

**DECOHERENCE MEETING:**

***DECOHERENCE OF FERMION QUIBIT PAIR AT COLLIDERS:  
TOMOGRAPHY AND EXPERIMENTAL PROSPECTS FOR  $t\bar{t}$   
PRODUCTION***

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## Prospects on $t\bar{t}$ production

### 1. Prospects for $e^+e^-$ collisions: the Linear Collider Facility (LCF)

- i. Inclusive concurrence results for  $t\bar{t}$  pair production.
- ii. Differential concurrence results for  $t\bar{t}$  pair production.
- iii. Performing purity tests in events with energetic emission.

### 2. Prospects for pp collision: the LHC

- i. Differential concurrence results for  $t\bar{t}$  pair production.

# 1. PROSPECTS FOR $e^+e^-$ COLLISIONS: THE LINEAR COLLIDER FACILITY (LCF)

## INCLUSIVE CONCURRENCE RESULTS FOR $t\bar{t}$ PAIR PRODUCTION:

Only leptonic final states. Still working in leptonic final states.

$\sqrt{s}$	NO EMISSION ( $t\bar{t}$ )			ENERGETIC EMISSION ( $t\bar{t}g$ ) *(selection in $p_{T^g}$ )					Decay channel		$R = C_{FSR}/C_{NORAD}$	$\epsilon_R$	Significance $S = \frac{1-R}{\epsilon_R}$
	$\sigma$ [pb]	$N_{\text{prospec. events}}$	$C[\rho] \pm \epsilon_{C[\rho]}$	$\sigma$ [pb]	$N_{\text{prospec. events}}$	$C[\rho] \pm \epsilon_{C[\rho]}$	Final states	BR					
500 GeV	0.5486	222183	0.133 $\pm$ 0.005	0.1304	11426 * $p_{T^g} > 20$ GeV	0.07 $\pm$ 0.02	$e^+e^-\mu^+\mu^- e^+\mu^\mp$	0.051	0.51	0.20	2.45 $\sigma$		
1000 GeV	0.1654	67004	0.249 $\pm$ 0.009	0.1354	3424 * $p_{T^g} > 150$ GeV	0.04 $\pm$ 0.04	$e^+e^-\mu^+\mu^- e^+\mu^\mp$	0.051	0.14	0.16	5.47 $\sigma$		
3000 GeV	0.0191	7752	0.28 $\pm$ 0.03	0.03359	1114 * $p_{T^g} > 400$ GeV	0.15 $\pm$ 0.07	$e^+e^-\mu^+\mu^- e^+\mu^\mp$	0.051	0.54	0.30	1.52 $\sigma$		



