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ORNL PUP-II STS Pulsed Dipole

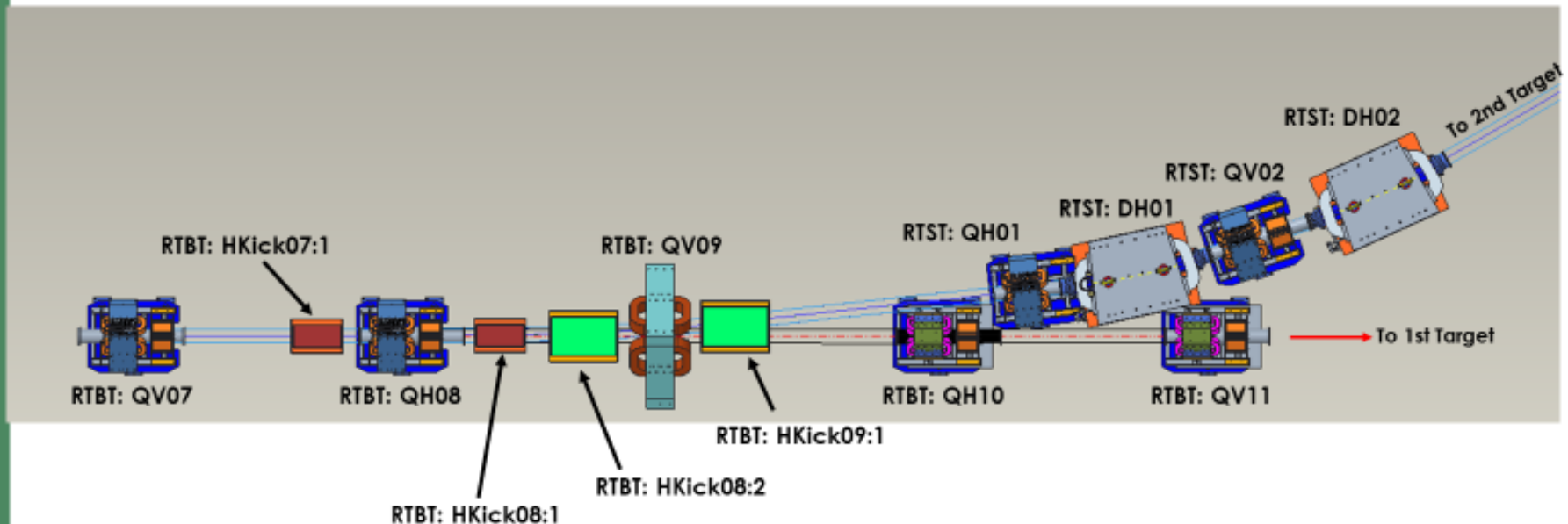
Vladimir Kashikhin

PDR Review

March 6, 2023

Magnets Layout

RTST Extraction Region Design Concept



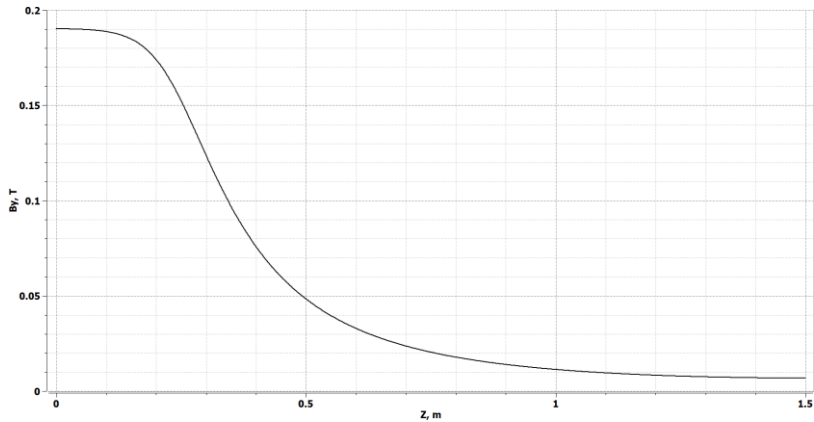
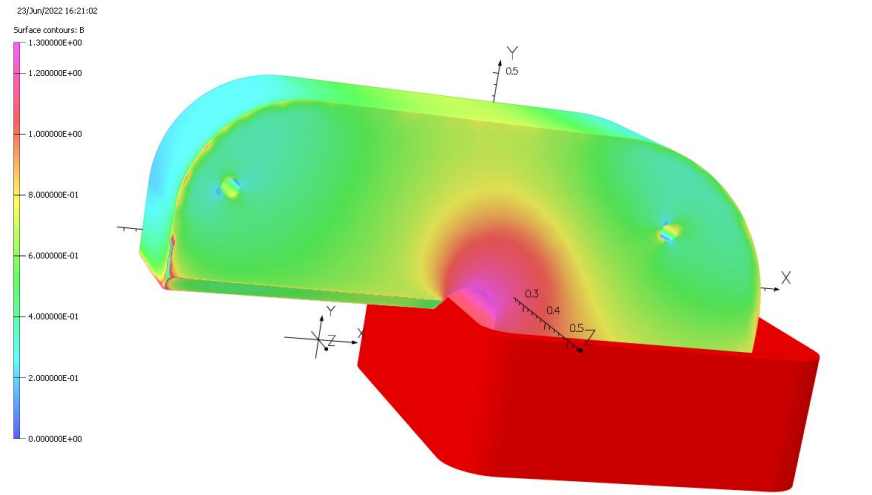
- RTBT transports proton beam to first target
- RTBT optics to remain unchanged
- RTST proton beam to intersect truck entrance wall at prescribed position and angle

