Search new physics with mumu+e events

Zero Kim

Chonnam National University

Korea CMS Collaboration Meeting

26. September. 2009

- **Introduction to Tri-lepton study**

- **MC samples : Signal and SM backgound**

- **Initial Study : Trimuon Synchronization Exercise**

- **Conclusion**

INTRODUCTION
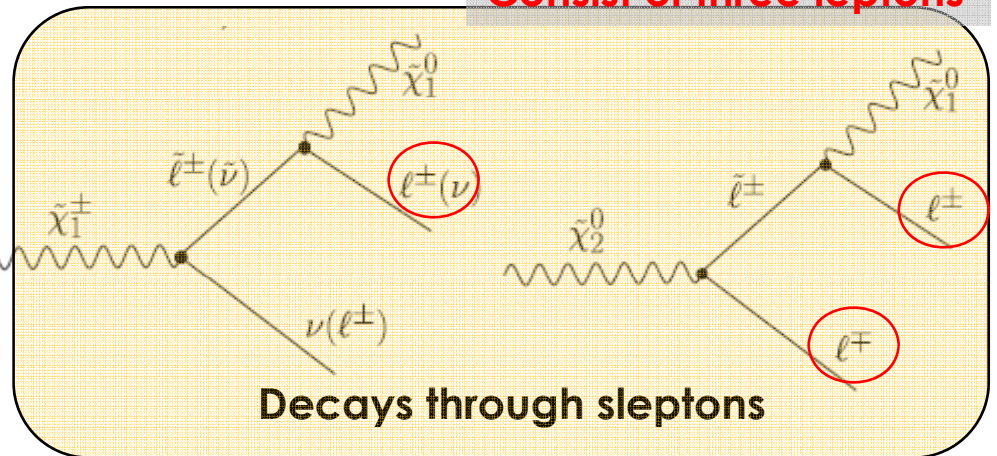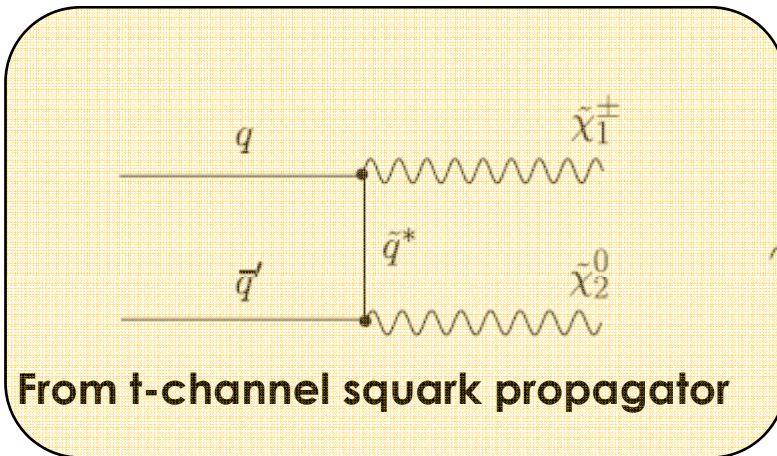
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Motivation and features

◆ The standard model predicts a low rate of trilepton events, which makes some supersymmetric processes, such as chargino-neutralino production

◆ Attractive point in connection between BOSON and FERMION

◆ SUSY Trileptons produced in direct $\chi_2^0 \chi_1^\pm$ and gluino/squarks decays

◆ Neutralino(2)Chargino(1) are lighter, it could be discovered early LHC phase

◆ Less dependant on the number of SUSY parameters

◆ Clear signature, cause of well isolated leptons, and large MET

Chargino-neutralino production

Decays to three leptons

From s-channel W boson

Decays through gauge bosons
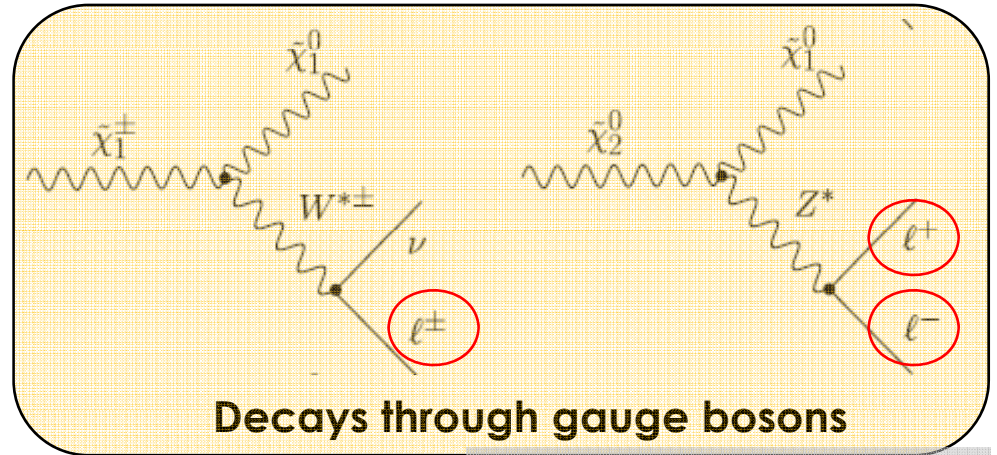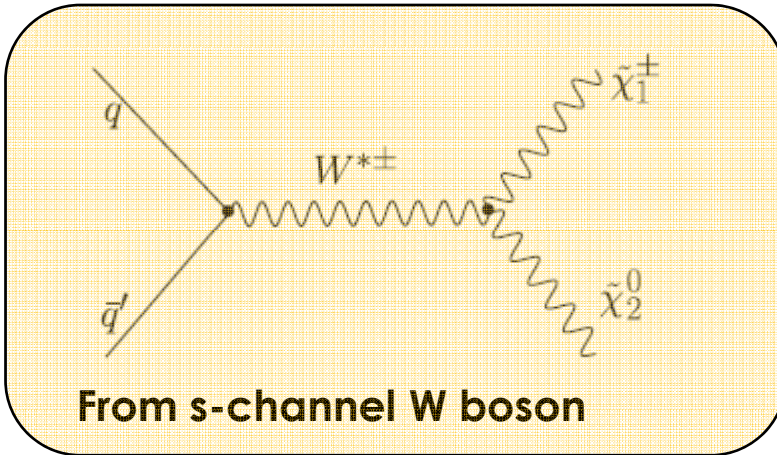
Consist of three leptons

