OXFORD 20-MARCH-99

TOP QUARK WORKING GROUP

$t\bar{t}$ THRESHOLD SIMULATION

DANIEL PERALTA
UNIVERSITAT DE BARCELONA

MOTIVATION FOR THRESHOLD STUDIES

INTERESTS

- m_t FROM THE POSITION OF THRESHOLD
- α_s FROM THE EFFECT OF QCD POTENTIAL
- MAYBE Γ_t, λ_t

MEASUREMENTS

- $\sigma(s) \Rightarrow m_t, \alpha_s, \Gamma_t, \lambda_t$
- $d\sigma/dp \Rightarrow m_t, \alpha_s, \Gamma_t$ (FROM FERMI MOTION)
- $A_{FB} \Rightarrow m_t, \alpha_s, \Gamma_t$ (FROM S-P INTERFERENCE)

- IN THIS PRESENTATION WE WILL CONCENTRATE ON $\sigma(s)$ MEASUREMENT AND m_t, α_s ESTIMATIONS IN VIEW OF NEW MASS DEFINITIONS AND NEW NNLO COMPUTATION.

THEORY

$\sigma_{t\bar{t}}$ CALCULATION

- TOPPIK : CALCULATION OF THE GREEN FUNCTION IN MOMENTUM SPACE BY SOLVING THE LIPPMANN - SCHWINGER EQUATION
  (A.H. HOANG , M. JEZABEK , T. TEUBNER)

- THREE ORDERS FOR THE QCD POTENTIAL

  LO → $O(1)$
  NLO → $O(\alpha_s)$, $O(v)$
  NNLO → $O(\alpha_s^2)$, $O(v \cdot \alpha_s)$, $O(v^2)$

- THREE MASS DEFINITIONS

  POL MASS
  1S MASS (HOANG)
  POTENTIAL SUBSTRACTED MASS (BENEKE)

