ATF2

Magnets

Report on New ATF2 Magnets & Power Supplies and their Commissioning Plans

to the ATF2 Project Meeting at DESY

31st May 2007

Cherrill Spencer, SLAC

Member of ATF2 Magnet Team

Speaking from California.

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New Magnets Being Made/Acquired for the ATF2

- **Need 28 new FF and extraction line quads ("QEA").** 24 been made by IHEP, Beijing and measured at KEK. 6 of these were "stolen" by ATF-DR. 11 more (1 spare) being made.
- **3 new dipoles B1,B2,B5** to be made: all one style.
- **5 new sextupoles** are needed: 3 in the FF: SD4, SF5 and SF6 and 2 in the "final doublet" (FD) (interleaved with final 2 quads): SF1 and SD0
- **2 new FD quads :** QF1 and QD0
- The sextupoles and FD quads will be recycled SLAC magnets

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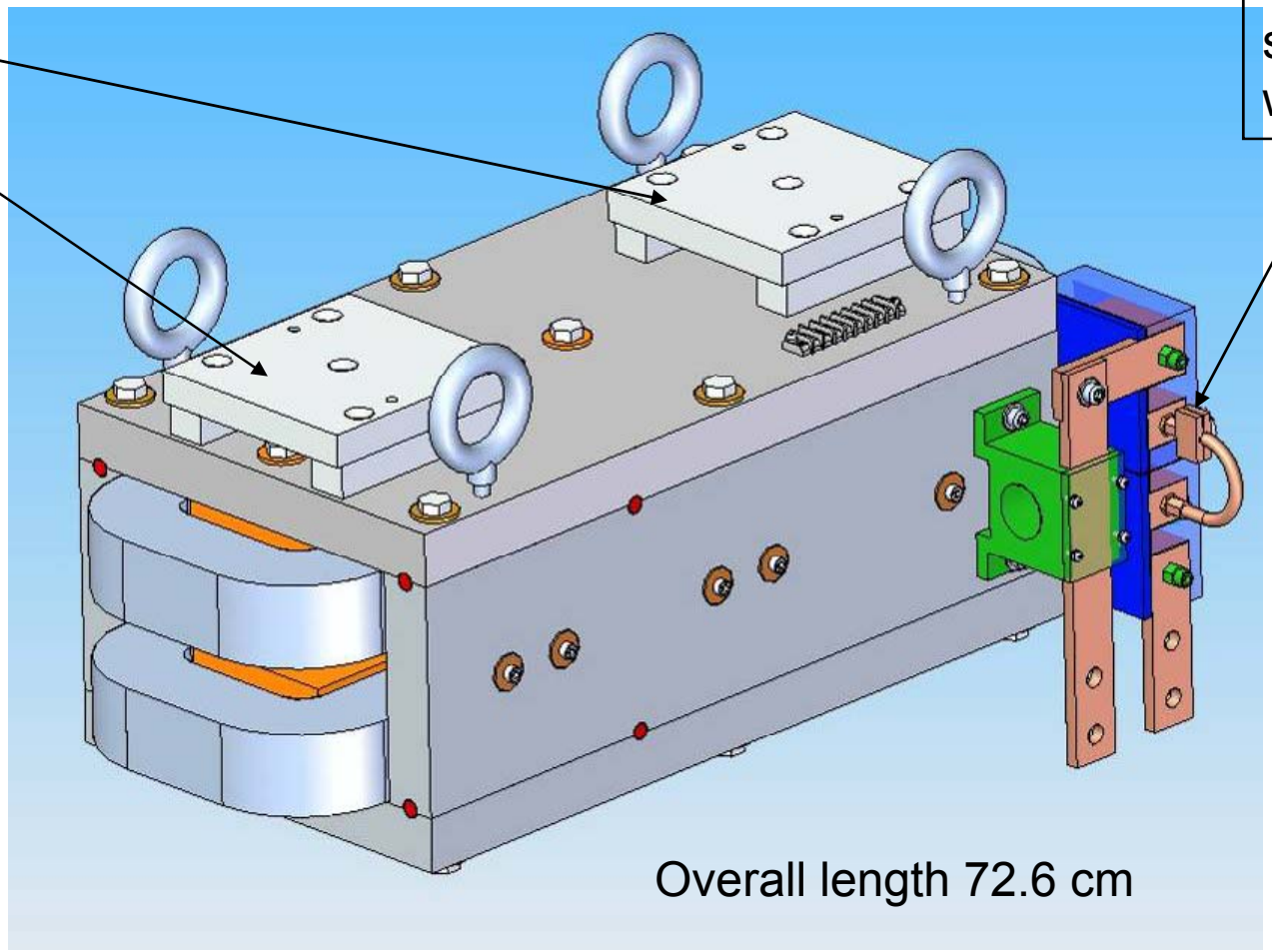
New Magnets Being Made for the ATF2: Philosophy & Constraints

- In general we are taking steps to minimize the cost of the new magnets and to produce them in timely way (present goal: all new magnets to be at KEK by end of December 2007)
  - Using existing magnets
  - Using existing magnet movers
  - Modifying existing magnet designs
  - Using existing adjustable mounts
- Constraints on magnet sizes, apertures, coil ends, operating currents & voltages, from:
  - Fit in with existing movers
  - Beam height from floor of 1.2 m
  - Interface with 2 different styles of BPMs
  - Fit in with new power supply's current & voltage

Design of ATF2 dipole: 3D figure

Bases for alignment tools

Thermal switch; one water circuit



Magnet can be split for installation in the beam line & precisely re-assembled

Power terminals oriented to receive power cables from floor

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Status of 3 new ATF2 dipoles

- 2nd request for bids sent to 6 vendors in mid-April, 2007
- 6 bids received on 4th May. Some bids were within our budget; wide range of costs in the 6 bids.
- Have decided to award contract to IHEP, Beijing. Purchase order being drafted.
- Have asked IHEP to magnetically measure each dipole with a Hall Probe, moving in an X,Y,Z grid, to measure integrated strength at various X, Y coordinates. This avoids shipping the heavy dipoles twice across Pacific to be measured at SLAC as KEK does not have the apparatus to measure these dipoles.
- Negotiating a shipping date from IHEP to KEK of early November 2007.

