status and plans
for 2018 testbeam campaign

Workshop “The evaluation of the leading hadronic contribution to the muon anomalous magnetic moment”

Mainz, 19-23 february 2018

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μ-on-e Test activity in 2018

- **We have been allocated also 1 week** (***week 34, 22-29 August 2018***) **of high energy muon beam (160 GeV) in H8 (A138)**
  (*optimization of this beam started)*

Main aim of the 2018 test activities:

- *study of a possible final apparatus*
  - *use of calorimeter*
  - *study of event multiplicity*
  - *localization of the interaction vertex*
  - *Mutiple Scattering study*
- *how to select elastic events*
- **ambitious goal:** **very preliminary mesurement of $d\sigma/d\theta_e$ (even if with a large error?)**

all Testbeams user schedule for 2018

schedule issue date: 18-Jan-2018 Version: 0 LHC Exp. PS/SPS Exp. Other Exp. INT Exp.

	Mar			Apr				Mai					Jun					Jul					Aug					Sep					Oct					Nov					Dec		
Week	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50					
Machine																																											
East Area T9	P356 ARIADNE 19			AZALEA 7		CMS MTD 7		RE22 muons 7	EnuBet 14		TIC 7	INSU-LAB 7	LHCb TORCH 21			RE13 T2K sFGD 14		BL4S 7	ALICE FOCAL 7	RE22 PANDA 21			RE22 muons 7	RE13 T2K TPC 14			EnuBet 14		BL4S 12		ALICE PHOS 14		SHiP com-bined 7	LHCb TORCH 21										
East Area T10	ALICE TOF-MRPC 12		RE21 CBM-PSD 7	ALICE ITS 7		ALICE ITS 7				ALICE ACORDE 7	ALICE TOF-MRPC 14		ALICE ITS 7	ALICE MFT 14		ALICE ITS 7	eAstro-gam 14		ALICE ITS 7	P355 35				RE21 CBM-PSD 7	ALICE ITS 7	ALICE FIT 14		SHiP com-bined 14		ALICE ACORDE 7	ALICE ITS 7	ALICE TOF-MRPC 12										
T2 - H2		HERD FIT 7	NA62 GTK 7	NA61 SHINE 14							Calice (Ahcal) 7		ATLAS ZDC 7	Calice (Ahcal) 7	NA61 K 60GeV/c 7	NA61 SHINE 21			AXIAL 7	KLEVER 7	LEMMA 7	CMS HGCAL 7	CMS HCAL 14	Calice (Sdhcal) 14	HERD 7	NA61 SHINE 7	CMS HGCAL 7	NP02 26				NA61 SHINE 28										
T2 - H4		NA63 9	CMS ECAL 7	GIF 14		NA64 42							CMS ECAL 7	AIDA WP14 7	SHiP nobeam 7	SHiP Muon 14	SHiP Charm 7	GIF 21				DsTau 7	NP04 7	NP04 7	CMS MTD 7	NP04 14		CMS ECAL 7	NP04 14		GIF 7	NP04 12	RE29 DAMPE 7	HERD 7	ATLAS ZDC 7	CaloCube 7					
T4 - H6		Clic pix 7	CMS Outer Tracker 9	ATLAS ITK 14		ATLAS ITK/Kartel 7	ATLAS eHGTD 7	RD42 7	ALICE muons 7	CERF 7	CMS Outer Tracker / AIDAwp2 7	Clic pix 7	CMS ITK 7	ATLAS ITK 14		ATLAS AFP 14		ATLAS HGTD 7	ATLAS BCM 7	Clic pix 7	ATLAS ITK 14		ATLAS AFP 14		ALICE muons 7	RD42 7	AIDA WP7 7	ATLAS ITK/Kartel 14	ATLAS eHGTD 7	CMS Outer Tracker 7	Clic pix 5										
T4 - H8		UA9 9	TOTEM PPS 7	ATLAS HV-CMOS 14		LHCb 14		ATLAS Tilecal 14		ATLAS HV-CMOS 7	TOTEM (+UA9) 7	ATLAS TRT 7	LHCb 21		crysbeam 7	CMS ITK 7	ALICE FOCAL 14		TOTEM (+UA9) 7	mu-e 7			FCCee 7	TOTEM (+UA9) 7	ATLAS HV-CMOS 7	CMS ITK 7	LHCb 26		ATLAS Tilecal 14		UA9 7	HNX 14		NUCLEON 7							

For further information contact the PS/SPS-Coordinator. Email: Sps.Coordinator@cern.ch, Tel: +41 75 411 3845.

The latest version of the schedule are available here: http://sps-schedule.web.cern.ch/sps-schedule/
This schedule in synchronized with injector schedule v0.6.
No beam to the North Area during Technical Stops (TS), Coldex, UA9 and Machine Developments (MD).
For TS a RP cool down time is needed and will be announced in the days preceding the stop.
Submit your ISIEC at least 2 weeks before your allocated beam time using https://ep-th-safety.web.cern.ch/isiec

Week 34 : 22-29 Aug

μ-on-e Test activity in 2018

For 2018 :

COMPASS has asked hadron beams, *but will use muons for alignment and calibration (M2 'modified')*

μ's will be run once per 1 - 2 weeks

(beam experts are simulating momentum and spatial distribution of muons behind COMPASS)

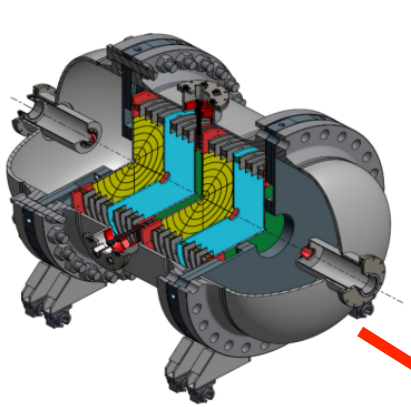
So, why not use the μ's from not only M2 modified, but also from the pion decays.

