$Z \rightarrow \tau\tau$ and R-parity Violating SUSY Search with taus at CDF-II

Takashi Ogawa
(Waseda Univ.)
For CDF Collaboration

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Outline

- **Motivation: Stop with R-parity violation and other new physics with ditau final states**
- **Run II Benchmark Analysis ($Z \rightarrow \tau\tau$)**
- **Run II Prospects (R-parity violating Stop)**
- **Summary**

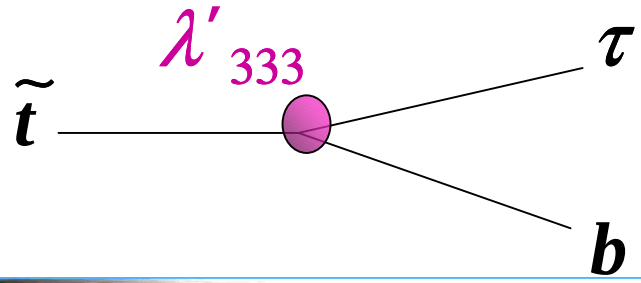
All Run II results are preliminary!!

Scalar Top (STOP) Quark

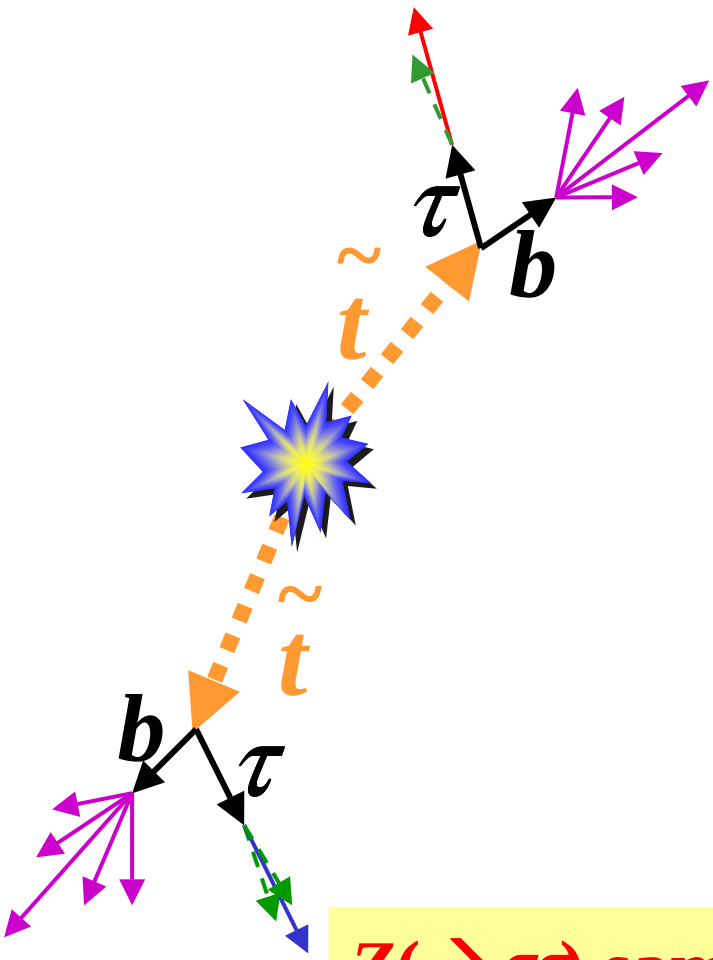
The Standard Model (SM)	Supersymmetry (SUSY)
$R_p = +1$	$R_p = -1$
t : heaviest SM fermion	$\tilde{t}$: lightest SUSY boson?
Spin = 1/2	Spin = 0
Charge = 2/3	Charge = 2/3
Mass = 175 GeV/c^2	Mass = ?? GeV/c^2

$$R_p = (-1)^{3B+L+2S}$$

If stop is the lightest SUSY particle, the branching ratio can be 100%.



