Pattern Recognition Lab

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
FACULTY OF ENGINEERING

Double Your Views – Exploiting Symmetry in Transmission Imaging

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BVM 2019

18.03.2019

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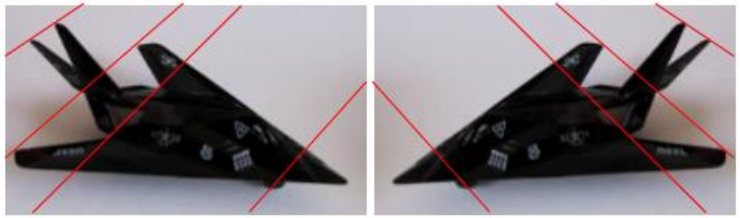
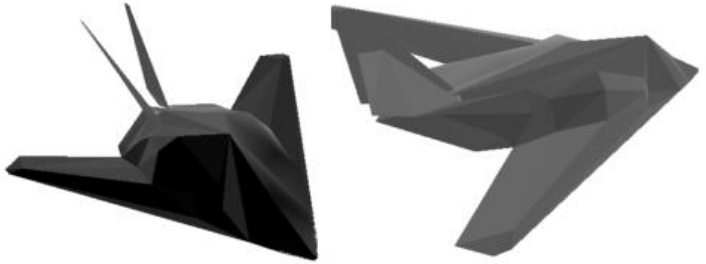
Basic Concepts of Symmetry

Plane Symmetry in Computer Vision

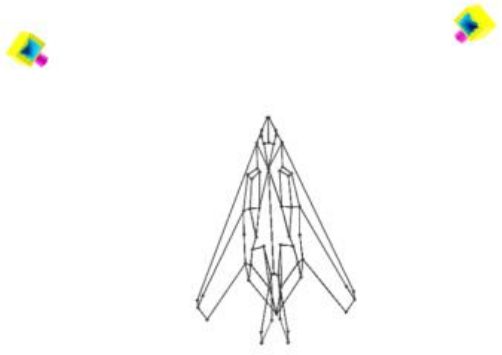
- Well examined property in computer vision
- Francois et al. ***Reconstructing mirror symmetric scenes from a single view using 2-view stereo geometry*** Pattern Recognition, 2002



a. Input image (left) of a (toy) F117 and inverted image (right), with overlaid epipolar pencils.



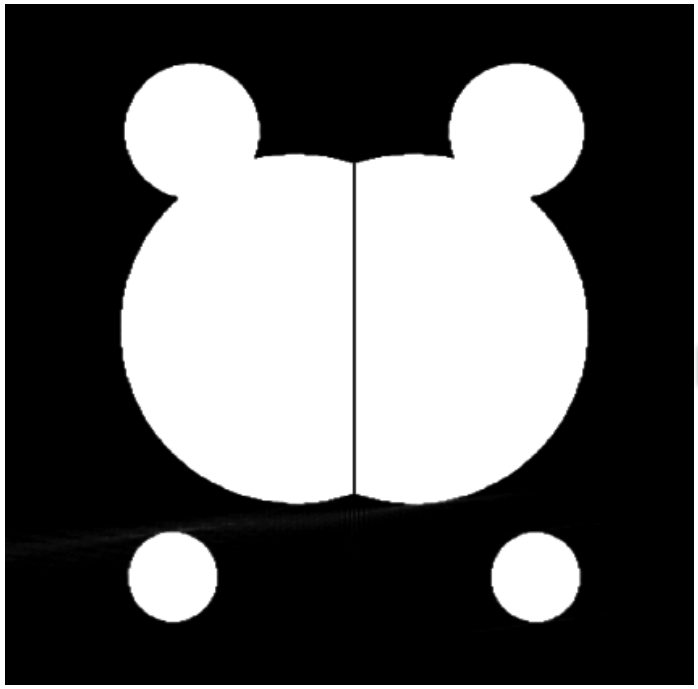
c. 3-D surface model of the F117

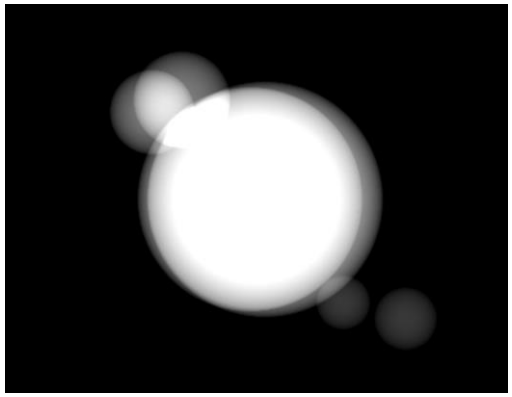


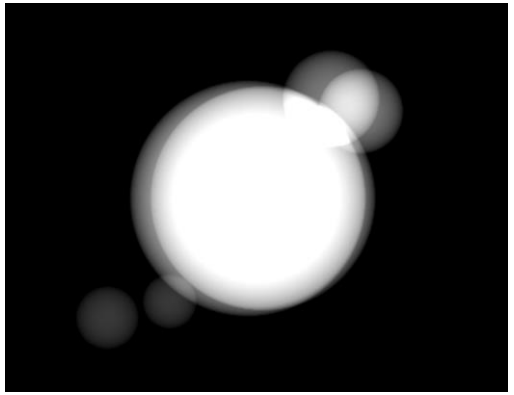
b. Wireframe model of the F117 and computed corresponding camera positions

