HIGH ENERGY ELECTORN RADIOGRAPHY EXPERIMENT RESEARCH BASED ON PICOSENCOND PULSE WIDTH BUNCH

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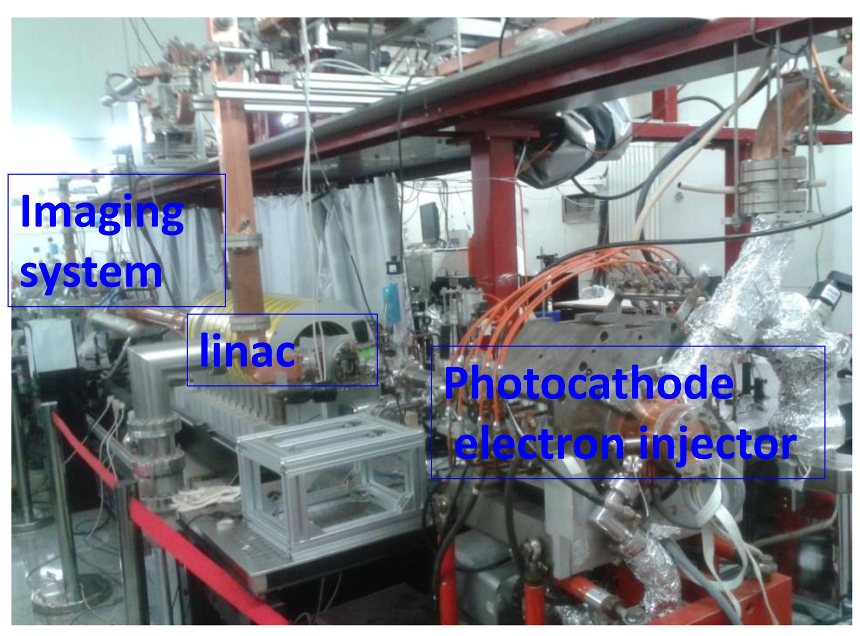
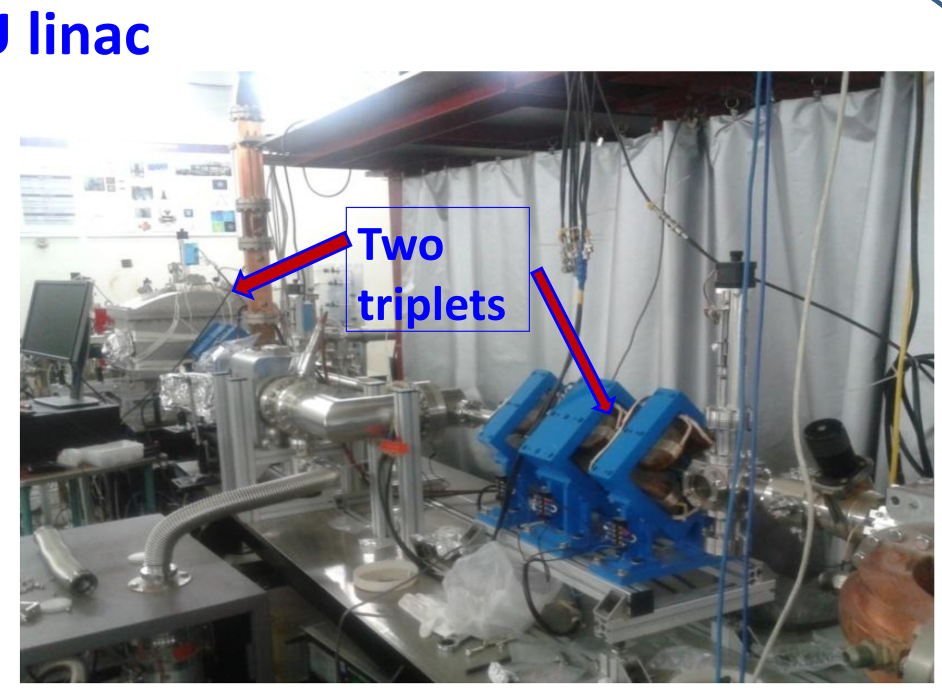
Introduction

