

Status of Detector Solenoid and Anti-DID

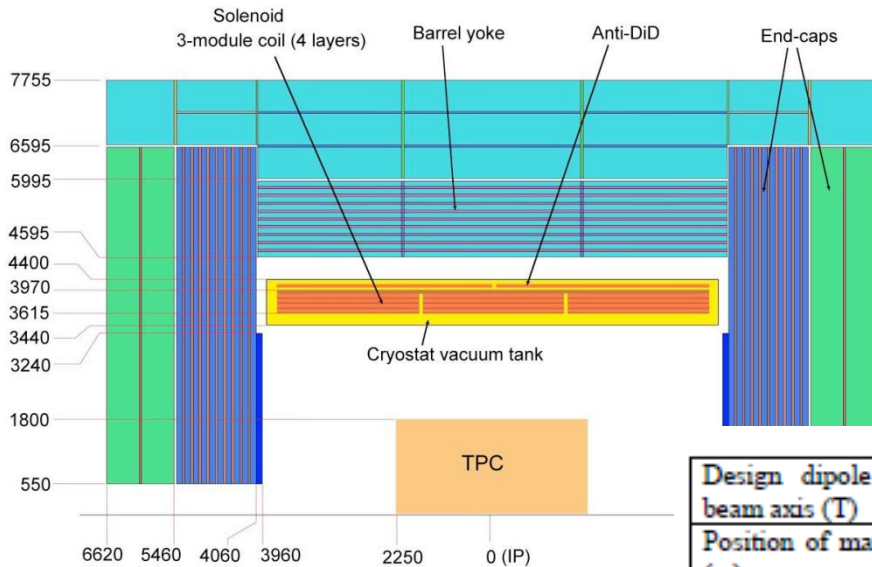
2017/9/28

Yasuhiro Makida, Takahiro Okamura

- Design study about ILD solenoid including Anti-DID has been carried out with the cooperation of Hitach and Toshiba.
- **Recently, Anti-DID design and stress analysis is in progress.**
- Hitach is analyzing stresses in the Anti-DID, which has same dimensions and parameters described in TDR.
- Toshiba is analyzing stessed in the Anti-DID, which has smaller and simpler dimensions, because of realistic transportation.

Hitachi Study

- Same dimension in TDR

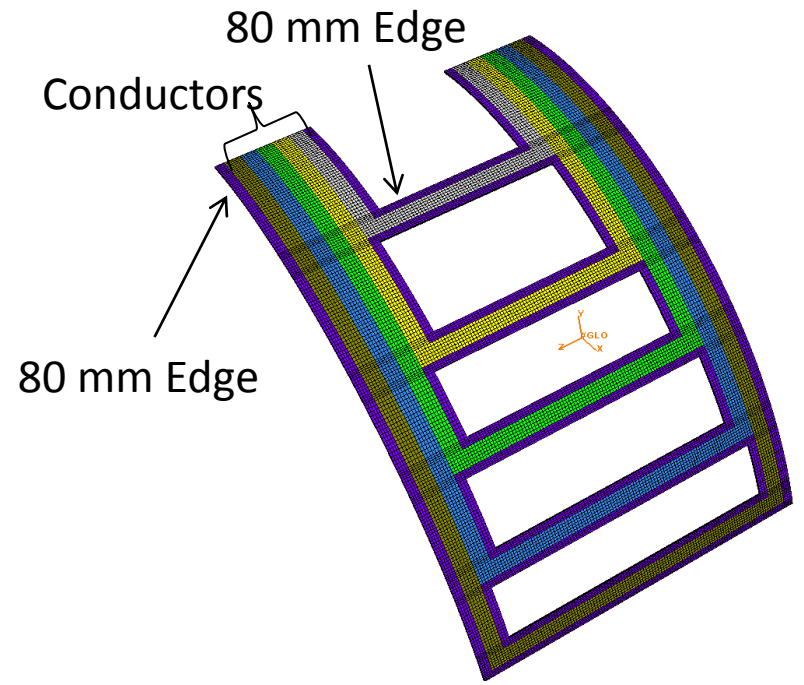
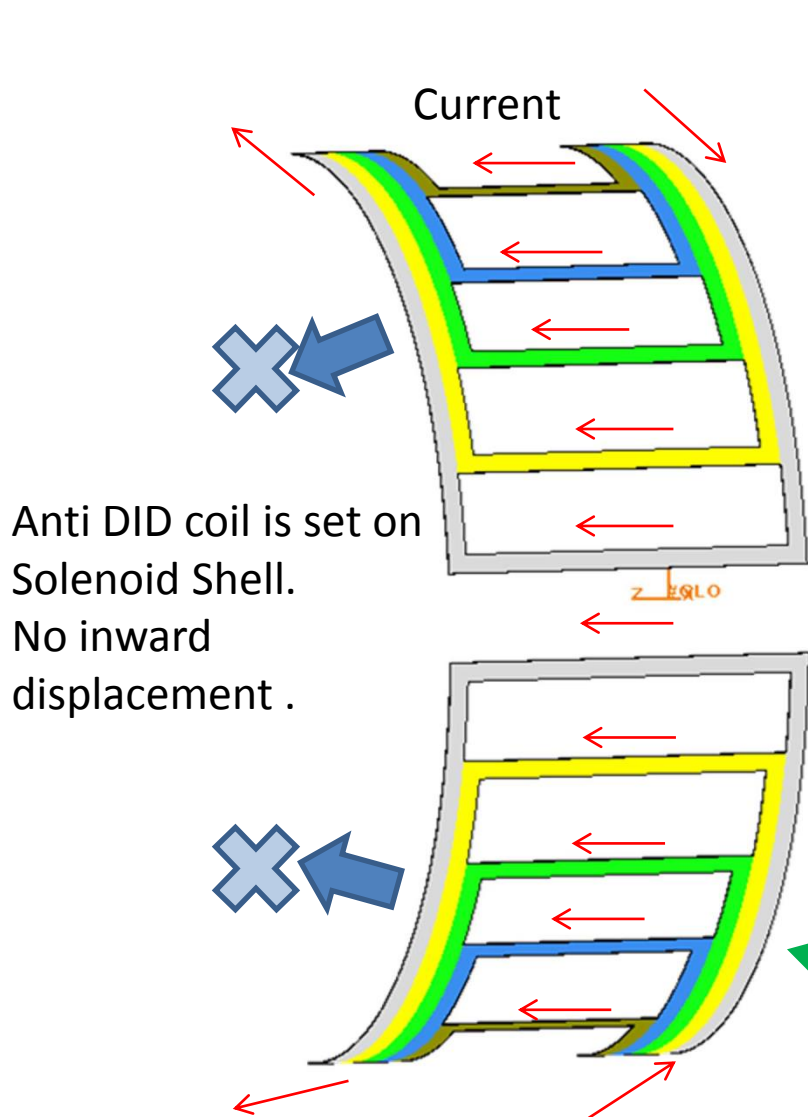


Turn #	412 turn/coil X 3 coil = 1236 turn
Solenoid Current	22.4 kA
B-H curve	From TDR
Iron dimension	From 3D CAD data

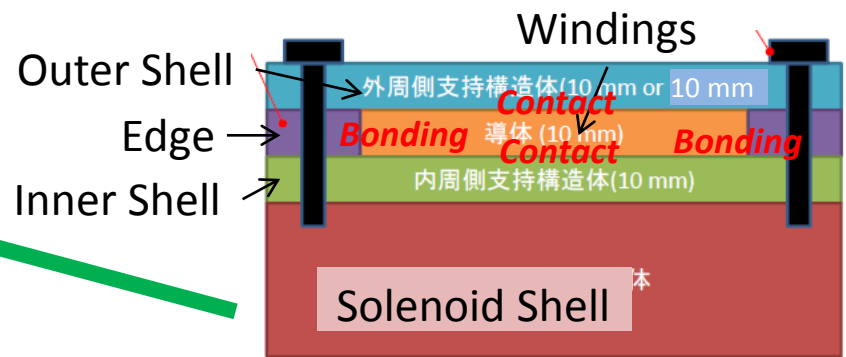
Tab 4: ILD anti-DiD main parameters (version 1)

Design dipole central field on beam axis (T)	0.035	Nominal current (A)	615
Position of max dipole field in z (m)	3	Overall current density (A/mm ²)	40
Maximum field on conductor (T)	2.0	Total ampere-turns anti-DiD (kA.t)	656 x 2
Anti DiD inner radius (mm)	4190	Stored energy (MJ)	4.4
Anti DiD total length in Z (mm)	6820	Total inductance (H)	23

Design Study by Hitach Anti-DID Stress Ana.



