Combination of Inertial Survey Systems and GNSS for Surveying

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Imego - Part of Swedish ICT

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Overview

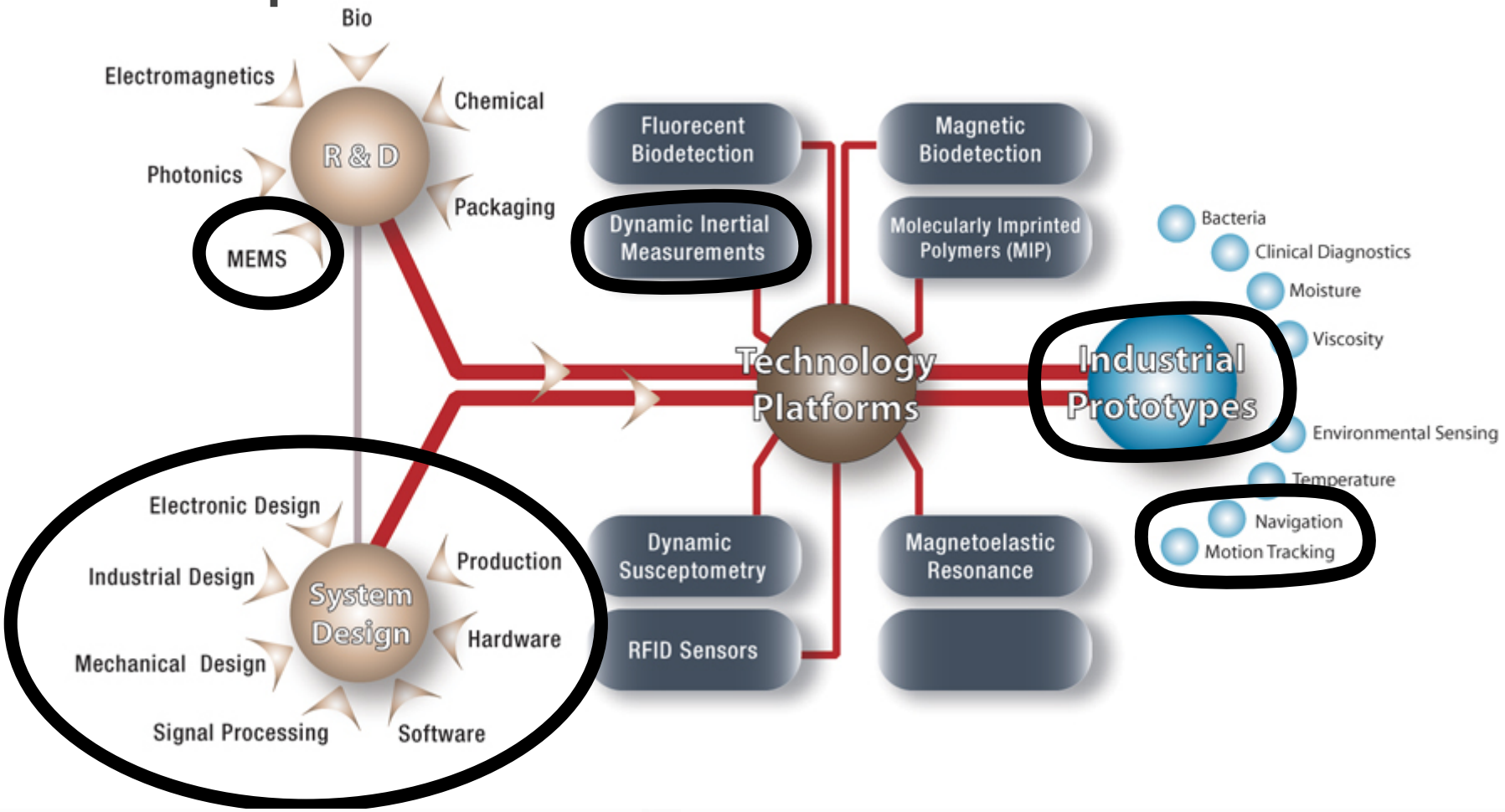
Introduction

- **Imego in general**
- **Imego's inertial sensors, systems and applications**

GNSS + INS

- **Comparison GNSS / Inertial Navigation Systems (INS)**
- **GPS Shadow Explorer (2004)**
- **Performance now and in the future**

Imego: a research institute focusing on microsensors, sensor systems and prototype development