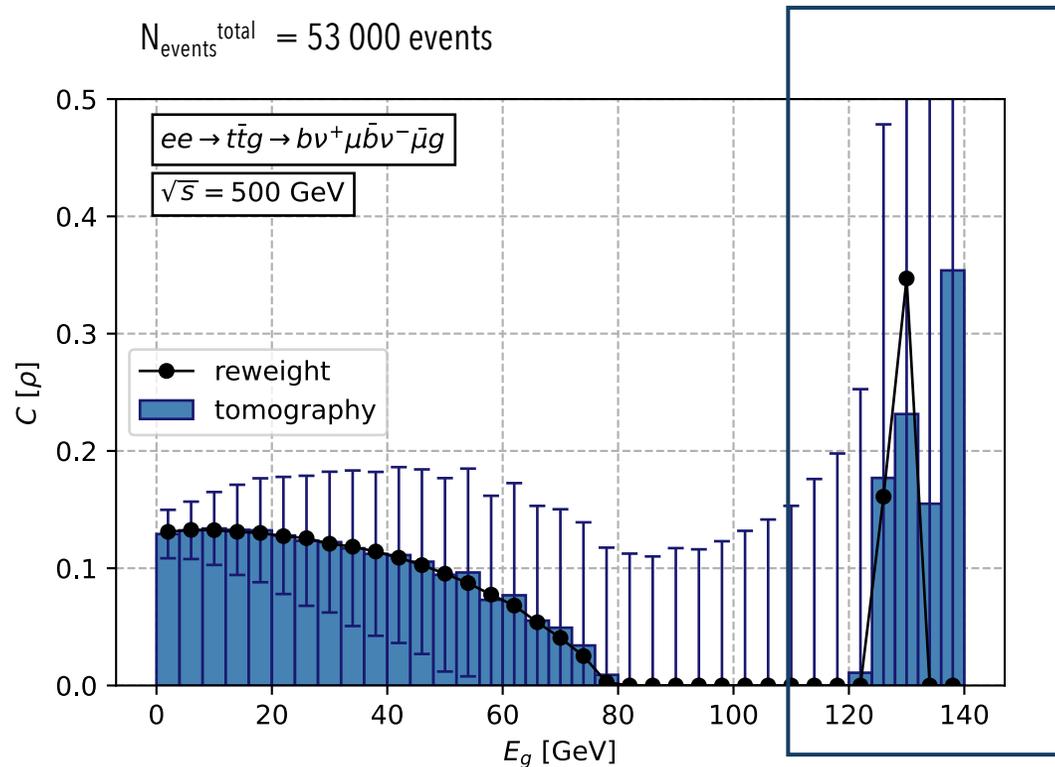
Introducing selection  $|\cos \theta_t^{t\bar{t} RF}| < 0.4$  (Eff  $\approx$  30-40%)  $\rightarrow$

**Improves concurrence  
Reduces significance**

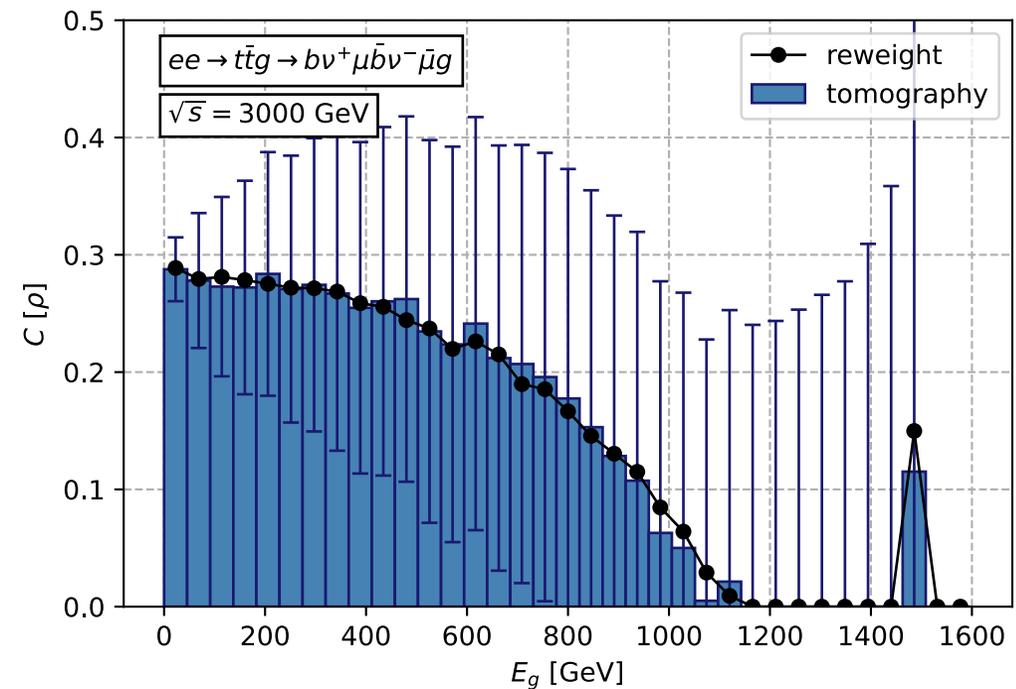
$\sqrt{s}$	NO EMISSION ( $t\bar{t}$ ) (* $ \cos \theta_t^{t\bar{t} RF}  < 0.4$ )			ENERGETIC EMISSION ( $t\bar{t}g$ ) (* $ \cos \theta_t^{t\bar{t} RF}  < 0.4$ ) *(selection in $p_{T^g}$ )					Decay channel		$R = C_{FSR}/C_{NORAD}$	$\epsilon_R$	Significance $S = \frac{1-R}{\epsilon_R}$
	$\sigma$ [pb]	$N_{\text{prospec. events}}$	$C[\rho] \pm \epsilon_{C[\rho]}$	$\sigma$ [pb]	$N_{\text{prospec. events}}$	$C[\rho] \pm \epsilon_{C[\rho]}$	Final states	BR					
500 GeV	0.5486	80110	0.212 $\pm$ 0.009	0.1304	3988 * $p_{T^g} > 20$ GeV	0.12 $\pm$ 0.07	$e^+e^-\mu^+\mu^- e^+\mu^\mp$	0.051	0.63	0.22	1.68 $\sigma$		
1000 GeV	0.1654	21874	0.428 $\pm$ 0.017	0.1354	1208 * $p_{T^g} > 150$ GeV	0.29 $\pm$ 0.12	$e^+e^-\mu^+\mu^- e^+\mu^\mp$	0.051	0.28	0.18	4.06 $\sigma$		
3000 GeV	0.0191	2459	0.50 $\pm$ 0.05	0.03359	423 * $p_{T^g} > 400$ GeV	0.13 $\pm$ 0.04	$e^+e^-\mu^+\mu^- e^+\mu^\mp$	0.051	0.58	0.28	1.48 $\sigma$		