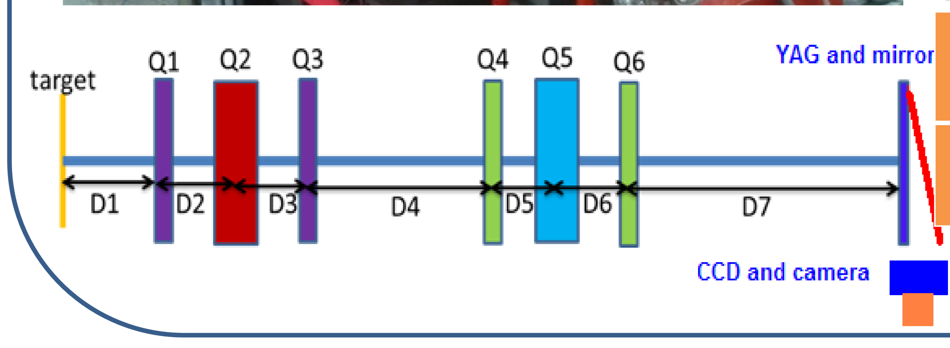
A new scheme is proposed that high energy electron beam as a probe is used for time resolved imaging measurement of high energy density materials, especially for high energy density matter and inertial confinement fusion. The first picosecond pulse-width electron radiography experiment was achieved by Institute of Modern Physics (IMP), Chinese Academy of Sciences (CAS) and Tsinghua University (THU), based on THU Linear electron accelerator (LINAC). It is used for principle test and certifying that this kind of LINAC with ultra-short pulse electron bunch can be used for electron radiography. The experiment results, such as magnifying factor and the imaging distortion, are consistent with the beam optical theory well. The 2.5 um RMS spatial resolution has been gotten with magnifying factor 46, without optimization the imaging lens section. It is found that in the certain range of magnifying factor, the RMS spatial resolution will get better with bigger magnifying factor. The details of experiment set up, results, analysis and discussions are presented here.

