ENERGY DEPOSITION IN MARCH’05 OPEN-MIDPLANE DIPOLE

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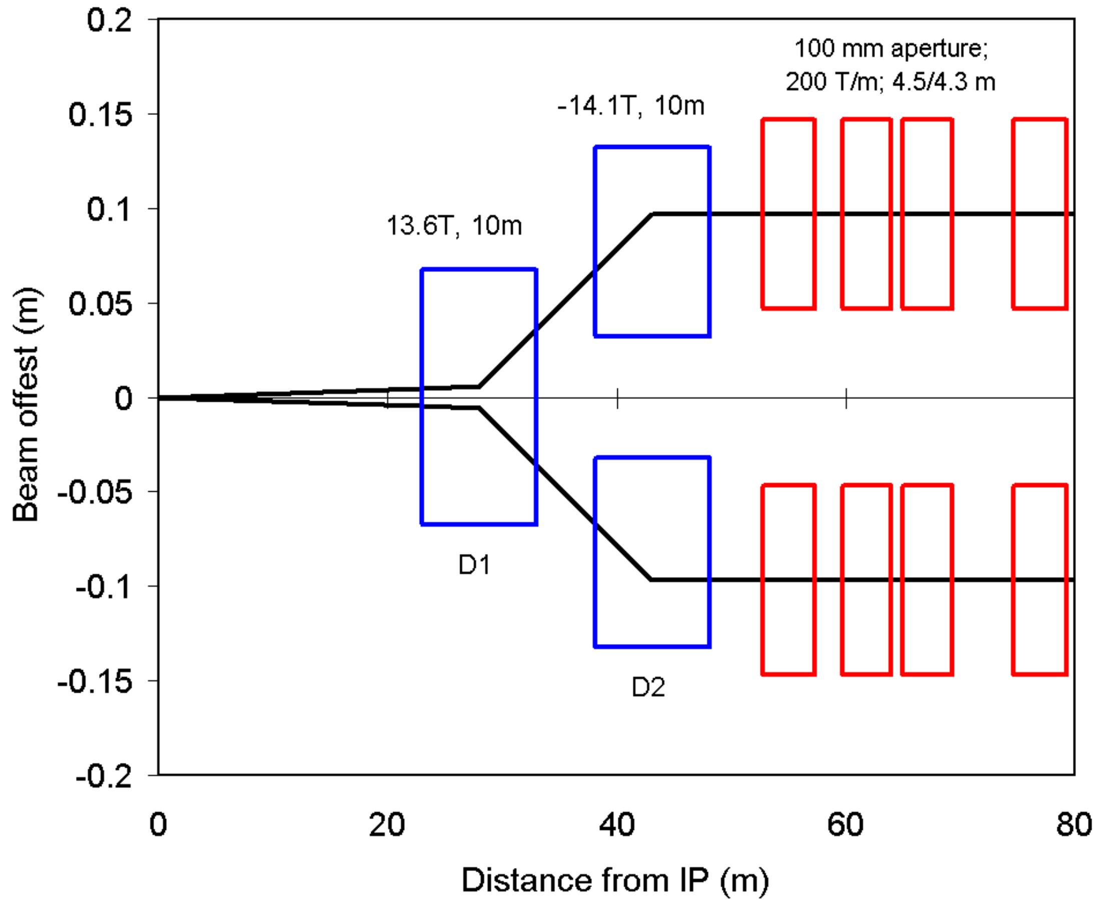
OUTLINE

- Dipole-first IR
- 2004 Results for the Open Midplane Dipole
- Splitted Dipole with Intermediate Absorber
- Results for March'05 Version
- Summary

