Wire scanner project status

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Summary

• The motor and the wire position read out are the key elements regarding performance

• Linear motor concepts:
  – Direct drive with commercial linear motor and bellows for atm./vacuum interface
  – Direct drive with linear motor inside the vacuum chamber
  – Ultrasonic linear motor inside the vacuum chamber

• Rotating wire motion
  – Rotating motor inside vacuum
Direct drive with commercial linear motor and bellows for atm./vacuum interface

• Tubular motor would be easier to implement
• The fastest and more accurate motors found until now have magnetic track construction
• Advantages
  – Simple and cheapest construction
• Disadvantages
  – Maximum speed found is 10 m/s (with accuracy 5 micron, repeatability 1 microns manufactured by Baldor)
  – Speed limit is determined by encoder accuracy
  – Larger loads due to interface atm./vacuum
  – Motors without encoder have less accuracy, ~100 to 300 microns
• Open questions
  – Radiation hardness of magnetic encoders to be verified
  – Other types of encoders besides optical and magnetic?
• Options
  – Modify the controller for faster speed and acquire the wire position with another method?
  – Add mechanism to amplify the speed losing in accuracy due to mechanical tolerances?
Direct drive with linear motor inside the vacuum chamber

• Actuator with permanent magnets inside vacuum driven by coils on the atm. side

• Advantages
  – No bellows, hence no loads to atmospheric pressure and bellows rigidity
  – Components with reduced mass => less inertia and reduced vibration amplitude

• Disadvantages
  – Never done before...
  – Same problem with maximum speed/accuracy limit due to encoder
  – Not sure if a UHV compatible encoder is available in industry. Renishaw proposes an encoder but outgassing data must be checked

• Open issues
  – What are the technological limits in terms of speed and accuracy?
  – Alternative method to find the wire position?
Ultrasonic linear motor inside the vacuum chamber

• Advantages
  – Already being used in vacuum applications such as semiconductor positioning
  – High accuracy, up to nanometer level

• Disadvantages
  – Low speeds, maximum found was 0.5 m/s
  – None of the models found until now could be used as is

• Open questions
  – What is the real maximum speed that can be reached?
  – Can they be made compatible with the LHC vacuum?
Rotating wire

• Advantages
  – Independently of the motor being inside the vacuum or not, it allows for simple transmission mechanisms to increase the wire speed

• Disadvantages
  – More calculations to measure the beam profile

• Open issues
  – What is the expected loss in accuracy due to the introduction of a mechanism?
Rotating motor inside vacuum...

- Rotating motor in the vacuum chamber with the wire at the end of an extension arm?
- No mechanisms!
- Wire position measured with a magnetic scale inside vacuum and read head in atmosphere?
Proposed actions

• Identify the technological limits of linear motors
• Research for other than usual position read out devices
• Compare feasibility linear and rotating motors inside vacuum
• Investigate bearings compatible with vacuum