Machine-Detector Interface Summary

Key advances, FY14 plans, refocusing efforts

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Fermilab

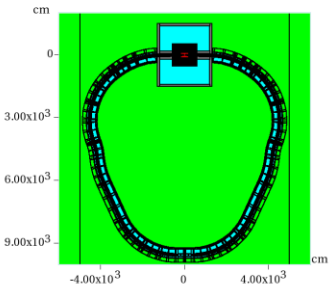
MAP Spring Workshop

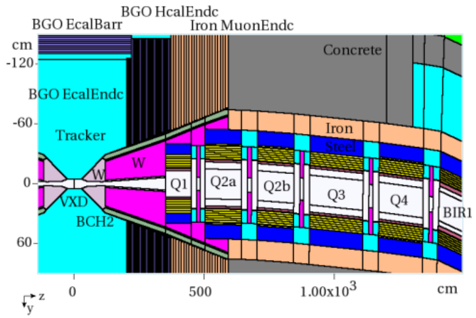
May 31, 2014

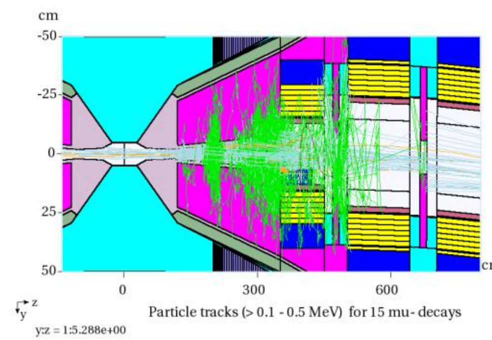
Nikolai Mokhov (FNAL)

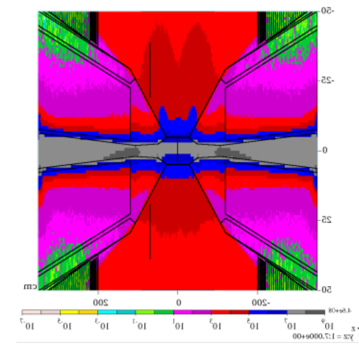
Higgs Factory Magnet Protection and MDI

Integrated HF collider, magnet, detector and MDI MARS15 model



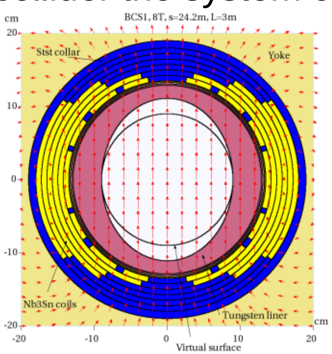


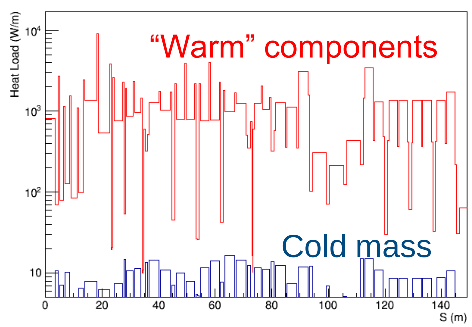




MDI - and nozzle in particular - optimized to reduce background loads to detector by10 to 50 times compared to the MAP13 of June 2013, to about the 1.5-TeV MC levels

Optimized individually for each magnet in the 300m collider the system of tungsten masks and liners





Peak power density, dynamic heat loads on cryogenics and radiation loads on materials reduced ~100 times, to the design values

FY14:

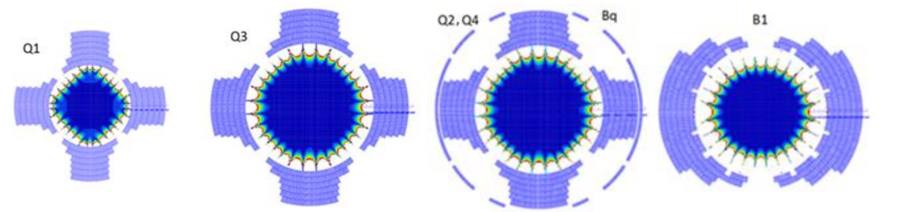
- Complete and document HF work
- Re-run 1.5-TeV MC

Once the lattice is available, complete building MARS model of 3-TeV MC, perform initial heat load and detector background studies; document

