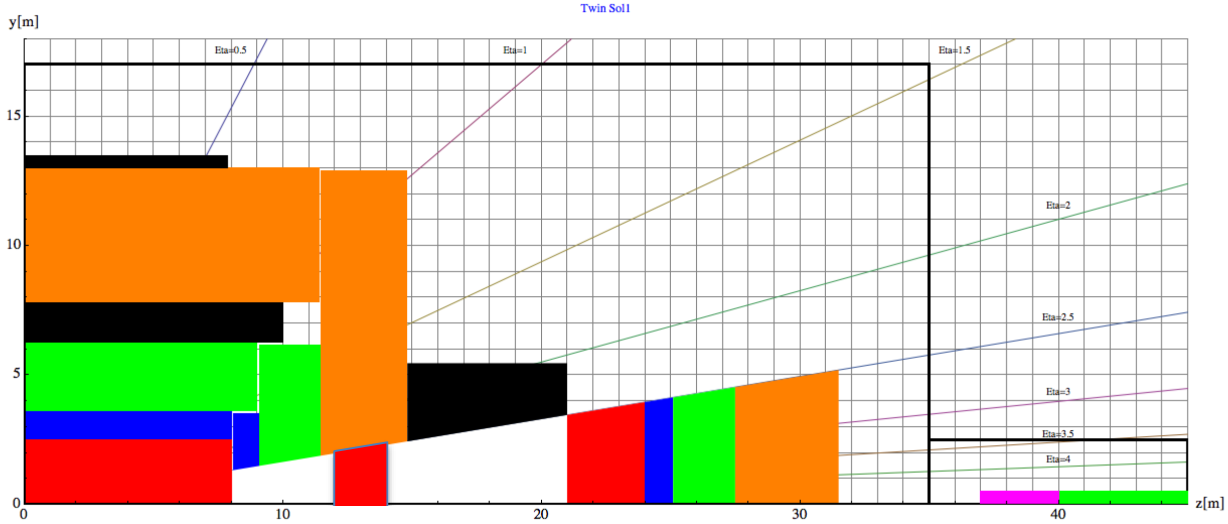
Detector Geometry update, FCC week organization

FCC Hadron Detector Meeting
Jan. 21st, 2016

W. Riegler

Baseline Geometry, Twin Solenoid



Barrel:

Tracker available space:
R=2.1cm to R=2.5m, L=8m

EMCAL available space:
R=2.5m to R= 3.6m → dR= 1.1m

HCAL available space:
R= 3.6m to R=6.0m → dR=2.4m

Coil+Cryostat:
R= 6m to R= 7.825 → dR = 1.575m, L=10.1m

Muon available space:
R= 7.825m to R= 13m → dR = 5.175m

Coil2:
R=13m to R=13.47m → dR=0.475m, L=7.6m

Endcap:

EMCAL available space:
z=8m to z= 9.1m → dz= 1.1m

HCAL available space:
z= 9.1m to z=11.5m → dz=2.4m

Muon available space:
z= 11.5m to z= 14.8m → dz = 3.3m

Forward:

Dipole:
z= 14.8m to z= 21m → dz=6.2m

FTracker available space:
z=21m to R=24m, L=3m

FEMCAL available space:
Z=24m to z= 25.1m → dz= 1.1m

FHCAL available space:
z= 25.1m to z=27.5m → dz=2.4m

FMuon available space:
z= 27.5m to z=31.5m → dz=4m

A few points of the baseline geometry are under revision

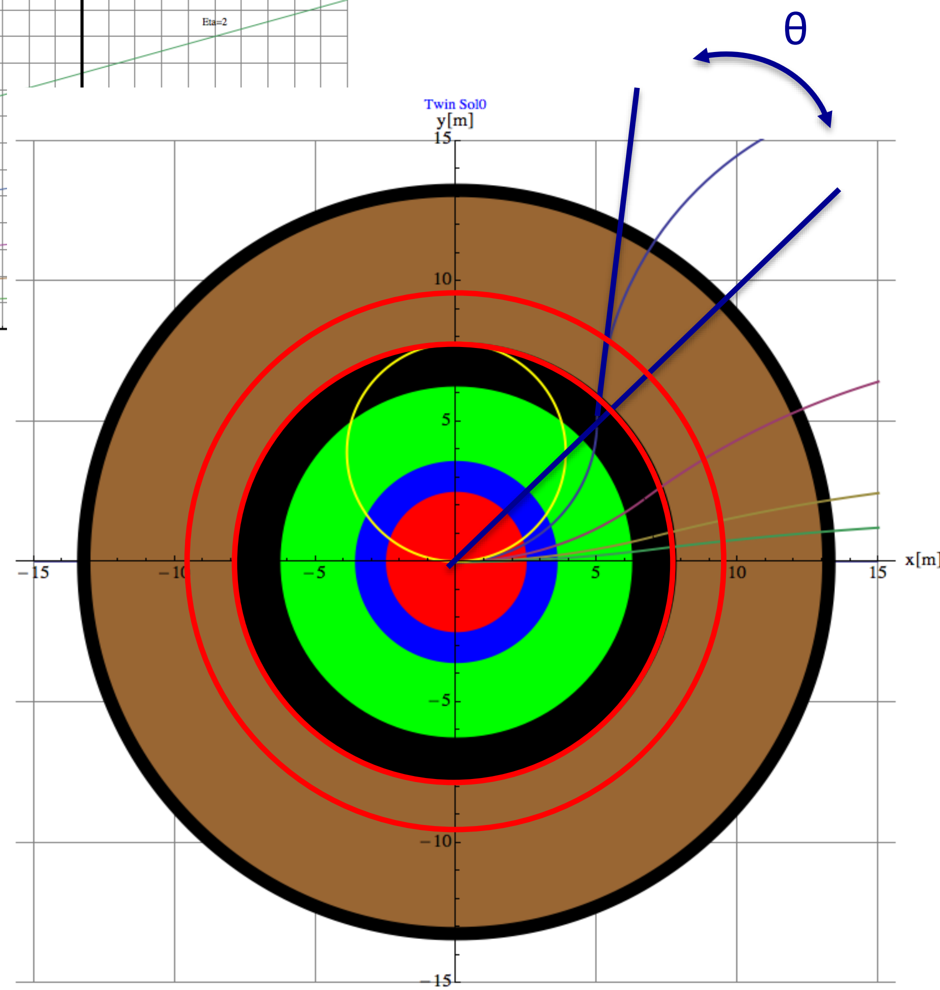
- **The gap between the two solenoid coils**
- **Cryostat of Twin Solenoid and Dipole**
- **Dimensions of Tracker/ECAL/HCAL**
- **Use a long TileCal Barrel and assume LArg for the endcap**
- **L* for inclusion of the compensator magnet and infrastructure between TAS and Triplet.**

→ **This is a list of things where work is in progress**

→ **The impact will be on radiation studies and machine optics, but not on the performance parametrization**

→ **We will not change things before the Rome FCC week, the next geometry update will be done some time in the middle of the year when the mentioned points are 'consolidated'.**

