Beam Halo Measurements at UMER and the JLAB FEL using an Adaptive Masking Method

H. D. Zhang#, R.B. Fiorito, A. Shkvarunets, R. A. Kishek, S. Bernal, P. G. O'Shea,
UMD, College Park, Maryland

S. Zhang, F. G. Wilson, S. V. Benson, D. Douglas

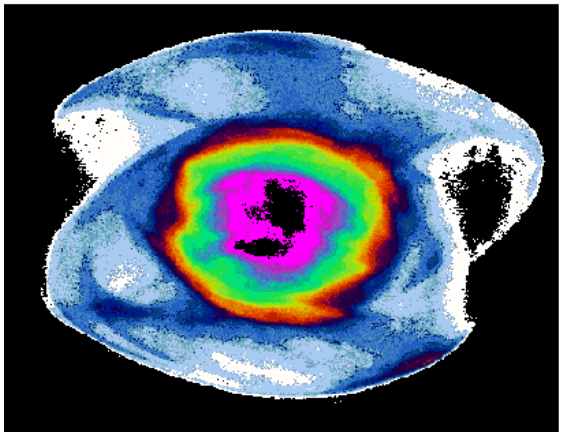
JLAB, Newport News, Virginia

*Work Funded by US ONR, DOD JTO and DOE Office of HEP

Outline

- Introduction
  - Motivation to Study Beam Halo
- Method
  - Adaptive Method Using Digital Micro-mirror Device
- Experiment
  - University of Maryland Electron Ring (UMER)
  - JLAB FEL

Motivation for Beam Halo Studies



- Beam Halo has many negative effects
  - Nuclear Activation of The Transport Channel
  - Emittance Growth
  - Emission of Secondary Electrons
  - Increasing Noise in The Detectors

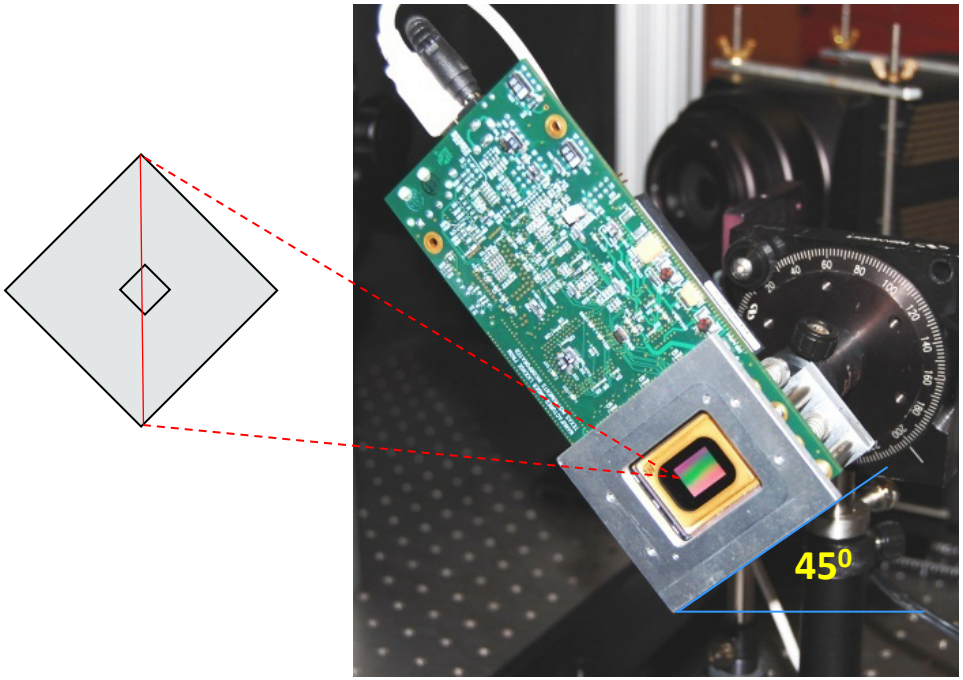
Challenge to detect faint halos in experiment

