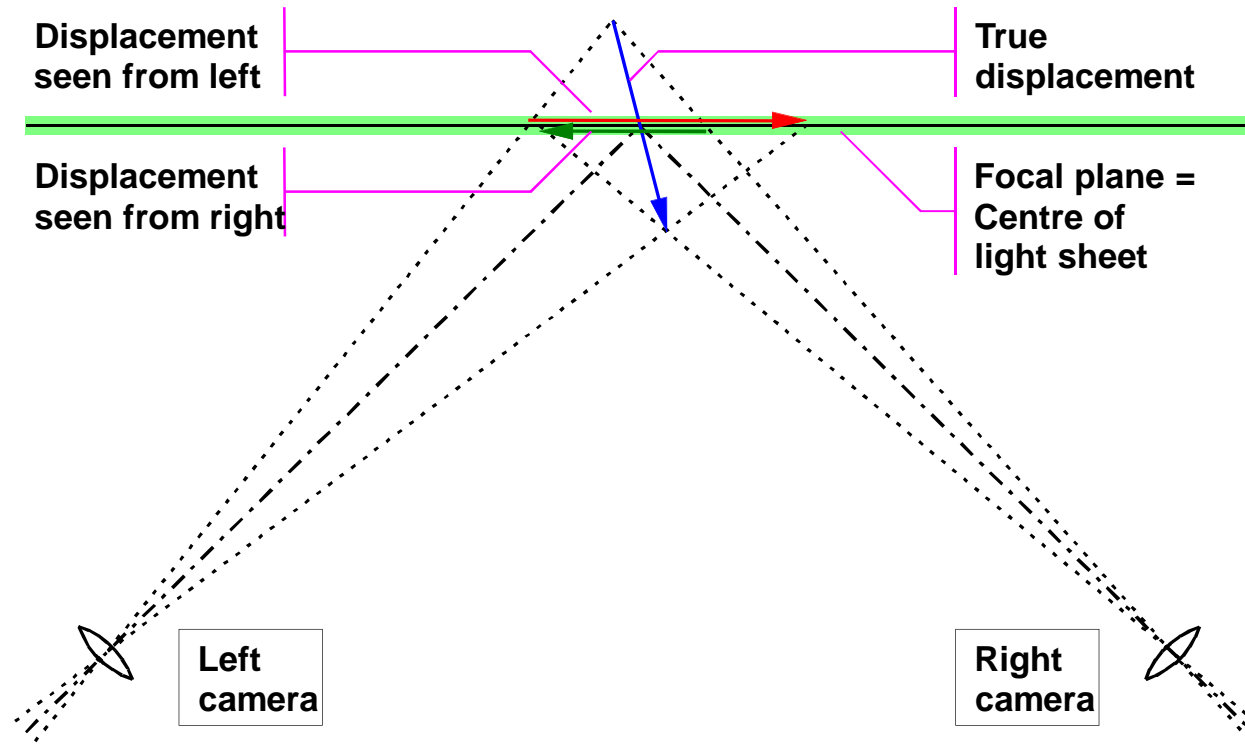


Stereoscopic PIV

Stereoscopic PIV

- Theory of stereoscopic PIV
- Dantec Dynamics' stereoscopic PIV software
- Application example:
Stereoscopic PIV in an automotive wind tunnel
(used as example throughout the slide show)

