# STUDY OF LASER SHAPING USING DIGITAL MICRO-MIRROR-ARRAY DEVICE
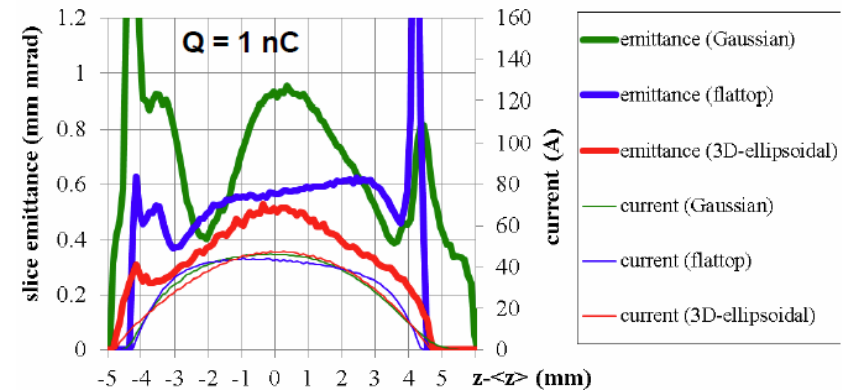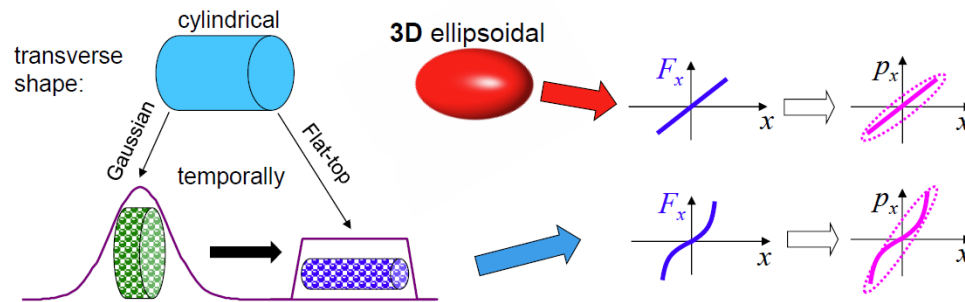
Hao Zhang

# outline

- Motivation
- Experiment setup
- Round beam generation
- Arbitrary beam generation
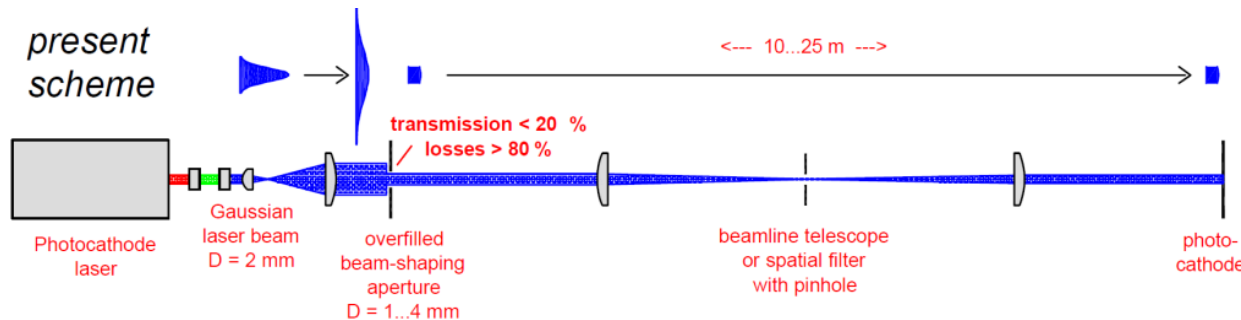- Implementation design
- Summary

# Motivation for laser shaping

## Laser shaping for photo-injector



**Main idea:** minimize the impact of the space charge on the transverse emittance.
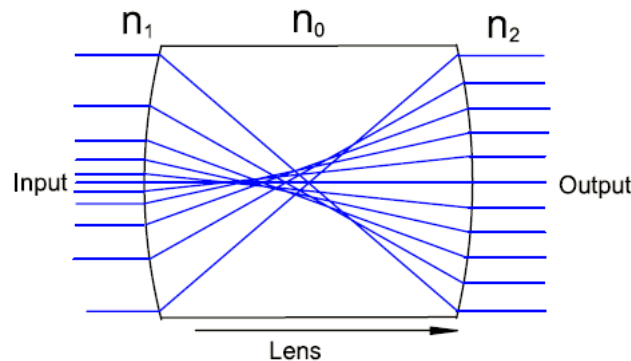
Credit: Frank Stephan from PITZ of DESY

