



Independent Testing of Locata: *A New High Accuracy Indoor Positioning Systems*

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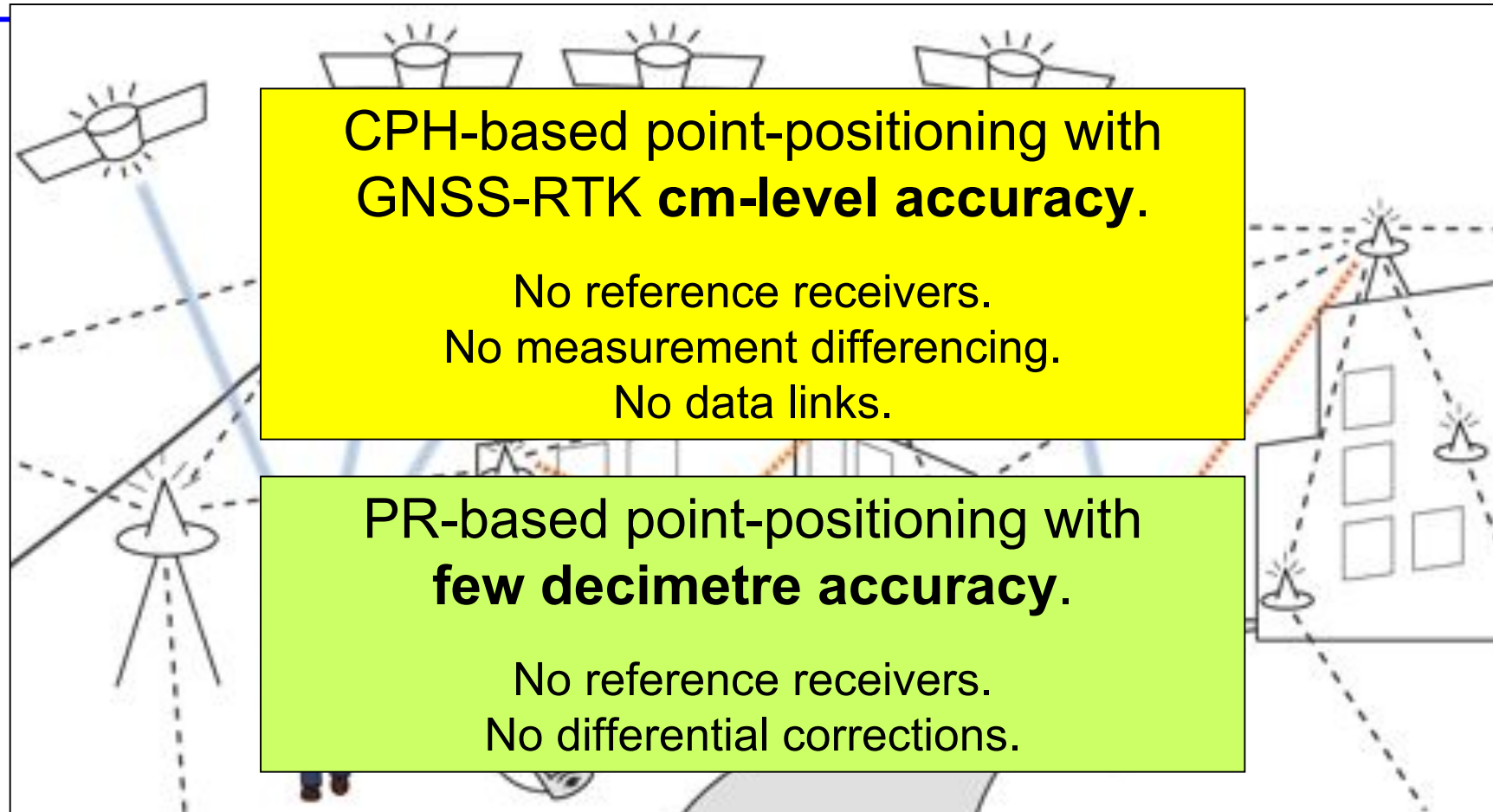
Never Stand Still

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Introductory Remarks

- GNSS signals can be obstructed outdoors leading to loss of availability, & *are vulnerable to RFI*.
- GNSS signals are attenuated indoors, & *cannot give performance similar to outdoors*.
- APNT systems such as *Locata* can address availability issues *both outdoors & indoors*, for land and air applications, *including at cm-accuracy*.
- New directional antenna technology appears to have addressed multipath & RFI issues.
- Now have option for indoor *local positioning system* with similar performance as (unobstructed GNSS).

