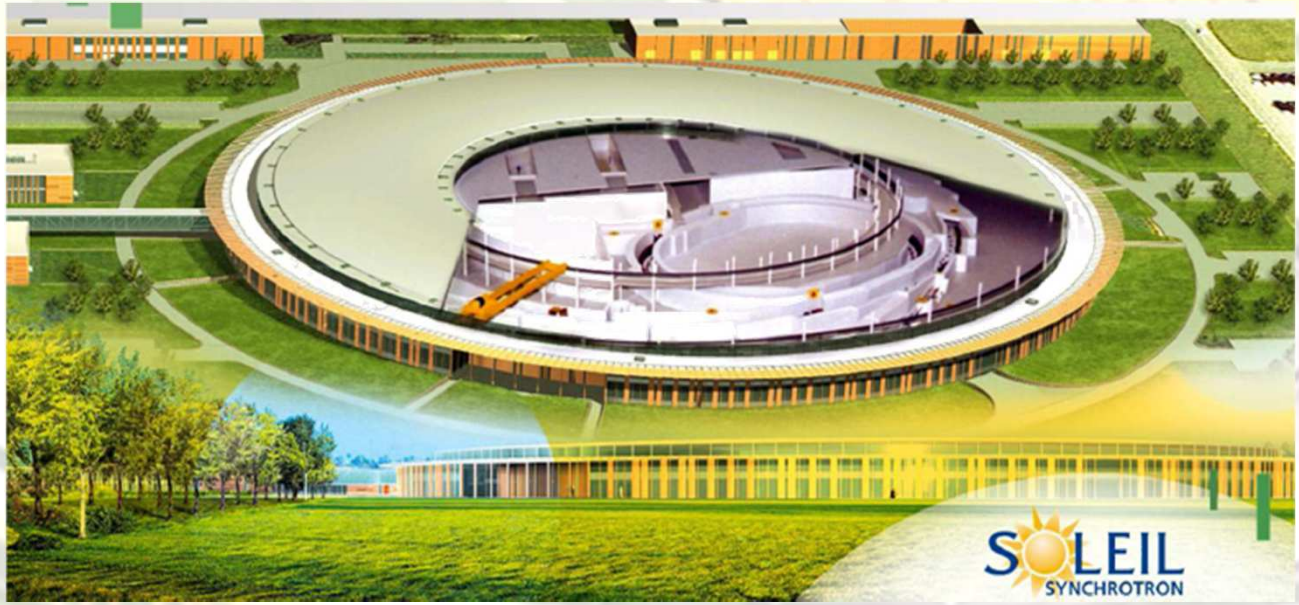


Nanoprobe Project – Sample Stage Control

ICALEPCS 2015

Christer Engblom

Introduction

- Duration - 4 years
- Collaboration Project
  - NanoMax [MAXIV], Lund in Sweden
  - Nanoscopium [Synchrotron SOLEIL], Paris in France
- Goal – Develop Nanoprobe Prototype
  - Hard X-ray scanning 3D XRF tomography
  - Capable of nanometric resolution & mm range
  - Full 360 degree rotation
  - Flyscan capability

Introduction





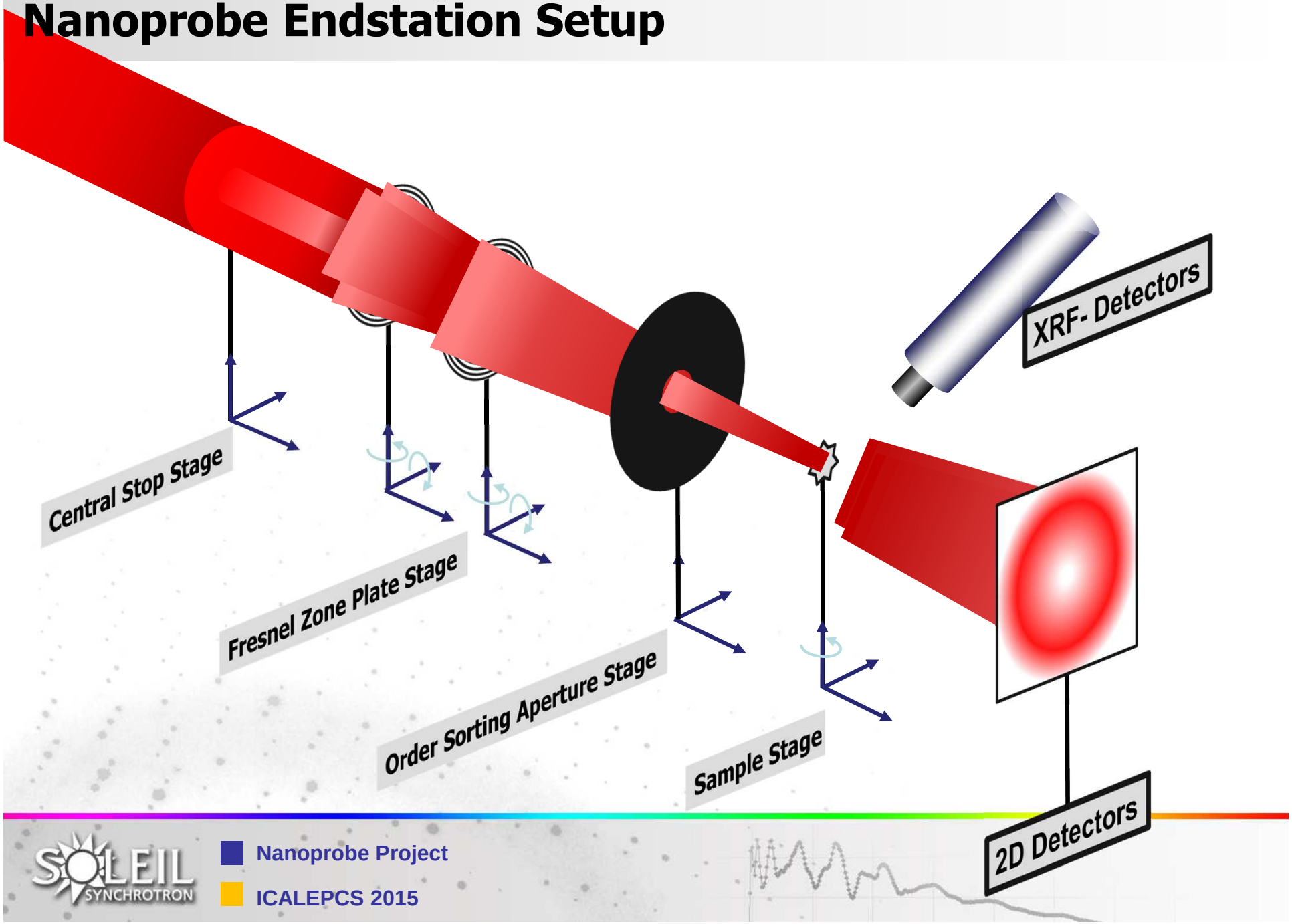



Nanoprobe Team – Synchrotron Soleil

	Name
Technical Project Leader	Stefan KUBSKY
Mechanics	Marc RIBBENS Jean Michel DUBUISSON Filipe ALVES
Metrology	Gilles CAUCHON Alain LESTRADE
Electronics & Motion Control	Yves-Marie ABIVEN Christer ENGBLOM
Software Development	Florent LANGLOIS
Thermals & Vibrations	Nicolas JOBERT
Logistics & Coordination	Vincent LE ROUX
Administrative	Thierry BUCAILLE
Vide	Jean-Pierre DUVAL

