

DIRECT SEARCH FOR NEW PHYSICS AT TLEP

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TLEP MEETING@CERN

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LIGHT ELECTROWEAK STATES

**LINKED TO EWSB
AND ITS HIERARCHY PROBLEM**

ARE HARD TO FIND AT A HADRON MACHINE

YET WELL MOTIVATED

**CLUES TO STABILIZATION OF THE EW SCALE
AND DARK MATTER ORIGIN**

**DIRECT PRODUCTION AT
LEPTON MACHINE**

**TLEP CAN SEARCH FOR NEW PHYSICS
WHICH WOULD EVADE LHC**

LIGHT, ELECTROWEAK STATES

EX. SLEPTONS, NEUTRALINOS

COMPRESSED SCENARIOS

EX. PSEUDO-DIRAC DM, STEALTH SUSY

LEPTOPHILIC (COLOR-PHOBIC) SCENARIOS

EX. DM COUPLED TO LEPTONS

**HIDDEN SECTORS W/ EW VECTOR BOSON
MEDIATION**

**EX. DARK FORCES, KINETIC MIXING, AXION/
Z' MEDIATORS**

... AND MANY MORE

DIRECT PRODUCTION OF NEW PHYSICS

IN THIS TALK

SUSY DARK MATTER

NEW FORCES

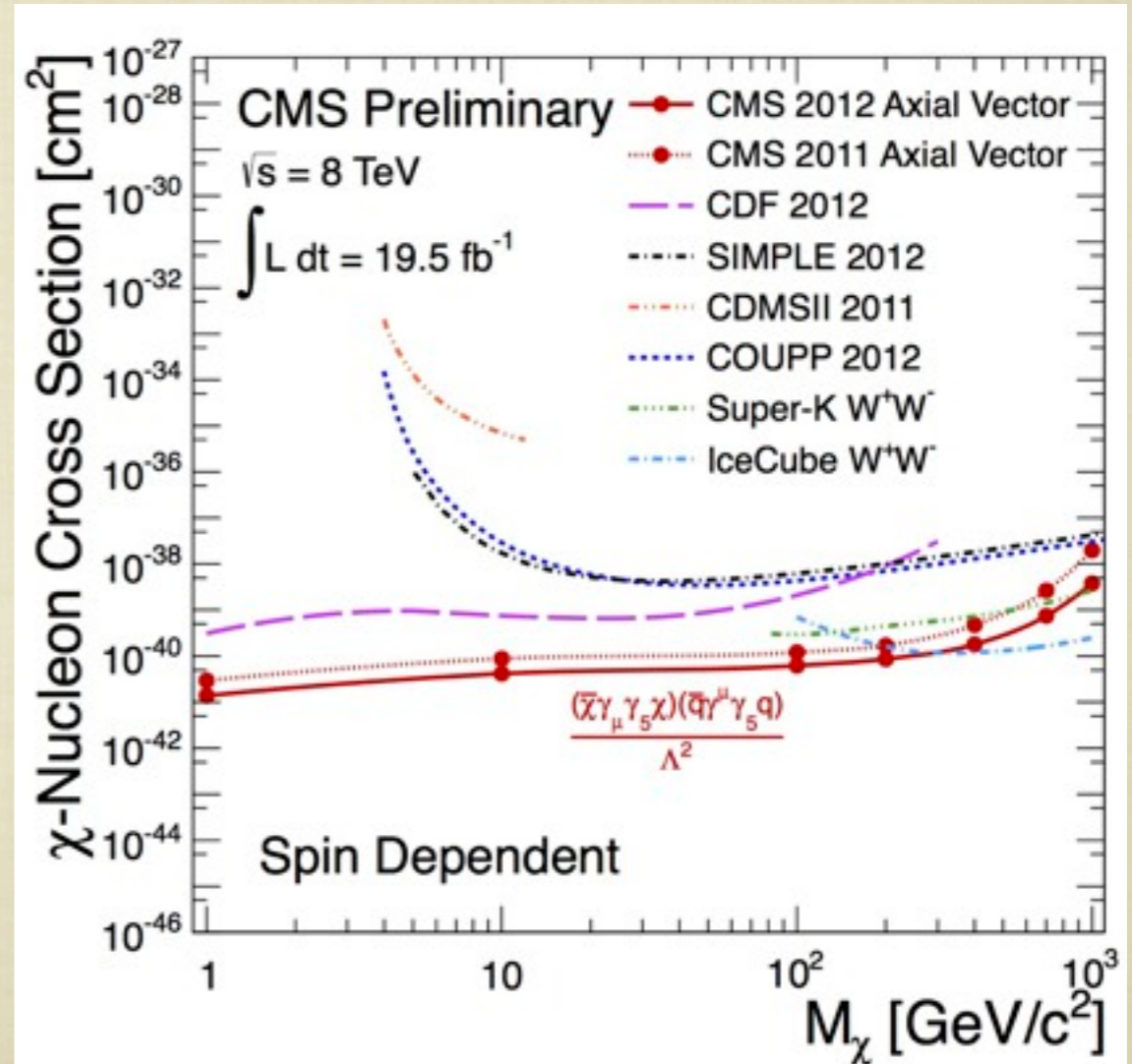
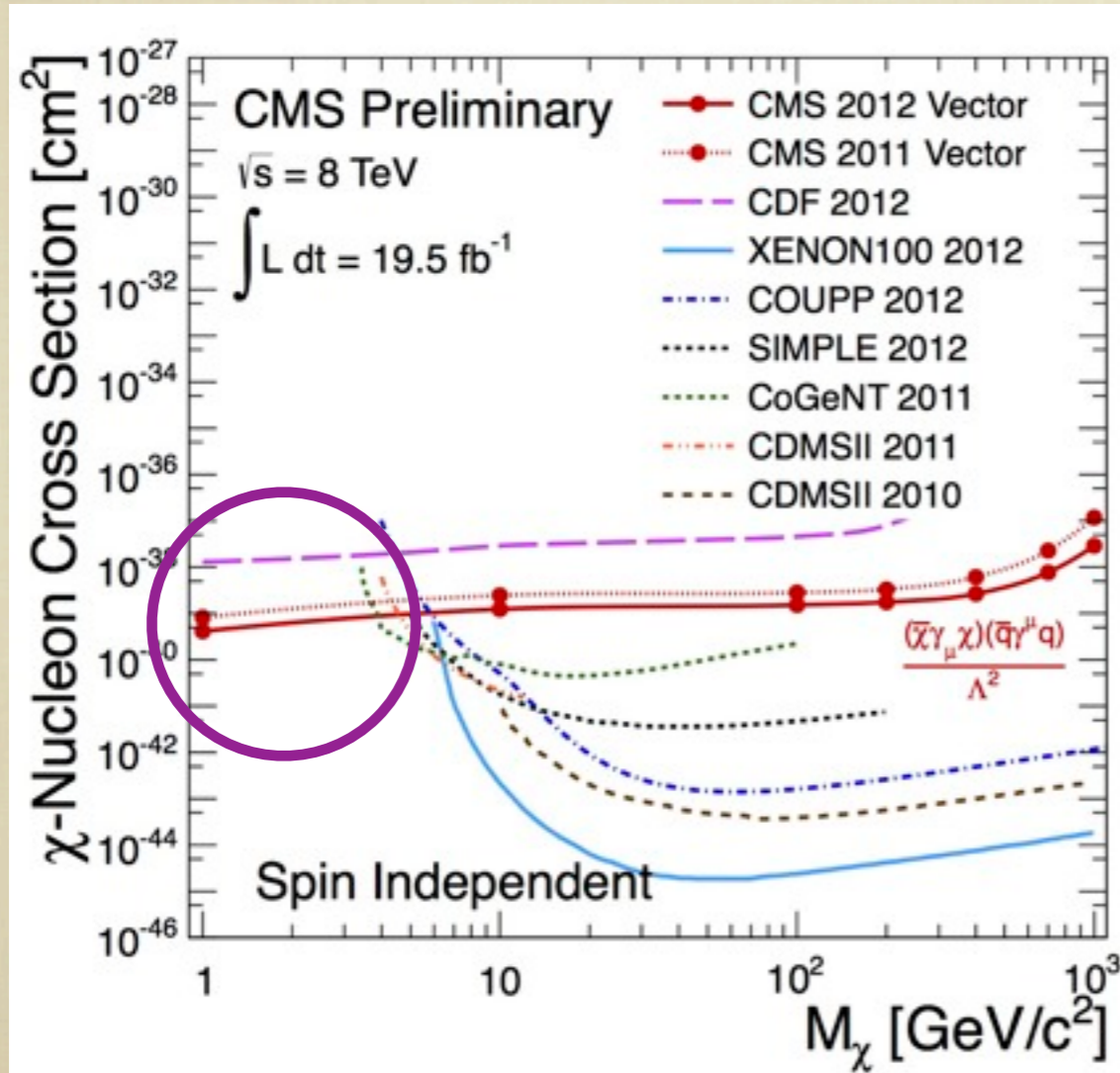
COMPRESSED SPECTRA

