**CBN 10-6**

# Undulator magnets for CHESS upgrade

## Alexander Temnykh, 5/4/2010

## Introduction

Presently we are developing a novel type of undulator magnet optimized to use in coherent light sources such as FEL and ERL (Temnykh, 2008). Undulator (we call it Delta) consists of four magnet arrays arranged symmetrically around beam axis as shown in Fig.1. Arrays are mounted inside of box-like frame on rails. Rails provide longitudinal displacement of the arrays which used to control magnetic field strength (Carr, 1991) and x-ray polarization.

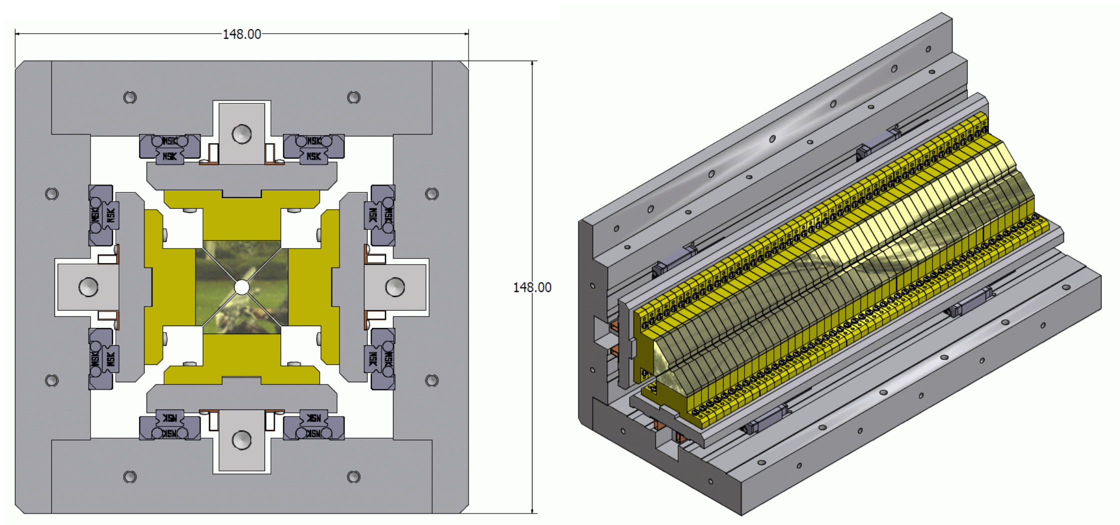


*Figure 1. Cross-section and internal view of Delta undulator. Dimensions are in mm.*

Undulator magnet is enclosed in vacuum vessel. Driver mechanisms mechanically coupled with arrays are placed outside of the vessel. In compare with conventional undulator magnets the Delta type is more compact, provides full x-ray polarization control and has stronger magnetic field. To verify basic ideas of the concept we built a short (30cm long) model prototype and evaluated main properties.

Although we are planning to conduct intensive bench testing, in foreseen future we cannot test these magnets under real operational condition. Thus, we propose to develop, build and test in CESR storage ring similar undulator magnets but fitted to use in storage ring.

## Proposed magnets

Schematic view of the proposed magnets is given on Fig. 2. The proposed undulator magnets have two planar magnet arrays of PPM structure. Similar to the Delta design, arrays connected to the solid box-like frame with miniature rails which provide motion in longitudinal direction. The motion is used to control magnetic field amplitude. The magnet will be enclosed in 10" diameter vacuum vessel. In compare with conventional undulator magnets given design is more compact. It does not require massive C-frame. Undulator can be easily fit into CESR ring without major component rearrangement.

