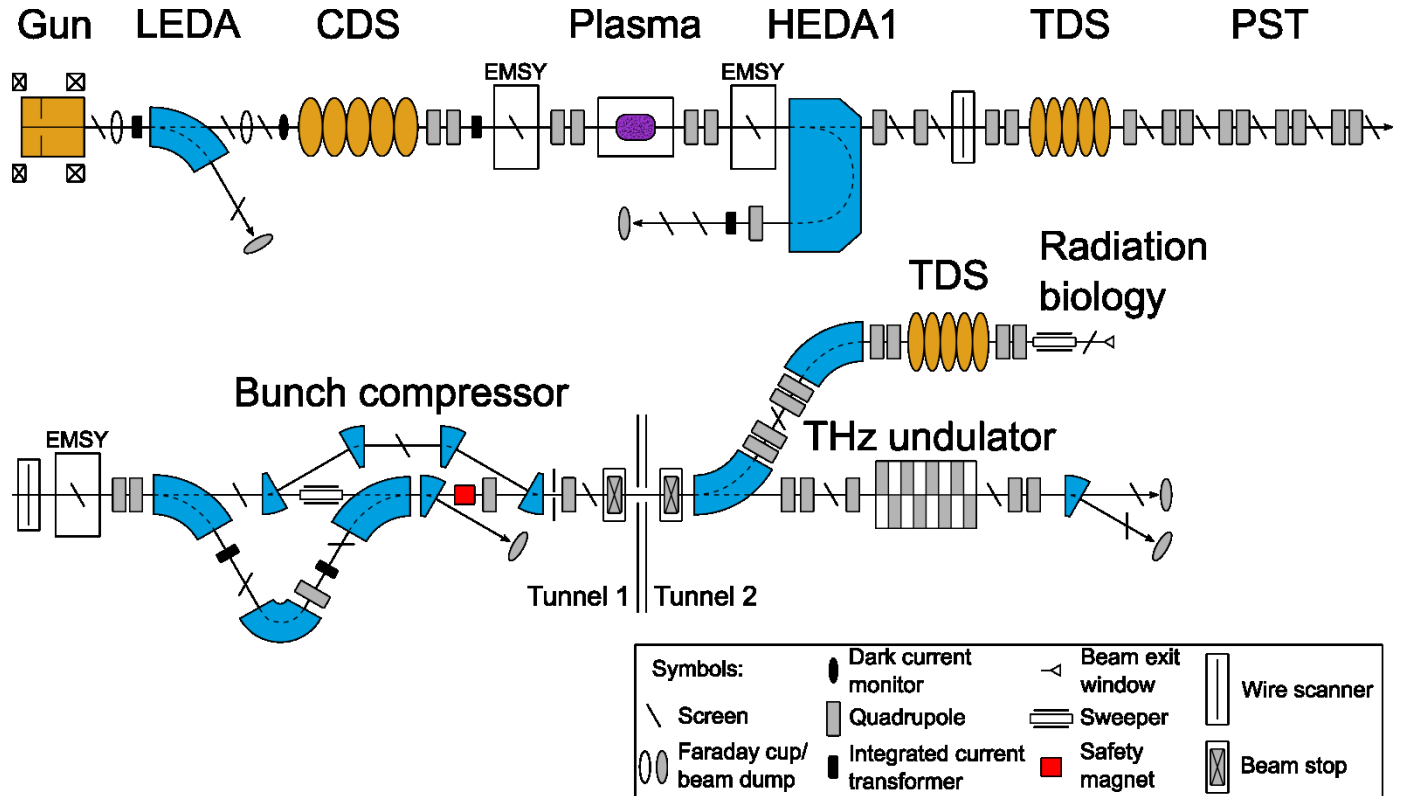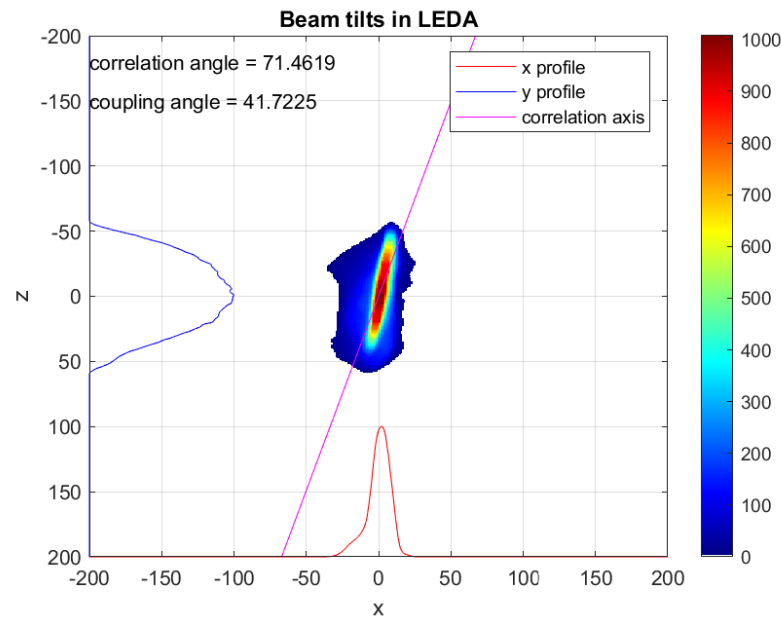# Update on PhD Thesis