Imego's applications in motion tracking

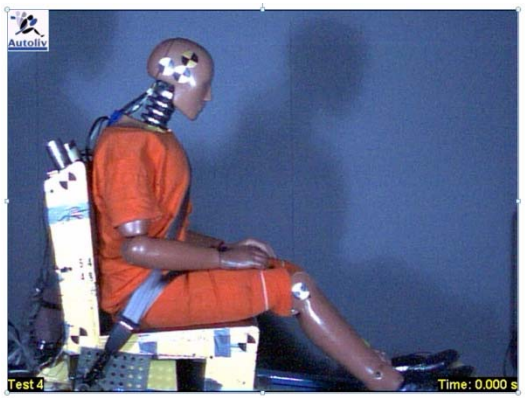
Surveying

Drill hole measurement

Fireman localization

Rocket navigation

Sport



Crash tests

+ Other applications

Imego's IMU-history

IMU = Inertial Measurement Unit

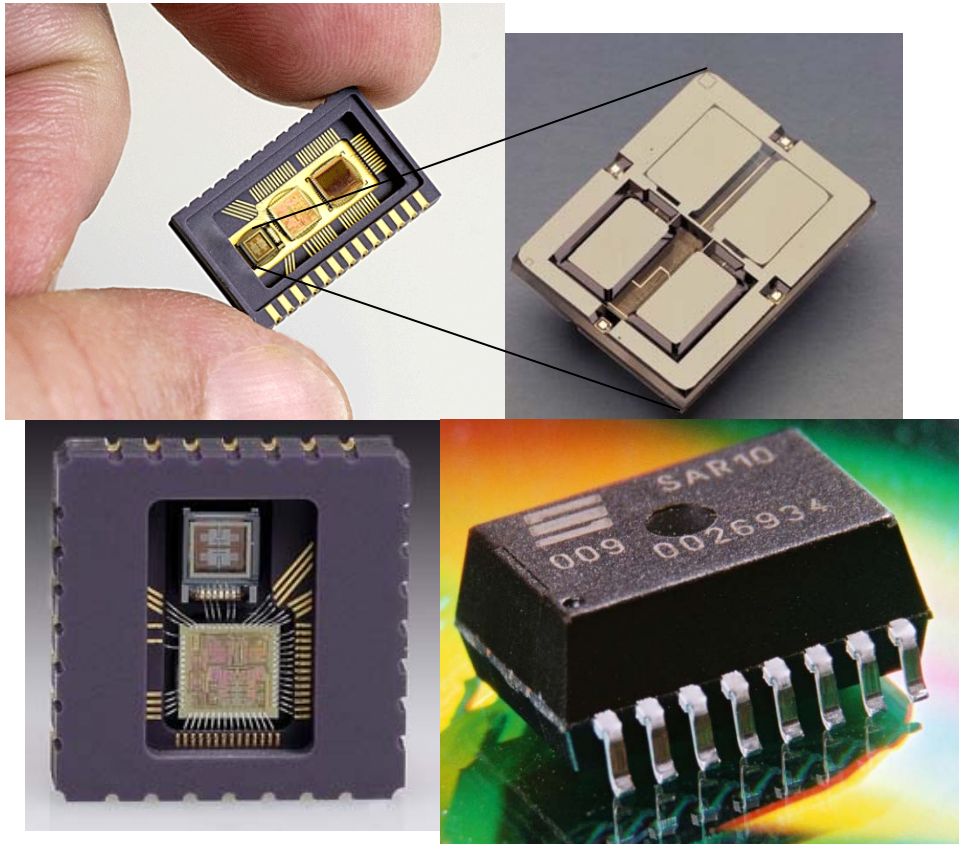
IMT 6000

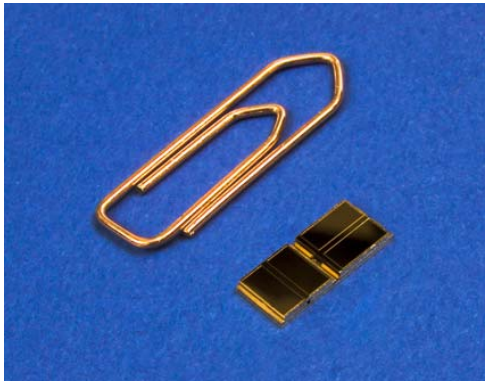
GyroSmart

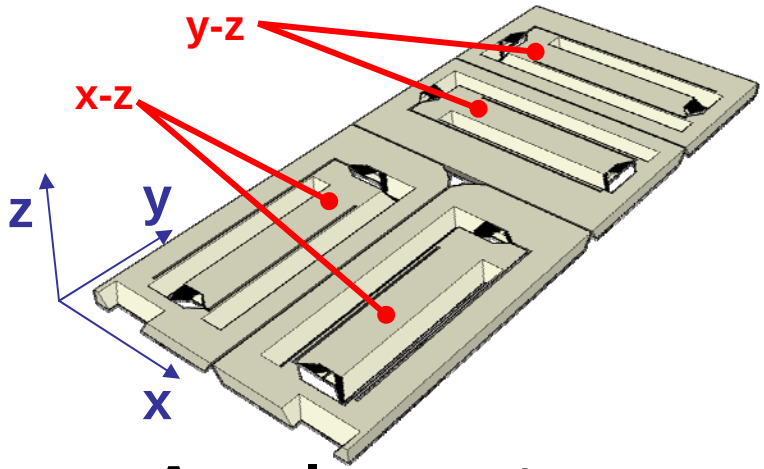
IMT30

IMT40

Imego's inertial sensors with MEMS-technology



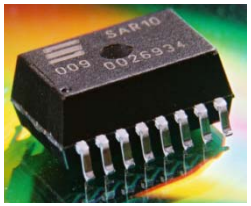