1.Achieve high dynamic range about 10^5~10^6

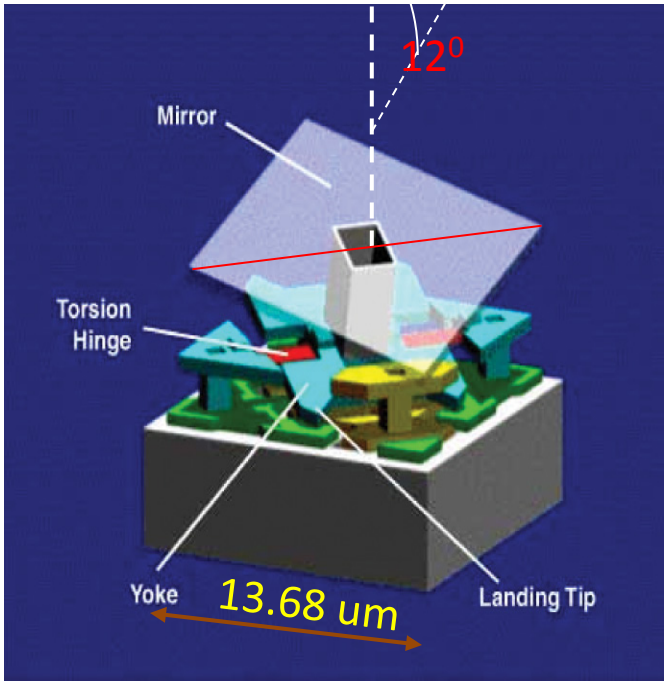
2.Adaptability

Halo Picture credit: Kishek, Stratakis

Digital Micro-mirror Device

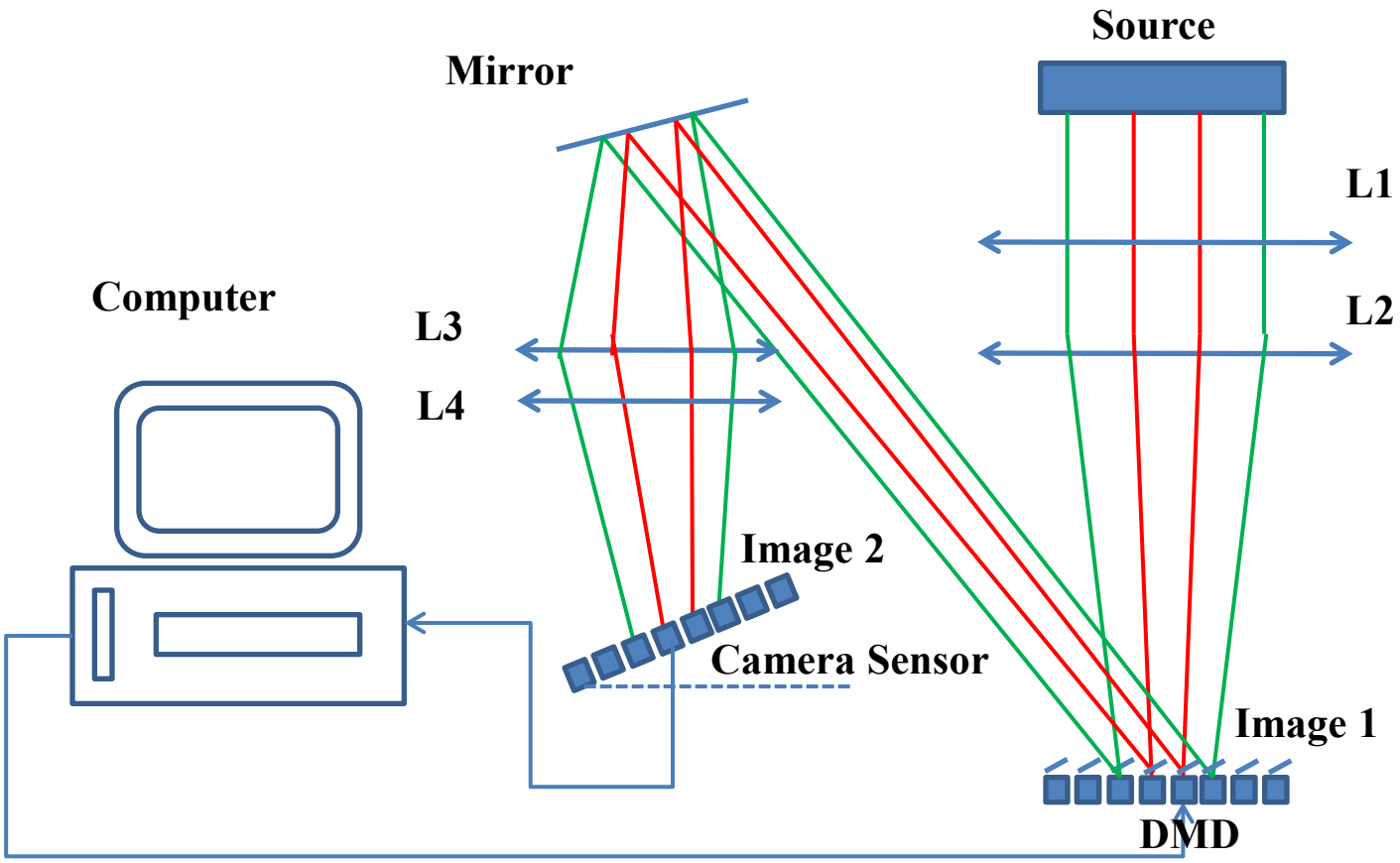


Commercial available

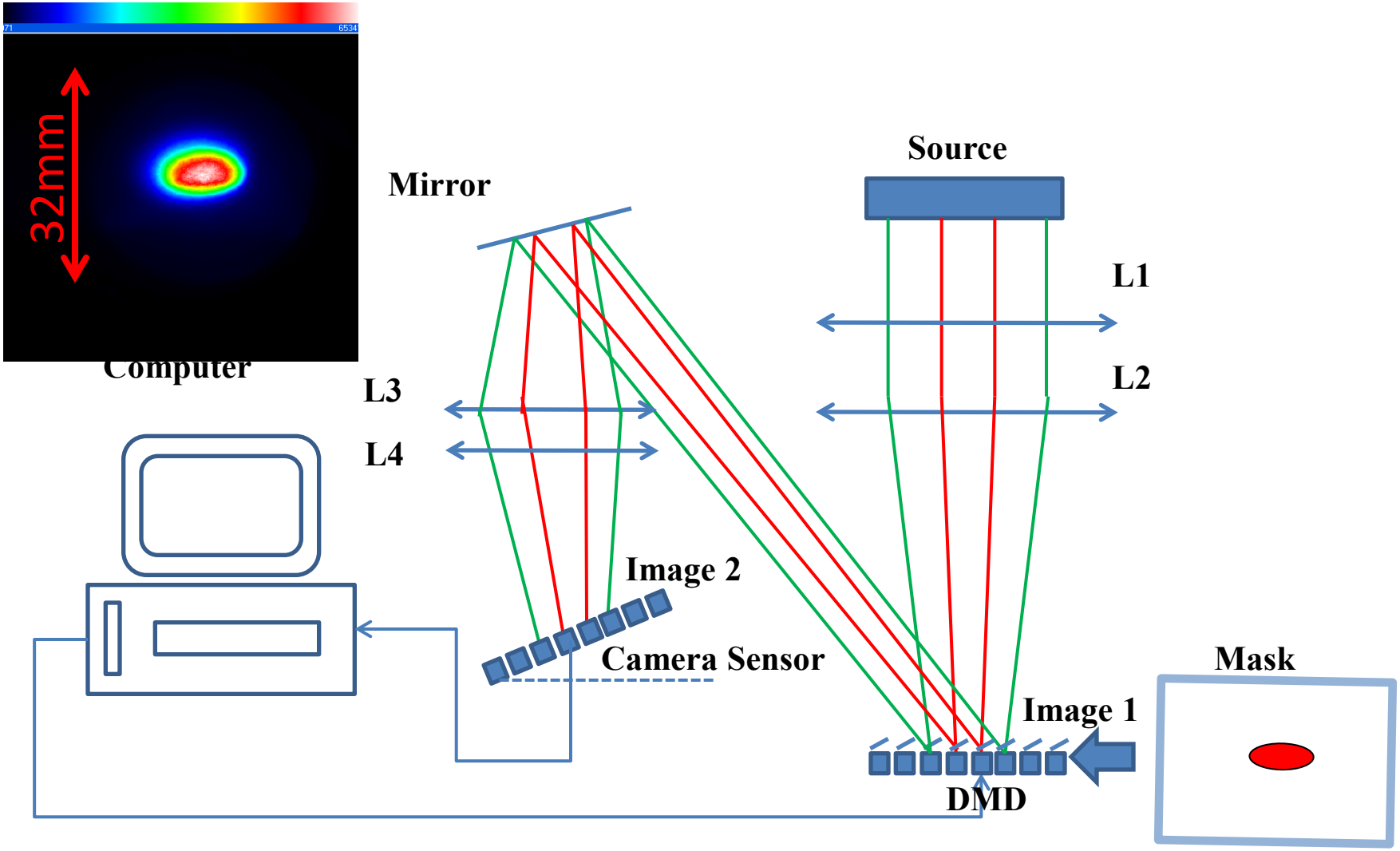


Micro-mirror architecture:

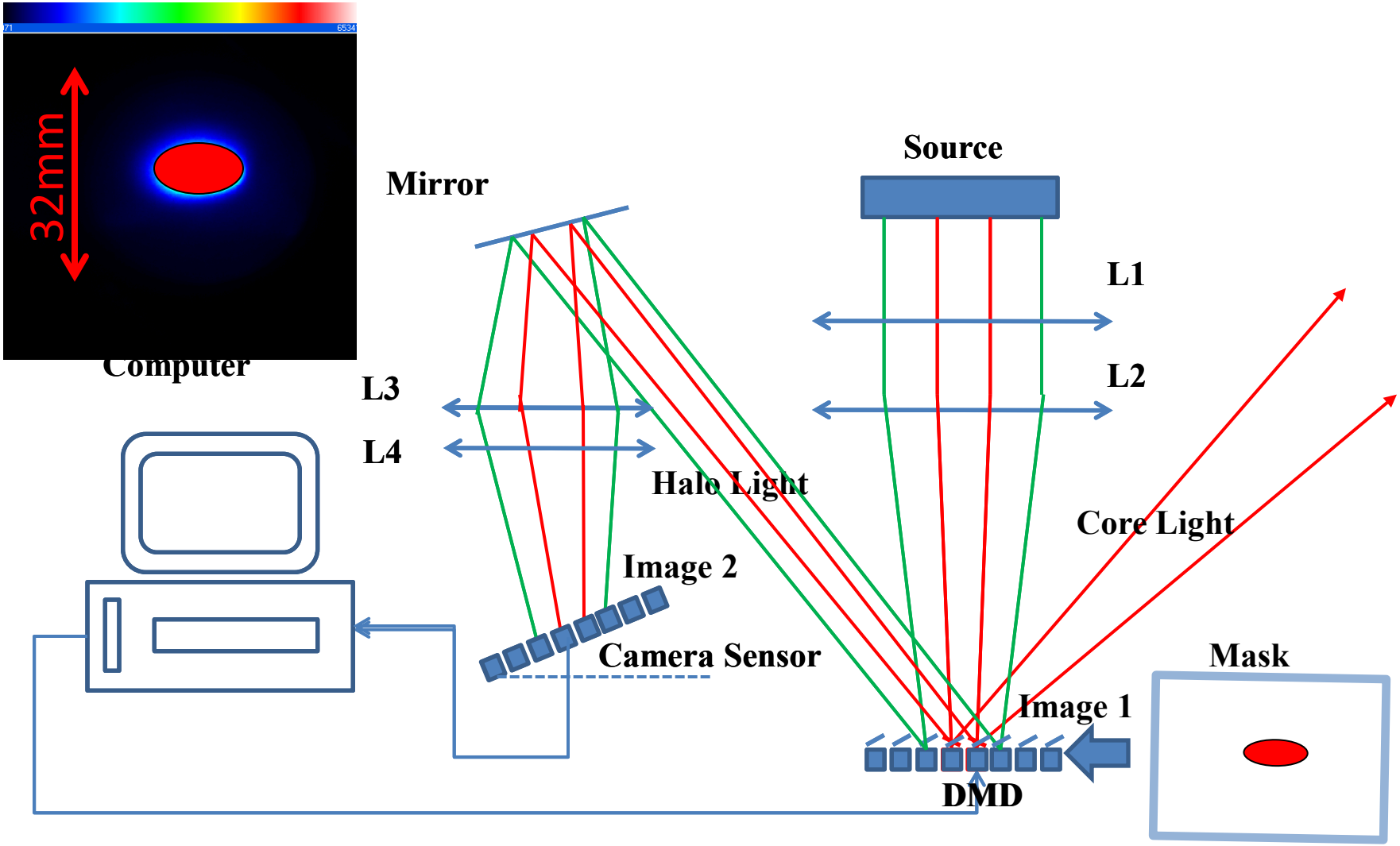
Adaptive Method for Halo Measurement



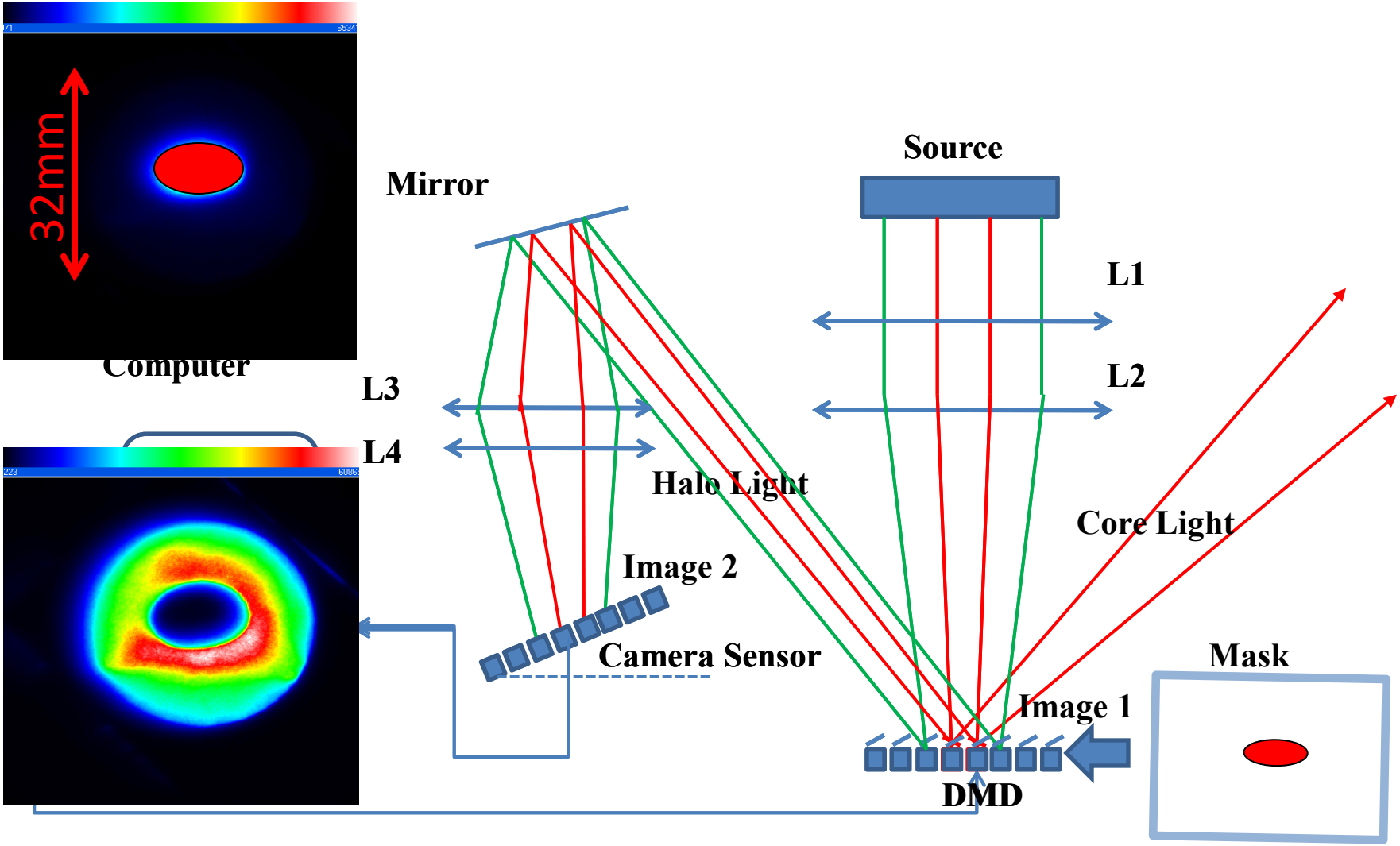
Adaptive Method for Halo Measurement



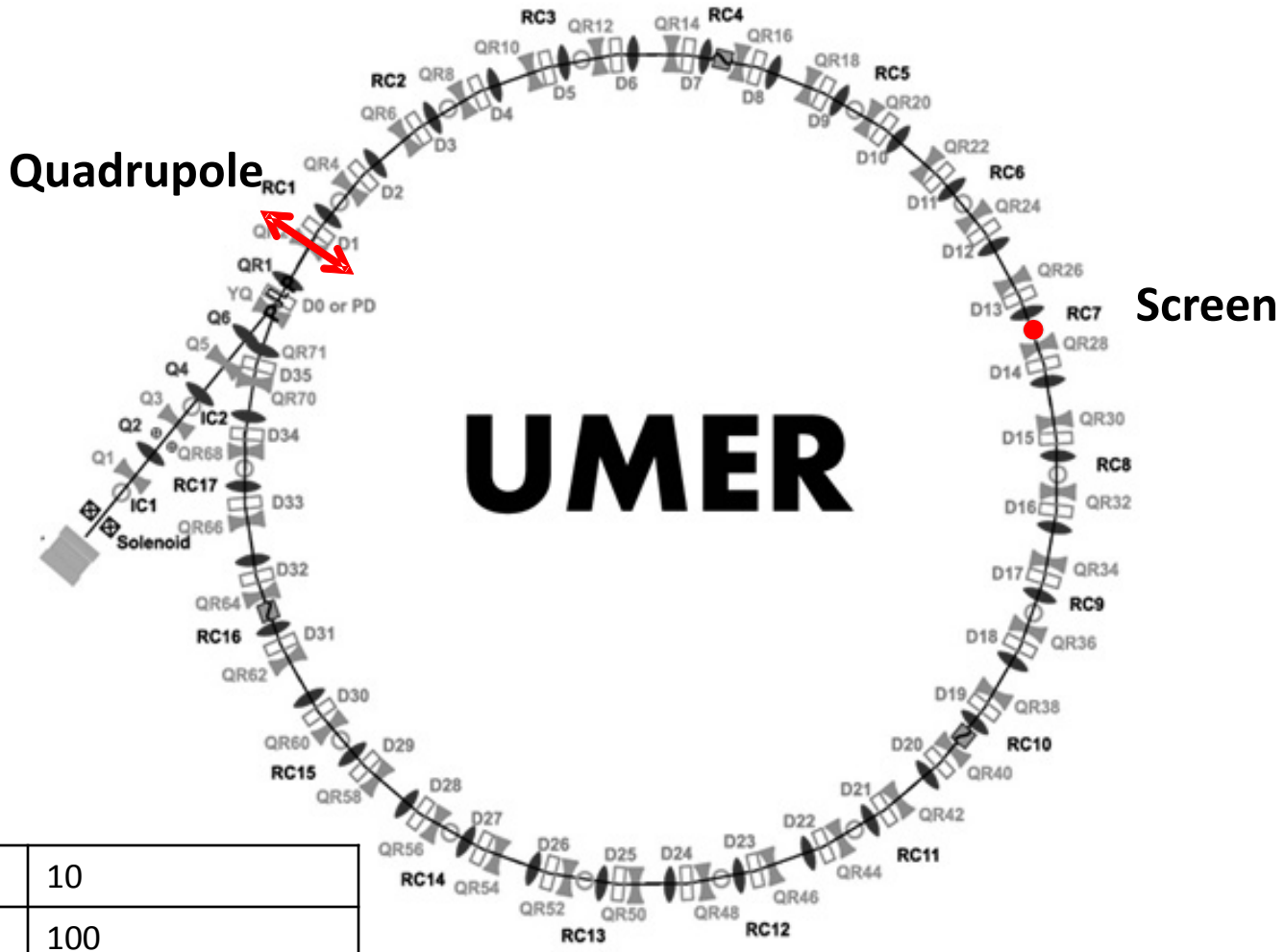
Adaptive Method for Halo Measurement



Adaptive Method for Halo Measurement

