Neutron background studies with GEANT4

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Introduction

- We have redone the neutron background studies using GEANT4 instead of GEANT3 (see http://ptc.home.cern.ch/ptc/down/nbgnd.html for CMSIM 121 studies)

- We have simulated minbias events and studied the TOF of hits produced in each muon chamber
  - Those with high TOF (>250 ns) are considered due to neutron interactions

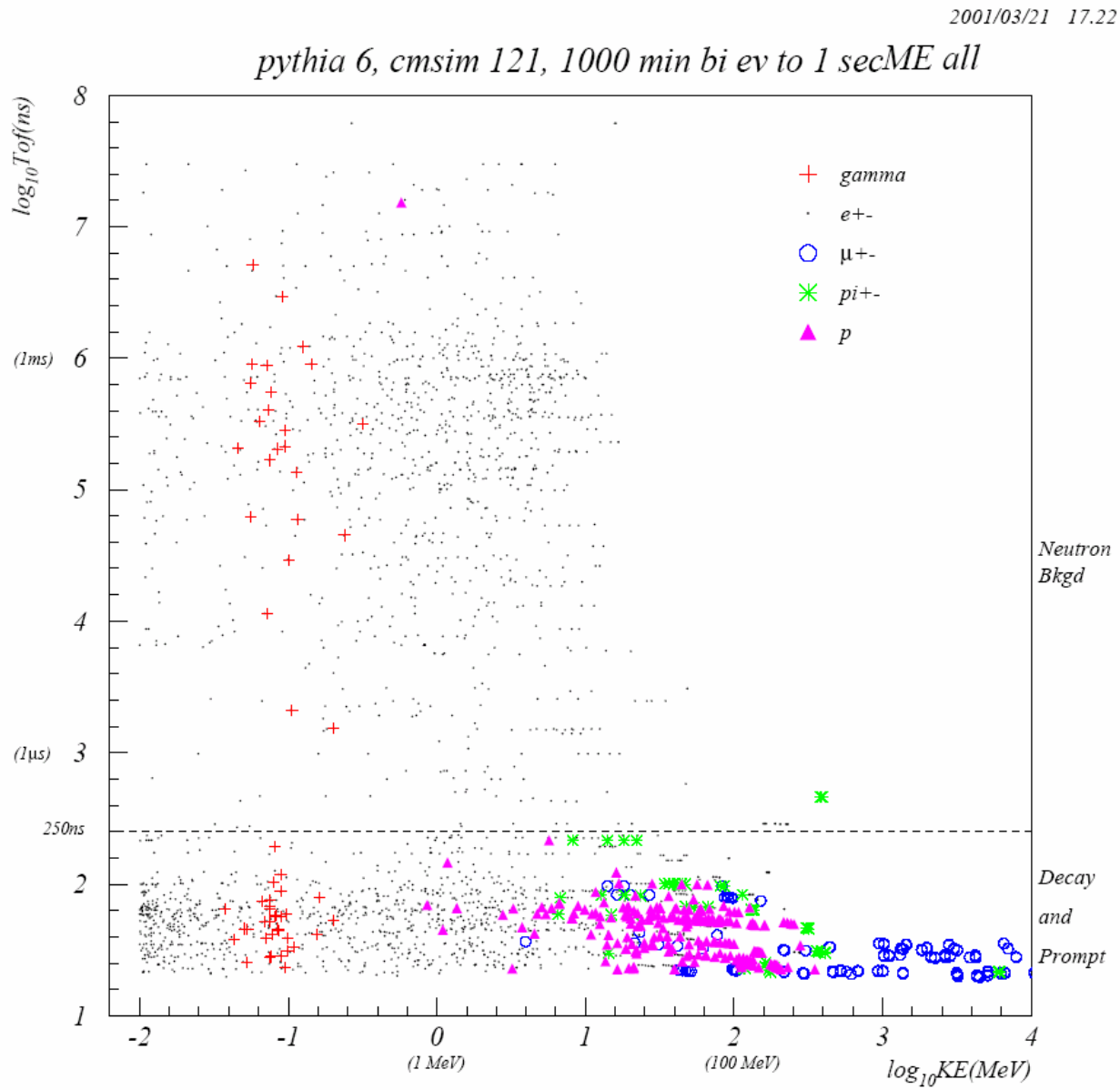
- We have used OSCAR_3_3_2 (GEANT4.6.1) with a physics list for neutrons, **QGSP_BERT_HP,** and compared results with other physics lists
  - QGSPlist (OSCAR default)
  - LHEP_HP
  - QGSP_HP