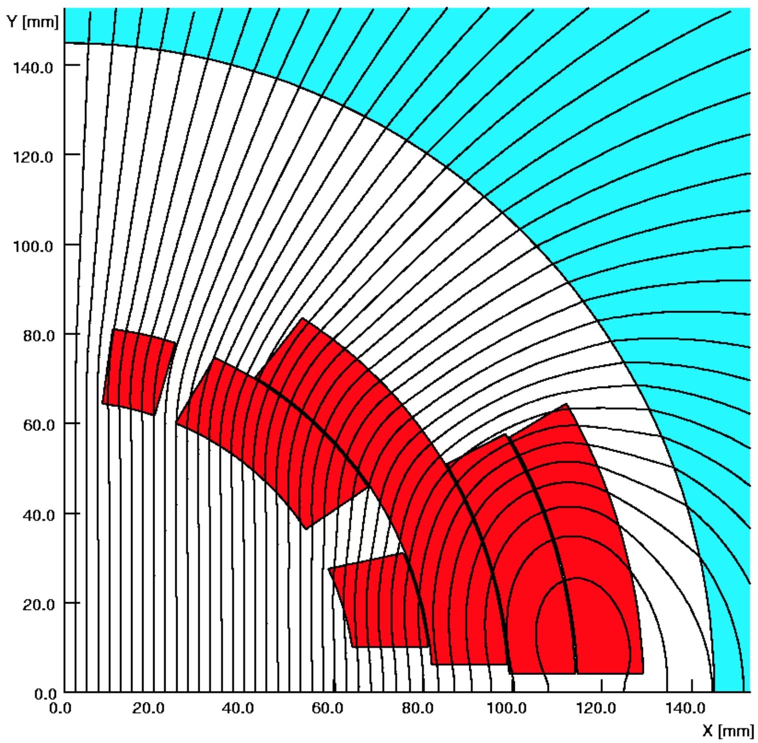
DIPOLE-FIRST IR LAYOUT

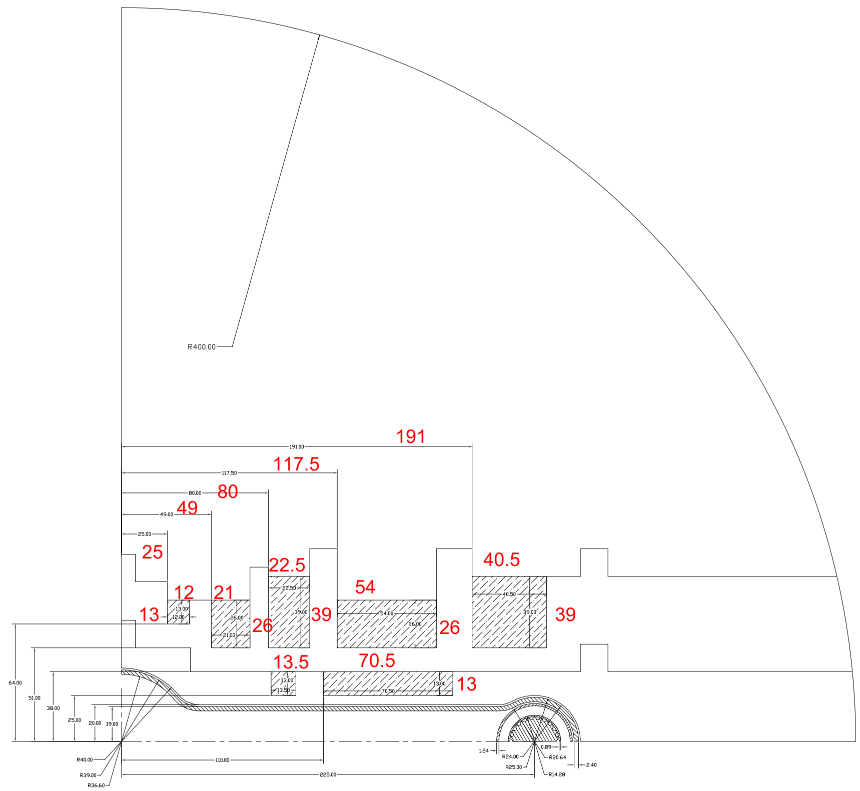


ENERGY DEPOSITION ISSUES

1. Quench stability: peak power density in SC coils and heat transfer.
2. Dynamic heat loads: Power dissipation and cryogenic implications.
3. Residual dose rates: hands-on maintenance.
4. Components lifetime: peak radiation dose in components and limits for various materials.

DIPOLE-FIRST MAGNET DESIGNS





Peak power density is a factor of 100 higher in LARP dipole ($\mathcal{L} = 10^{35}$) than in LHC IR quads ($\mathcal{L} = 10^{34}$).

MARS15 ENERGY DEPOSITION RESULTS FOR DIPOLE-FIRST

1. 2003: Peak power density is 49 mW/g in copper spacer and 13 mW/g in SC coil and only 1.1 mW/g in the SC coils of block-type dipole-v1. Total power dissipated in the dipole is 3.5 kW in either design.
2. 2004: Realistic MARS modeling of the dipole-first **(v2)** IRs addressing four energy deposition issues: quench stability, dynamic heat load, DPA and residual dose $\longrightarrow$ overdesigned (peak PD $\sim$ 0.01 mW/g)!
3. Move to a compact version **(v3)** $\longrightarrow$ underdesigned (quench limits exceeded and excessive heat loads)!
4. After December'04 Review at BNL: New optimized design with dipole splitted in two pieces, D1A (1.5 m) and D1B (8.5 m), with 1.5-m TAS2 in between $\longrightarrow$ promising results for March'05 version.

DYNAMIC HEAT LOAD TO DIPOLE CRYO (V2)

Component	Power Dissipation (W)
SC coils	30.4
Beam pipe	49.3
W-rod	235
Rod vessel	5.0
Collar	184
Yoke	14.1
TAS	1750
Downstream	5315

Heat loads to seven coils: 1.6, 6.7, 0.3, 1.2, 1.5, 2.5, 2.8 Watts.

Longitudinal distribution of heat load to the coils is rather uniform: 3 W/m.

