Update of the Prompt Photon Cross Sections

Dana Partos
Brandeis University

Steve Kuhlmann
Argonne National Laboratory

Review of Previous Photon Analyses

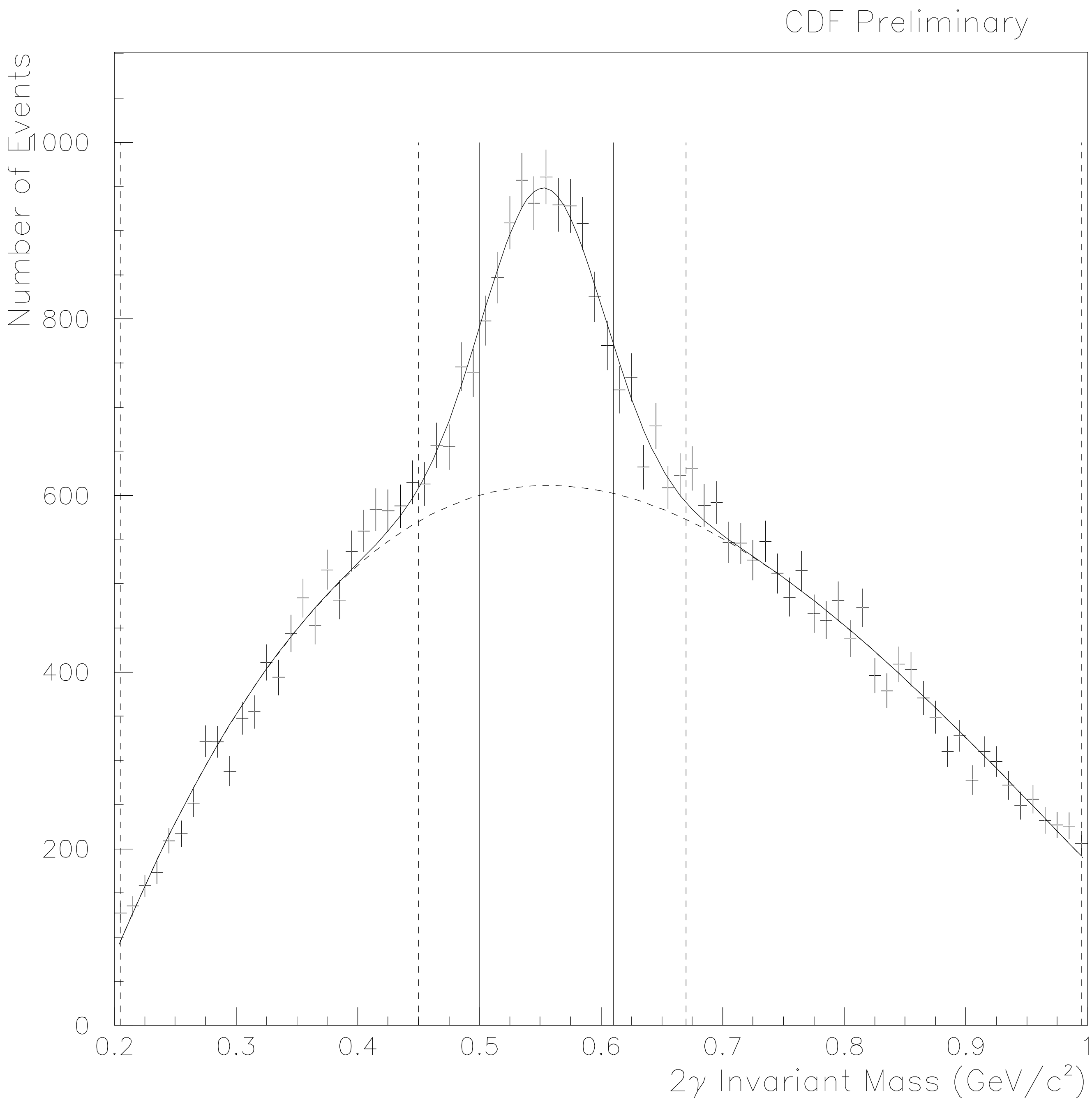
- Two methods for finding photons (CPR and CES)
- Both methods should give same cross section
- Run 1a cross sections agreed to 2%
- Originally Run 1b cross sections did not agree
- Must recalibrate efficiencies
- Use π^0 from $\rho^\pm \to \pi^\pm\pi^0 \to \pi^\pm\gamma\gamma$ to check background efficiencies
- Significant difference between data and expected values
  - Measured CES Efficiency = 0.458 ± 0.009
  - Expected CES Efficieny = 0.472 ± 0.005
  - Measured CPR Efficiency = 0.866 ± 0.006
  - Expected CPR Efficiency = 0.838 ± 0.006
- Changed both signal and background efficiencies to agree with predicted values
- Appplied same CES and CPR corrections to the 630 GeV data
- Brought CES and CPR cross sections together in both 1b and 630 GeV data sets