Twin Solenoid Size

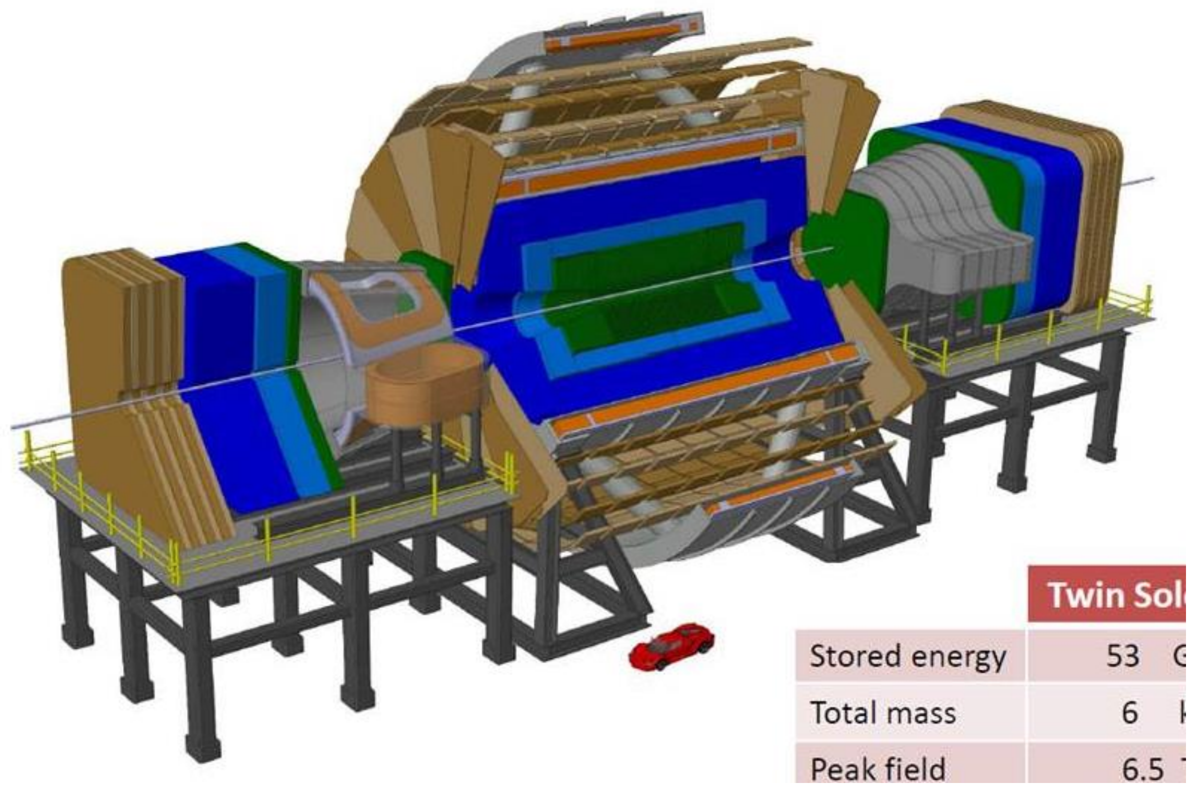


The gap between the two solenoid coils that is currently around 5m is being minimized in order to reduce the overall system size.

A smaller gap is fine for the muon measurement (Dec. 9th meeting).

Big impact on shaft size, cavern size …

Solenoid and Dipole Cryostat



The geometry for the radiation calculation does for now only assume the cold mass (Aluminum) and not the cryostats.
→ To be implemented.

Tilecal Module Size

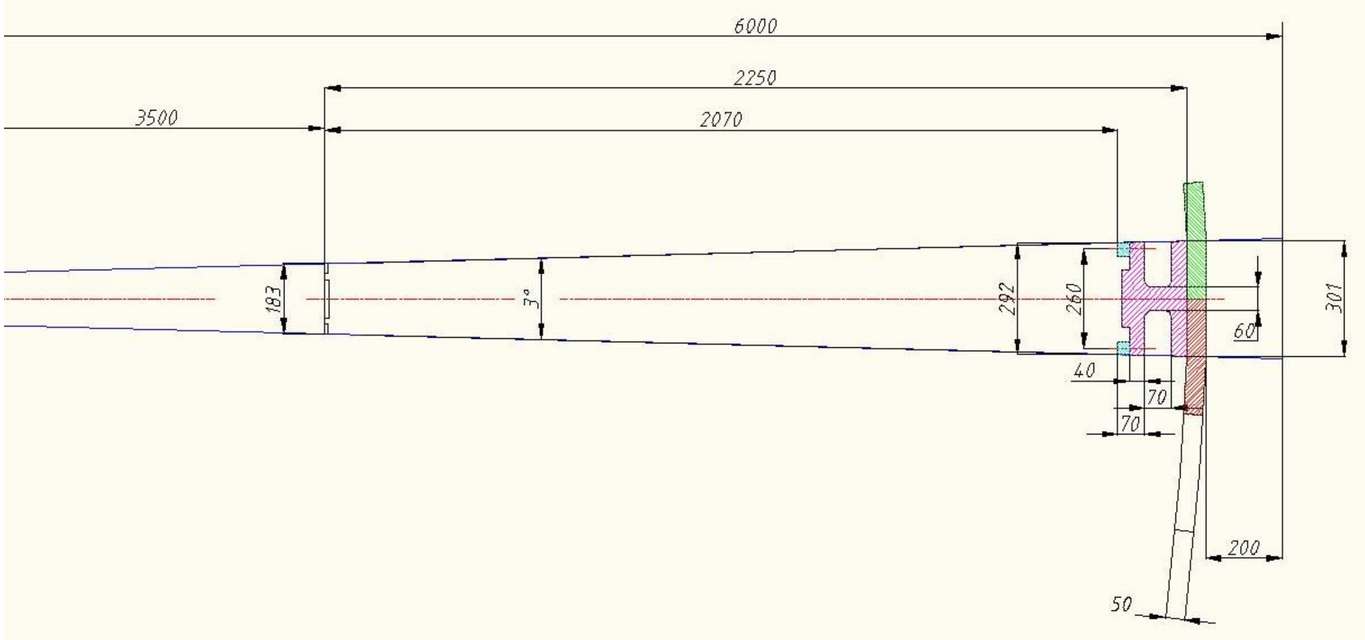
Baseline:

Tracker available space:
R=2.1cm to R=2.5m, L=8m

EMCAL available space:
R=2.5m to R= 3.6m → dR= 1.1m

HCAL available space:
R= 3.6m to R=6.0m → dR=2.4m

Update: →

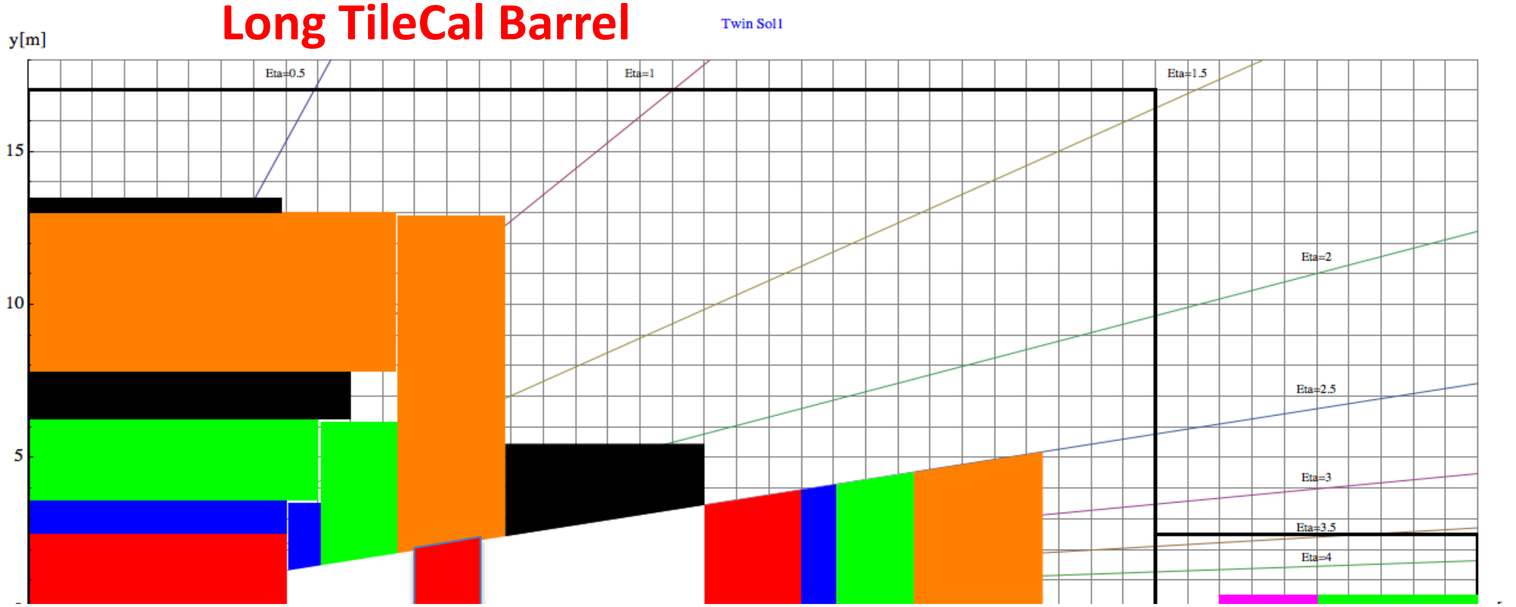


- **Rmin=3.5m** (OR 3.4m IF em calo+tracker <2λ). Need to keep 12λ in total…
- **Rout =5.8m** (with supports and Xbars). Need 20cm for supports/rails at least…
- Depth active cells = 207 cm = 10λ (;1λ=20.7cm).
- **Depth Outer Supports=20cm** (15cm girder+5cm Xbars)