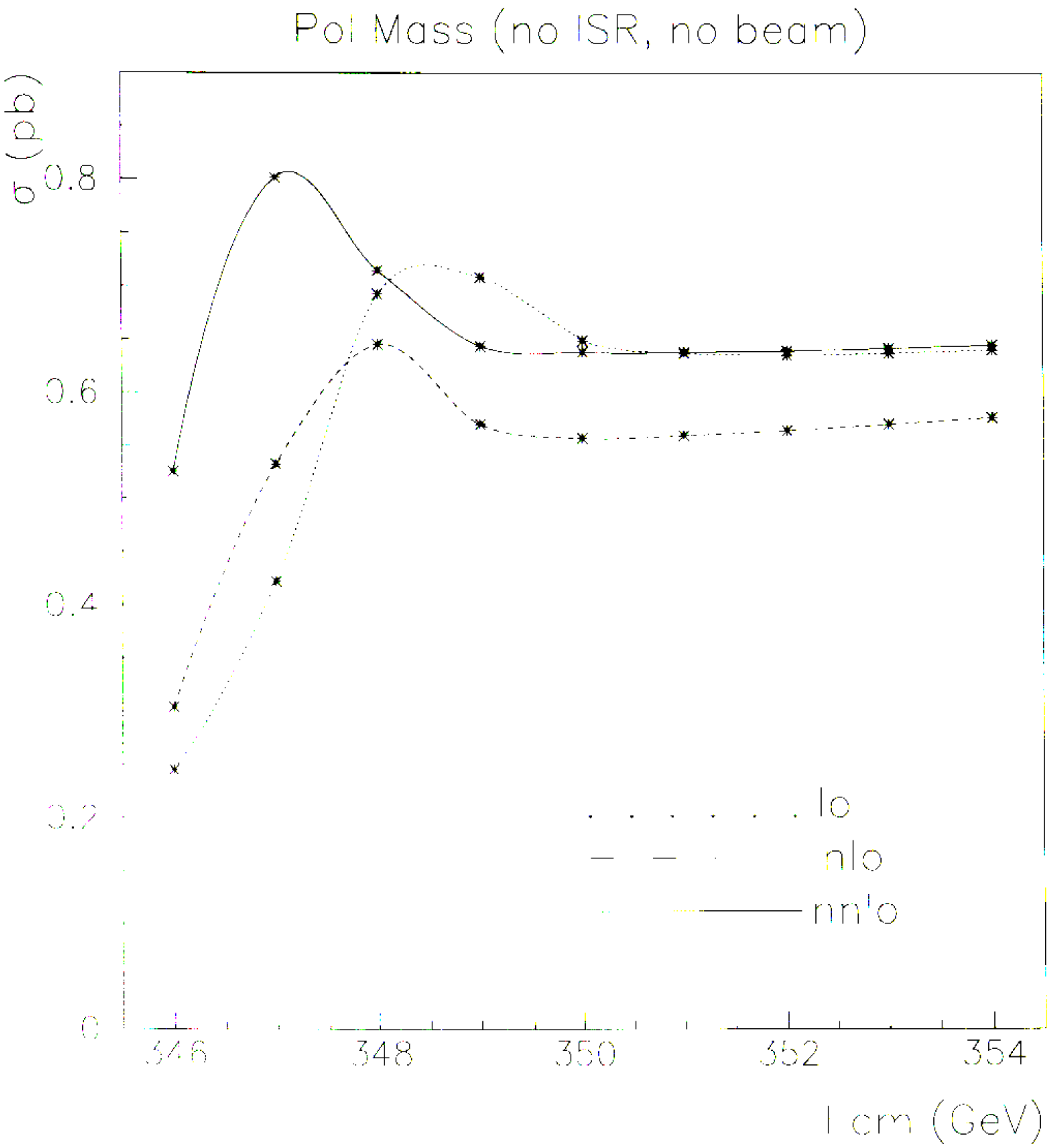
- UP TO NOW POL MASS USED

PROBLEMS: - DEPENDENCE BETWEEN PEAK POSITION AND LO / NLO / NNLO

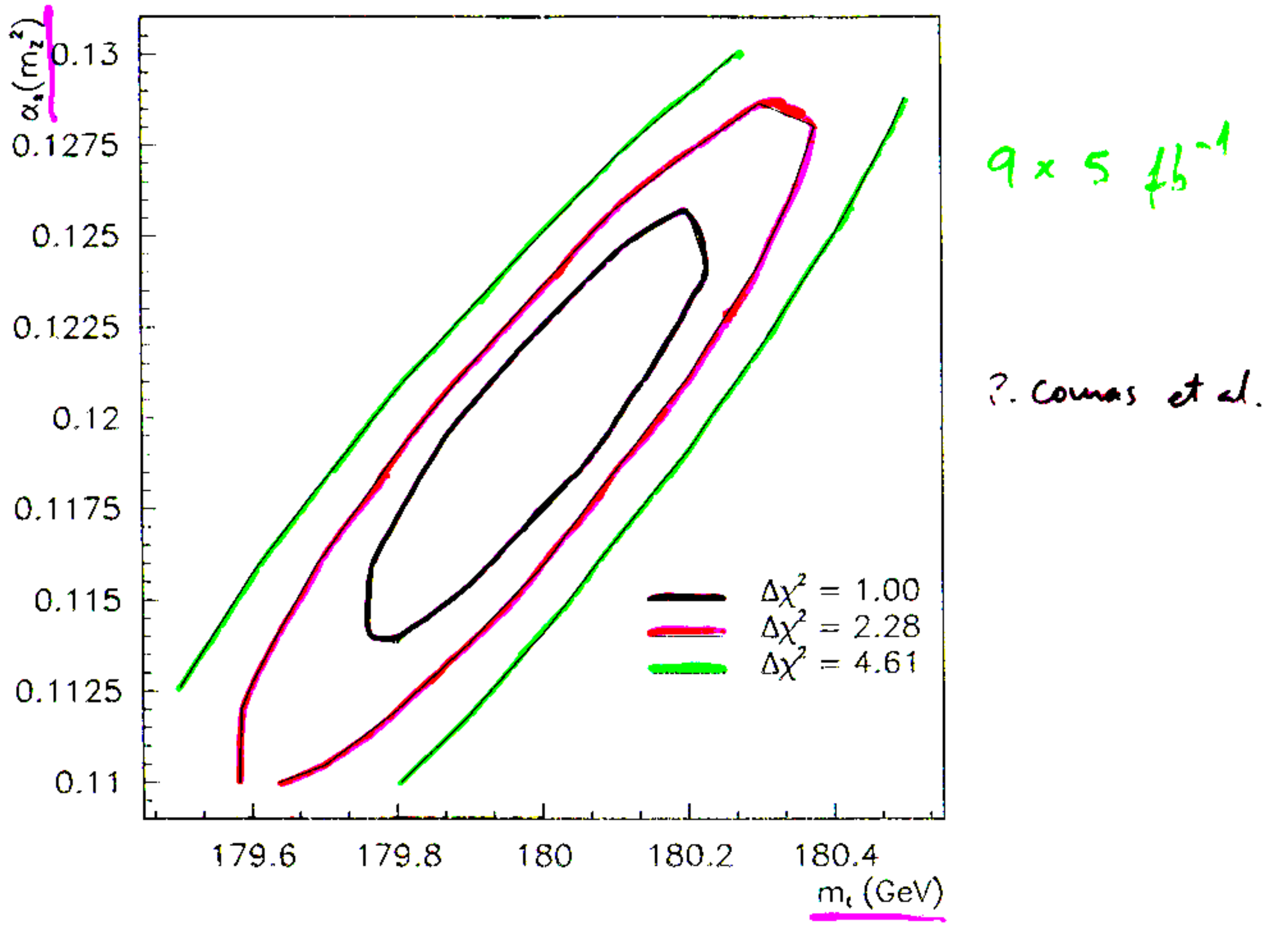
- LARGE CORRELATION BETWEEN m_t AND α_s (RAMON MIQUEL 95)

m_t = 175 GeV

α_s = 0.120



- CORRELATION $m_t - \alpha_s$



σ ONLY

- FOR ONE-PARAMETER FIT

Δm_t = 120 MeV (α_s = 0.12 FIXED)

$\Delta \alpha_s$ = 0.0025 (m_t = 180 GeV FIXED)

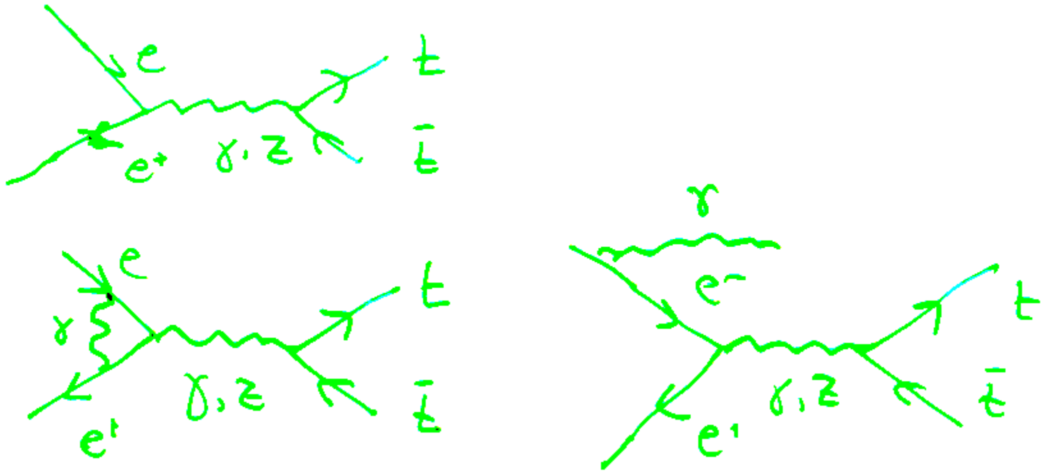
- FOR TWO-PARAMETER FIT

Δm_t = 250 MeV

$\Delta \alpha_s$ = 0.006

DISTURBING EFFECTS → ENERGY?