To Do List at Time of Blessing

- Recalibrate signal efficiencies using $\eta \to \gamma\gamma$
- Measure trigger efficiencies (flat 5% at time of blessing)
- Apply lateral shower leakage corrections
- Find source of discrepancy between the measured CPR/CES efficiencies and the expected values
- Calculate CPR/CES systematic errors

Eta Analysis

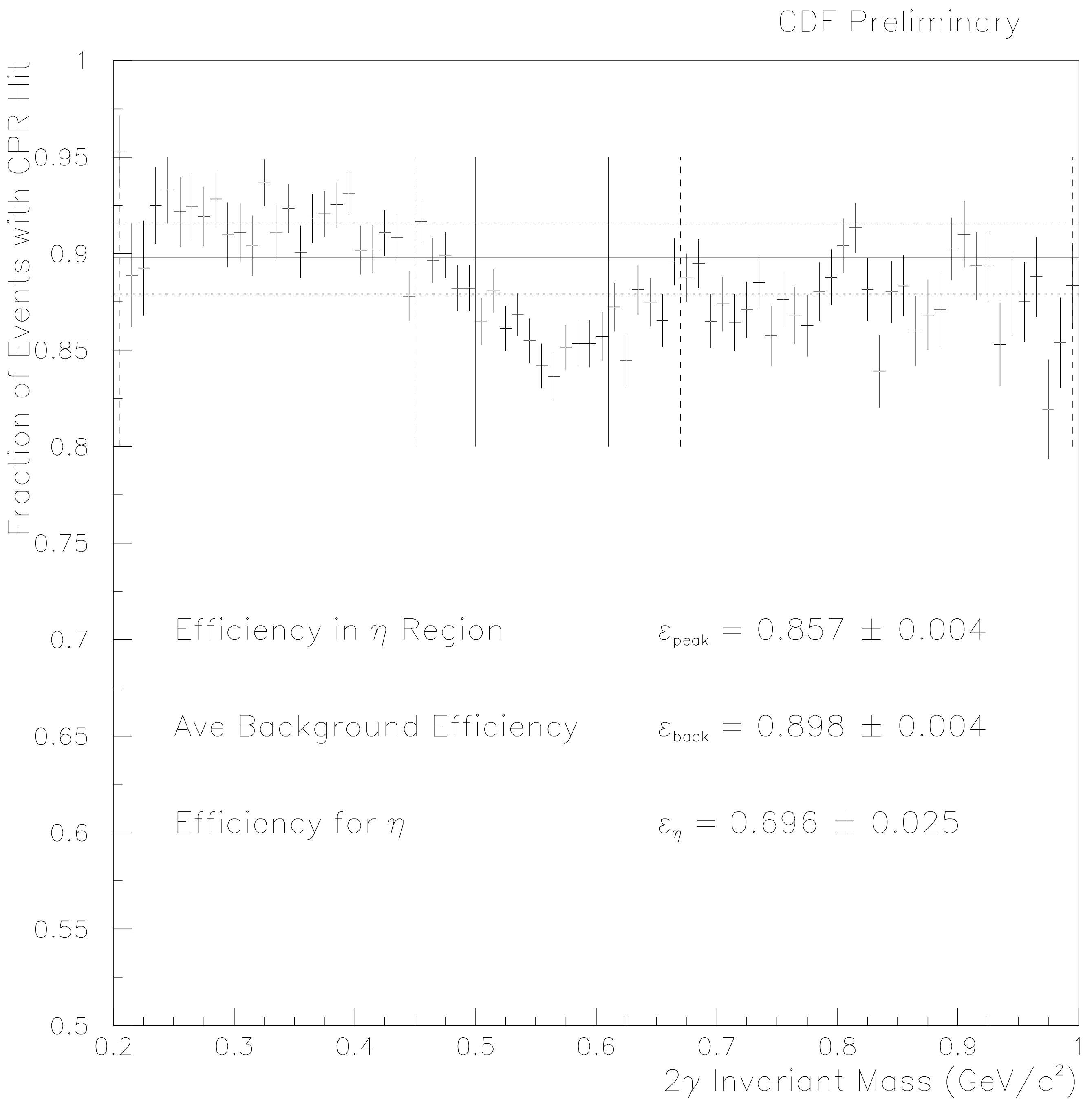
- Followed same steps as in the 1a analysis
- Event selection
  - Passed PHOB_CEM4_10_ISOL
  - Central ELES cluster
  - No track pointing to cluster
  - Energy in cone 0.4 $<$ 4 GeV (old - cone 0.7)
  - 11 channel clustering (old - 5 channel)
  - Each ELES cluster needs at least 2 CES strip clusters and 1 CES wire cluster
  - Strip clusters must be in different EM towers
  - CES strip and wire isolation < 0.2
  - $|CESx| <$ 17.5 cm
  - $|CESz| <$ 217 cm
  - $|Zvert| <$ 60 cm
  - $\frac{|E_1 - E_2|}{E_1 + E_2} < 0.75$
  - 10 GeV $< P_T <$ 25 GeV



