

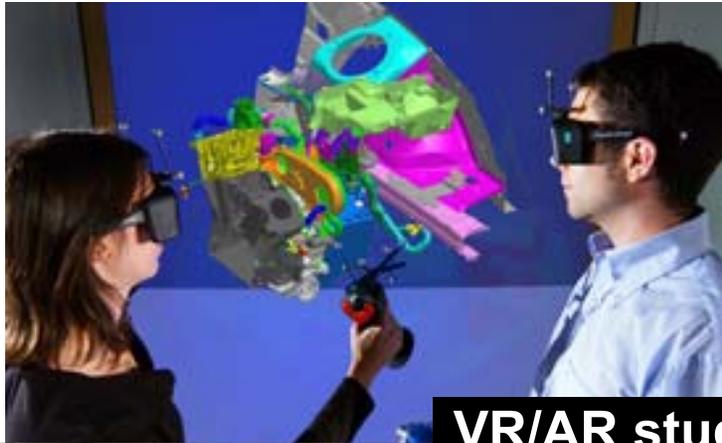
# Bringing Tracking from Labs to Industry: Challenges

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# Introduction

## Bringing Tracking from Labs to Industry



## Industrial environment (AR)



“Tracking”:  
A.R.T.’s tracking systems

- IR-optical
- inside out

# Introduction

## Bringing Tracking from Labs to Industry

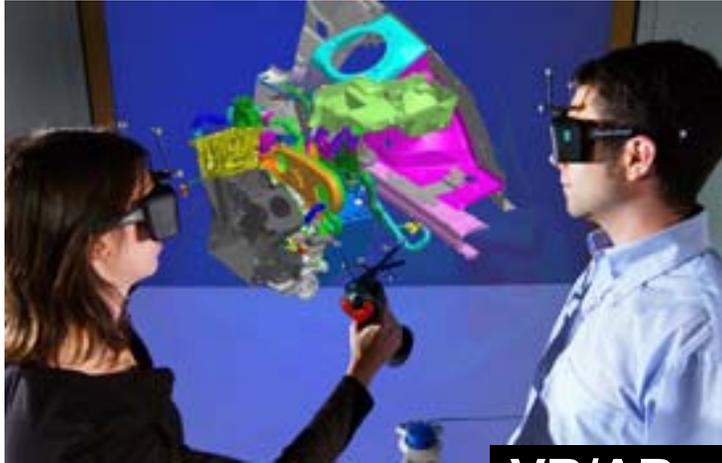


### Industrial environment (AR)



- Environment
- User-friendly operation
- Reliable operation
- Measurement volume
- Accuracy
- Speed

# Environment



**VR/AR studio**

## Industrial environment



- **Environment**
- **User-friendly operation**
- **Reliable operation**
- **Measurement volume**
- **Accuracy**
- **Speed**

