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Introduction

LCLS injector laser

- At Linear Coherent Light Source (LCLS) at SLAC, the injector laser consists of a Ti:Sapphire laser system.
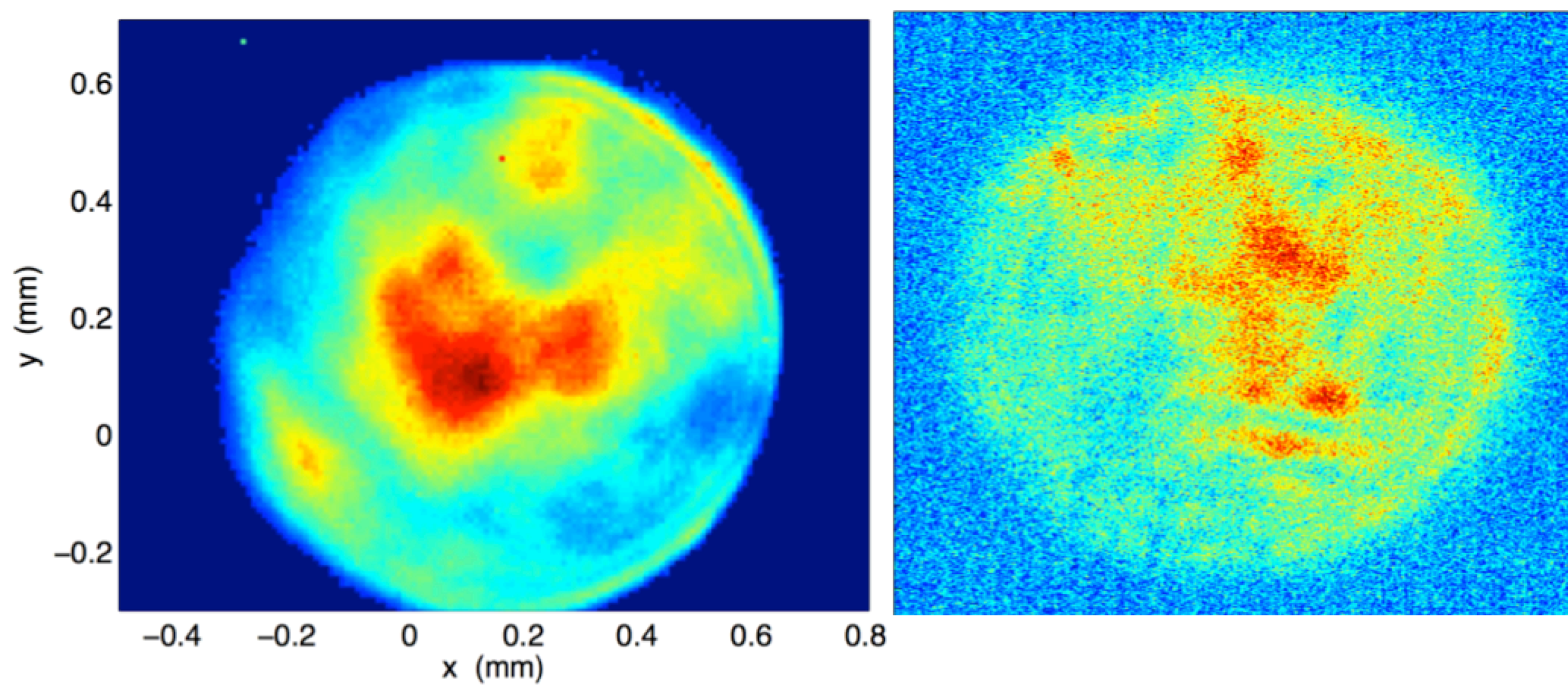- The infrared laser is then converted to ultra-violet wavelength 253nm in a tripler.

Figure 1. Example of LCLS injector laser transverse profile (left). Example of electron beam transverse profile (right).

