TEMA软件技术培训

软件介绍

公司介绍
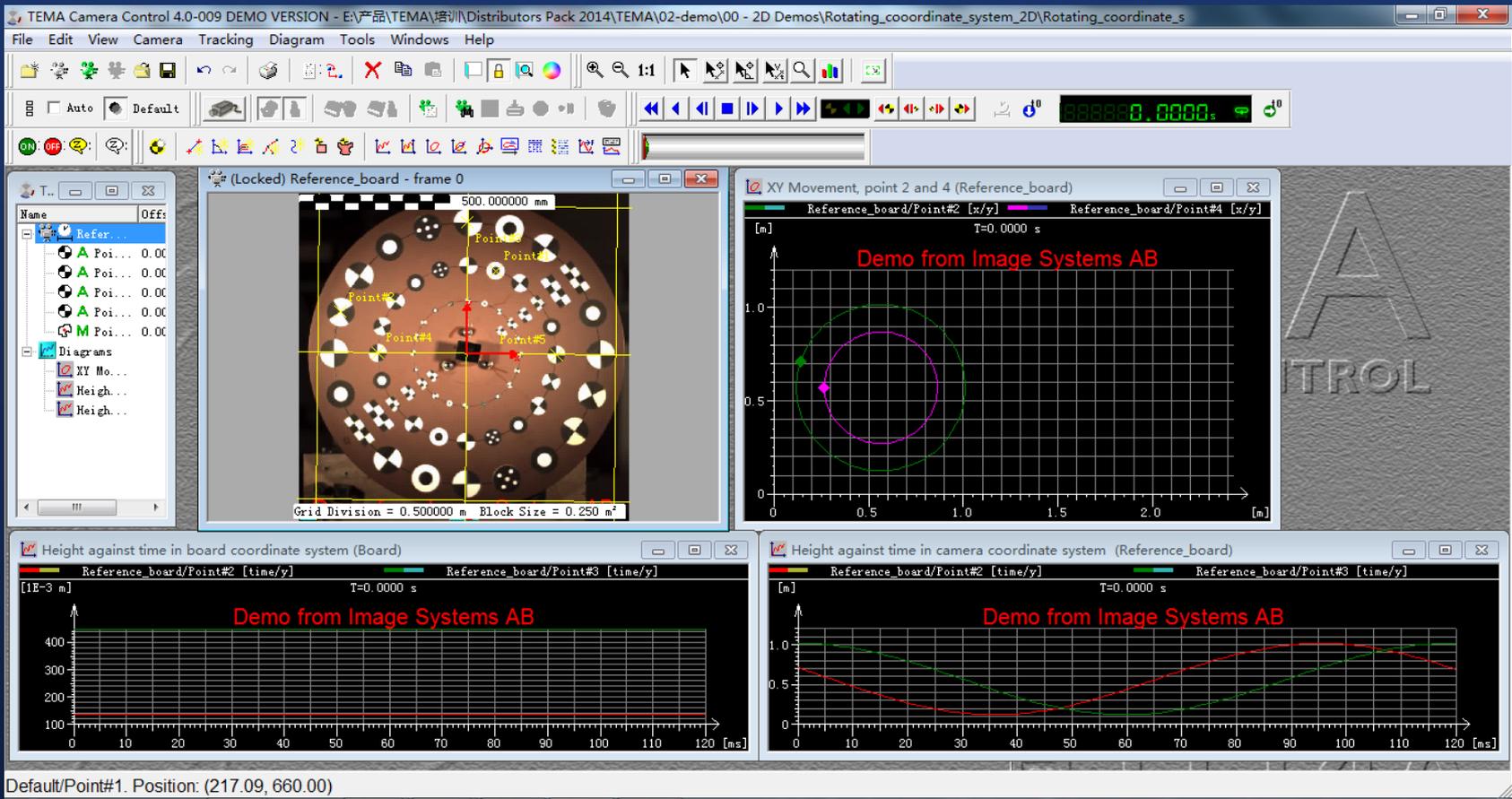
- 瑞典Image Systems AB公司，成立于1985年
- 致力于高级运动分析领域32年，运动分析产品和解决方案的最完全供应商
- **TEMA**，TrackEye, and Golden Eye Reconnaissance

# TEMA是什么

- 世界领导地位的高级运动分析软件
- Off-the-Shelf

TEMA是什么

- 多版本、多功能模块可选

|	Part Number	Name	Description	LITE	MOTION	AUTOMOTIVE	DEFENCE
TRACKING ALGORITHMS	TEMACORTRK	Correlation tracker	Looks in each successive image for the area contained within the correlation template. This method is the default and is applicable to most cases.	•	•	•	•
	TEMAQUADTRK	Quad tracker	The quadrant marker, or "bow tie tracker", is significantly more accurate than the Correlation Tracker but requires quadrant markers / stickers to be used.	•	•	•	•
	TEMACIRTRK	Circular tracker	Tracks circular objects	○	•	•	○
	TEMAADVCIRTRK	Advanced Circle tracker	The advanced circular tracker can track circular objects even if part of the object is obscured.	○	•	•	○
	TEMACOGTRK	Centre of Gravity tracker	Tracks the outline of a body that contrasts with background on a greyscale level. The shape can change during tracking and the tracker will adapt accordingly. The tracking result is the centre of gravity of the object.	○	•	•	•
	TEMACONSTRK	Constant tracker	Specifies a fixed pixel in the image that can subsequently be used as a reference point for coordinate systems or distance measurements.	N/A	•	•	•
	TEMAINTRSTRK	Intersection tracker	Detects and tracks intersections between the straight line fittings within a specified search area.	N/A	•	•	•
	TEMACORNRTRK	Corner contour tracker	Detects edges and tracks corners along these edges. One corner will be selected as the track point.	N/A	•	•	•
	TEMADICTRK	DIC tracker	Digital image correlation tracker, surface deformation and strain analysis. Highly recommended to use the TEMAANGMP.	N/A	○	○	○
	TEMAOUTLTRK	Outline and advanced outline tracker	TEMA Outline / Airbag Tracker – Tracking algorithms for outlines and shapes. Commonly used for airbag analysis. The option includes the following tracking algorithms: Basic and Advanced tracker. The Advanced tracker is for image sequences with background noise / distraction.	N/A	○	○	○
	TEMAVPTRK	Virtual point tracker	Virtual points – option used to track virtual point(s) whose position is related to other tracked points in the image sequence. Useful for tracking objects which are moving outside the field of view (FOV) of the camera, or to track a hard-to-track point in the image in relation to another easier-to-track point.	○	•	•	•
	TEMAMOUSETRK	Mouse tracker	Manual tracking using a computer mouse or equivalent control peripherals. Tracking is performed by hovering above the tracked object with the mouse cursor	○	○	○	•
	TEMAMXTTRK	MXT tracker	Finds the symmetry center of the image within the search area and is applicable to MXT targets with either four or five outer white dots on a black circular background.	N/A	○	○	○
FEATURES	TEMAADD5P	5 Additional Points (10 in total)	5 additional points gives a total of 10 tracked points	○	•	•	•
	TEMAUNLMTDP	Unlimeted number of points	unlimited number of tracked points	○	•	•	•
	TEMAEXLUD	Exclude/Include areas	Ability to exclude/include certain areas of the image so that the tracking algorithm concentrate it's search to a specific area.	○	•	•	•
	TEMAPONTFUNC	Point function	Includes the following features: **Suggest reference point position**: This function predicts and suggests positions of reference points **Autofind similar point**: Functionality for automatic detection of tracking points in images	○	•	•	•

TEMA是什么

- 应用领域广泛
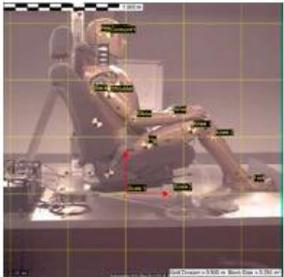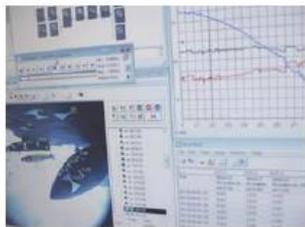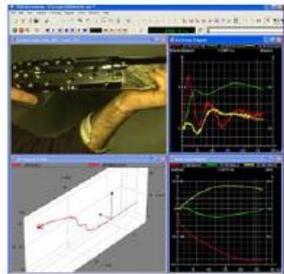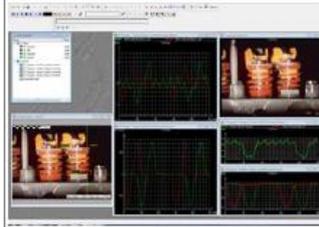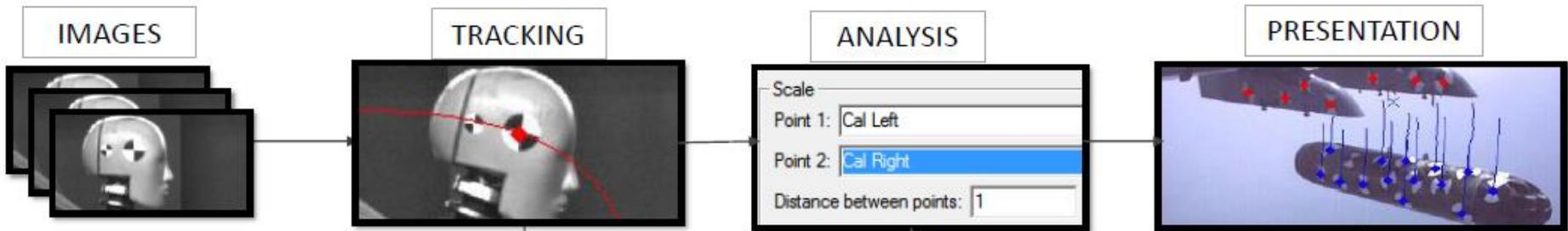
TEMA跟踪流程

- 已知图像序列的时间信息和参考点，可得出跟踪点的位移、速度、加速度、相对角度等信息
- 跟踪精度最高达0.1个像素

图像导入   标记点跟踪   运动分析   跟踪结果展示
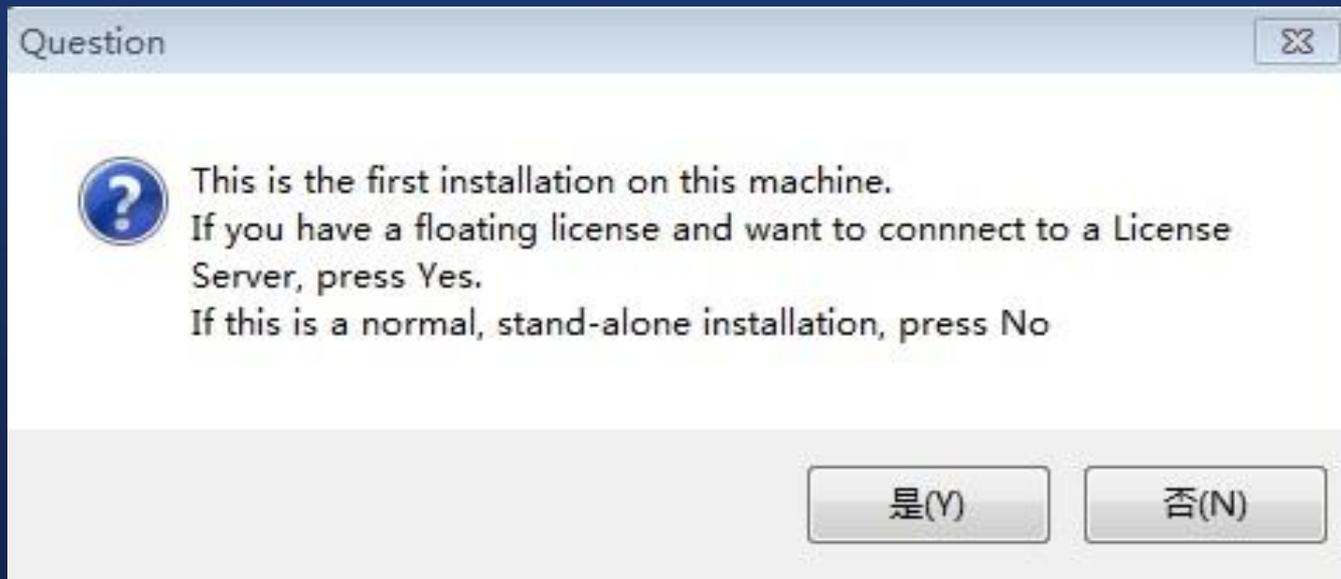
本培训针对功能模块

- TEMA Motion
- 镜头畸变校正——标定板使用
- TEMA 3D

软件安装

注意事项
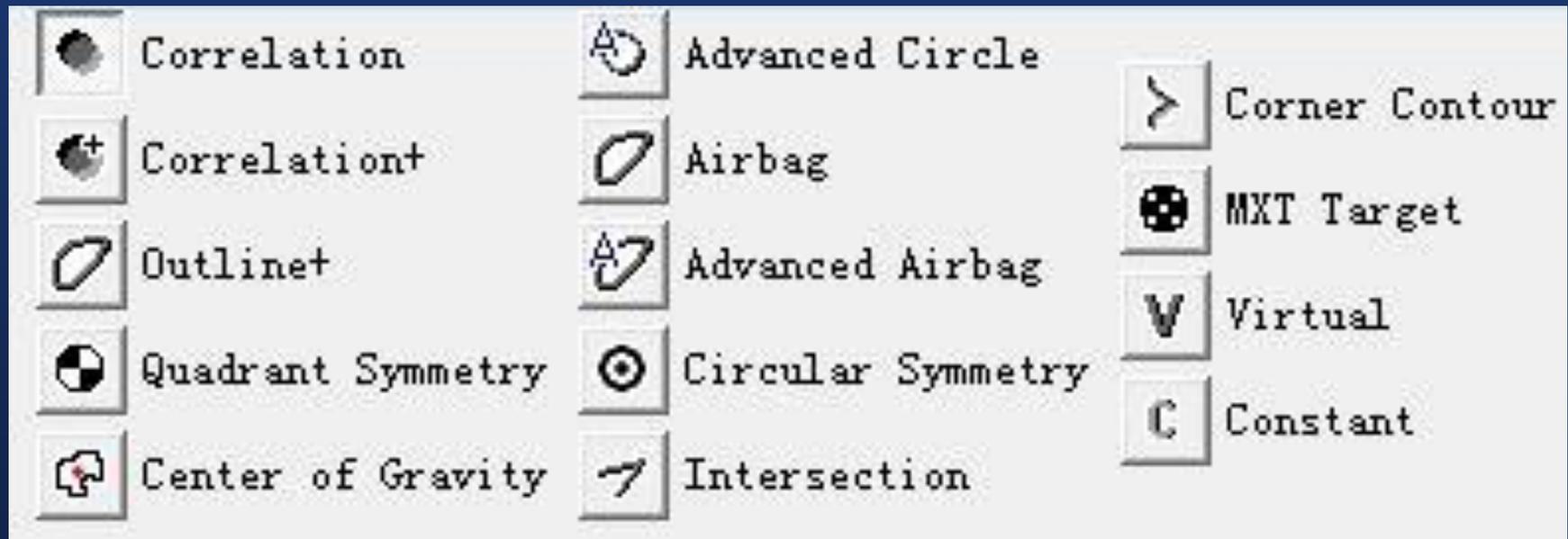
- 软件安装过程中需确保加密狗 **不在** 计算机上
- 若此版本非Floating License，需点"否"

Question

This is the first installation on this machine.
If you have a floating license and want to connnect to a License Server, press Yes.
If this is a normal, stand-alone installation, press No

是(Y)   否(N)

- 需正确输入加密狗上串码，区分大小写，注意空格

跟踪算法介绍

TEMA跟踪算法总览

- 几乎可以跟踪任何类型的目标物

相关性算法

Correlation

- 应用最广泛
- 需要被跟踪点与背景有一定对比度
- 跟踪精度为0.5 pixels
- 易受图像旋转和亮度变化影响

相关性算法

 Correlation

Template
Core Size: 3
Total Size: 10
Update Factor: 0.08
● Circle ○ Square ○ Cross

Search Area
Size   X: 35   Y: 30
☑ Reduce After 2nd Image

☐ Filter with Sobel filter

Pull point to straight path
0
None   Medium   High

Tracker Tolerance
50 %
Strict Normal Lenient

相关性算法 Correlation

- Sobel Filter—索贝尔算子
- 离散型差分算子，主要用作边缘检测
- 提高跟踪效率和跟踪准确性

滤波前

滤波后

相关性算法 Correlation
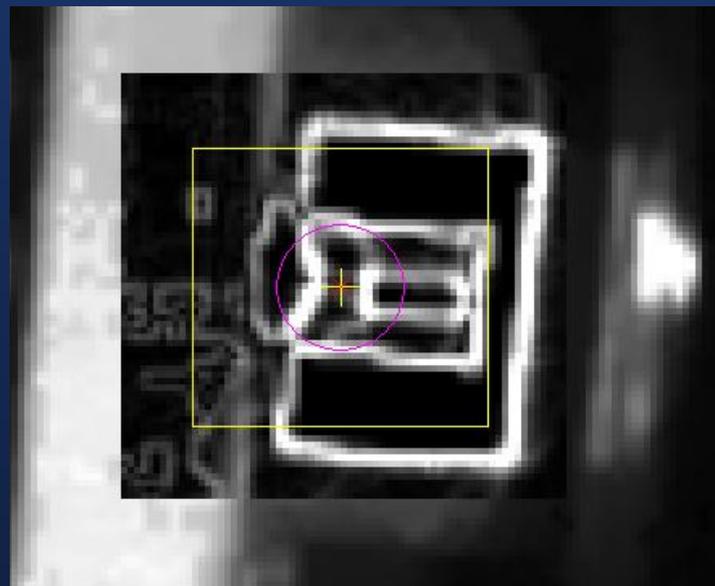
- **Pull point to straight path**
- **当搜索区域较大时，可能出现多个与目标跟踪点相类似的匹配点**
- **数值越高，跟踪算法会选择距离上一图像该目标点所在位置越近的匹配点**