ISR INITIAL STATE RADIATION



ACCELERATOR EFFECTS

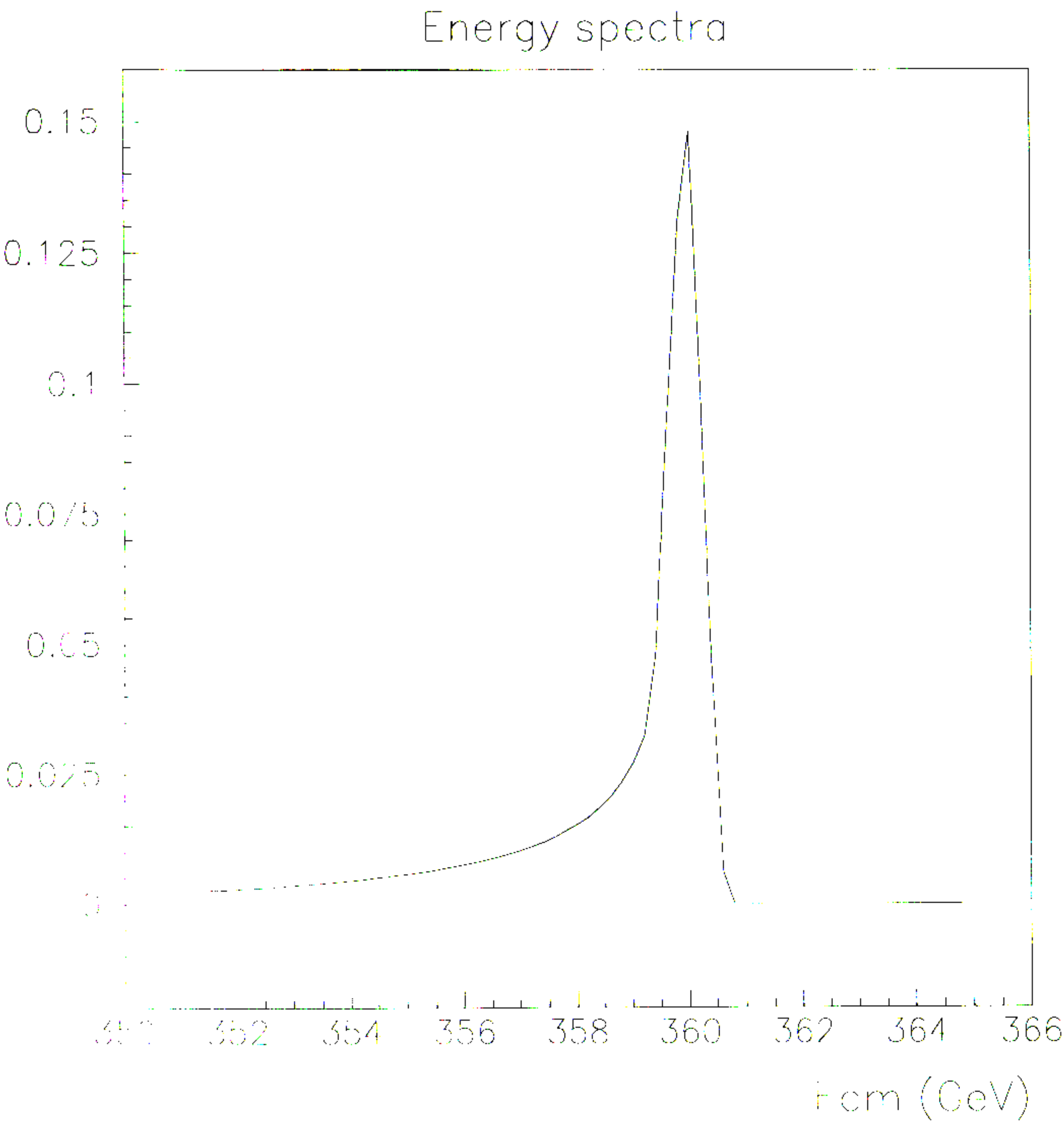
BEAMSTRAHLUNG AND LINAC ENERGY SPREAD CAUSE A BIG SPREAD IN $\sqrt{s_{eff}}$

↳ DISTORTIONS IN THRESHOLD STRUCTURE IS WASHED OUT LOSS OF USEFUL $\mathcal{L}$ } DECREASED SENSITIVITY

- WE NEED SMALLEST POSSIBLE AMOUNT OF BEAMSTRAHLUNG AND LINAC BEAM ENERGY SPREAD

- WE NEED EXCELLENT CONTROL ($\lesssim 0.1\%$) OF $d\mathcal{L}/d\sqrt{s}$ FROM DATA

TESLA 1998



Energy spectra
0.15
0.125
0.1
0.075
0.05
0.025
0
352
354
356
358
360
362
364
366
Ecm (GeV)

RESULTS FOR σ_{ee} COMPUTATION

- STABLE PEAK POSITION WITH NEW MASS DEFINITIONS.

  → SYSTEMATIC ERROR WILL BE HIGHLY REDUCED. BUT NOT COMPUTED

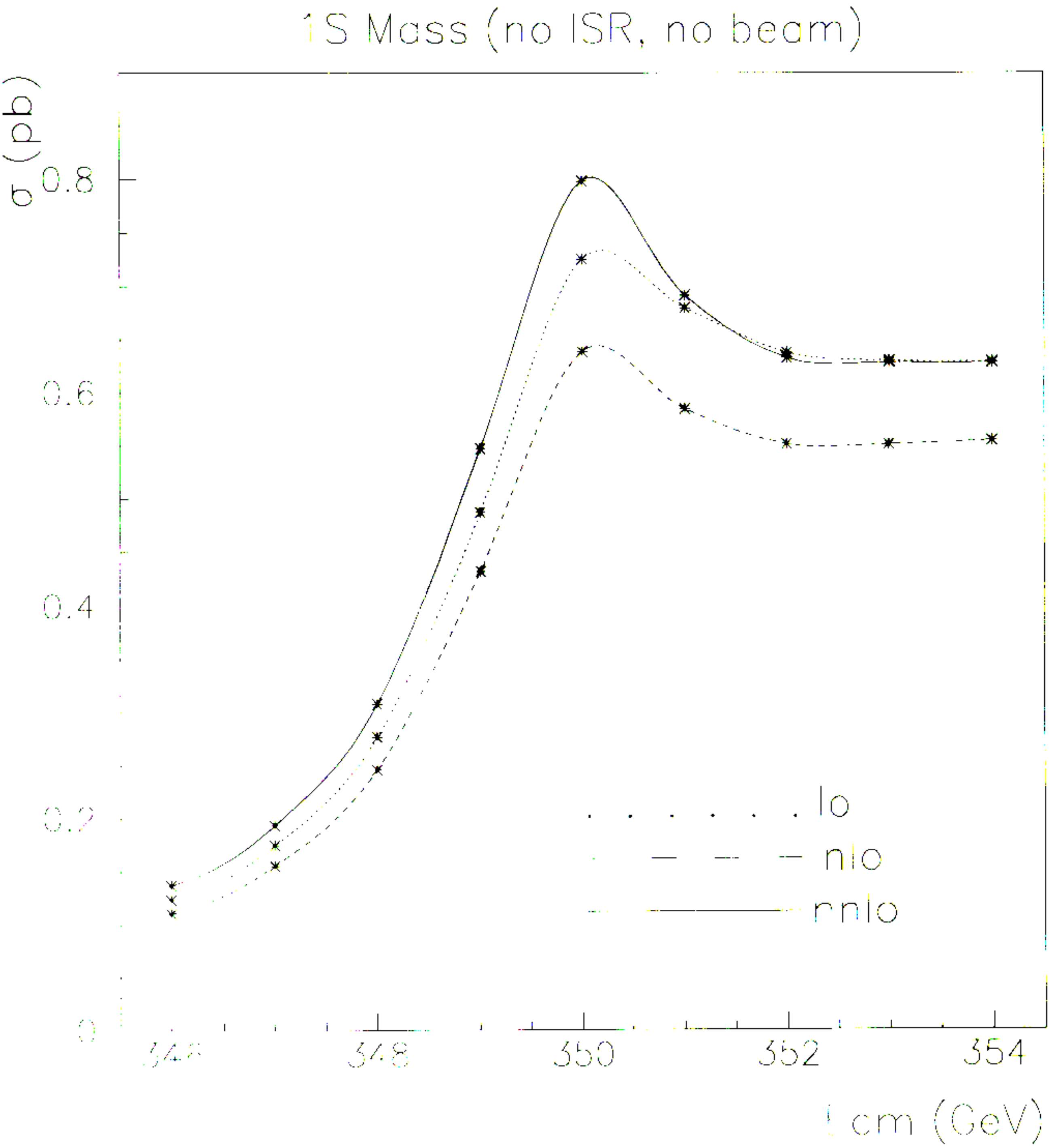
- ISR AND BEAM EFFECTS DECREASE SENSITIVITY