Pulsed magnets : K07:1, K08:1, K08:2, K09:1.

Pulsed Magnet Specification

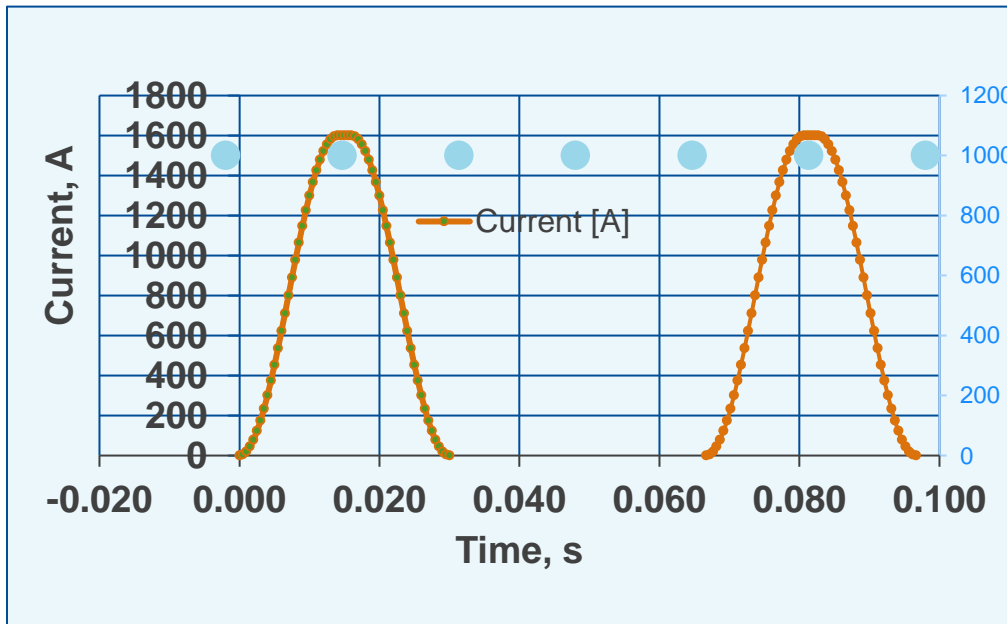
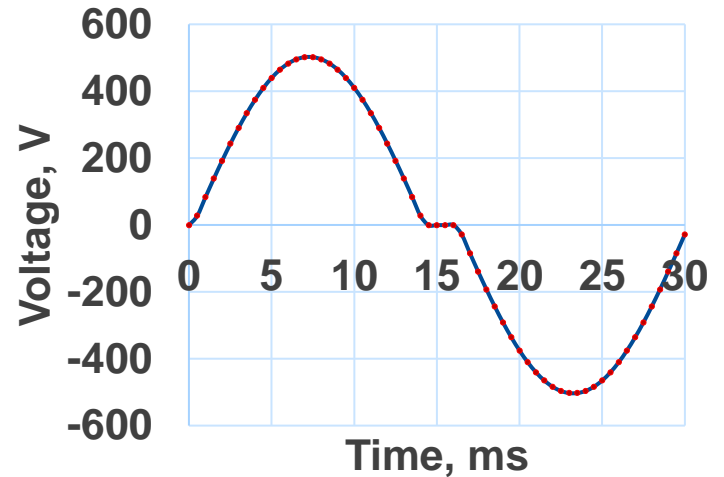
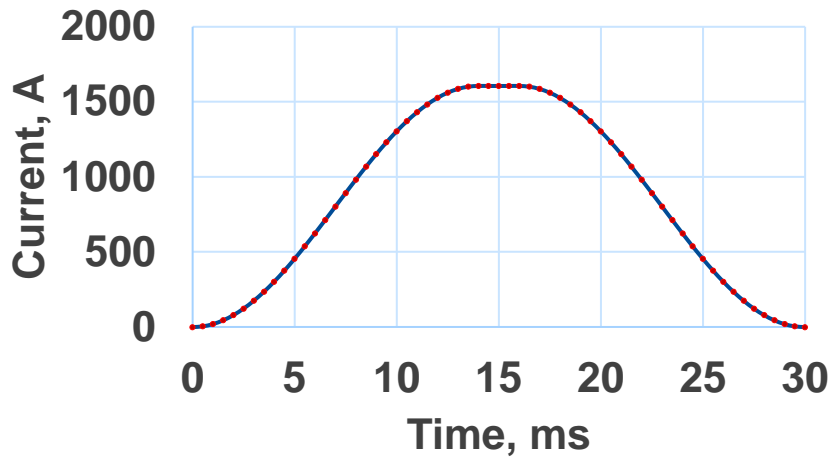
Parameter	Unit	Spec
Vertical aperture no less than	m	0.2473
Horizontal aperture no less than	m	0.35
Center field	T	0.189
Effective length	m	0.88
Integrated field	T-m	0.1662
Remnant field in the gap less than	Gauss	5.0
Peak current less than	A	1750
Pulses repetition rate 15 Hz with the period	ms	66.66
Inductance less than	mH	3.5
Resistance less than	m Ω	7.0
Good field area width/height	mm	$\pm 45 / \pm 57$
Integrated field homogeneity	%	± 0.1
Magnet maximum dimensions (width x height x length)	m	1.2 x 1.0 x 0.7

