



# Vertex finder performance



## LFCIPlus vertex finder algorithm

### ◆ Vertex Fitter for Primary Vertex

- ◆ if beam spot is constrained, beam spot centre as initial 3D point
- ◆ 3D fit performed for the vertex position by adding  $\chi^2$  contribution from each track; tracks with highest  $\chi^2$  and above a threshold are removed
- ◆ *output*: minimized  $\chi^2$ , vertex uncertainty and probability, tracks associated to PV

### ◆ Vertex Fitter for Secondary Vertices

- ◆ tracks not associated to the PV are paired and used as seeds for the SVs
- ◆ 3D fit performed for the vertex position by adding  $\chi^2$  contribution from each track pair; tracks with highest  $\chi^2$  and above a threshold are removed + additional selection criteria (e.g.  $V^0$  discarded)
- ◆ additional tracks are added to the SV and accepted if  $\chi^2$  contribution below threshold
- ◆ at this point: tracks may have been used for more than one vertex
- ◆ to remove overlap: vertices are scanned in order of probability (high to low) and number of tracks (3 to 2); tracks associated to vertices are removed from further SVs
- ◆ *output*: minimized  $\chi^2$ , vertices uncertainty and probability, tracks associated to SVs



# Vertex finder performance



## Tracks association

### ◆ Classification of tracks for vertex finder performance

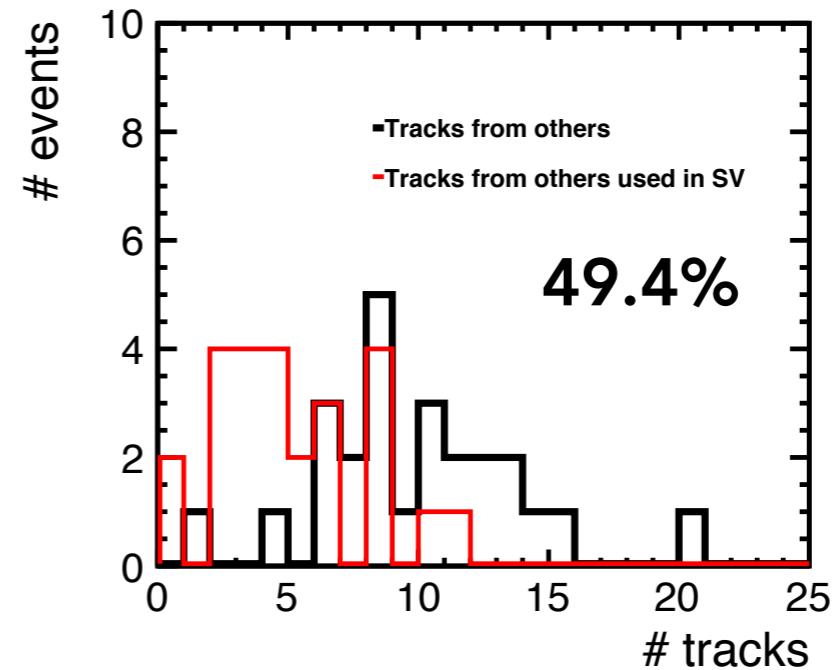
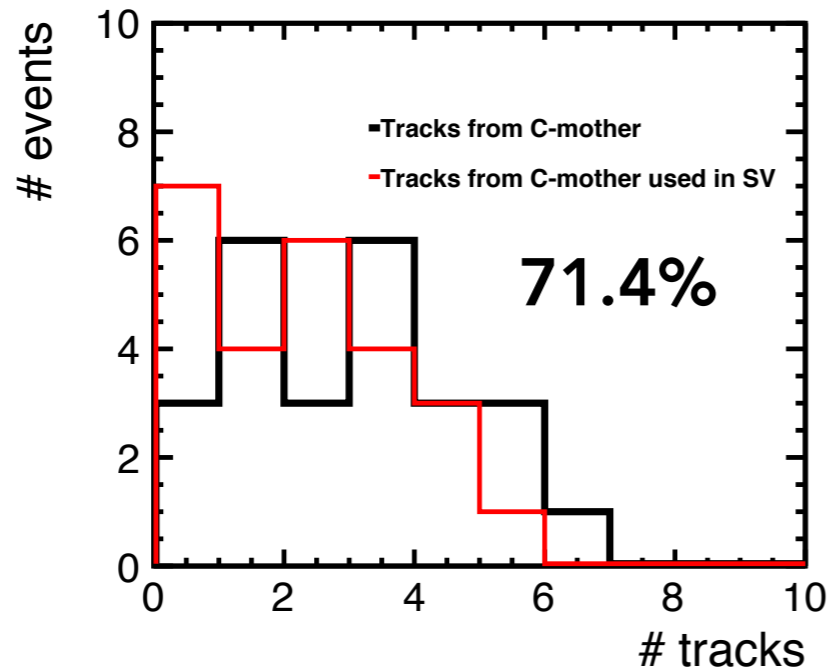
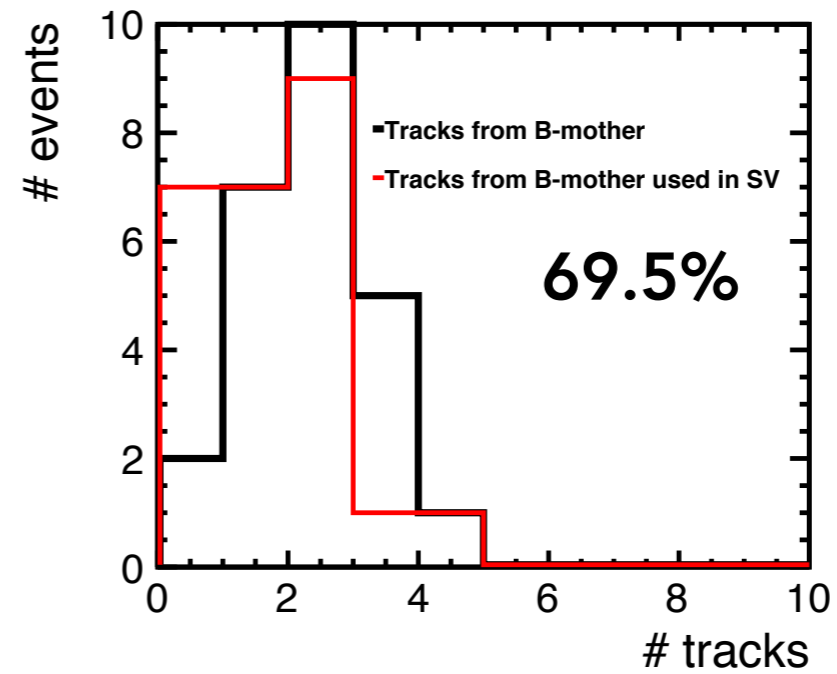
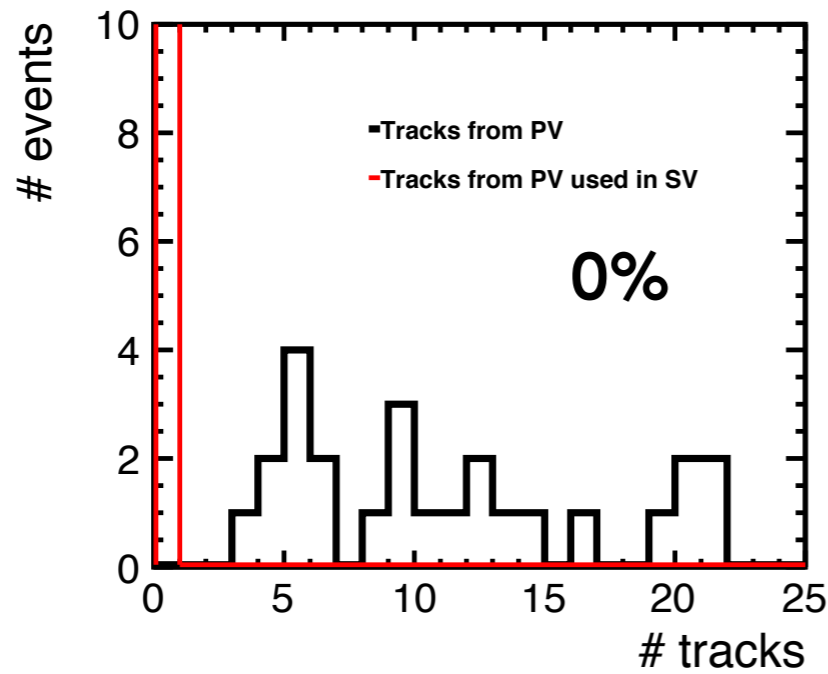
- ◆ *Primary*: tracks originated from the primary vertex
- ◆ *Bottom*: tracks whose most immediate parent with a non-zero lifetime contains a b quark
- ◆ *Charm*: tracks whose most immediate parent with a non-zero lifetime contains a c quark
- ◆ *Others*: all other tracks ( $\tau$  decays, strange hadrons, photon conversions, ...)

