FD Movers and Alignment Methods

Superconducting Magnet Division, BNL

IRENG07 Workshop: September 19, 2007

Introduction

Andrei's E-mail; 08/30/07

The simplified picture is that FD cryostat is a pipe 390mm Outer Diameter, inserted into cylindrical opening in the detector, with ID of 390mm+Delta. Where Delta is maybe 10-50mm.

What type of movers could be used so that they would fit in this space, provide range of about a mm, step of maybe several microns, good mechanical stability and radiation resistance?

FD support and alignment options

- Allow for magnet positioning

  -Coarse adjust

  ~First time alignment

  ~Remote alignment to remain within fine adjustment range

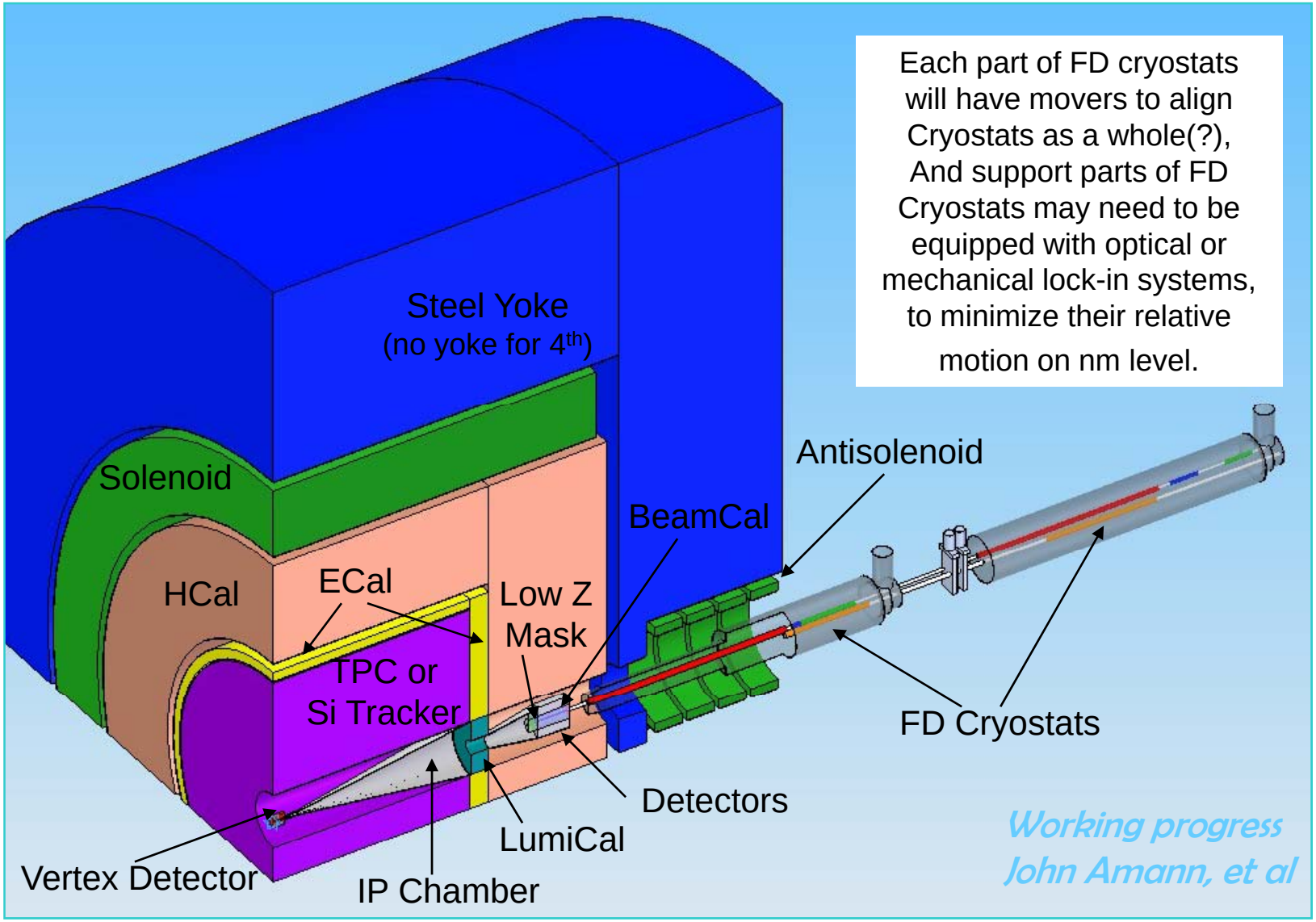
  -Fine adjust

  ~Go to final magnet location

  ~Active positioning

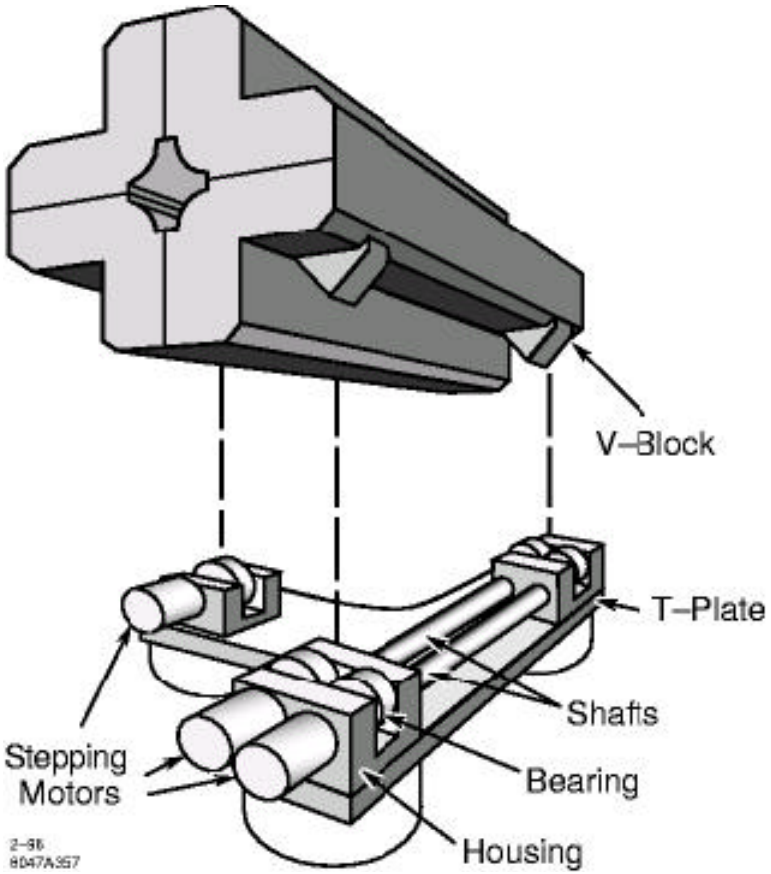
- FD has its own alignment system of the ?mm range that can be used for finer alignment without beam or with beam. The beam-based measurement of FD position and application of its alignment system will bring it to ideal position with ?nm.

