E161 SPECTROMETER DESIGN

RPC Meeting, August, 2001

P. Bosted

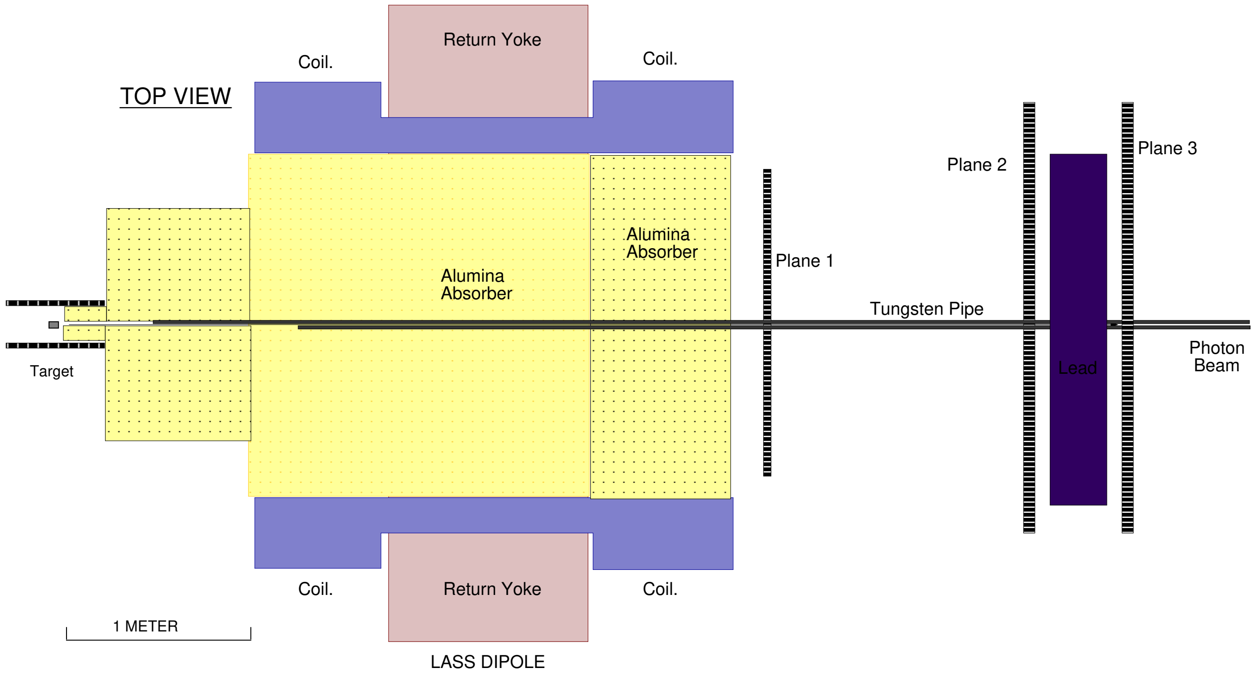
- Design Criteria: Resolution, Rates, Backgrounds
- Problem with Proposal Design
- Adding Shims to LASS
- Adding more Alumina to LASS
- Using Magnetized Iron
- Things To Do