高级相关性算法 Correlation+
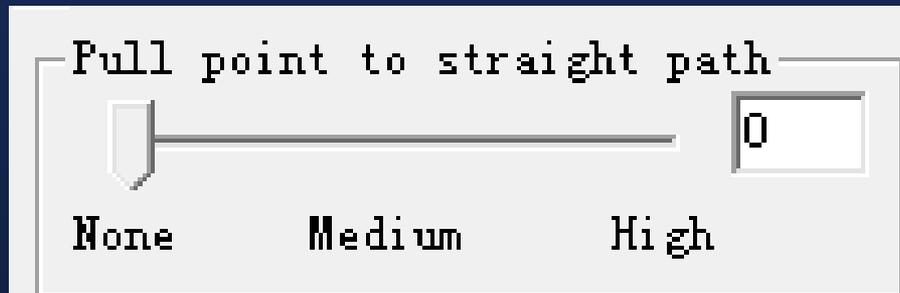
- 由DIC算法延伸
- 跟踪精度0.01个像素
- 受图像亮度改变影响较小
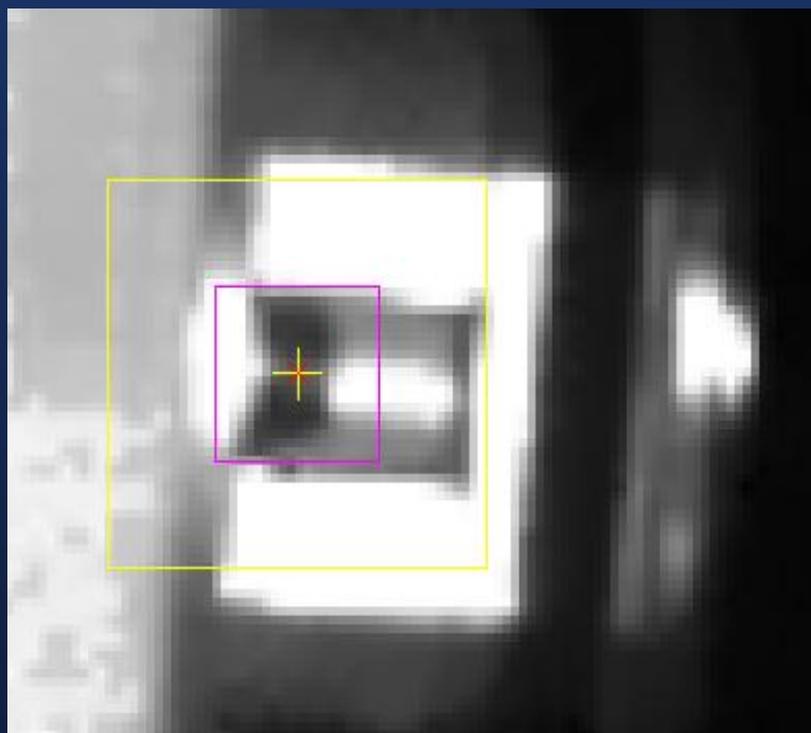
- 需要贴四象限标记点
- 锁定四象限的中心
- 不受旋转和亮度变化影响
- 跟踪精度为0.1 pixels

四象限算法 Quadrant Symmetry

- 模板略小于标记点
- 根据图像帧率调整搜索区域
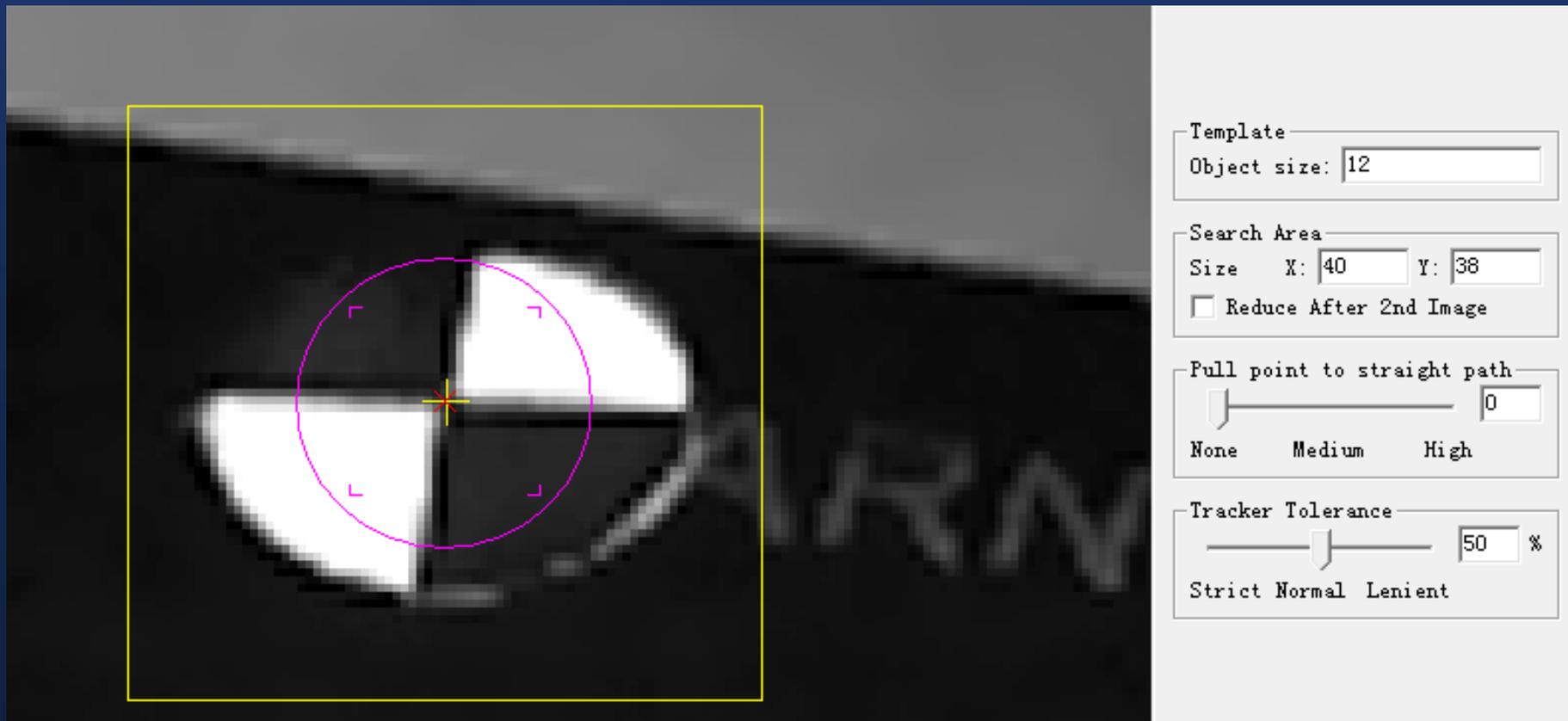
重心算法 Center of Gravity

- 适于跟踪与背景对比度较好的不规则形状
- 自动定义被跟踪区域及其重心
- 跟踪精度0.2 pixels

常量算法　C Constant

- 跟踪不动的点
- 无额外设置
- 进行测量时可用于跟踪标定点

虚拟点跟踪 ⊻ Virtual

- 虚拟点虚拟轮廓跟踪
- 适于跟踪刚体运动中被遮挡的点
- 可根据虚拟点与刚性物体点群的关系跟踪该虚拟点和轮廓
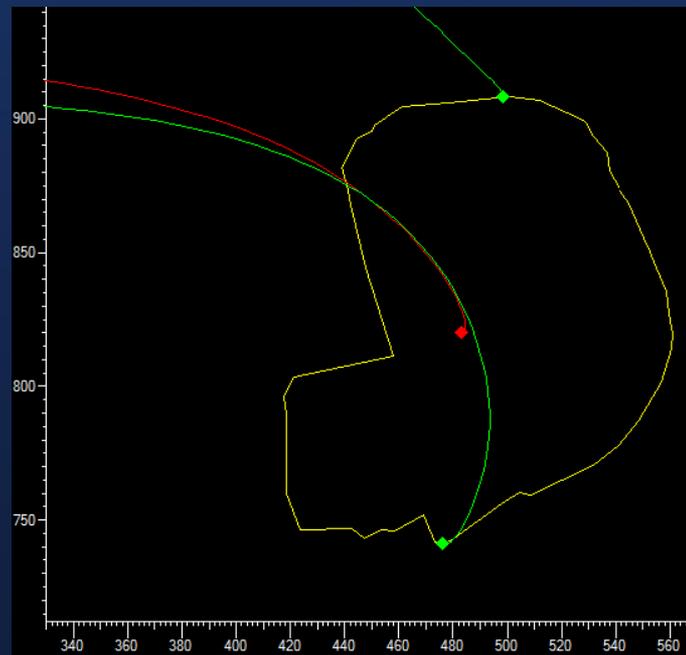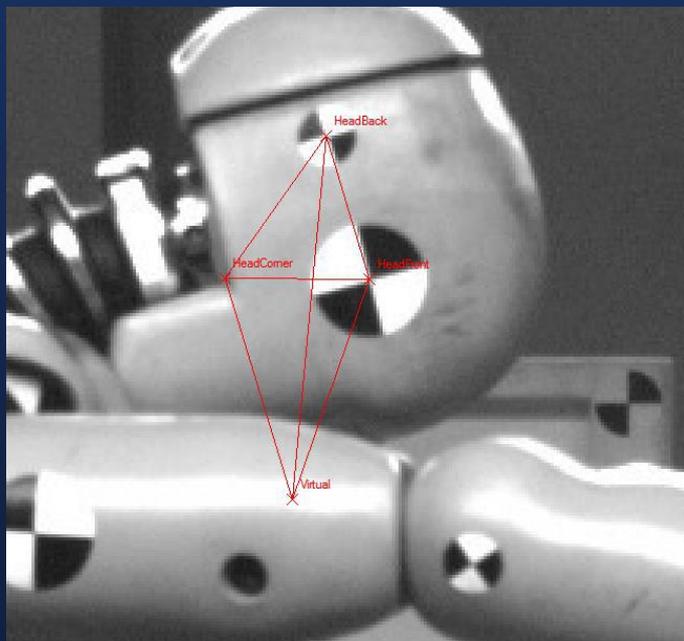
虚拟点跟踪

- 刚性物体
- 设置点群
- 至少2个参考点

Demo from Image Systems AB
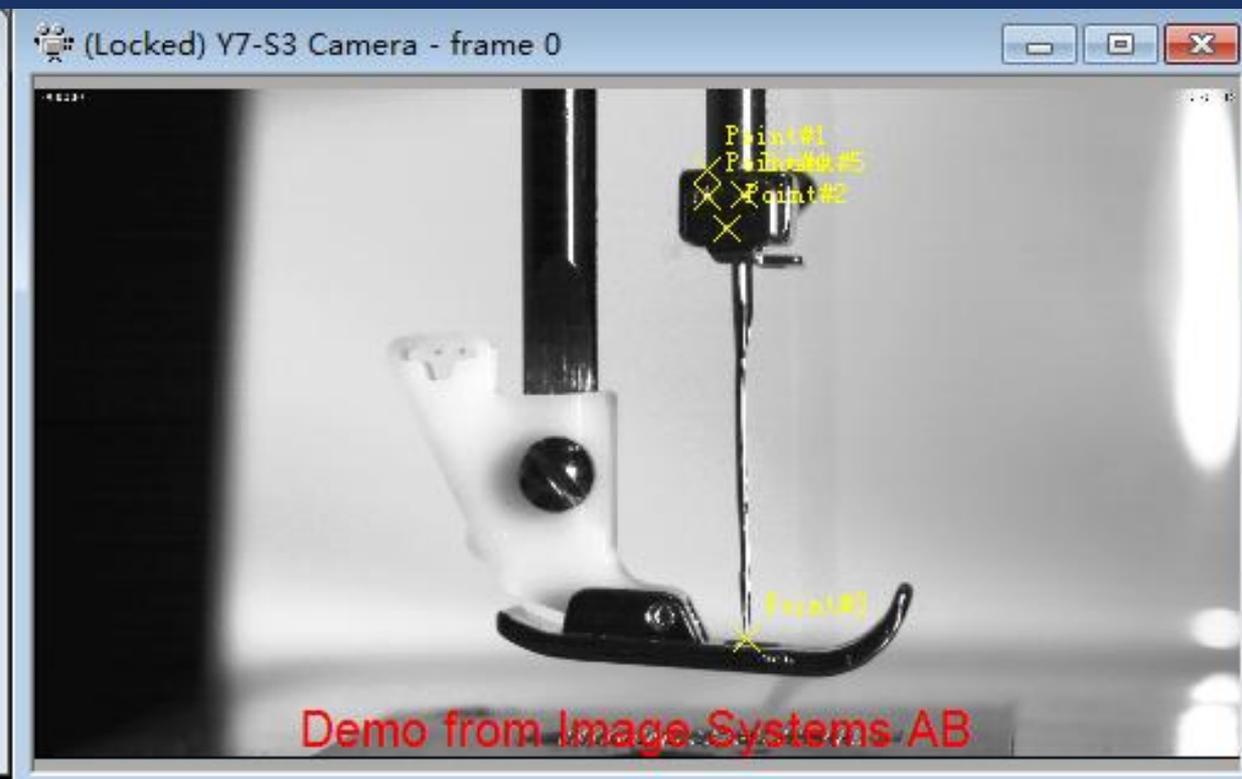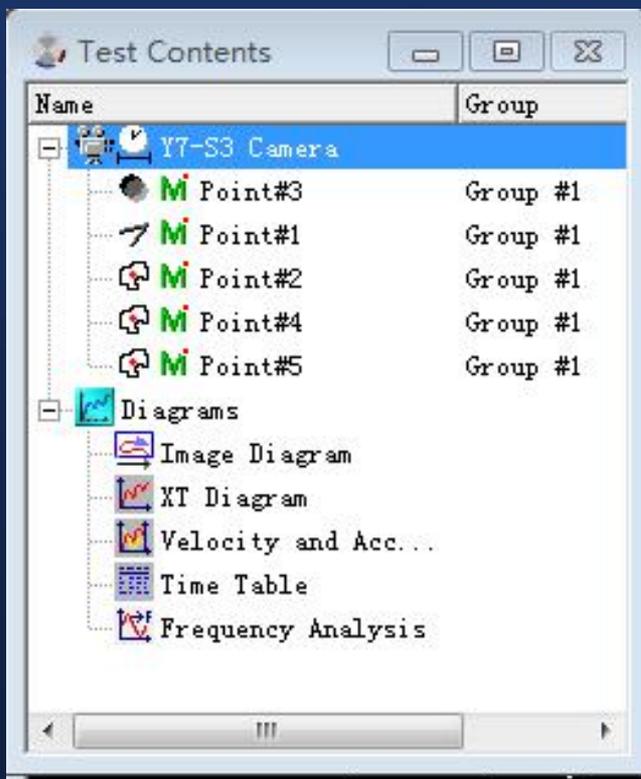
外轮廓算法

- 外轮廓算法
- 适于变形物体

- 高级外轮廓算法
- 能够更准确跟踪亮度不均匀的变形物体
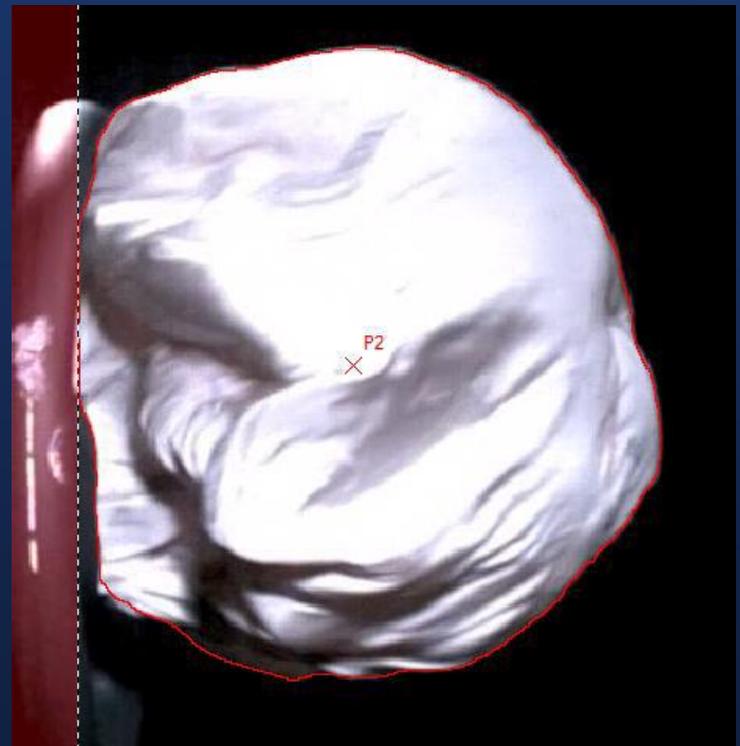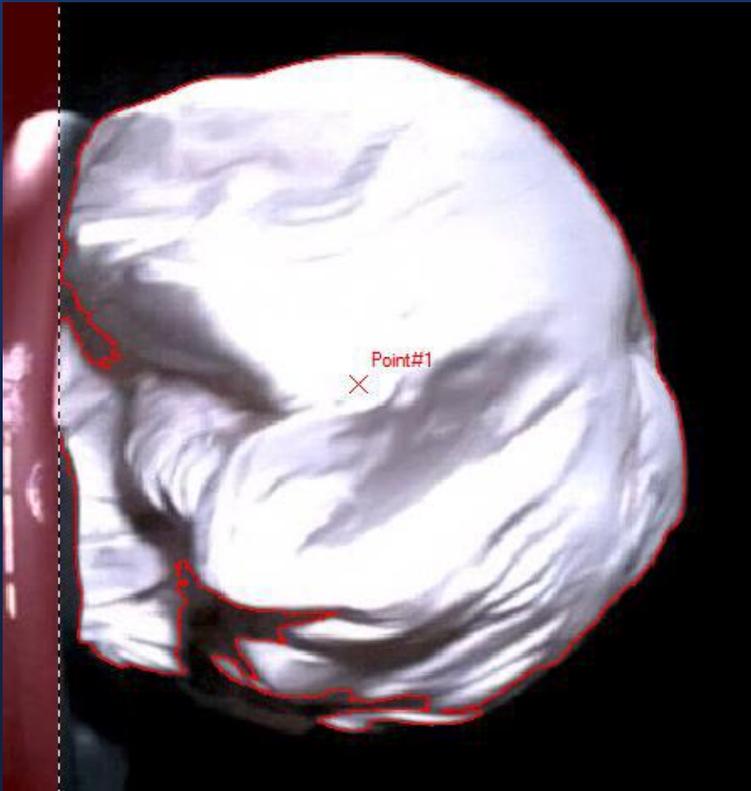
外轮廓算法

