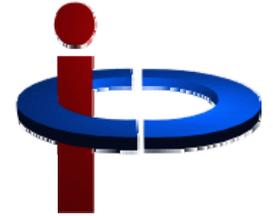


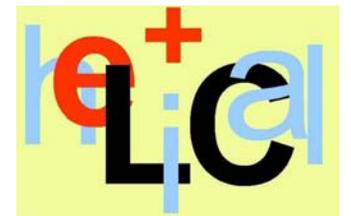
ILC Positron Source Meeting,  
ANL, Sep 2007



# Baseline Target Prototype Status

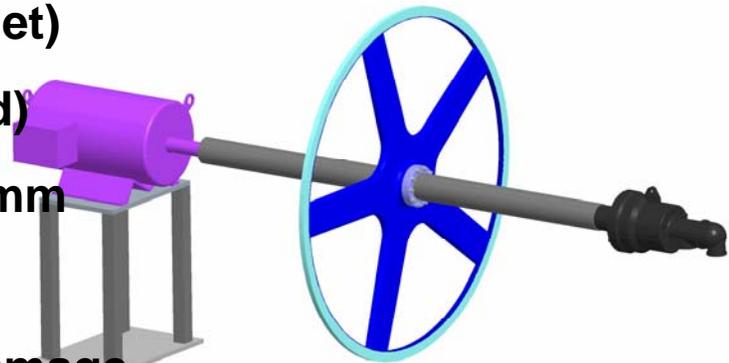
Ian Bailey

University of Liverpool / Cockcroft Institute

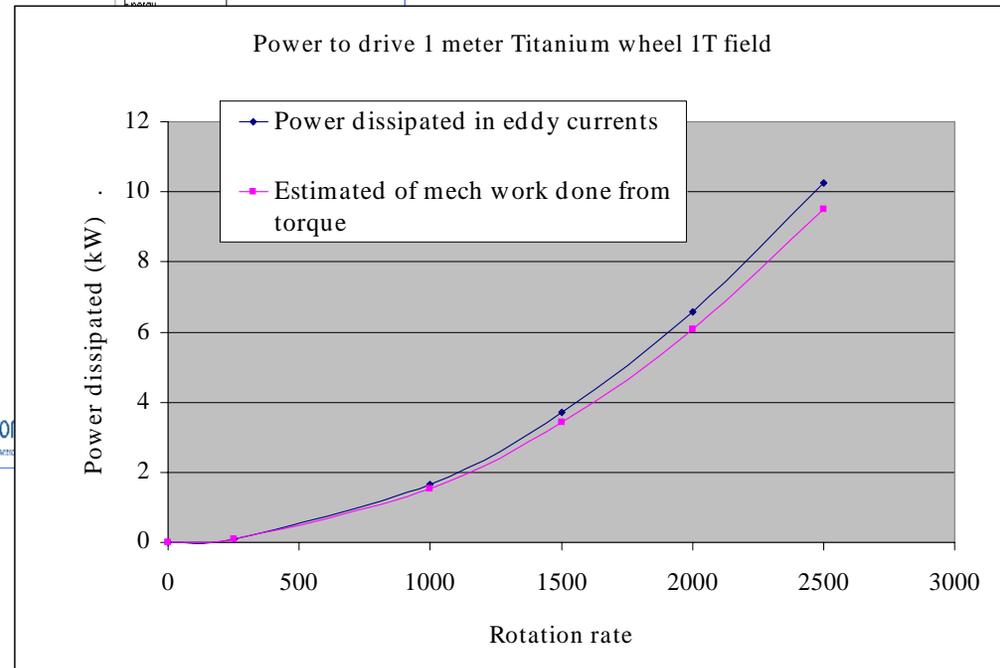
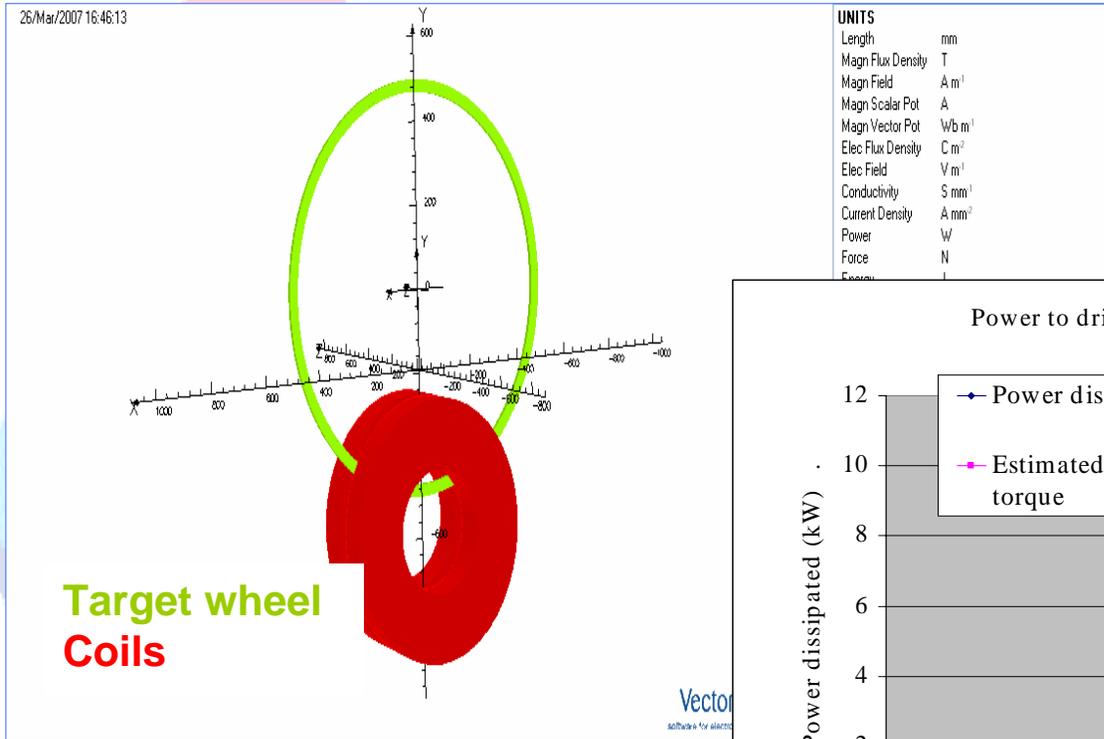


# Baseline Target Design

- Wheel rim speed (100m/s) fixed by thermal load
  - ~10.5kW from beam + ~10kW eddy current (immersed 1T)
  - ~19kW from beam + 0 kW eddy current (not immersed)
- Rotation reduces pulse energy density
  - from ~900J/g to ~22J/g (immersed target)
  - from ~1500J/g to ~36J/g (not immersed)
  - beam spot radius taken as  $\sqrt{2} \times 2.2\text{mm}$
- Cooled by internal water-cooling channel
- Wheel diameter (~1m) fixed by radiation damage
- Materials fixed by thermal and mechanical properties and pair-production cross-section (Ti6%Al4%V)
- Wheel geometry (~30mm radial width) constrained by eddy currents in immersed target case.
- 20cm between target and rf cavity.
- Axial thickness ~0.4 radiation lengths.



# 1m Wheel Eddy Current Simulations



- For 1T field at 2000rpm
  - RAL predicts ~6.6kW
  - ANL predicts ~9.5kW
  - Cornell? LLNL?