Differences GEANT3 and GEANT4

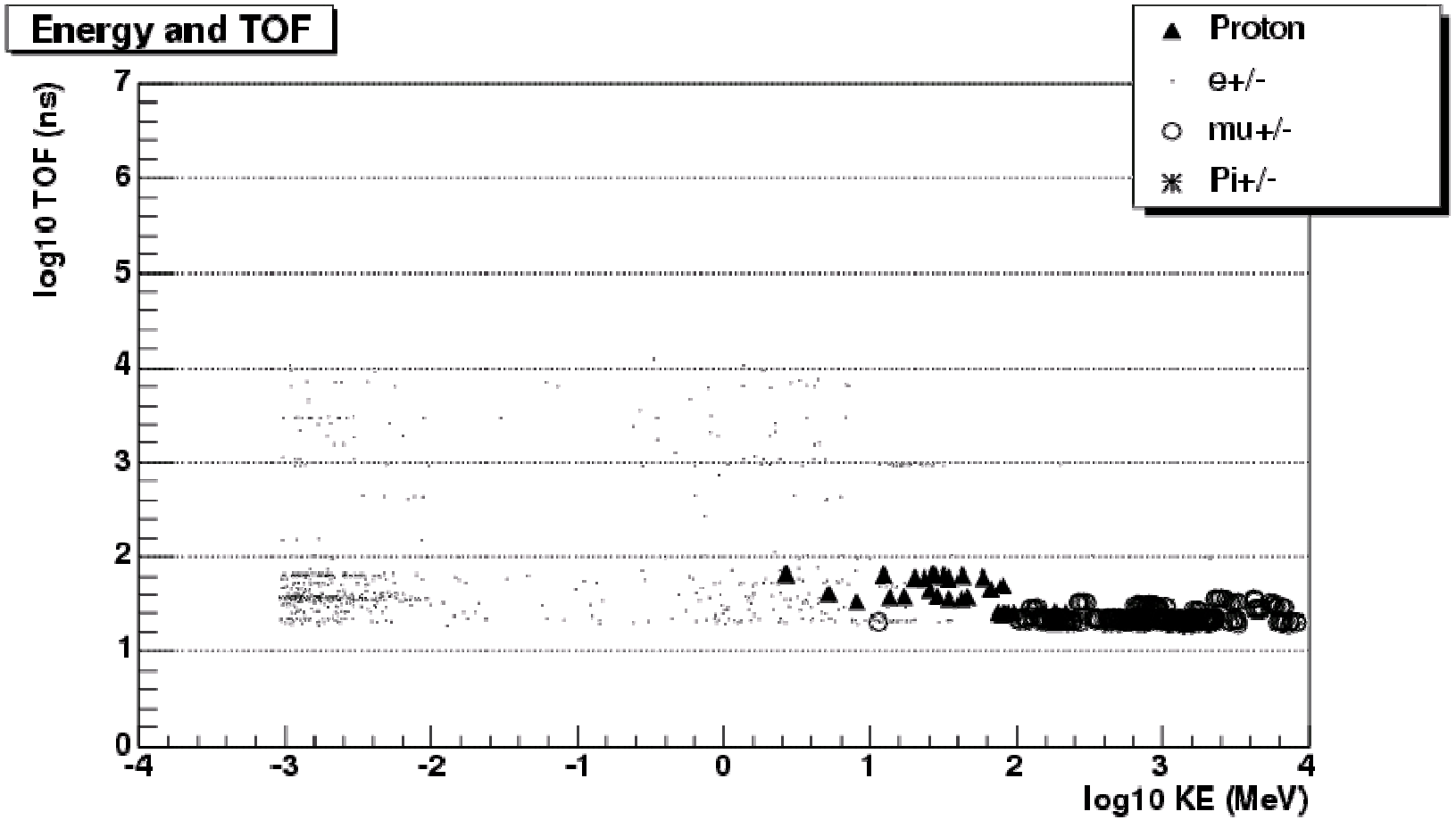
GEANT3 → no ion simulation

GEANT4 → ion simulation
→ perfect elastic scattering of neutron
→ additional physics package for thermal neutrons

