Angular Acceptance of gDIRC

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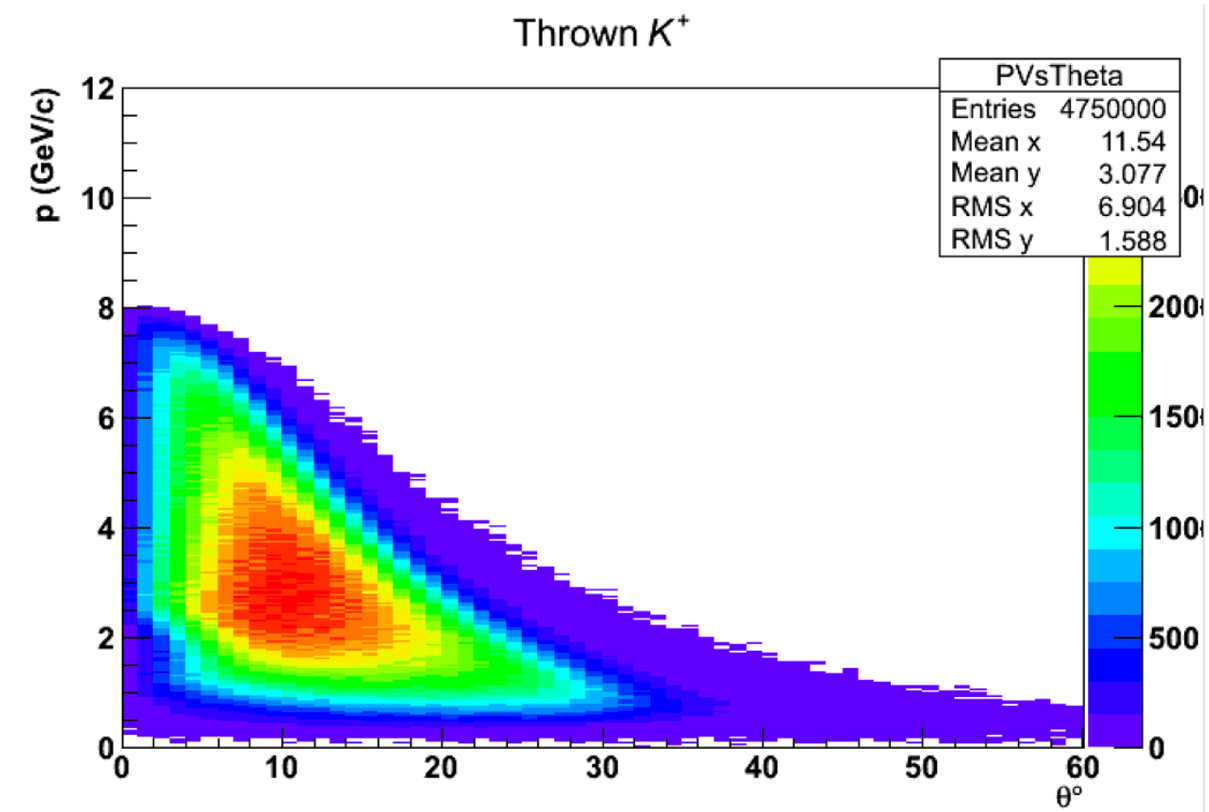
Introduction

- Reminder: we studied the impact of the gDIRC detector on the channels used for the PAC proposal
- There was significant improvement in the selection efficiency using the gDIRC detector (some up to x3 for 95% purity)
- Most of the improvement was due to the DIRC detector, with smaller improvements from the Gas CKOV
- Questions:
  - Are there other channels, or observables which require the Gas CKOV?
  - Maybe uniformity of angular acceptance for amplitude analysis?

η_1'(2300)



$$\gamma p \to \eta_1'(2300) p$$

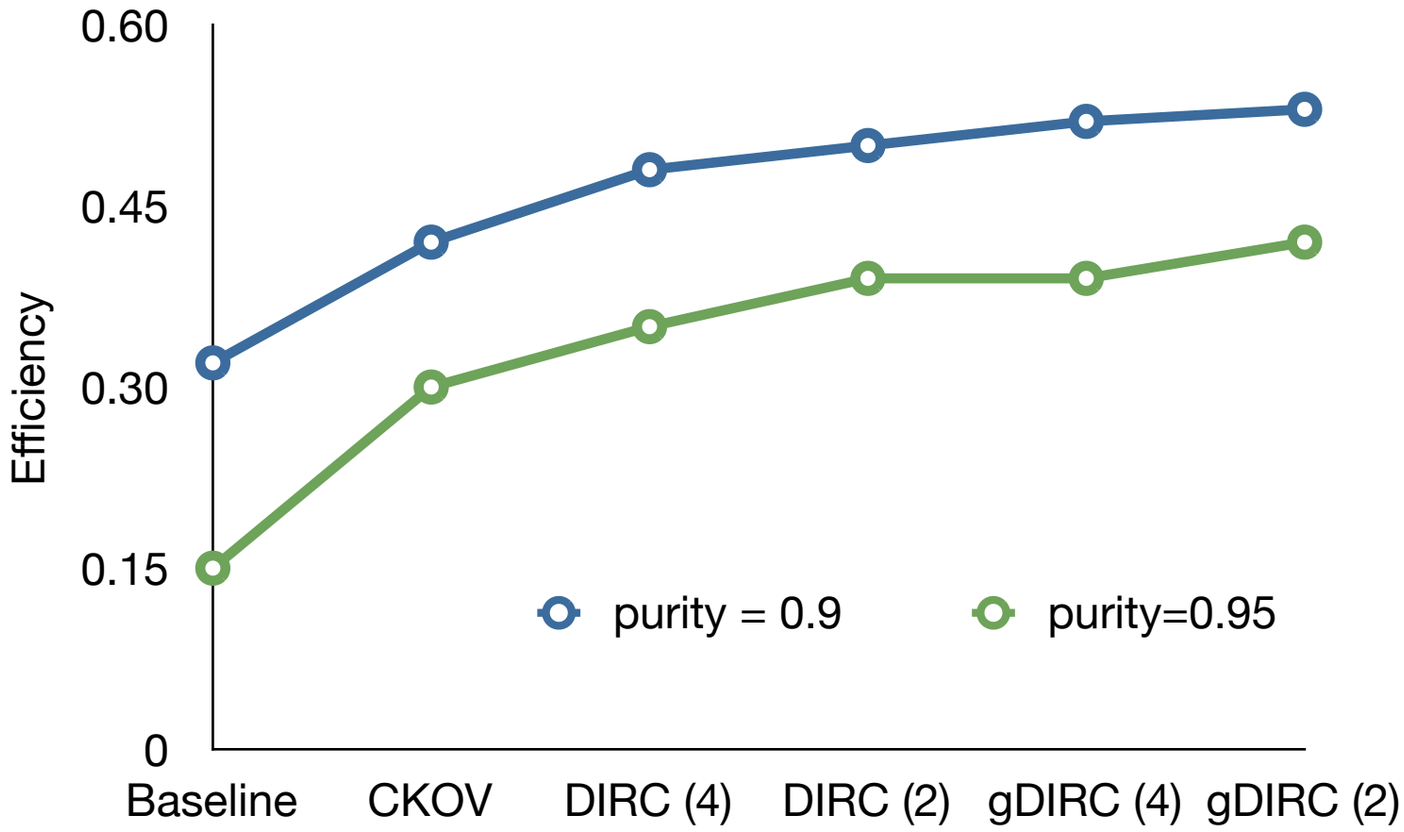
$$\eta_1'(2300) \to K^*(892)^0 K_s^0$$

$$K^*(892)^0 \to K^+ \pi^-$$

$$K_s^0 \to \pi^+ \pi^-$$

Note: Displaced vertex!