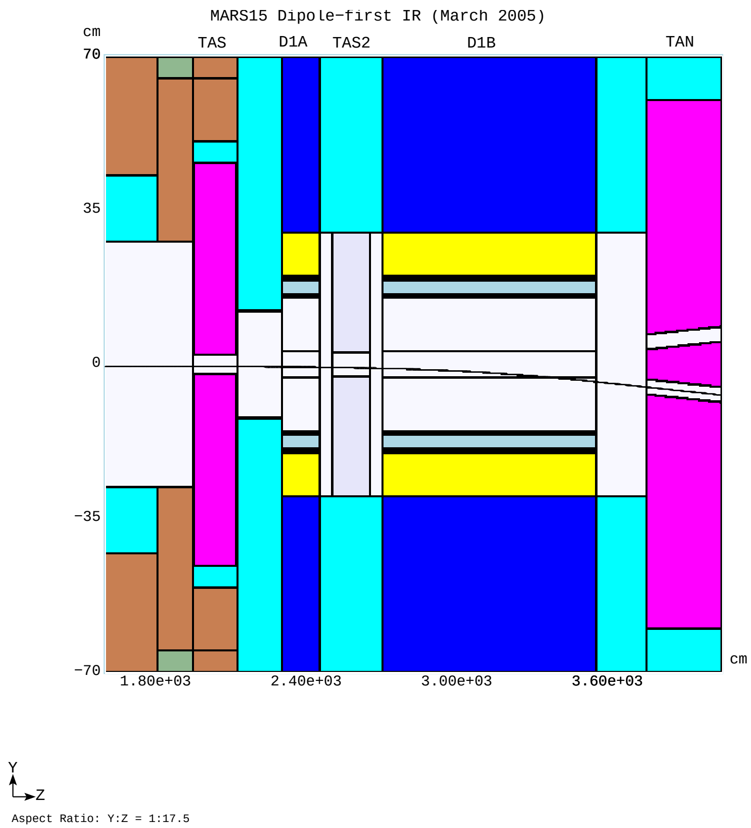
PARAMETERS CRITICAL TO ENERGY DEPOSITION: V2 → V3

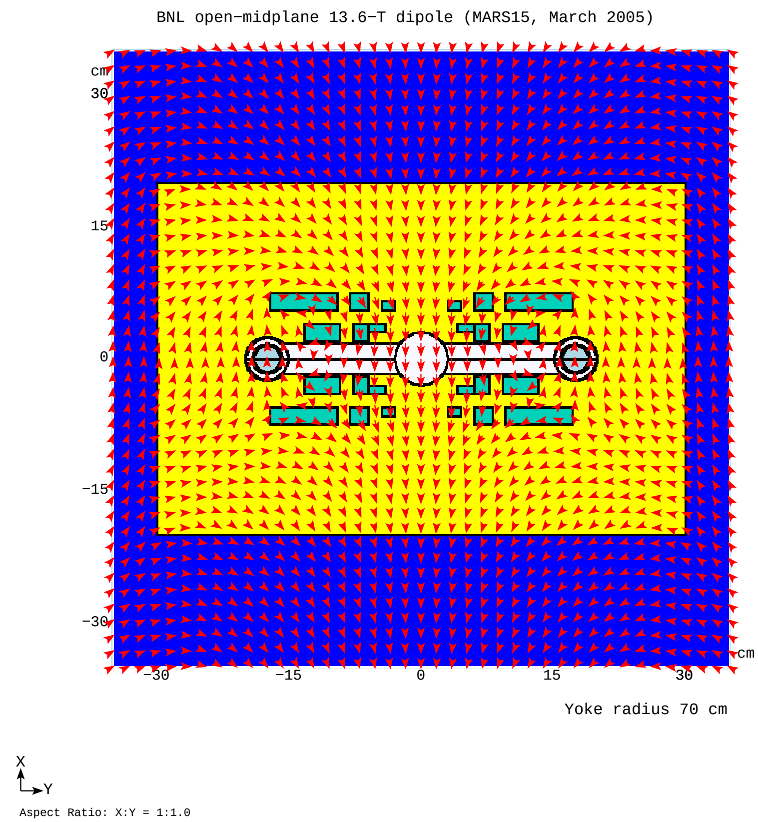
Parameter	V2	V3
Distance to the closest SC coil (vert/hor)	25/80	17/40
Open midplane half-width (rod location)	300	200
Space between midplane and collar	20	14
Open midplane half-height	16.6	10.6
Radius of central hole in collar	40	34
Radius of central aperture	36.6	30.6
Radius of tungsten rod	30	15
Yoke inner/outer radii	400/1000	300/700