- 适于对比度较好的情况

外轮廓算法
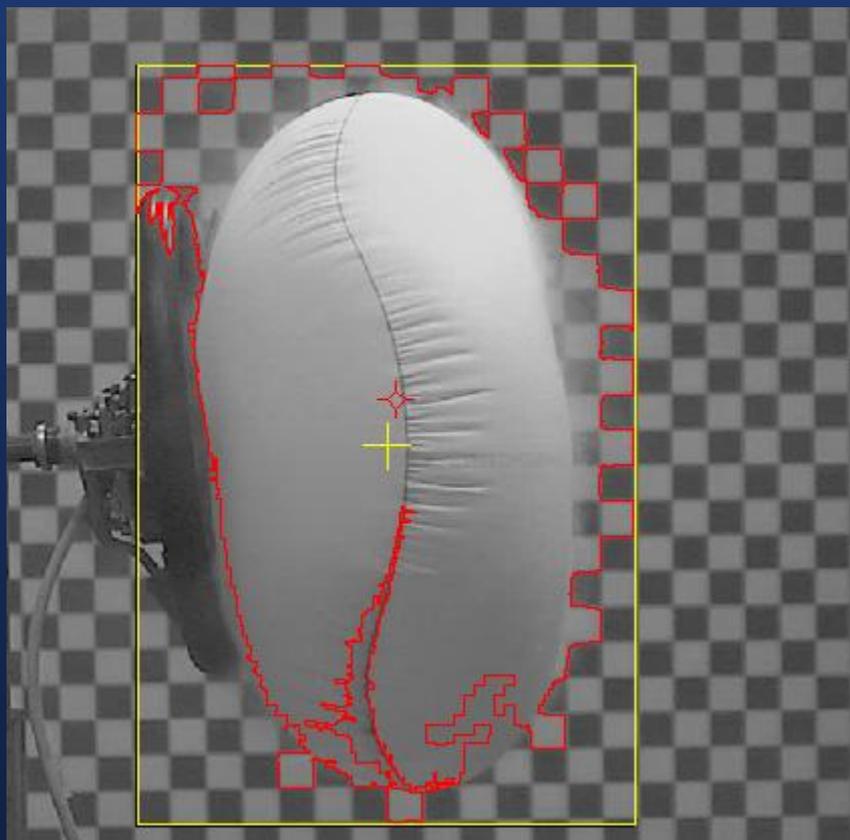
- **Accept search area edge hits：当目标物部分在搜索区域外时，区域内的部分仍被当做目标物**
- 滤除噪声算法——高斯滤波、均值滤波
- 高斯滤波：对图像进行加权平均，主要用于抑制服从正态分布的噪声
- 均值滤波：使用邻域平均法，可能破坏图像细节

高级外轮廓算法

- 手动添加边缘
- 适于背景干扰较强的情况
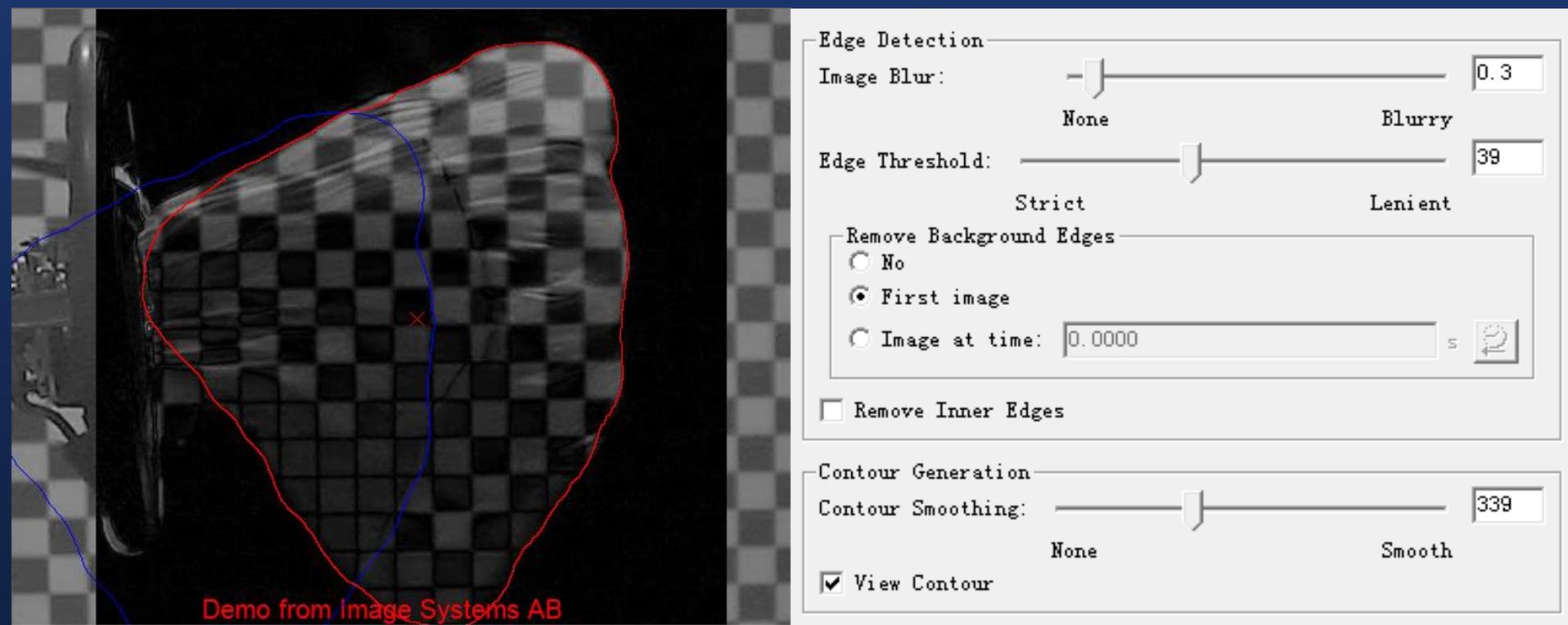
高级外轮廓算法

- Image Blur：图像运动模糊情况，值越高，在边界处所滤掉的噪声越多

- Edge Threshold：边缘阈值，边缘像素与非边缘像素的比值，用于控制被当做是边缘的像素数量；值越高，被当做边缘的像素数量越多

- Remove Background Edges：找一张图像作为参考图像，将图像序列中其他图像相比于该图像变化的部分作为目标物

外轮廓分析

- 轴向极值点
- 周长、面积、旋转体积
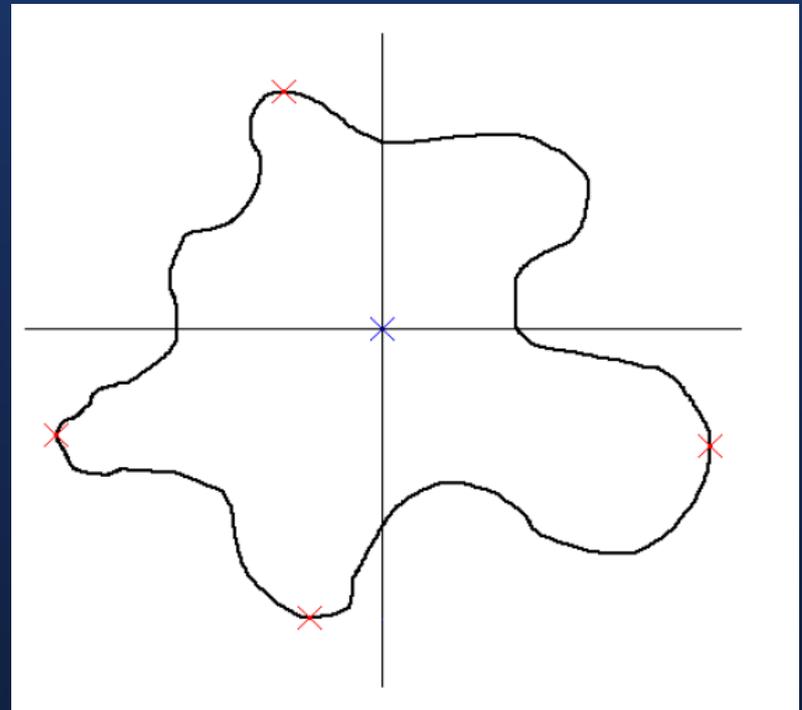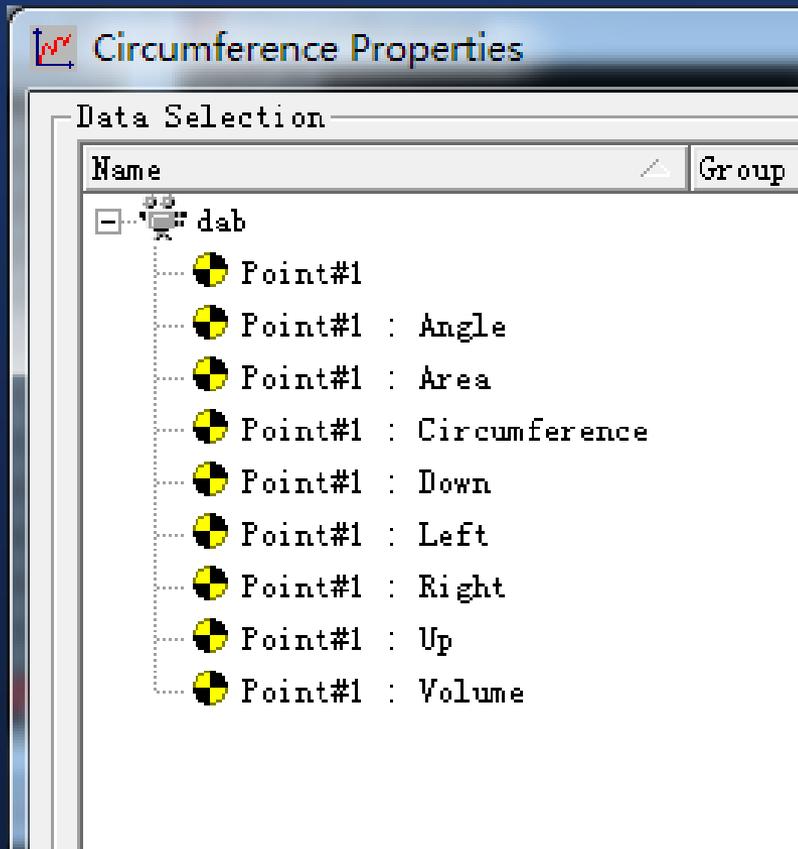
Outline+

Outline+

- 新增高级算法
- 更多图像处理功能
- 跟踪精度更高
- 更准确识别目标物轮廓，如气囊

MXT算法

- 自动寻找MXT标记点的中心
- 支持1+4/1+5 MXT 标记点
- 目前只支持32位系统
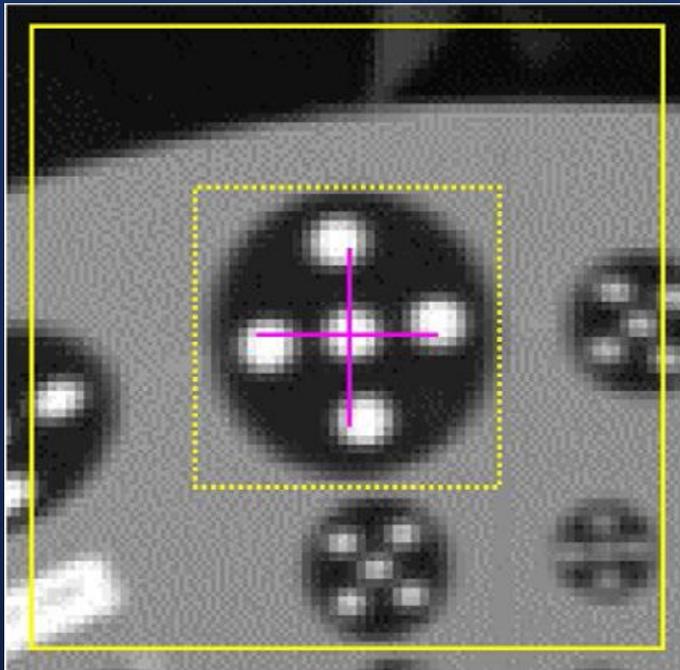
鼠标跟踪

- 首先添加相关性标记点
- A（-）和D（+）用于控制图像播放速度
- F用于控制 开始鼠标跟踪/停止鼠标跟踪
- S用于控制图像播放停止
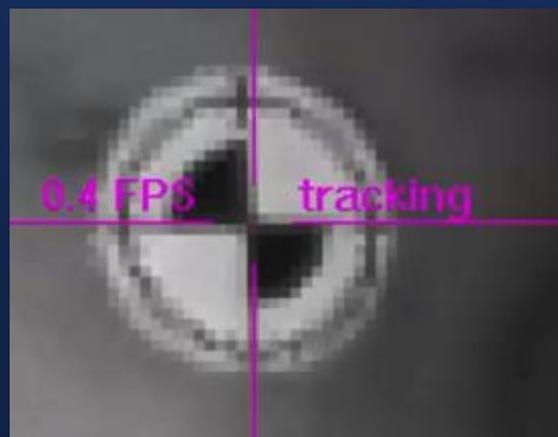
高级圆形算法

Advanced Circle
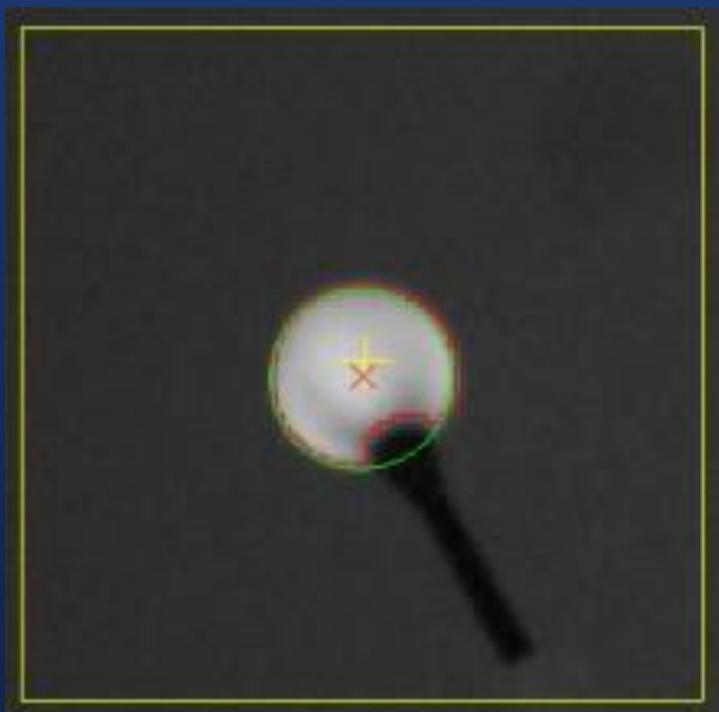
Edge Detection

Image Blur: [slider] 1

None   Blurry

Edge Threshold: [slider] 35

Strict   Lenient

Remove Background Edges

- ⦿ No
- ○ First image
- ○ Image at time: 0.0000 s ↺

☑ Remove Inner Edges

Contour Generation

Contour Smoothing: [slider] 180

☑ View Contour   None   Smooth

Radius

Current radius: 6.46919

☐ Limit radius change

Max difference/frame: 1

Accepted deviation (fraction of radius): 0.05

同心圆算法

Circular Symmetry

- 被跟踪点必须为与背景对比度较好的圆形
- 不受旋转和亮度变化的影响
- 适于跟踪同心圆、圆或者自行车轮辐条

交叉点算法 Intersection

- 自动识别
- 直线交点

拐角轮廓算法 Corner Contour

- 自动识别
- 搜索区域很重要

跟踪

跟踪流程

- 添加标记点
- 设置标记点
- 跟踪
- 测量标定
- 坐标系建立
- 生成图表
- 分析结果导出

添加标记点

- 添加被跟踪目标

跟踪点设置

- 选择合适的跟踪算法
- 设置搜索区域及模板大小
- 设置算法系数

相关性算法　　四象限算法　　重心算法

跟踪

- 播放、跟踪、时间工具栏

设置被跟踪视频的首尾时间

设置播放及自动跟踪频率

跟踪

- 标记点状态切换

- 当被跟踪点被遮挡时，可将其置于睡眠模式，其轨迹及运动分析结果将由前后运动情况计算得到
- 当一些点只在部分图像中有用后续无需再跟踪时，可将其关闭，如用于静态标定的点。

测量标定

单一平面

- 静态标定：以某时刻图像为参考
- 动态标定：以每一个当前图像为参考
- 通过实际测量，已知某两固定点之间的距离，如图中的Point 1和Point 2，输入软件中