η_1'(2300)



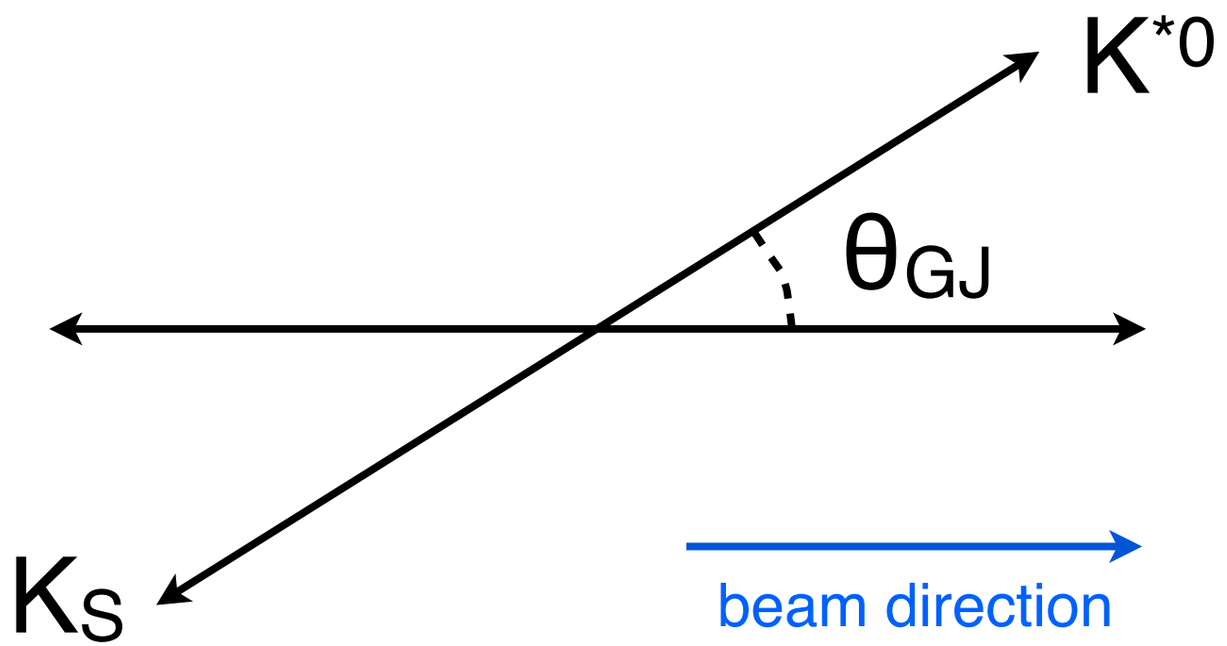
- Improvement with DIRC better than CKOV
- Combination gDIRC improves by ~10%
- Gains are larger for higher purity

Angular Acceptance

- Study the acceptance vs polar angle (θ_{GJ}) in the Gottfried-Jackson frame
- $\cos(\theta_{GJ}) = 1$ corresponds to the K^{*0} (and thus decay K^+) in the forward direction
- $\cos(\theta_{GJ}) = -1$ corresponds to the K_s is forward direction

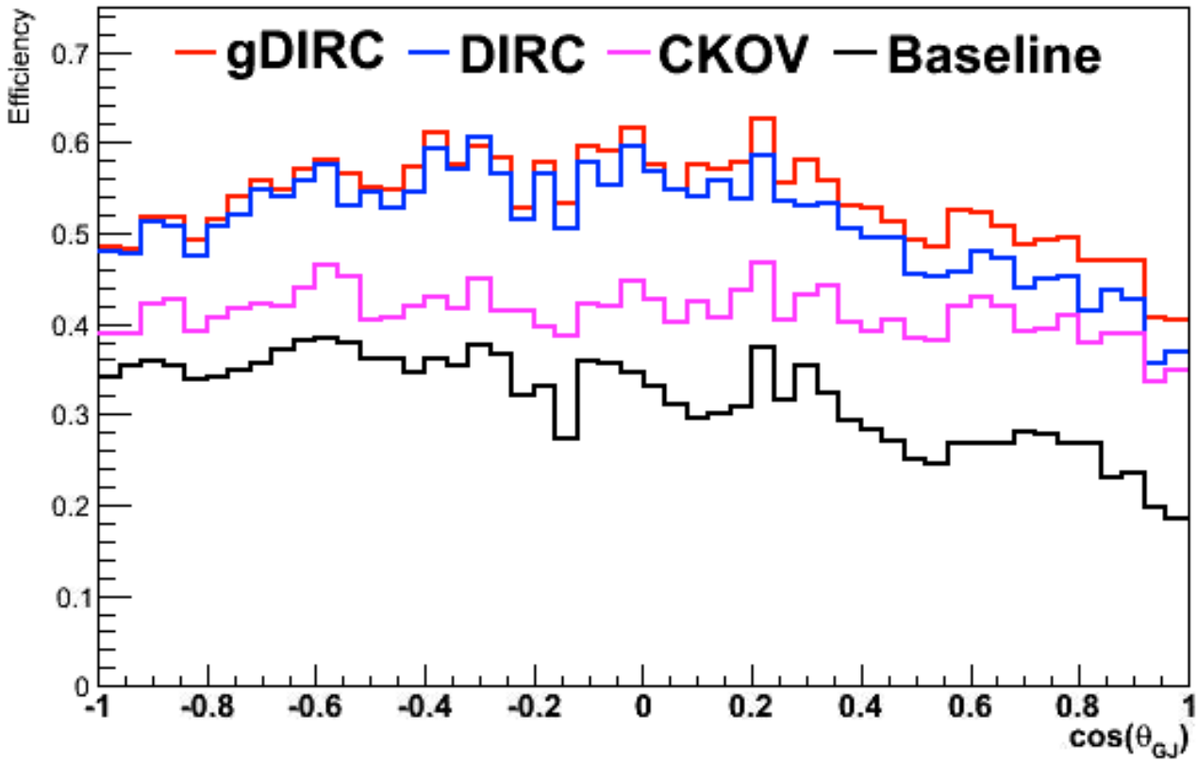
Example:

$$\gamma p \to \eta_1'(2300) p$$
$$\eta_1'(2300) \to K^*(892)^0 K_s^0$$
$$K^*(892)^0 \to K^+ \pi^-$$
$$K_s^0 \to \pi^+ \pi^-$$