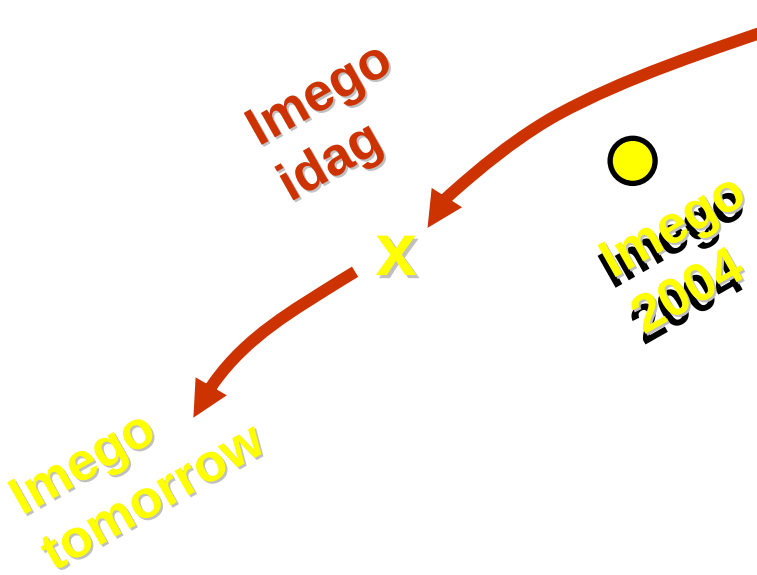


Gyroscopes
– measure angular velocity

Accelerometers
- measure linear acceleration

Gyro technologies





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GNSS compared to INS

Satellite navigation

- Absolute position data
- Limited resolution
- Slow
- Worse at orientation
- Easily disturbed
- Best at X&Y

Inertial navigation

- Drift in integrated terms
- High resolution (rel.)
- Fast (kHz)
- Best at orientation
- Disturbance-free (no external ref)
- Best at Z

- complement eachother well!