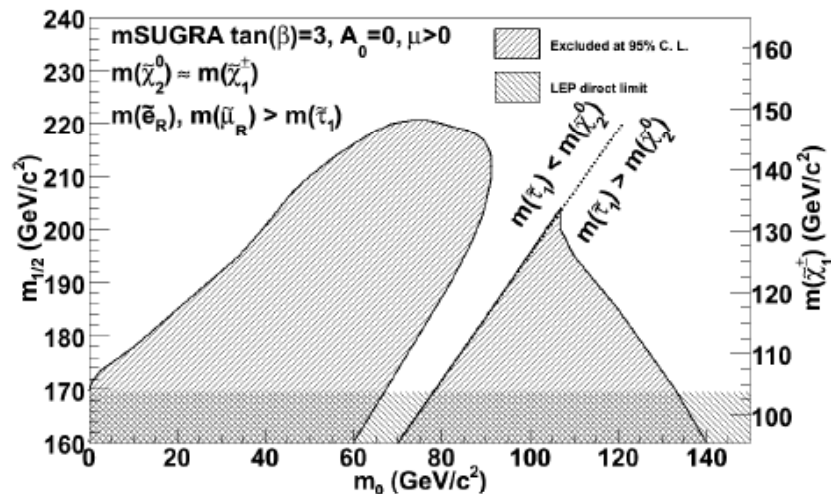**From t-channel squark propagator**

Decays through sleptons
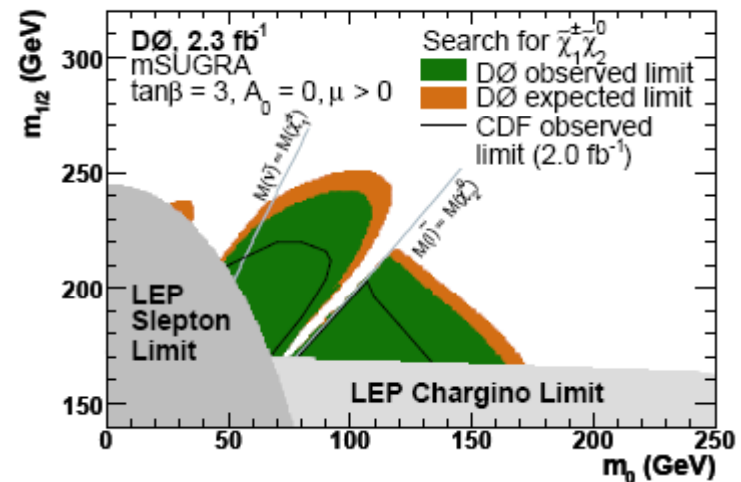
[Tevatron Trilepton search]

◆CDF Search

✓Trilepton study was investigated with CDF data at 1.96 TeV and 2.0 fb^{-1}
  (arXiv:0808.2445, PHYSICAL REVIEW D 79, 052004 (2009), CDF Collaboration)
✓First limits after LEP

◆ D0 Search

✓ Using a data set of 2.3 fb^{-1} D0 experiment during Run Ⅱ of the Tevatron
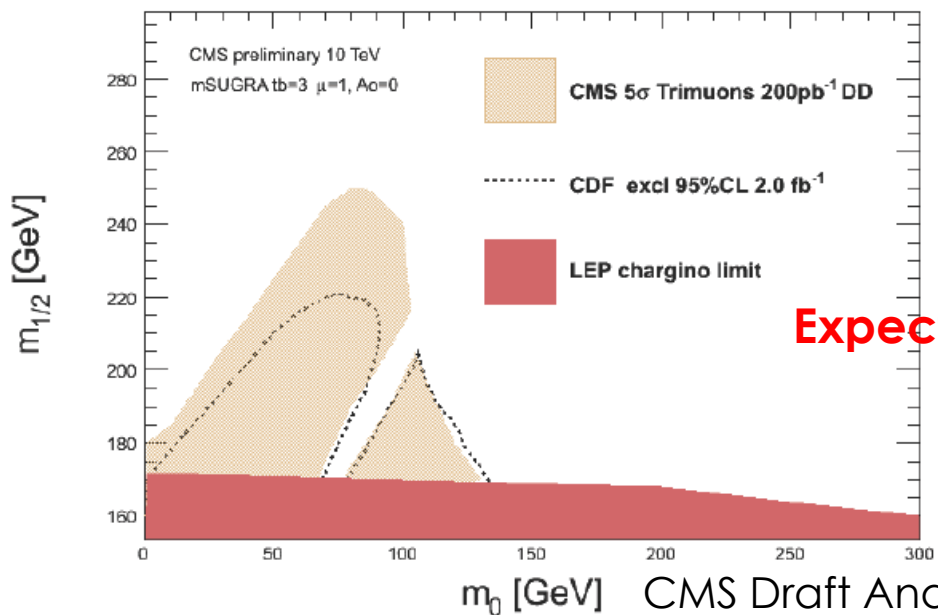 (arXiv:0901.0646)

CDF : arXiv:0808.2446

D0 : arXiv:0901.0646

[At CMS experiment]

◆**Reference Analysis 7(SUSY) by Leptonic Working Group**
  ✓Tri-muon channel is focused by University Karlsruhe
  ✓Multi-Muon + Jets, by Rutgers University
  ✓Tri-electron, by University of Colorado
  ✓Events with tau, by University of Califonia Daivis

◆**This study is focused on 2mu+e+MET channel at 10 TeV**

Expectation from Trimuons study

CMS Draft Analysis Note (CMS AN 2009/077)

SUSY Lepton Subgroup Reference Analyses

SUSY Leptonic Subgroup Reference Analyses		
Reference Analysis	**RA number with link to Organization Page**	**Links to Signature Project Tables**
Description	**(Contributing people, Documents and Talks)**	**(Detailed Technical Summary)**
Single-lepton analysis	RA4	SingleLept
Same-sign dilepton analysis	RA5	SS_Dilepto / SS_Dilepto
Opposite-sign dilepton analysis	RA6	OS_Dilept / OS_Dilept
Trilepton analysis	RA7	Trilepton
Dilepton + photon	RA8	LeptonPho

Contributing Institutions/Groups and People

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Joined newly Sep. 2009

CNU group

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◆Interested in Multi-leptons at CMS

- ❖CNU Trilepton Group on SUSY Study
  - ✓J.Y. Kim[Prof.]
  - ✓Z. Kim[Grad], S.H. Song[Grad]
- ❖Interested in '2μ+e+MET', '2e+μ+MET'

◆Trilepton Study Plan/Goals:

- ❖Contribute to 'Reference Analysis 7'
- ❖Study on mSUGRA, which Tevatron scaned
- ❖Keep muon selection cuts from Rutgers
- ❖Get improved proper cuts for rare events
- ❖Going with early data(100 pb^{-1})

MC SAMPLES

MC signal sample

Scenario	Cross Section [pb]	Number of events
sample01	110	1000
LM0	110	202686
LM1	16.06	240000
LM2	2.42	240000
LM3	11.79	240200
LM4	6.7	230000
LM5	1.94	229400
LM6	1.28	217600
LM7	2.9	236800
LM8	2.86	201240
LM9	11.09	200784

[MC Generation test]