→ Look at realistic assumptions of EMCAL and adapt tracker and ECAL

Long TileCal Barrel

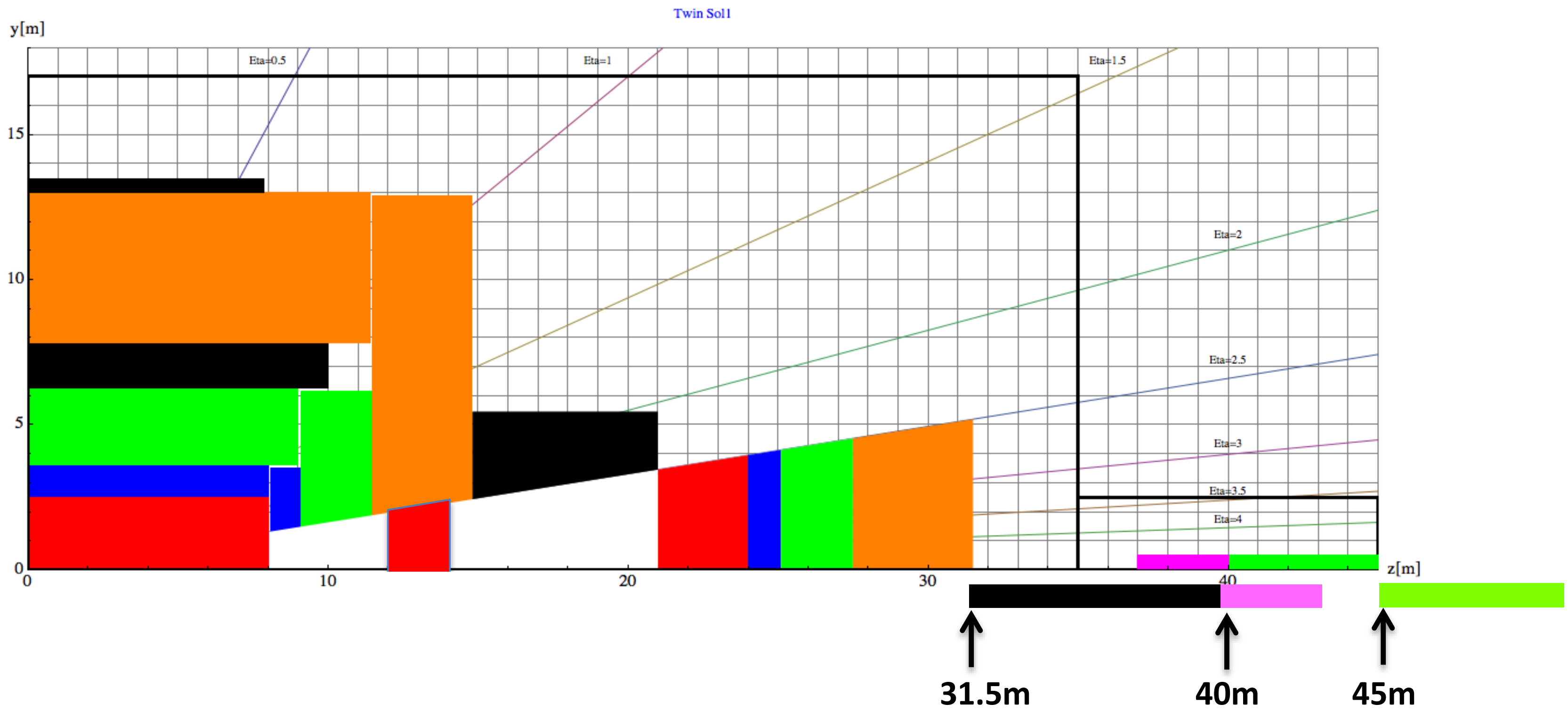
Baseline



Update

Radiation load for the (scintillator based) TileCal barrel seems excessive.
→ long TileCal Barrel and make the hadronic end-cap with same technology as EMCAL (LArg/Si+absorber/…)

L* and Compensators



For the baseline geometry we assumed an L* of 40m = distance from the IP to the start of the magnetic field in the triplet.

Up to now we assumed a TAS of 3m length with no free gap between TAS and Triplet.

We omitted necessary compensator magnets for the dipoles, that need to be placed between the dipole and the triplet.

- → **Increase L* to 45m**
- → **Leave 2m between TAS and Triplet**
- → **8.5m envelope for a (normal conducting) dipole compensator + beampipe + infrastructure + …**