  → IMPROVED CONDITIONS SINCE 95

EVERYWHERE $\mu = 25$ GeV

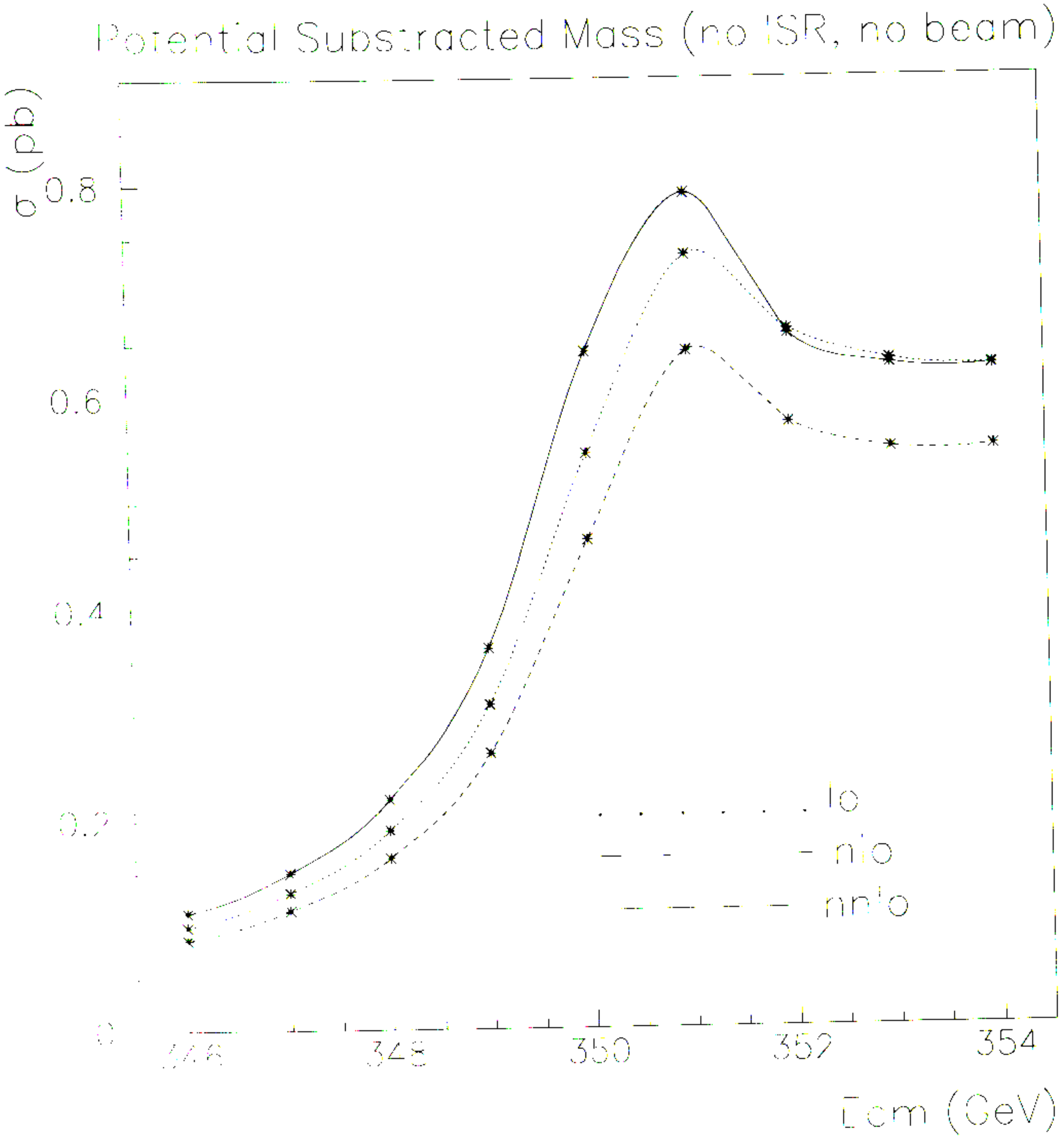
$m_t = 175$ GeV

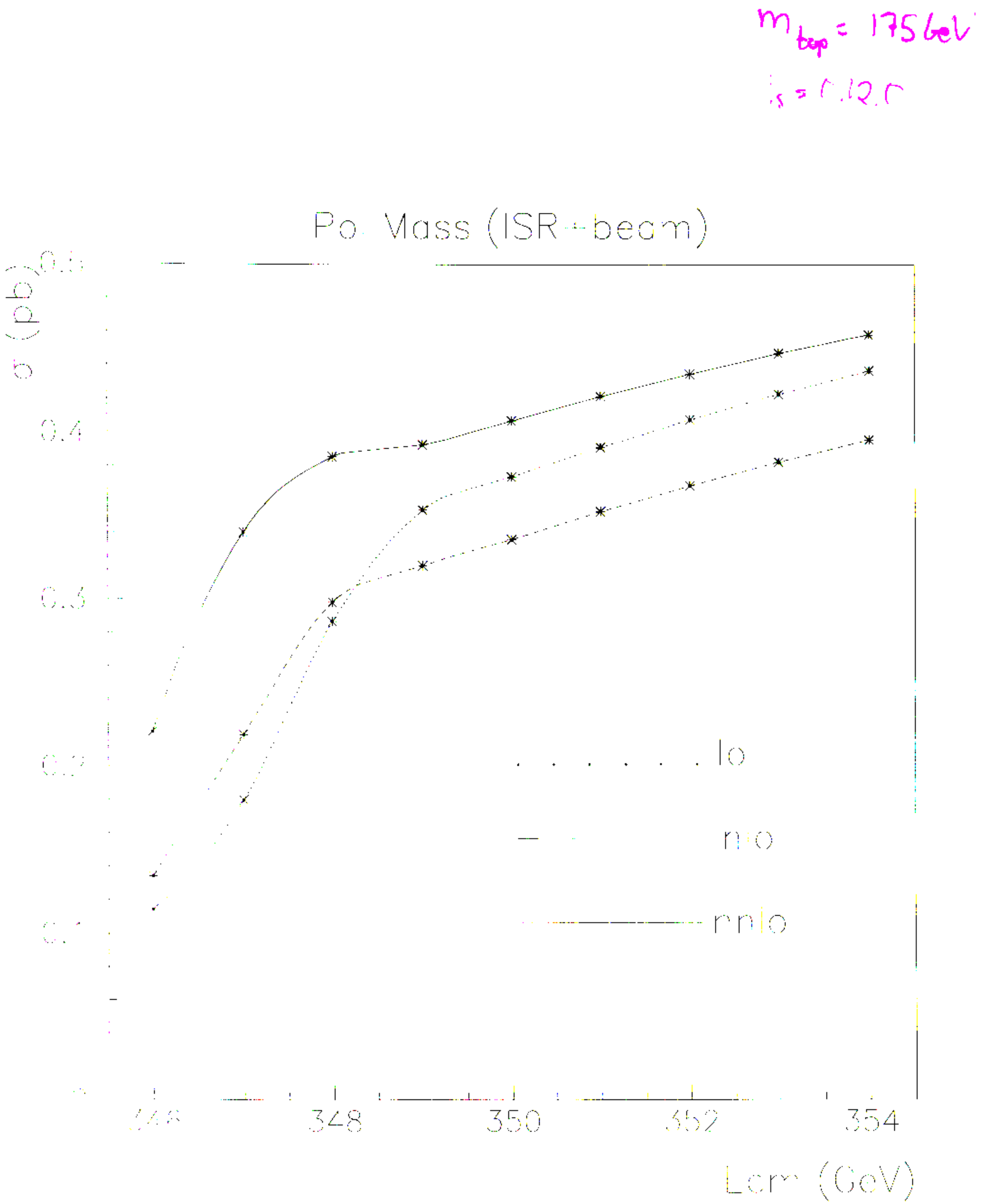
$\alpha_s = 0.120$



$m_t = 175$ GeV

$\alpha_s = 0.120$

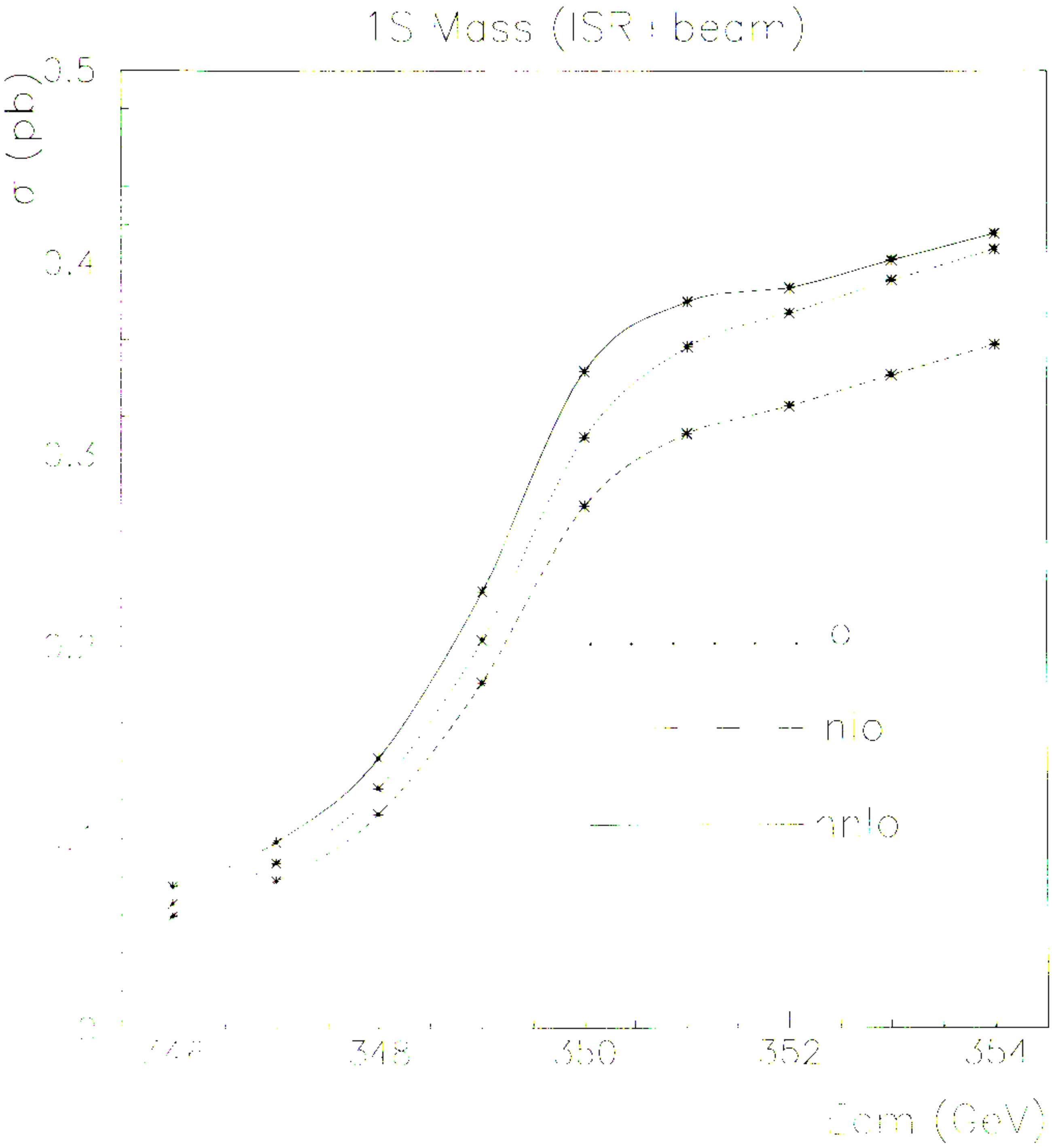


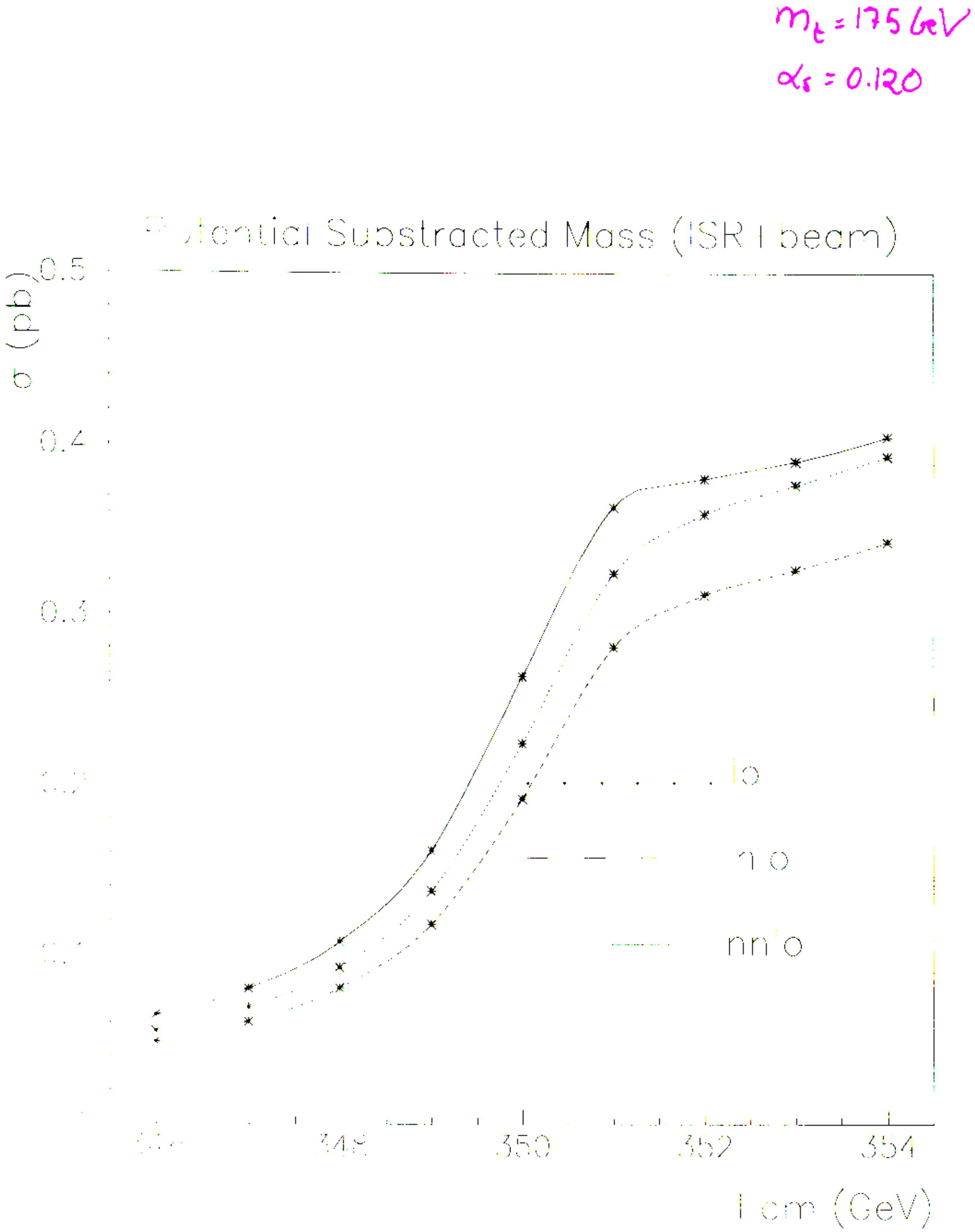


m top = 175 GeV
αs = 0.120
Po. Mass (ISR+beam)
σ (pb)
0.5
0.4