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◆**Data Sample : sample01**
◆**Software** : CMSSW_3_1_2
◆**Tool** : PATv2
◆**MC generator :** Pythia6, SLHA(Susy Les Houches Accord)
◆**Objects** : PAT Layer1, reco tracks
　　　　　(PAT Object: μ, e, τ, Jet, MET, γ)
◆**Number of sample events :** 1000 events

[SUSY MC samples]

◆**Software** : CMSSW_2_1_12
◆**Objects** : Reco, reco tracks
◆**Data Samples** : LMX
/SUSY_LM0sftsht/Summer08_IDEAL_V11_v1/GENSIMRECO
/SUSY_LMXsftsht/Summer08_IDEAL_V11_redigi_v1/GENSIMRECO
/SUSY_LM9t175sftsht/Summer08_IDEAL_V9_v2/GENSIMRECO
/TTJetsmadgraph/Fall08_IDEAL_V11_redigi_v10/GENSIMRECO
/VVJetsmadgraph/Fall08_IDEAL_V11_redigi_v1/AODSIM
/Zjetsmadgraph/Summer08_IDEAL_V11_redigi_v1/GENSIMRECO
/AstarJetsmadgraph/Fall08_IDEAL_V11_redigi_v1/GENSIMRECO
/QCD100to250madgraph/Fall08_IDEAL_V11_redigi_v1/GENSIMRECO
/QCD250to500madgraph/Fall08_IDEAL_V11_redigi_v1/GENSIMRECO
/QCD500to1000madgraph/Fall08_IDEAL_V11_redigi_v1/GENSIMRECO

More information on MC Production
https://twiki.cern.ch/twiki/bin/view/CMS/ProductionSummer2008
(generated by MC generation group)

Backgrounds can be grouped according to prompt lepton multiplicity (prompt from W,Z decays, fake from jets)

[Main Backgrounds]

3 prompt : Diboson ZW, ZZ (irreducible bkg)

      suppressed by $M(mm) < 75$ GeV

      WWW, ttW have negligible cs < 0.5 fb

2 prompt : Zjets, ttbar (dangerous bkg)

      dangerous due to large cs

      WW less important

1(0) prompt : Wjets, QCD

      can be effectively rejected in spite of large cs

Data Samples

/Wjets-madgraph/Fall08_IDEAL_V9_v1
/Zjets-madgraph/Fall08_IDEAL_V9_reco0v2
/TTJets-madgraph_Fall08_IDEAL_V9_v2
/VVJets-madgraph_Fall08_IDEAL_V9_v2
inclusiveMuPt15_Summer08_IDEAL_V9_v1

Scenario	Cross Section	Generator	Number of events
W + jets (W→e,μ,τ)	40 nb	MadGraph+PYTHIA6	10334223
Z + jets (Z→e,μ,τ)	3.7 nb	MadGraph+PYTHIA6	1163479
ttbar	317.0 pb	MadGraph+PYTHIA6	1028322
VV+ jets (V=Z,W→e,μ,τ)	11.8 pb	MadGraph+PYTHIA6	101778
QCD	121.6 nb	MadGraph+PYTHIA6	6238383

INITIAL STUDY

- **RA7 Synchronization with Trilepton group**
  - Validation code with CMSSW 2.2.X
  - Try to use the same MC samples which the others used
  - Apply to every different cross section scenario for 10TeV
  - Use general cuts from what Martin Niegel has used
  - Targeted analysis tools are PATv2 and SUSY-PATv5

- **3μ and 2μ events from Chargino-Neutralino channel**
- **3 study region**

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Synchronization cuts
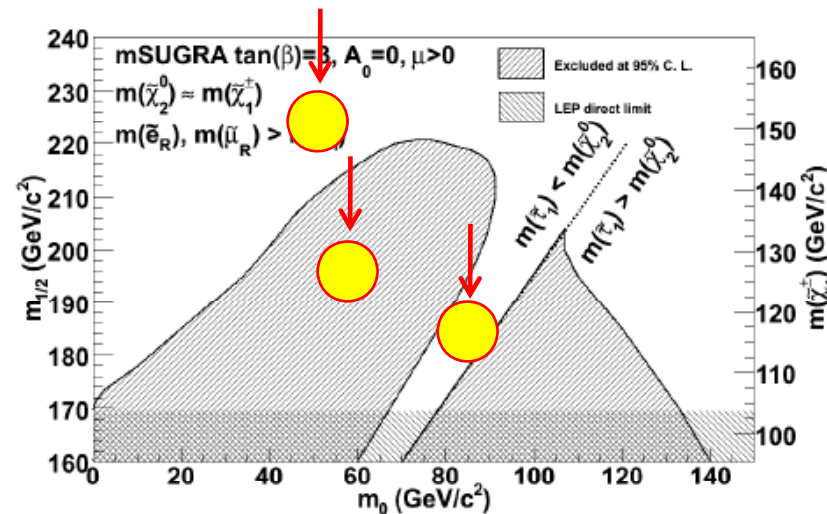
❖Initial muon and jet selection cuts for identical analysis to be applied to different analyzers

❖We might lean from any differences observed

Muon Selection

Quantity	Cut
Mu type	AllGlobalMuons
p_T	> 10 GeV
eta	-2.4 < eta < 2.4
Rel. track isolation	< 0.06
Rel. calo. Isolation	< 0.06
Opp. sign dimuon mass	(10<m<75) Or m > 105 GeV
Combined chi^2	< 10
abs(d_0)	Skip initially (<0.02)
Tracker Nhits	> 8

Taken from Martin(KIT)'s talk
(*M.Niegel, Susy Lep, Jan 29, 2009*)

Jet selection

Quantity	Cut
p_T	> 30 GeV
abs(eta)	< 2.5

Number of Global muon per a event
(LM0 with 202,686 events)

RECO GlobalMuons
No cut

Entries : 85146

~7000

Reco GlobalMuons
Pt > 10 GeV
-2.4 < eta < 2.4

~4000
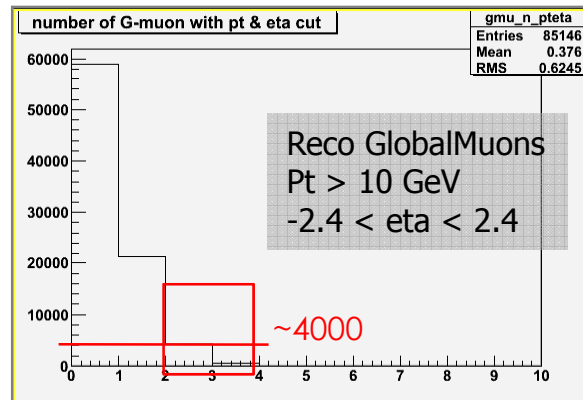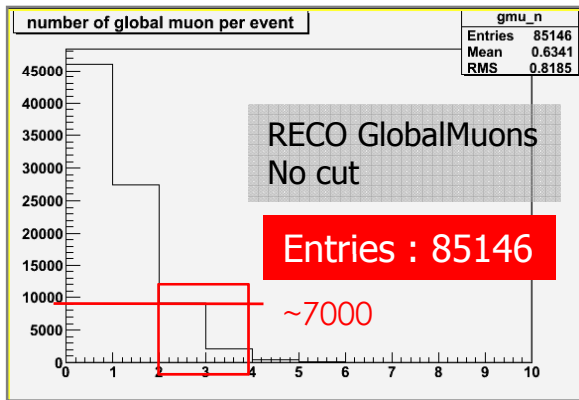
❖**Frame work**
  : CMSSW 2.2.13
❖**Analyzer : ED Analyzer**
❖**Process :** LM0 signal
❖**Cross Section :** 110pb
❖**Events :** 202,686