# 1. PROSPECTS FOR $e^+e^-$ COLLISIONS: THE LINEAR COLLIDER FACILITY (LCF)

## DIFFERENTIAL CONCURRENCE RESULTS FOR $t\bar{t}$ PAIR PRODUCTION:



High uncertainty due to  
 $N(120 < E_g < 140) \sim 26$  events !



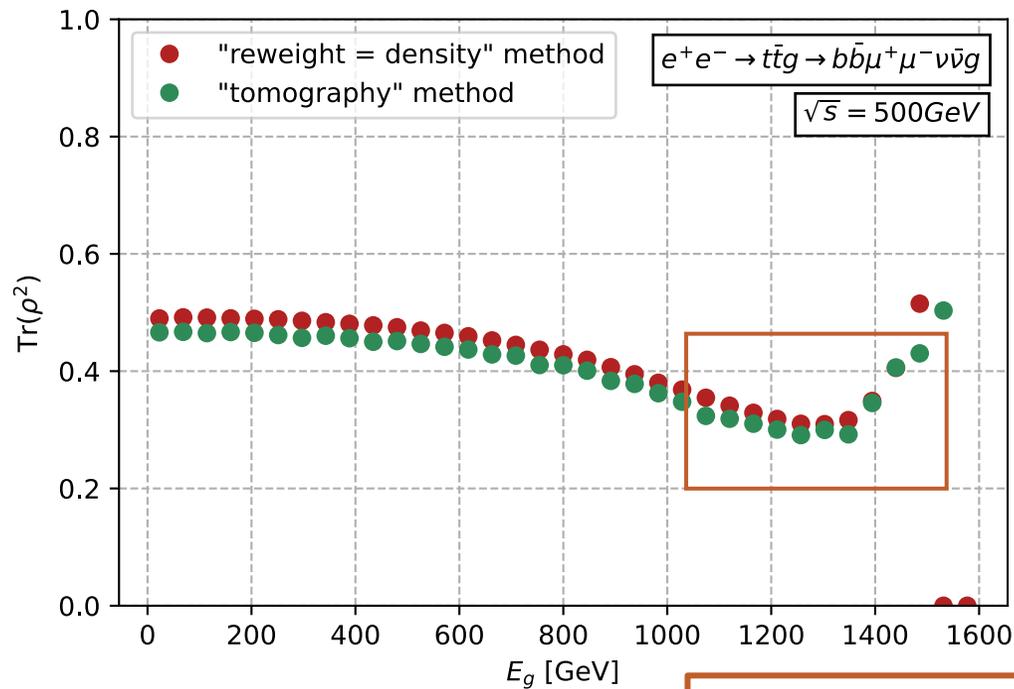
# 1. PROSPECTS FOR $e^+e^-$ COLLISIONS: THE LINEAR COLLIDER FACILITY (LCF)

