Some Improvement of FPCCD Track Finder

October 11, 2013

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About Development of Track Finder

- I evaluated “cos(incident angle)” VS “Fraction of Good Track”

- Setup
  - sample : ttbar 350GeV (1000 events)
  - **|P| > 1 GeV/c**

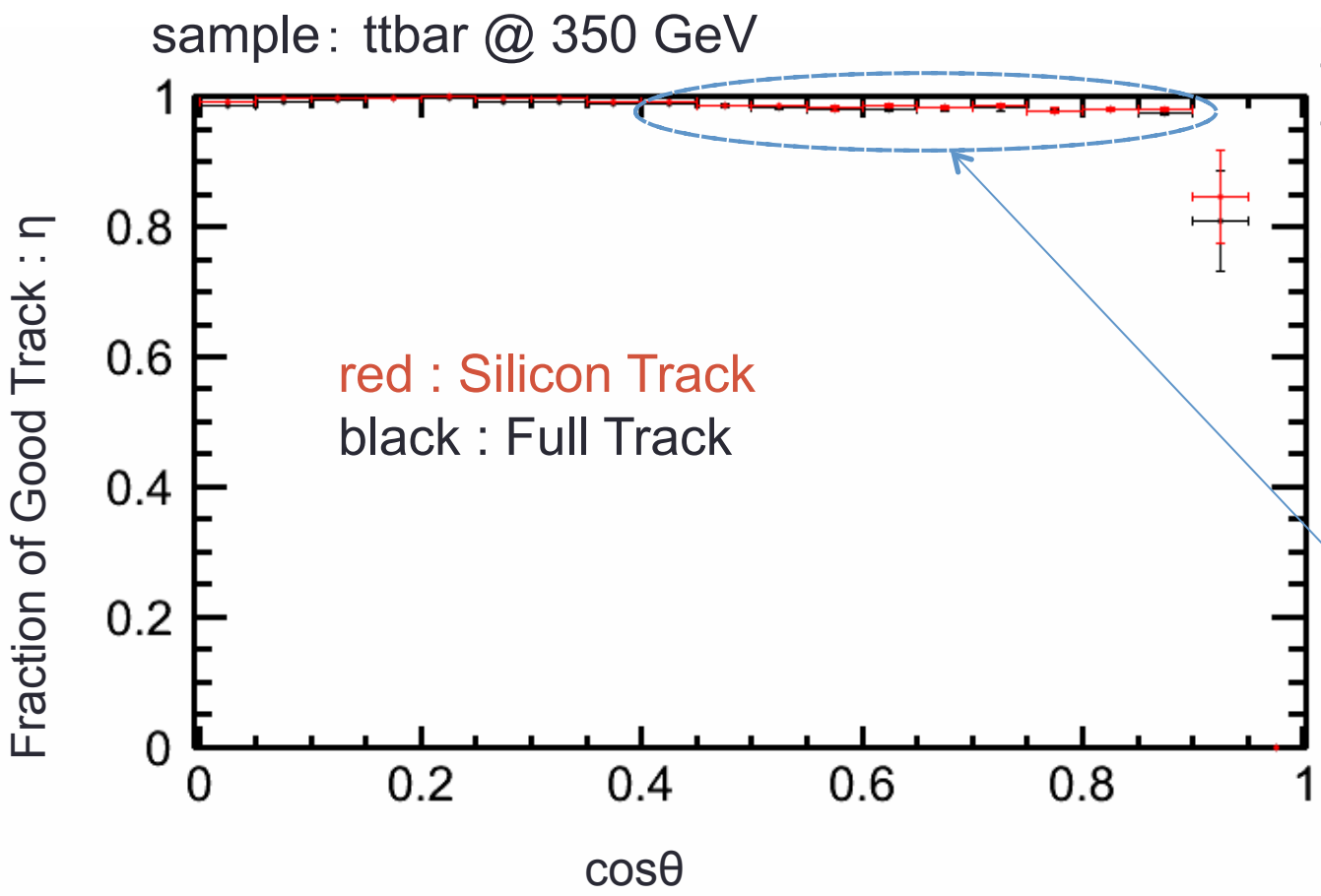
  - Fraction of Good Track : η ≡

$$\frac{\text{\# of tracks with VXD hits >= 5 \&\& purity > 75\%}}{\text{\# of MCParticles creating VXD sim-hits >= 6 \&\& SIT sim-hits >= 4}}$$

Previous Study: FPCCD Track Finder + FPCCD

Fraction of Good Track : η ≡

$$\frac{\text{\# of tracks with VXD hits >= 5 \&\& purity > 75\%}}{\text{\# of MCParticles creating VXD sim-hits >= 6 \&\& SIT sim-hits >= 4}}$$



ex-1) : needed P_T
TPC R_{in} : > 0.4 GeV/c
TPC R_{out} : > 1.8 GeV/c

ex-2) : SIT coverage
cosθ < 0.9

In this region,
97~98%
Why?

single mu+ check

- I evaluated “cosθ” VS “Fraction of Good Track”

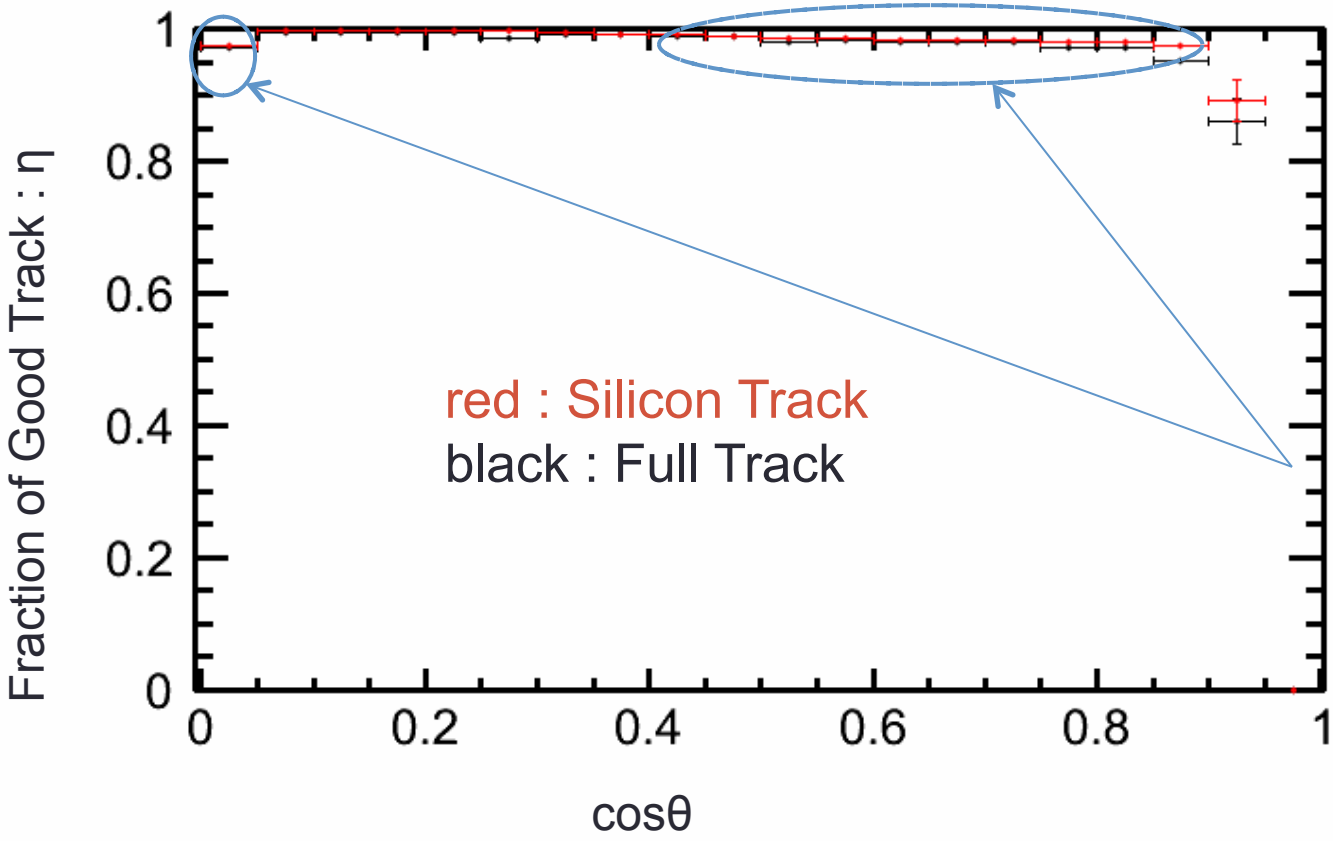
- Setup
  - sample : single mu+ (200K events) ← Φ,θ is uniformly distributed
  - **|P| = 1 GeV/c (“Fixed”)**

  - Fraction of Good Track : η ≡

$$\frac{\text{\# of tracks with VXD hits >= 5 \&\& purity > 75\%}}{\text{\# of MCParticles creating VXD sim-hits >= 6 \&\& SIT sim-hits >= 4}}$$

Another Setup 1

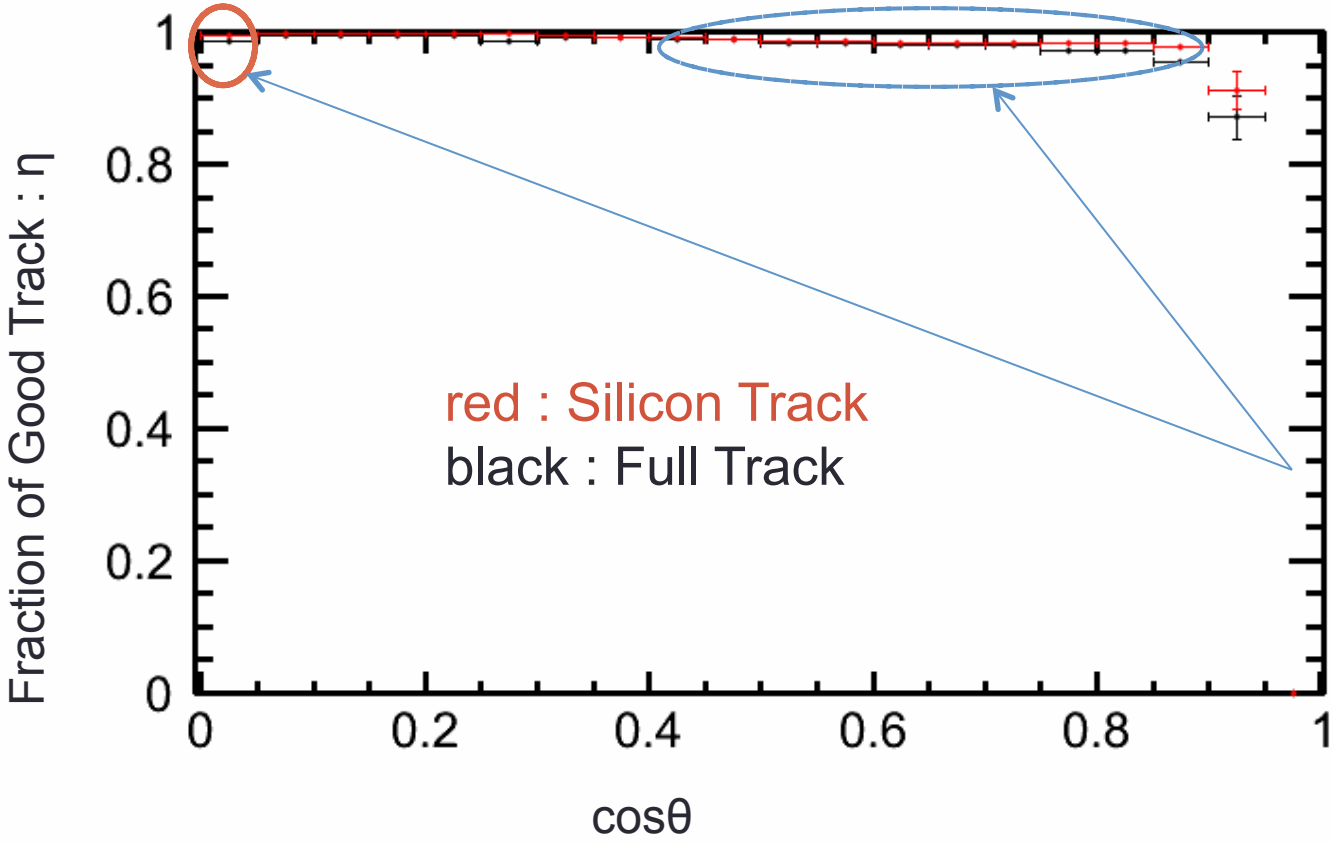
- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**



worse than the case of ttbar setup
→Is low Pt the reason?

