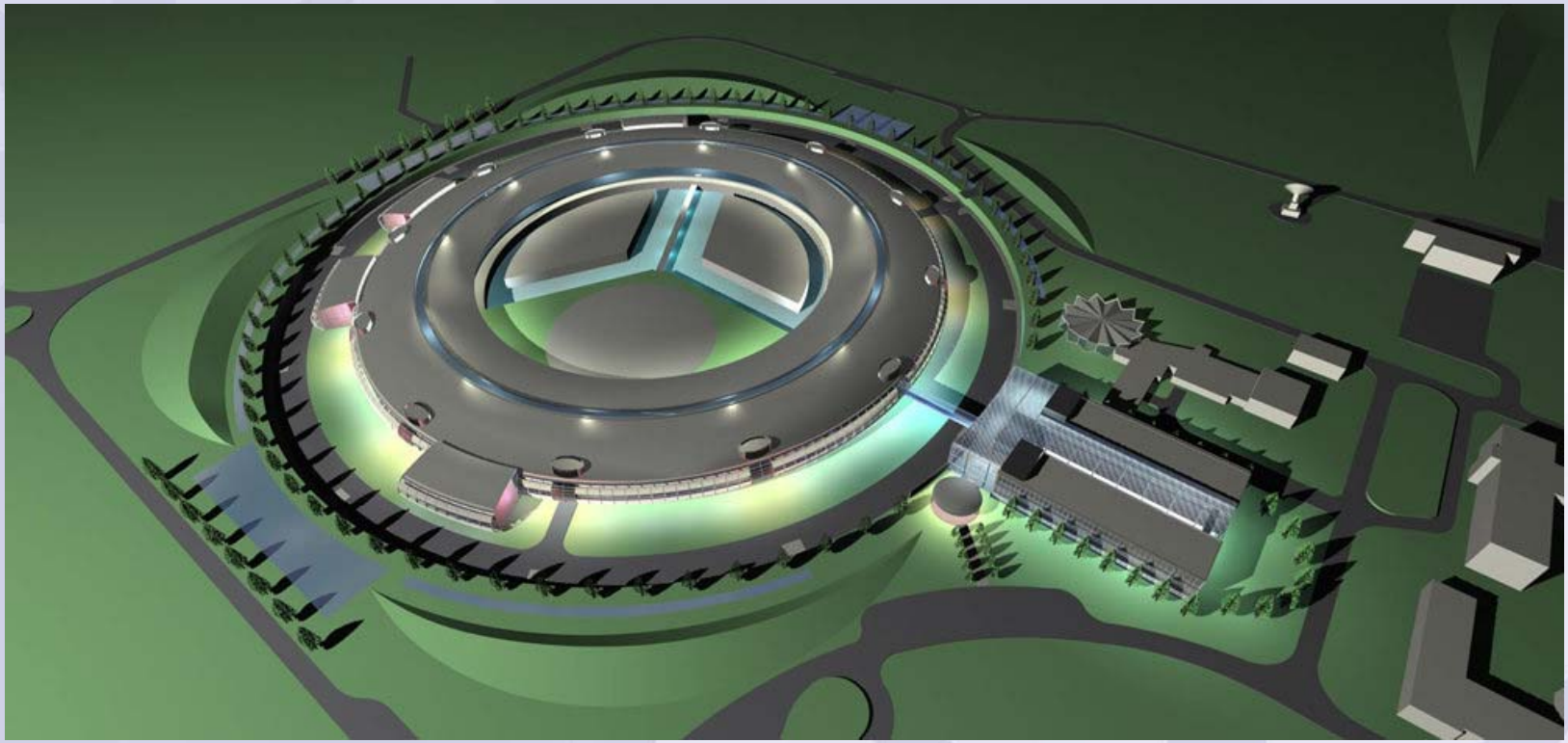
DIAMOND



Design drawing of the new diamond synchrotron at Chilton in Oxfordshire (Courtesy of JacobsGIBB Ltd/Crispin Wride Architectural Design Studio).