Fundamentals of Stereo Vision



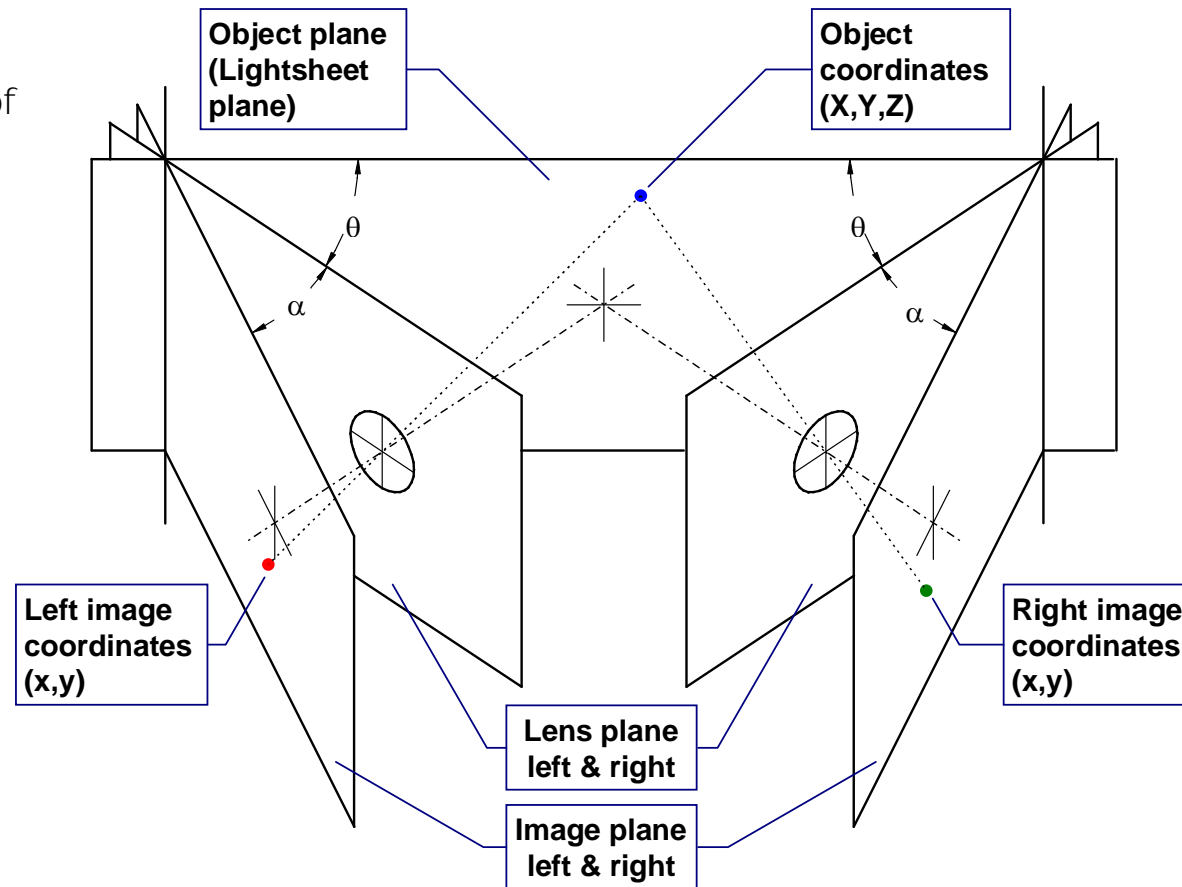
True 3D displacement ($\Delta X, \Delta Y, \Delta Z$) is estimated from a pair of 2D displacements ($\Delta x, \Delta y$) as seen from left and right camera respectively

Stereo Recording Geometry

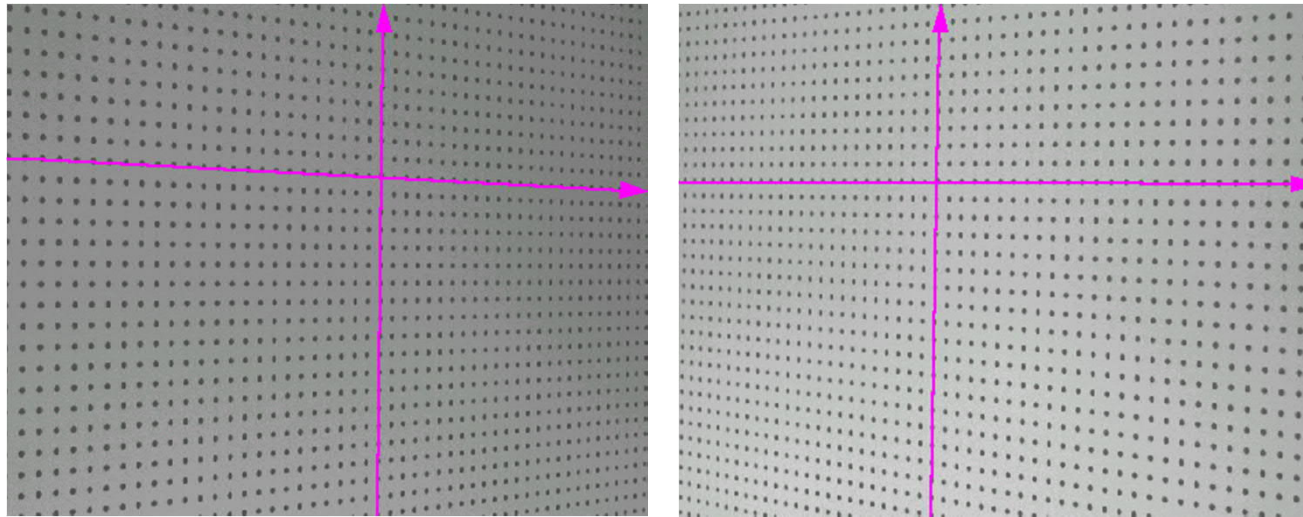
Focusing an off-axis camera requires tilting of the camera sensor (Scheimpflug condition)

Stereoscopic evaluation requires a numerical model, describing how objects in space are mapped onto the sensor of each camera

Parameters for the numerical model are determined through camera calibration



Camera Calibration



Images of a calibration target are recorded.