### ◆ bb @ 91.2 GeV for ILD detector

Track origin	Primary	Bottom	Charm	Others
Total number of tracks	496897	258299	247352	56432
Tracks in secondary vertices	0.6%	57.5%	64.3%	2.5%

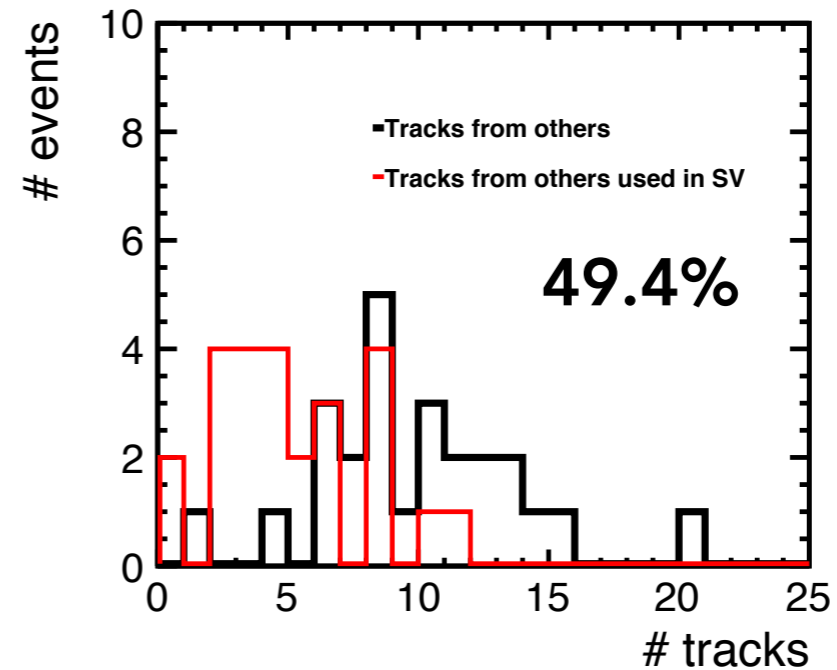
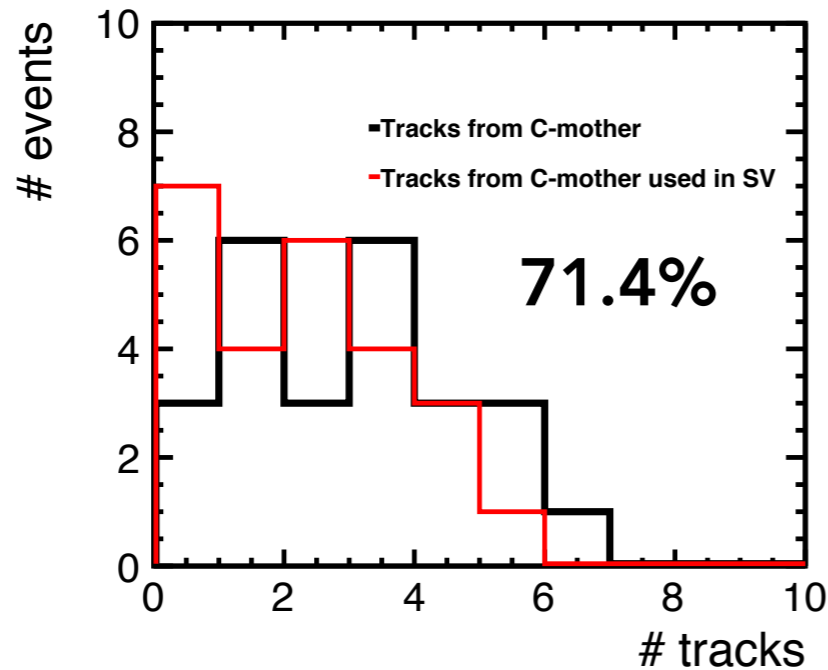
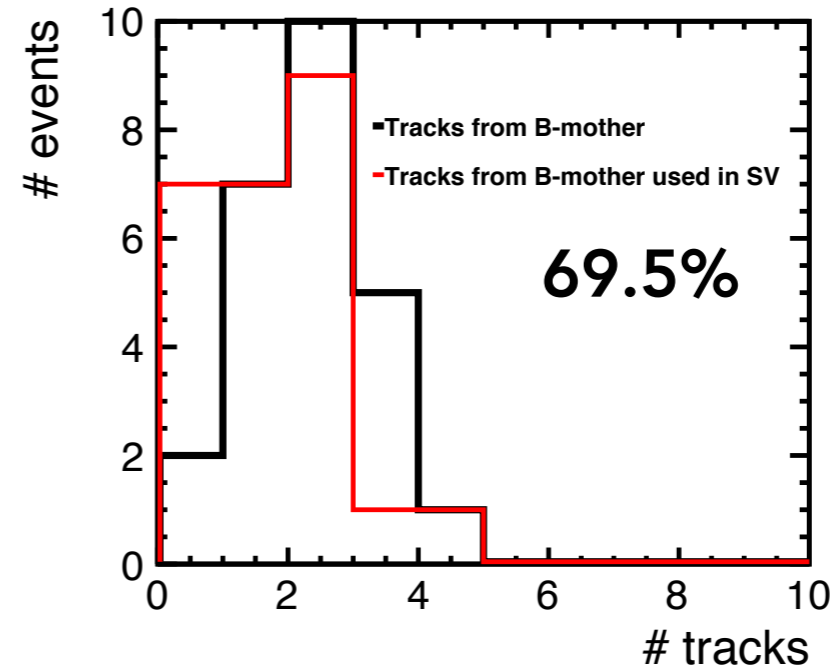
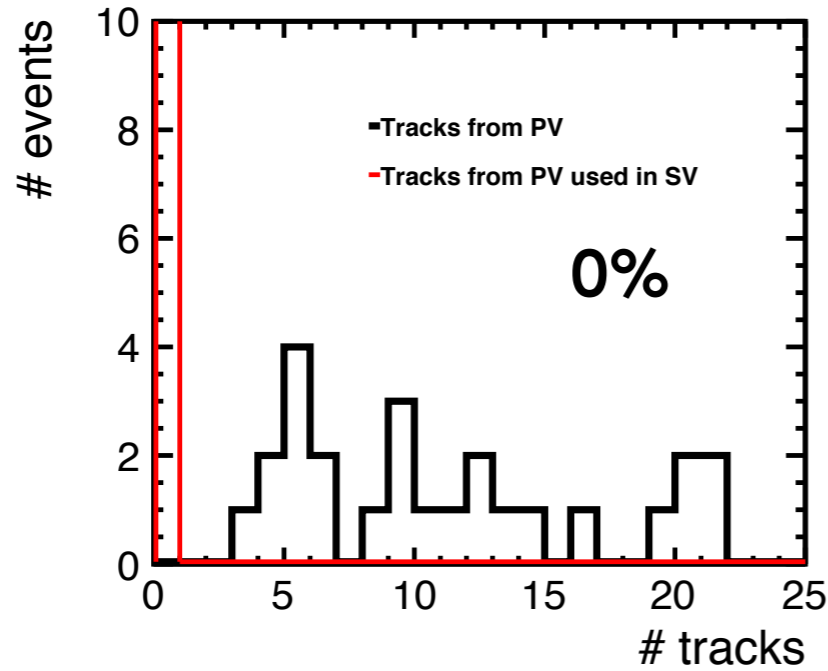
## Tracks association

- ◆ bb @ 91 GeV & 80deg for CLICdet [25 events]



## Tracks association

◆ bb @ 91 GeV & 80deg for CLICdet [25 events]



*others contain interaction with material*



# Vertex finder performance



## Tracks association - polar angle dependence

♦ **bb @ 91 GeV & 80deg for CLICdet [25 events]**

	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	267	46	63	237
tracks in sv	0%	69.5%	71.4%	49.4%

♦ **bb @ 91 GeV & 20deg for CLICdet [25 events]**

	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	283	22	74	302
tracks in sv	0.35%	45.5%	58.1%	22.2%



