Presentation of Master's Thesis

Investigation of Control Approaches for a High Precision, Piezo-actuated Rotational Stage

Niklas Ericson

August 29, 2016

Linköping University — European Organization for Nuclear Research

Table of contents

Introduction

CERN

The Large Hadron Collider (LHC) at CERN.

Source: [**?**].

Collimation

Collimation system used in the LHC.

Source: [**?**].

Crystal Collimation

The UA9 collaboration at CERN investigates how bent crystals can be used to extract halo particles.

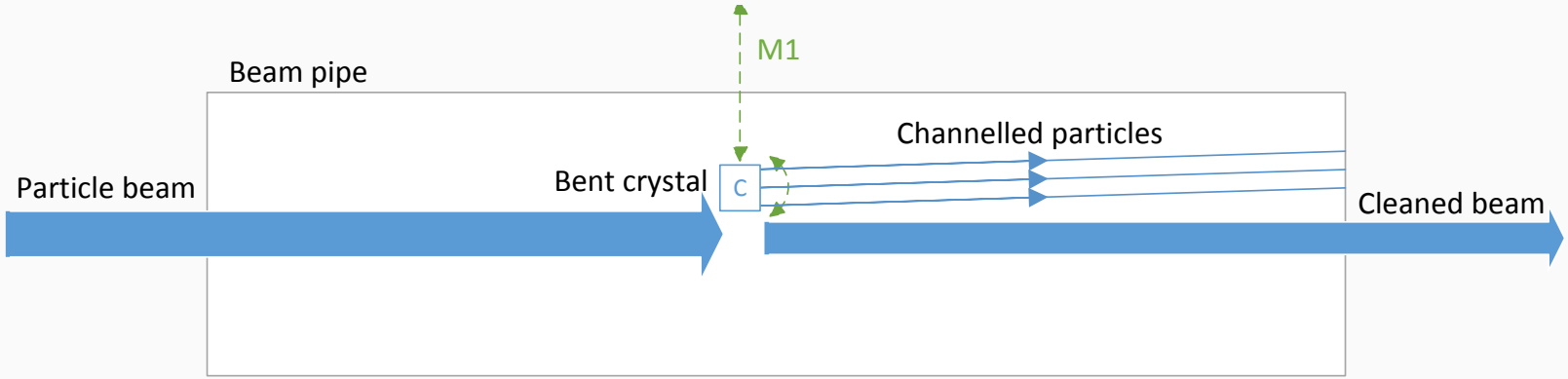

Figure 1: Illustration of the crystal collimation principle.

Implies in a more efficient cleaning, a less complex system and a reduction of the machine impedance.

Purpose and Goal

The **higher the energy** of the particle the **lower the angular acceptance** for channeling.

- have a total range of $20\ \mathrm{mrad}$
- be able to track reference trajectories at ramp rates of $100\ \mu\mathrm{rad/s}$
- reject external disturbances to maintain a maximum tracking error of $\pm 1\ \mu\mathrm{rad}$ even when the linear axis is moving

Challenges

- Nonlinear effect such as hysteresis and creep
- Highly resonant structure
- The linear movement adds additional perturbation
- System changes due to rotational and linear position, moving center of rotation.

Method

Hello

System Overview

Crystal Collimators

The theme provides sensible defaults to *emphasize* text, accent parts or show **bold** results.

Rotational stage

- Regular
- *Italic*
- SmallCaps
- **Bold**
- **Bold Italic**
- **Bold SmallCaps**
- `Monospace`
- *`Monospace Italic`*
- `Monospace Bold`
- *`Monospace Bold Italic`*

Modeling

Present Control Approach

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

Approaches and Simulation Results

Integral Resonance Control

Model Reference Adaptive Controller

Harmonic Cancellation

Comparison

Implementation

Setup

Experimental Results

Conclusion

Simulation Results

Experimental Results

Summary

Questions?

References I

H. G. Morales.
opac hector garcia morales - lhc collimation system optimization, 2015.
Available at https://www.youtube.com/watch?v=h2-ocLjUhTU.