# Environment



VR/AR Studio

**Clean**

**Dark**

**Silent**

**Constant temperature**

**Delicate equipment**

=>

=>

=>

=>

=>

=>



Industrial environment

**dust, smoke etc.**

**sunlight,**

**strong illumination**

**reflecting materials**

**noisy**

**changing temperature**

**mechanically robust**

# Environment: dirt, robustness



## Cameras

**sealed, no fan  
front window**

## Targets

**sealed  
covered passive markers  
wireless active markers (LEDs)**

## SW

**self diagnosis,  
error tolerant,  
self re-calibrating**

# Environment: Cameras

- No fan => heatsink
- Sealed
- Front window



# Environment: Targets, Markers

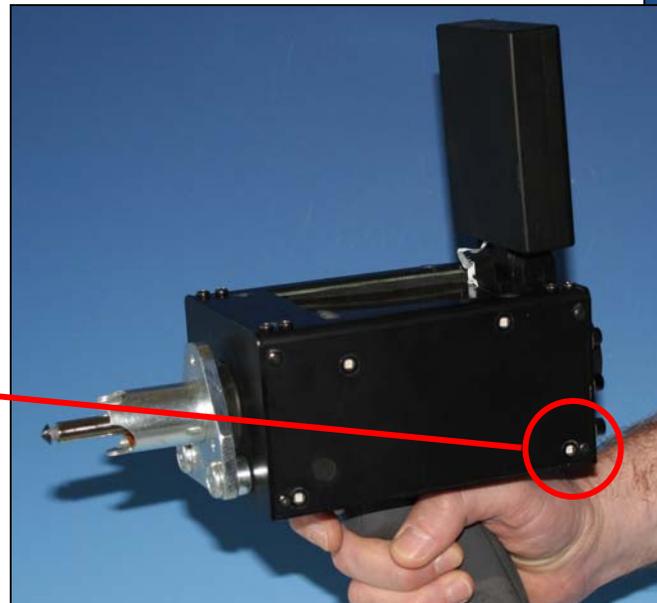
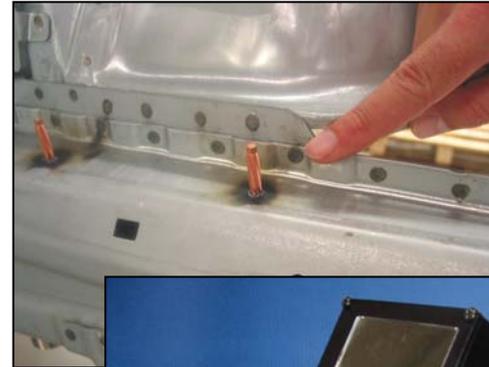
- Sealed
- Sometimes: covered passive markers possible
- **Wireless active markers (LEDs)**
  - covered – rugged
  - high intensity
    - Battery operation – energy efficiency required
    - Pulsed operation – synchronisation necessary
    - Wireless sync via modulated IR flash



# Example (1): Welding gun – stud welding



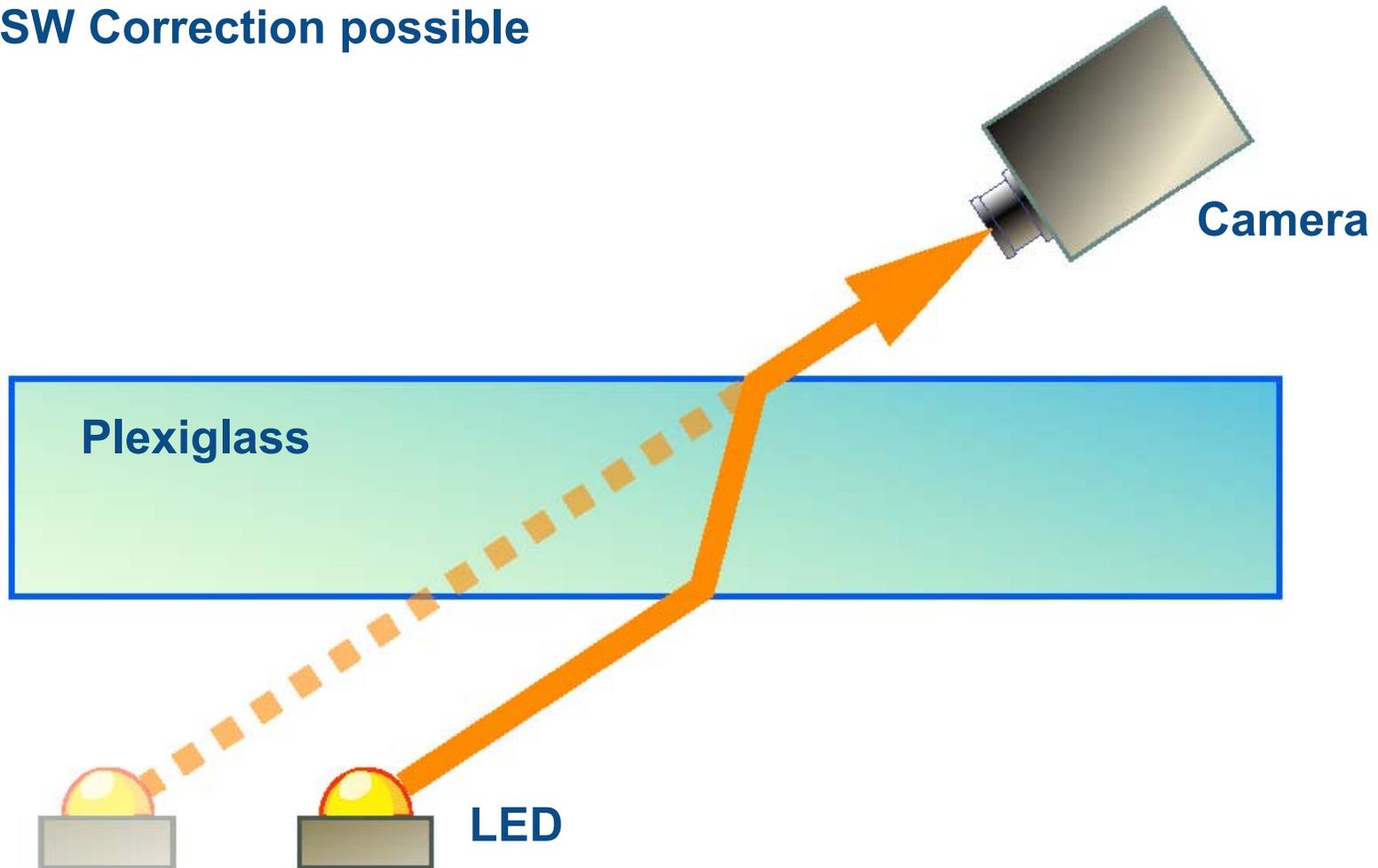
- Purpose: guiding the user to right place for stud welding
- Target: 3 or 4 planes with LEDs, covered with plexiglass – parallax problem
- Measurement point: tip (tip calibration)
- Display, buttons, welding sensor – complex user interface