TOWARDS SPLITTED OPTIMIZED DIPOLE WITH TAS2

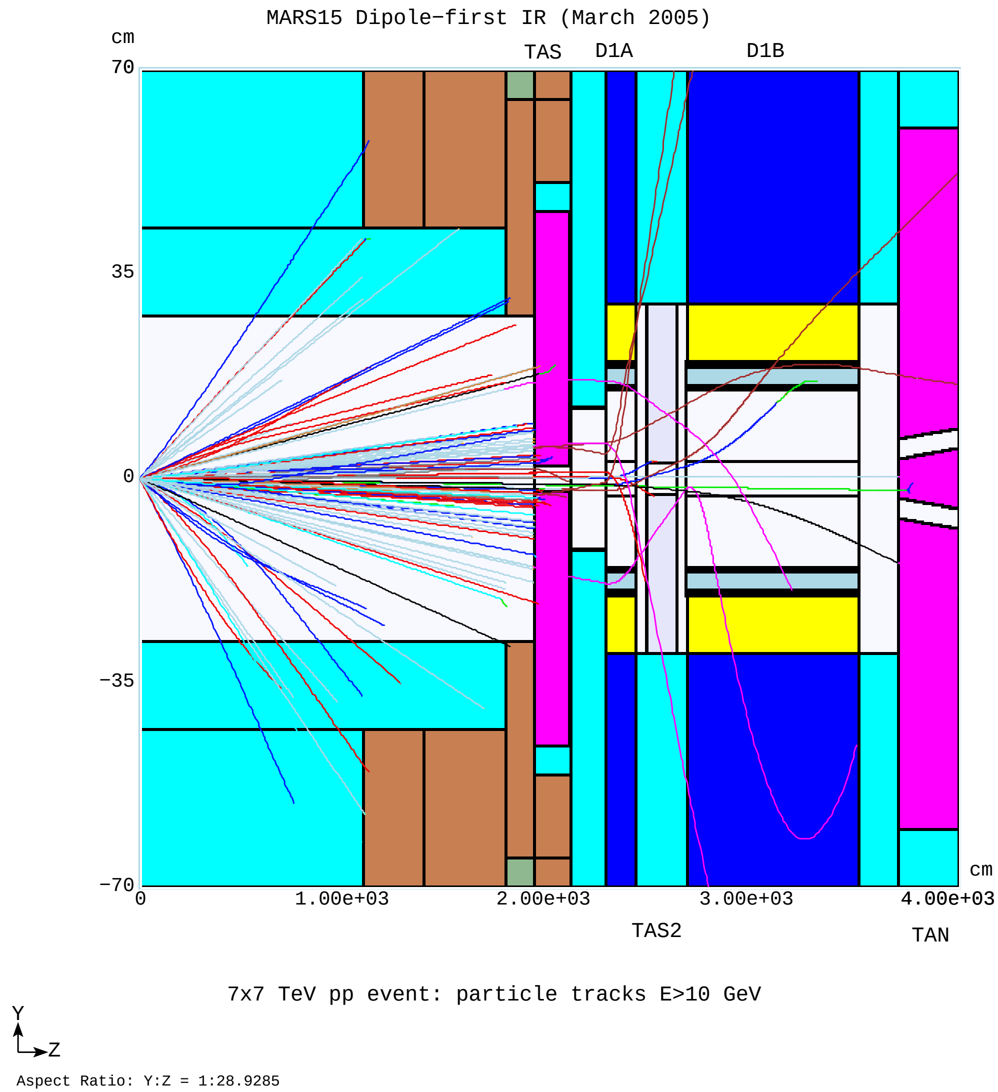
1. Front absorber TAS does an excellent job absorbing soft particles from IP.
2. Left are energetic particles swept by a strong magnetic field to the aperture, with a build-up at the non-IP end.
3. Dipole (or triplet) IP-end is well protected and using a magnetized TAS does not help. Estimates show that one needs about 20 T-m to make it working.
4. Idea: split D1 in two sections, D1A (20 T-m) and D1B, and intercept spray from D1A by TAS2 absorber: A natural two-stage approach to D1 design and manufacturing.
5. MARS15 optimizations for 13.6-T open midplane dipole-first: 1.5-m D1A + 0.5-m ICR + 1.5-m TAS2 (R_a = 27 mm, copper/SS) + 0.5-m ICR + 8.5-m D1B.

