Status of Target Design

Chris Booth
Sheffield
28th October 2004

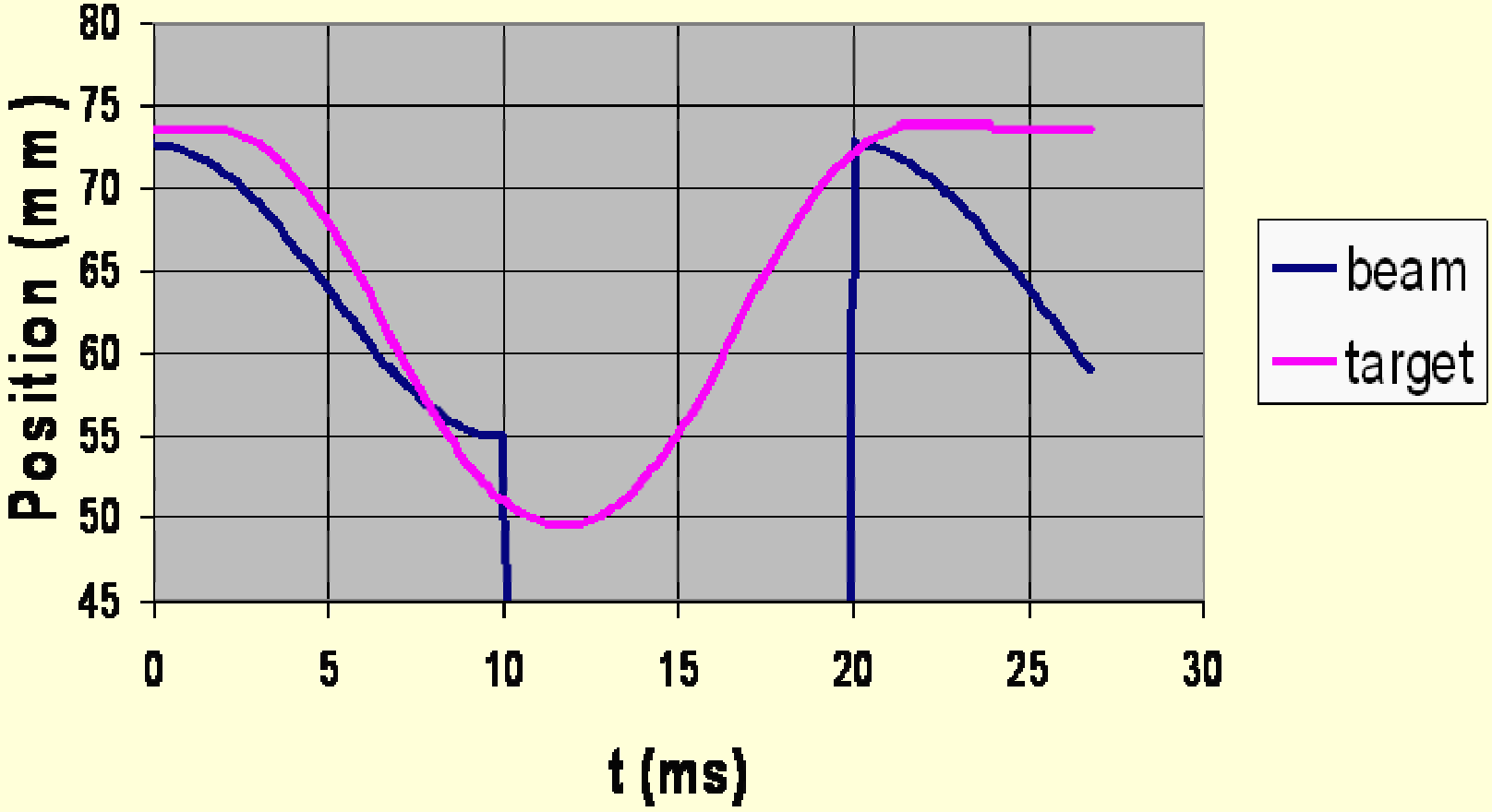
Outline

- Specifications
- Diaphragm Spring suspension
- Linear Drive
  - First prototype
  - New design
- Plans