Another Setup 2

- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **layer combinations for triplet search : plus [5 4 2] [5 3 2] [4 3 2]**

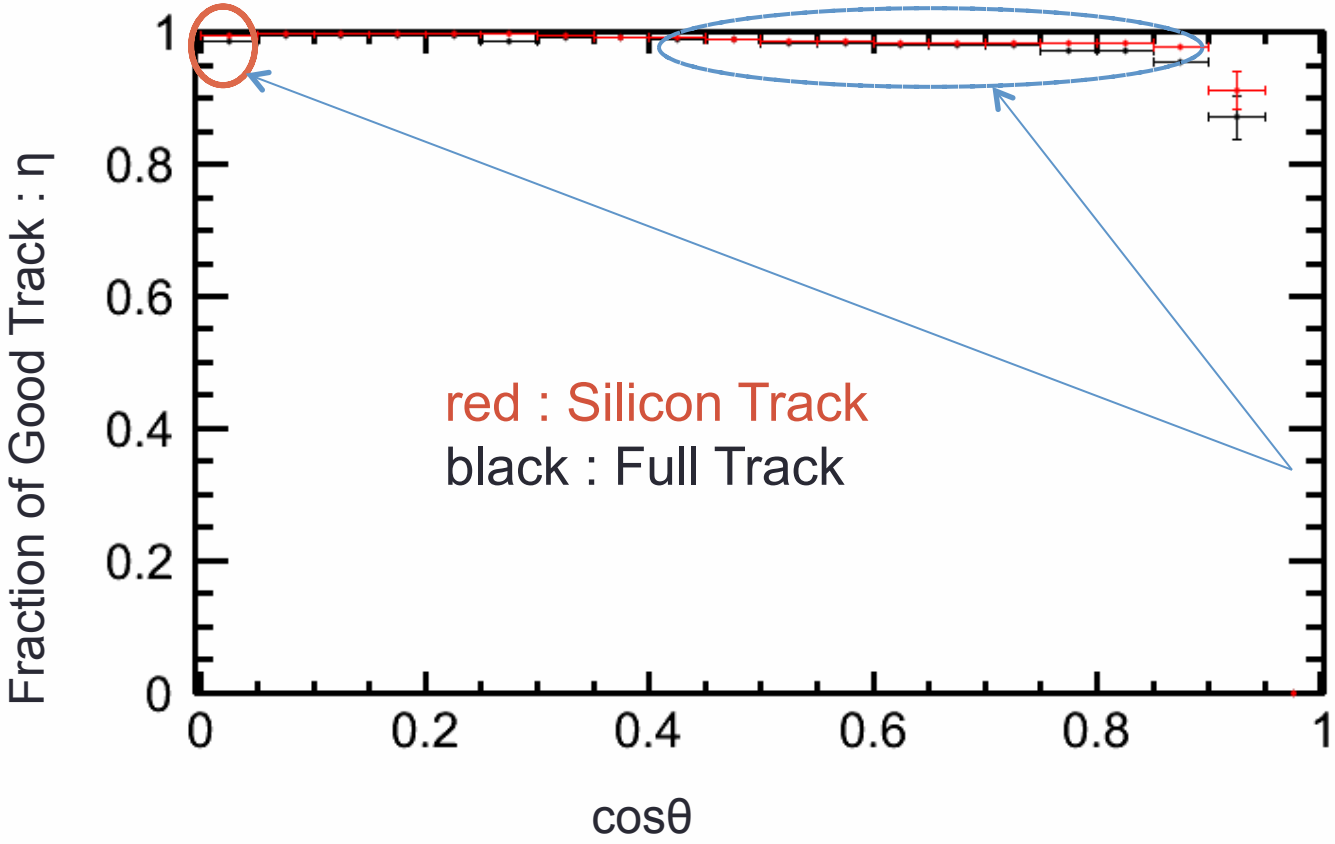


Large improvement can be seen cosθ ~ 0

In cosθ > 0.5, 0~1% improvement can be seen

Another Setup 3

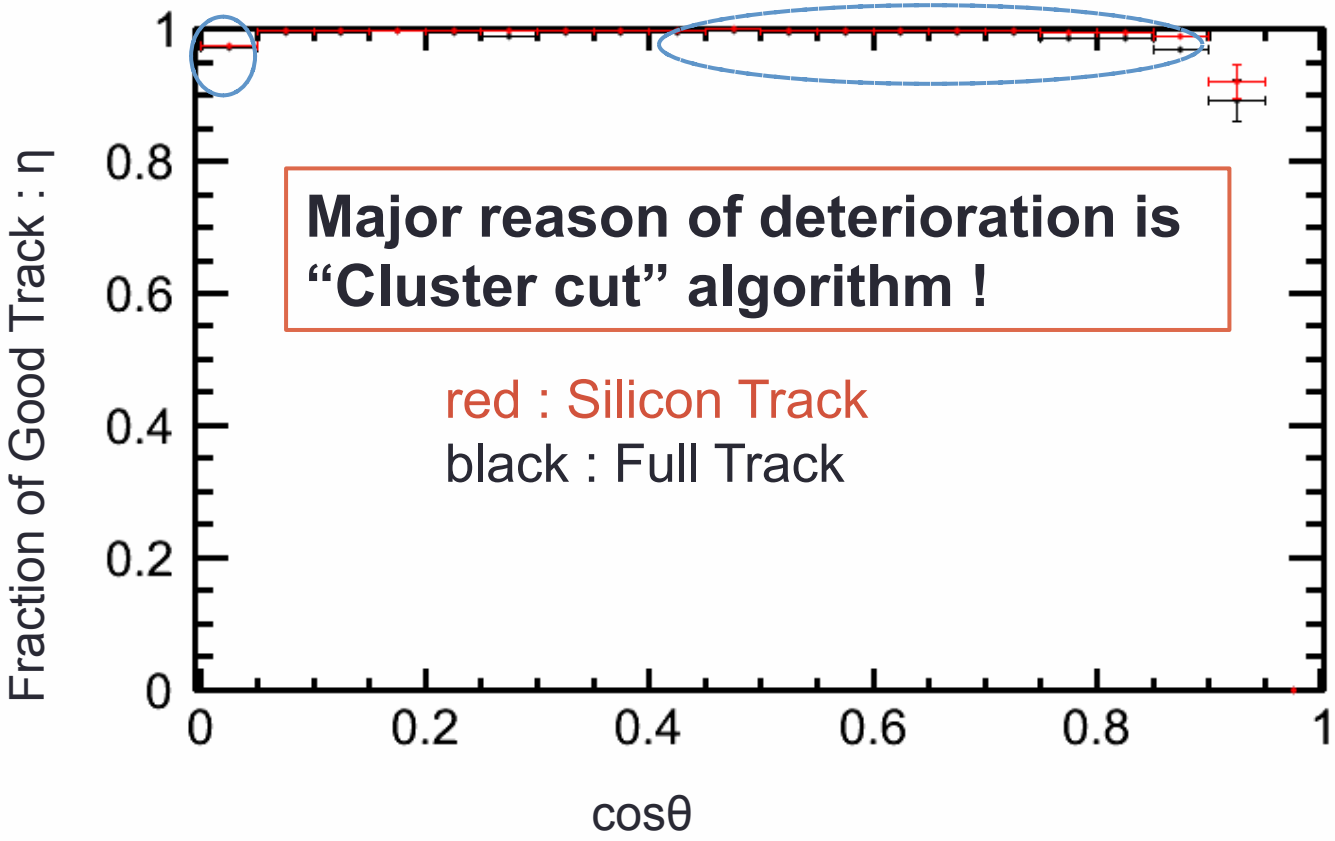
- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **layer combinations for triplet search : plus [5 4 2] [5 3 2] [4 3 2] [4 3 1] [4 2 1] [3 2 0]**



completely same as setup 2 !!
→If we add [5 4 2] [5 3 2] [4 3 2], we don't need [4 3 1] [4 2 1] [3 2 0]

Another Setup 4

- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - Cluster cut in BuildTrack → **inactive**