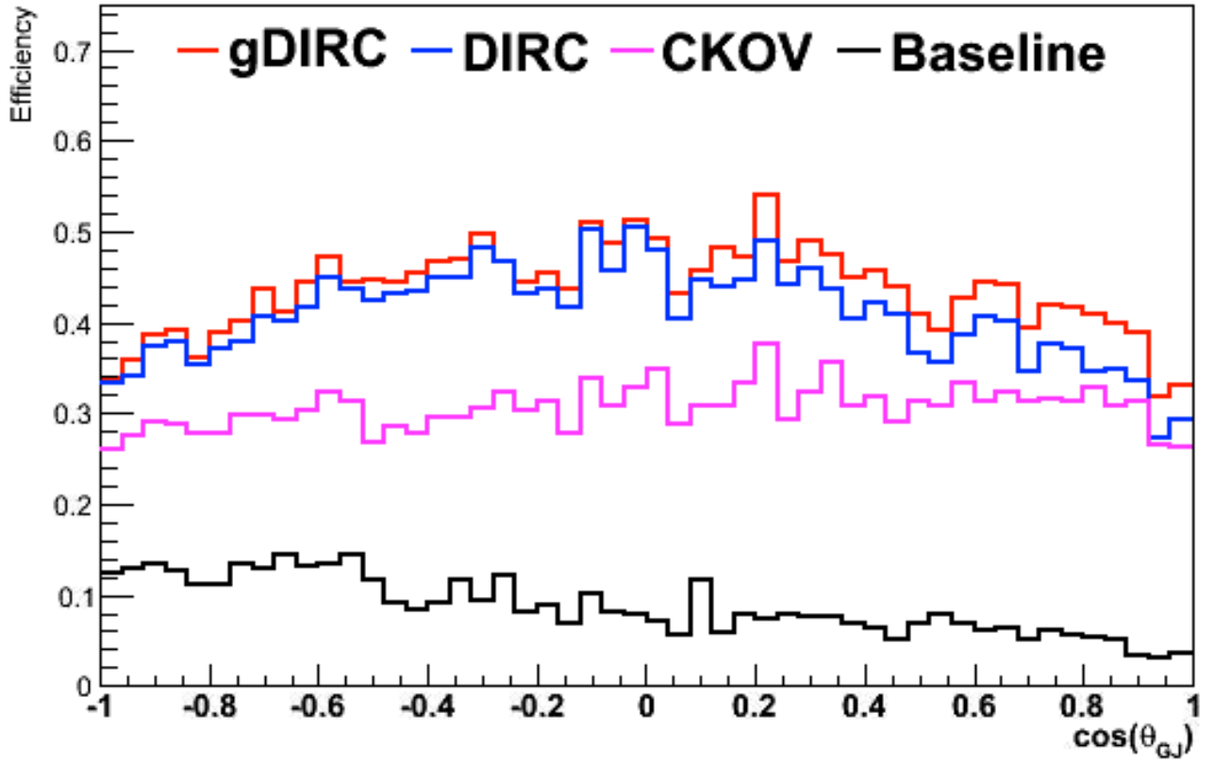
η_1'(2300)