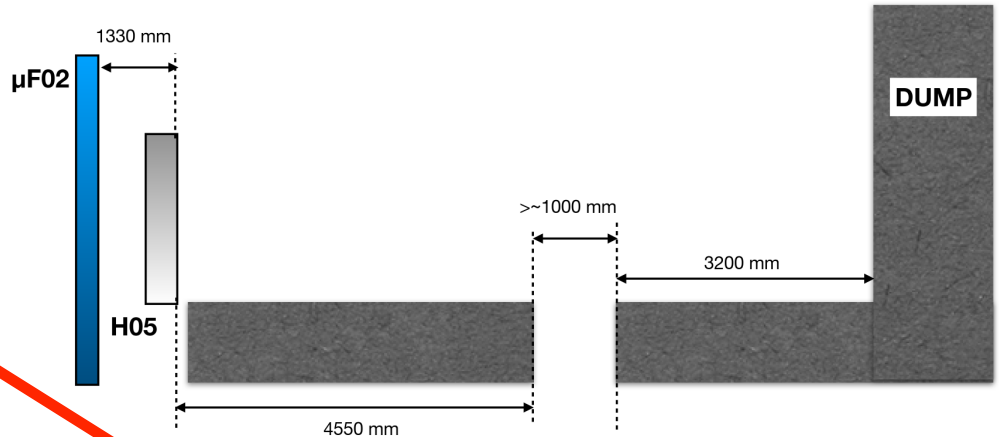
this means being able to run more or less from april to october

EHN2 Test Beams 2018

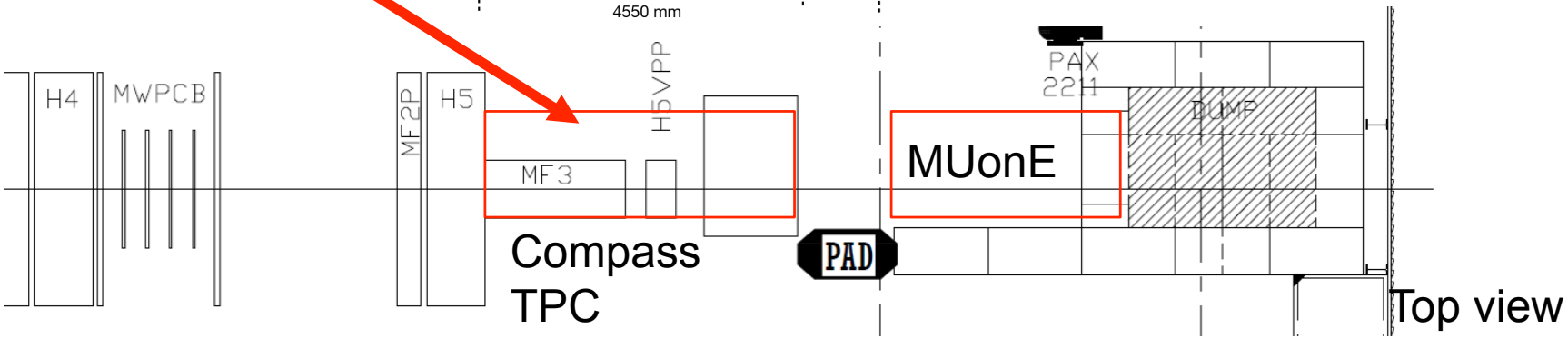
- MUonE: Measure μe scattering on 2 target modules with Silicon instrumentation + 1 EM calorimeter. Total length ~ 3m.
- Compass TPC: Measure μp scattering in high pressure TPC + Silicon telescope

Slide from Johannes (11/12/2017)