The target contains calibration markers in known positions.

Comparing known marker positions with corresponding marker positions on each camera image, model parameters are adjusted to give the best possible fit.

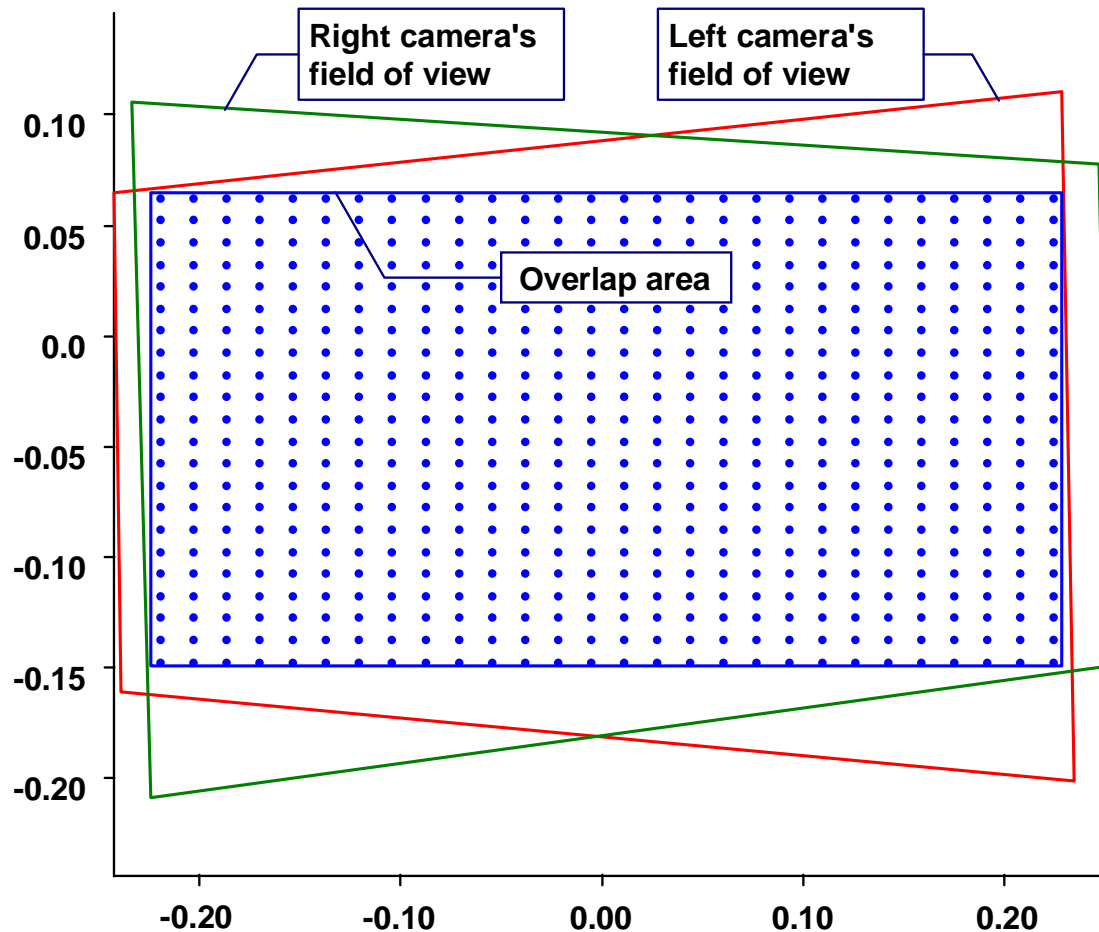
Overlapping Fields of View

Stereoscopic evaluation is possible only within the area covered by both cameras.

Due to perspective distortion each camera covers a trapezoidal region of the light sheet.

Careful alignment is required to maximize the overlap area.

Interrogation grid is chosen to match the spatial resolution.