Locata Positioning Concept



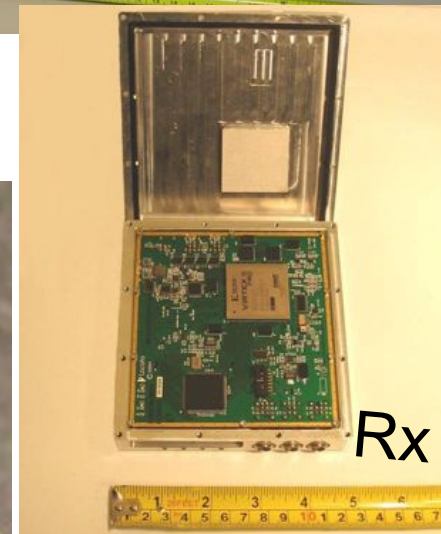
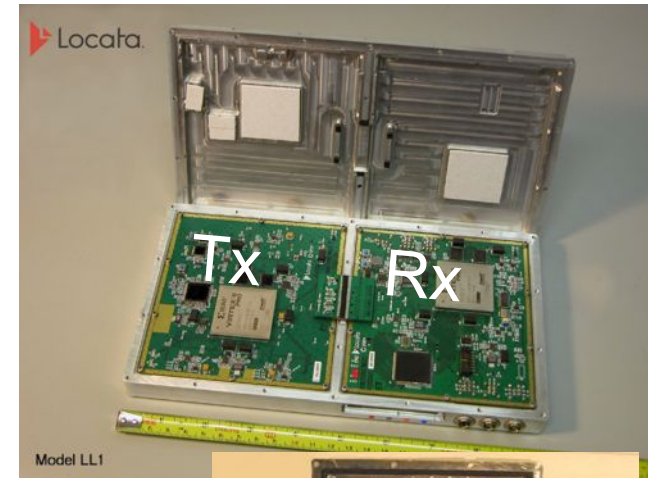
Locata receiver can use signals from *LocataNet*.

Integrated *Locata* & GNSS receiver possible for certain applications.

But once a *LocataNet* is established it can operate independently of GNSS.

Locata... *Current System*

- Signal Structure
 - Licence-free ISM frequency band (2.4GHz)
 - Dual-frequency carriers
 - Bespoke CDMA PRN codes - *ICD released Sept 2011 at ION-GNSS*
 - Precise TDMA pulsing - *for near-far problem*
 - >1 Watt output power - *range of over 10's km*
- *LocataLite*
 - Time-synchronised transceiver network
 - Dual Tx antennas
 - Prototype has modular board design based on FPGA technology
 - Uses low-cost clock (TCXO), shared by receiver section
- *Locata Receiver*
 - CPH or PR single point-positioning
 - CPH AR at known point or OTF
 - Real-time positioning at 10Hz



