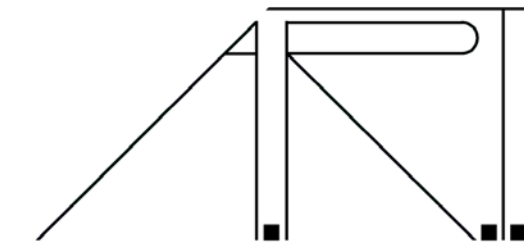


# The Achilles´ Heels of Optical Tracking Systems: Occlusions and Optical Interferences - A.R.T.´s Solutions

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[www.ar-tracking.de](http://www.ar-tracking.de)

Optical tracking is accurate and reliable

- in limited measurement volumes
- indoor
- for VR & AR applications

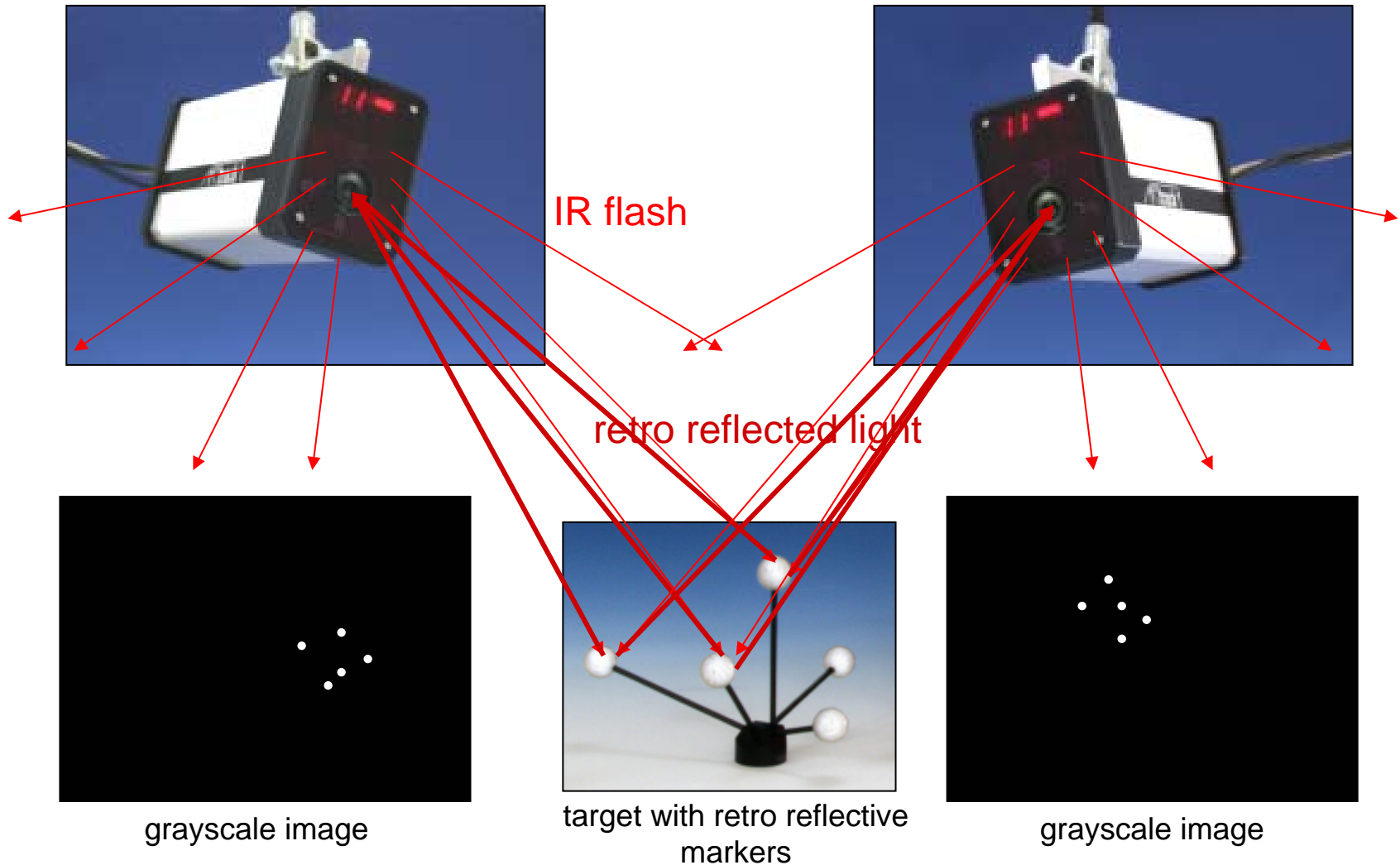
Line of sight: function principle

Achilles´ heels:

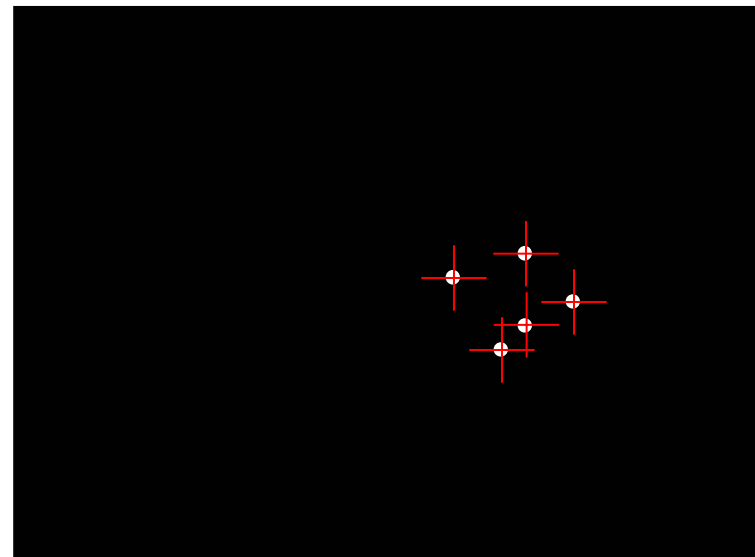
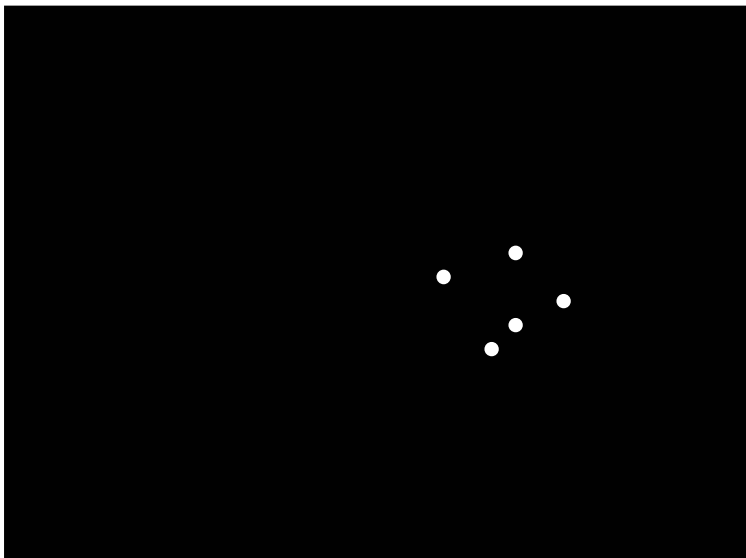
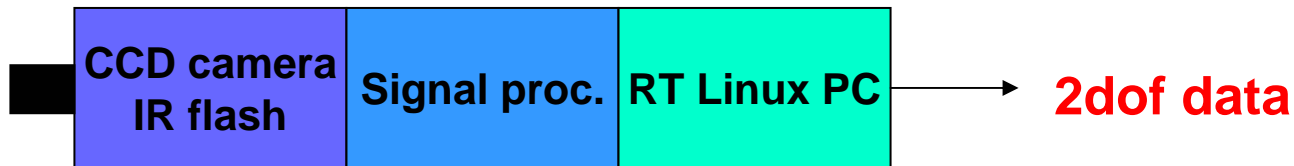
- occlusions
- interferences

# A.R.T. Tracking: Function Principle

tracking camera (ARTtrack1)