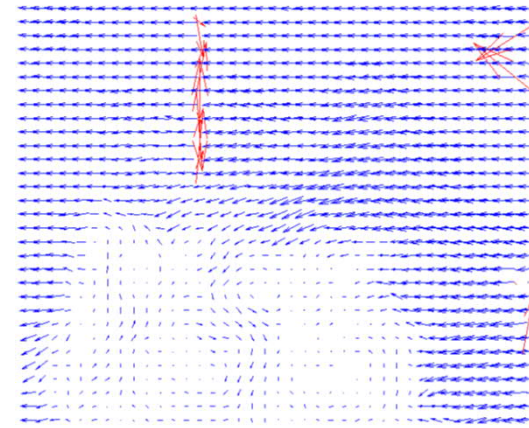
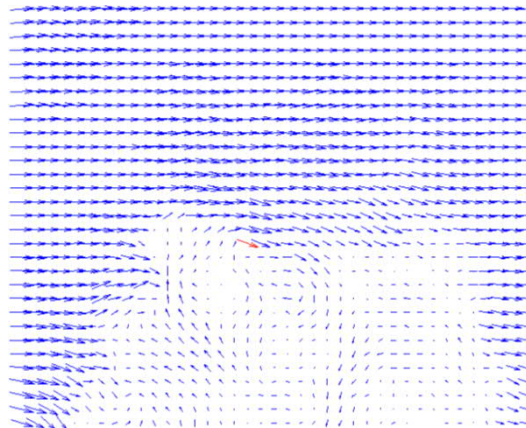
Left / Right 2D Vector Maps

Left & Right camera images are recorded simultaneously.

Conventional PIV processing produces 2D vector maps representing the flow field as seen from left and right.

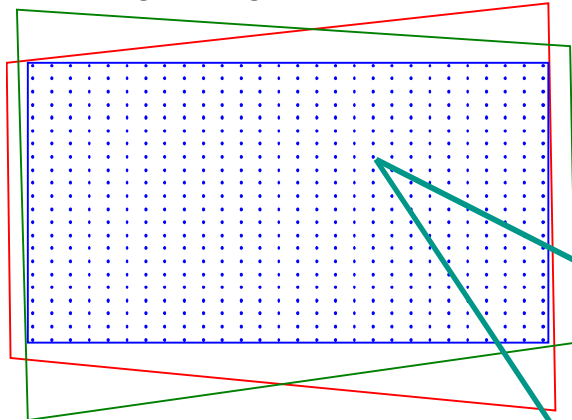
The vector maps are re-sampled in points corresponding to the interrogation grid.

Combining left / right results, all three velocity components are calculated.

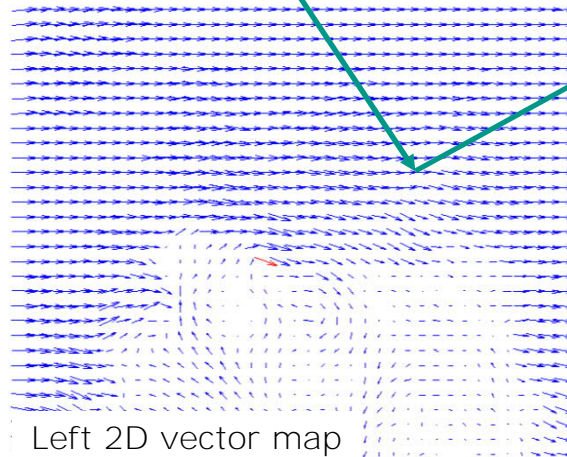
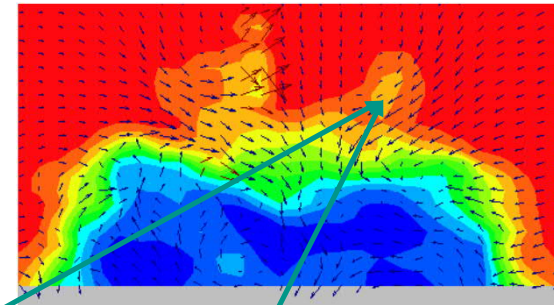