# Vertex finder performance



## Tracks association - polar angle + energy dependence

◆ **bb @ 500 GeV & 80deg for CLICdet [25 events]**

	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	166	33	70	340
tracks in sv	0%	81.8%	78.6%	39.4%

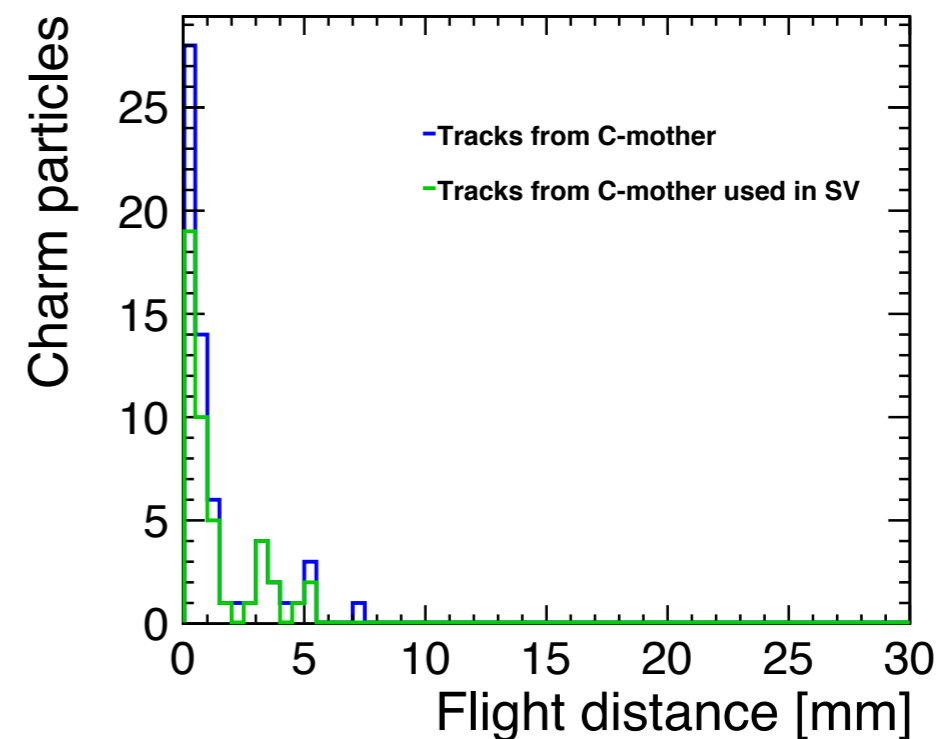
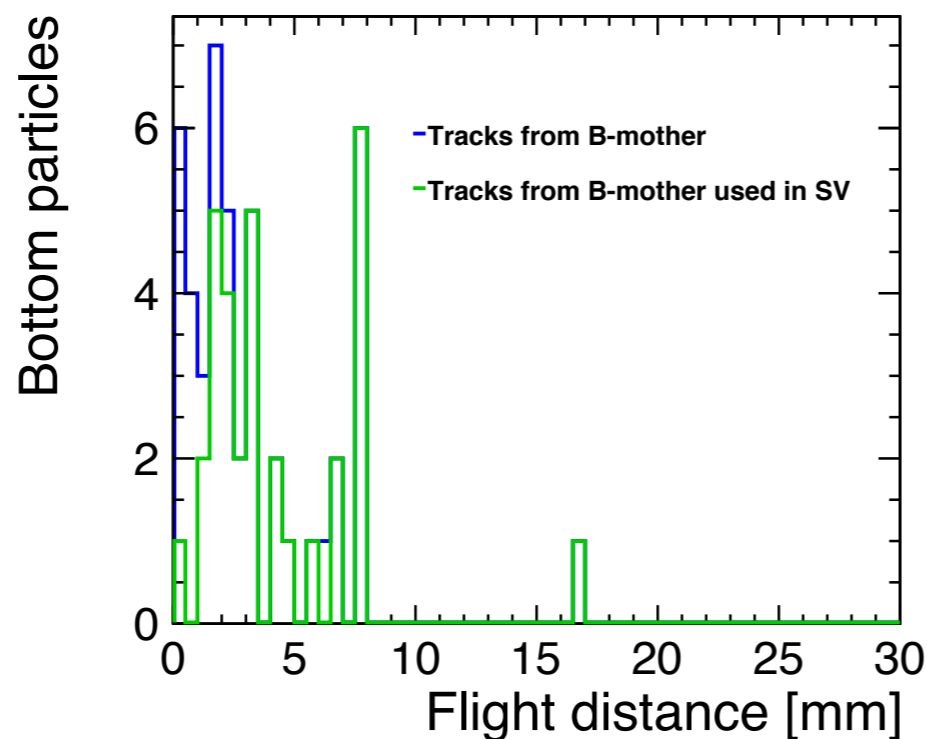
◆ **bb @ 500 GeV & 20deg for CLICdet [25 events]**

	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	154	38	72	245
tracks in sv	1.9%	44.7%	76.4%	38.0%