**IDEAS, WORK IN
PROGRESS**

INVISIBLES: DARK MATTER

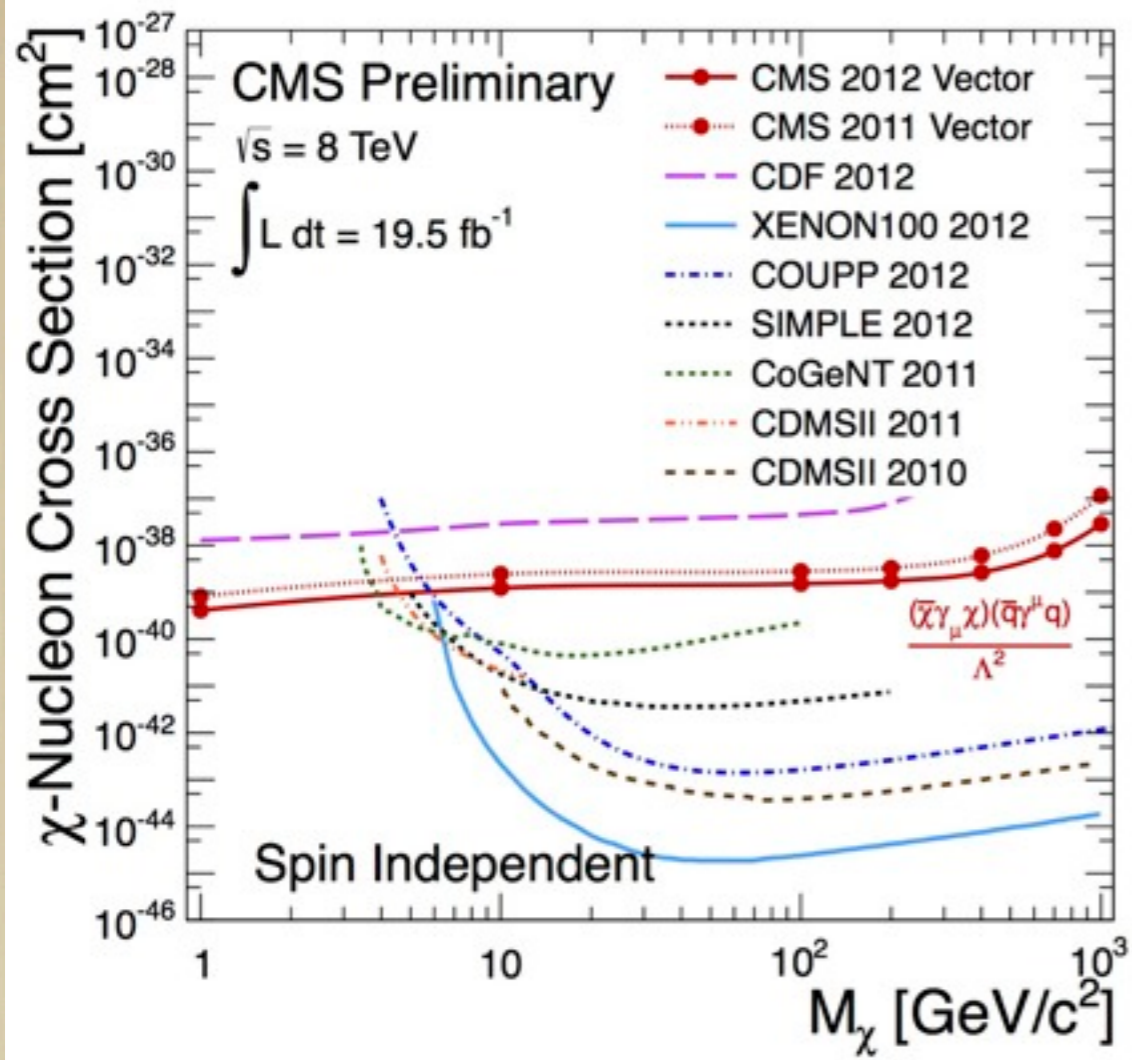
LIGHT DARK MATTER COULD EVADE THE
BUSY ENVIRONMENT OF THE LHC

WHAT ABOUT MONOPHOTON/MONOJET ???



