Temporal electric field reconstruction

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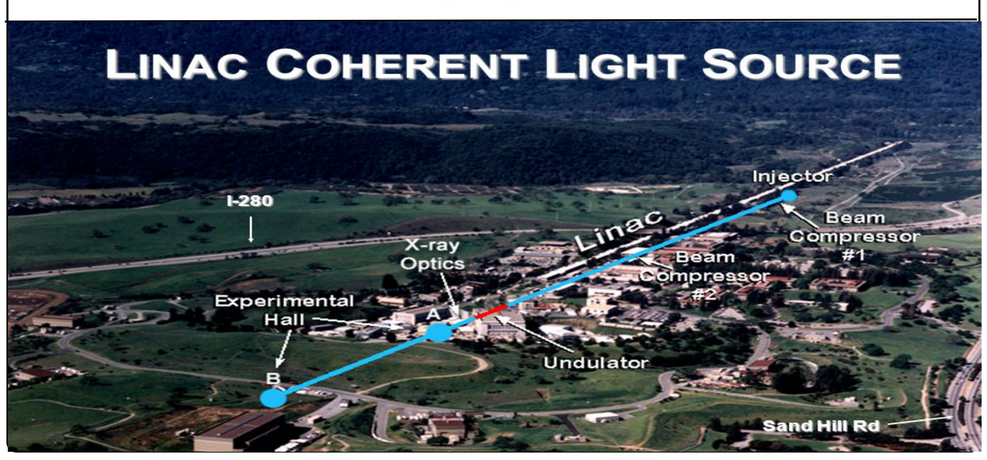
ICFA workshop

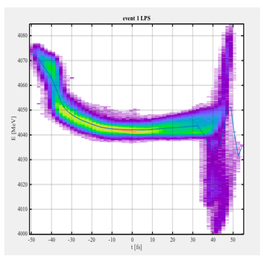
LCLS



Dataset and Method

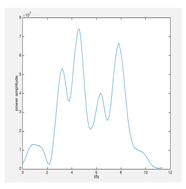
Prediction on Genesis simulated SASE dataset

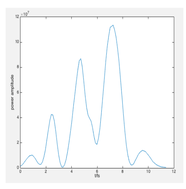
Datasets:



Lasing off beam data

Genesis

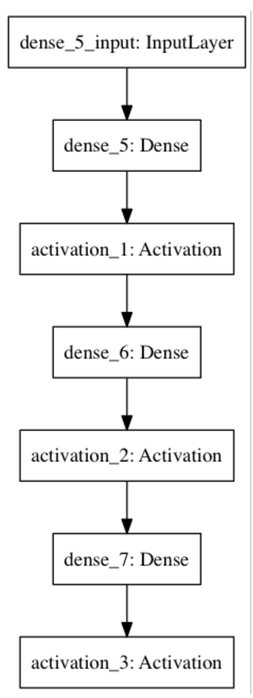




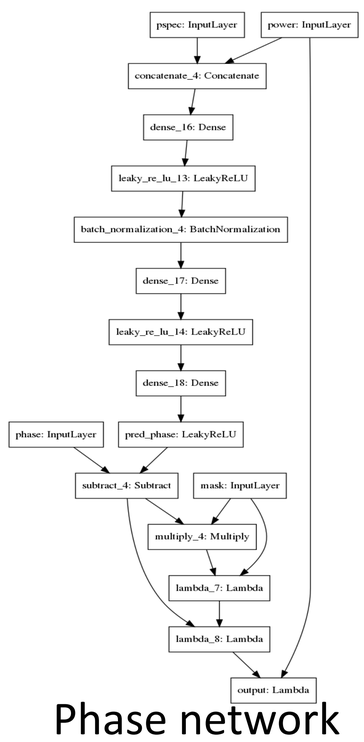
Simulated power profiles

Preprosessing:
normalization of temporal and spectral input power. Add smearing and noise

Network:



Power network



Phase network

Metric:

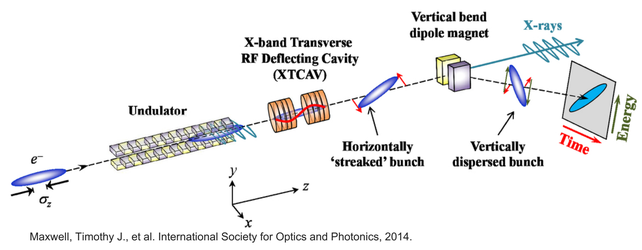
Power

$$metric = \frac{mean(|predicted\ power - power\ groundtruth|^2)}{mean(power\ groundtruth)}$$