# Parallax error

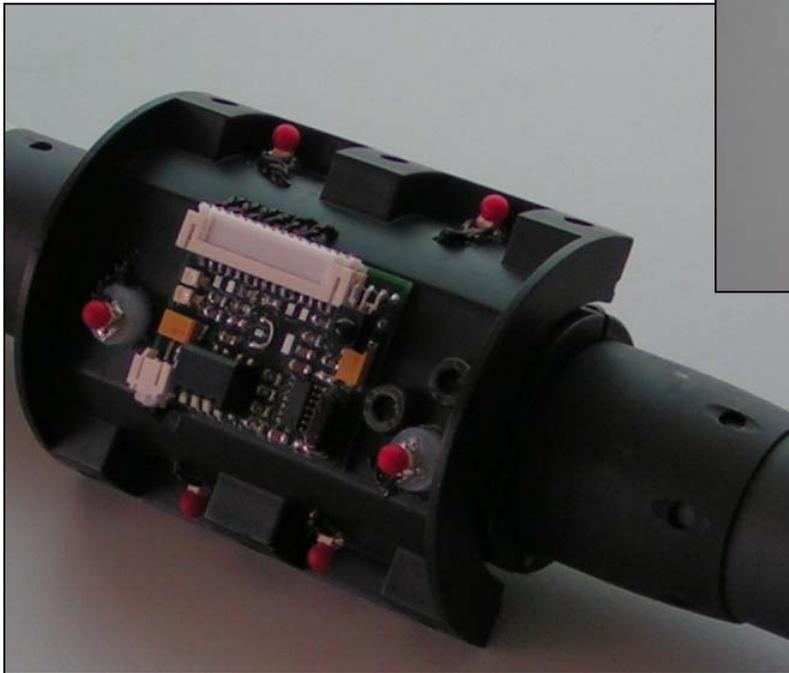


- SW Correction possible



# Example (2): electric screwdriver

- Purpose: adjusting the torque for each screw, quality control
- Active markers: LEDs with scattering spheres
- Curved plexiglass cover