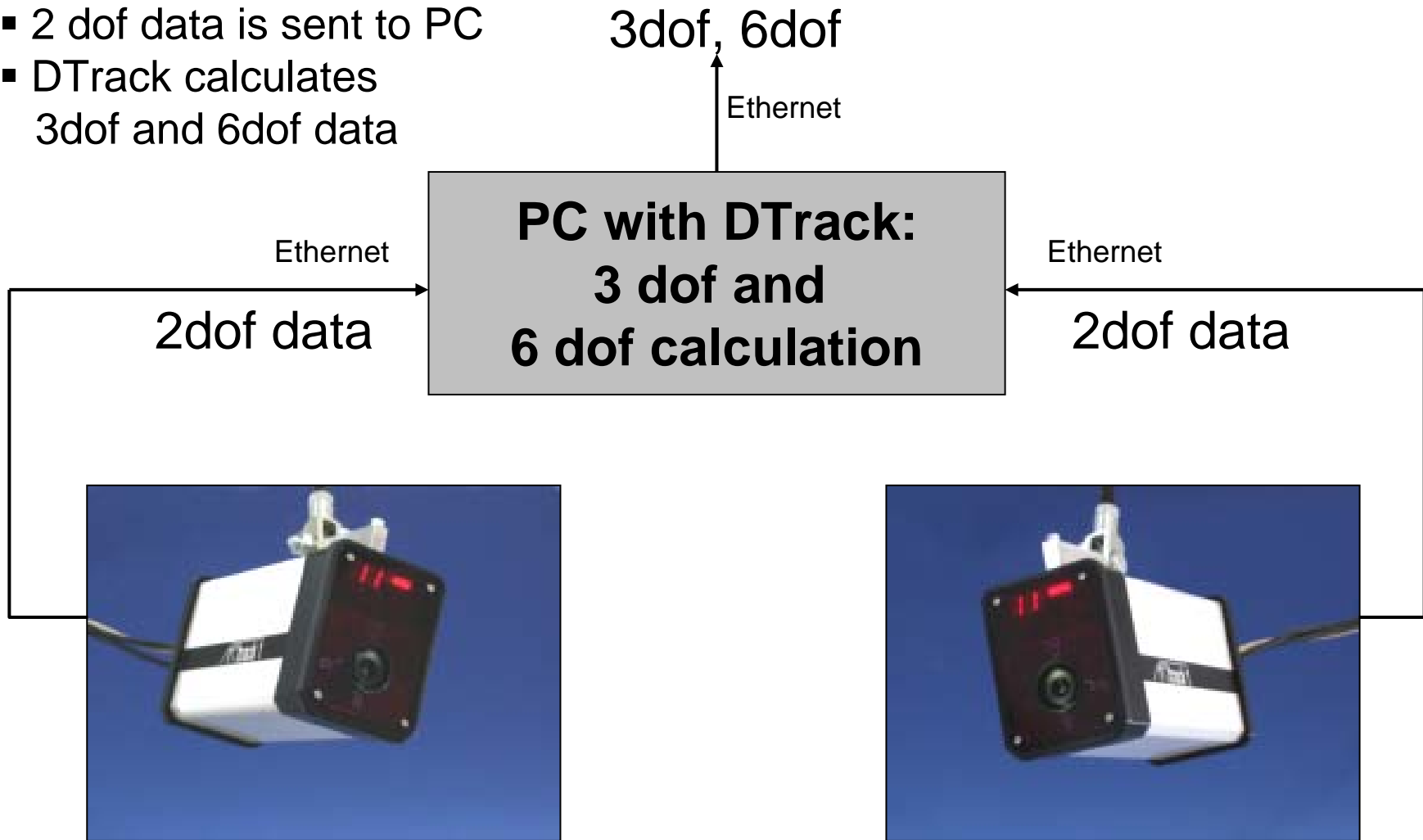
# A.R.T. Tracking camera functionality



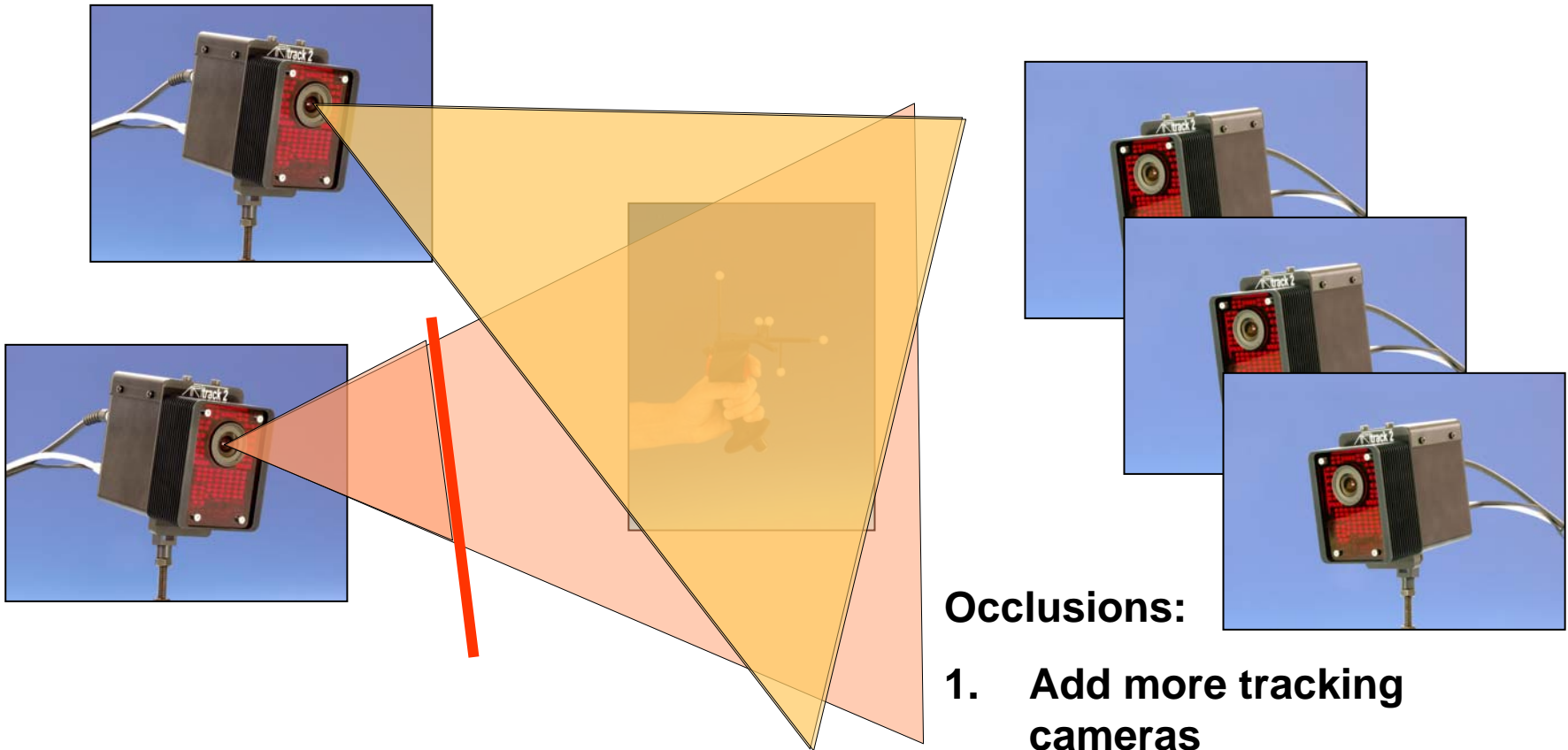
„Centers of gravity“ of all marker images are calculated: **2dof data**

