



DYNAMIC POSITIONING CONFERENCE
November 15-16, 2005

Sensors II

CyScan: **The Benefits of Multiple Hypothesis Tracking for Laser Based DP Reference Sensors**

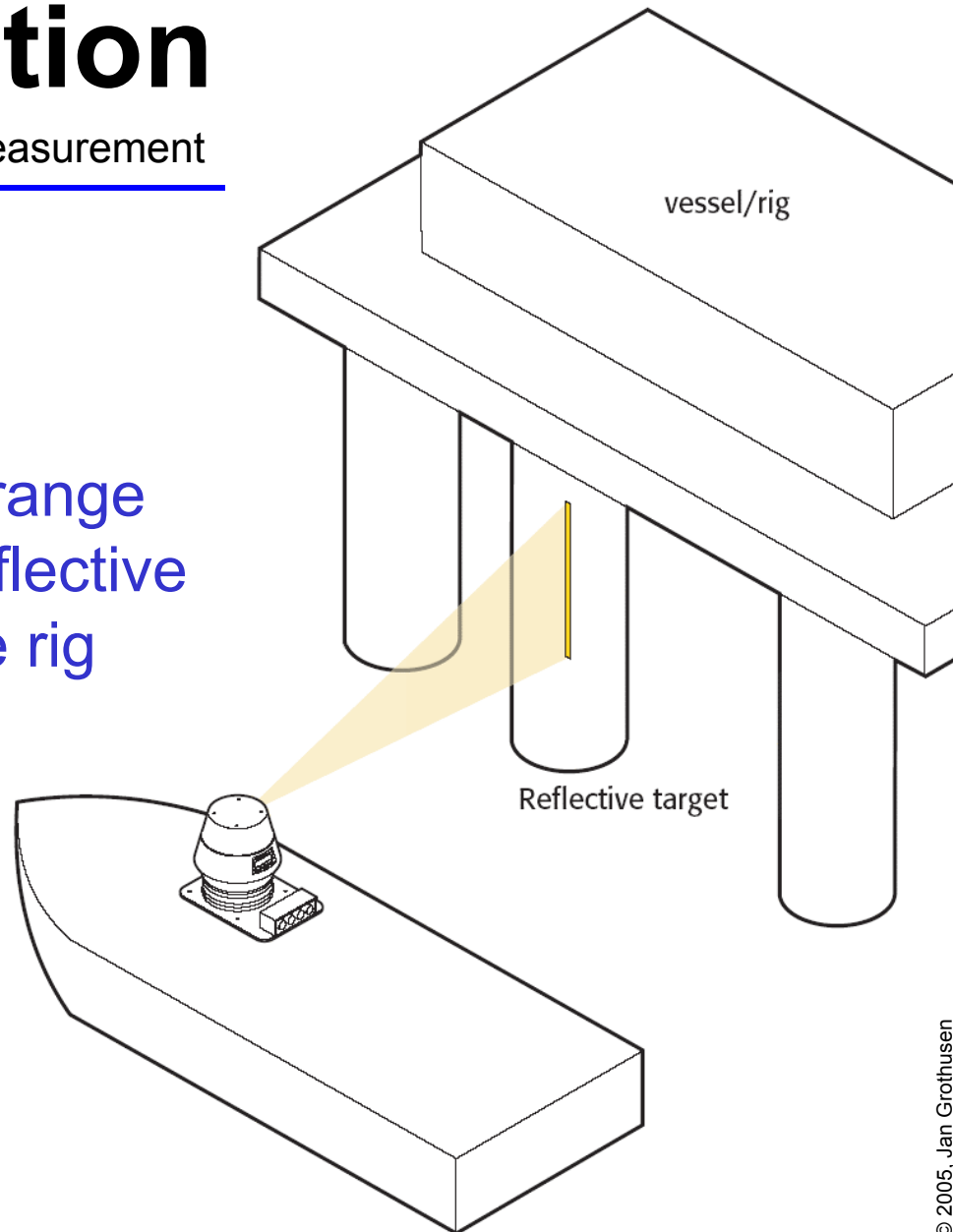
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Introduction