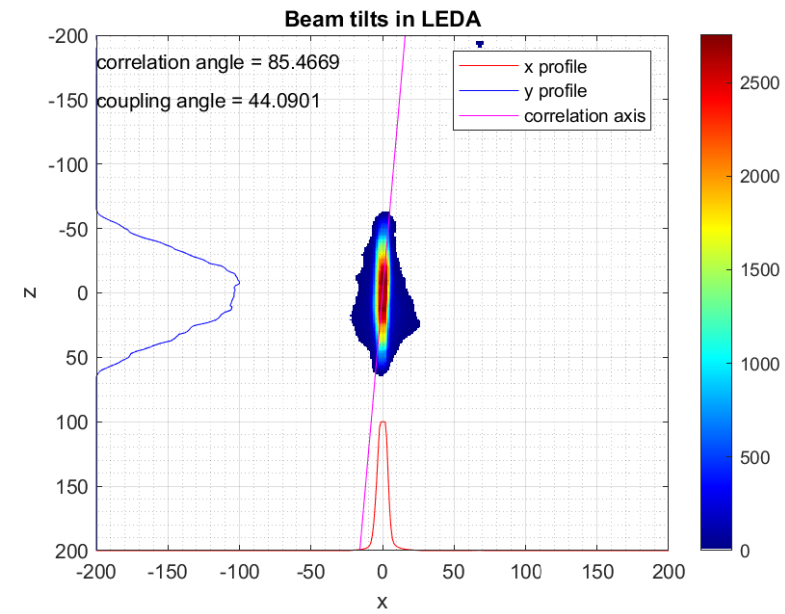**Namra Aftab**

PITZ Physics Seminar, DESY

Activities in past month

- Implementation of Virtual Pepper Pot Method
- Slit scan teaching preparation
- Screen Alignment with Raffael
- Collaboration with other students of similar topic at Hamburg
- LEDA measurement analysis for transverse to longitudinal coupling

SP=54, Charge=250pC
Imain+Ibuck

SP=60, Charge=100pC
Imain+Ibuck+Quads 1,2

Virtual Pepper Pot Technique(VPP)

