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# How to analysis Muon?

--Muon software

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All credit to Muon software developer

Hugo, Melynda, David, Jamie, et al.....

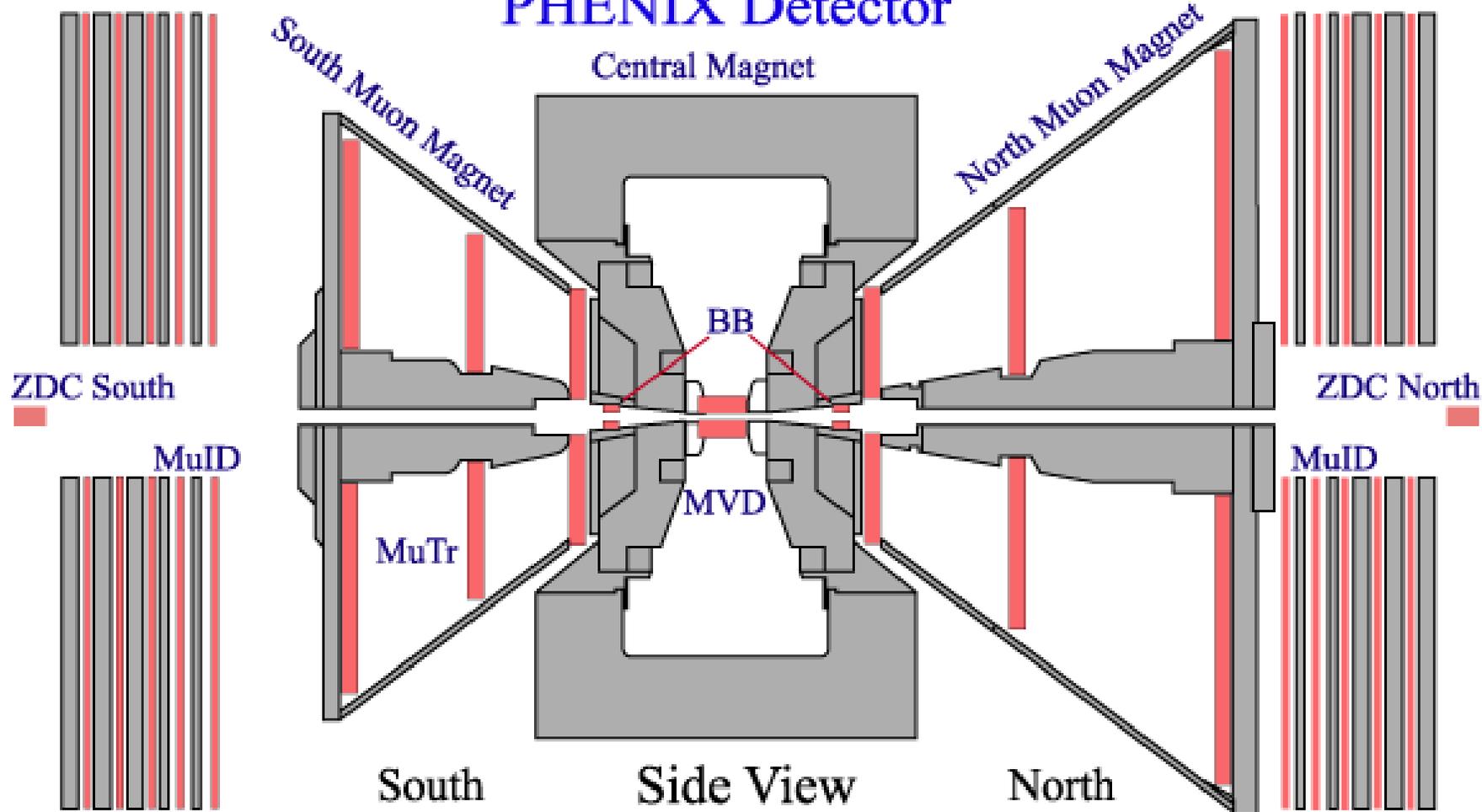
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# outline