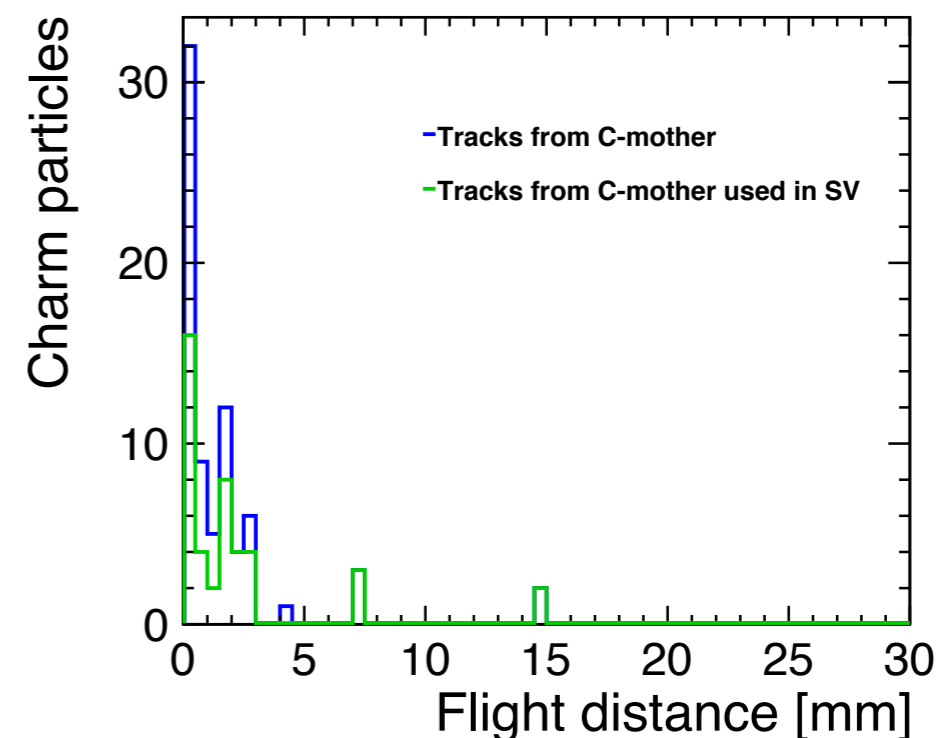
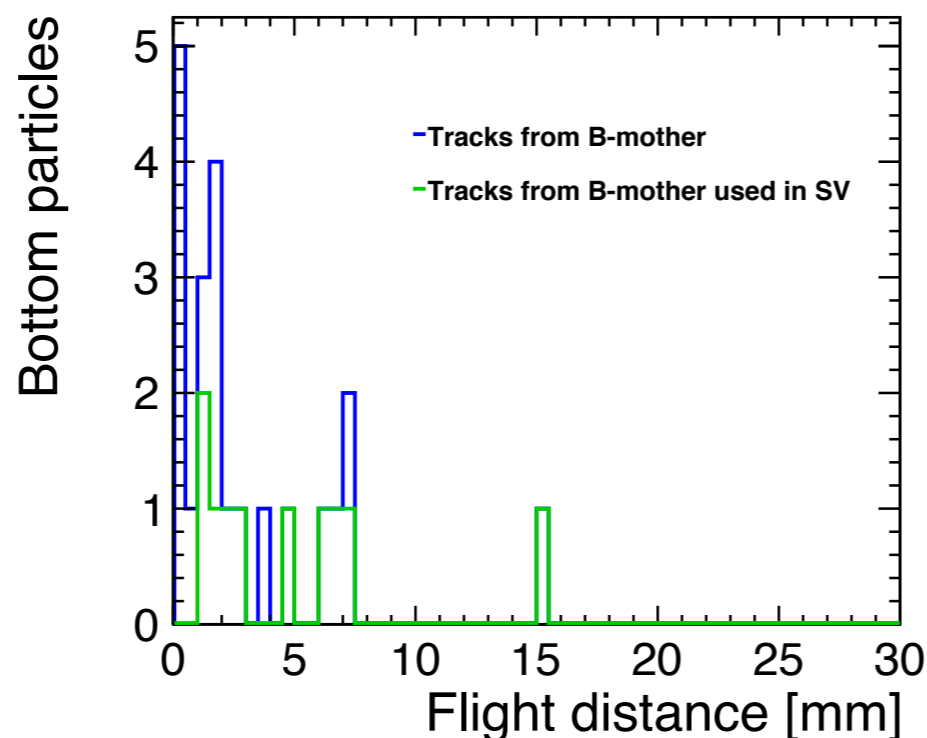
## Definition of reconstructable vertices