Field Simulation



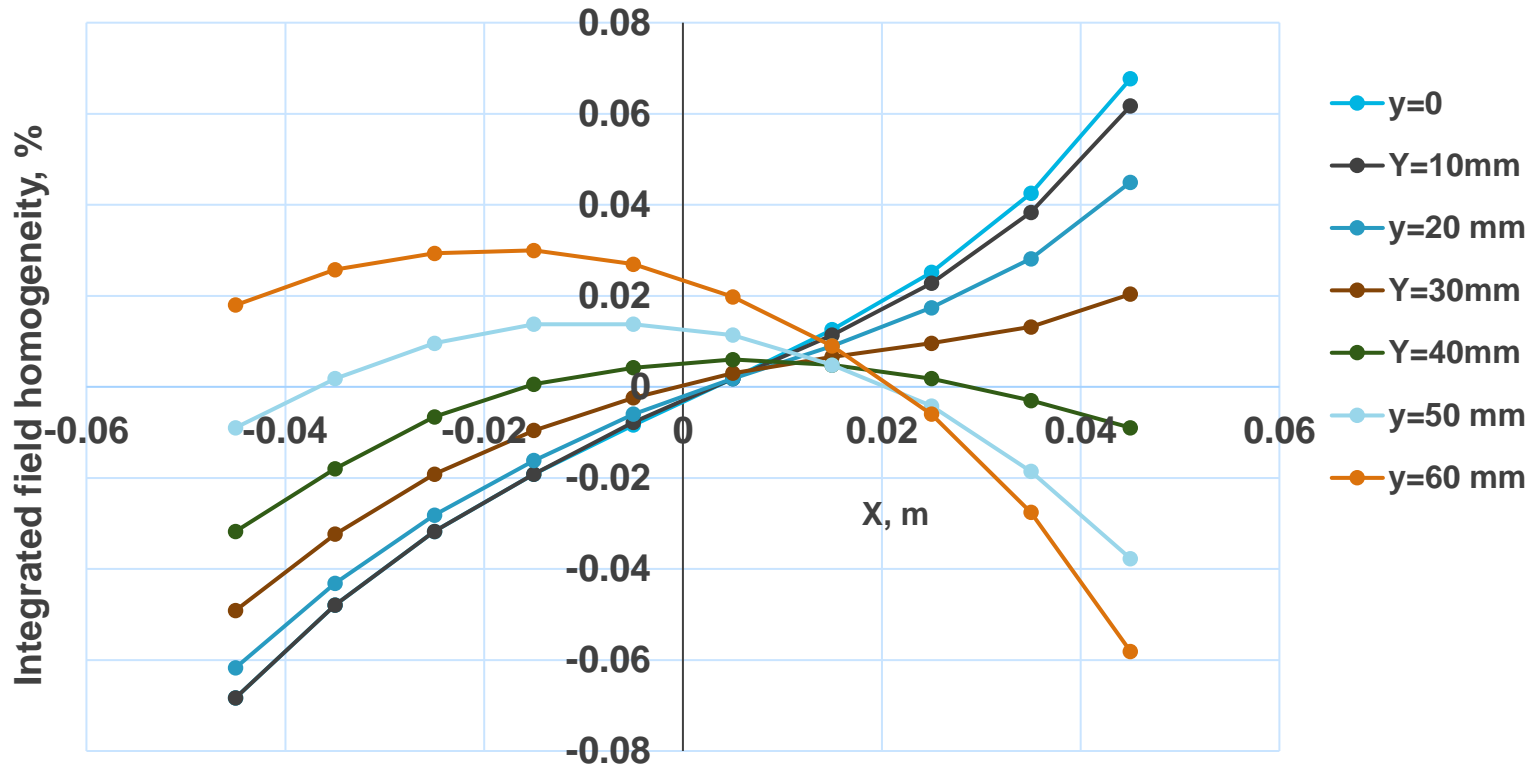
Parameter	Unit	Value
Gap field (at 38543 A)	T	0.188
Yoke peak field	T	1.3
Gap	m	0.25
Gap width	m	0.52
Yoke length	m	0.5
Integrated field (Spec 0.166)	T-m	0.166
Total magnet length	m	0.65
Integrated field homogeneity in the good field area	%	+/-0.07*
Magnet efficiency lw_{Gap}/lw_{Total}	%	97

Power Losses in Coil



- ✓ Updated current pulses from L. Boyd and D. Harding.
- ✓ Peak current 1606 A.
- ✓ Peak AC voltage 502 V.
- ✓ Average power losses 3371 W for the period of 66.66 ms.