Laser Based Position Measurement

Laser measures range and bearing to reflective target on offshore rig



Introduction

- Basic Principles
- Multiple Hypothesis Tracking
- Results & Specifications
- Summary

Traditional Approach

Introduction

Range & Bearing single target

Oscillating sector sweep

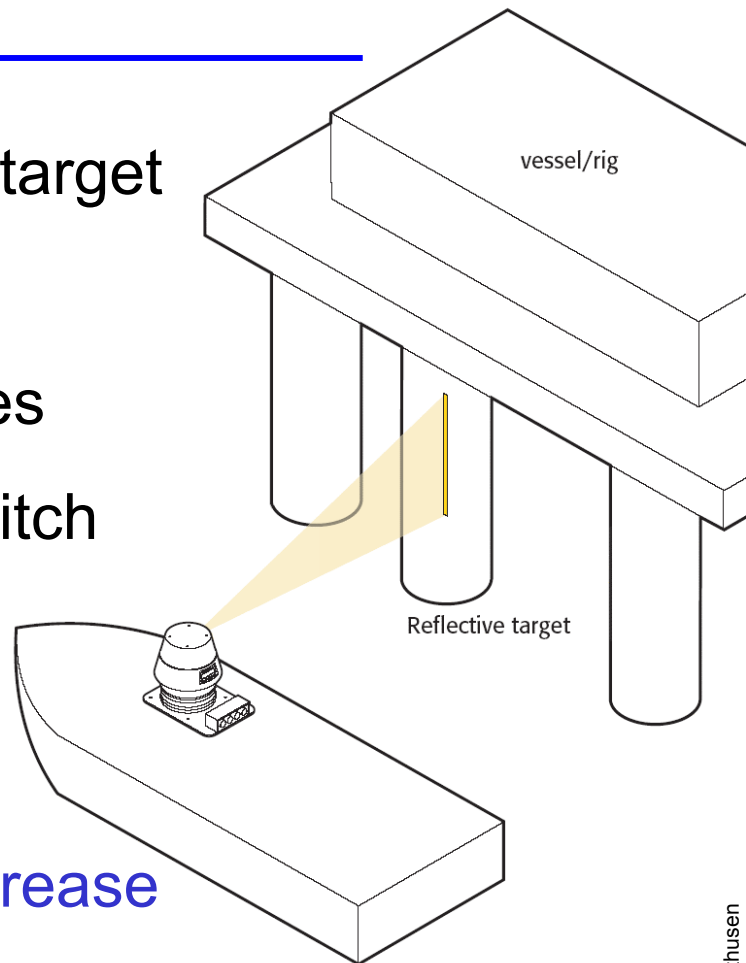
Tracking with signal gates

No correction for roll & pitch

Multiple targets →

wide sweep / latency increase

n independent Single Targets



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'Smart' Sensing

Basic Principles

Continuous rotation 360°/s

Multiple targets (n per rev)