# A.R.T. Tracking: Function Principle

- 2 dof data is sent to PC
- DTrack calculates 3dof and 6dof data



# Occlusions



## Occlusions:

1. Add more tracking cameras
2. Use large targets
3. Single camera tracking

# Occlusions

- Two or more users in front of a VR projection
- Self-occlusions

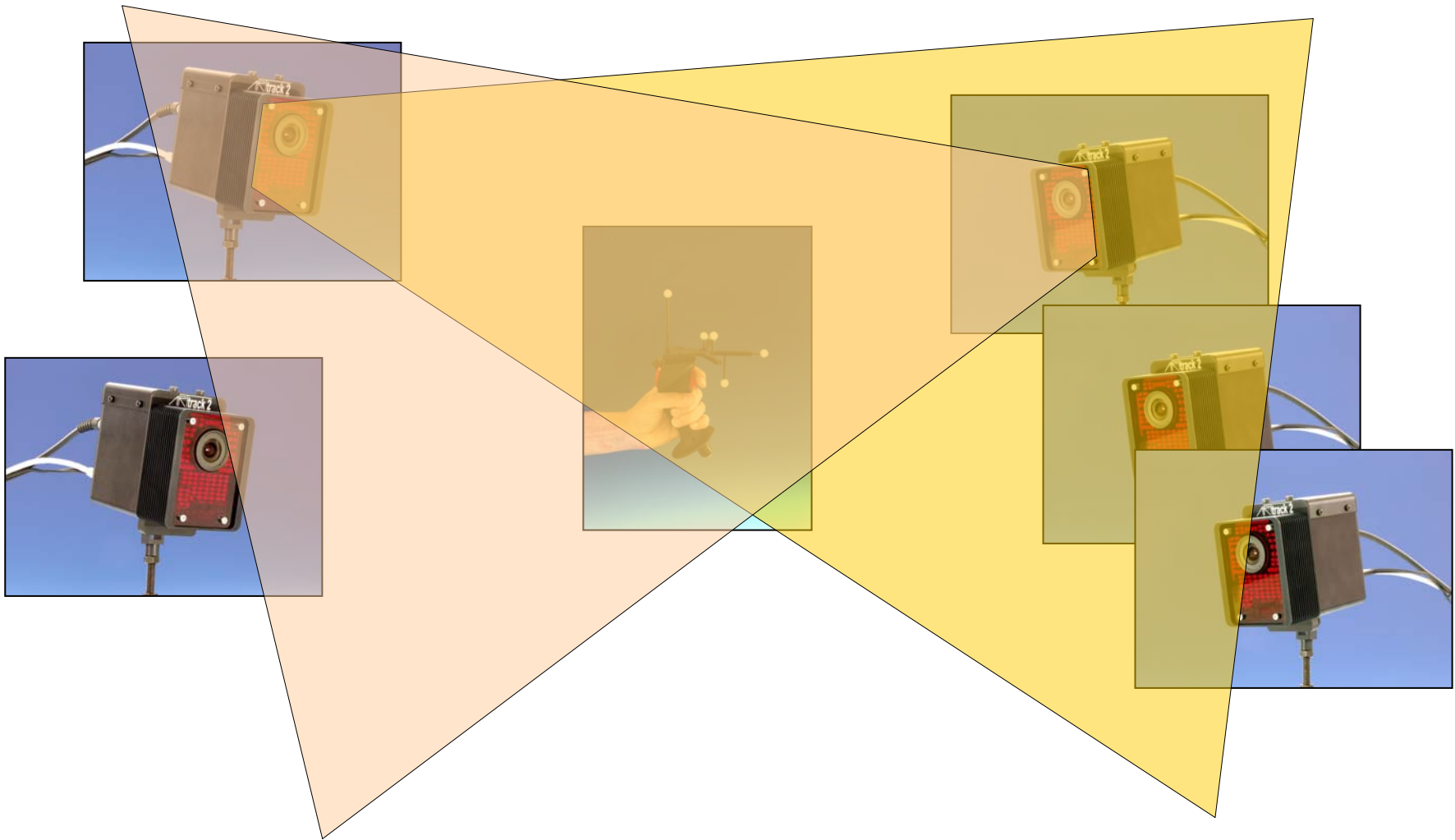