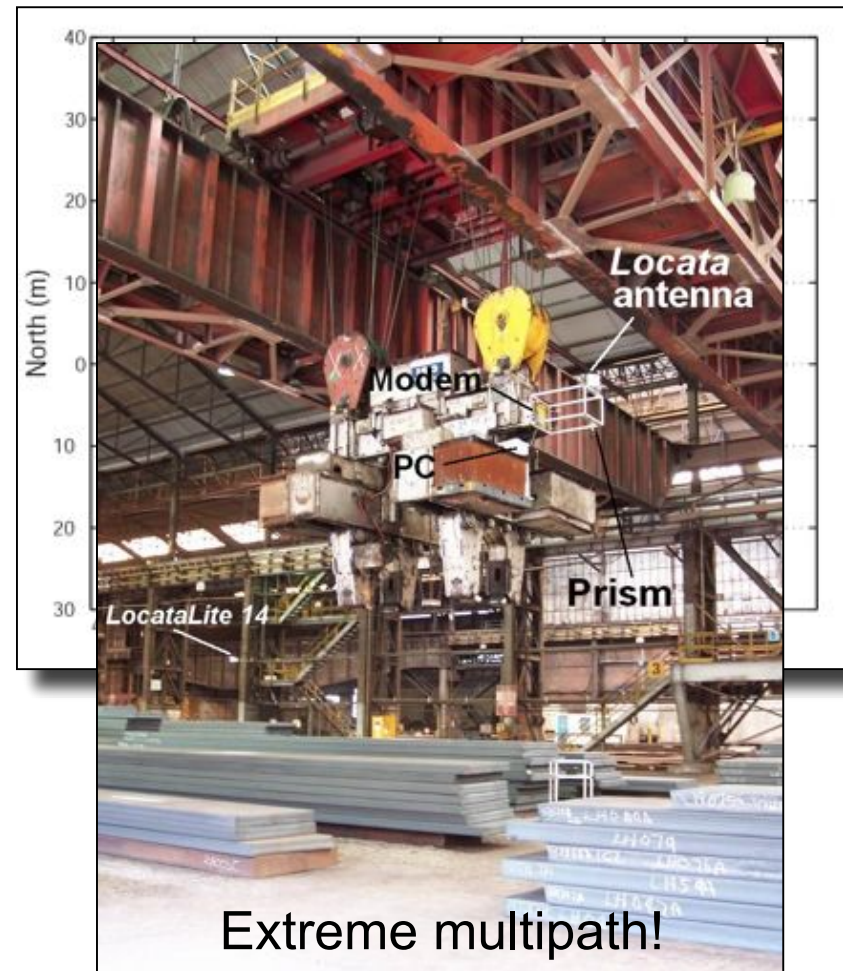
LocataLite Setup



ION-GNSS, Portland, Oregon, USA, 20-23 September 2011

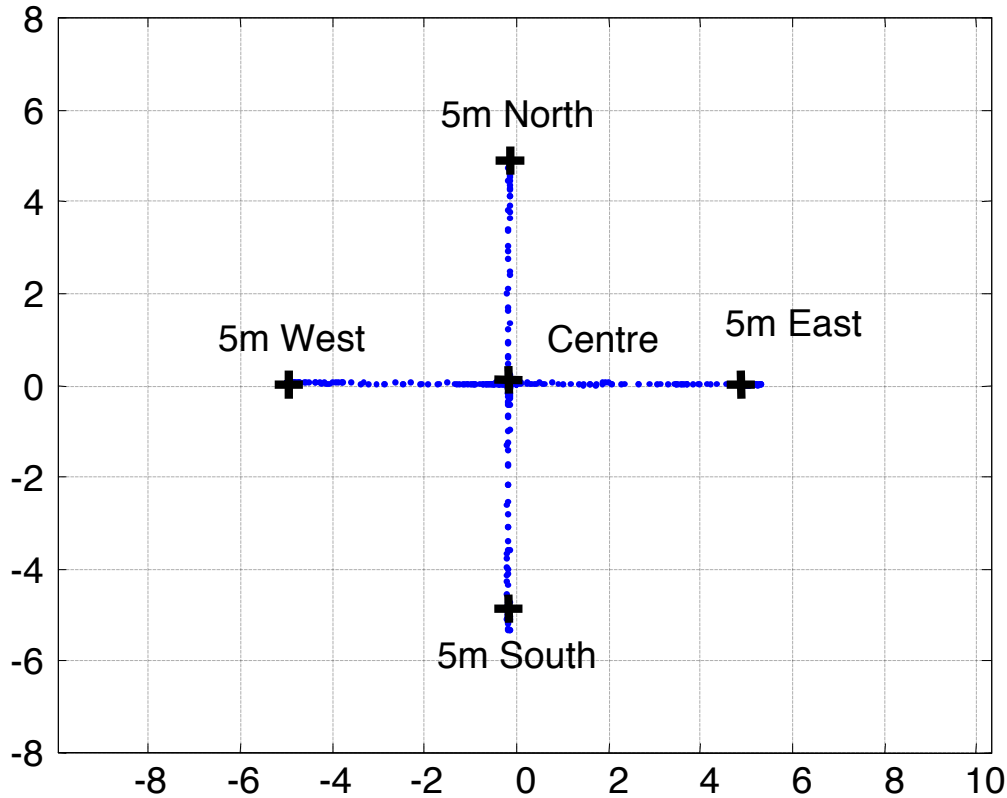
Industrial Machine Tracking...*Locata* 2004

BlueScope Steelworks crane tracking (Wollongong, Australia)



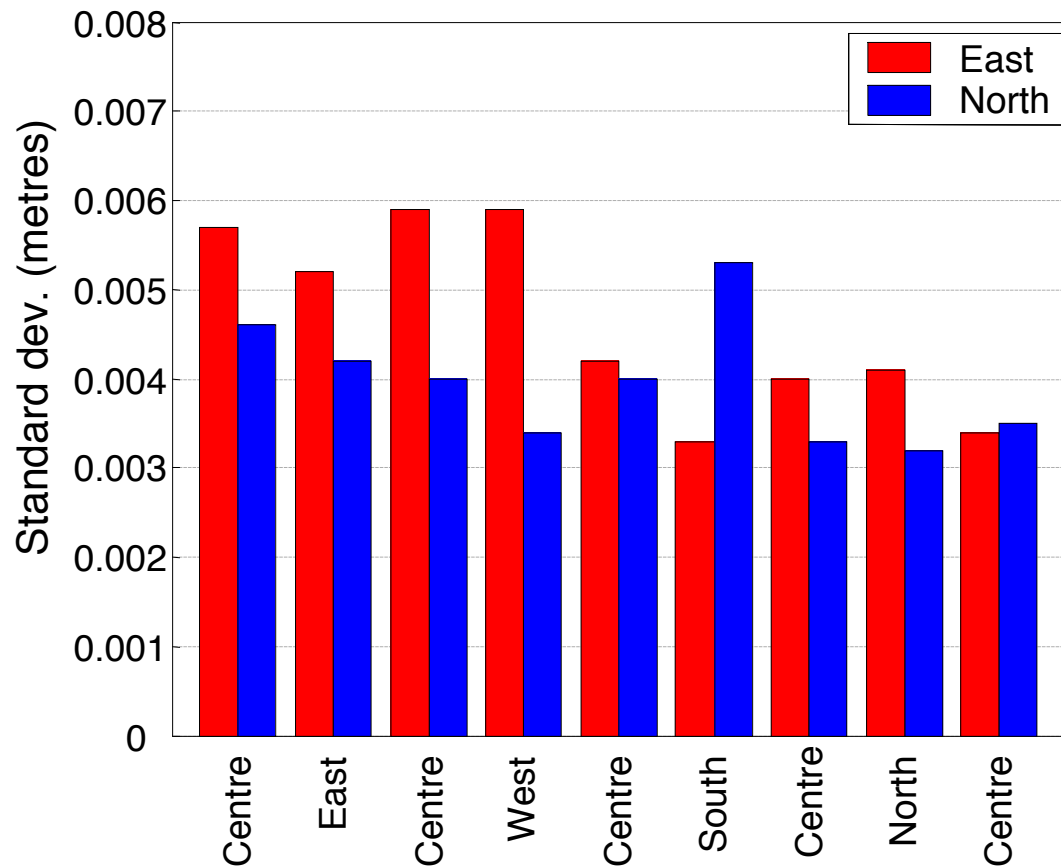
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Industrial Machine Tracking...*Locata* 2004



Crane tongs moved to 9 known points (measured with Total Station).