Scattering of High Energy Muons

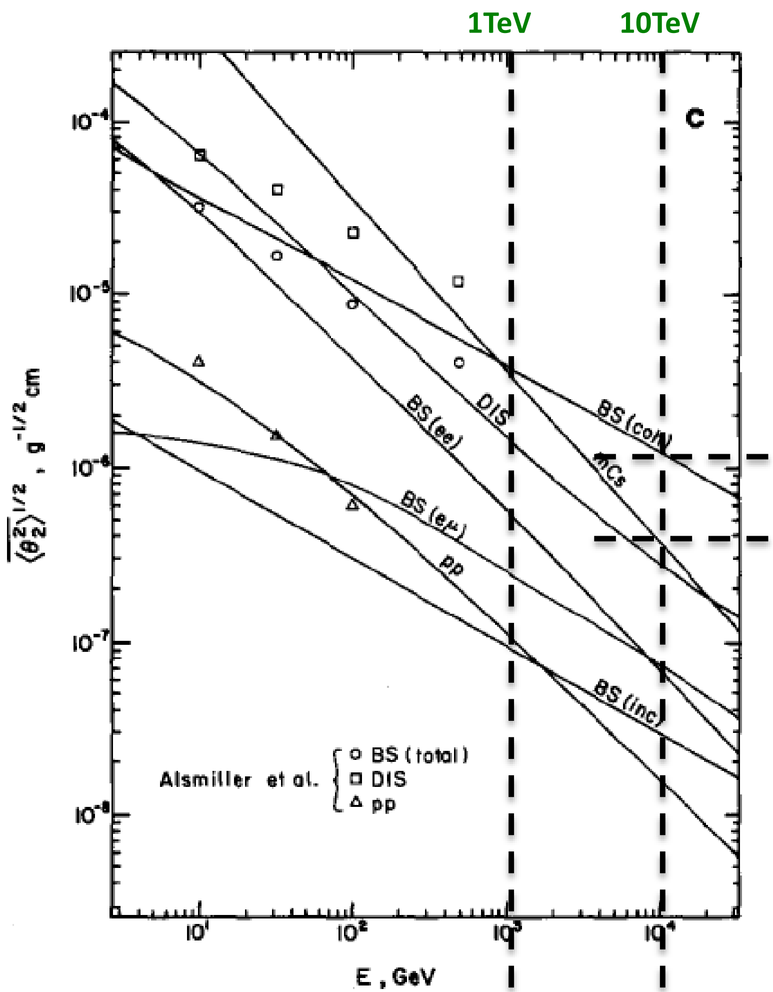


Fig. 17. Rms angle in bulk matter for muons as a function of energy due to the various processes in (a) beryllium, (b) soil, (c) iron and (d) lead. Also shown are comparisons with Alsmiller et al. in (b) and (c). Legend: BS, bremsstrahlung; (coh), coherent (inc), incoherent nuclear; ($e\mu$), muon vertex (ee), electron vertex, atomic electron; DIS, deep inelastic scattering; pp, pair production; mCs, multiple Coulomb scattering.

GEANT simulations (discussed in previous meetings) suggested that the effect of Bremsstrahlung for High Energy Muons (1-10 TeV) does not add significantly to the angular scattering of muons.

The above quoted publication (pointed out by A. Ferrari, F. Cerutti) would however suggest that at 10TeV, Bremsstrahlung dominates over Coulomb scattering by about a factor 3.

It would imply that the momentum resolution due to angle measurement in the muon system is affected by a factor 3 !!

Possibly the approximations in this paper are much coarser than what we have in GEANT today, but the point has to be clarified.

GEANT team is looking into that. Theory, LHC data, Cosmics data with LHC experiments …

Nuclear Instruments and Methods in Physics Research A251 (1986) 21–39 21
North-Holland, Amsterdam