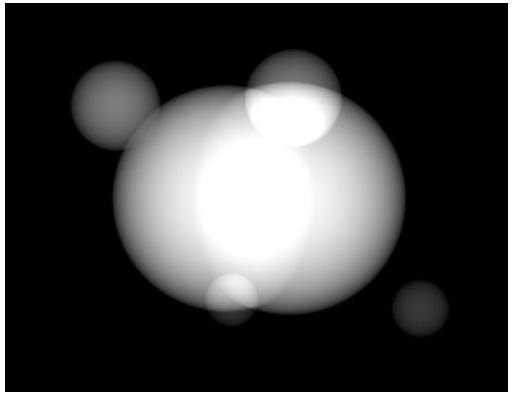
d. Textured model of the F117

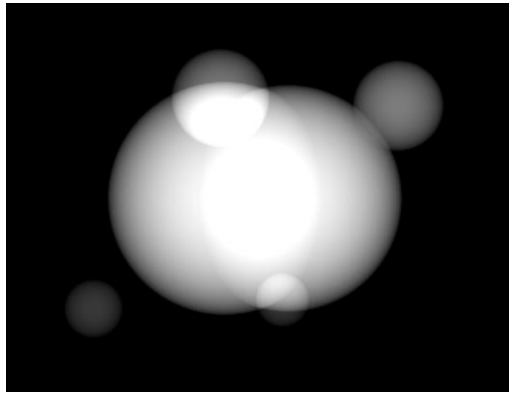
Synthetic Data



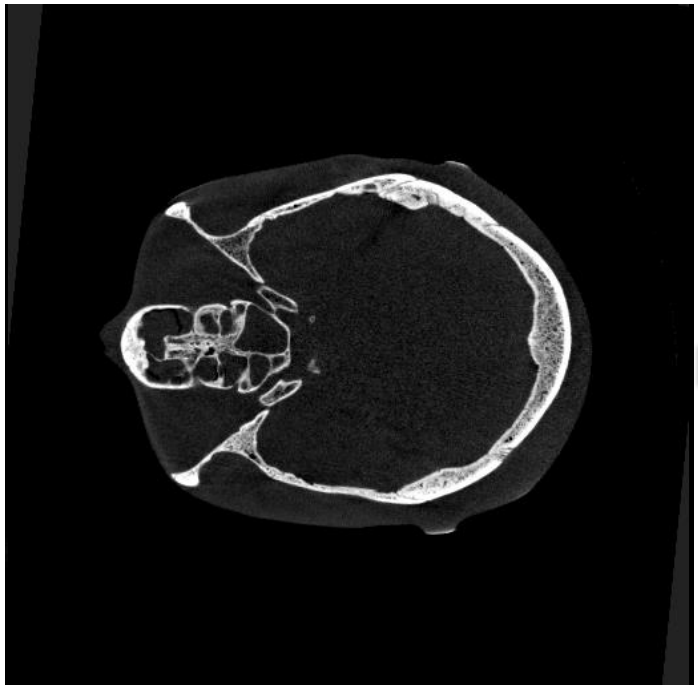


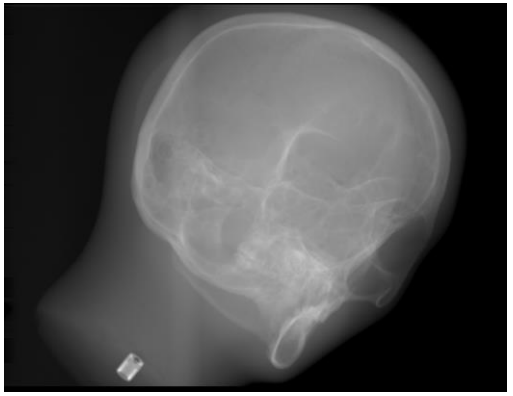






Anthropomorphic Head Phantom





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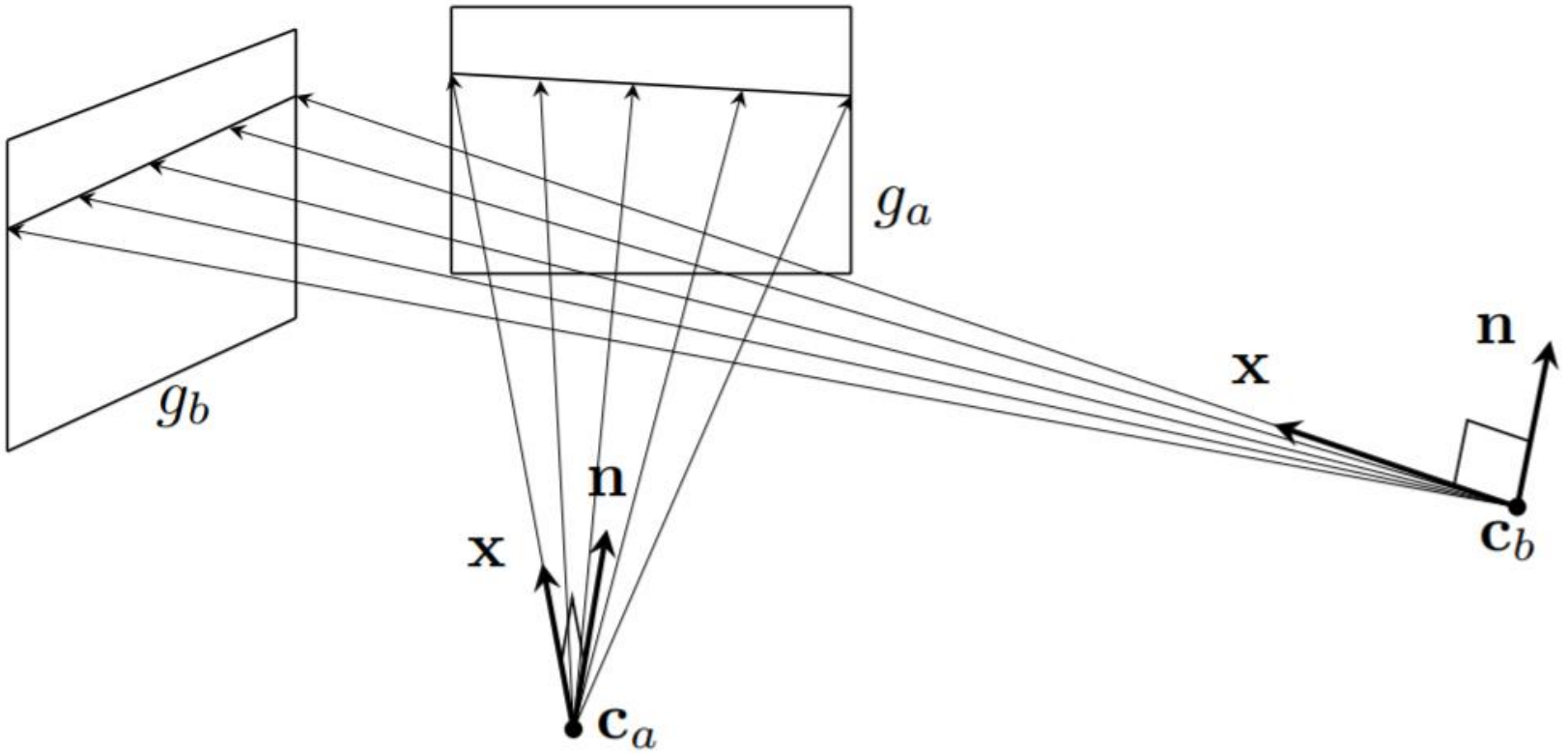
Symmetry Plane Estimation using Epipolar Consistency

Grangeat's Theorem and Epipolar Geometry

Forming Epipolar Consistency



Grangeat's Theorem and Epipolar Geometry

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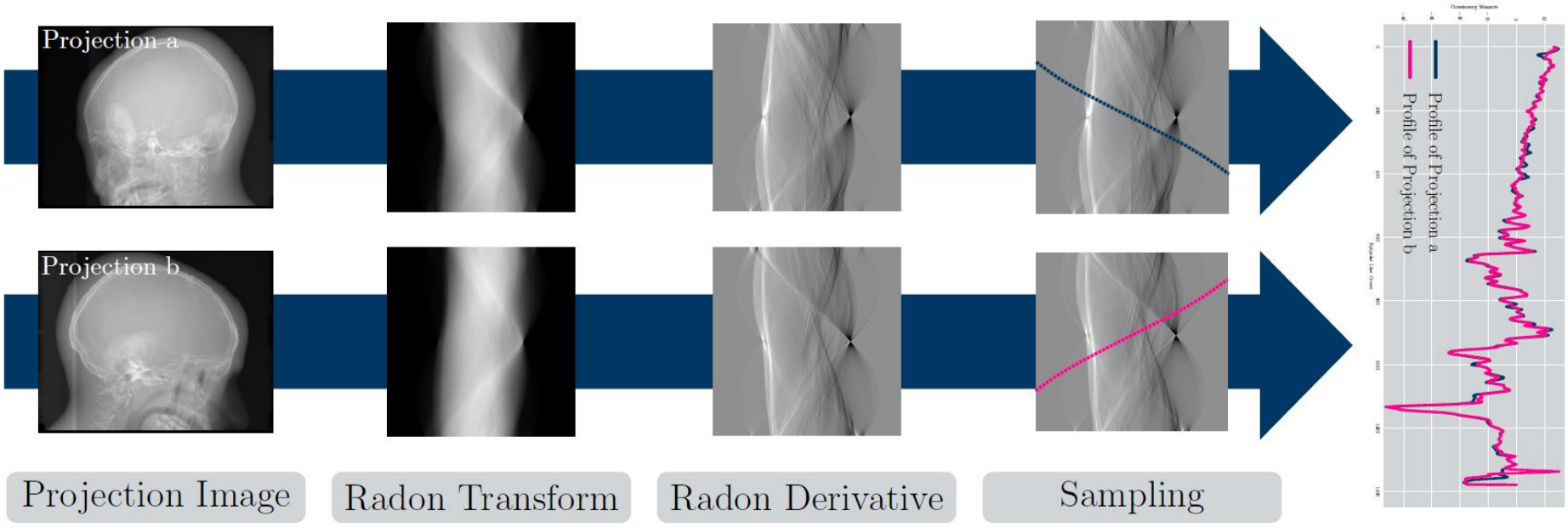
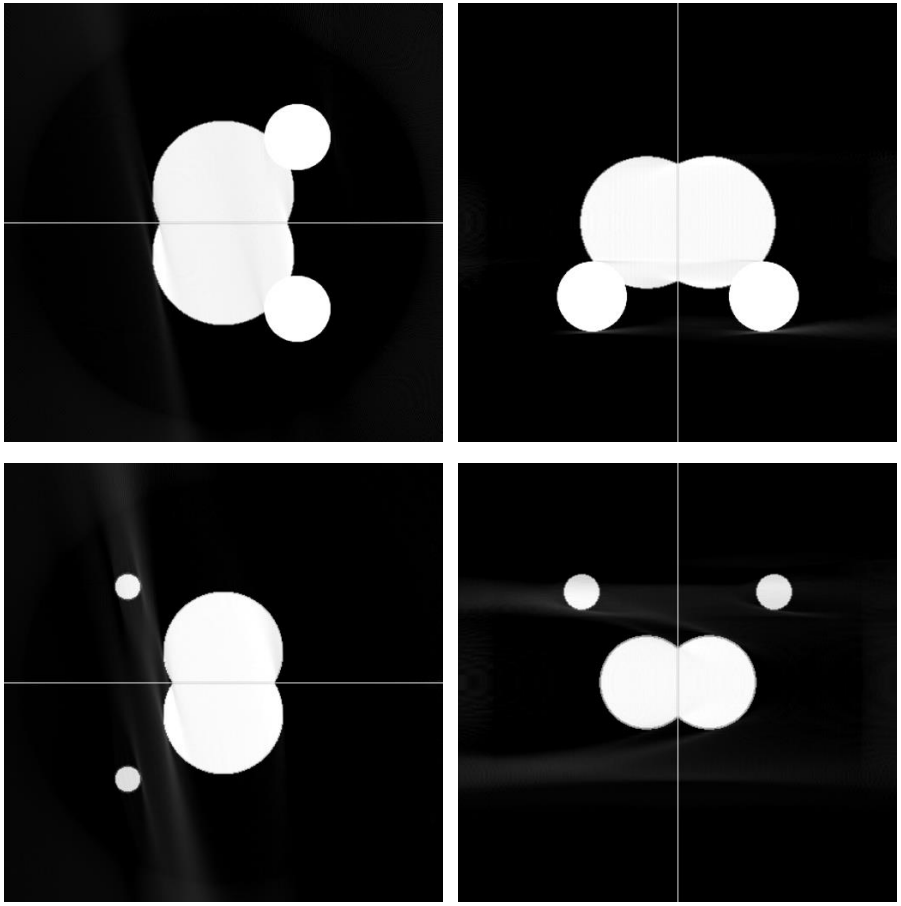