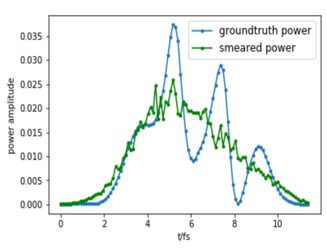
Phase

$$score = \frac{\int \cos\left(\Phi_{pred} - \Phi_{original} + \varphi\right) * P(t)dt}{\int P(t)dt}$$

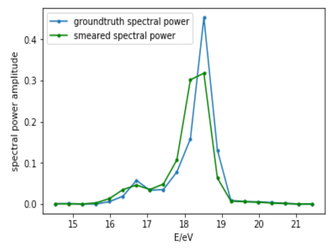
Problem Definition



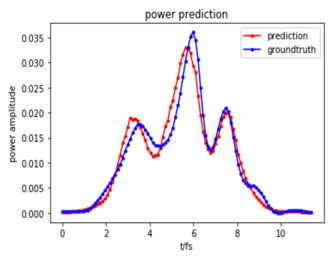
Maxwell, Timothy J., et al. International Society for Optics and Photonics, 2014.



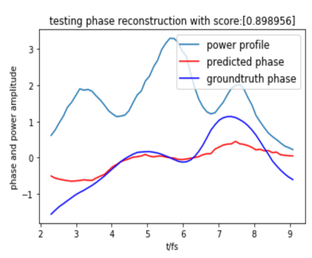
Power power



Spectral power



Power reconstruction



Phase reconstruction

a) Goal: full reconstruction of a femtosecond X-ray pulse (both power and phase)

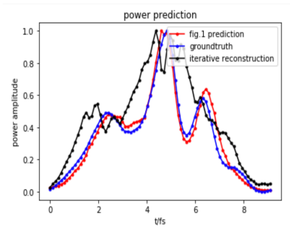
b) Problem: temporal power diagnostics have bad resolution. No way to measure precisely. No way to retrieve phase

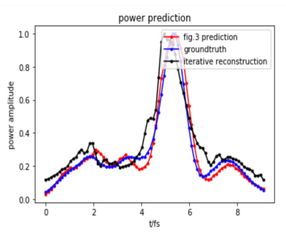
c) Proposed solution: combine temporal+spectral diagnostics with iterative optimization... or with a neural network!

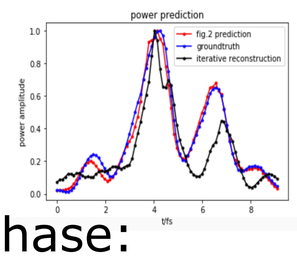
Result

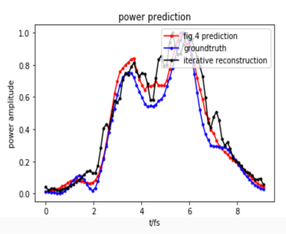
Comparison with traditional iterative reconstruction:

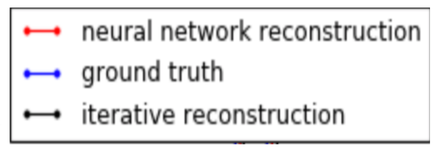
Power:







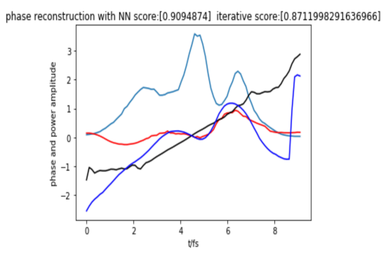


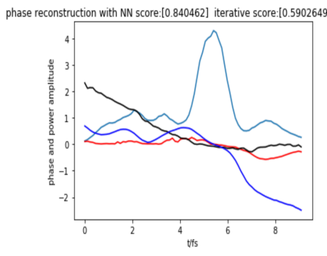


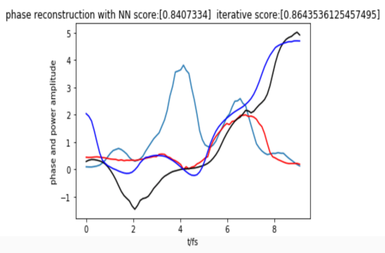
Power error

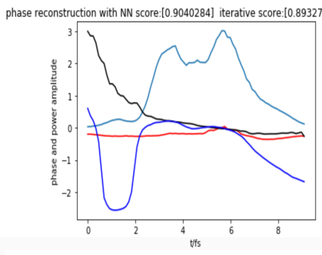
NN	0.08%
Iterative	0.22%

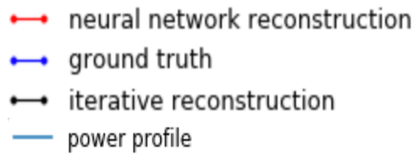
Phase:











Phase score

NN score: 0.83

Iterative score: 0.80

Neural network reconstruction: On average 0.19ms per prediction
Iterative reconstruction: 30s per prediction
NN: ~ 10^5 faster