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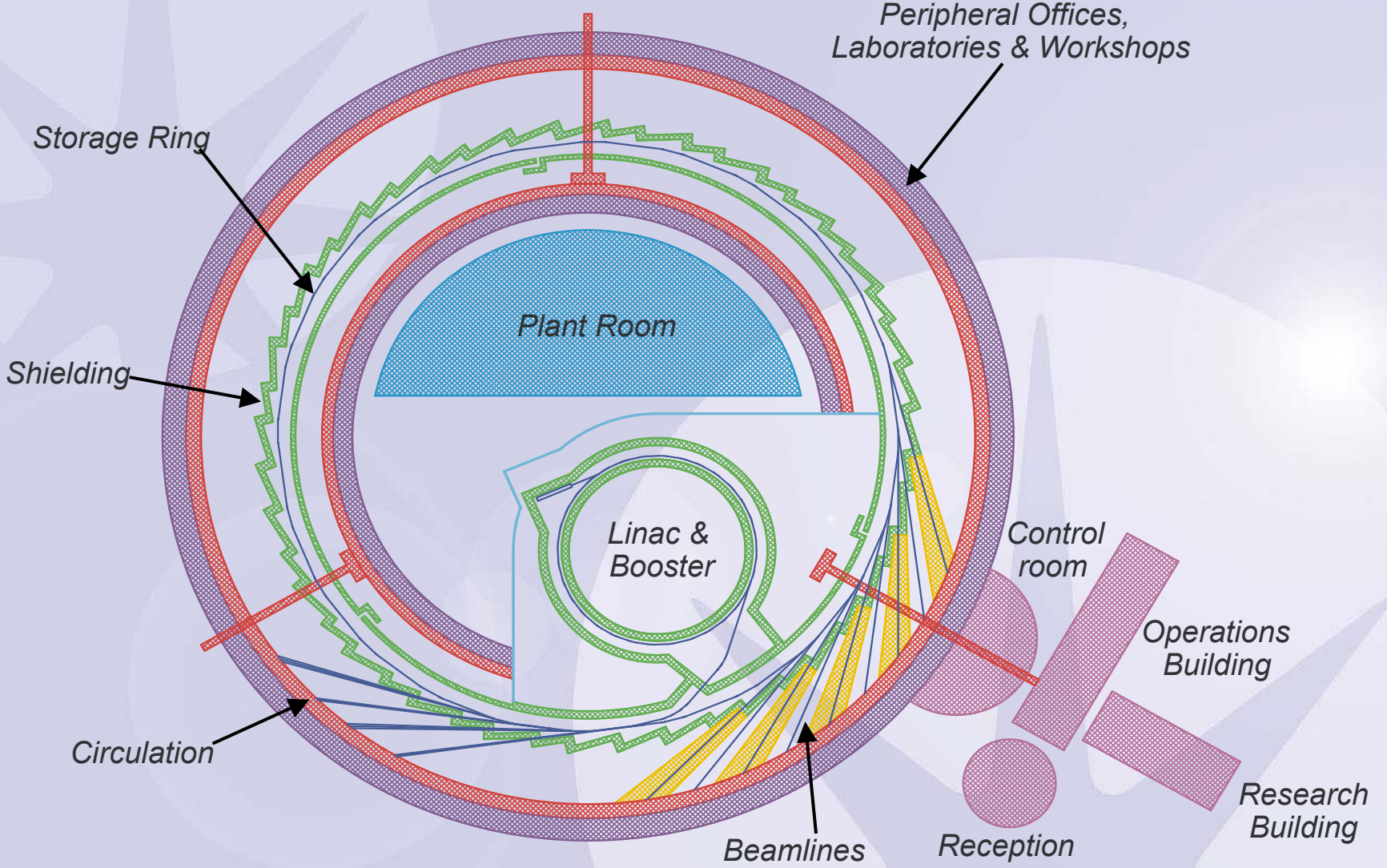
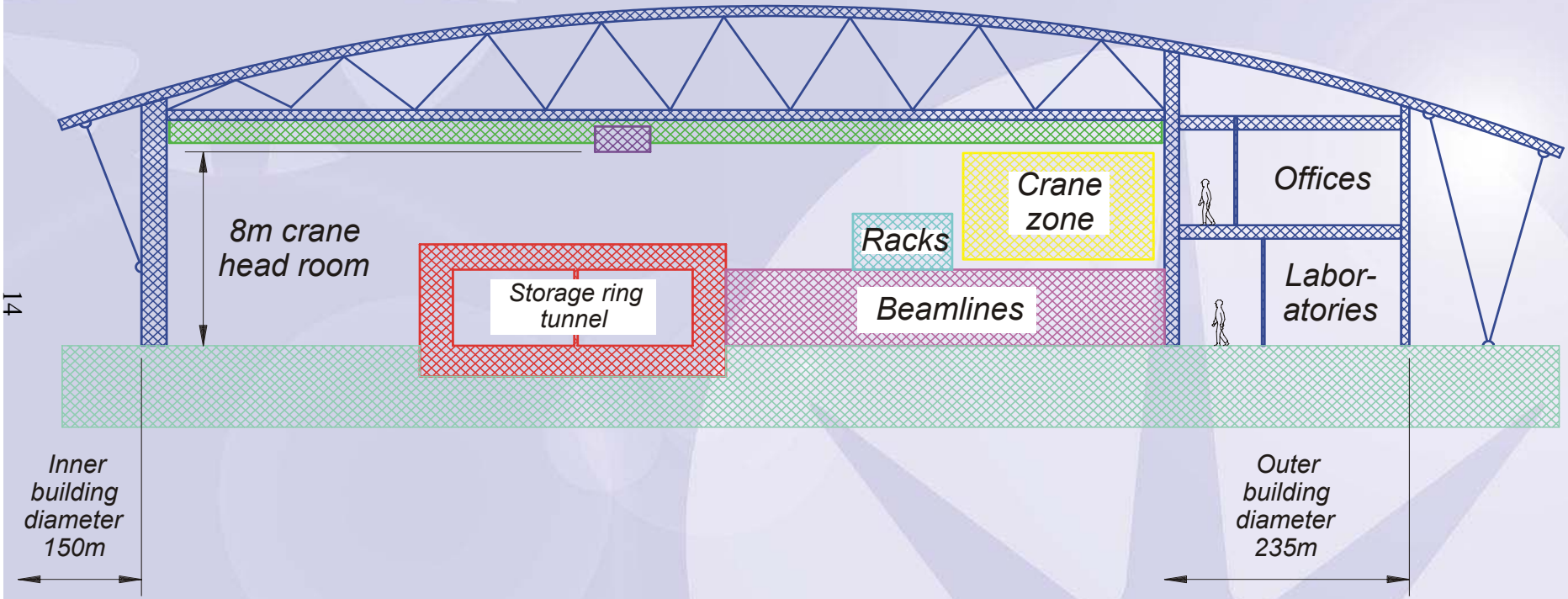
Storage Ring, Mechanical Engineering Design

Some Basic Diamond Facts and Figures

- £235m Total budget
- 3GeV energy and 300 mA current
- 22 Insertion Device Beamlines
- 20 Bending Magnet Beamlines
- 600 kW of radiated power
- 560m Storage Ring circumference
- 235m Diameter building
- 7 Beamlines at machine start up
- First experiments September 2006