Generic Detector - IR Details

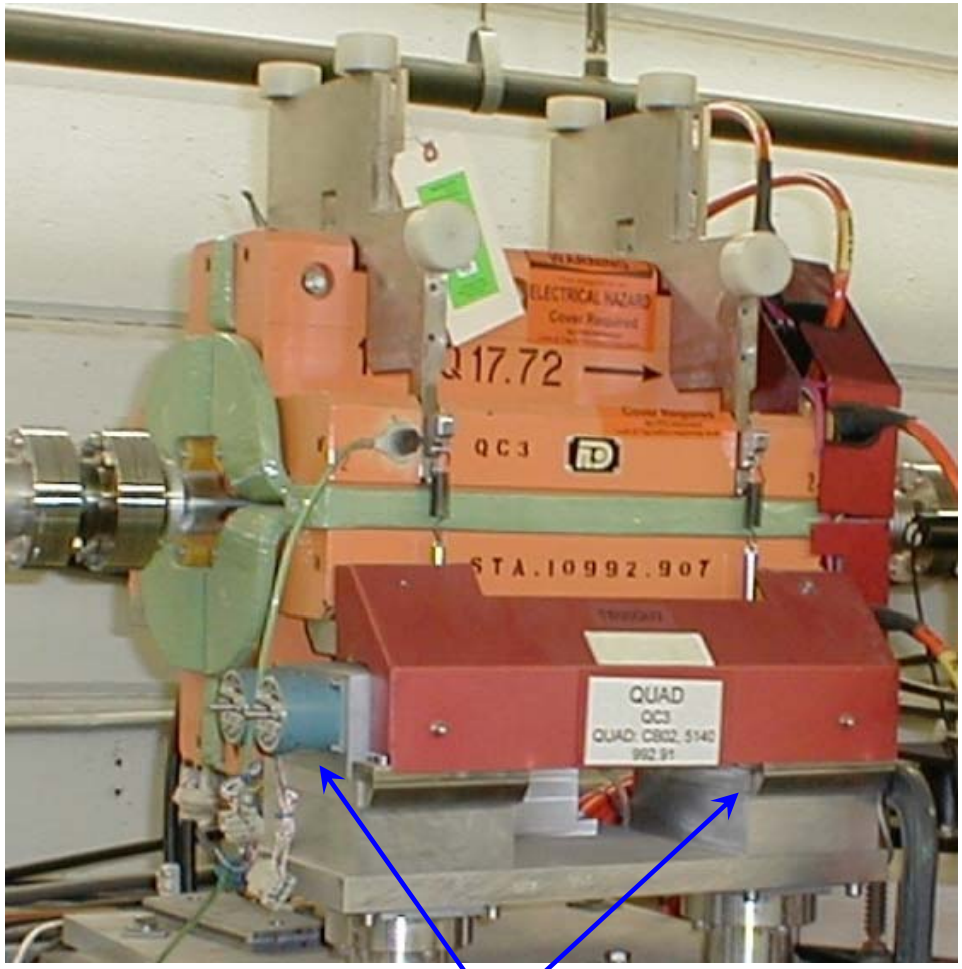


SLC/FFTB Movers

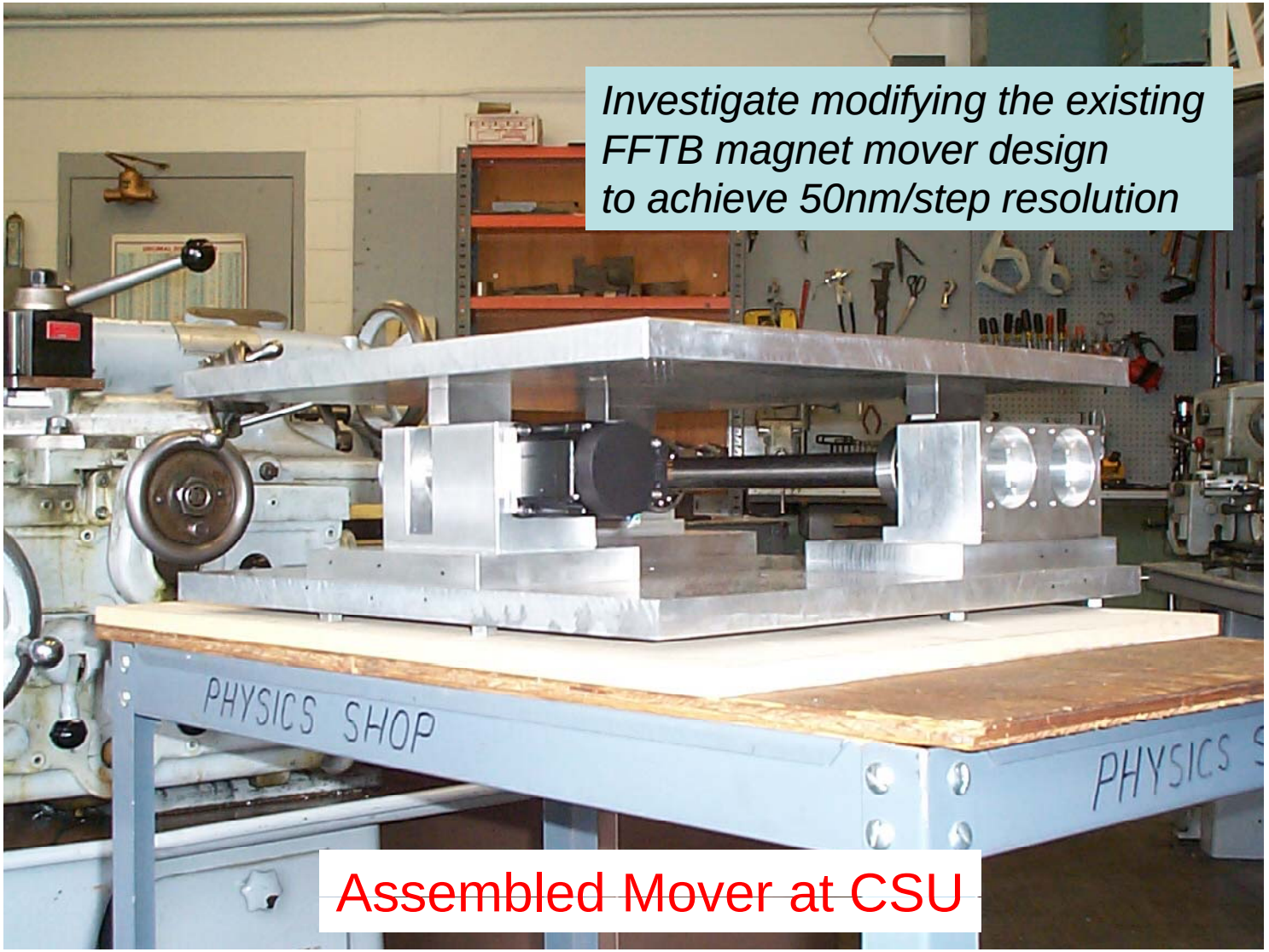
- They were measured to achieve a position resolution which is about 0.4 micron with range ~ +/- 1.5mm.
- Cam-based design: Rotation of the eccentric shafts inside the roller cams shifts the magnet position.