## PERFORMING PURITY TESTS IN EVENTS WITH ENERGETIC EMISSION.

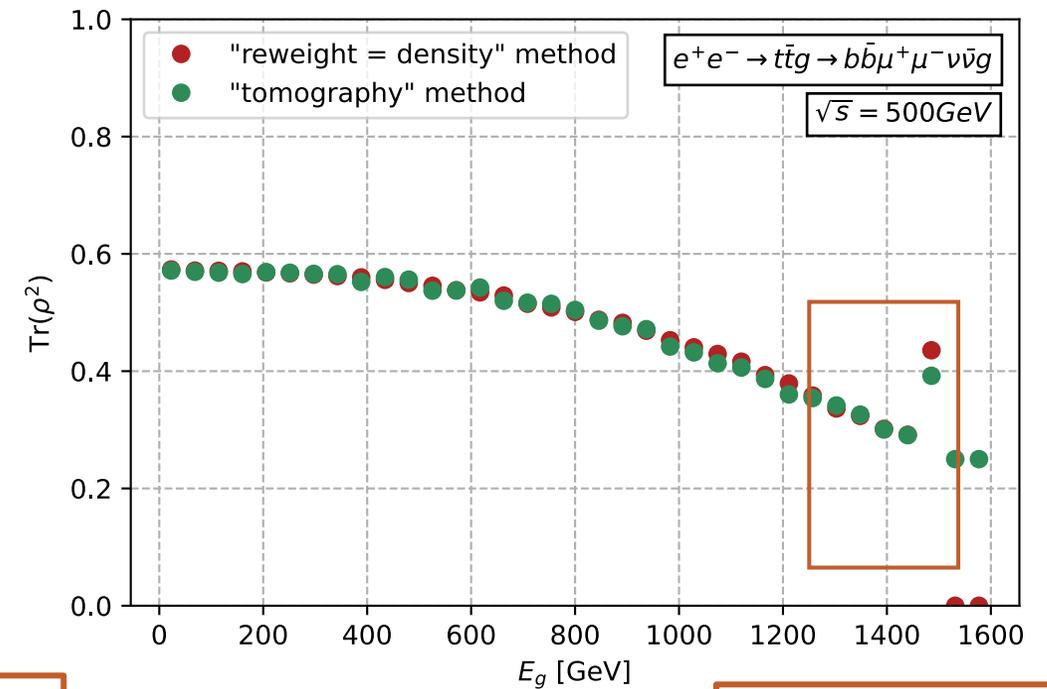
What is present in the sample to produce decoherence in the intervals  $80 < E_g < 120$  GeV (500 GeV) and  $1100 < E_g$  (3000 GeV) ?

PURE STATE  $\text{Tr}[\rho^2] = 1$

MIXED STATE  $\text{Tr}[\rho^2] < 1$



Minimum of  $\text{Tr}[\rho^2] \sim 0.3$  at  
 $80 < E_g < 120$  GeV (500 GeV)