PAT Layer1 Muons
No cut

~850

Entries : 5491

PAT Layer1 Muons
Pt > 10 GeV
-2.4 < eta < 2.4

~400
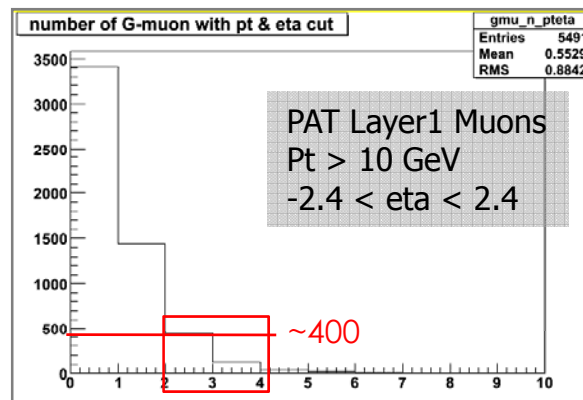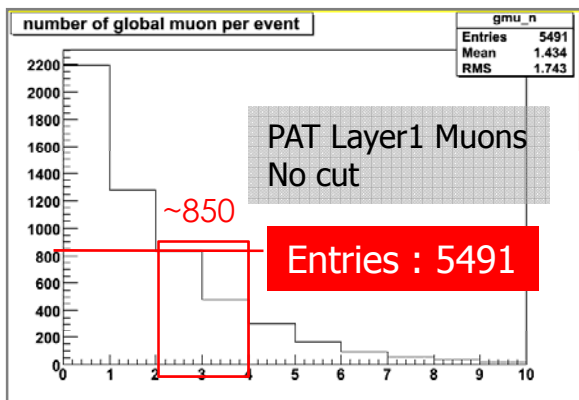
❖**Frame work**
  : CMSSW 2.2.13
❖**Analyzer : PATv2**
❖**Process :** LM0 signal
❖**Cross Section :** 110pb
❖**Events :** 202,686

Distribution of Muon Transverse Momentum
(LM0 with 202,686 events)

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RECO GlobalMuons
No cut

Entries : 53987

Reco GlobalMuons
Pt > 10 GeV
-2.4 < eta < 2.4

Entries : 32017

Reco GlobalMuons
Pt > 10 GeV
-2.4 < eta < 2.4
3muons events cut

Entries : 4864

9%

PAT Layer1 Muons
No cut

Entries : 8267

PAT Layer1 Muons
Pt > 10 GeV
-2.4 < eta < 2.4

Entries : 3061

PAT Layer1 Muons
Pt > 10 GeV
-2.4 < eta < 2.4
3muons events cut

Entries : 1688

20%
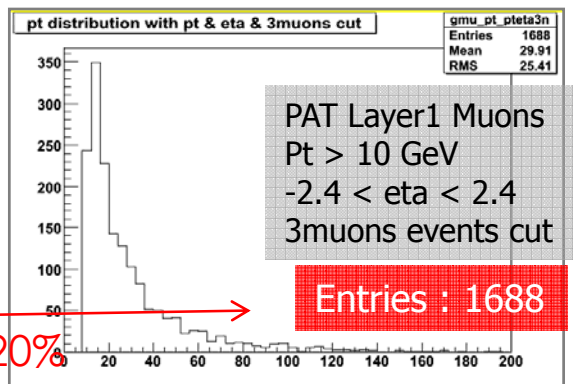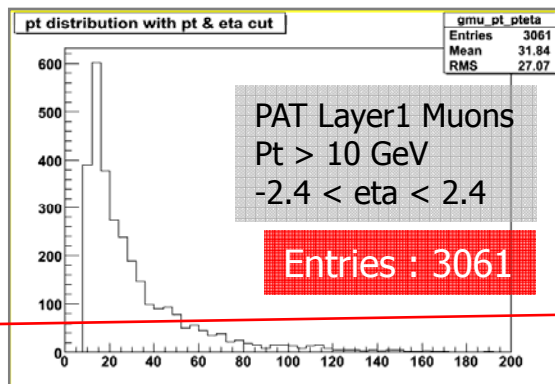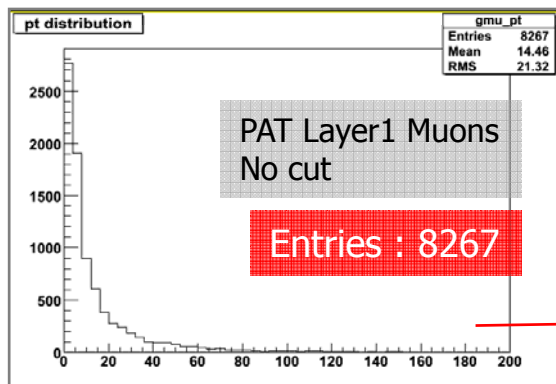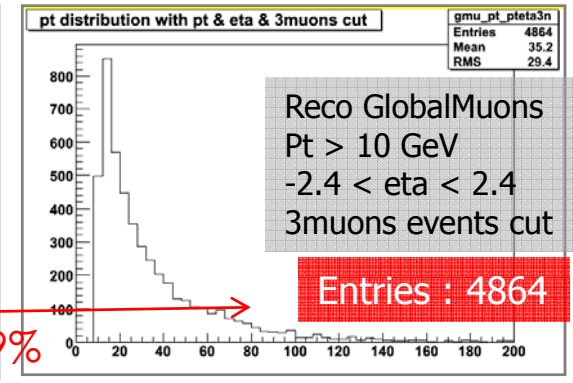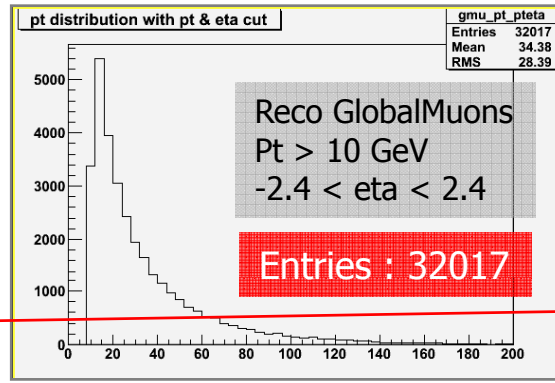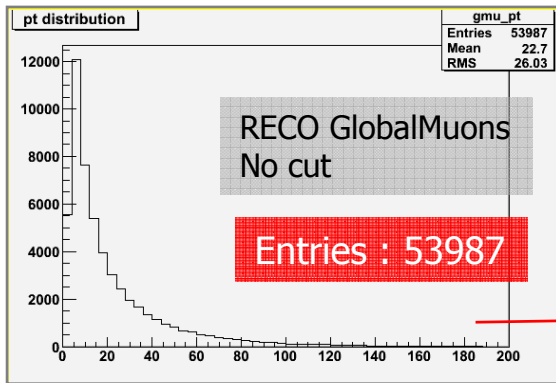
Distribution of Muon Eta
(LM0 with 202,686 events)
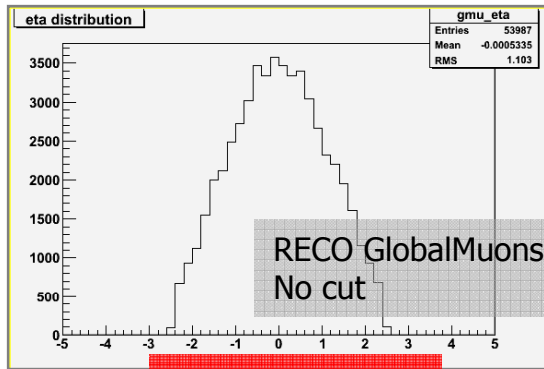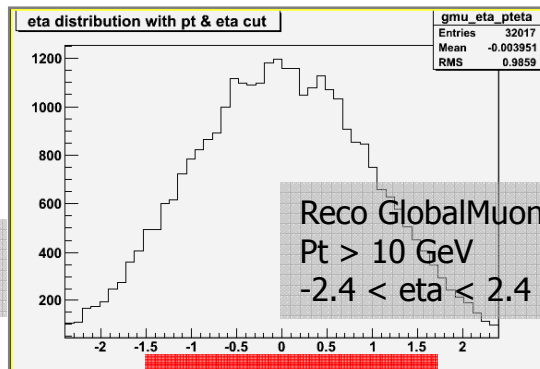
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RECO GlobalMuons
No cut