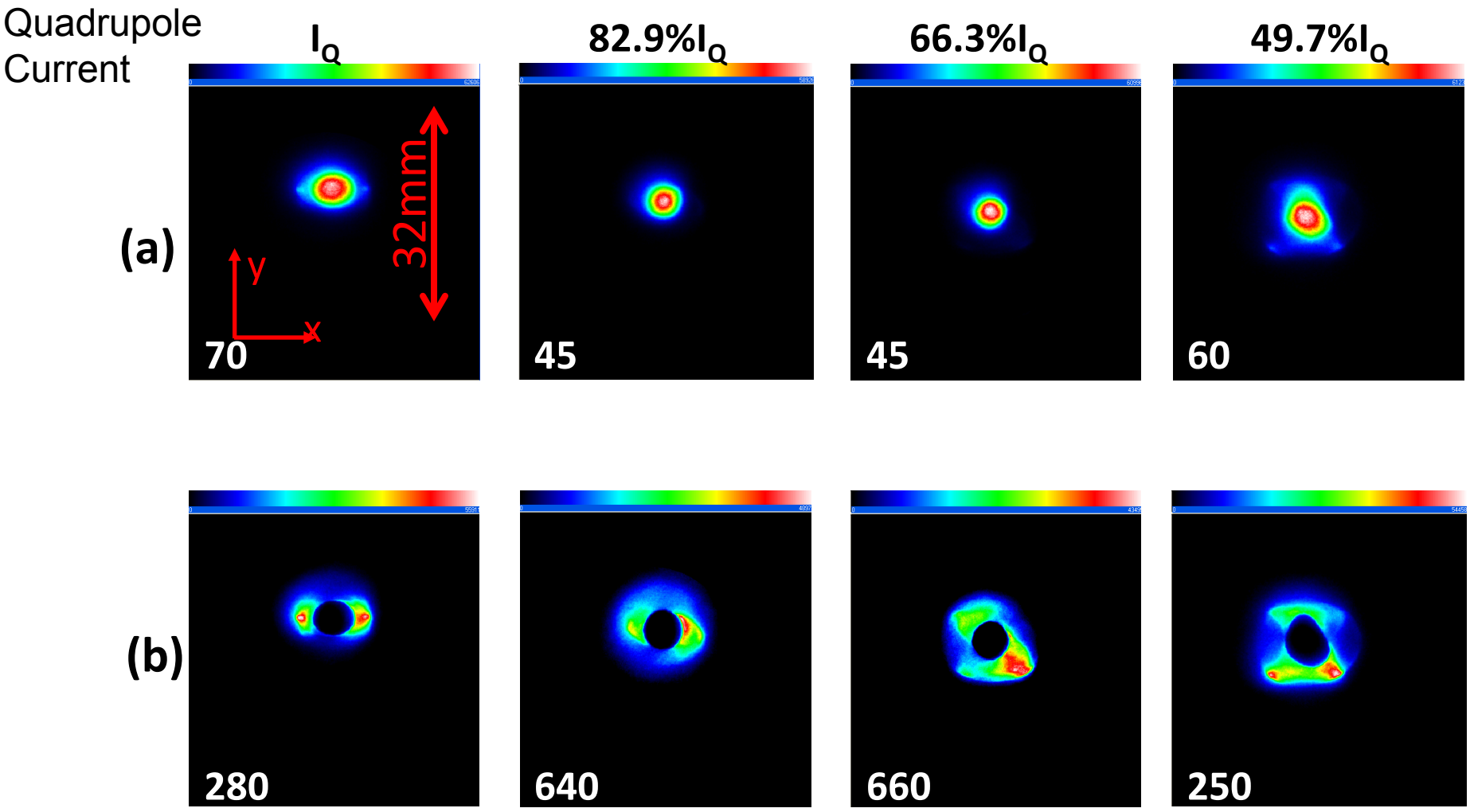


UMER Experiment

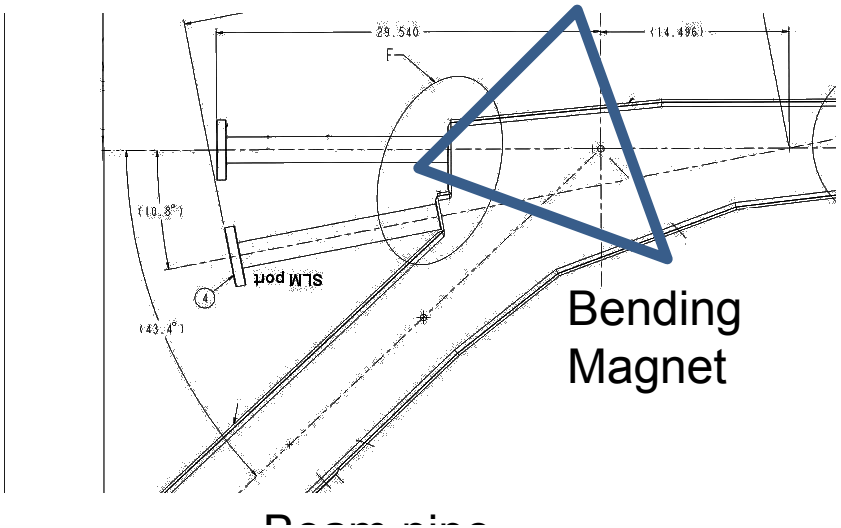


Energy (keV)	10
Pulse width (ns)	100
Repetitive rate (Hz)	20-60
Beam current (mA)	0.6 , 6, 21,80

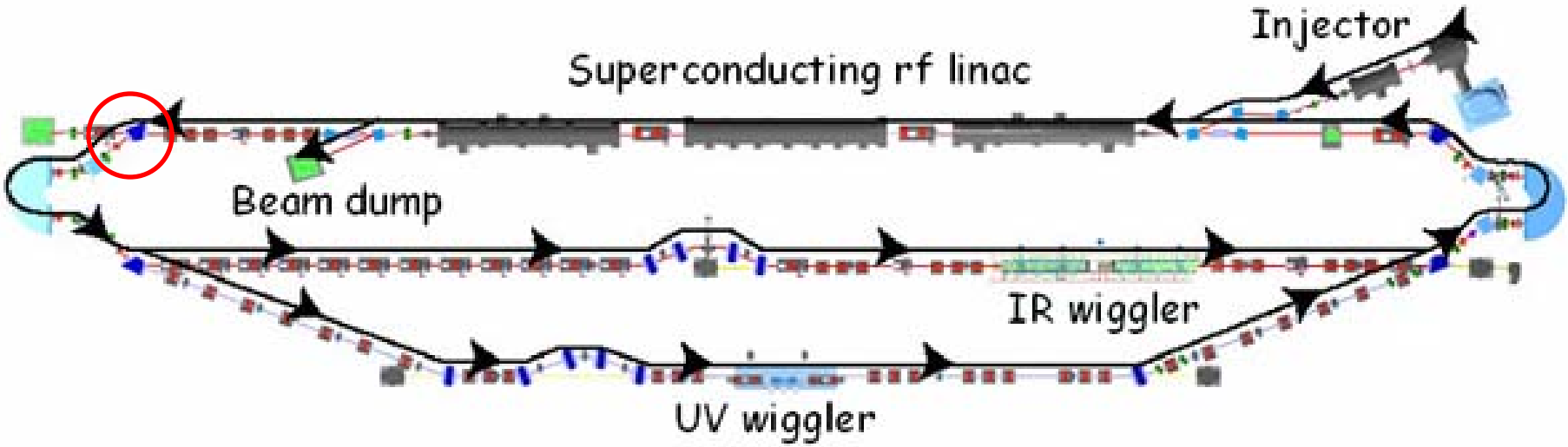
Demonstration of Adaptive Masking on UMER