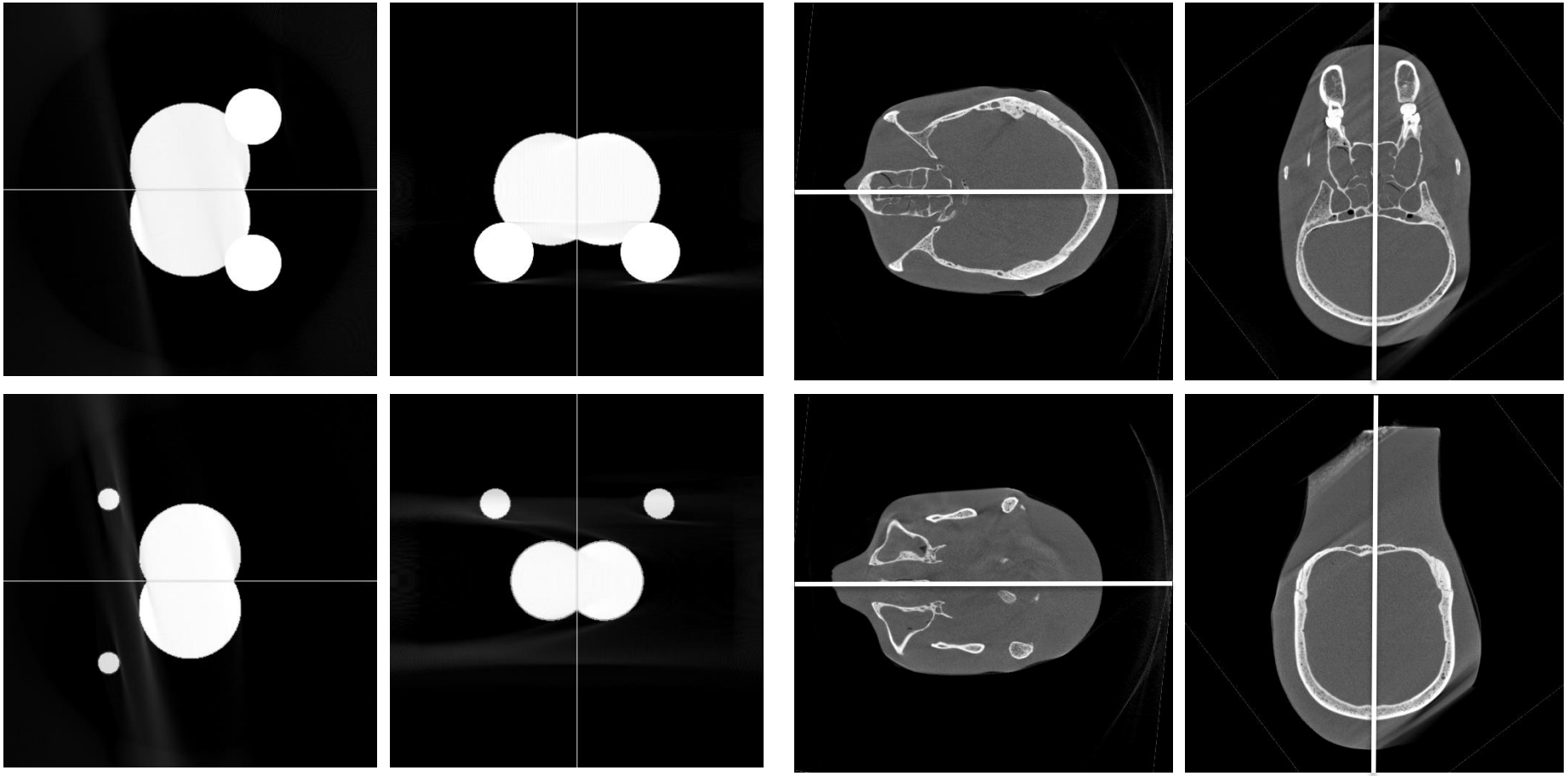
Symmetry Plane Estimation

- Measurement error in the range of $\mathbf{10^{-4}}$ mm/degree for phantom data



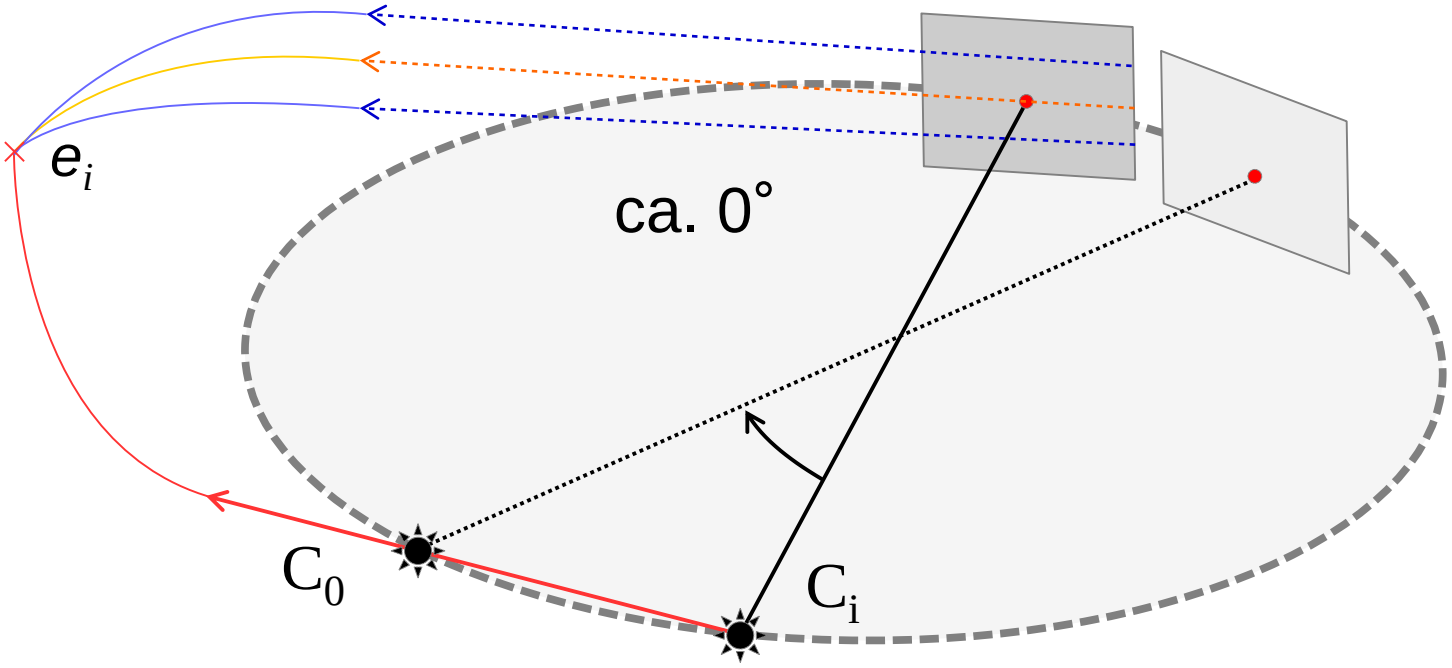
Symmetry Plane Estimation

- Well defined symmetry plane for real data (no GT available)