Foto: Volkswagen, at IZB 2004



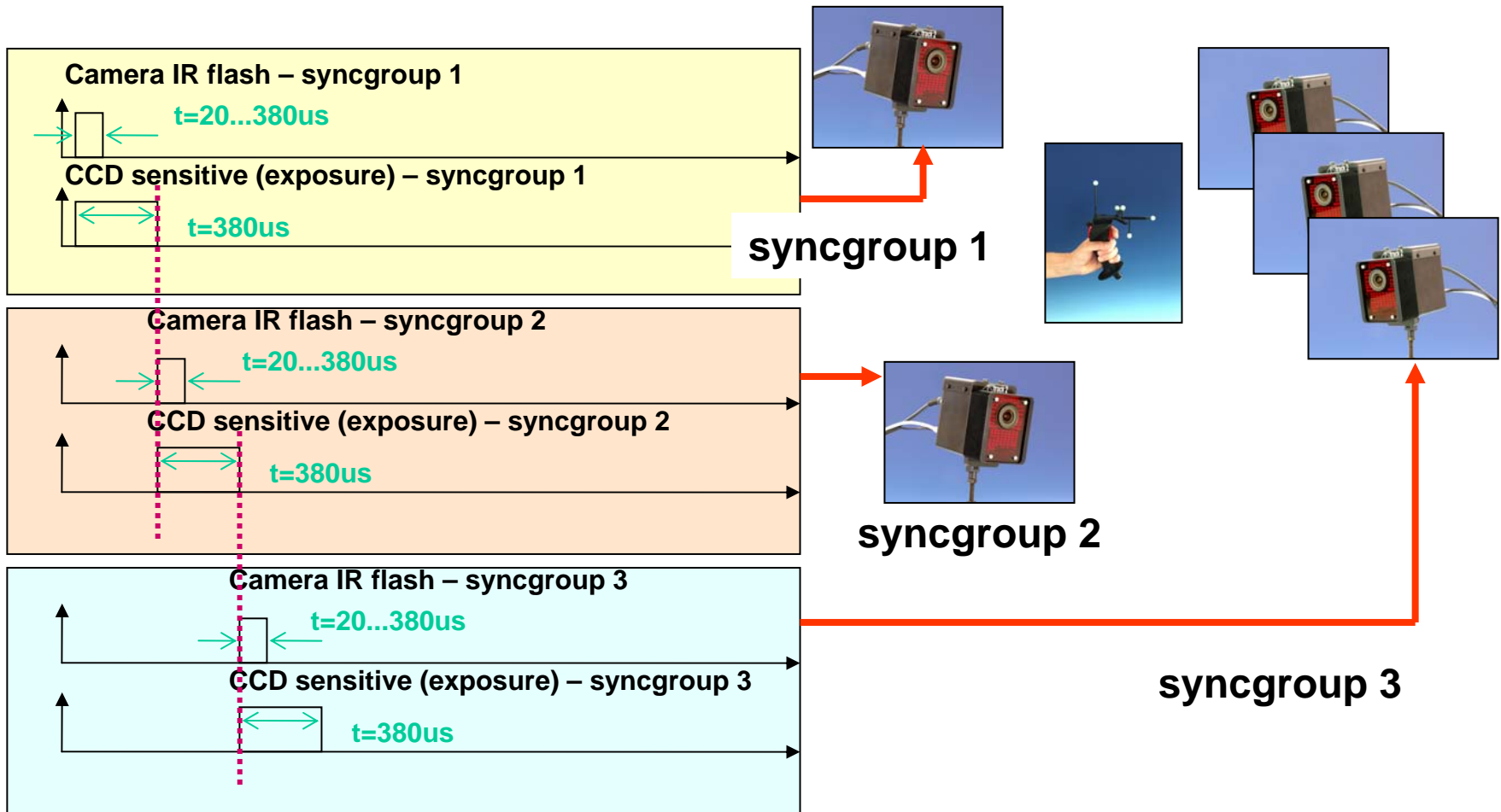
Foto: imagination & vrvis

# Multi-camera systems: mutual blinding

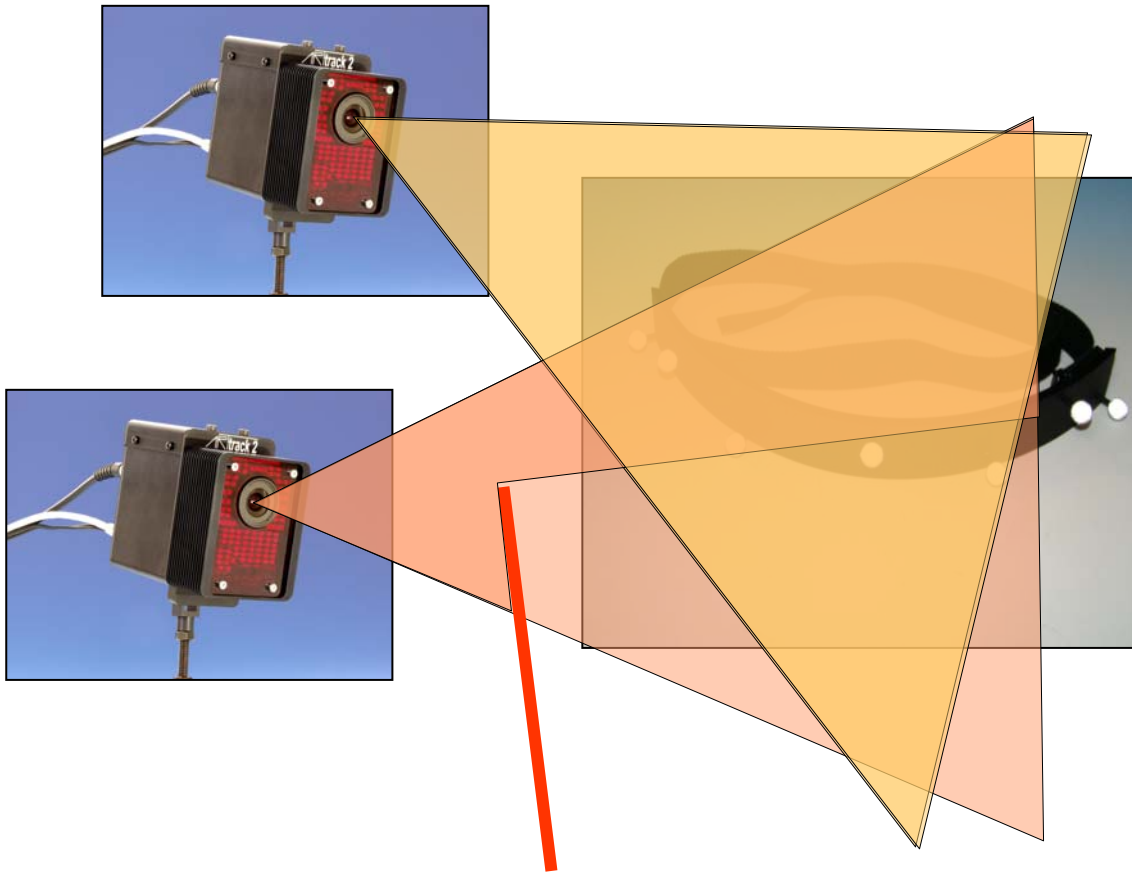




# Time multiplexing - no blinding



# Occlusions: large targets



## large redundant targets with >4 markers

- begin tracking  
if 4 markers are seen by  
2 cameras