FFTB movers & design
Suggestion for ATF2 Final Doublet Quads

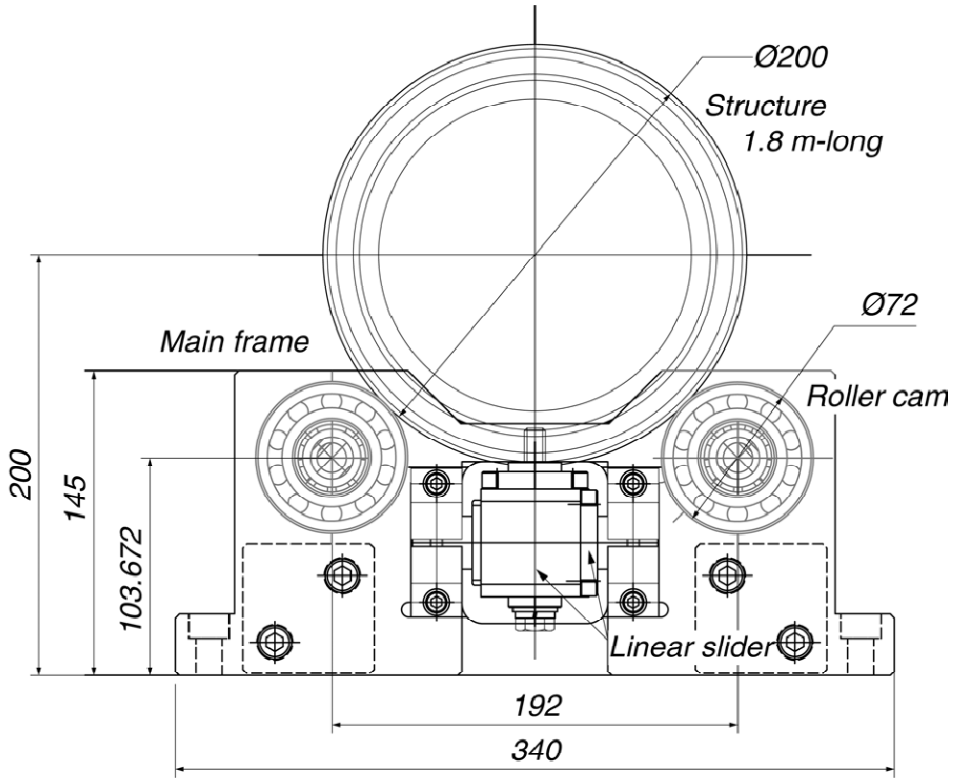


Colorado State Univ. R&D

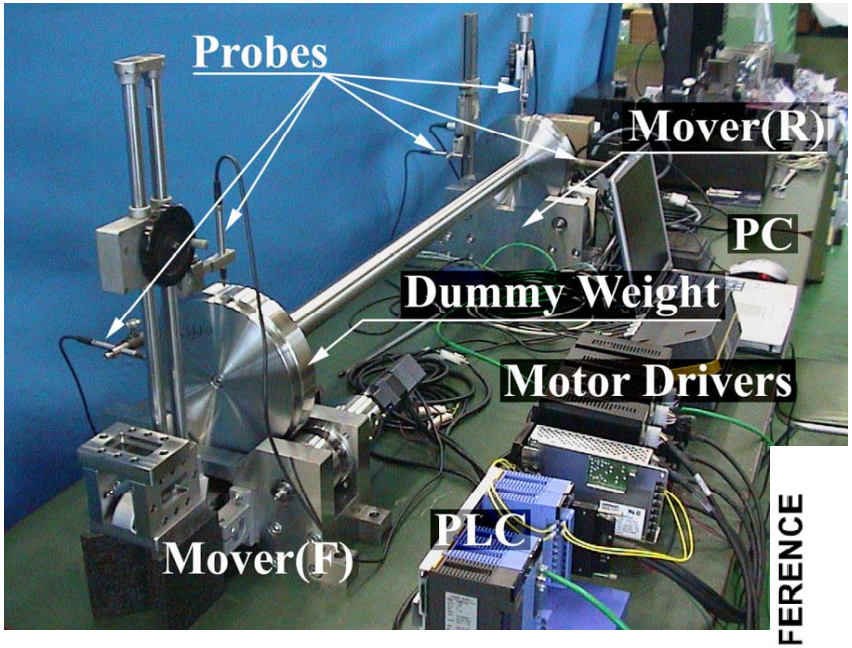


Roller Cams Mover

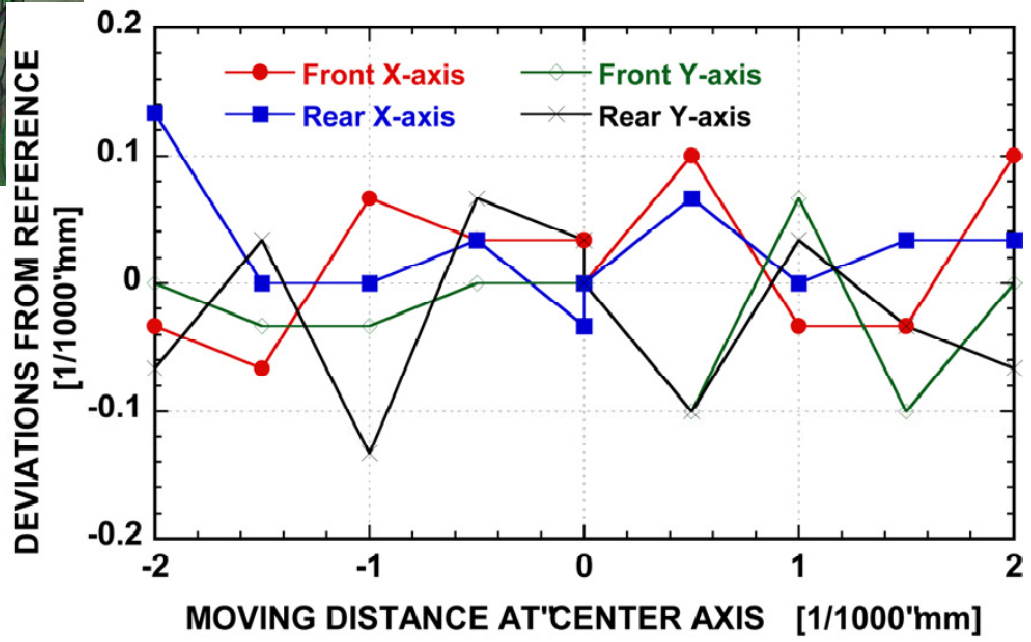
- KEK/RIKEN/TAKENAKA Co./OHTSUKA Co.
- The new roller cams mover unit is comprised of two roller cams, their stepping motors drivers, two linear sliders and support frames.
- This new type roller cams mover system (designed for JLC main Linac) provides a position repeatability of ±0.1μm, within the ±1mm adjusting area.



Measurement Setup of the Roller Cams Mover



The measured adjustable area agreed with the expected theoretical results.



Two Stages Movers

- ICEPP (Univ. of Tokyo)/KEK
- The coarse mover stage is a cam mover type.
- The precision mover utilizes piezoelectric transducers.

