NASS - Introduction

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Contents

1 Context of this thesis / Background and Motivation

- ?? (Figure 1.1)

Figure 1.1: European Synchrotron Radiation Facility

- ID31 and Micro Station (Figure 1.2)

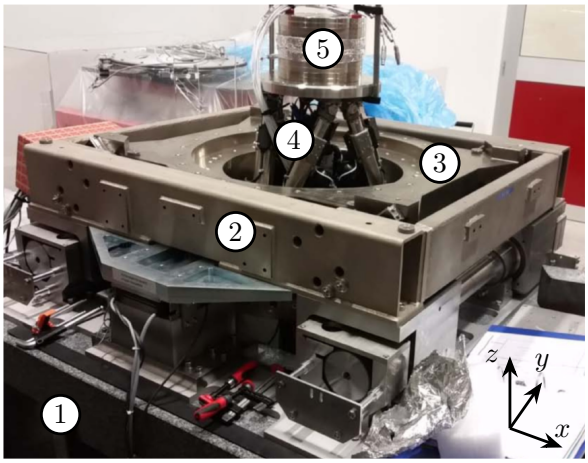


Figure 1.2: Picture of the ID31 Micro-Station with annotations

Alternative: `id31_microstation_cad_view.png` (CAD view)

- X-ray beam + detectors + sample stage (Figure 1.3)
- Few words about science made on ID31 and why nano-meter accuracy is required
- Typical experiments (tomography, …), various samples (up to 50kg)

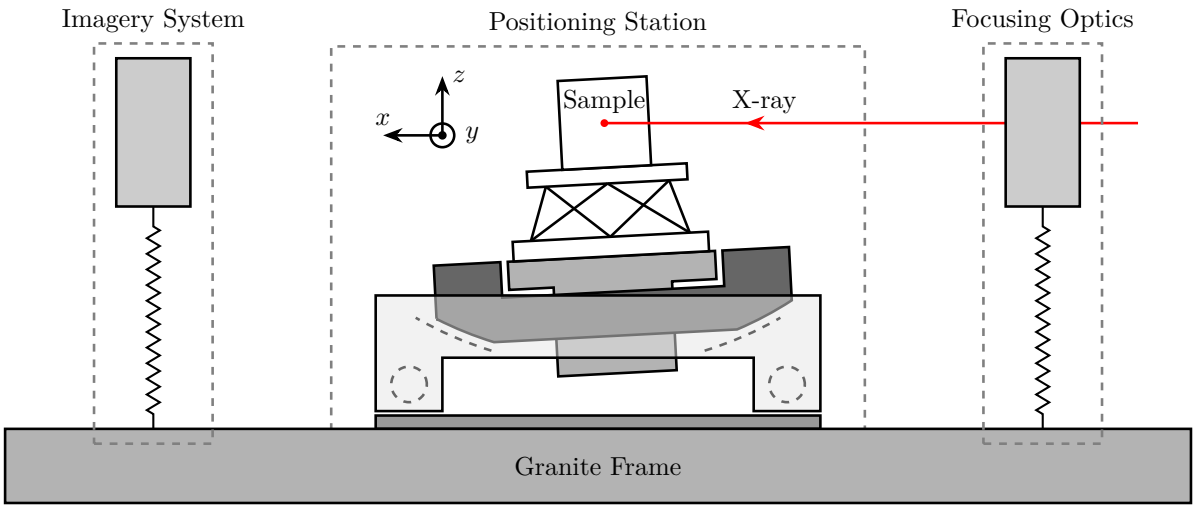


Figure 1.3: ID31 Beamline Schematic. With light source, nano-focusing optics, sample stage and detector.

- Where to explain the goal of each stage? (e.g. micro-hexapod: static positioning, Ty and Rz: scans, …)
- Example of picture obtained (Figure 1.4)

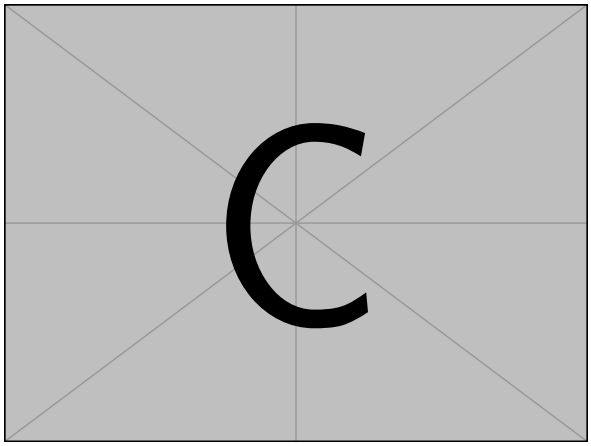


Figure 1.4: Image obtained on the ID31 beamline

- Explain wanted positioning accuracy and why micro-station cannot have this accuracy (backlash, play, thermal expansion, …)
- Speak about the metrology concept, and why it is not included in this thesis