- maintain tracking  
if *the same* 3 markers  
are seen by 2 cameras
- maintain tracking  
if *any* 3 markers are  
seen by 2 cameras (or  
similar conditions)

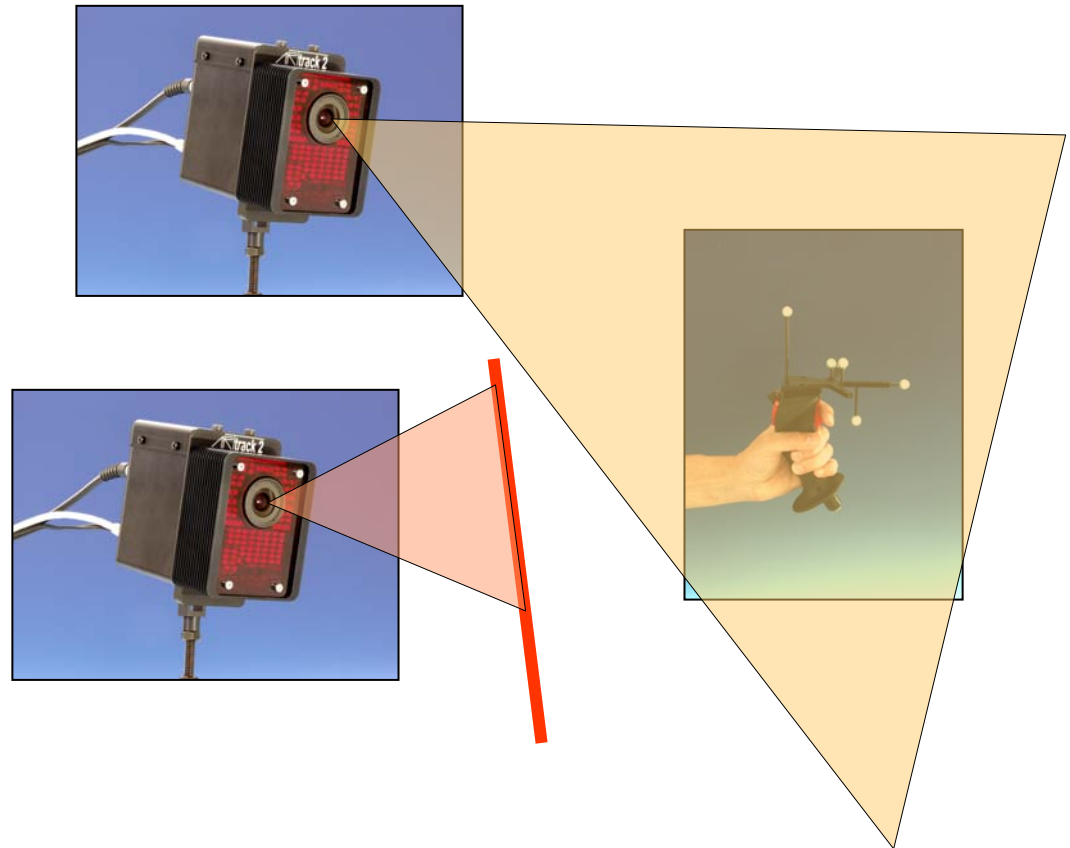
# Single camera tracking

- + Target geometry (body file)
- + Last 6 dof target coordinates before occlusion
- + 2dof information of one camera

