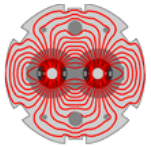


US LHC Accelerator Research Program

BNL - FNAL - LBNL - SLAC

SLAC RC Status Report

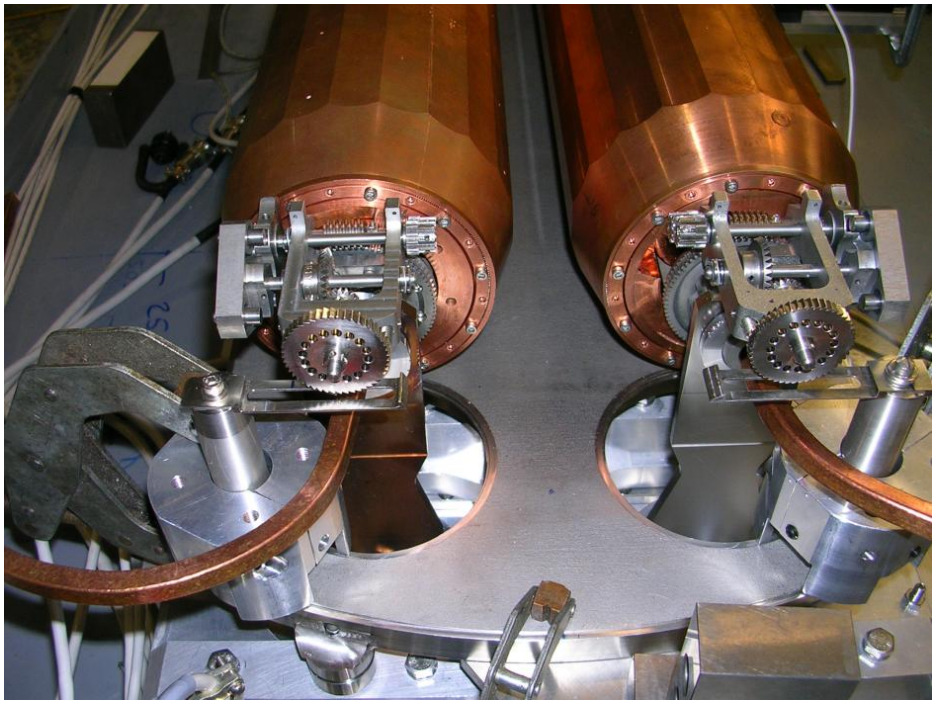
30 August 2010

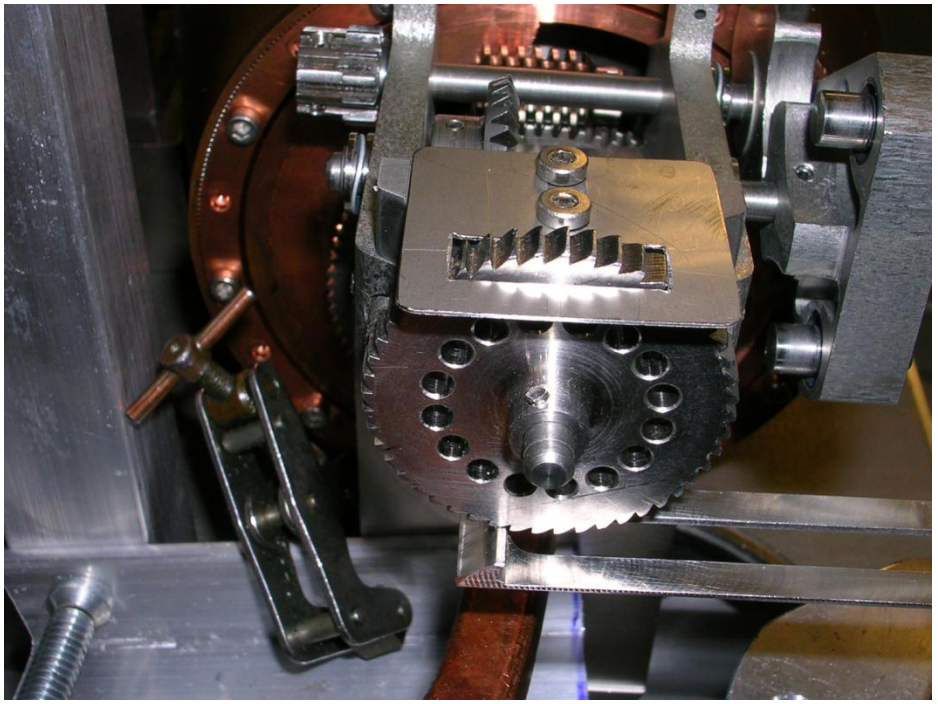
LHC Collimation Working Group Meeting

Tom Markiewicz/SLAC