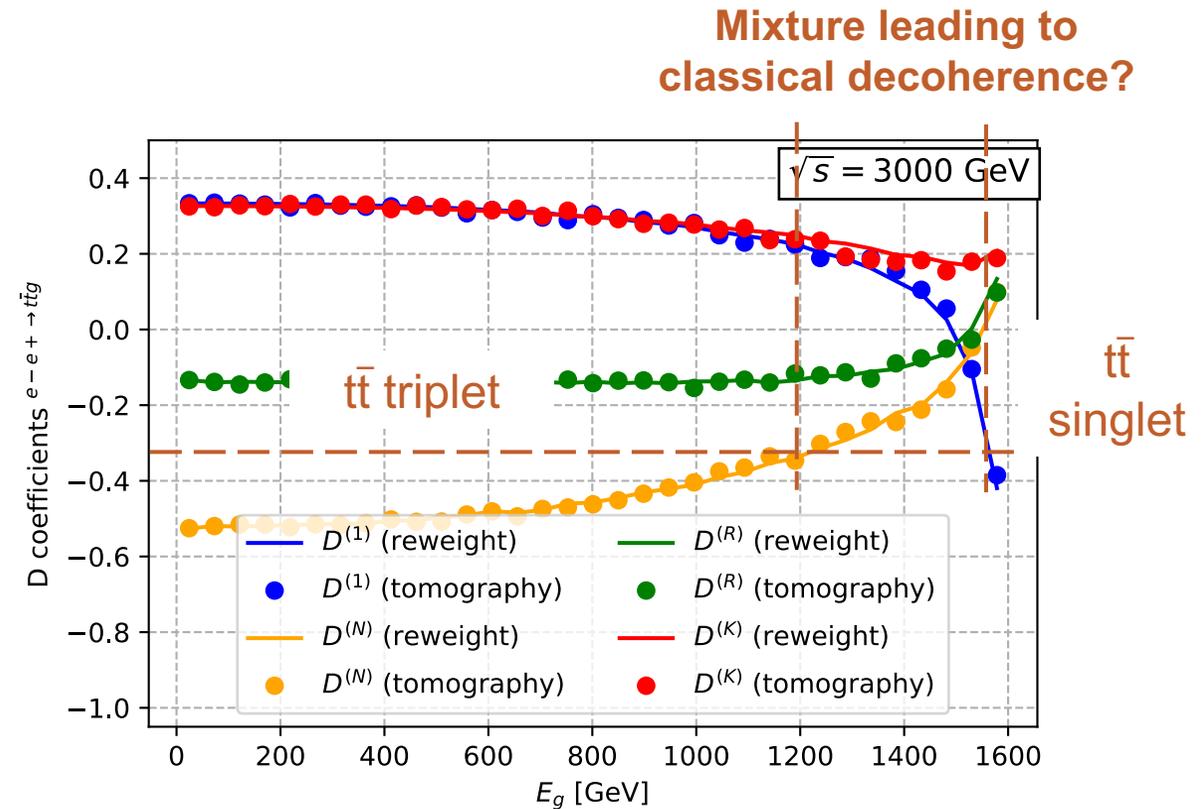
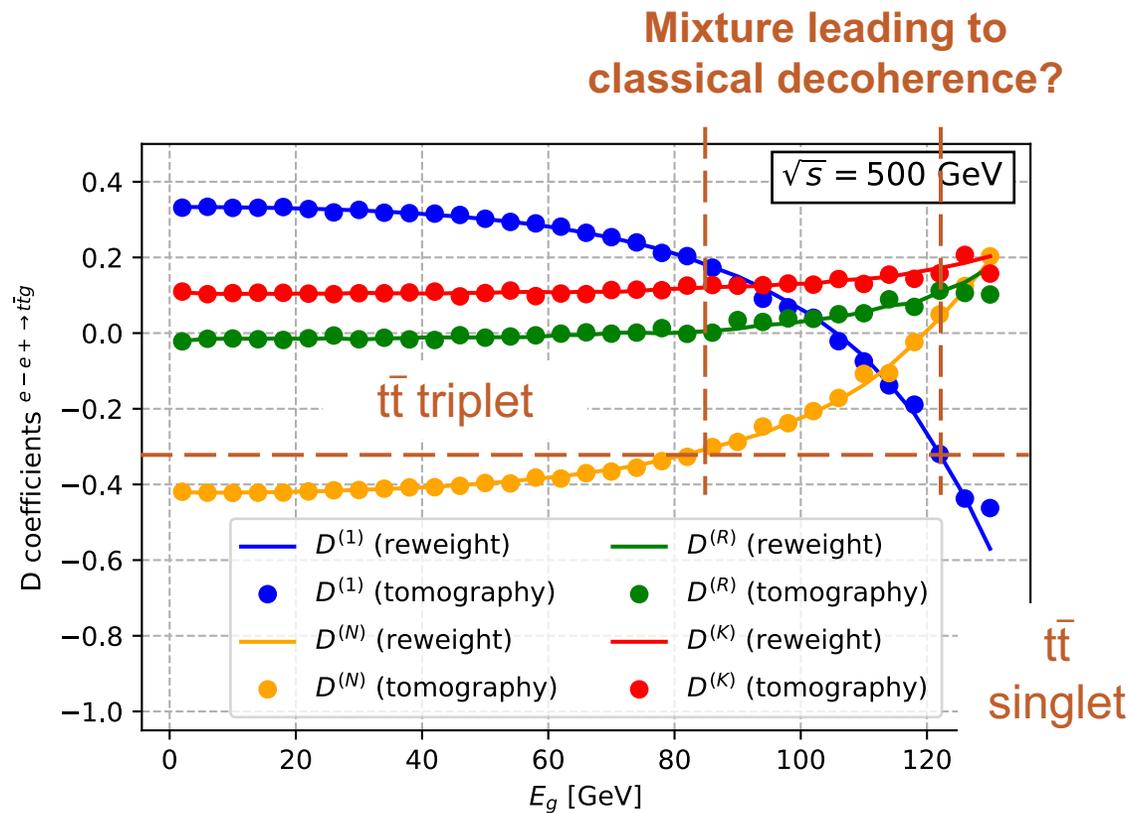