- Muon arms overview
- Muon software tutorial
- Real data analysis
  - What do we get from production?
  - How to extract muons from Muon Nanodst?
  - What is in Muon picodsts?
    - Dimuons
    - Sngmuons
- Muon simulations

# Muon track + muon identifier

## PHENIX Detector



South Muon arm :  $-1.2 > \eta > -2.0$

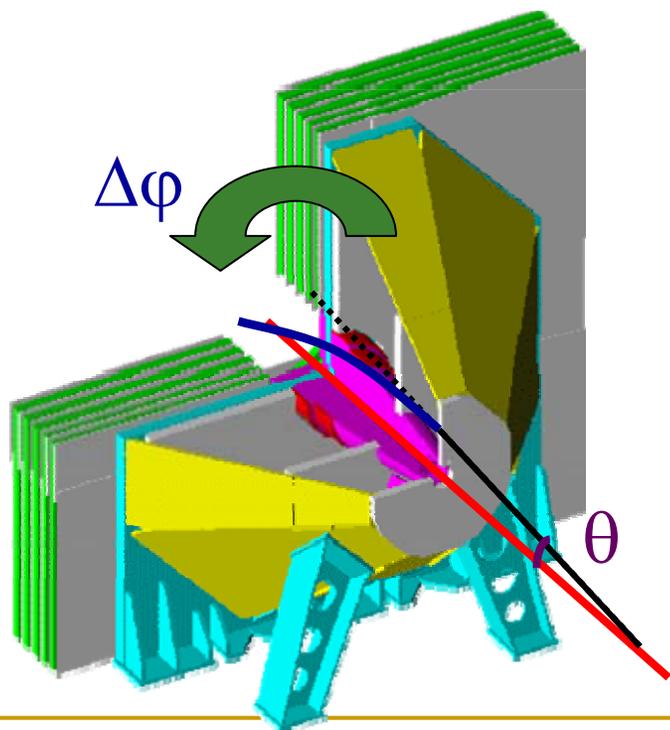
North Muon arm :  $2.4 > \eta > 1.2$

# Measure charged particle tracks

Charged particle bend

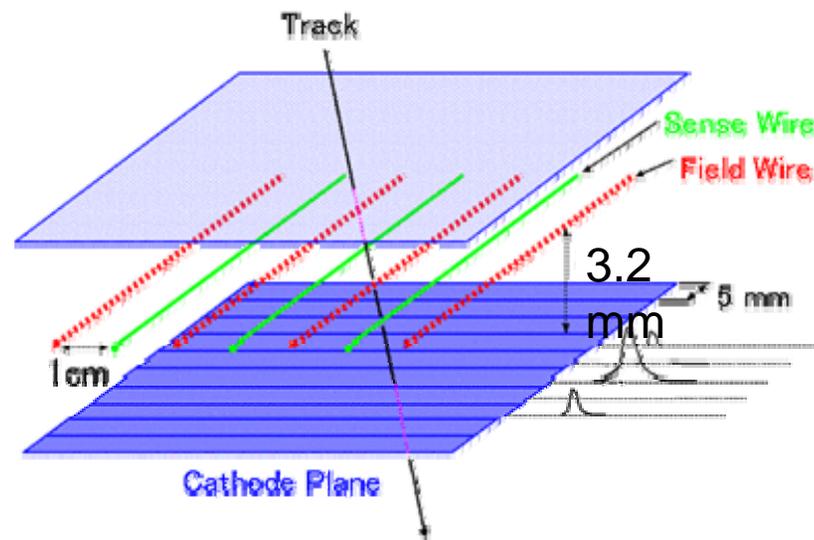
$$\Delta\phi (\sim P_L)$$

$\Delta\phi$  &  $\theta$ : particle momentum



Particles passing through a gap

- Ionization in the gas
- Strips collect induced signal



More detail: vi-nham's run4 mutr focus talk

# Useful PHENIX focus talks

- Run4 Vi-Nham Tram: hardware

[http://www.phenix.bnl.gov/WWW/run/04/focus/index\\_run4](http://www.phenix.bnl.gov/WWW/run/04/focus/index_run4)