Entries : 53987

Reco GlobalMuons
Pt > 10 GeV
-2.4 < eta < 2.4

Entries : 32017
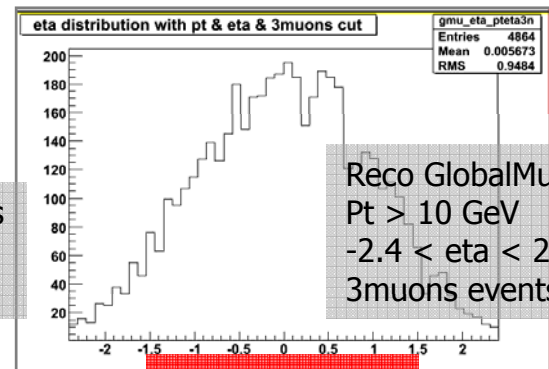
Reco GlobalMuons
Pt > 10 GeV
-2.4 < eta < 2.4
3muons events cut

Entries : 4864
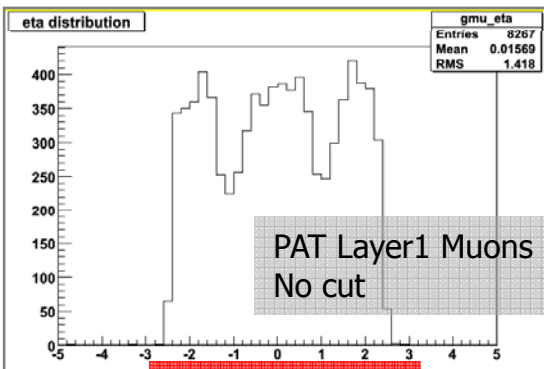
PAT Layer1 Muons
No cut

Entries : 8267
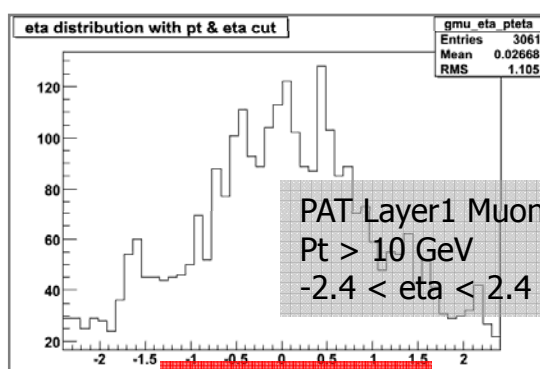
PAT Layer1 Muons
Pt > 10 GeV
-2.4 < eta < 2.4

Entries : 3061
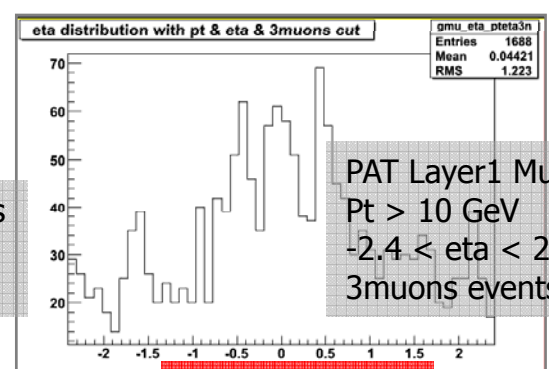
PAT Layer1 Muons
Pt > 10 GeV
-2.4 < eta < 2.4
3muons events cut

Entries : 1688

Mass distribution of Dimuons
(LM0 with 202,686 events)