Peripheral Offices,
Laboratories & Workshops
Storage Ring
Plant Room
Shielding
Linac &
Booster
Control
room
Operations
Building
Circulation
Research
Building
Beamlines
Reception

diamond


8m crane
head room
Storage ring
tunnel
Racks
Crane
zone
Beamlines
Offices
Labor-
atories
Inner
building
diameter
150m
Outer
building
diameter
235m

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Storage Ring Girder and Support System Design Aims

- **Hold magnet centres 1400mm from tunnel floor.**
- **Magnet axes must be inline to within +/- 100μm when assembled to the girder and placed on the supports in the storage ring tunnel.**
- **Girder and support system must have a first natural frequency greater than 40Hz.**
- **Dynamic response to ground vibration must produce RMS displacements at the magnet centres of less than 0.1 μm horizontally and 0.02 μm vertically.**
- **Removal of the girder should be simple and quick.**
- **Mover system should be capable of moving the girder in as many degrees of freedom as possible while being accurate (micron level), reliable and cost effective. Operating range should be greater than ±3mm.**

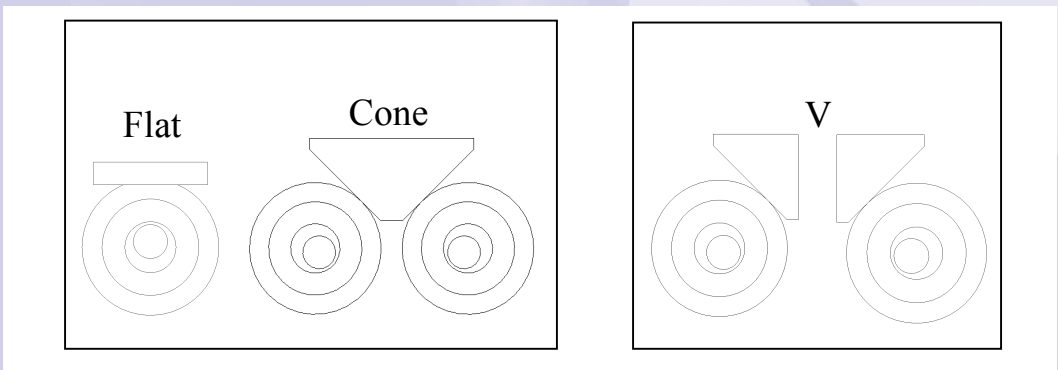
SLS Cam System

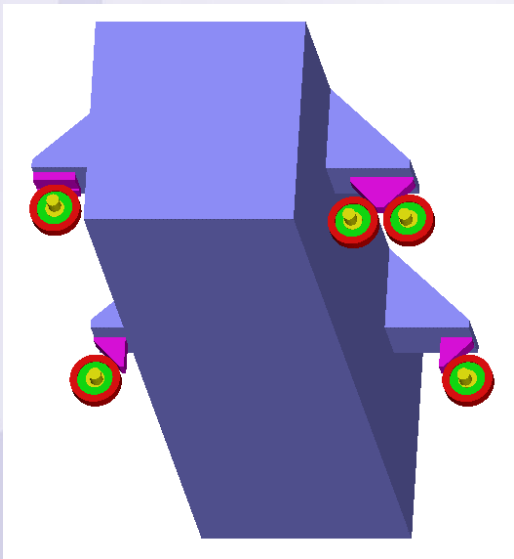
Advantages:-

- 5 point support is capable of moving the girder in sway, heave, roll, pitch and yaw while still being a kinematic system (Cams and supports make flat, cone and V).
- Girder is moved in rolling motion, giving a smoother movement.
- Small compact units are stiff, but rely on a stiff supporting structure.
- No joints need to be disconnected before removing a girder.
- Proven design is available with EPICS control software.

Disadvantages:-

- Adjustment for surge is manual.
- System is expensive in comparison to a manual system.
- System cannot be operated manually.
- Supports take up space on the sides of the girder.