OBVIOUSLY, RELIES OF
COUPLING TO COLOURED
PARTICLES

BUT ON TOP OF THAT...

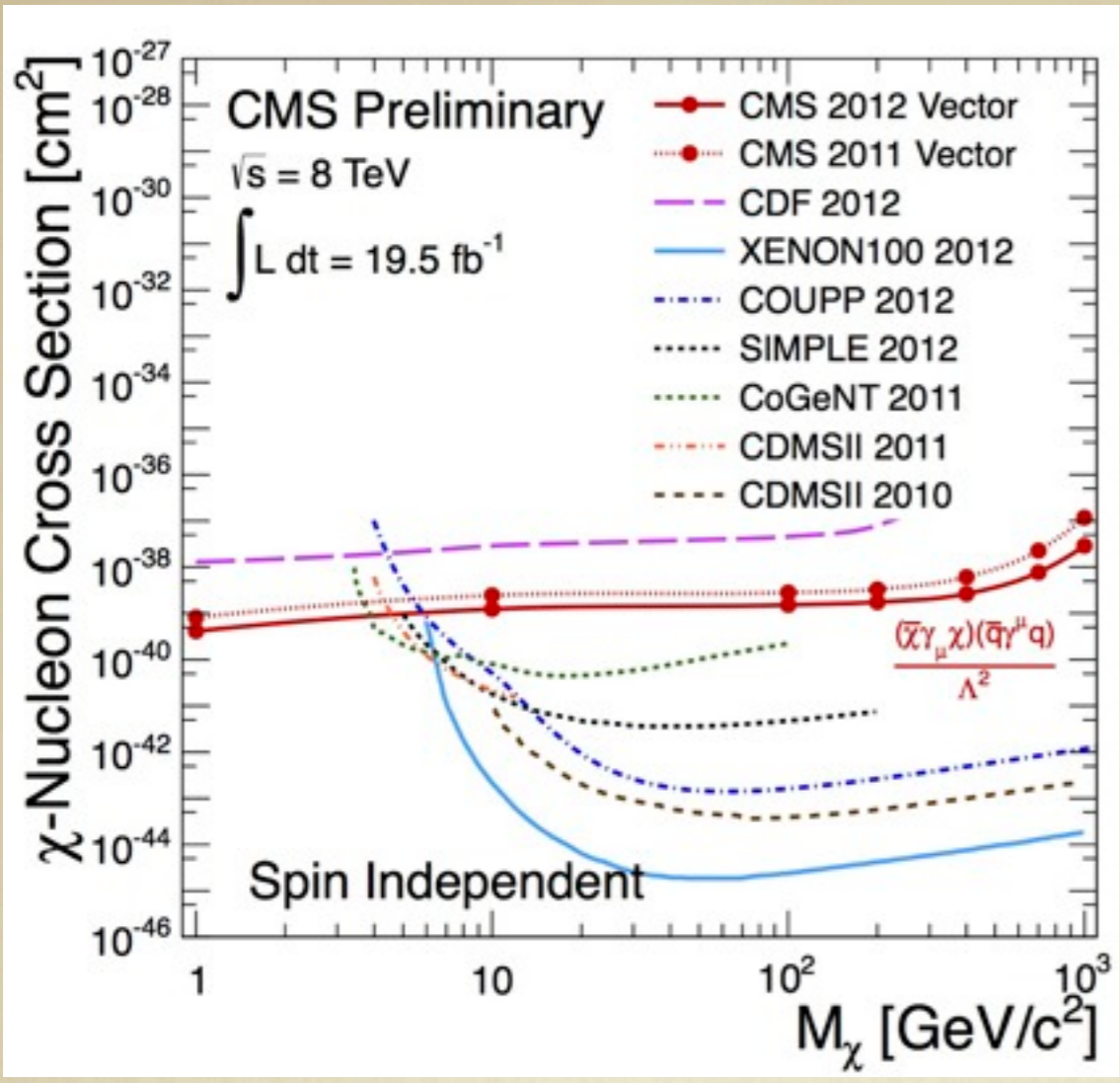


BASED ON **EFT**
AND THIS **PARADIGM**



EFT VALID AT LHC IF

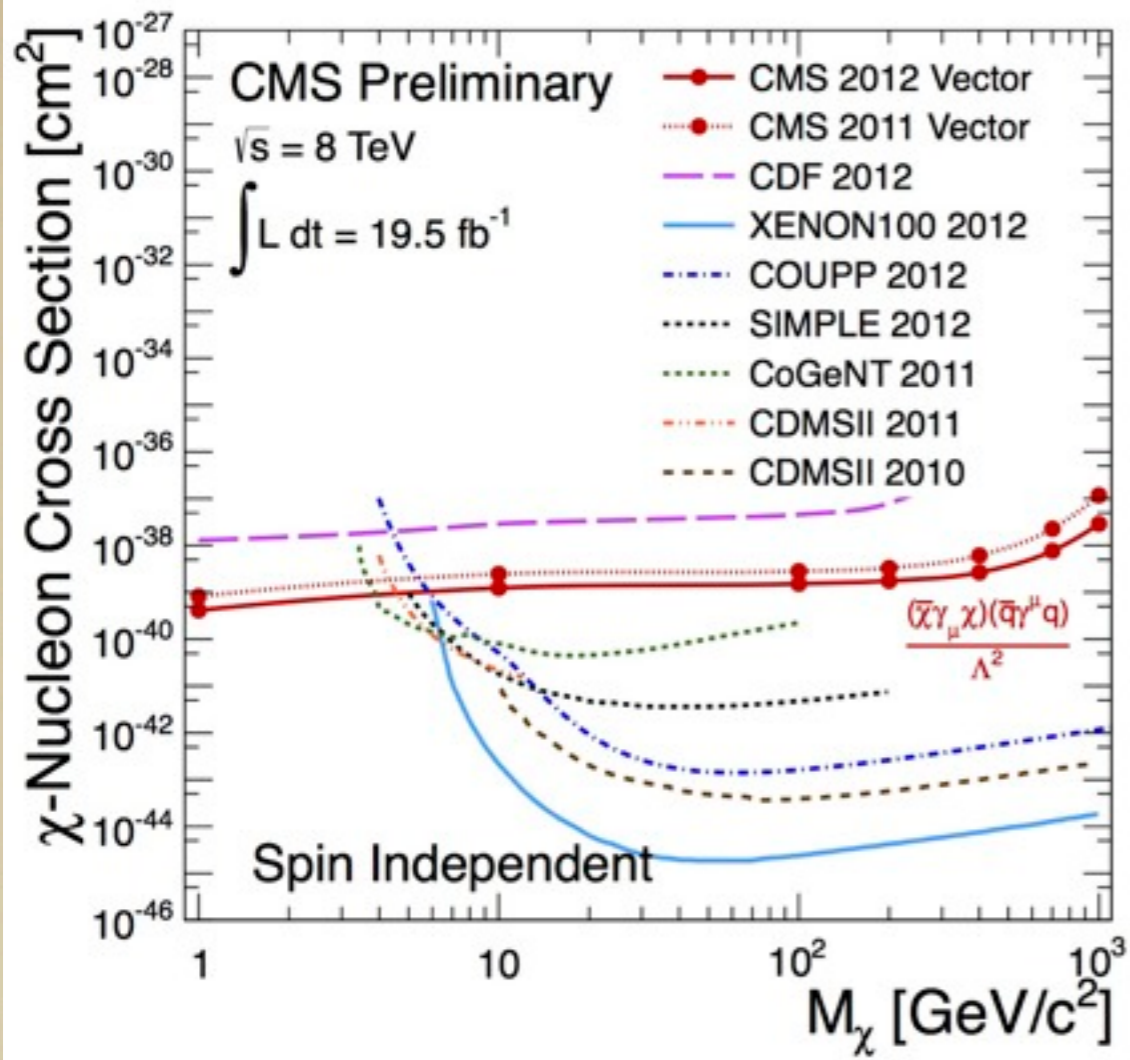
$$M \geq 5 \text{ TeV} \ \& \ g_{\chi,f} \geq 5$$