Known Target configuration

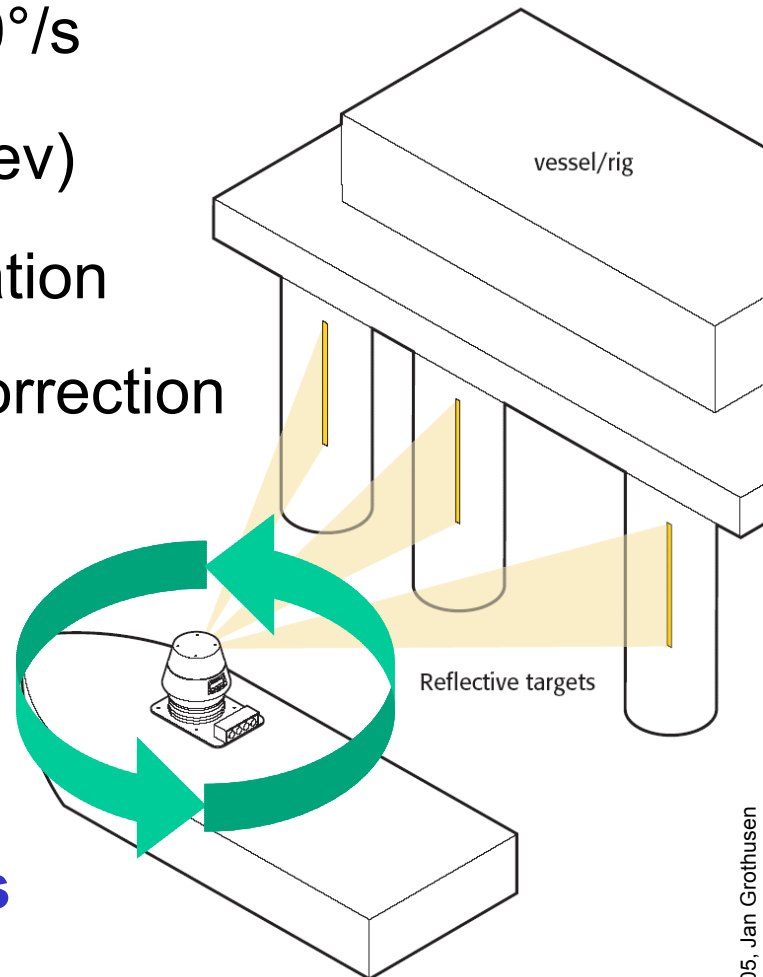
Automatic roll & pitch correction

Designed for DP ops...

→ Auto-survey

→ Draught follow

→ **Multiple Hypothesis
Tracking**



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CyScan Approach

Basic Principles

Continuously rotating 360°/s vertical fan 16°

→ Sees “all” targets / rev (fixed latency)

3-axis solid-state vertical reference unit

→ Automatically correct $\pm 20^\circ$ roll & pitch

Multiple hypothesis tracking with Kalman Filter based on ‘Vessel Dynamics’

→ Replaces single target “gating”

→ “History” of all previous reflections drives decision making

→ True real-time position & heading fix

Introduction

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**Basic
Principles**

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Multiple
Hypothesis
Tracking