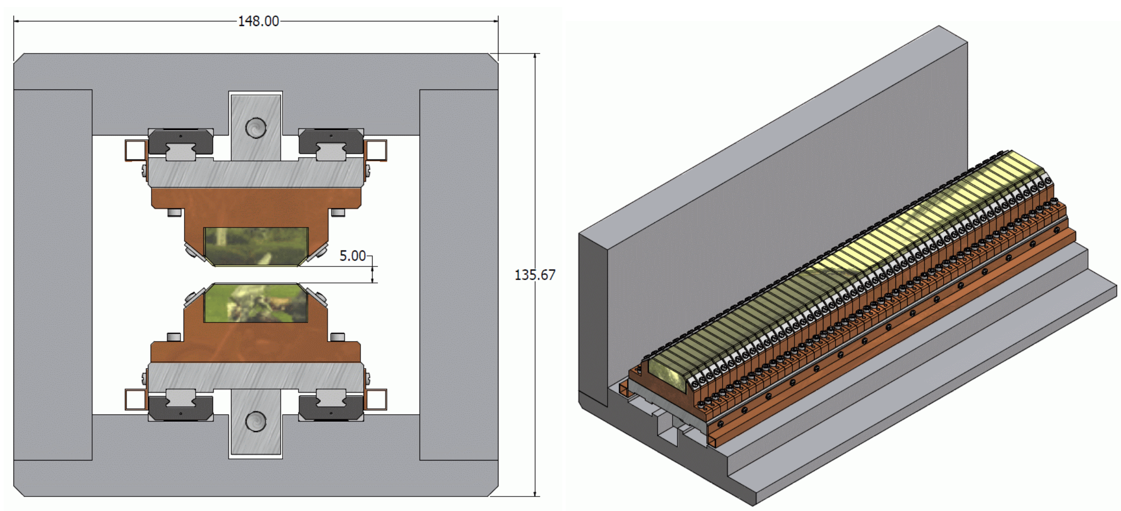


*Figure 2. Cross-section and internal view of the proposed undulator magnets. Dimensions are in mm.*

Proposed undulator magnets will have NdFeB (40SH) permanent magnet material, 1.8m length, 2.4cm period, 5mm fixed gap, ~1.0T peak field. Magnetic design will allow 100degC vacuum baking without risk of demagnetization. Temperature monitors and cooling elements included in the design should help us to stabilize temperature under varying heat load generated by the beam image current and HOMs. The cooling system should also be able to provide operation at low temperature (~120degK). Advantage of the low temperature operation is described in (T. Hara, et al., 2004).

Drawings illustrating some engineering solutions are included in Appendix.

## Acknowledge

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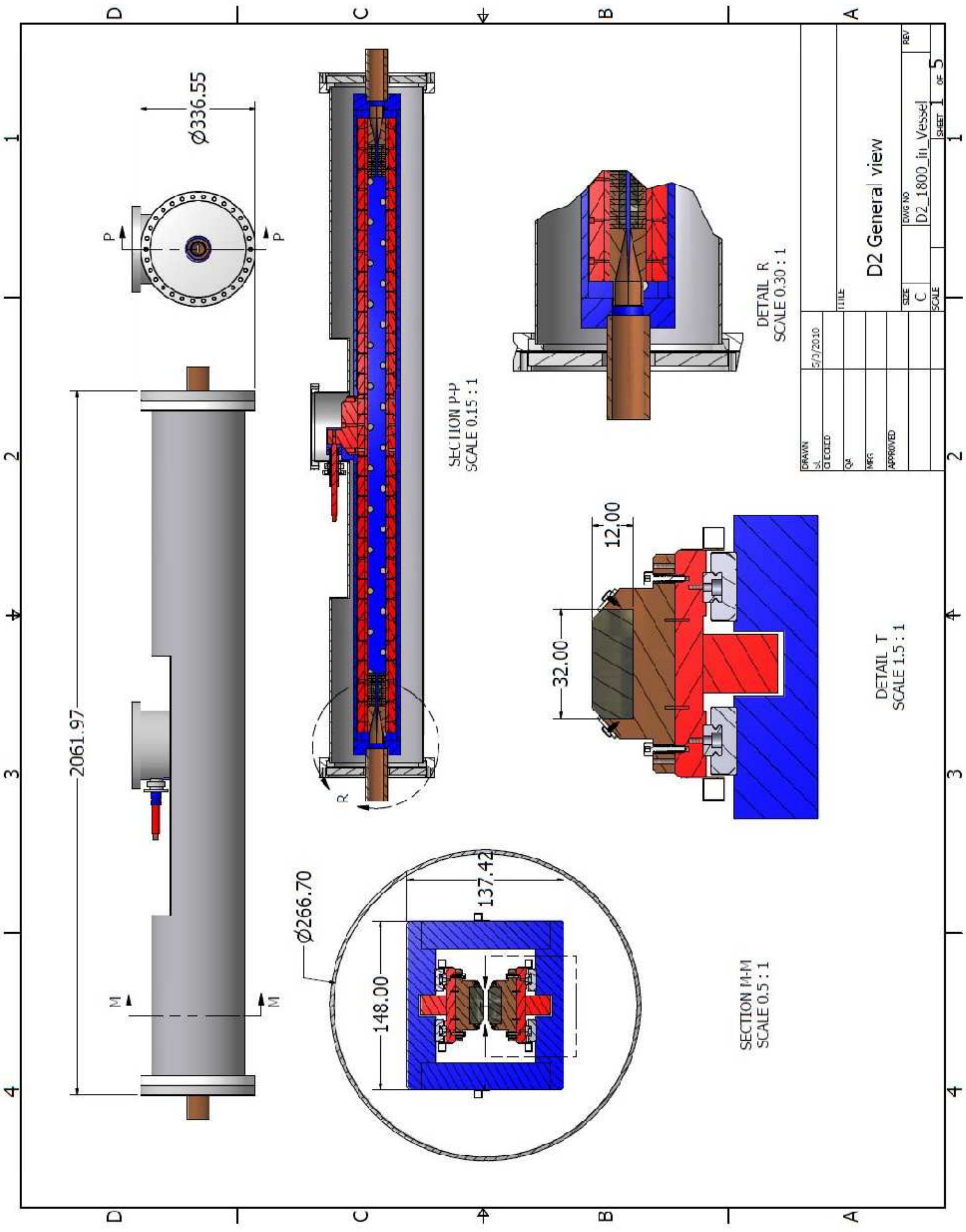
### ***References***