单一平面
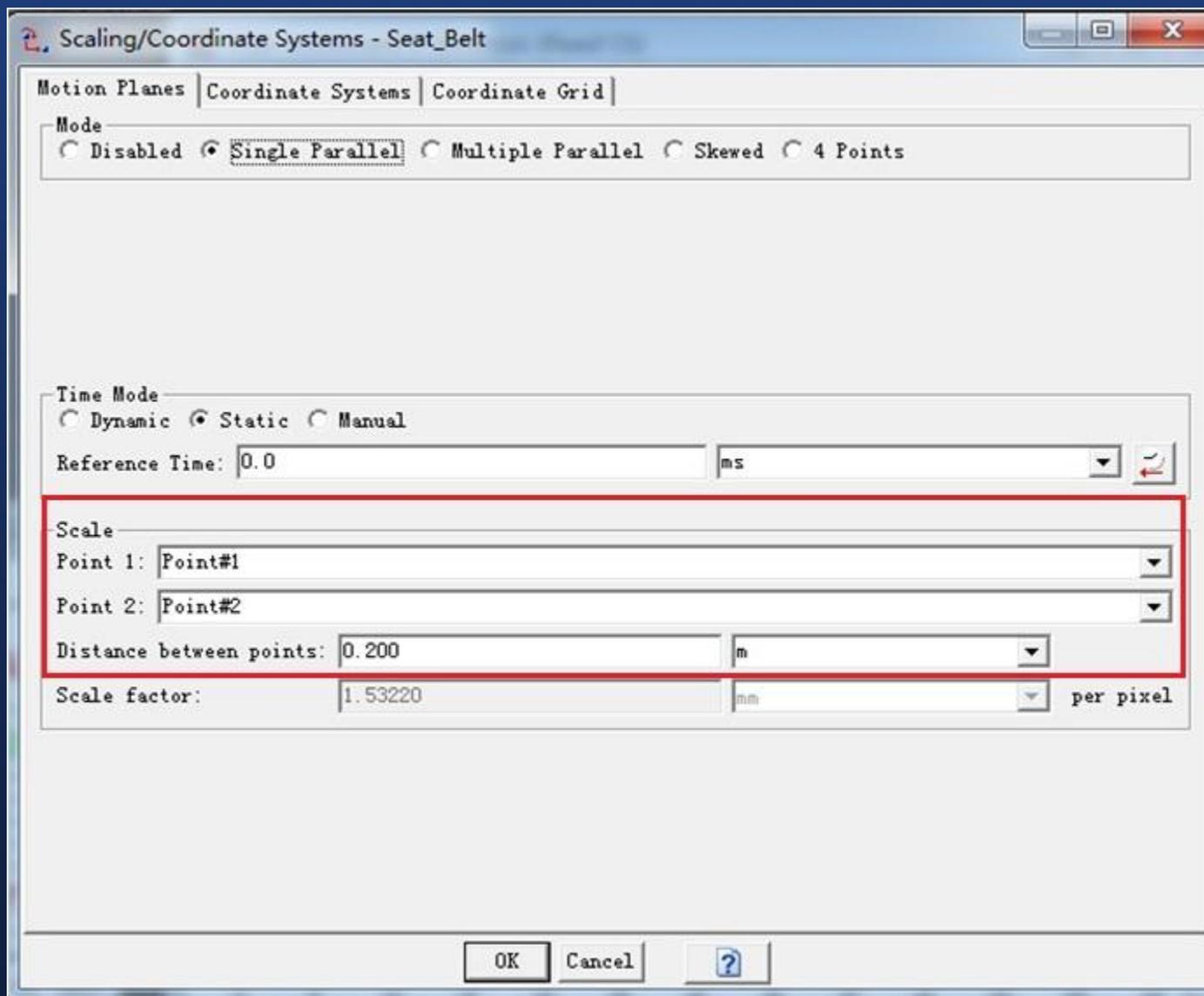
多平面

- 近大远小
- 需已知相机与参考平面的距离，目标物与参考平面距离

Scale factor: 100 px = 4 m
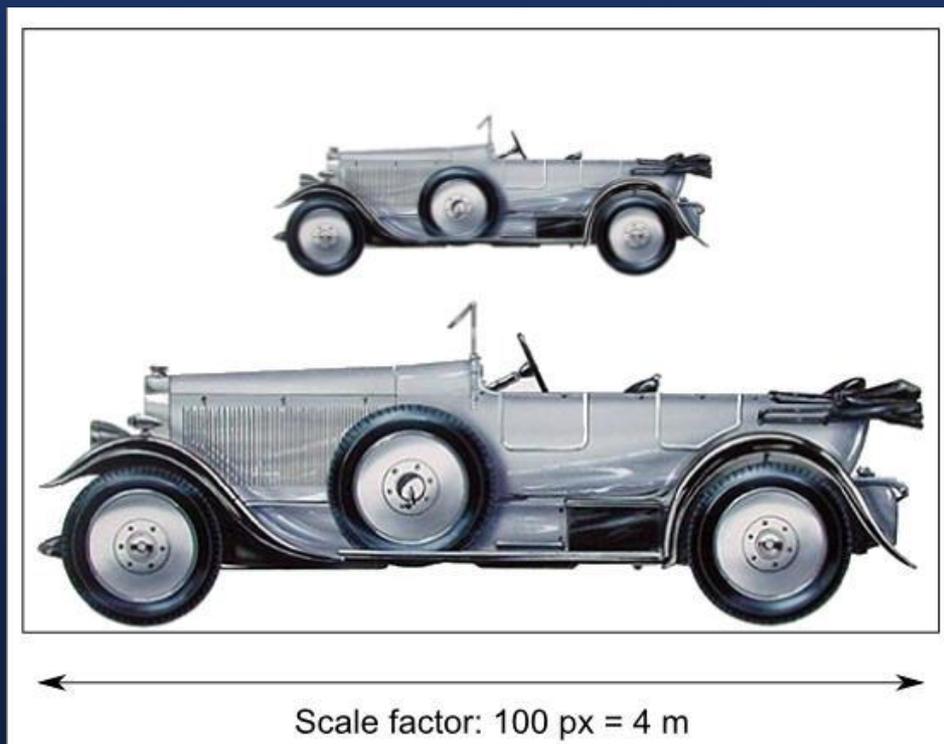
多平面
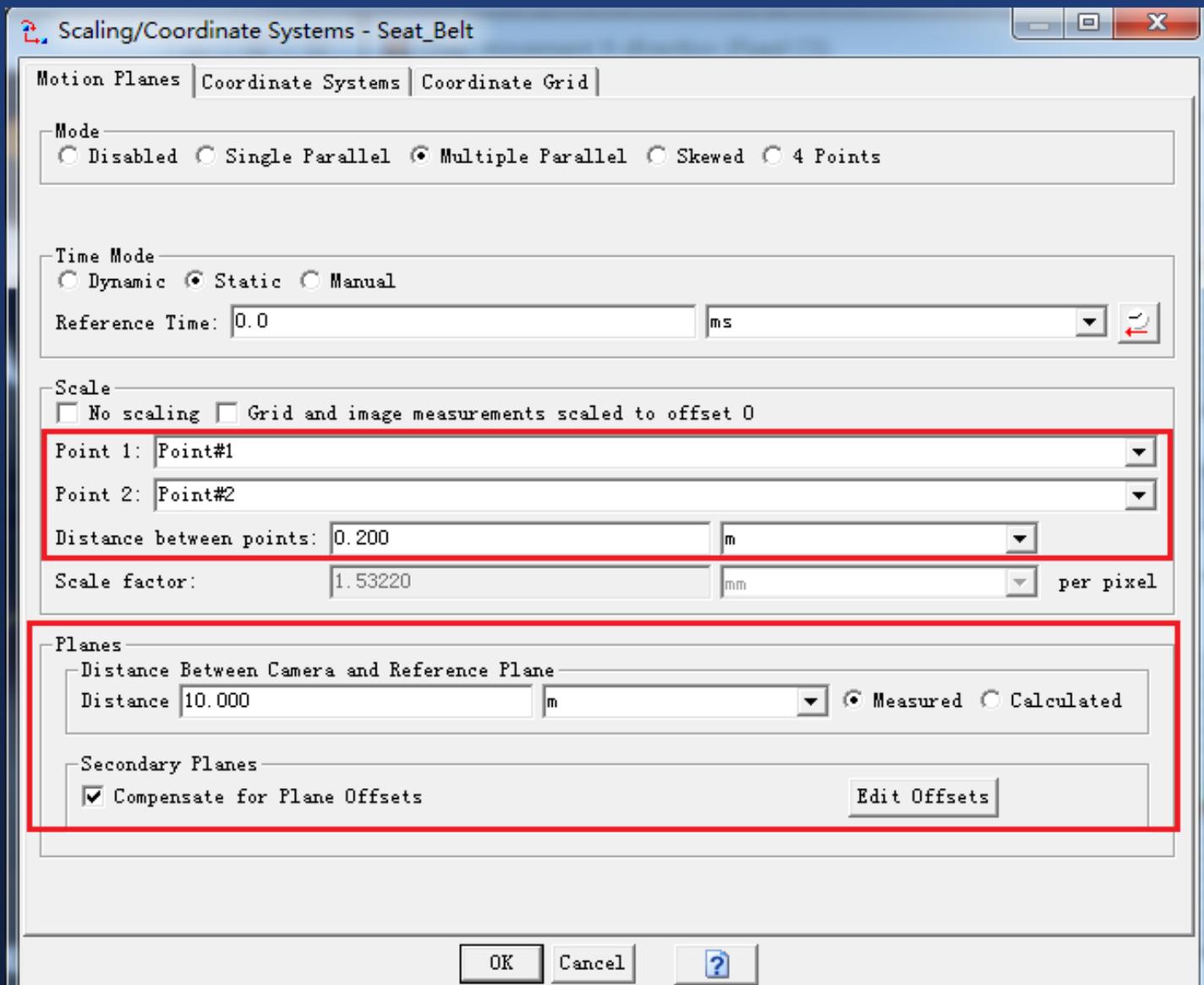
2.5D

- 定义：2.5D是指相机与被测物运动平面有一个固定的夹角，该夹角角度任意但不是直角
- 近大远小
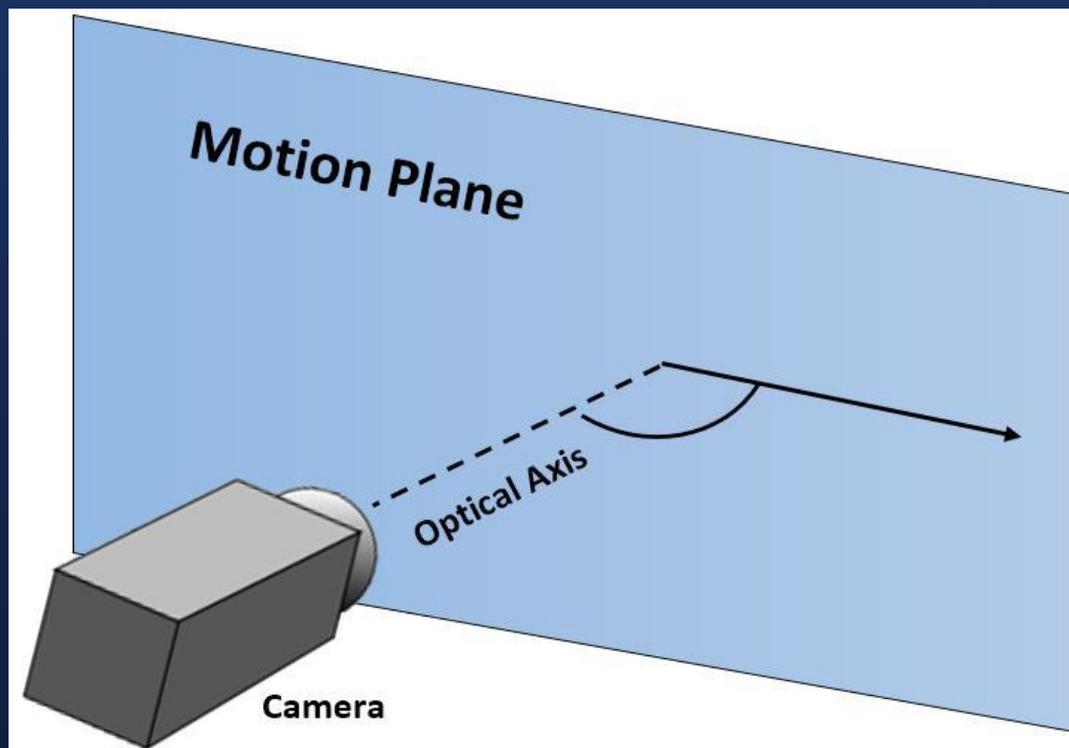
Skewed

- 需要的参数：
  - 相机到运动平面中心的距离
  - 已知两点间距离
  - 方位角（偏航）
  - 俯仰角（俯仰）
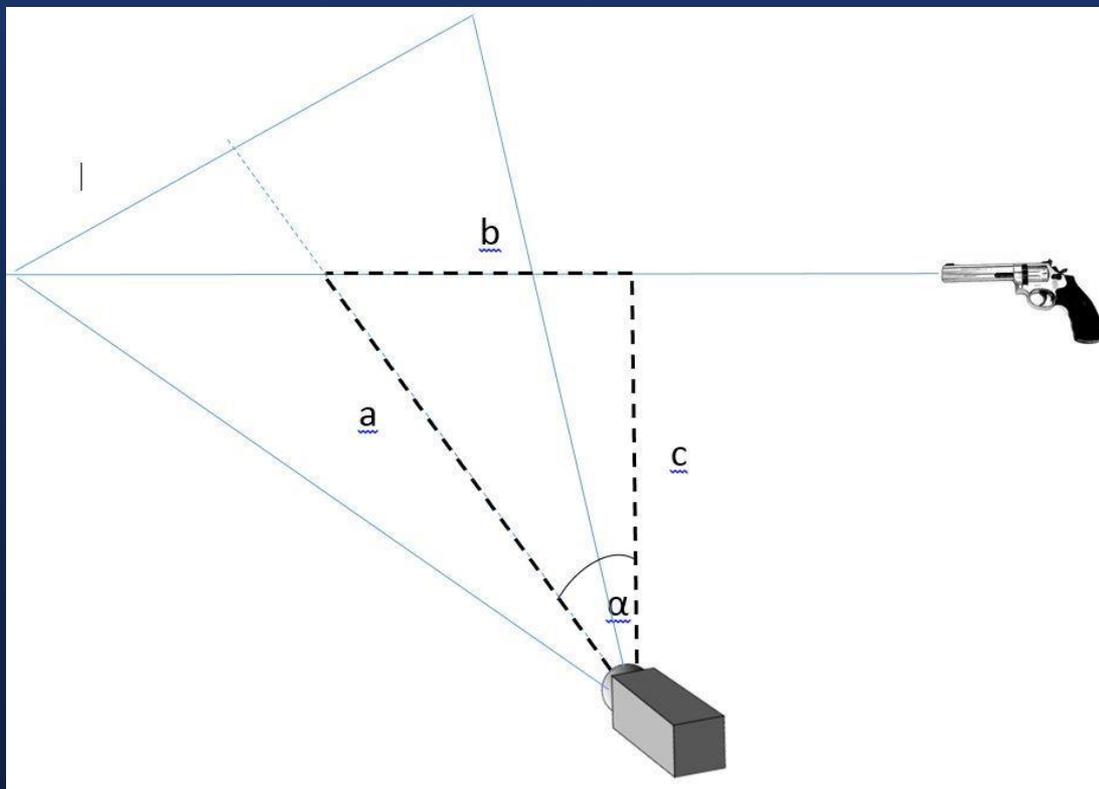
Skewed
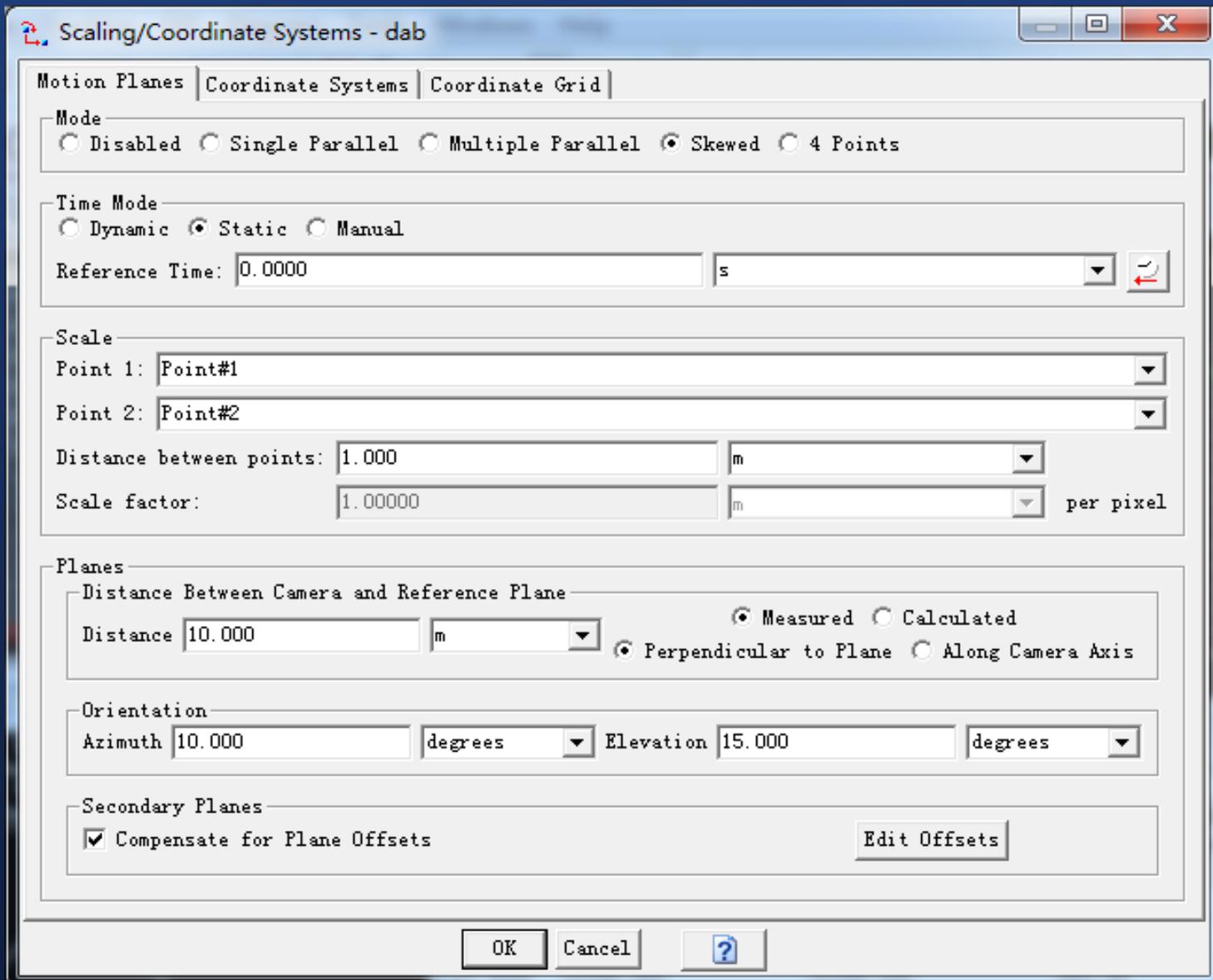
四点校正