**LIGHT MEDIATORS:
SOFTER MET**

**ISSUES WITH
PERTURBATIVITY AND
RELIC ABUNDANCE**

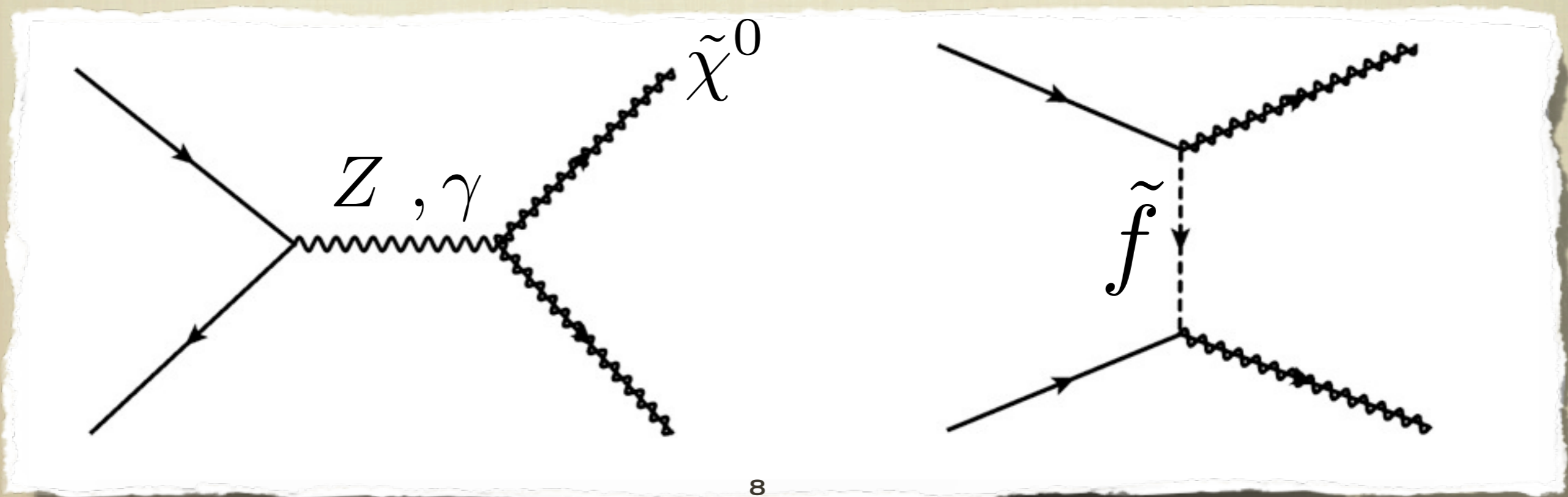
EX. BUCHMUELLER ET AL.
1308.6799



THE SECLUDED PARADIGM



ISN'T SUPERSYMMETRY,
 OR ANY THEORY
 DM COUPLES DIRECTLY TO THE
 SM

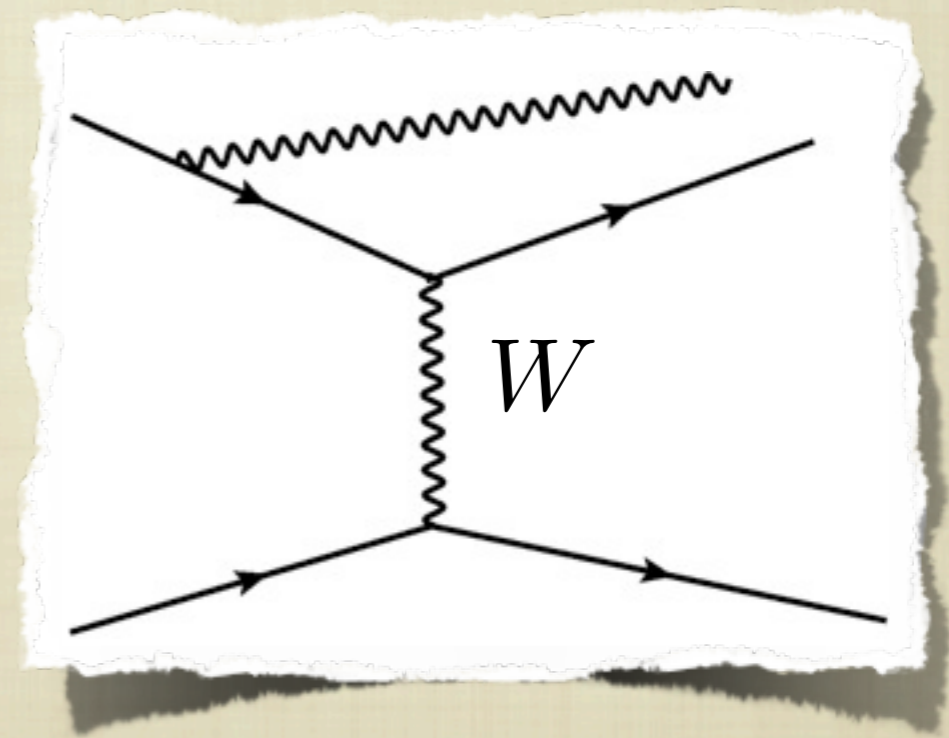
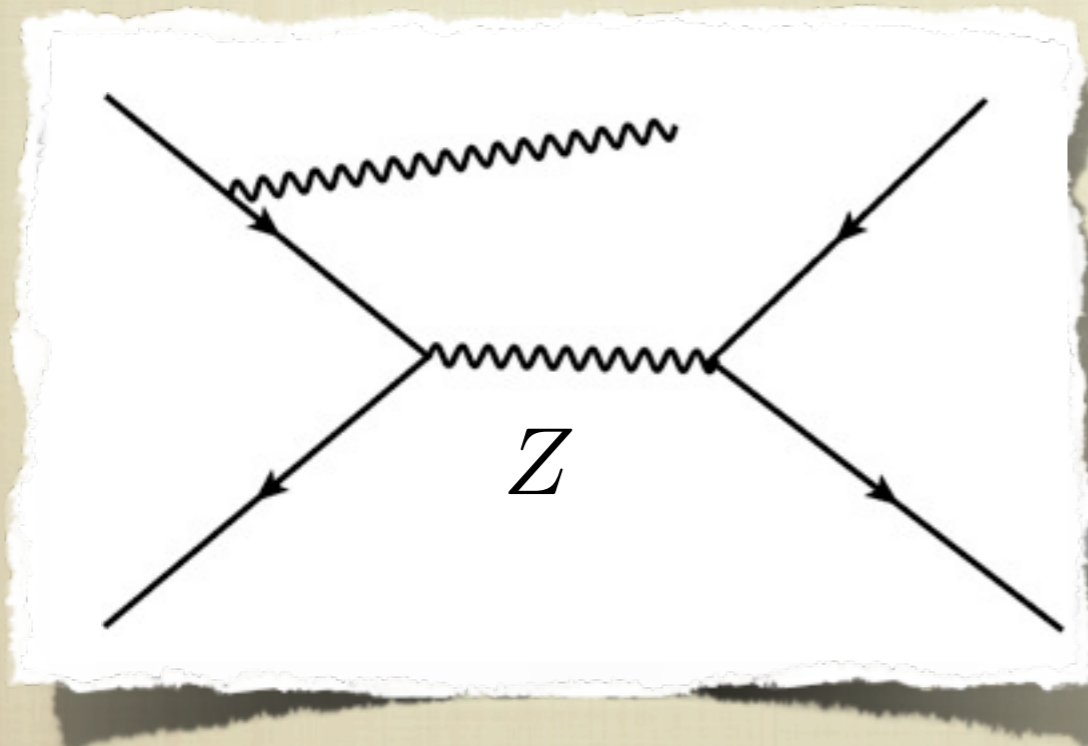