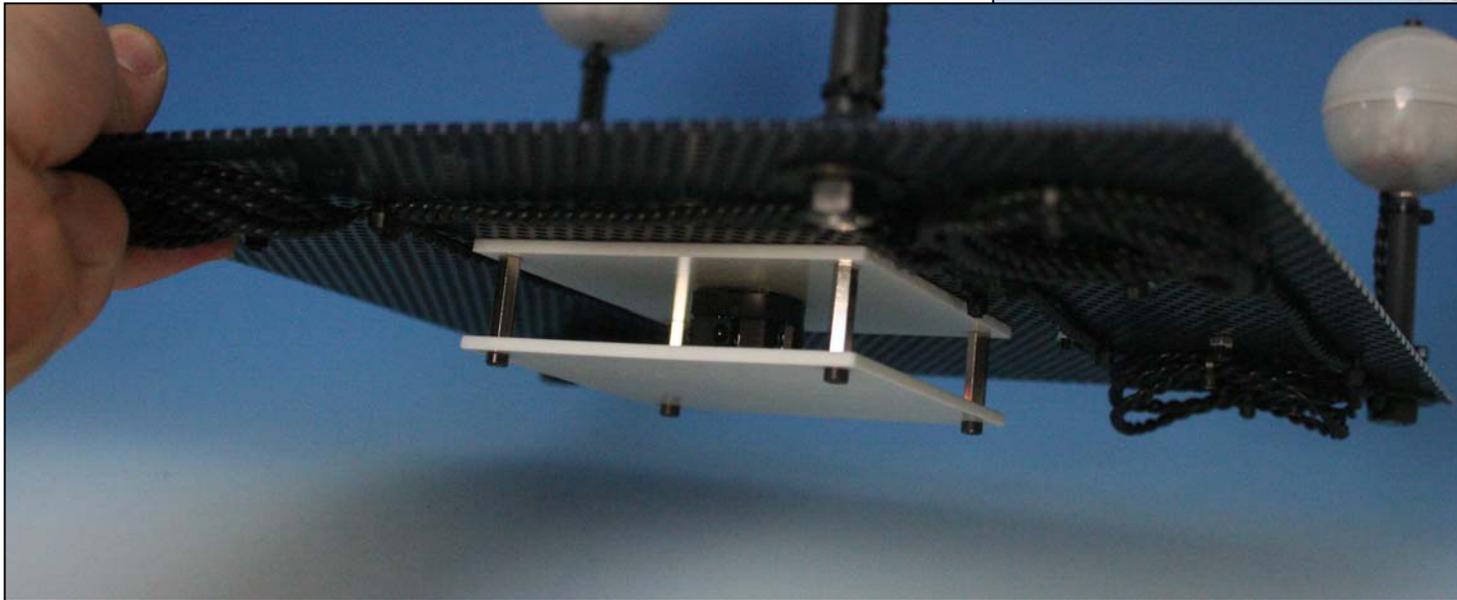
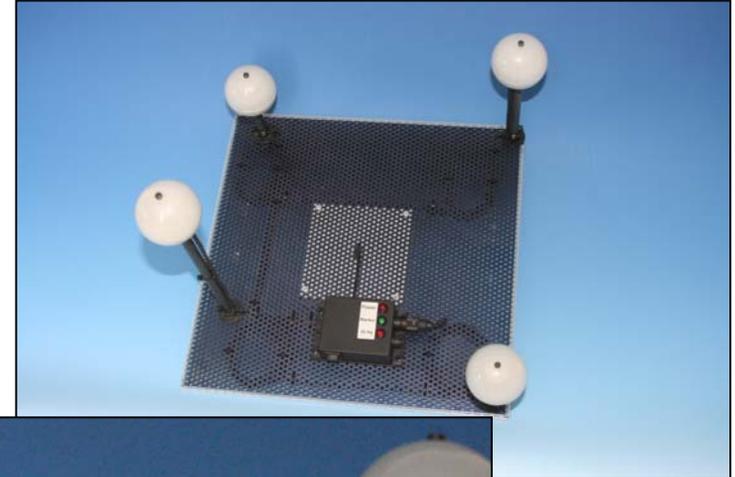
# Example (3): outdoor tracking

- Purpose: tracking a small robot
- strong active markers – 20m range
- 24 LEDs, pulse current = 24A
- Covered with spheres for light scattering



# Example (3): outdoor tracking

- **Wireless synchronization:** a modulated flash from one tracking camera triggers the target