Stereoscopic Reconstruction

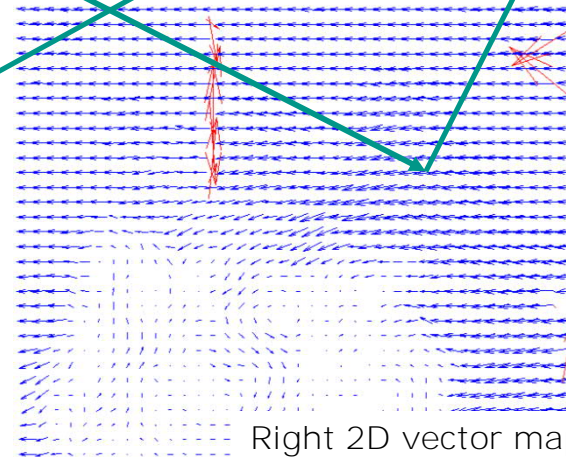
Overlap area with
interrogation grid



Resulting 3D vector map



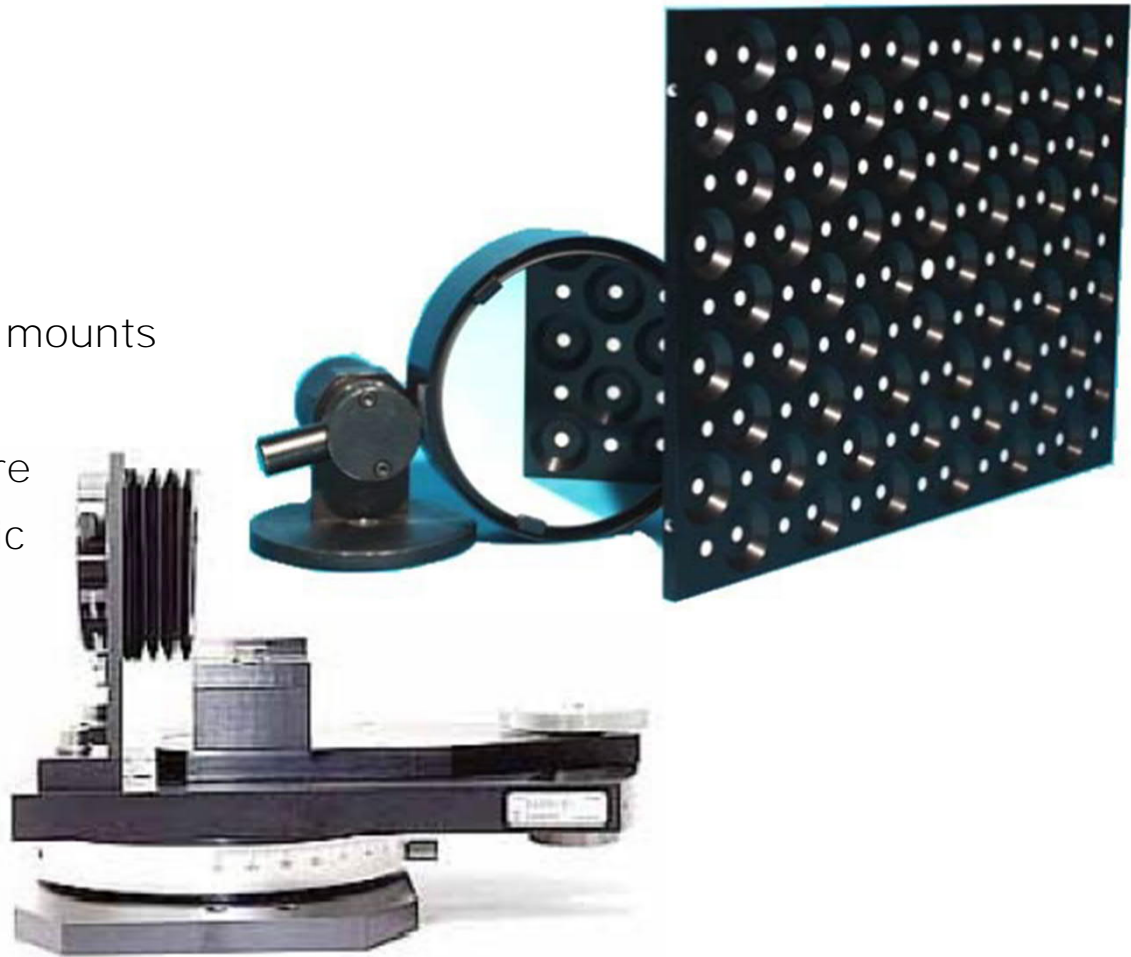
Left 2D vector map



Right 2D vector map

Dantec Dynamics Stereoscopic PIV System Components

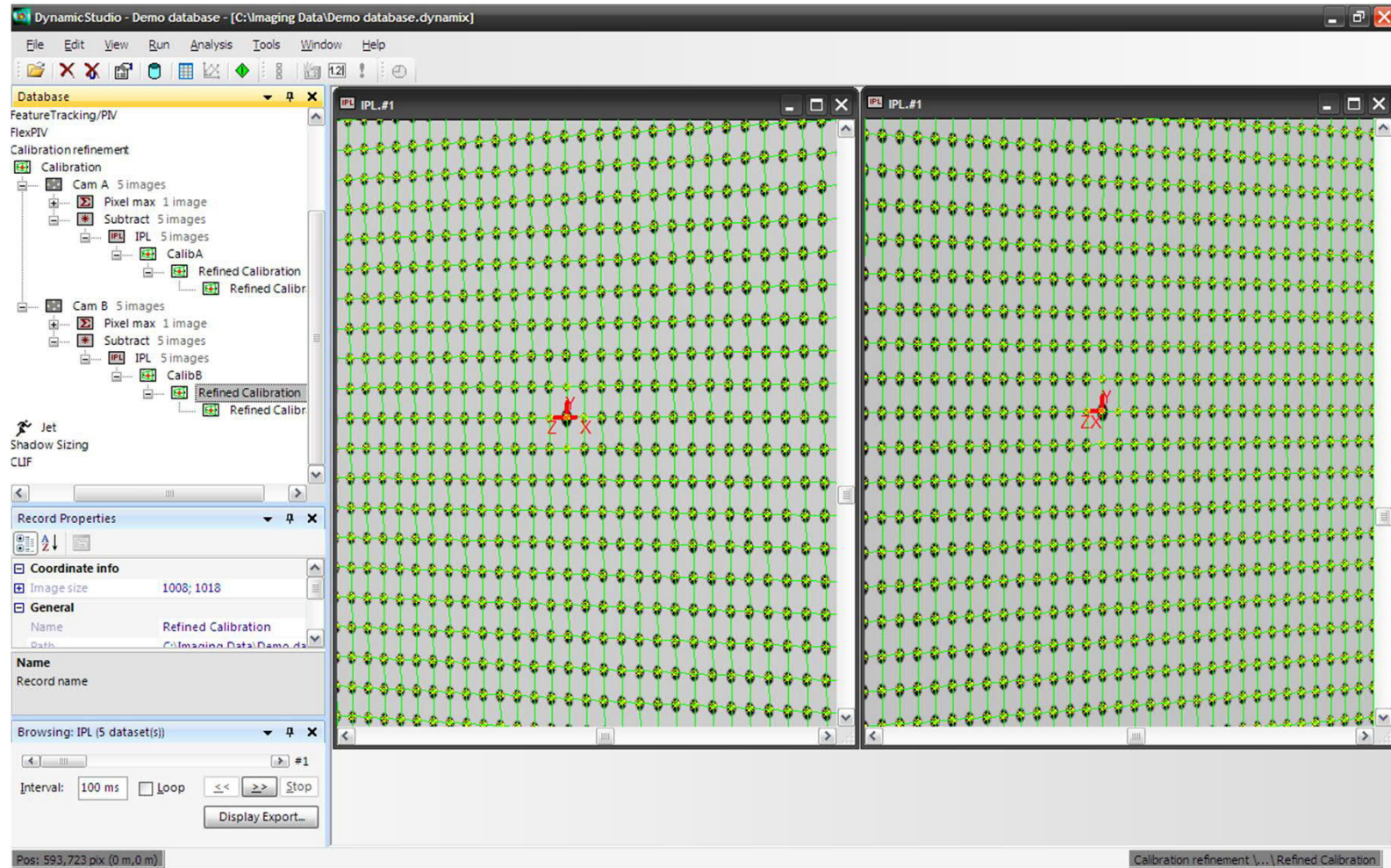
- Seeding
- PIV-Laser (Double-cavity Nd:YAG)
- Light guiding arm & Lightsheet optics
- 2 cameras on Scheimpflug mounts
- Calibration target
- DynamicStudio PIV software
- DynamicStudio stereoscopic PIV Add-on



Recipe for a Stereoscopic PIV Experiment

- Carefully align the light sheet with the calibration target
- Record calibration images in the desired measuring position using both cameras (Target defines the co-ordinate system!)
- Perform camera calibration based on the calibration images
- Record particle images with the laser turned on
- Perform a Calibration Refinement to correct for the residual misalignment between calibration target and laser light sheet
- Record particle images from your flow using both cameras
- Calculate 2D-PIV vector maps
- Calculate 3D vectors based on the two 2D PIV vector maps and the (refined) camera calibration

Camera Calibration



Calibration Refinement

DynamicStudio - Demo database - [C:\Imaging Data\Demo database.dynamix]

File Edit View Run Analysis Tools Window Help

Database

- FeatureTracking/PV
- FlexPIV
- Calibration.refinement
 - Calibration
 - Cam A 5 images
 - Pixel max 1 image
 - Subtract 5 images
 - IPL 5 images
 - CalibA
 - Refined Calibra
 - Refined C
 - IMF:DLT
 - Cam B 5 images
 - Pixel max 1 image
 - Subtract 5 images
 - IPL 5 images
 - CalibB
 - Refined Calibra
 - Refined C
 - IMF:DLT
 - Jet
 - Cam A 10 images
 - Adaptive Correlation 10 vector n
 - 3D Vector Processing 10 v
 - Vector Statistics 1 ve
 - Cam B 10 images
 - Adaptive Correlation 10 vector n

Record Properties

Name IMF:DLT

Name Record name

Dataset Browser

Interval: 1 ms Loop << >> Stop

Display Export...