Very low statistics

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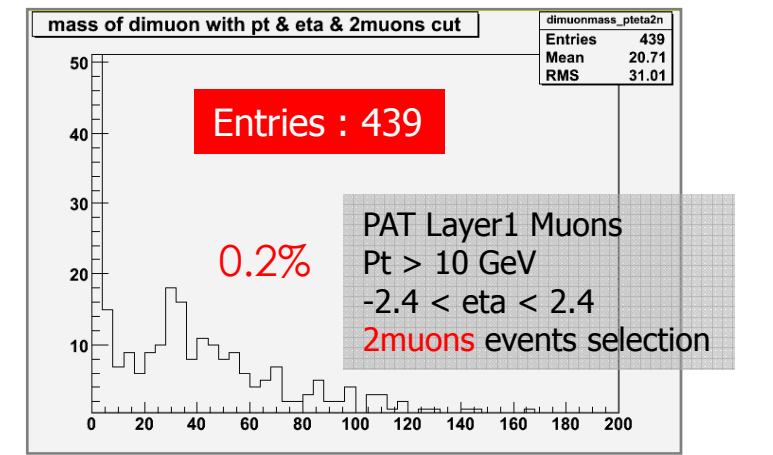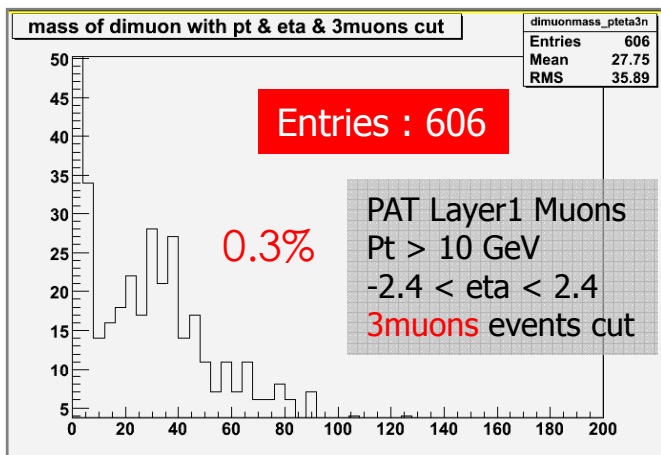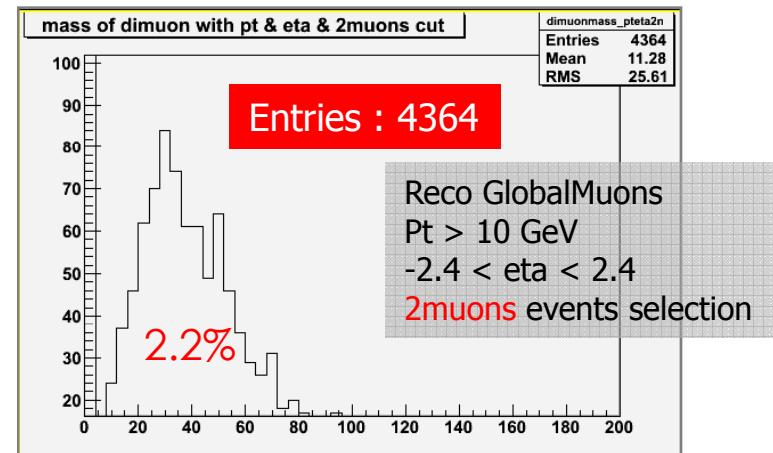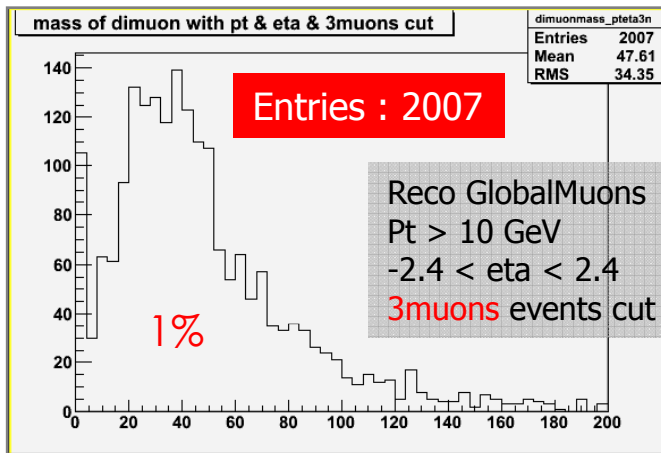
Sample	Generator	step	# evts RECO	# evts PAT	X-sec / pb	Filter Eff.	Lumi / Pb-1	# 3muon Events
LM0	Pythia 6	GEN-SIM-RECO	202686	202686	110	1.0	1842	**606**

Entries : 606 / 202686

~ 0.3%

Veto 'Z->mumu' mass

dimuonmass_pteta3n
Entries	606
Mean	27.75
RMS	35.89

PAT Layer1 Muons
Pt > 10 GeV
-2.4 < eta < 2.4
3muons events cut
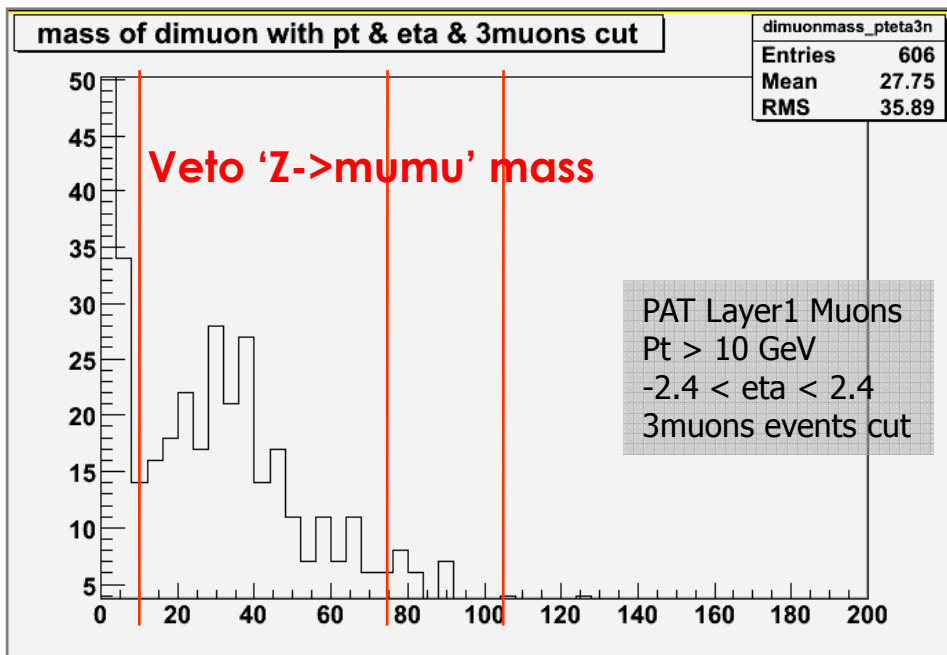
Should apply more cut quantities
✓Dimuon Mass(10<M<75, 105<M)
✓Track relative isolation < 0.06
✓Calo relative isolation < 0.06
✓Combined chi^2 < 10
✓Tracker Nhits > 8
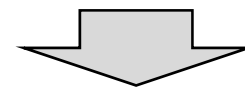
▪Will be reduced under 100 events
▪Much statistics are needed

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Conclusion

◆Generated MC Signal sample 1k events with CMSSW_3_1_2, and go on generating much more samples on Grid

◆Initial study on Trilepton channel
- used ~200k MC signal events, generated with CMSSW 2.2.9
- analysized with PATv2 analyzer in framework CMSSW 2.2.13
- able to get ~600 3muon events after only pt and eta cuts

◆Just started recently, much more in expectation of prosperous study from now on

Next step and plan

◆Validate analyzer through synchronization exercise with trimuon events
- apply more precise cuts to get 3muon events
- get the result for the whole scenario signal and sm background samples