- 已知运动平面的四个点
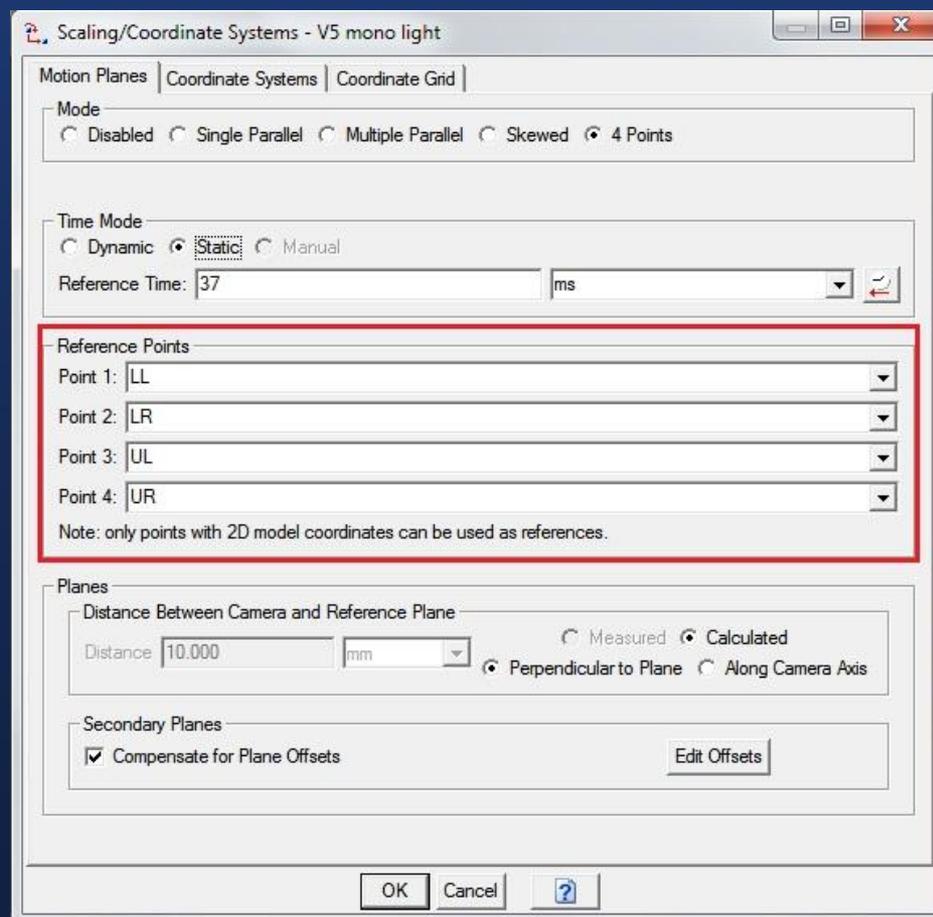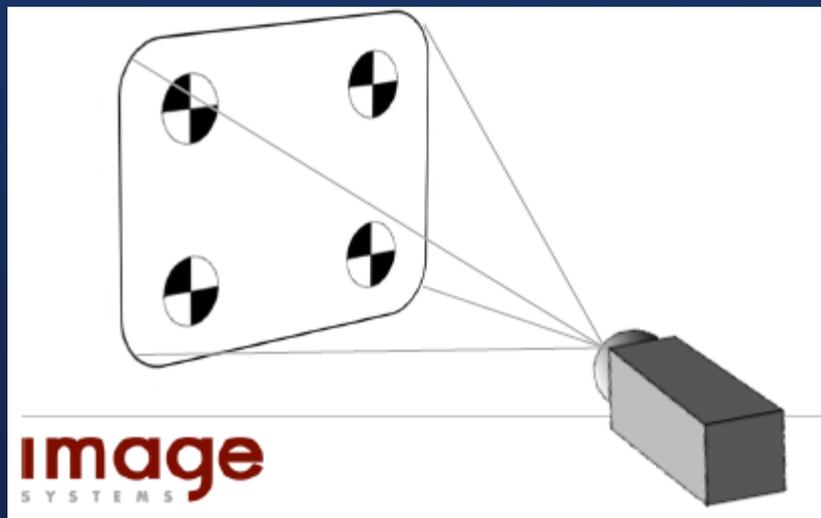
坐标系建立

坐标系建立

- 系统默认坐标系
  - 图像左下角为坐标原点
  - **y**轴向上为正
  - **x**轴向右为正
- 自定义坐标系
  - 确定坐标原点
  - 设置坐标轴方向

坐标系建立

- 自定义坐标系

坐标系建立

- 静态坐标系
  - 选定参考时间，该时刻的坐标系原点位置及坐标轴方向应用于整个图像序列
  - 大部分应用

- 动态坐标系
  - 参照系在图像序列中的每一张图像中都重新计算
  - 主要应用于振动消除或相对运动分析

动态坐标系应用
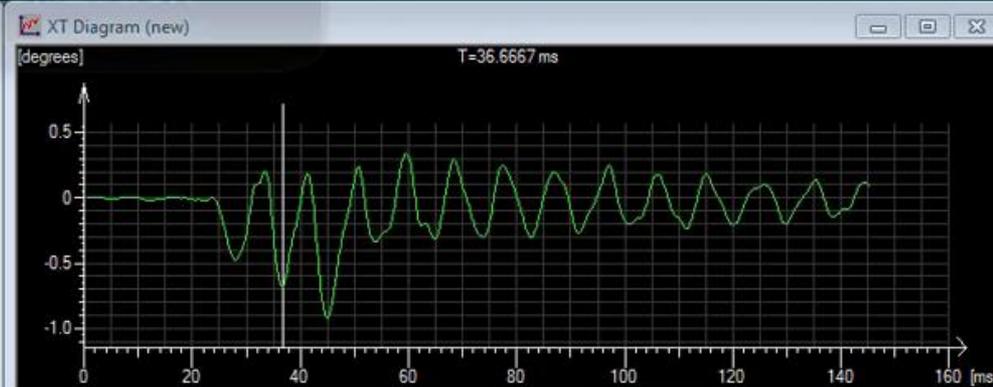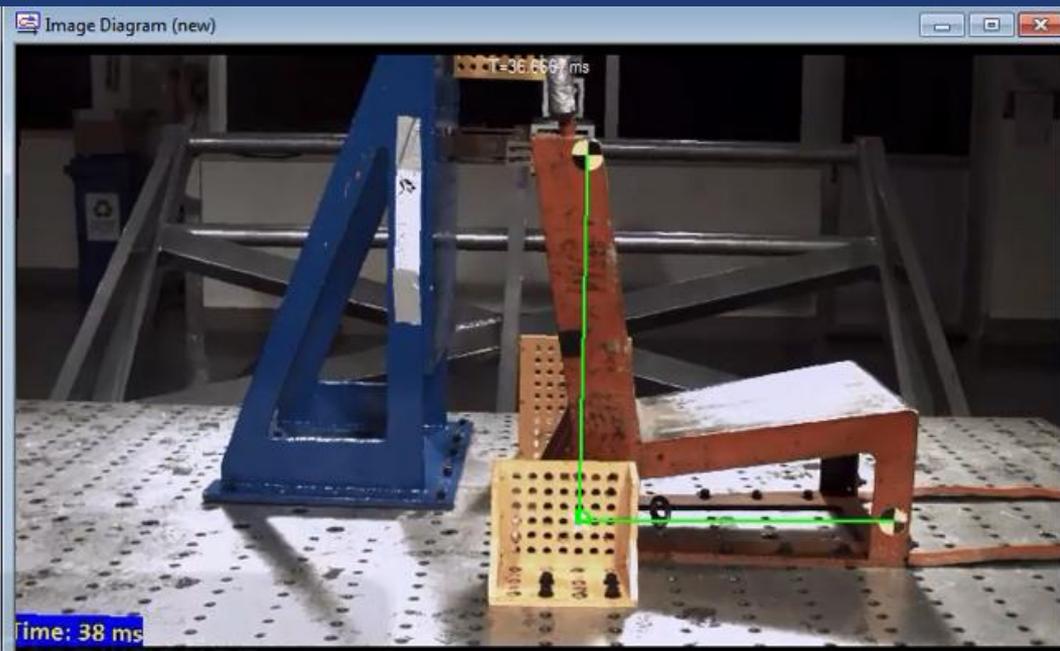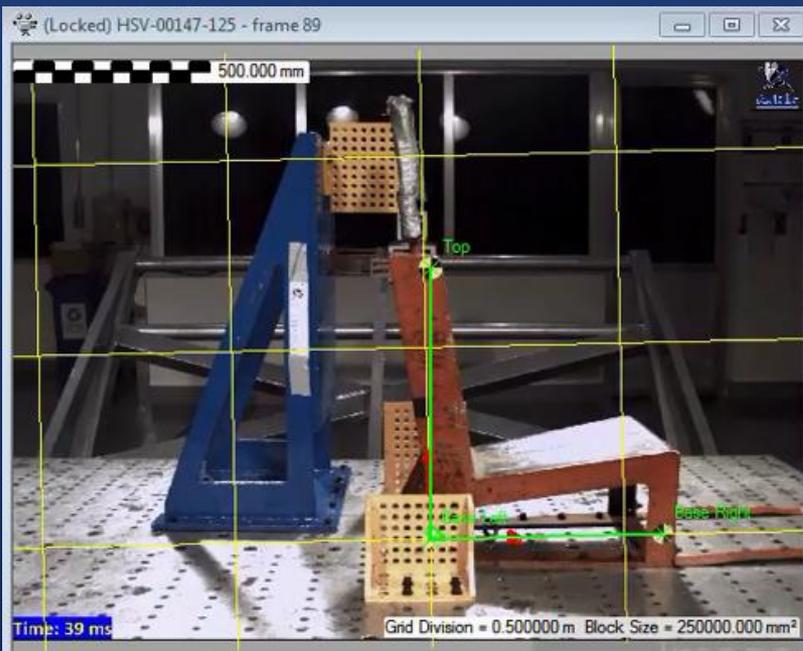
保持坐标系网格

- 设置网格尺寸、颜色
- 直观得到距离信息
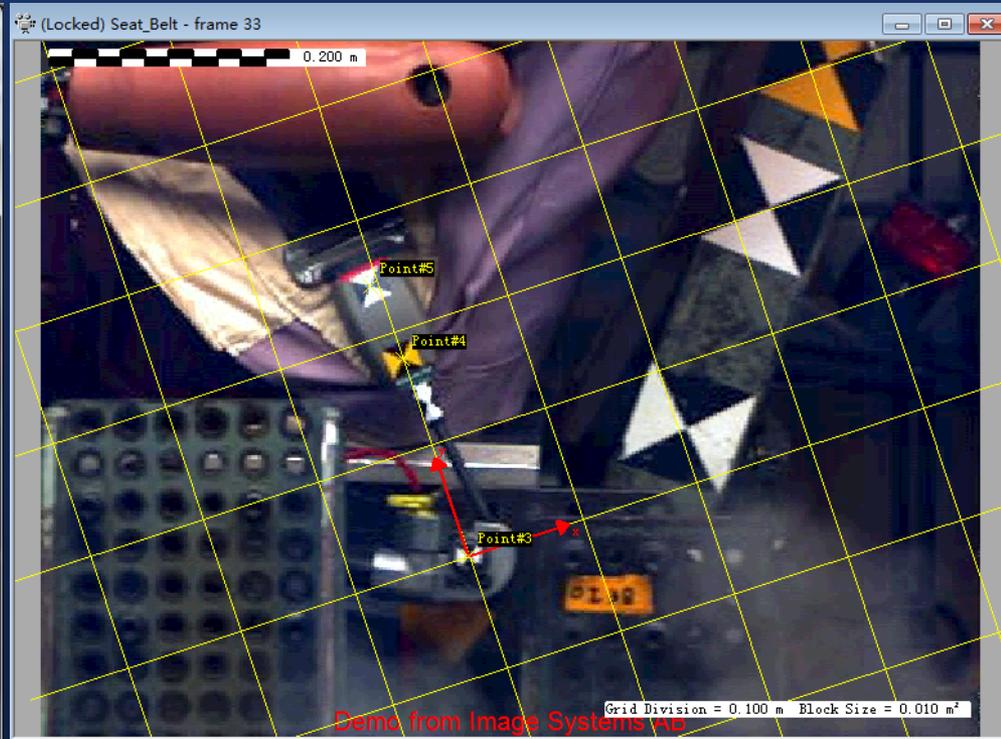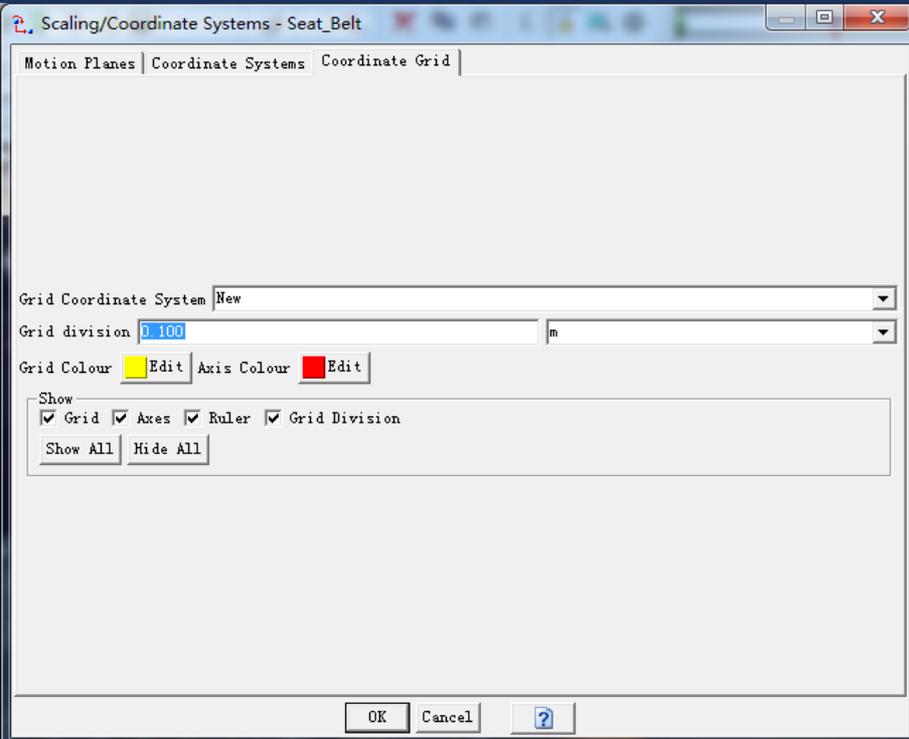
生成图表

图表概览

XT Diagram

Multi-Axis Diagram

XY Diagram

Advanced Diagram

Image Diagram

Time Table

Point Table

Frequency Analysis

Report

Tiled Window

X-T

- X-T：表示距离、速度、加速度等相对于时间的关系
- X方向，Y方向，绝对值
- 可显示分析精度

X-T
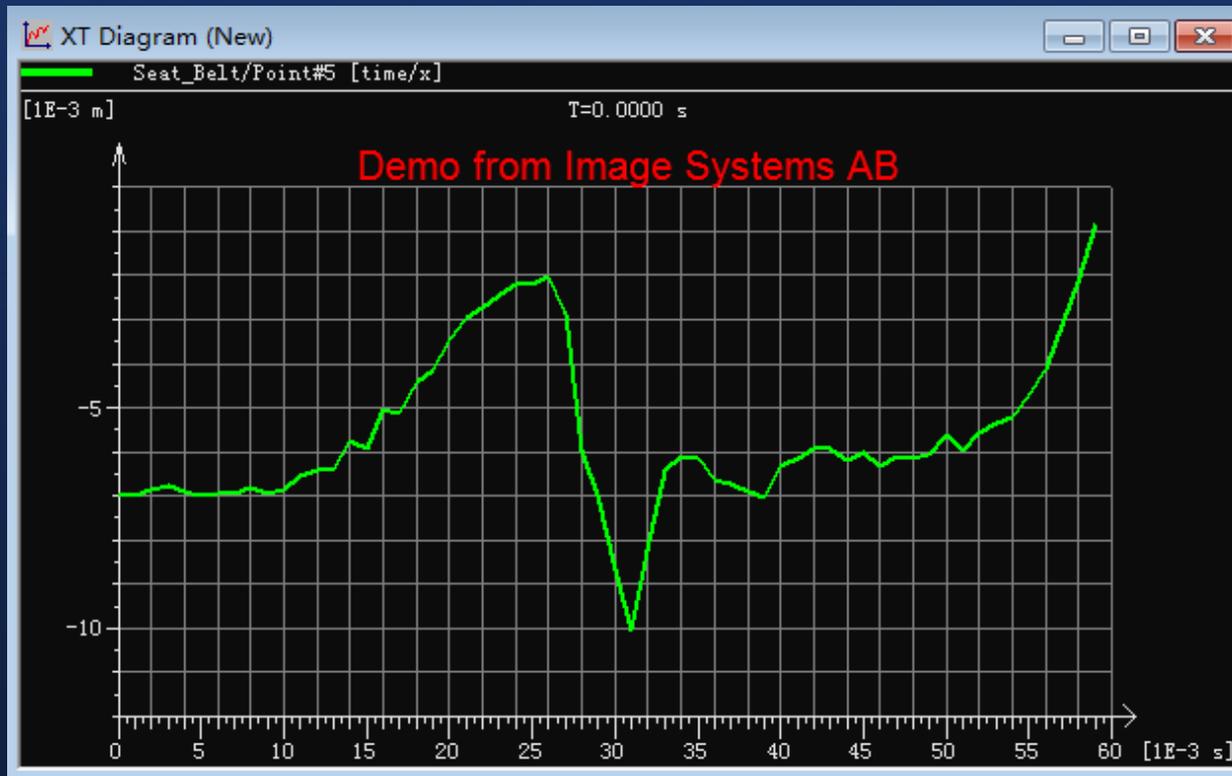
- 可同时添加多个点
- 显示多点在同一方向的运动分析曲线
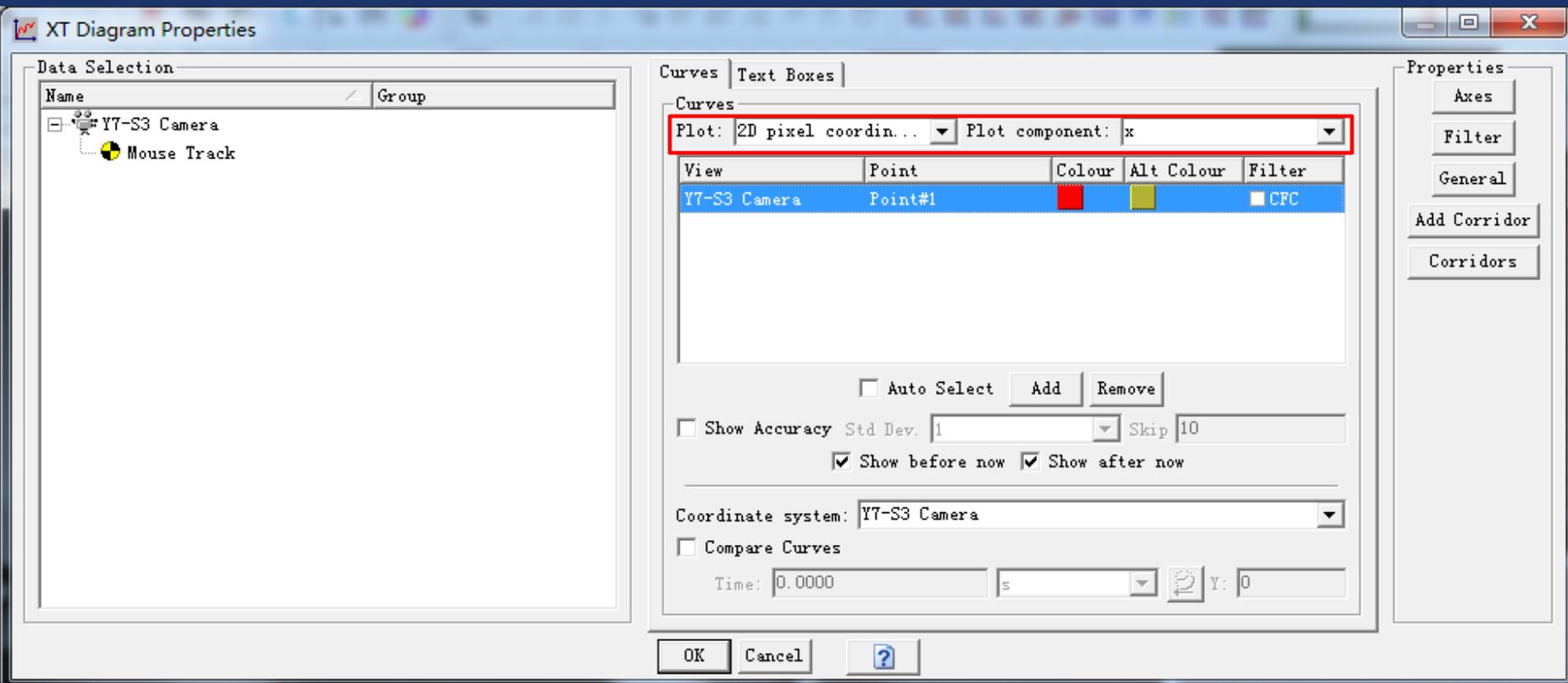
Multi-Axis