- Non-flat laser profile; hot spots
- Non-uniform quantum efficiency on cathode

Motivation

- Remove non-uniformities in electron beam by smoothing out hot spots in laser profile.
- shape electron beam into arbitrary profile by modulating laser profile.
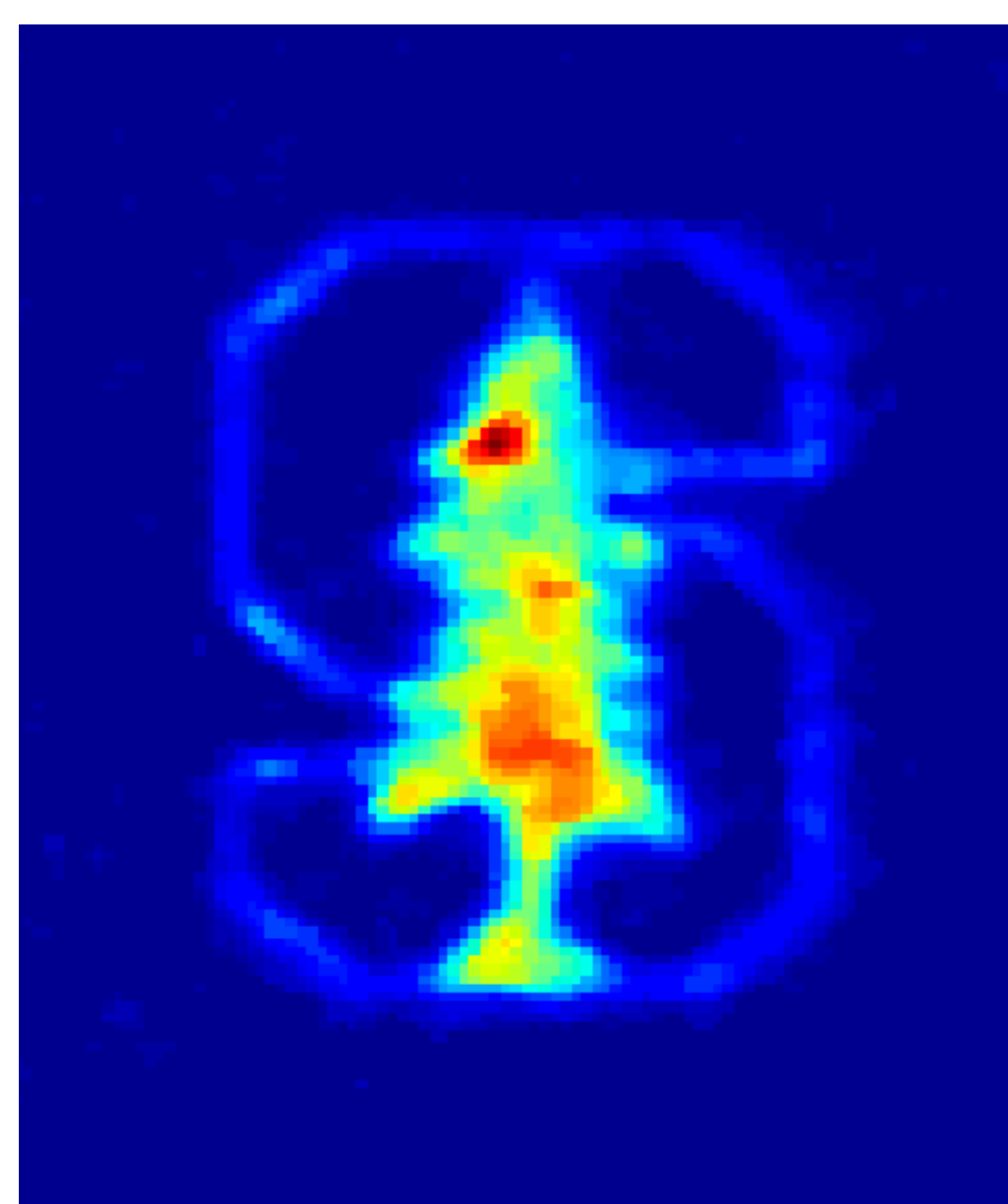