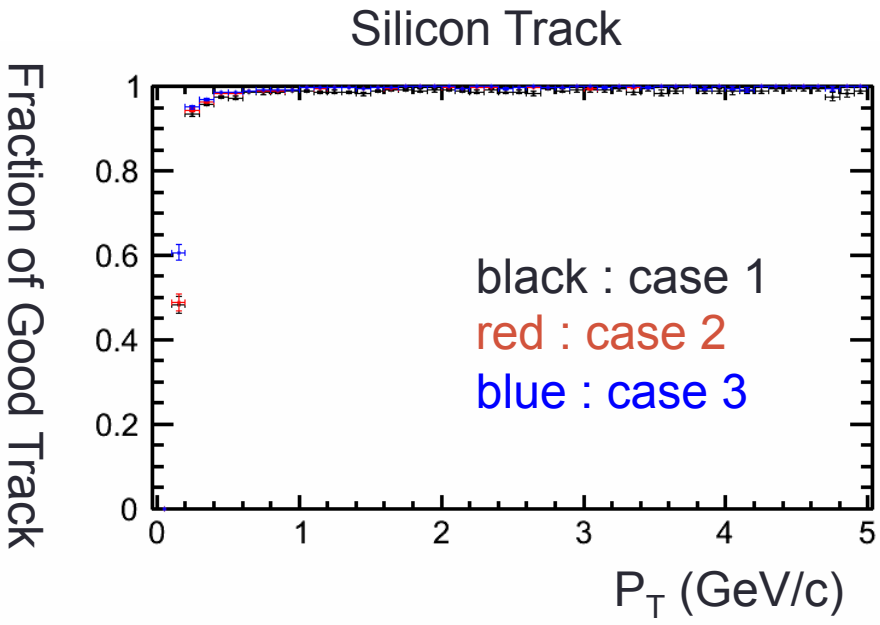
Check with ttbar 350GeV

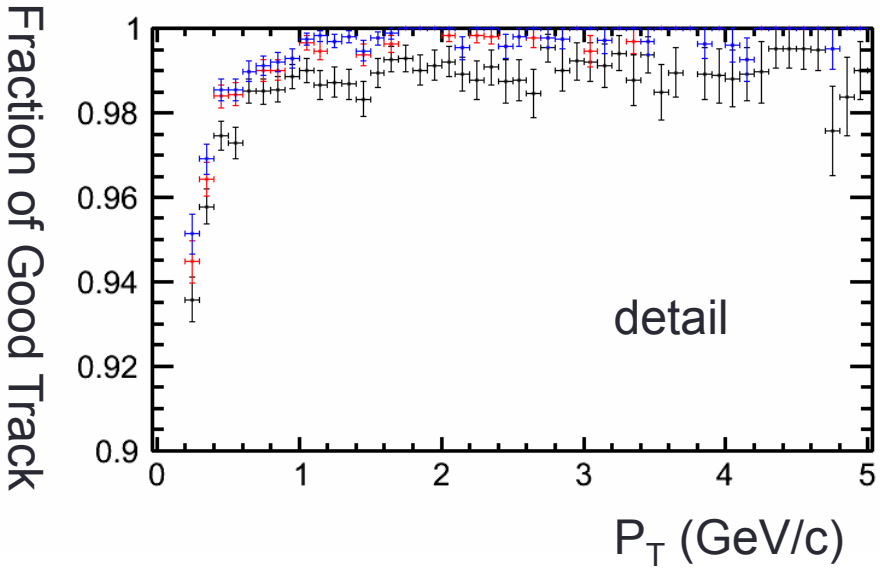
About Development of Track Finder

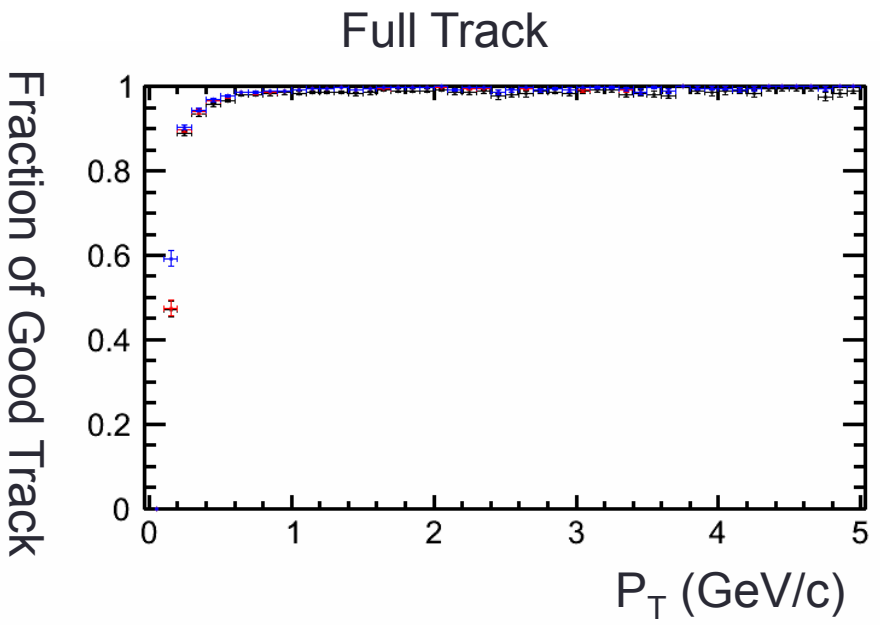
- “Pt” VS “Fraction of Good Track”
- “cos(incident angle)” VS “Fraction of Good Track”

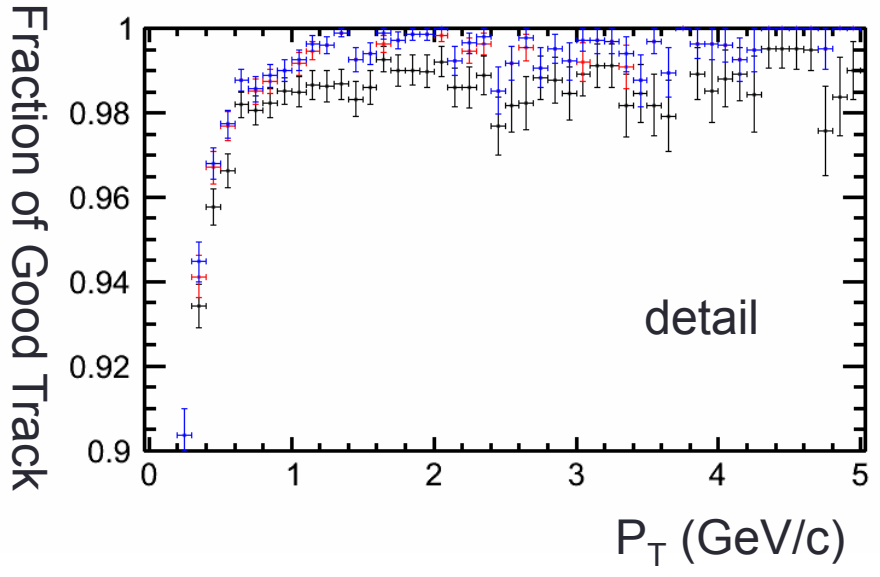
- Setup
  - sample : ttbar 350GeV (1000 events) without BG
  - **|P| > 1 GeV/c**
  - **case 1 :**
    - **default**
  - **case 2 :**
    - **cluster rejection in extrapolation : turned off**
  - **case 3 :**
    - **cluster rejection in extrapolation : turned off**
    - **adding 3 layer combinations for triplet search : [5 4 2] [5 3 2] [4 3 2]**

