Development of TQ models based on 3-layer Coils

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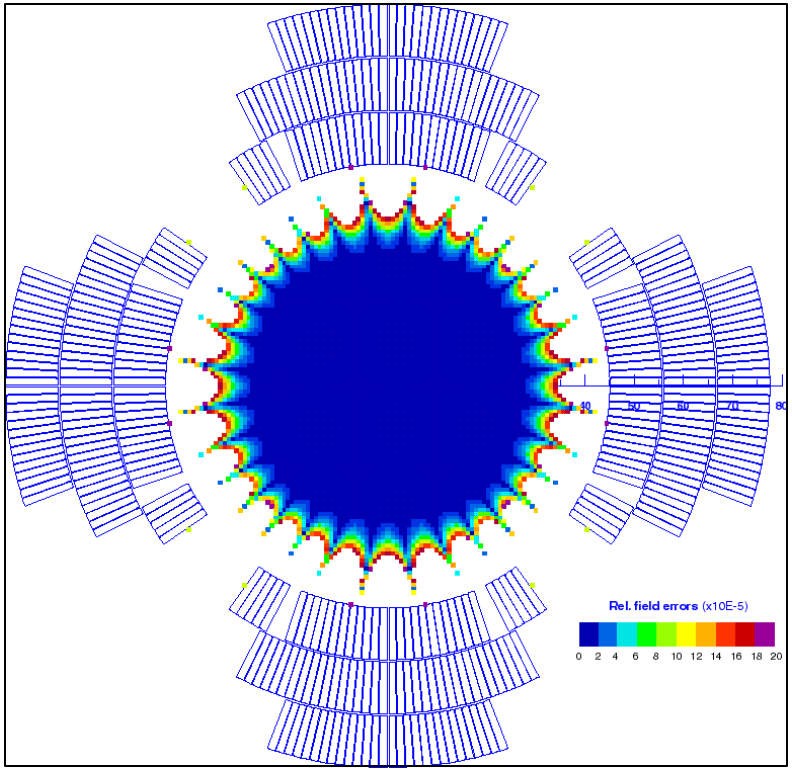
LARP Collaboration Meeting
April 6-8, 2005

TQ2b Objectives

- Increase G_{max} to ~260-280 T/m
- Develop and evaluate innovative 3-layer shell-type coil design without internal splice and coil fabrication technology
- Study collar-yoke-skin mechanical structure and magnet quench performance in the field range up to 13-14 T

TQ2b coil design



Coil:

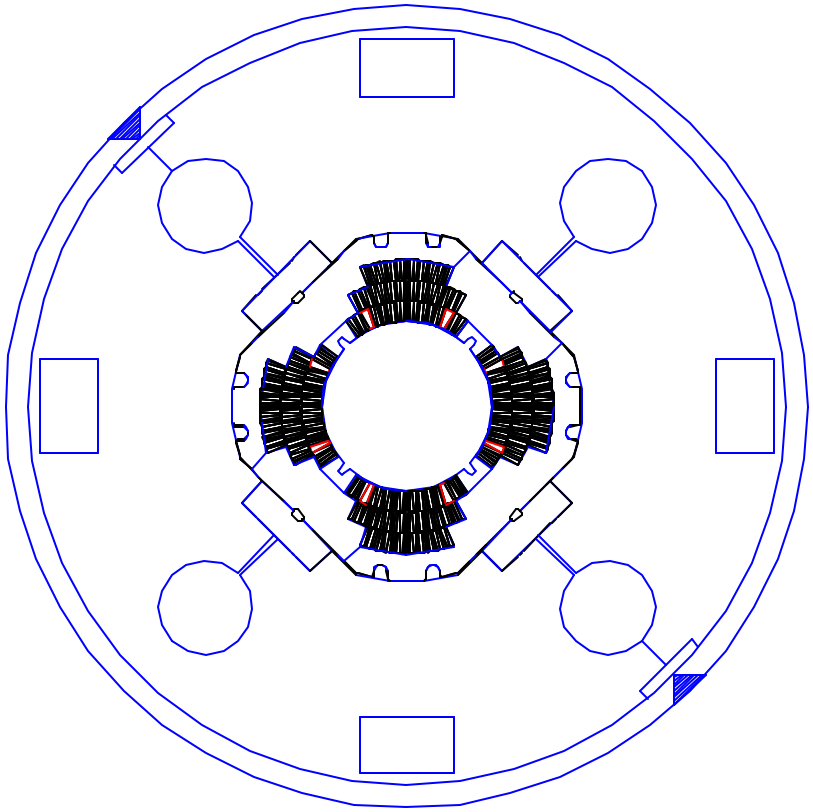
- 3-layer shell-type coils made of single cable piece without internal splices
- Inner-layer wedges/no wedges
- Inner-layer pole glued into the coil