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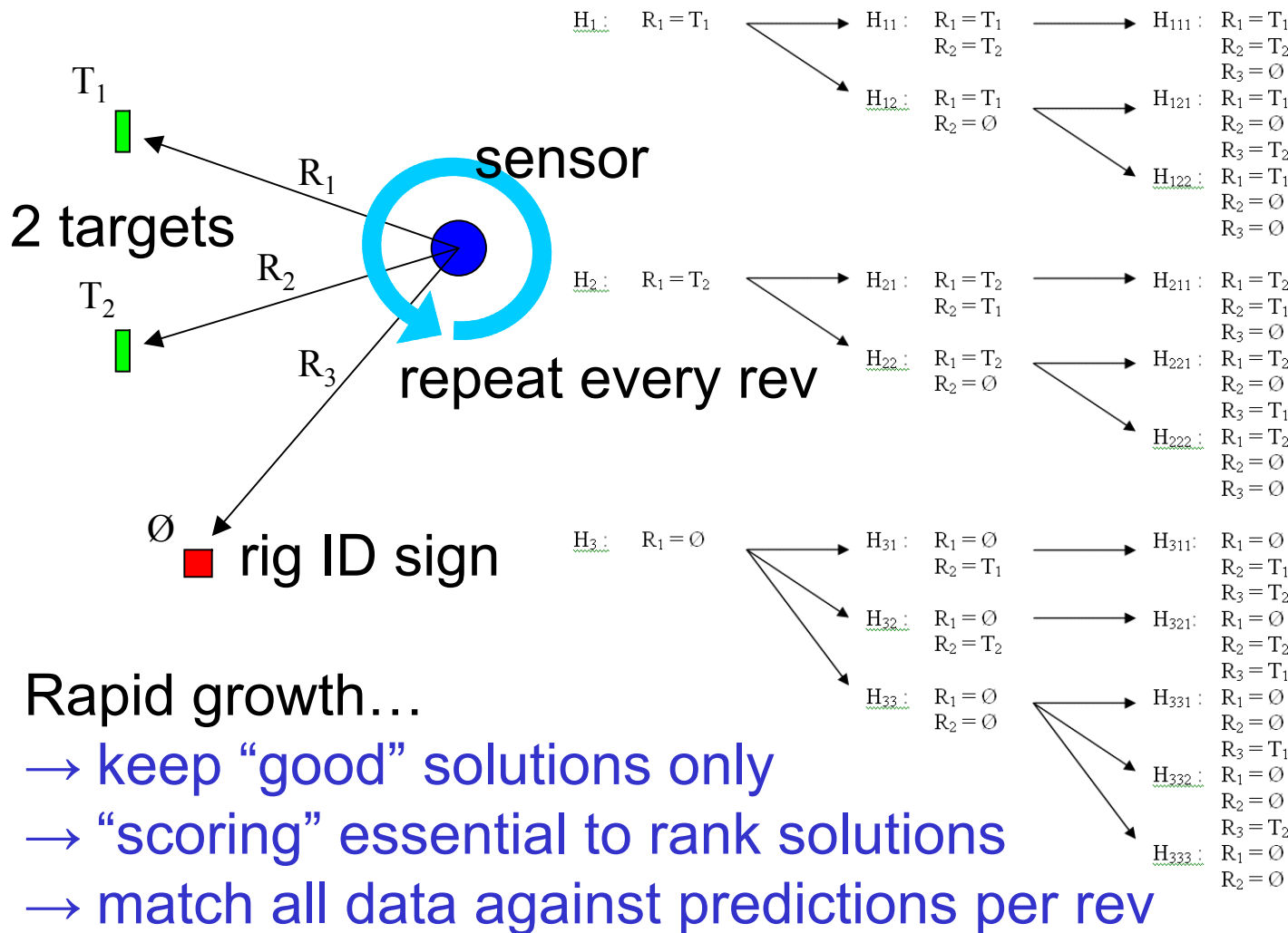
Results &
Specifications