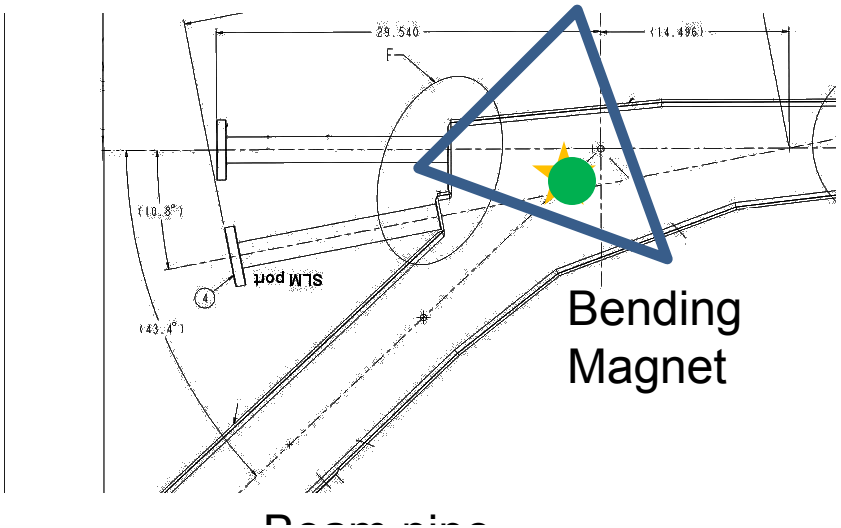
Halo Experiment with OSR in JLab FEL



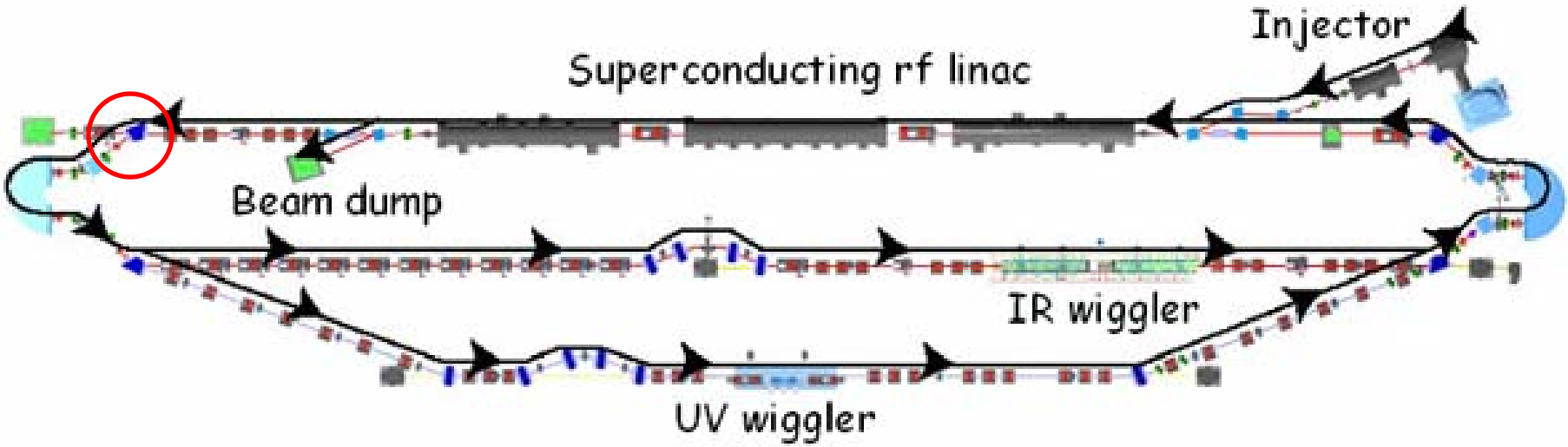
Energy	**135 MeV**
Macro pulse width:	**1 ms**
Repetitive rate:	**60 Hz**
Micro-pulse repetition rate :	**4.68 MHz**
Charge:	**60 pc/micro pulse**