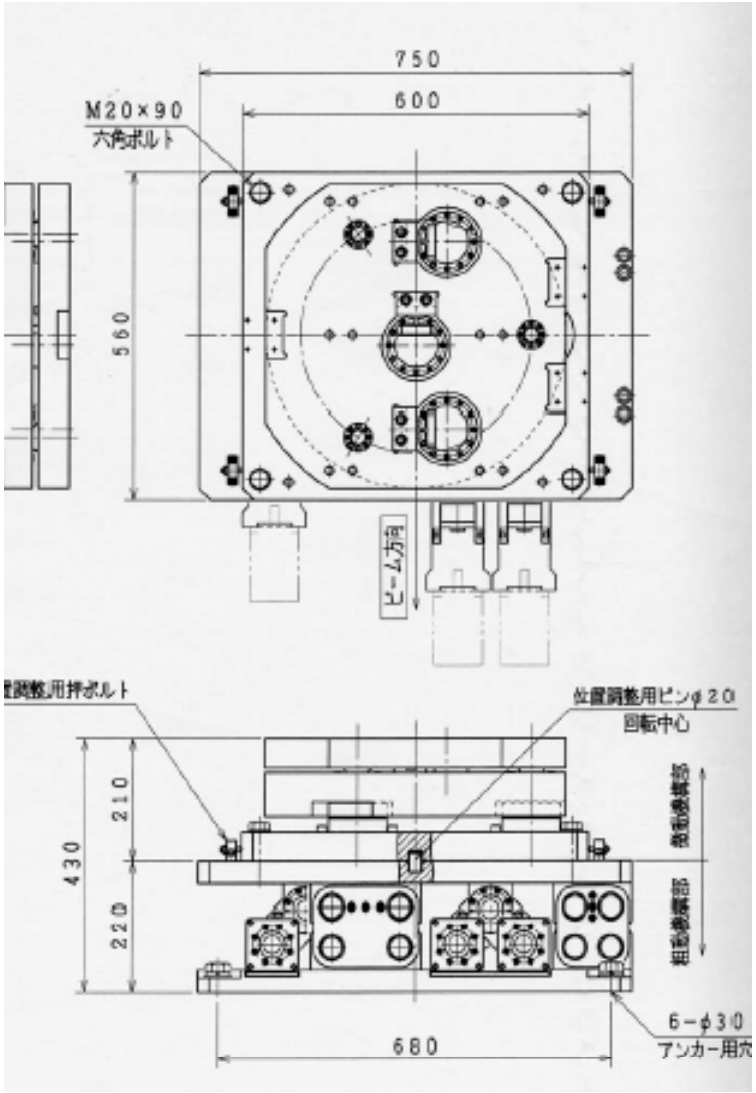
SPECIFICATION

	CAM mover	Piezo mover
Movement range	> 3mm	> 0.4mm
Resolution	0.1μm	1nm
Speed	> 0.1 mm/sec at max.	> 0.5 mm/sec
Direction of Motion	X, V and θy	X, Y, V and θx, θy, θv

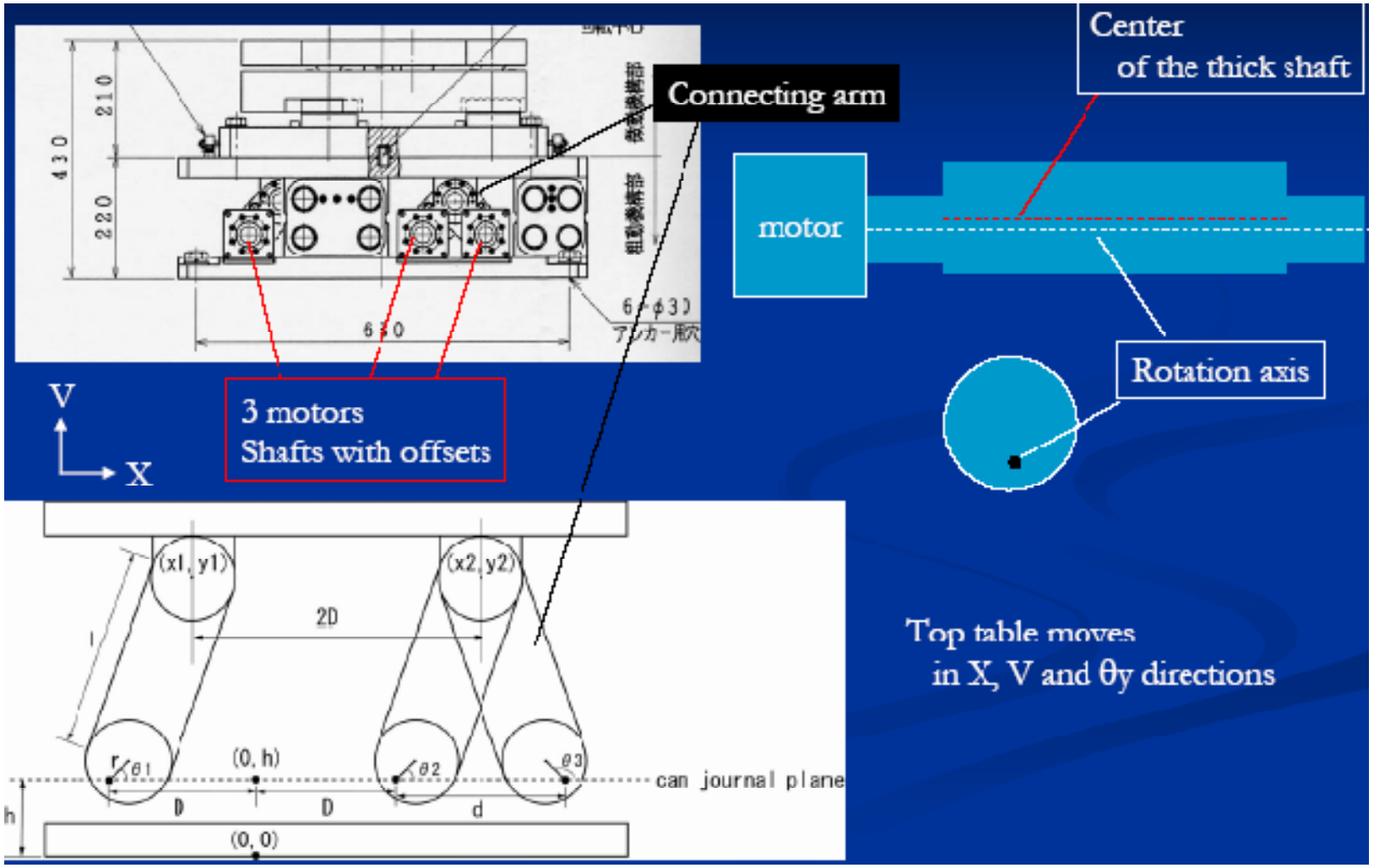
(X and Y are horizontal directions, and V is vertical. X is perpendicular to the beam and Y along the beam.)