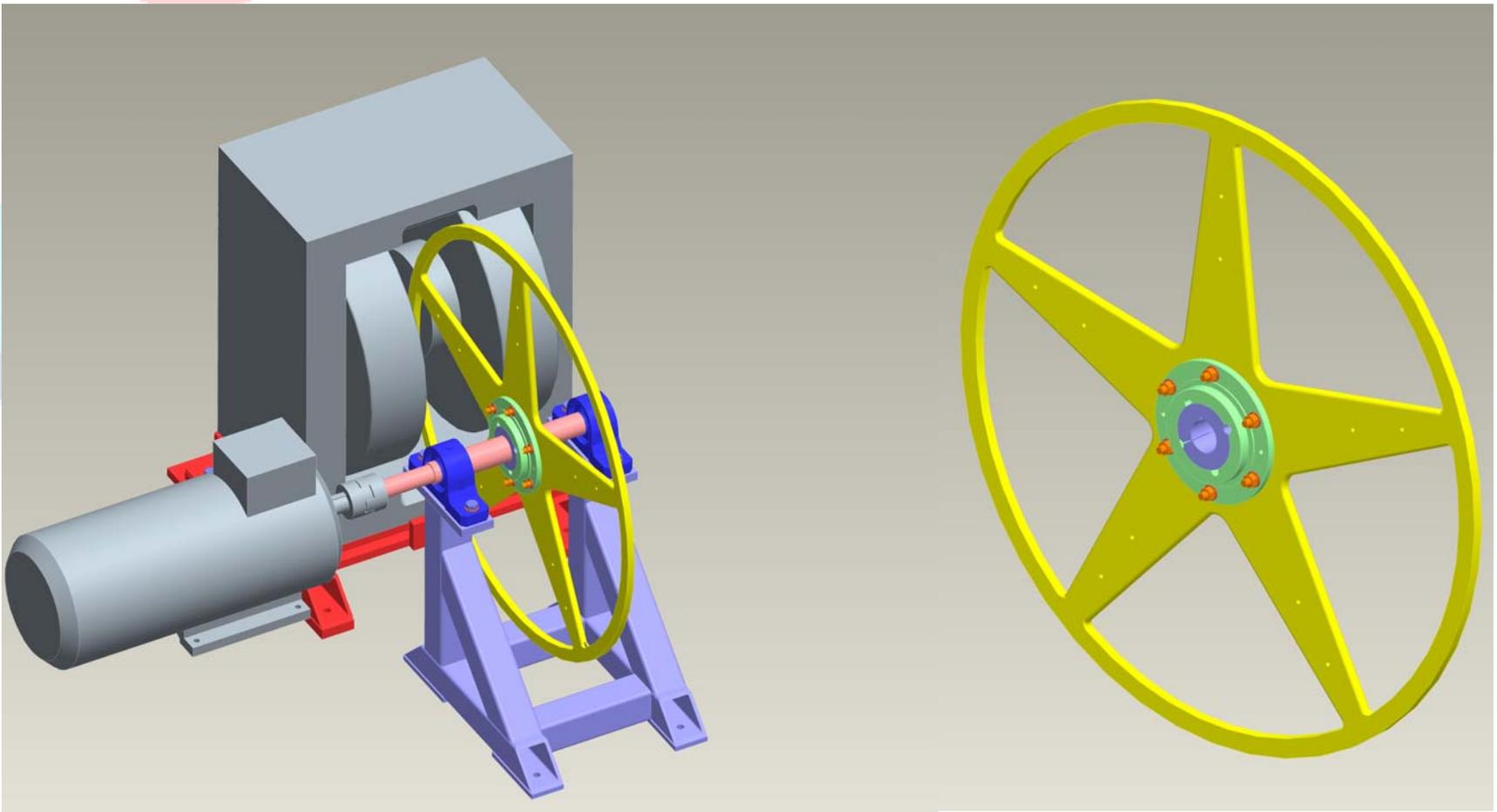
• Difference not yet understood...