90% Purity



Forward K_s Forward K+

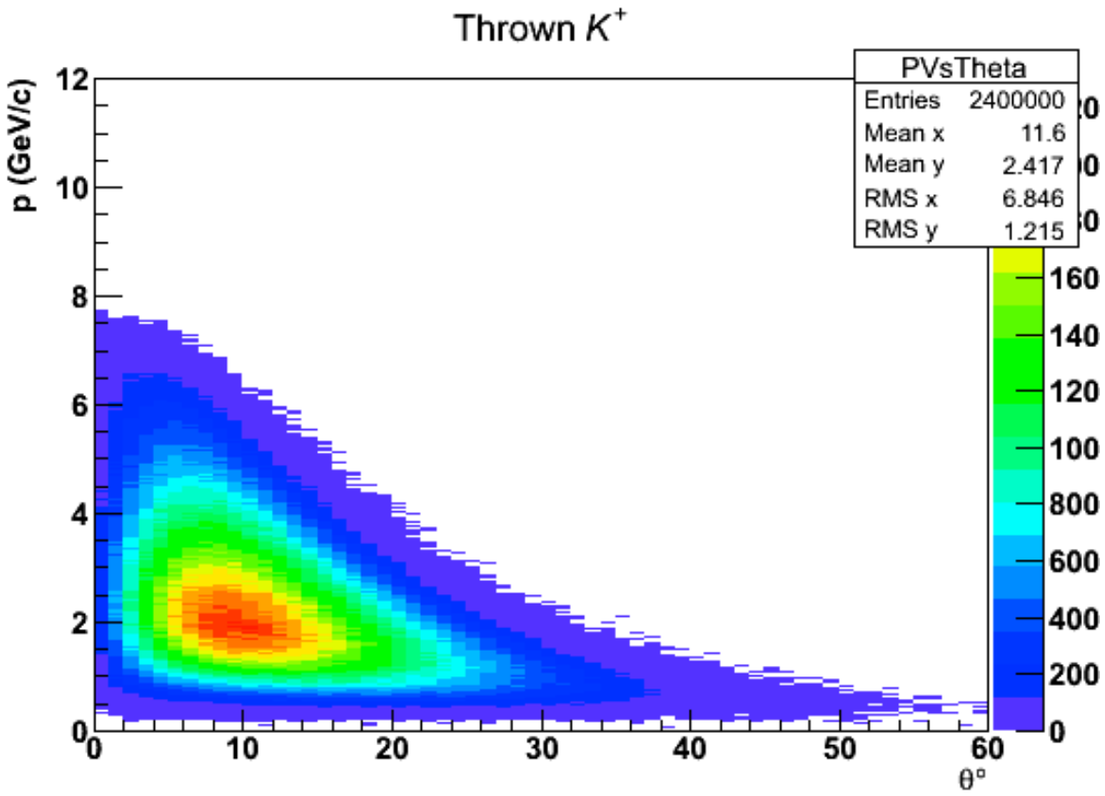
95% Purity

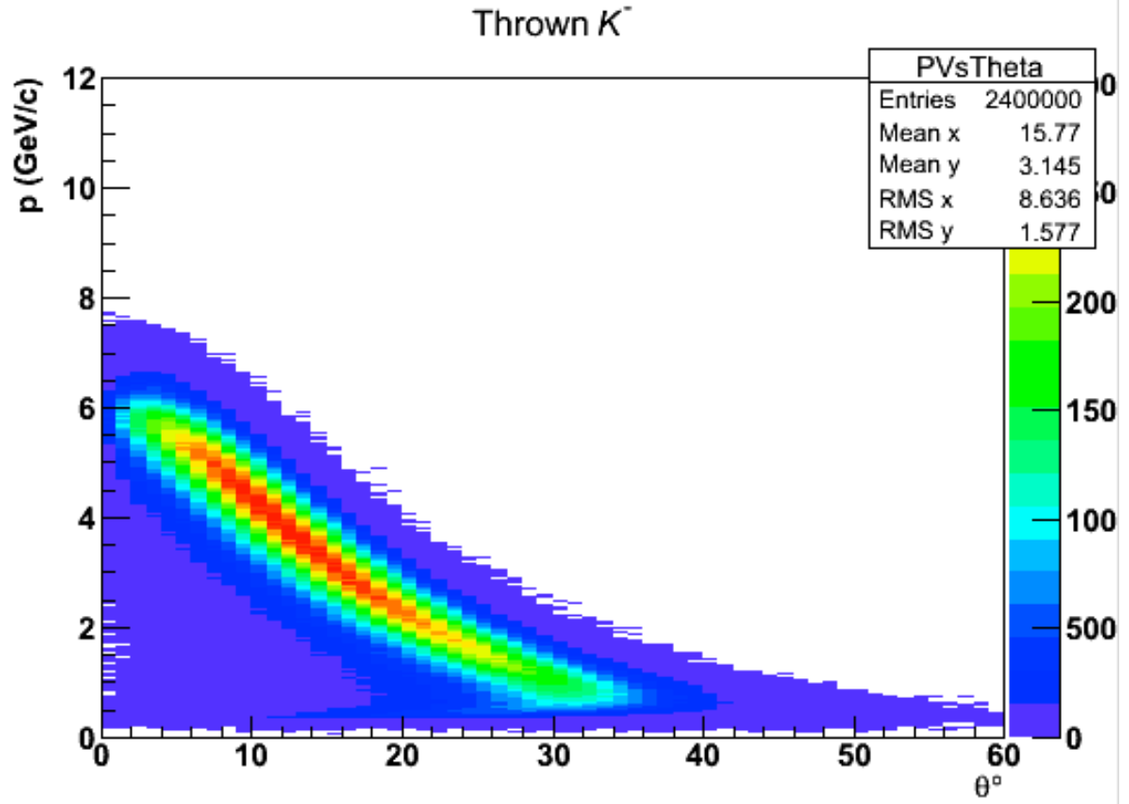


Forward K_s Forward K+

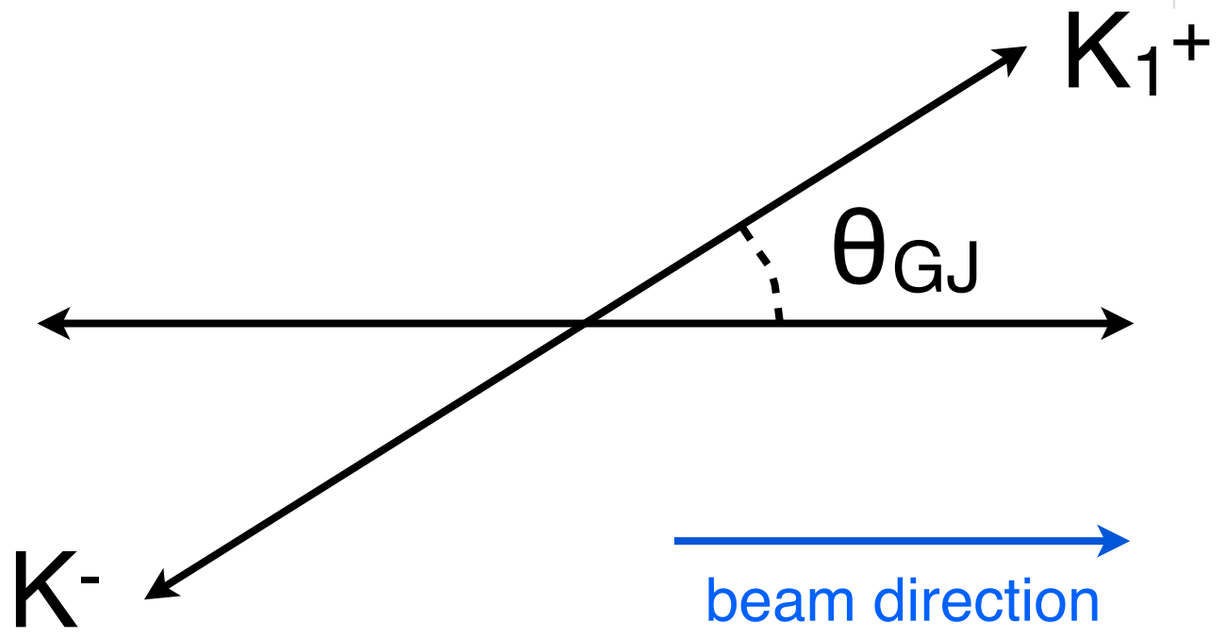
- Baseline: lower efficiency for high momentum forward going K+
- DIRC: Improve efficiency of high momentum forward going K+, but still lower efficiency for highest momentum. Smaller increase in efficiency for forward K_s since secondary vertex now has less impact in the BDT
- CKOV: Improve efficiency for all high momentum forward going K+, but not as powerful in BDT as DIRC variables so less biased for forward K_s from secondary vertex like
- gDIRC: Similar to DIRC with small improvement highest momentum K+