## Gaussian to flat top clipping
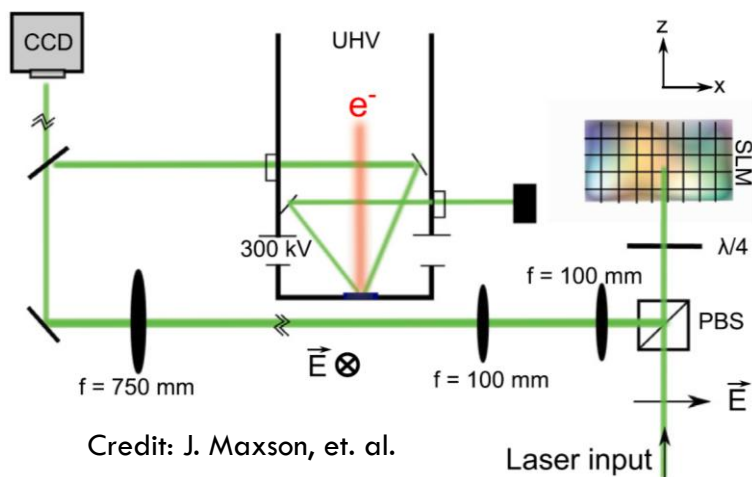


Credit: PITZ and ATF/DESY

# Existing schemes for laser shaping
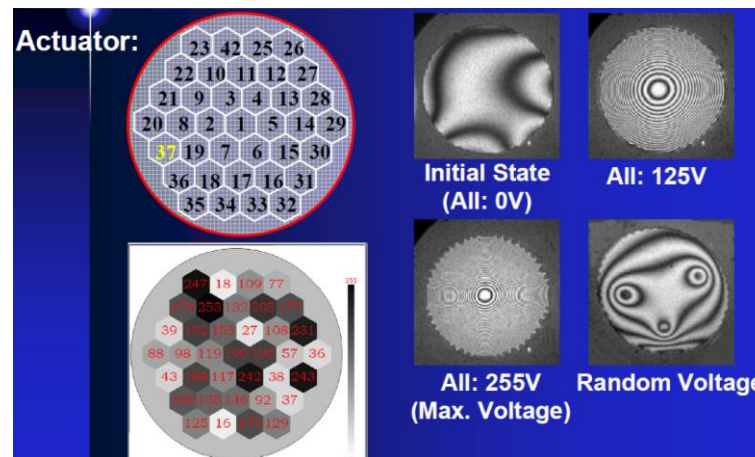
Shaping with lenses system



Zhang et al., J. Opt. A9, 945 (2007).

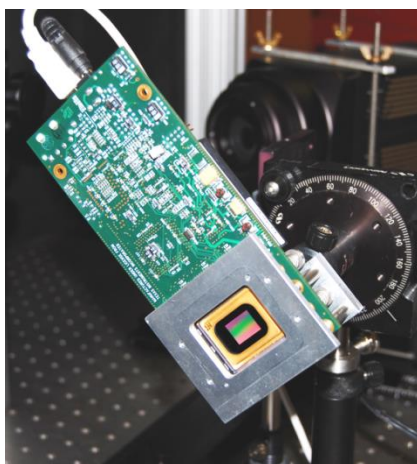Shaping with Spatial light modulator (SLM)



Credit: J. Maxson, et. al.

Shaping with Deformable Mirror
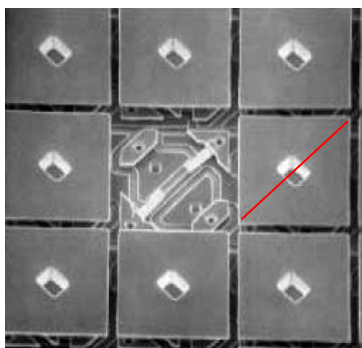


Credit: H. Tomizawa, et. al.

# Core device for laser shaping
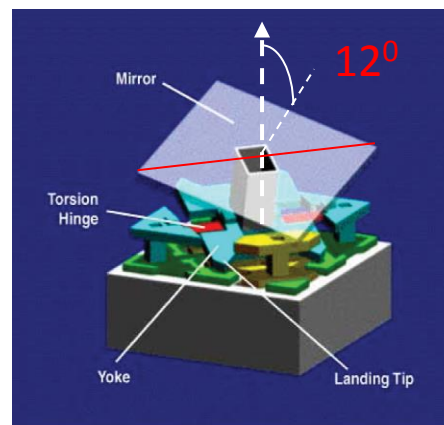


Digital Micro-mirror-array Device (DMD)

- 1024 x 768 pixels (XGA) [ Discovery 1100]