⇒ Alternative capture optics,  
alternative materials, prototyping

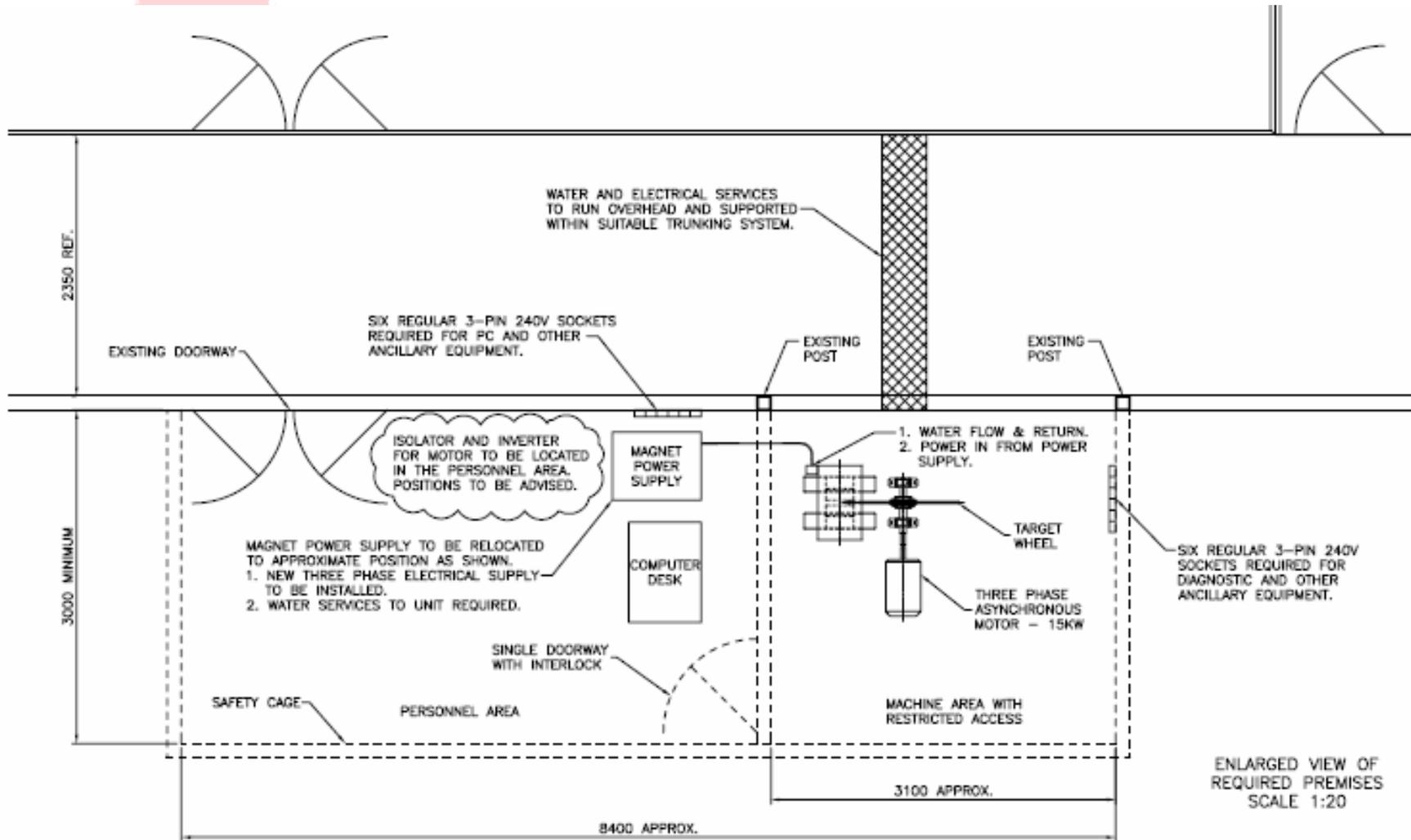
# Target Prototype Design

Prototype I - eddy