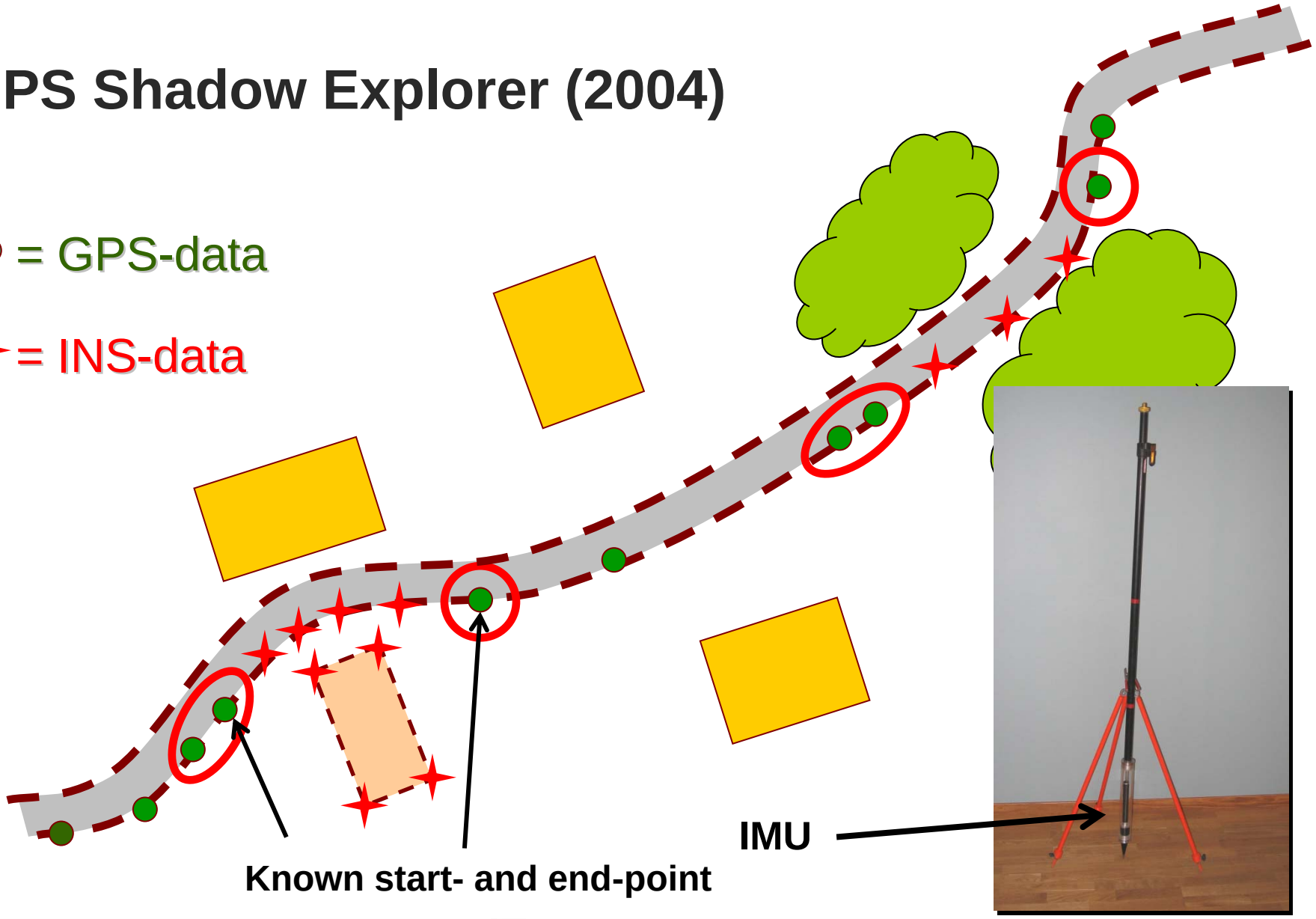
GPS Shadow Explorer (2004)

- Demonstrator
- With Lantmäteriet (National Land Survey) and other governmental inst.
- Inertial navigation used during GNSS/RTK shadow intervals
- Light and (relatively) inexpensive

GPS Shadow Explorer (2004)