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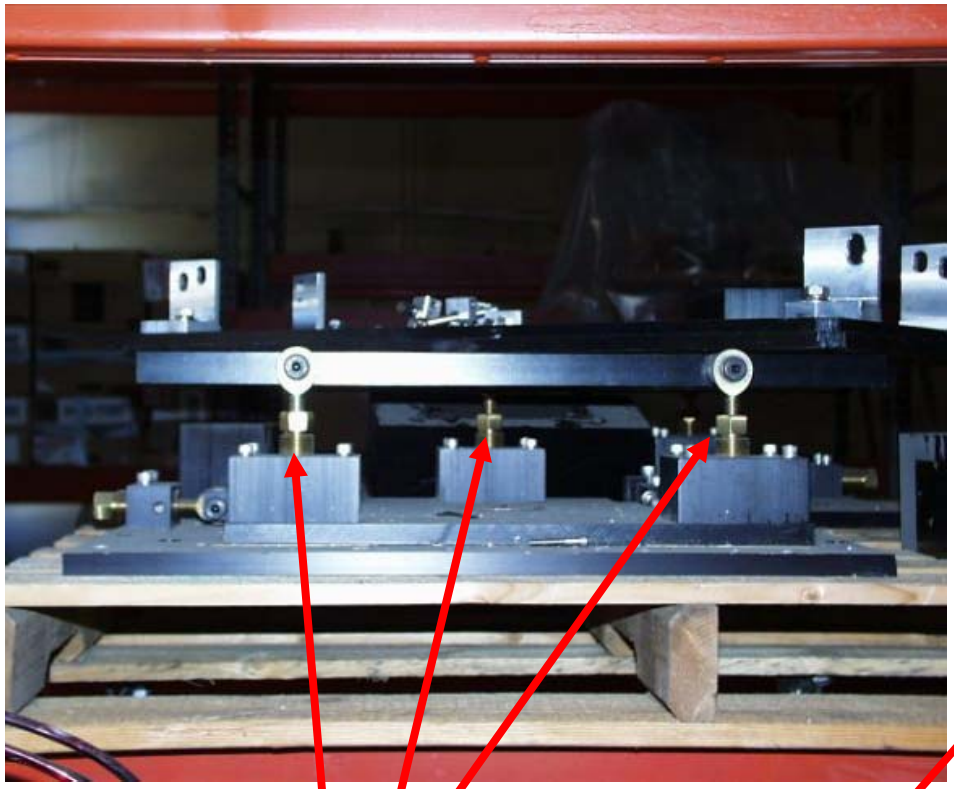
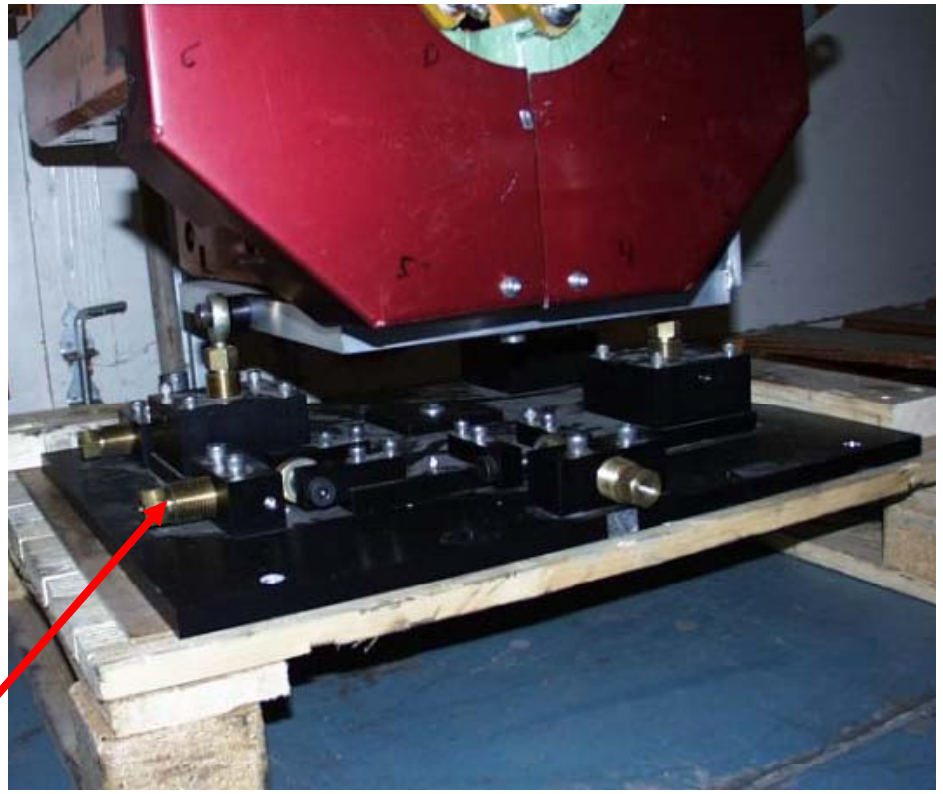
Adjustable precision mount used under many magnets at SLAC, allows all needed motions for aligning dipoles





Has 3 adjustable differential screws sitting vertically and 3 sitting horizontally

We have 3 spare mounts of correct size to donate to ATF2, to support dipoles.