- ◆ particle distribution vs mother flight distance

◆ **bb91GeV80deg**



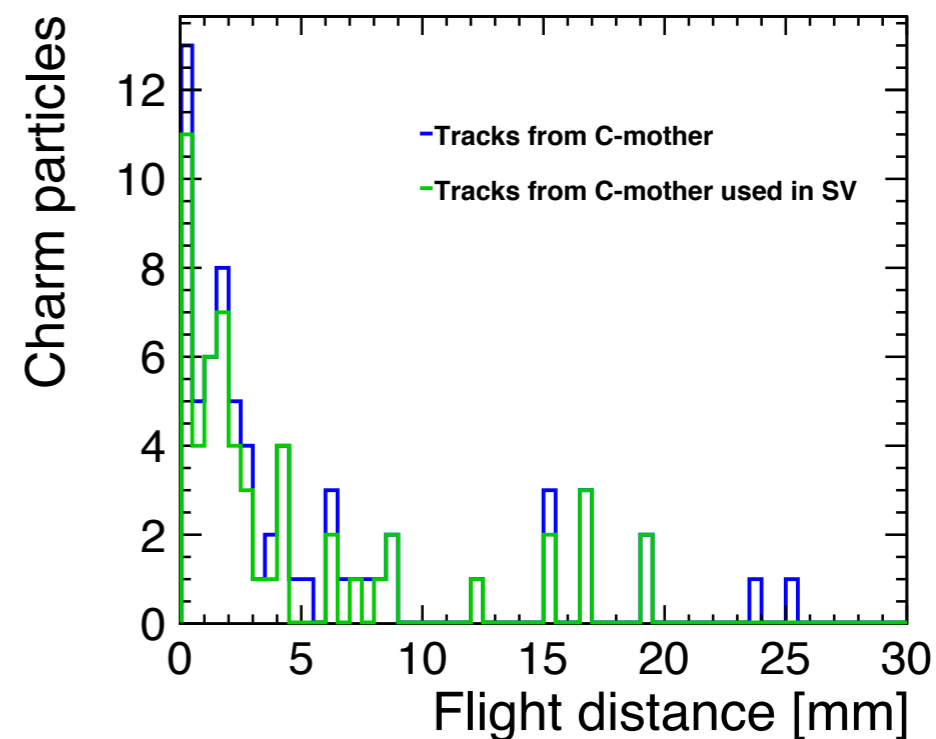
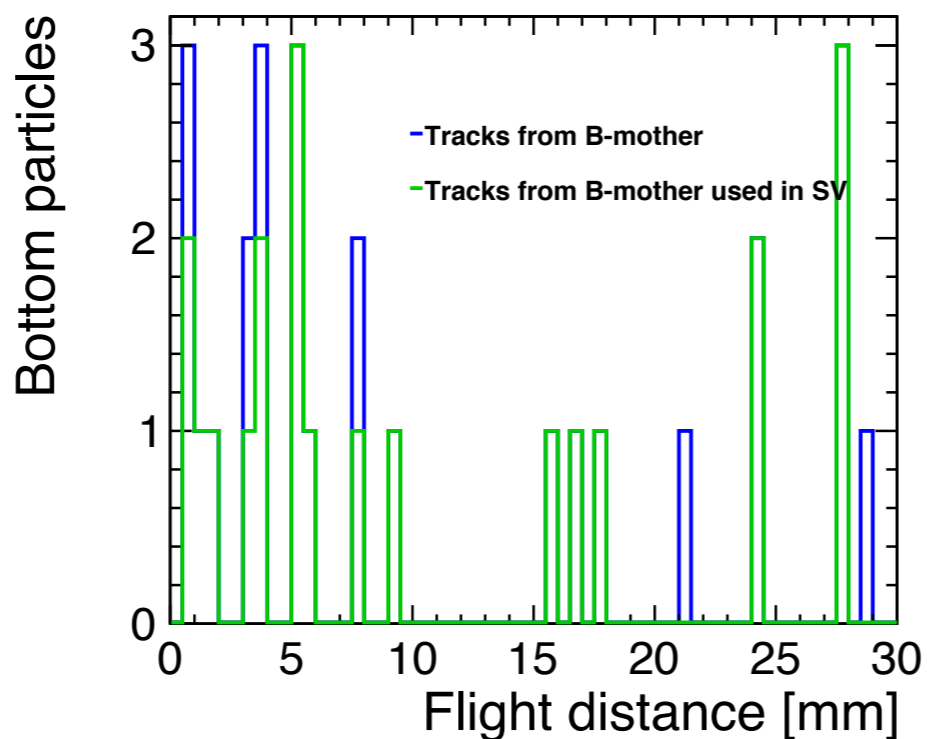
