Ion Beam Energy Verification

Requirements, Analysis and Outlook on Design

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Overview

- Requirements for the particle energy distribution
- Reasons for energy verification
- Candidates for energy verification
- Possible solutions
- Strategy and Outlook

Requirements

Range measurement: 0.5 mm precision (ICRU)

Homogeneity: below 111% (CNAO)

For low-energy protons without ridge filter:

Energy accuracy: 0.1 MeV

Reasons for energy verification

Energy ⇨ **Range verification:**
Critical ingredient for dose distribution

Motivation

Lower safety requirements for accelerator
→ Relax complexity and cost of risk management

Recommended by ICRU (Report 78)

Candidates (selected)

Spectrometer
- "B-train" (synchrotron as spectrometer)
- "90° dipole field" (transfer line as spectrometer)

Time-of-flight
- "Radio frequency" (TOF in the synchrotron)

→ Non-destructive measurement

Particle range
- "Multi-layer Faraday cup"

Calorimetry

Depth-dose distribution
- "Water phantom"

→ Destructive measurement

ebg MedAustron

Possible solutions

Synchrotron ToF	Calorimetry	Depth-dose distribution
• Advantage: Few additional hardware • Drawback: Works only on bunched beam	• Advantage: “Ultimate” particle energy measurement • Drawback: Low radiation hardness	• Advantage: “Like the doctors” • Drawback: Intensity dependent

Strategy

Synchrotron ToF	Transfer line Depth-dose	Build and Test

Synchrotron ToF

- Conceptual design
- Performance expectations
- Extraction influences
- Reliability?

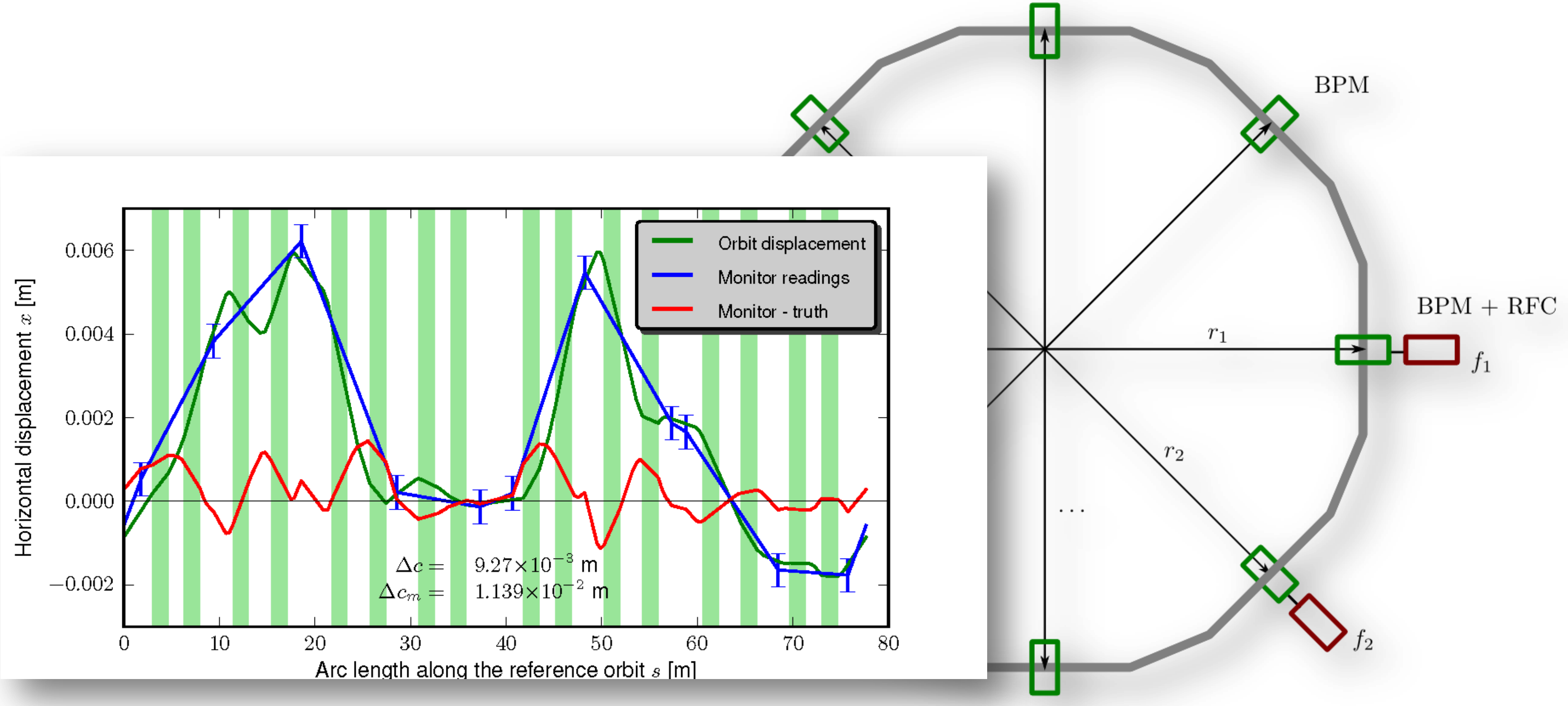
Transfer line Depth-dose

- Feasibility
- Conceptual design
- Performance expectations
- Reliability?