0.3
0.2
0.1
348
350
352
354
Ecm (GeV)
lo
nlo
nnlo

$m_t = 175$ GeV

$\alpha_s = 0.120$

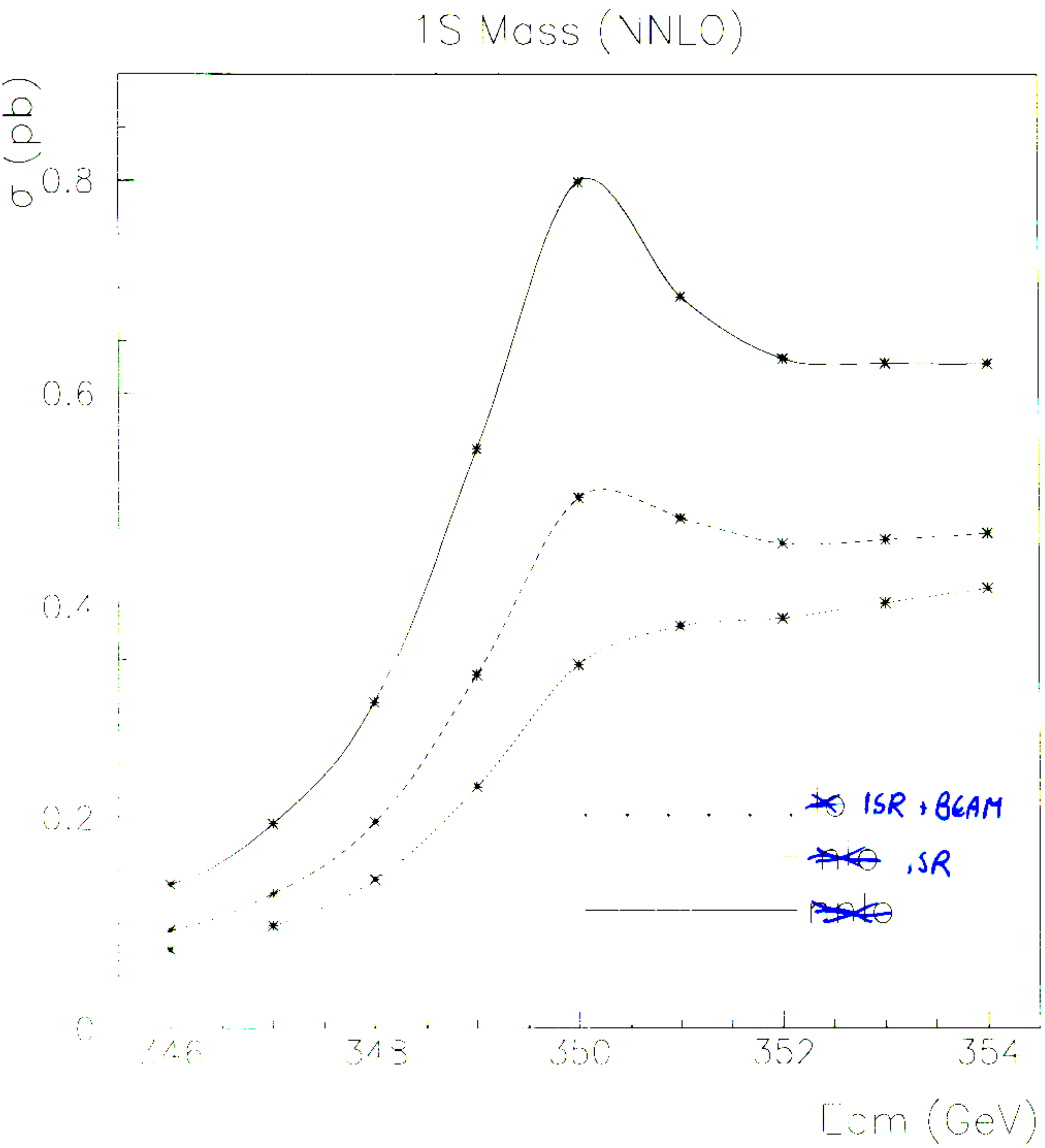




$m_t = 175$ GeV
$\alpha_s = 0.120$
Potential Substracted Mass (ISR+beam)
σ (pb)
0.5
0.4
0.3
lo
nlo
nnlo
348
350
352
354
Ecm (GeV)

$m_t = 175$ GeV

$\alpha_s = 0.120$



CROSS SECTION MEASUREMENT

- EVENT SELECTION (AURELIO JUSTE)

  - 6 JETS (44%) OR 5 + $\not{E}$ (44%)
  - SPHERICAL EVENT
  - 2 W MASS CONSTRAINTS
  - 2 TOP MASS CONSTRAINTS

EFFICIENCY IN SELECTION 41.4%

BACKGROUD CROSS SECTION 0.0084 pb → $S/B \sim 4$

SYSTEMATIC ERROR IN SELECTION AND/OR LUMINOSITY 3%

FIT RESULTS

- TAKE 100 fb^{-1}: 9 POINTS SCAN + 1 POINT BELOW TO MEASURE BACKGROUND

- FIT DATA WITH THEORY

  SHOWN CASE:

  DATA = THEORETICAL EXPECTATION FOR $m_t = 175$ GeV AND $\alpha_s = 0.120$ WITH ERRORS AS COMING FROM EXPERIMENT

  THEORY = $\sigma_{t\bar{t}}$ COMPUTED FOR MANY m_t AND α_s

- RESULTS

- FOR 1S MASS DEFINITION WE GET

  $m_t = 175.00 \pm 0.04$ GeV

  $\alpha_s = 0.120 \pm 0.002$

  → $\Delta(m_t) = 40$ MeV $\Delta(\alpha_s) = 0.002$

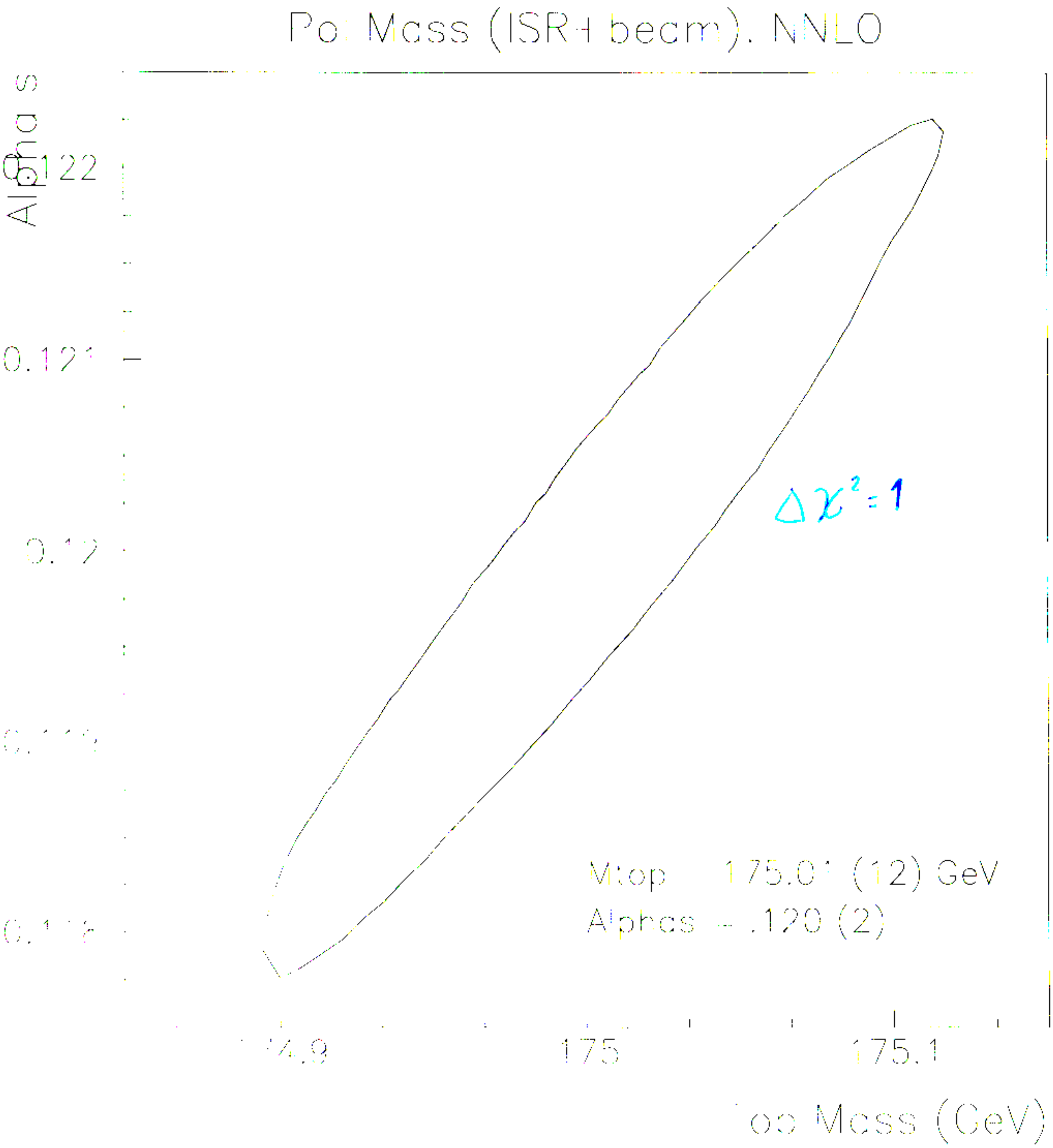
  THEORETICAL SYSTEMATIC ERRORS NOT INCLUDED

- CORRELATION BETWEEN m_t AND α_s MUCH SMALLER WITH 1S MASS DEFINITION THAN POL MASS.