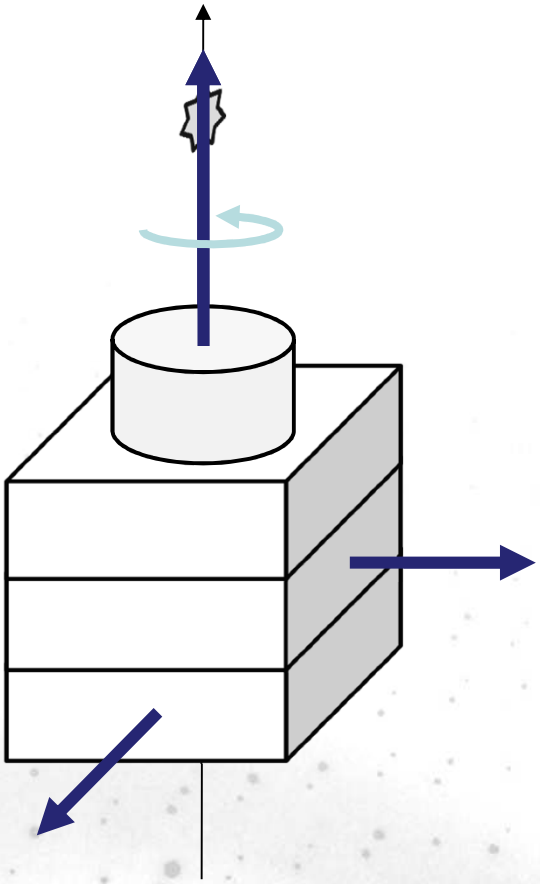


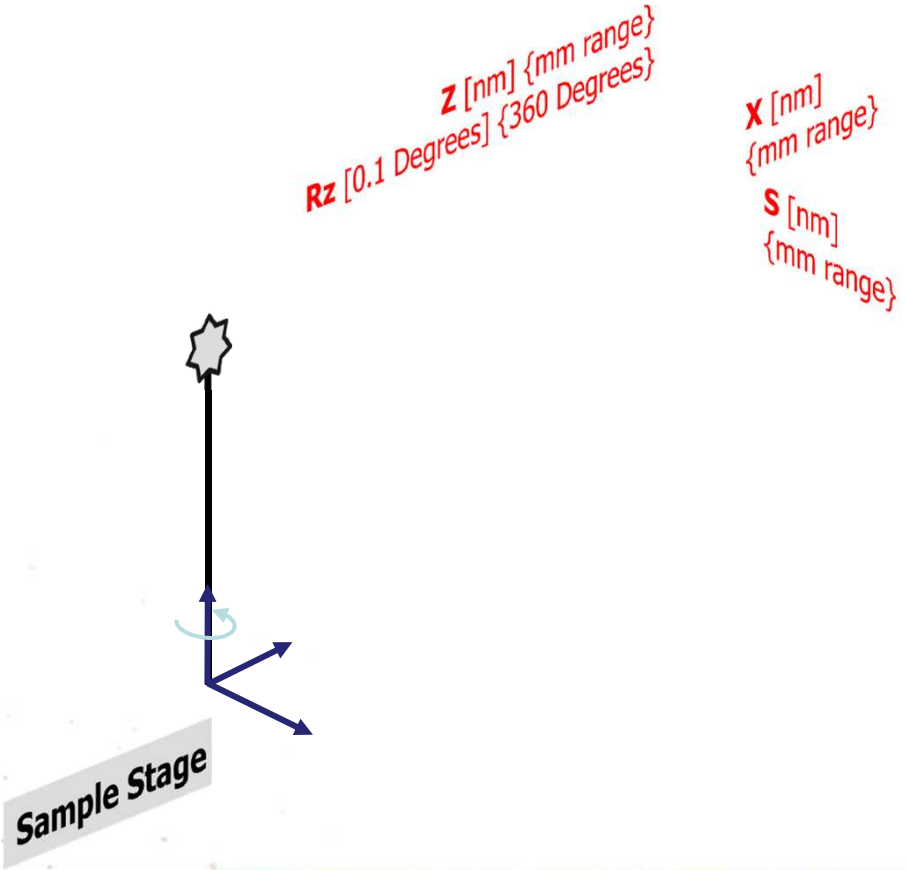

Nanoprobe Endstation Setup



Sample Stage – Design Structure

- Stage Stacking
- Small Rotation Stage





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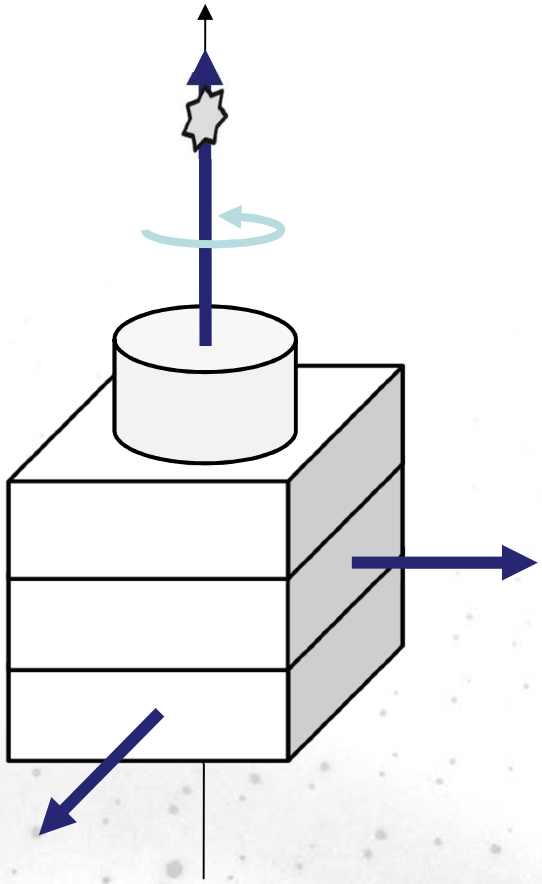


➤ **Advantages**

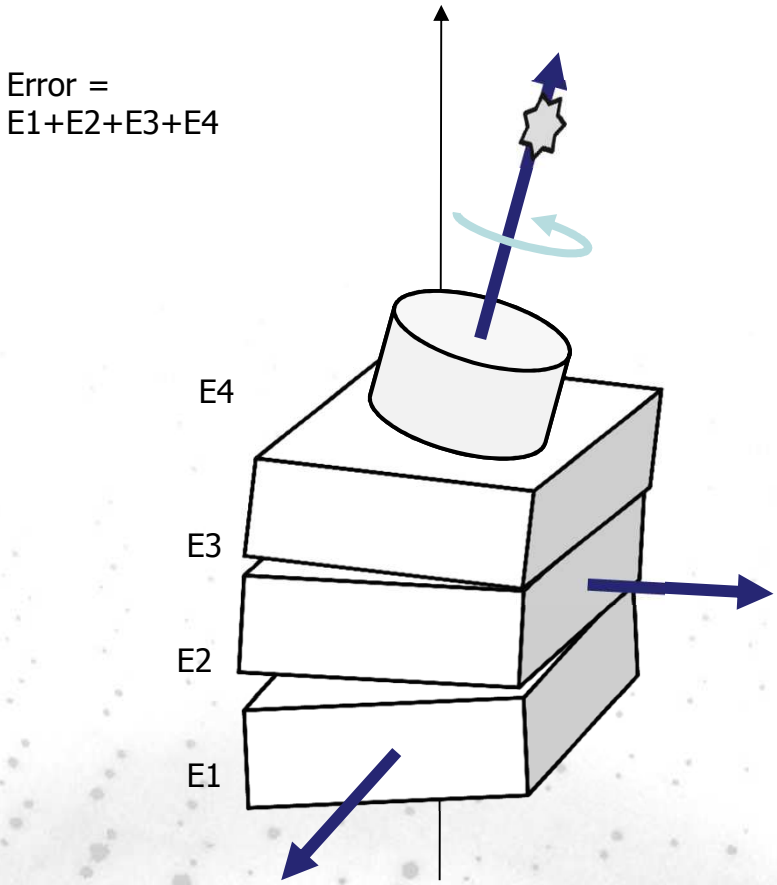
- Modular & Compact
- Long-range movements with nanometric resolution
- Low Complexity Build

