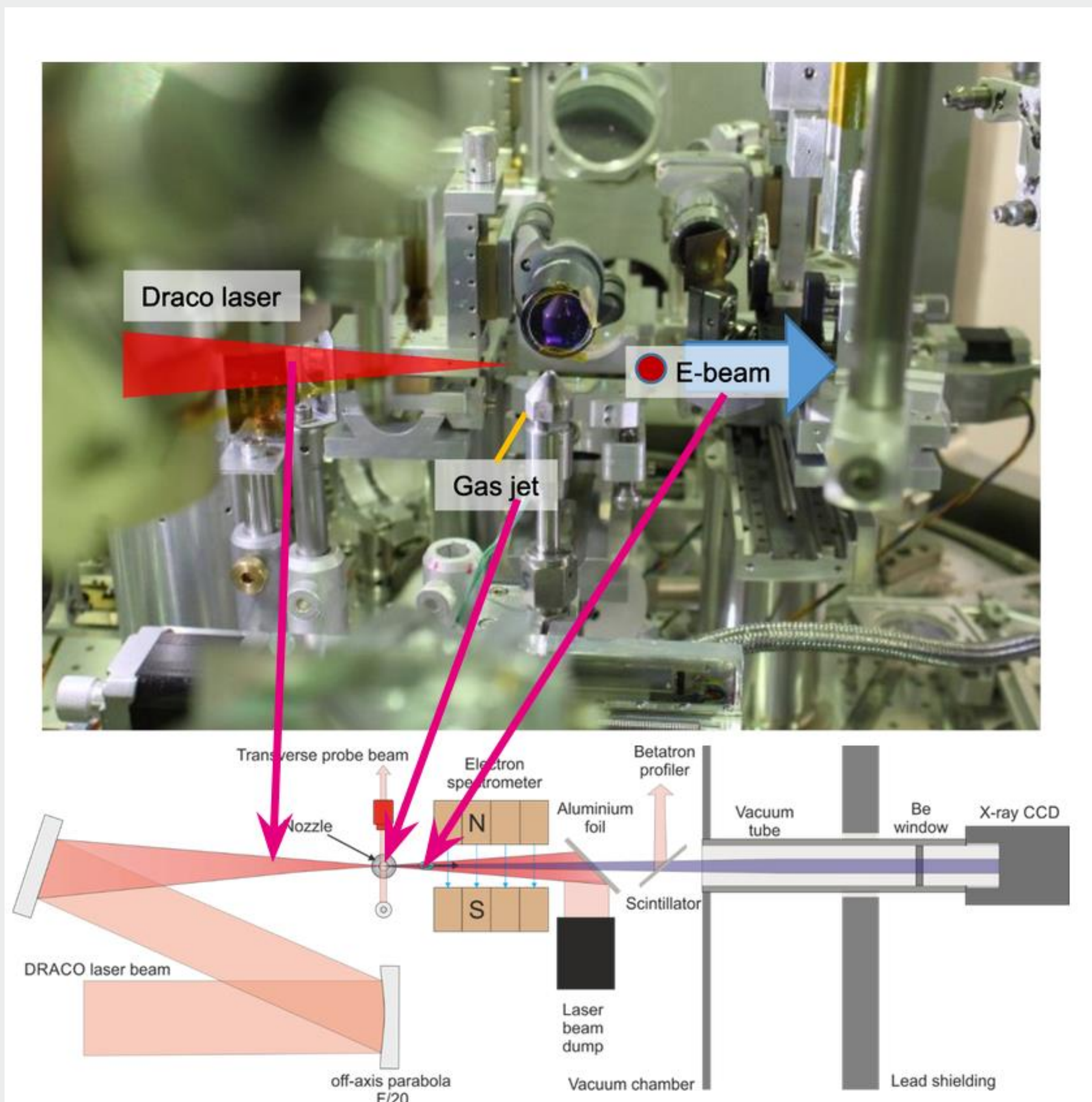


## Machine Learning Based Reconstruction and Optimization of experiments