current and mechanical stability

Ken Davies - Daresbury Laboratory

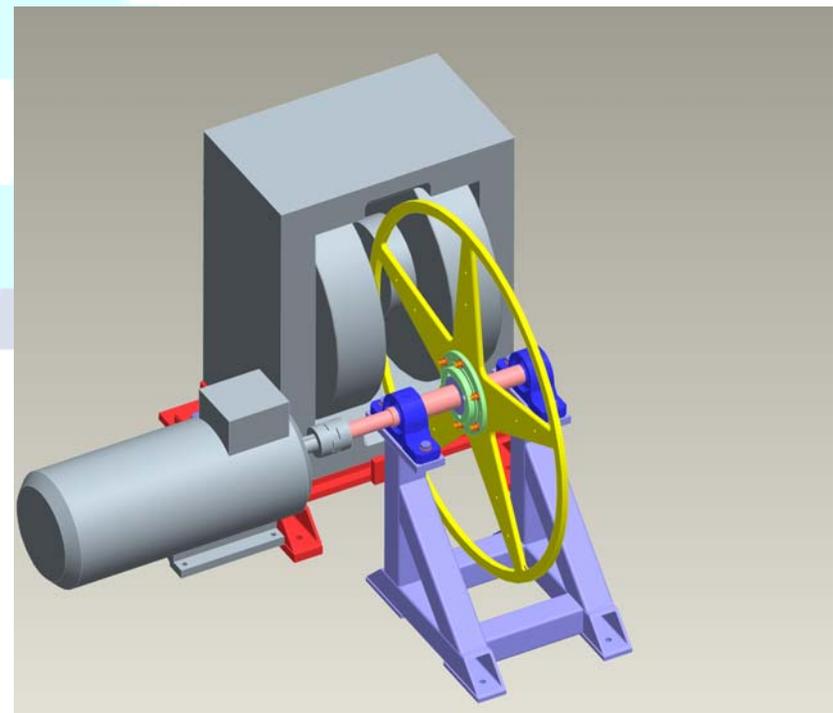
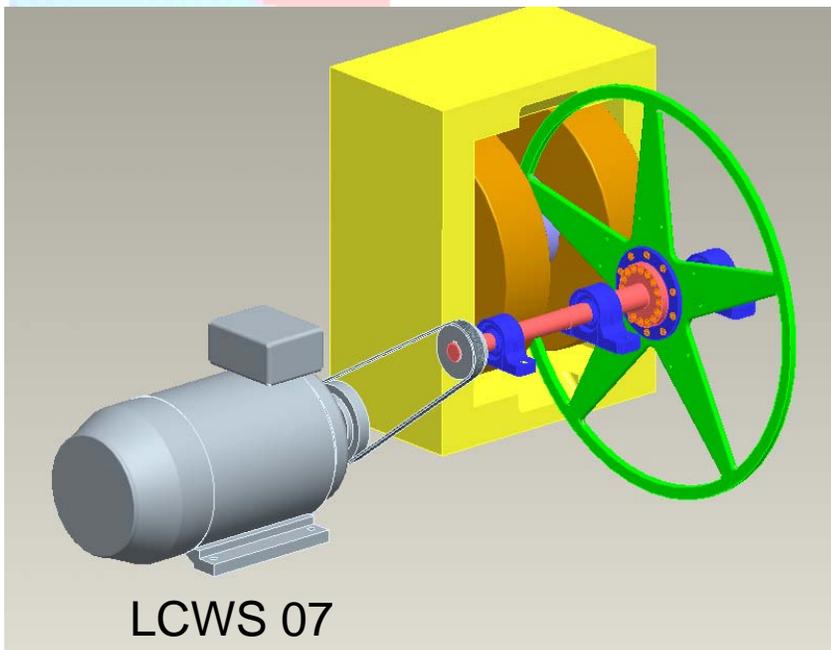