◆Move analyzer into 2mu+e study after synchronization

BACKUP SLIDE

Synchronization exercise

Synchronization results with Trimuon (May 2009)

Process	Num evts in MC sample All/3m/minv			Num evts in 100/pb			Efficiency in %		
	Colorado	Karlsruhe	Rutgers	Colorado	Karlsruhe	Rutgers	Colorado	Karlsruhe	Rutgers
LM0	202686/109/73	202686/109/73	202686/109/73	5.9/4.0	5.91/3.96	5.9/4.0	0.054/0.036		0.054/0.036
LM1	240000/240/177	104800/112/82	240000/240/177	1.6/1.2	1.71/1.25	1.6/1.2	0.100/0.074		0.10/0.074
LM2	238000/76/49	116800/41/27	240000/77/50	0.077/0.050	0.08/0.06	0.077/0.050	0.032/0.021		0.032/0.021
LM3	240200/174/83	153000/114/50	240200/174/83	0.85/0.41	0.88/0.39	0.85/0.41	0.072/0.034		0.072/0.035
LM4	226000/186/40	110400/110/23	230000/190/41	0.55/0.12	0.66/0.14	0.55/0.12	0.082/0.018		0.082/0.018
LM5	183400/69/31	171600/64/28	171600/65/29	0.073/0.033	0.072/0.032	0.073/0.033	0.038/0.017		0.038/0.017
LM6	217600/459/301	134400/277/177	134400/280/180	0.27/0.18	0.26/0.17	0.27/0.17	0.211/0.138		0.208/0.134
LM7	236800/236/83	82400/71/29	82400/73/31	0.29/0.10	0.25/0.10	0.26/0.11	0.100/0.035		0.090/0.038
LM8	201240/309/77	201240/332/82	161302/251/59	0.44/0.11	0.47/0.12	0.45/0.10	0.153/0.038		0.16/0.037
LM9	198784/115/59	199248/153/119	175250/100/48	0.67/0.34	0.85/0.66	0.66/0.32	0.058/0.030		0.057/0.027
VV+ jets	101778/230/35	101778/225/34	101778/230/35	2.7/0.41	2.61/0.39	2.7/0.41	0.226/0.034		0.226/0.034
W + jets	9366223/0/0	10334223/0/0	40000/0/0	0	0/0	0	0		0
Z + jets	1163479/2/0	1163479/2/0	1163479/2/0	0.64/0	0.64/0	0.64/0	0.00017/0		1.7e-4/0
ttbar	1028322/2/1	905369/2/1	983676/2/1	0.06/0.03	0.07/0.035	0.06/0.03	0.0002/0.0001		0.0002/0.0001
QCD**	2008990/0/0			0			0		

Global Run : CRAFT09 (~2009.09.01)

●**RPC off-line commissioning**
- **Prompt and CRAFT Analysis**
    - **mid week global runs**
    - **CRAFT09**
    - **StreamExpressCRAFT09-RpcCalHLT-v1ALCARECO (129 runs)**

- **Developing Monitoring Tool for reading RPC comditions**

- **Offline shift**
    - **3~4 times per a week for CRAFT09**
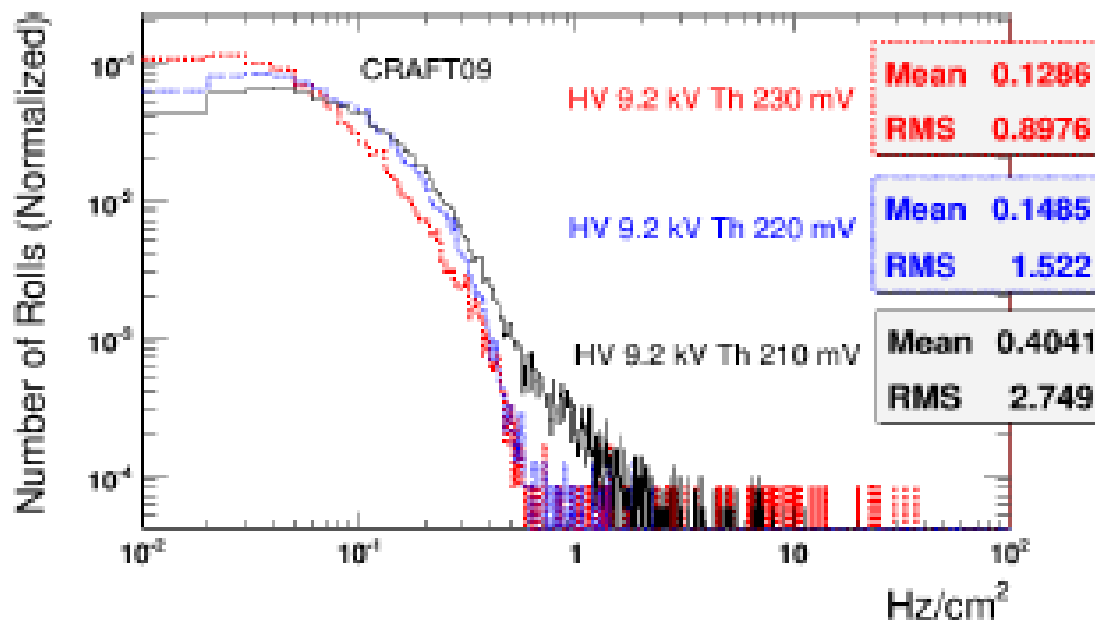   - **once per a week for mid week global runs**

Good Run List : CRAFT09

https://twiki.cern.ch/twiki/bin/view/CMS/RPClistofRunP5CRAFT09

List of CRAFT 09 runs

Run Summary Plots	HV	TH	Start	N. of Ev	Trigger configuration and rate	Readout	B* field	Quality Flag	fresh mask file		P5 elog link	! CAF elog link
108168	9.2kV all	210mV	2009.07.23 14:11:21	1M	TTU(108 Hz) + PAC(180Hz)	all RPC detector YB+1FAR	0	BAD	yes		elog	
108239	9.2kV all	210mV	2009.07.23 18:08:40	4M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	OK	yes		elog	elog
108265	9.2kV all	210mV	2009.07.23 21:22:24	2.7M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	OK	yes		elog	elog
108290	9.2kV all	210mV	2009.07.24 01:04:19	5M	TTU(106 Hz) + PAC(166Hz)	all RPC detector	0	OK	yes		elog	elog
108298	9.2kV all	210mV	2009.07.24 03:28:45	20M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	OK	yes		elog	elog
108521	9.2kV all	210mV	2009.07.24 22:36:56	5M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	possibly BAD (out-sync)	yes		elog	elog
108526	9.2kV all	210mV	2009.07.25 00:30:46	45M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	ok but spike E0R	yes		elog	
108562	9.2kV all	210mV	2009.07.25 10:54:43	13M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	ok	yes		elog	elog
108597	9.2kV all	210mV	2009.07.25 13:58:33	27M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	ok	NO		elog	
108624	9.2kV all	210mV	2009.07.25 19:52:08	14M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	OK but LB_RE+1_S8_EP12_CH0 link broken + ye-3 6chambers@6kv	New for RB1far		elog	
108645	9.2kV all	210mV	2009.07.25 23:31:40	45M	TTU(106 Hz) + PAC(180Hz)	all RPC detector	0	OK but LB_RE+1_S8_EP12_CH0	No		elog	