Introduction

- Ability to perform 4D Transverse phase space measurements

- Crossing of Horizontal and Vertical Slits

- Imitation of Pepper pot but multi-shot

Algorithm
Laser: MBI long gaussian, Charge: 500pC , BSA: 1.2 mm, Gun SP: 60

- EMSY Image
  i. Process EMSY Image and produce projections
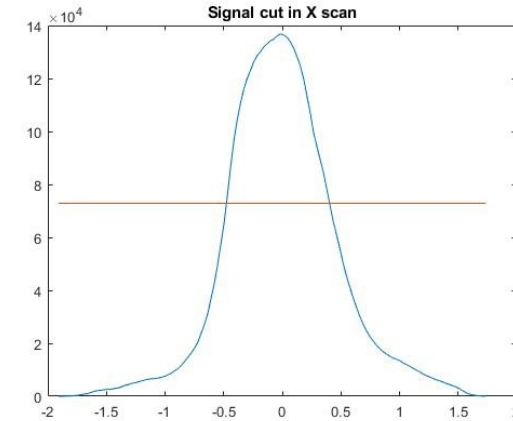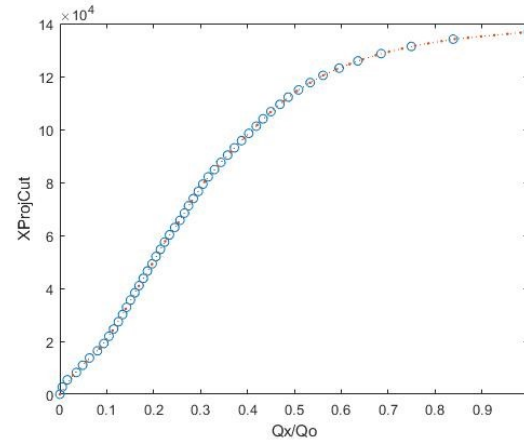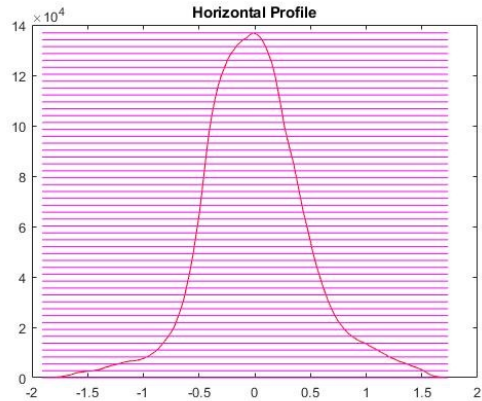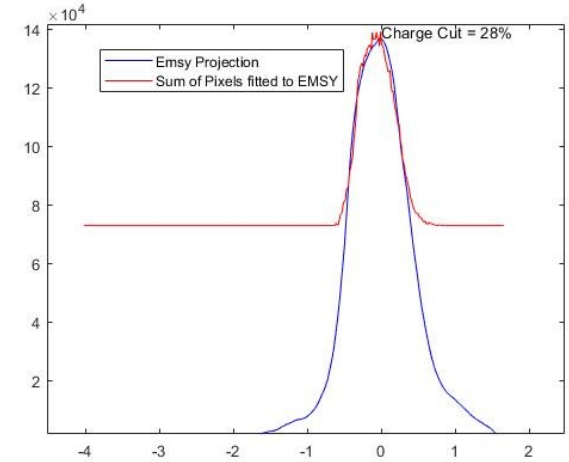 ii. Shift projections to center of mass
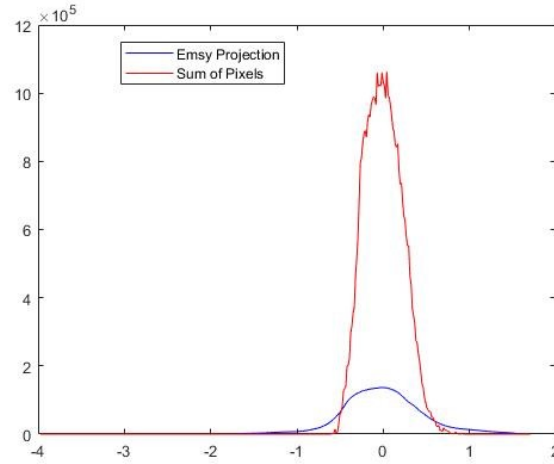 iii. EMSY projections charge cuts
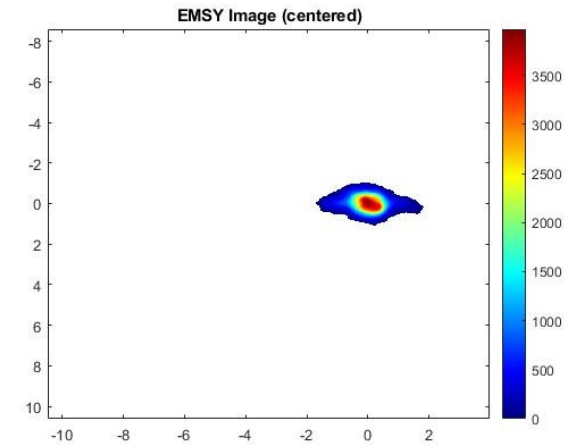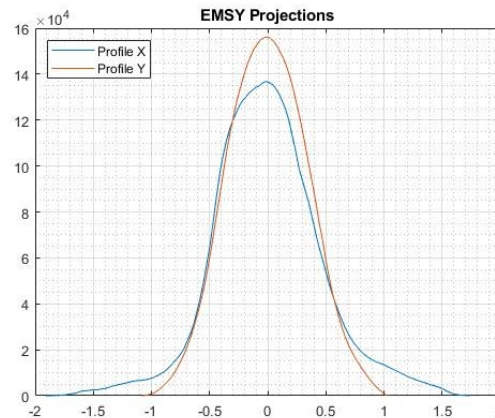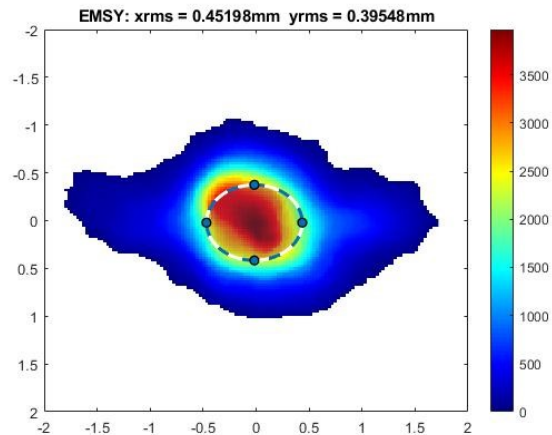
Beam log: xrms = 0.4946,
yrms = 0.3512

VPP

Algorithm

- Beamlets X
  - Sum of pixels
- SoP to EMSY fit X
  - 1D cut
  - Least square fitting