CDF Preliminary
Number of Events
0
200
400
600
800
1000
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2γ Invariant Mass (GeV/c²)

Eta Analysis

- **Fit invariant mass with gaussian + quadratic polynomial**
- η **signal region** $0.5 < M < 0.45$
- **Sideband regions** $0.2 < M < 0.45$ **and** $0.67 < M < 1.0$
- **Calculated CPR efficiency**
  - **Efficiency in signal region 0.857 $\pm$ 0.004**
  - **Efficiency in low mass region 0.916 $\pm$ 0.003**
  - **Efficiency in high mass region 0.879 $\pm$ 0.003**
- **What is correct background efficiency in signal region?**
- η **efficiency can vary from 0.625 $\pm$ 0.023 to 0.771 $\pm$ 0.023**
- π^0 **CPR discrepancy 0.028**
- **Does not improve on old measurement**


CDF Preliminary
Fraction of Events with CPR Hit
2γ Invariant Mass (GeV/c²)
Efficiency in η Region
$\varepsilon_{peak} = 0.857 \pm 0.004$
Ave Background Efficiency
$\varepsilon_{back} = 0.898 \pm 0.004$
Efficiency for η
$\varepsilon_{\eta} = 0.696 \pm 0.025$

Trigger Efficiencies

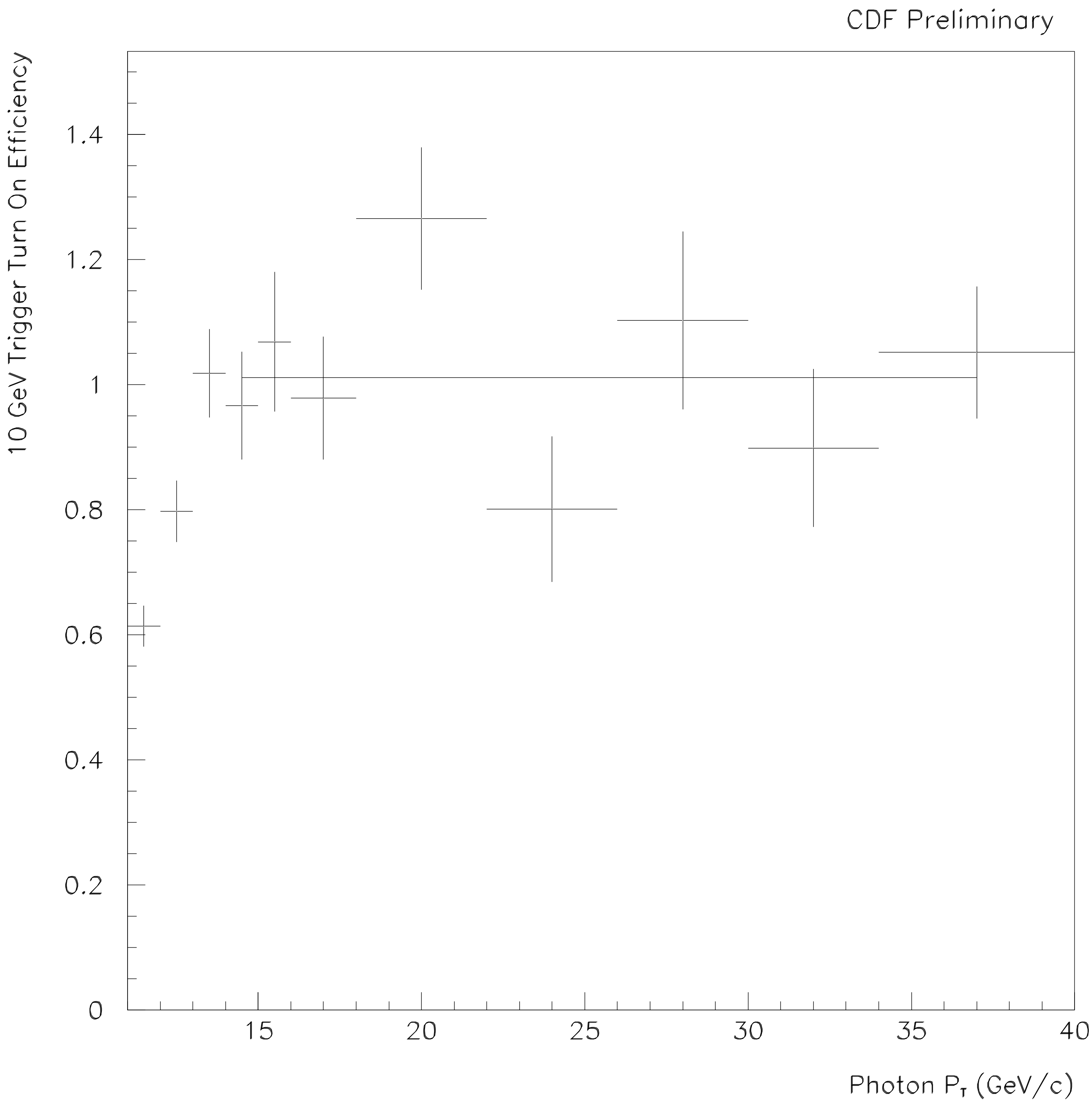
- 3 triggers used in photon cross section
  - PHOB_CEM4_10_ISOL
    - Used from 11 GeV $< P_T <$ 26 GeV
    - Fiducial CES cluster
    - Level 2 and 3 EM cluster with $E_T >$ 10 GeV (with HAD/EM cut)
    - Neural net isolation $<$ 1552
  - PHOB_CEM3_23_ISOL
    - Used from 26 GeV $< P_T <$ 55 GeV
    - Fiducial CES cluster
    - Level 2 and 3 EM cluster with $E_T >$ 23 GeV (with HAD/EM cut)
    - Neural net isolation $<$ 1552
    - Level 2 XCES $<$ 60
  - PHOB_CEM5_50_NOISOL
    - Used from 55 GeV $< P_T <$ 152 GeV
    - Fiducial CES cluster
    - Level 2 and 3 EM cluster with $E_T >$ 50 GeV (with HAD/EM cut)