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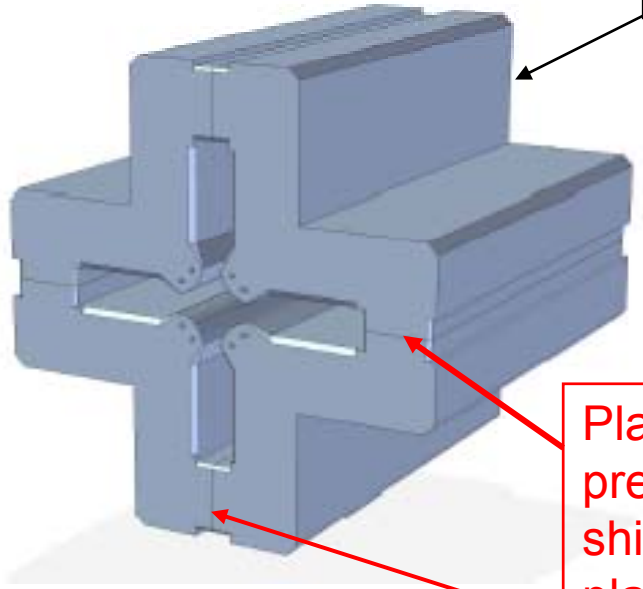
Chosen method for enlarging the old "QC3" quad's bore diameter

Dimensions of shims:

10.607mm thick
58.09mm wide
450.00mm long

QC3's solid steel core, made from 4 equivalent pieces

Diameter to be enlarged from 35mm to 50mm



Shim will be low carbon steel, ground to 0.0005" (0.0127mm) flatness.

Tolerances on width& length: +/-0.127mm

Place a very flat and precise thickness shim in each split plane to "explode" the quad and enlarge the bore diameter.

Spencer reckons split planes were made to 0.02mm flatness & 0.02mm perpendicularity

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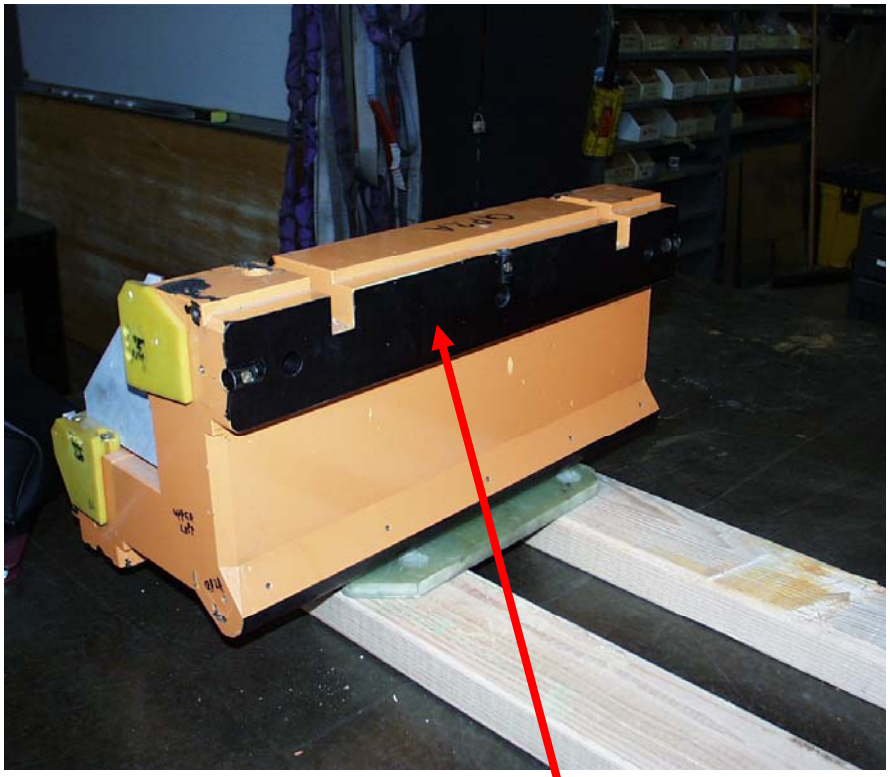
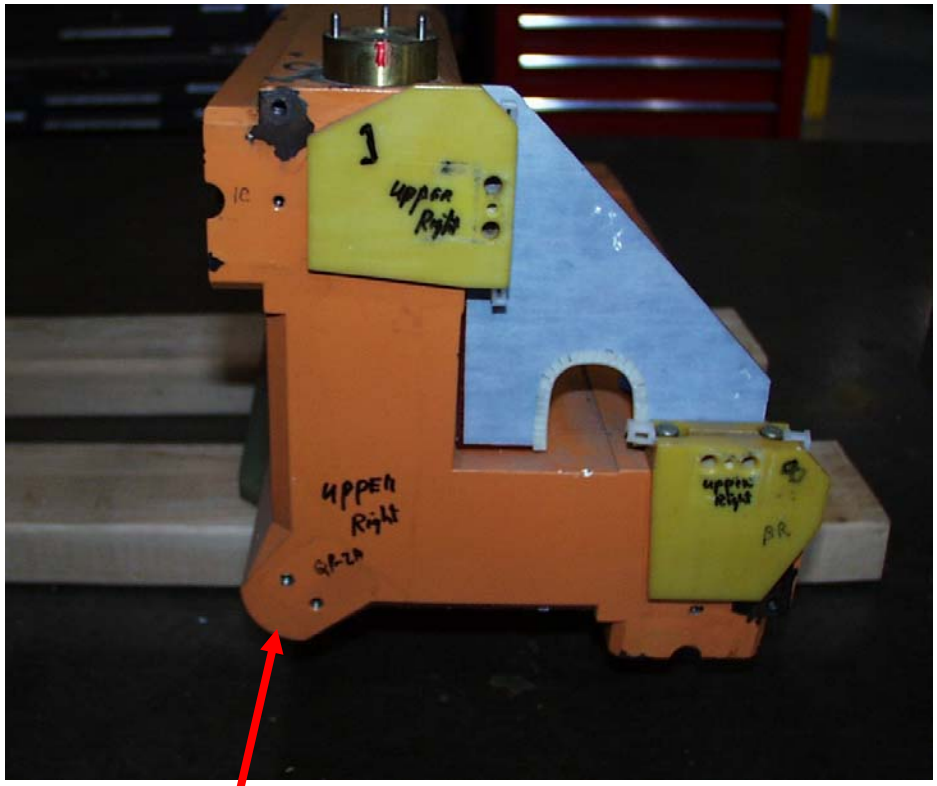
First of the 2 old FFTB quads has been disassembled in SLAC Magnet Shop