Industrial Machine Tracking...*Locata* 2004



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Accuracy -

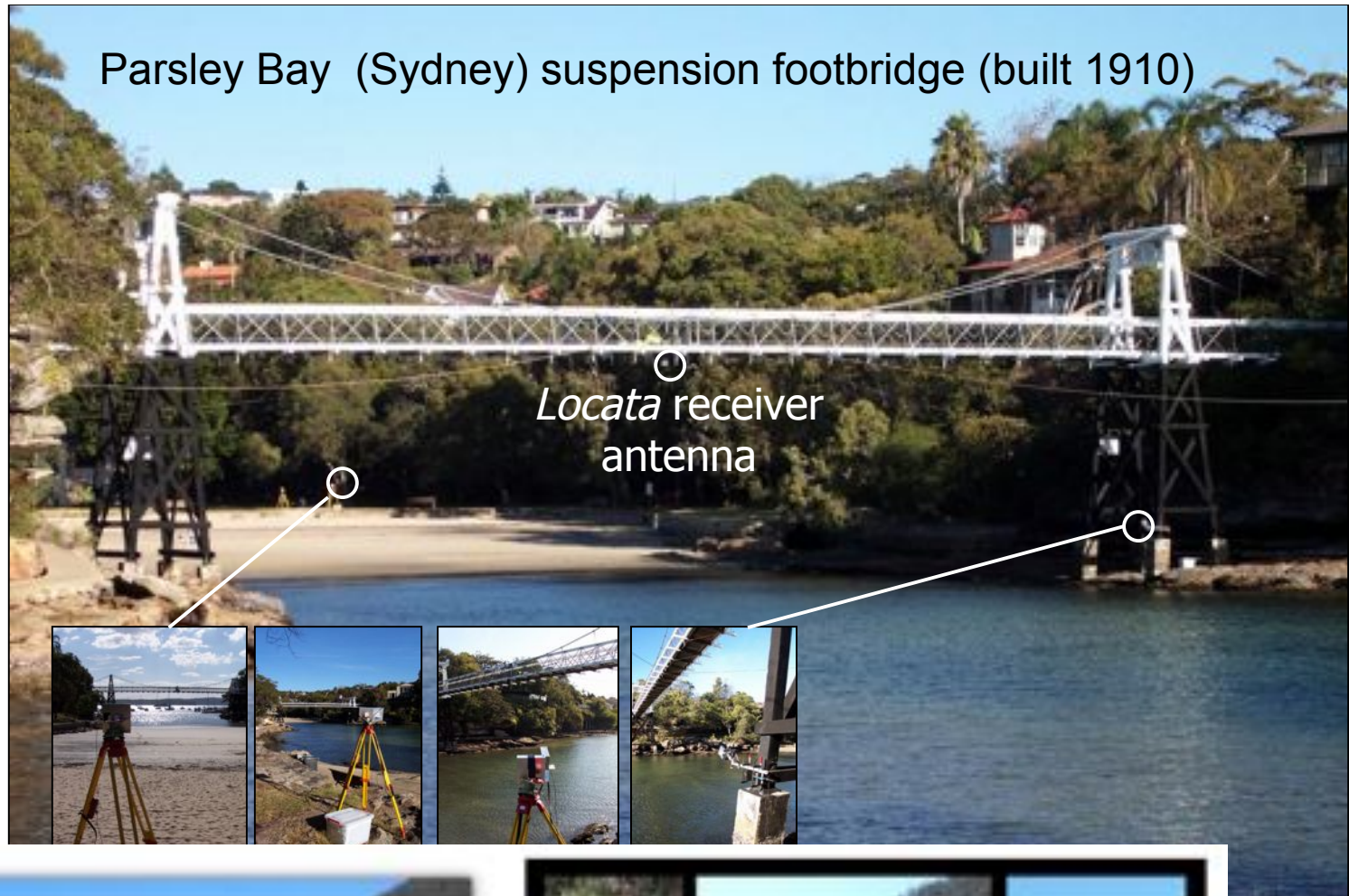
Max position error 1.8 cm

Precision -

Standard deviation <0.6 cm

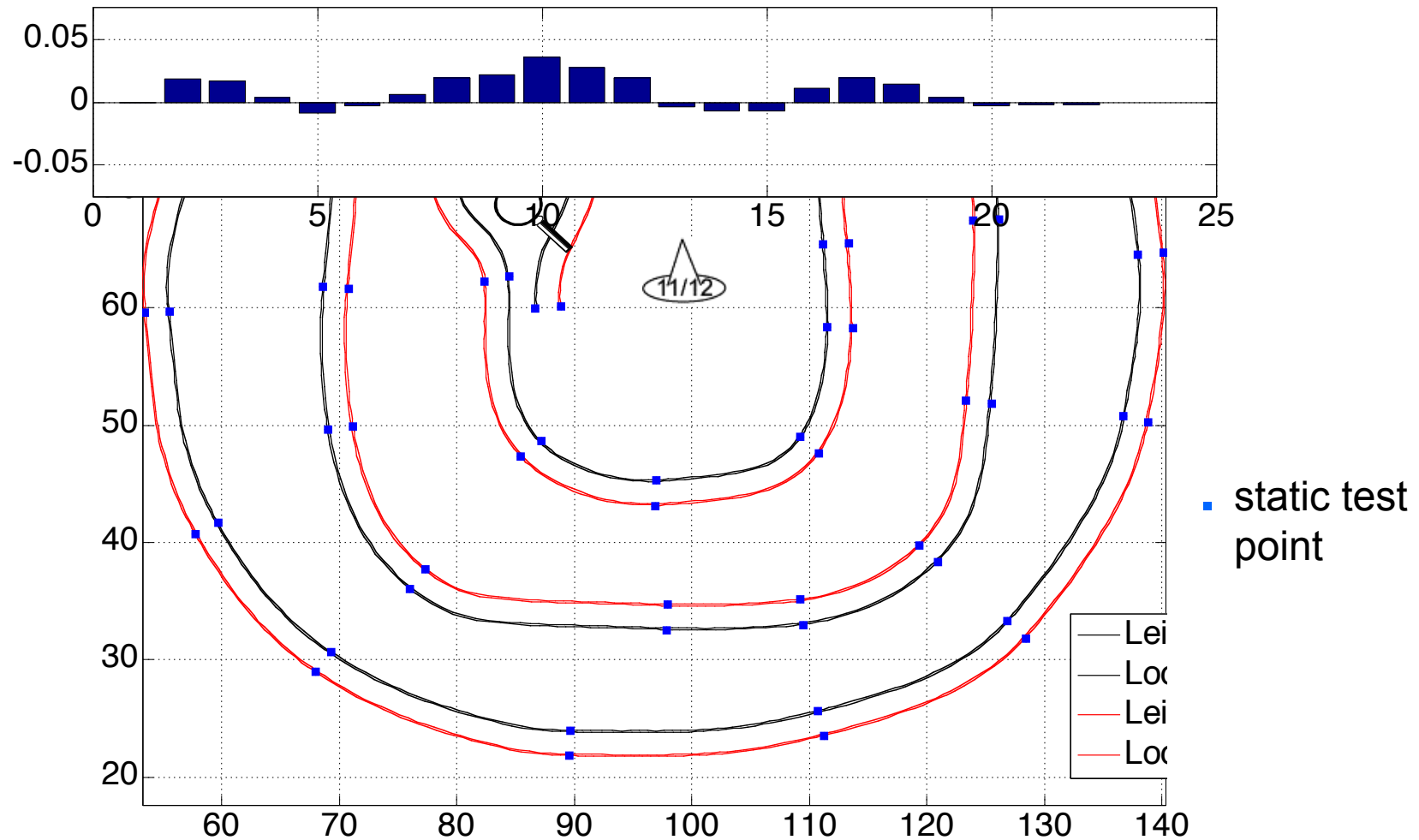