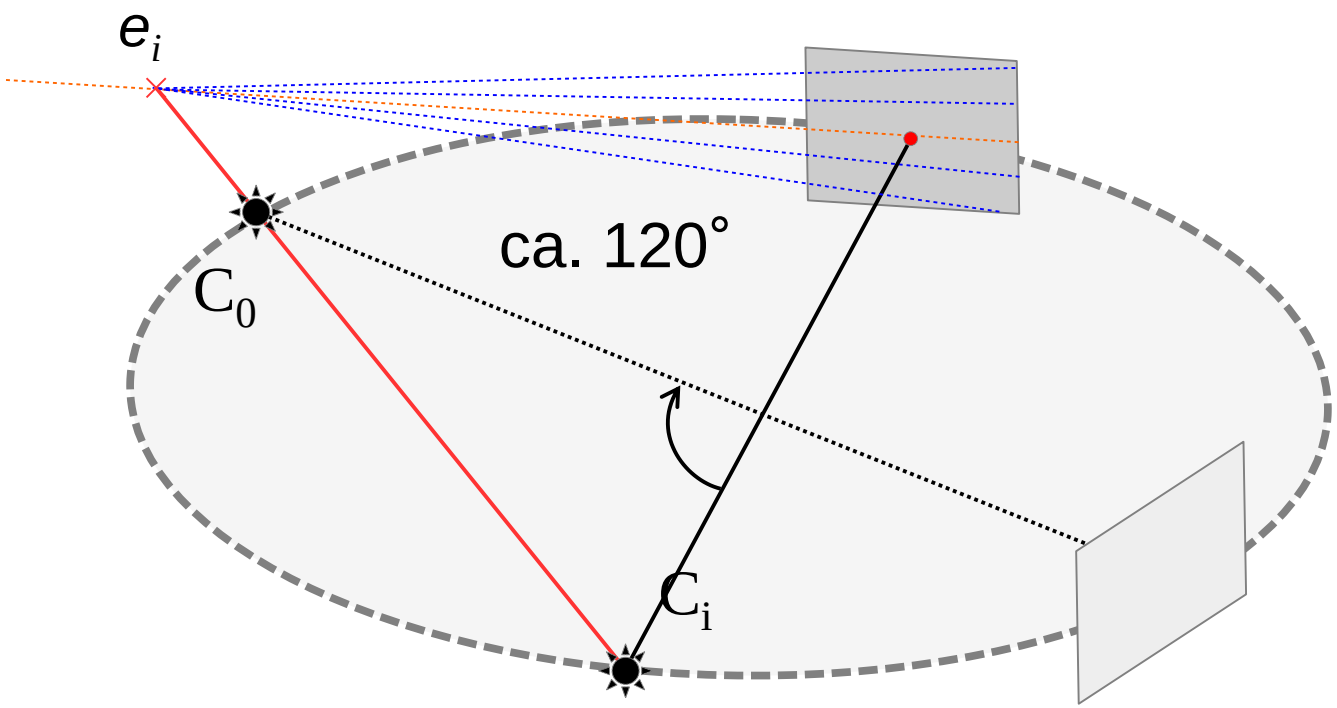


With the Symmetry Plane: Double your Views

Problem: Epipolar Lines Mostly Horizontal



Problem: Epipolar Lines Mostly Horizontal



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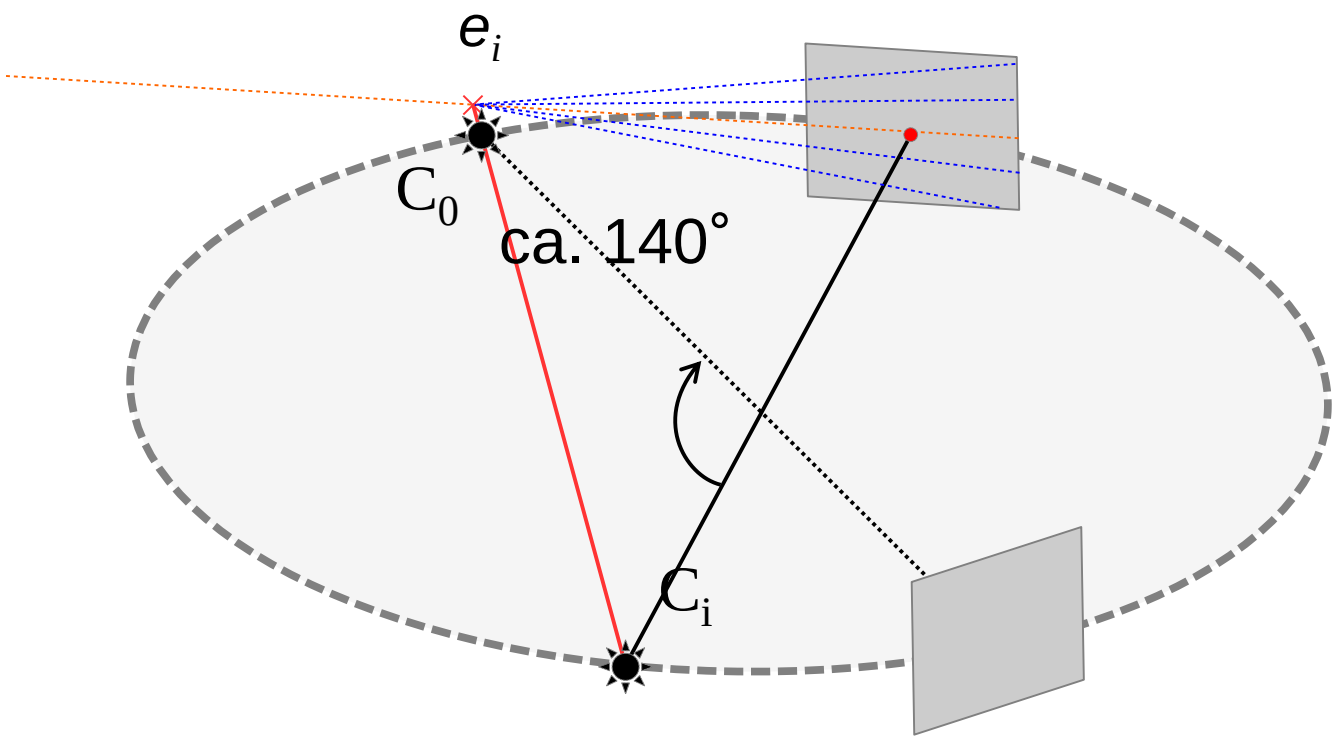

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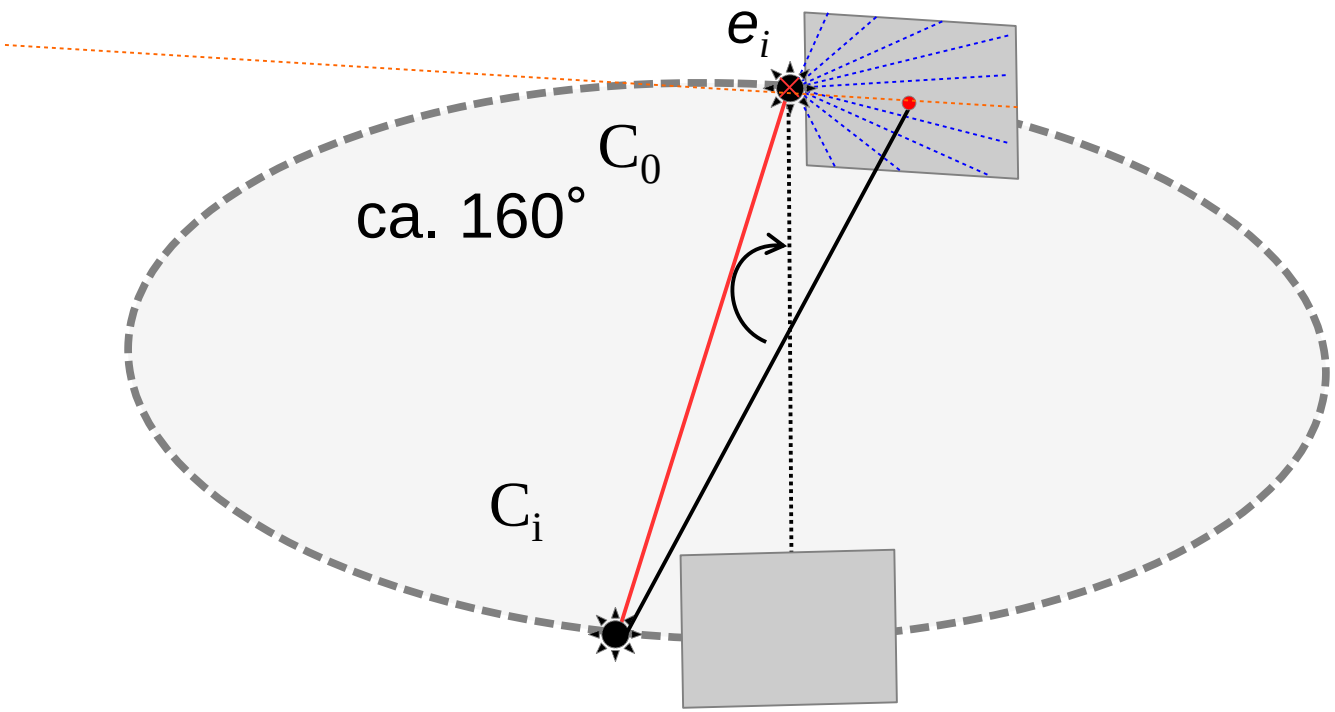
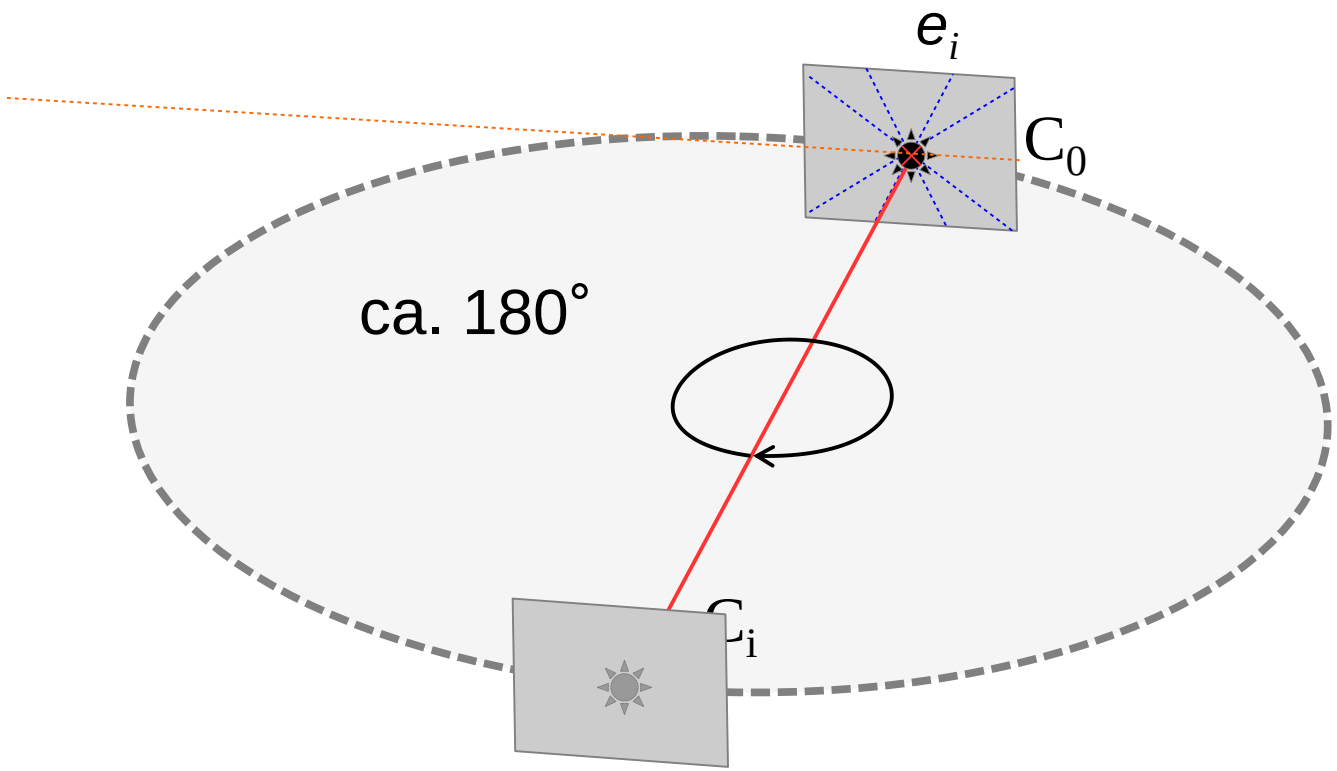


Problem: Epipolar Lines Mostly Horizontal



Problem and Possible Solutions

- Epipolar geometry provides:
  - Good estimates for motion directions, that are directed away from the source rotation plane
  - Bad estimates for motion directions, that are within the source rotation plane

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Idea

Can we incorporate the symmetry prior to improve motion detection ?