- USB Interface

- high-speed port 64-bit @ 120 MHz for data transfer

- up to 9.600 full array mirror patterns / sec (7.6 Gbs)
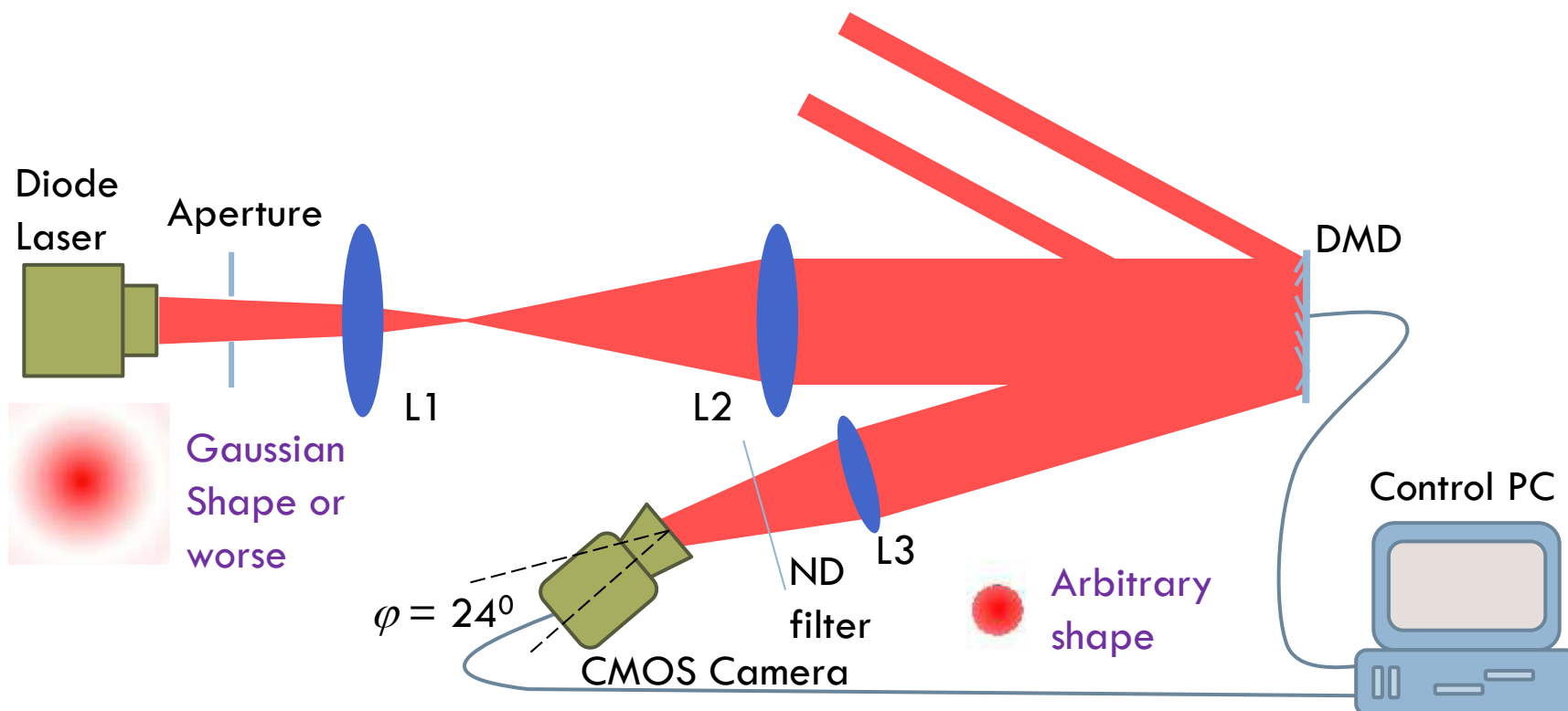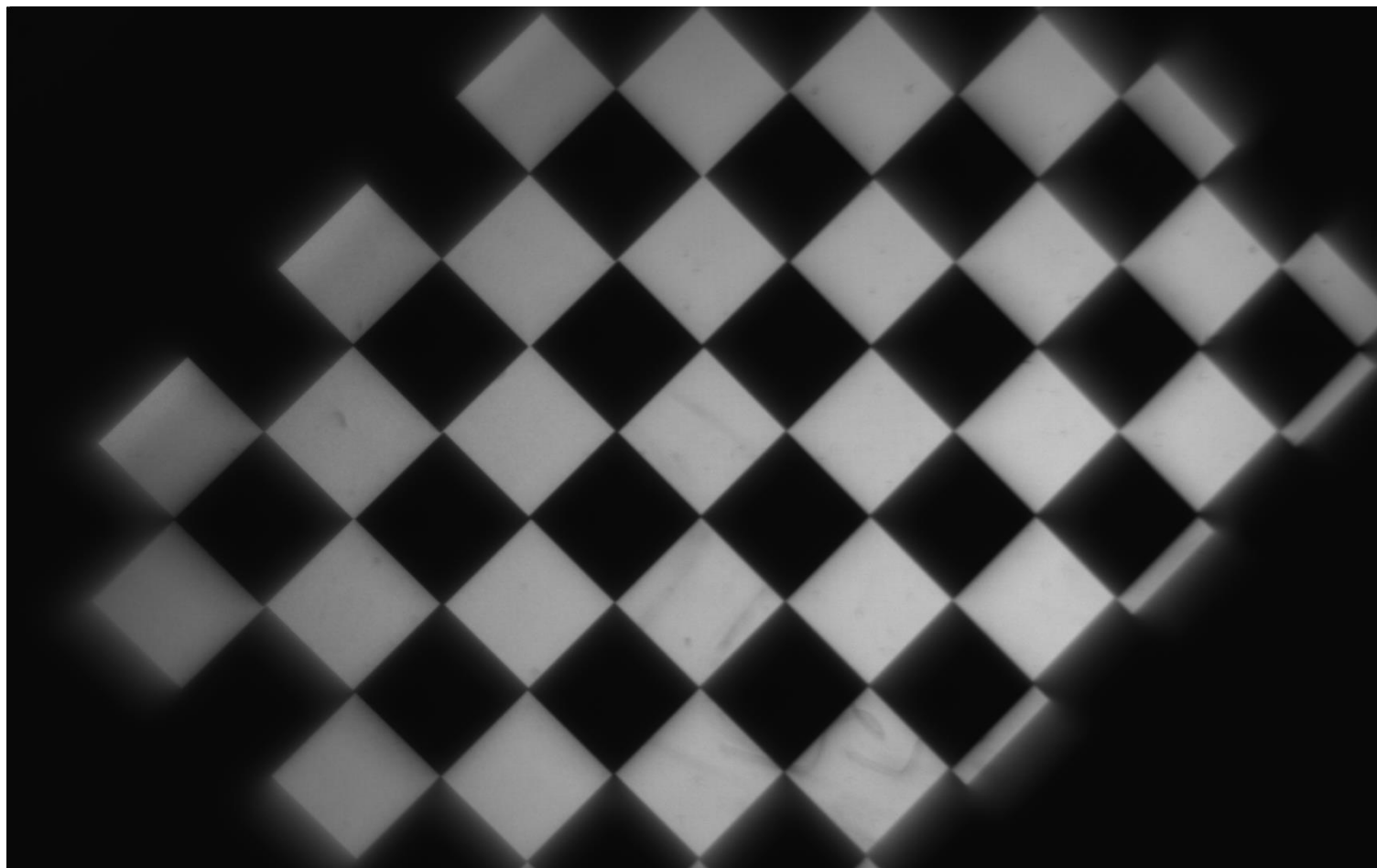
Segment of DMD:
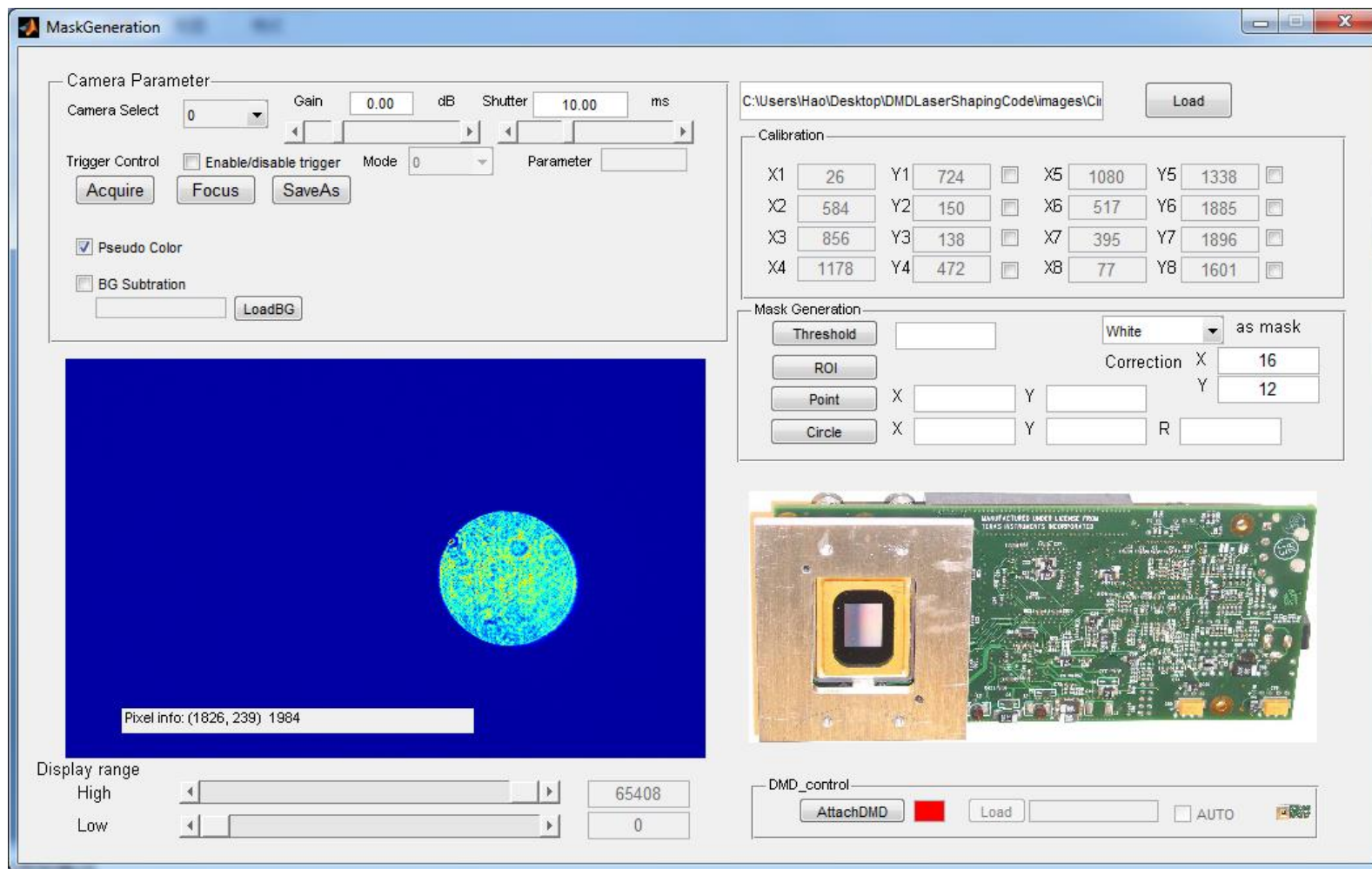


