iGPS used as Kinematic Measuring System

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Introduction

- **iGPS**
  - Formerly Arcsecond, then Metris
  - Since November 2009 – Nikon Metrology NV
- **Used by industrial manufactures**
  - Aerospace, automotive and shipbuilding industries
- **Static and kinematic measurement mode**
  - Rapid development of iGPS system
  - Advancements in kinematic mode

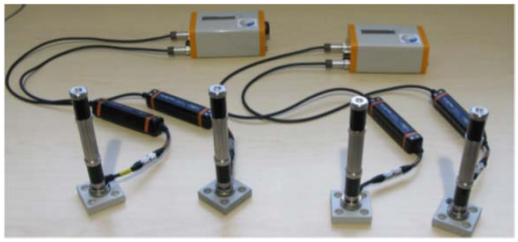
Introduction

- Laser-based indoor system
- Internal time measurements of spatial rays
- Process of triangulation

- Measurement range 2 – 40 m
- Static accuracy < 0.2 mm (depending on numbers of transmitter and geometry)

iGPS Technology

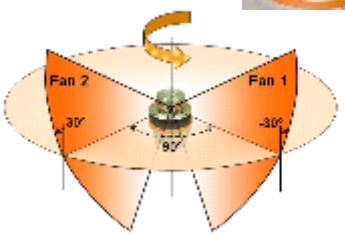
- **Components of an iGPS network**
  - At least 2 transmitters
  - Mini-vector bar with 2 sensors
  - Amplifier as analog-digital converter
  - Position calculation engine (PCE)
  - Scale-bar for the network



iGPS Technology

- **Transmitter**
  - Rotational speed 40-50 Hz
  - Emits 2 types of signals
  - Strobe signal into the whole working volume
  - 2 fan-shaped beams

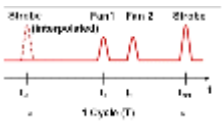
- **Fan**
  - Beam width of ± 30°
  - Separated by 90° (horizontal)
  - Tilted at 30° to the spin axes



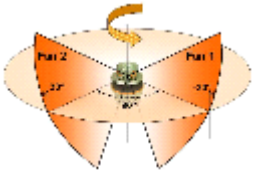
- **Sensor**
  - Receives signals from each visible transmitter
  - Arrival time is measured

iGPS Technology

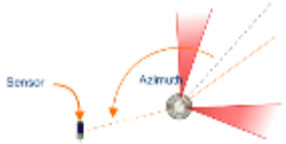
- **Angle values based on time measurement and fan beams geometry**

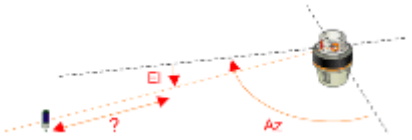


- **Elevation**
  - Time interval between fan beam 1 and 2



- **Azimuth**
  - Reference time of the strobe
  - Time interval of mean of fan beam 1 and 2





Kinematic Mode of iGPS

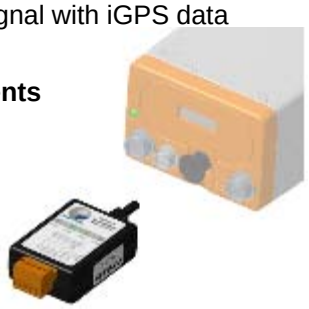
- **Measurement principle is based on time measurements of non-synchronous signals**
- **The sensor moves during a time measurement**
- **Delay times for azimuth and elevation determination**
- **Elimination of these effects**
  - Good internal time base
  - Interpolation method

4D Test and Calibration System

- **Delay time determination**
- **Time-referenced system (real time)**
- **Tiltable rotating arm**
- **Angular position $U_{k=2}$= ± 4.2"**
- **Velocities up to 6 m/s (rotating arm end)**

Time Referencing

- **Analyzing the kinematic performance of iGPS time-referenced measurements are strictly necessary**
- **PCE Digital Input Module**
  - Since summer 2009
  - Synchronize an external digital input signal with iGPS data
- **DIM enable time-referenced measurements**
- **Function generator as external trigger**



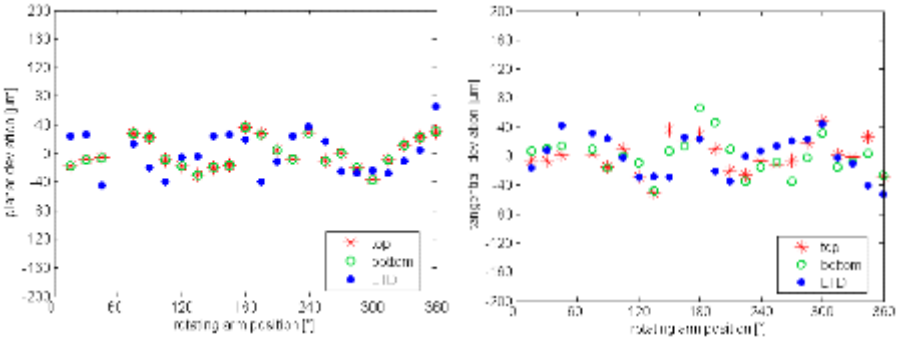
Measuring Result Examples

- **Measurement procedure**
  - 4 transmitter around the rotating arm
  - Mini-vector bar at the rotating arm end
  - Scale bar for bundling
  - Different rotating arm positions (horizontal, slant, vertical)
  - Angular velocities up to 160°/s (3 m/s)
  - Leica laser tracker LTD 500 (vertical rotating arm)
  - Surveyor software version 1.2.30