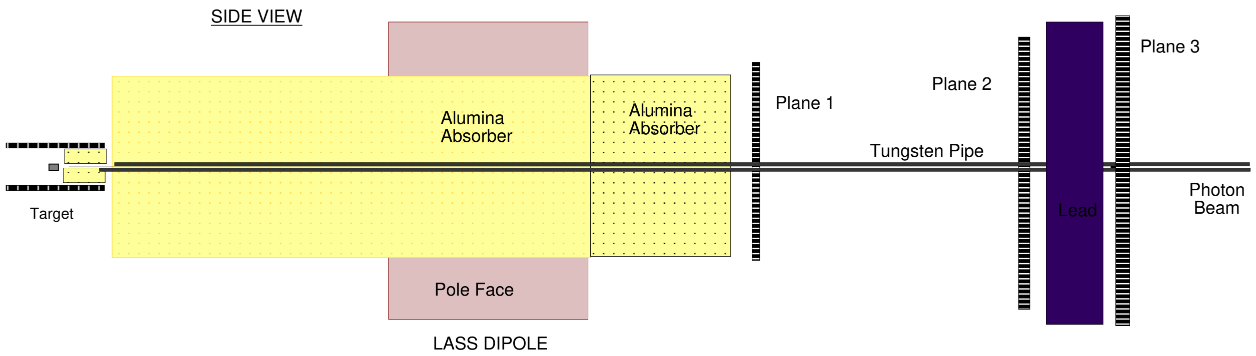
DESIGN CRITERIA

- **High enough counting rates for $p_t > 0.5$ GeV, $P > 5$ GeV.**
- **Good p_t resolution: ideally want 0.08 GeV. As resolution increases, need more statistics to correct for decay backgrounds**
- **Minimize pion and kaon decays (want lots of int. len. close to target).**
- **Good acceptance for second muon from Bethe-Heitler process**
- **Minimize sprinkle hit and non-muon track rates in detectors**
- **Backgrounds are from non-charm hadronic interactions, e pair production, and Compton scattering.**
- **Conclude: hard to meet all these goals at once!**

PROPOSAL DESIGN

Uses 3 m of alumina absorber, LASS dipoles with 21 kG-m, ±5 cm W collimator around 0.85 cm radius beam pipe.