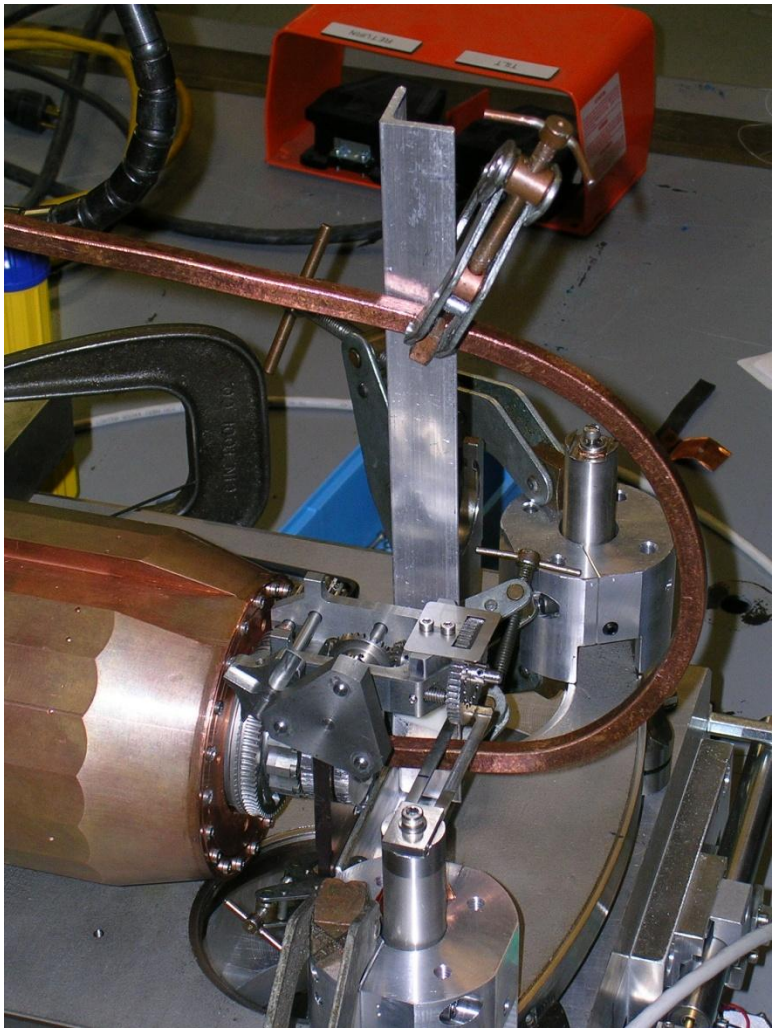
Activities Since 19-July-2010 Status Report

- Tests of Right Hand drive successful
- Tests of Left Hand drive revealed problems that “pawl” could not “hide”
  - Left and Right different as L jaw rotates CW while R jaw rotates CCW