A core quadrant, black surface is a split plane. New shim will cover this face.



Poletip shape will not be altered

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Water-cooled hollow copper conductor coils will move back with their core quadrant

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Tasks for modifying the two “QC3” quads, page 1/2

- Measured one of the 2 quads, as is, with our best rotating coil set-up: harmonics at various strengths. Turned out one coil was leaking at its input block. Managed to run with a LCW diverter in place, but sextupole value was not reasonable- too large for the mechanical quality of the cores. Had to stop measuring so could move ahead.
  - NOTE IT IS VERY DIFFICULT TO MEASURE VERY SMALL SEXTUPOLES, these quads have very tight sextupole tolerances
- Draw drawings of flat shims and how they will fit into the core. Hampered by lack of detailed QC3 drawings- getting dimensions off the disassembled core. Almost done.
- Have 8 shims roughly made at SLAC, drill mounting holes, and ground at local grinding shop (they have low carbon steel plate in stock). Expect to place fabrication order next week
- Completely disassemble 2 quads, refurbish main coils, remove trim coils (will not use), clean up and repaint steel
- Reassemble core with new shims, drill 3 new dowel holes

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Future Tasks for modifying the two "QC3" quads, page 2/2

- Re-assemble core, shims & coils; check critical dimensions
- Re-measure with same rotating coil set-up: integrated strength over 5 to 150 amps; harmonics at nominal operating currents.
- If necessary: decrease 12 pole component by one method or another. If sextupole is too high then several techniques available to reduce it.
- Goal: 2 modified quads shipped to KEK by late Dec '07
- LAPP working on how the T-1 plate and magnet mover layout: needs to be modified to fit the wider quad.
- One smaller mover needs to be modified for the 2nd FD quad [there is only one larger mover-is in LAPP, Annecy]

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Status of the 5 new ATF2 sextupoles

- **Five new sextupoles** are needed: 3 in the FF: SD4, SF5 and SF6 and 2 in the “final doublet” (interleaved with final 2 quads): SF1 and SD0.
- In continuing effort to save money I have been looking for existing sextupoles that we can use. Are constraints:
- **SF1 & SD0 constraints**:
  - will have (large) S-band BPMs attached to their core
  - their bore should match the QD0/QF1 bore (= 50 mm)
  - Cores can be somewhat longer than 90mm [am concerned about shortness of core relative to bore: fringe field effects]
  - their cores need to fit in with sitting on a plate on top of an FFTB mover & must put center of bore at 1.2m from floor
  - Current to be less than 50 amps, voltage less than 30 volts

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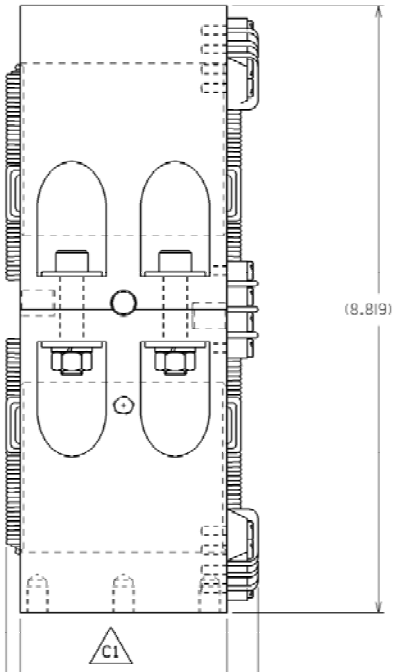
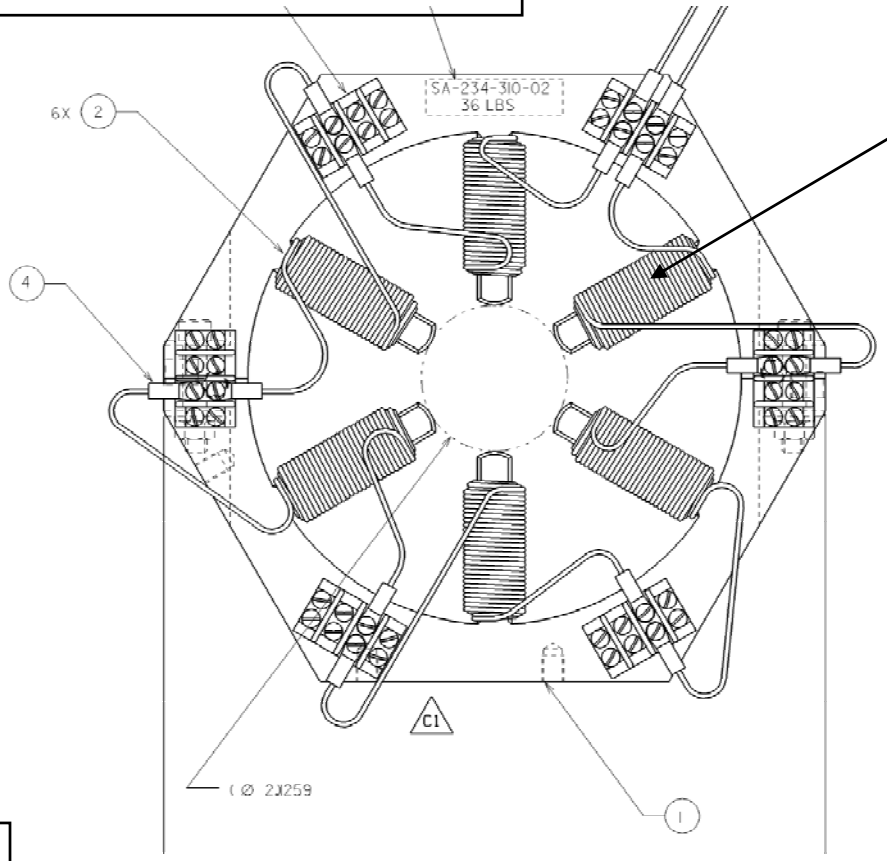
Two old FFTB sextupoles, “2.13SX3.00”, in use in ATF extraction line until it is re-configured for ATF2, then not needed there anymore. MEET SF1 & SD0 rqts