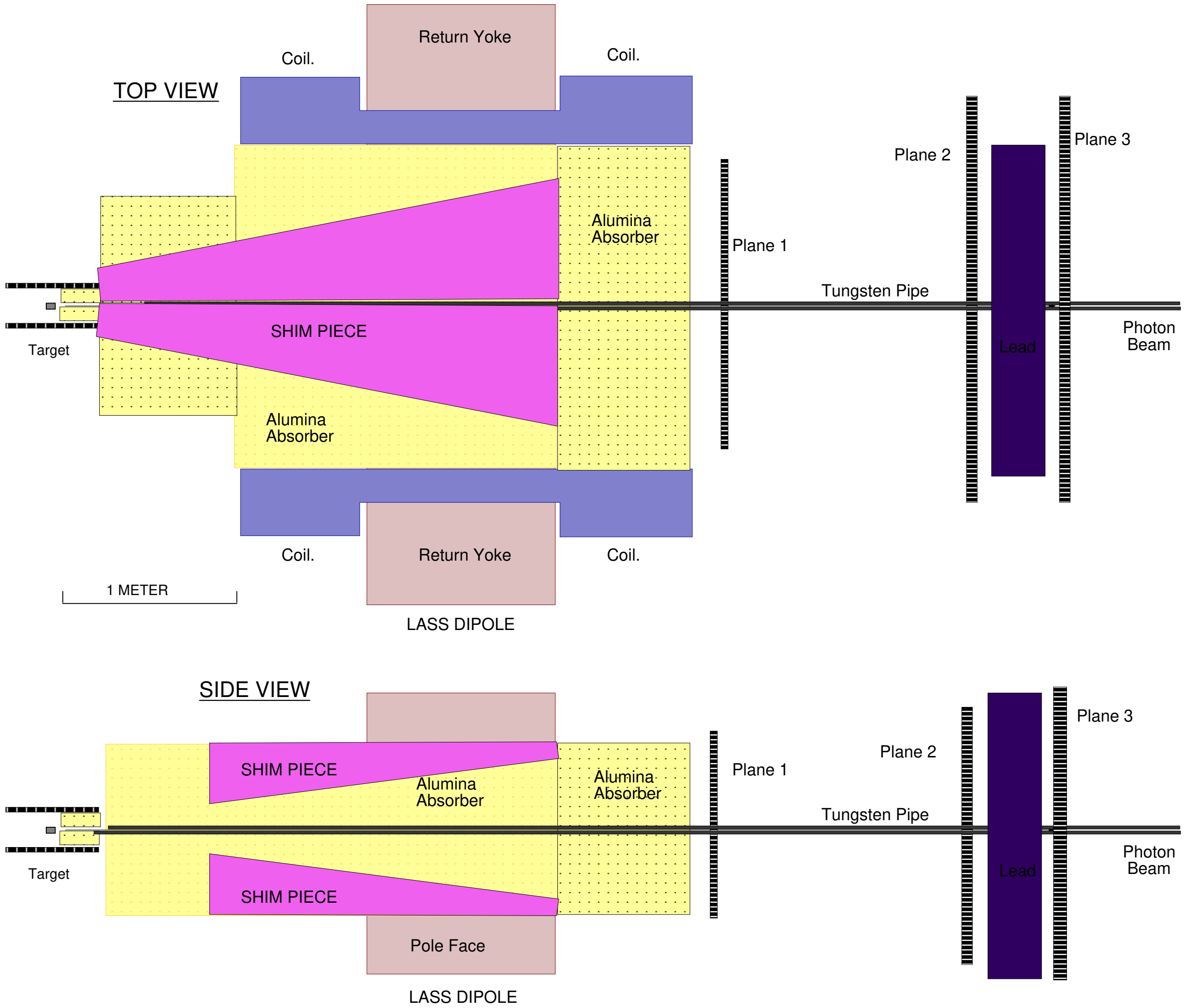


PROBLEMS WITH PROPOSAL DESIGN

- All rates calculated with flux of 5×10^7 photons/spill, spectrum with coherent peak at 40 GeV (about 3x proposal flux).
- Hadronic punch-through rates in alumina were under-estimated by factor of about 3. Now using detailed PYTHIA simulations to generate hadronic events, rather than simply one pion per NI. Get about 17 pions/spill, 12 muons/spill, 4 proton sprinkle hits/finger per spill. Too high by factor of 5 or so.
- Small angle BH muons go through too much W: many are lost.
- Biggest problem, get about 120 sprinkle hits/finger per spill from BH electron pairs: too high by factor of 100!

ADD BIG MAGNETIC SHIMS

Will this work to generate about 15 kG over length of 2.5 m or so?



ADD BIG MAGNETIC SHIMS

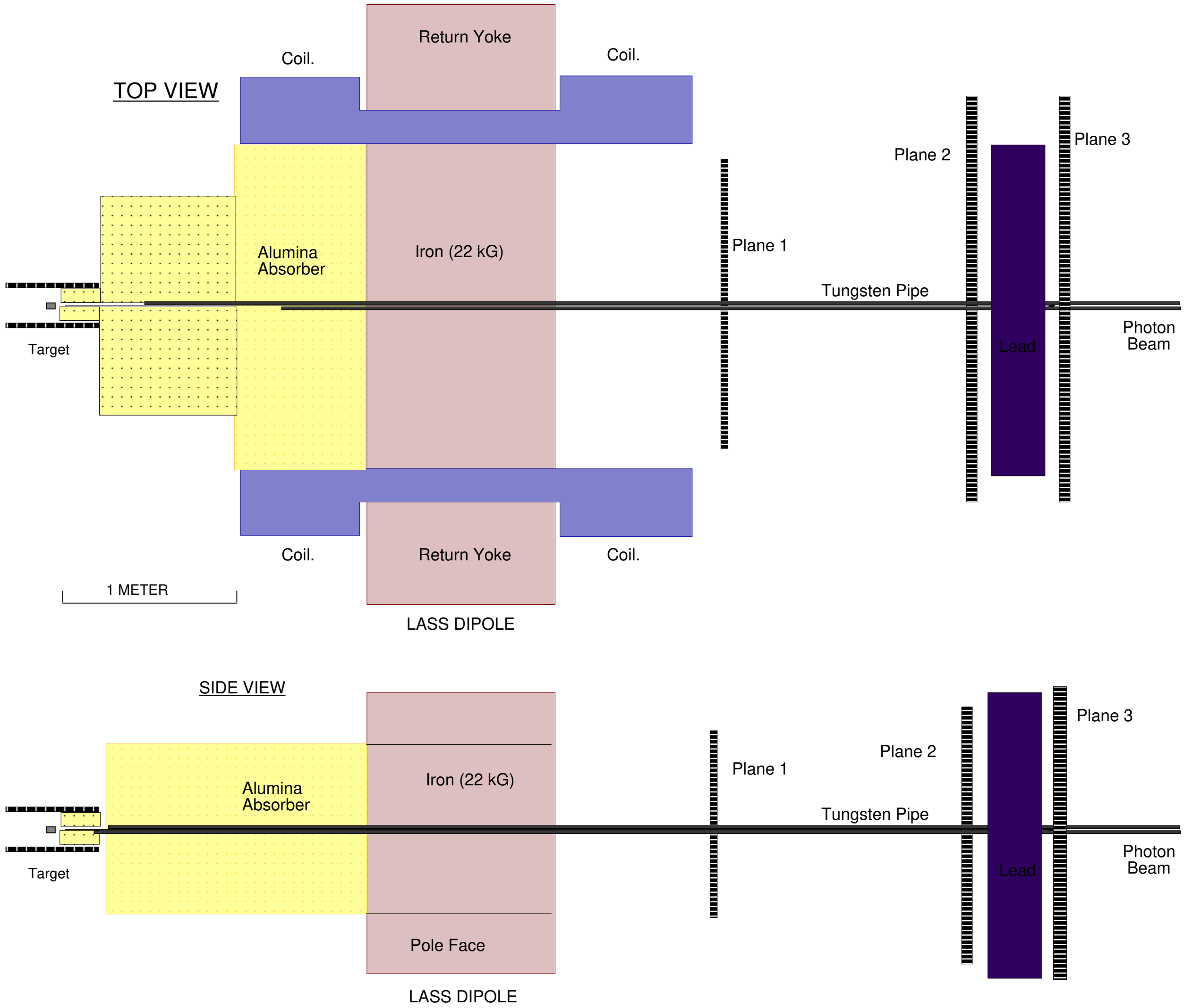
- This bends electrons sooner: hit W earlier and hit rate goes down from 120 to 4 hits/finger/spill: now in right ball park!
- Bends muons sooner, so mostly miss the W collimator or spend less time in it (assuming W starts 2 m from target). We now get most of the 12 BH single muons/spill.
- Hadron punch through rate about the same, but get more pion tracks (38/spill) perhaps due to statistical fluctuation. Still too high.
- pt Resolution is good at (0.081, 0.090, 0.113 GeV) at P=5, 10, 15 GeV, respectively. Almost same as Design, because even though more integrated field, it is closer to the target.