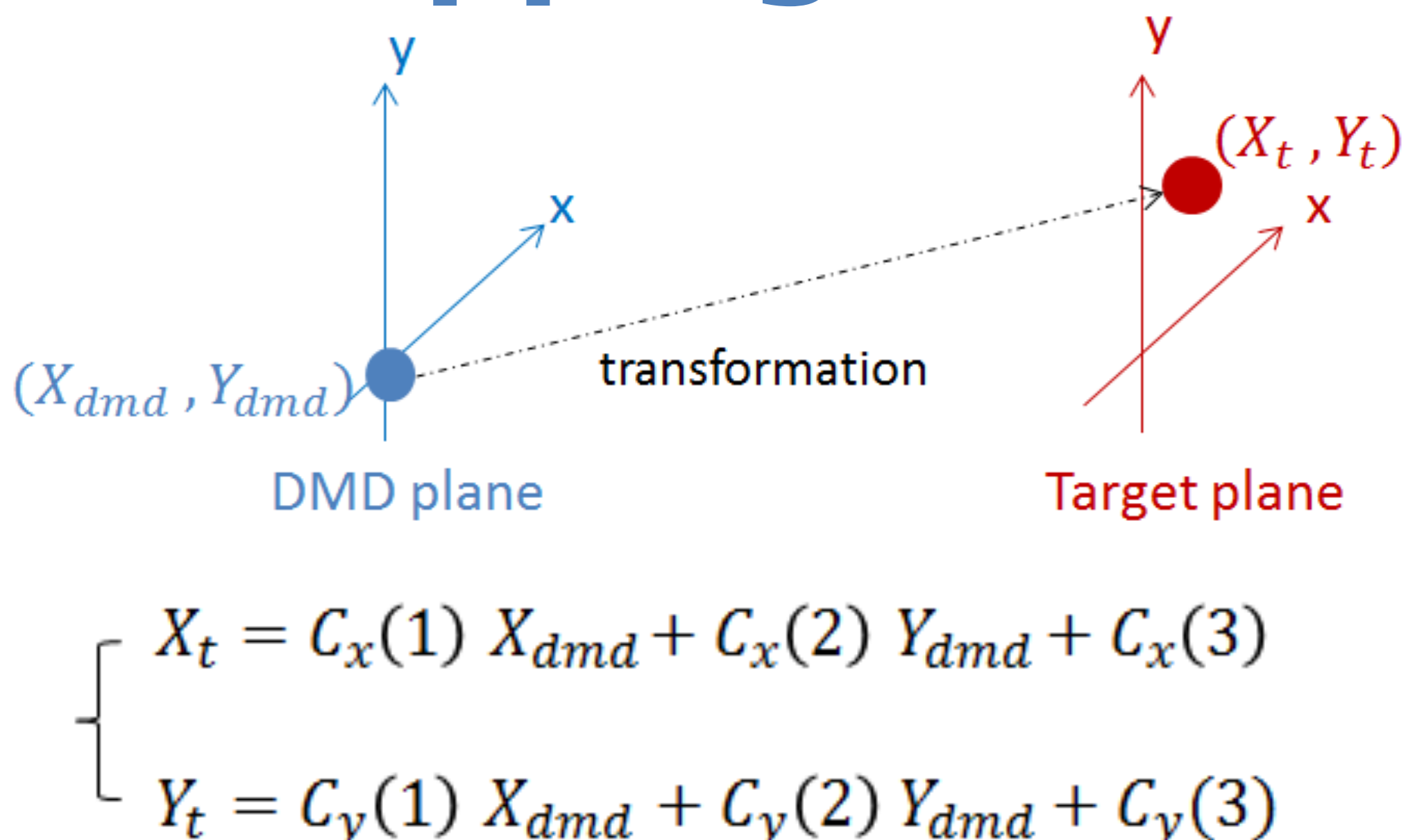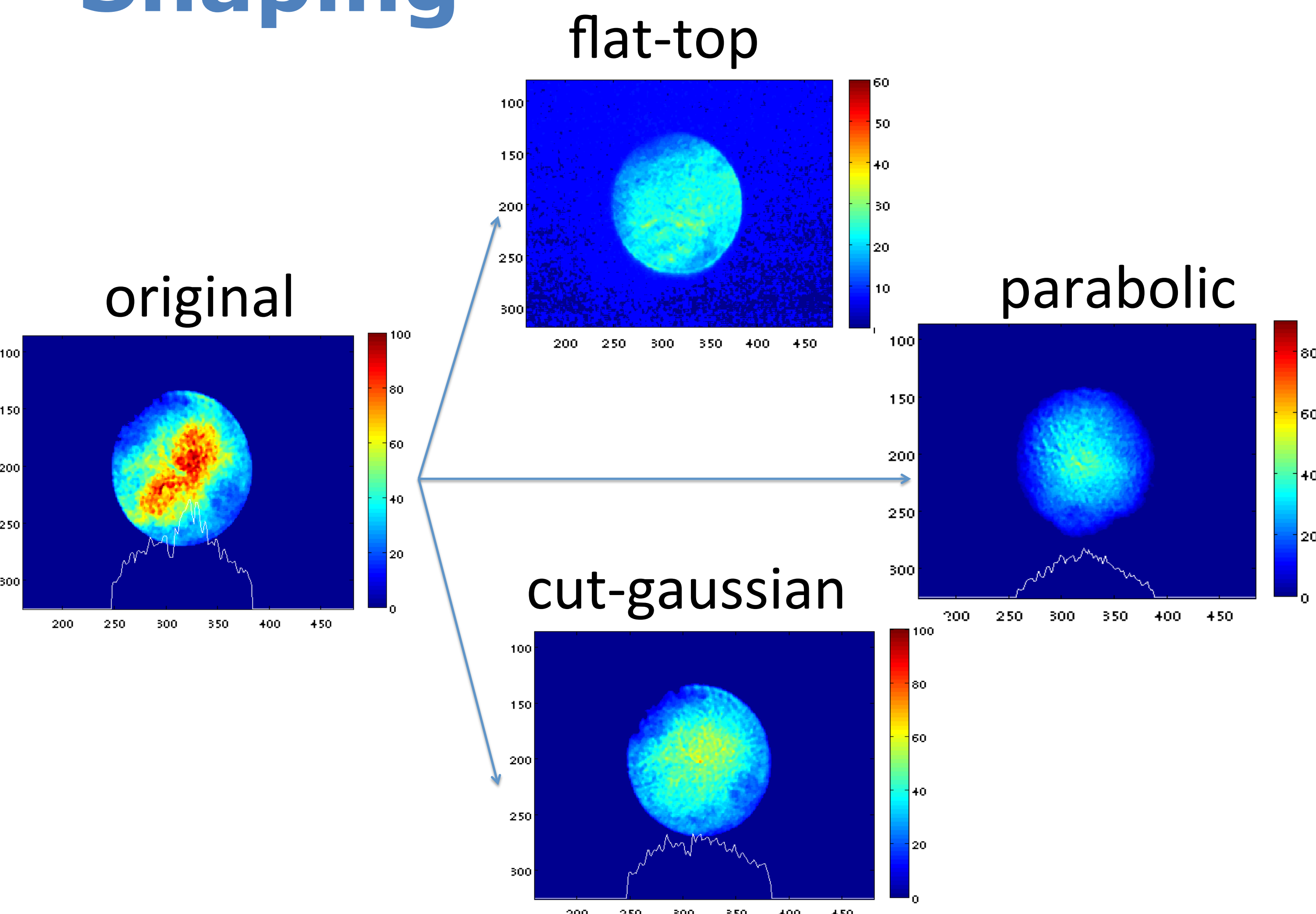- Improve electron beam, FEL performance, up-time in operation.