Carr, R. (1991). Adjustable phase insertion devices as X-ray sources. *Nuclear Instrumentation and Methods A 306* , 391-396.

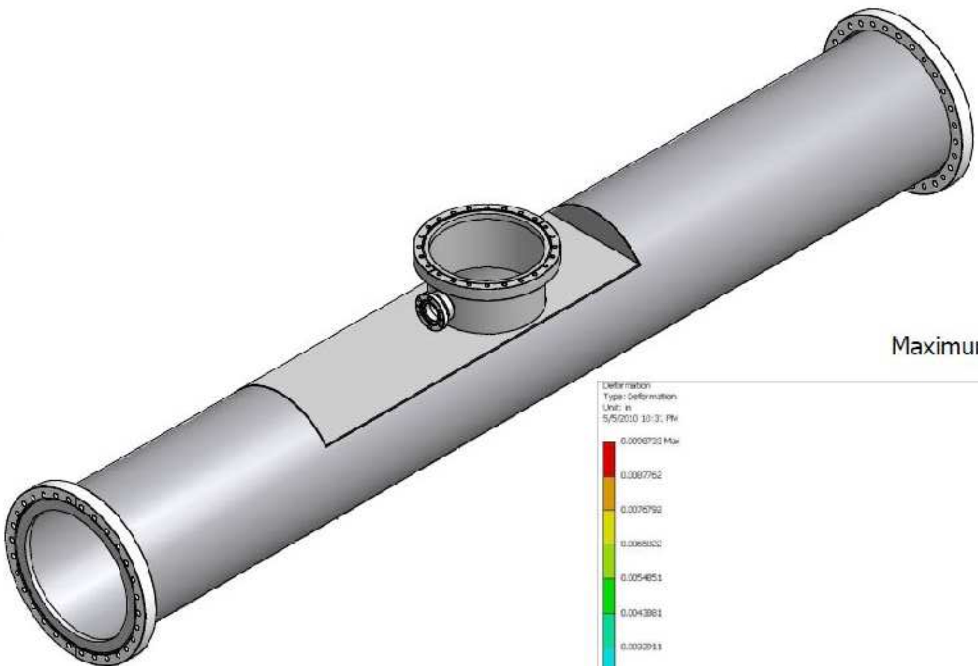
T. Hara, et al. (2004). Cryogenic permanent magnet undulators. *PRST-Accelerators and Beams, volume 7, 050702* .

Temnykh, A. B. (2008). Delta undulator for Cornell energy recovery linac. *PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 11, 120702* , 120702-1 - 120702-10.