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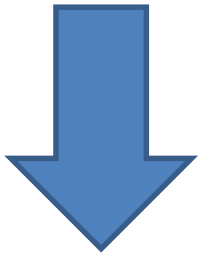
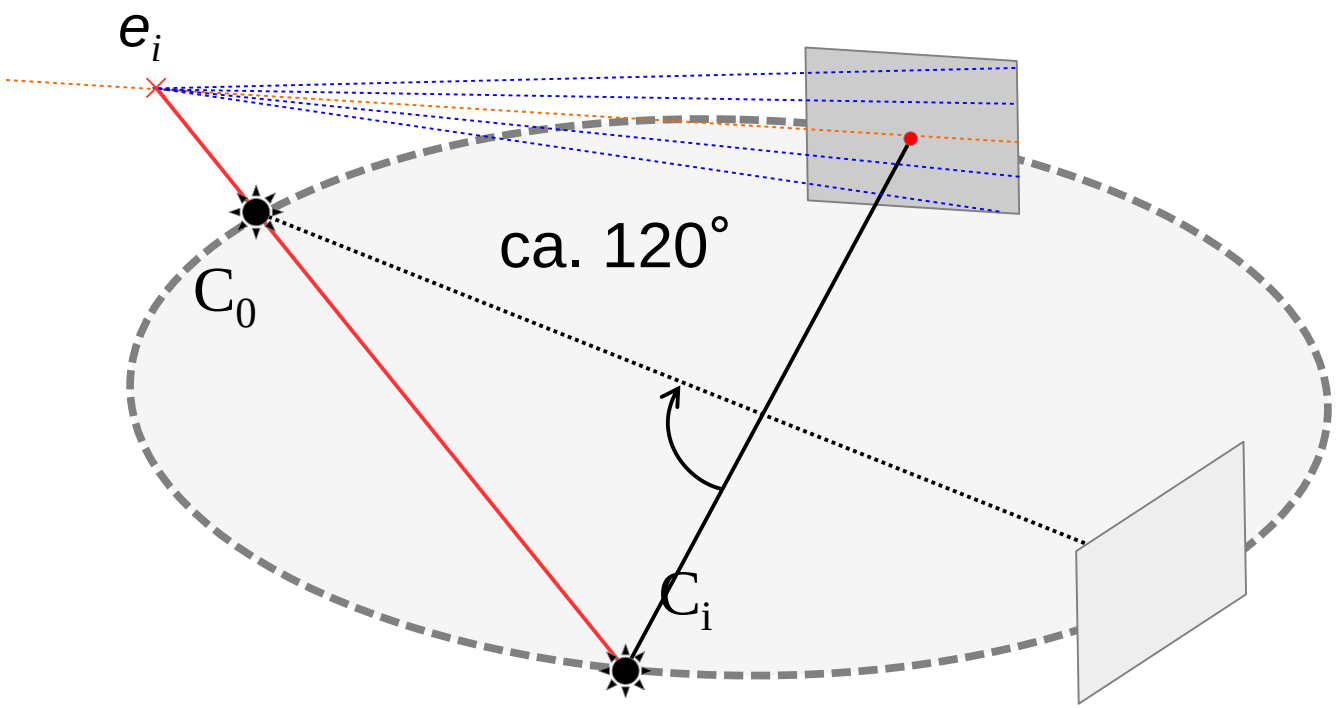
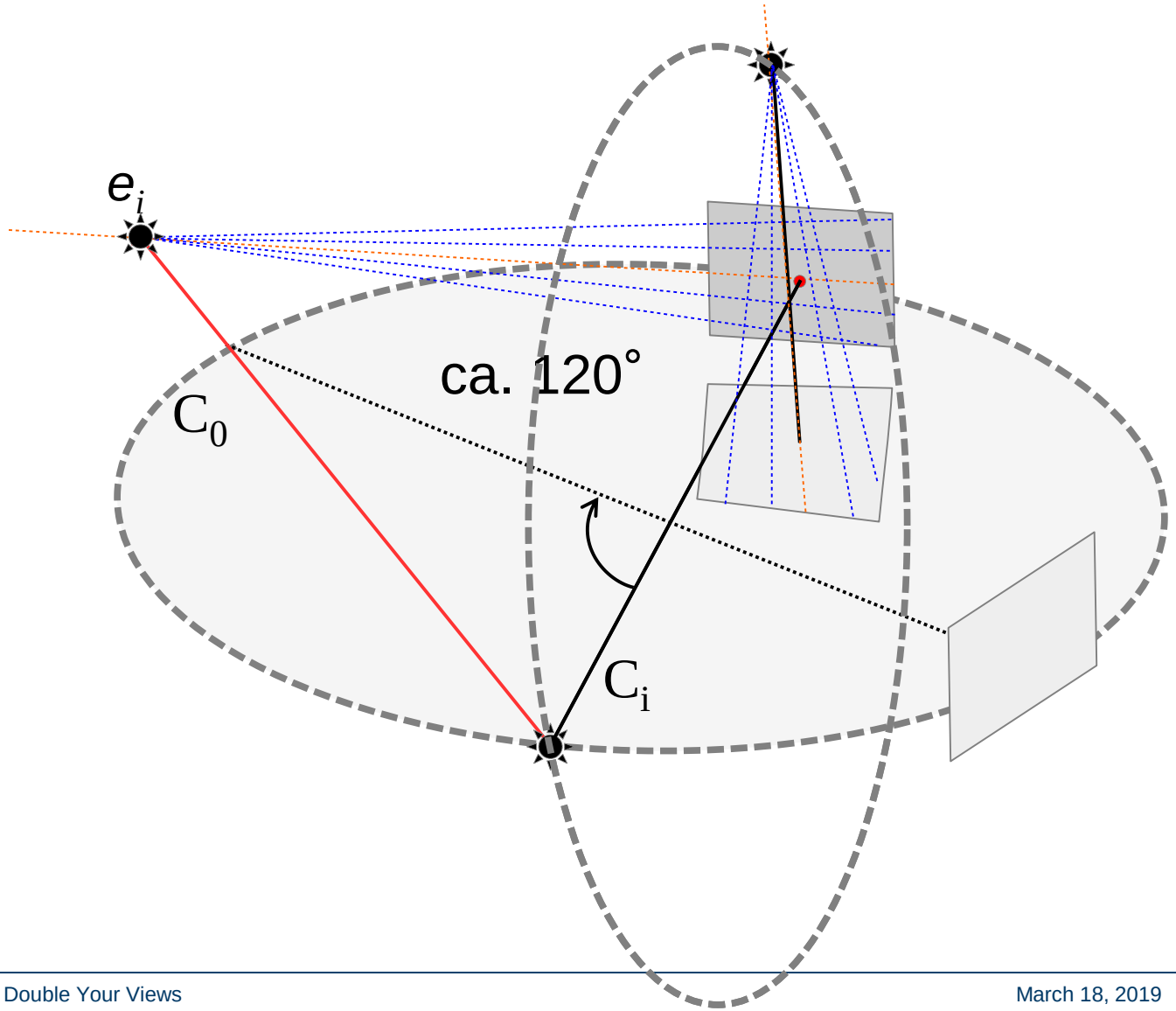


Use symmetry to generate checkboard pattern-like appearance of epipolar lines!

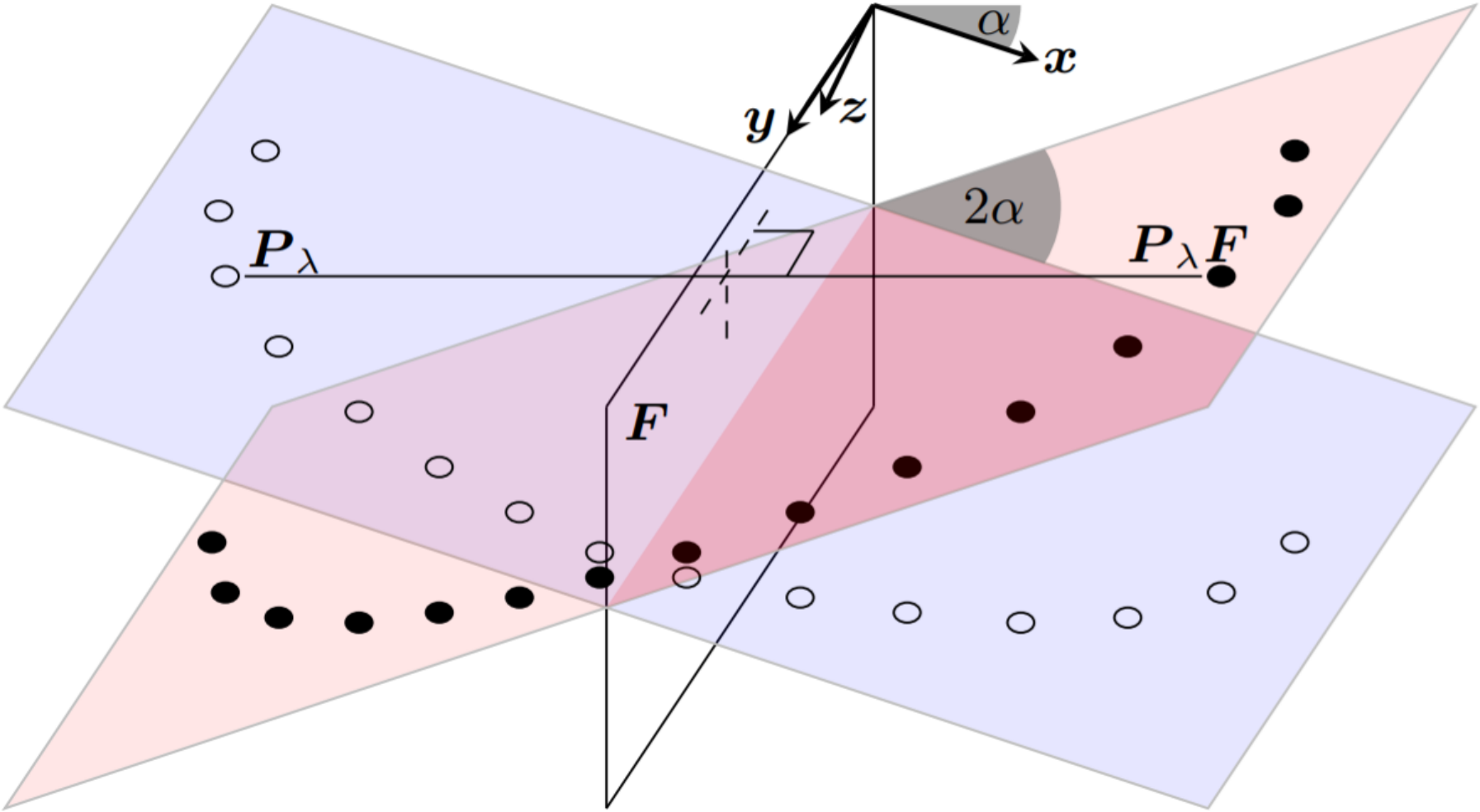
Problem: Epipolar Lines Mostly Horizontal



Solution: We need a Second Trajectory Plane!