- 相当于多个X-T表格的组合
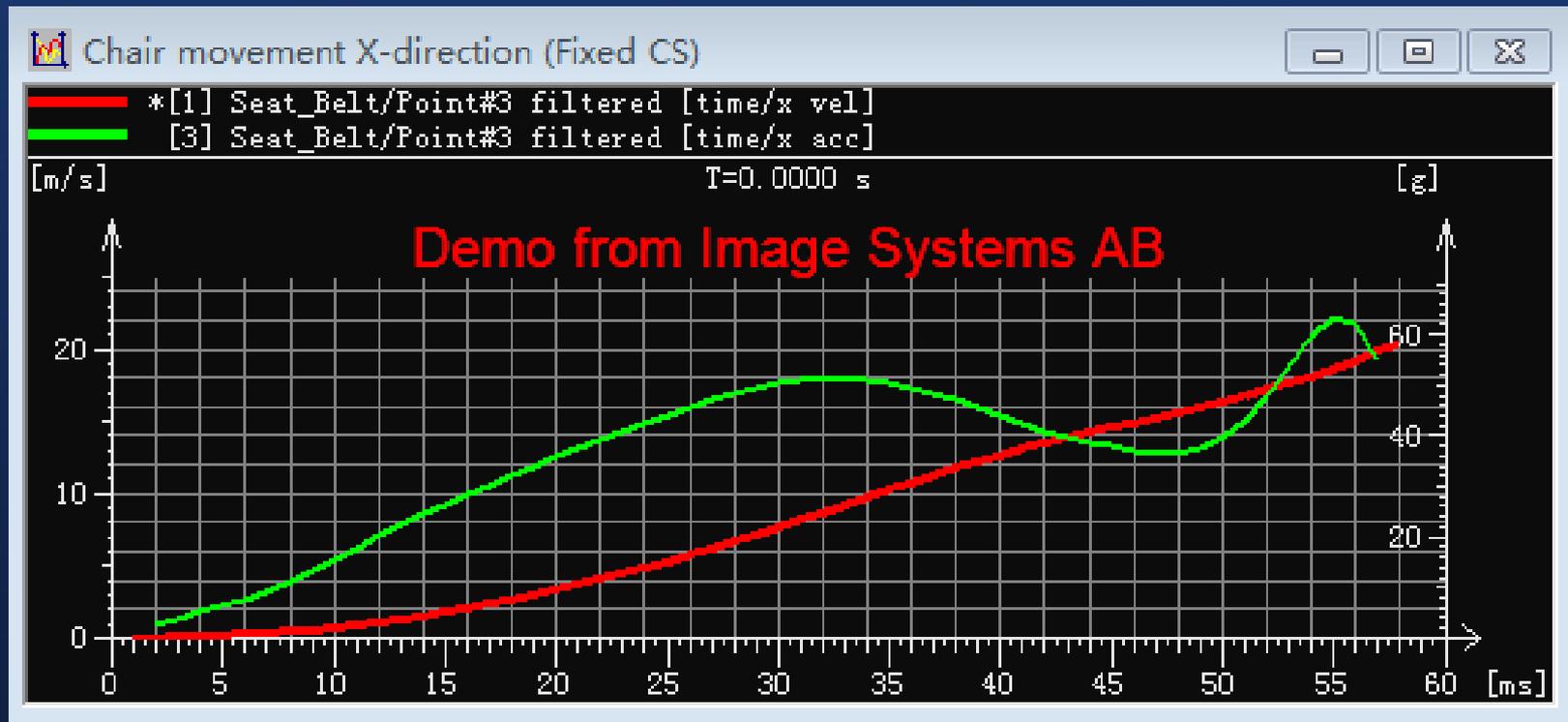
Multi-Axis

- 可添加多个点，绘制多种曲线
- 每个点的曲线单独设置
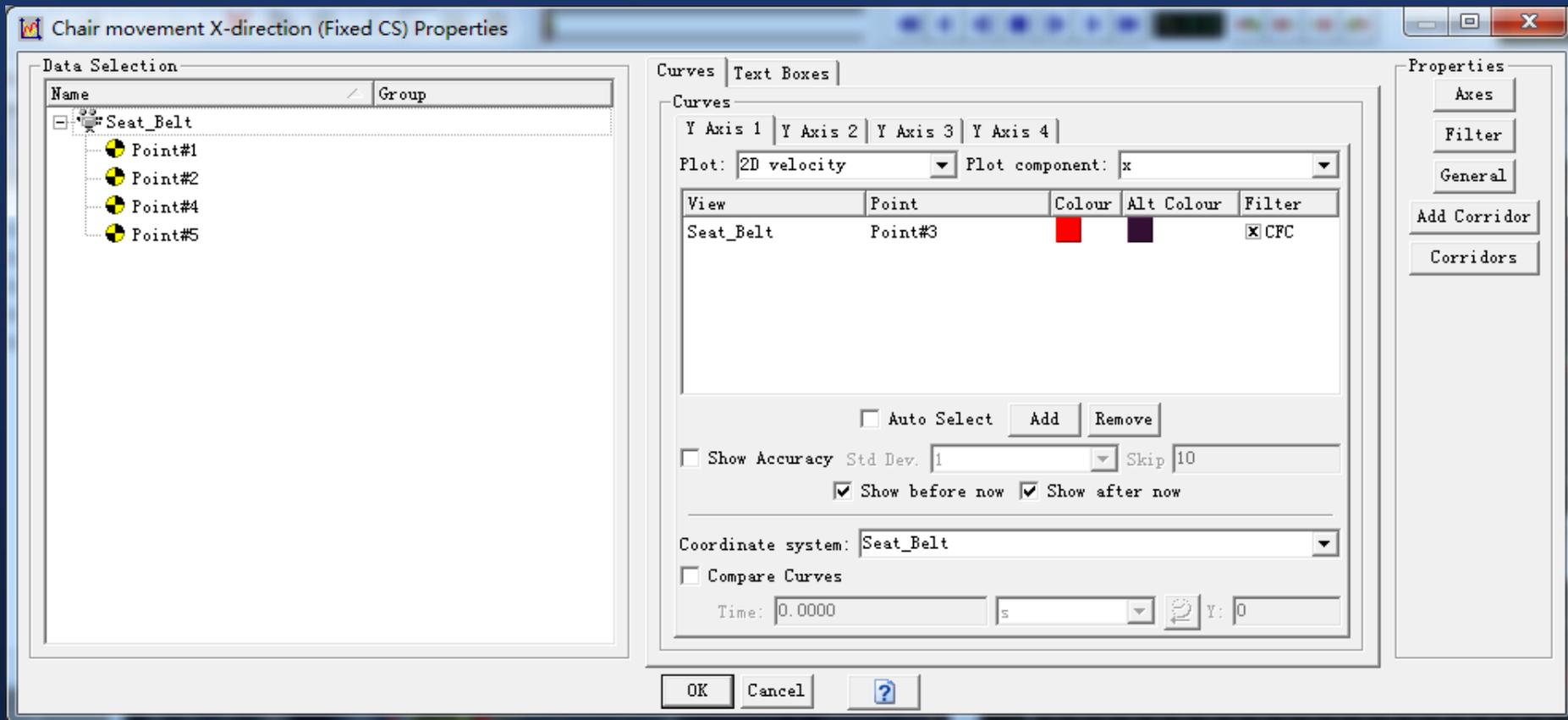
X-Y

X-Y：横坐标为X轴，纵坐标为Y轴
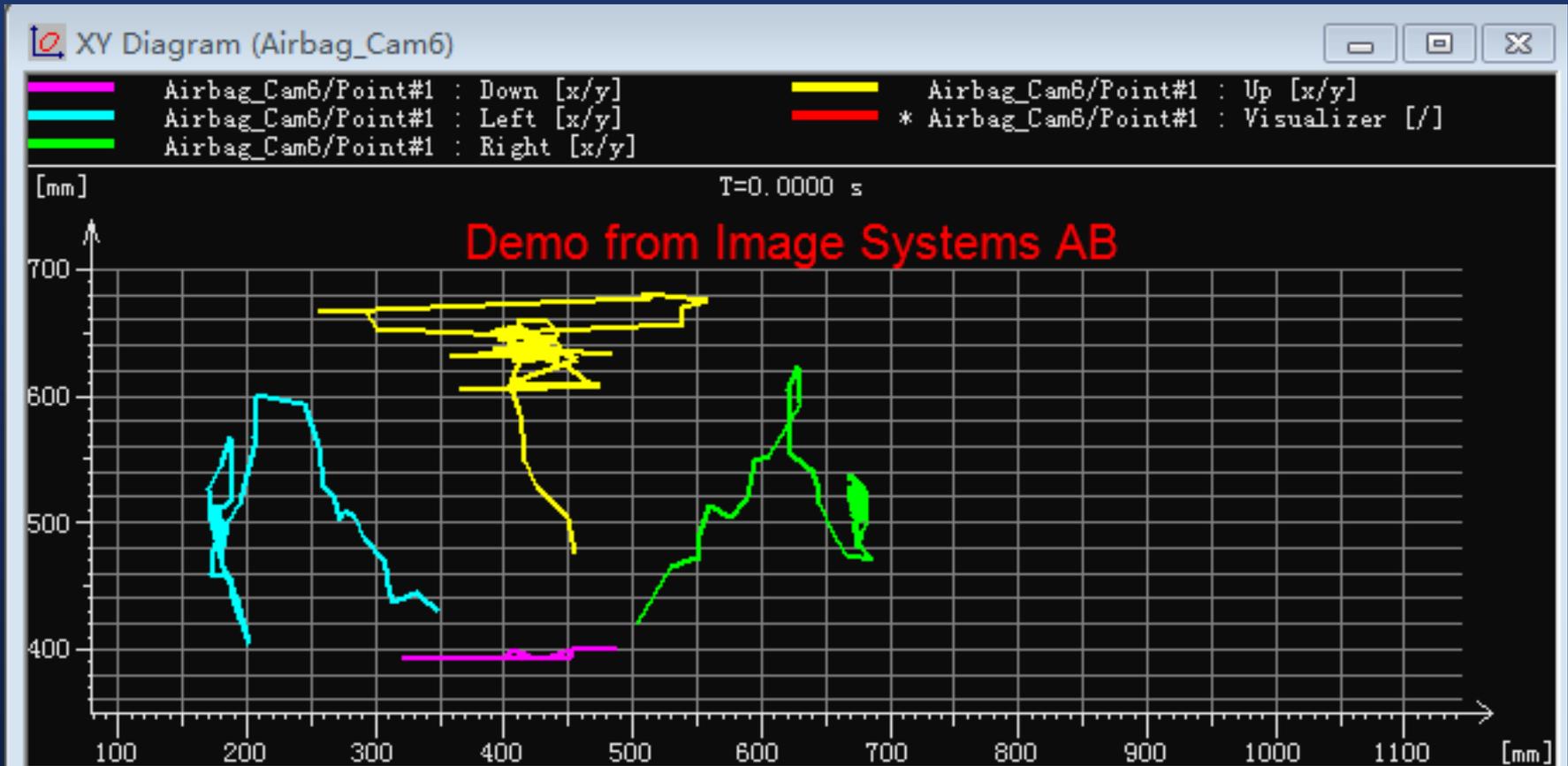
X-Y

- 可添加多点，显示其X-Y位移情况
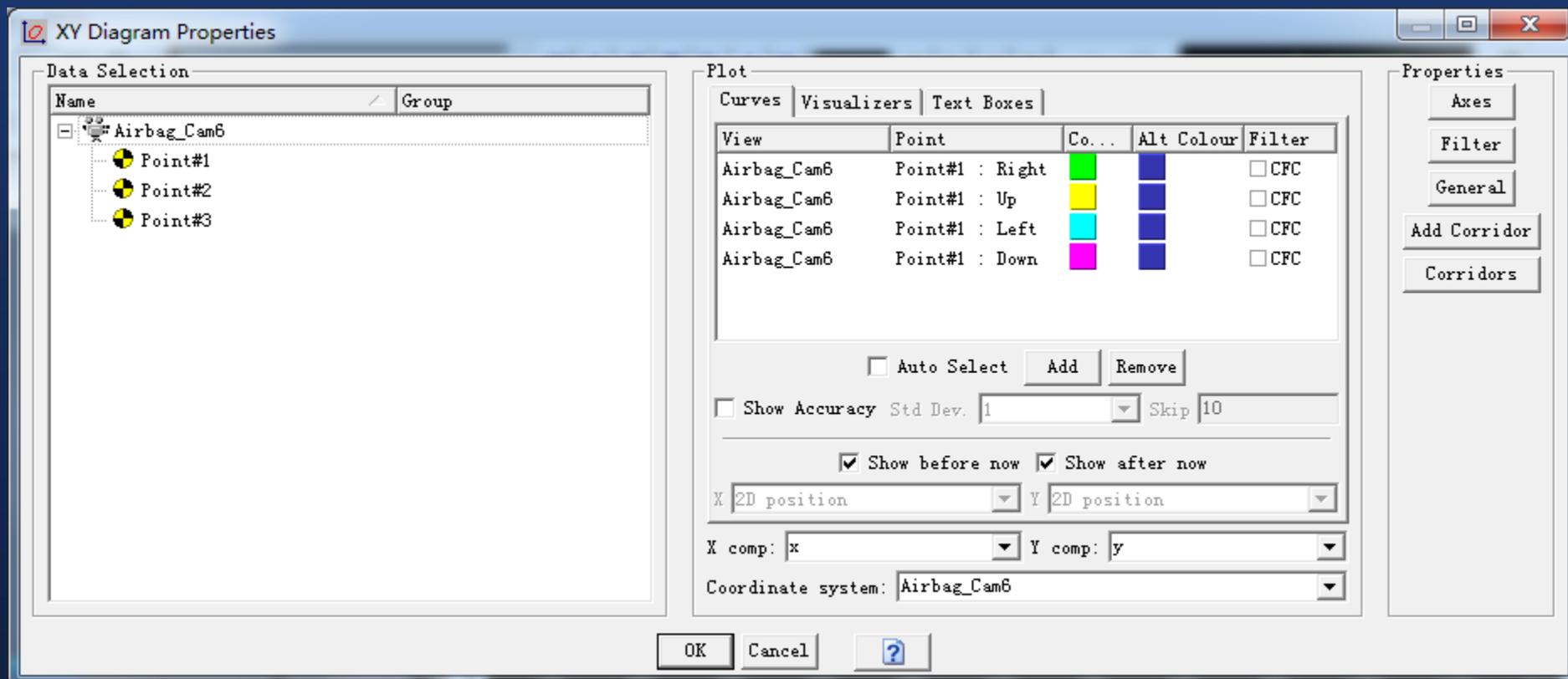
Time Table

- X-T、X-Y、Multi Axis等表格都可以转换为时间表格Time Table，表示每一时刻各个点的运动分析结果。

Point Table

- 点表格：给出当前时刻每个点的位置信息

CS1:1	CS2:1	CS2:2	CS3:1	CS3:2
Point Name	Position x[m] Board(Reference_bo...	Position y[m] Board(Reference_bo...	Position x[m] Reference_board	Position y[m] Reference_board
Point#2	-0,425	0,138	0,141	0,712
Point#3	-0,001	0,447	0,568	1,017
Point#4	-0,300	0,000	0,265	0,572
Point#5	0,300	0,000	0,865	0,567

Point Table

- 主要应用：当需要将点的位置信息导出到其他软件做进一步分析时使用，TEMA 6DoF分析需要此表格
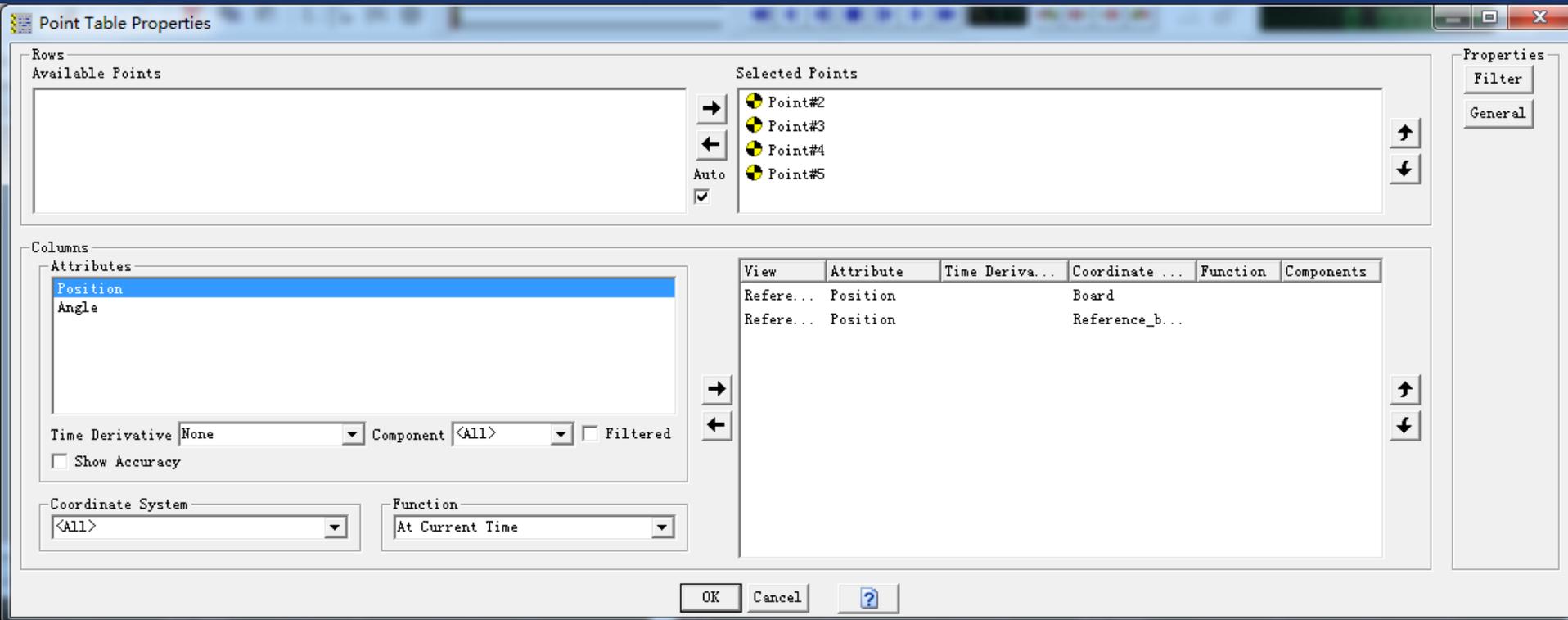
Image Diagram