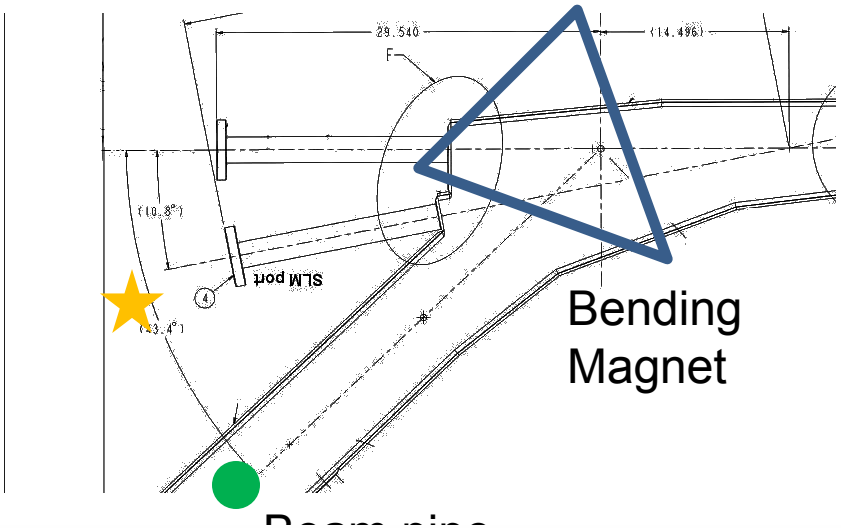
Halo Experiment with OSR in JLab FEL



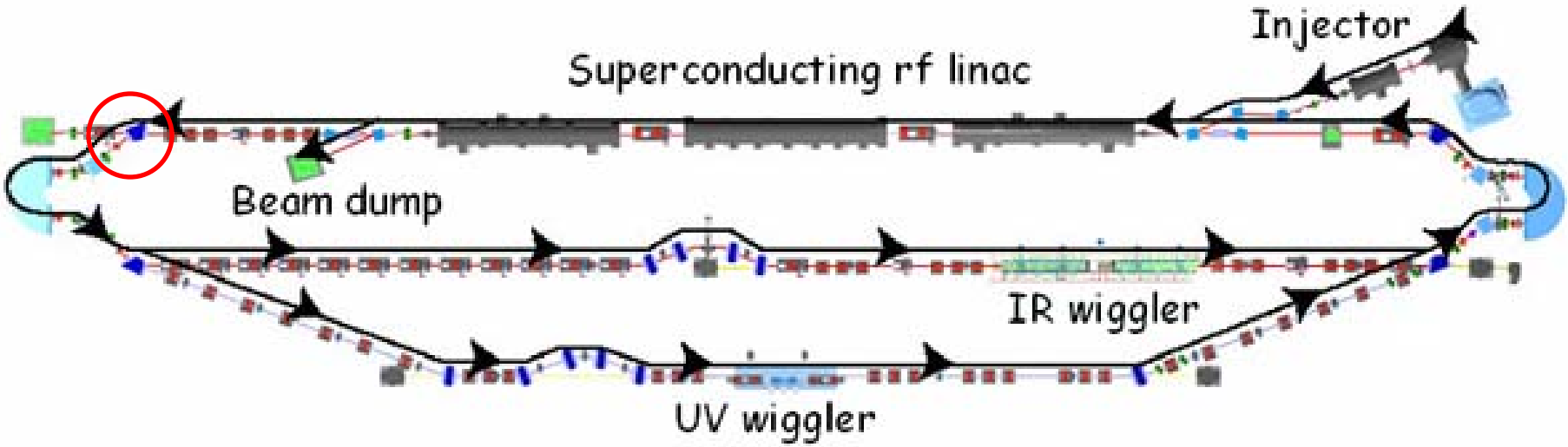
Energy	**135 MeV**
Macro pulse width:	**1 ms**
Repetitive rate:	**60 Hz**
Micro-pulse repetition rate :	**4.68 MHz**
Charge:	**60 pc/micro pulse**