- Run5: Physics analysis

[http://www.phenix.bnl.gov/WWW/run/05/focus/index\\_run5](http://www.phenix.bnl.gov/WWW/run/05/focus/index_run5)

- Walt Sondheim: how to design muon arm
- David silvermy: Jpsi and dimuons
- Xiaorong Wang: single muons
- Anuj Purwar: hadron

# Muon software tutorial (doxygen)

mutoo + muioo + rpcoo + fvtxoo + ...

## Class library

<https://www.phenix.bnl.gov/WWW/p/draft/hpereira/doc/mutoo/html/>

<https://www.phenix.bnl.gov/WWW/p/draft/hpereira/doc/muioo/html/>

## Analysis modules: fun4all modules

[https://www.phenix.bnl.gov/WWW/p/draft/hpereira/doc/mutoo\\_subsysreco/html/](https://www.phenix.bnl.gov/WWW/p/draft/hpereira/doc/mutoo_subsysreco/html/)

# Real data analysis:

- MWG\_Minbias
- MWG\_Muon: triggered

- Single muon trigger

MUIDLL1\_N1D&BBCLL1 0x00004000

MUIDLL1\_S1D&BBCLL1 0x00008000

MUIDLL1\_N1S&BBCLL1 0x00010000

MUIDLL1\_S1S&BBCLL1 0x00020000

- Dimuons trigger (lvl2 filtered)

MUIDLL1\_N1D1S&BBCLL1 0x00040000

MUIDLL1\_S1D1S&BBCLL1 0x00080000

MUIDLL1\_N1D&S1D&BBCLL1 0x00100000 (back to back dimuon trigger(run6))

(MUIDLL1\_N2D||S2D)&BBCLL1 0x00200000

See Kenichi's SpinFest EmCal talk, to see how to extract trigger information.

# How to extract muon from Nanodsts

DST node: PHMuoTracksOO (PHIODataNode)

Get Node:

```
muoo = findNode::getClass<PHMuoTracksOut>(top_node,"PHMuoTracksOO");  
if (first && !muoo) cout << "MWGpico::GetNodes - PHMuoTracksOO (new framework) not in Node Tree" << endl;
```

Library: offline/packages/MWGpico/MWGpico.C  
          /singlemuons  
          /dimuons

Macros: /direct/phenix+u/xrwang/spinFestTutorial/data\_macros

Fun4Muons\_RecoNDST.C

```
MWGpico *picoDST = new MWGpico(choice,"RCF");  
picoDST->set_nano_file( inputfile );  
picoDST->MakePico("dimuonsOO", outputfile_dimuons );  
picoDST->MakePico("sngmuons", outputfile_sngmuons );
```

Output: sngmuons\_pdst.root and dimuons\_pdst.root

# Inside sngmuons\_pdst.root and dimuons.root

- Dimuons\_pdst.root: dimuons,
- Sngmuons\_pdst.root : Sngmuons, Sngvtx

Contents of "/ROOT Files/sngmuons\_pdst.root/sngmuons"