# Environment: interfering light sources



**Cameras**

**interference filter**

narrow bandwidth spectral filter fitted to the IR LED spectrum

**Targets**

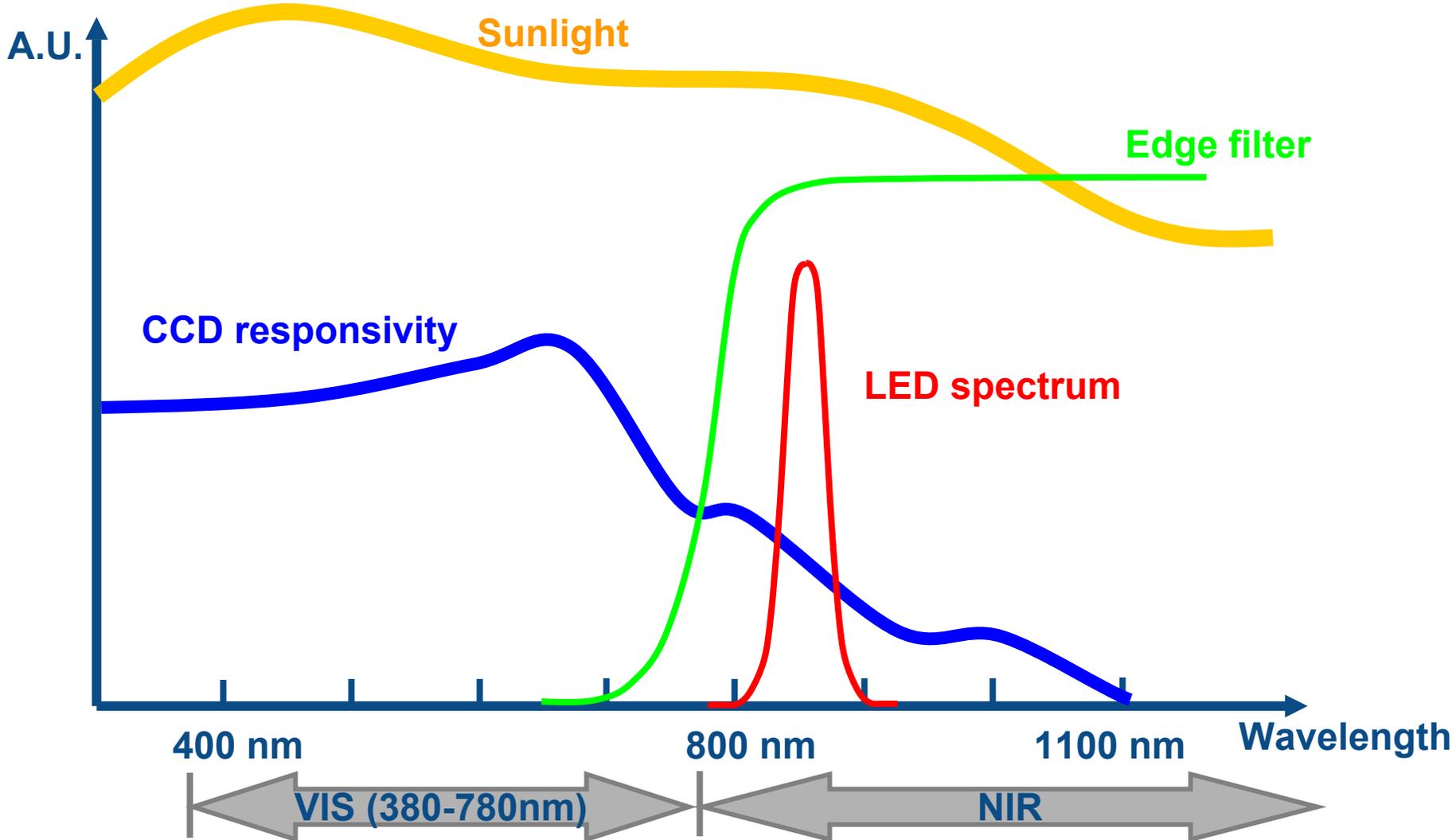