- 可将图像及分析结果在表格中显示
- 包括运动曲线、标记点等
- 特色应用：图像融合
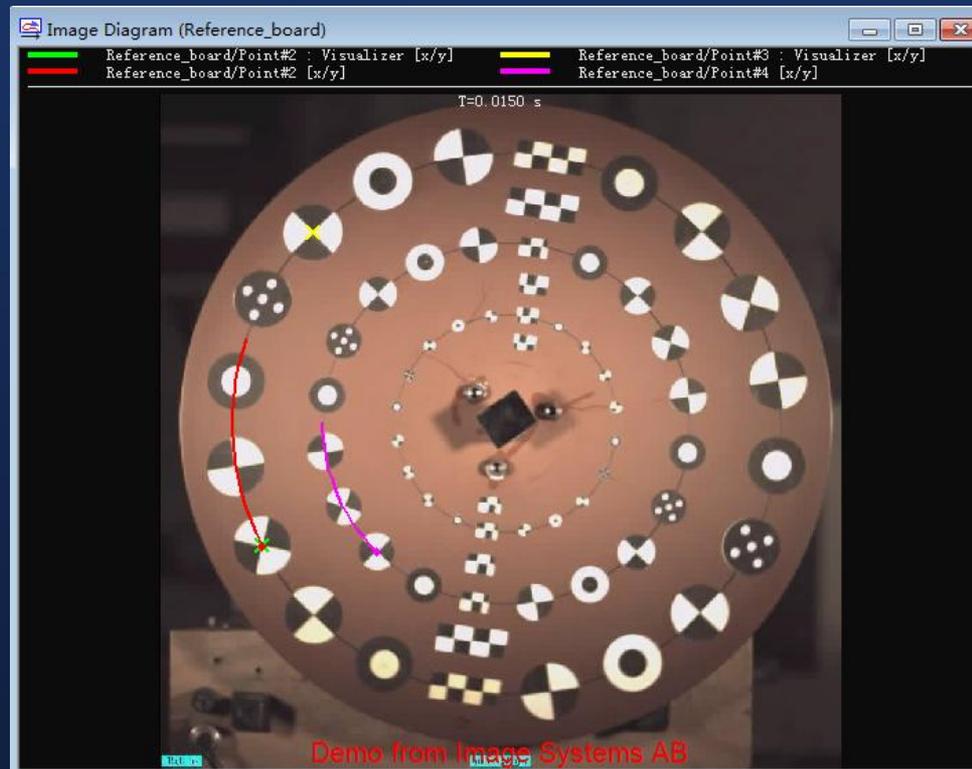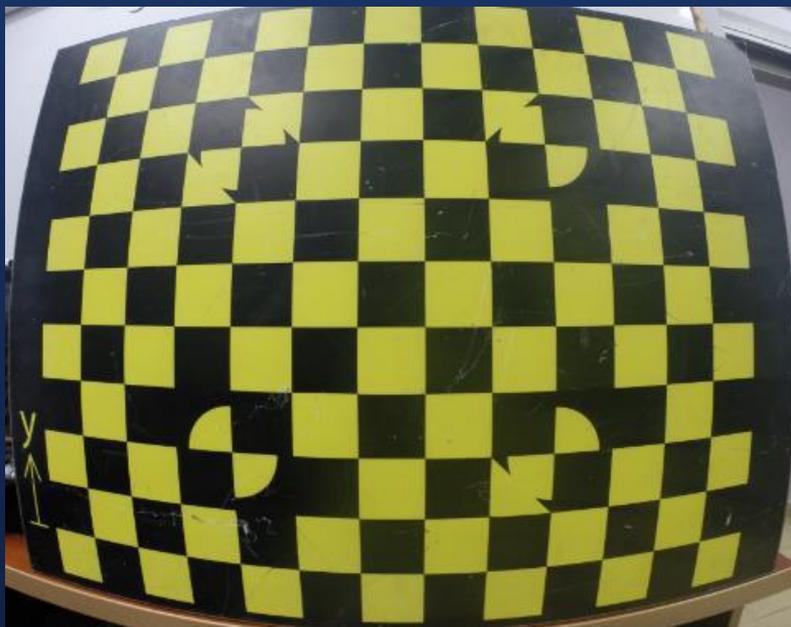
Image Diagram

分析结果导出
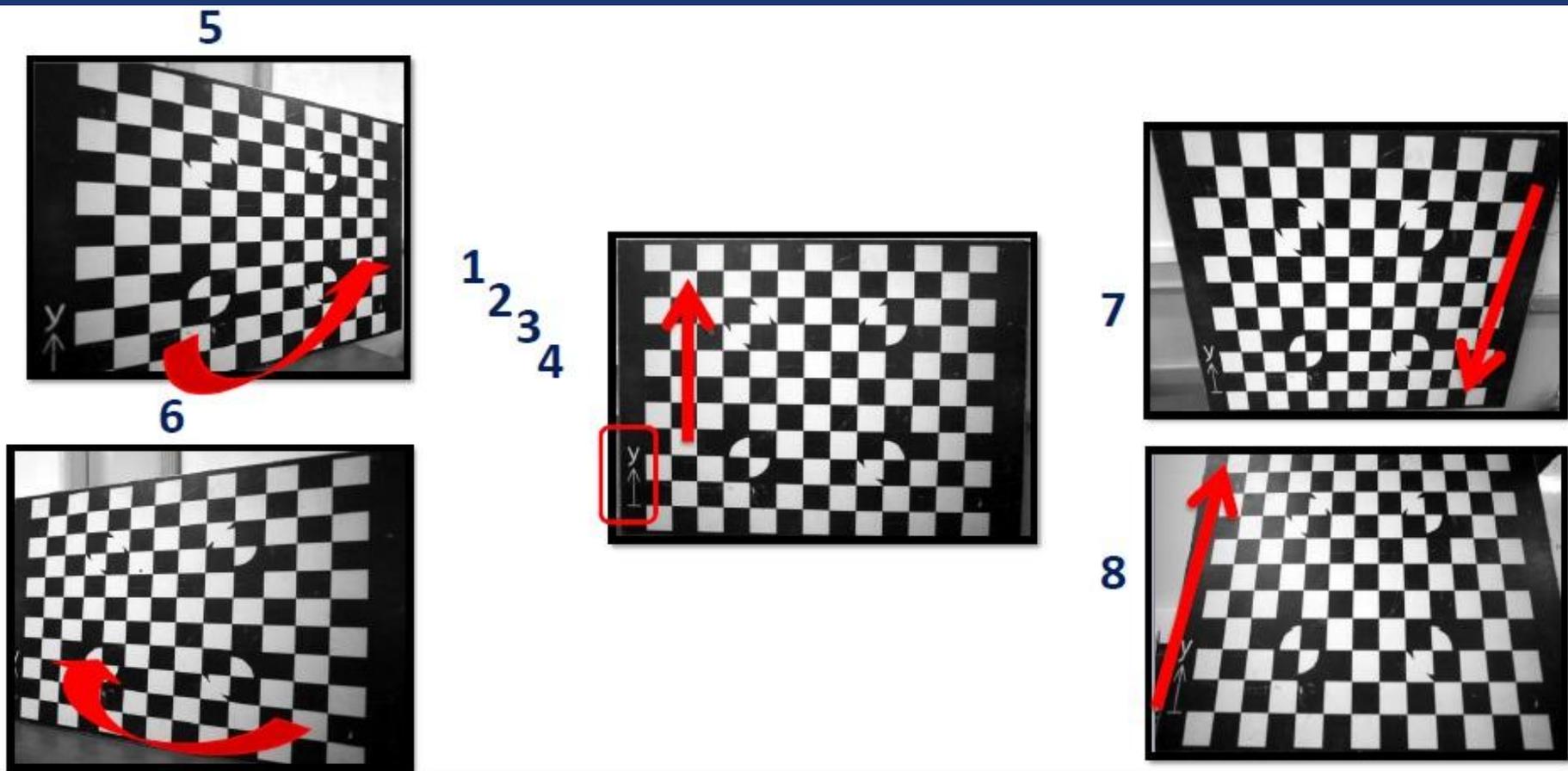
组合图表视频导出

生成打印报告
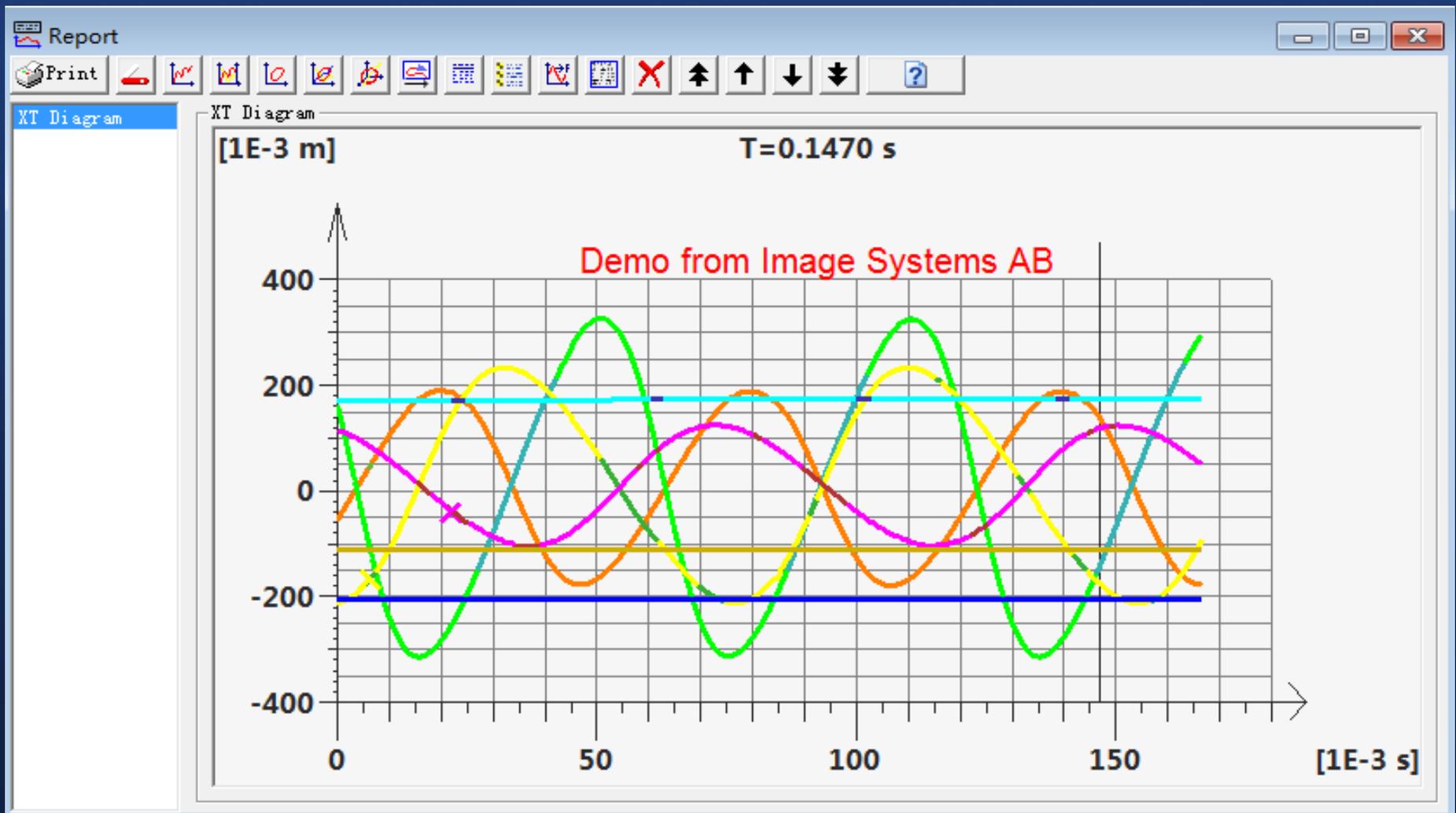
镜头畸变校正

镜头校正

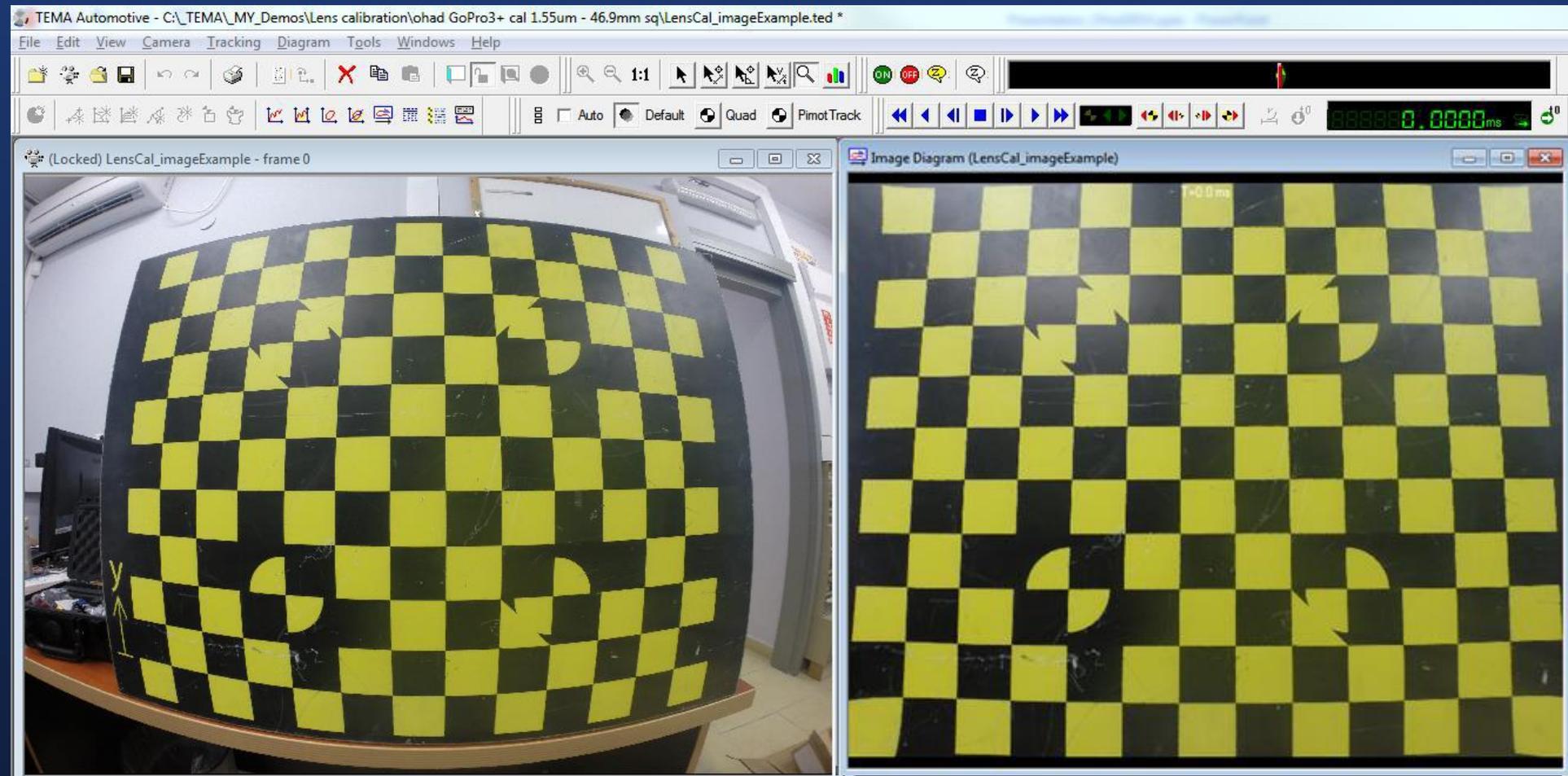- 镜头焦距小于35mm 、3D、6D、气囊体积测量等情况都需要进行镜头校正
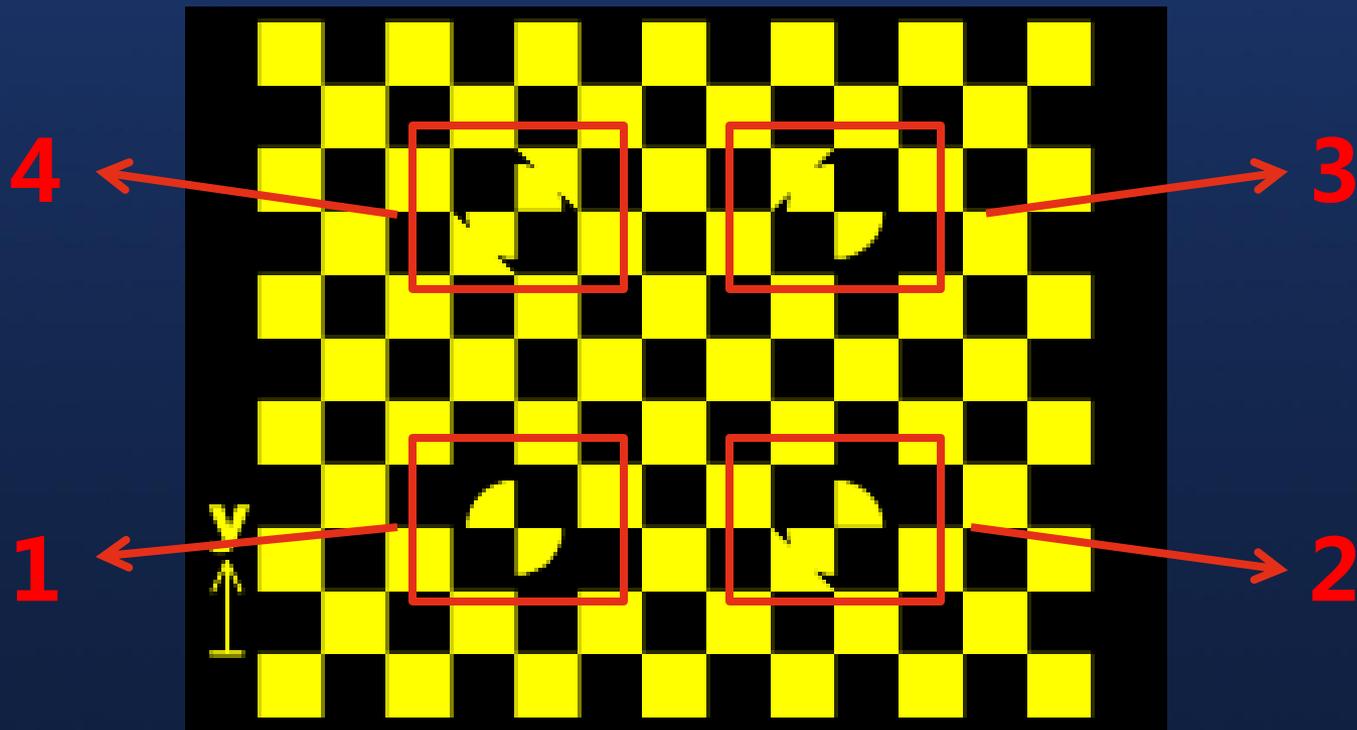
镜头校正