Pt vs Fraction

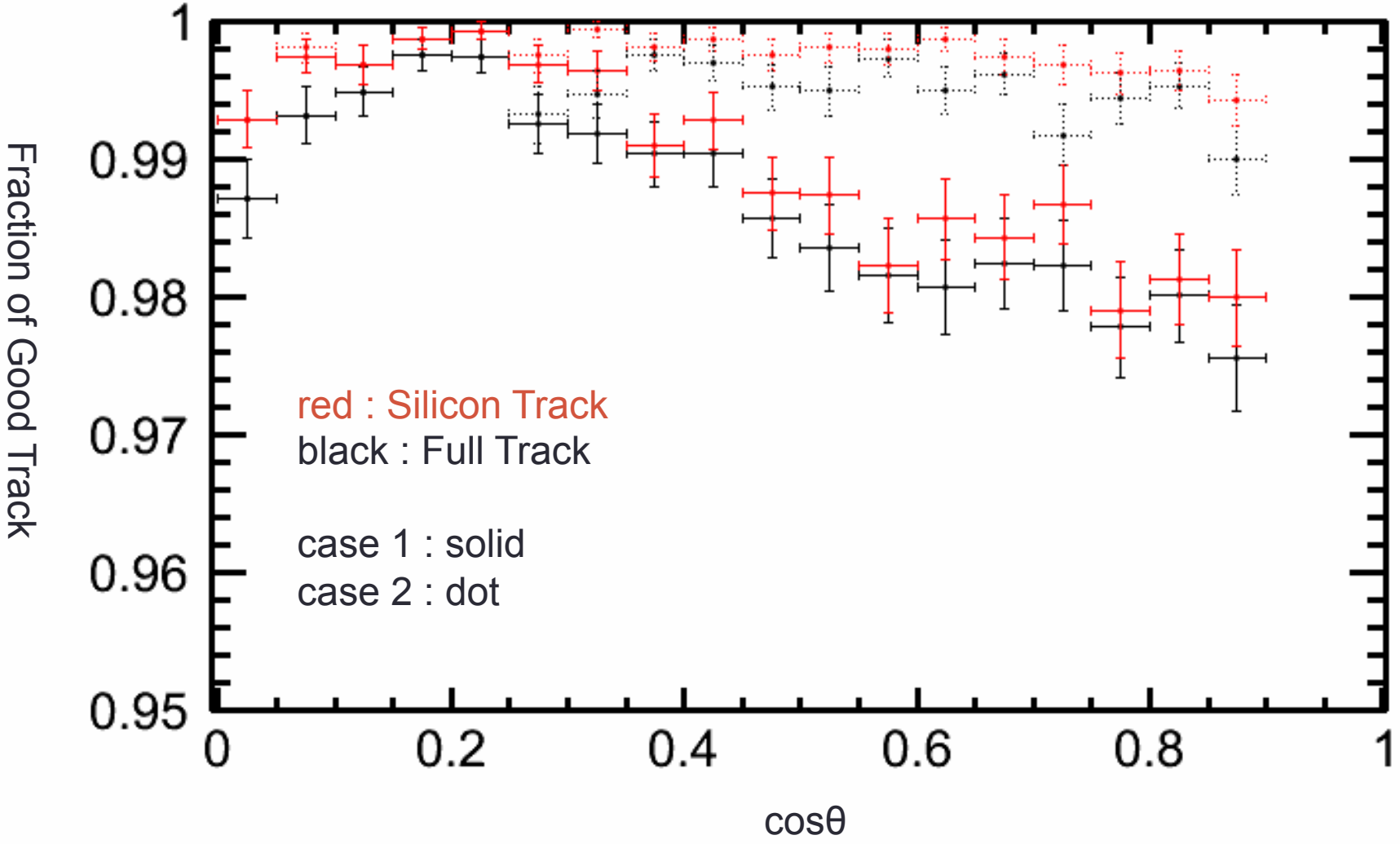




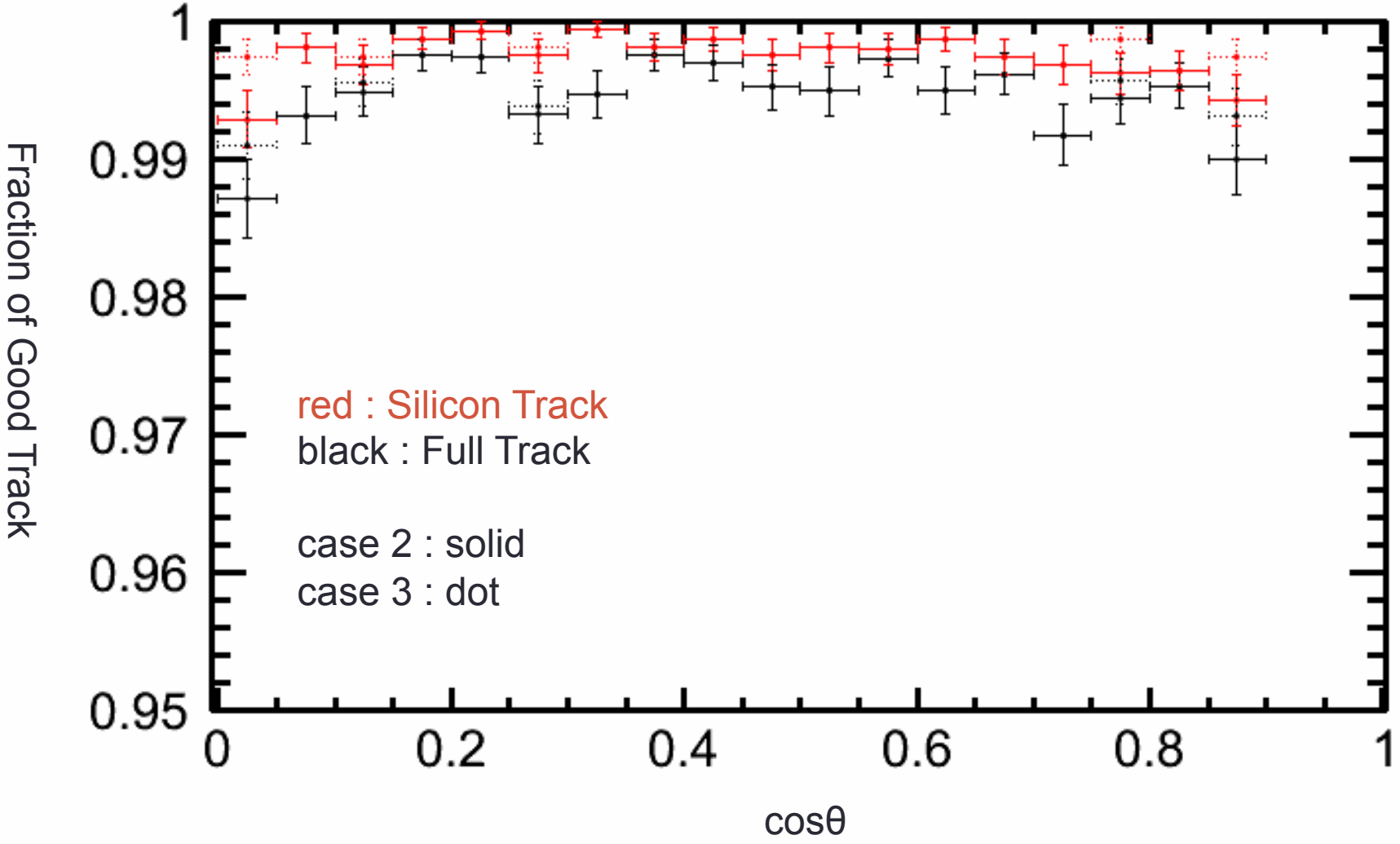




Cosθ VS Fraction ~ case 1 VS case 2 ~



Cosθ VS Fraction ~ case 2 VS case 3 ~



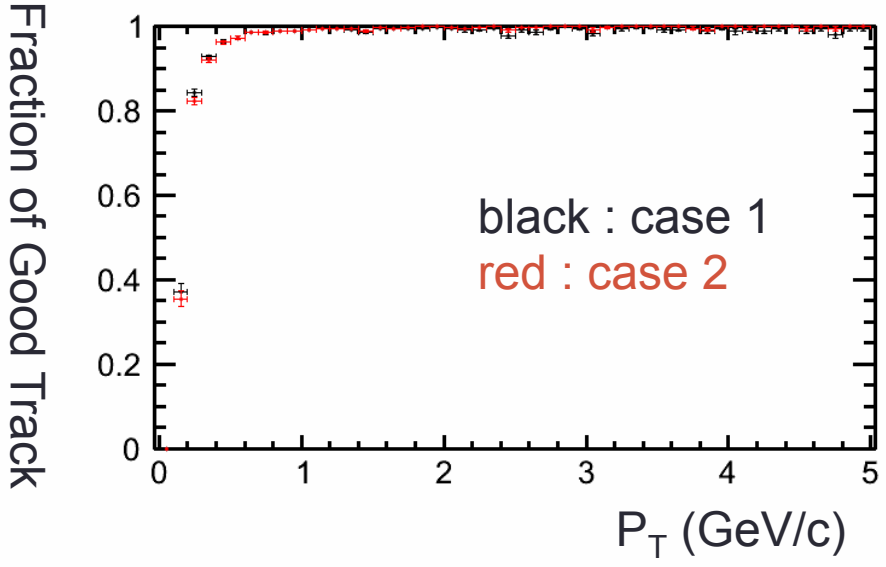
With Background

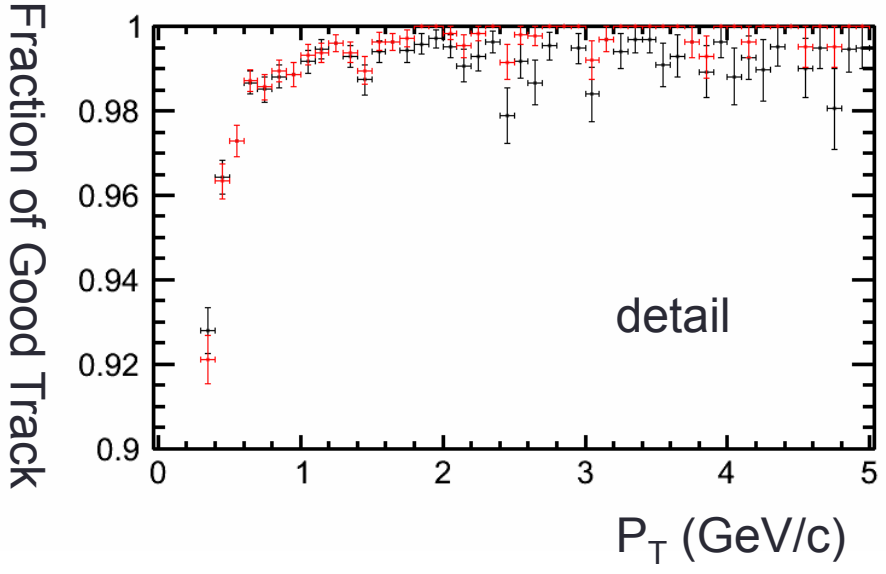
- Setup
  - sample : ttbar 350GeV (1000 events) **with pair BG**
  - **|P| > 1 GeV/c**
  - **case 1 :**
    - **default**
  - **case 2 :**
    - **cluster rejection in extrapolation : turned off**

→case 3 takes much longer time than case 1 & 2 , so I haven't prepare the result of case 3 yet