Decrease up to  
 $\text{Tr}[\rho^2] \sim 0.2$  observed

# 1. PROSPECTS FOR $e^+e^-$ COLLISIONS: THE LINEAR COLLIDER FACILITY (LCF)

## PERFORMING PURITY TESTS IN EVENTS WITH ENERGETIC EMISSION.

Can we describe the nature of the states using the D coefficients?

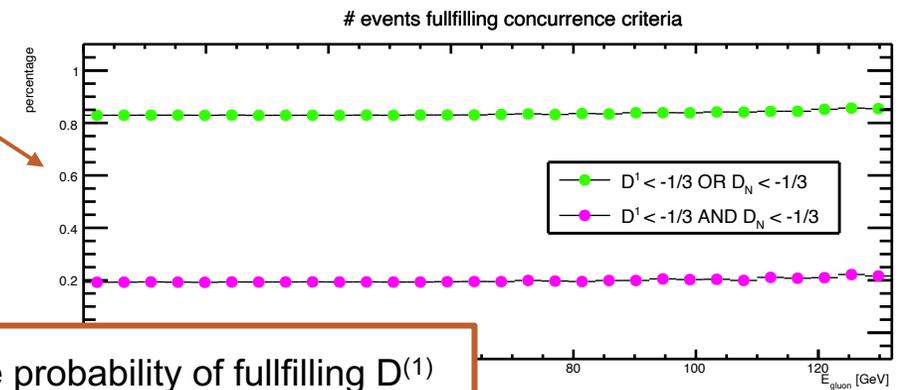
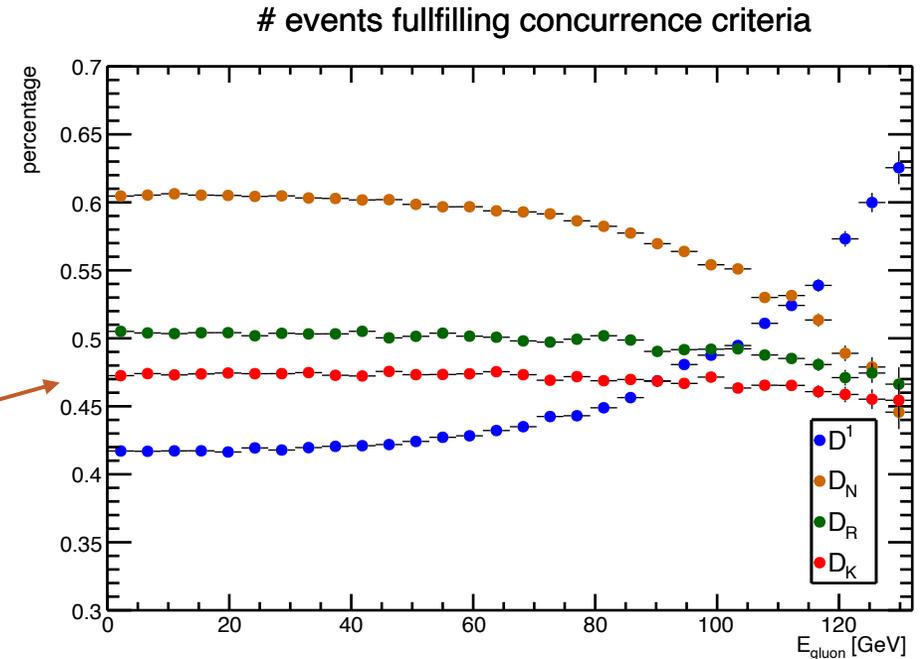
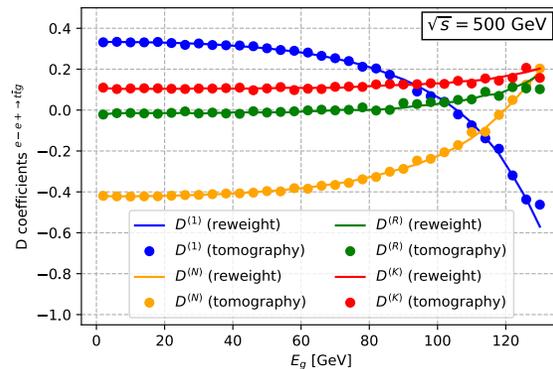
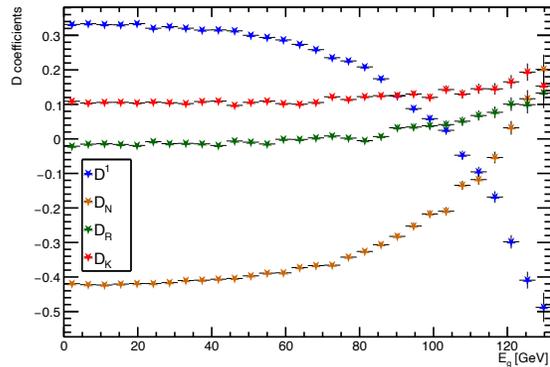


# 1. PROSPECTS FOR $e^+e^-$ COLLISIONS: THE LINEAR COLLIDER FACILITY (LCF)

## PERFORMING PURITY TESTS IN EVENTS WITH ENERGETIC EMISSION.

1. Define  $D^{(1)}$  and  $D_i$  event by event instead of using the mean of the mean of their angular distribution.
2. Create a new boolean variable for each  $D^{(1)}$  and  $D_i$  in each event:  

$$D^{(1)}, D_i < -1/3.$$
3. Obtain the mean value of each boolean variable.
4. Combine this boolean variables using logic criteria.



The probability of fulfilling  $D^{(1)}$  and/or  $D_i$  is flat for all energies!

(Work in progress)

## 2. PROSPECTS FOR $pp$ COLLISIONS: THE LHC AND THE HL-LHC OPERATION

In  $pp$  collision, we are able to coherence.

We have tested:

- We restrict ourselves to  $m_{t\bar{t}} > 800$  GeV.
- Even at parton level, a minimum selection of

$$|\cos\theta_t^{t\bar{t}RF}| < 0.4$$

is required to observe coherence due to the  $gg$  channel.

- A kinematic cut of  $m_{t\bar{t}} < 1000$  GeV does not improve coherence.