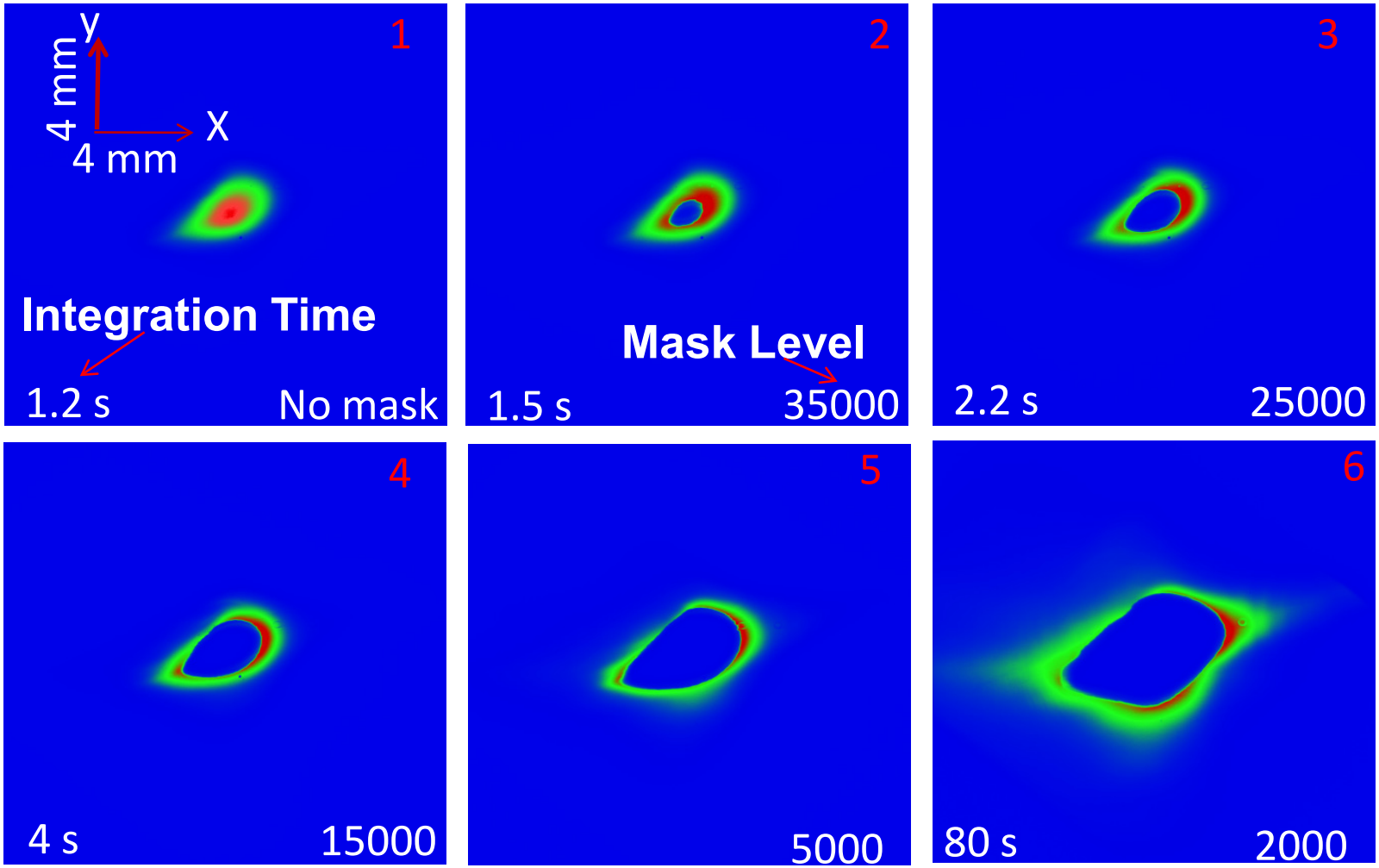
Halo Experiment with OSR in JLab FEL



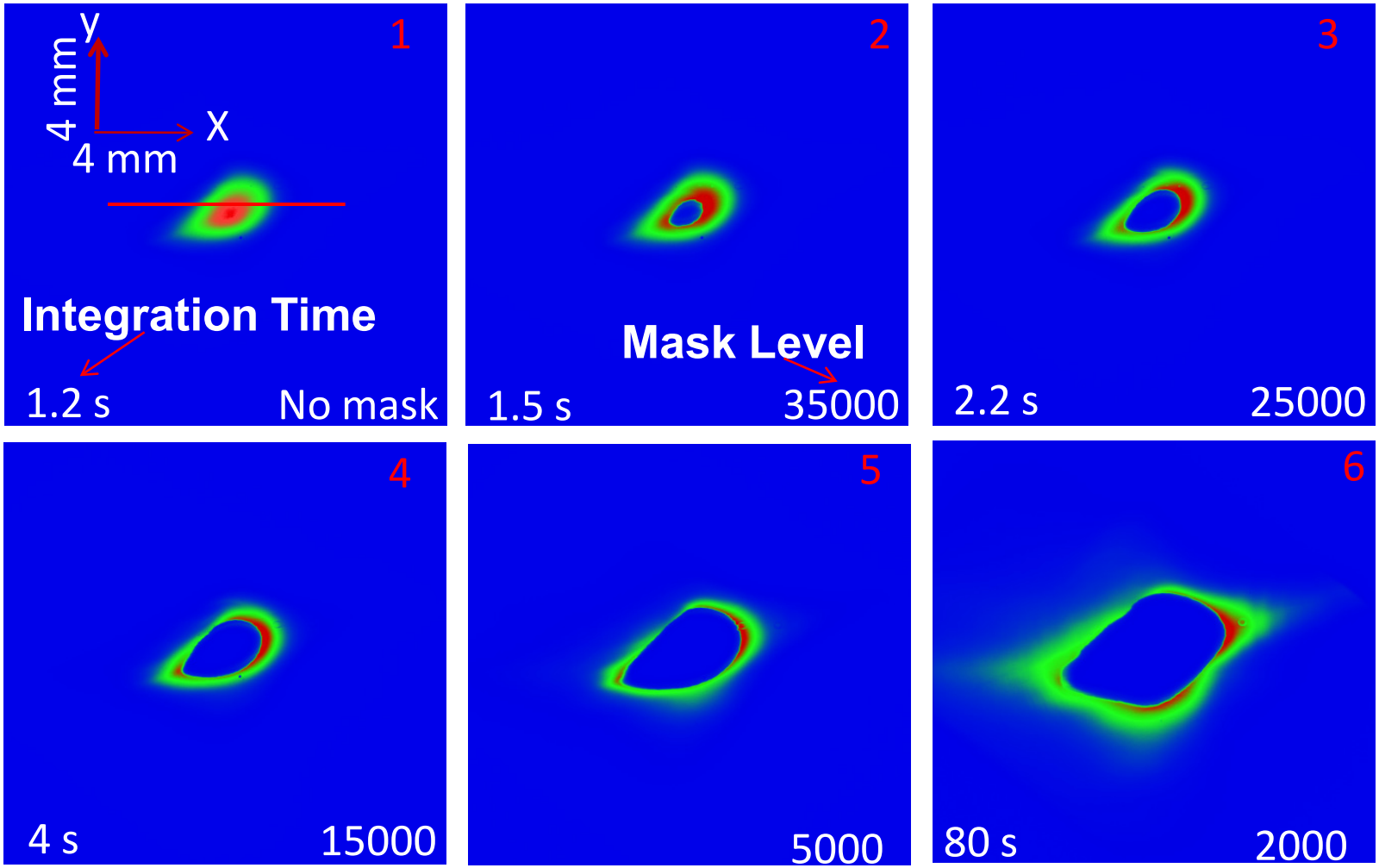
Energy	**135 MeV**
Macro pulse width:	**1 ms**
Repetitive rate:	**60 Hz**
Micro-pulse repetition rate :	**4.68 MHz**
Charge:	**60 pc/micro pulse**