X-Trajectory



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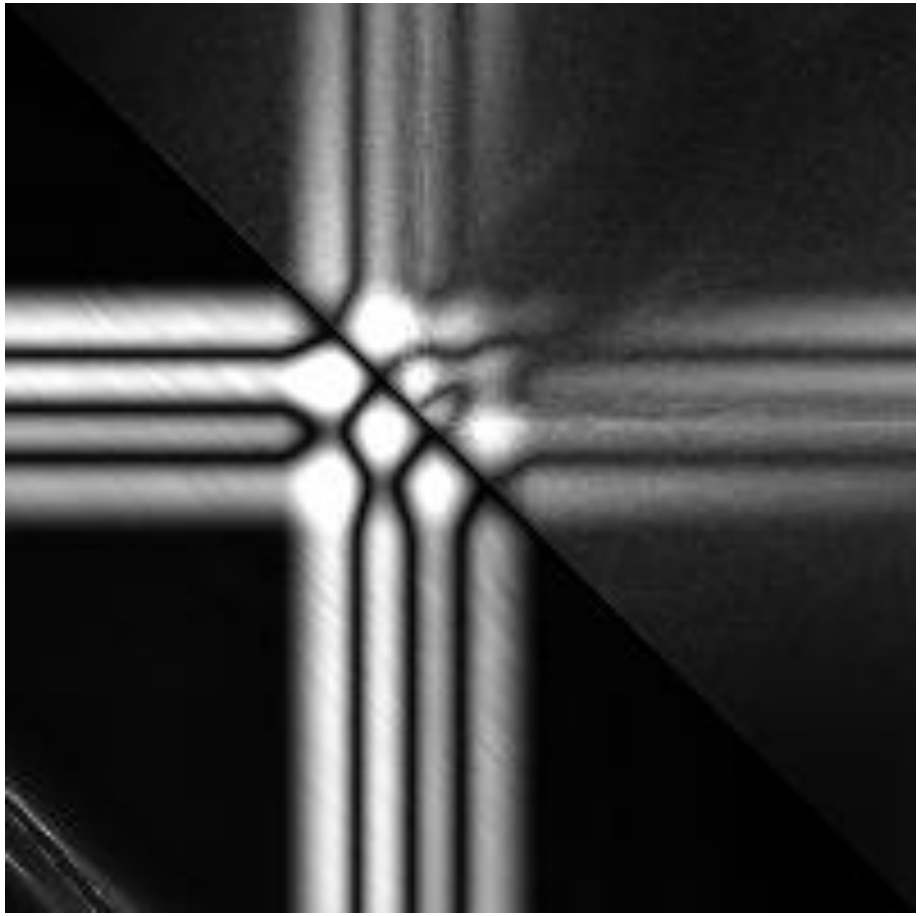
Motion Compensation using the Symmetry Prior