Side view



Top view

The 2018 setup

μ-on-e Test activity in 2018

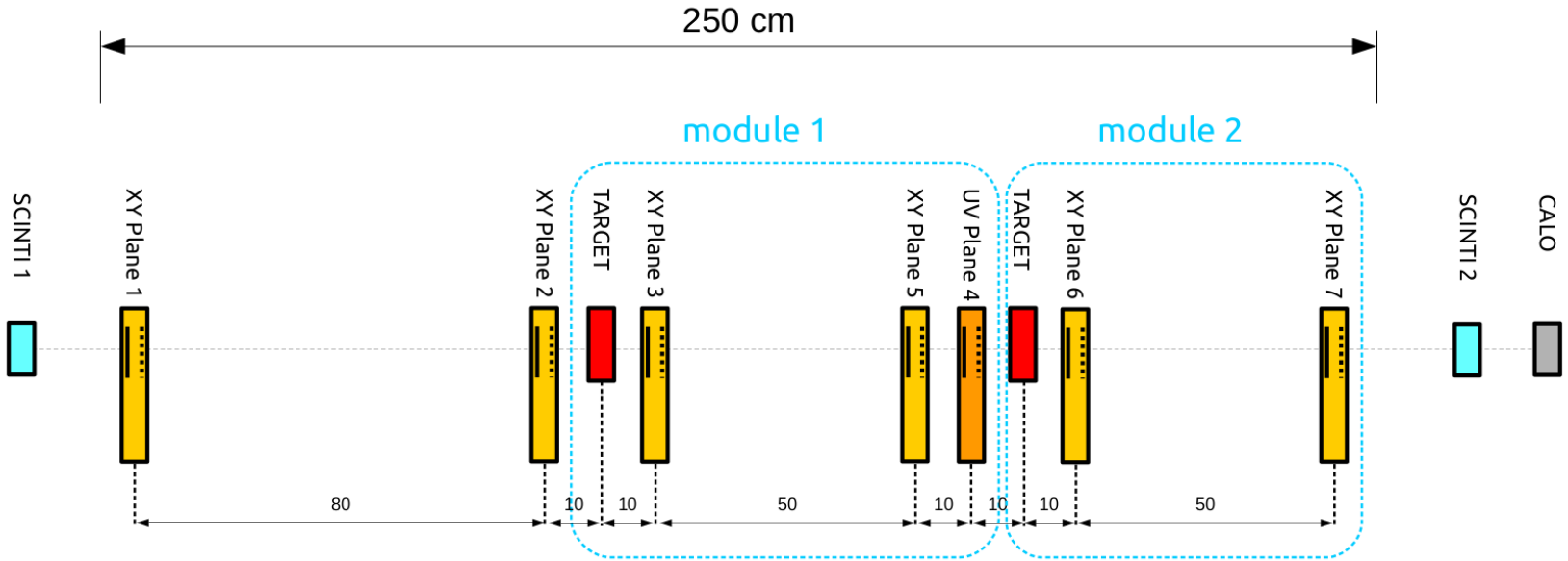
We will take data with muon beams

See talk by Claudia Brizzolari

- We will use the setup being prepared by E. Vallazz… M. Prest group

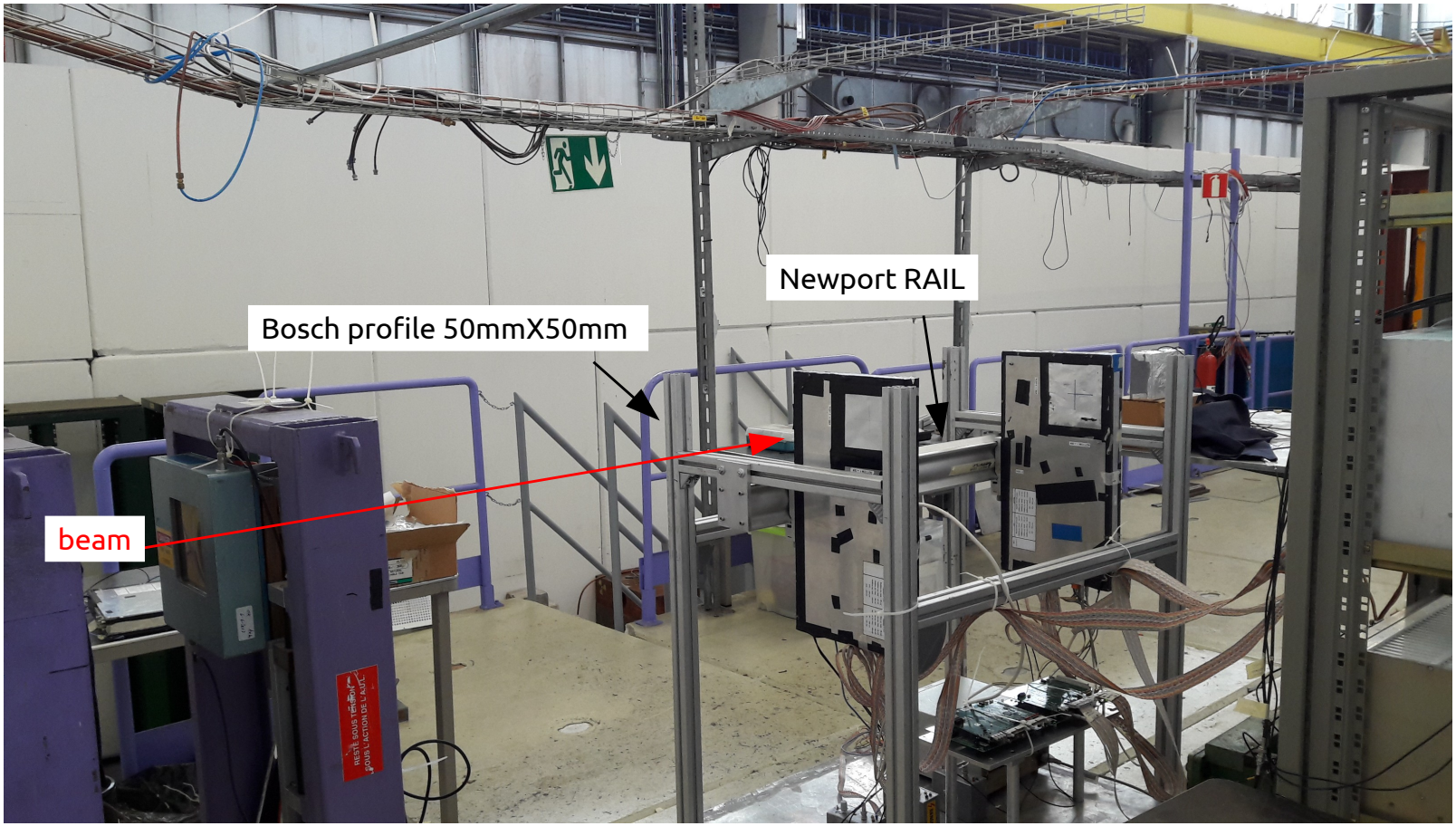
(they have produced and tested the missing electronics cards, preparing the mechanics, etc…)