  $\rho_{POL} = 0.966$ $\rho_{1S} = 0.629$

$m_t = 175$ GeV

$\alpha_s = 0.120$



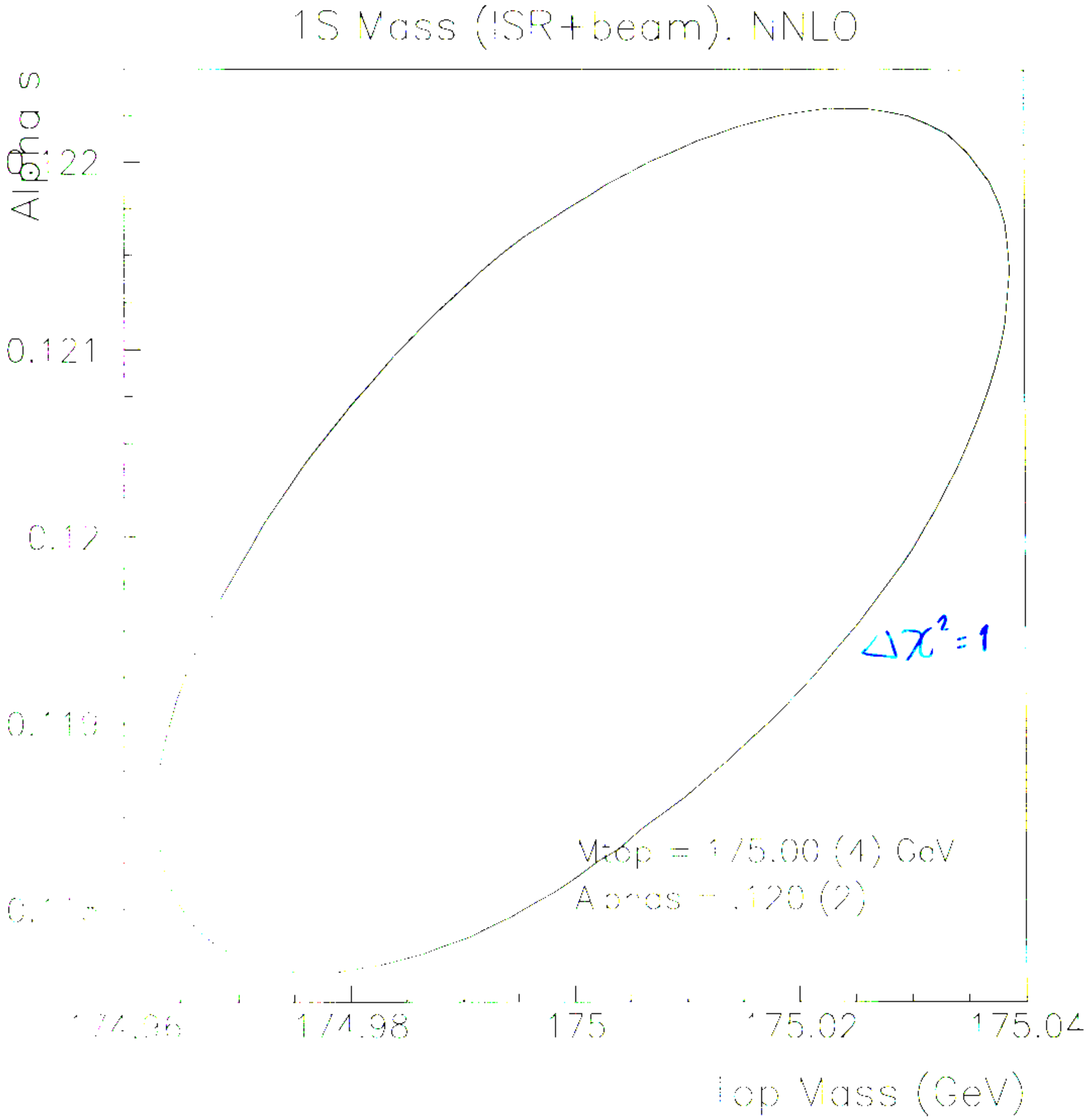
$m_t = 175.01 \pm .12$ GeV

$\alpha_s = 0.120 \pm 0.002$

$\rho = 0.966$

$m_t = 175$ GeV

$\alpha_s = 0.120$



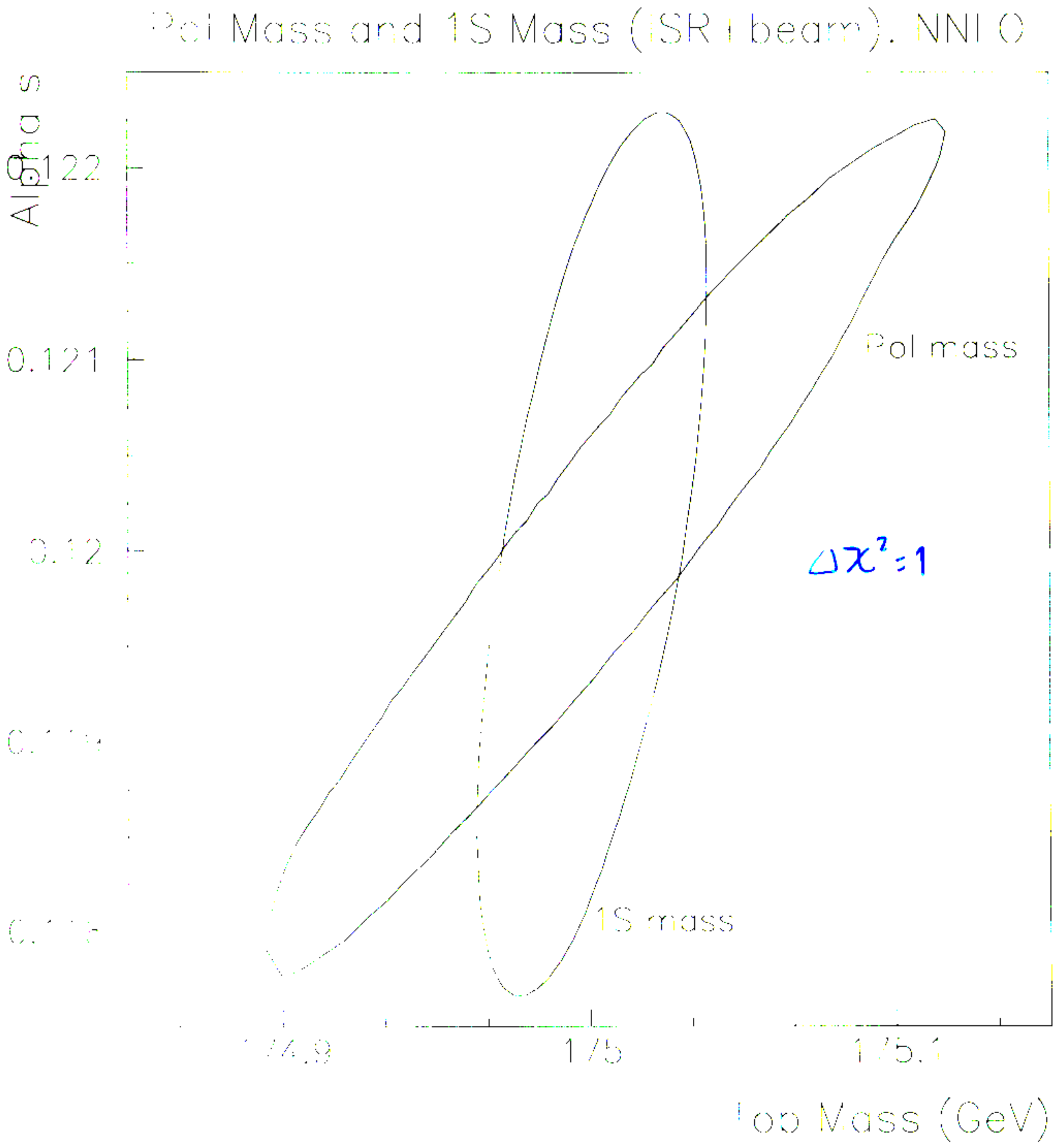
$m_t = 175.00 \pm 0.04$ GeV

$\alpha_s = 0.120 \pm 0.002$

$\rho = 0.629$

$m_t = 175$ GeV

$\alpha_s = 0.120$



$\rho_{POL} = 0.966 \rightarrow \rho_{1S} = 0.629$

CONCLUSIONS

- FOR 1S MASS AND POTENTIAL SUBSTRACTED MASS PEAK POSITION NOT DEPENDS STRONGLY ON THE ORDER $\sigma_{t\bar{t}}$ IS COMPUTED

- FOR 1S MASS CORRELATION BETWEEN m_t AND α_s IN $\sigma_{t\bar{t}}$ MEASUREMENT IS SMALLER 0.966 → 0.629

- WITH 100 fb^{-1} + PRESENTED EXPERIMENTAL AND BEAM CONDITIONS + CURRENT THEORY STATUS WE GET RESOLUTION IN m_t AND α_s WHEN MEASURING $\sigma_{t\bar{t}}$ NEAR THRESHOLD:

$$\Delta m_t = 40\ \text{MeV}$$

$$\Delta \alpha_s = 0.002$$