# Floor Plan



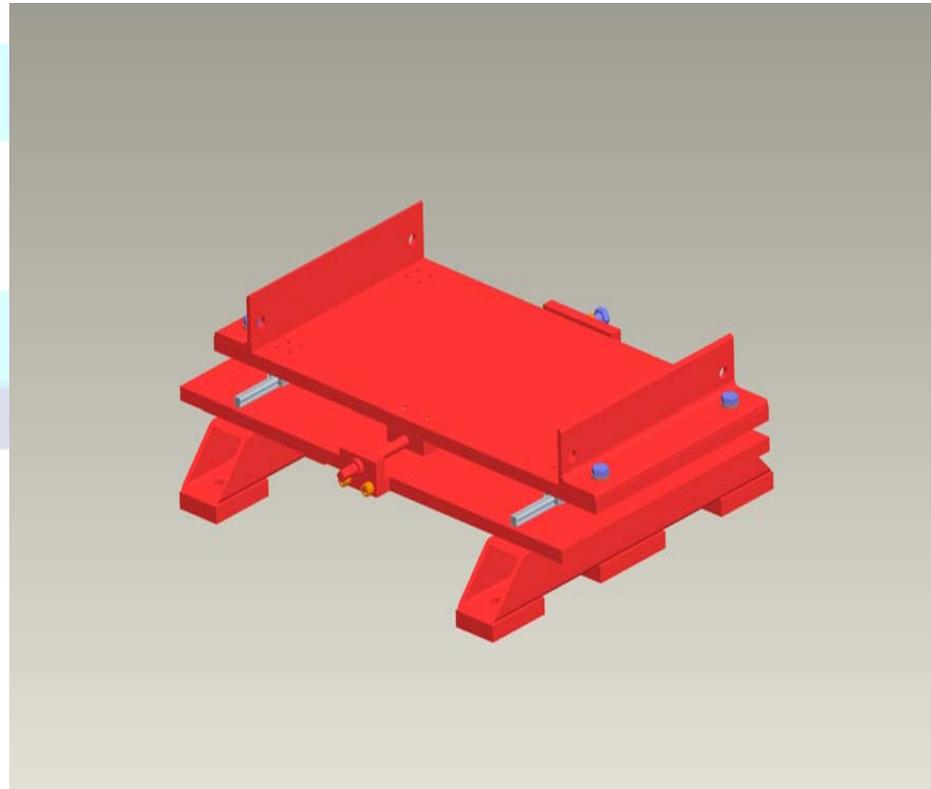
# Mechanical Updates / Changes Since LCWS07 (I)

- Direct drive (c.f. belt drive)
- Single solid throughshaft  $\Rightarrow$  simplified hub
- Two bearing blocks (c.f. three previously)
- Initial support structure design



# Mechanical Updates / Changes Since LCWS07 (2)

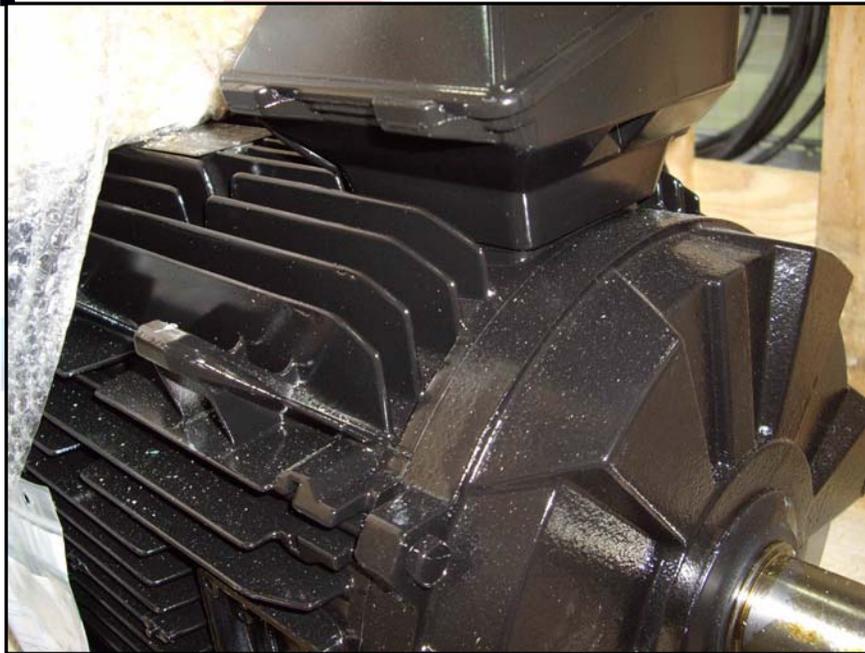
- Magnet support structure allows length of rim arc immersed in high-field region to be adjusted from 0mm to 190mm.
- Separate from wheel support structure and motor support structure.
- Is vibration damping required?