Draft Specification

- Transit: 40 mm
- Entry ≥ 5 mm into beam in ≤ 2 ms
  (see plot)

Target edge trajectory



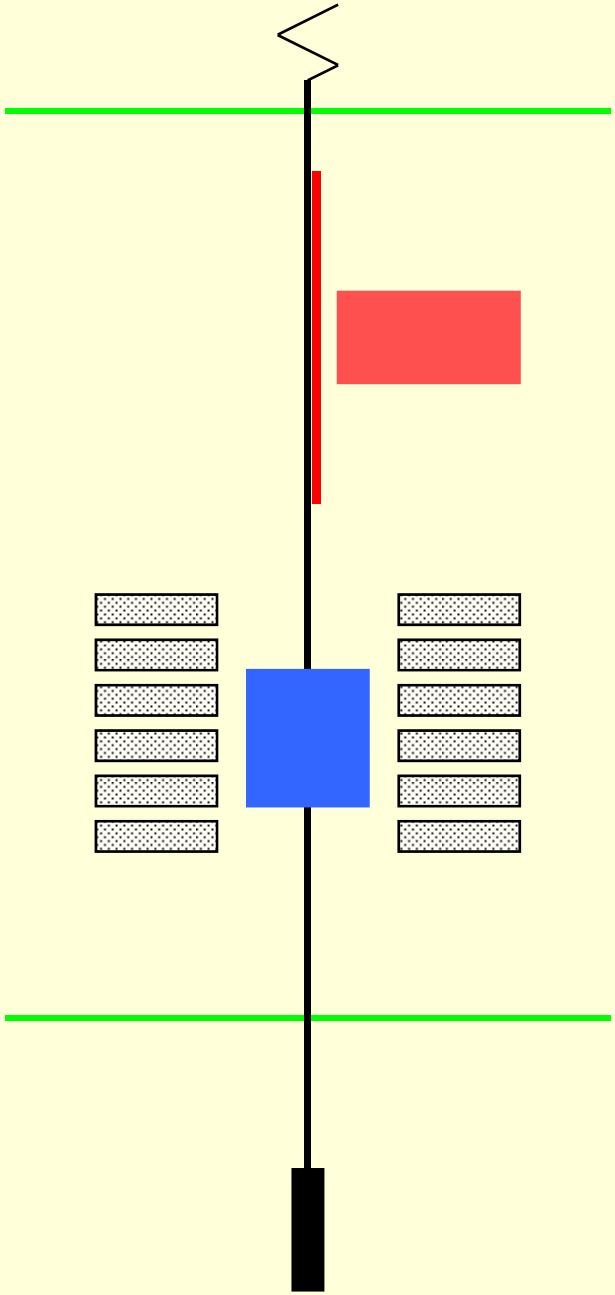
Draft Specification

- Transit: 40 mm
- Entry ≥ 5 mm into beam in ≤ 2 ms
  (see plot)
- Cycle time: 20 ms
- Positioning accuracy: ≤ 0.5 mm
- Timing accuracy: ~ 0.2 ms
- Frequency: (baseline) 1 to 3 Hz on demand
- (optimal) 1 to 50 Hz
- Maximum proton rate: 1.4×10^{12} per second

Specs Continued

- Must operate in vacuum and radiation environment
- Must not interfere with ISIS operation!!

Schematic design



Diaphragm spring

Position measurement

Array of coils

Magnet(s)