Refocus MDI effort to ED studies on targetry, Front End and muon acceleration

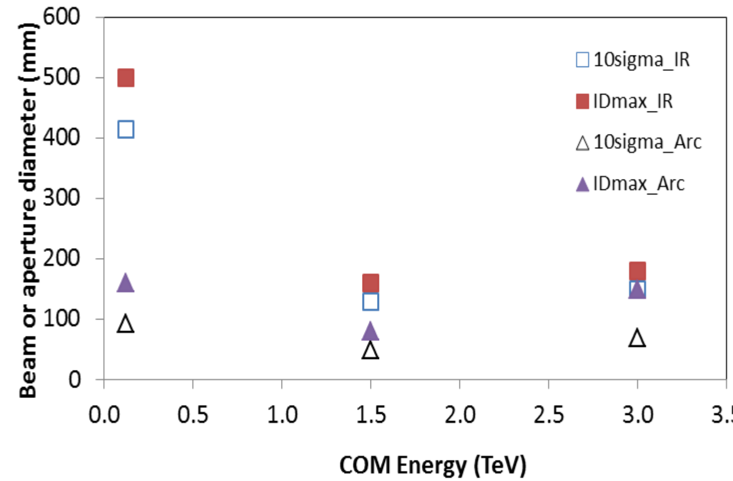
Alexander Zlobin (FNAL)
Magnets

- HF IR Nb_3Sn magnets
  - IR magnet aperture is large 32-50 cm
  - Results
    - B_{des}~17-18 T requires *6-layer coils* for quench protection and to limit maximum coil stress
    - 20-50% operation margin in IR magnets
- HF Nb_3Sn CCS, MS and Arc magnets
  - Max B_{op}=10 T (D), max G_{op}=36 T/m (Q)
  - Beam aperture: 92 mm (Arc), 231 mm (MS,CCS)
    - defined in arc by beam sagitta in dipoles
  - Large aperture cosθ Dipoles and cos2θ Quads
  - coil ID 16 cm (Arc) and 27 cm (MS, CCS)
  - Results
    - Max B_{op}=10 T with ~30% margin at 4.5 K (B_{max}~14 T) with *2-layer dipole coils*
    - Max G_{op}~36 T/m with ~60-80% margin at 4.5 K (max B_{coil} ~15 T) with *2-layer quadrupole coils*



Q1, 320 mm Q3, 500 mm Q2,4, 500 mm B1, 500 mm

MC Magnets: 0.125 → 1.5 → 3 → 6 TeV



FY14: HF cryostat integrated with W masks and liners
To GARD: 20-40cm coil ID, B_{des} ~18 T Nb_3Sn and B_{des} > 25 T HTS

Lewis Keller (SLAC)

$e^+e^- \rightarrow \mu^+\mu^-$ as the Muon Source

Annihilate E > 43.7 GeV positrons and atomic electrons to produce low-emittance muon beams for injection into a ~3 TeV muon storage ring ($\Delta p/p$ = 0.1% at the IP).

A 44.5-GeV e+ beam produces (σ = 0.42μb) muons with central energy E_0 = 22 GeV and corresponding $\Delta p/p$ = 13.5%.

Target chosen: 0.4cm Cu (0.28 rl and equivalent thickness = 10^{24} e^-/cm^2)

Comparing p-source with ILC-like 41μA positron source, one gets:

Source	Proton	e^+e^-
μ/bunch	2.0×10^{12}	1.1×10^{7}
$\gamma\varepsilon_T$ (πm)	25×10^{-6}	5.4×10^{-8}
β^* (cm)	0.5	0.025
L (cm^{-2} s^{-1})	8.8×10^{34}	2.0×10^{28}

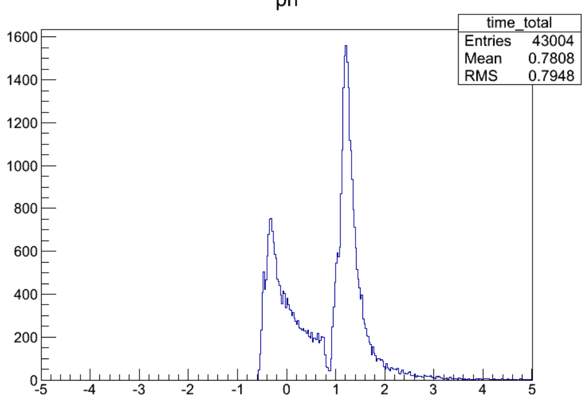
Because of large divergence in muon production angle, only a factor of 450 reduction in $\gamma\varepsilon_T$. To get a comparable luminosity, one could increase positron beam current x2000, i.e. to 80 mA, beyond current technology.
Target: ~0.5 MW in Cu; a very long plasma as alternative