**high intensity markers**

**SW**

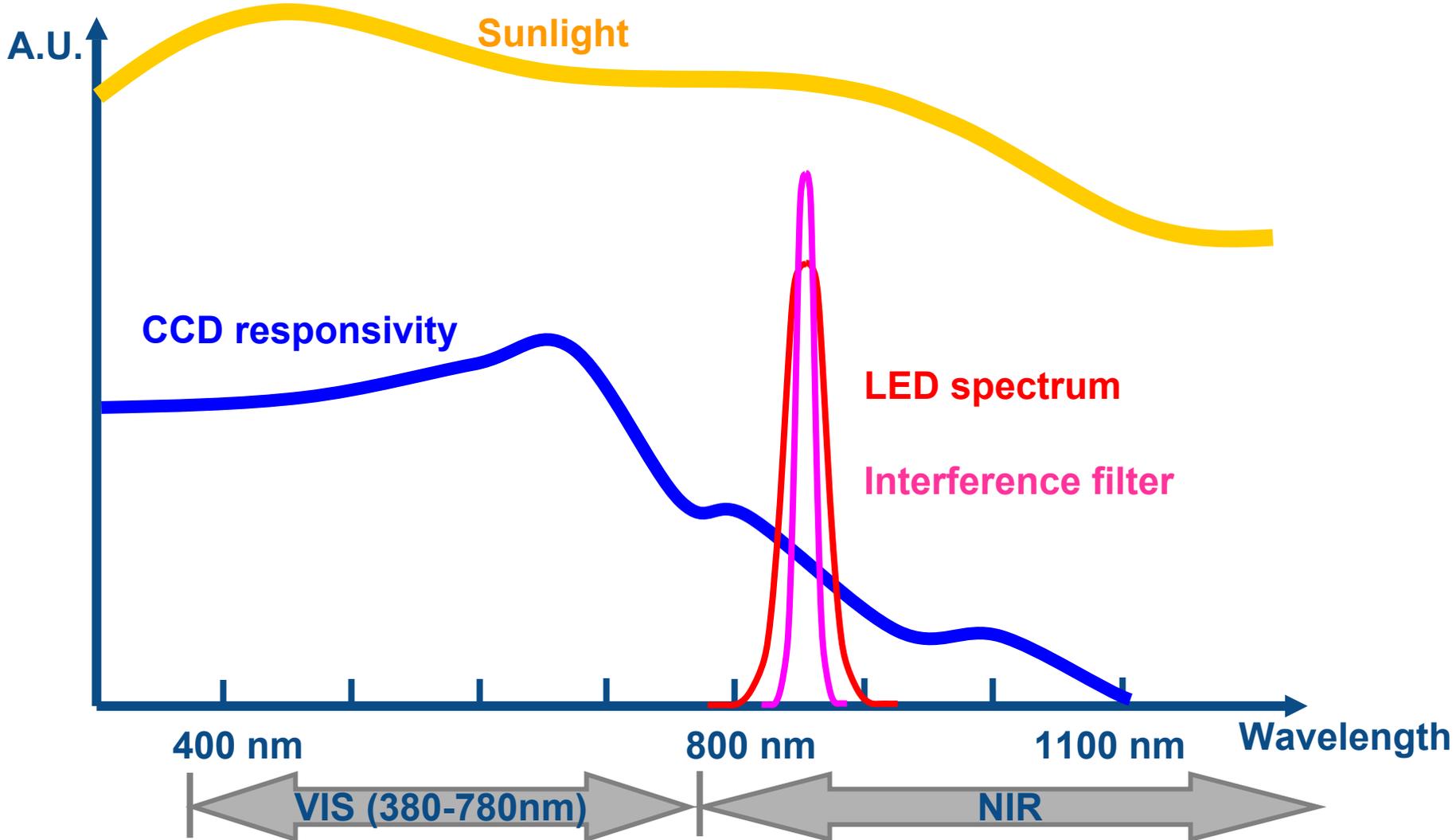
**error tolerant**

suppression of static/dynamic reflexes,  
**target concept** (not single markers)