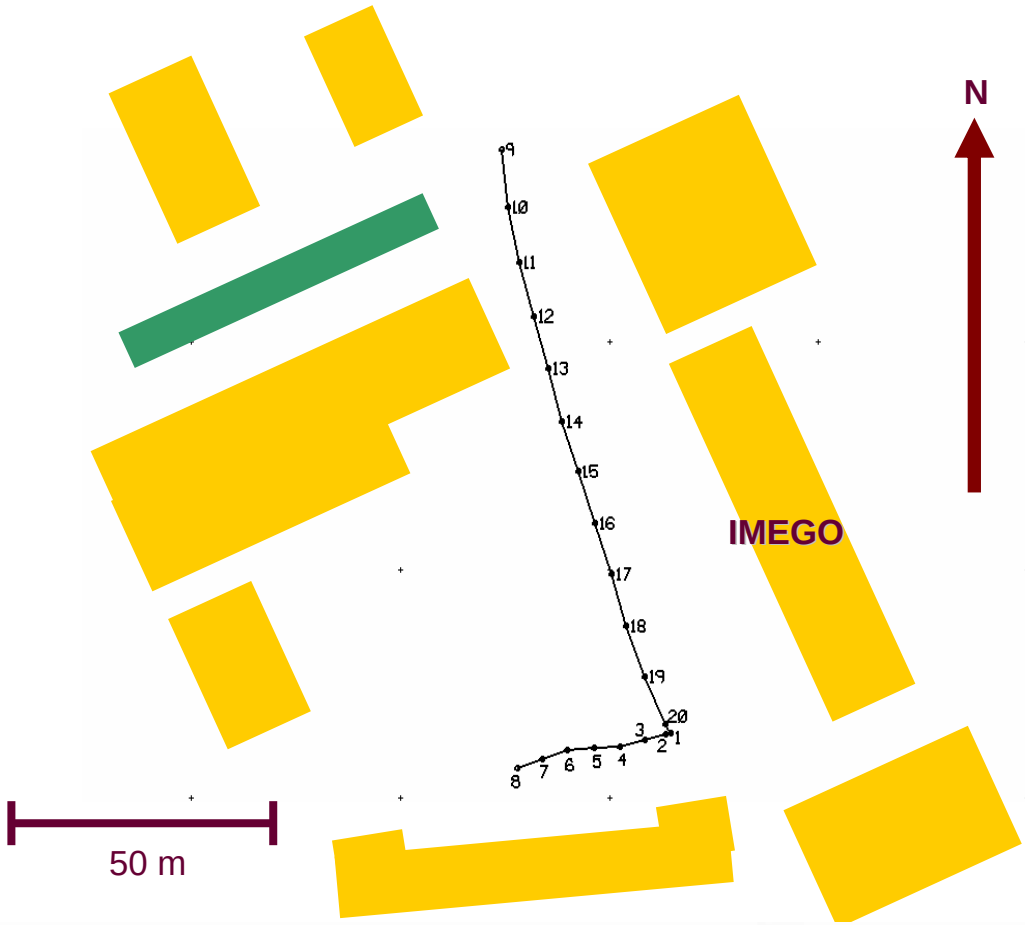
= GPS-data

= INS-data



GPS Shadow Explorer (2004)

- Two reference courses with a number of measured points 5/10 m apart



- Measuring rod is held at the known-point markers
- Pauses appr. 2 s
- 5/10 s between points
- Known start- and end-points, inbetween GPS-shadow