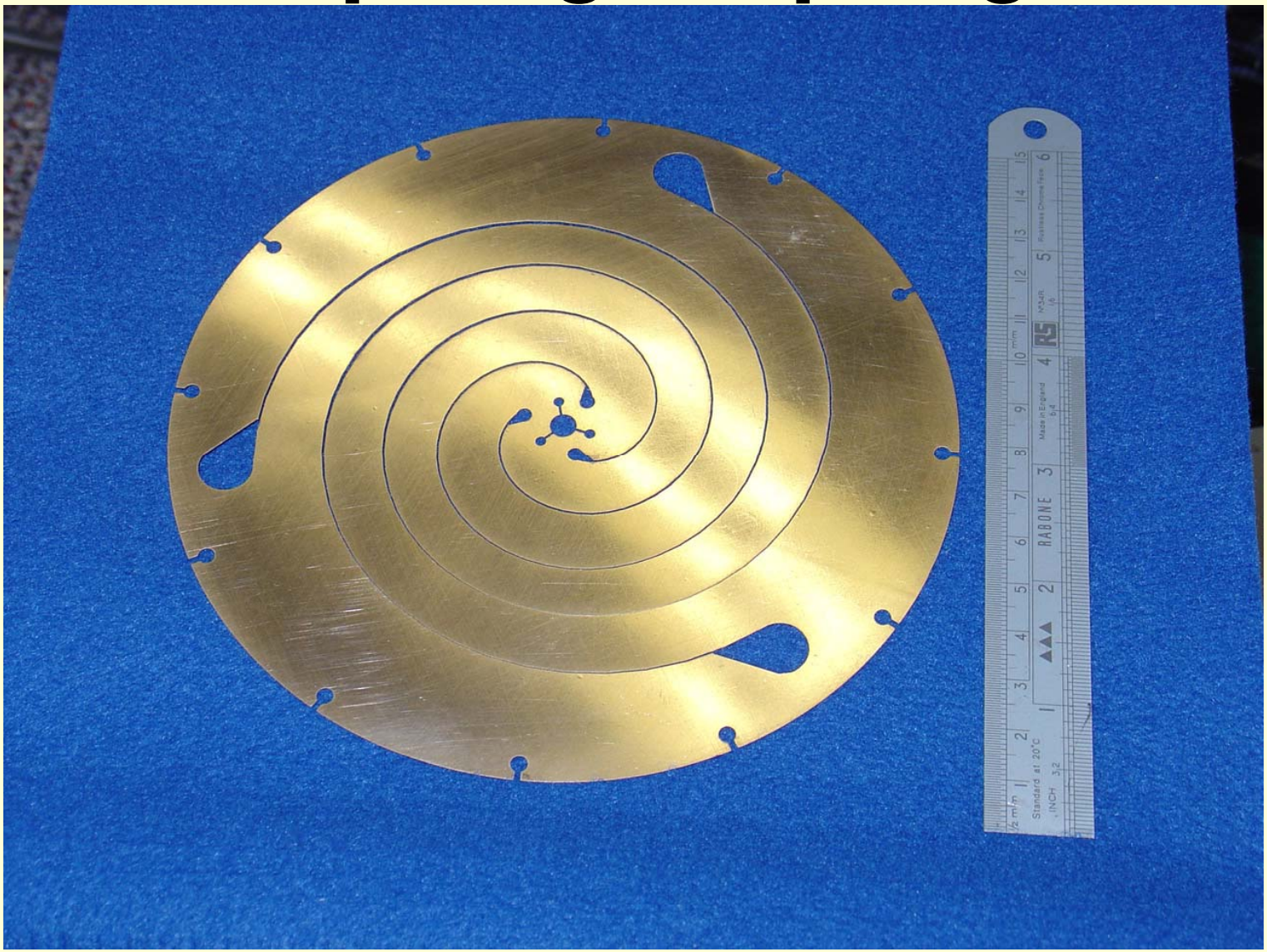
Linear Drive

Target

Diaphragm Spring suspension

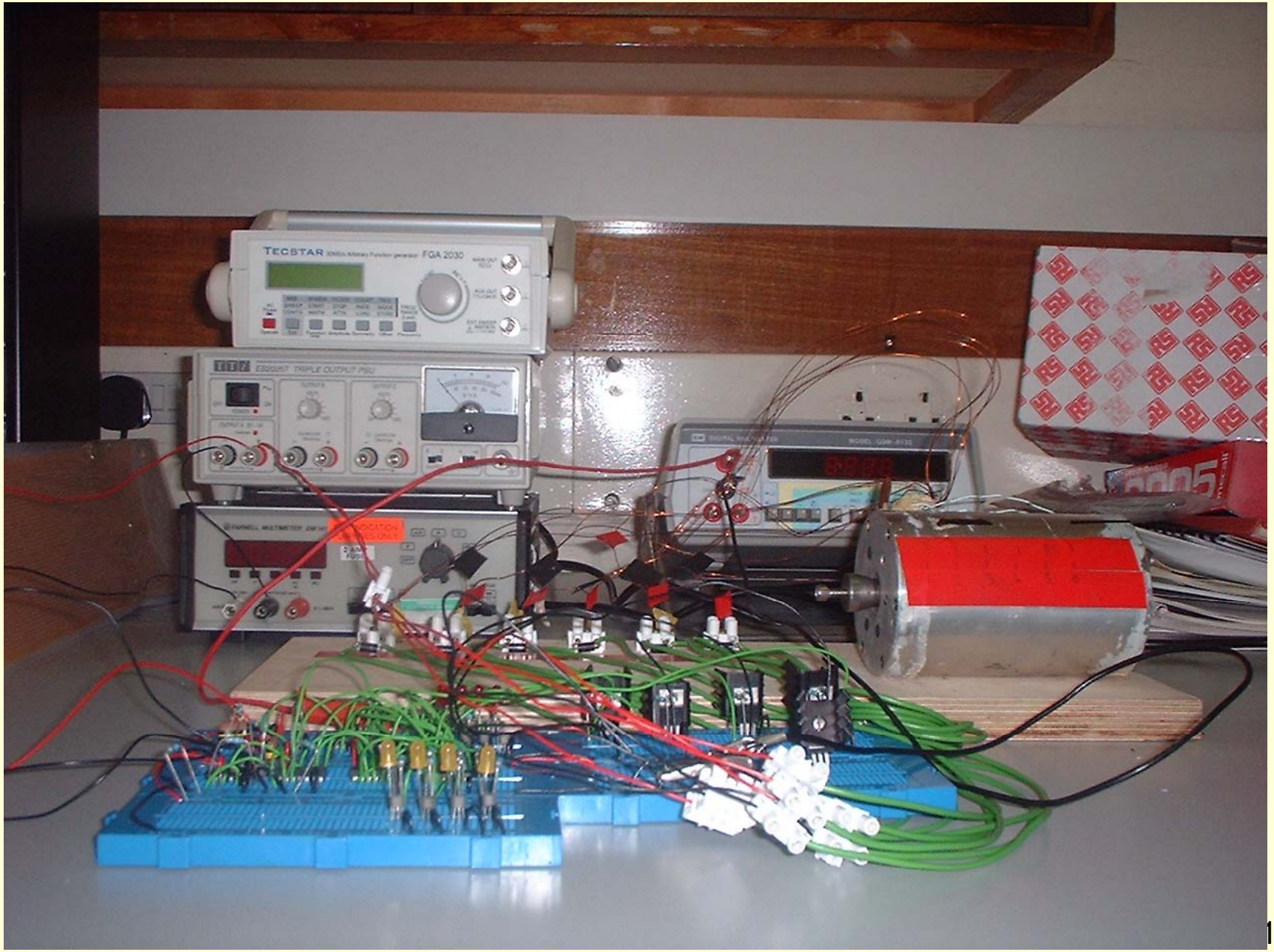
- Frictionless “bearing” allowing vertical movement
- Must keep armature on axis to $\pm$0.2 mm (for magnet and position monitor)
- Design of small spring obtained from Tom Bradshaw (RAL)
- Scaled up to allow ≥40 mm travel
- Finite element studies to check stress and lifetime issues (Lara Howlett)
- Be-Cu sheet procured
- Wire-erosion performed in Eng. Dept. workshop