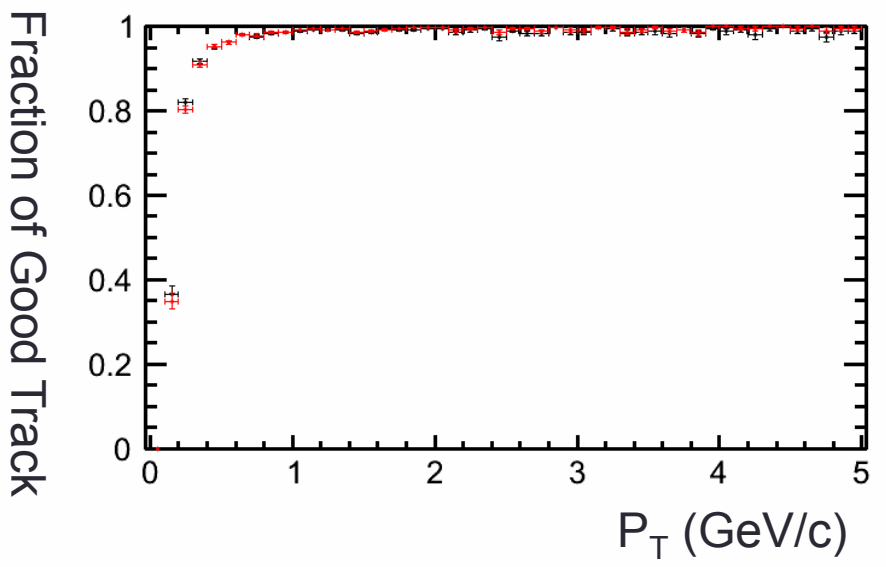
Pt vs Fraction with Pair BG

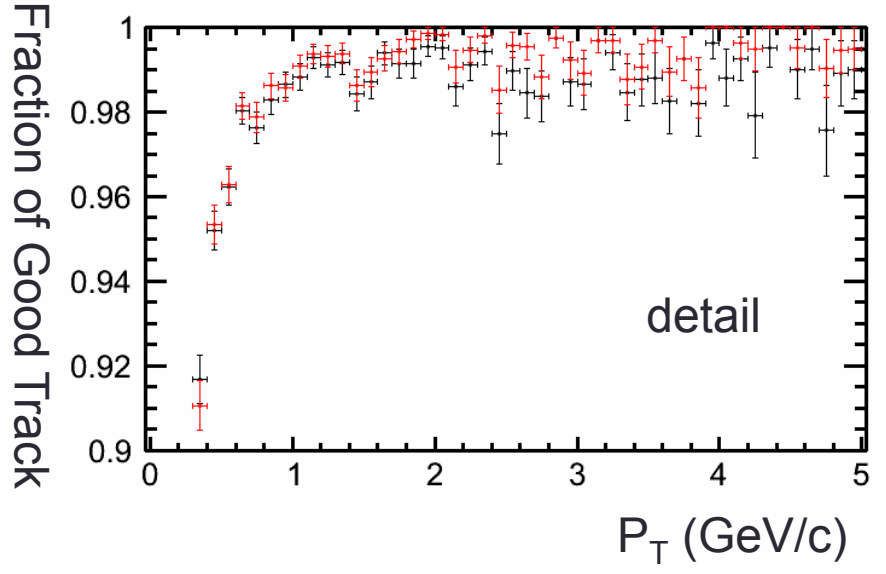
Silicon Track



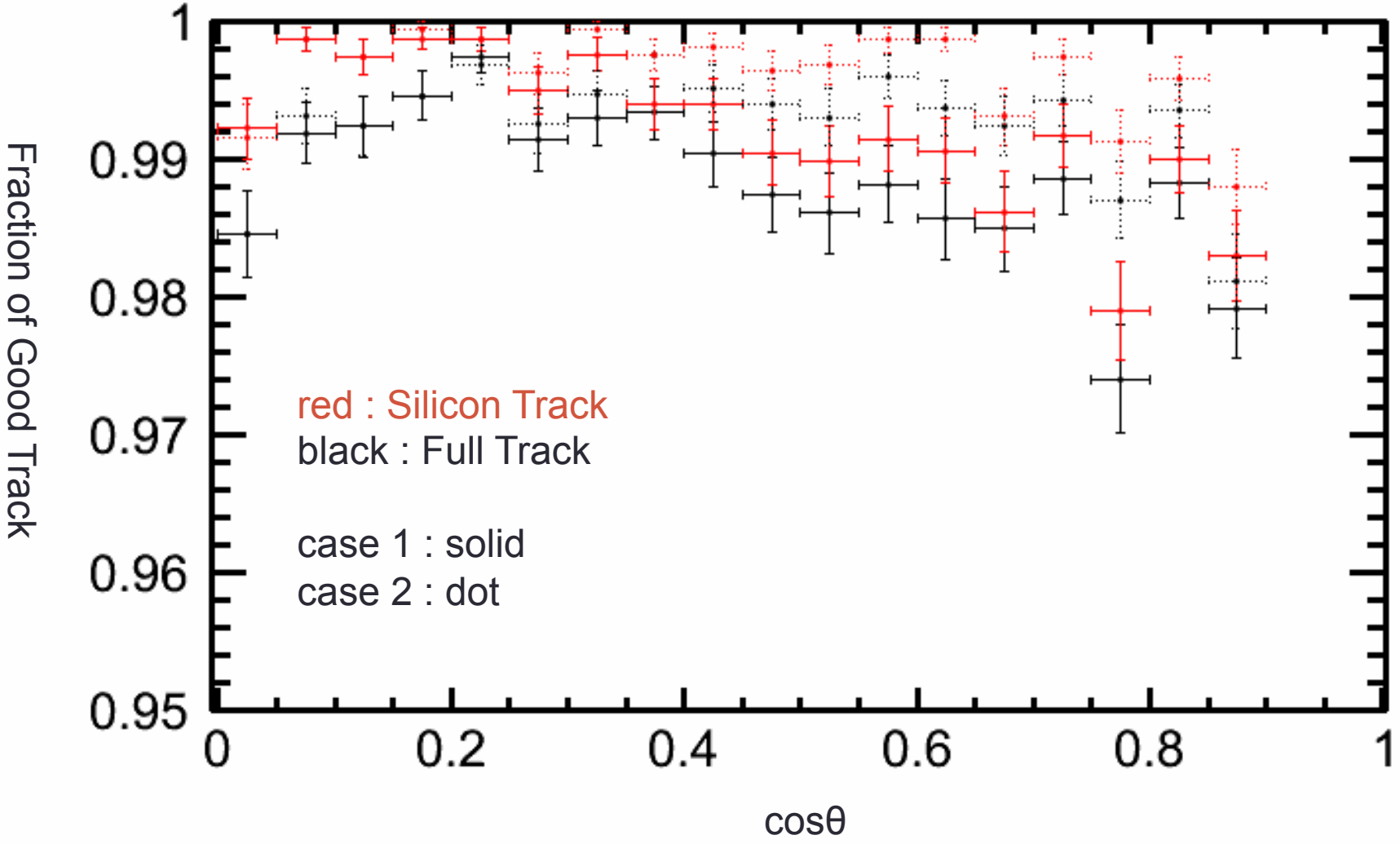


Full Track





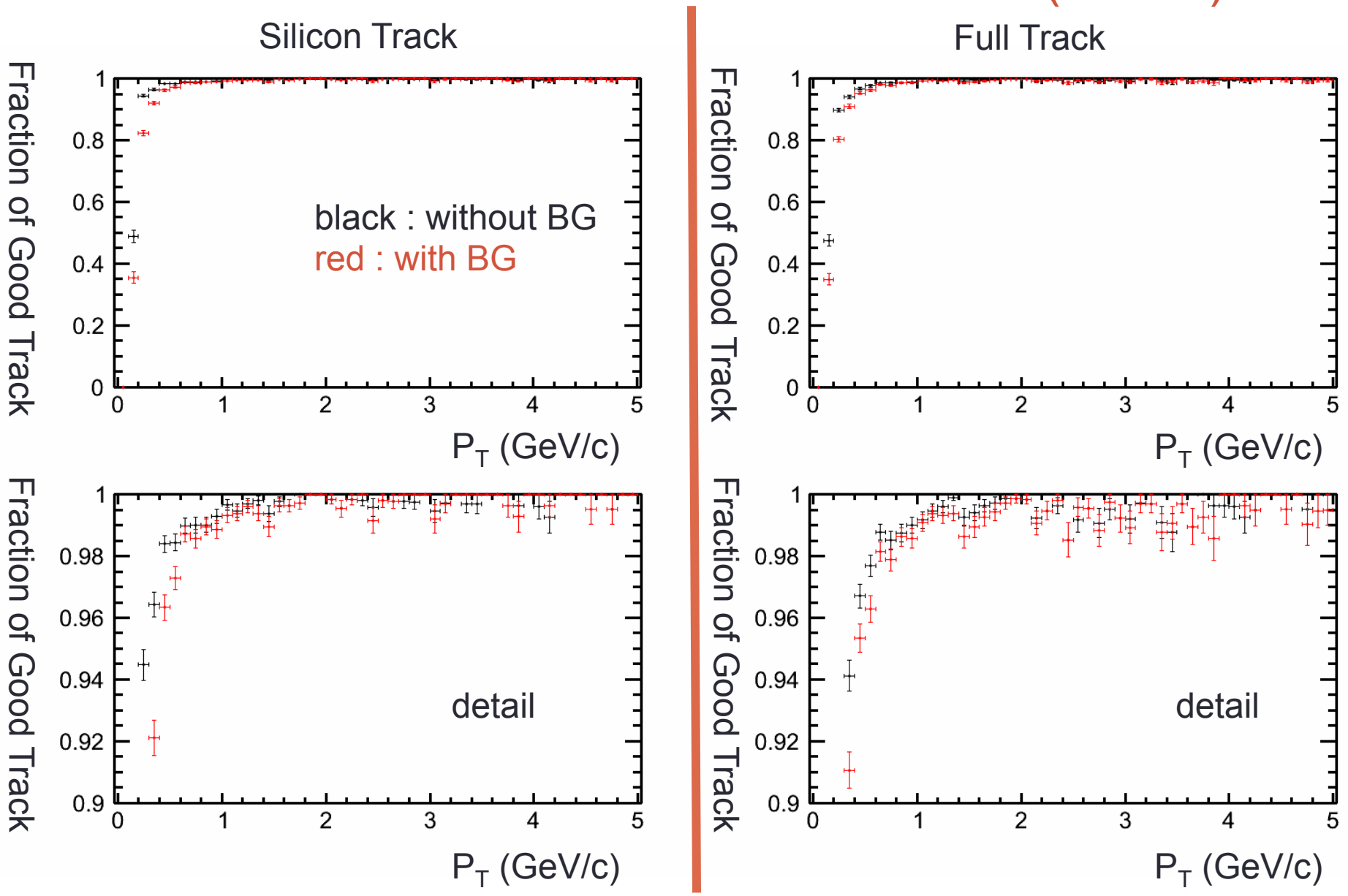
Cosθ VS Fraction with Pair BG
~ case 1 VS case 2 ~



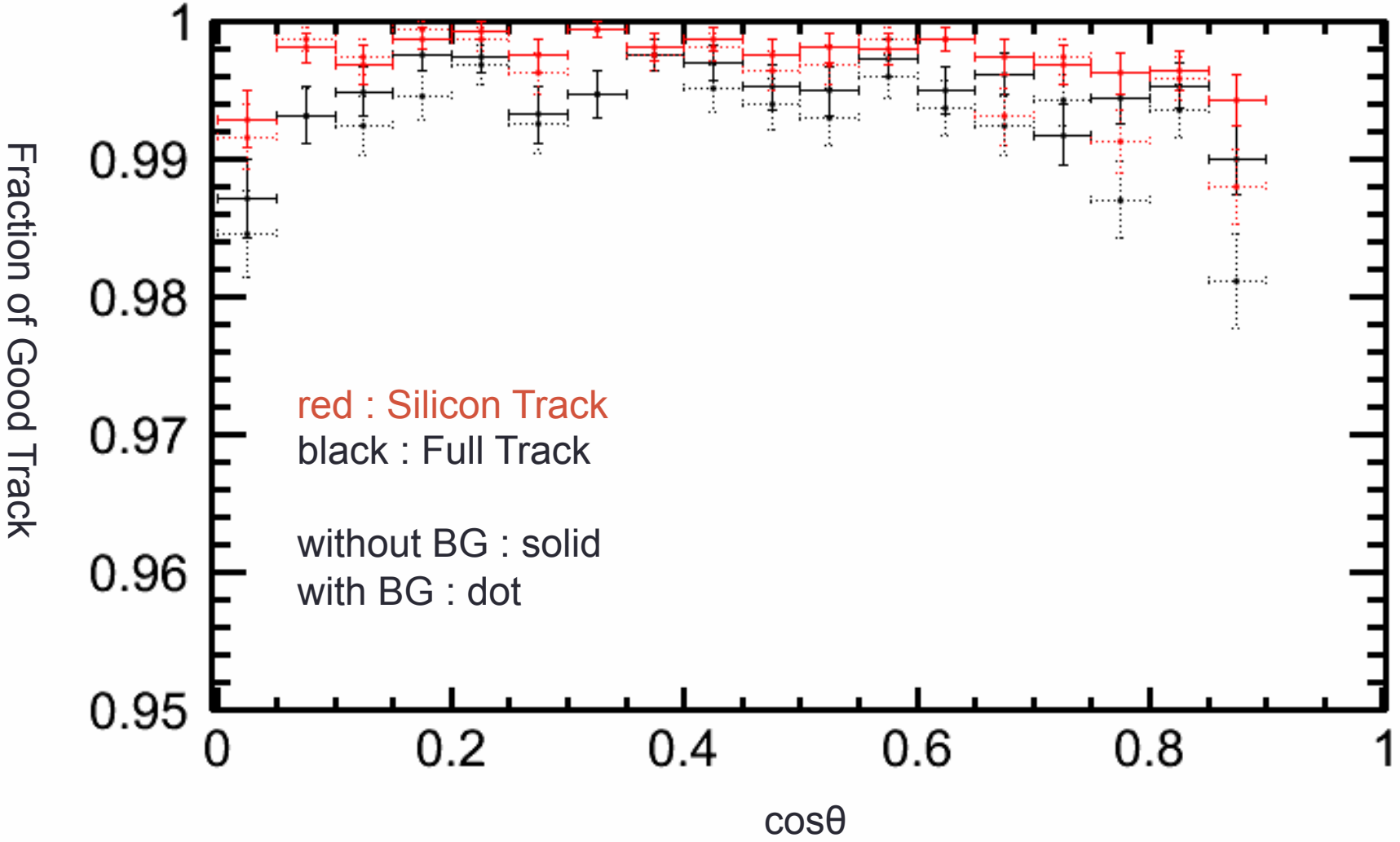
Without BG VS With BG in the case 2

- Setup
  - sample : ttbar 350GeV (1000 events) **without VS with pair BG**
  - **|P| > 1 GeV/c**
  - **case 2 only:**
    - **cluster rejection in extrapolation : turned off**

Pt vs Fraction with VS without Pair BG (case 2)



Cosθ VS Fraction without VS with Pair BG (case 2)



About Full Track

- Why the efficiency of full track is worse than that of silicon track, especially in cosθ > 0.5 ?

- → Full LDC Tracking choose the silicon tracks with chi2/ndf < 15
  (This is one of my modifications.
  Old version choose the silicon tracks with probability > 0.01)

- I think there is no point to be modified in Full LDC Tracking except the way of calculating either
  - chi2 in the fitter
  - position resolution of SIT hits in the SIT Digitizer

➢ The lower P_T gets, the higher chi2 is output from Kalman Filter and Simple Helix Fitter ← should be modified down the road

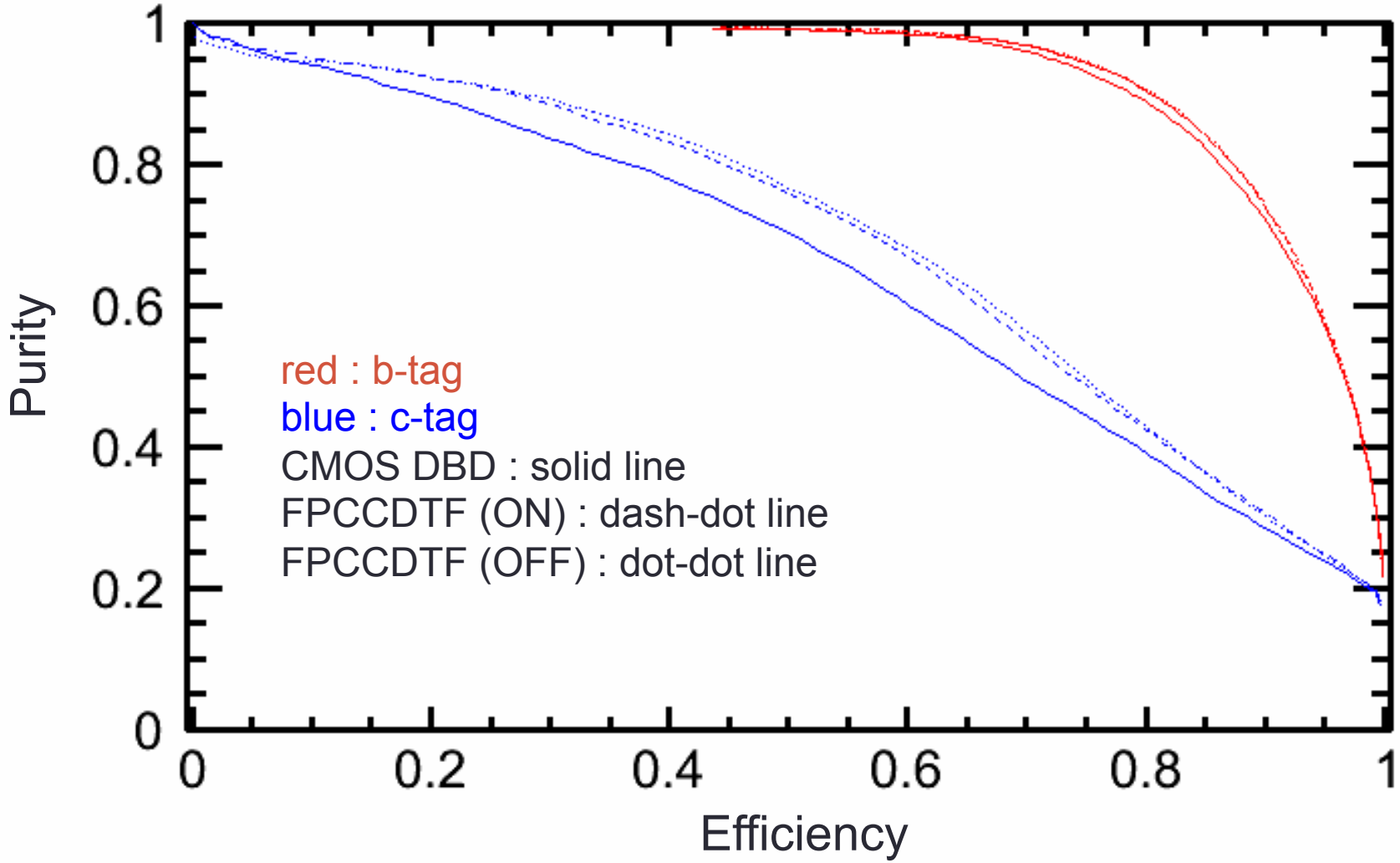
Comparison : Flavor Tag Performance

Setup :

- MC sample : Z→bb, cc, qq (q : u, d, s) @ 91.2GeV

- Assumption of Branching Fraction :
  →for calculating purity
- BF(Z→bb) = 0.1512
- BF(Z→cc) = 0.1203
- BF(Z→qq) = 0.428

- case 1 : DBD Tracking + CMOS
- case 2 : FPCCD T.F. (cluster rejection : ON) + FPCCD
- case 3 : FPCCD T.F. (OFF) + FPCCD



Turning cluster rejection of FPCCD T.F. off
improves c-tag performance a little bit