$h_2'(2600)$

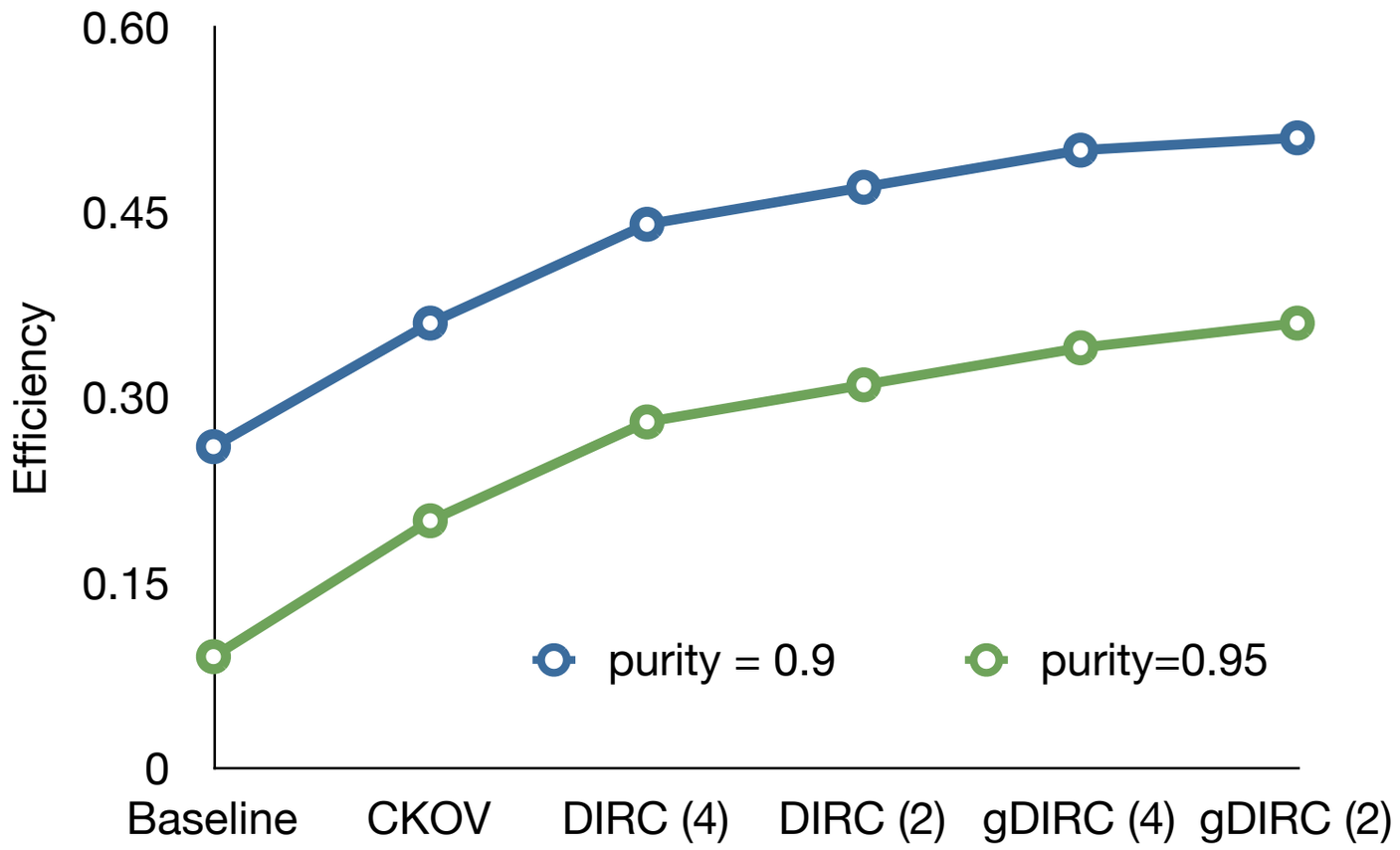




$$\gamma p \to h_2'(2600) p$$
$$h_2'(2600) \to K_1(1400)^+ K^-$$
$$K_1(1400)^+ \to K^*(892)^0 \pi^+$$
$$K^*(892)^0 \to K^+ \pi^-$$



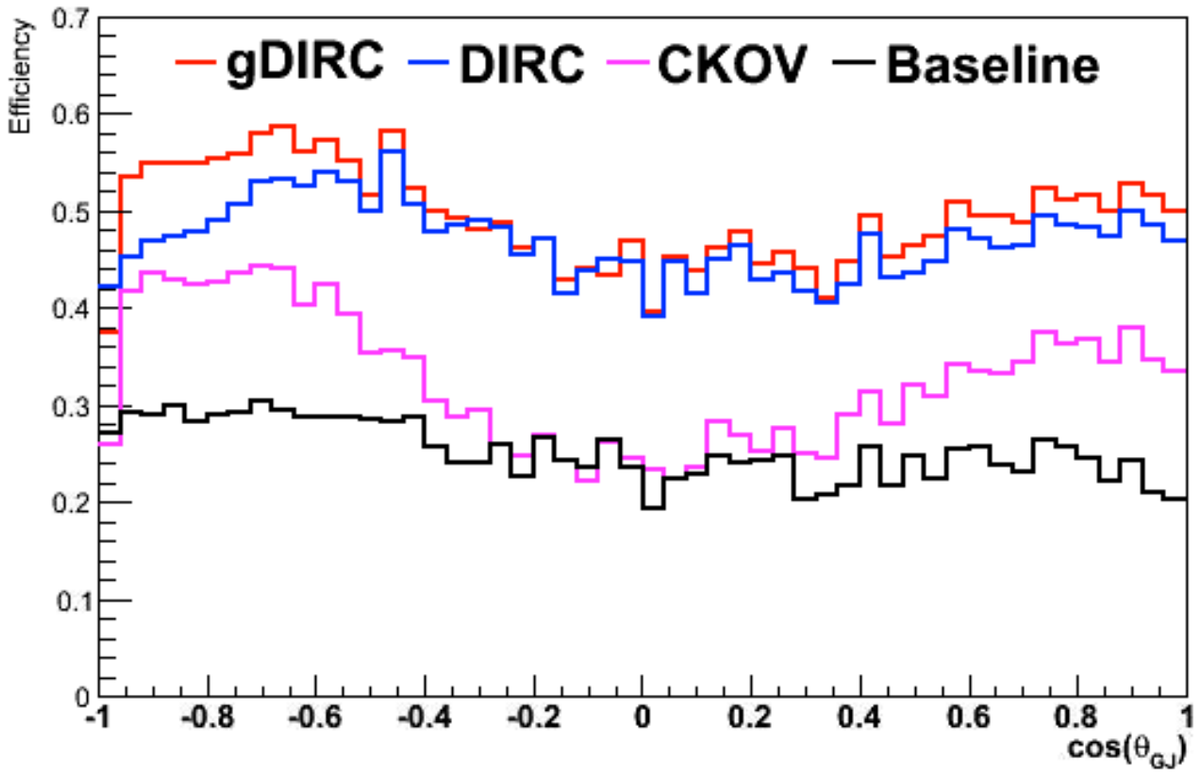
h_2'(2600)



- Improvement with DIRC better than CKOV
- Combination gDIRC improves by ~20%
- Gains are larger for higher purity