GPS Shadow explorer

GPS Shadow Explorer

IMEGO

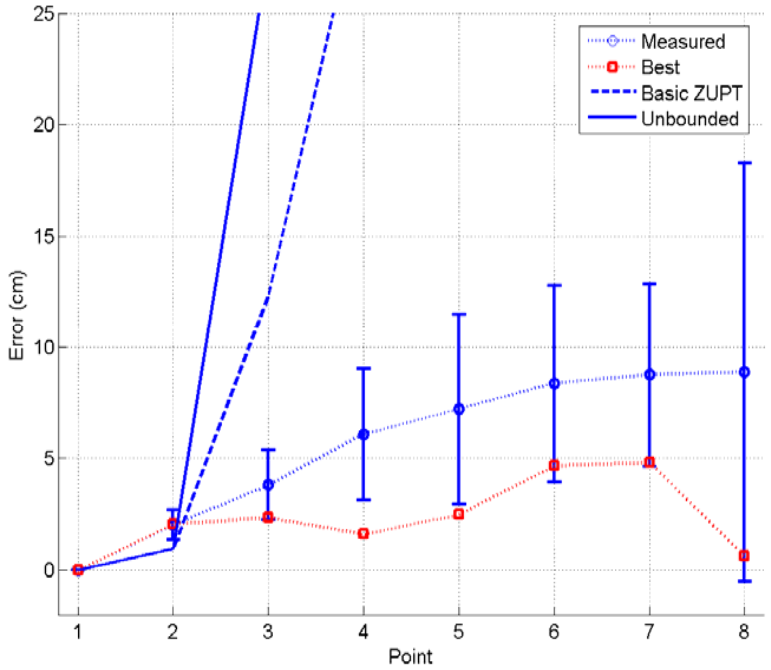
Applied Micro Sensor Systems

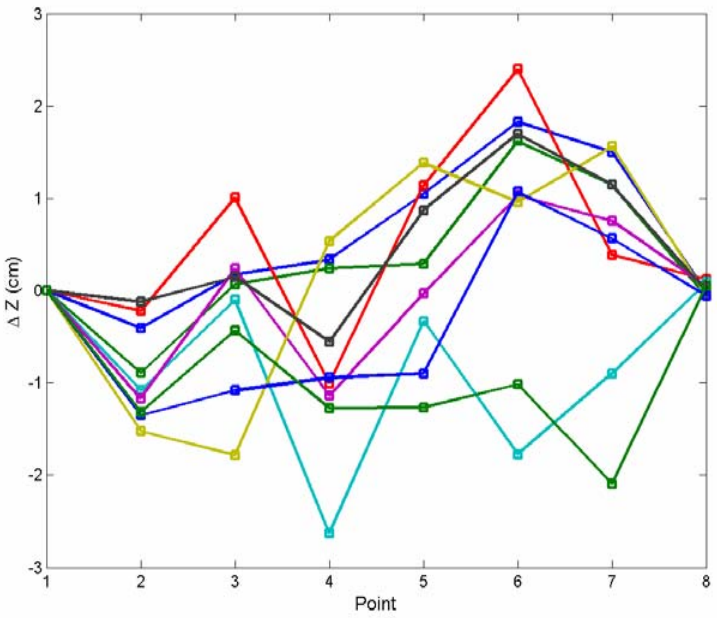
Navigation software

- **Kalman filter**
- **Pauses identified**
- **ZUPT - zero velocity update**
  - recalibration of offset-values of gyros and accelerometers
  - at pauses when measuring rod is held fixed on the ground
- **Navigation performed between pauses**
- **Coordinates of start- and end-points known (GPS)**

Results 2004

Short course (appr. 50s, 35 m):



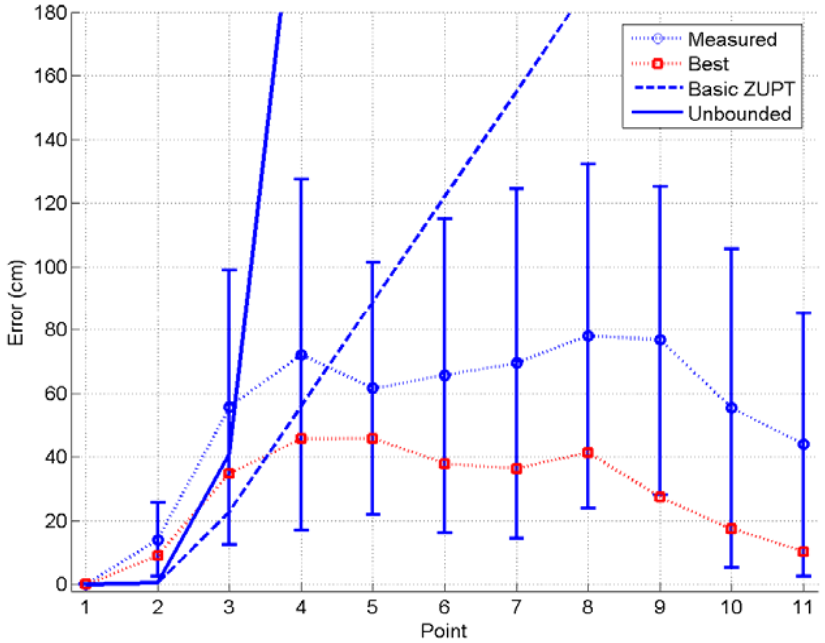


9 cm horisontal accuracy

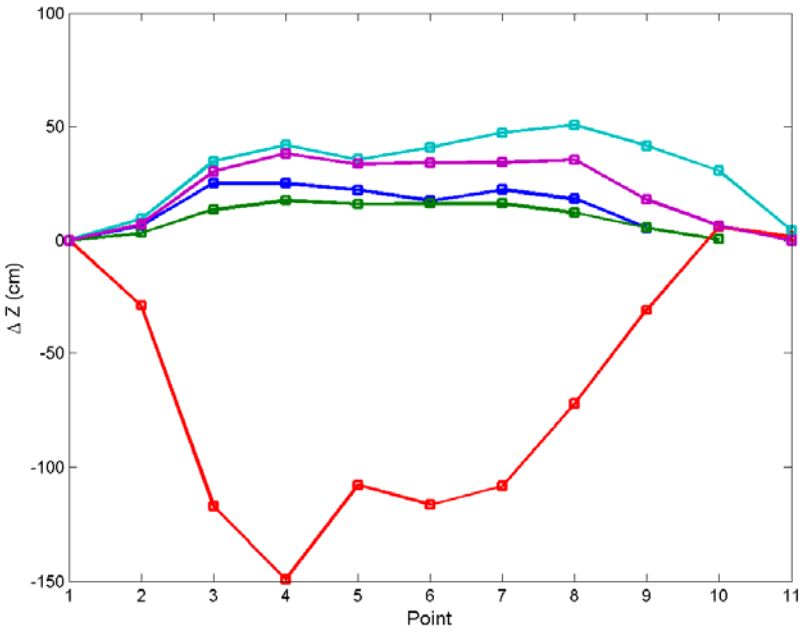
1 cm vertical accuracy

Results 2004

Long course (appr. 120 s, 100 m):