DIPOLE-FIRST IR of MARCH'05

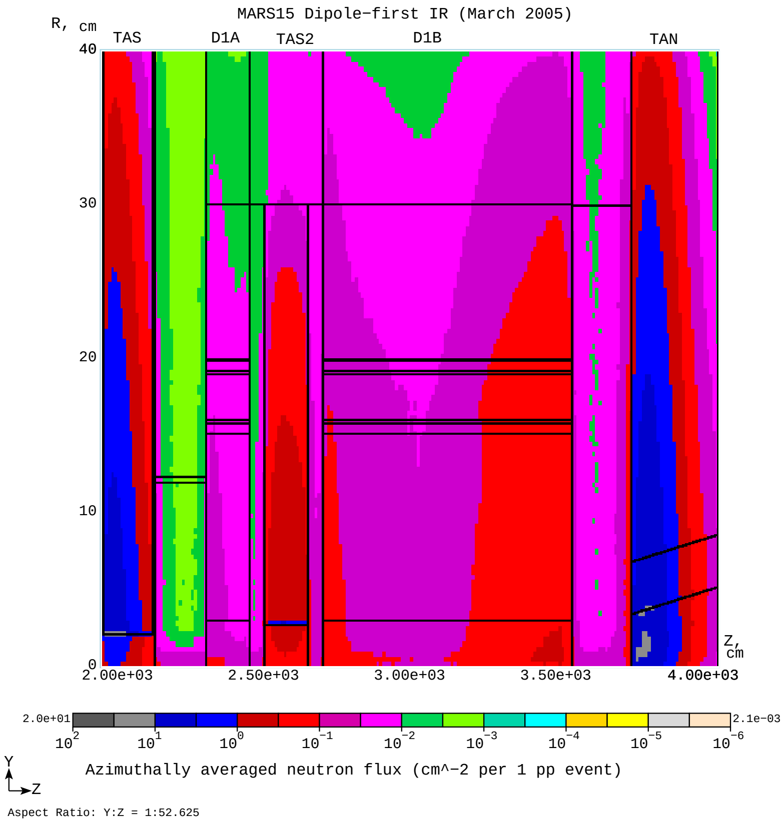


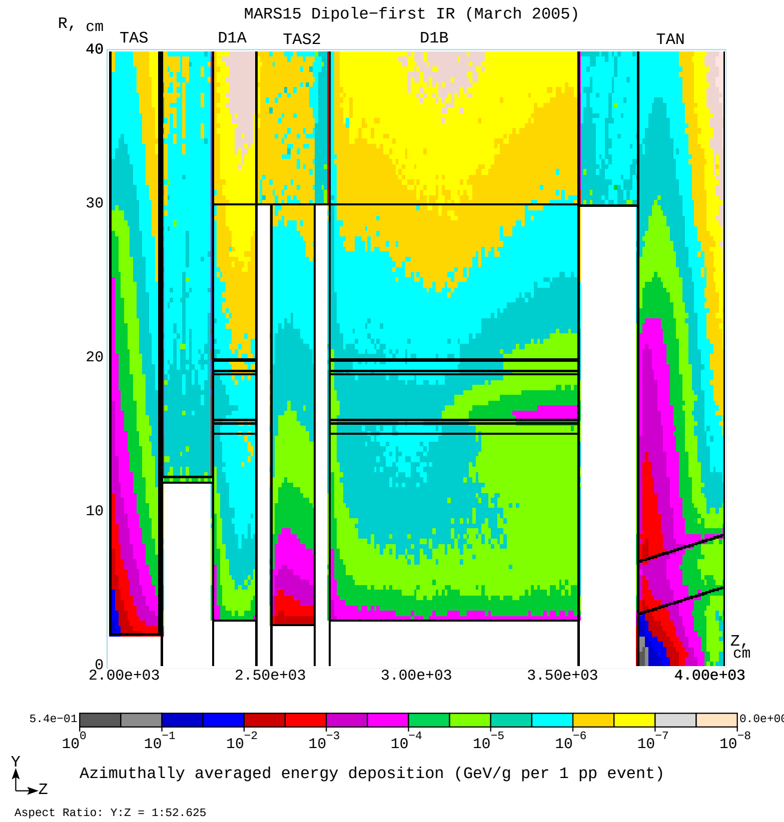


DIPOLE-FIRST IR of MARCH'05: ONE PP-EVENT

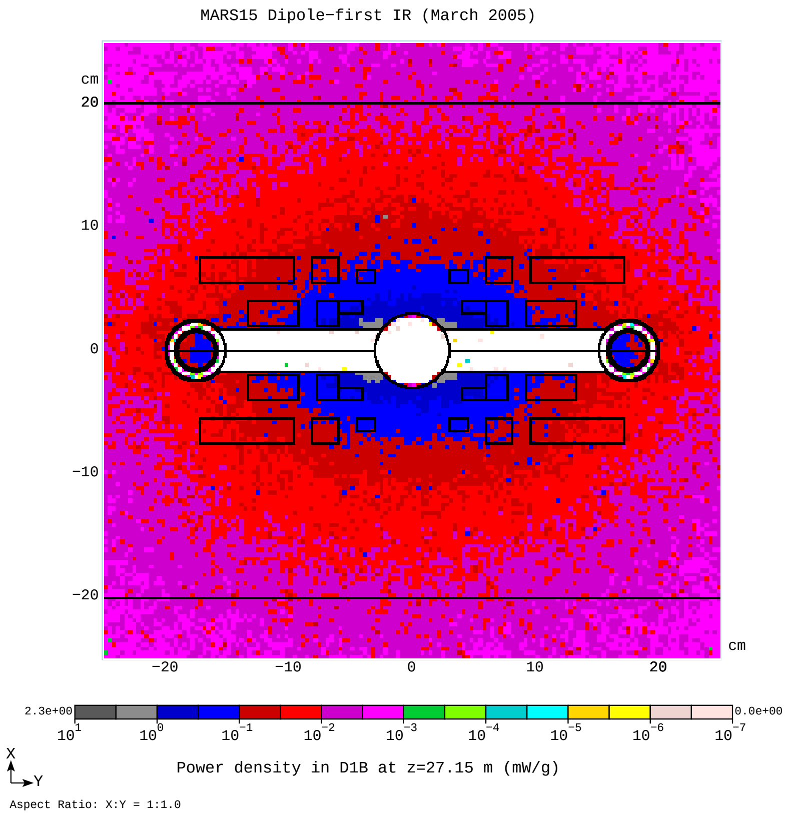