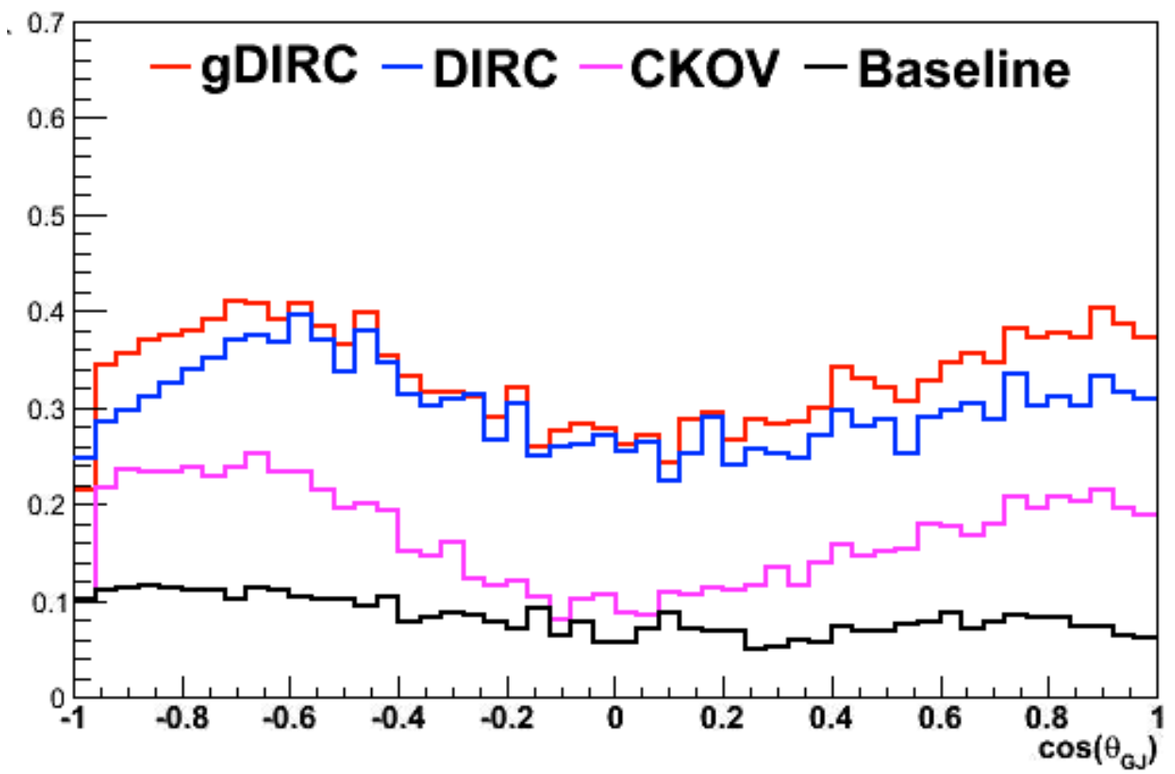
$h_2'(2600)$

90% Purity



Forward K- Forward K+

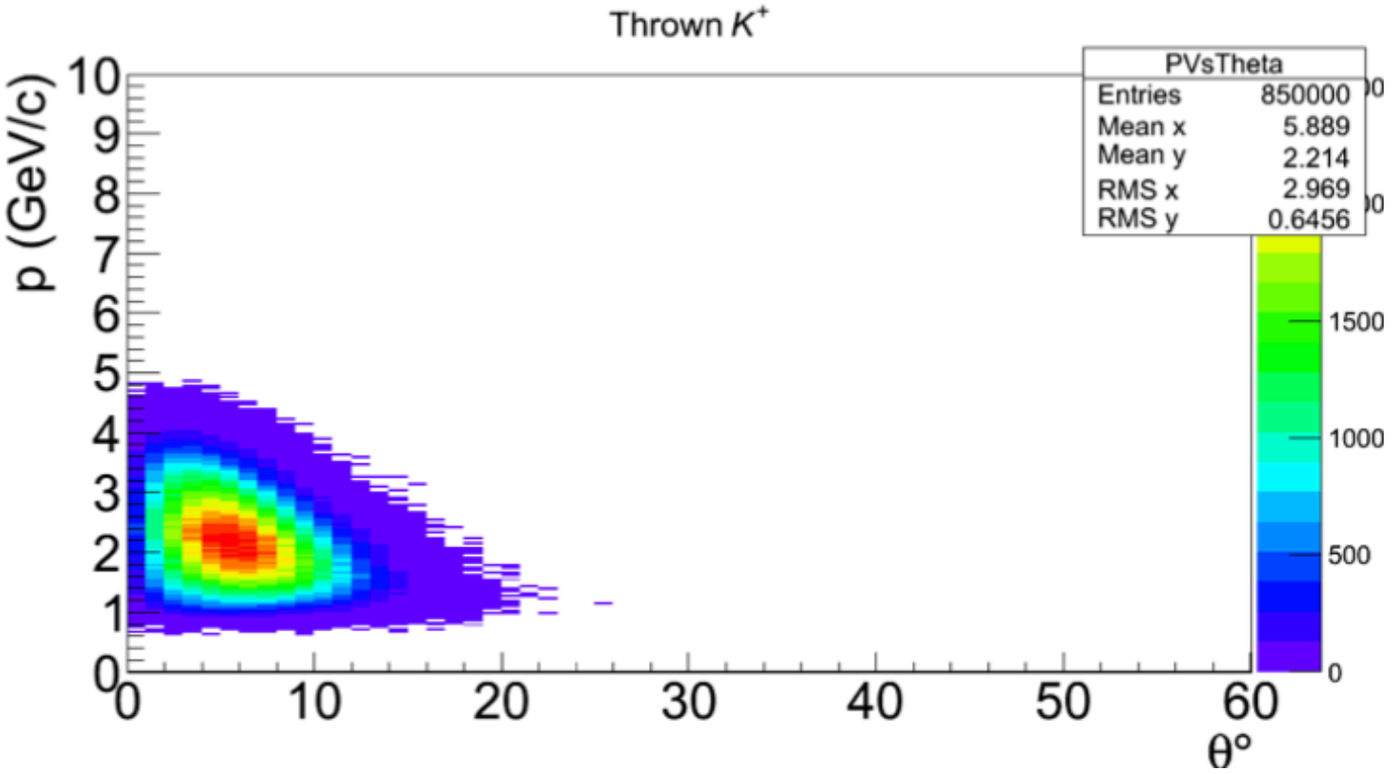
95% Purity



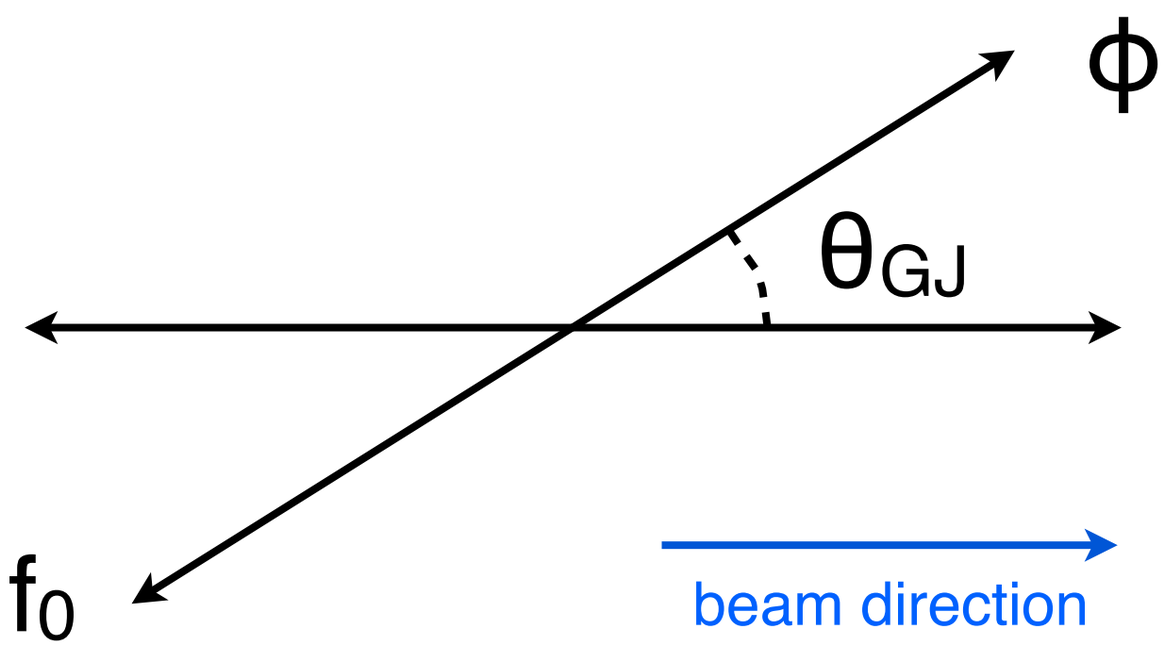
Forward K- Forward K+

- Baseline: Fairly uniform acceptance
- DIRC: Improve efficiency near the edges, but far forward going K- gain is smaller since 3σ π-K separation runs out at ~4.5 GeV
- CKOV: Biased toward higher efficiency for forward K+ and K- since gas CKOV gains are bigger for more forward angle, higher momentum kaons
- gDIRC: Improvement over DIRC for more forward/higher momentum K+/K-