- 至少需要八张图像

镜头校正

- 校正结果：

镜头校正流程

- 采集图像前，调整相机、镜头，固定
- 标定板多角度，至少8张图像，注意图像命名连续
- 注意打光，确保图像清晰锐利

IMG1_0_degr

IMG2_90_degr

IMG4_45_degr_from_left

IMG5_45_degr_from_right

IMG3_180_degr
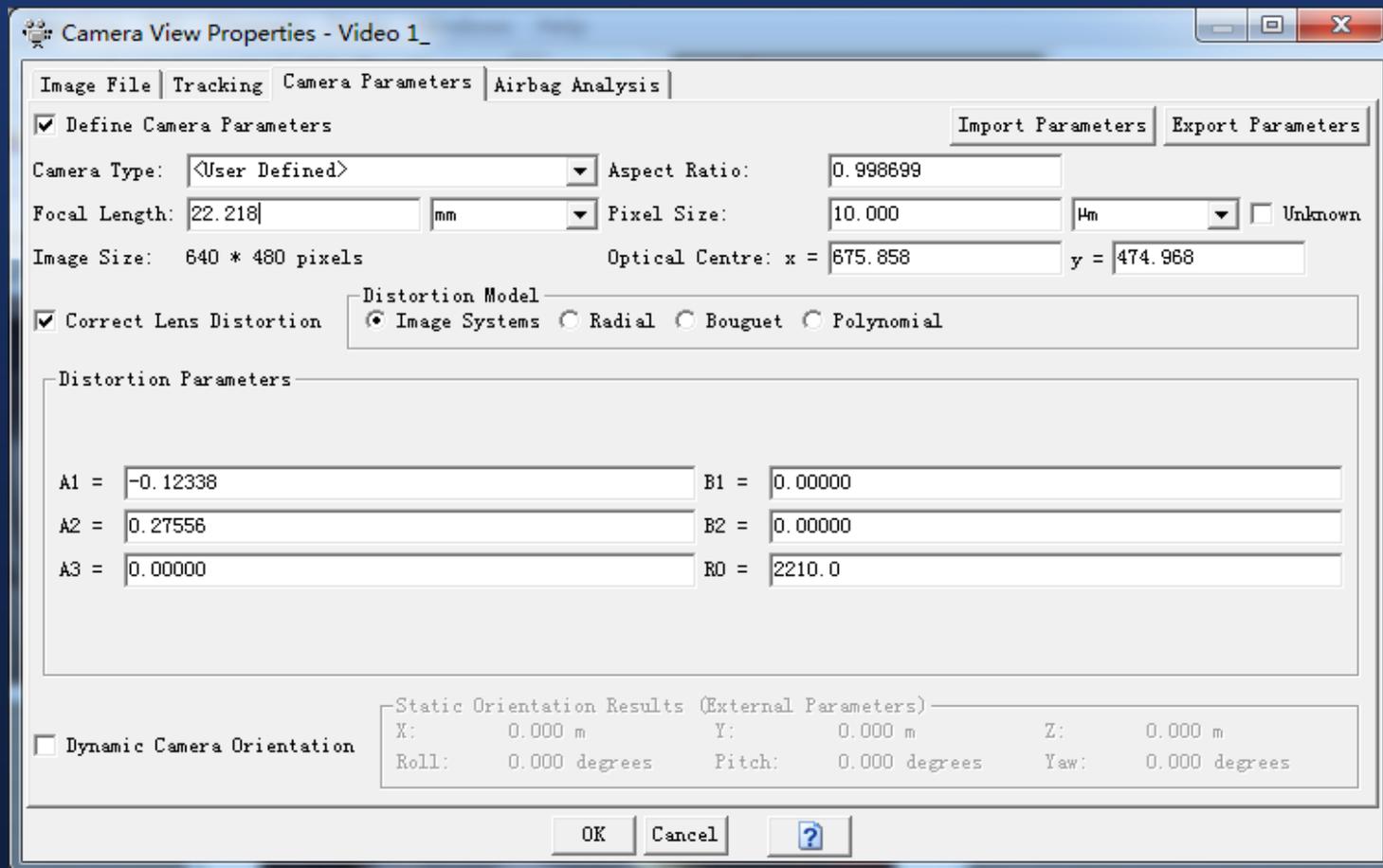
IMG6_45_degr_from_below

IMG7_45_degr_from_top
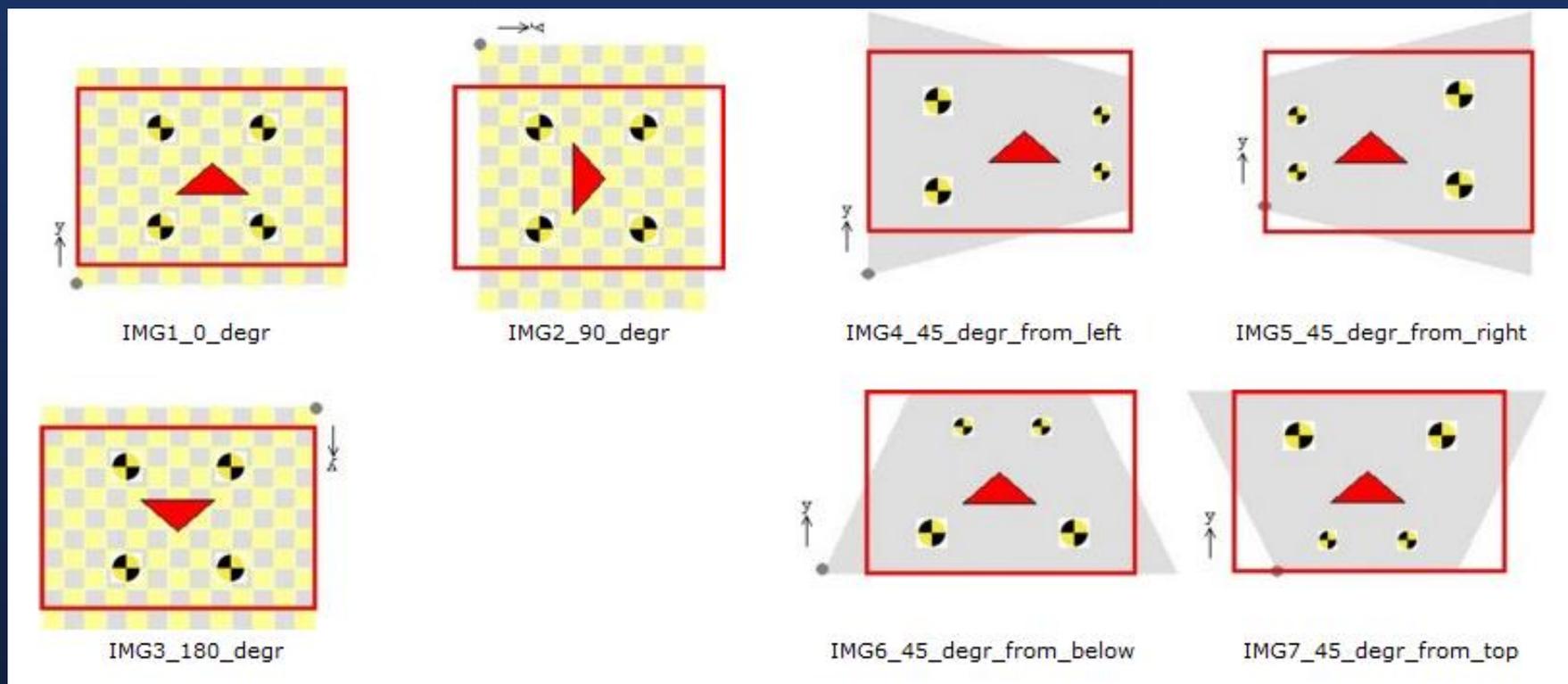
镜头校正流程

- 将标定板图像序列导入TEMA
- Camera ->Lens Calibration->Calibrate
- 输入标定板网格尺寸，单击生成"Generate"
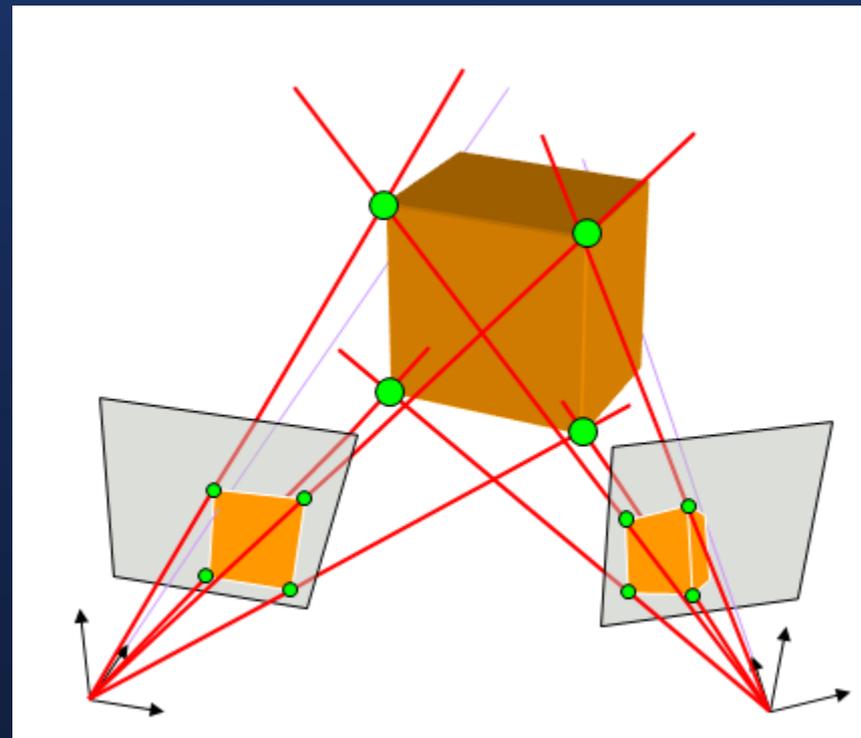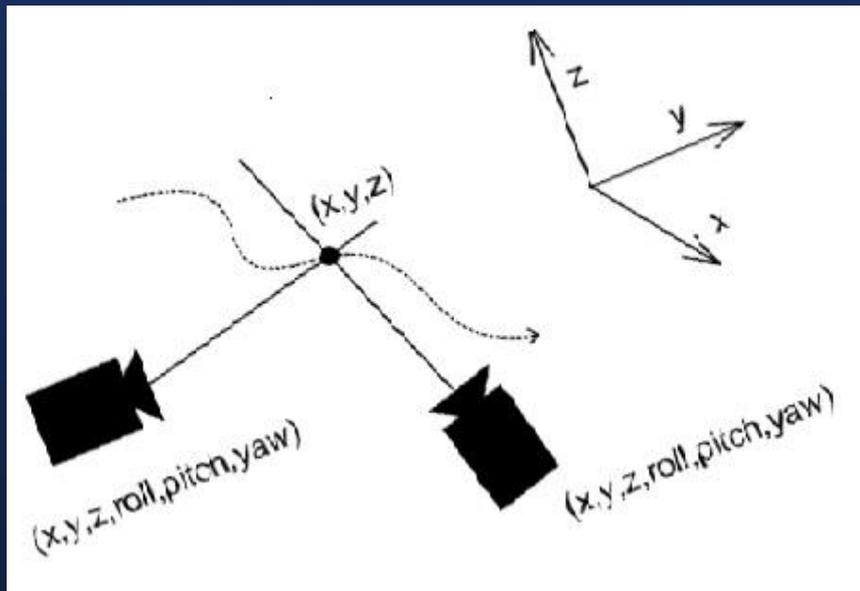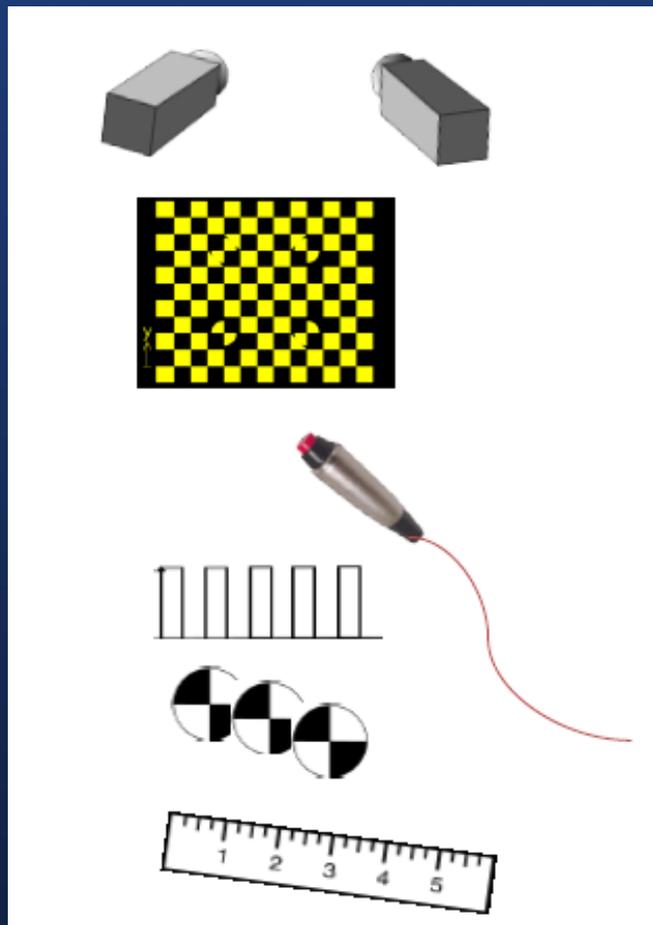
镜头校正流程

- 保存校正结果 ".xml" 格式
- 做运动分析时，加载该校正结果

TEMA 3D分析

TEMA 3D

TEMA 3D

- 从多个相机视野中跟踪一个目标物
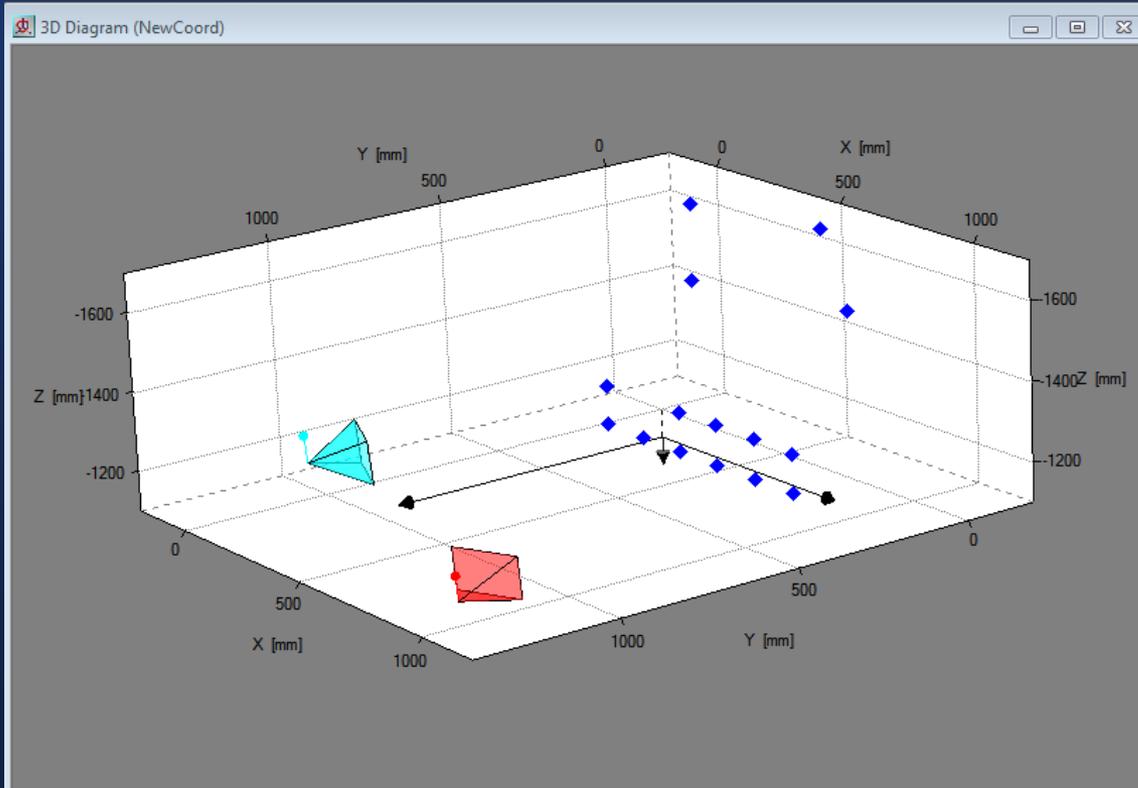- 6D 需要知道相机的方向信息（x, y, z, roll, pitch, yaw）
- 图像必须包含时间信息

TEMA 3D

- 要求：
  - **2只以上相同FOV**的相机
  - 相机夹角**30°~90°**
  - 每只相机都做好镜头校正
  - 相机外同步采集
  - **8~10**个分散的标记点（或使用标定棒）
  - 已知两个标记点间的实际距离
  - 相同曝光时间

TEMA 3D分析结果

- 3D表格

偏好设置

偏好设置