2 Challenge definition

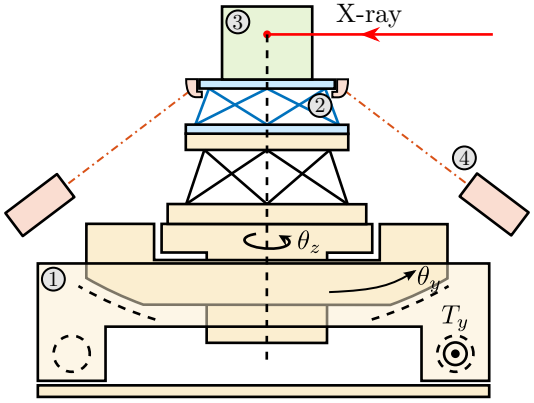
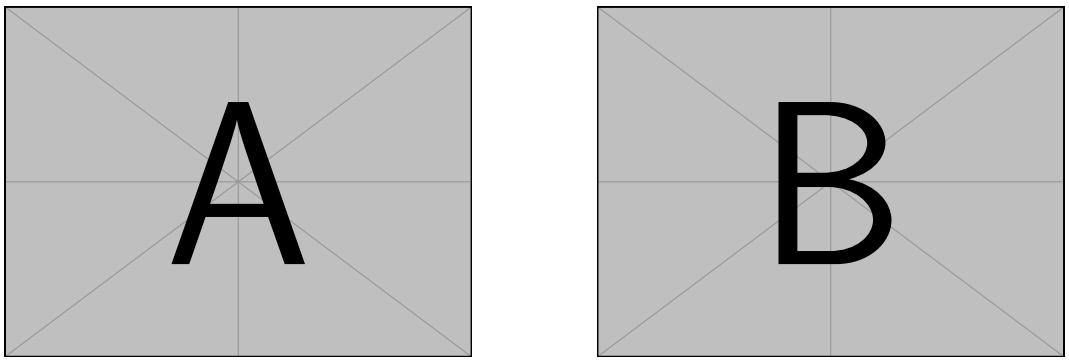


Figure 2.1: Nass Concept. 1: micro-station, 2: nano-hexapod, 3: sample, 4: 5DoF metrology

- 6DoF vibration control platform on top of a complex positioning platform
- **Goal**: Improve accuracy of 6DoF long stroke position platform
- **Approach**: Mechatronic approach / model based / predictive
- **Control**: Robust control approach / various payloads. First hexapod with control bandwidth higher than the suspension modes that accepts various payloads?
- Rotation aspect
- Compactness? (more related to mechanical design)

3 Literature Review

- Hexapods [1] [2] [3] [4] [5]
- Positioning stations
- Mechatronic approach? [6] [7] [8]



(a) Stewart platform based on voice coil actuators **(b)** Stewart platform based on piezoelectric actuators

Figure 3.1: Examples of Stewart Platforms

4 Outline of thesis / Thesis Summary / Thesis Contributions

Mechatronic Design Approach / Model Based Design:

- [7] high costs of the design process: the designed system must be **first time right**. When the system is finally build, its performance level should satisfy the specifications. No significant changes are allowed in the post design phase. Because of this, the designer wants to be able to predict the performance of the system a-priori and gain insight in the performance limiting factors of the system.

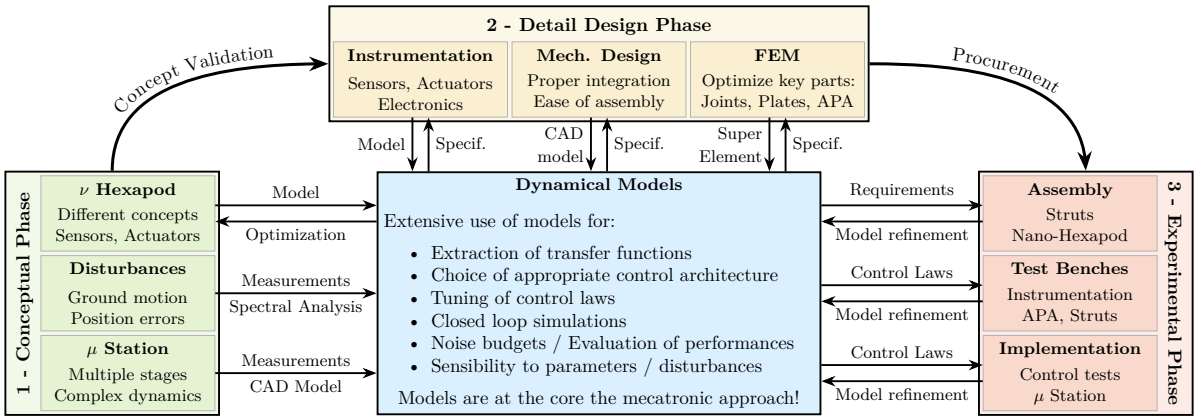


Figure 4.1: Overview of the mechatronic approach used for the Nano-Active-Stabilization-System

Goals:

- Design ?? such that it is easy to control (and maintain). Have good performances by design and not by complex control strategies.

Models:

- Uniaxial Model:
  - Effect of limited support compliance
  - Effect of change of payload
- Rotating Model
  - Gyroscopic effects
- Multi Body Model

- Finite Element Models

Bibliography

[1] X. Li, "Simultaneous, fault-tolerant vibration isolation and pointing control of flexure jointed hexapods," Ph.D. dissertation, University of Wyoming, 2001 (cit. on p. 8).

[2] R. M. Bishop Jr, "Development of precision pointing controllers with and without vibration suppression for the NPS precision pointing hexapod," Ph.D. dissertation, Naval Postgraduate School, Monterey, California, 2002 (cit. on p. 8).

[3] A. A. Hanieh, "Active isolation and damping of vibrations via stewart platform," Ph.D. dissertation, Université Libre de Bruxelles, Brussels, Belgium, 2003 (cit. on p. 8).

[4] B. Afzali-Far, "Vibrations and dynamic isotropy in hexapods-analytical studies," Ph.D. dissertation, Lund University, 2016 (cit. on p. 8).

[5] M. Naves, "Design and optimization of large stroke flexure mechanisms," Ph.D. dissertation, Univeristy of Twente, 2020 (cit. on p. 8).

[6] A. M. Rankers, "Machine dynamics in mechatronic systems: An engineering approach.," Ph.D. dissertation, University of Twente, 1998 (cit. on p. 8).

[7] W. Monkhorst, "Dynamic error budgeting, a design approach," Ph.D. dissertation, Delft University, 2004 (cit. on pp. 8, 9).

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