13.8 um

Micro-mirror architecture:

# DMD optics setup and shaping principle

Diode
Laser

Aperture

L1

L2

L3

DMD
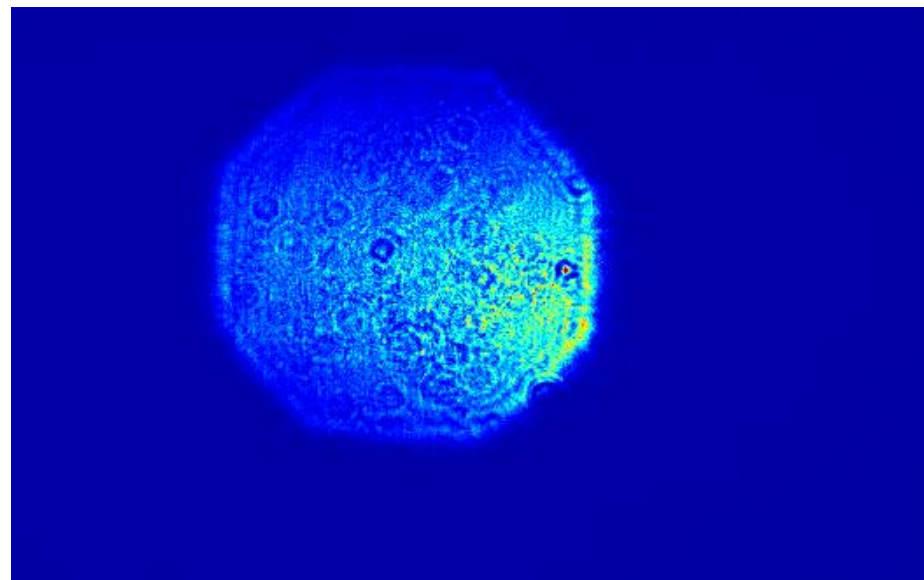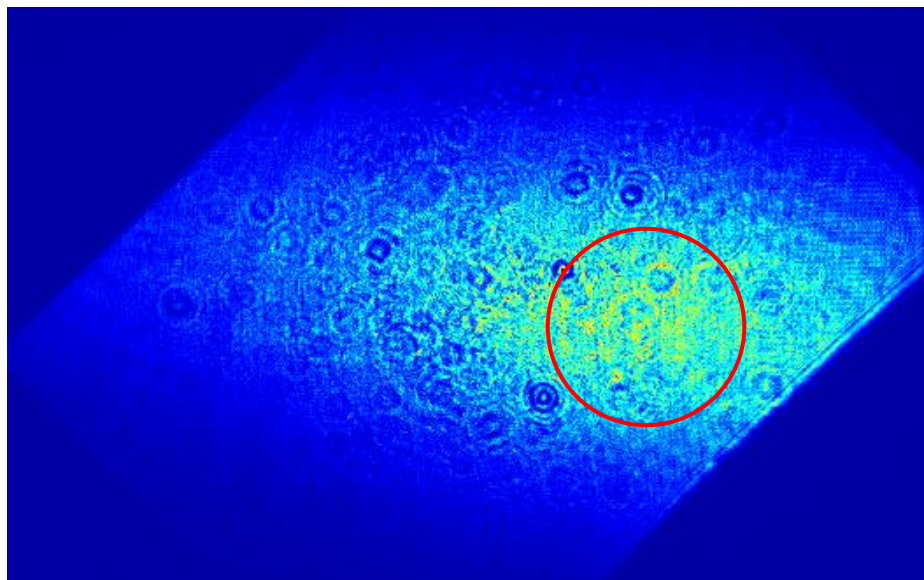
Gaussian
Shape or
worse