But multipath caused BIG problems

Parsley Bay (Sydney) suspension footbridge (built 1910)





Trajectory GPS-RTK vs. *Locata*



Indoor Testing... *September 2010*

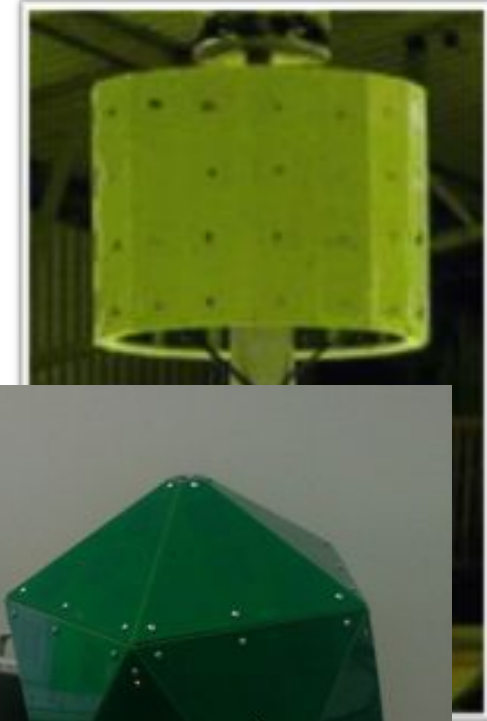
- Indoor experiments conducted in a metal shed at Numerella (30m × 15m).