Coil windings with edge structure



Cross Section of Anti DID structure

Displacement



最大変位

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USUM
RSYS=0
DMX =.592189
SEPC=15.8464
SMX =.592189

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Max 0.5921 mm

Stress



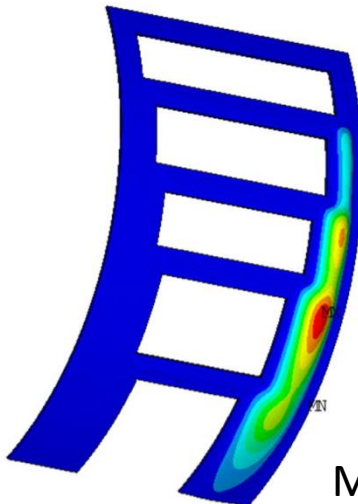
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29.7256
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44.5807
52.0082
59.4357
66.8632

Max 66.9 MPa

MPa

Solenoid End Solenoid Center

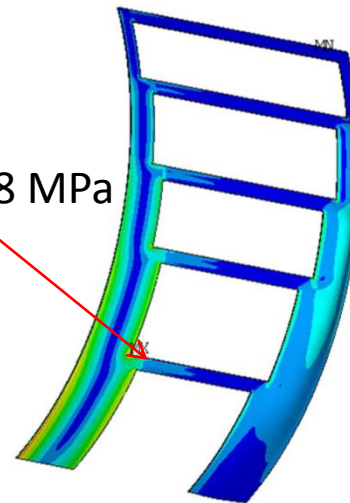


Max 0.5408 mm

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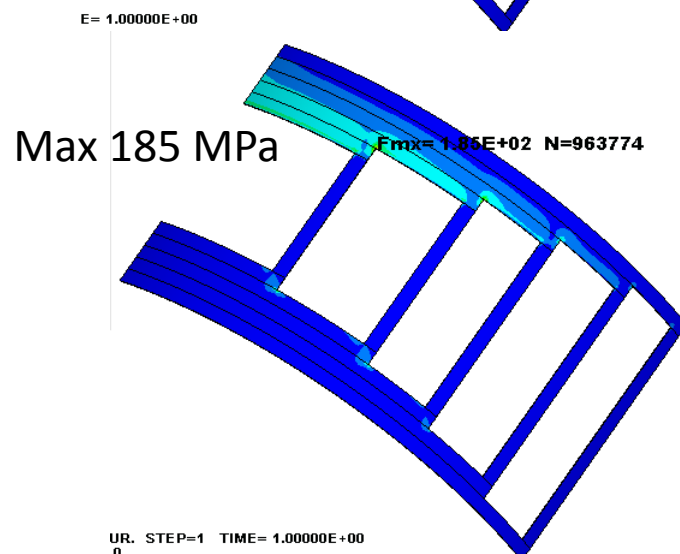
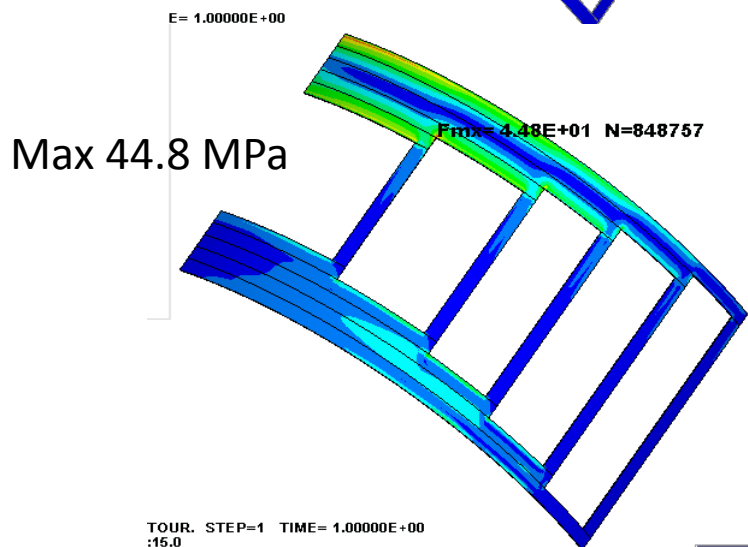
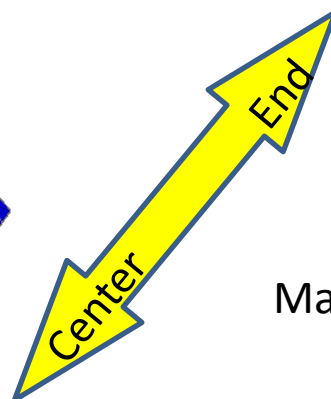
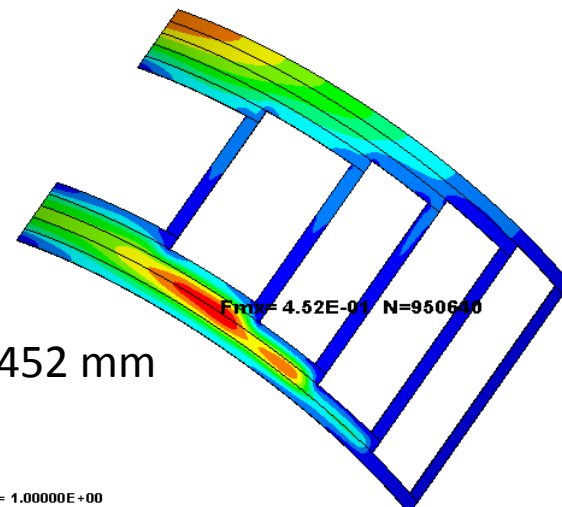
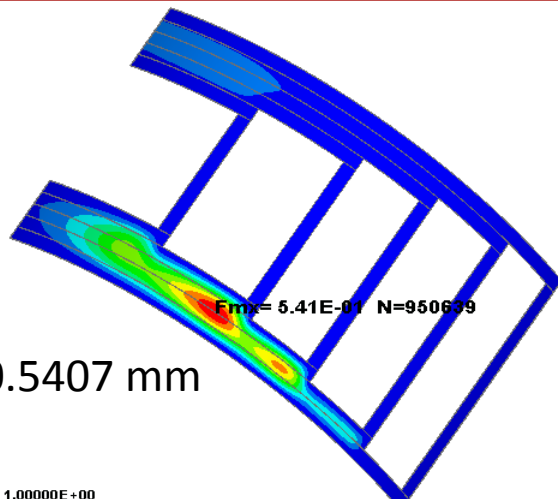
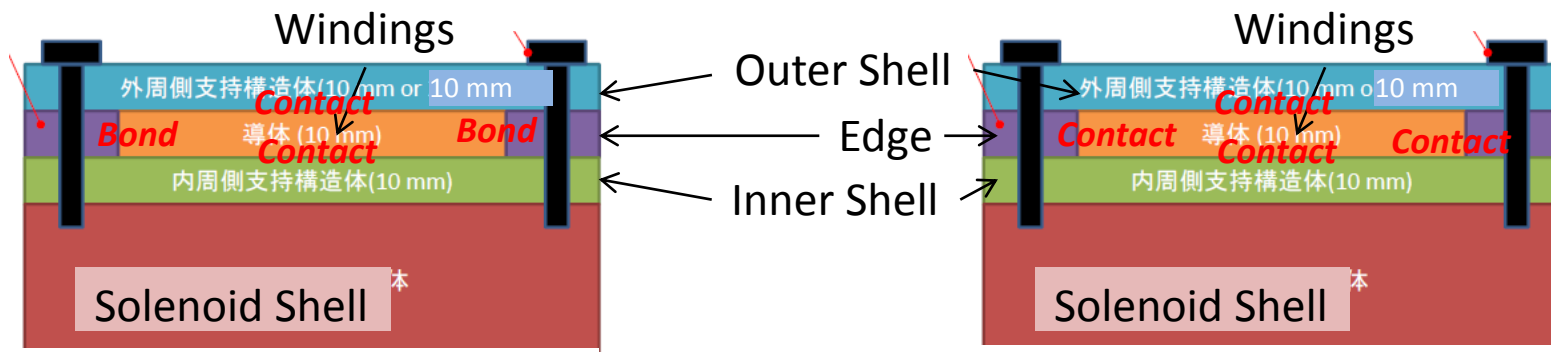
Max 44.8 MPa