➤ **Disadvantages**

- System Stiffness
- Additive Errors

Sample Stage – Design Structure

- Stage Stacking
- Small Rotation Stage



Advantages

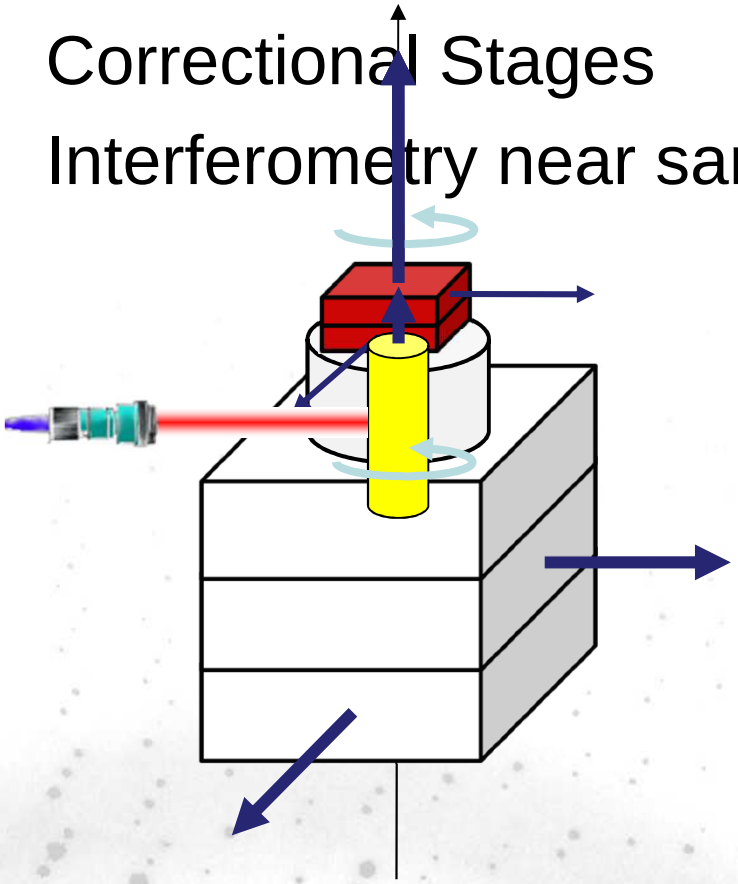
- Modular & Compact
- Long-range movements with nanometric resolution
- Low Complexity Build

Disadvantages

- System Stiffness
- Additive Errors

Sample Stage – Design Structure

- Stage Stacking
- Small Rotation Stage
- Correctional Stages
- Interferometry near sample



Advantages

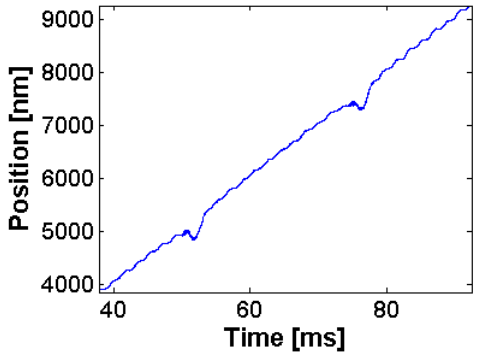
- Modular & Compact
- Long-range movements with nanometric resolution
- Low Complexity Build

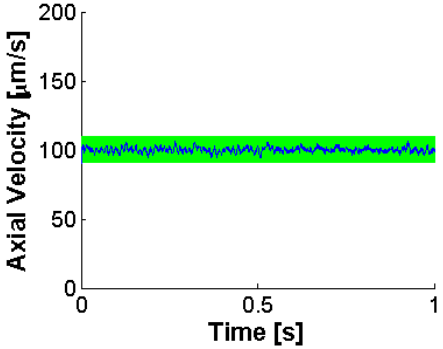
Disadvantages

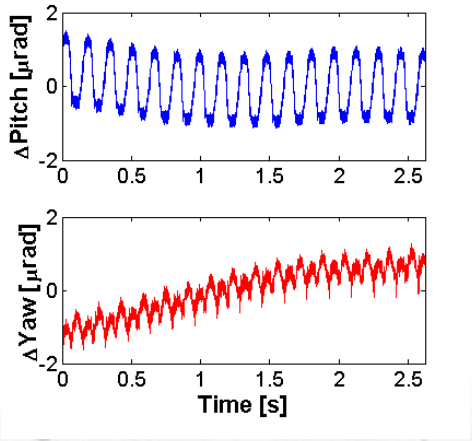
- System Stiffness
- Additive Errors

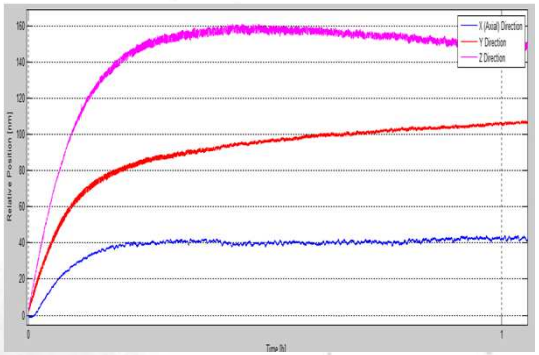
Positioner Characterizations

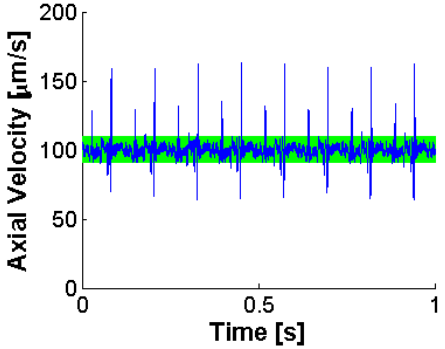
- Market Studies (at the start & ongoing)
  - Available technology on the market (long-range & nanometric)
- Characterization with Interferometry
  - Positioning Capabilities (Static & Dynamic)
  - Velocity constance
  - Parasitic Movements
  - Thermal Behaviour





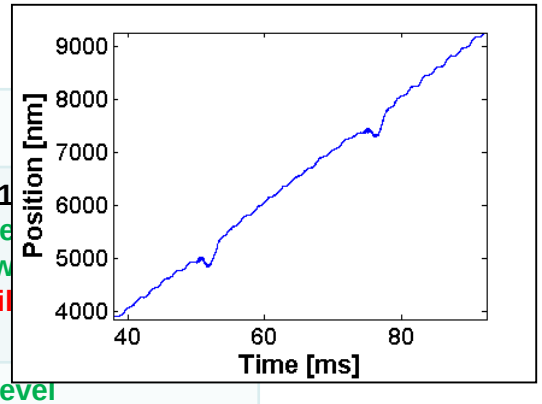


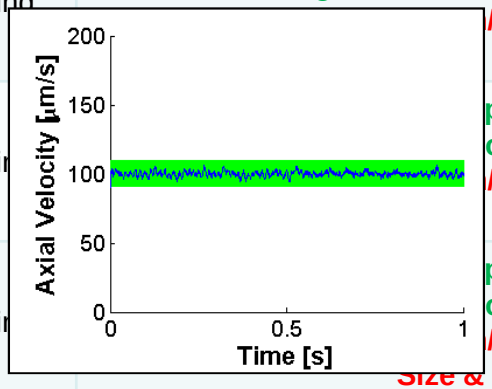


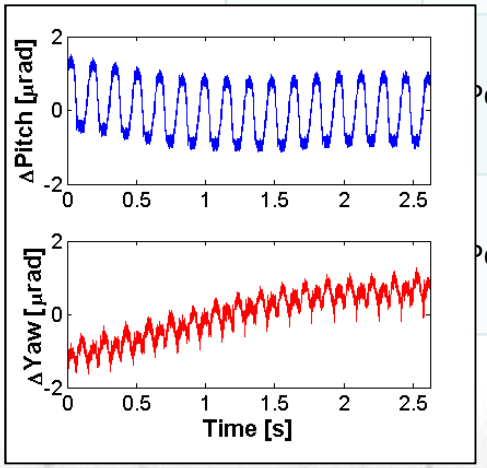


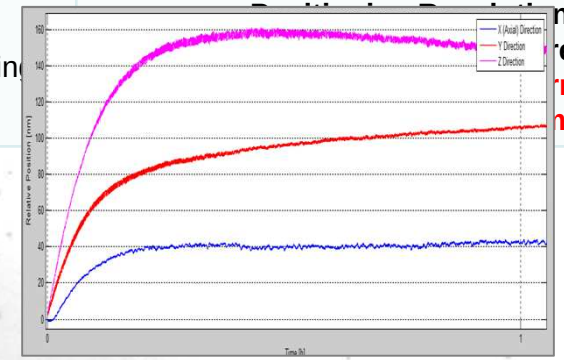
Positioner Characterizations → Assigning