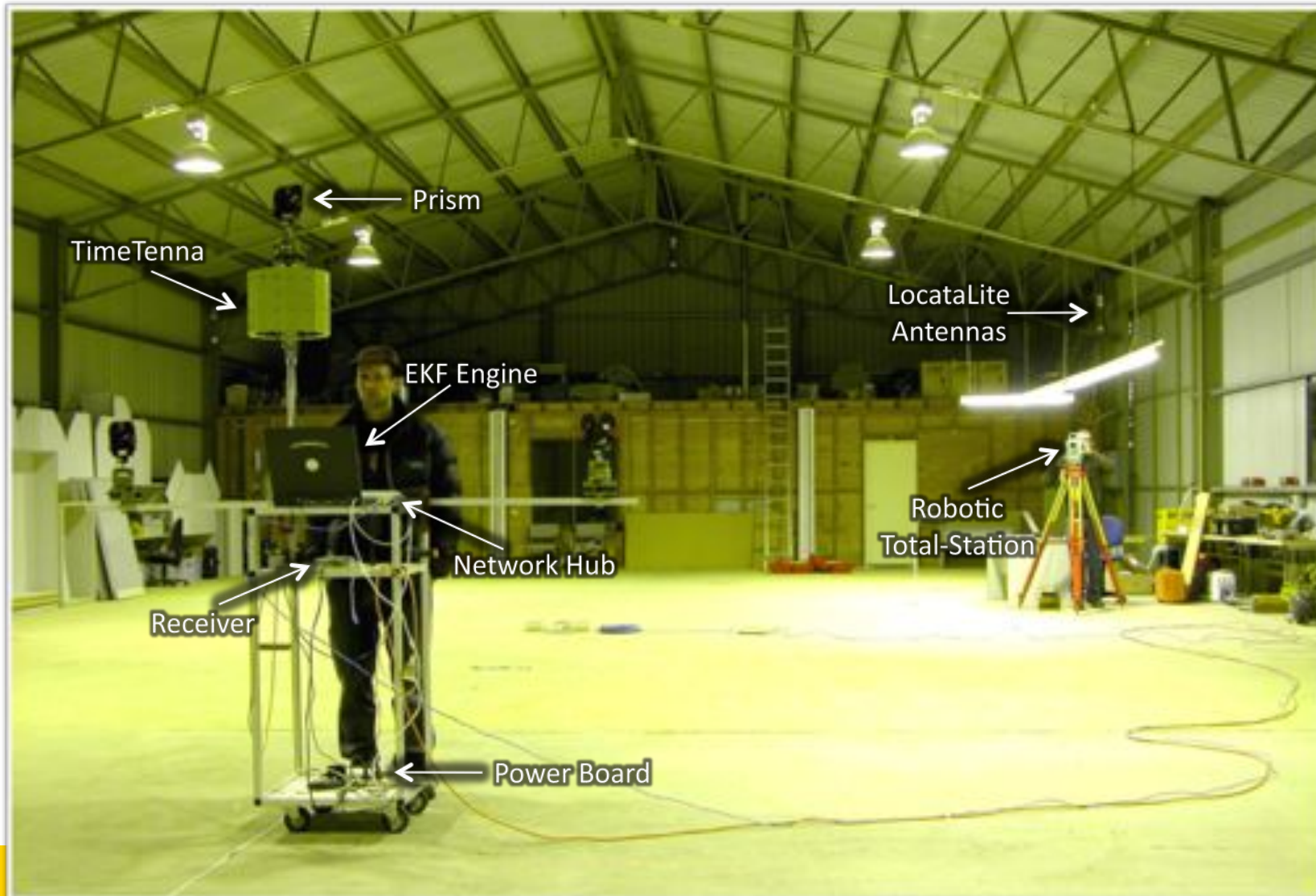
- Severe multipath environment for signals.

TimeTenna

- Uses an array of antenna elements & SW-controlled directional beams.
- Takes advantage of *Locata's* proprietary signal structure and time synchronisation.
- Dynamically tracks *only* direct line-of-sight ranging signals.
- Prototype 3D design.