# Target Prototyping Status

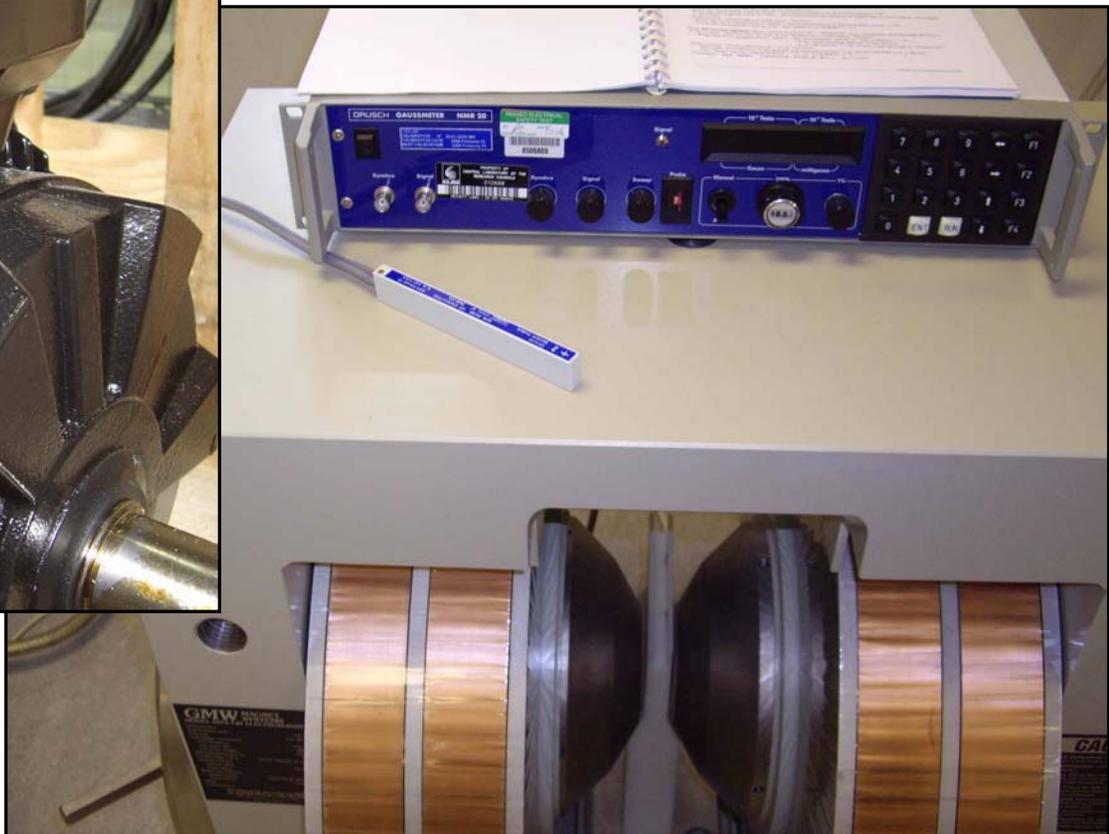
- Prototype funding in place (but limited!)
- Experimental area at DL allocated
- Services will be rerouted soon (water and electricity)
- Magnet has been sourced
  - model 3474-140 GMW water-cooled electromagnet
  - variable pole gap (0mm to 160mm)
- Drive motor (15kW) purchased
  - Interlock circuit designed and under construction
- Ti alloy wheel is being manufactured
  - Delivery expected in next couple of weeks
  - Also possible Al wheel (grade 5083).
- Assembly to be carried out in Oct '07
- DAQ design still being finalised
- Cooling system not yet designed
  - Rim temperature estimated to reach 200°C for convective cooling in air.
- Guarding being designed