Cable:

- Strand – Nb3Sn, RRP, 0.7 mm
- Number of strands – 27
- Keystone angle – 1 deg/1.3 deg
- Width – 10.05 mm
- Thickness – 1.26 mm

Insulation: 0.125 mm S2-glass sleeve

TQ2b mechanical structure



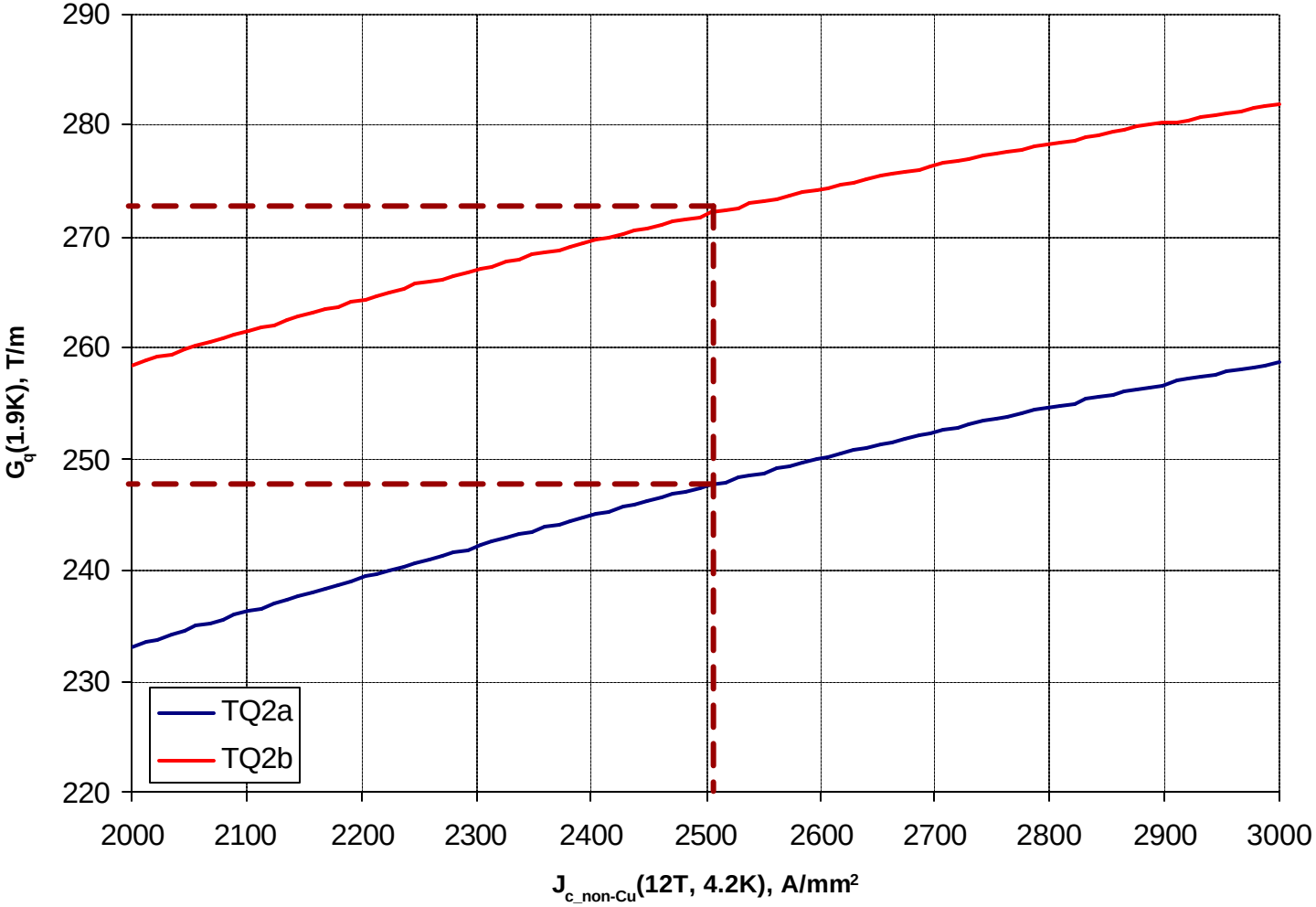
TQ2b cross-section

- Thin SS collar - modified MQXB collar
- Mechanical structure similar to TQ2a, using modified MQXB collar blocks with outer-layer poles for coil alignment. Inner-layer poles are glued into the coil.
- Radial yoke cut per lamination to provide symmetrical load.
- Control spacers for collared coil alignment and yoke motion control.
- Four shims in the midplanes to control coil-yoke interference.
- The 10 mm thick stainless steel skin.
- Mechanical structure and coil pre-stress will be studied and optimized using short (~30 cm) mechanical model.