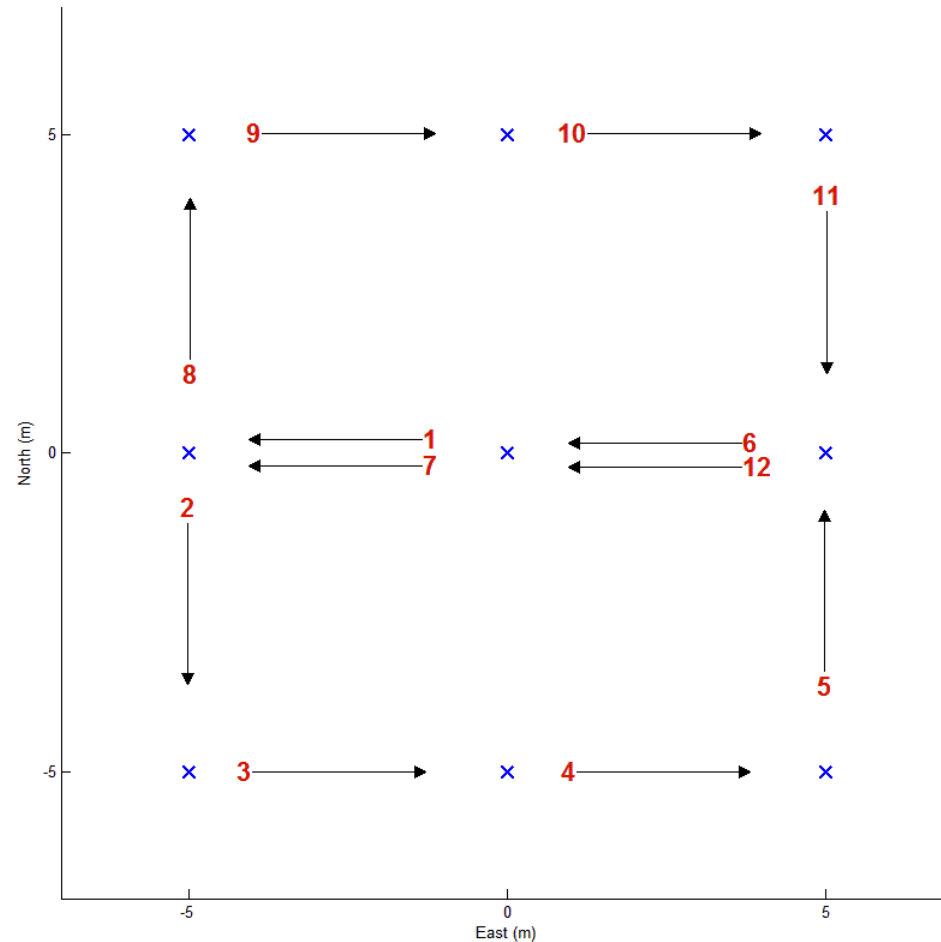


Indoor Test Setup



Static Test

- Receiver moved between adjacent marked points.
- Static for at least one minute per point.

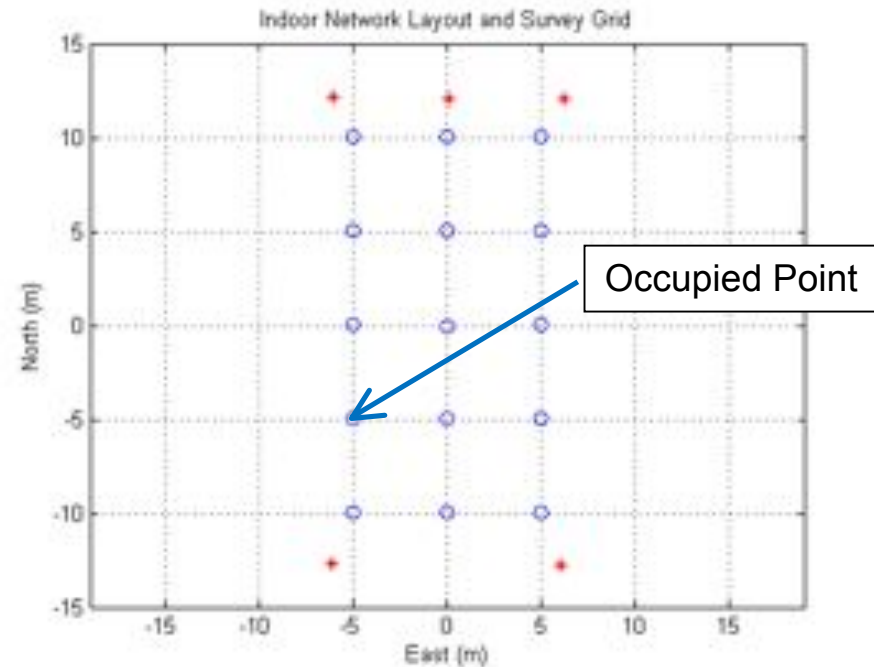
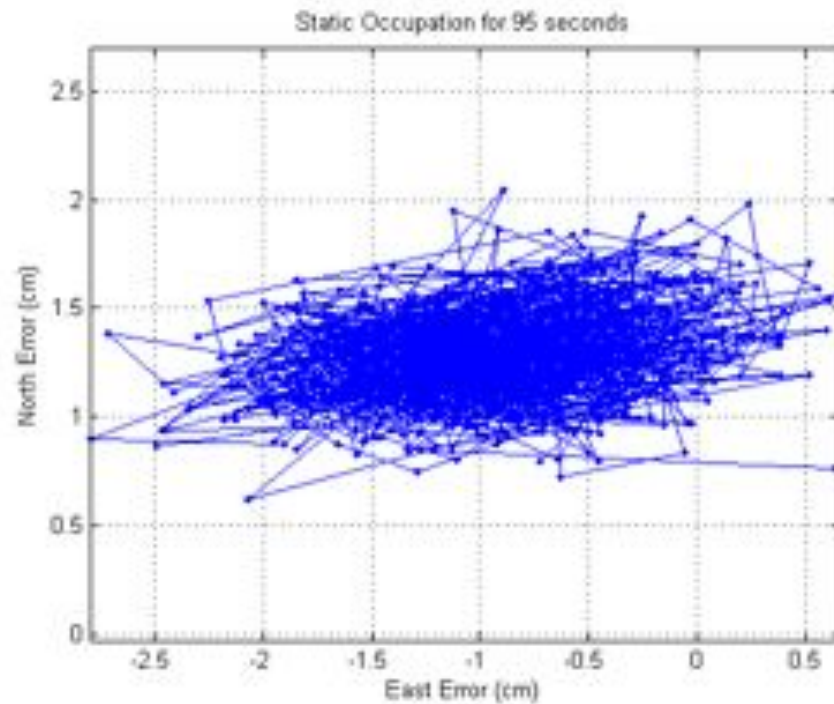


Static Results

- RTS solutions considered as 'truth'.
- Nav Engine: (mostly) better than 2cm accuracy.
- EKF-based: better than 3cm accuracy (after convergence).