Trigger Efficiencies

- Separated into 4 components and analyzed separately
  - P_T turn on
    - Look at data sample with lower P_T threshold
    - Calculate fraction that pass trigger of interest
  - Isolation
    - Get neural net wedge and isolation information from TL2D bank
    - Match neural net wedge with photon wedge
    - Measure fraction with neural net isolation < 1552
  - XCES
  - HAD/EM (taken from CDF3120)

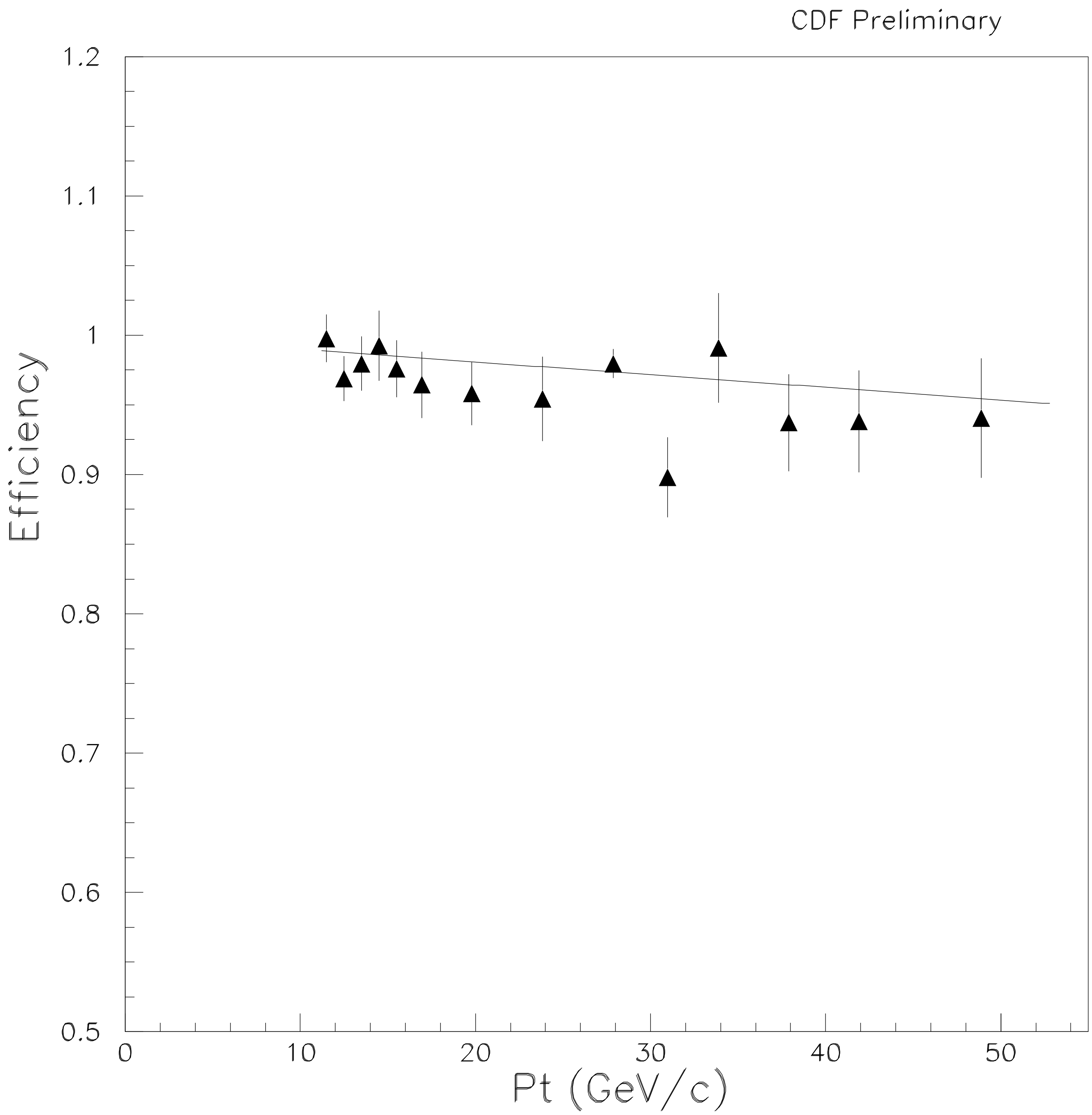
PHOB_CEM4_10_ISOL P_T Turn On

- Used 8 GeV Level 2 electron data sample (stream ELCB_5P, trigger CEM_8*)
- Both triggers prescaled
- Got prescales from Get_lum_trig code
- Turn on curve multiplied by photon prescale (77.8)
- Fit plateau region 1.012 $\pm$ 0.039
- Efficiency taken as 1.000 $\pm$ 0.039


CDF Preliminary
10 GeV Trigger Turn On Efficiency
1.4
1.2
1
0.8
0.6
0.4
0.2
0
15
20
25
30
35
40
Photon P_T (GeV/c)