Bore diameter: 2.1259” = 54mm





#14 round solid wire coils, 3 layers, 87 turns total.

From old mag mst estimate about 3.6A for SF1 and ~6.6 A for SD0 to reach required ∫S.dl

Solid steel core, 3” long = 76.2mm

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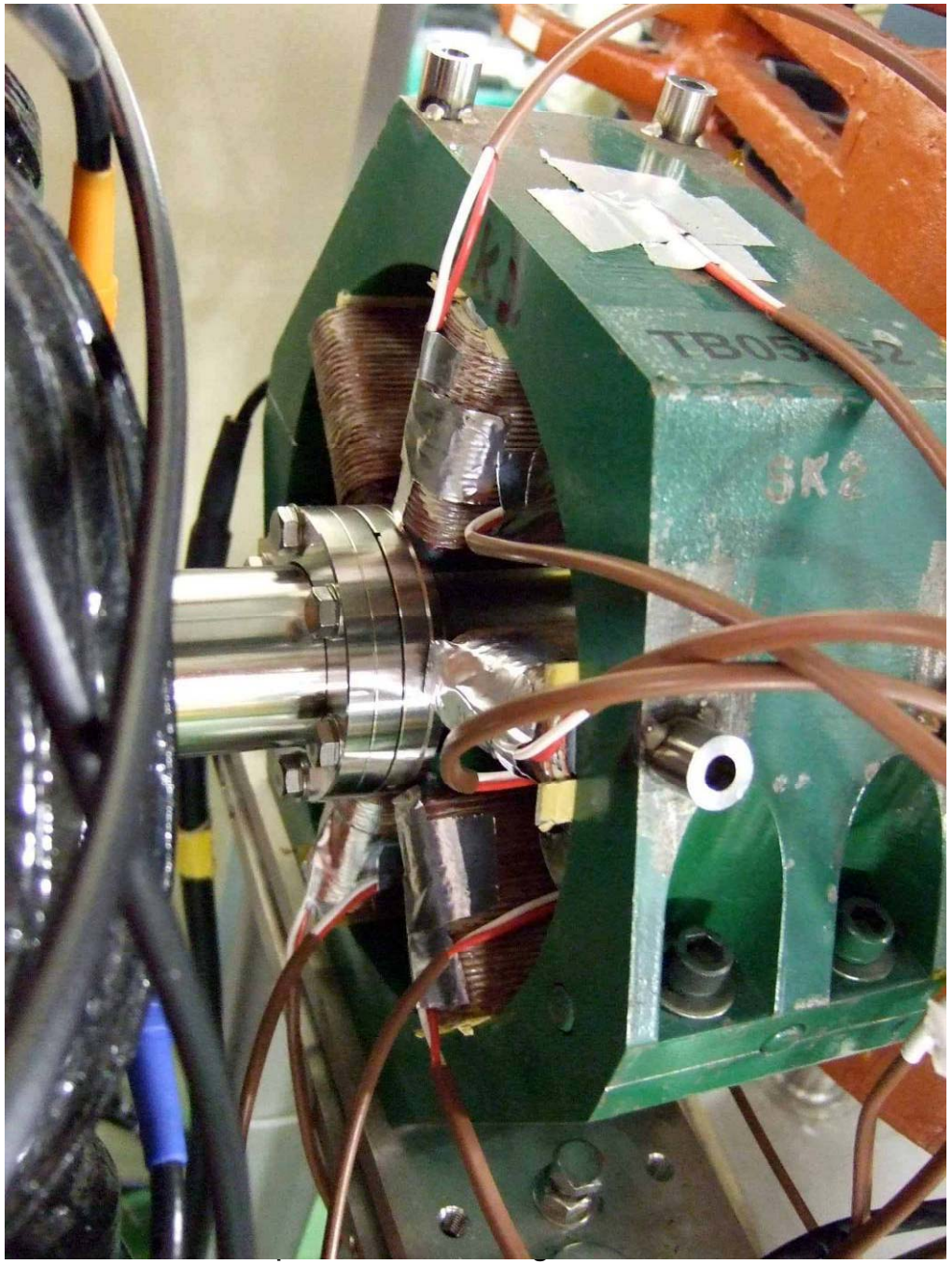
OLD FFTB solid wire sextupole with 2.13” bore diameter and 3.0” long steel core.