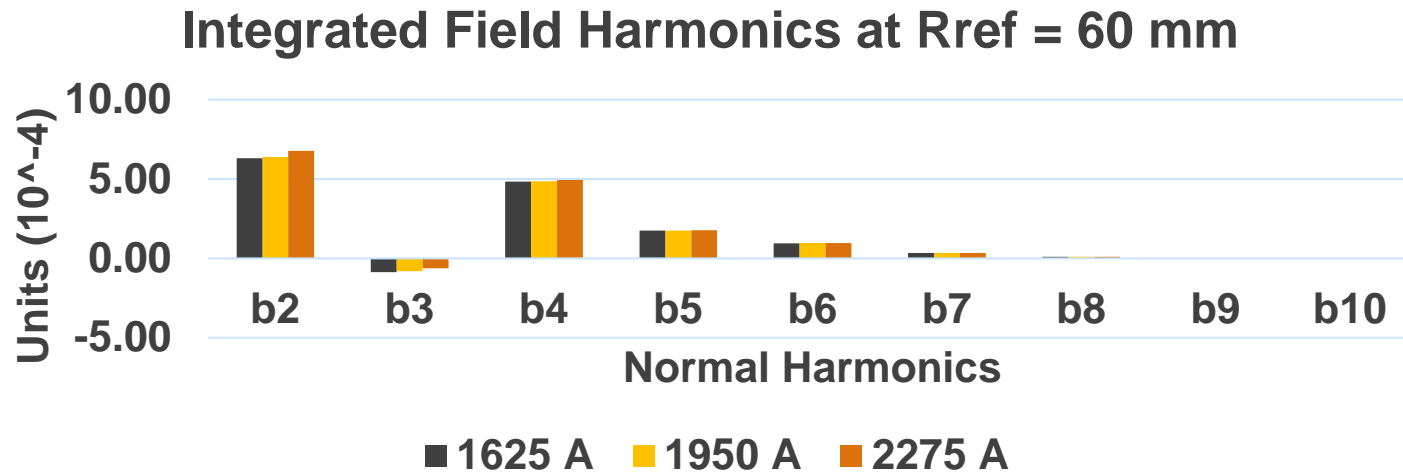
Integrated Field Homogeneity



Integrated field V29: 0.16692 T-m

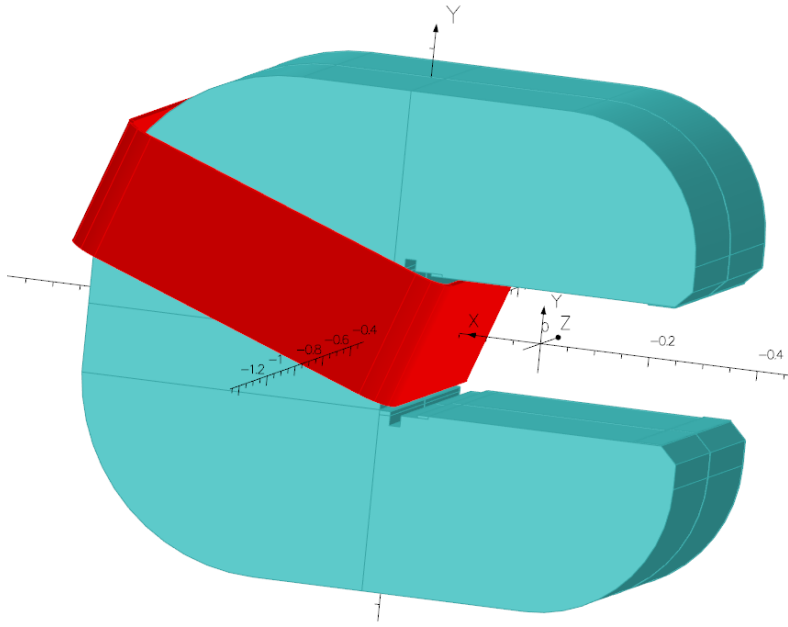
Integrated field homogeneity +/- 0.07 % (spec. +/- 0.1 %) in the good field area $x=+/- 45$ mm, $y=+/- 60$ mm.

Magnet at High Power



Power	100%	120%	140%
Current, A	1625	1950	2275
Peak voltage, V	682	818	955
Power, kW	3.37	4.85	9.51
Center field, T	0.19	0.228	0.266
Water flow, l/s	0.138	0.138	0.138
Water temp. rise C	5.8	8.4	16.5