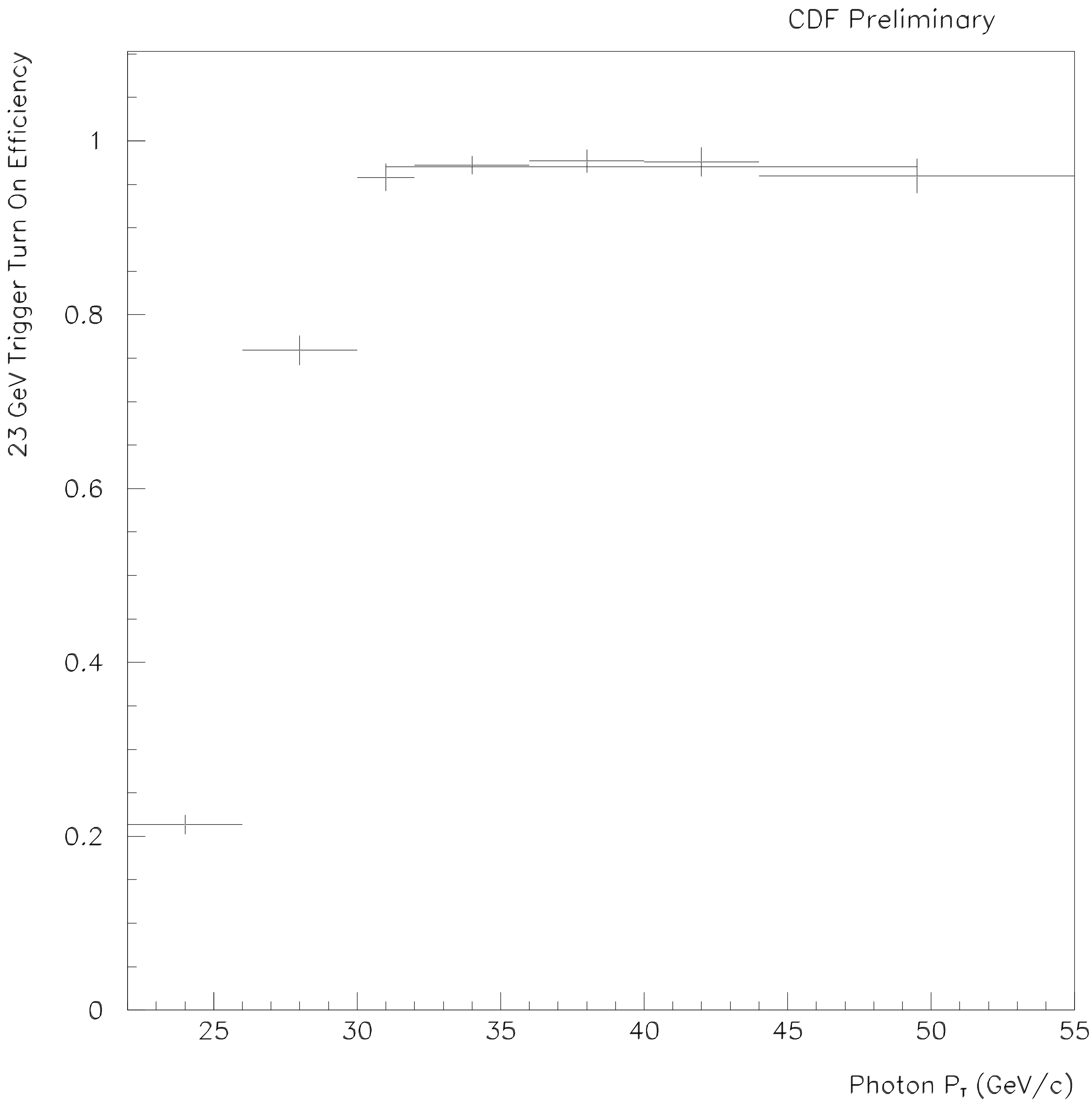
PHOB_CEM4_10_ISOL Isolation

- Used 10 and 23 GeV non-isolated data sample
- Matched neural net wedge with photon wedge (more than 98.5% agreement)
- Found neural net isolation value associated with photon
- Calculated fraction of weighted events with neural net isolation < 1552
- Fit fractions with line
- Efficiency taken as fitted value with error equal to the error on the fit


CDF Preliminary
Efficiency
Pt (GeV/c)
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
10
20
30
40
50