Studies of neutron background in the **endcap** chamber by using old version of PYTHIA and the CMSIM 121 software (GEANT3)

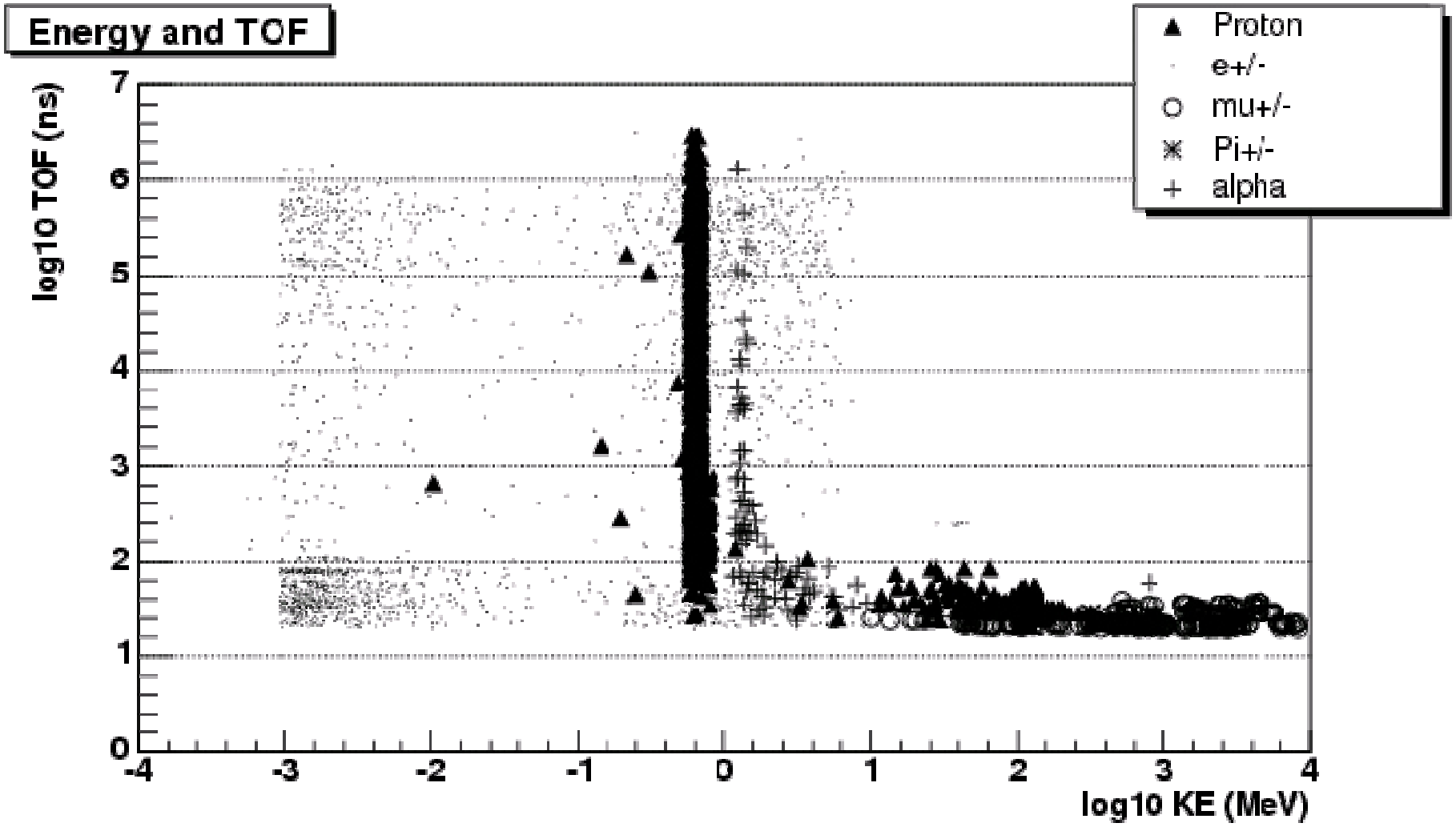


Results



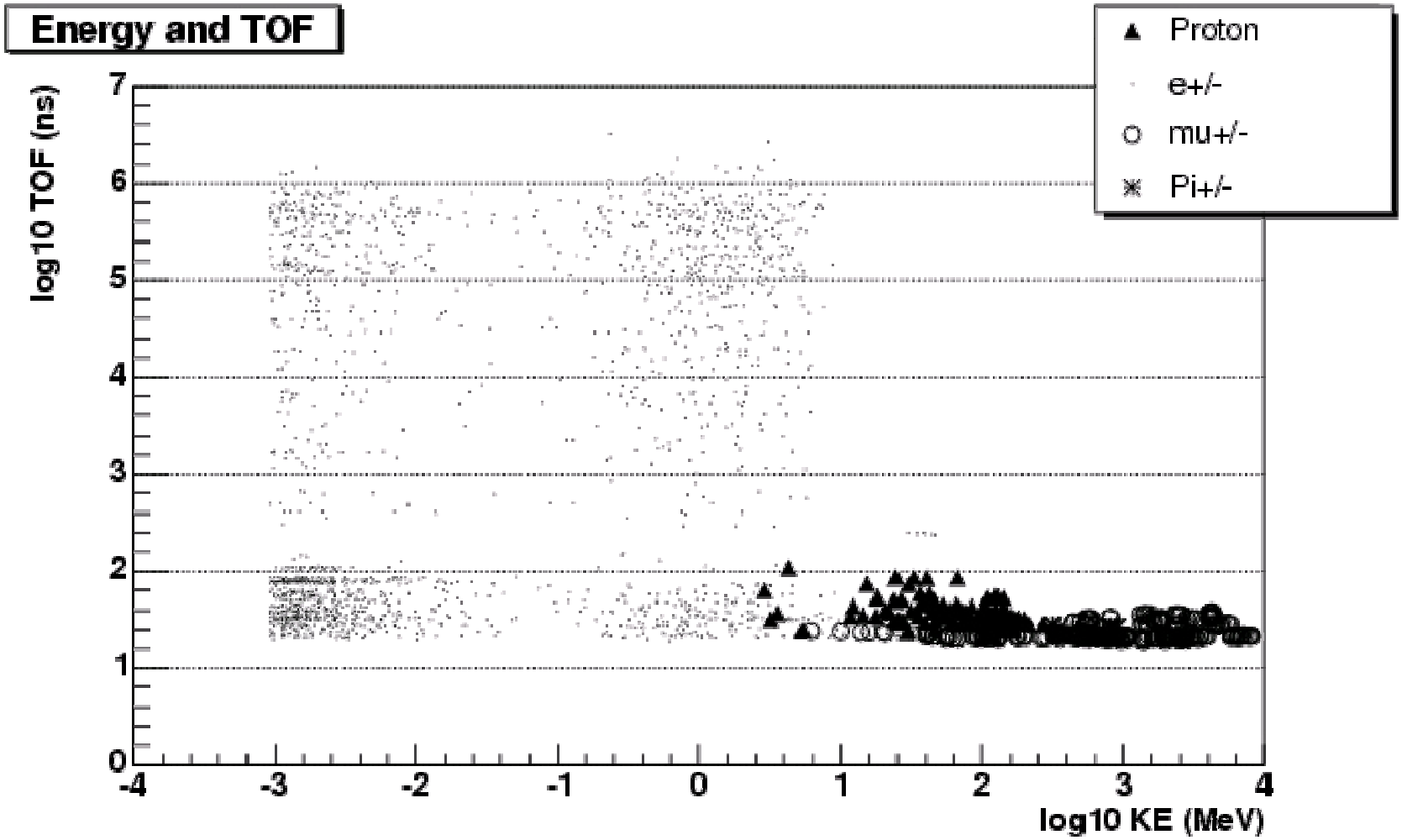
QGSPlist, 2k