RPC CRAFT09

CRAFT09

HV 9.2 kV Th 230 mV

Mean	0.1286
RMS	0.8976

HV 9.2 kV Th 220 mV

Mean	0.1465
RMS	1.522

HV 9.2 kV Th 210 mV

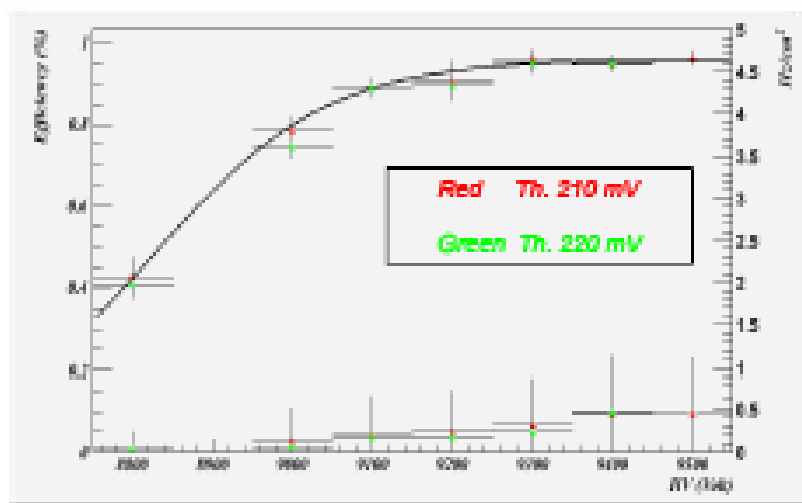| Mean	0.4041
RMS	2.749

Barrel noise distributions at 9.2 kV for three different thresholds.
Each entry refers to one eta partition

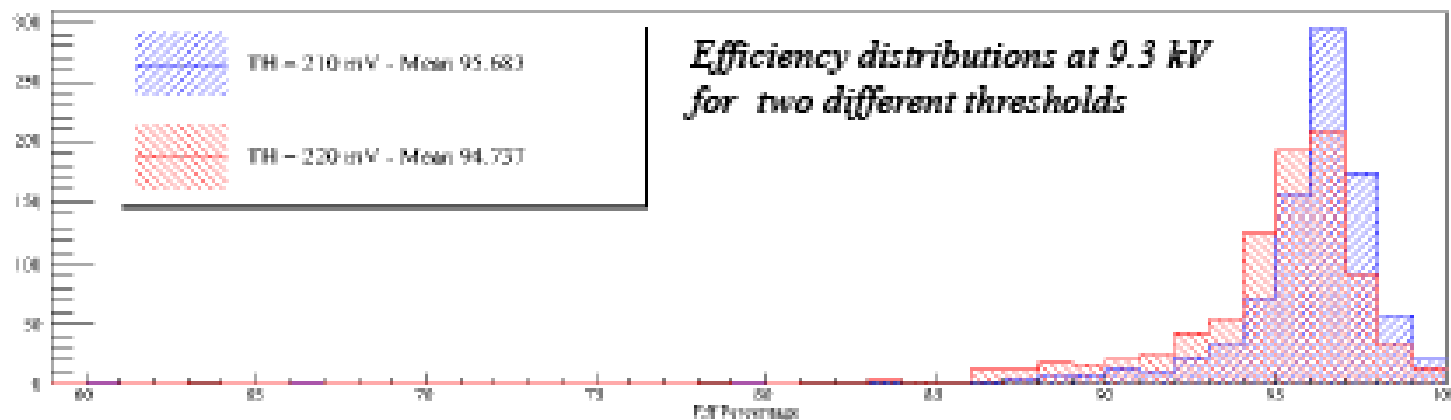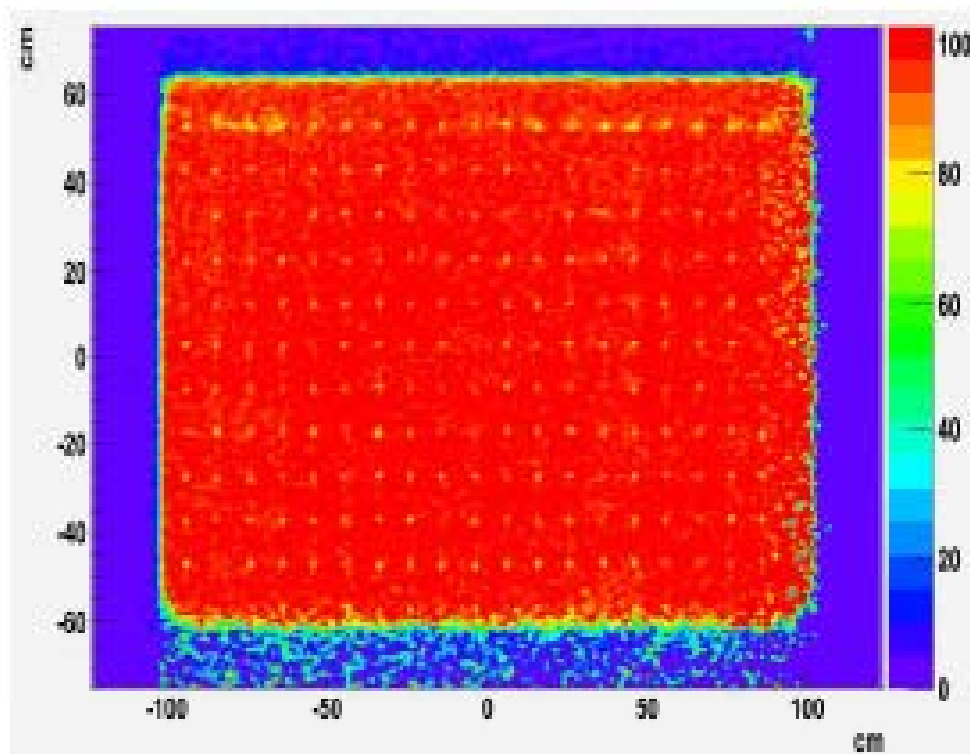**Approval CRAFT09**
by RPC commissioning group

Example of one barrel chamber HV scan for noise and efficiency at two different thresholds.

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Efficiency distributions at 9.3 kV for two different thresholds

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High resolution "muongraphy"

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