Setup: 7 Si planes 95x95 mm2, 2 in front to measure incoming muon direction

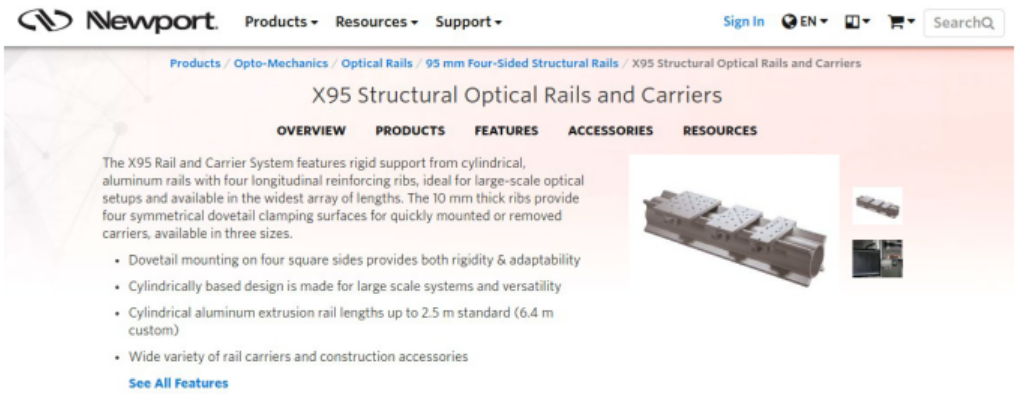


μ-on-e Test activity in 2018

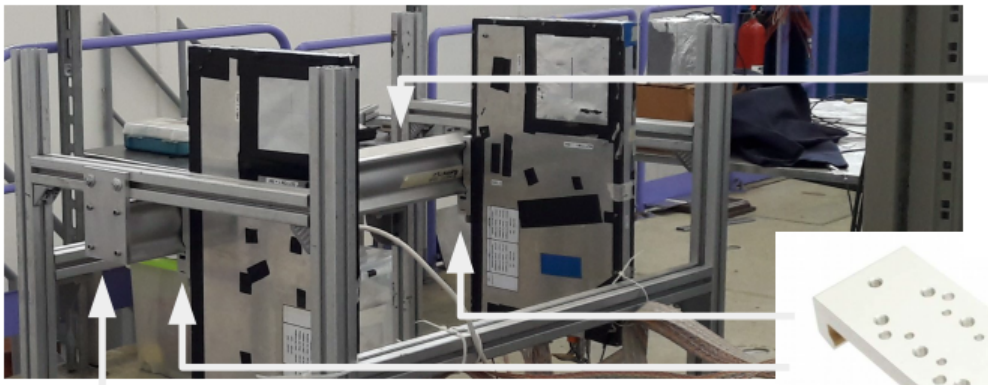
Table for silicon strip detectors installed for a testbeam (CERN T9, 2017)



μ-on-e Test activity in 2018



https://www.newport.com/f/x95-structural-optical-rails-and-carriers



Bosch – Newport mounting plate

L max 2.5 m

X95-1
Aluminum Structural Rail, 1000 mm Length, M6 Threads, X95 Series

M-CXL95-50
Rail Carriage, 50 mm Length, M6 Thread, X95 Series

μ-on-e Test activity in 2018

SERVICES:

★ Network connections

Connection to computing center (and from there to CNAF)

★ *No gas will be used*

★ Setup is a light structure, no crane necessary unless pre-assembled supporting mechanical structure will be used

★ All services close to the apparatus, signal fiber optics cable ~ 40 m to the control room

★ Survey for a first alignment already asked

➡ Need to know properties of the muons arriving behind COMPASS

μ-on-e Test activity in 2018

The target:

4 graphite tiles **95 x 95 x 8 mm** ready

(material parameters available and implemented in the MC)

Supports made in MI-B by *R.Mazza*

The calorimeter

μ-on-e Test activity in 2018

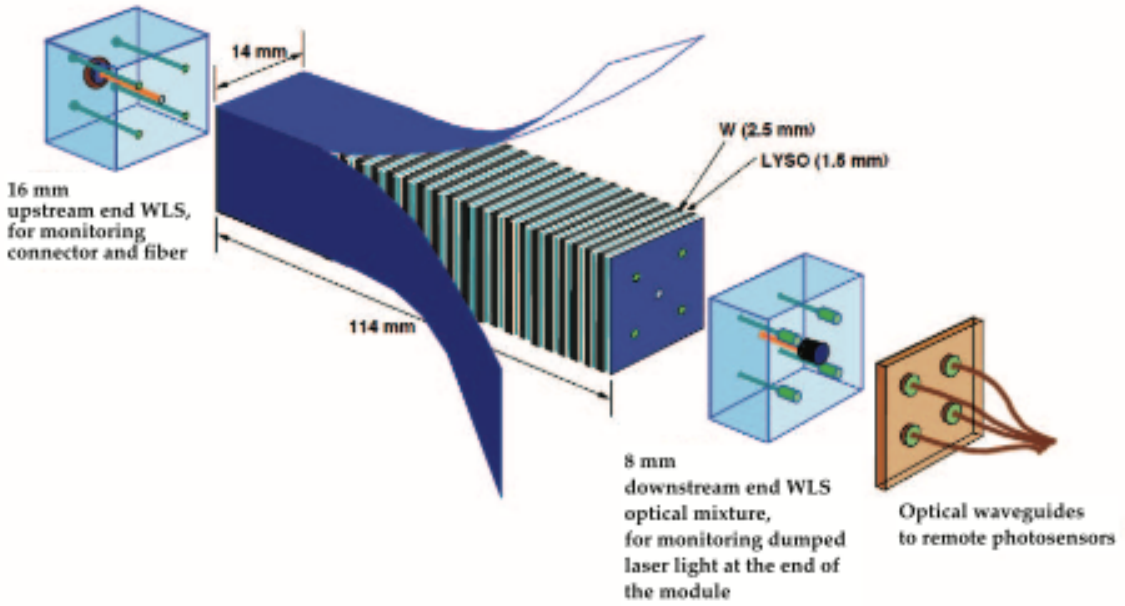
Calorimeter element (to be put at the end immediately after the last plane of the tracker)