events, All muon detector

Results



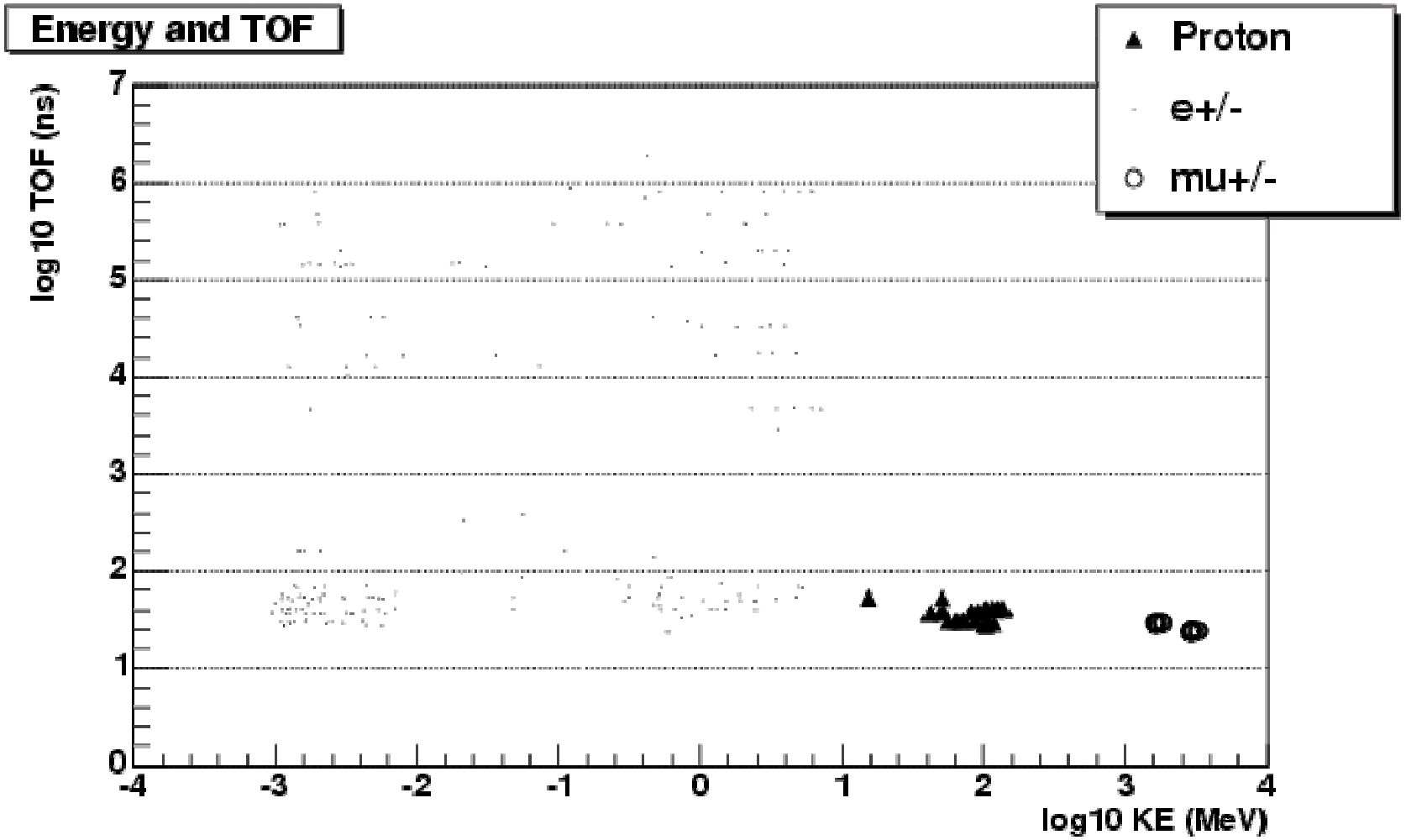
QGSP_BERT_HP, 2k events, All muon detectors