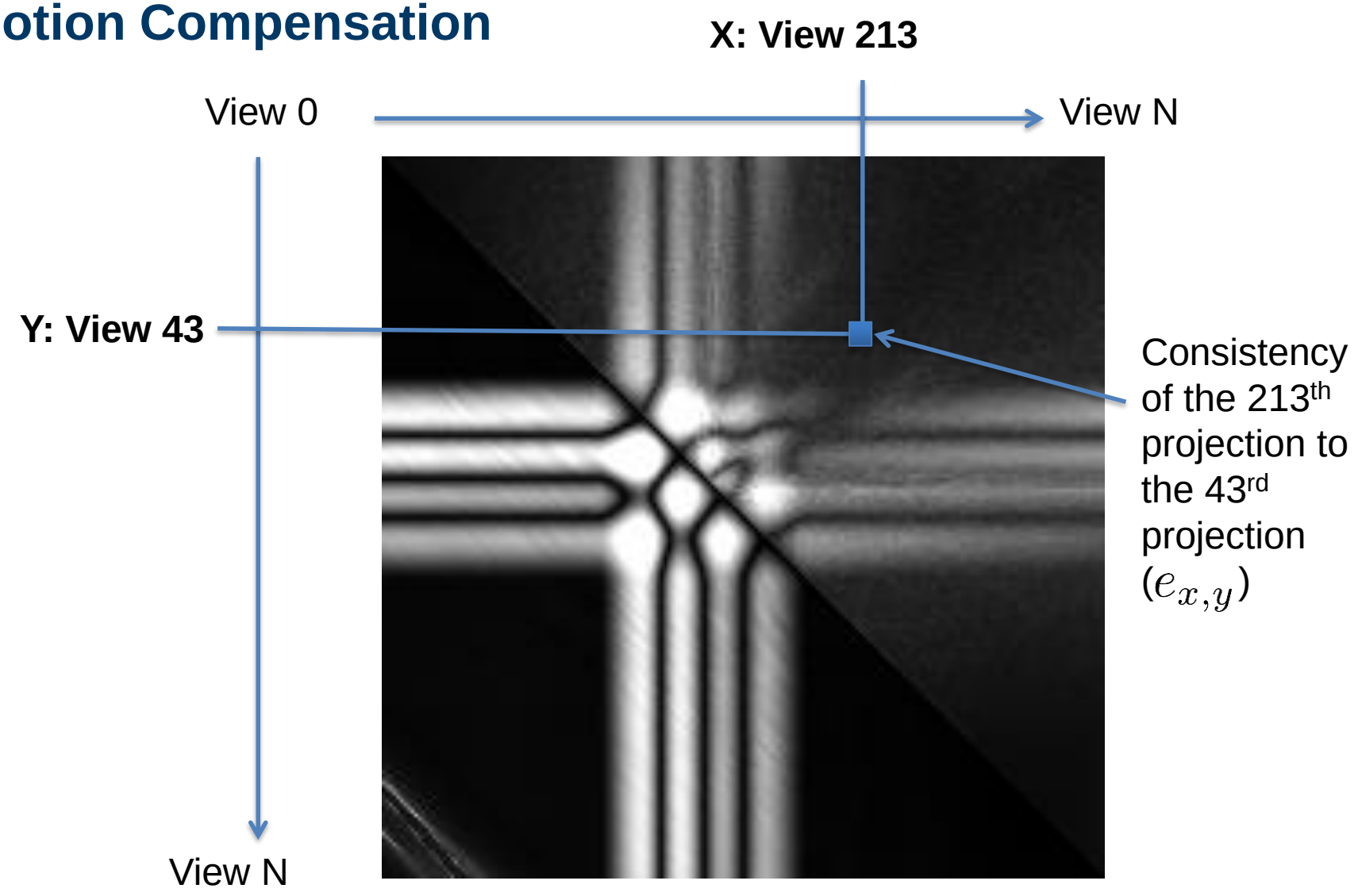
Motion Compensation

View 0 → View N



View N

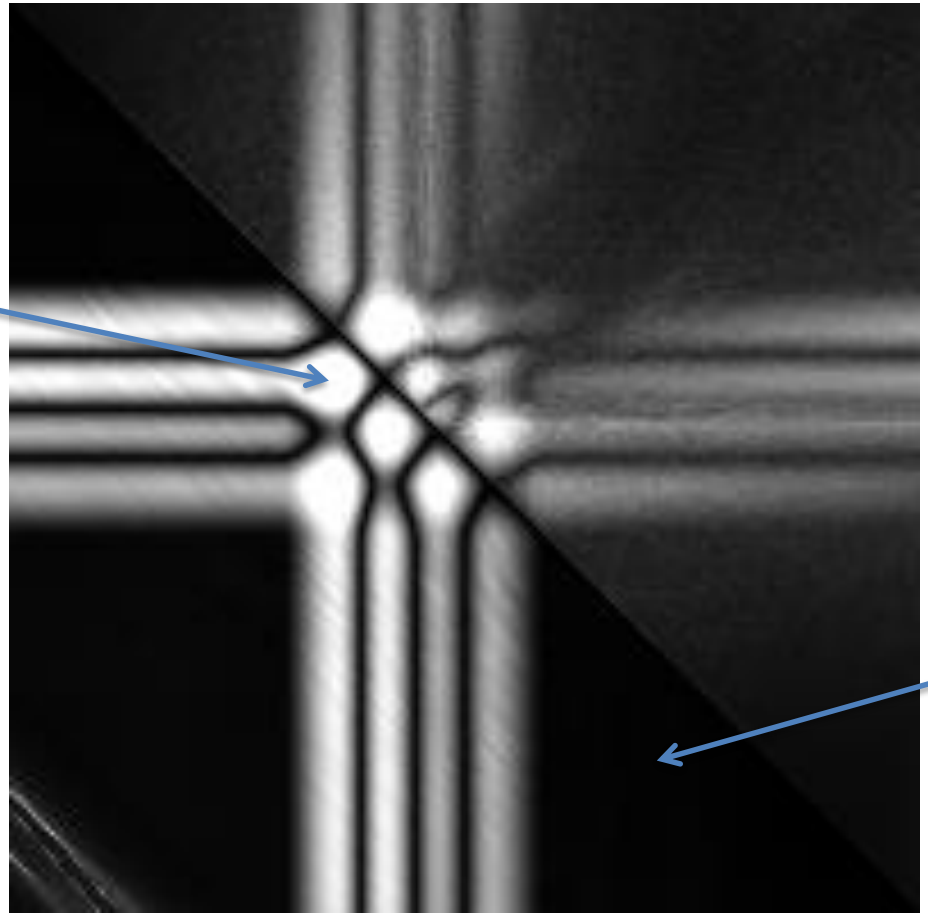
Motion Compensation



Motion Compensation

View 0 → View N

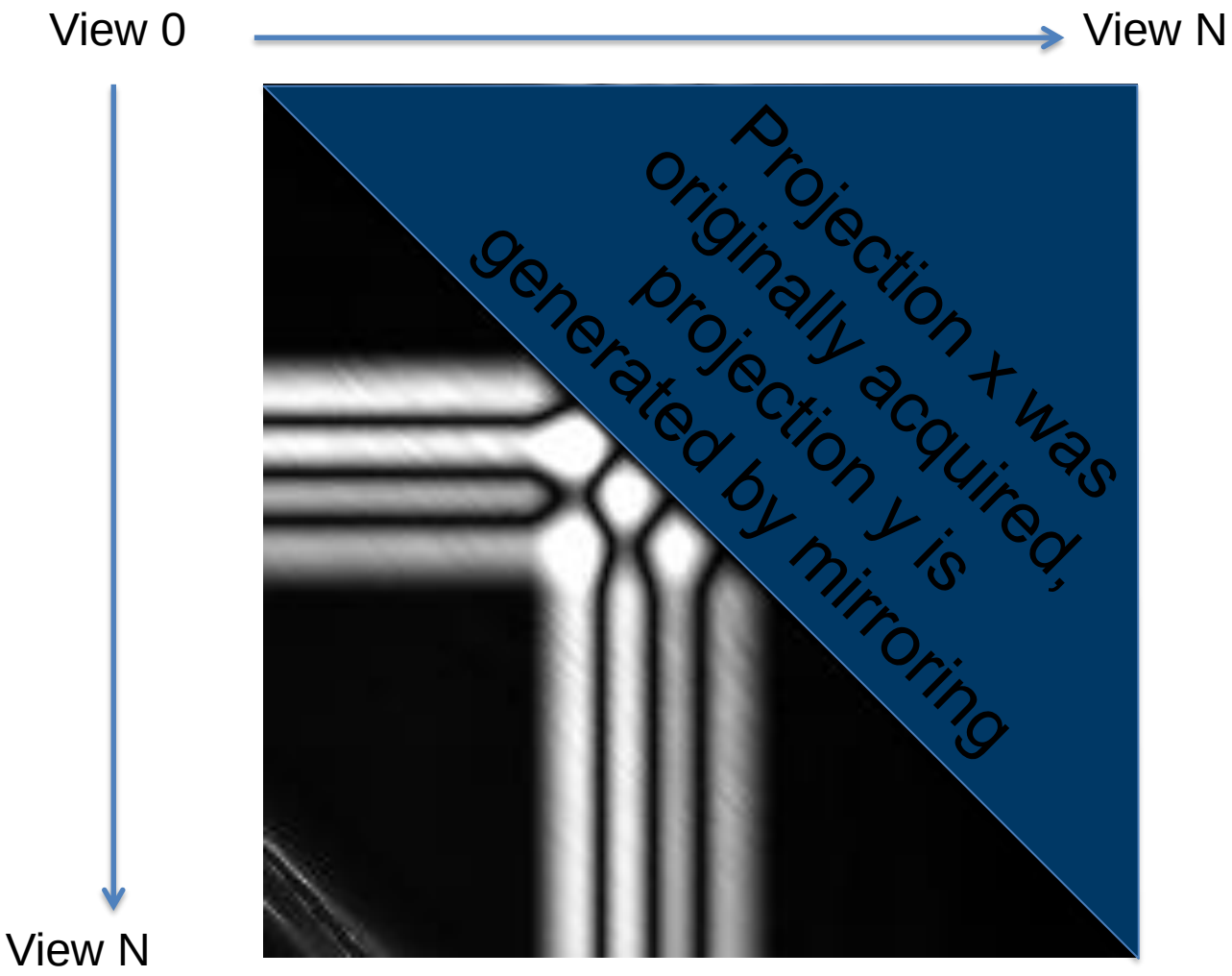
White area encodes high **in**consistency (Eventually due to motion in-between the vies)