Hardware Device
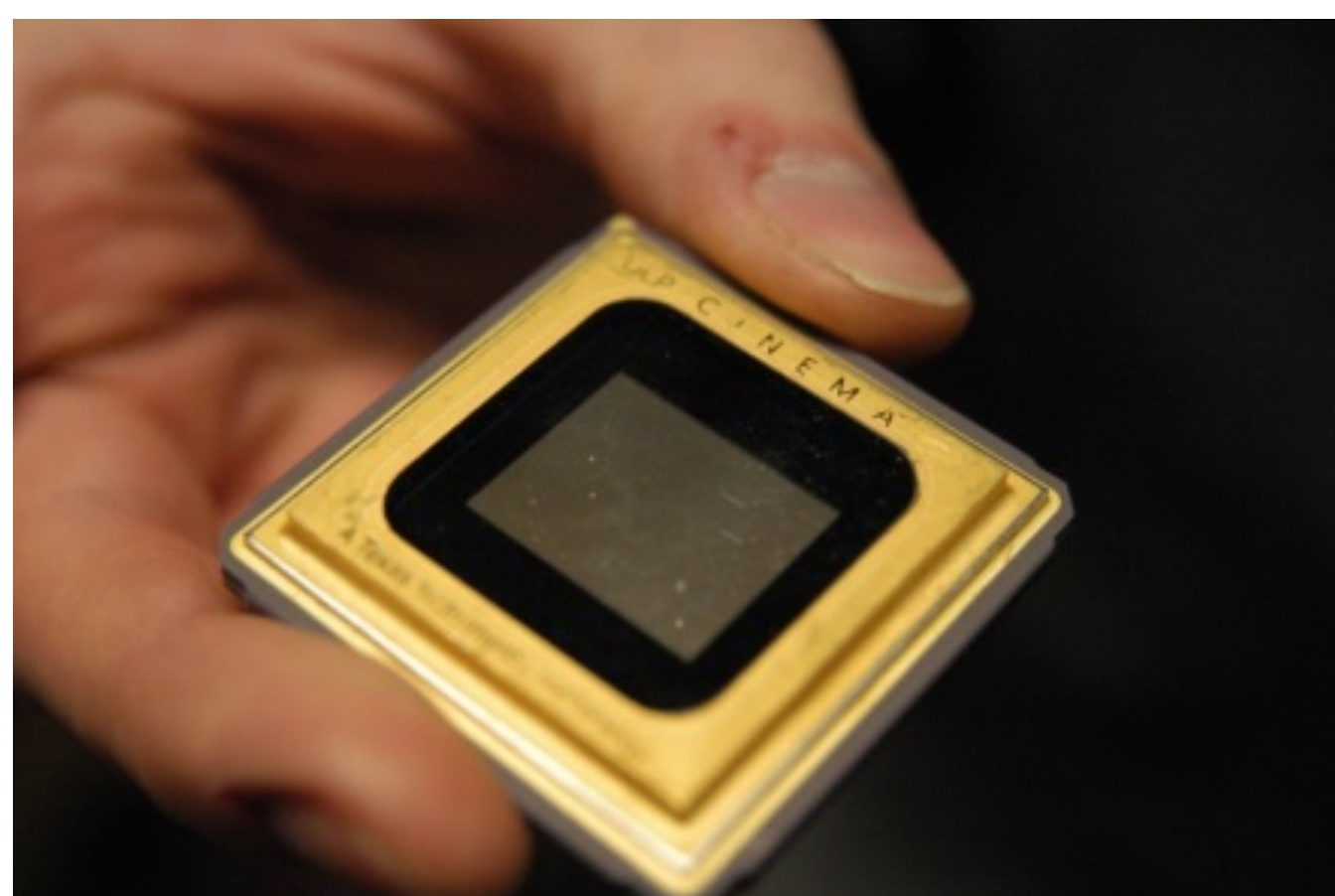
Digital Micro-Mirror Device (DMD) from Texas Instruments. Swapped window glass to transmit UV.