Pos: 666,1017 pix (666 mm, 1,017 m); Pixel=255

Calibration.refinement \...\ IMF:DLT.

Calibration Refinement

Description (of Calibration Refinement):
Calibration Refinement, improves the accuracy of an existing stereo calibration by using particle images acquired simultaneously from both cameras.

Settings

Interrogation Area Size: 256x256 Frame: 1

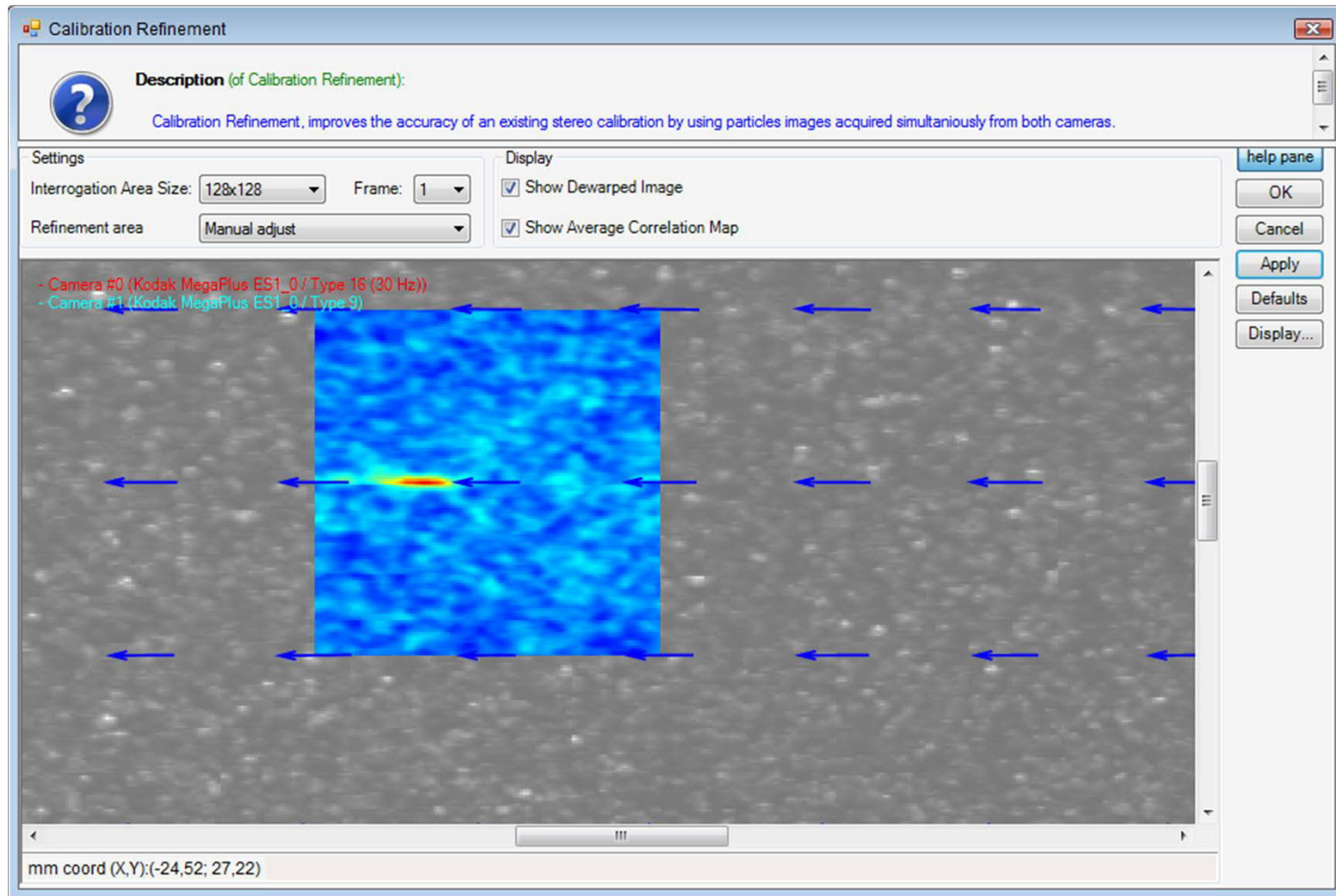
Refinement area: Common Calibration area

help pane
OK
Cancel
Apply
Defaults
Display...