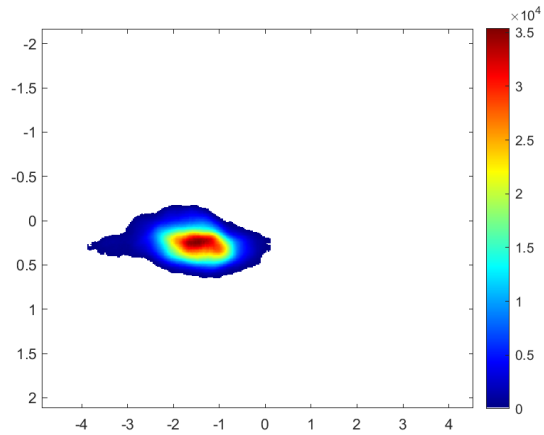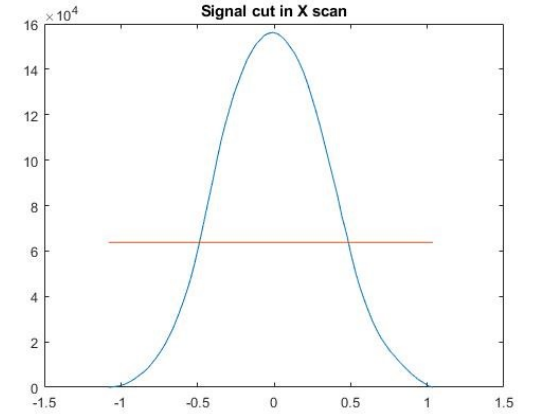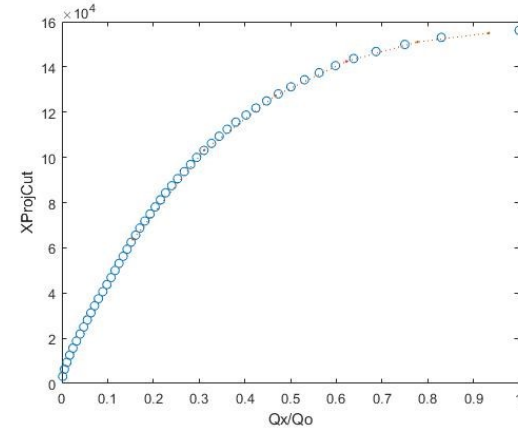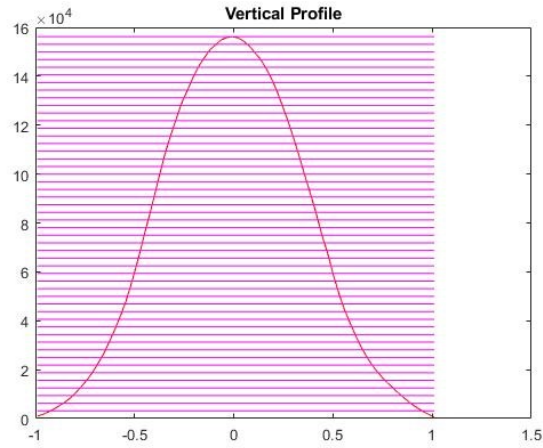$$\varphi(\Delta, thresh, A) = sqrt(sum(|\text{ProjEmsy} - \text{threshold} - A.\text{SoP}|^2 * \text{ProjEmsy}))$$

- Charge cut (sum(ProjEmsy<threshold)/sum(ProjEmsy))

Qo: integral of full projection
Qx: integral of projection below a cut step

cutstep=1 →ProjCut=0 →charge(Qx/Qo)=1

VPP

Algorithm
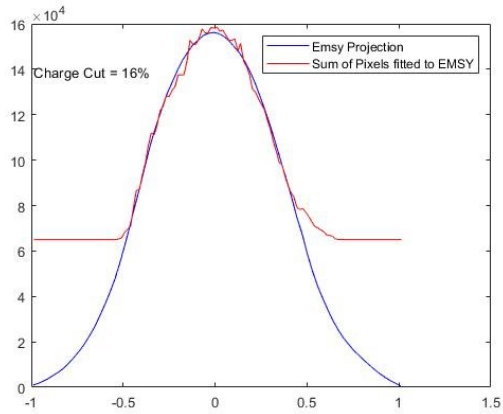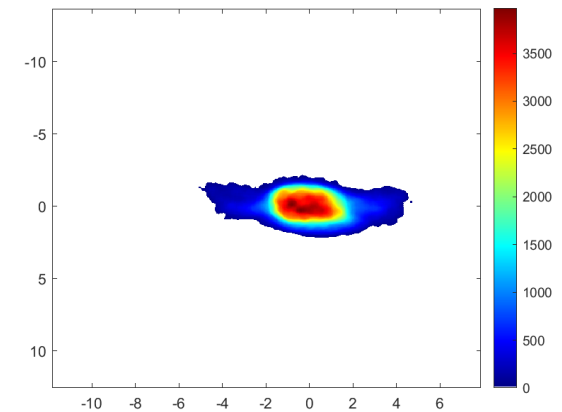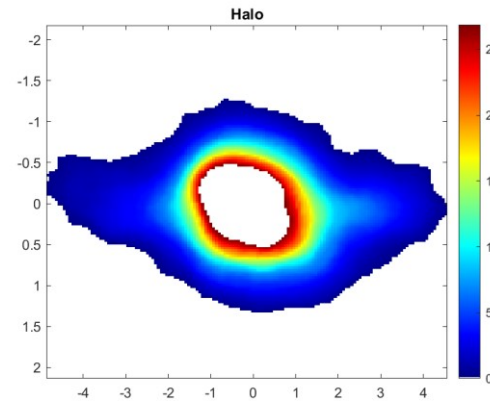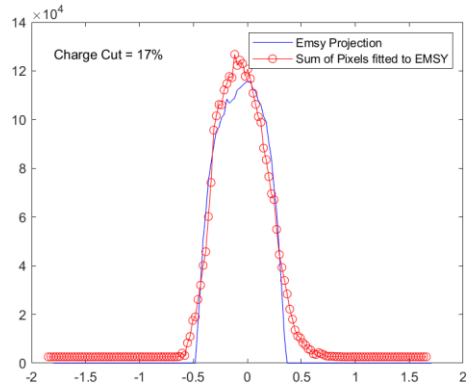
- SoP to EMSY fit Y