In the ATF extraction line at KEK.

With 10 thermocouples attached to various coils and top and bottom of core



Terunuma - san ran this sextupole one night at 2,4,and 8 amps and measured temps in various places- heated up slowly and got quite hot.

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Preliminary conclusions on using the old FFTB sextupoles for ATF2 SD0&SF1

- Can run them to get required strength without heating coils too much from epoxy point of view
- But too long a time to come to constant temp and too large a temp raise for FD usage
- Could cool the wire coils by putting some copper cooling tubes around them – have to test empirically.
- We will find 4th sextupole still at SLAC and test ourselves with cooling tubes- will do in next 2 months
- Harmonics (measured in 1993) satisfy requirements
- Can design new water cooled coils if cannot cool enough with external Cu tubes: will be cheaper than my other idea of sawing up core of an old SLC FF sextupole

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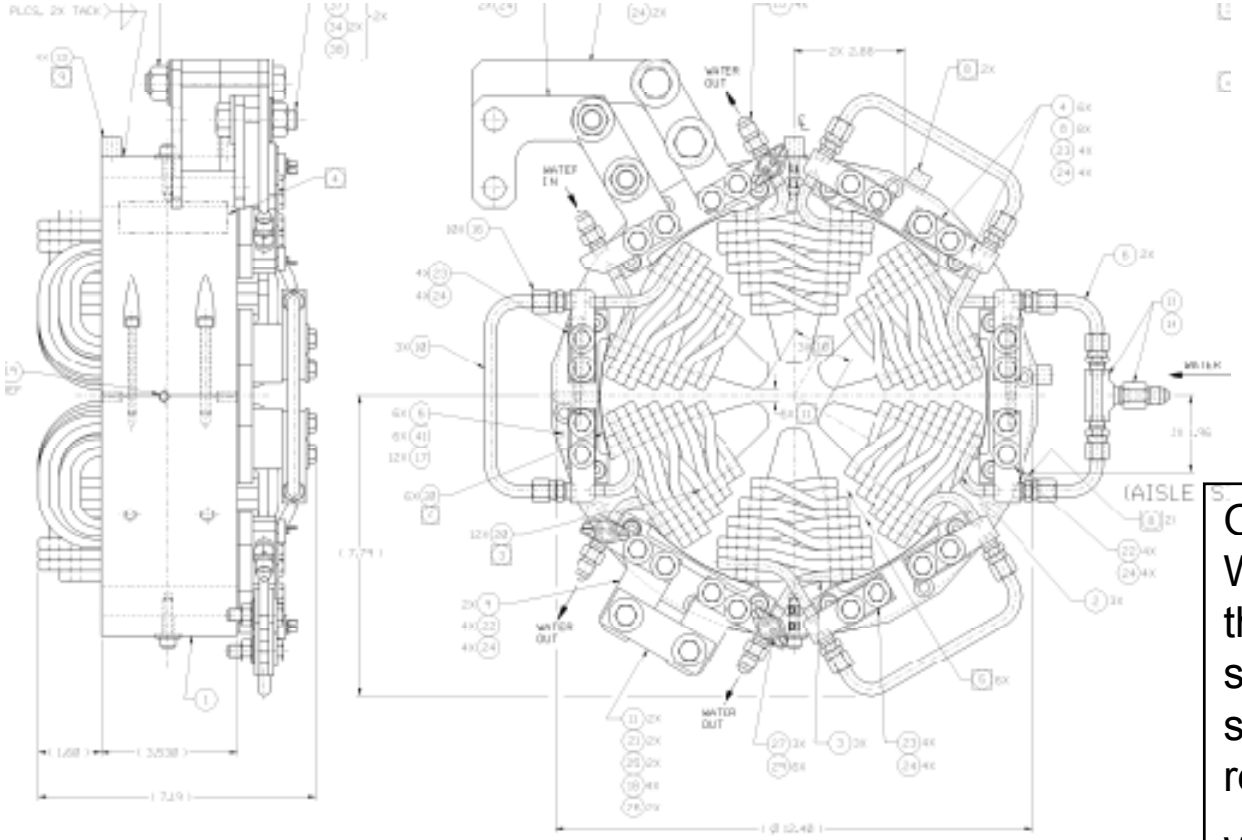
Style of existing SLC FF sextupole, 4 of which acquired (with much effort) for the ATF2

Style name= 1.625SX3.53

Bore diameter= 41.28 mm

Core length =89.66mm

26 turns of 0.255” sq hollow Cu conductor per coil



Only 4 exist. We may use them: they satisfy FF sextupole requirements

We need 3 for ATF2 FF.