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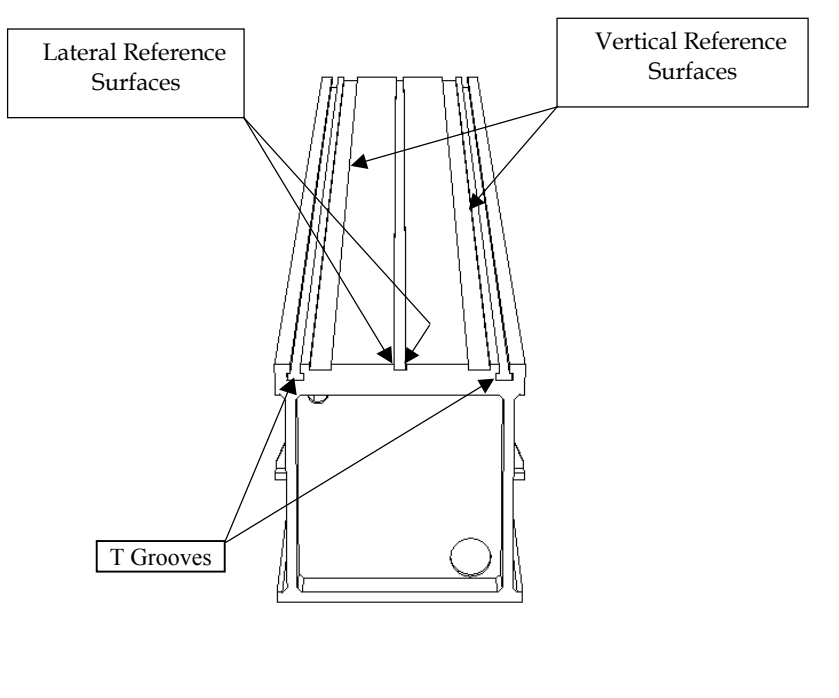
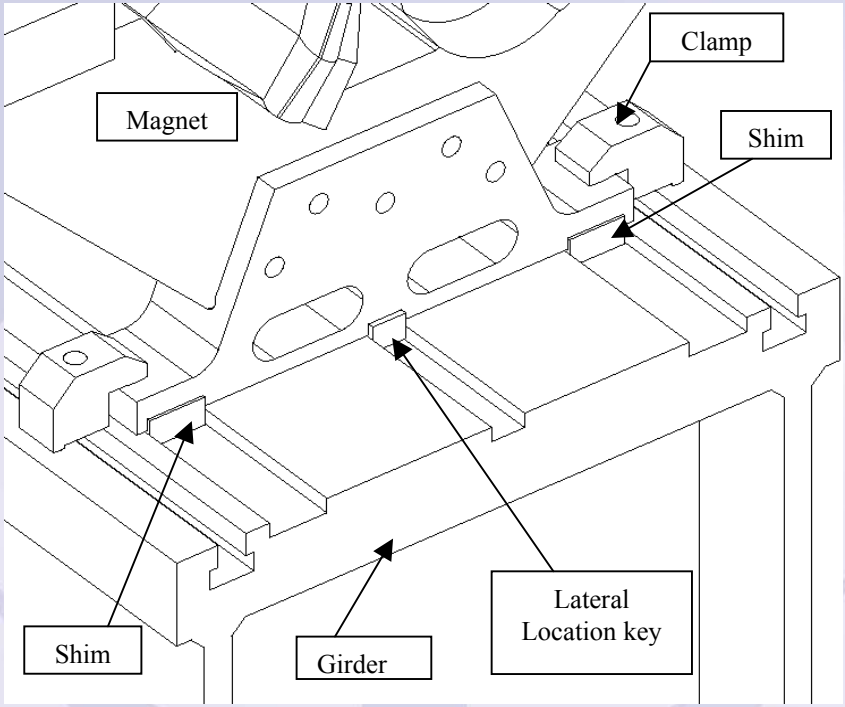
Magnet Mounts





- The girder tops have datum faces machined flat and straight to within a ± 15μm tolerance band along the entire length of the girder.
- Magnets will be supplied with shims so that when they are mounted on the girder, the magnetic centres are coaxial.

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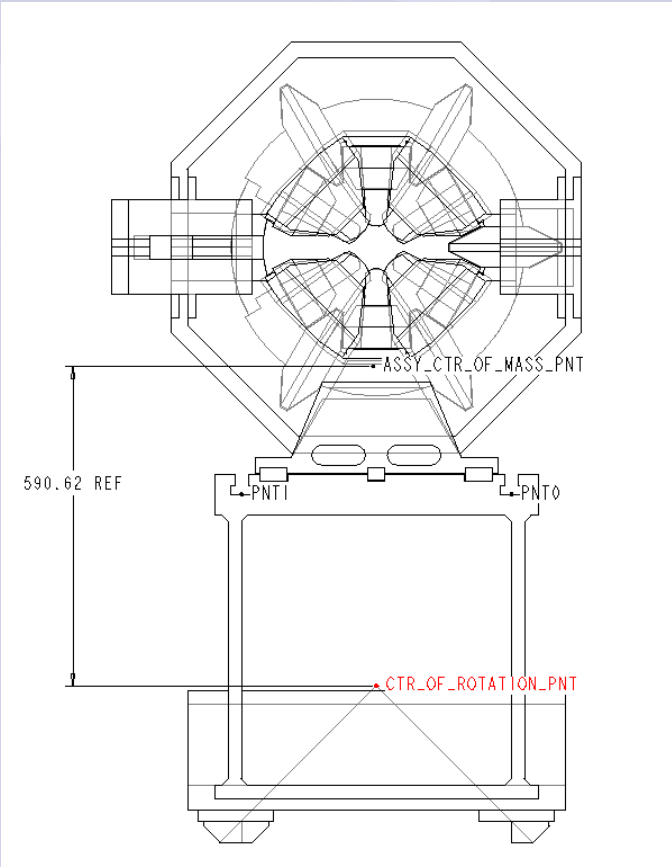
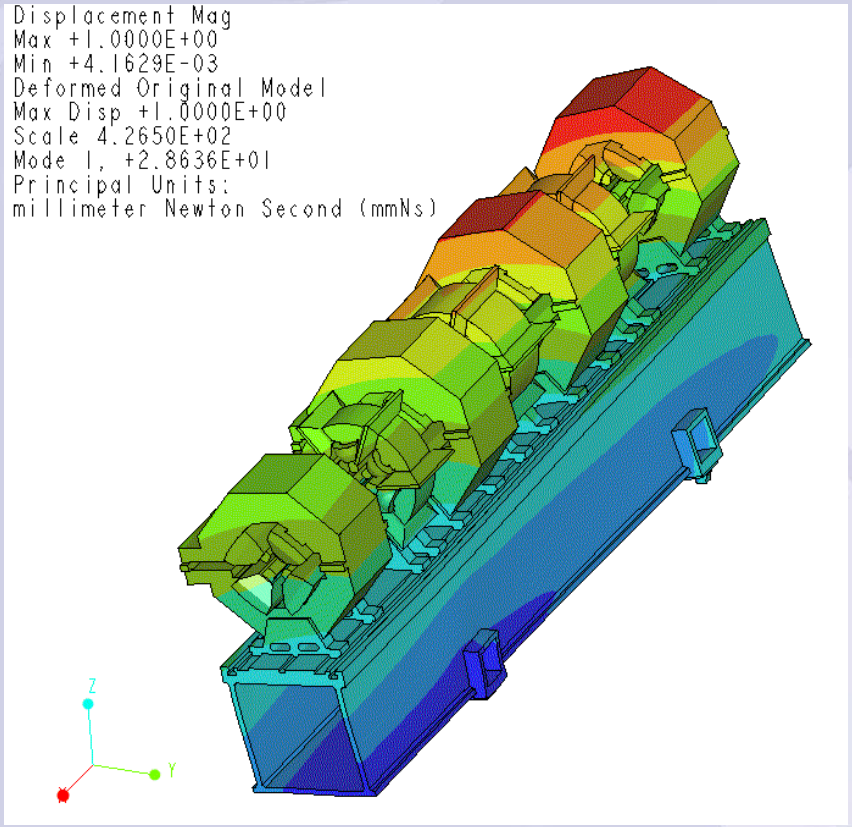
Girder Natural Frequency

