LASER BASED ALIGNMENT SYSTEM

A Non-Contact, High Precision Detector Alignment Tool

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Outline

- Motivation
- System Components
- LBAS Operation
- Examples of Results
- Conclusions
Practical Motivations

- Need to know the position of each detector strip (1.95mm wide) to within 1/4mm
- Non-Contact
- Small enough to operate in a scattering chamber
Motivation for Nuclear Physics

- Inverse kinematics display strong kinematic broadening $dE/d\theta$ -- up to 4MeV/degree

Simulations provided by Jenny Lee
Motivation for Nuclear Physics

- Calibrating the position can be more crucial than the energy resolution of the detector
- Reconstruction of excited states requires precise knowledge of the location of the beam, target and detectors
System Components

- **Class II Laser provides distance**
  
  http://www.acuilitylaser.com/AR600/index.shtml
  
  - Measures distances in the range 25.4-40.6cm
  - Resolution: 45.6µm
  - Uses triangulation to determine distance
    - Sensitive to very low amounts of reflected light

- **2 Rotary stages provide angle**
  
  http://www.owis-staufen.com/
  
  - Capable of measuring 360°
  - Resolution less than 0.006°, 26.6-41.9µm

- **Overall position resolution**: 52.8-61.9µm
Laser Operation

- Software was developed to:
  - Control the laser, scan edges with specified step sizes. Output is distance, theta', and phi'
  - Convert laser coordinates to spherical coordinates
  - Correct position for off axis rotation
  - Combine different reference systems
  - Convert positions to final lab reference frame of choice

- For 0.01° step in angle, the position resolution is ~0.2mm which exceeds the specifications of 0.25mm
Examples of Results

- Green dots are directly from laser scans
- Red outlines are design drawings of scanned objects
Examples of Results
Conclusions

- Nuclear experiments such as transfer reactions, other direct reactions, and resonance spectroscopy require knowing the precise location of the target and detectors.
- A system, LBAS, has been designed to exceed the measurement precision needs.
- The device works accurately, as evidenced by the agreement between the measurements and the physical dimensions of objects.
Price

• Price of alignment system (2001)
  - laser: $2800
  - power supply: $100
  - Rotary Stages x2: $2000
  - Structural Materials: $800

• Total: ~$5700 + labor