SEARCHES FOR LIGHT DM

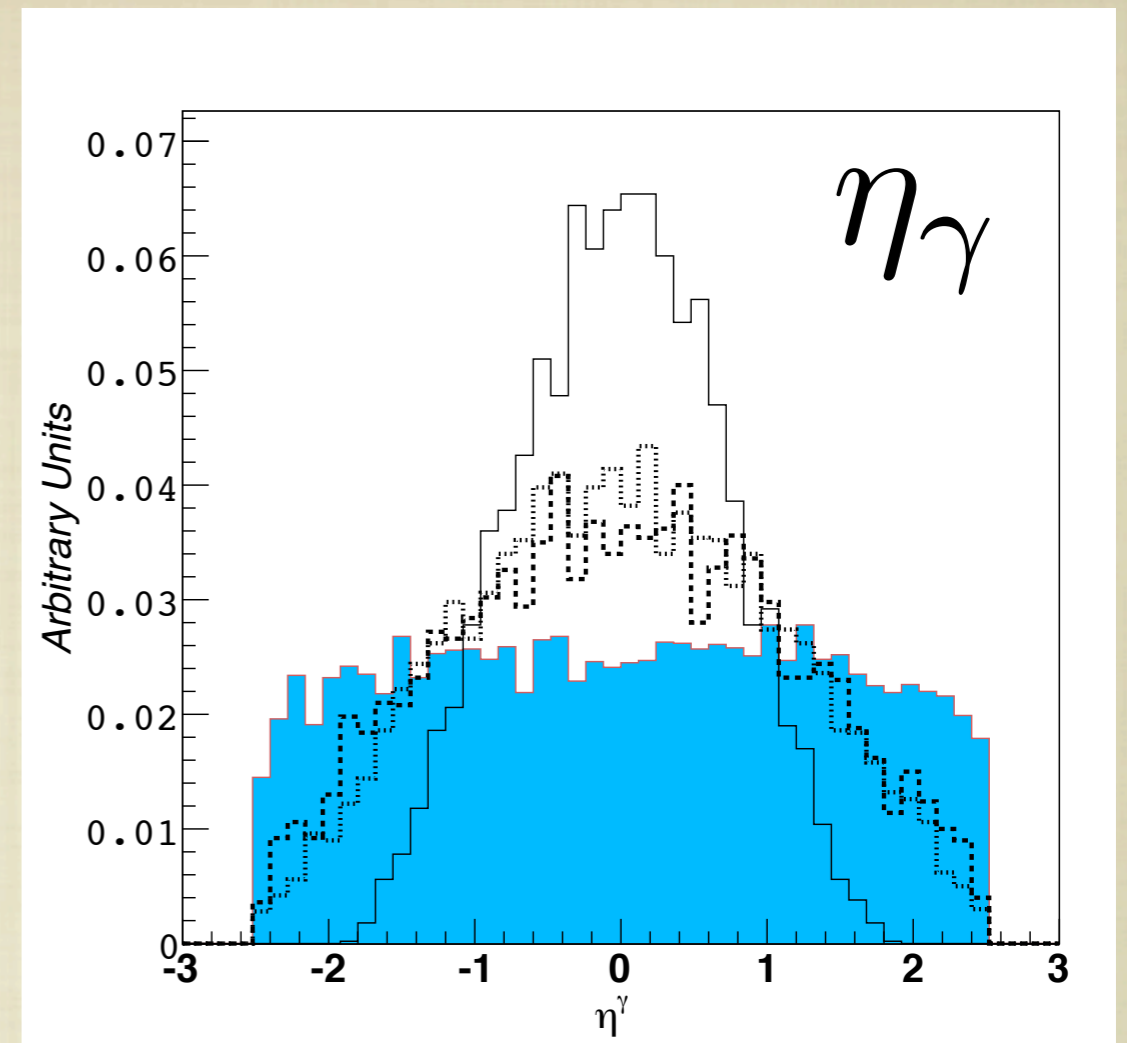
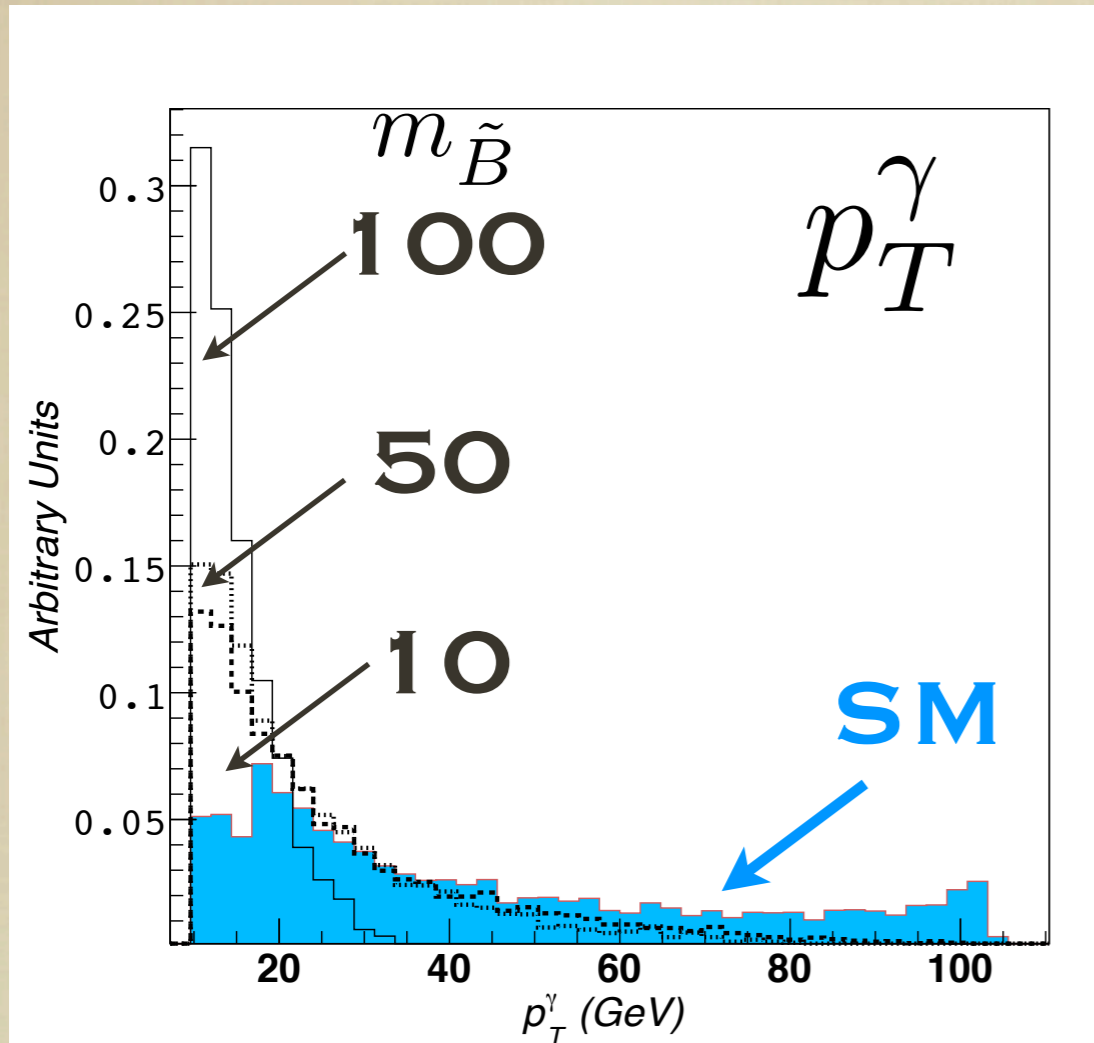
MONOPHOTON + MET EVENTS