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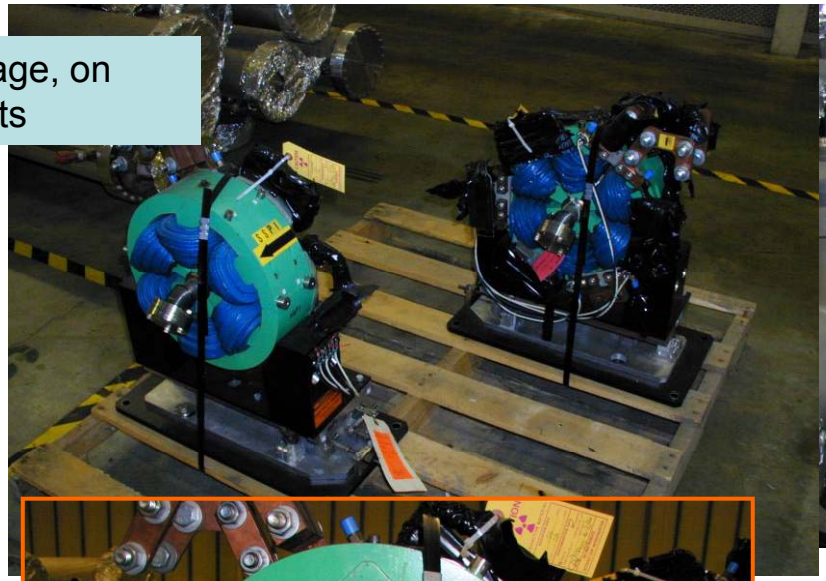
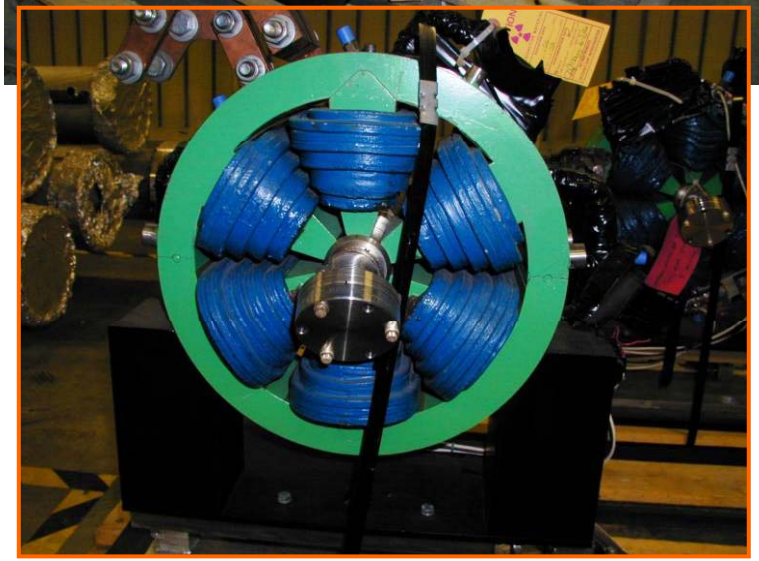
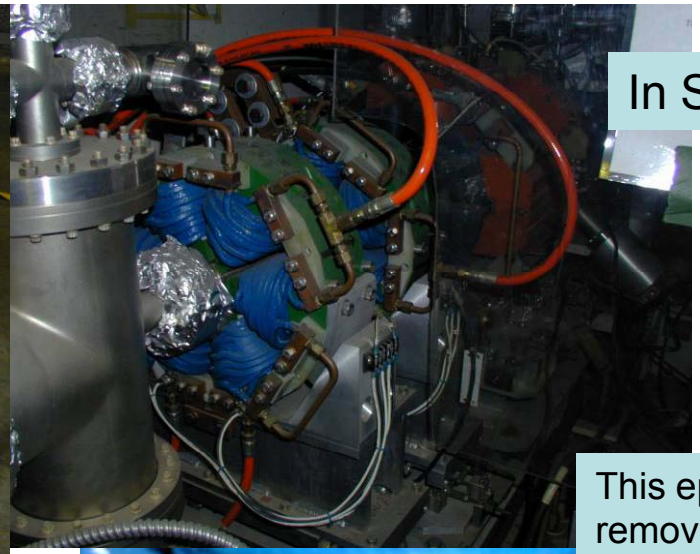
Photos of the SLC "SX3" style sextupoles we will be using for ATF2 sextupoles

In storage, on supports





In SLC FF



This epoxy will be removed

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Future tasks to prepare the ATF2 sextupoles: will take until December 2007

- Remove 3 sextupoles from SLC (2 already out)
- Magnetically measure one of them to check its low current behavior and harmonic content
- Design and fabricate special cradles for holding sextupoles – must be finely adjustable in roll
- Design and fabricate special fixtures for holding alignment reference base plate on top of magnet
- Magnetically measure 3 sextupoles after refurbishment

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Magnets

Magnet Installation & Commissioning Topics

- Support system & schedule will be described by Sugahara-san
- Magnets will be placed on top of concrete blocks or on old FFTB movers on blocks, by contracted workers
- Later- LCW hoses and manifolds will be added
- Later - power cables and thermal switch wires added by SLACers
- Later- magnets will be split and BPMs/vacuum pipes will be installed. Who will supervise this operation?
- ALIGNMENT: have resolved that the magnet roll tolerances on page 16 in the ATF2 proposal are un-necessarily tight and that rolls of less than 300μradians are sufficient. Will work towards this goal.
- Quads & sextupoles on movers will have rough alignment done first and then fine alignment using the movers.
- KEK people are working on making the movers work (software too)
- Magnets will be connected to new Power Supplies so the complete system can be tested out.