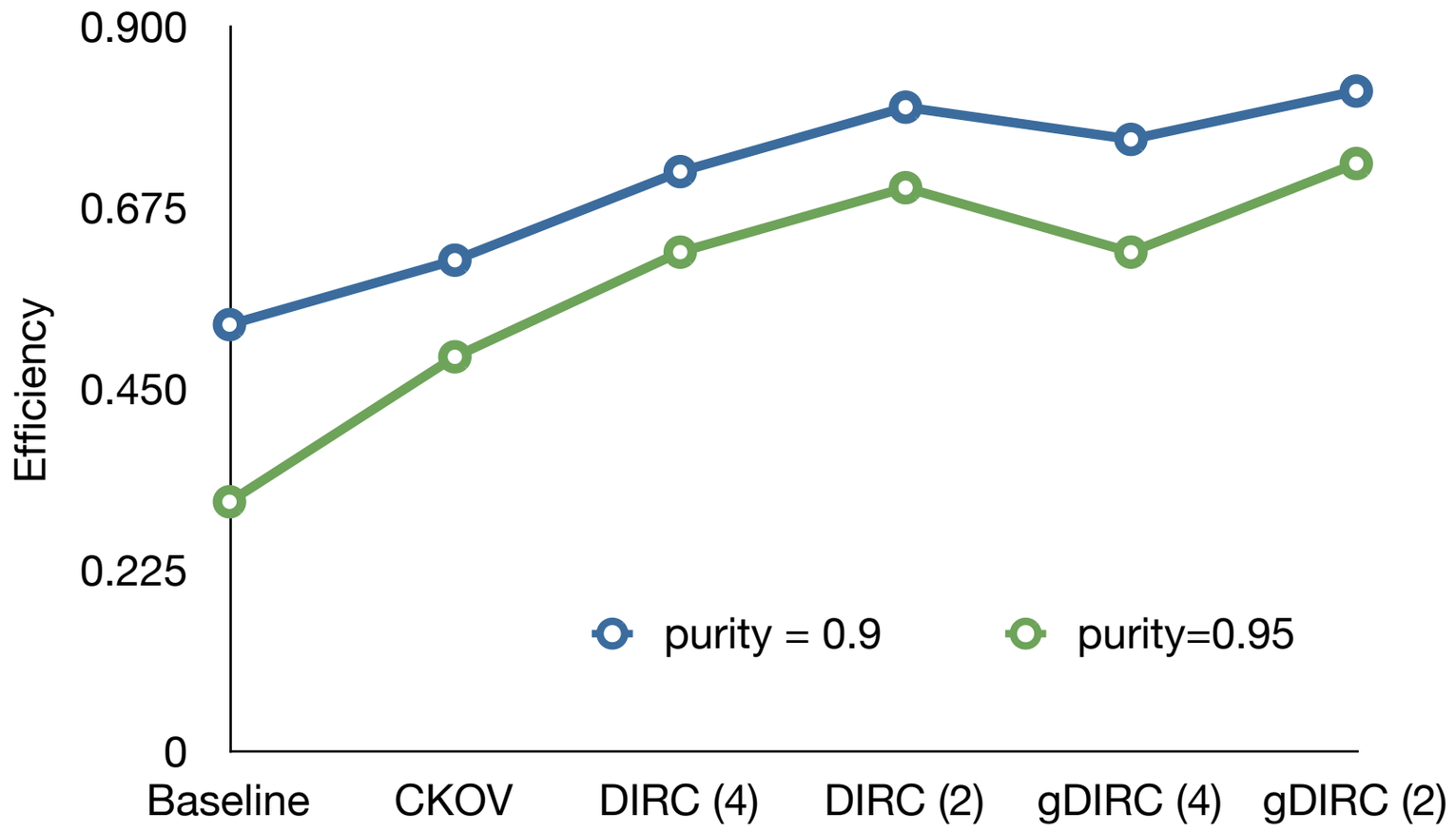
Y(2175)



$$\gamma p \to Y(2175)p$$
$$Y(2175) \to \phi\ f_0(980)$$
$$\phi \to K^+K^-$$
$$f_0(980) \to \pi^+\pi^-$$



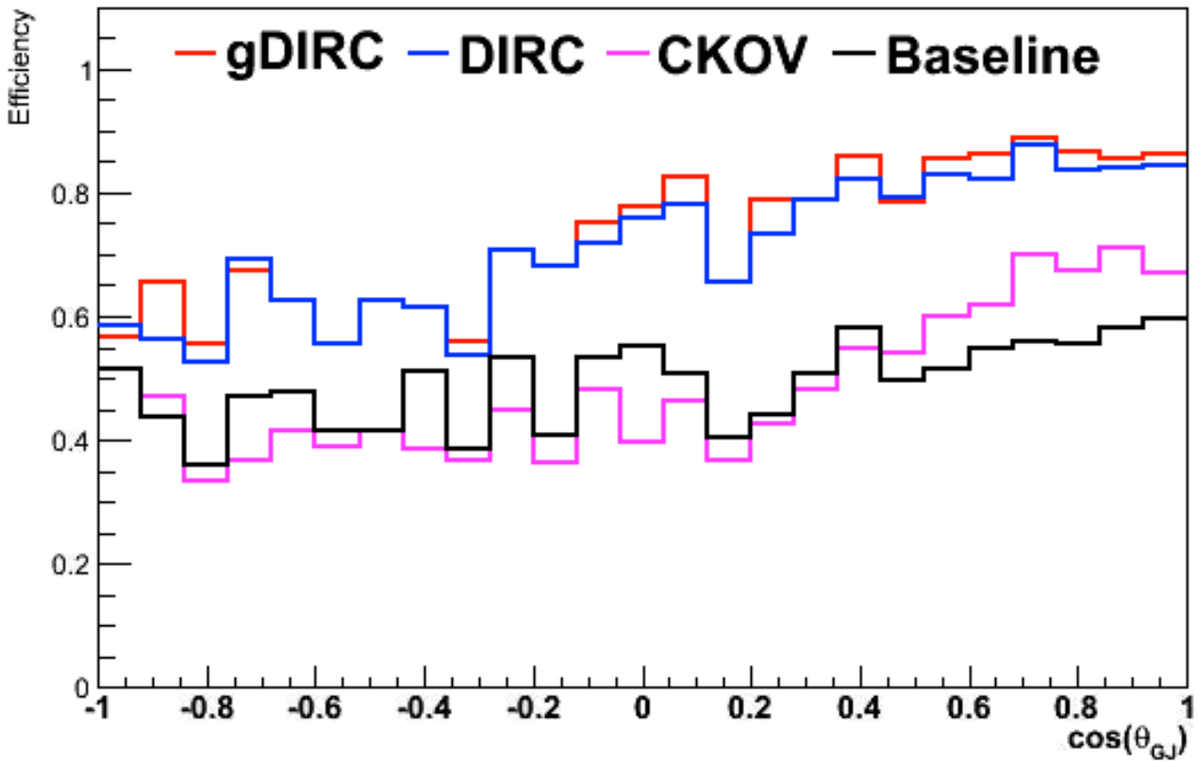
Y(2175)