View N

Black area encodes high consistency

Motion Compensation

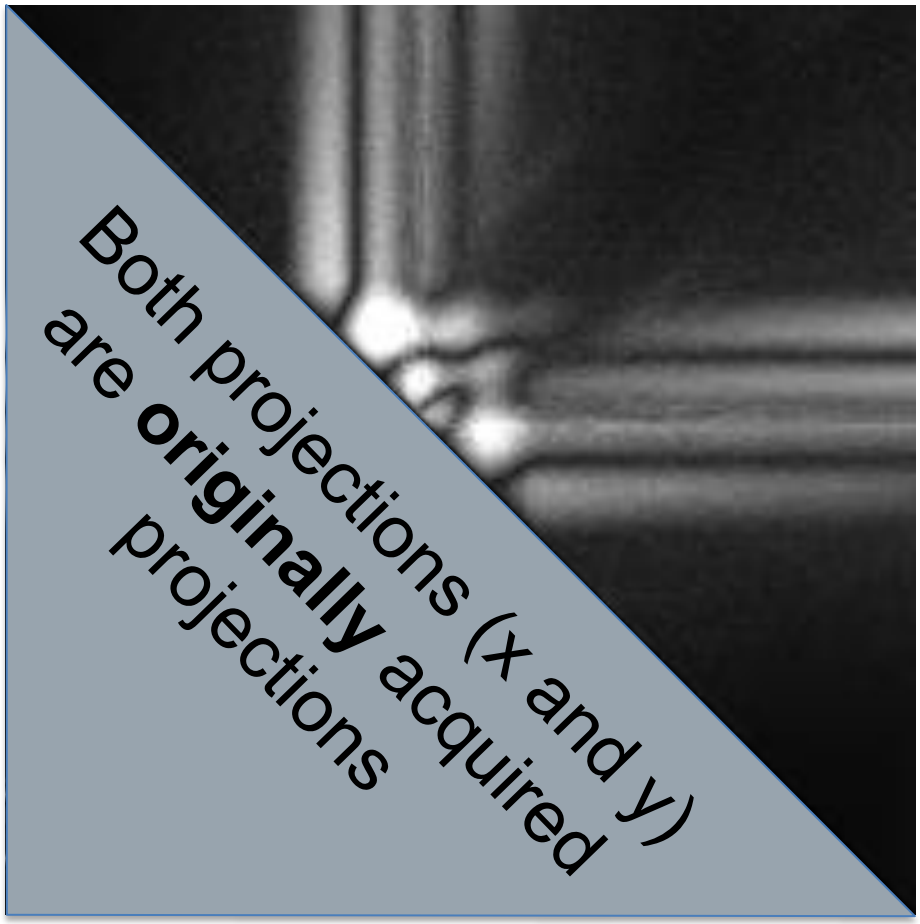


Motion Compensation

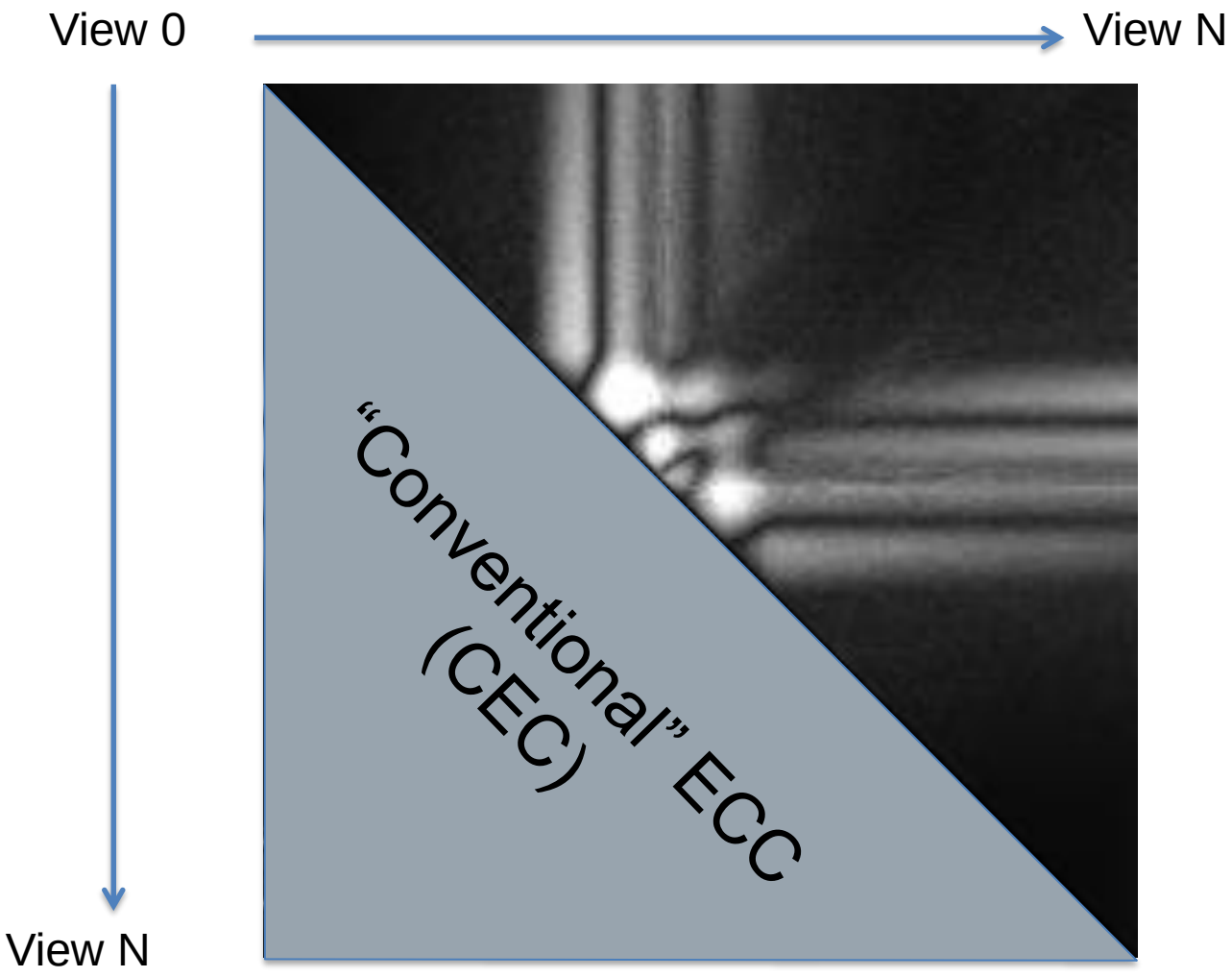
Motion Compensation

View 0 → View N

View N ↓

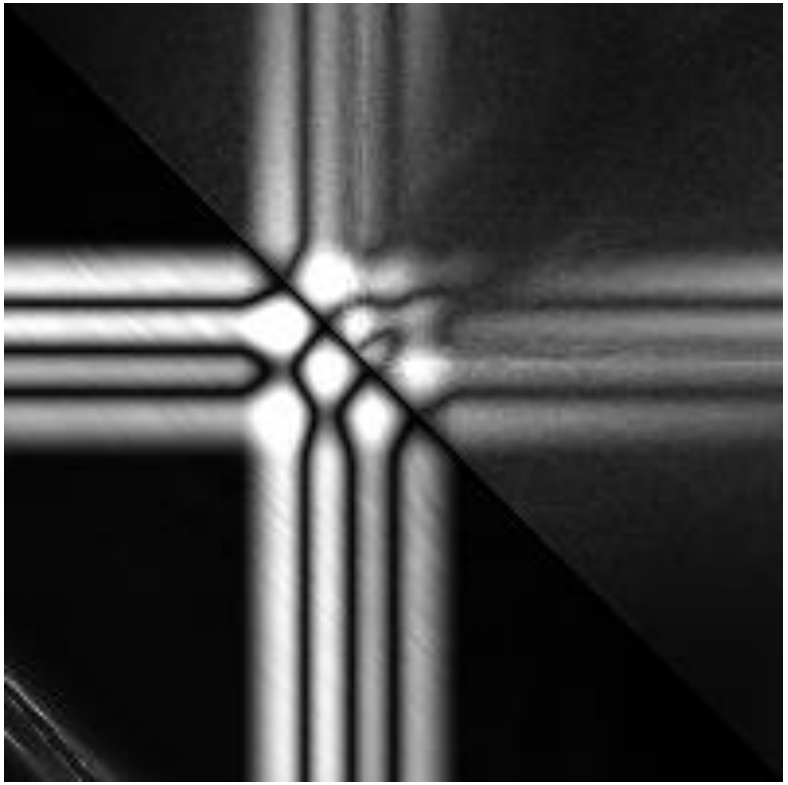


Motion Compensation

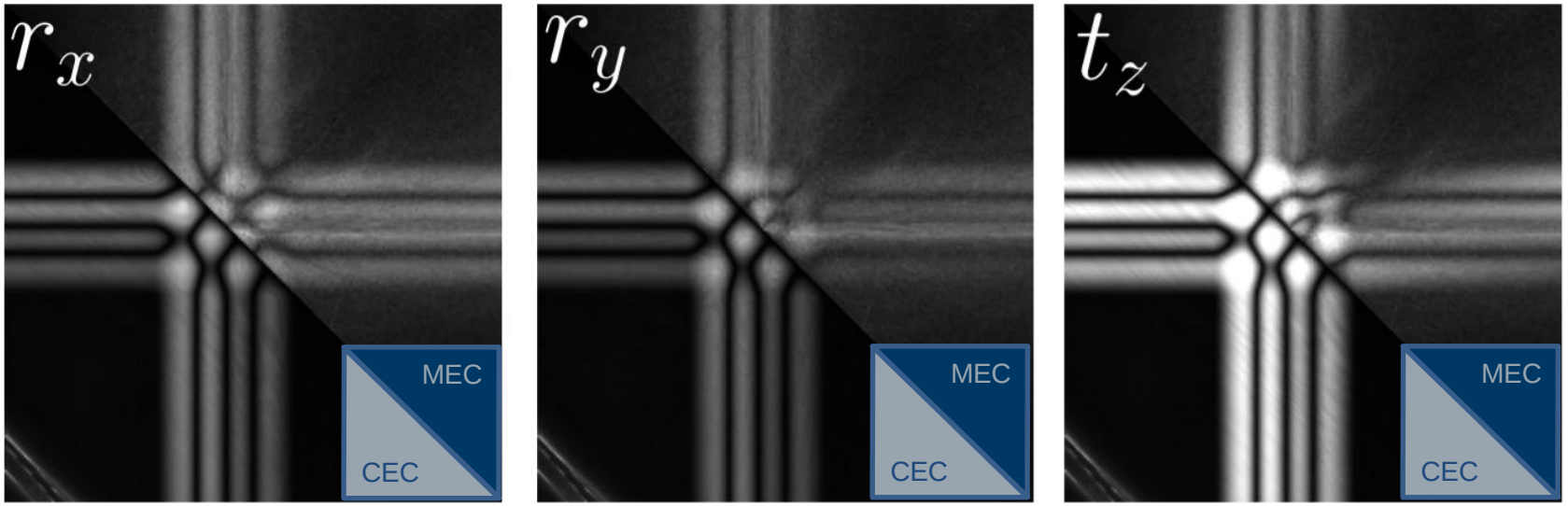


Motion Compensation

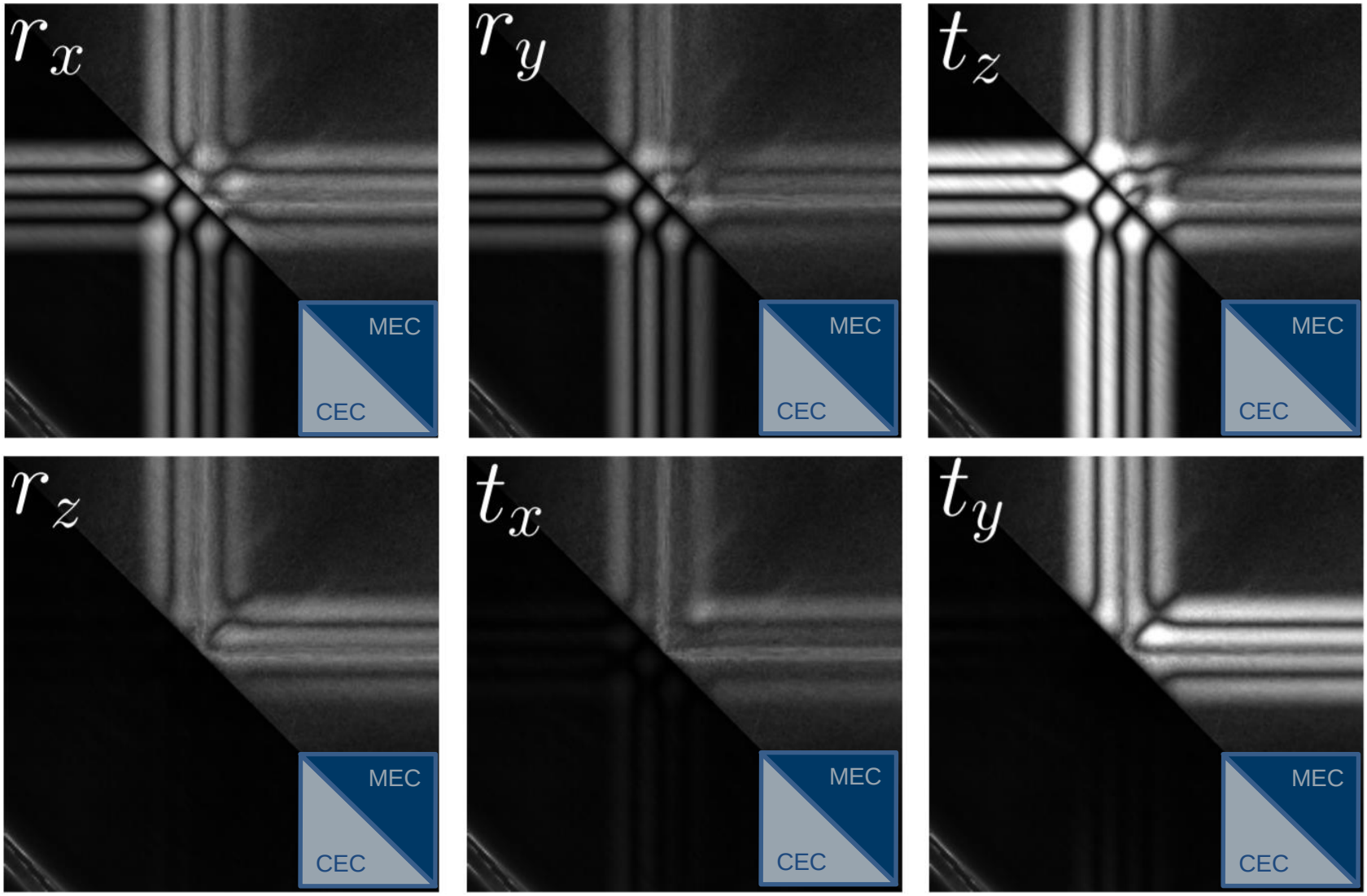
- We apply rigid motion modeled by the same spline to every axis
  - Rotation around x, y and z axis
  - Translation along x, y and z axis
- Ideally each plot would look like the one below



CEC vs MEC: 30 Degree Tilt – Inplane and Outplane Motion



CEC vs MEC: 30 Degree Tilt – Inplane and Outplane Motion



Conclusion & Outlook

- If the symmetry plane is oblique to the trajectory plane we can obtain a checkboard pattern of epipolar lines
- Inplane parameters can then be detected
- Trajectory is Tuy complete

- How view dependent is the metric?
- Is it applicable to other problems?

Thank you for your attention!