TQ2b parameters

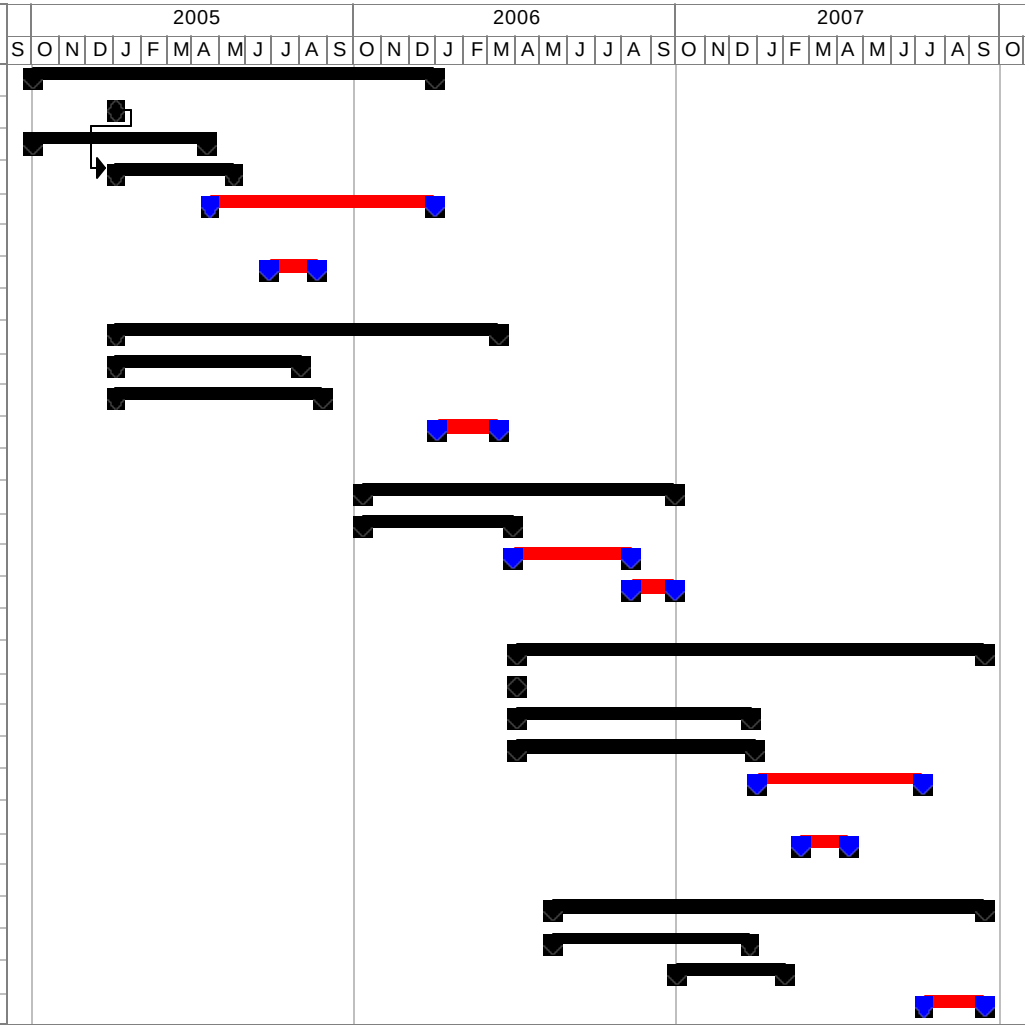
Parameter	Unit	TQ2a	TQ2b
N of layers	-	**2**	**3**
N of turns	-	**136**	**208**
Coil area (Cu + nonCu)	cm^2	**29.33**	**44.86**
Assumed non-Cu J_c at 12 T, 4.2 K	A/mm^2	**2000**	**2000**
Quench gradient at 1.9 K	T/m	**233.1**	**258.5**
Quench current at 1.9 K	kA	**14.07**	**11.7**
Peak field in the coil at 1.9 K	T	**12.1**	**13.0**