Diaphragm Spring

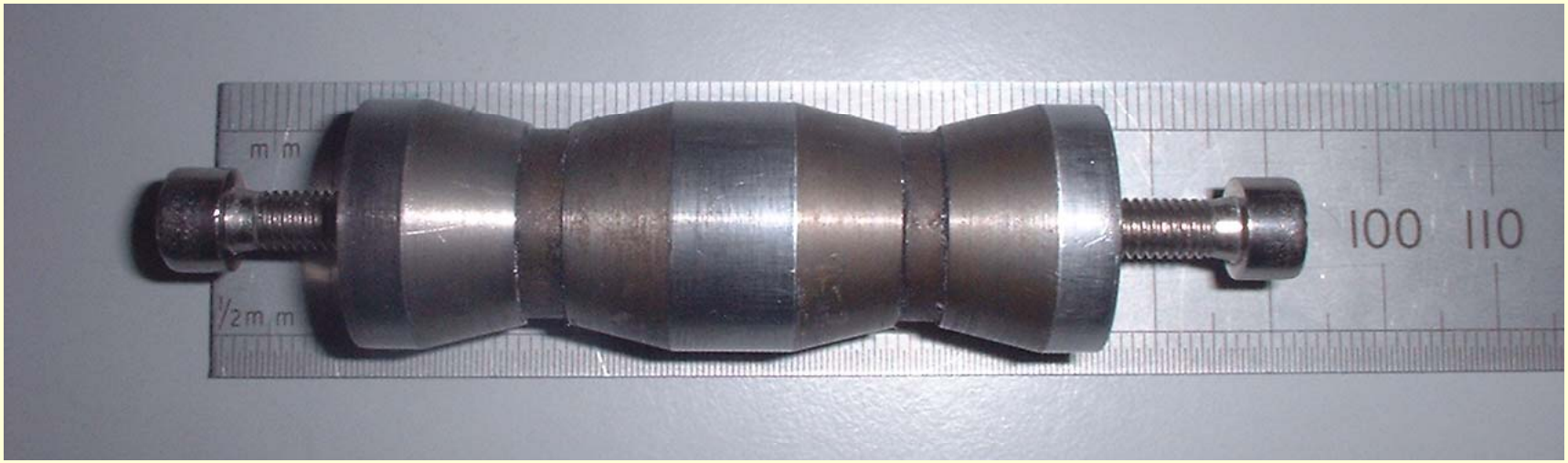


Linear Drive (1)

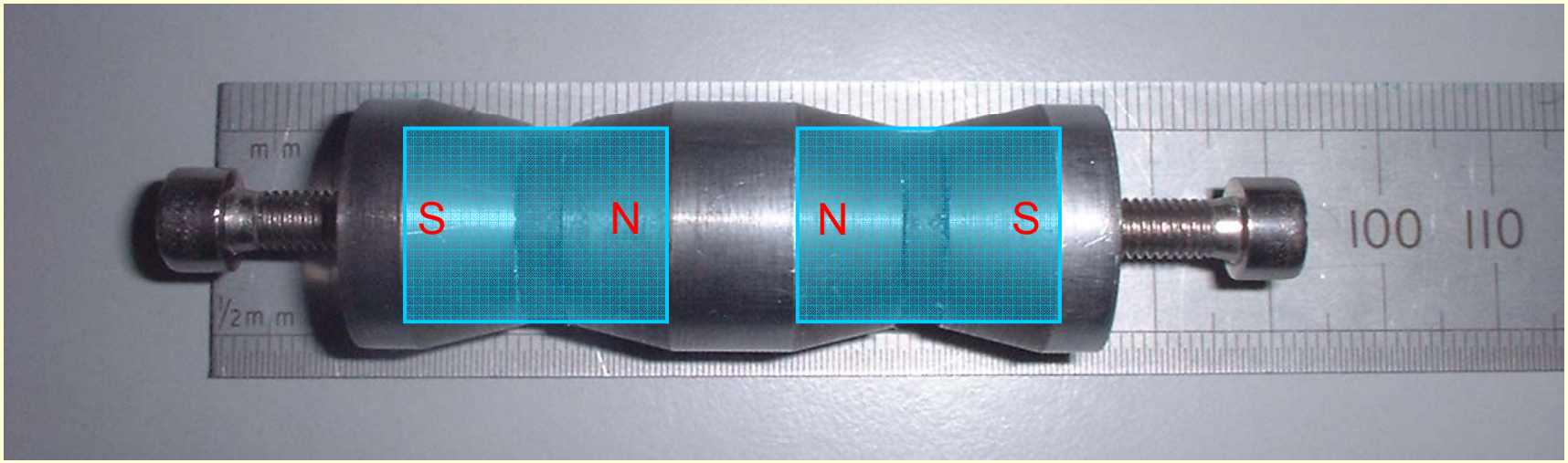
- Tests with first prototype
  - Moving magnet shuttle (2 magnets)
  - Static single/double coil excitation
  - No commutator


