SESAME DIPOLE MAGNET DESIGN

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The SESAME storage ring will have 16 dipole magnets with the maximum magnetic field of 1.455 T and a vertical gradient of 2.79 T/m. The dipole is a 'C' type magnet, with parallel end and with the yoke laminations stacked parallel according to the nominal bending radius; the full gap is 40 mm at the transverse magnetic center.
The magnetic properties of dipoles have been modeled using 2D POISSON code. For the yoke material, the commercial laminated cockerill steel was used. From these analysis the electrical requirements were determined.

Specifications

The dipole magnets are gradient magnets with a bending angle of 22.5^0. The field strength of 0.4657T and 1.4554T are required for injection and full energy. The "C" type configuration is used to make simple the beam line ports design.

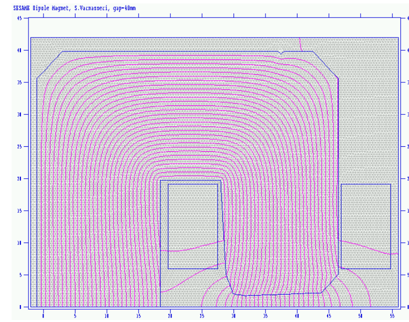


Fig.1. SESAME dipole magnet top-half cross section for POISSON code.

Harmonic Analysis

In a storage ring usually one need a *good field region* in the transverse direction (few cm) in which the field is uniform (ΔB/B ~ few units in 10-4) in order to have a good *dynamic aperture*.

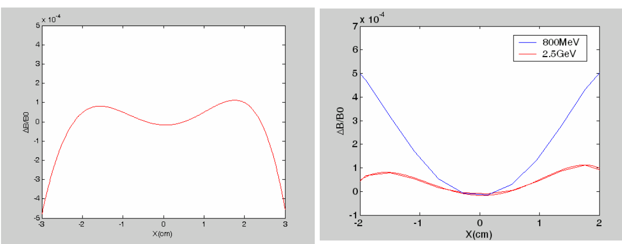


Fig.2. Transversal field quality prediction on y=0 axis at the field level 1.4554T, left within ±3cm region at 2.5 GeV, right for ±2cm at 2.5GeV and 800MeV.

Multipole	At 2.5 GeV	At 800 MeV
X^2	$+2.42\times10^{-4}$	$+6.65\times10^{-4}$
X^3	$+4.7\times10^{-5}$	$+1.36\times10^{-5}$
X^4	-3.09×10^{-5}	-2.63×10^{-5}
X^5	-1.36×10^{-5}	-1.1×10^{-5}
X^6	-1.17×10^{-4}	-1.169×10^{-4}

Table1. SESAME multipole components of dipole magnet within 2cm off-center

Furthermore is not only the absolute value of ΔB/B which is important, but also the multipoles content that is affected by the pole profile, iron saturation etc. This task of pole profile optimization and harmful harmonic reduction has been carried out in an iterative way by looking at the dynamic aperture.

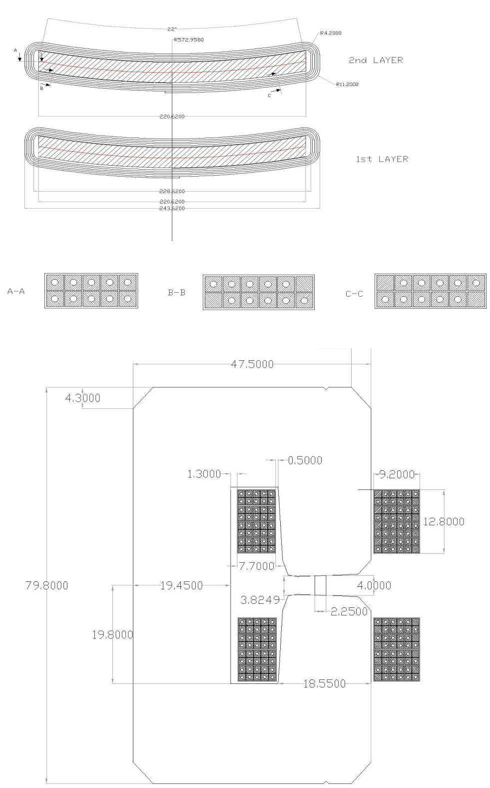
Dipole Parameters

The coil design is based on copper conductors of square cross section and a central hole for water cooling. Moreover the electrical connections are assumed to be in the center of the magnet. There will be 8 pancakes, each pancake consists of 2 layers of 5 conductors. The conductor cross section is 14x14 mm^2 copper with a 6mm diameter hole for cooling water. In addition there is 0.5mm insulation for each conductor. The overall conductor length is 413.7m, with the total resistance of 41.5mΩ and total inductance of 90mH. The nominal current to have the maximum field of 1.4554T is 654A which results in 27.2 V voltage drop and 17.75 kW thermal power dissipation in the conductors.

Table.2 SESAME dipole parameters list

Number of magnets	16	Number of pancakes (2 layers)	8
Bend angle	22.5	Conductor dimensions (mm)	14*14
Energy (GeV)	2.5	Cooling hole diameter (mm)	6
Magnetic flux density (T)	1.4554	Conductor area (mm^2)	167.7
Gradient (T/m)	2.79	Conductor length (m)	413.72
Bending radius (m)	5.72958	Current density (A/mm^2)	4.02
Magnetic length (m)	2.25	Resistance (mOhm)	41.5
Iron length (m)	2.22	Inductance (mH)	90
Central Gap height (mm)	40	Voltage drop (V) per magnet	27.2
Pole width (mm)	177÷186	Power (kW) per magnet	17.75
Iron weight (kg)	5660	Number of cooling circuits	8
Copper weight (kg)	622	Temperature rise (C)	10
Total weight (kg)	6282	Cooling water flow (l/s)	5.43E-2
Ampere turns (Total)	52260	Cooling water speed (m/s)	1.92
Number of turns (Total)	80	Pressure drop (bar)	6
Nominal current (A)	654	Reynold number	13634

Fig.3 Upper is Top view of pancake and cross section. Down is the lamination and coil cross section.



@ CERN Accelerator School, 2-14 October 2005, Trieste, Italy