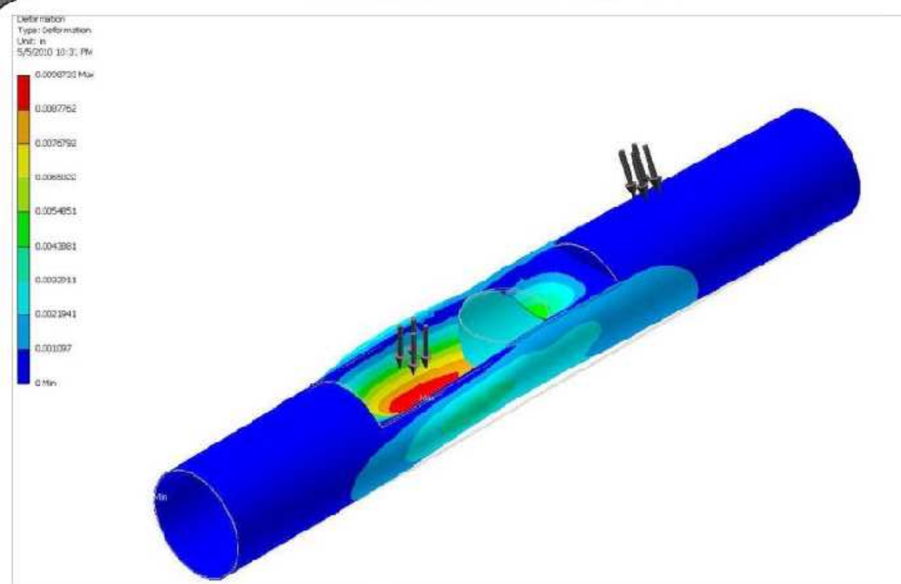
## Appendix



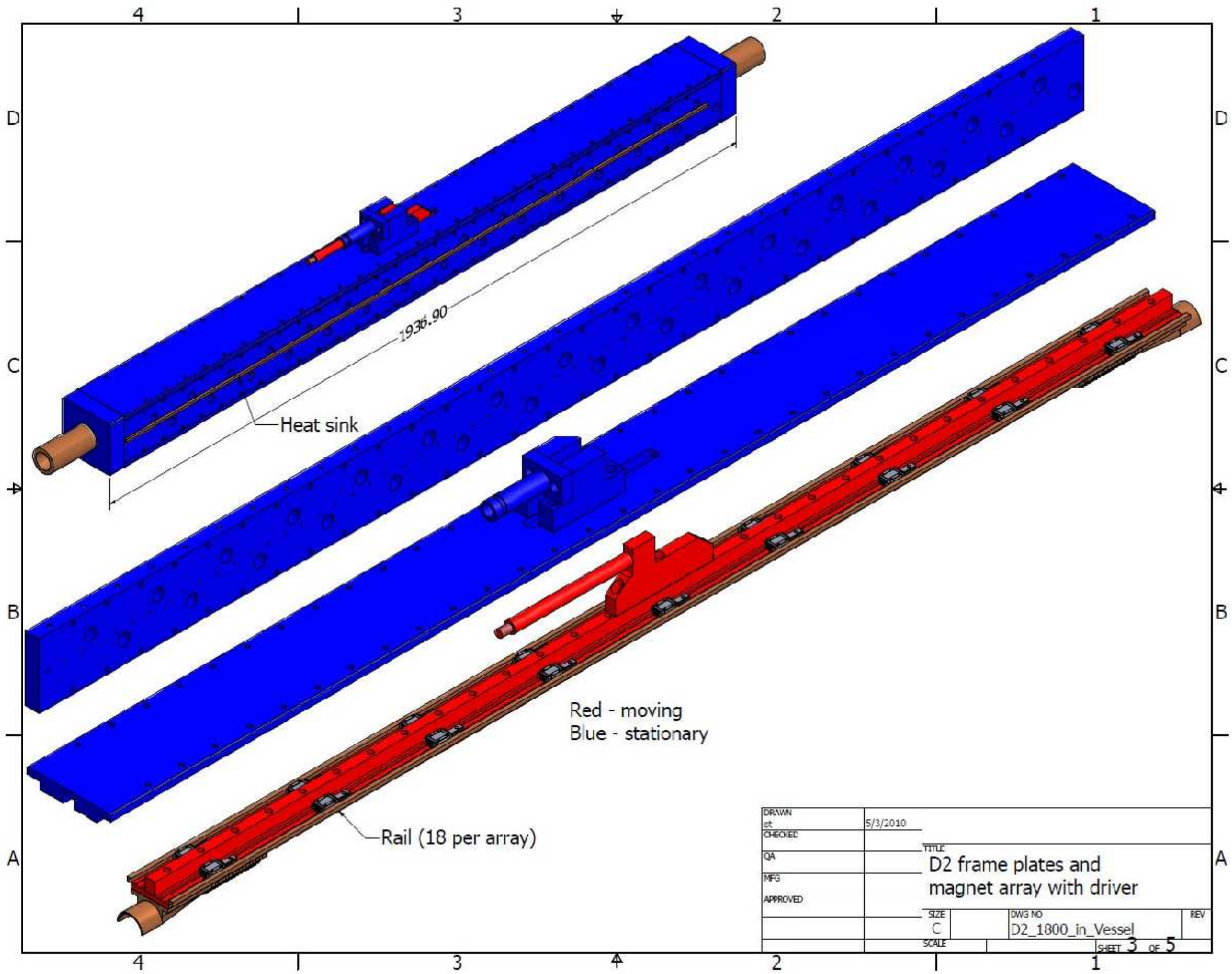
Ø336.55
2061.97
Ø266.70
137.42
148.00
32.00
12.00
SECTION P-P
SCALE 0.15 : 1
DETAIL R
SCALE 0.30 : 1
DETAIL T
SCALE 1.5 : 1
SECTION M-M
SCALE 0.5 : 1
D2 General view
D2_1800_in_Vessel
SHEET 1 OF 5