Beamlet X on BCS
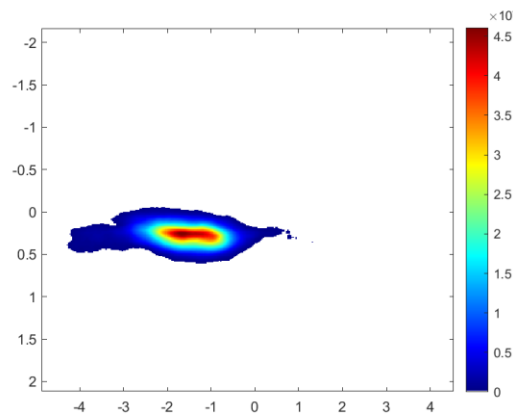
Beamlet Y on BCS

MOI on BCS

VPP

Algorithm

- 2D cut: $cutEmsy = EmsyRaw > threshold$ $\varphi(\Delta, A) = sqrt(sum(|ProjcutEmsy - A.SoP|^2 * ProjcutEmsy))$

- SoP to EMSY fit X

- SoP to EMSY fit Y

VPP

Algorithm
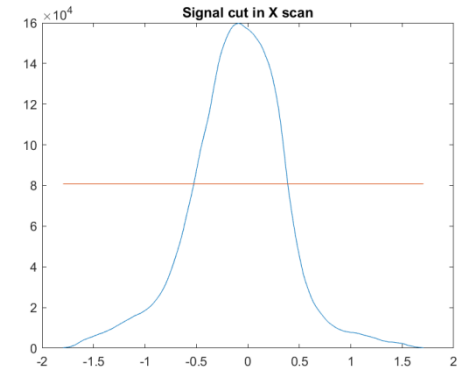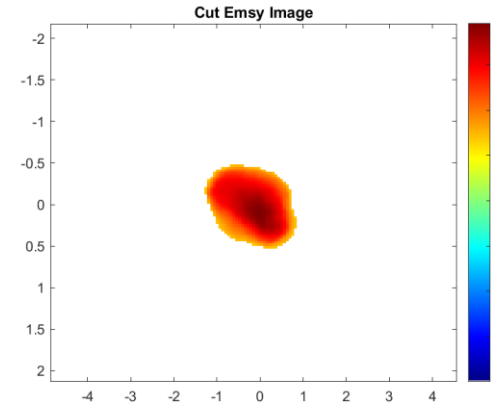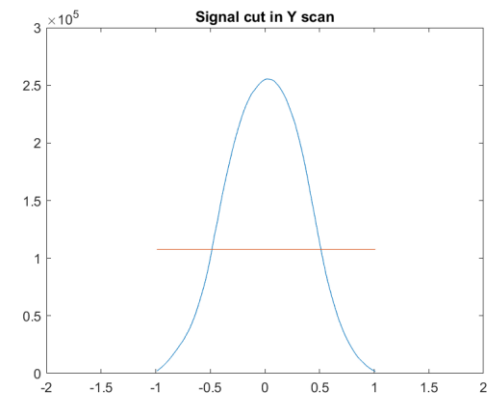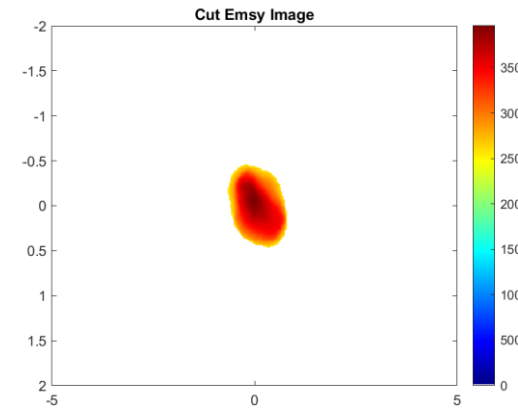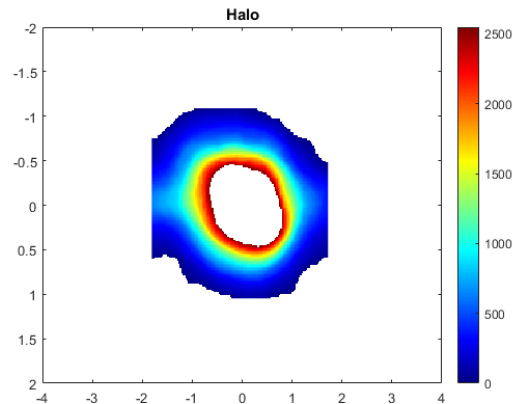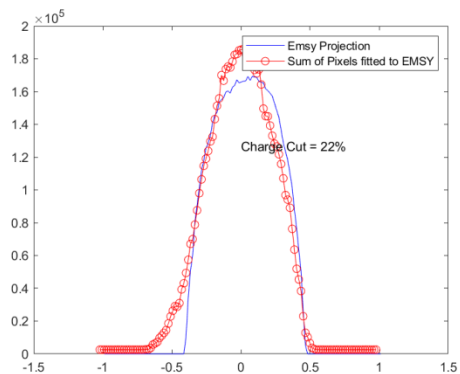
- **PP Mask and Beamlets**
  - Crossing horizontal and vertical slits