Results



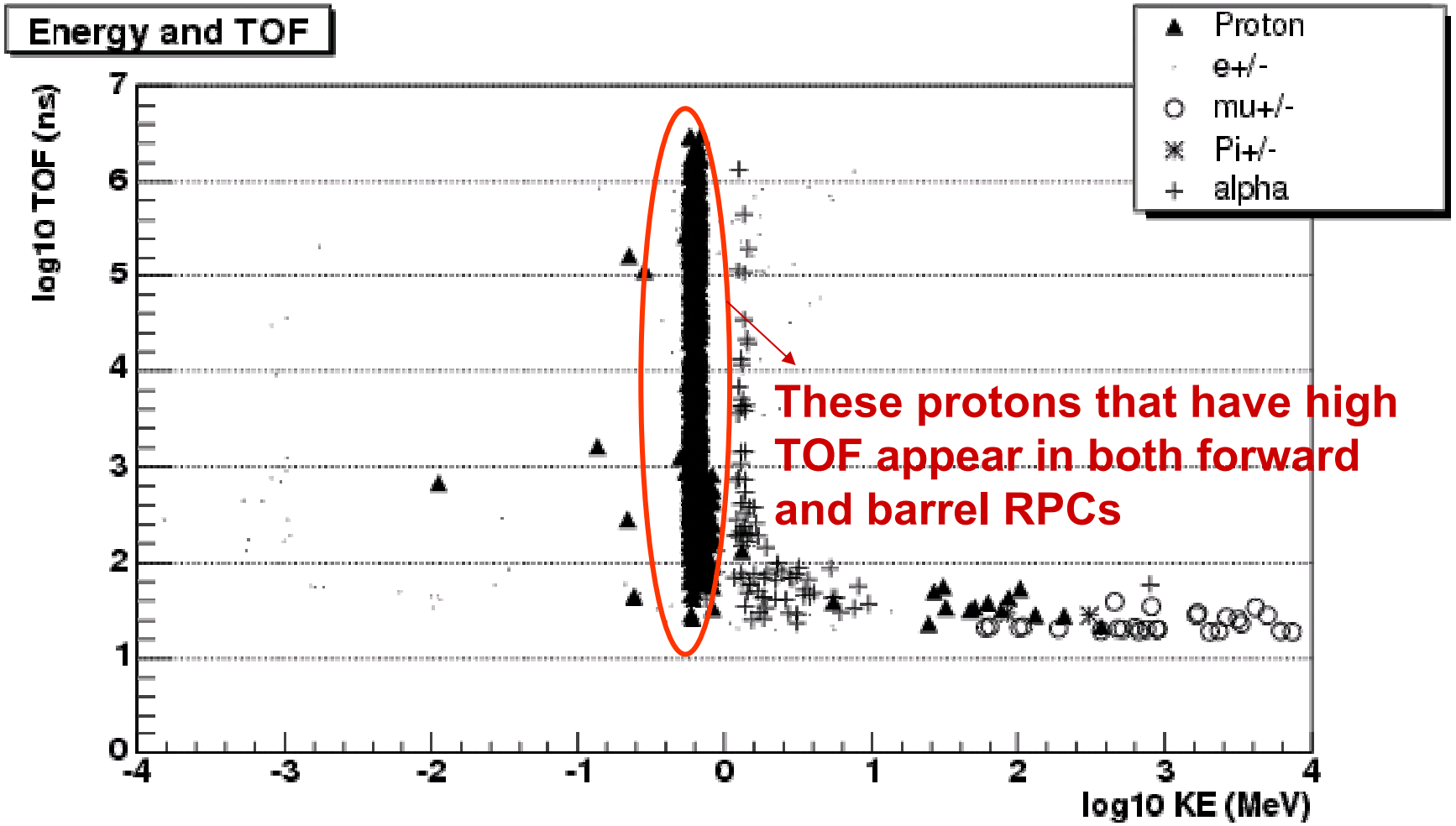
QGSP_BERT_HP, 2k events, Endcap detectors