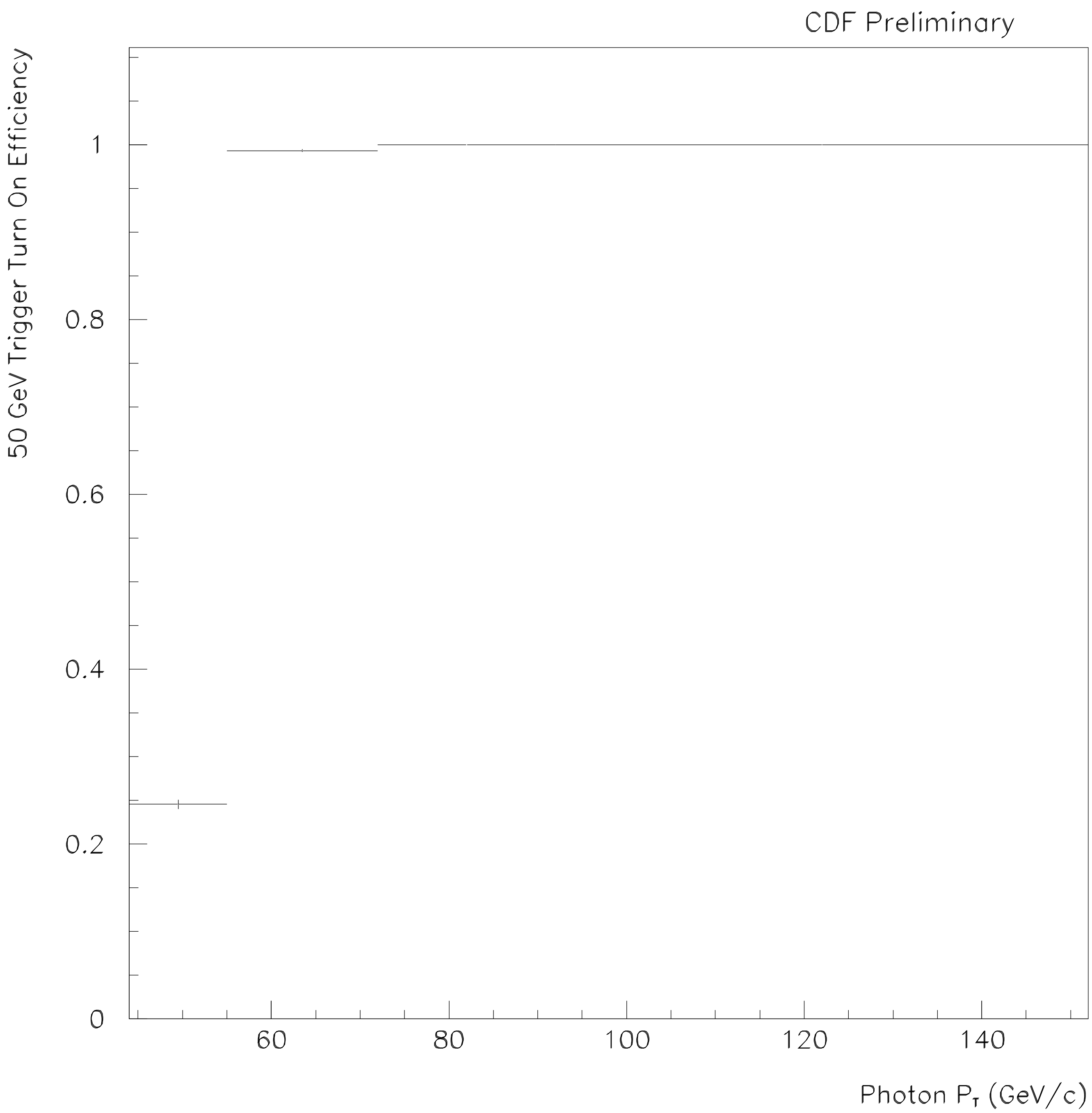
PHOB_CEM3_23_ISOL P_T Turn On and XCES

- Used 10 GeV isolated data sample from cross section
- Measured fraction that passed 23 GeV isolated trigger
- Not sure if it should be weighted or not
- Used weighted value but statistical error chosen has difference between weighted and unweighted value
- Should plateau at 1.00 but 23 GeV trigger has XCES requirement
- XCES efficiency 0.970 ± 0.006


CDF Preliminary
23 GeV Trigger Turn On Efficiency
Photon P_T (GeV/c)
0
0.2
0.4
0.6
0.8
1
25
30
35
40
45
50
55

PHOB_CEM5_50_NOISOL P_T Turn On

- Used 23 GeV isolated data sample from cross section
- Measured fraction that passed 50 GeV nonisolated trigger
- Statistical error on last 2 points really equal to 0.000



CDF Preliminary
50 GeV Trigger Turn On Efficiency
1
0.8
0.6
0.4
0.2
0
60
80
100
120
140
Photon P_T (GeV/c)

Final Trigger Efficiencies

P_T bin	P_T Turn On	Isolation	HAD/EM	XCES	Total
11-12 GeV	0.628±0.033	0.98±0.02	0.992±0.008		0.611±0.057