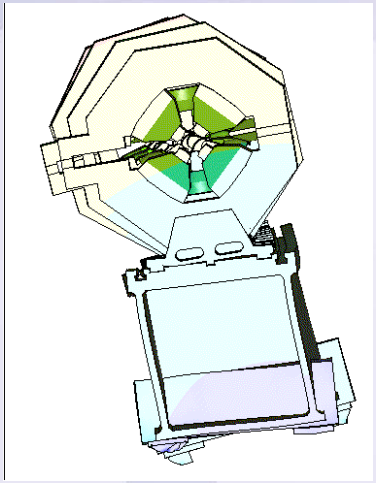


Initial Design

- **Supports placed under the girder to make it more compact.**
- **Centre of rotation to centre of mass = 590mm**
- **Large mass moment of inertia about centre of rotation.**
- **Low frequency**
- **Mover system and girder supports were not included in this early work.**

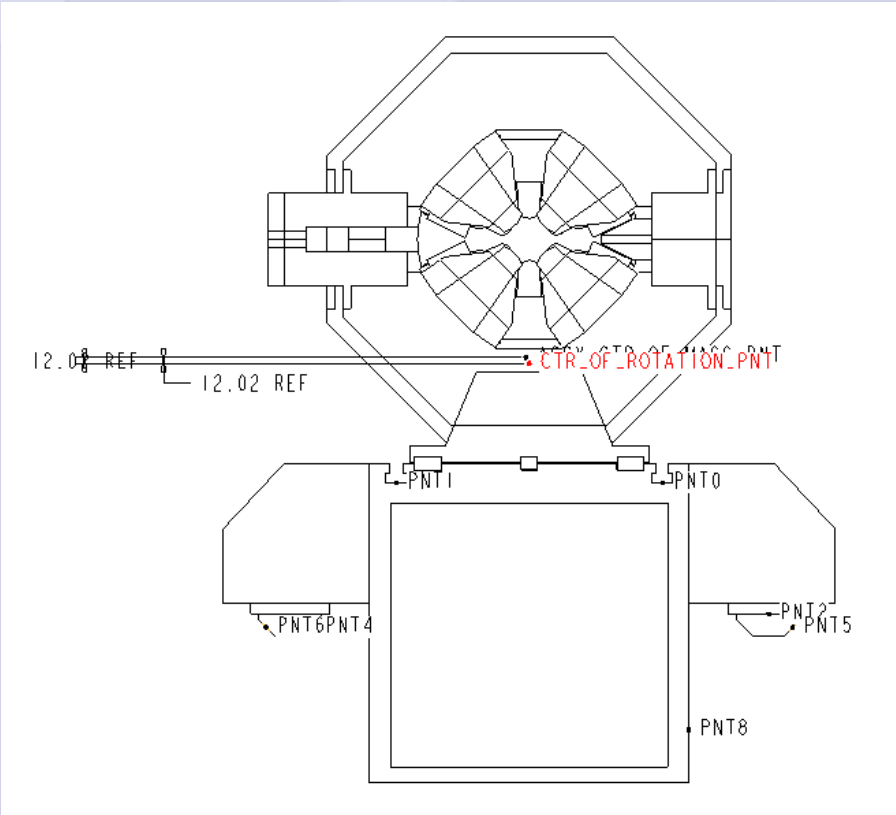
Girder Natural Frequency





- **Frequency = 29Hz**
- **Mode of vibration is twist. The front end of the girder (end on three cams) stays still while the far end (on two cams) rotates.**