ADD 80 CM OF ALUMINUM

- add aluminum between alumina and front detector
- Rate from BH electron/positrons goes to zero (based on 1/100 sample), not even any photons recorded.
- Compton rate is about 0.03 hits/finger/spill, which is fine.
- Hadron punch through rate goes down factor of 2 to 3 on sprinkle hits, factor of 4 to 5 for unwanted pion tracks.
- pt Resolution is goes to (0.088, 0.108, 0.134) from (0.081, 0.090, 0.113 GeV) at P=5, 10, 15 GeV. Probably increase in statistics by factor 2 to 3 is worth it.

FILL LASS WITH IRON

This has 2 m alumina, then 1.1 m of iron at 22 kG



FILL LASS WITH IRON

- This would take less electric power, and provides more absorber for hadronic punch-through. Could iron be extended in z to make longer effective length?
- No electron/positron hits because assume zero field in beam pipe. Probably used flared pipe to avoid low momentum ones with big m.s. angle, and the 110 Compton photons hitting pipe near detectors.
- Hadron rates go down more, but surprisingly still have some pion and proton hits:

	Front		Back		
particle	hits	$<E>$	hits	$<E>$	tracks
elec+pos	7	0.019	9	0.014	4
muons	9	2.209	5	3.353	5
pions	15	1.190	6	2.299	6
protons	104	0.015	25	0.030	3
neutrons	711	0.041	225	0.078	191
photons	237	0.012	77	0.020	42

- **Mostly come from small angle, high momentum pions (hit alumina up to 1 m from target). Would more field help? Is there bug in code?**
- **Resolutions are worse, but not so terrible (?): (0.113, 0.135, 0.161). Again, want more integrated field.**

PARTIAL "TO-DO" LIST

- **Check GEANT setup carefully for bugs.**
- **Field calculations with shims: what is possible?**
- **Field calculations with magnetized iron: what is possible (with or without LASS)**
- **Full simulation of tradeoff of statistics and resolution.**
- **Is pion decay to muons being underestimated (GEANT seems to give more, in alumina, than in proposal)?**
- **What about using like-sign di-muon signal (one comes from a kaon decay, other is semi-leptonic)? Lower statistics, but better signal/noise, and good resolution less important.**
- **Can BH muons pairs be used to measure $P_t P_B$? In principle, they can, but resolution and acceptance issues need to be simulated.**