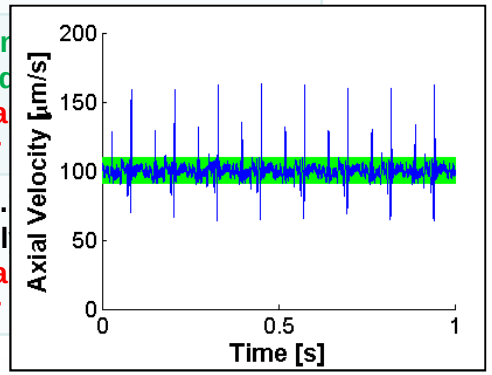
Annotation	Type	Primary Constraints/Needs
X	Flyscan Positioning	±10% Max Velocity Fluctuation @ ≤ 1 Positioning Capabilties to nm-le Straightness of Motion [pitch, yaw /Thermal Capabil Formfactor
S	Positionir	pabilties to nm-level o below µrad [pitch, yaw, roll] /Thermal Capabilities Formfactor
	Positionir	pabilties to r o below µrad /Thermal Ca Size & Formfactor
	Positionin	n to ~0. referabl rmal Ca nfactor



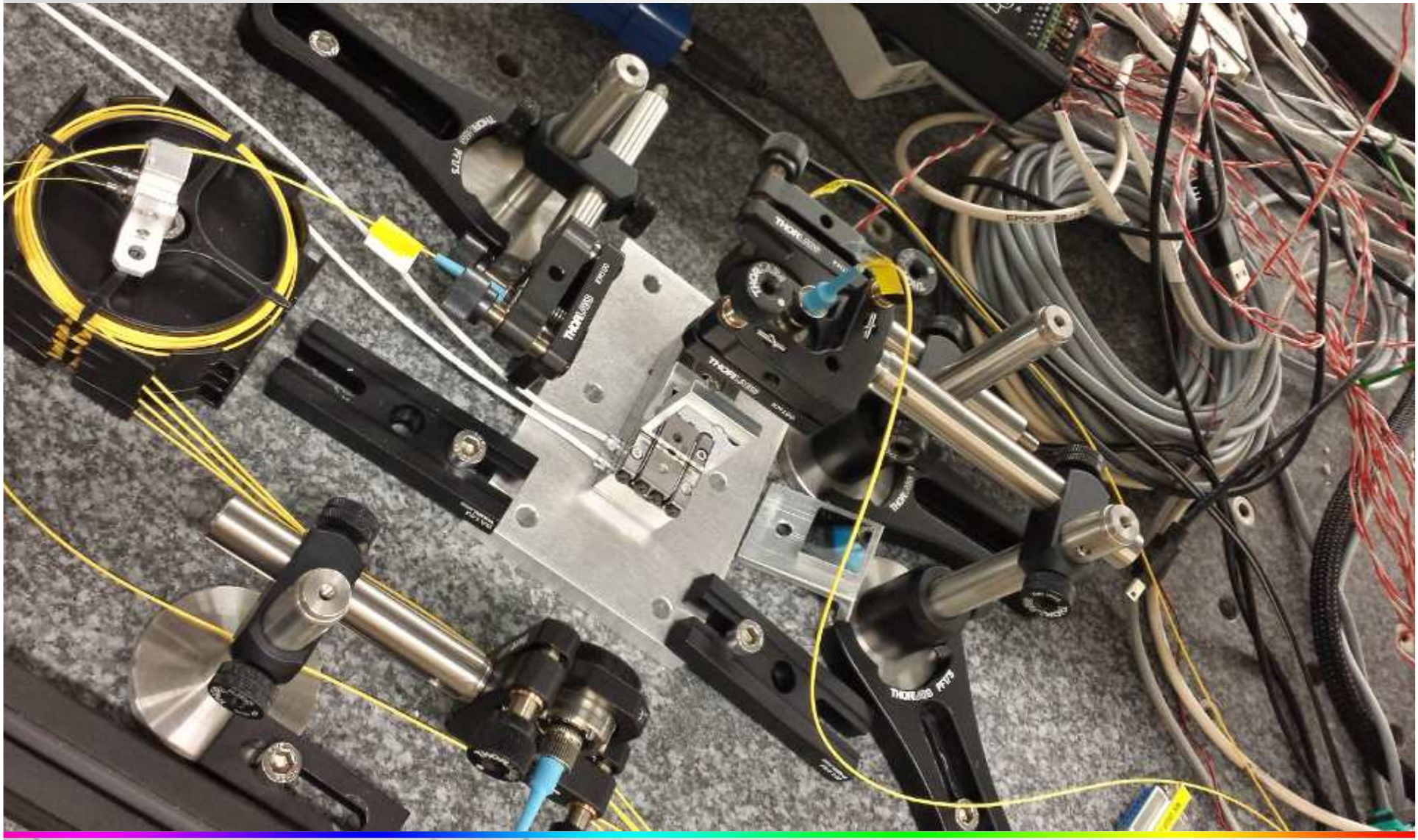




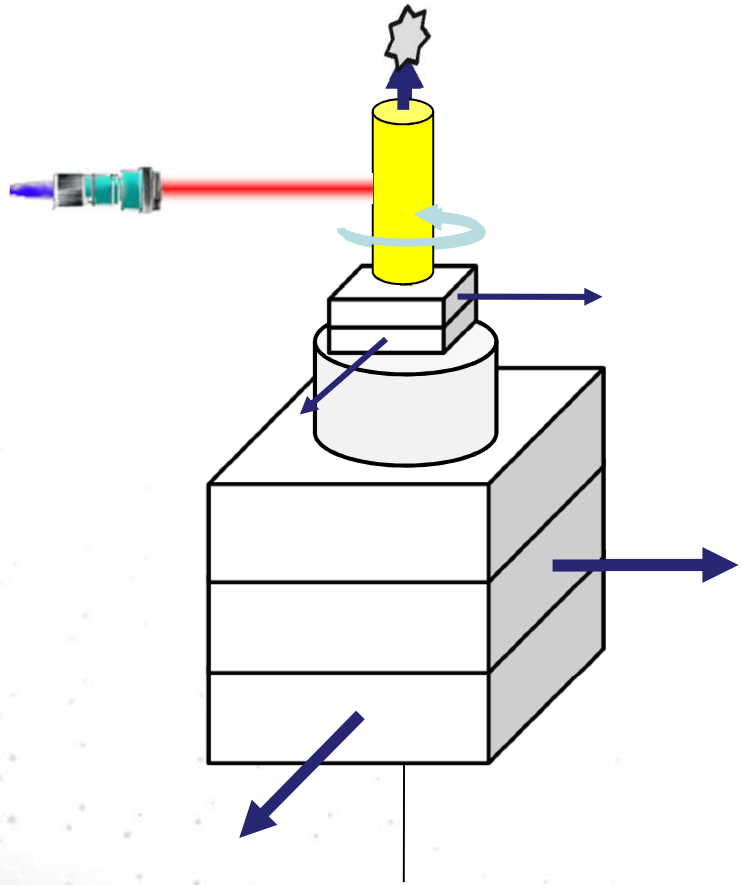




Positioner Characterizations

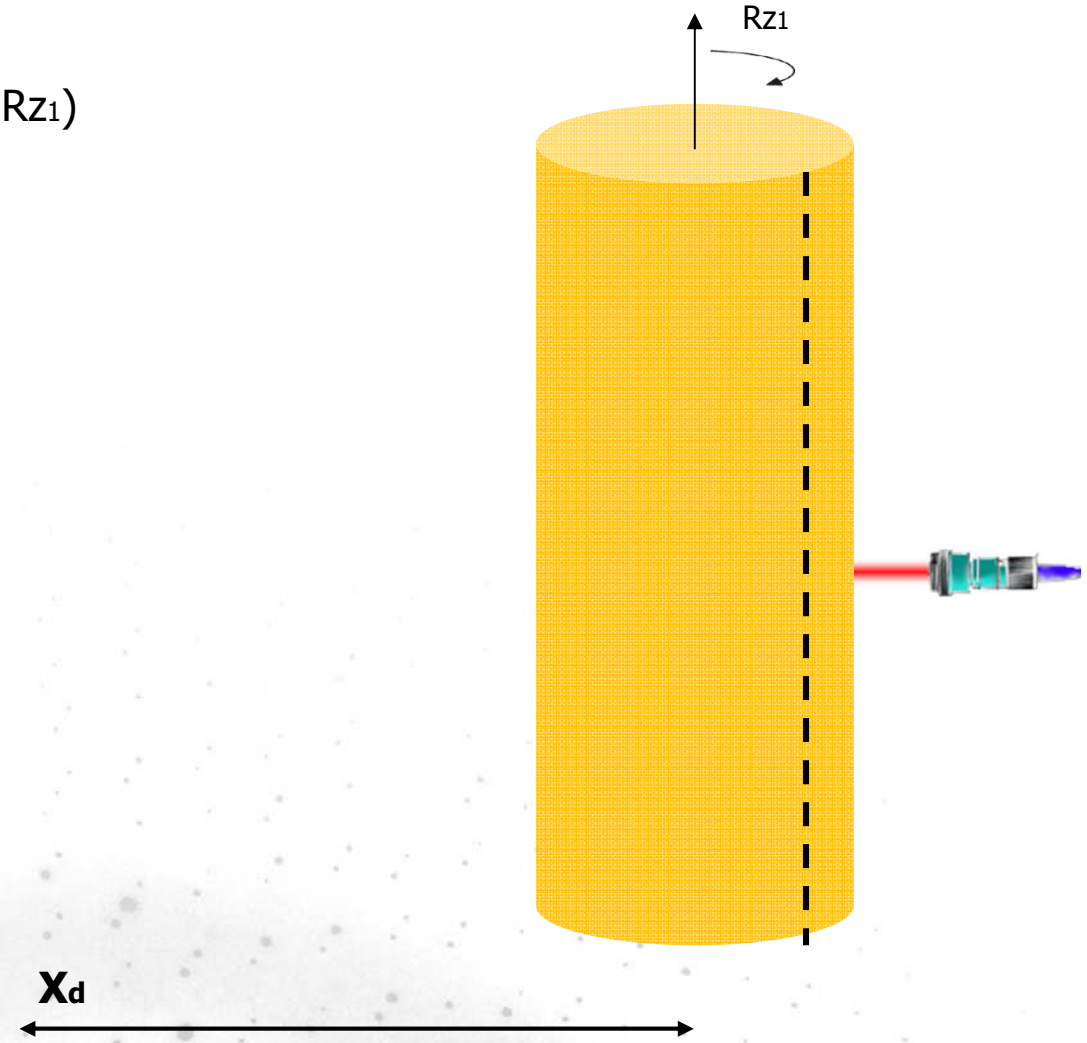


The 'Corona' Principle