MPa

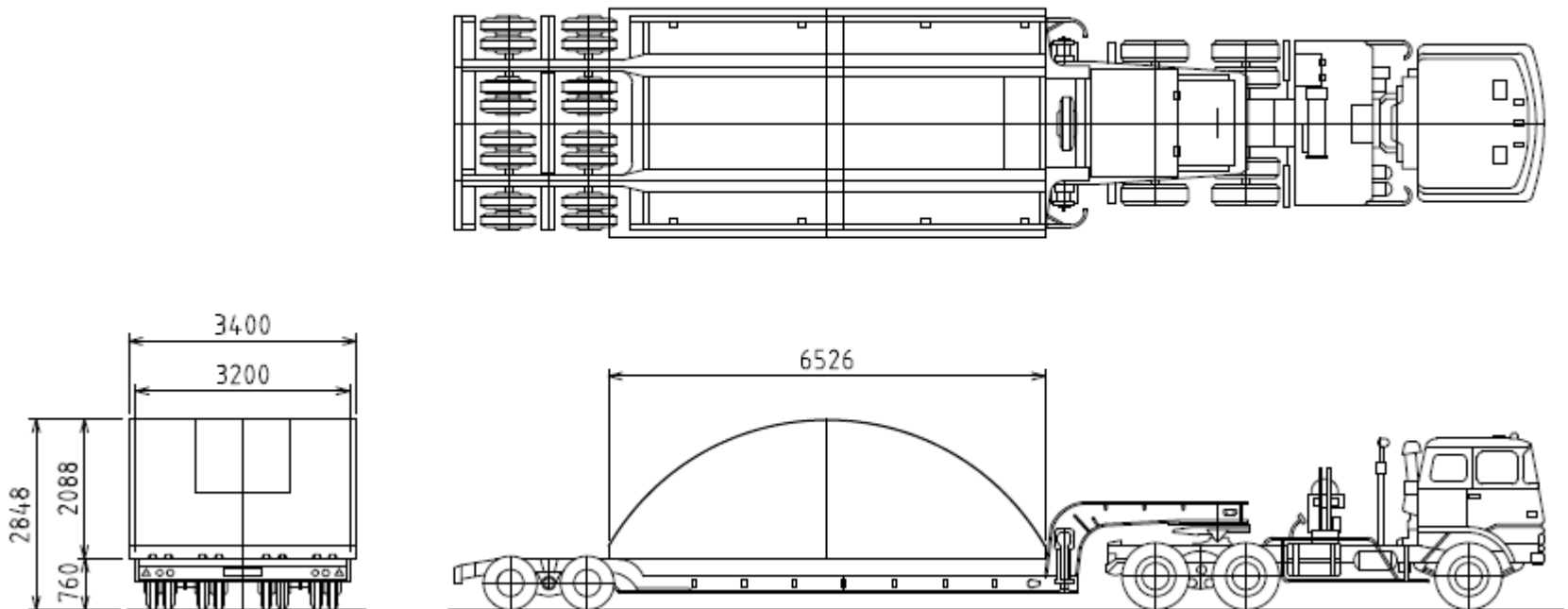
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SMN =.023949
SMX =44.7684
SMXB=55.4136

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29.8536
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39.7968
44.7684



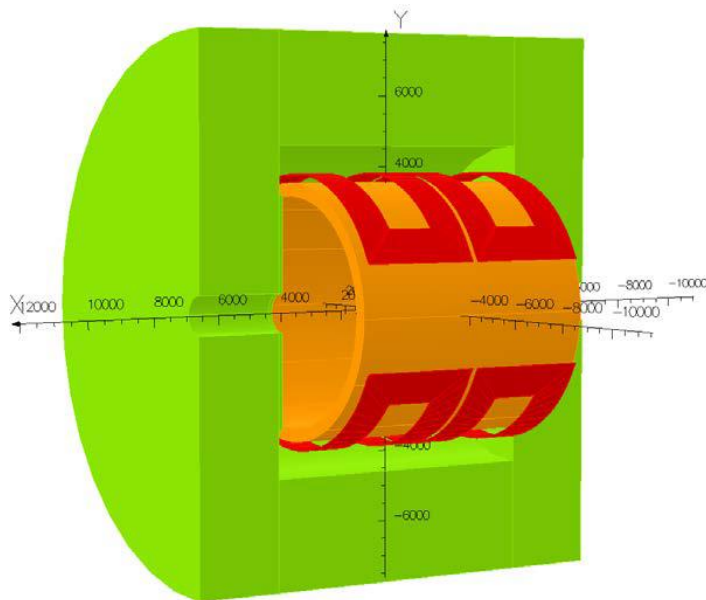
TOSHIBA Study

- TOSHIBA is considering smaller and simpler anti-DID, which meet the field requirement.
- Anti-DID coils are wound in a factory and are set on solenoid in an assembly build on-site.