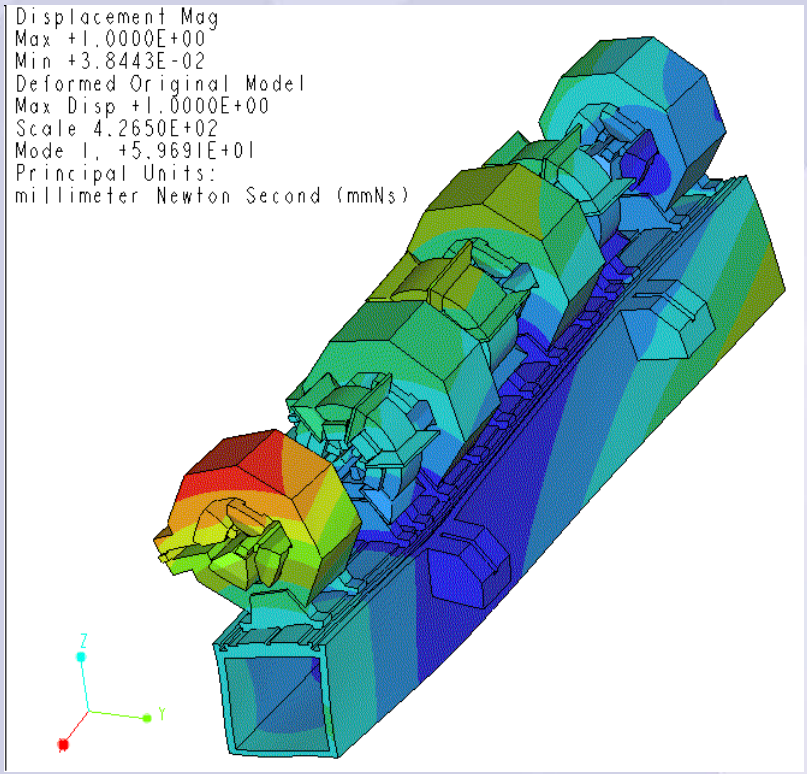
Girder Natural Frequency

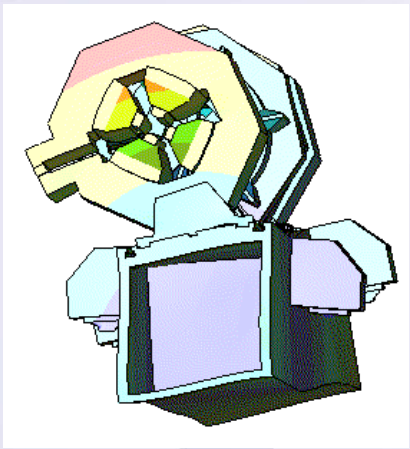


First Revision

- **Supports placed on the side of the girder and stiffened.**
- **Girder plates thickened and ribs added.**
- **Centre of rotation to centre of mass = 12mm**
- **Lower mass moment of inertia about centre of rotation.**
- **Higher frequency**
- **Cams and supports were not included in this early work.**