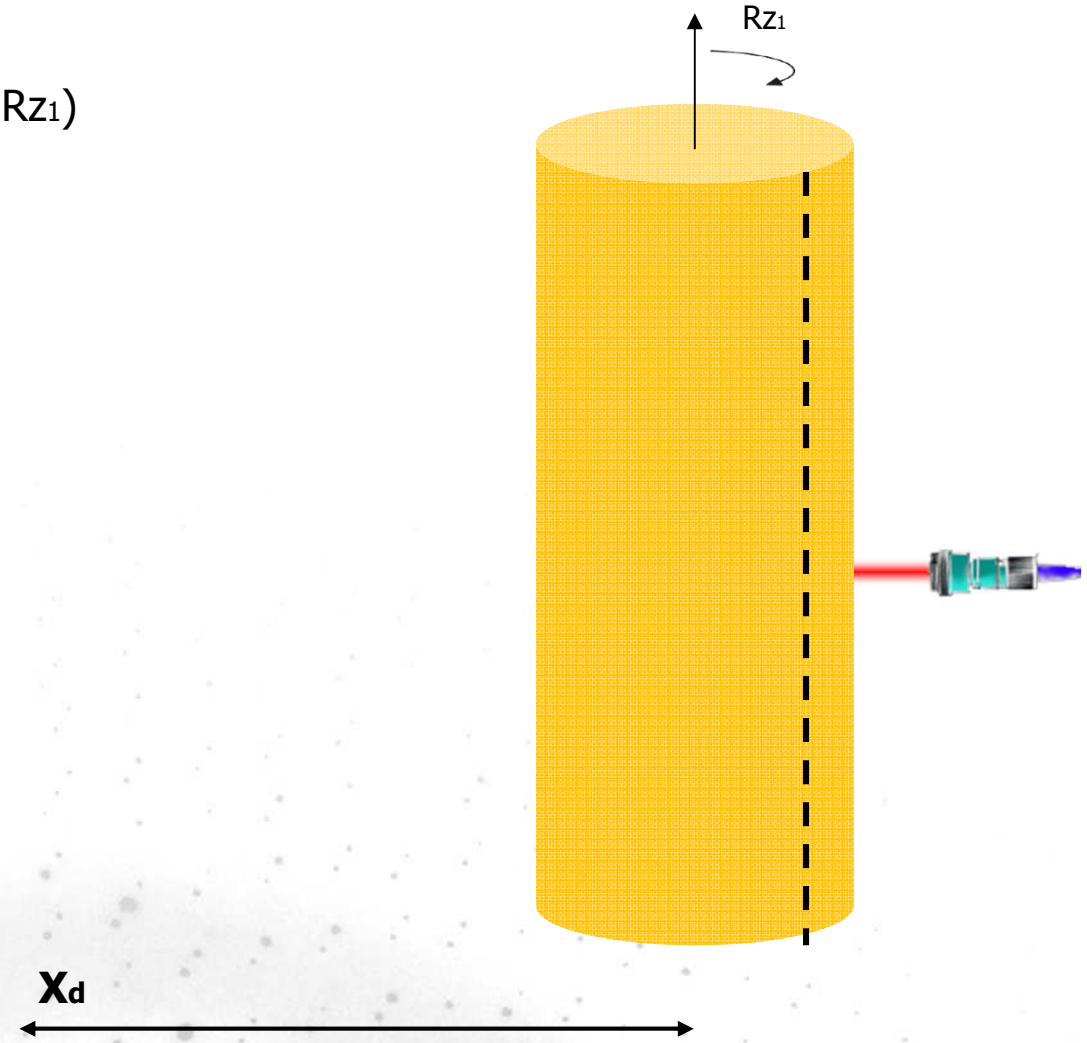
The 'Corona' Principle

$X_1 = dist(X_d, Rz_1)$



The 'Corona' Principle

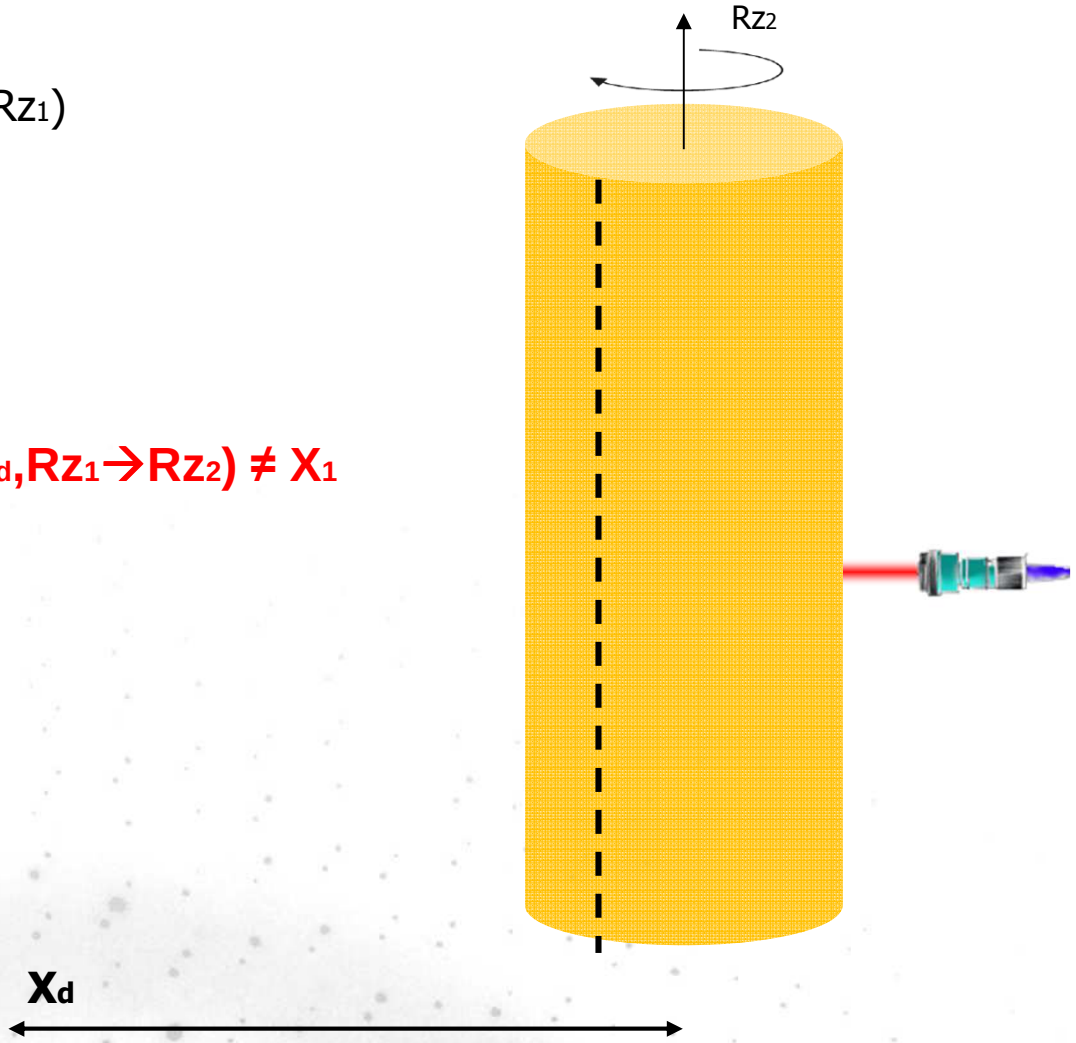
$X_1 = dist(X_d, Rz_1)$



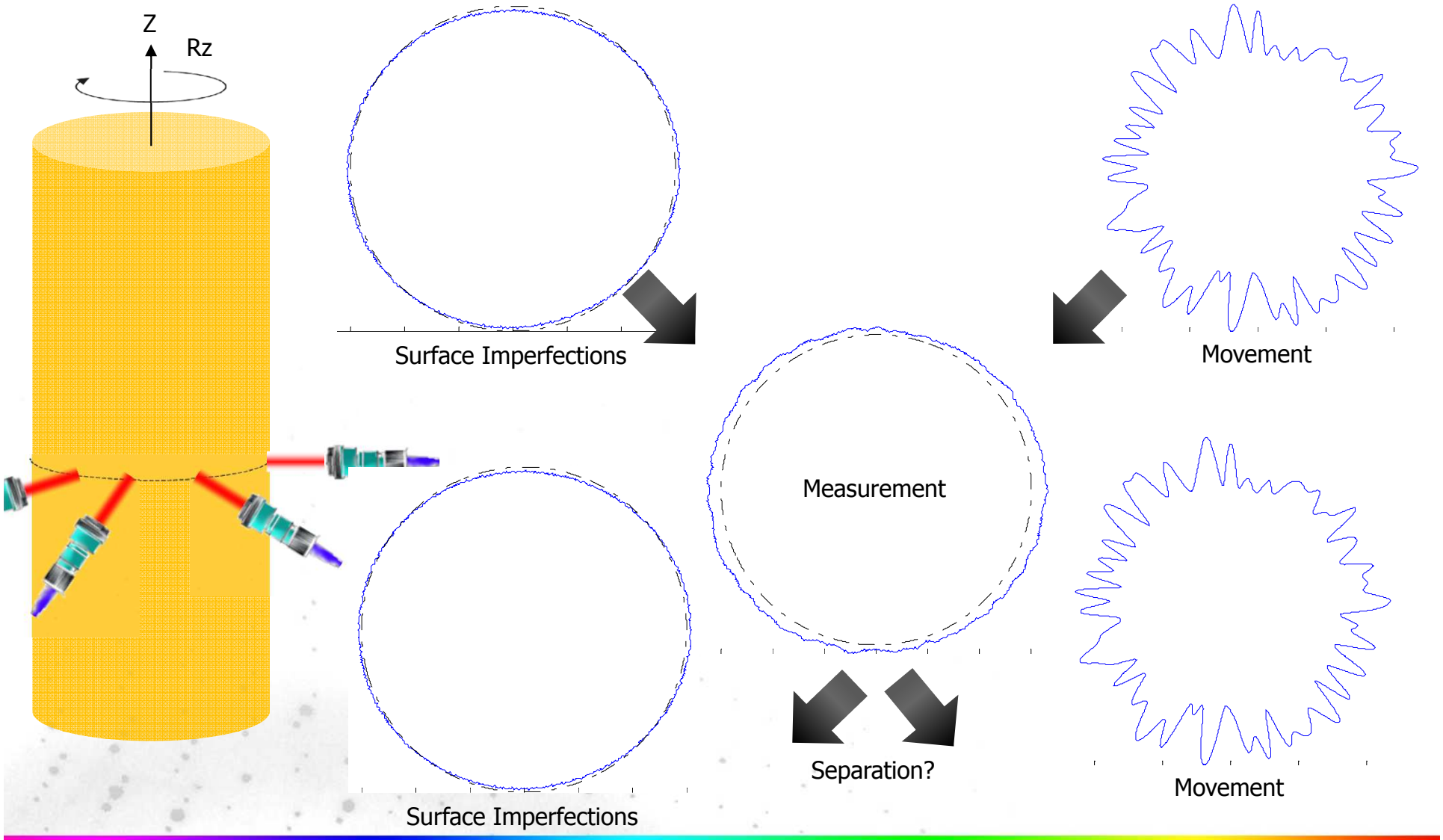
The 'Corona' Principle

$X_1 = dist(X_d, Rz_1)$

$X_2 = dist(X_d, Rz_1 \rightarrow Rz_2) \neq X_1$