C-Magnet Mechanical Concept

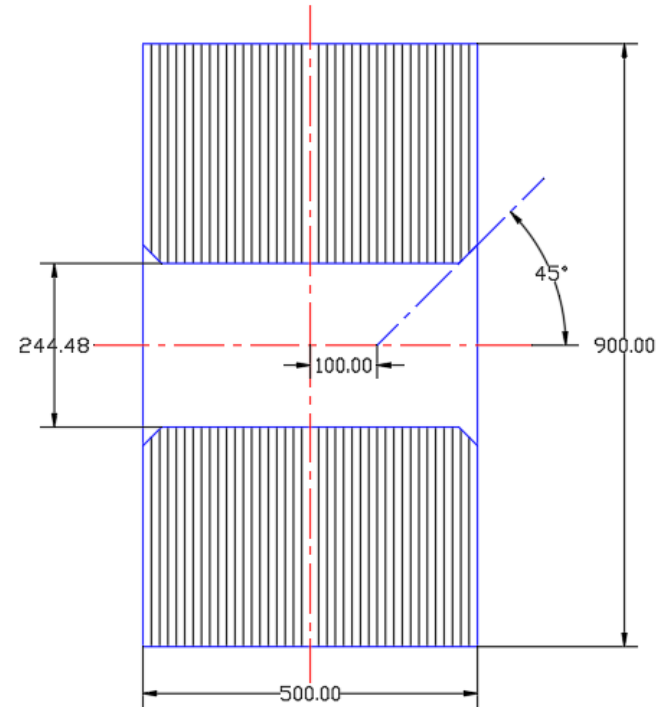
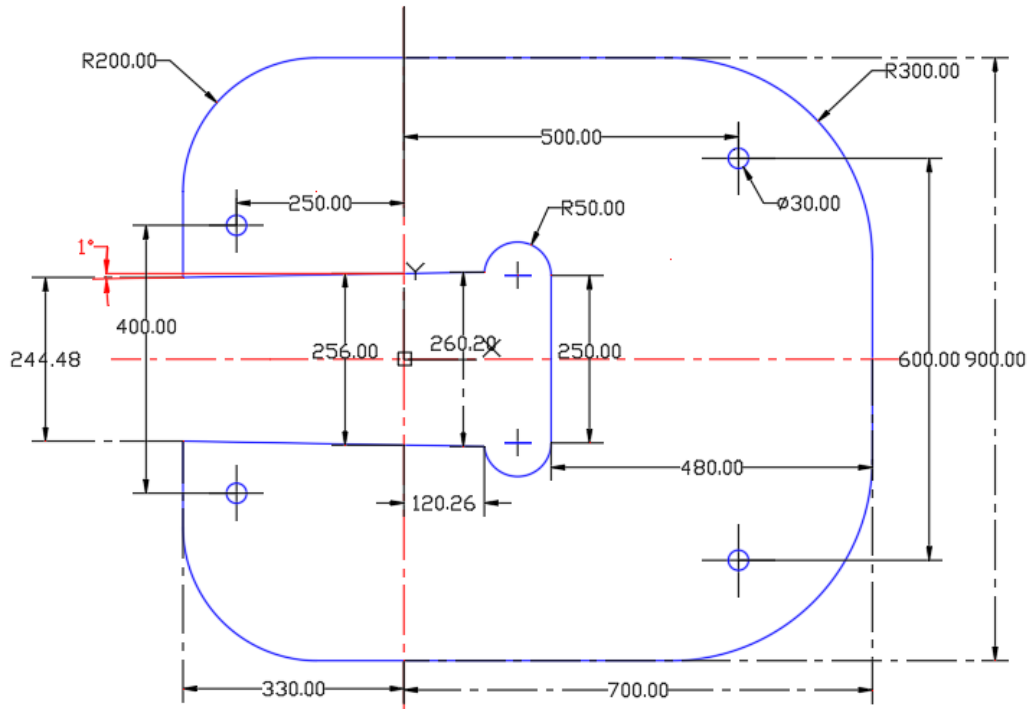


- ✓ C-magnet yoke assembled from the low carbon electrical steel laminations. 3D core .igs file transferred in NX for the mechanical design.
- ✓ The possible core material is steel AK M15, with C-5 electrical insulation.
- ✓ The core could be stamped, laser cut or EDM machined.
- ✓ The racetrack winding has two sections mounted through the magnet gap as shown.