· The mass of the mover is about 350kg.
· The material is SUS303.
· The load limit is about 700kg.

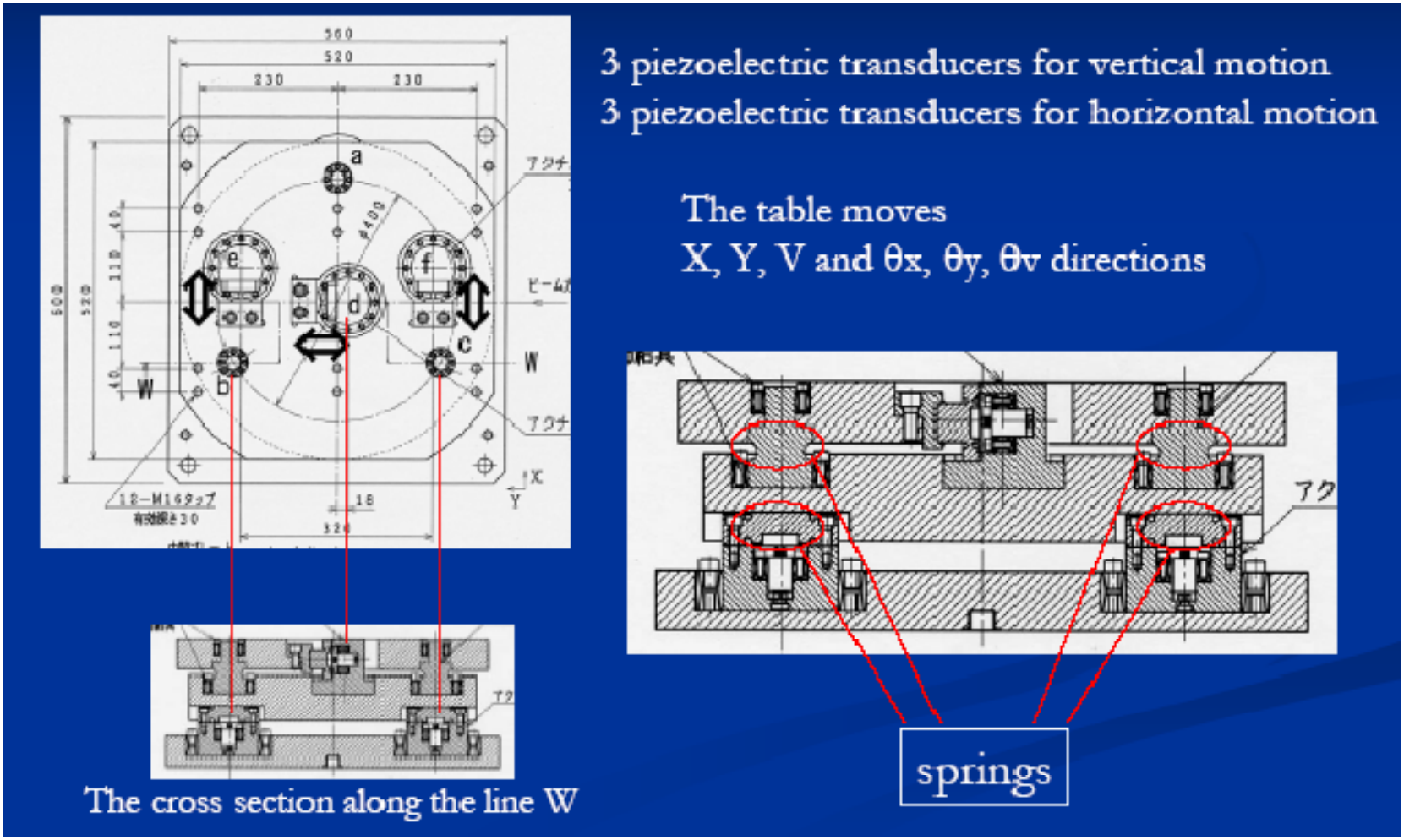
Structure of the Mover



Cam Mover


Center
of the thick shaft
Connecting arm
motor
Rotation axis
3 motors
Shafts with offsets
V
X
Top table moves
in X, V and θy directions
(x1, y1)
(x2, y2)
2D
l
r
θ1
(0, h)
θ2
θ3
can journal plane
h
D
D
d
(0, 0)