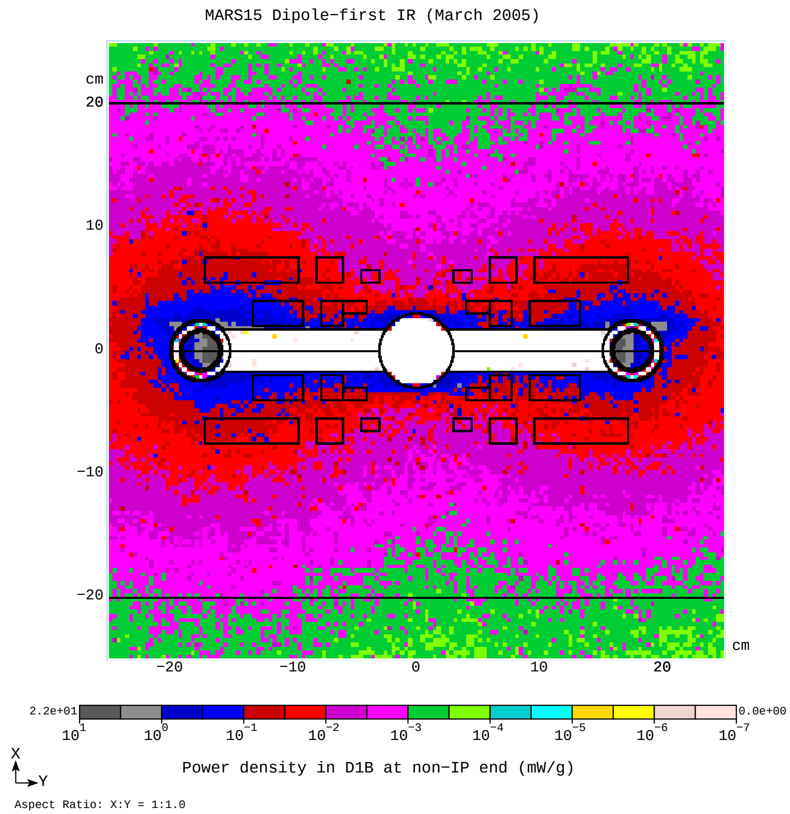
NEUTRON FLUX AND ENERGY DEPOSITION PROFILES





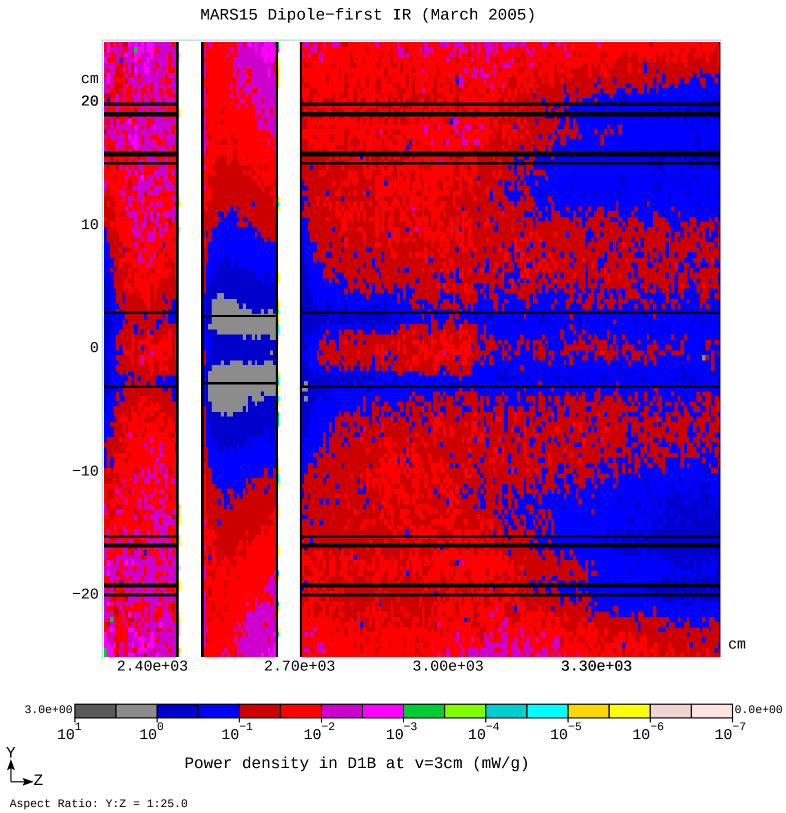
POWER DENSITY AT TWO LONGITUDINAL MAXIMA