The 'Corona' Principle



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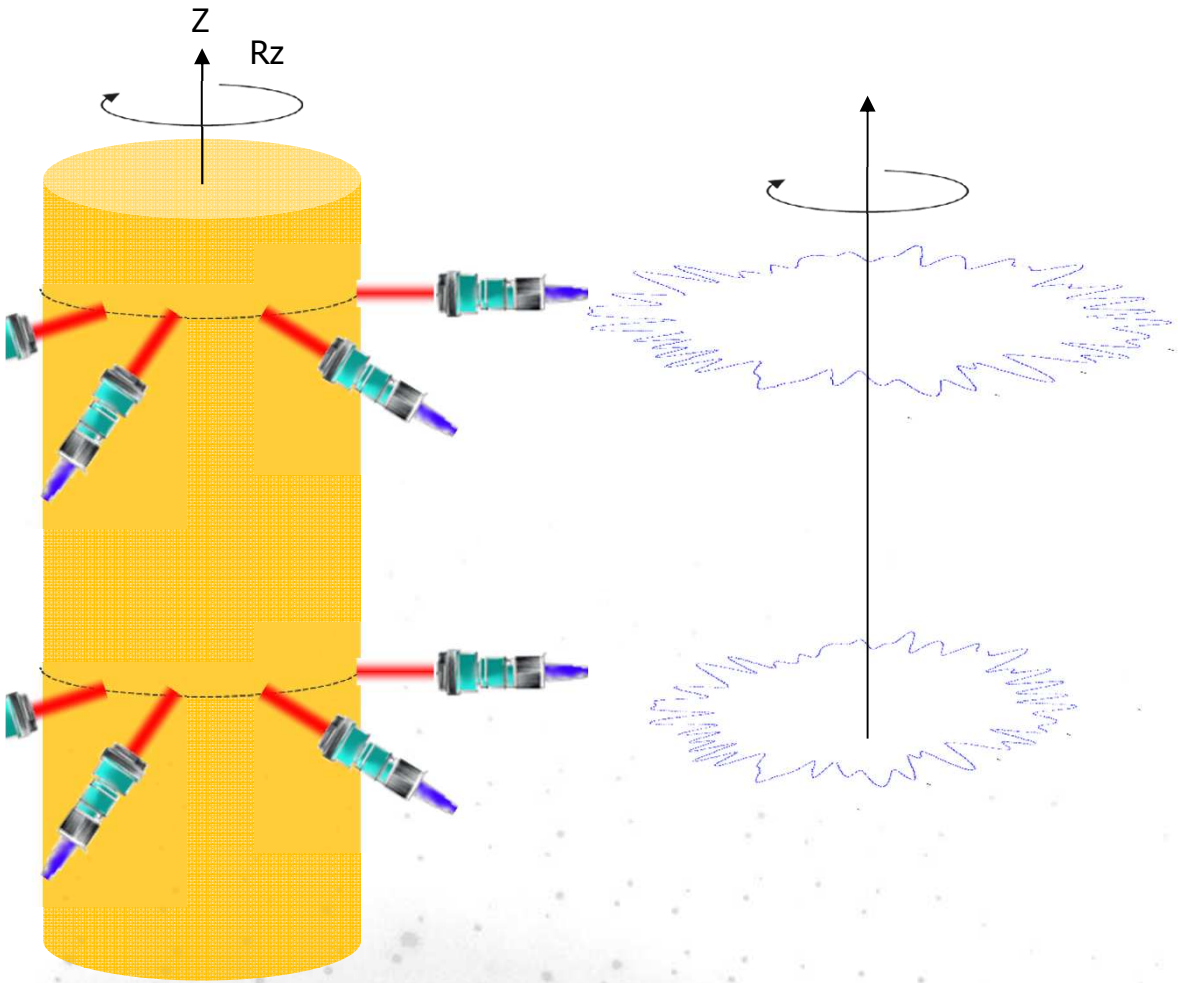
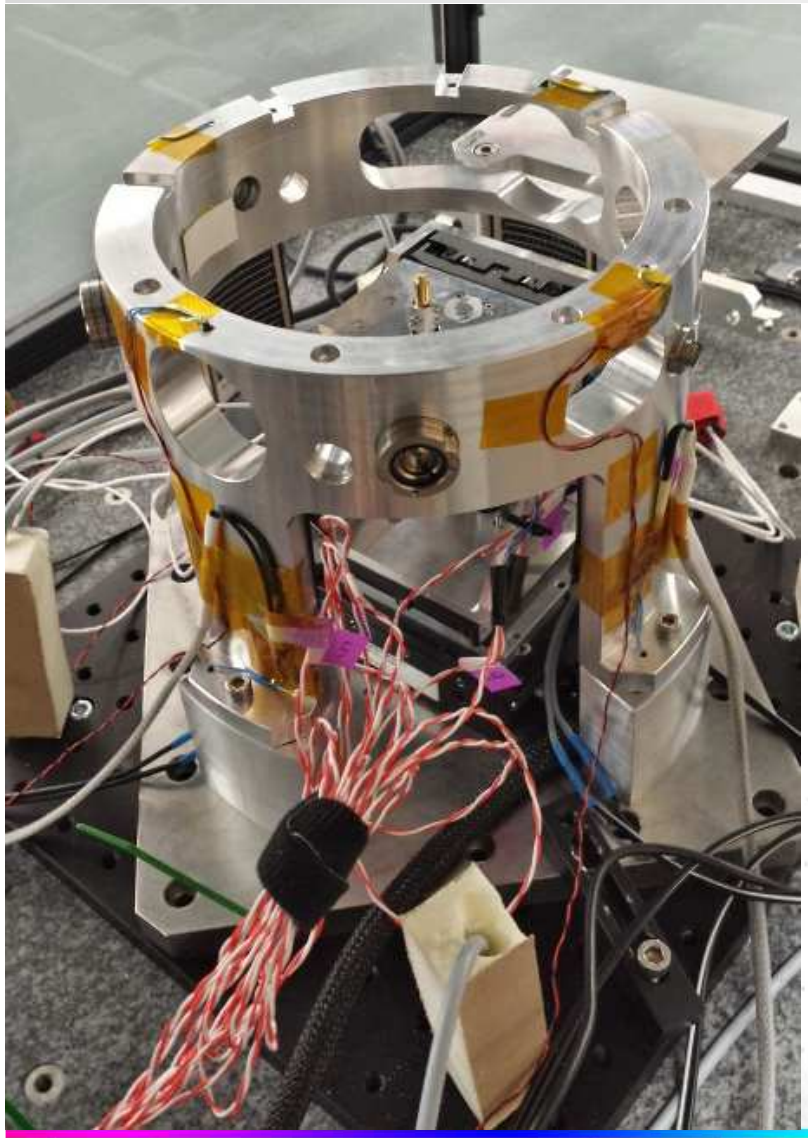
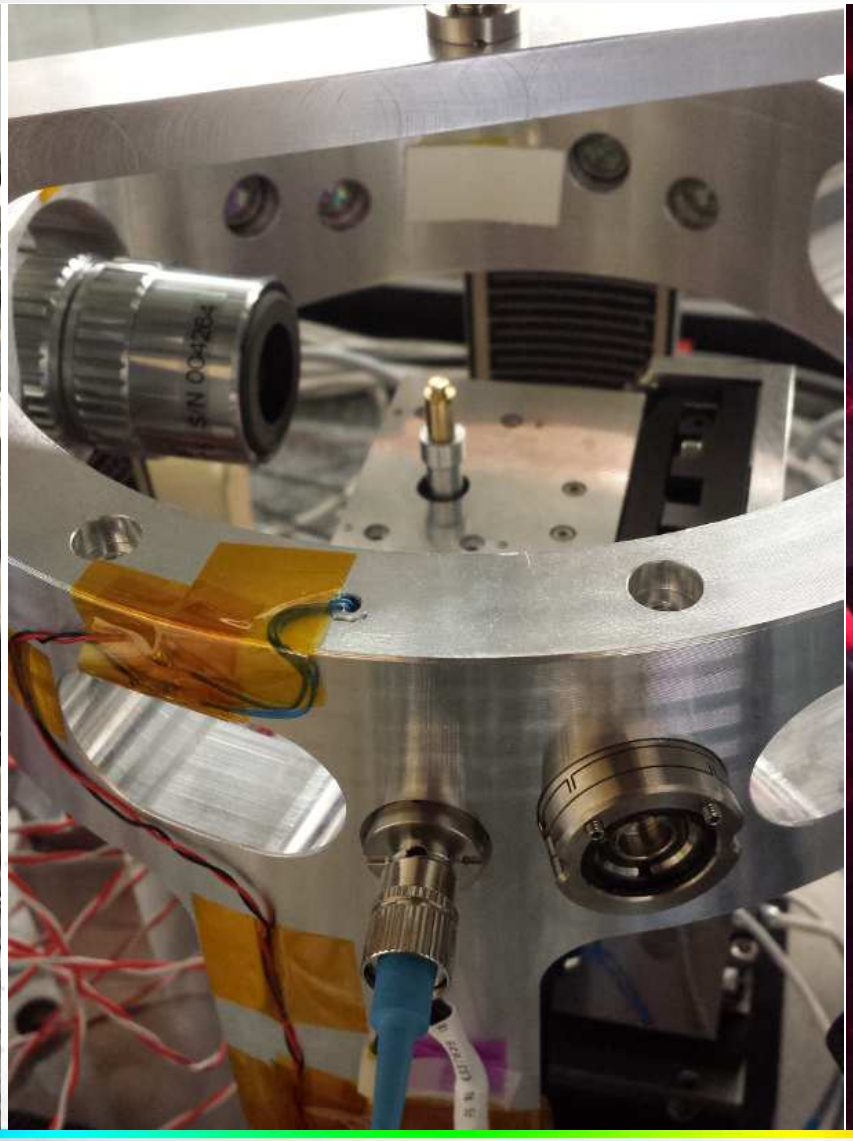


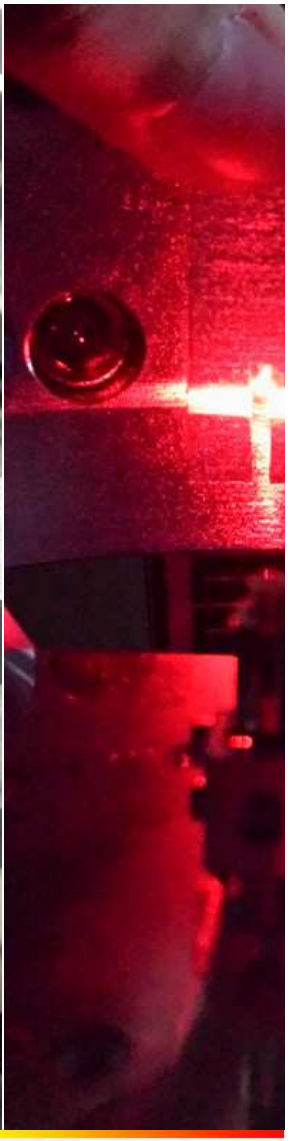
- Form Estimations
  Pin Reflector
- Movement Estimations
  During Rotation