12-13 GeV	0.818±0.049	0.98±0.02	0.992±0.008		0.795±0.064
13-14 GeV	1.000±0.071	0.98±0.02	0.992±0.008		0.972±0.074
14-15 GeV	1.000±0.039	0.98±0.02	0.992±0.008		0.972±0.045
15-16 GeV	1.000±0.039	0.98±0.02	0.992±0.008		0.972±0.045
16-18 GeV	1.000±0.039	0.98±0.03	0.992±0.008		0.972±0.050
18-22 GeV	1.000±0.039	0.97±0.03	0.992±0.008		0.962±0.050
22-26 GeV	1.000±0.039	0.97±0.03	0.992±0.008		0.962±0.050
26-30 GeV	0.836±0.026	0.97±0.03	0.992±0.008	0.970±0.006	0.780±0.045
30-32 GeV	1.000±0.000	0.96±0.03	0.992±0.008	0.970±0.006	0.924±0.033
32-36 GeV	1.000±0.000	0.96±0.04	0.992±0.008	0.970±0.006	0.924±0.043
36-40 GeV	1.000±0.000	0.95±0.04	0.992±0.008	0.970±0.006	0.914±0.043
40-44 GeV	1.000±0.000	0.95±0.04	0.992±0.008	0.970±0.006	0.914±0.043
44-55 GeV	1.000±0.000	0.94±0.05	0.992±0.008	0.970±0.006	0.904±0.054
55-72 GeV	0.995±0.001		0.992±0.008		0.987±0.008
72-92 GeV	1.000±0.000		0.992±0.008		0.992±0.008
92-152 GeV	1.000±0.000		0.992±0.008		0.992±0.008