Screen pixels
35um
50um
50um
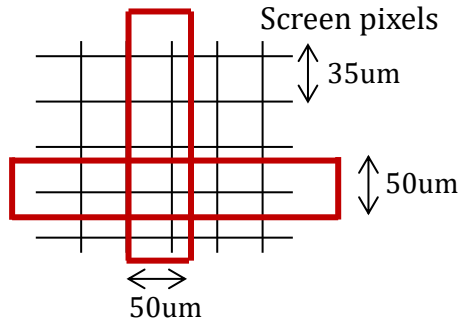
  - Assigning Emsy values to sub-images

Without Extrapolation | With Extrapolation
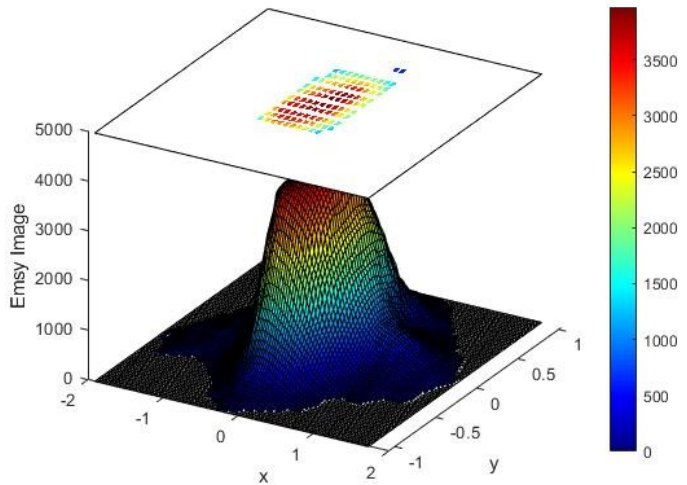
6th beamlet crossing

4th beamlet crossing

3th beamlet crossing

VPP

Algorithm
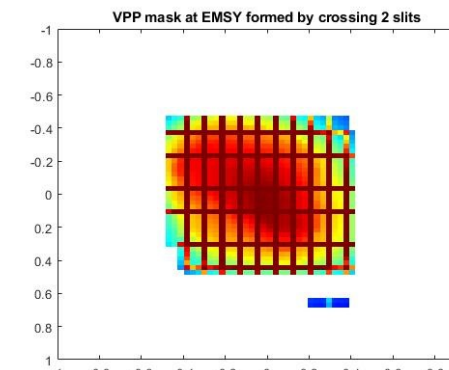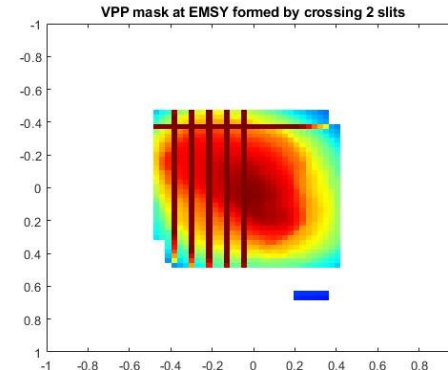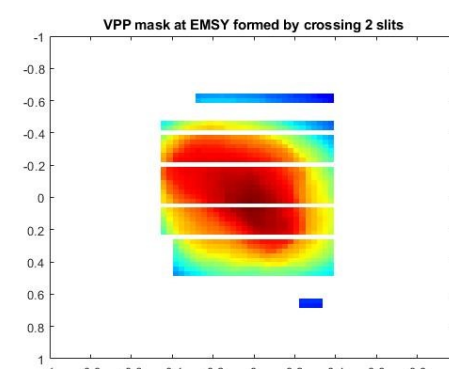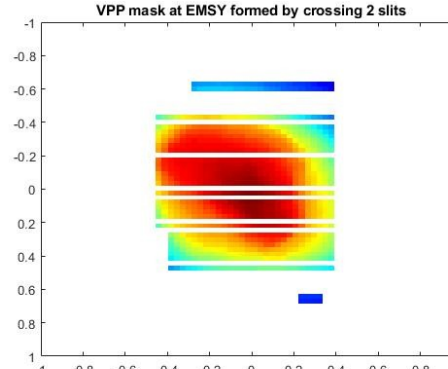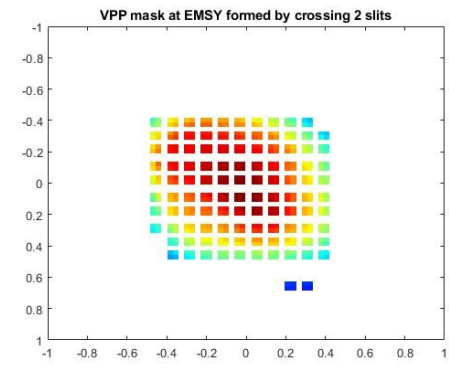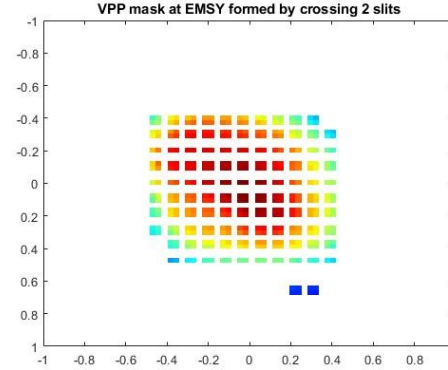
- Renormalizing beamlets according to XprojCut, YprojCut