51 cm horisontal accuracy



13 cm vertical accuracy

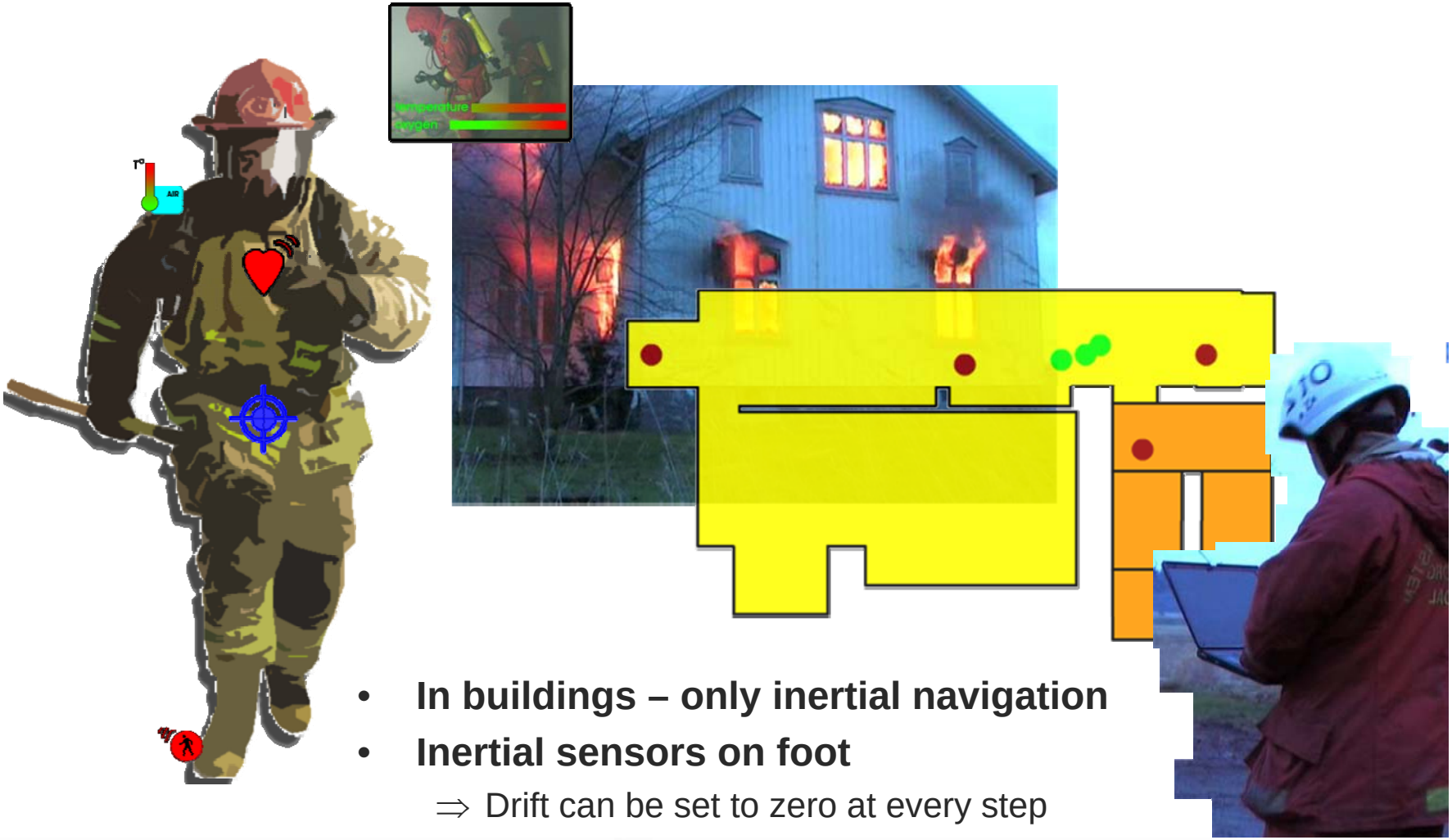
Then, Now, Tomorrow

- **GPS Shadow Explorer 2004**
  - Analog gyroelectronics and 30 deg/h bias-stability
  - 51 / 13 cm (h/v) error after 120 s with known start- and end-points

- **Present generation's digital IMU (2009)**
  - IBG20/21 gyros with appr. 1-3 deg/h bias-stability
  - 5 / 2 cm (h/v) error after 100 s *without known end-point*