ENERGY LOSS AND ANGULAR CHARACTERISTICS OF HIGH ENERGY ELECTROMAGNETIC PROCESSES

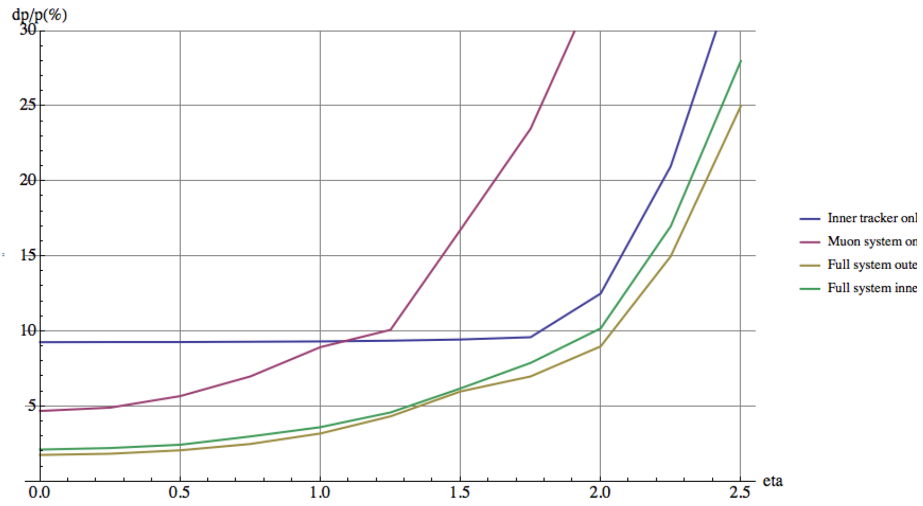
A. VAN GINNEKEN

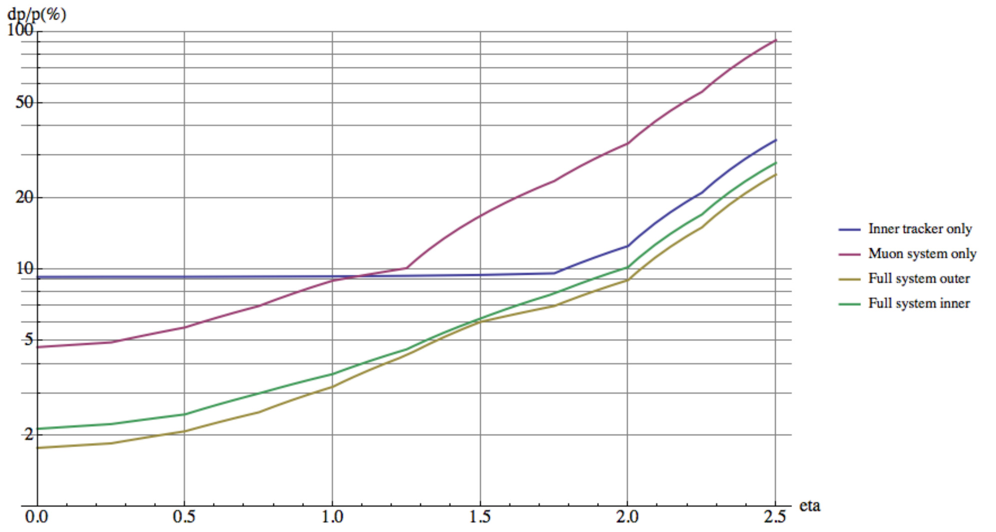
Fermi National Accelerator Laboratory PO Box 500, Batavia, IL 60510, USA

Received 13 March 1986

For high energy protons, pions and muons (up to 30 TeV) the energy and angle of the final state particles in bremsstrahlung, direct pair production and, for muons, deep inelastic scattering are determined as a function of the fractional energy loss of the incident particle. The results are parametrized for convenient use in Monte Carlo simulations. The average energy loss and rms angular deflection of muons, pions and protons in bulk matter are determined and compared with other work.

Momentum resolution for a 10 TeV/s muon vs. eta





Twin Solenoid assuminginner tracker with baseline resolution curves and multiple scattering limit in the muons system.

P_T=10TeV/c eta = 0: 5% muon standalone (angle)
10% inner tracker only
2% combined

P_T=10TeV/c eta=2.: 35% muon standalone (angle)
12.5% inner tracker only
8% combined

Compare to the CMS numbers:

P_T=1TeV/c, 0<eta < 0.8: 20% muon standalone (angle)
10% inner tracker only
5% combined

P_T=1TeV/c, eta 0<eta<2.4: 40% muon standalone (angle)
20% inner tracker only
10% combined