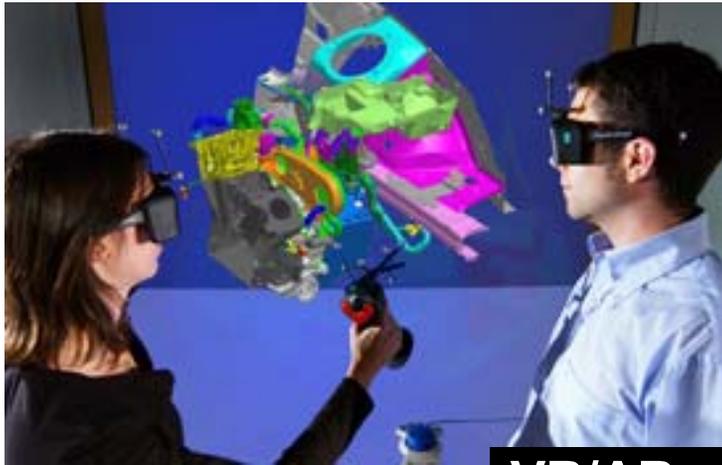
# Spectral issues – outdoor use



# Spectral issues



# User-friendly & reliable operation



**VR/AR studio**

## Industrial environment



- Environment
- **User-friendly operation**
- **Reliable operation**
  
- Measurement volume
- Accuracy
- Speed

# User friendly operation/human centered



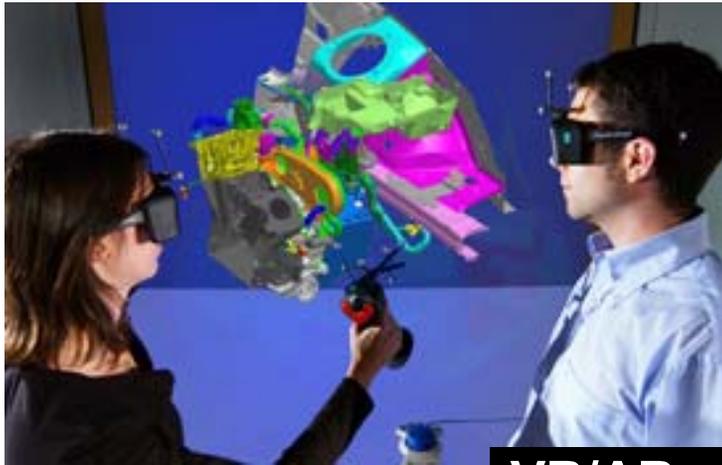
- for AR almost unskilled user
- Good man-machine interface
- Line of sight problem
  - Problem not only for optical tracking
    - Any electromagnetic wave (microwave, light etc.)
    - Reflections and multi path propagation
    - Both for bearing (direction finding) and time of flight principle
  - Many cameras (redundancy) – expensive
  - Second tracking modality
    - Local & autonomous
    - Sensor fusion

# Reliable operation



- **In production environments: any failure costs a lot**
- **Redundant systems**
  - N+1 tracking cameras, 2 PCs
- **Self diagnosis**
  - Is actual accuracy acceptable?
- **Quick exchange of system components**