Tom Markiewicz (SLAC)

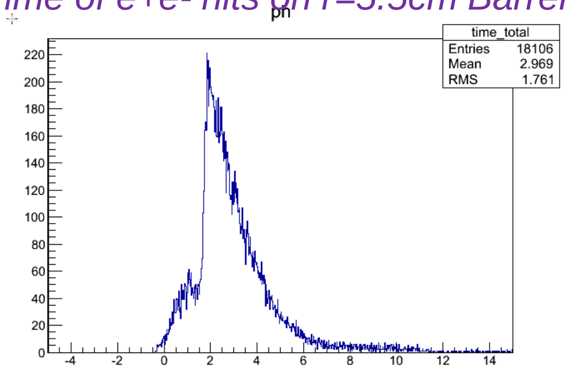
γ & e^+e^- Hits in Muon HF

For the June 2013 MDI configuration, FLUKA+Geant3 background results at SLAC agree within 15% with those by MARS15 at Fermilab.

Time of photon hits on r=5.5cm Barrel



Time of e+e- hits on r=5.5cm Barrel



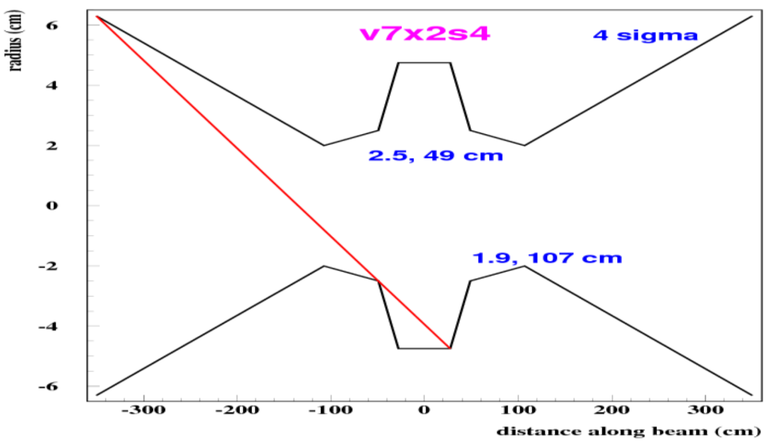
- Irreducible backgrounds emanating from the IP come predominately from the downbeam cone tip and are thus largely in time with the collision
- ~1 MeV photons that convert (2% probability) in Silicon VXD and Tracking layers are the dominant background
- Timing cuts not particularly effective given (in this IR geometry) proximity of cone tips to the IP (±0.7ns away)
- >10% occupancy per BX obtained
- Reading each readout element each BX probably required

Future work:

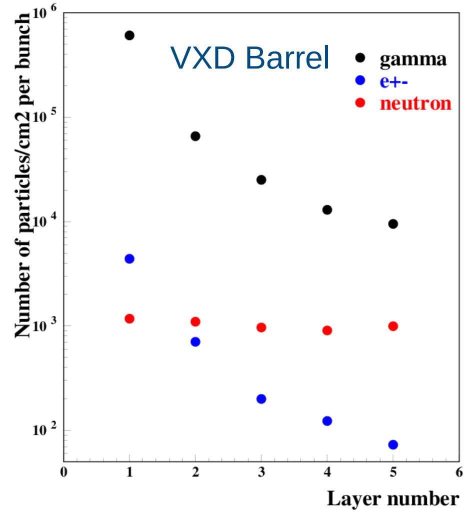
- Fix problems with how FLUKA timing info is used
- Consider using the optimized FNAL MDI configuration
- Investigate larger beam pipe, more relaxed shielding cone geometries

Sergei Striganov (FNAL)
HF Backgrounds

Thorough W-nozzle optimization since June 2013: v2 → v7x2s4



Particle	1.5-TeV MC 10deg	125-GeV HF V2 (MAP13 06/13)	125-GeV HF V7x2s4 (Jan. 2014)
Photon	1.8×10^{8}	3.2×10^{9}	2.8×10^{8}
Electron	1.0×10^{6}	1.2×10^{8}	2.0×10^{6}
Neutron	4.1×10^{7}	1.7×10^{8}	5.2×10^{7}
Ch.Hadron	4.8×10^{4}	1.0×10^{5}	1.0×10^{4}
Muon	8.0×10^{3}		2.8×10^{3}



Layer radii: 5.4, 9.45, 13.49, 17.55, 21.59 cm;
-20 < z < 20 cm.