◆ **bb91GeV20deg**



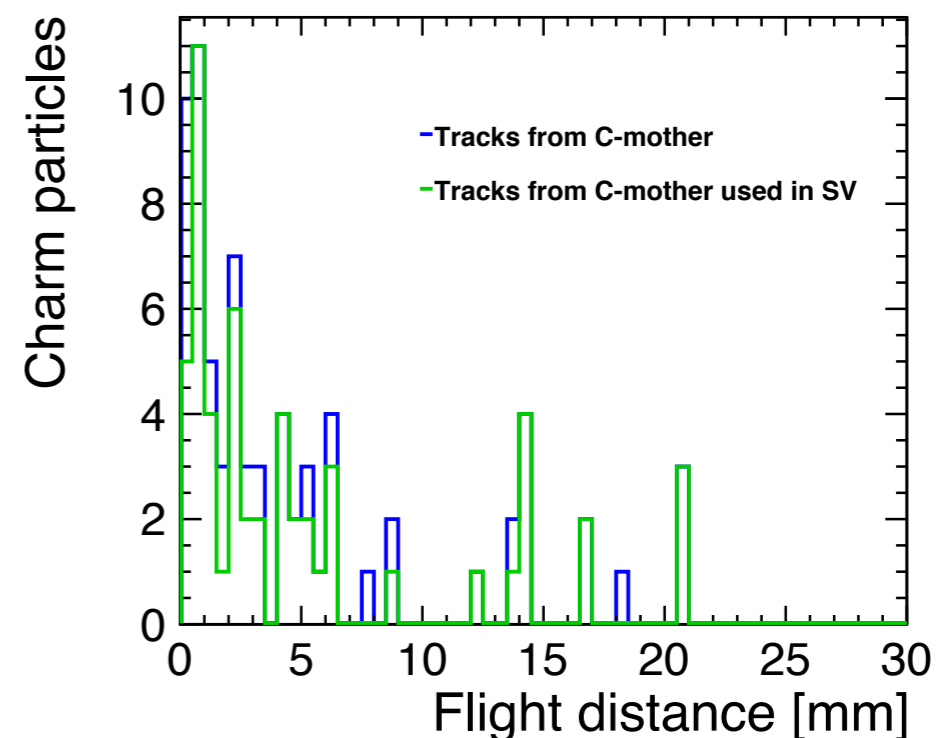
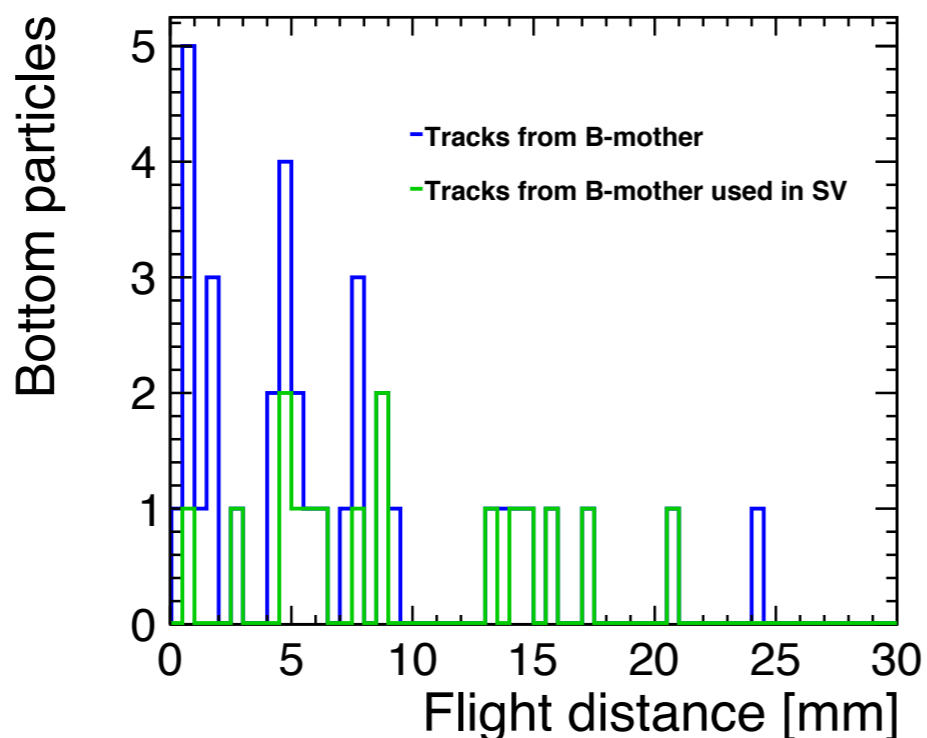
## Definition of reconstructable vertices