FCC Week Rome, April 11-15

Version: 0.5 Date: 08/01/2016

Preliminary FCC Week 2016 Program

Time	Sunday	Monday (11.4)		Tuesday (12.4)				Wednesday (13.4)								Friday (15.4)	Time
08:30-09:00		Registration	Welcome (invited speakers)	FCC-hh Injector & Overall Optics Design	SC Magnets	Physics/Pheno I Physics at 100TeV (SM, Higgs, BSM)	RF I RF parameters hh and system concept	FCC-hh Inj., extr., RF sections, TLs	SC Magnets	MDI		Beam vacuum & cryogenics	FCC-ee energy calibration & pol.	SC Magnet Design	Physics/detecto software projec		08:30-09:00
09:00-09:30																	09:00-09:30
09:30-10:00																	09:30-10:00
10:00-10:30		Coffee Break		Coffee Break				Coffee Break								Coffee Break	10:00-10:30
10:30-11:00				FCC-hh Collimation	SC Magnets	Physics/Pheno II Heavy ions, njectors Physics o	RF II RF parameters ee and system concept	FCC-hh Beam dump concepts	SC Magnets	MDI	Communications WG	Cryogenics (II) F. Millet/CEA	FCC-ee error tolerances, emittances	Beam induced effects	Comon detector technologies		10:30-11:00
11:00-11:30																	11:00-11:30
11:30-12:00																	11:30-12:00
12:00-12:30		Lunch		Lunch				Lunch				Lunch				Lunch	12:00-12:30
12:30-13:00																	12:30-13:00
13:00-13:30																	13:00-13:30
13:30-14:00				FCC-hh Beam dynamics collective effects	SC Magnets	Physics/Pheno III Physics of FCC-ee	RF III (S)RF R&D cavity fabrication	Beam transfer, warm magnets, instrumentation	SC Magnets	FCC-hh experiments	FCC-ee overview, beam-beam, parameters	Implementaion, Electricity, CV	FCC-ee Injector Design & top-up injection	FCC-he experiments	FCC-ee experiments		13:30-14:00
14:00-14:30																	14:00-14:30
14:30-15:00																	14:30-15:00
15:00-15:30	Registration	Coffee Break		Coffee Break				Coffee Break									15:00-15:30
15:30-16:00				FCC-hh EIR design + related MDI	SC Magnets	Physics/Pheno IV Selected topics	RF IV RF efficiency optimizitaion	Beam energy deposition & machine protect.	SC Magnets	FCC-hh experiments	FCC-ee optics design IR arcs & related MDI	Safety, reliability, survey	16T Magnet Cost Model	FCC-he experiments	FCC-ee experiments		15:30-16:00
16:00-16:30																	16:00-16:30
16:30-17:00																	16:30-17:00
17:00-17:30		Teatime		Tour (3 hours, Sistine Chapel and Vatican museums)				Teatime									17:00-17:30
17:30-18:00								Poster Session				Plenary session: special topics					17:30-18:00
18:00-18:30																	18:00-18:30
18:30-19:00								FCC / EuroCirCol Collaboration Boards		Gender Equality working group							18:30-19:00
19:00-19:30		Welcome reception															19:00-19:30
19:30-20:00								Workshop Banquet with Poster Award Ceremony									19:30-20:00

Plenaries on Monday and Friday, 4 parallels Tuesday/Wednesday/Thursday.

Sessions of 90 minutes with 3-4 talks.

Tuesday:
4 sessions of Physics/Phenomenology (hh and ee)

Thursday for FCC-hh:
1 session on MDI (3-4 talks)
2 session of hh experiments (6-8 talks)
1 session on common software (3-4 talks)
1 session on common technologies (3-4 talks)

Discussion …

Academic Training Lecture Regular Programme

FCC (1/4)

by Michael Benedikt (CERN)

Tuesday, 2 February 2016 from **10:30** to **12:30** (Europe/Zurich)
at CERN (222-R-001 - Filtration Plant)

Description Following the 2013 update of the European Strategy for Particle Physics, the Future Circular Collider (FCC) Study has been launched by CERN, to design an energy frontier hadron collider (FCC-hh) in a new 80-100 km tunnel with a centre-of-mass energy of about 100 TeV, an order of magnitude beyond the LHC's, as a long-term goal. The FCC study also includes the design of a 90-350 GeV high-luminosity lepton collider (FCC-ee) installed in the same tunnel, serving as Higgs, top and Z factory, as a potential intermediate step, as well as an electron-proton collider option (FCC-he). The physics cases for such machines will be assessed and concepts for experiments will be developed in time for the next update of the European Strategy for Particle Physics by the end of 2018.
The lectures will summarize the machine concepts and parameters and discuss the essential technical components to be developed in the frame of the future circular collider studies. Key elements are superconducting accelerator-dipole magnets with a field of 16 T for the hadron collider and high-power, high-efficiency RF systems for the lepton collider. In addition the unprecedented beam power presents special challenges for the hadron collider for all aspects of beam handling and machine protection. The status of the infrastructure study will also be summarized. The physics questions that may be answered by such machines will be discussed and initial considerations for experiments will be presented.

Other occasions 2 3 4

Academic Training Lecture on FCC, Feb. 2,3,4,5 10:30 – 12:30

Tue. 2nd: Physics
Wed. 3rd: Experiments
Thu. 4th: Machines
Fri. 5th: Infrastructure