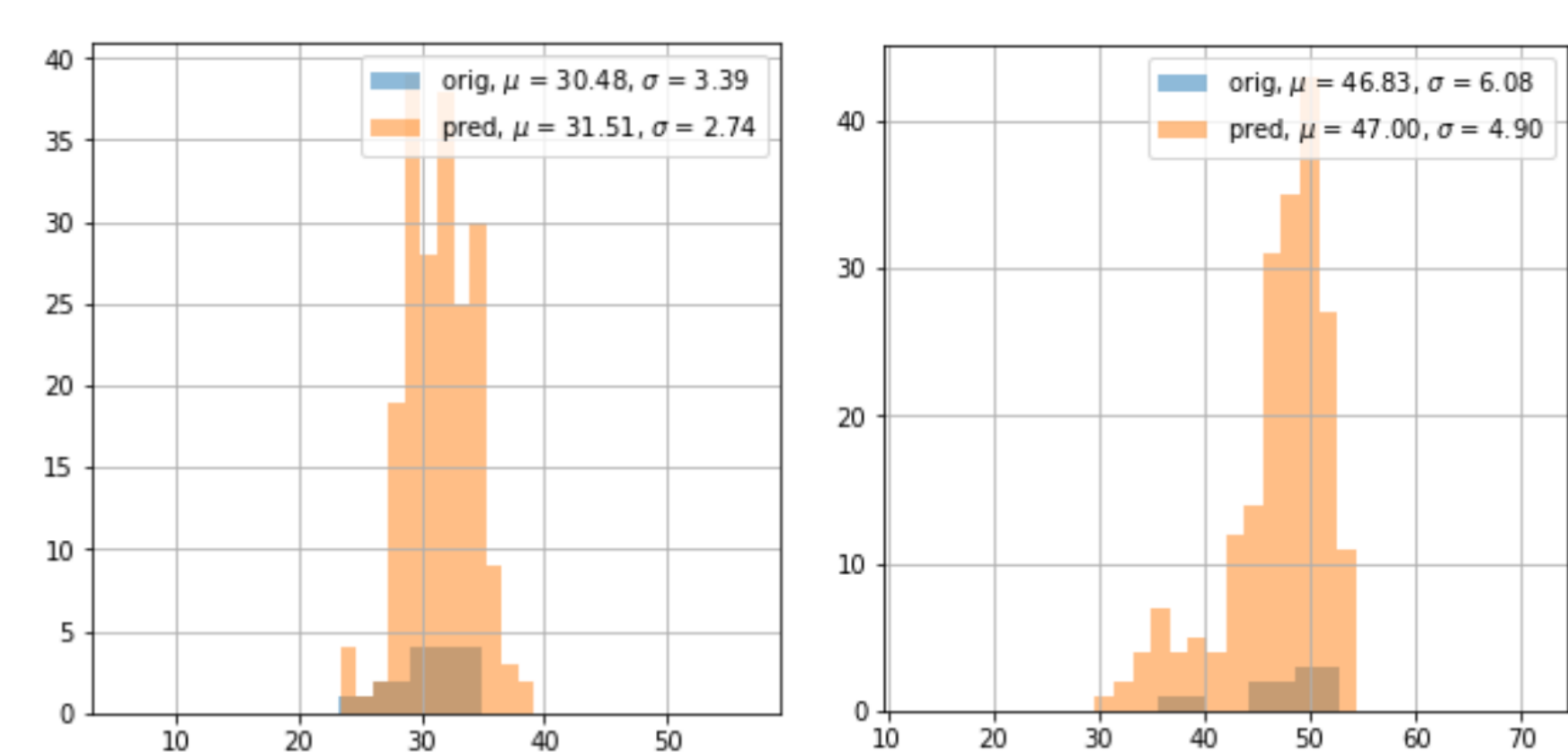
Supportive surrogate model to optimize experiments of different acceleration processes