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Next 5 slides provided by Briant Lam, SLAC PS Engineer. Responsibilities for PS & cables

Power supply system	Responsibility
Controllers	SLAC
Bulk Power Supplies	SLAC
Power Supplies (Power Modules)	SLAC
Cooling Fans	SLAC
Racks	SLAC
Intra-rack cables	SLAC
Controller Software	SLAC
System Software	KEK
Performance Test	SLAC
Cables	
Input AC cables	KEK
DC cables to magnets	KEK
DC cable raceway system	KEK
Ethernet Cables to Controllers	KEK
Magnet Interlock Cables to Controllers	KEK
Installation	
Wiring and Layout Diagrams	SLAC
Training	SLAC
Cable Termination	SLAC
Testing System	SLAC

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First PS Commissioning Phase

- Items needed from KEK (first SLAC needs PS layout diagram so can calculate lengths and styles of cables)
  - AC Power Cables
    - 400 V AC 100 Amp (6 total)
    - 100 V AC 20Amp (9 total)
  - DC Power Cables
    - 2 AWG or 40 mm^2 for 50 Amp Power Supplies
    - 4/0 or 140 mm^2 for other Power Supplies
  - Control Cables
    - Ethernet Cables and Switch
  - Interlock Cable
    - Water Flow and Thermal Switch

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First PS Commissioning Phase (continued)

- Planned Delivery
  - Deliver the Power System Feb-Mar 2008
- Commissioning Team
  - Briant Lam + 1 SLAC Technician/Engineer
- Initial Tests at KEK
  - Turn On Power Supplies with Local Laptop or Local Control Board.
  - Tune each Power Supply to Magnet Load

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Power Supply Progress as of end of May 2007

- New Racks: In transit to SLAC
- Programmable Logic Controller: Received, fabricating chassis
- Bulk Power Supplies: Received, waiting for a transformer to test
- Ethernet PS Controller: Mid-June 2007
- High Availability Power Supplies:
  - Prototype: Mid-August 2007- will test and verify
  - 1st Batch: Mid-October 2007
  - 2nd Batch: Mid-November 2007

ATF2 Rack Layout: to indicate mass of the PS system.

Will be shipped by sea to arrive at KEK by March 2008.

Magnets

RACK NO. 1

DCCT BLANK PANEL	
BLANK PANEL	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
FAN	
PLC	
FAN	
QD10 30V, 50A 1.5KW EI-446-548-01	QD10' 30V, 50A 1.5KW EI-446-548-01
FAN	
QD10X 30V, 150A 4.5KW EI-446-548-01	
FAN	
QF11X 30V,150A 4.5KW EI-446-548-01	
FAN	
QD12X 30V, 150A 4.5KW EI-446-548-01	
FAN	
LAMBDA-EMI ESS BULK POWER SUPPLY 40V, 375A, 15KW EI-446-548-01	

RACK NO. 2

DCCT BLANK PANEL	
BLANK PANEL	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
FAN	
	SF6 30V, 50A 1.5KW EI-446-548-02
FAN	
QF9X 30V, 50A 1.5KW EI-446-548-02	QF9' 30V, 50A 1.5KW EI-446-548-02
FAN	
QF15X 30V, 150A 4.5KW EI-446-548-02	
FAN	
QD16X 30V, 150A 4.5KW EI-446-548-02	
FAN	
QF17X 30V, 150A 4.5KW EI-446-548-02	
FAN	
LAMBDA-EMI ESS BULK POWER SUPPLY 40V, 375A, 15KW EI-446-548-02	

RACK NO. 3

DCCT BLANK PANEL	
BLANK PANEL	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
FAN	
SF5 30V, 50A 1.5KW EI-446-548-04	QD6 30V, 50A 1.5KW EI-446-548-04
FAN	
QF7 30V, 50A 1.5KW EI-446-548-03	QD8 30V, 50A 1.5KW EI-446-548-03
FAN	
QD18X 30V, 150A 4.5KW EI-446-548-03	
FAN	
QF19X 30V, 150A 4.5KW EI-446-548-03	
FAN	
B5 30V, 200A 6KW EI-446-548-03	
FAN	
LAMBDA-EMI ESS BULK POWER SUPPLY 40V, 375A, 15KW EI-446-548-03	

RACK NO. 4

DCCT BLANK PANEL	
BLANK PANEL	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
FAN	
QD4X 30V, 50A 1.5KW EI-446-548-05	QD4' 30V, 50A 1.5KW EI-446-548-05
FAN	
QF5 30V, 50A 1.5KW EI-446-548-04	QF5' 30V, 50A 1.5KW EI-446-548-04
FAN	
QM14 30V, 150A 4.5 KW EI-446-548-04	
FAN	
QM15 30V, 150A 4.5KW EI-446-548-04	
FAN	
QM16 30V, 150A 4.5KW EI-446-548-04	
FAN	
LAMBDA-EMI ESS BULK POWER SUPPLY 40V, 375A, 15KW EI-446-548-04	

RACK NO. 5

DCCT BLANK PANEL	
BLANK PANEL	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
FAN	
QD2A 30V, 50A 1.5KW EI-446-548-06	QD2B 30V, 50A 1.5KW EI-446-548-06
FAN	
QF3 30V, 50A 1.5KW EI-446-548-05	SD4 30V, 50A 1.5KW EI-446-548-05
FAN	
QM11 30V, 150A 4.5 KW EI-446-548-05	
FAN	
QM12 30V, 150A 4.5KW EI-446-548-05	
FAN	
QM13 30V, 150A 4.5KW EI-446-548-05	
FAN	
LAMBDA-EMI ESS BULK POWER SUPPLY 40V, 375A, 15KW EI-446-548-05	

RACK NO. 6

DCCT BLANK PANEL	
BLANK PANEL	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
UNIPOLAR ENET PS CTRL 125-347	
FAN	
SD0 30V, 50A 1.5KW EI-446-548-06	SF1 30V, 50A 1.5KW EI-446-548-06
FAN	
QD0 30V, 150A 4.5KW EI-446-548-03	
FAN	
QF1 30V, 100A, 3KW EI-446-548-06	
FAN	
B1 30V, 200A 6KW EI-446-548-06	
FAN	
B2 30V, 200A 6KW EI-446-548-06	
FAN	
LAMBDA-EMI ESS BULK POWER SUPPLY 40V, 375A, 15KW EI-446-548-06	