TECSTAR
FGA 2030

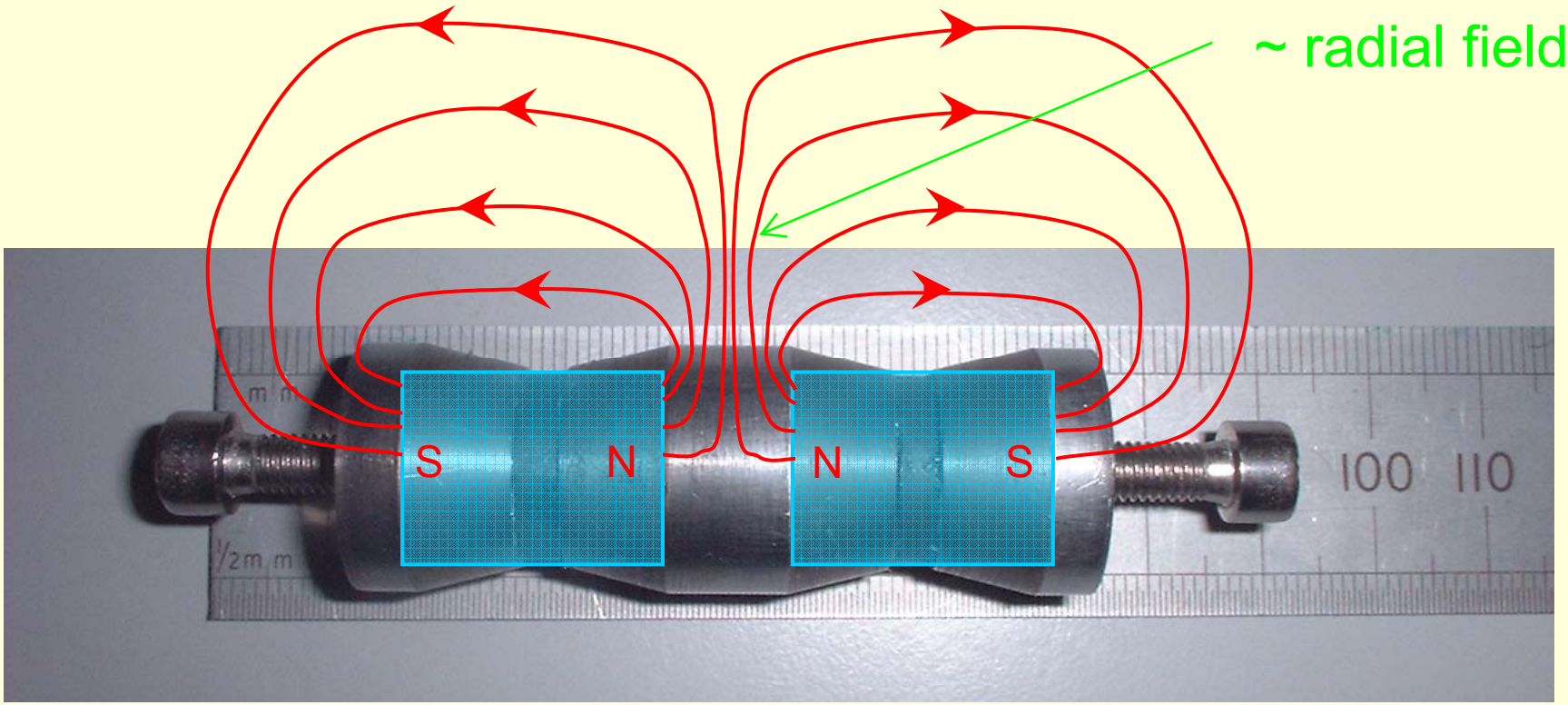
Armature



Armature



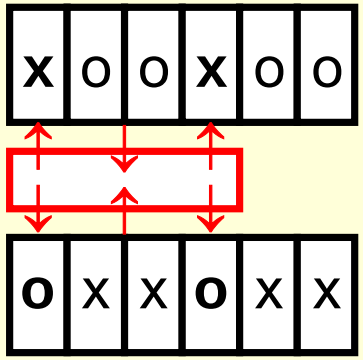
Armature



“3-phase” drive

Magnetic actuator plus Hall switches ⇒ bipolar drive

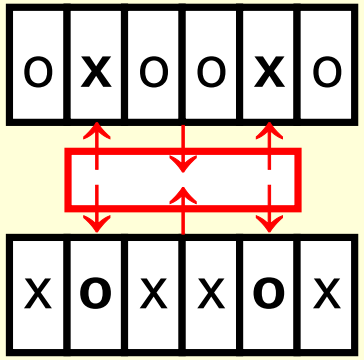
1



Coils

Armature

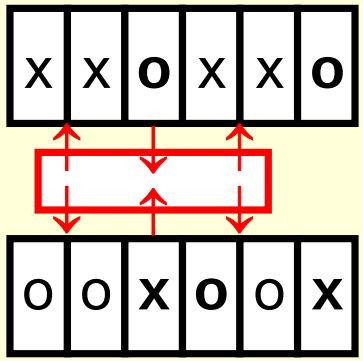
3



Coils

Armature

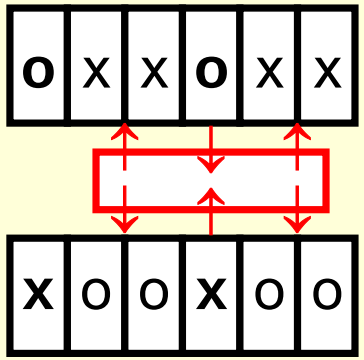
2



Coils

Armature

4



Coils

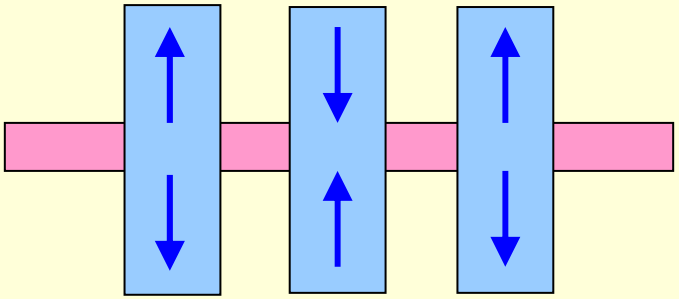
Armature

However!

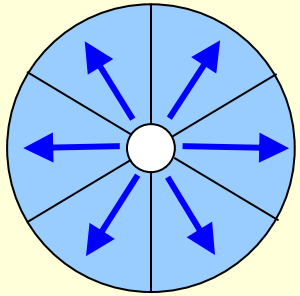
- Current armature/coil design does not give required acceleration
  - 280 N kg^{-1} at 20 A mm^{-2}
  - Need ~950 N kg^{-1}
- $\Rightarrow$ revised armature design
- $\Rightarrow$ current density 35 A mm^{-2} for short pulses
- Effective cooling essential

Improved armature design

Nd-Fe-B magnets



soft iron



Sectored magnets – fixed together with aircraft glue

Cooling

- Coils potted in thermally conductive resin
- Water cooling circuit integrated into outer aluminium housing
  - Resin inside vacuum housing?
- Coil temperature monitored with thermistors
- Possible to monitor magnet temperature too?

Radiation concerns

- Wasn’t possible to make in situ measurements this autumn
- Radiation levels may be radically different without target in operation
- Studying documented radiation hardnesses
- Still hope to make measurements at ISIS in spring

Plans for next months

- Complete revised design
  - Optimised coil, armature design
  - 3-phase switched drive circuit
- Currently mounting 1st prototype vertically on diaphragm springs
  - Measure lateral stability
  - Debug position readout system, check read speed
  - Develop cooling and temperature measuring system
- Switch to new drive as soon as available
- Develop control hardware & software