Shaping the Laser

Mapping

$$X_t = C_x(1) X_{dmd} + C_x(2) Y_{dmd} + C_x(3)$$
$$Y_t = C_y(1) X_{dmd} + C_y(2) Y_{dmd} + C_y(3)$$

Shaping

flat-top

original

parabolic

cut-gaussian

- Emittance measurement is on-going
- Charge after shaping 90~130pC limited by DMD damage, and QE variation across cathode.

Shaping the e- beam

- Cannot do mapping as in laser case since magnification changes with charge
- Scan small square on DMD and measure laser intensity, laser signal position, electron charge counts to reconstruct e beam profile after cathode
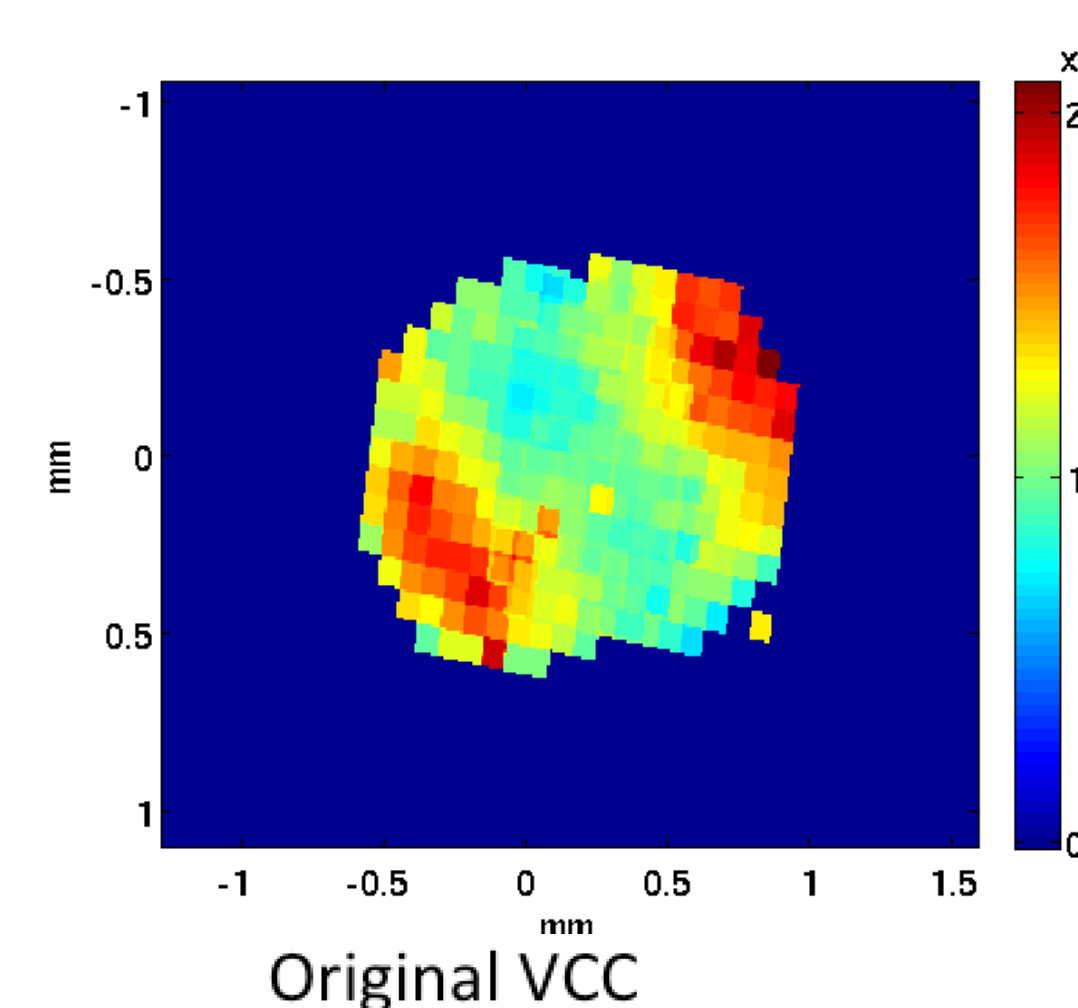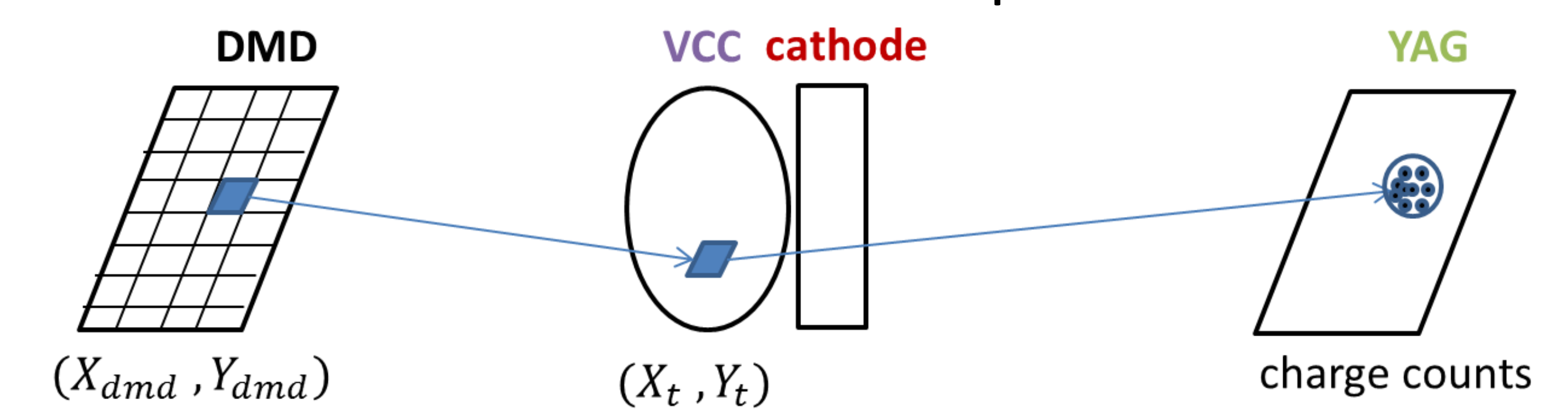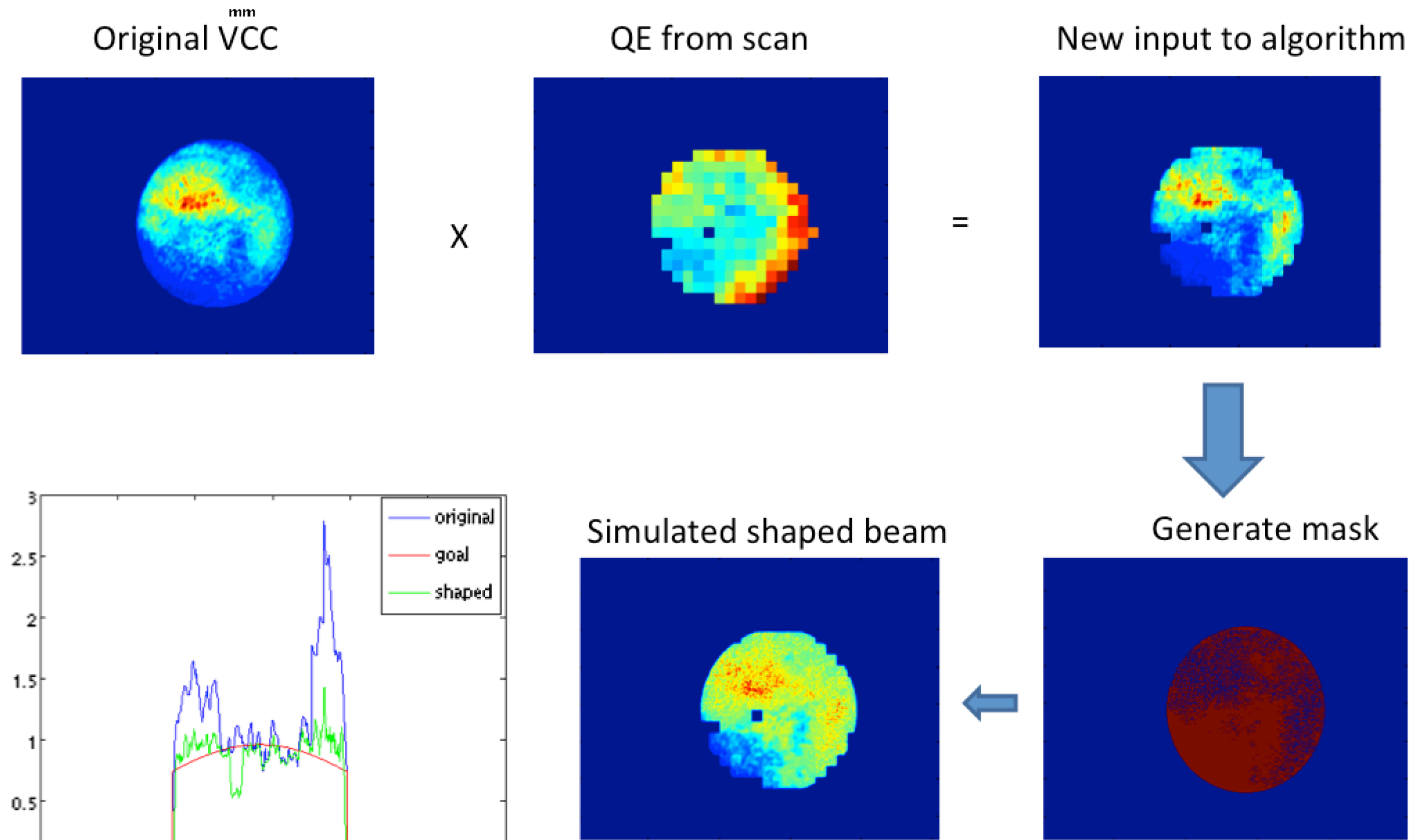

DMD   VCC cathode   YAG

(X_{dmd}, Y_{dmd}) (X_t, Y_t) charge counts

Figure 2. QE map across laser profile. (flat-top mask included)

Original VCC   QE from scan   New input to algorithm

X   =

Generate mask

Simulated shaped beam

- e- beam experiments in progress.