Build and Test

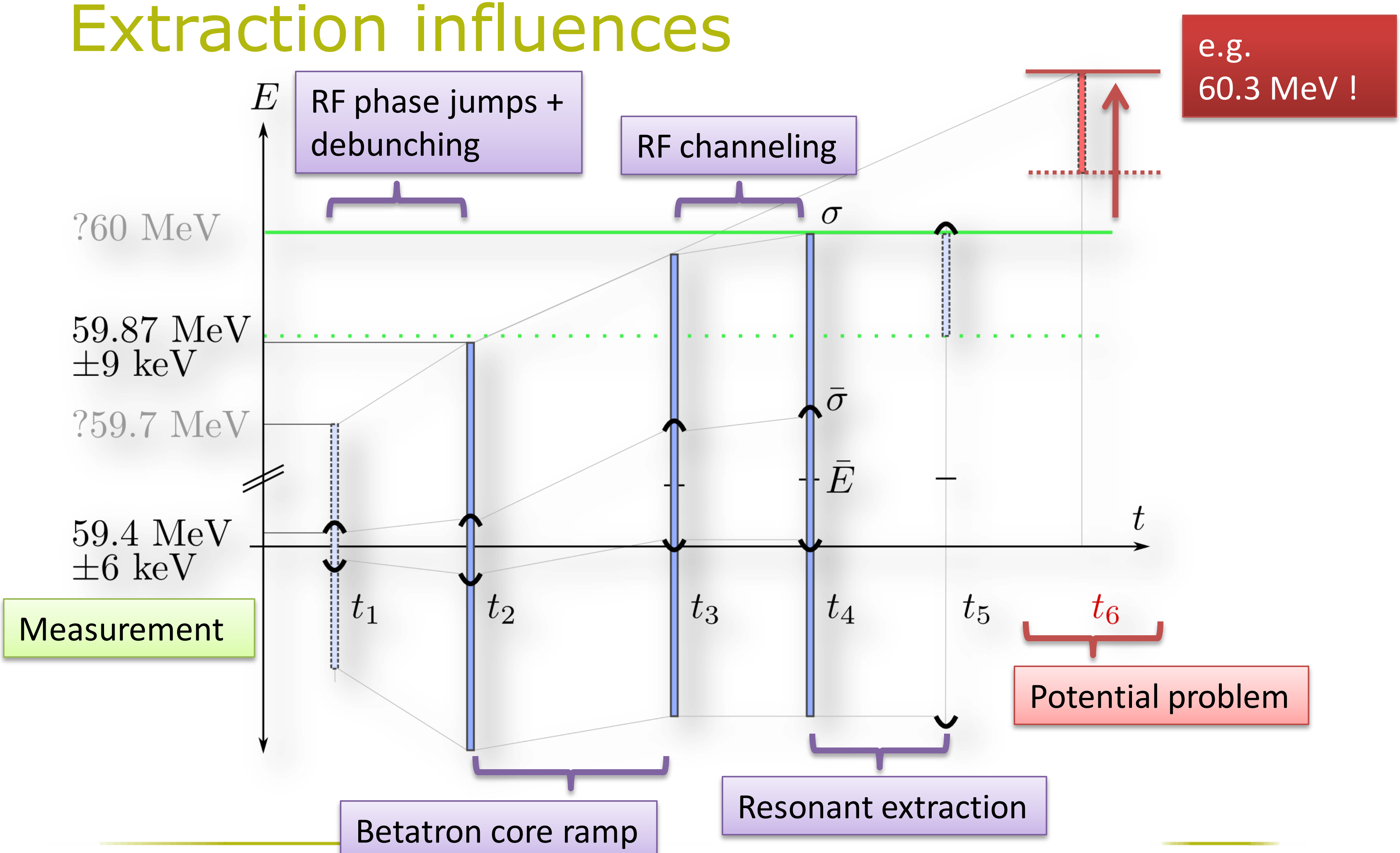
?

Time-of-Flight in the Synchrotron



Precision: O[ΔE] ≈10 keV

Extraction influences



Outlook

- Evaluation of extraction influences (ongoing)
- Feedback on design
- Approximation of reliability
- Start with feasibility/design of depth-dose measurement

Backup: Steinbach diagrams