The eRAD experiment set up

The sketch of the eRad based on THU linac



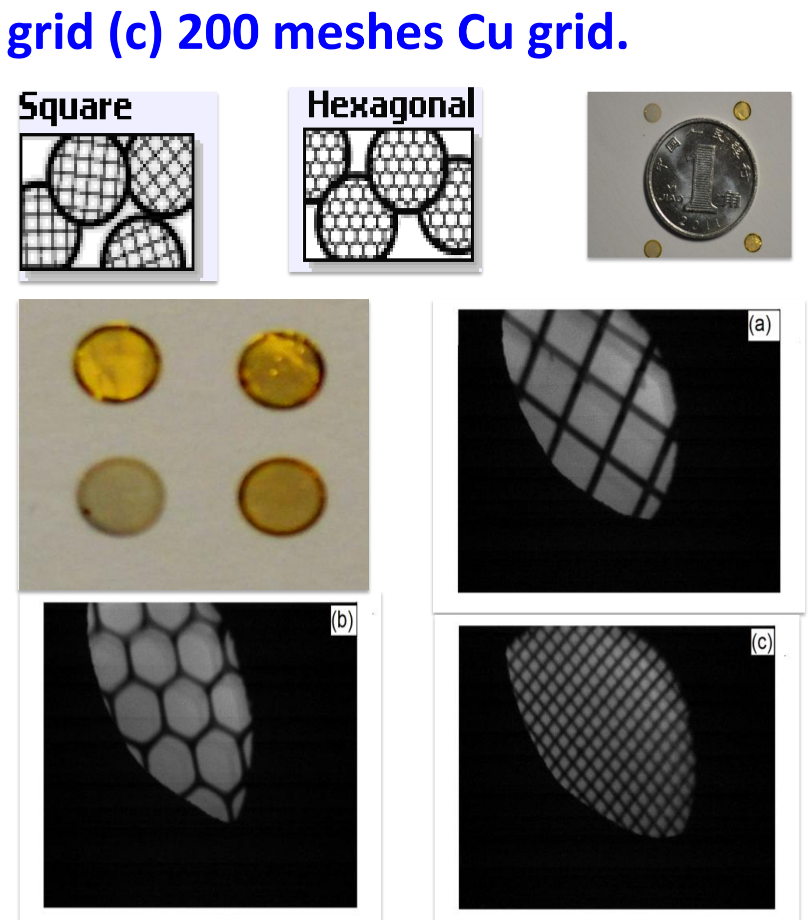




	D1	D2	D3	D4	D5	D6	D7
Ld(cm)	10	10	10	216.1	10	10	166

Experiment results and analysis

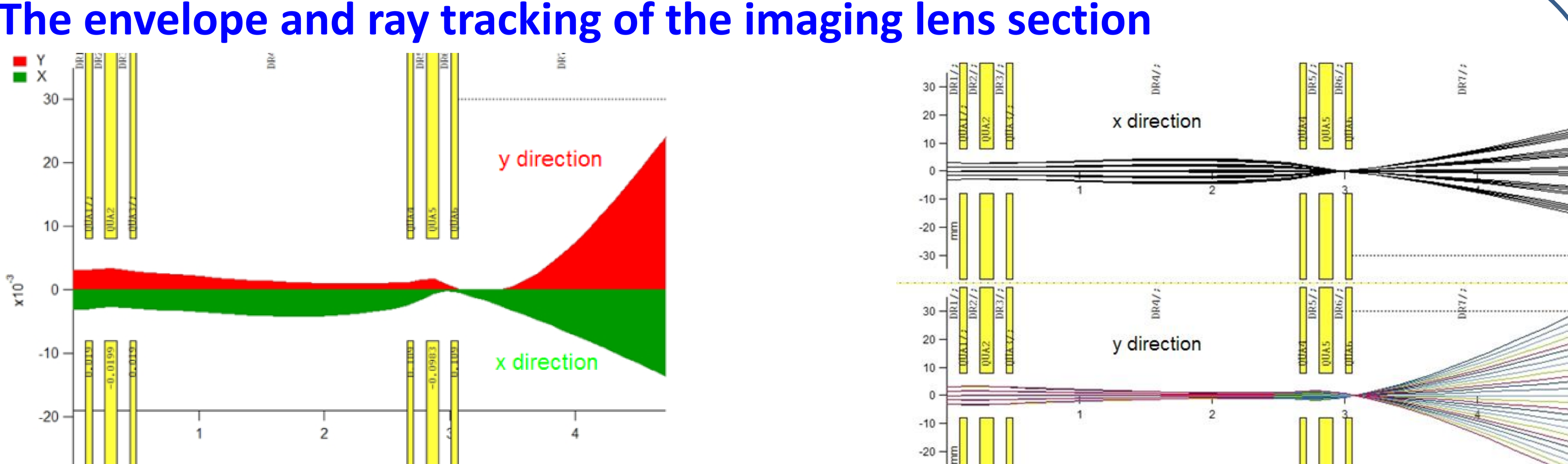
The images of the TEM grids: (a) 50 meshes Ni grid (b) 75 meshes Cu grid (c) 200 meshes Cu grid.



The field strength of the imaging quadrupoles

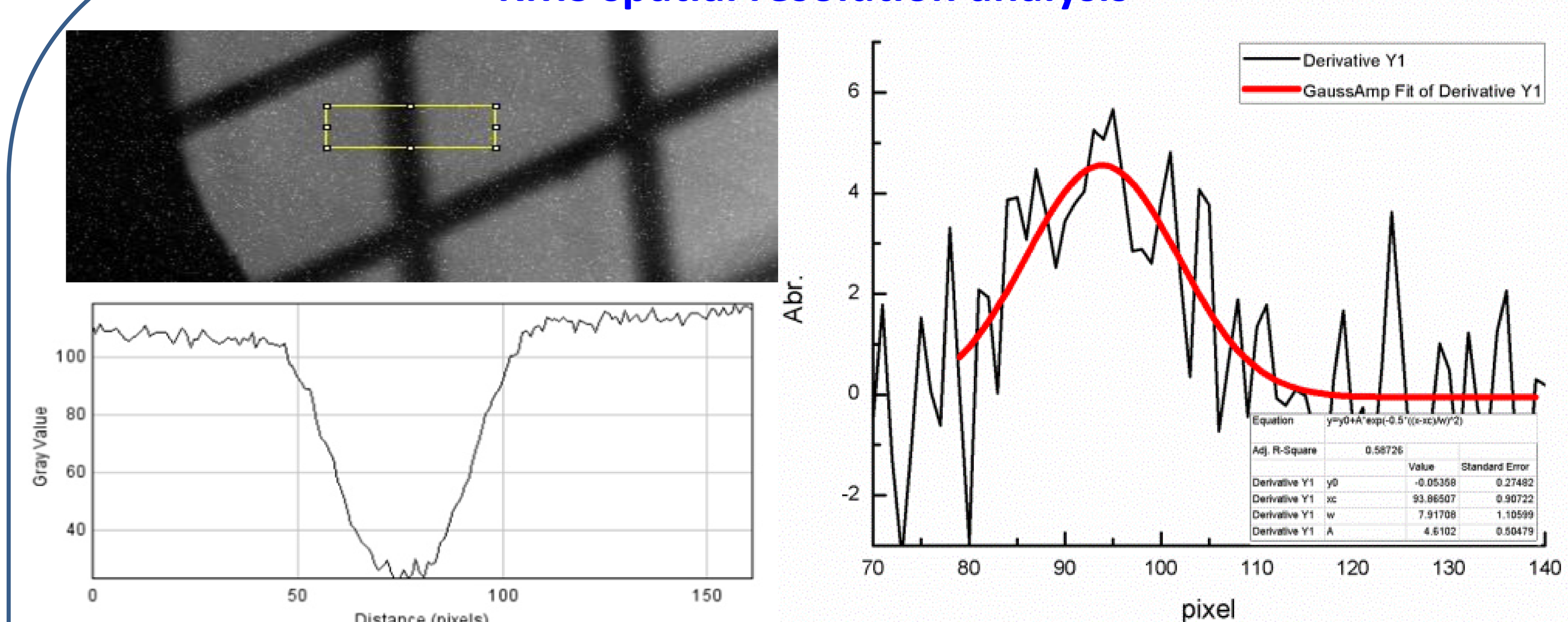
	Lq (cm)	Pole radius (cm)	Magnetic on the poles (kGauss/cm)
Q1	5.0	0.8	0.1896
Q2	10.0	0.8	-0.1991
Q3	5.0	0.8	0.1896
Q4	5.0	0.8	1.093
Q5	10.0	0.8	-0.9825
Q6	5.0	0.8	1.093