Piezoelectric Mover

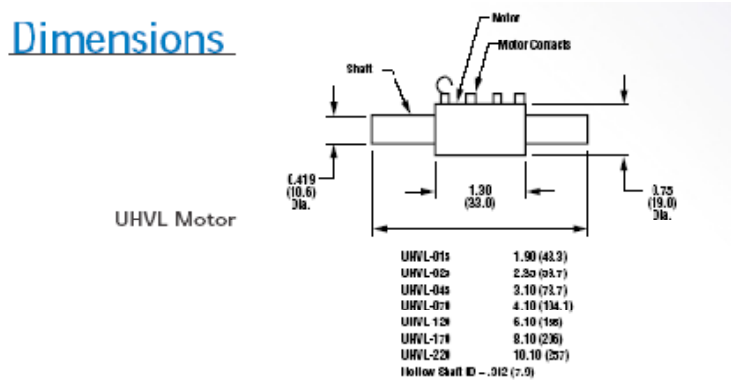


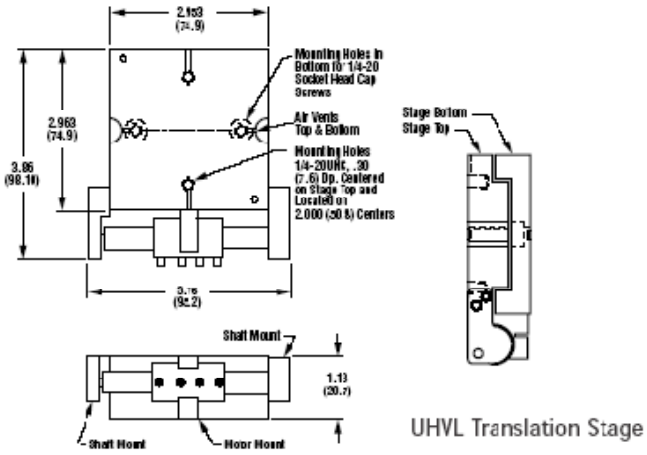
“Inchworm” Movers

- These are piezoelectric devices, in which a shaft is stepped through a cylindrical housing, using a clever arrangement of clamping and stretching piezoelectric elements in the housing.
- In SLD, this compact device operate in vacuum to position fine carbon fibers in the beampipe to assist in tuning beam-beam collisions.
- The UHV motors never failed during the life of SLD.

--Stan Hertzbach(UMass)

Developed by EXPO Burleigh





“Inchworm” Mover Specifications

Specifications

UHVL Motor

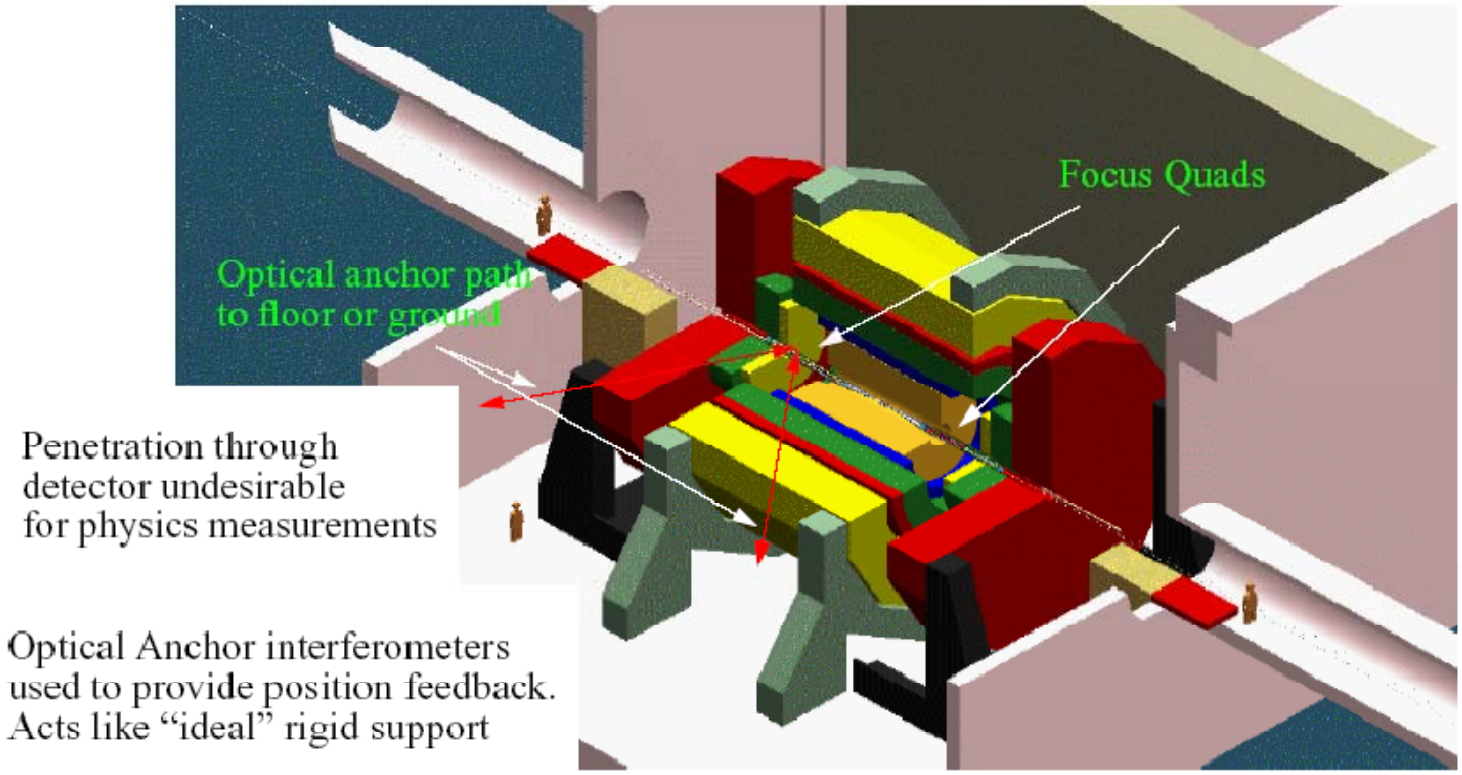
Maximum range of motion:	15, 25, 45, 70, 120, 170, 220 mm
Mechanical resolution:	< 1 nm
Nominal speed:	0.7 mm/sec
Maximum axial load:	0.7 kg
Maximum lateral load:	0.1 kg
Lateral motion:	± 1 µm
Operating temperature:	10 to 70°C
Bakeout temperature:	150°C