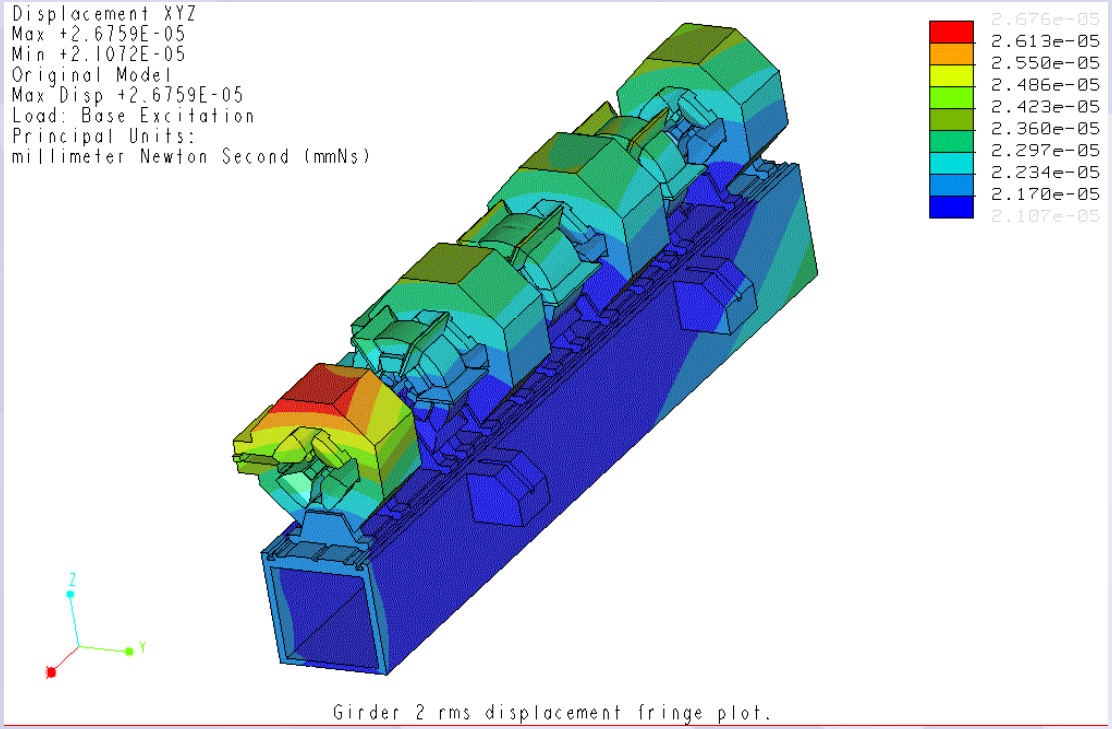
Girder Natural Frequency





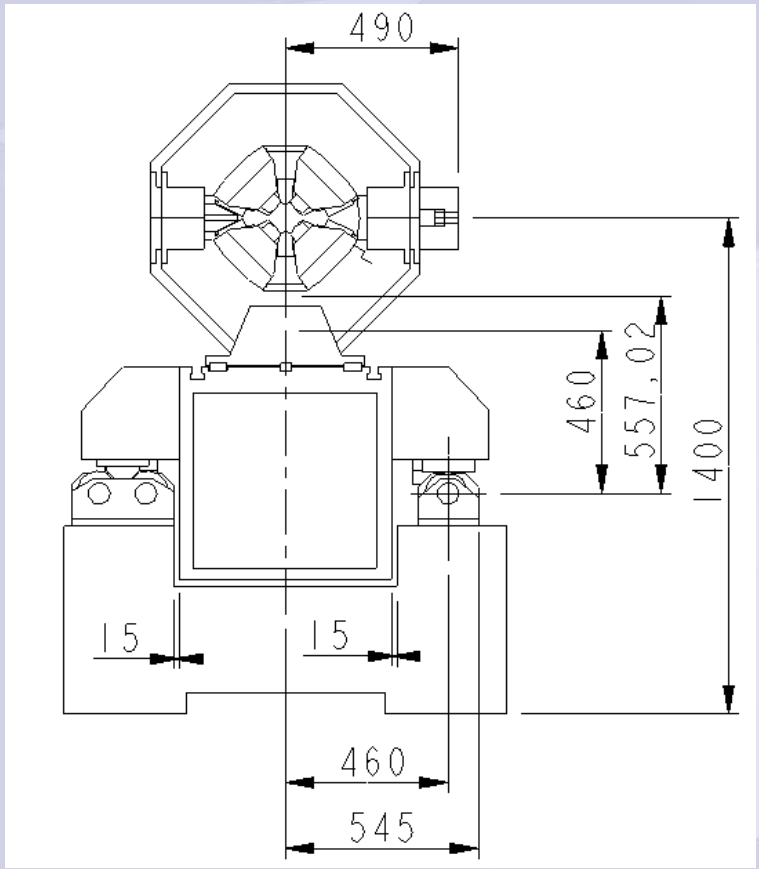
- **Frequency = 60Hz**
- **Mode of vibration is twist. The front end of the girder (end on three cams) stays still while the far end (on two cams) rotates.**

Dynamic Response



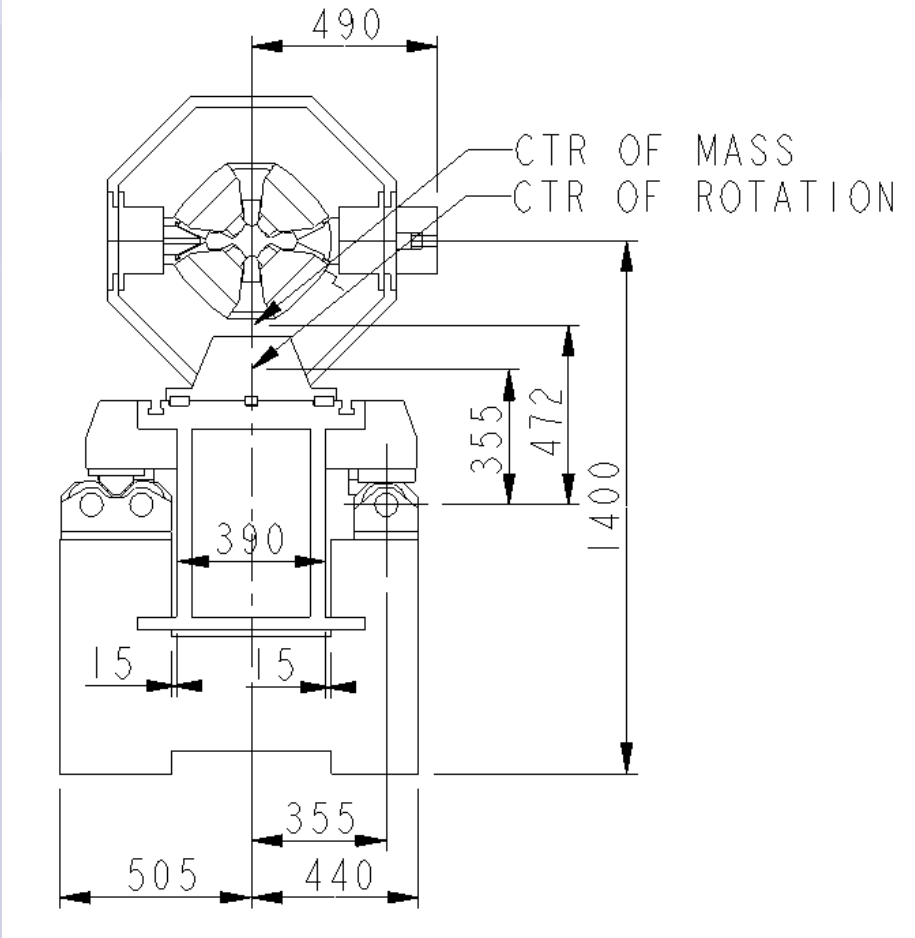
- **At this stage, the Ground vibration PSD for the Diamond site was applied to the model. This input needs to be modified to allow for the extra noise expected when the machine is installed.**
- **Maximum RMS displacement = 0.027μm(0 to 100Hz)**