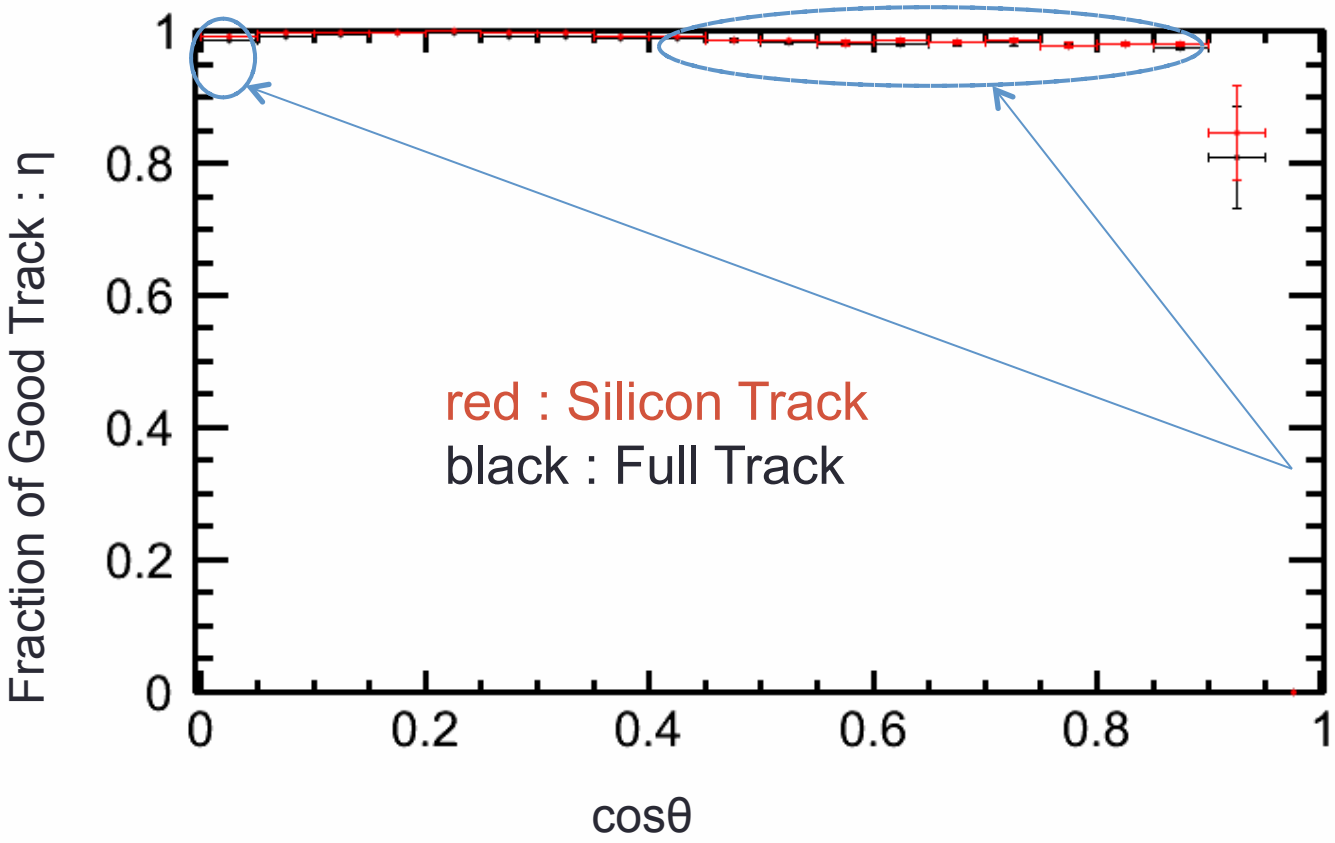
Summary and Plan

- Cluster rejection is found to make the fraction worse mainly
  - For now, I regard turning off cluster rejection as default setting
- Flavor tag performance in each of the 3 cases is shown
- Plan
  - I plan to report at ILD Software Meeting and to try to submit new tracking code, FPCCDDigitizer, and FPCCDClustering to ILCSoft
  - I just start physics analysis of higgs coupling (b,c,q) by using ZH @ 250 GeV), to show the effect of “FPCCD + FPCCD T.F.”

backup

Another Setup 2

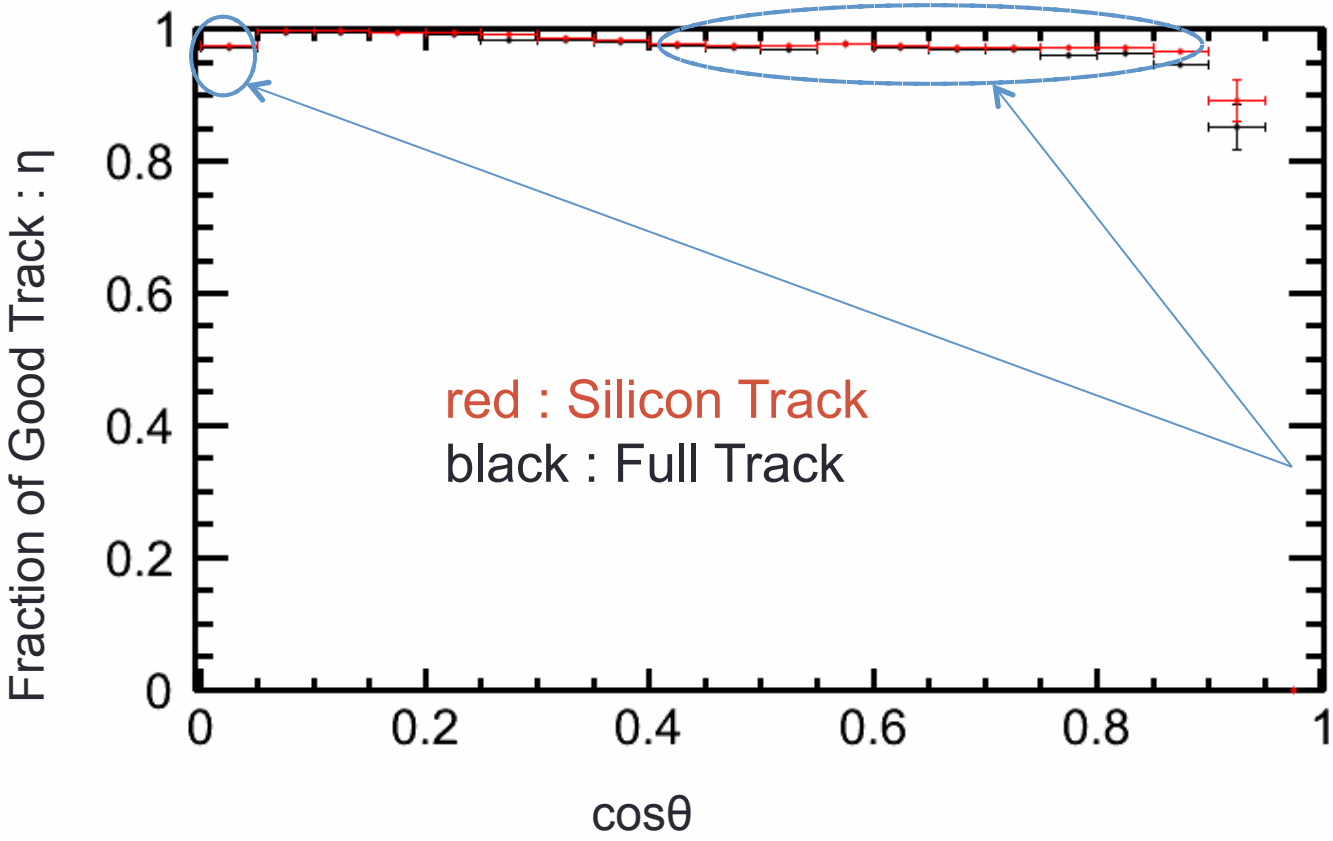
- Setup
  - sample : single mu+ (200K events)
  - **|P| = 10 GeV/c ("Fixed")**



better than the case of another setup 1
→ however, cosθ > 0.5 is still bad

Another Setup 3

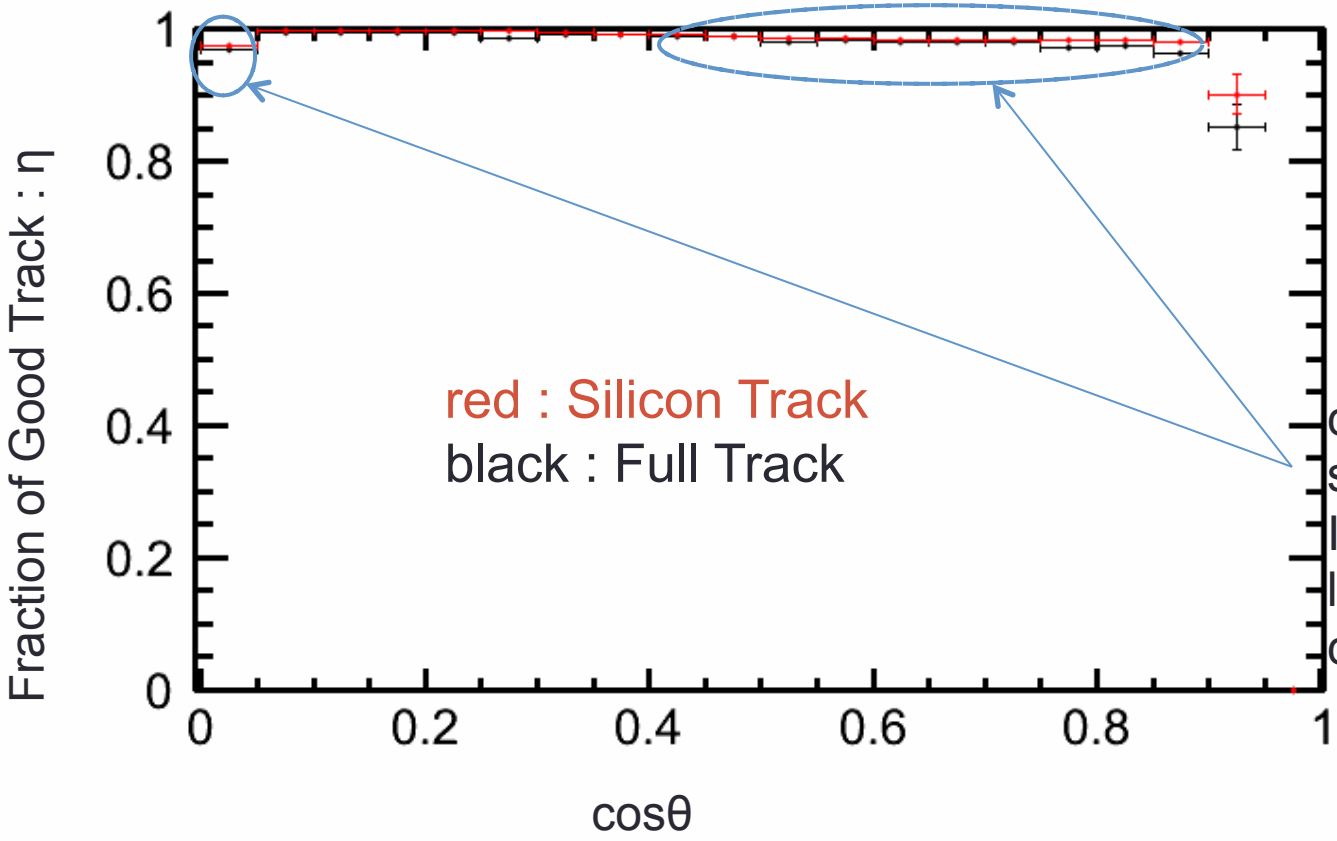
- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **Energy deposit threshold of pixel hit → 0**



worse than the case of threshold : non-zero
→ Threshold seems not to be the reason