- Improvement with DIRC better than CKOV
- Combination gDIRC improves by ~5%
- Gains are larger for higher purity

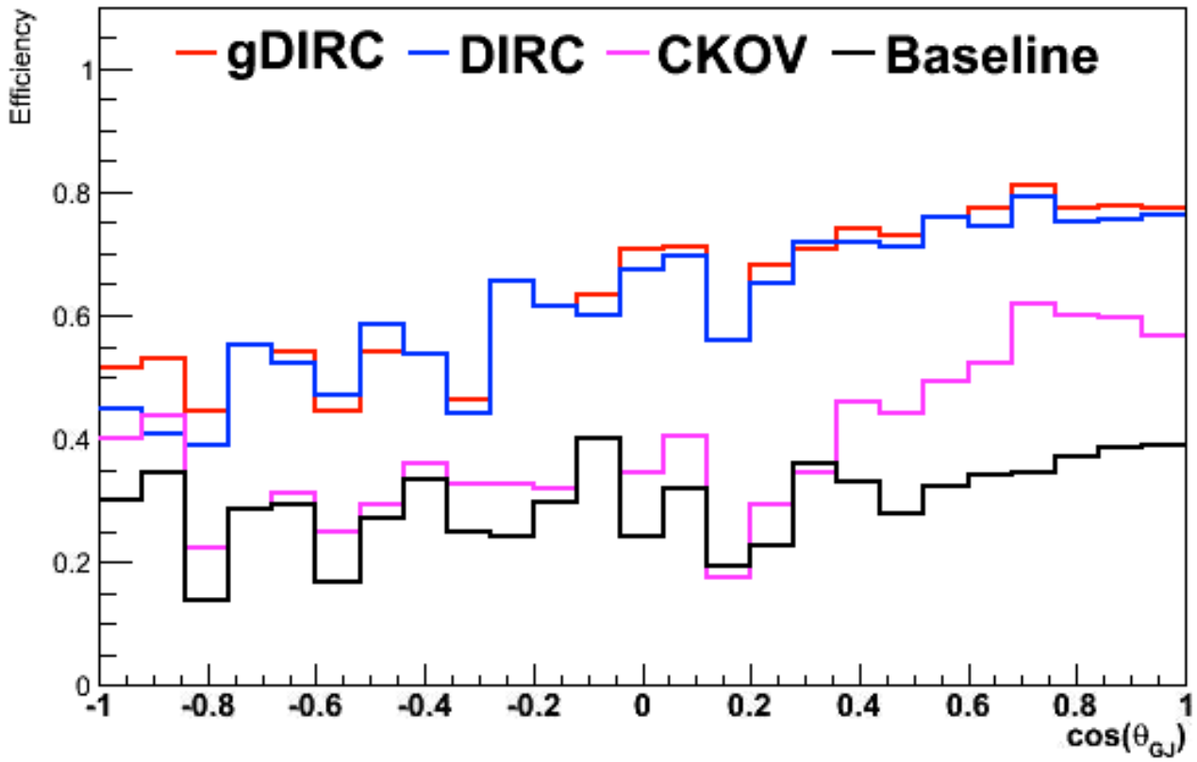
Y(2175)

90% Purity



Forward ϕ

95% Purity



Forward ϕ

- Baseline: Fairly uniform acceptance
- DIRC: More improvement in efficiency for forward ϕ
- CKOV: Small improvement in efficiency for forward ϕ
- gDIRC: Very similar to DIRC

Summary

- The Gas CKOV and DIRC detectors have different impacts on the angular dependence of the selection efficiency due to their different momentum coverage
  - gDIRC behaves similar to DIRC due to the larger separation power of the DIRC variables in the BDT
  - The addition of a Gas CKOV (ie. gDIRC) would not significantly improve the uniformity of the angular acceptance relative to the DIRC detector alone

Backup

Efficiency Table

h'(2600) Efficiency				
Analysis	Proton Reconstructed		Proton Missing	
	purity = 0.9	purity=0.95	purity=0.5	purity=0.8
No Upgrade	0.26	0.09	0	0
CKOV	0.36	0.20	0.19	0.03
DIRC (2 mrad)	0.47	0.31	0.17	0.02
DIRC (4 mrad)	0.44	0.28	0.14	0.02
CKOV+DIRC (2 mrad)	0.51	0.36	0.26	0.01
CKOV+DIRC (4 mrad)	0.50	0.34	0.25	0.03

η'(2300) Efficiency				
Analysis	Proton Reconstructed		Proton Missing	
	purity = 0.9	purity=0.95	purity=0.5	purity=0.8
No Upgrade	0.32	0.15	0.41	0.06
CKOV	0.42	0.30	0.46	0.10
DIRC (2 mrad)	0.50	0.39	0.59	0.25
DIRC (4 mrad)	0.48	0.35	0.56	0.23
CKOV+DIRC (2 mrad)	0.53	0.42	0.60	0.26
CKOV+DIRC (4 mrad)	0.52	0.39	0.58	0.24

Efficiency Table

ϕ(1850) Efficiency				
Analysis	Proton Reconstructed		Proton Missing	
	purity = 0.9	purity=0.95	purity=0.5	purity=0.8
No Upgrade	0.73	0.67	0	0
CKOV	0.88	0.84	0.47	0
DIRC (2 mrad)	0.76	0.69	0.53	0
DIRC (4 mrad)	0.76	0.69	0.09	0
CKOV+DIRC (2 mrad)	0.87	0.83	0.67	0
CKOV+DIRC (4 mrad)	0.87	0.83	0.47	0

Y(2175) Efficiency				
Analysis	Proton Reconstructed		Proton Missing	
	purity = 0.9	purity=0.95	purity=0.5	purity=0.8
No Upgrade	0.53	0.31	0.13	0
CKOV	0.61	0.49	0.30	0.04
DIRC (2 mrad)	0.80	0.70	0.65	0.22
DIRC (4 mrad)	0.72	0.62	0.53	0.16
CKOV+DIRC (2 mrad)	0.82	0.73	0.68	0.20
CKOV+DIRC (4 mrad)	0.76	0.62	0.58	0.20