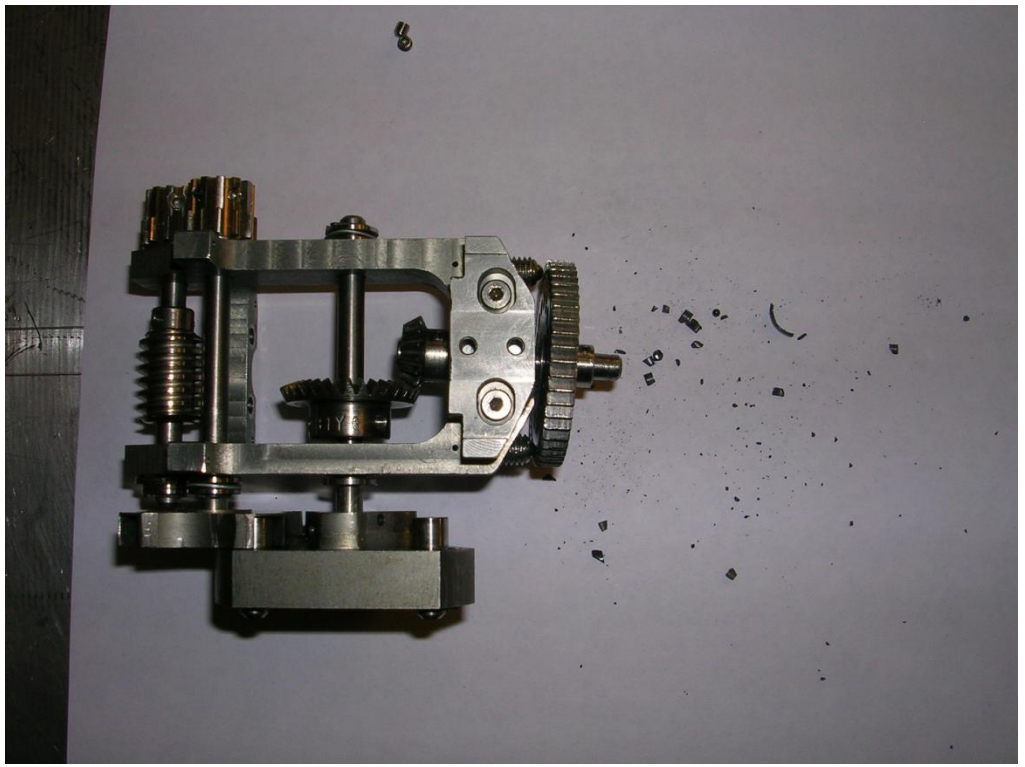


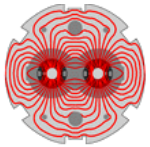


Problems Reveal Themselves on 21 July 2010



- Rotate several facets while twisting Cu tube (note it is clamped in L photo)
- Ceramic race on one of the two bearings on actuator fails under load





Fundamental Problems

- We did not appreciate load rating of races of ceramic bearings
  - Note that each drive has 16 10mm OD / 5mm ID races
  - Ceramics chosen for thermal expansion characteristics & because they are guaranteed not to cold weld in vacuum
  - Solution
    - All bearings (as well as the spline gears, bevel gears and worm drive) replaced with ion-deposited W-S_2 stainless
- Shafts supported on one end can tilt under load
  - Solution
    - Use of thrust bearings

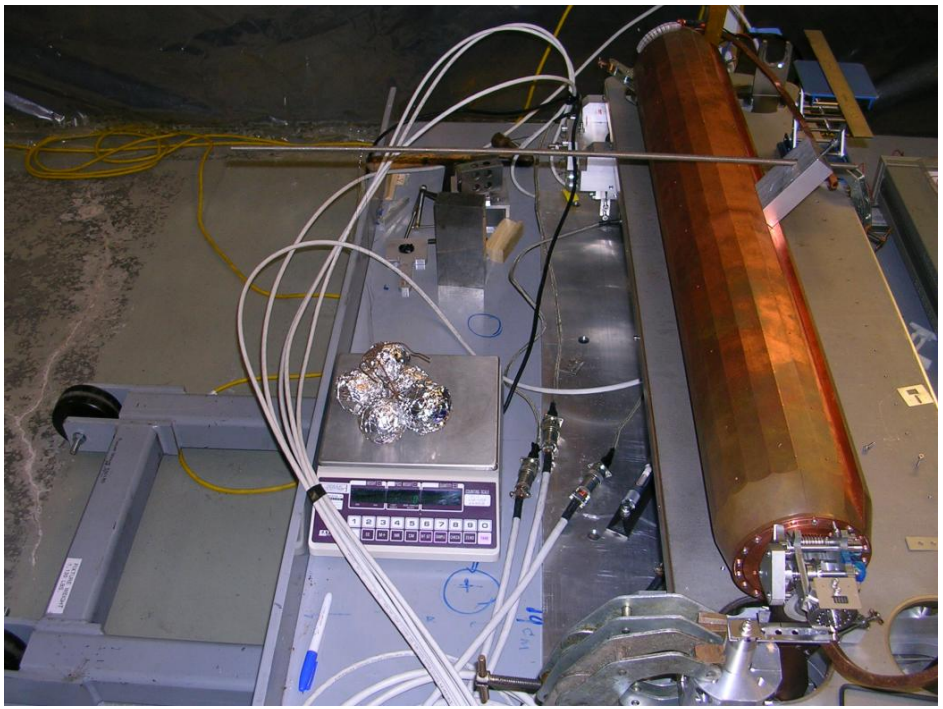
Problems Related to Testing Prior to Final Welding

We always planned to spot weld all screwed & pinned parts as part of final assembly procedure.