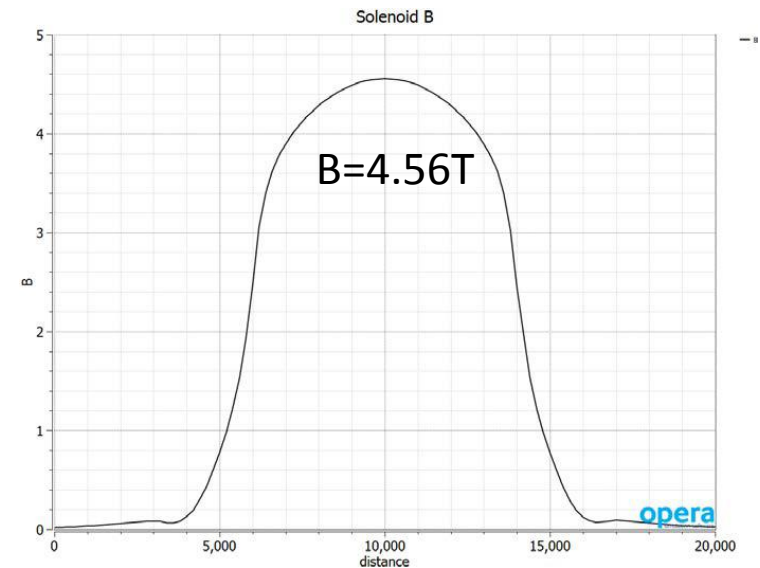


Design Study by Toshiba Solenoid Field

I.R. (mm)	29.7	3215	Axial turn #	40
O. R. (mm)		3570	Radial turn #	11
L (mm)		7350	Total turn #	440
Conductor axial W (mm)		61.3	Current (kA)	22.5
Conductor radial W (mm)		32.3	Current Density (A/mm ²)	11.4
			Ampere Turn (MA _t)	29.7

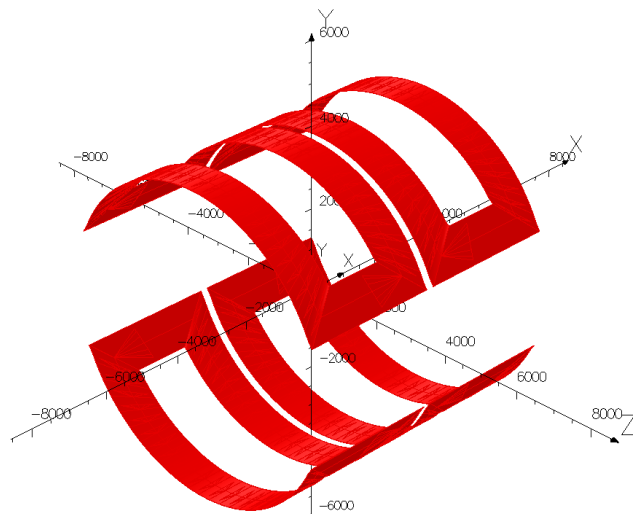


Stored Energy 2.16GJ

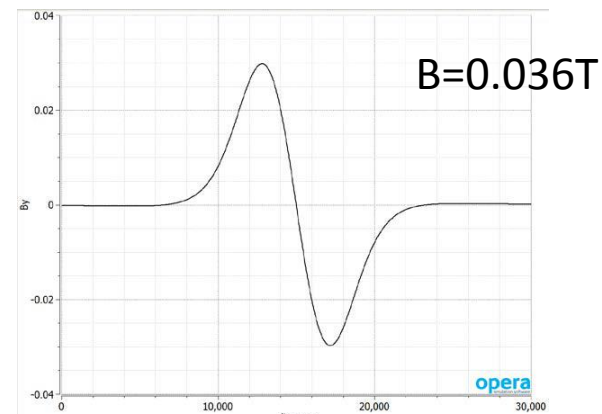


Design Study by Toshiba **Anti-DID**

I.R. @ Curve (mm)	3760	Straight region elevation angle (degree)	30
O. R. @ Curve(mm)	3768	Radial turn #	150
L @ straight (mm)	1200	Thickness turn #	2
Winding W (mm)	1000	Total turn #	300
Winding Thickness (mm)	8	Current (A)	1067
Conductor Width (mm)	6.67	Current Density (A/mm ²)	40
Conductor Thickness (mm)	4	Ampere Turn (MA _t)	0.32

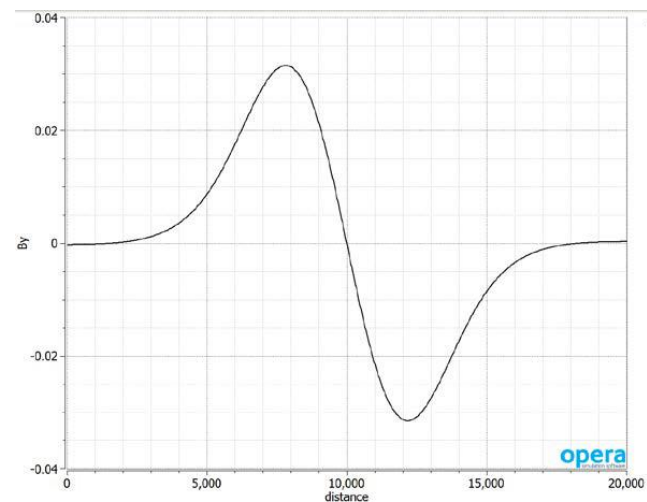
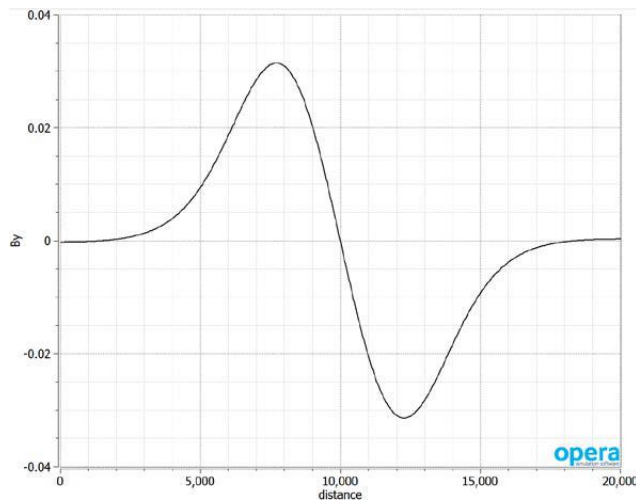
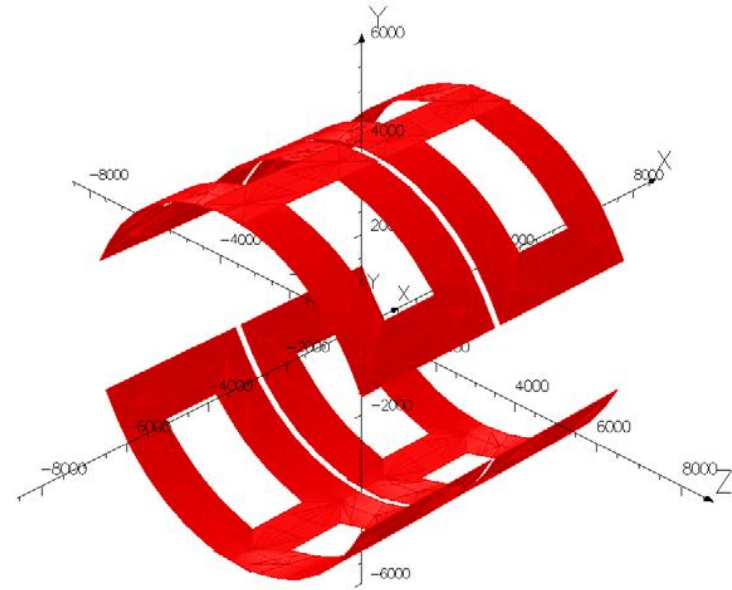
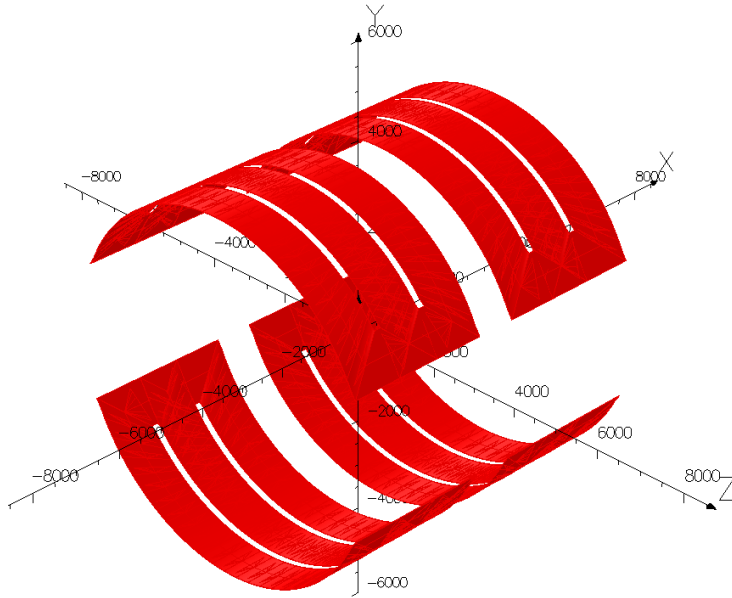