$\varphi = 24^0$

ND
filter

CMOS Camera

Arbitrary
shape

Control PC

# Compensations and calibration

# GUI interface

# Results: Aperture or not

Projections!!
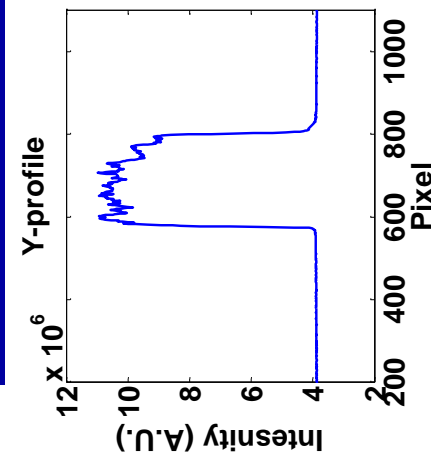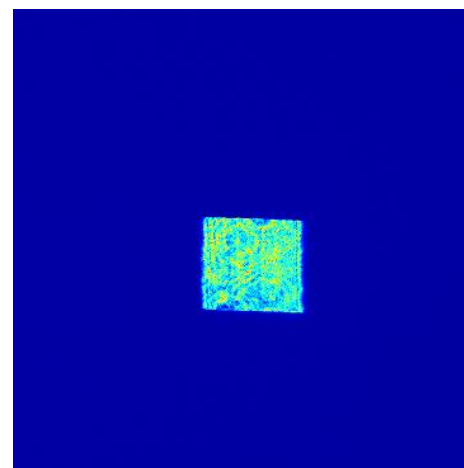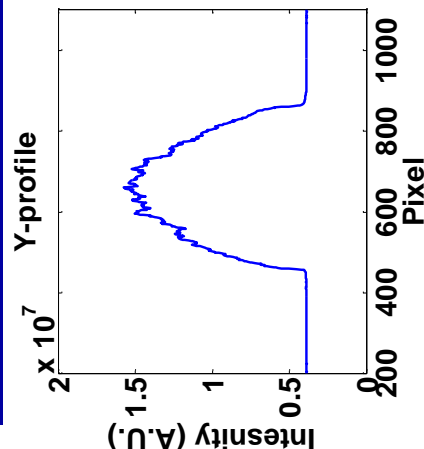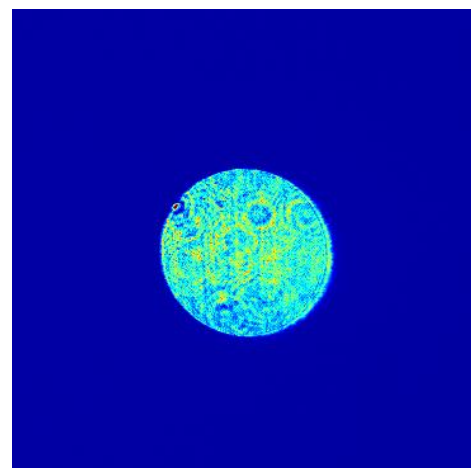
# Regular shape beam generation (Cont.)
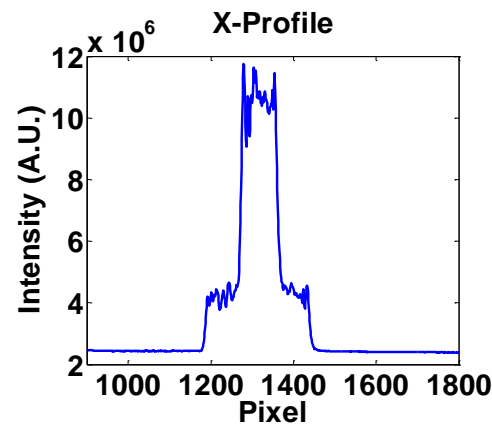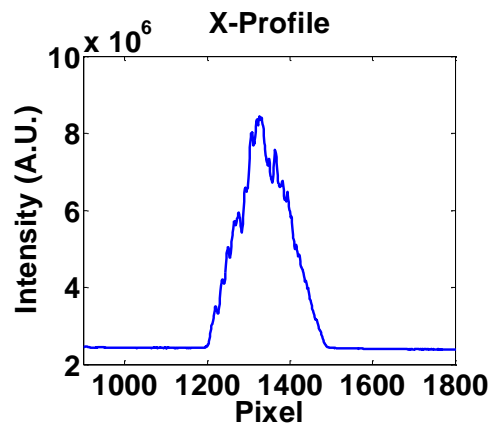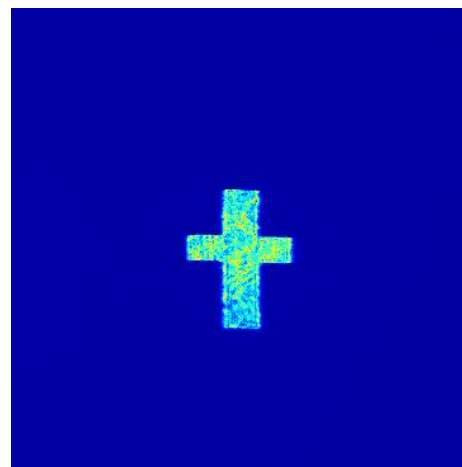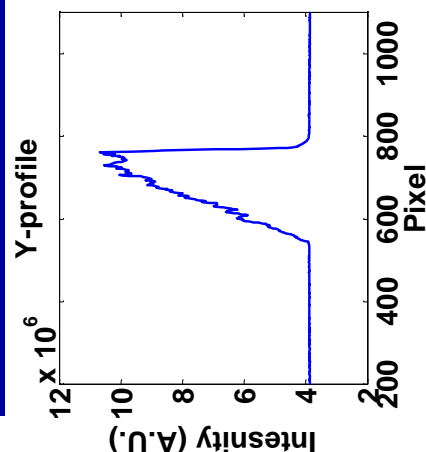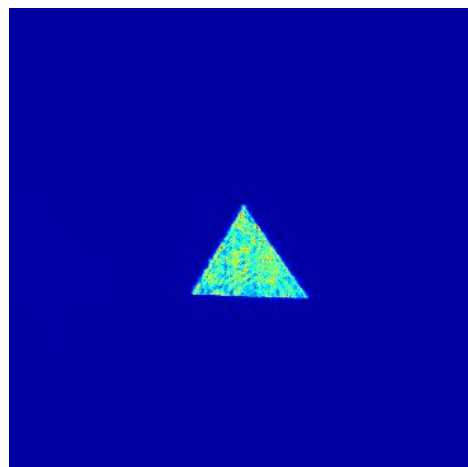


Projections!!