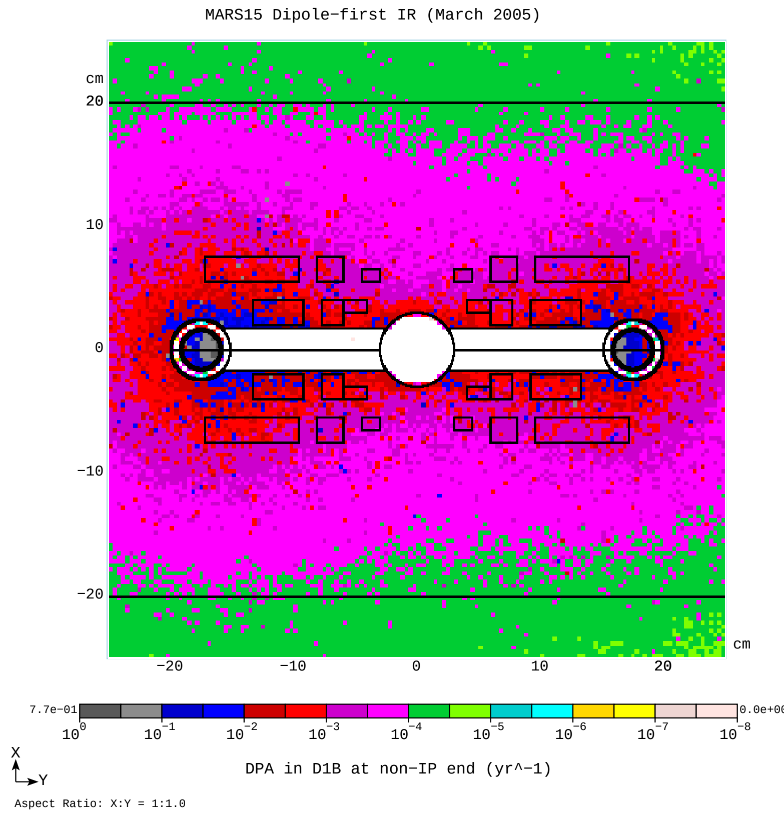




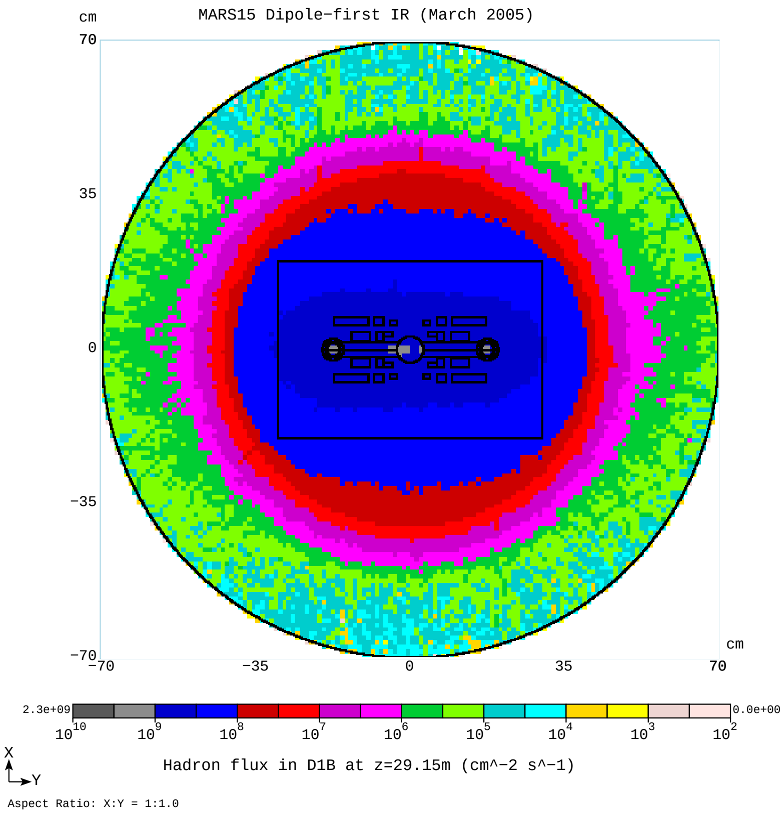
Peak power density in SC coils $\leq$ 0.7 mW/g, below the quench limit with a safety margin!