Stored Energy 0.179GJ



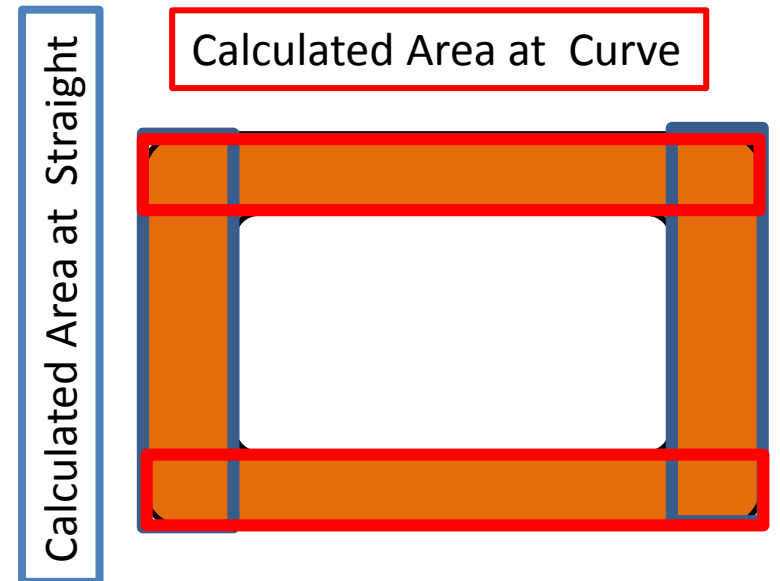
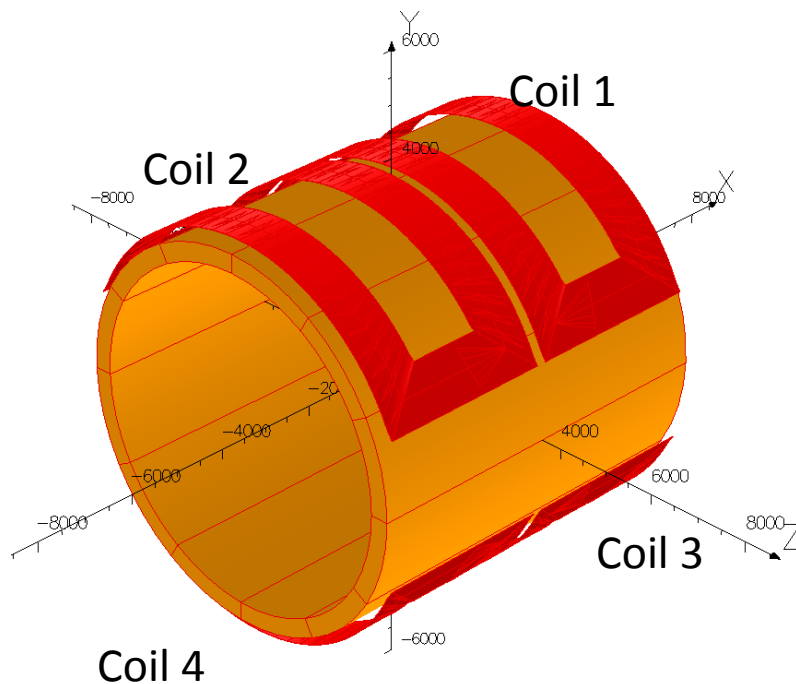
Design Study by Toshiba

Anti-DID alternative configuration



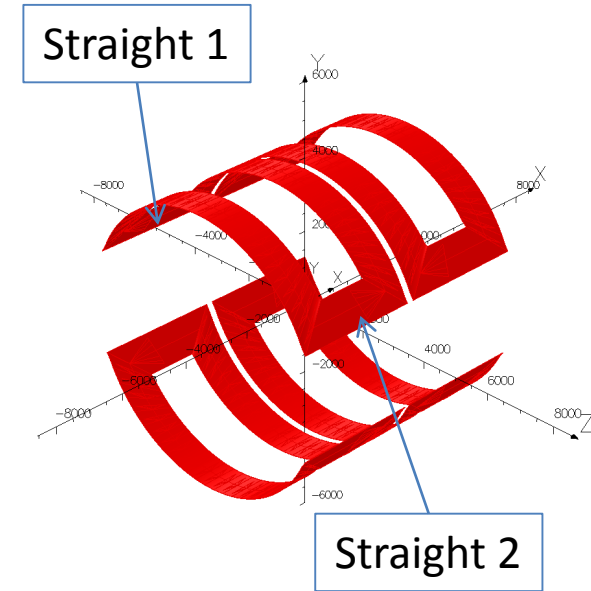
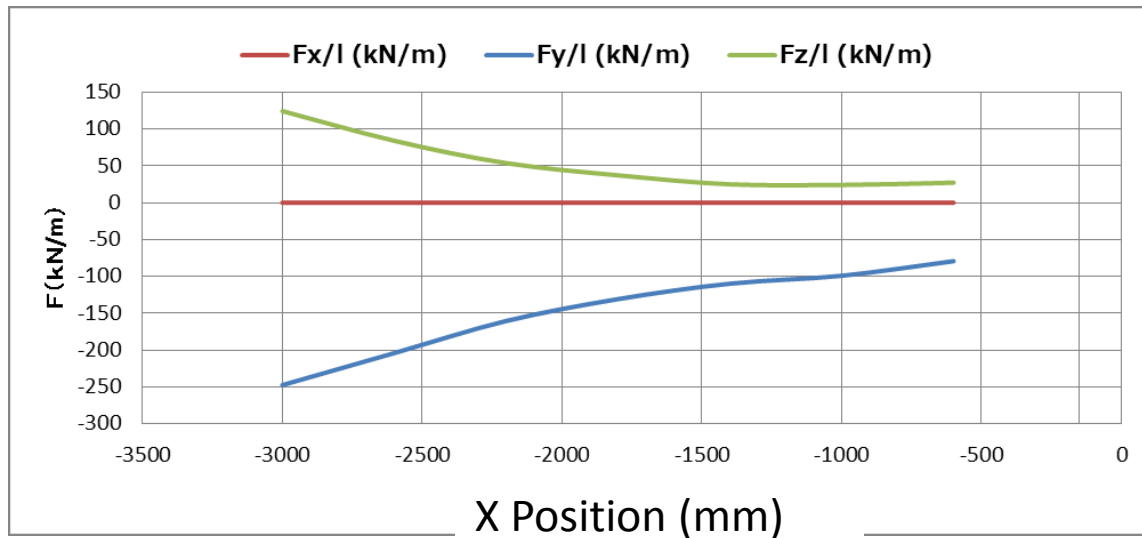
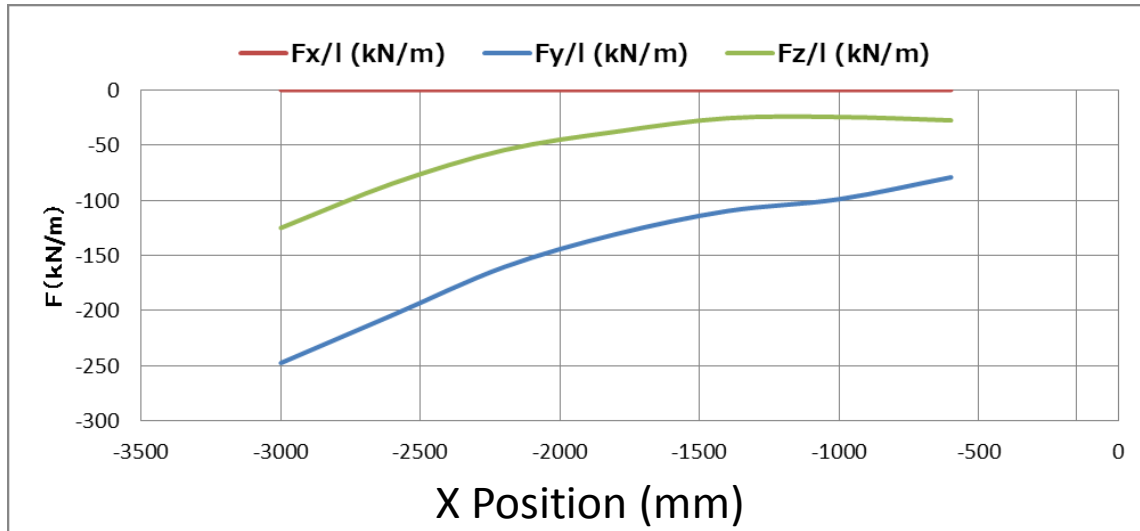
EMF in Anti-DID with Yoke and Solenoid