UHVL Translation Stage

Straightness:	< 2 µm
Pitch/yaw:	< 40 arc-sec
Motor:	UHVL-045 (solid shaft)

Optical Interferometry

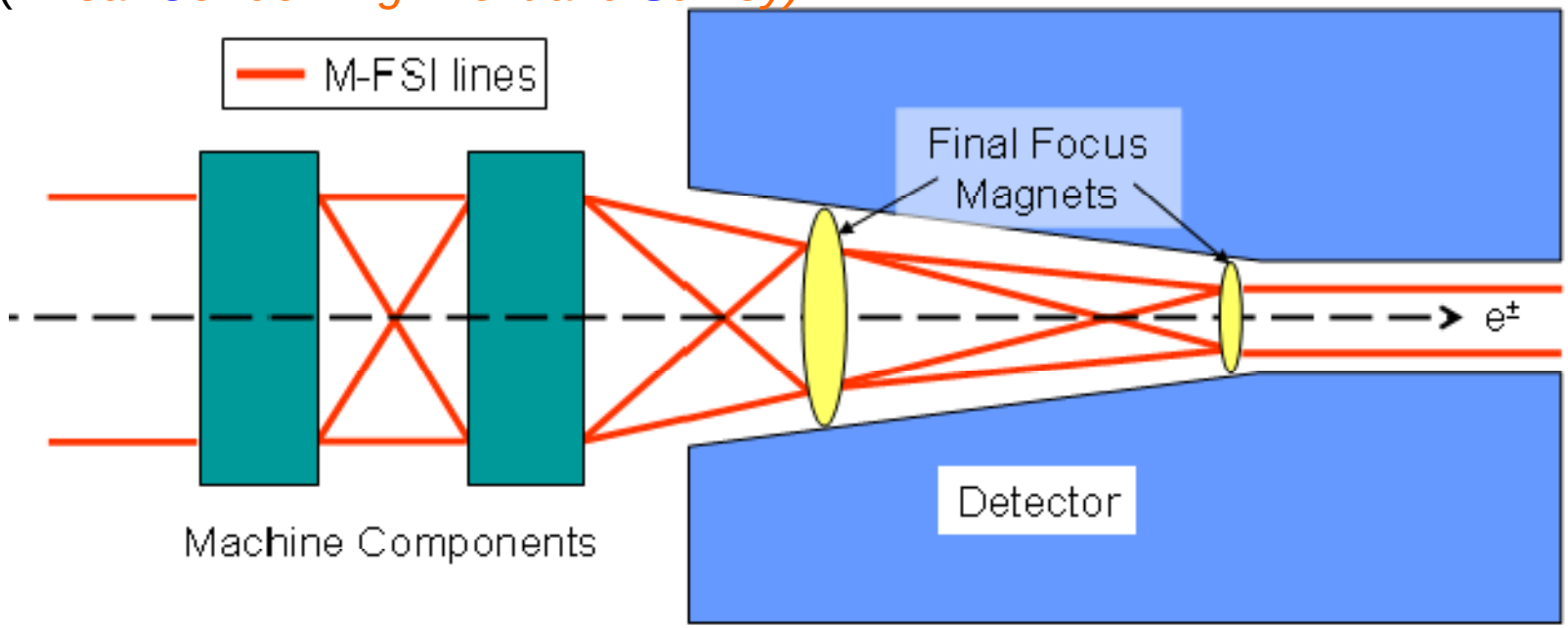
Measure quad positions with interferometer(s) referenced outside detector.
Correct quad positions with piezoelectric(s).



UBC

LiCAS: Final Focus Stabilisation

(*Linear Collider Alignment and Survey*)



- **M-FSI can measure absolute and relative lengths**
  - Position is not dependent on beam
- **Light fed by fibres**
  - No complex geometry for light path
  - Can follow same route as DAQ cables out of detector
- **Grid can measure all degrees of freedom**

University of Oxford

Summary

- Several kinds of the high precision movers have been developed around the world. The space limitation need to be concerned for the further modification.
- Optical metrology can be used for Final Focus stabilization.

  The final adjust will depend on the beam-based measurement.
- Material requirements:

  -Needs to be radiation hard

  -Non-magnetic
- Some new ideas may come out during this workshop. Several issues will be studied and prototyped (if possible) in the future.