Most realistic solution: a prototype from CMS

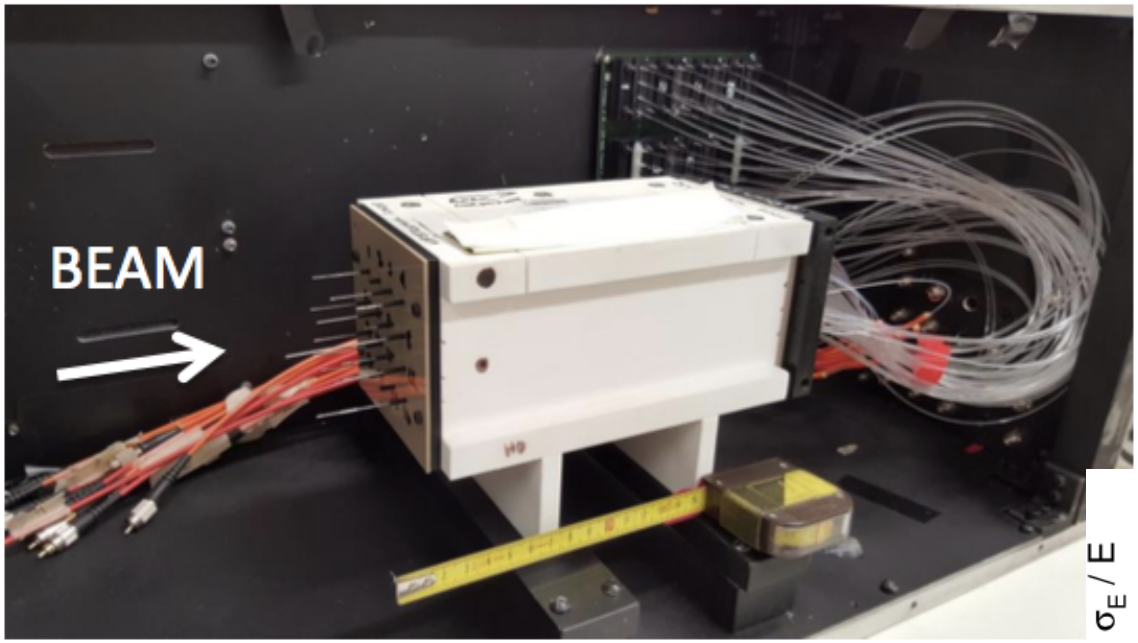
★ Shashlike style LYSO+W :

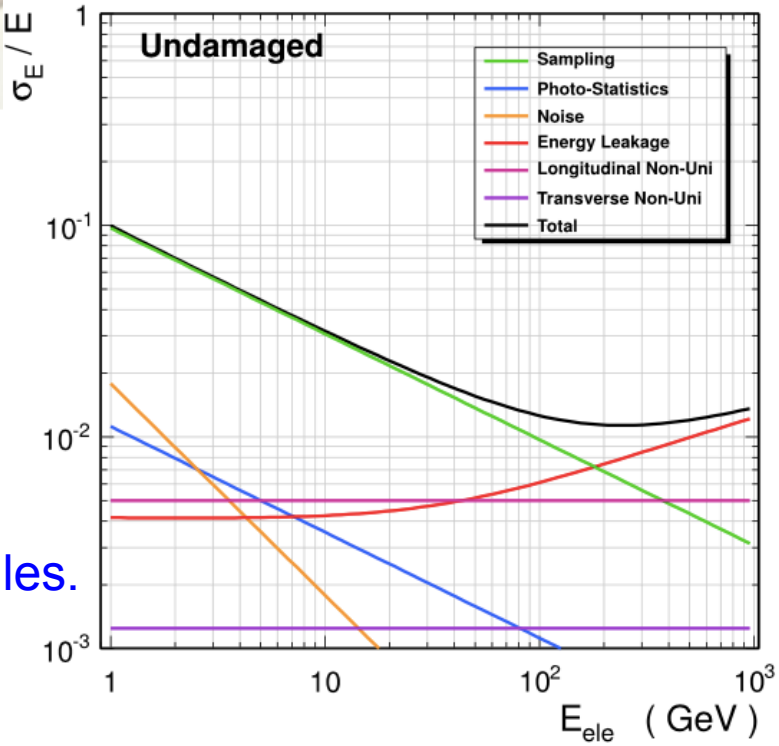
quite invulnerable to radiation damage
excellent energy resolution
Moliere radius = 13.7 mm
Length = 114 mm (24 X_0)

4 x 4 array of this module
(~ 60 x 60 mm trasversally)



μ-on-e Test activity in 2018





Main goal of using a calorimeter:

study the possibility of building a template (θ_e vs E_e) to understand how a cut in angle can be representative of a cut in energy to apply to the upstream modules.

μ-on-e Test activity in 2018

W/LYSO Shashlik Prototype of 16 modules:

- 28 W plates 2.5mm thick
- 29 LYSO Plates 1.5mm thick
- 64 WLS Capillaries: 1mm dia, DSB1 WLS
- Monitoring Fiber 0.9mm dia
- Holes drilled in LYSO Plates/No polishing

Readout

- SiPM (10μm pixels, adjustable PDE = 7-25%)
- Fermilab PADE Boards (Preamp/Digitizer)
- Total 64 channels

More information next Monday (meeting with A. Bornheim)

The μ beam

μ-on-e Test activity in 2018

Conditions for running behind COMPASS in 2018:

Startup around mid-april (9th april): start with 2 weeks of *M2-modified*

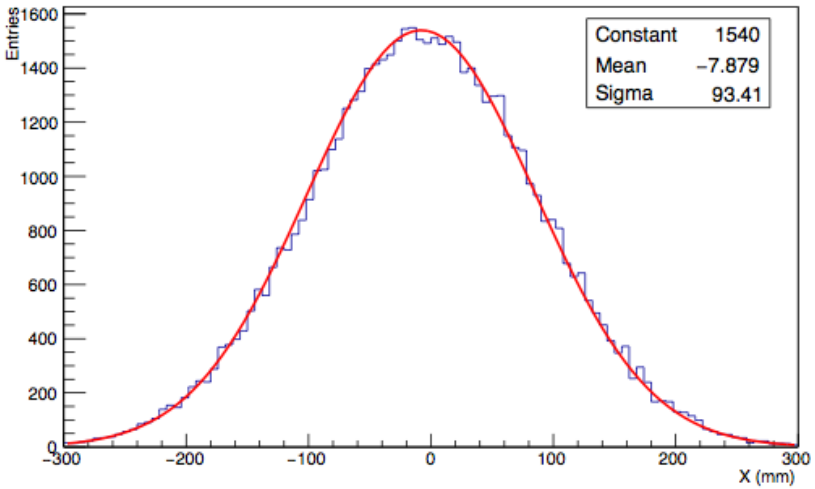
Simulations have been started *(see study by Dipanwita BanerJee)*
to determine beam parameters at the entrance of our setup
(*see plots)*

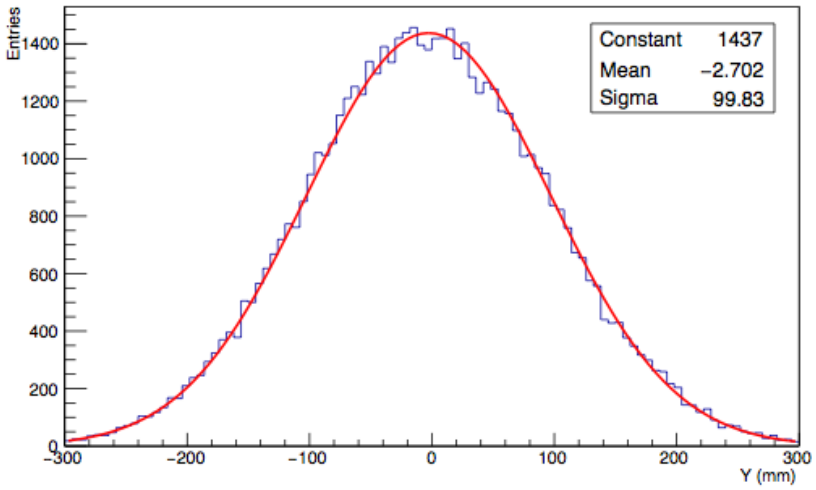
Energy could be 190 GeV→ this is ok for us
simulation undergoing as for the case of lower energy from Dipanwita

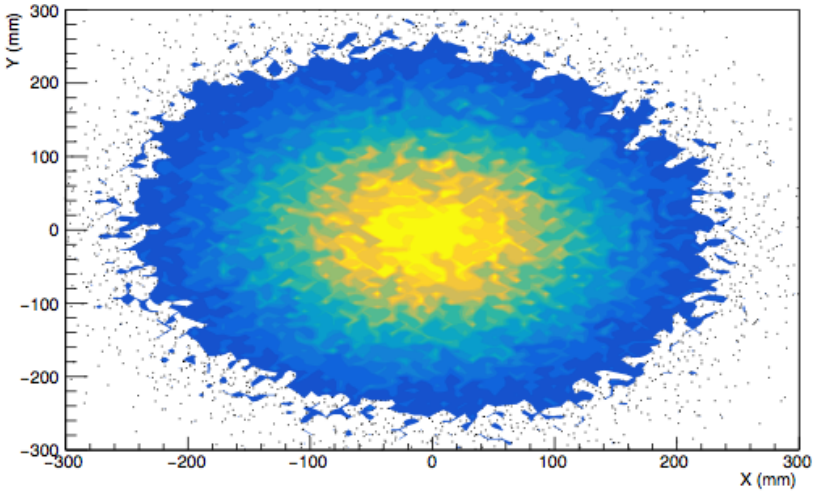
MAIN NOVELTY: COMPASS will put a TPC prototype in the same area, in front of us…..

M2 Beam Distribution Studies at Downstream End

Very preliminary







σx = 93.4 mm; σy = 99.8 mm

Flux for 10^{13} pot/spill ~10^{6}/cm^{2}

Note: Change of scale

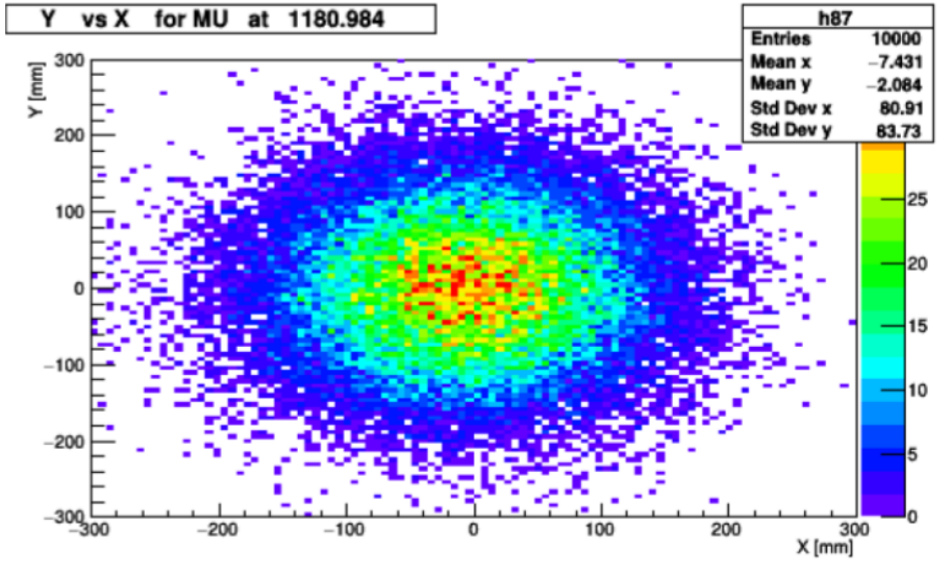
Deflection of beam downstream (due to SM1 and SM2) ~ 30 cm from undeflected beam axis