- ◆ particle distribution vs mother flight distance

◆ bb500GeV80deg



◆ bb500GeV20deg







# Vertex finder performance



## Tracks association - Truth vs Conformal (I)

♦ **bb @ 91 GeV & 80deg for CLICdet [25 events]**

	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	267 (282)	46 (48)	63 (66)	237 (201)
tracks in sv	0% (0%)	69.5% (66.7%)	71.4% (62.1%)	49.4% (56.2%)

♦ **bb @ 91 GeV & 20deg for CLICdet [25 events]**

	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	283 (316)	22 (22)	74 (83)	302 (232)
tracks in sv	0.35% (1.0%)	45.5% (36.4%)	58.1% (55.4%)	22.2% (28.0%)



# Vertex finder performance



## Tracks association - Truth vs Conformal (II)

♦ **bb @ 500 GeV & 80deg for CLICdet [25 events]**

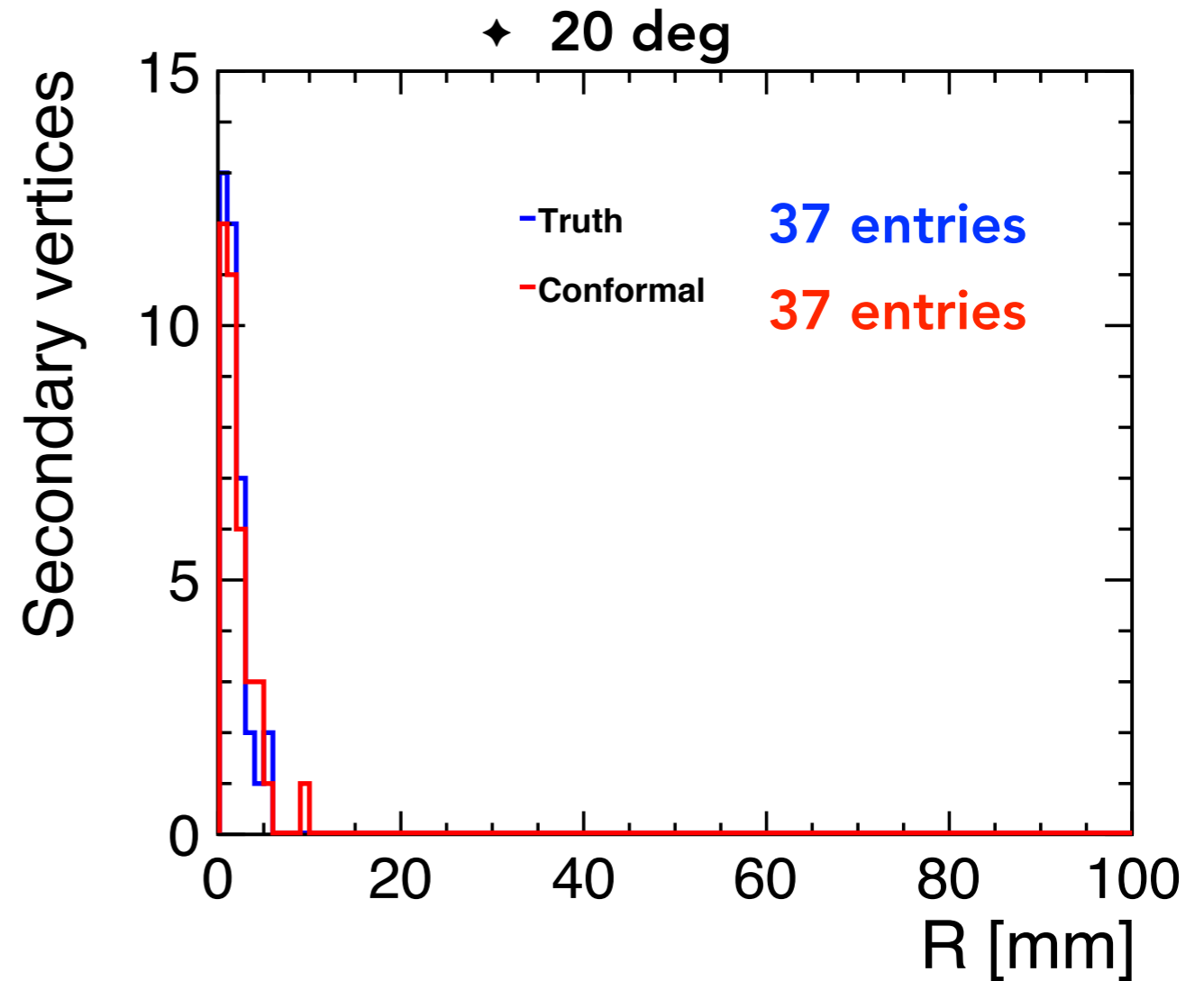
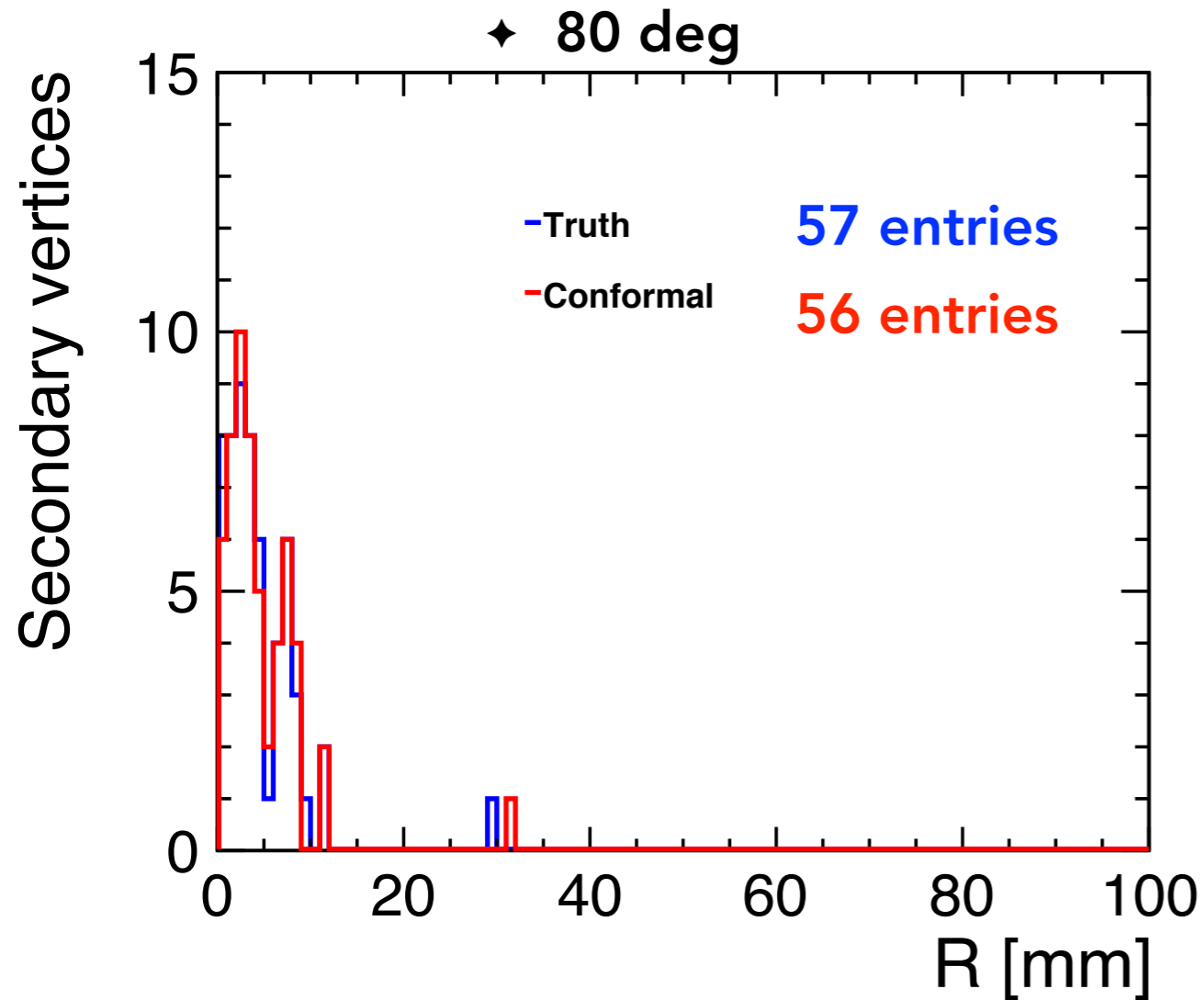
	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	166 (125)	33 (35)	70 (75)	340 (241)
tracks in sv	0% (4.8%)	81.8% (62.9%)	78.6% (60%)	39.4% (45.6%)

♦ **bb @ 500 GeV & 20deg for CLICdet [25 events]**

	<i>primary</i>	<i>bottom</i>	<i>charm</i>	<i>others</i>
tot tracks	154 (158)	38 (42)	72 (77)	245 (278)
tracks in sv	1.9% (2.5%)	44.7% (45.2%)	76.4% (68.8%)	38% (32%)

## Secondary Vertices - Truth vs Conformal (I)

♦ bb @ 91 GeV for CLICdet [25 events]



## Secondary Vertices - Truth vs Conformal (II)

♦ bb @ 500 GeV for CLICdet [25 events]