Clock_trig	DDG0	DG0	DS0
DS3	DS3ctp	ELoss	Evt_Nmu
Evt_Number	Evt_Z	Evt_bbcCentralityByClock	Evt_bbcCentralityByPerp
Evt_bbcZ	Evt_fclGreyN	Evt_livetrigN_1D	Evt_livetrigN_1S
Evt_livetrigS_1D	Evt_livetrigS_1S	Evt_pseudotrigN_1D	Evt_pseudotrigN_1S
Evt_pseudotrigS_1D	Evt_pseudotrigS_1S	Evt_realtrigN_1D	Evt_realtrigN_1S
Evt_realtrigS_1D	Evt_realtrigS_1S	Evt_realtrig_MB	Evt_recoN_1D
Evt_recoN_1S	Evt_recoS_1D	Evt_recoS_1S	Evt_zdcCentrality
Evt_zdcEnerN	GL1X_ID	Pol_B	Pol_Y
Run_Number	SpinX_ID	X1	X2
X3	X4	X5	X6
charge	chi2	dxdz	dycz
eta	gap0x	gap0y	gap0z
ghost	idchi2	idhits	idquad
lastGap	mc_d_n	mc_d_pid	mc_d_ptot
mc_d_px	mc_d_py	mc_d_pz	mc_d_z
mc_hits	mc_n_part	mc_p_pid	mc_p_ptot
mc_p_px	mc_p_py	mc_p_pz	mc_p_z
mc_pid	mc_ptot	mc_px	mc_py
mc_pz	mc_x	mc_y	mc_z
muid_nhits	mutr_nhits	p	pSt1
pT	phi	px	pxSt1
pxSt3	py	pySt1	pySt3
pz	pzSt1	pzSt3	refX
refY	ref_vtx_r	ref_vtx_rdca	ref_vtx_z
refit_zvtx	trhits	trstat	xSt1
xSt2	xSt3	ySt1	ySt2
ySt3	zSt1	zSt2	zSt3

Contents of "/ROOT Files/dimuons\_pdst.root/dimuons"

Evt_Nmu	Evt_Number	Evt_bbcCentralityByPerp
Evt_bbcCentralityByPerp	Evt_bbcZ	Evt_I2MutrN
Evt_I2MutrS	Evt_I2N	Evt_I2S
Evt_pseudotrigN_1D1S	Evt_pseudotrigN_2D	Evt_pseudotrigS_1D1S
Evt_pseudotrigS_2D	Evt_recoN_1D1S	Evt_recoN_2D
Evt_recoS_1D1S	Evt_recoS_2D	Evt_vtxchi2
Evt_vtxoor	Evt_vtxooz	GL1X_ID
MuID2primitiveek	MuIDlevel2ok	Pol_B
Pol_Y	Run_Number	SpinX_ID
Tr0_DDGO	Tr0_DGO	Tr0_DGOx
Tr0_DGOy	Tr0_DS3	Tr0_DS3ctp
Tr0_chi2	Tr0_idchi2	Tr0_idhits
Tr0_idquad	Tr0_px	Tr0_py
Tr0_pz	Tr0_trhits	Tr1_DDGO
Tr1_DGO	Tr1_DGOx	Tr1_DGOy
Tr1_DS3	Tr1_DS3ctp	Tr1_chi2
Tr1_idchi2	Tr1_idhits	Tr1_idquad
Tr1_px	Tr1_py	Tr1_pz
Tr1_trhits	charge	costhCS
dca	mass	p
pT	rapidity	x1
x2	xF	xvtxbp
yvtxbp	zvtxbp	

Contents of "/ROOT Files/sngmuons\_pdst.root/sngvtx"

BBCNN	BBCNS	BBCQN	BBCQS	Clock_trig
Evt_Z	Evt_livetrigN_1D	Evt_livetrigN_1S	Evt_livetrigS_1D	Evt_livetrigS_1S
Evt_realtrig_MB	GL1X_ID	Pol_B	Pol_Y	Run_Number
SpinX_ID	ZDCN	ZDCS	bbcCentrality	bbcZ
zdcCentrality				

# Simulations

/direct/phenix+u/xrwang/spinFestTutorial/sim\_macros

Fun4Muons\_Pisa.C:

from PISAEvent.root to sim\_dst.root

```
SubsysReco *Muon_pisa = new MuonUnpackPisa();
```

**\*Making modifications**

**\*Changing the Muid efficiency in the response, HV map applied here**

Fun4Muons\_RecoDST\_sim.C:

from sim\_dst.root to nanodst or picodst