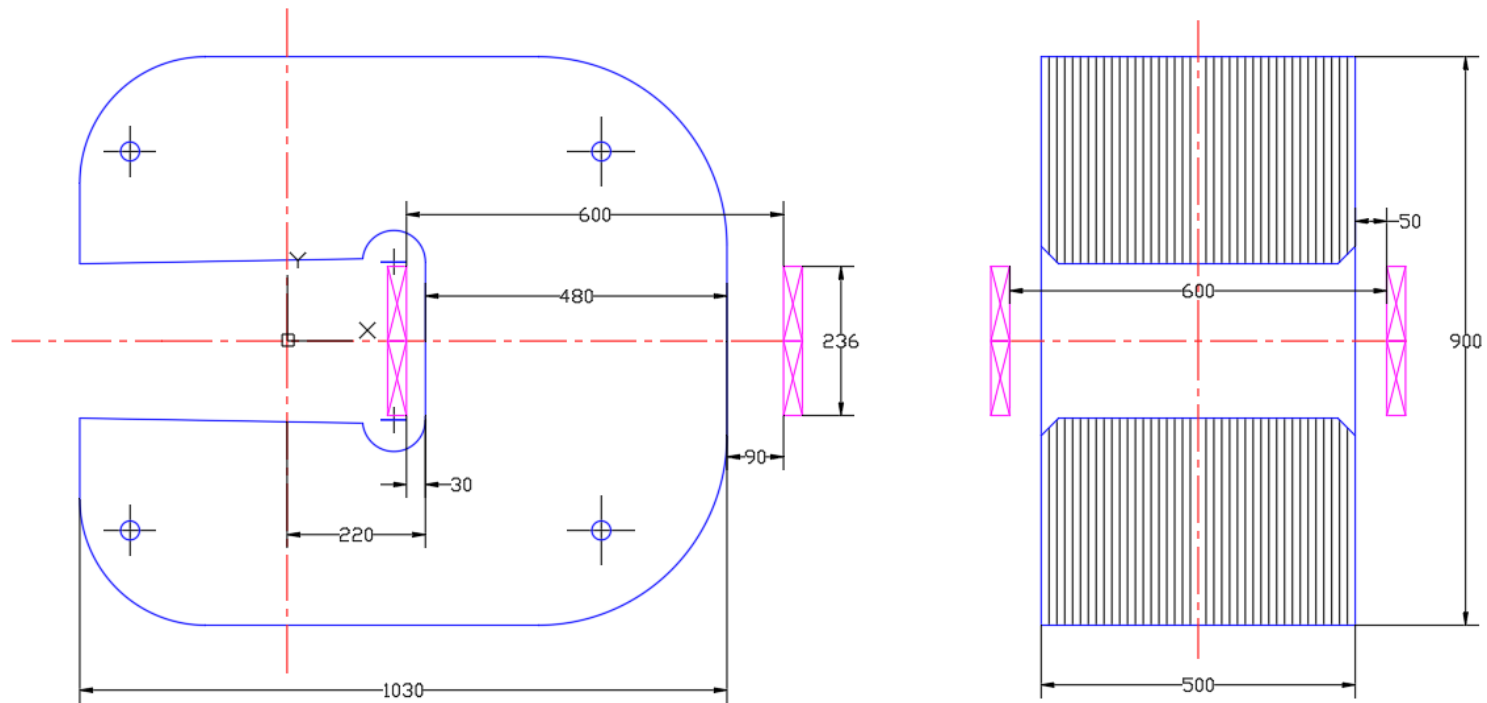
Magnet Parameters

Parameter	Unit	Value
Gap	m	0.25
Total ampere-turns	A	38543
Peak current	A	1606
Gap center field	T	0.188
Yoke length	m	0.5
Integrated field	T-m	0.166
Effective length	m	0.883
Number of turns for 2 coils		24
Magnet inductance	mH	2.79
Peak voltage	V	682
Average power losses	kW	3.371
Conductor dimensions (hole diameter)	mm	12 x 18 (8)
Water pressure drop (20 psi)	MPa	0.138
Total water flow	l/s	0.138
Water velocity	m/s	1.375
Water temperature rise at 2 water circuits	°C	6

Magnet Main Dimensions



Coil Position