 # hits/cm²/BX:
1.3×10^{4} in first layer at r=5.4cm

Occupancy in 10×10μm pixel:
2.6% in first layer
< 0.3-0.5% in other layers and VXD endcap

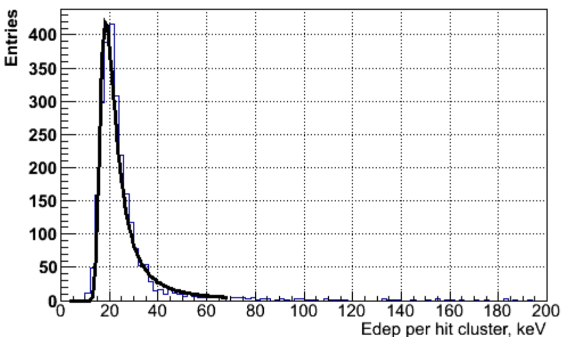
- **FY14:**
- Document HF work
- Re-run 1.5-TeV MC
- Start first pass for 3-TeV MC

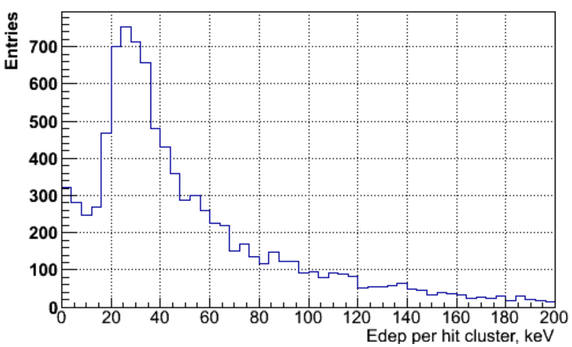
Nikolai Terentiev (CMU)
Background Rejection in VXD and Tracker

In addition to timing with < 100 ps time resolution in front-end ROC and double layer geometry to reject space random neutral background and preserve IP charged tracks (in trigger software):

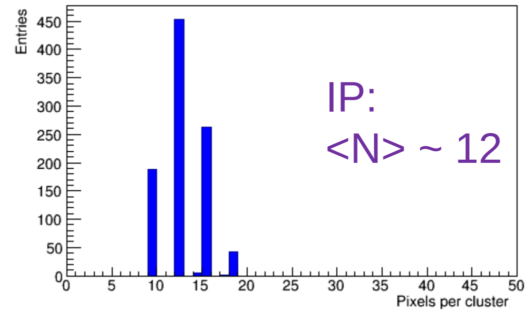
Background rejection factor in single layer Si VXD and Tracker:

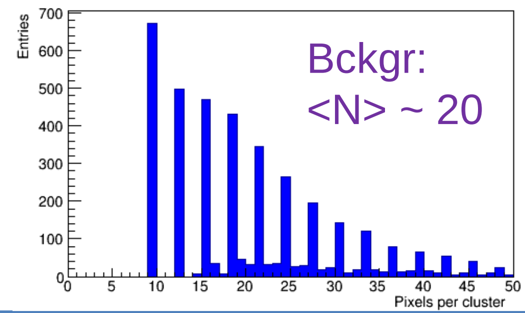
1. Hit cluster energy deposition cuts: 1.5 to 2





2. Number of pixels per cluster: ~2.5





FY14:

- Combine all rejection techniques
- Run HF
- Re-run 1.5-TeV MC

In longer term, implement 3-TeV MDI in ILCroot and study efficiency of combined rejection set

(Post-P5) MDI Plans

MDI activities to be completed by the end of FY14:

- Complete implementation in the HF MARS model of magnet cooling system, improved timing and hit scoring algorithms
- Re-run MARS for HF magnet protection & background files and perform studies on background rejection in detector components
- Document results on HF magnet protection and detector backgrounds
- Re-run 1.5-TeV MC

MDI activities to be completed by the end of 2014 – early 2015:
Complete building MARS model of 3-TeV MC, perform initial heat load and detector background runs; document findings

Refocus MDI effort to energy deposition studies on Targetry, Front End, muon acceleration and higher-field Nb_3Sn and HTS magnets (Transferred to GARD?)