Fast and reliable interpolation of experimental diagnostics in parameter space

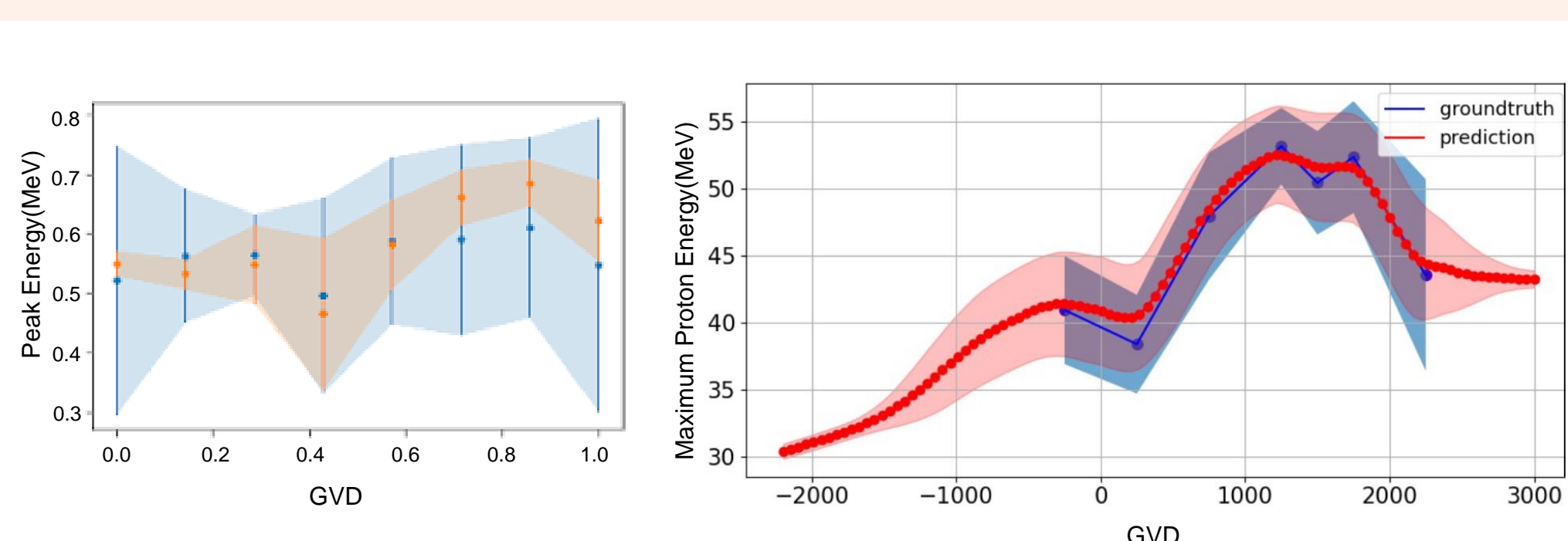
Automatic parameter search to archive minimal spread with maximum energy