# Photo Gallery...



15kW motor

Dipole magnet with NMR probe



# DAQ

- Transducers interfaced to PC / LabView
- Torque transducer
  - Coupled to motor and drive shaft
    - Moduflex coupling
  - 0.1% accuracy
  - Sampling at  $\sim 3$  kHz  $\Rightarrow$  at least one reading per spoke per revolution at 2000 rpm
- Accelerometers (one per bearing)
  - Require  $1 \times 10^{-3}$  m" g" sensitivity at  $\sim 1$  kHz
  - Currently sourcing...
  - FFT using software or hardware?
- Temperature transducers
  - Thermocouples (pole caps?, exhaust air, support structures)
  - IR sensors (pole caps?, shaft, wheel rim)
  - Black paint to reduce emissivity of metal surfaces?
  - Tests underway...
- Hall probe

# Experiment Programme

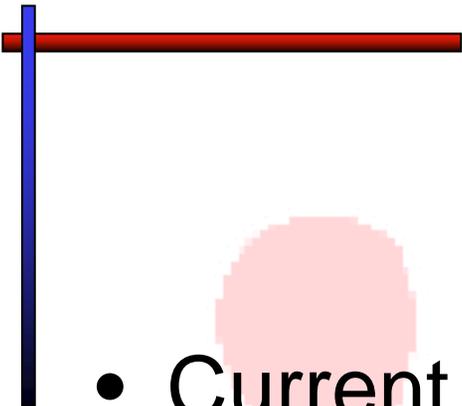
- Balancing and initial commissioning ~Nov 07
- Operation of wheel without magnet ~Dec 07 Cooling needed
  - Calibrating transducers and DAQ
- Operation of wheel in magnetic field ~Jan to Mar 08
  - Systematic scan of field strength (0T to 1T in 0.2T steps)
  - Systematic scan of ang. vel. (0rpm to 2000rpm in 50rpm steps)
  - Avoiding critical speeds.
  - Torque and temperature readings to be compared with the predictions of computer simulations.
  - Immersion depths?
- Long-term operation of wheel to monitor stability ~Apr 08
- Additional investigations using aluminium wheel or modifying conductivity of wheel rim also possible.
- Experiment complete by May 08.

# To Complete Current Programme

- Eddy current simulations (ANL?, RAL?)
  - Effects of spokes in field (~1% torque increase?)
  - Varying rim immersion
- Thermal and fatigue calculations (LLNL)
- Material tests (LLNL, RAL?)
  - Hardness tests to gauge stress state of wheel
- Torque transducer (CI, DL, SLAC?)
- Accelerometers (CI, DL)
- Finalise DAQ (CI, DL)

# Future R&D

- Beyond May 08
- Do we need to prototype the vacuum and water-cooling systems?
- Will require
  - New wheel with cooling channel (~£35K)
  - Vacuum vessel + feedthroughs
  - Thermal load
    - Eddy currents? Cap. Optics prototype?
    - Electron beam welder?
- Will not know if there are UK resources available until end '07 (STFC review)



# Summary

- Current prototype under construction
  - Assembly in Oct '07
  - First operation in Nov '07
  - Cooling needed by Jan '08
  - Further prototyping?
- 