	Fx (MN)		Fy(MN)		Fz(MN)	
	Opera	EXCEL	Opera	EXCEL	Opera	EXCEL
Coil 1	1.59	1.15	-0.33	-0.44	0.00	0.00
Coil 2	-1.59	-1.17	-0.33	-0.44	0.00	0.00
Coil 3	-1.76	-1.27	-0.56	-0.43	0.00	0.00
Coil 4	1.76	1.28	-0.56	-0.43	0.00	0.00

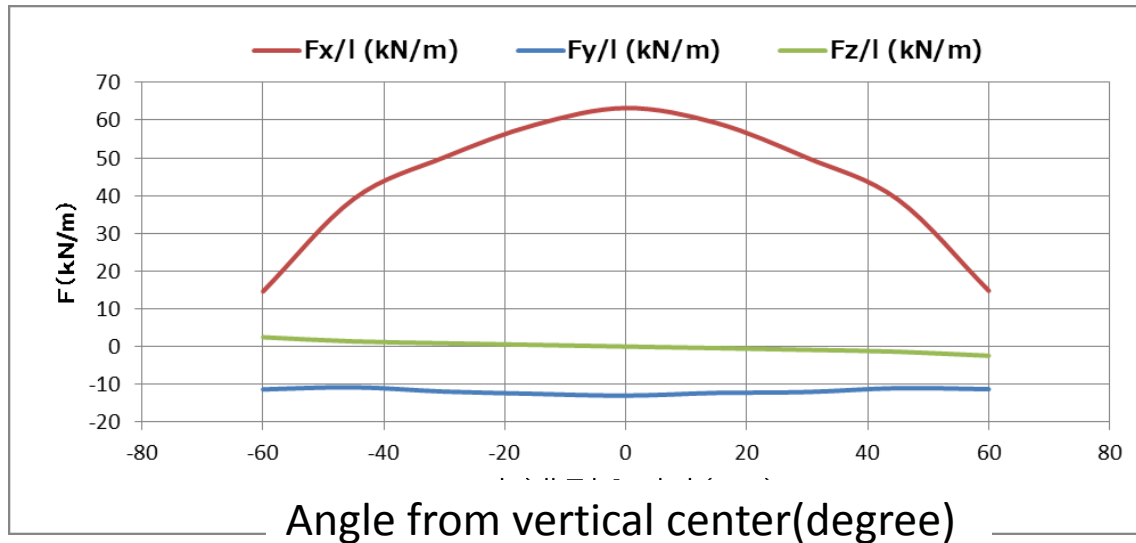
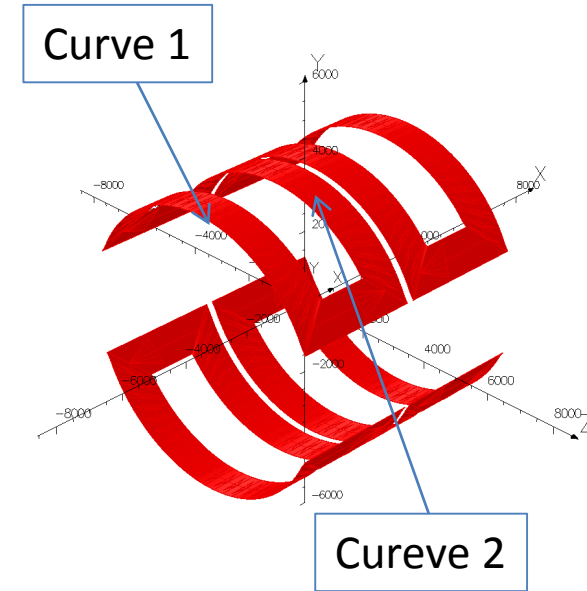
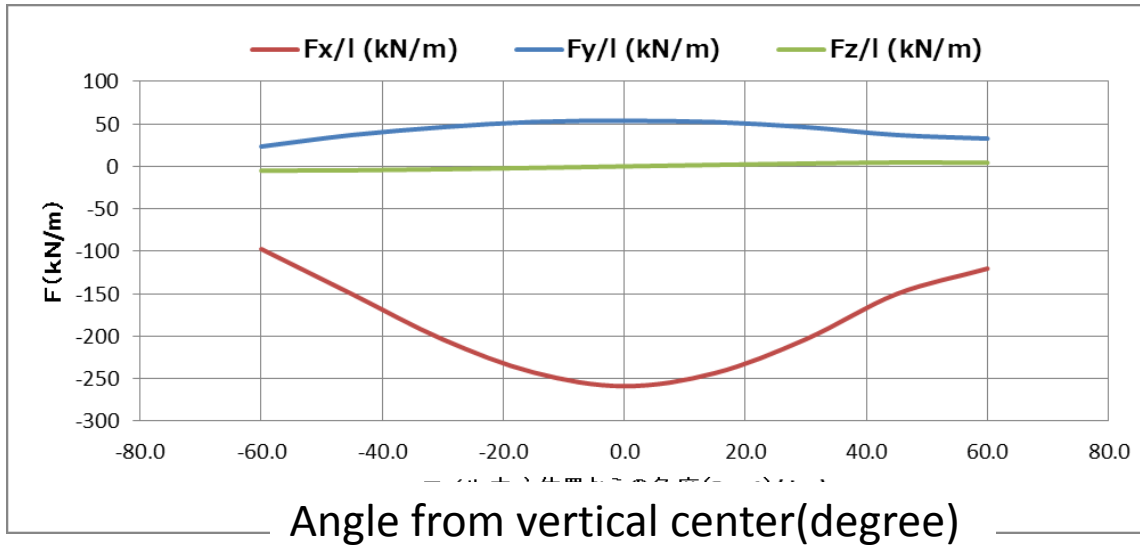