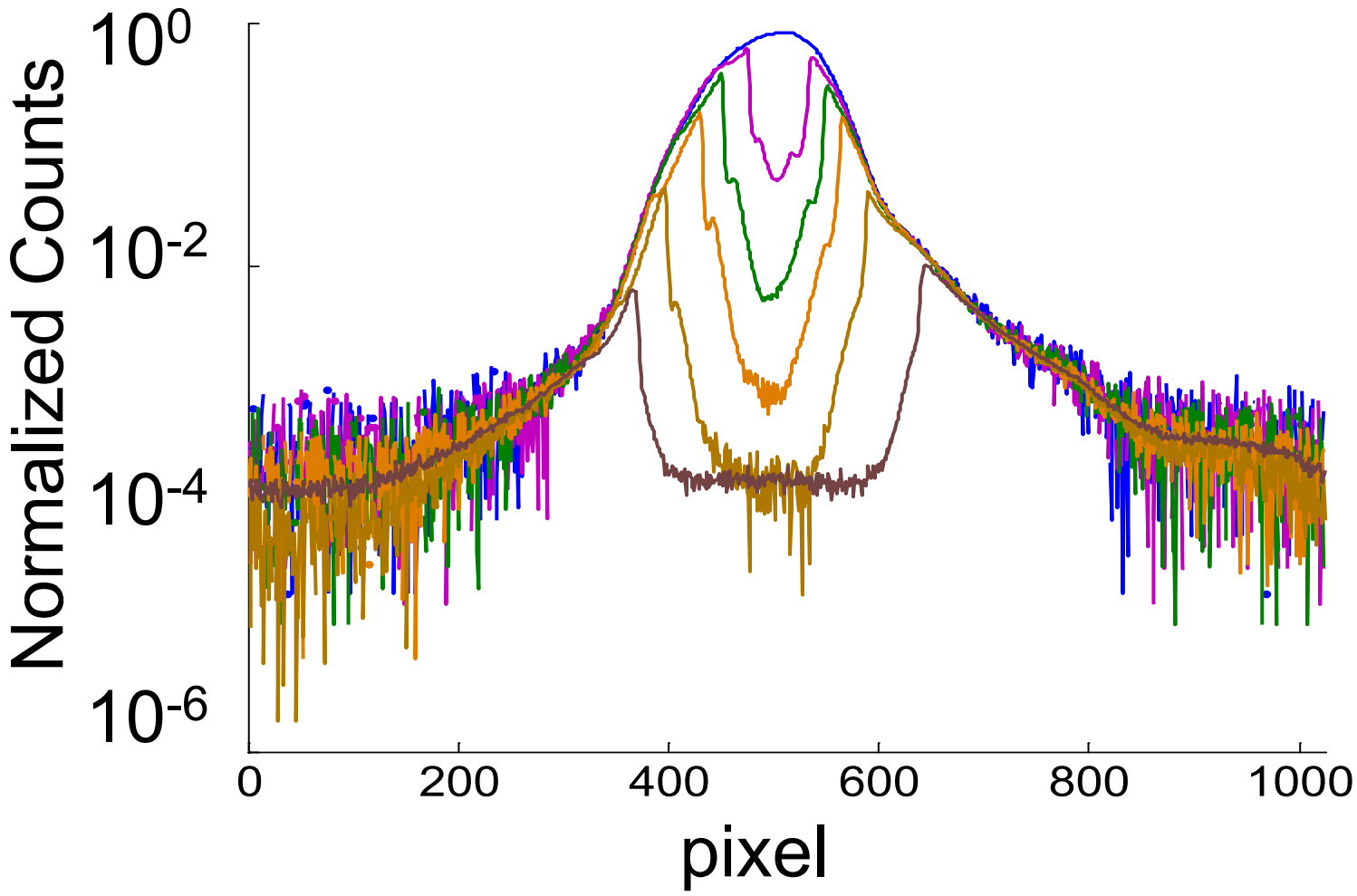
Preliminary Results:
Masking OSR Image of JLAB FEL Beam



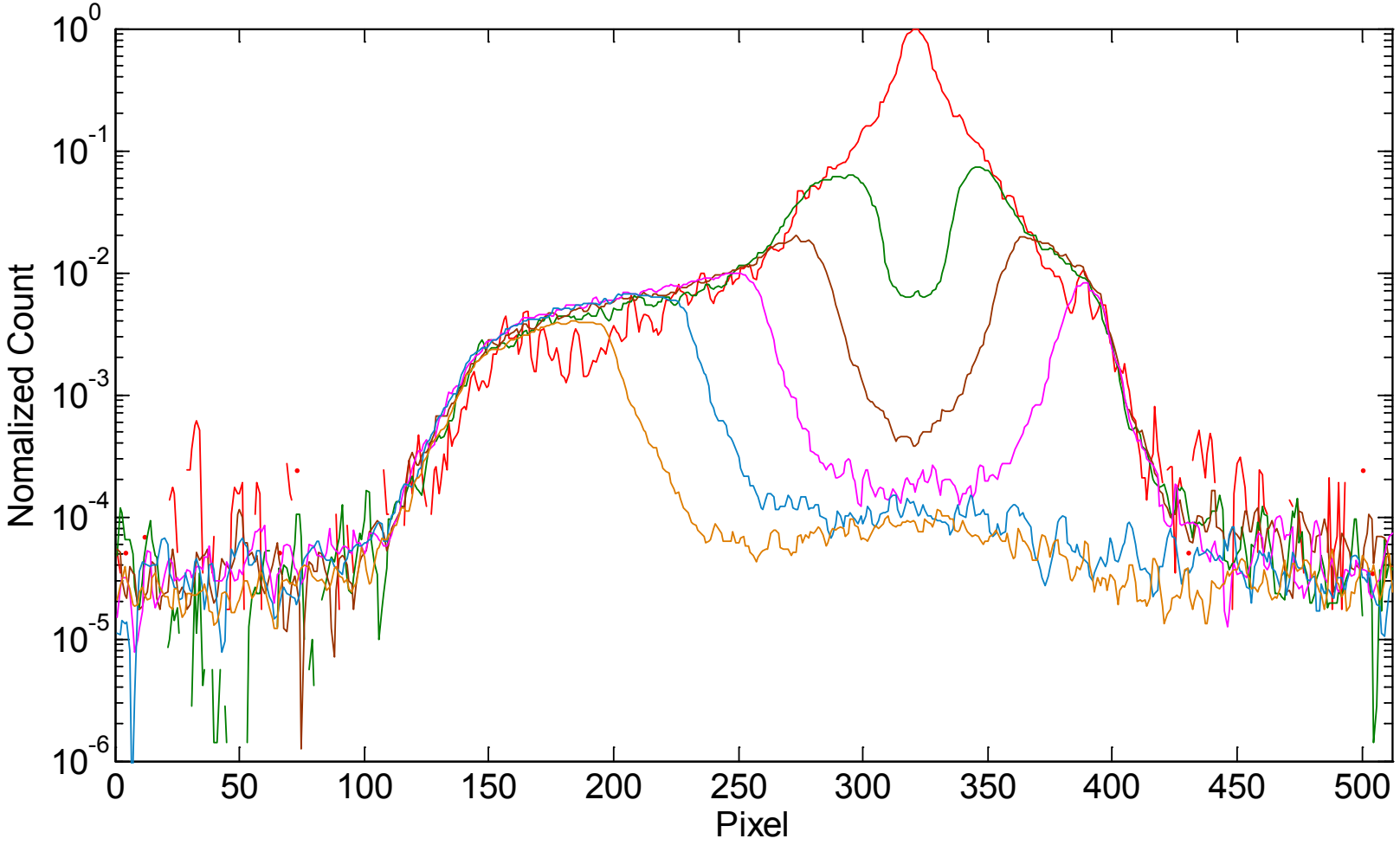
Preliminary Results:
Masking OSR Image of JLAB FEL Beam



Preliminary Measurement of Dynamic Range for OSR DMD System



The Dynamic Range Measurement in UMER



Conclusion

- Results
  - Developed and Tested high-dynamic range halo diagnostic using a DMD
  - Verified a dynamic range of up to 10^5 at UMER and > 10^4 at JLAB
  - Used DMD optical system to observe Halo Propagation in UMER, and OSR image of beam at JLab FEL

- Future prospects
  - Time-resolved Beam Halo Profiling in UMER
  - Multi-turn Studies of the Evolution of the Halo in UMER
  - CW Beam measurement at JLab FEL with improved dynamic range