Results



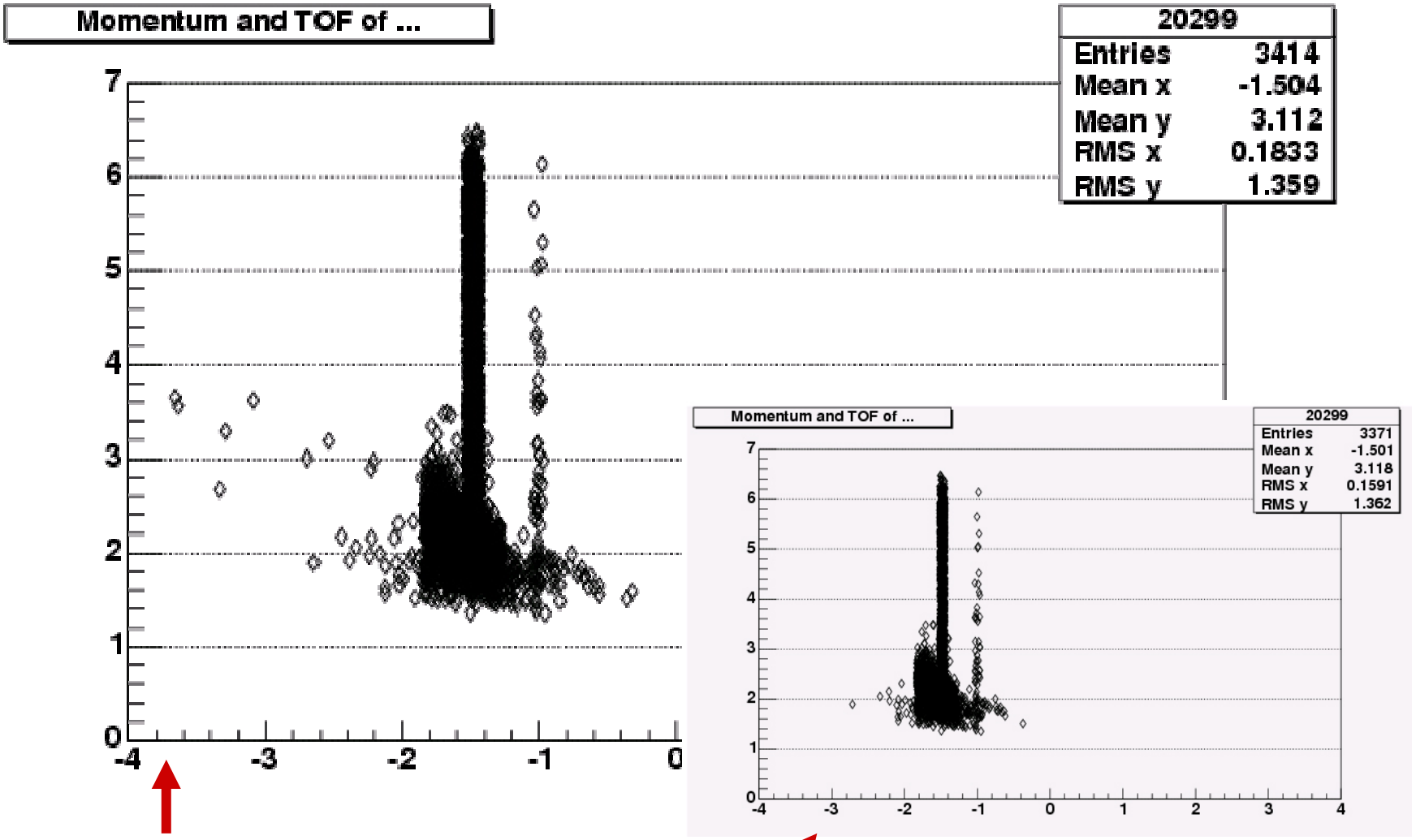
QGSP_BERT_HP, 2k events, Barrel detectors

Results



QGSP_BERT_HP, 2k events, RPCs

Results : ions in the CMS detector



QGSP_BERT_HP, 2k events,
All muon detectors

RPCs

Almost all in RPCs (3371/3414)

Ions and protons of high TOF

We had a look to 5 events and the protons come from ions produced by LElastic of neutrons:

• 6 S35 ions and 1 F19 ion in the volumes RExn, made of material “RPC Gas“

RPC Gas: density="1.87685*mg/cm3"
0.017572792 Argon
0.2588934 Carbon
0.031188319 Chlorine
0.016714124 Fluorine
0.67563137 Oxygen