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Summary

Hypothesis Generation

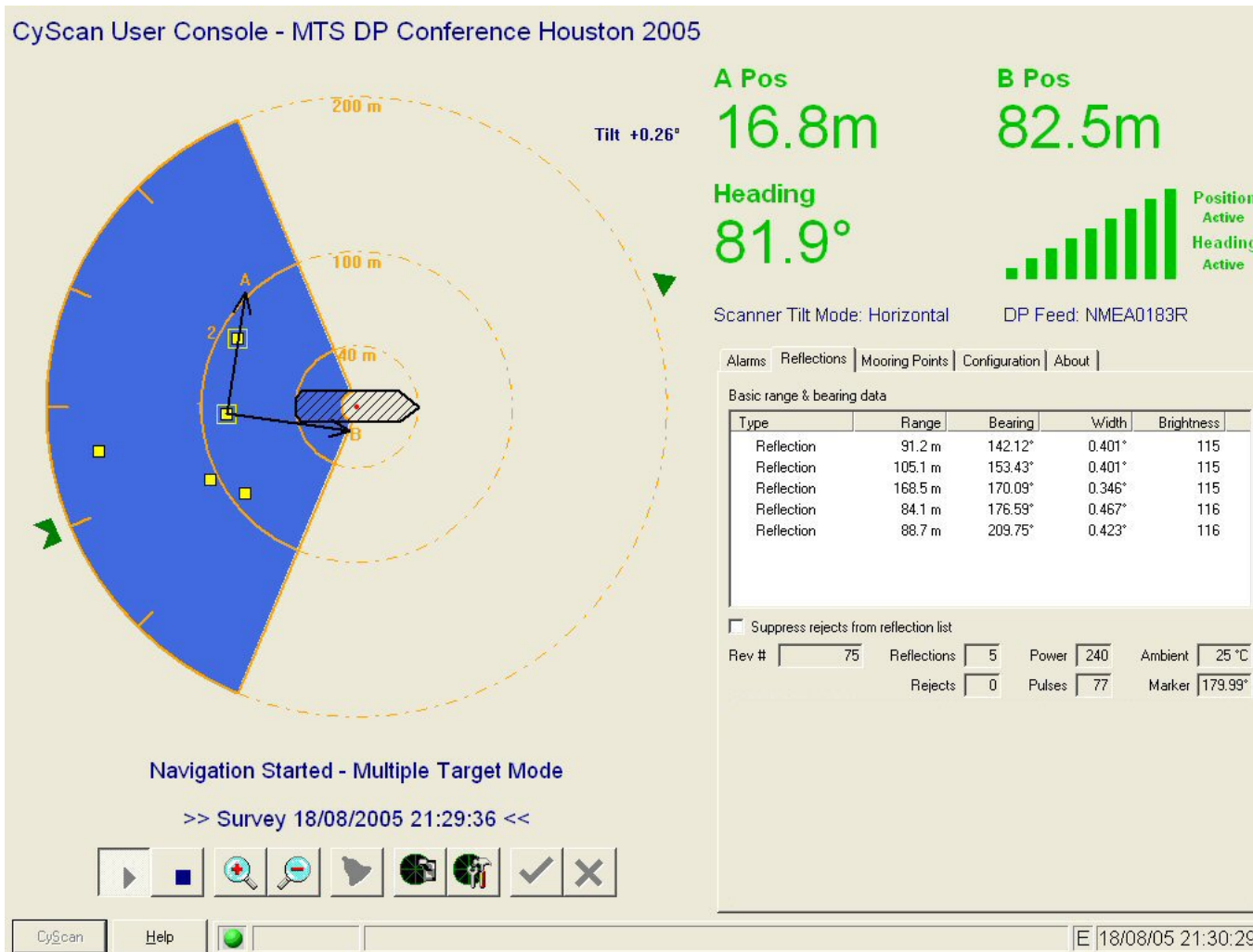
Multiple Hypothesis Tracking



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Benefit: Robustness

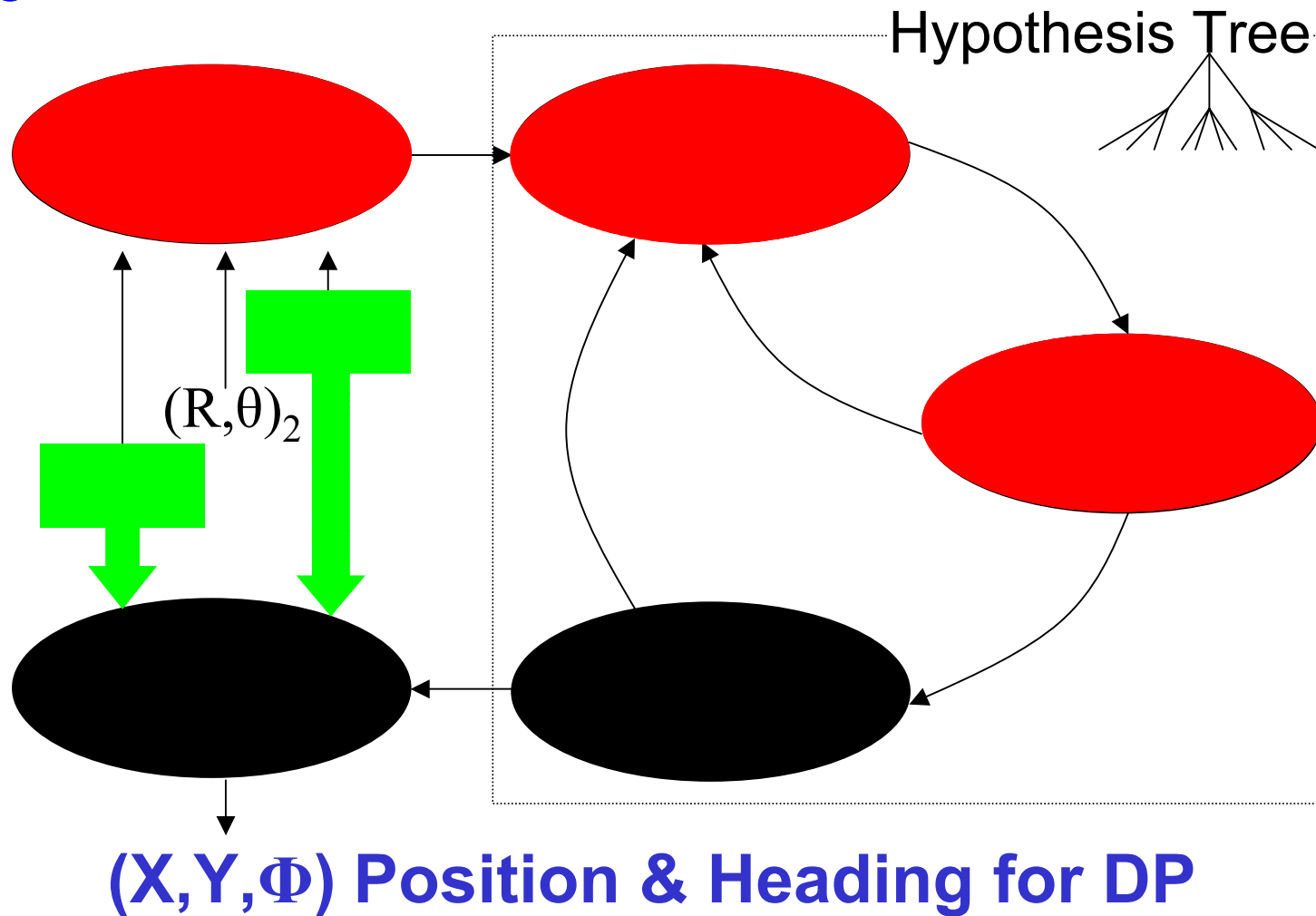
Results & Specifications



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Position Algorithm

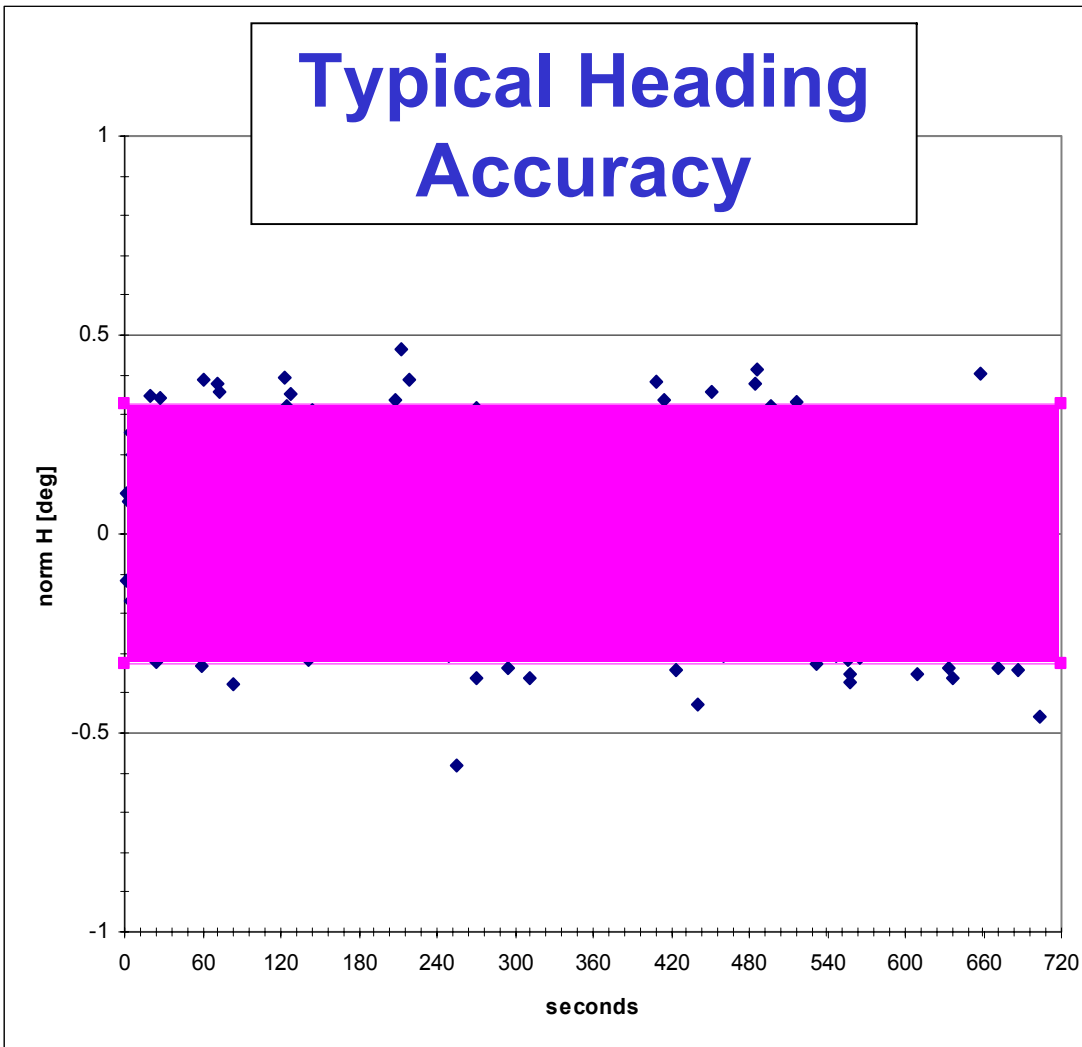
Multiple Hypothesis Tracking