### Approximating experimental diagnostics' probability density

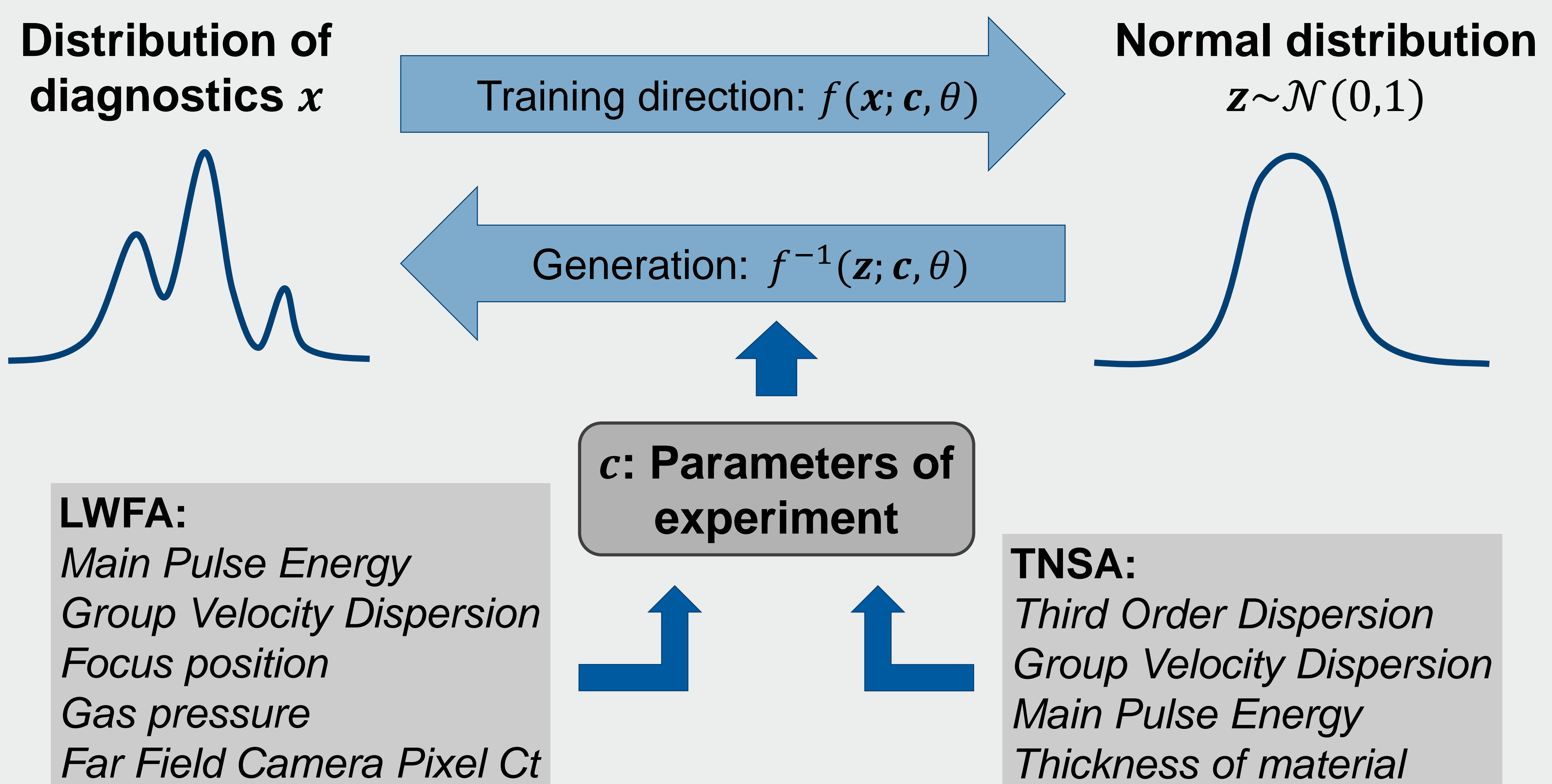


### Generating artificial experimental data for unseen parameter sets



## Conditional Invertible Neural Network(cINN) Model

Mapping from parameters of an experiment to distribution of diagnostics



### References:

1. Couperus, J. P., et al. Nature Communications, 8, 487 (2017), Irman, A., et al. Plasma Physics and Controlled Fusion, 60(4), 044015. (2018)
2. Ziegler, T. et al (2021). Proton beam quality enhancement by spectral phase control of a PW-class laser system. Scientific Reports, 11(1), 7338
3. Ardiszone, Lynton, et al. "Guided image generation with conditional invertible neural networks." arXiv preprint arXiv:1907.02392 (2019)
4. Bethke, F., Pausch, R., Stiller, P., Debus, A., Bussmann, M., & Hoffmann, N. (2021). Invertible Surrogate Models: Joint surrogate modelling and reconstruction of Laser-Wakefield Acceleration by invertible neural networks. arXiv preprint arXiv:2106.00432.