THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY

12000 Jefferson Avenue
Newport News, VA 23606

TITLE: PMAG0000-0011-S0001 Specification
Compton Magnet Functional and Requirements Specs

DATE: 03/16/2022

PREPARED BY: P Ghoshal (Magnet Grp)

CHK: J Grames (Injector)

APP: R. Suleiman (Injector)

APP: S Gopinath (Magnet Grp)

APP: J Meyers (Engineering – Measurement Grp)

Revision History

0		First release.	P Ghoshal				
REV.	ECO#	DESCRIPTION	BY	CHK.	APP.	APP.	DATE
SUMMARY OF CHANGES FROM PREVIOUS REVISION:							

Contents

1. PURPOSE OF DOCUMENT

This document translates physics requirements into engineering requirements for the injector group.

2. KEY PERFORMANCE PARAMETERS (KPPs)

The KPPs tabulated below refer to the complete assembled magnet.

	Physics Driven Requirements	Value	Comments
1	**Magnet Current**	**Threshold KPP** The iron with the magnet bore to be saturated to >1.7T with 1" (minimum) diameter (using the FEA model – OPERA) ±10% to normal operating current (Say 5 A)	< 5 A
2	**Maximum length (mm)**	75 (includes all accessories)	
3	**Magnetic Field Stability**	**Threshold KPP** The variation of the measured field over a 8 hour period will be <1%	Bipolar magnet Power Supply (MPS) to be defined
4	**Magnetic field uniformity**	<5% of volume magnetization (equivalent volume B field) over the full length 75 mm and diameter 1"	The diameter will be optimized between 1' and 3".
5	**Alignment Tolerances**	**Threshold KPP** - NA (plan to use the outer magnet case surfaces to define the axis along with the front/back surface of the iron core)	

3. MATERIALS

	Physics Driven Requirements	Value	Comments
1	**Steel/Iron for Iron core**	1005/1006/other (select the steel normally used in accelerator magnets), JLAB needs to test the steel type.	Team to identify the iron available at JLab
2	**Winding with copper**	Copper, glass fiber, Kapton (Polyamide), Wire/conductors to be pre-insulated Conductor dims to be engineered Coil ID/Iron OD =>1" (min)	JM/SG to identify

4. MAGNETS (QTY 02)

1	**Expected beam power (X-ray) deposition for magnet (integrated over a coil) - For 0.1 µA**	<1 W *Note from J Grames (marked up spec document dated 03/14/2022) Electron beam power will be less than 10 MeV x 0.1 uA, or <1 W, with electron beam stopping in 6 mm. The total power spectrum from radiator is therefore <1 W too.* ***We don't yet have detail power spectrum simulations, however, we can shield coils (no core) region with an upstream collimator, if that is what's required.*** **Note**: 1. Worst case for coils would be 5x1W this number <5 W 2. *Radiation dose will decide the potting medium requirements (if any) or dry winding*	Physics to define later
2	**Coil current direction**	The magnet current would be revered in time and must have the capability to adopt so (the field memory from hysteresis loop will be decided by Physics). *Intend - For zero magnetization calibration measurements, de-magnetize the target by running the PS in successively smaller hysteresis loops, e.g. +5 A, -4A, +3A etc.*	NA
3	**Fringe field**	The magnetic field >10 cm upstream of the iron face (either face on axis) <50 G	50G @ 10 cm from the Iron surface

5. MAGNET ENCLOSURES

	Physics Driven Requirements		**Comments**
1	**Solenoid magnet Environments**	The iron enclosure to be provided to enclose the solenoid and also to provide the flux return path and support for installation	the magnetic field should be cylindrically symmetric

6. COLLIMATORS / BLOCKERS

	Physics Driven Requirements	**Value**	**Comments**
1	**Collimator diameter**	As mentioned above, once the magnet design is completed (maps produced), Physics will perform a GEANT simulation to compute power spectrum and suggested (if required) will design/fabricate a non-magnetic collimator to shield the magnet (or define acceptance of x-rays through the iron core).	Through GEANT simulation later

7. FIELD MEASUREMENT

	Physics Driven Requirements	Value	Comments
1	**Individual Coil (s)** – during fabrication and on receipt at JLab engineering	Quality Assurance/Quality Check for each coil a) Gauss/Amp (assembled magnet) b) Polarity	None
2	**Complete Magnet** – after assembly of magnet	a) BMOD measurements (component of field, BMOD ~ $B_ø$) on the surface of the Iron core outside on axis and some off-axis including off-surface points of well (accommodate the spatial resolution of the probe) b) Stray field measurements (location of 5 Gauss line) c) Field stability d) Model with as wound data and design	None

8. INSTRUMENTATION

	Physics Driven Requirements	Value	Comments
1	Connection Wire insulation	i. Either insulate bare wire with Kapton or wrap Kapton around already insulated wire or 'sandwich' already insulated wire between two strips of Kapton. ii. Voids and gaps at turn transitions etc. must be filled with spacer material (e.g. Kapton tape or G10 blocks or strips wrapped with glass cloth or other) to be evaluated based on radiation if any iii. Hi-pot test to conform >1kV (Line to GND)	Potential vendor: https://www.allectra.com/
2	Location of instrumentation	Locate all instrumentation (if any) and terminal termination to adopt to the MPS connections – typically will be at the outermost radii of the Iron enclosure – i.e. where the leads connections exit.	TBD

9. INTERFACES, WORKSPACE, ETC WITH SUB-SYSTEMS

	Physics Driven Requirements	Value	Comments
1	Target, Detectors, floor support, MPS, etc.	Magnet will be supported by non-magnetic fixture within a lead "house" constructed of 2x4x8 inch bricks. *Will run through the designers once the preliminary design is completed.*	MPS - 5A (Nominal) and <50V (Class I).

1. NEMA Standards for Electrical Control 1C1-1954, latest revision, 155 East 44th St., N.Y., which shall constitute the minimum acceptable standards (Generally to have all Class I, and no water or water spray environment outside, primarily inside the closed confined lab environment)
2. Institute of Electrical and Electronics Engineers (IEEE). All electrical equipment shall conform to the latest standards of the Institute of Electrical and Electronics Engineers (IEEE). This is primarily towards the hi-pot test and field measurement requirement(s).