# Slit beam for beam line study
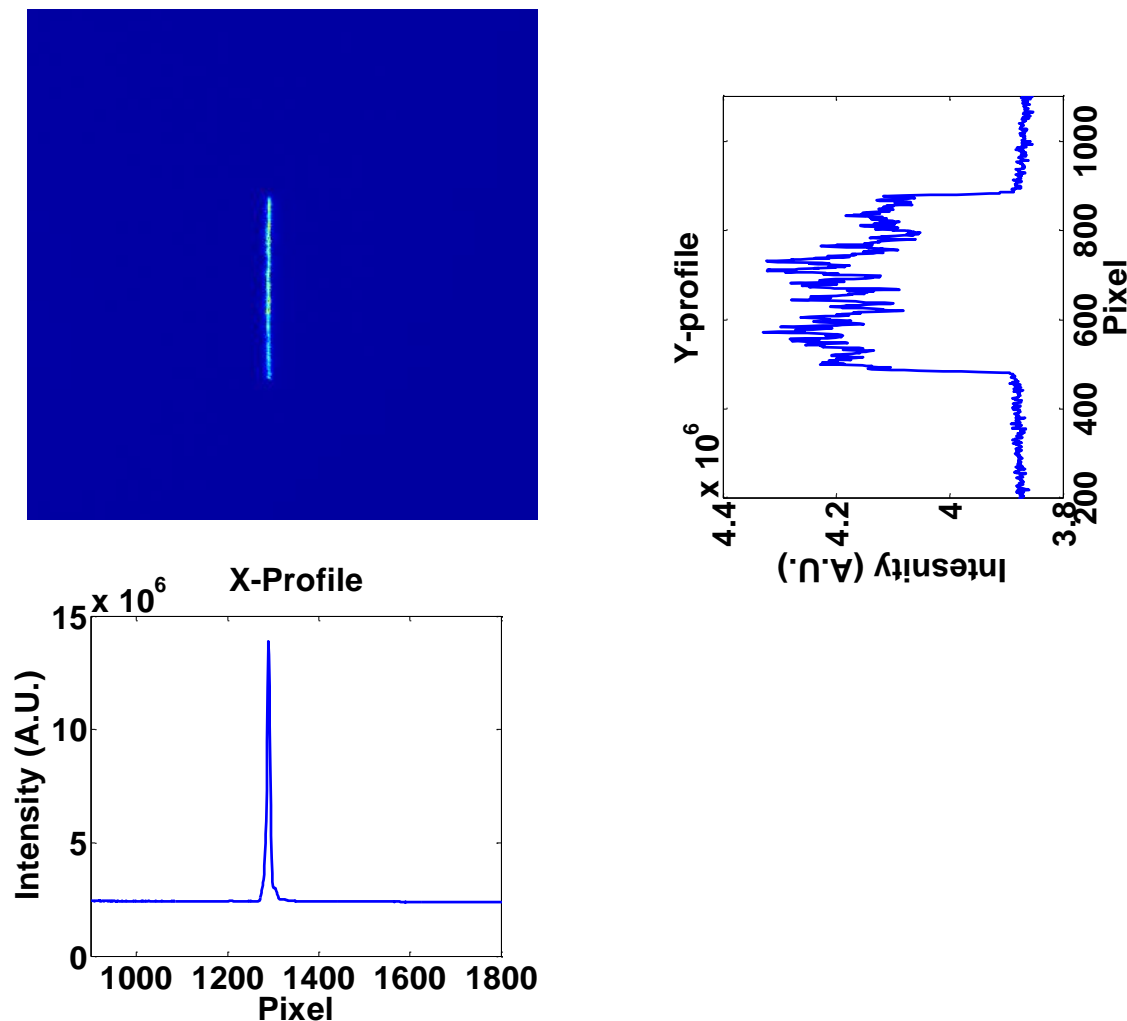
# Implement design into injector laser system for transverse beam shaping
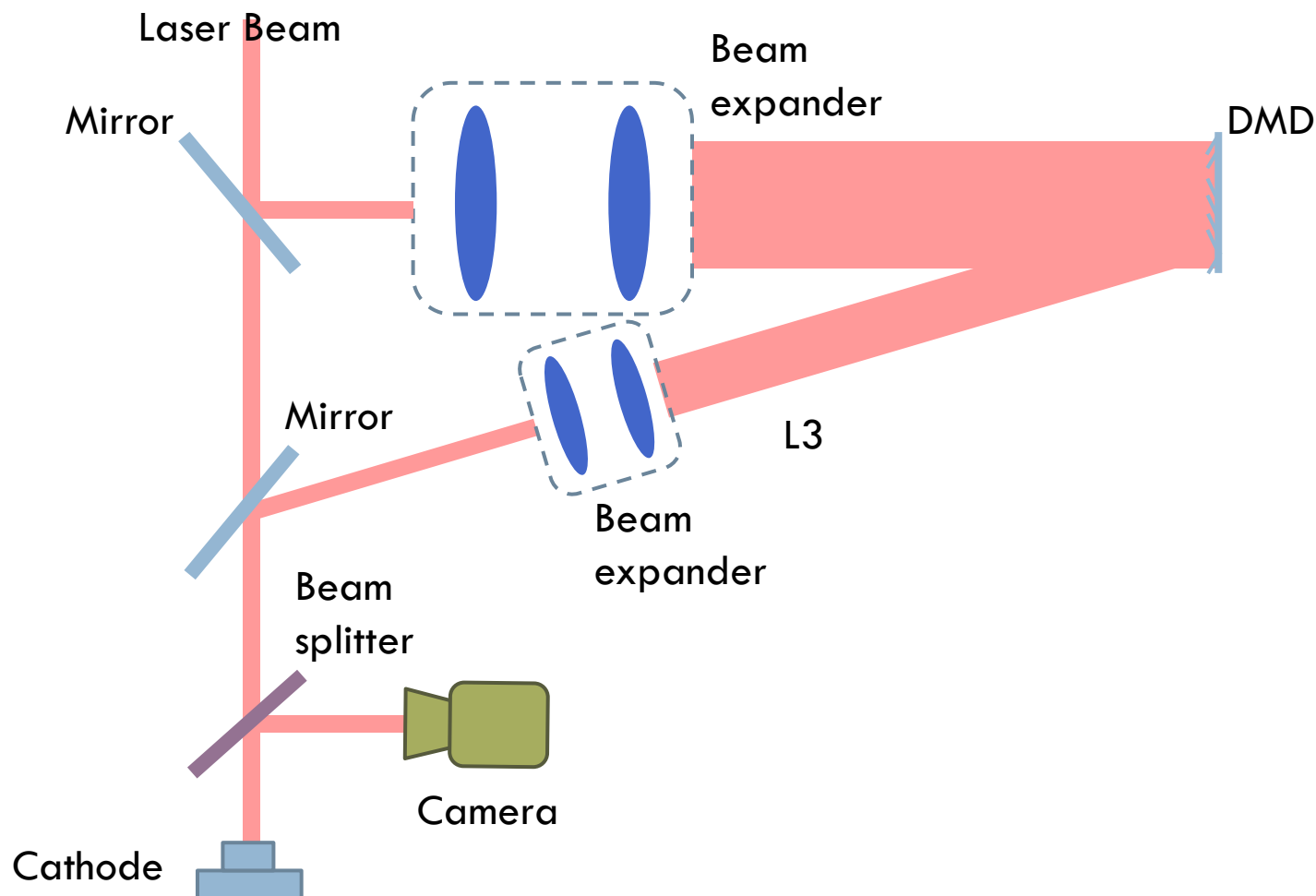
# Summary and future plan