- Improved Sample Tracking
  Controller LUT

The Corona







Sample Stage – Control

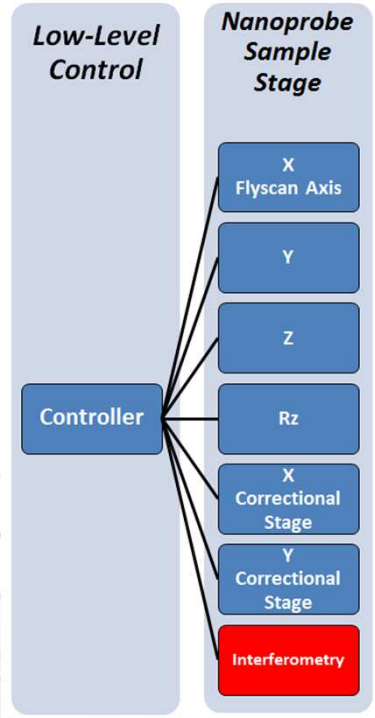
- Stacking Design
  - **X, Y, Z, Rz**
  - Correctional stages **X, Y**
- Interferometry

- Combine, How?
  - Repeatable Errors [Corona]
    - Positioner Characterizations
    - Sample Holder Surface

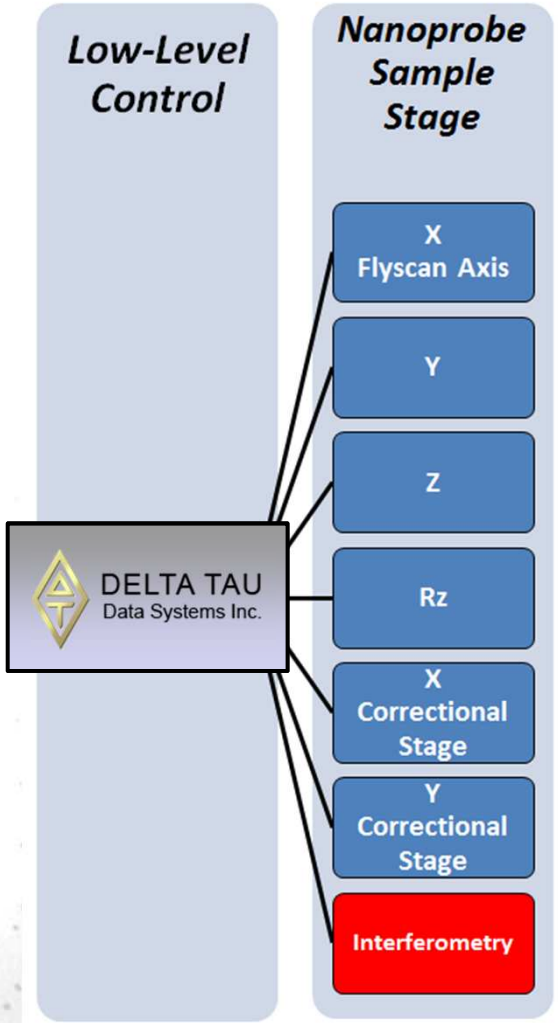
  Controller: **Feedforward**
  3D Compensation Tables

  - Interferometry Sample Tracking, **X, Y, Z**

  Controller: Error Feedback
  Real-Time Kinematic Conversions



Sample Stage – Control



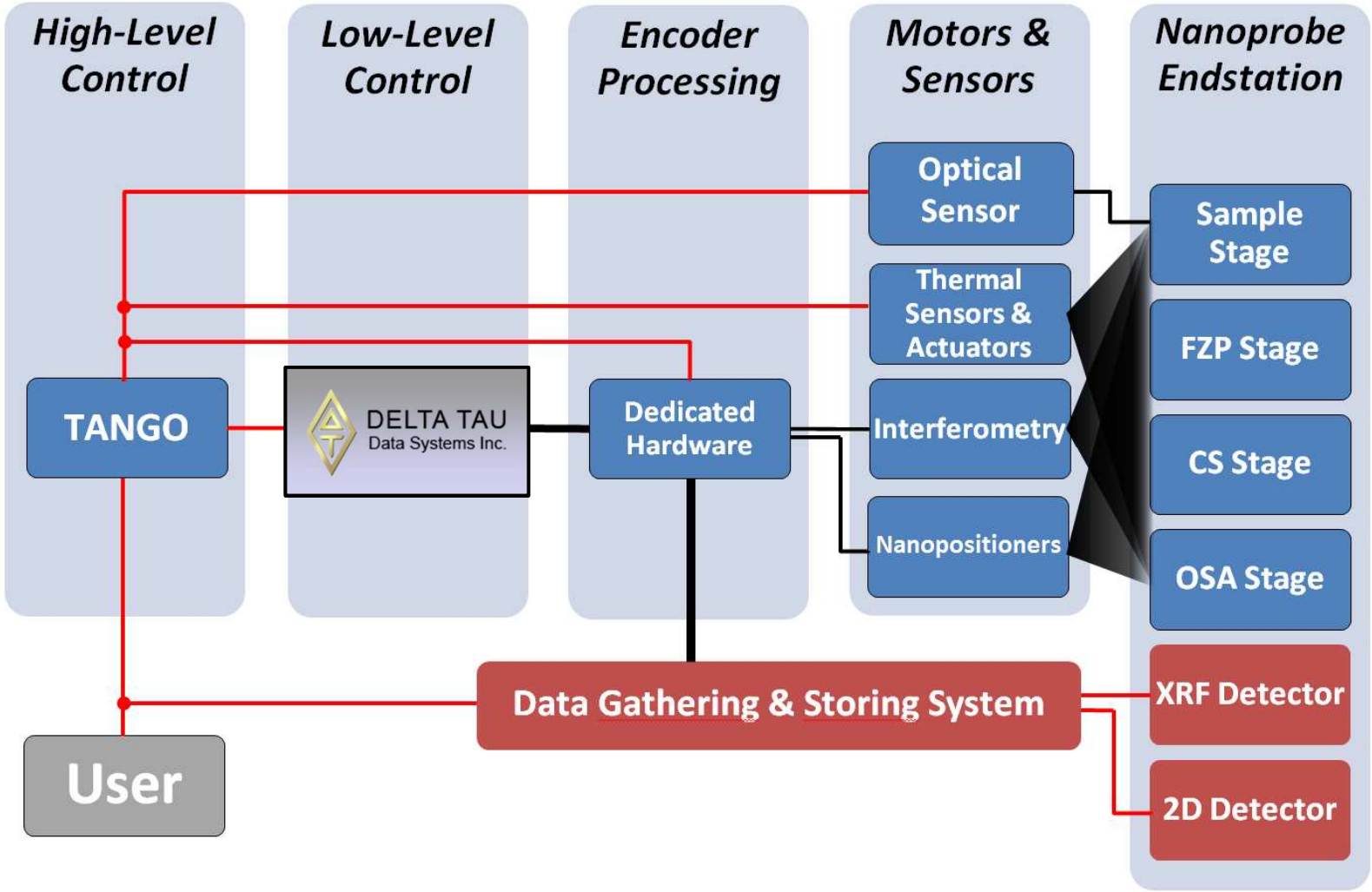
- Needs of Low-Level Master Controller
  - Multiaxis-, high-frequency-, synchronized Control
  - Axis Compensation (1D, 2D, 3D) via LUT
  - Real-Time Kinematic Conversions
  - Support multiple encoder standards (AquadB,SIN/COS)
  - Programmable (C, PLC) with available GPIO

Delta Tau Controller

– Joint decision between SOLEIL/MAXIV -

DELTA TAU
Data Systems Inc.

Control Architecture – Nanoprobe Endstation



Thank You for your time

Questions?