- Crossing the beamlets and normalizing them by SoP

- Calculating center of mass of all pepper pot beamlets and mask sub-images

- Shifting all PP beamlets and mask subimages to common center of mass

- Calculating new center position and second order moments for each PP beamlet and mask sub-images

VPP Beamlets

VPP

Results
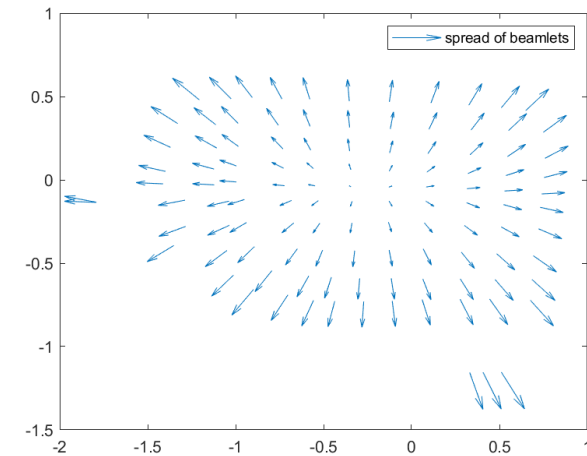
Unscaled Emit	VPP with 1D cut	VPP with 2D cut	Slit scan
Emit X	0.3574	0.3522	0.594
Emit Y	0.4044	0.4037	0.602
Emit XY	0.3802	0.3770	0.598
Emit 4D	0.3761	0.3730	-

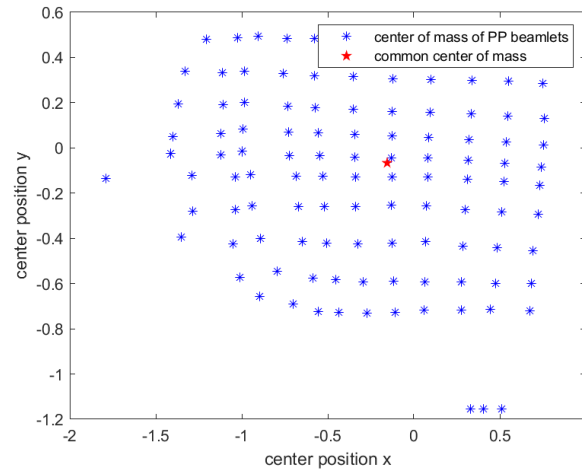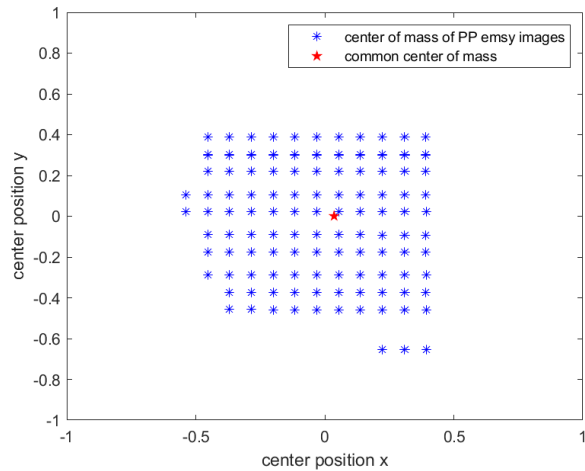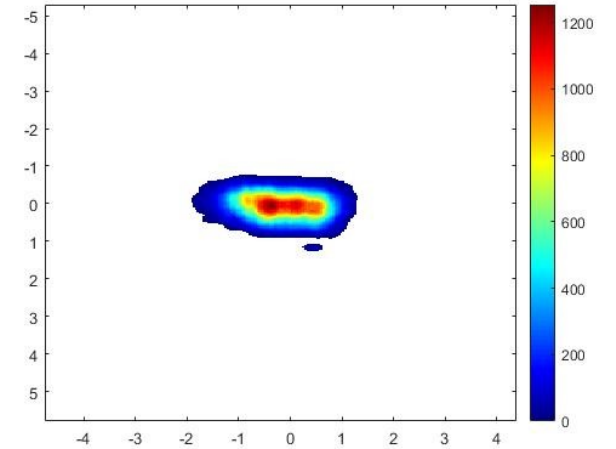- Beam matrix $= \begin{pmatrix} <x^2> & <xx'> & <xy> & <xy'> \\ <xx'> & <x'^2> & <x'y> & <x'y'> \\ <xy> & <x'y> & <y^2> & <yy'> \\ <xy'> & <x'y'> & <yy'> & <y'^2> \end{pmatrix} =$