Another Setup 4

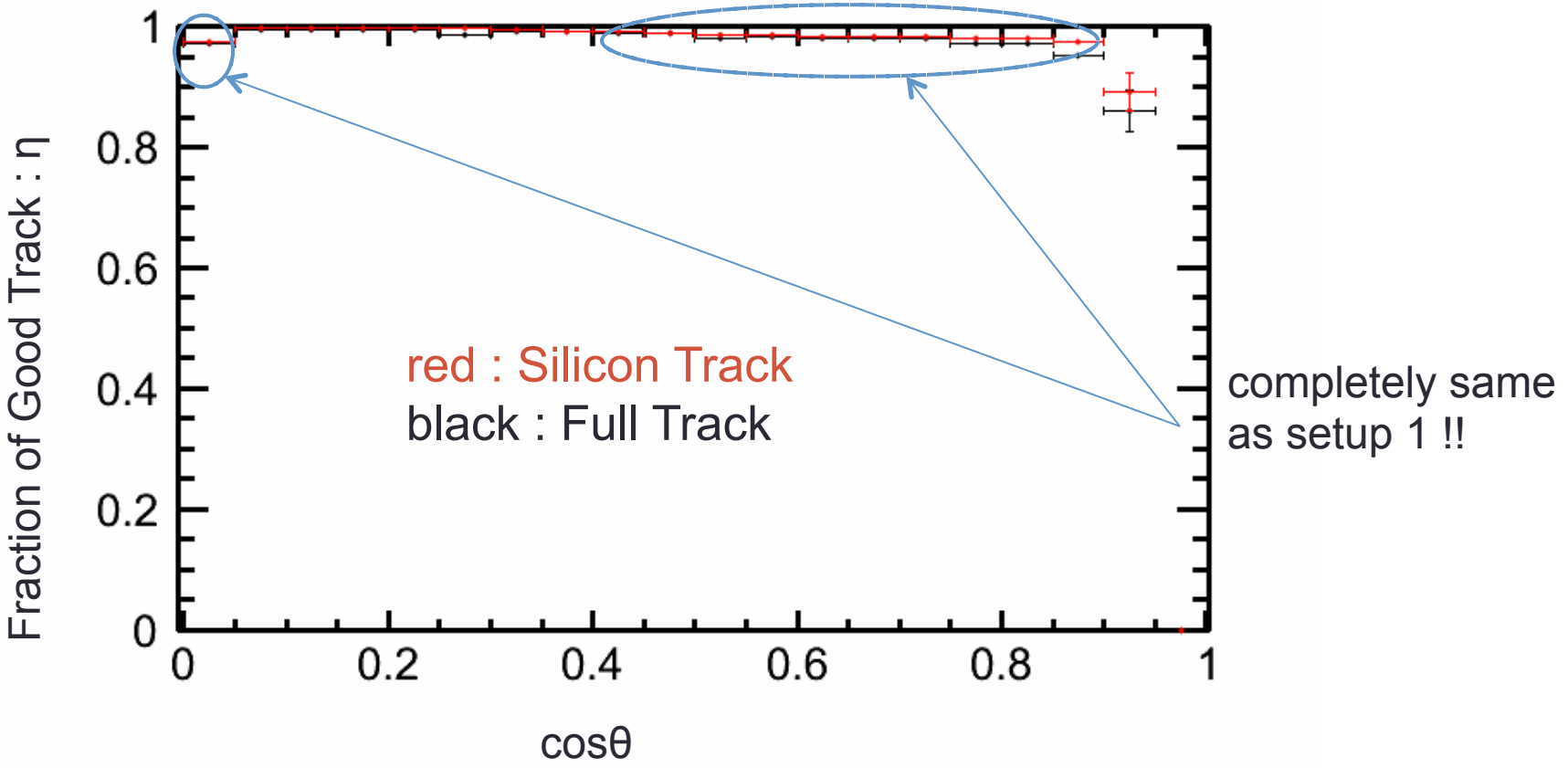
- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - Chi2 requirement in Triplet : 120 → 500



completely same as setup 1 until cosθ = 0.5
In cosθ > 0.5, only a very little bit of improvement can been seen

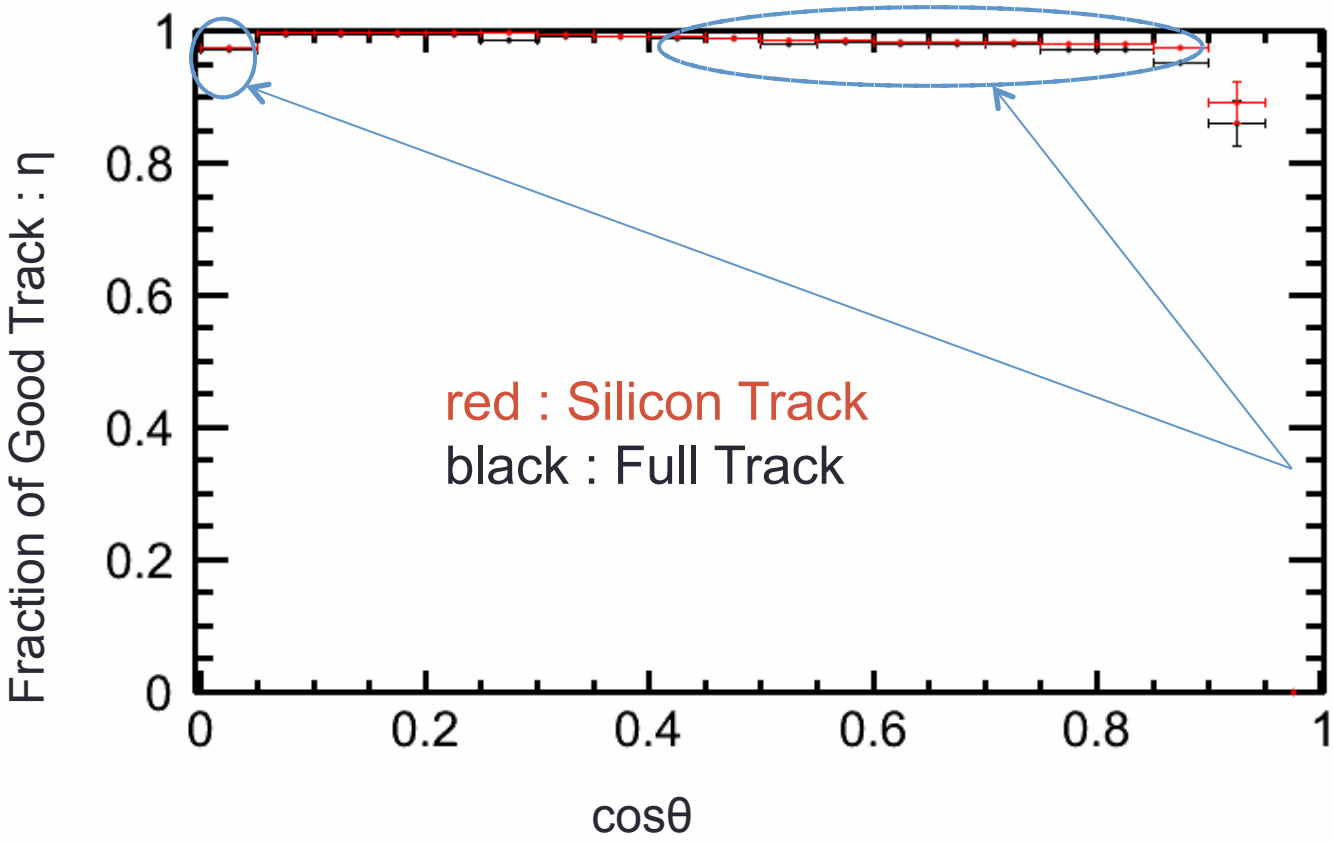
Another Setup 5

- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - Search window for triplet : 12 → 60 sectors



Another Setup 7

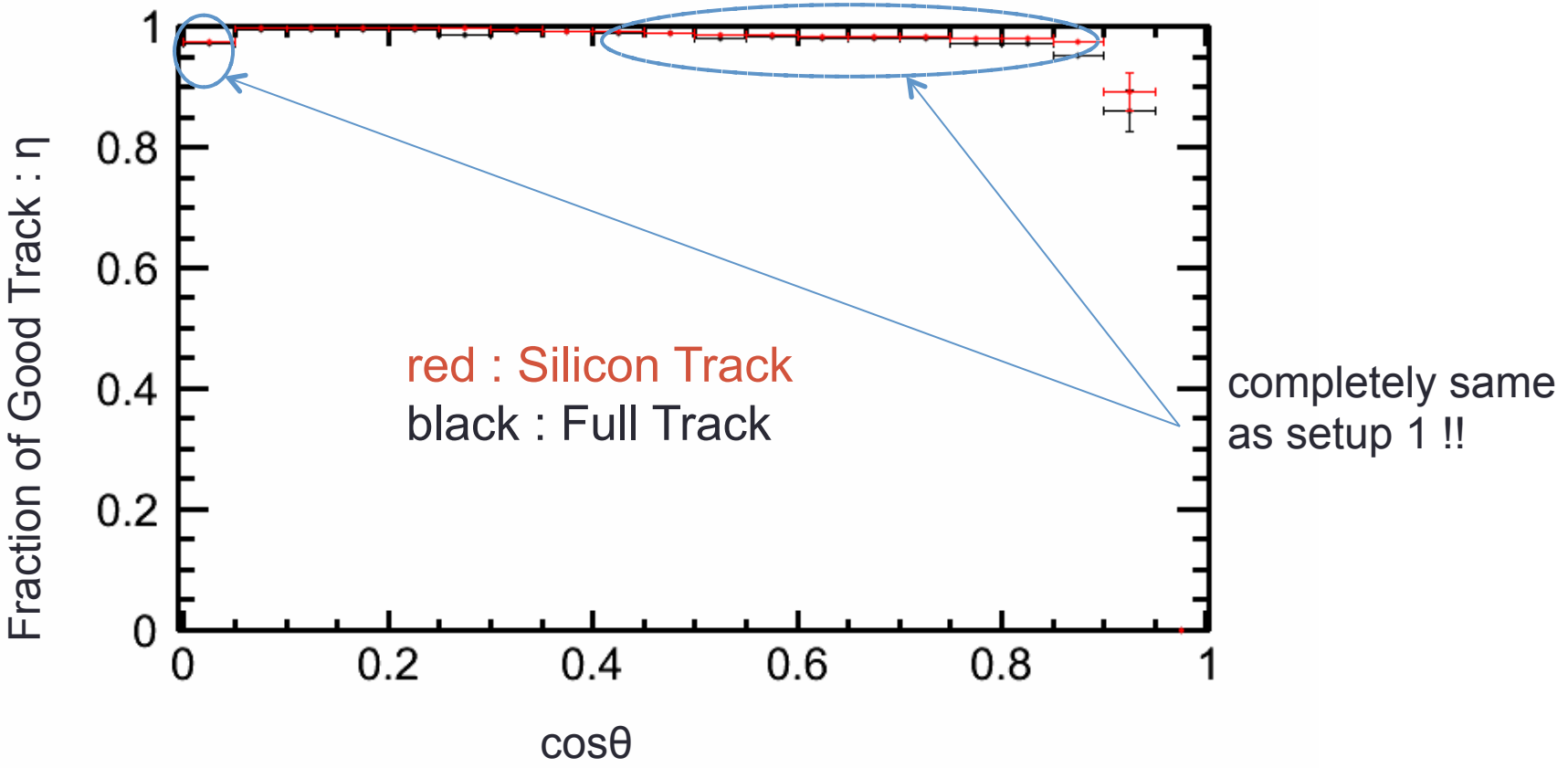
- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **fudge phi range in BuildTrack : 10 → 100**



completely same as setup 1 !!