IRRED BACKGROUND

$$e + e^- \rightarrow \nu \bar{\nu} \gamma$$



EXAMPLE BINO PRODUCTION AT TLEP-H



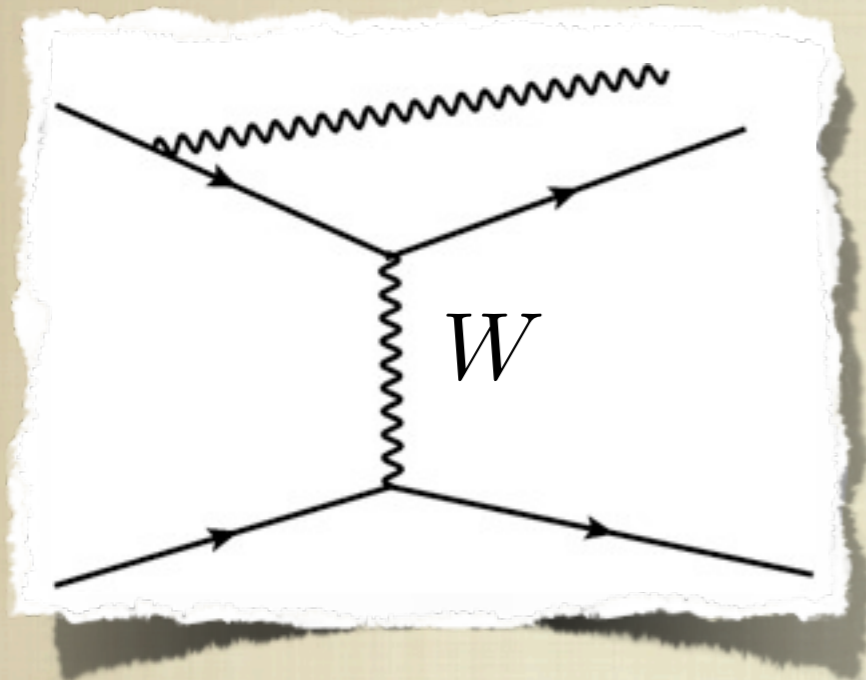
Bino-like:
1-20 fb (100-10 GeV)

SM: $\sim 3\text{pb}$

NEED MORE HANDLES

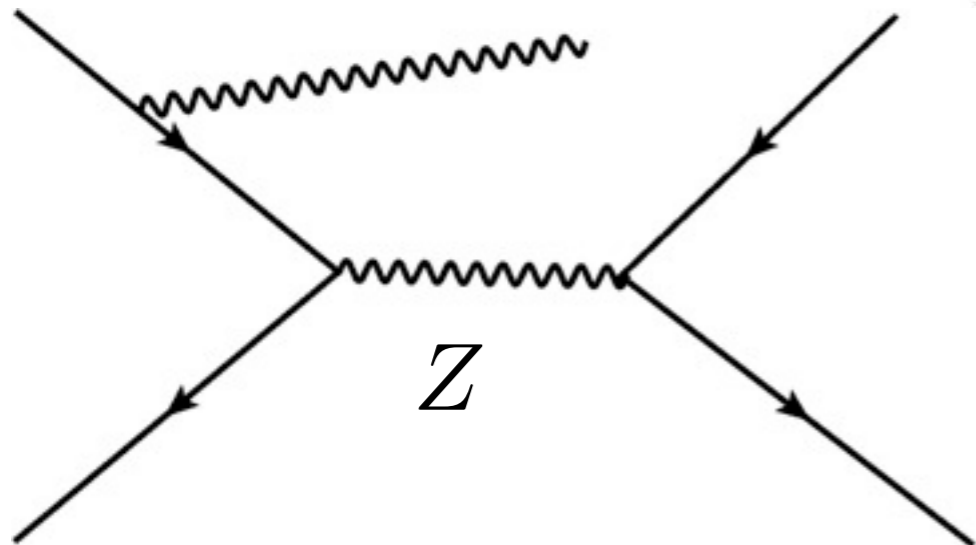
POLARIZED BEAMS?

AT ILC500, DOMINANT T-CHANNEL



$$W(\text{t-channel})/Z(\text{s-channel}) \sim 4$$

AT TLEP-H, DOMINANT S-CHANNEL



$$W(\text{t-channel})/Z(\text{s-channel}) \sim 0.45$$

NEEDED:

DEDICATED STUDY ON POLARIZATION
+BOTTOM-UP FRAMEWORK, INDIRECT
ASTRO CONSTRAINTS

NEW FORCES, DARK SECTORS

KINETIC MIXING

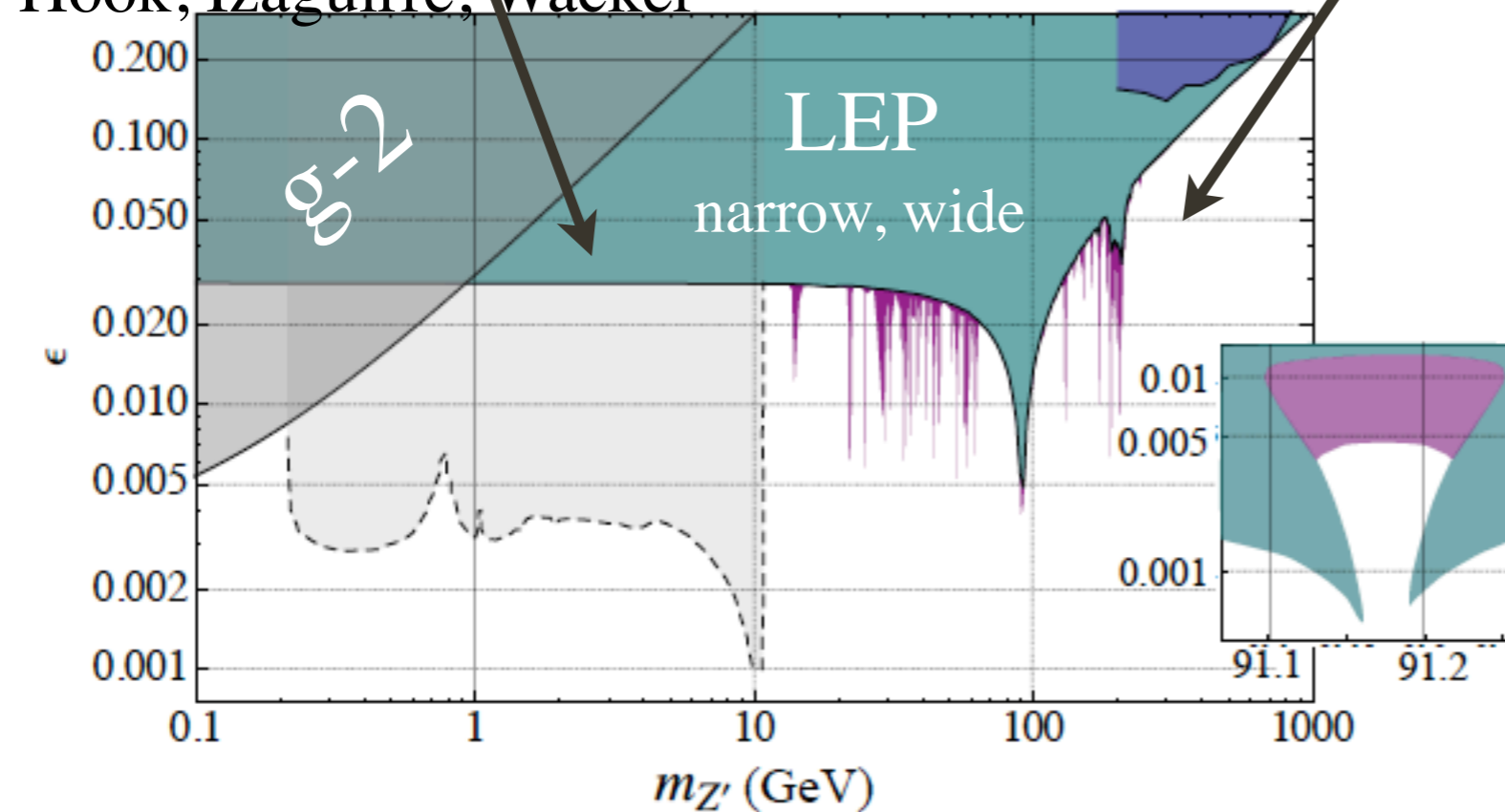
$$-\frac{\sin \epsilon}{2} F'_{\mu\nu} B^{\mu\nu} \leftarrow \text{HYPERCHARGE}$$

\nwarrow DARK PHOTON

HIGH LUMI/HIGHER E
SENSITIVITY TO SMALLER
MIXING

HIGHER MASS
REACH

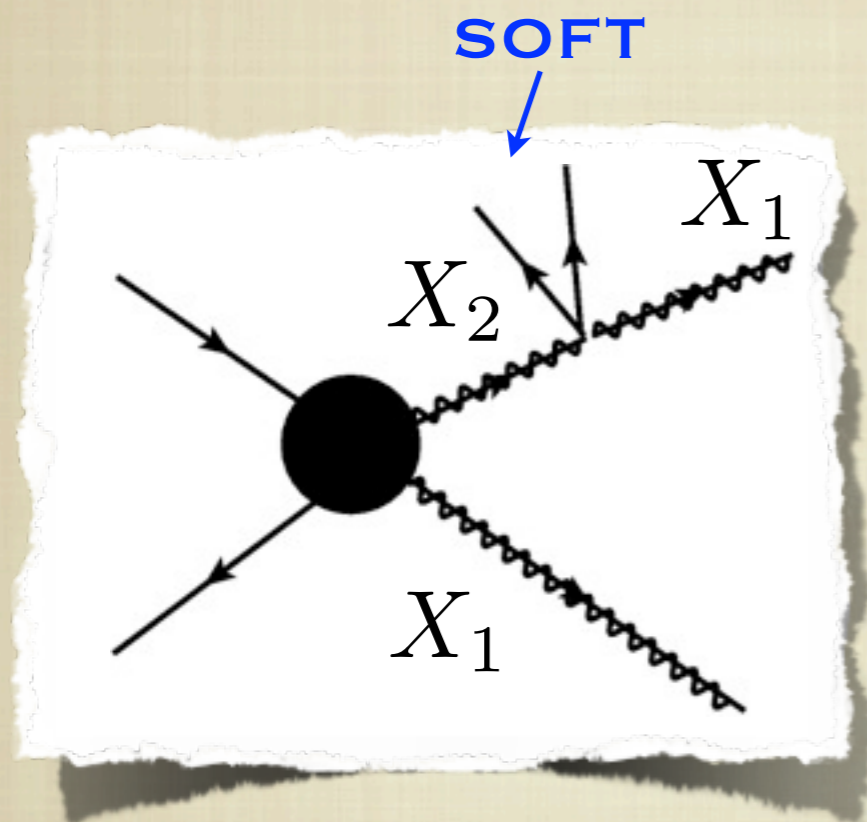
Hook, Izaguirre, Wacker



NEEDED:
START WITH MODEL
INDEPENDENT STUDY AT
TLEP-Z

COMPRESSED SPECTRA

$$\Delta m = m_{X_2} - m_{X_1} \ll m_{X_1}$$



MOTIVATED BY
DARK MATTER
(COANNIHILATION)

EVENT: SOFT LEPTONS/JETS
DISPLACED VERTEX

EXAMPLE-
SUSY W/ DIRAC GAUGINO MASSES
BOTTOM-UP APPROACH-
PSEUDO-DIRAC DM (1004.1567)

NEEDED - TRIGGER STUDY,
DISPLACED VERTEX
CAPABILITIES

CONCLUSIONS

NEW LIGHT ELECTROWEAK STATES
MOTIVATED BY DARK MATTER AND THE
STABILIZATION OF THE ELECTROWEAK SCALE
EVADE LHC BUT COULD BE DISCOVERED BY TLEP

THREE EXAMPLES: SUSY DM, DARK FORCES,
COMPRESSED SPECTRA

WORK NEEDED TO MAKE SURE DIRECT SEARCHES
ARE PERFORMED

THEORY MOTIVATED, BUT AS MODEL INDEPENDENT
AS POSSIBLE (BOTTOM-UP)