Problems

- Rotation drive mounts via two screws on a tab on one half of the split bearing that houses the main shaft support and we are temporarilly using Aluminum nuts to attach to shaft
  - Under load, tab rotates as worm pushes against it especially if nuts not tight enough
  - Solution for pre-weld tests:
    - Elaborate clamp referenced to steel support shaft to prevent any rotation as well as any tilt
- Gears pinned in place with “rolled pins” (not very strong)
  - Solution: Replace 6 of 7 pins with solid stainless pins
    - 7^{th} rolled pin acts as “fuse” to protect housing

Tests with Measurable Torque



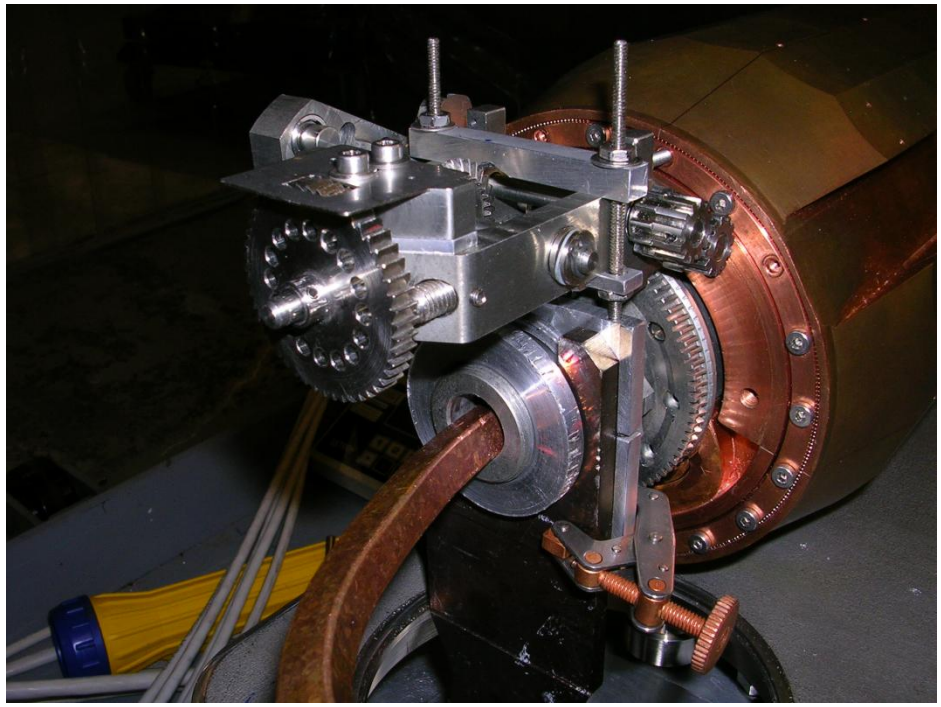
Lever arm (16”) and weights (13.36 lbs.) with scale provides measurable torque for systematic studies

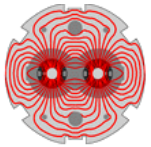
- ~214 inch-pounds available (with currents weights)
- Measurements of torque required to overcome friction of split race support bearing (50 in-#) and to bend the copper tube (14in-#)
  - **~ 64 inch-pounds total**

Clamp to Simulate Welded Fixtures

Clamp is registered to sides to steel support to prevent rotation and to top of support to prevent tilt

Thrust bearing between 40-tooth ratchet and housing prevents tilt of ratchet under load





Most Recent Test Results

27 August 2010

- With 4 of 7 rolled pins replaced with solid stainless pins, the clamp, thrust bearings, stainless bearings
  - Pawl fails at 150 inch-pounds torque
  - Rolled pin holding first bevel gear shears at 204 inch-pounds

Immediate plan: improve L drive unit

- Replace rolled pins on ratchet axle with solid stainless
- Replace pawl with a more classic design where a radial spring causes a “dog” to engage ratchet tooth
- Test unit to ~400 inch-pounds

Then implement these changes on R unit and test it

Then final assembly & welding & testing & alignment in clean-room using ion-deposited W-S_2 parts . Then bake out & ship.

SLAC design details