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Benefit: Accuracy

Results & Specifications



$$R_m \approx 200m$$

$$2\sigma_R \approx 6 \text{ cm}$$

2½ inch

$$2\sigma_\theta \approx 3 \text{ cm}$$

1¼ inch

$$\Delta_2 \approx 23m$$

$$2\sigma_\Theta \approx 0.3^\circ$$

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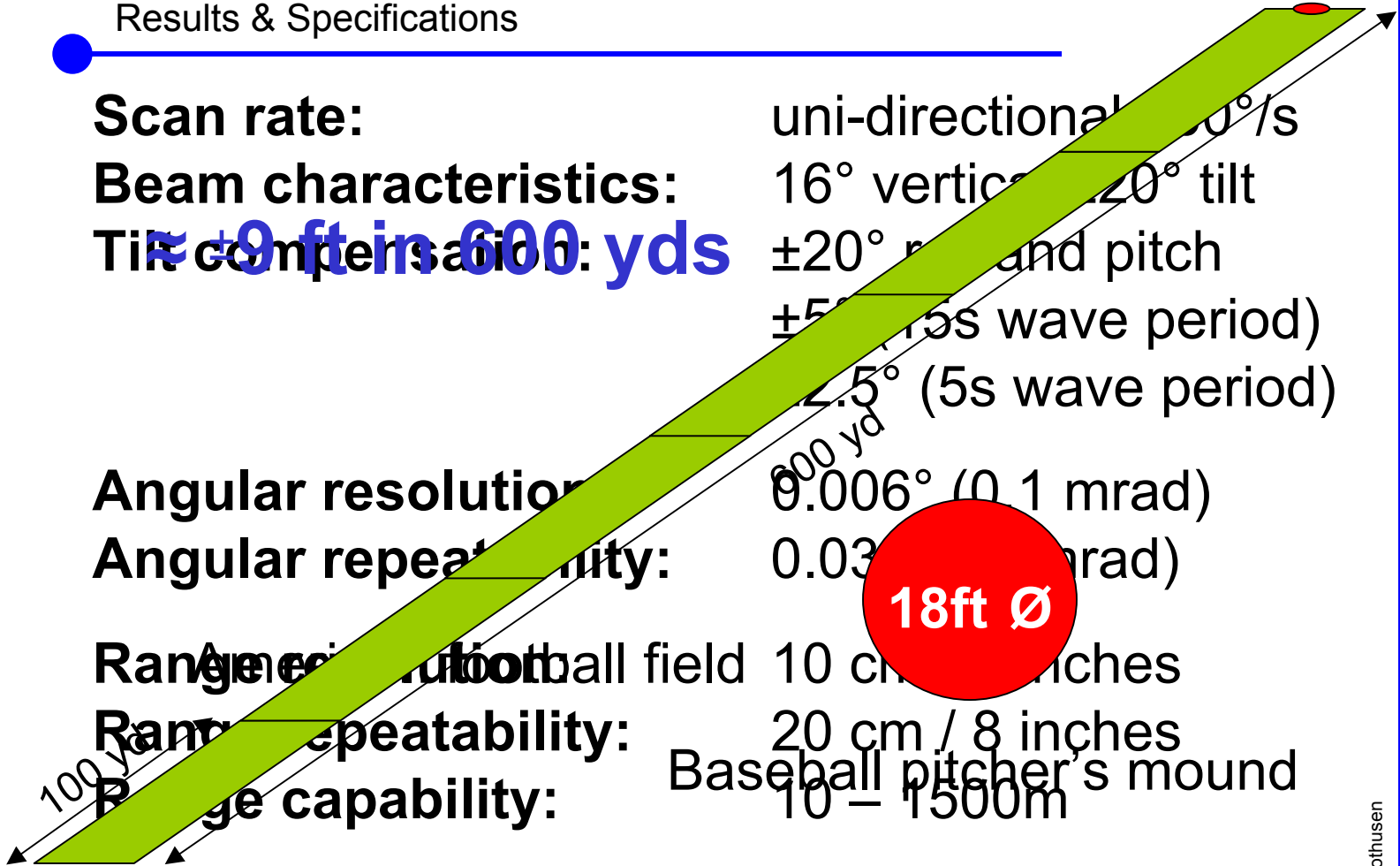
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**Results &
Specifications**

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Sensor Performance

Results & Specifications

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Scan rate: uni-directional 30°/s

Beam characteristics: 16° vertical, 20° tilt

Tilt compensation: ±20° roll and pitch
±5% (15s wave period)
±2.5° (5s wave period)

Angular resolution: 0.006° (0.1 mrad)

Angular repeatability: 0.03° (0.5 mrad)

Range capability: Football field 10 cm / 8 inches

Range repeatability: 20 cm / 8 inches

Range capability: Baseball pitcher's mound 10 – 1500m

Positional accuracy: better than 0.5% range

Summary

CyScan Laser Position Reference Sensor

Multiple hypothesis tracking gives:

- More accurate position & heading fix
- More robust to missing / false targets
- Designed for multi-target redundancy
- Fixed latency < 1 second
- Ease of use

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