Clearance



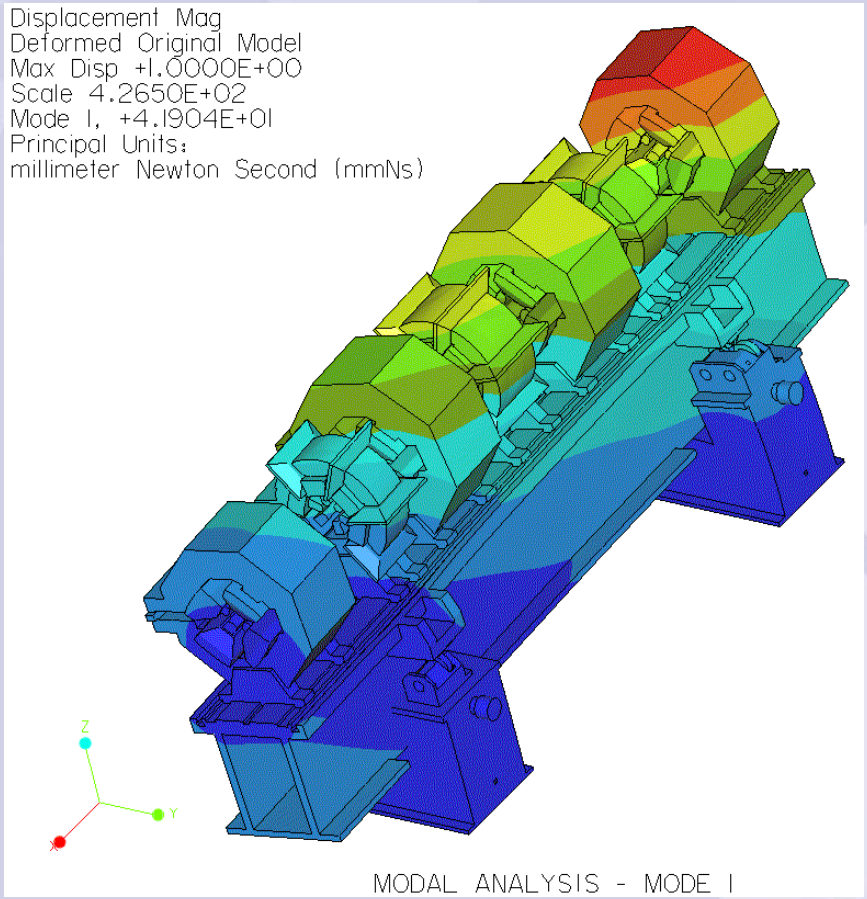
- **With the model at this size, cam movers and supporting structures were added.**
- **Distance from beam centre line to outside of supports = 610mm**
- **Supports clash with ratchet wall.**

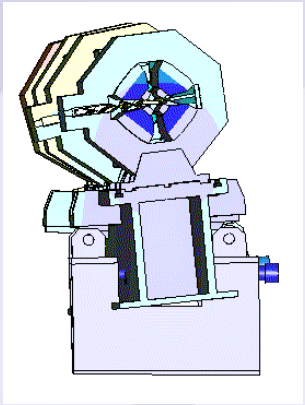
Clearance



- **Modified girder and supports to fit (60mm clear) and moved centre of rotation as close as possible to centre of mass.**

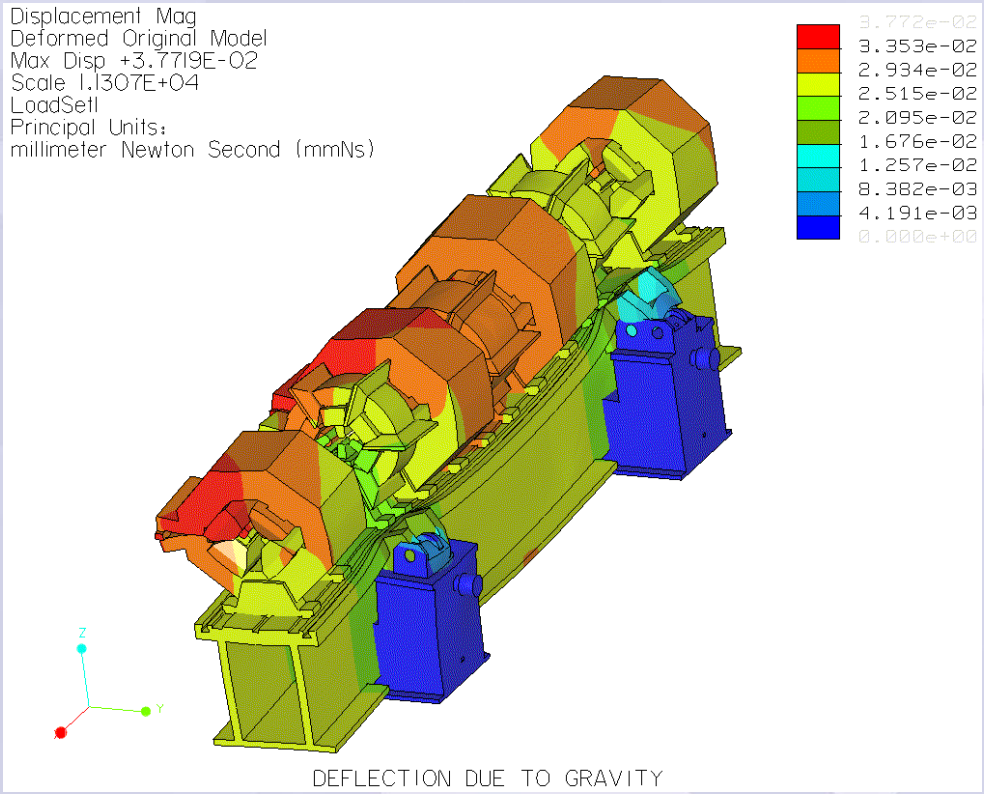
Girder Natural Frequency





- **Frequency = 42Hz**
- **Tie rods make the supports stiffer.**
- **Mode of vibration is twist. The front end of the girder (end on two cams) rotates on cams, while the far end (on three cams) moves with the stands.**

Girder Displacement Due to Gravity



- **Tie rods reduce the the deflection of the cam supports and gives us a more distributed deflection due to gravity.**
- **Maximum displacement is now 0.04mm.**

diamond

Work Still To Be Done

- Refine cam supports to ensure a stiff design that allows adjustment without clashing with the ratchet wall.
- Input a modified ground vibration PSD.
- After all of the design criteria are met, detailed design can begin.
- Order a prototype girder and support system for testing to verify results of FEA work.