Maximum deformation ~10/1000"




| | | |
|---|---|---|
| DRAWN sL | 5/3/2010 | |
| CHECKED | | TITLE |
| QA | | D2 Vacuum vessel |
| MFG | | |
| APPROVED | | SIZE C — DWG NO D2_1800_in_Vessel — REV |
| | | SCALE — SHEET 2 OF 5 |


1936.90
Heat sink
Red - moving
Blue - stationary
Rail (18 per array)
DRAWN
ct
5/3/2010
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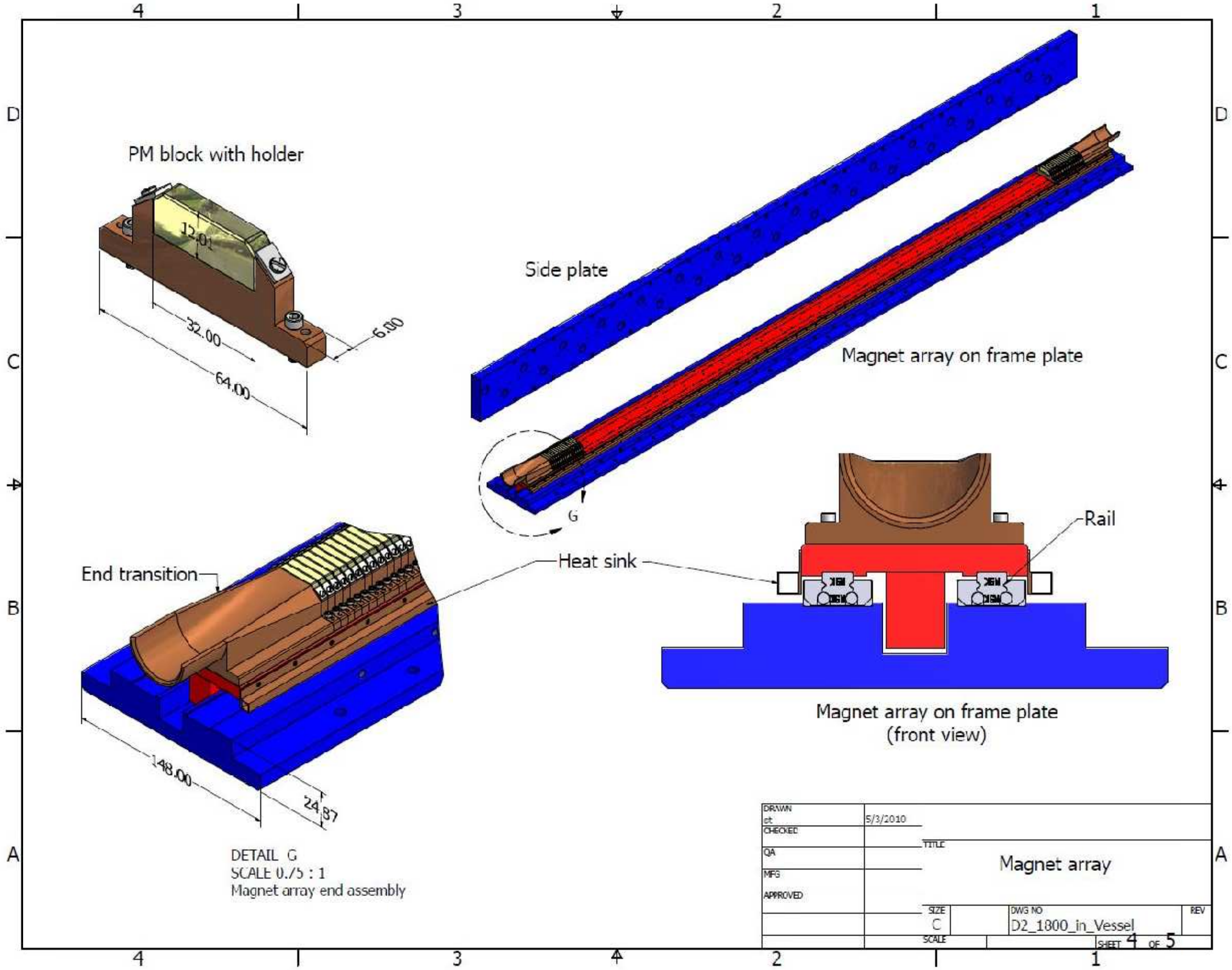
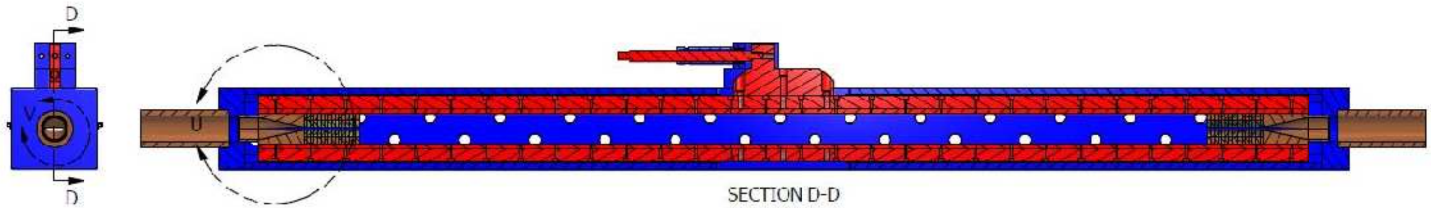
QA
MFG
APPROVED
TITLE
D2 frame plates and
magnet array with driver
SIZE
C
DWG NO
D2_1800_in_Vessel
REV
SCALE
SHEET 3 OF 5