□ Developed a system for arbitrary laser beam shaping in bench

□ Discussed transverse shaping quality

□ Proposed design principles for transverse laser shaping using DMD

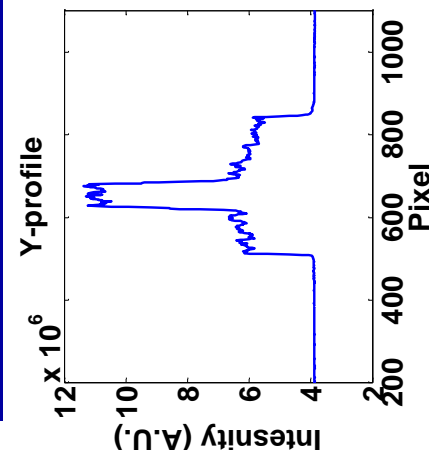In the future, we want to implement this system into the laser injector system which could be either in VELA or Alice.

# Thanks for your attention

# References

Y. Li, Laser application in accelerators: Laser pulse shaping, *USPAS course material*, 2008 summer section

F. Stephan, New developments at PITZ, *Advanced School on Laser Applications at Accelerators*, September 29th - October 3rd 2014, CLPU, Salamanca, Spain

H. Tomizawa, Advanced laser technology for 3D-shaping, *Mini-Workshop on Laser Pulse Shaping*, November, 2006.

H. Zhang, et al., Beam halo imaging with a digital optical mask, PRSTAB, 15, 072803, 2012.

J. Liang, et al., High-precision laser beam shaping using abinary-amplitude spatial light modulator, *APPLIED OPTICS*, Vol. 49, No. 8, 2010

J. Maxson, et al., Adaptive electron beam shaping using a photoemission gun and spatial light modulator, *PRSTAB* 18, 023401, 2015.