| Point Index | Nav Error Distance (mm) | EKF Error Distance (mm) |
|-------------|-------------------------|-------------------------|
| 1 | 7.0 | 633.0 |
| 2 | 19.7 | 287.9 |
| 3 | 12.8 | 7.1 |
| 4 | 7.1 | 12.2 |
| 5 | 2.9 | 6.5 |
| 6 | 5.2 | 23.5 |
| 7 | 9.3 | 24.7 |
| 8 | 0.7 | 16.9 |
| 9 | 42.6 | 0.3 |
| 10 | 18.5 | 5.5 |
| 11 | 12.1 | 21.0 |
| 12 | 8.7 | 23.0 |
| 13 | 8.5 | 16.3 |

Positioning Test Results

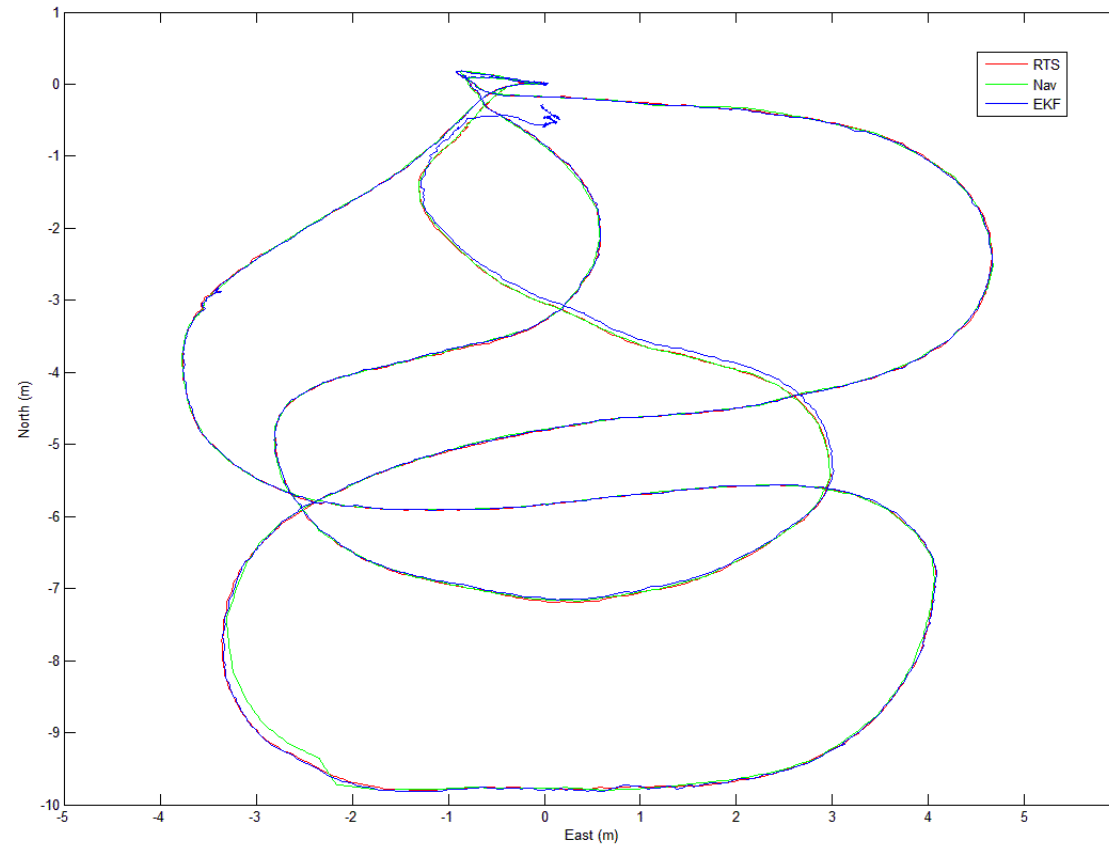


MEAN - E:-0.00940,N:0.0129
1 σ RMS - E:0.0111,N:0.0131

Kinematic Test

- Receiver started on initial known point.
- Moved continuously in a random pattern.
- The EKF-based solution converges after some initial movement.
- *A visual* inspection of the results confirms relative accuracy performance.

Kinematic Results



- *Majority of the trajectory errors less than 3cms*

Orientation Test Results

| | Mean error (deg) | Max absolute error (deg) | 95% RMS error (deg) |
|--------------------|------------------|--------------------------|---------------------|
| 0 Degrees | 0.0555 | 1.2423 | 0.6336 |
| 90 Degrees | -0.1560 | 1.0121 | 0.6782 |
| 180 Degrees | 0.3789 | 1.0303 | 0.7150 |
| 270 Degrees | -0.1595 | 1.0442 | 0.6317 |

Indoor Demos at ION-GNSS 2011



ION-GNSS, Portland, Oregon, USA, 20-23 September 2011

Concluding Remarks

- First indoor tests in September 2010 of *Locata's* new prototype antenna successfully demonstrated multipath mitigation.
- Live demos at ION-GNSS in September 2011.
- Robust cm-level indoor positioning accuracy for *industrial* applications is now a reality.
- Orientation accuracy at <1 deg, using single antenna.
- ICD released at ION-GNSS.