# Measurement volume, accuracy, speed



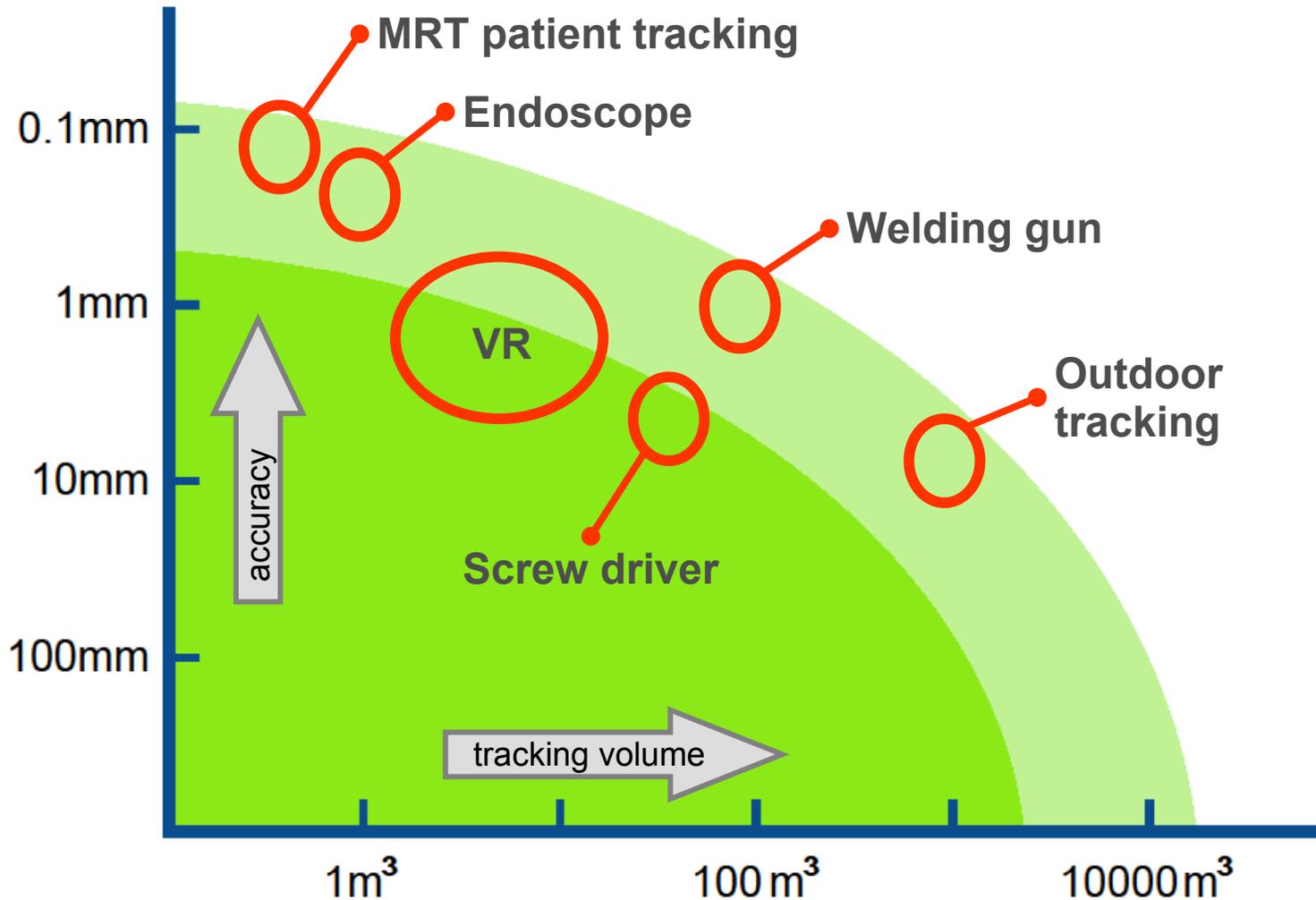
**VR/AR studio**

## Industrial environment



- Environment
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# Accuracy vs. volume: examples



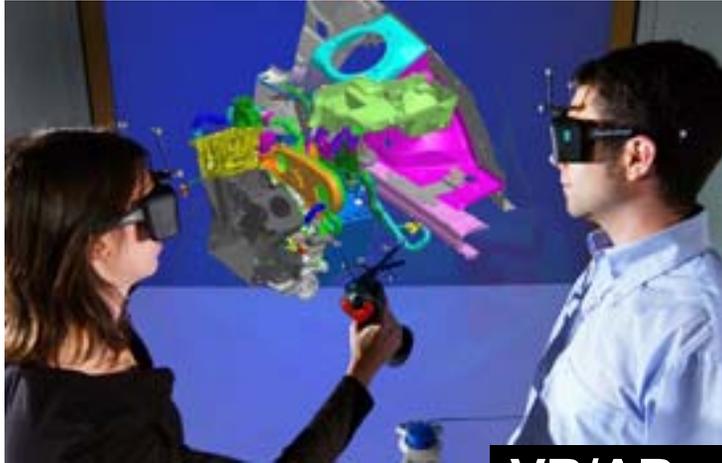
# Requirements



## Screwing machine vs. welding gun

	<b>electric screwdriver</b>	<b>welding gun</b>
<b>working points</b>	well defined working positions (screws)	free selectable working points
<b>task</b>	automatic adjustment of correct torque	guiding the user to correct working point
<b>task</b>	control of correct order	
<b>task</b>	quality control	quality control
<b>measurement volume</b>	small (car engine)	medium (around car body)
<b>accuracy</b>	low	high

# Summary



**VR/AR studio**



## Industrial environment



- robust cameras
- robust (active) targets
- error tolerant and user friendly SW

**Thank you for your attention**