$$\begin{bmatrix} 21.3157 & -0.0068 & 10.7263 & -0.0034 \\ -0.0068 & 0.0000 & -0.0034 & 0.0000 \\ 10.7263 & -0.0034 & 31.7752 & -0.0101 \\ -0.0034 & 0.0000 & -0.0101 & 0.0000 \end{bmatrix}$$

- **Improvements**

- Noise Filtering

- Suggestions??

Testing VPP Algorithm on recent data

Testing for experimental data with following parameters:

Laser: Pharos flat top 9ps, **Charge**: 250pC , **BSA**: 1.1 mm, **Gun SP**: 58, **Booster SP**: 16
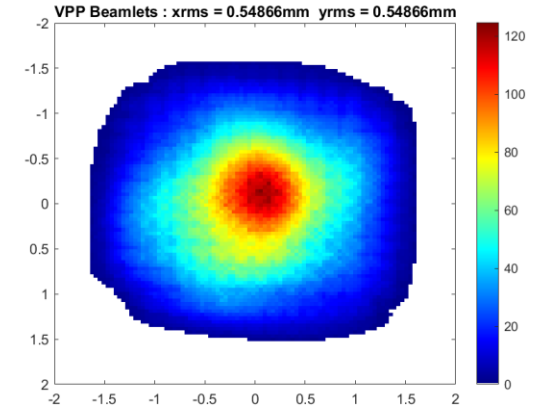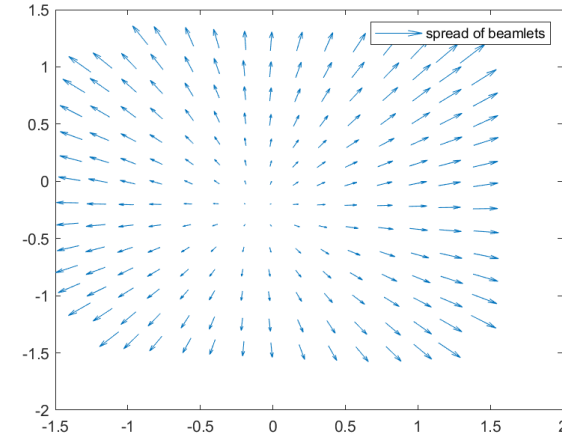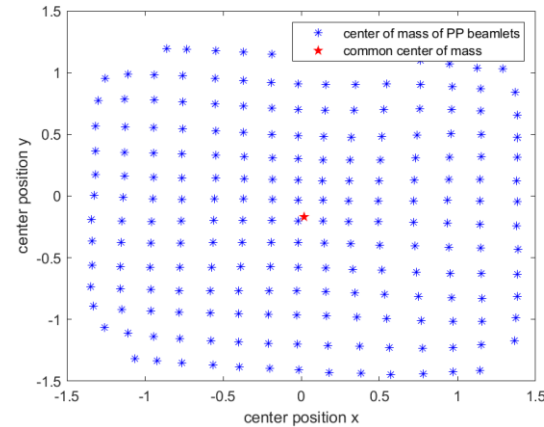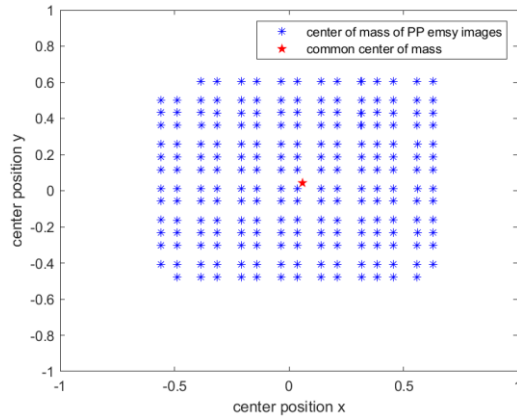
		Unscaled Emit	**VPP**	**Slit scan**
H1Scr5 (LYSO)		Emit X	0.3689	0.742
		Emit Y	0.3682	0.714
		Emit XY	0.3686	0.728

Outlook

- Testing of Virtual Pepper Pot script for 4D analysis of various experimental data sets

- Testing of Virtual Pepper Pot script for 4D analysis of ASTRA generated beam (coupled and uncoupled)

- Data taking for LPS during run week (if booster available)

THANK YOU