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6 dof target coordinates can be calculated

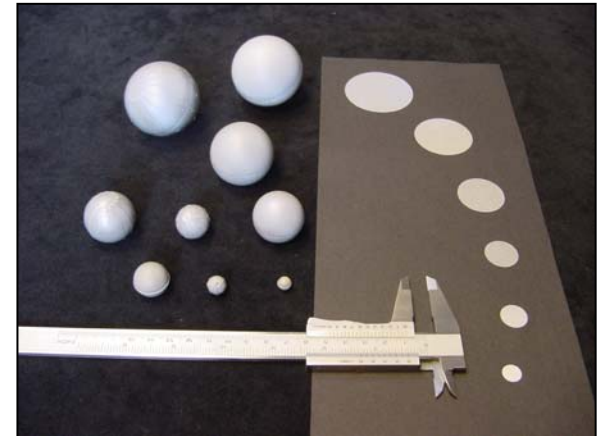
However: larger errors (compared to normal 2 camera tracking) in z direction (optical axis)



# Targets: improved accuracy

Merging markers: less accuracy

- **Improved pattern recognition algorithm**
  - Test for roundness (“marker quality”)
  - Feedback algorithm (adaptive pattern recognition)
- **non-merging targets** with
  - Flat round markers on planes
  - Unidirectional active markers
  - Addressable active markers

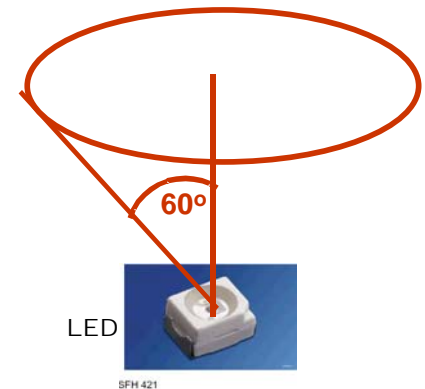
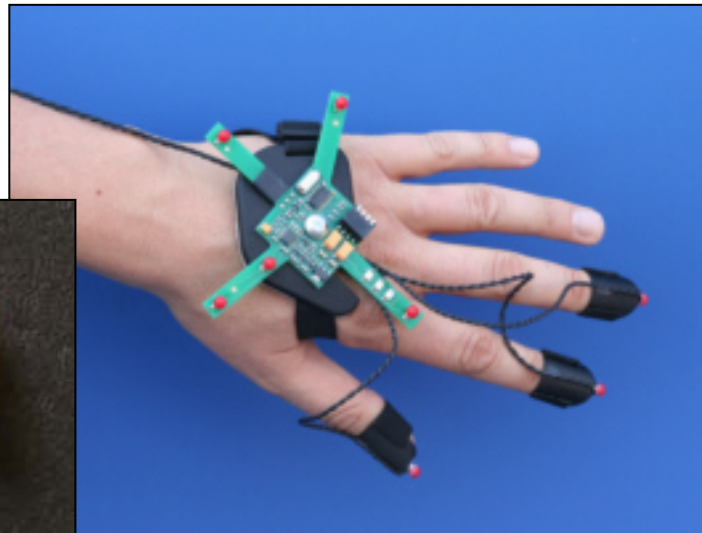
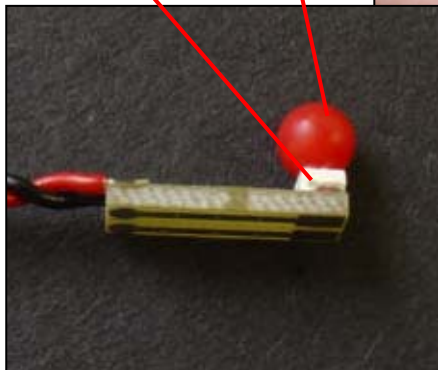


# Active markers and targets

- Welding gun
  - Unidirectional target planes
- Finger tracking
  - Time sequentially addressed active markers (wireless, controlled by camera IR flash)