PM block with holder
12.01
32.00
64.00
6.00
Side plate
Magnet array on frame plate
G
Heat sink
Rail
End transition
Magnet array on frame plate
(front view)
148.00
24.87
DETAIL G
SCALE 0.75 : 1
Magnet array end assembly
DRAWN
ct
5/3/2010
CHECKED
QA
MFG
APPROVED
TITLE
Magnet array
SIZE
C
DWG NO
D2_1800_in_Vessel
REV
SCALE
SHEET 4 OF 5




SECTION D-D
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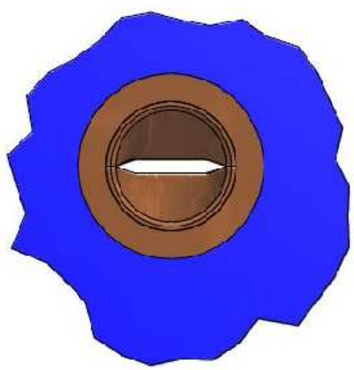
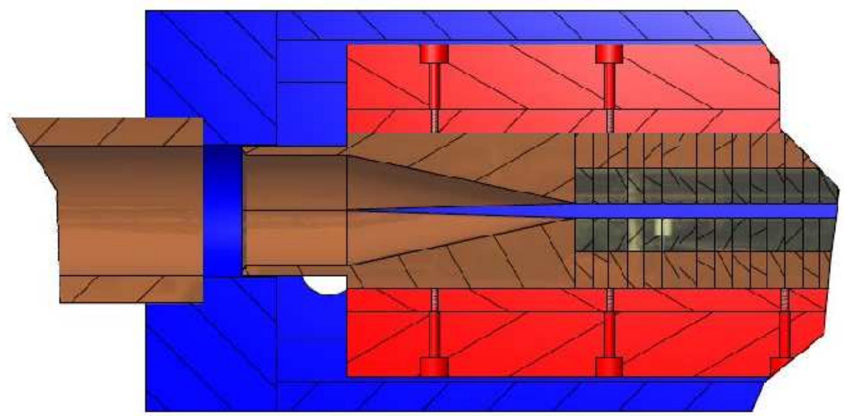


DETAIL V
SCALE 1 : 1



DETAIL U
SCALE 1 : 1

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| DRAWN ct | 5/3/2010 | |
| CHECKED | | TITLE |
| QA | | End transition details |
| MFG | | |
| APPROVED | | |
| | | SIZE C |
| | | DWG NO D2_1800_in_Vessel |
| | | REV |
| | | SCALE |
| | | SHEET 5 OF 5 |