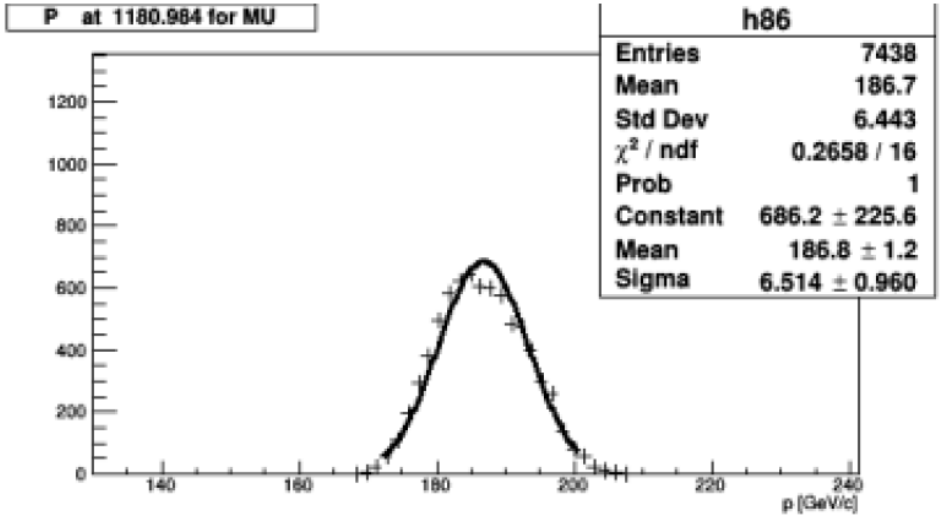
μ-on-e Test activity in 2018

190 GeV/c μ-beam at the MuonE test-setup position : Y vs X and Pμ

σ_X = 80.9 mm
σ_Y = 83.7 mm

<Pμ> = 186.8 GeV
$\sigma_{P\mu}$ = 6.5 GeV





μ-on-e Test activity in 2018

?? Are we going to take data at low energy electron beams ??

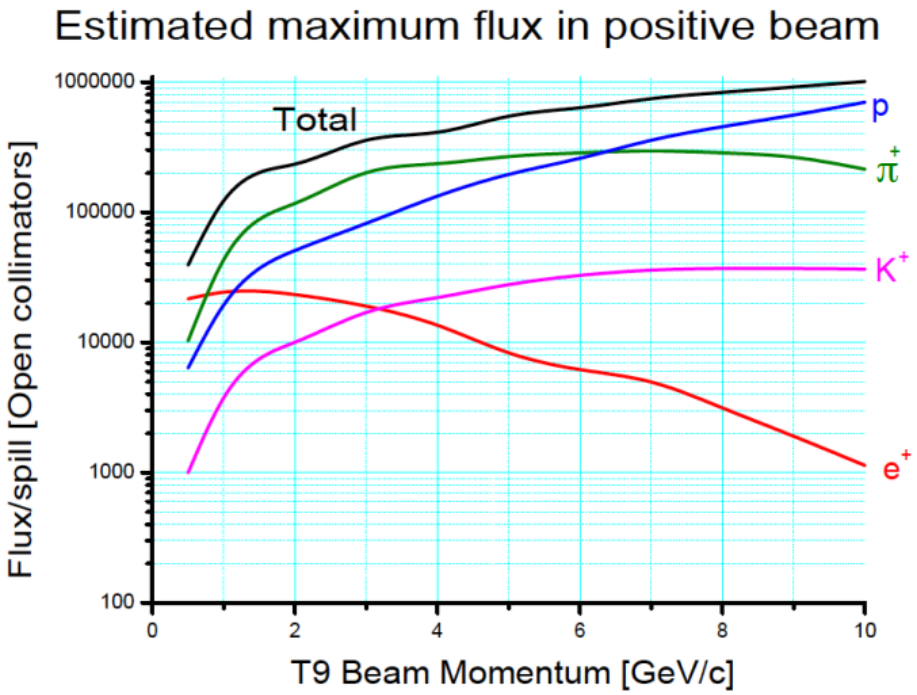
Electron beams available in East Area with E_e= 1-15 GeV (poor purity though), ***if we decide to take low energy data can negotiate some time even if not main user***