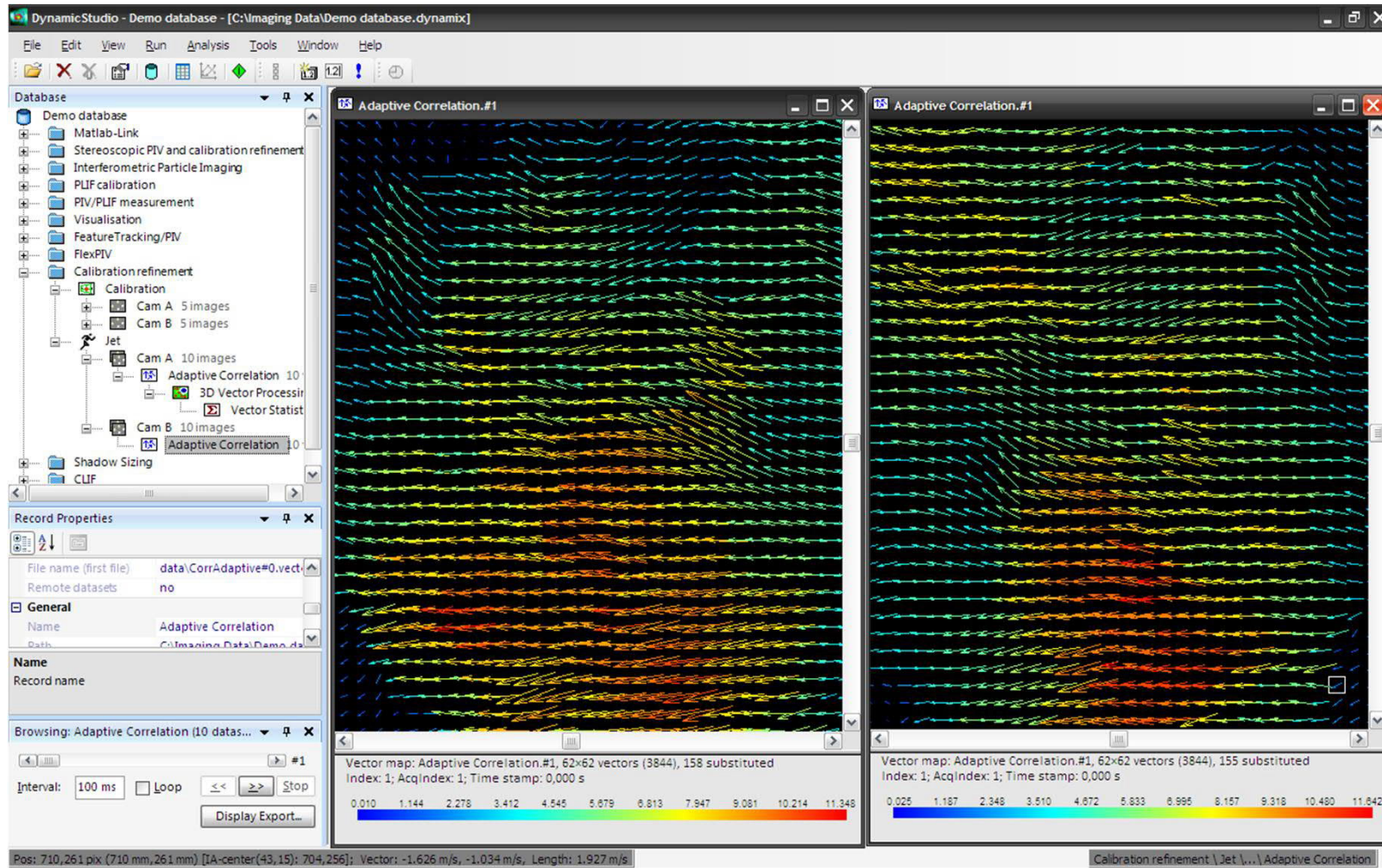
- Camera #0 (Kodak MegaPlus ES1_07 Type 16 (30 Hz))
- Camera #1 (Kodak MegaPlus ES1_0 / Type 9)

mm coord (X,Y):(167,89; 109,89)

Calibration Refinement



Calculating 2D Vector Maps



Stereoscopic Evaluation & Statistics