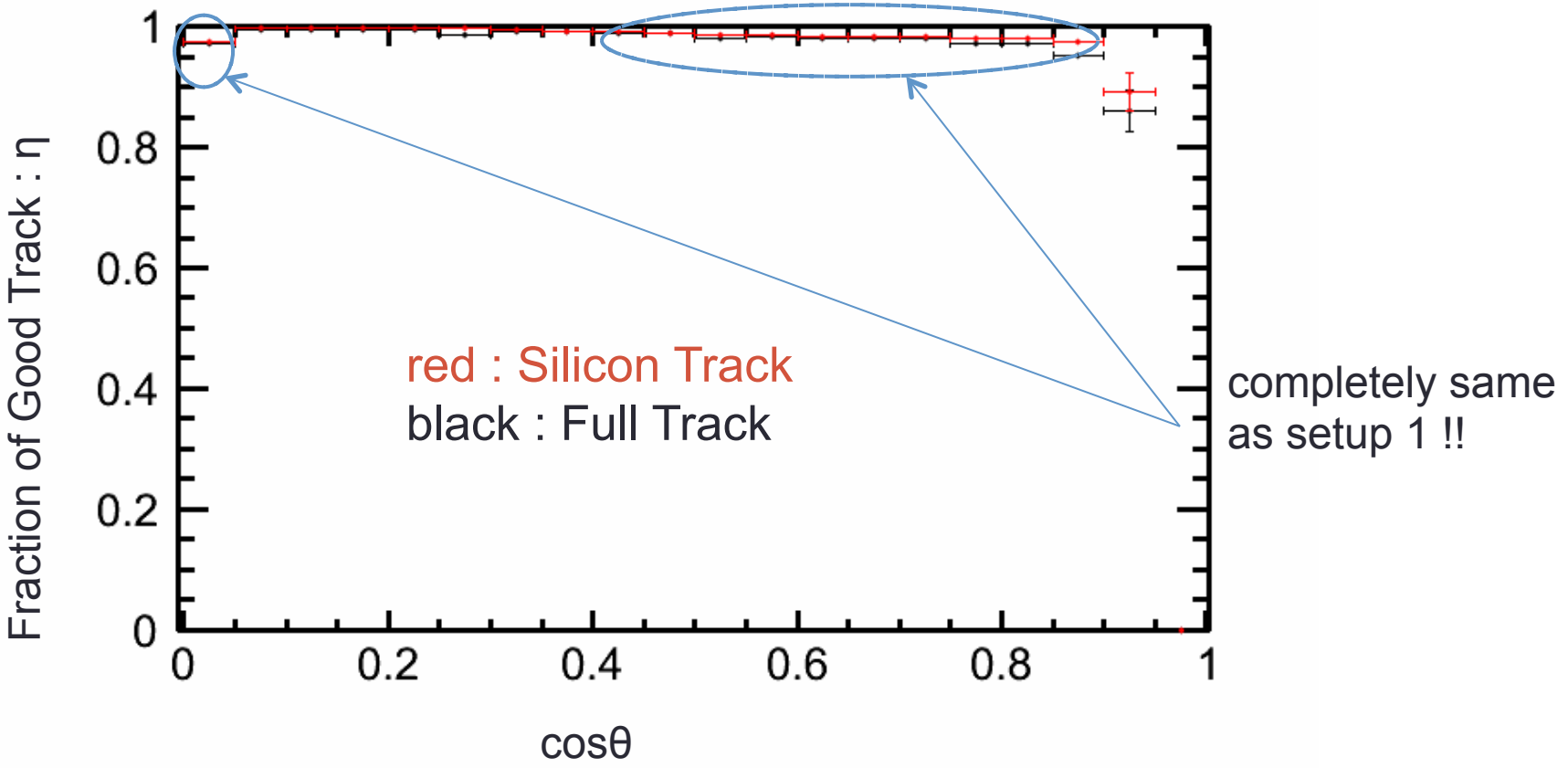
Another Setup 8

- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **fudge theta range in BuildTrack : 2 → 100**



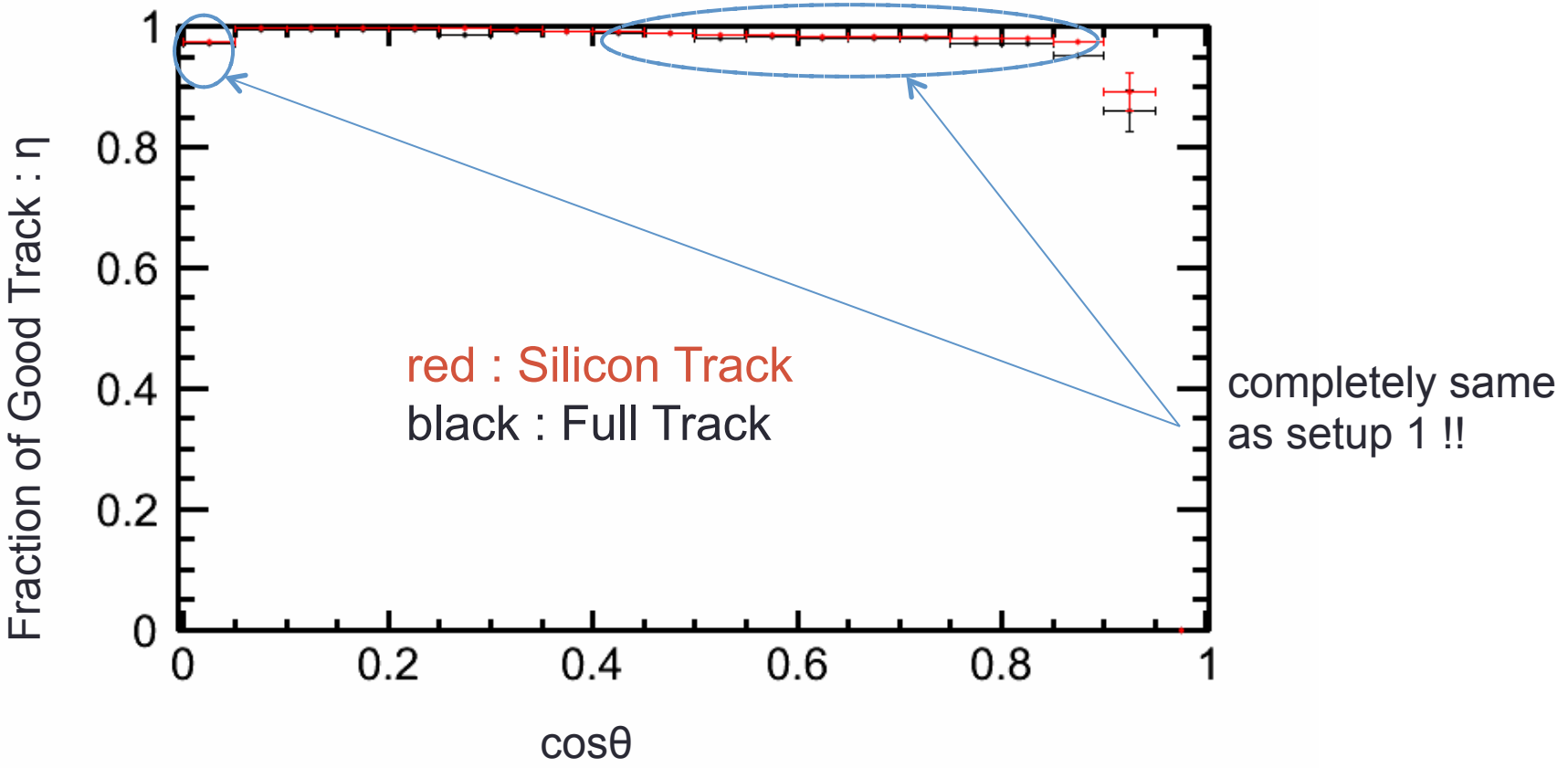
Another Setup 9

- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **angle cut for merging : 0.01 → 0.000001**



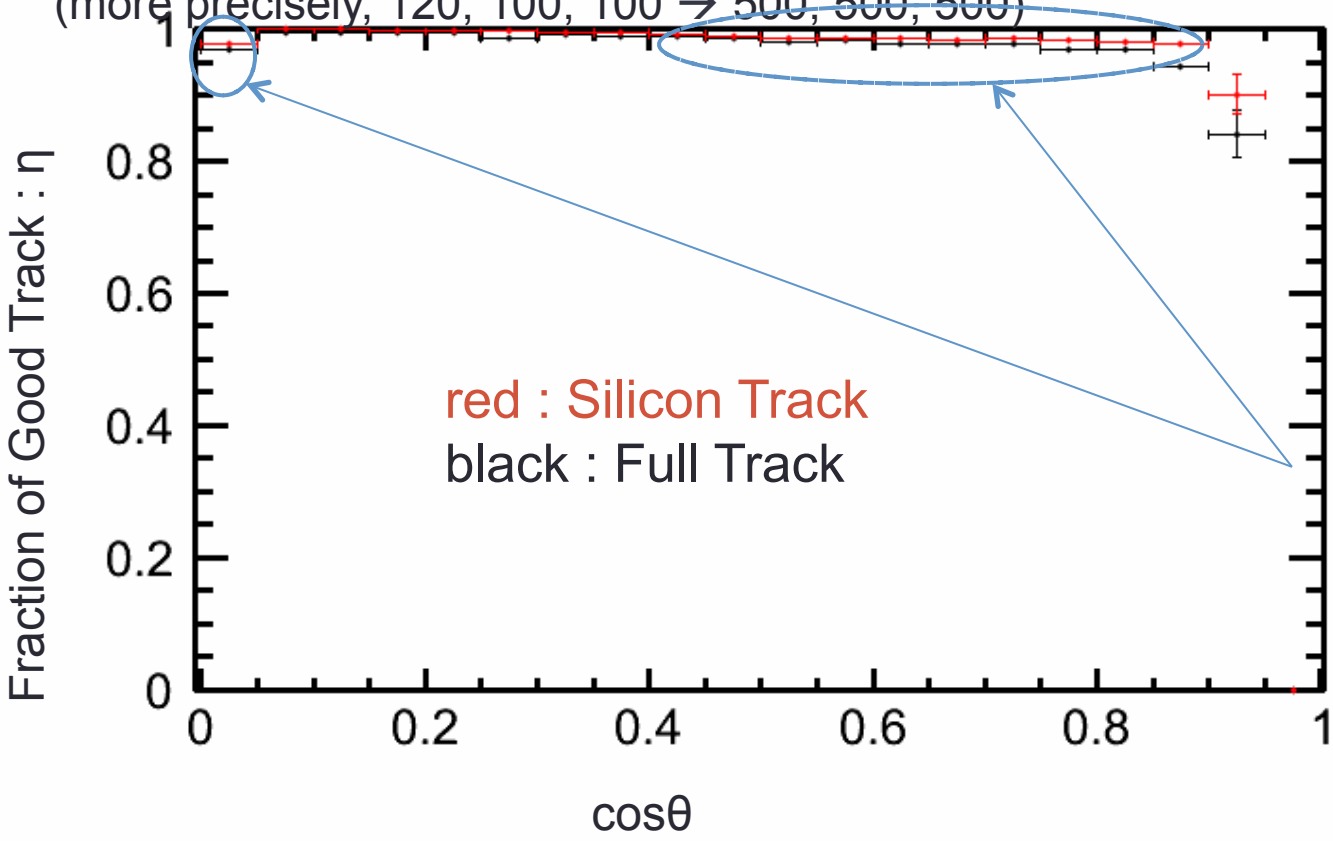
Another Setup 10

- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **distant cut in BuildTrack : 2.0mm → 10.0mm**



Another Setup 11

- Setup
  - sample : single mu+ (200K events)
  - **|P| = 1 GeV/c ("Fixed")**
  - **Chi2 Requirement of Kalman Filter : 120 → 500**
    (more precisely, 120, 100, 100 → 500, 500, 500)



Almost same as setup 1.
Silicon : slightly up in cosθ >~ 0.7
Full : slightly down
→Why Full down?

Summary Table of Inspections about CosTheta VS Fraction

Silicon Setup (sample : mu+ 1GeV/c)	Silicon	Full
normal	basis	basis
threshold : 0	worse	worse
Chi2 in Triplet : 120 → 500	slightly better @ cosθ > 0.5	slightly better @ cosθ > 0.5
θ search window for triplet : 12 → 60	no change	no change
Cluster rejection in BuildTrack : off	much better	much better
fudge Φ range in BuildTrack : 10 → 100	no change	no change
fudge θ range in BuildTrack : 2 → 100	no change	no change
angle cut for merging : 0.01 → 0.000001	no change	no change
distant cut in BuildTrack : 2.0mm → 10.0mm	no change	no change
Chi2 in Kalman Filter : 120 → 500	slightly better @ cosθ > 0.7	slightly worse @ all range
plus 3 combinations for triplet search	better	better
plus 6 combinations for triplet search	better(same as plus 3 comb)	better(same as plus 3 comb)