B field by Opera → EMF by Excel

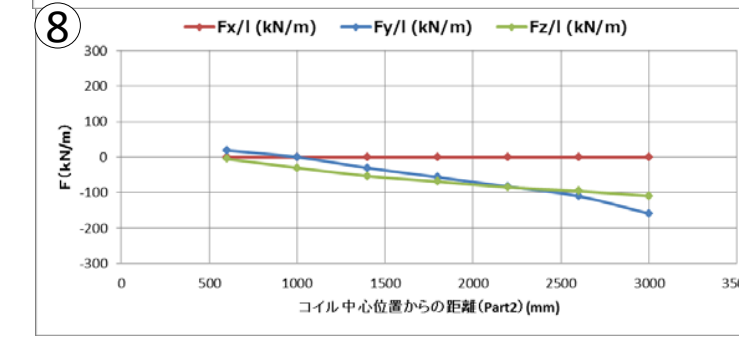
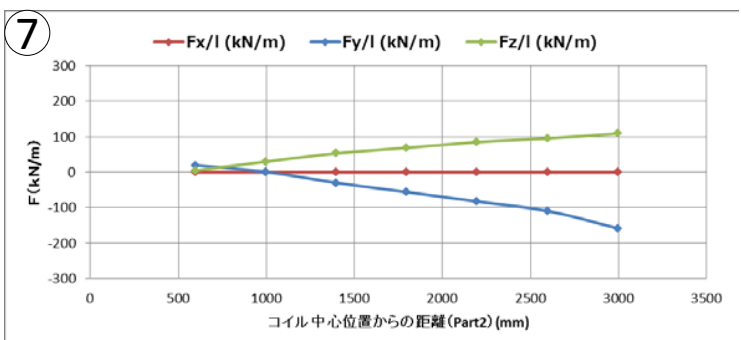
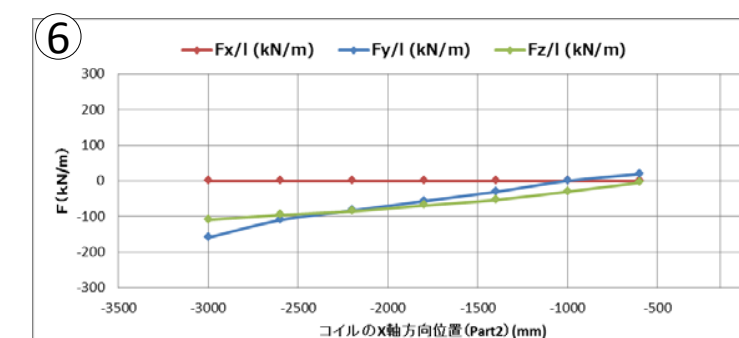
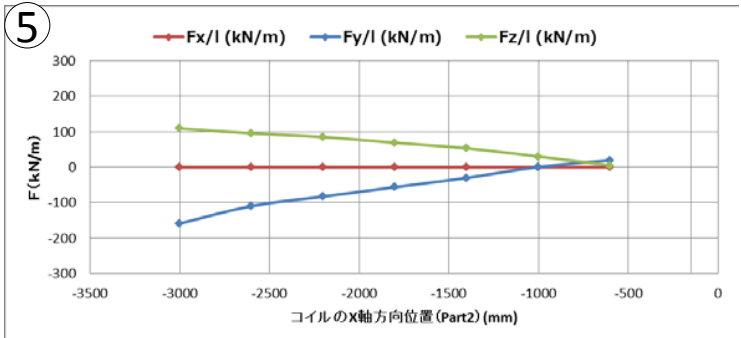
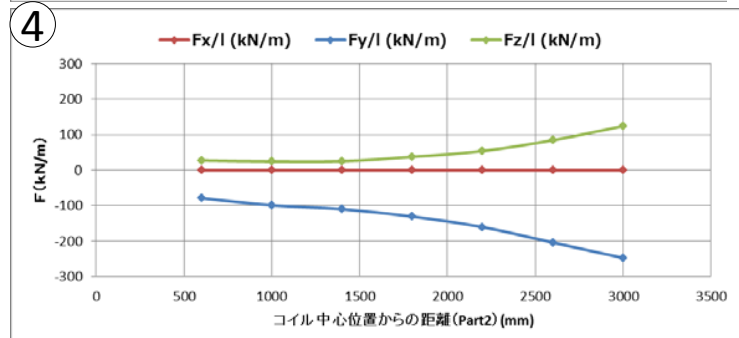
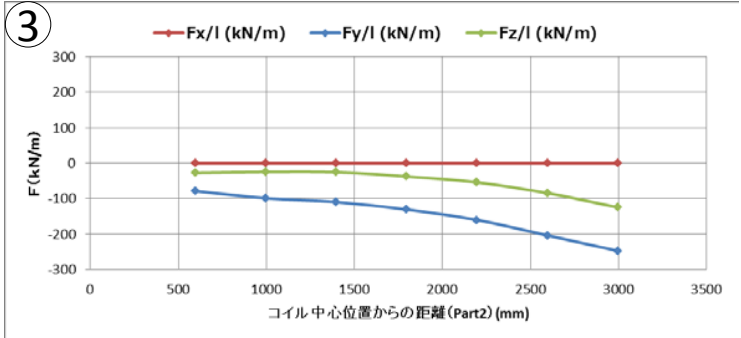
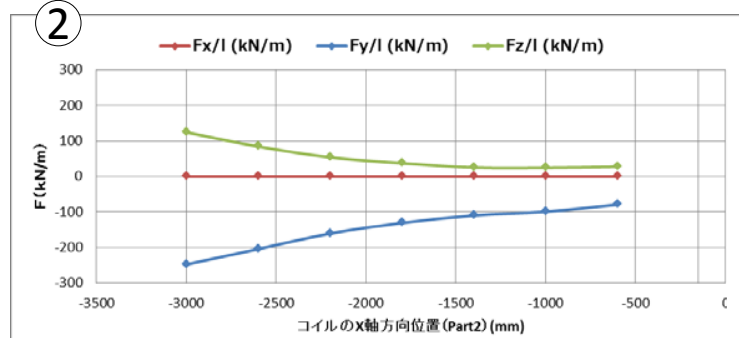
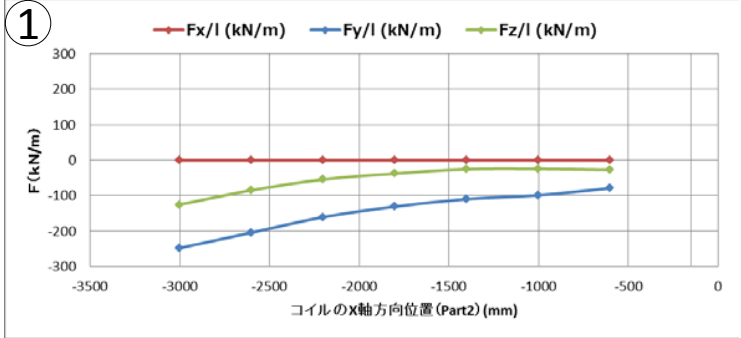
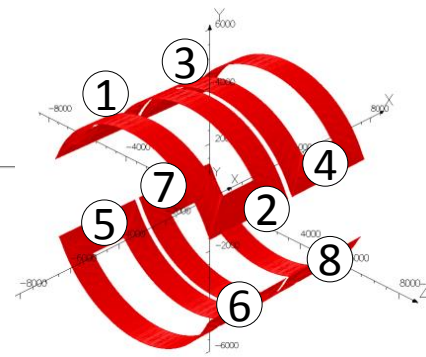
Design Study by Toshiba **Anti-DID EMF**