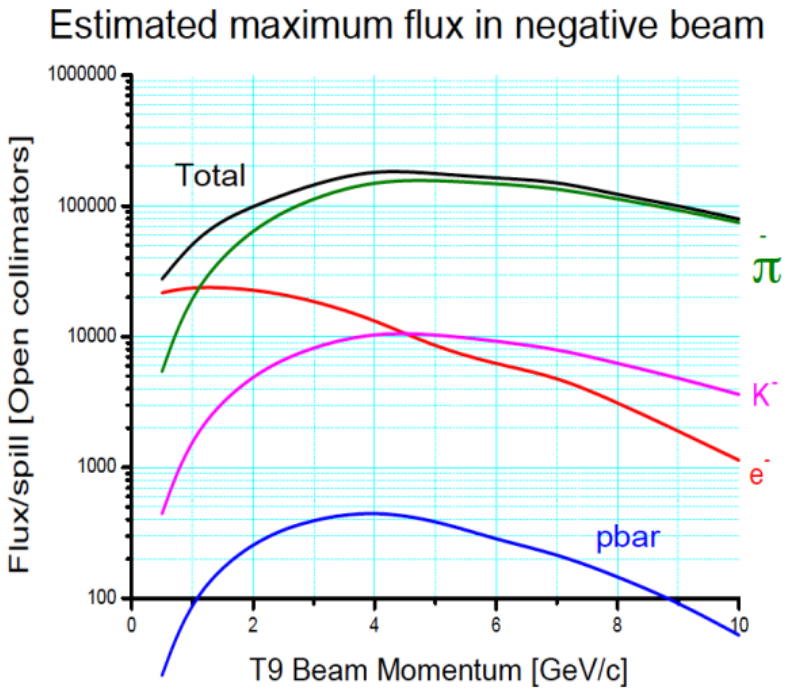
Not a negligible effort in term of man power
we must evaluate if worthwhile during 2018

Electron beams of 6 GeV available at DESY BTF if these tests postponed

In any case we must show a clear strategy to PBC (in june or at the latest at the end of the year) *on how to address all the critical points.*

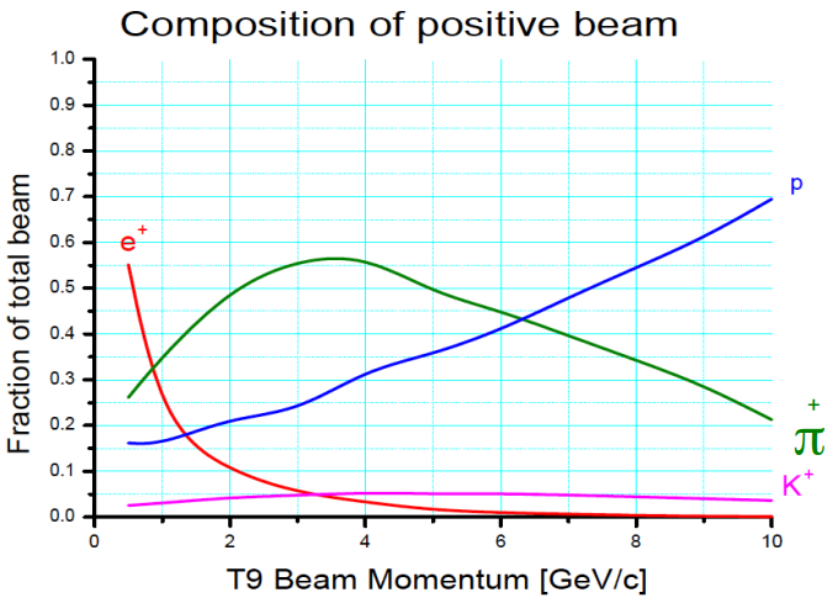
T9 Maximum Beam rates

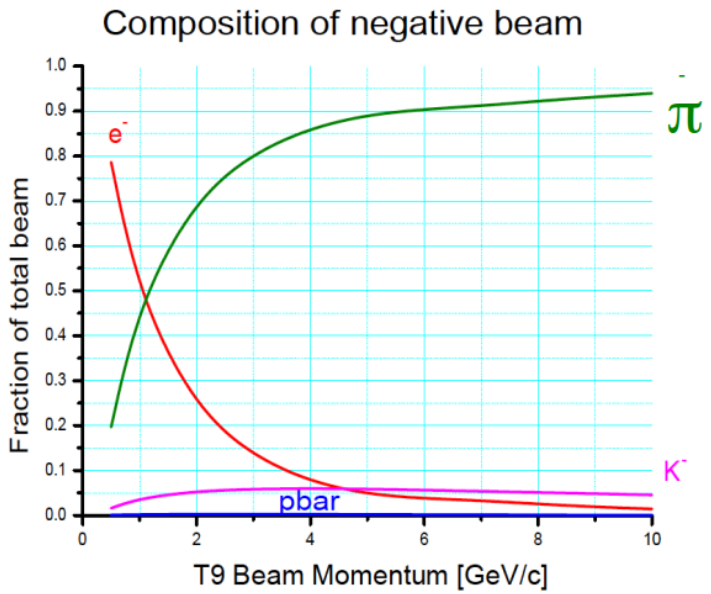




For wide open collimators, i.e. $\Delta p/p \approx \pm 7.5\%$

T9 Beam Composition





With electron enriched target (otherwise $e^{\pm}$ strongly reduced)

μ-on-e test activity in 2018

★ We must be ready for the first 2 weeks of muon beams requested by COMPASS

michela+erik group preparing the tracker
C targets of 90x90 mm to be prepared
contacts have been taken for getting the calorimeter

★ Test of TPC of COMPASS: bad news, but a positive aspect could be that they need μ for the test (μ-p study)

★ Simulation of the muons behind COMPASS undergoing , also for muons from pions decay (beam requested in 2018 by COMPASS)

★ Eventual improvement possible? *(re-focus, see Lau's comment)*

★ Electron beams available in East Area with E_e= 1-15 GeV (poor purity though), if we decide to take low energy data

The possibility of measuring μ-e cross section must be pursued

Summary

Quite a lot of work planned in 2018

★ We will report to COMPASS our plans for assembling and Commissioning the setup at the beginning of March

On C. Vallee request :

> we must prepare for end 2018 a study of feasibility and cost of the infrastructure for housing the final apparatus behind COMPASS

(this is being done by the responsables of the NA)

★ For > 2020 we must keep in contact with NA64 (on top of COMPASS) and their beam requests *(they will not be necessarily uniform with ours…)*