The envelope and ray tracking of the imaging lens section



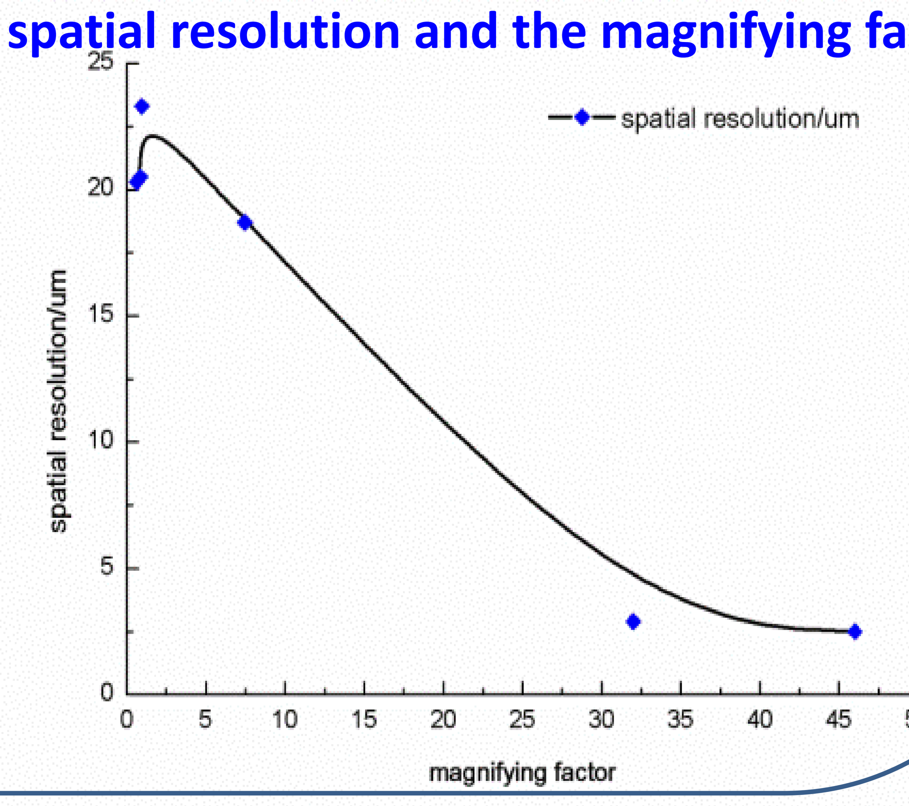
Parmela simulation: Beam distribution (a) after the grid on the object plane (b) on the image plane.

RMS spatial resolution analysis



The relationship between RMS spatial resolution and the magnifying factor

Magnifying factor	RMS spatial resolution（um
46	2.5
32	2.9
7.46	18.7
0.95	23.3
0.86	20.5
0.64	20.3



Conclusion

The first experiment of eRad based on picosecond pulse-width electron bunch has been achieved. It is certified that this kind of LINAC and picosecond pulse-width electron bunch can be used for eRad perfectly. Because of the short pulse width electron bunch (~picosecond), the dynamic imaging can be achieved with nanosecond time interval, which just limited by the detector recording velocity and the data capturing method. So the dynamic radiography with 10 nanosecond time interval becomes available. The experiment results are consistent with the beam optical theory well, such as magnifying factor and the imaging distortion. The 2.5 um RMS spatial resolution has been gotten with no optimization the lens section. During this experiment, there is no aperture used, so if the aperture is adopted properly and placed on the right position, the RMS spatial resolution will be enhanced more. So the RMS spatial resolution of the eRad can be get better than 2.5 um with some optimization in the future. Furthermore, the density resolution and dynamic radiography of the eRad will be gotten in the future experiment.

Reference

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