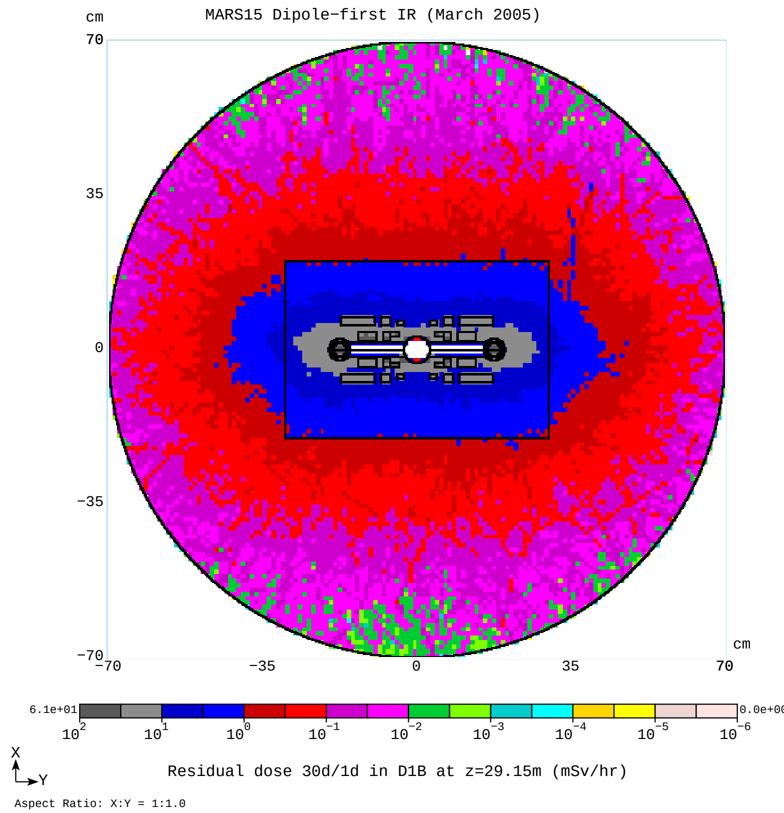
POWER DENSITY AND DPA





HADRON FLUX AND RESIDUAL DOSE at z=29.15 m

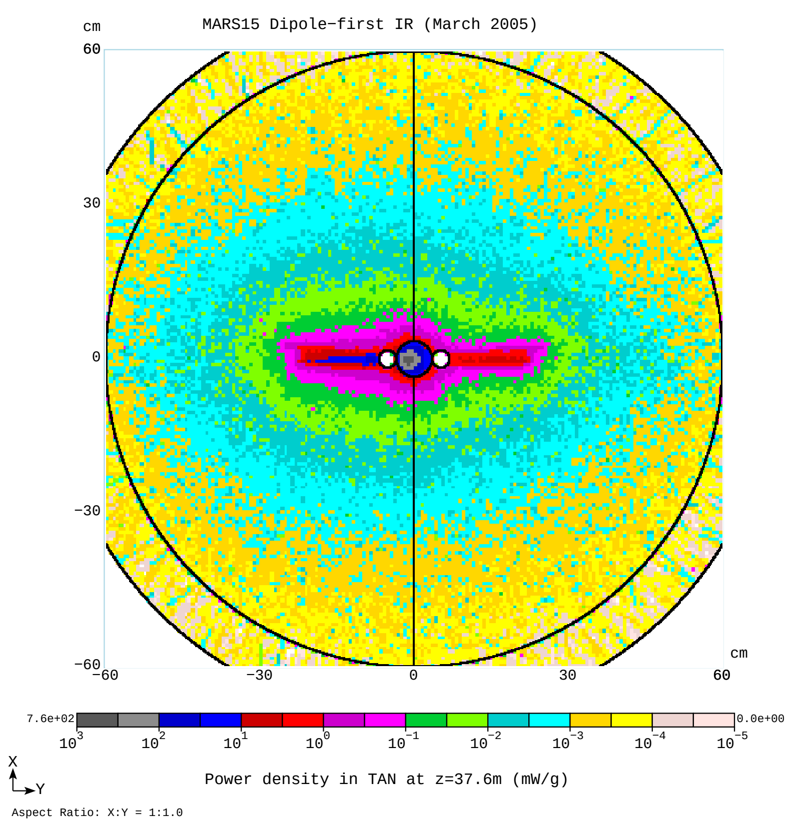


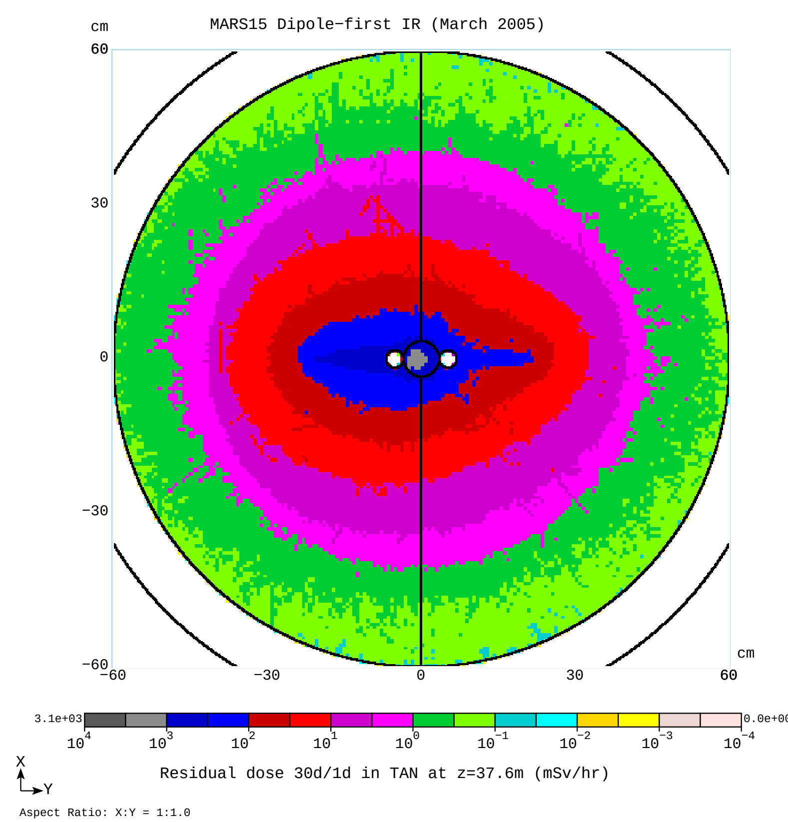


Fermilab

N. Mokhov

POWER DENSITY AND RESIDUAL DOSE IN TAN





SUMMARY

- The open midplane dipole is very attractive option for the LARP dipole-first IR at $\mathcal{L} = 10^{35}$. The design accommodates large vertical forces, has desired field quality of 10^{-4} along the beam path and is technology independent.
- After several iterations with the BNL group over last two years, we have arrived at the design that – being more compact than original designs – satisfies magnetic field, mechanical and energy deposition constraints.
- We propose to split the dipole in two pieces, 1.5-m D1A and 8.5-m D1B, with a 1.5-m long TAS2 absorber in between.
- With such a design, peak power density in SC coils is below the quench limit with a safety margin, heat load to D1 is drastically reduced, and other radiation issues are mitigated. This is a natural two-stage way for the dipole design and manufacturing.