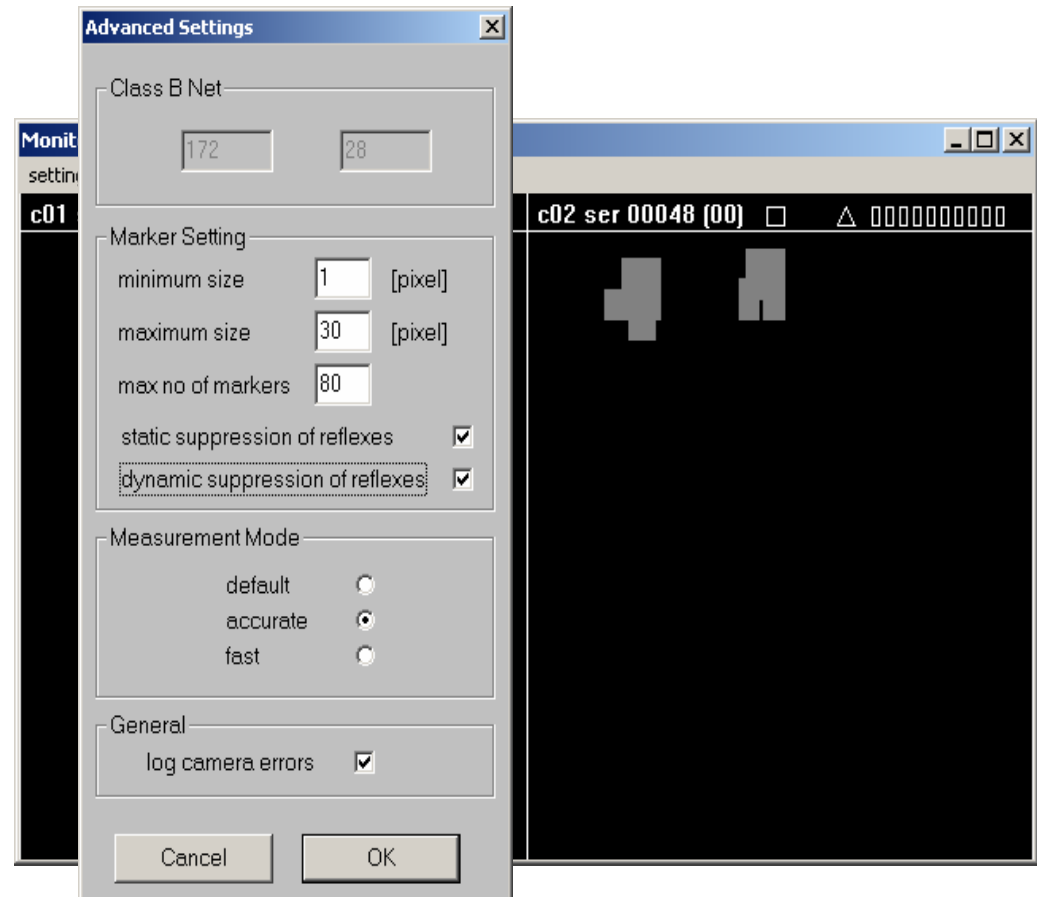
diffusing sphere  
IR-LED



# External Interferences

- **Unwanted reflections**
  - Retro reflecting objects:
    - sport clothes or sport shoes
    - car back lights
    - Car licence plate
  - Some metal surfaces
- **IR light sources**
  - Sun light
  - Light bulb illumination

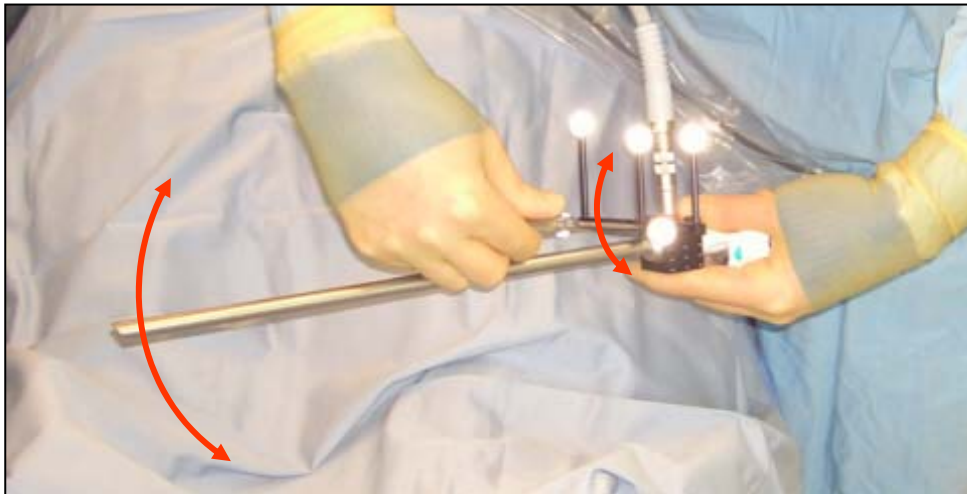
- **Static reflex suppression**
- **Dynamic reflex suppression**



# Hybrid (optical) tracking

<b>outside in</b>	<b>inside out</b>
fixed cameras, moving target(s)	fixed targets, moving camera(s)
high position accuracy	<b>high angular accuracy</b>
wireless moving objects: simple	wireless moving objects: difficult (radio transmission in real time)

## Tracked endoscope in minimal invasive surgery



Small angular error at target transfers into a large position error at tip of instrument

Foto: University of Erlangen  
Florian Vogt, sfb-603

- A lot of “special features” must be implemented in an optical tracking system to be
  - accurate and
  - reliable and
  - fast (realtime)

A.R.T. provides such tracking systems based on our own hardware and software.