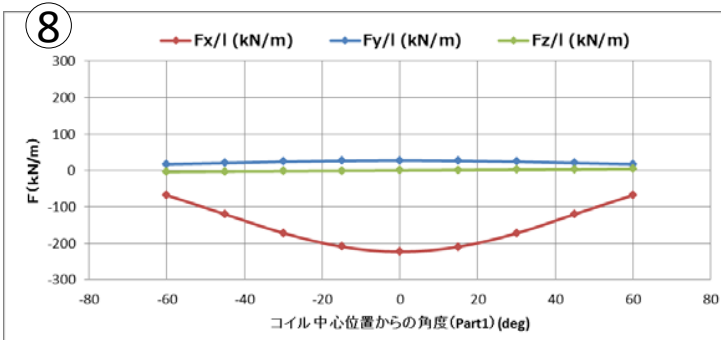
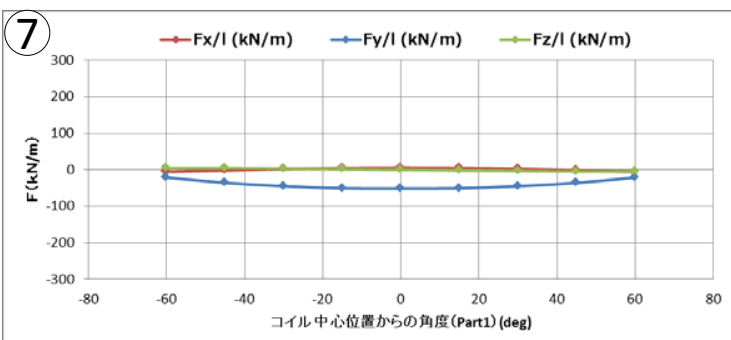
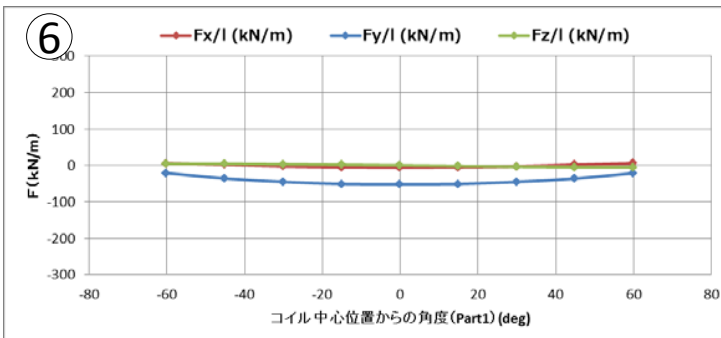
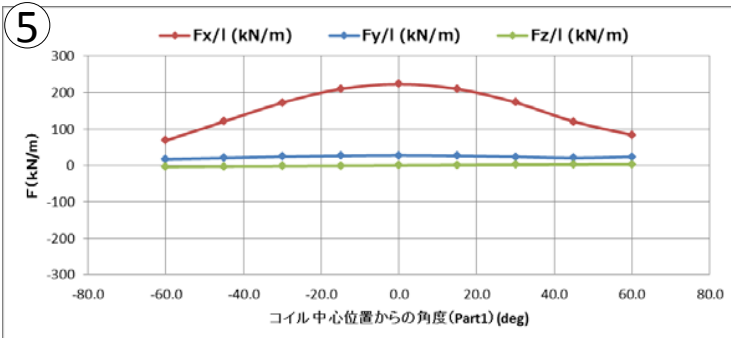
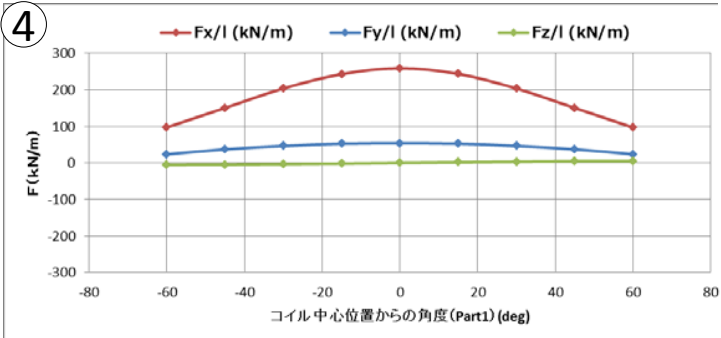
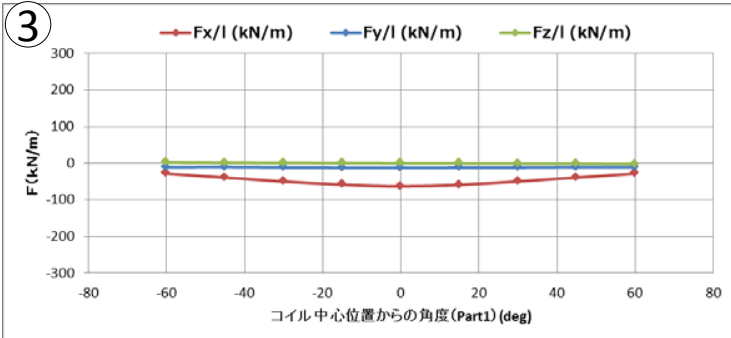
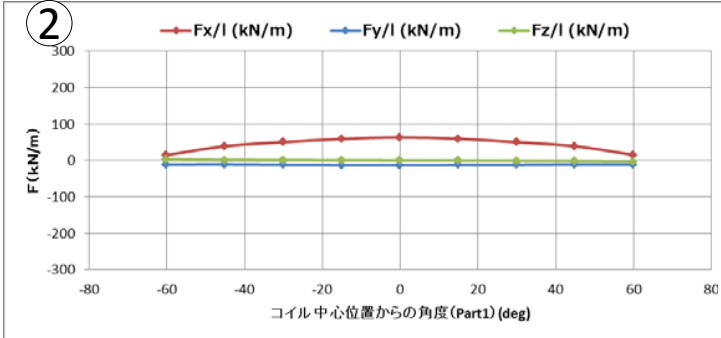
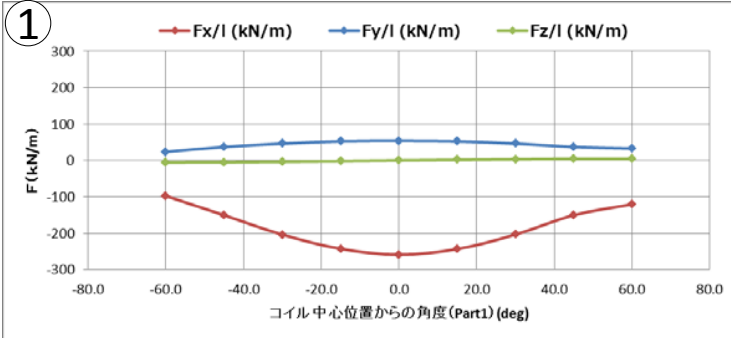
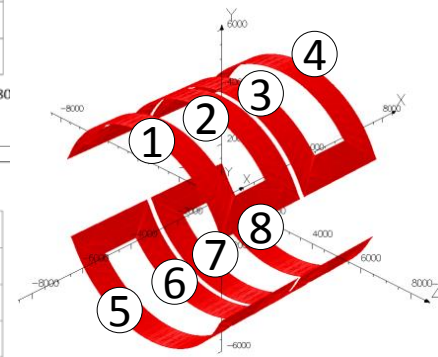
Design Study by Toshiba **Anti-DID EMF**



EMF @ straight



EMF @ curve



Design Study by Toshiba **Anti-DID Support**

Anti DID coils are supported by frame wall raising from outer support shell of the main solenoid.