Gradient vs. J_c



TQ2a/b Schedule FY2005-2007

ID	Task Name	Start	Finish
1	**Shared TQ1a/2a Tasks**	**Fri 10/1/04**	**Fri 12/30/05**
2	Establish Cross Section	Mon 1/3/05	Mon 1/3/05
3	**TQ1a/2a Coil Tooling**	**Fri 10/1/04**	**Fri 4/15/05**
6	**TQ1a/2a Coil Parts**	**Mon 1/3/05**	**Mon 5/16/05**
9	**TQ1a/2a coil fabrication**	**Wed 4/20/05**	**Fri 12/30/05**
16			
17	**TQ Mech Model Assy**	**Mon 6/27/05**	**Fri 8/19/05**
20			
21	**TQ2a Magnet Assembly**	**Mon 1/3/05**	**Mon 3/13/06**
22	**TQ2a Magnet Assy Tooling**	**Mon 1/3/05**	**Tue 8/2/05**
25	**TQ2a Magnet Assy Parts**	**Mon 1/3/05**	**Fri 8/26/05**
28	**TQ2a Magnet Assy Fabrication**	**Tue 1/3/06**	**Mon 3/13/06**
34			
35	**TQ2a'**	**Mon 10/10/05**	**Thu 9/28/06**
36	**TQ2a' coil parts**	**Mon 10/10/05**	**Wed 3/29/06**
38	**TQ2a' coil fabrication**	**Thu 3/30/06**	**Wed 8/9/06**
41	**Assembly**	**Thu 8/10/06**	**Thu 9/28/06**
47			
48	**TQ2b**	**Mon 4/3/06**	**Fri 9/14/07**
49	Establish Cross Section	Mon 4/3/06	Mon 4/3/06
50	**TQ2b Coil Tooling**	**Mon 4/3/06**	**Mon 12/25/06**
53	**TQ2b Coil Parts**	**Mon 4/3/06**	**Fri 12/29/06**
56	**TQ2b coil fabrication**	**Mon 1/1/07**	**Fri 7/6/07**
61			
62	**TQ2b Mech Model Assy**	**Mon 2/19/07**	**Fri 4/13/07**
65			
66	**TQ2b Magnet Assembly**	**Mon 5/15/06**	**Fri 9/14/07**
67	**TQ2b Magnet Assy Tooling**	**Mon 5/15/06**	**Fri 12/22/06**
70	**TQ2b Magnet Assy Parts**	**Mon 10/2/06**	**Fri 2/2/07**
73	**TQ2b Magnet Assy Fabricatio**	**Mon 7/9/07**	**Fri 9/14/07**



TQ2b milestones

FY06		
- Start design of coil and tooling:	FNAL	4/1/2006
FY07		
- Finish design of coil and tooling	FNAL	6/15/2006
- Procure coil fabrication tooling/parts:	FNAL	01/01/2007
- Procure cold mass parts:	FNAL	02/01/2007
- Fabricate insulated cable:	LBNL	01/01/2007
- Fabricate practice coil:	FNAL	02/15/2007
- Assemble and test mechanical model:	FNAL	04/01/2007
- Wind and cure coils:	FNAL	05/15/2007
- React and impregnate coils:	FNAL	07/01/2007
- Assemble magnet:	FNAL	09/15/2007
FY08		
- Test magnet:	BNL+FNAL	11/01/2007

Cost of TQ2a/b FY2005-FY2007

	FY04	FY05	FY06	FY07
TQ1a/2a				
TQ1a/2a coils				
Analysis		$18,000		
Tooling	$62,199	$101,049		
Parts		$138,528		
Fabrication		$214,800		
TQ2a Magnet				
Analysis		$39,363		
Tooling				
Parts		$24,639	$102,882	
Fabrication		$83,238	$240,900	
TQ2a'				
TQ2a' coils				
Tooling				
Parts		$14,717	$23,400	
Fabrication			$58,200	
TQ2a Magnet				
Tooling				
Parts			$51,057	
Fabrication			$98,100	$10,800
TQ2b				
TQ2b coils				
Analysis		$18,000		
Tooling			$84,600	$28,749
Parts			$45,300	$89,739
Fabrication				$154,800
TQ2b Magnet				
Analysis		$23,618	$15,745	
Tooling				
Parts				$110,502
Fabrication				$299,400
FNAL Totals	**$62,199**	**$675,952**	**$720,184**	**$693,990**
Base Program Contribution		$289,952		

Total by Magnet

TQ2a'	$256,274
TQ2b	$870,453

Strand, cable and test are not included.