Static Measurement

- Horizontal rotating arm position
  - iGPS (top and bottom sensor)
  - Laser tracker (LTD)
- 3D circle
  - Planar and tangential deviations < ± 60µm



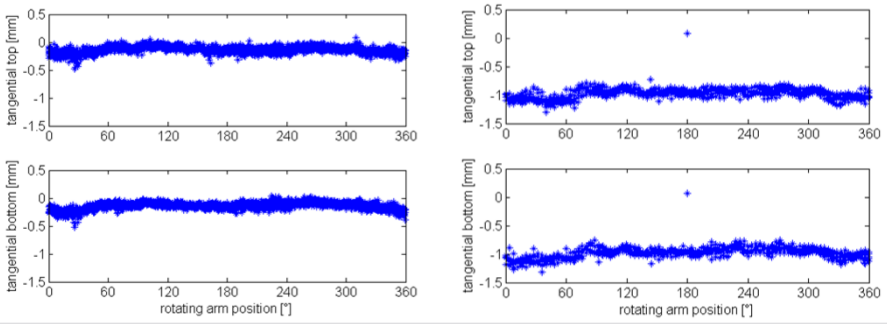
Kinematic Measurement

- Horizontal rotating arm position
  - iGPS (top and bottom sensor)

4D

- 20°/s (0.4 m/s), 4 revolutions
- Tangential deviations < -0.5 mm
- 160°/s (3 m/s), 4 revolutions
- Tangential deviations < -1.3 mm

spatiotemporal – position and time



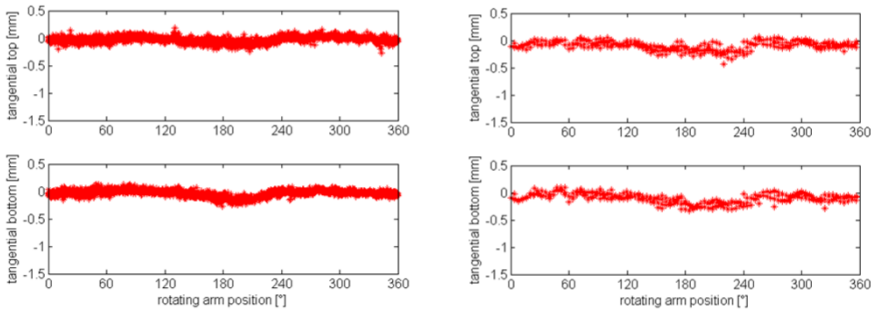
Kinematic Measurement

- Horizontal rotating arm position
  - iGPS (top and bottom sensor)

3D

- 20°/s (0.4 m/s), 4 revolutions
- Tangential deviations < -0.2 mm
- 160°/s (3 m/s), 4 revolutions
- Tangential deviations < -0.3 mm

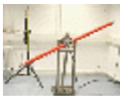
time - offset 0.3 ms – spatial – path tracking



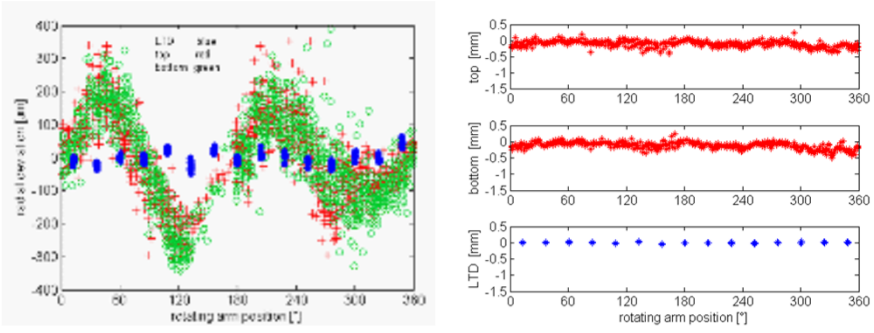
Kinematic Measurement

- Vertical rotating arm position
  - iGPS (top and bottom sensor)
  - Laser tracker (LTD)

3D



- This geometrical configuration is not well suited to the iGPS system but the only configuration to use iGPS and laser tracker together
- 120°/s (2.2 m/s), 4 revolutions, radial and tangential deviations



Conclusion

- The aim was to analyze the kinematic performance of iGPS system
- The system could collect and process data up to velocities of 3 m/s
- Spatiotemporal – time offset ("running ahead" about 0.3 ms)
- Tracking deviations
  - "spatial" (3D) at 3 m/s less than 0.3 mm
  - "spatiotemporal" (4D) at 3 m/s less than 1.3 mm
- The development of latest iGPS system has reached to reduce the theoretical delay time
- iGPS can be used as a static or kinematic measuring system
- Due to the flexible measuring performance iGPS provides an interesting range of applications

Thank you very much for your attention