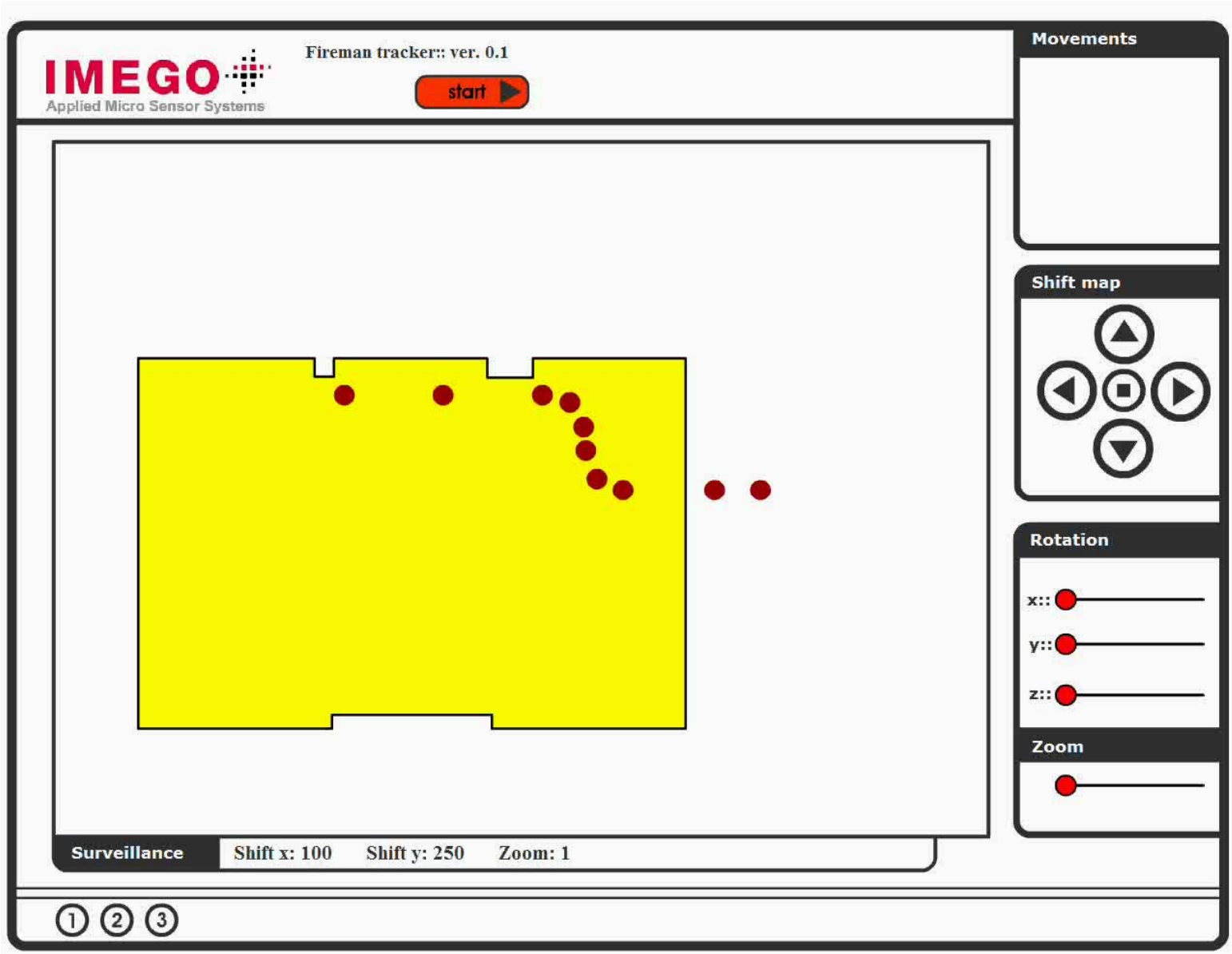
- **Next generation gyros (under development)**
  - Goal: appr. 10 times better performance
- **Tight integration between INS and GNSS**
  - INS used to support GNSS's phase tracking

Personal navigation – fireman localization



- **In buildings – only inertial navigation**
- **Inertial sensors on foot**

  ⇒ Drift can be set to zero at every step


IMEGO
Applied Micro Sensor Systems
Fireman tracker:: ver. 0.1
start
Movements
Shift map
Rotation
x::
y::
z::
Zoom
Surveillance
Shift x: 100
Shift y: 250
Zoom: 1
1
2
3


IMEGO
Solutions beyond sensors
Part of Swedish ICT

Personal navigation (INS only) - stairs

Due to zero-velocity updates,

drift is minimized