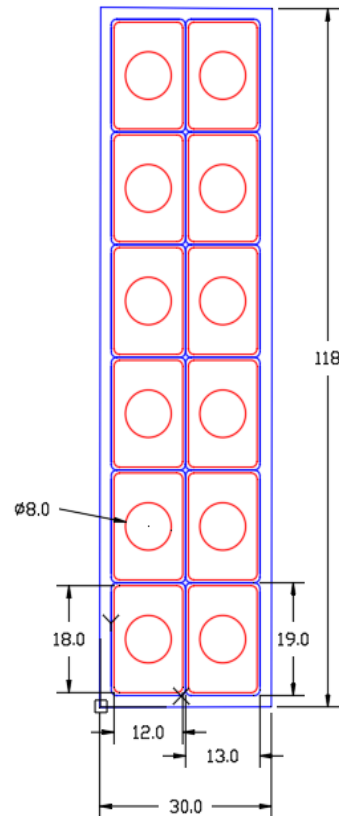


Laminations from M15 low carbon steel have 0.5 mm thickness.

At magnet core ends placed stainless steel plates of 10 mm thick (not shown).

Longitudinal rods should be electrically insulated from laminations.

Coil Requirements



- ✓ Copper conductor 12 x 18 dia. 8 mm.
- ✓ Coil number of turns 12
- ✓ Turn electrical insulation 0.5 mm.
- ✓ Coil ground insulation 2 mm.
- ✓ Two coils mounted vertically through the magnet gap.
- ✓ Coil dimensions could be increased to avoid interference with laminations clamping structure.
- ✓ High pot test at 3 kV.