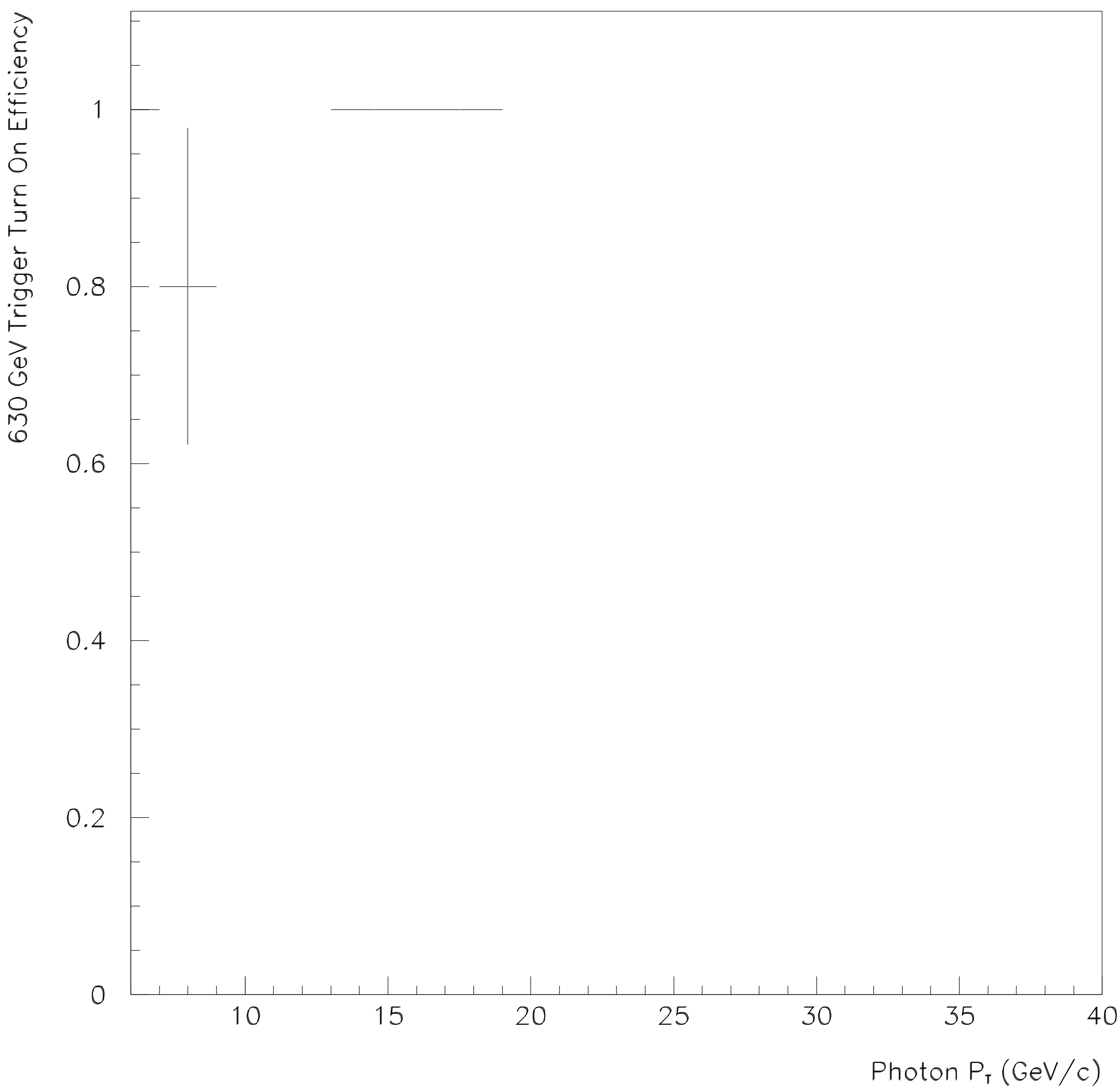
630 GeV Trigger Efficiencies

PHOB_CEM4_6_ISOL

- Used above 9 GeV
- Fiducial CES cluster
- Level 2 and 3 EM cluster with $E_T > 6$ GeV (with HAD/EM cut)
- Neural net isolation < 1552
- Used same methods as in the 1b analysis
- Check if 1b efficiencies can be applied to the 630 GeV data

PHOB_CEM4_6_ISOL

- P_T turn on
  - Used 5 GeV Level 3 electron data sample (ELEB_CEM_5*)
  - Problem with very low statistics
  - Apply 1b efficiencies starting 3 GeV above trigger threshold (13 GeV bin)
- Isolation
  - Used 6 GeV non-isolated photon events (PHOB_CEM2_6_NOISOL)
  - Again had problem of low statistics
  - Could not measure isolation efficiency bin by bin
  - 98% of unweighted (96% of weighted) events passed isolation cut
  - Consistent with 1b measurement 98 $\pm 2\%$ at low P_T
  - Apply 1b efficiencies


630 GeV Trigger Turn On Efficiency
1
0.8
0.6
0.4
0.2
0
10
15
20
25
30
35
40
Photon P_T (GeV/c)

Final 630 Trigger Efficiencies

P_T bin	**P_T Turn On**	**Isolation**	**HAD/EM**	**Total**
9-11 GeV	**1.000±0.071**	**0.98±0.02**	**0.992±0.008**	**0.972±0.074**
11-13 GeV	**1.000±0.039**	**0.98±0.02**	**0.992±0.008**	**0.972±0.045**
13-16 GeV	**1.000±0.039**	**0.98±0.02**	**0.992±0.008**	**0.972±0.045**
16-19 GeV	**1.000±0.039**	**0.98±0.03**	**0.992±0.008**	**0.972±0.050**
19-23 GeV	**1.000±0.039**	**0.97±0.03**	**0.992±0.008**	**0.962±0.050**
23-29 GeV	**1.000±0.039**	**0.97±0.03**	**0.992±0.008**	**0.962±0.050**
29-30 GeV	**1.000±0.039**	**0.96±0.04**	**0.992±0.008**	**0.952±0.058**