• 1 S35 ion in RHAX, made of “Bakelite”

Bakelite" density="1.3*g/cm3"
0.074565894 Hydrogen
0.77748634 Carbon
0.14794776 Oxygen

☹ We don’t understand yet why this happens only in RPC volumes, while other materials in CMS have the same elements

Number of hits

2k events QGSP_BERT_HP:

	TOTAL	> 250 ns	< 250 ns
ENDCAP	**2493**	**928**	**1565**
ME1	1138	320	818
ME2	702	396	306
ME3	534	148	386
ME4	119	64	55
BARREL	**235**	**74**	**161**
MB1	174	65	109
MB2	37	2	35
MB3	17	0	17
MB4	7	7	0
RPC Barrel	**312**	**228**	**84**
RPC Endcap	**1072**	**853**	**219**
TOTAL	**4112**	**2083**	**2029**

CMSIM 121: **1.1 hits per event in ME t>250 ns**

OSCAR_3_3_2+QGSP_BERT_HP: 0.46 hits per event in ME t>250 ns

minbias_neutron.ntpl, NSEL = 10000

	QGSPlist				QGSP_HP				QGSP_BERT_HP				LHEP_HP			
NumberOfEventToBeProcesses	2000				1837				2000				1633			
# of events have hits	123				539				1073				546			
	#	events	# > 250	# < 250	#	events	# > 250	# < 250	#	events	# > 250	# < 250	#	events	# > 250	# < 250
# of hits in ME1	655				715				1155				602			
# of hits in ME2	190				259				720				210			
# of hits in ME3	149				129				539				235			
# of hits in ME4	36				63				119				99			
# of proton that have hits in ME1	22		0	22	18		0	18	88		0	88	12		0	12
# of proton that have hits in ME2	2		0	2	5		0	5	21		0	21	3		0	3
# of proton that have hits in ME3	4		0	4	4		0	4	20		0	20	2		0	2
# of proton that have hits in ME4	0		0	0	1		0	1	0		0	0	7		0	7
# of e+/- that have hits in ME1	354		21	333	367		120	247	747		320	427	328		110	218
# of e+/- that have hits in ME2	132		4	128	194		133	61	621		396	225	154		89	65
# of e+/- that have hits in ME3	115		34	81	68		32	36	471		148	323	210		60	150
# of e+/- that have hits in ME4	19		2	17	29		6	23	95		64	31	79		21	58
# of mu+/- that have hits in ME1	272		0	272	319		0	319	265		0	265	237		0	237
# of mu+/- that have hits in ME2	54		0	54	57		0	57	60		0	60	49		0	49
# of mu+/- that have hits in ME3	28		0	28	55		0	55	43		0	43	19		0	19
# of mu+/- that have hits in ME4	17		0	17	33		0	33	24		0	24	9		0	9
# of pi+/- that have hits in ME1	3		0	3	6		0	6	38		0	38	6		0	6
# of pi+/- that have hits in ME2	1		0	1	0		0	0	0		0	0	2		0	2
# of pi+/- that have hits in ME3	0		0	0	0		0	0	0		0	0	0		0	0
# of pi+/- that have hits in ME4	0		0	0	0		0	0	0		0	0	0		0	0
# of K+ that have hits in ME1	0		0	0	0		0	0	0		0	0	12		0	12
# of K+ that have hits in ME2	0		0	0	0		0	0	0		0	0	0		0	0
# of K+ that have hits in ME3	0		0	0	0		0	0	0		0	0	0		0	0
# of K+ that have hits in ME4	0		0	0	0		0	0	0		0	0	0		0	0

Summary and plans

We have made an study of hits from neutron background in 2k events with OSCAR_3_3_2 + QGSP_BERT_HP

- Results show an smaller number of hits in ME stations
- Hits from proton and ions were not present in GEANT3
  - Wrong physics in GEANT3
  - Only appear in GEANT4 when a physics list specialized in neutrons is used

Next steps:

- Update to latest GEANT4 and physics list
- Compare to FLUKA
  - Simulation of all CMS detectors is too complicated
  - Choose an small setup with the most relevant elements
- Redo parameterization for ORCA