Experimental Signature



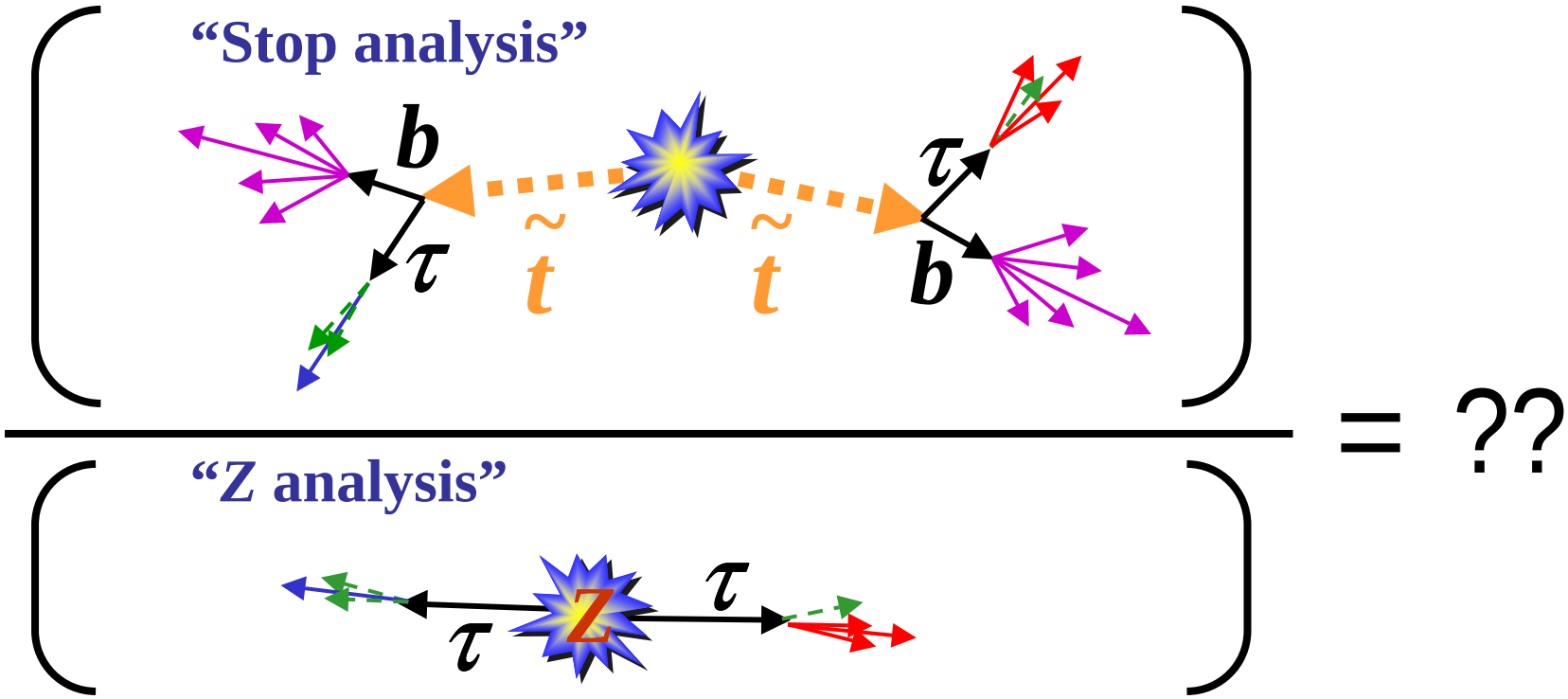
$$\underbrace{l + \tau_h}_{\text{Trigger}} + \underbrace{b + b}_{\text{No } b\text{-tag for Run I}}$$

Dominant SM BGs

- $Z(\rightarrow \tau\tau)$ + $\geq$2 jets
- $W(\rightarrow l\nu)$ + $\geq$3 jets
- QCD
- $t\,t \rightarrow Wb+Wb$
- $WW/WZ/ZZ$

$Z(\rightarrow \tau\tau)$ sample can be our calibration sample.

Stop and Z Analyses



- **Cancellation : Luminosity, BR($\tau \to l$) $\cdot$BR($\tau \to \tau_h$)**
- **Reduce Sys. Uncertainty: Lepton and τ_h ID, Iso cut**

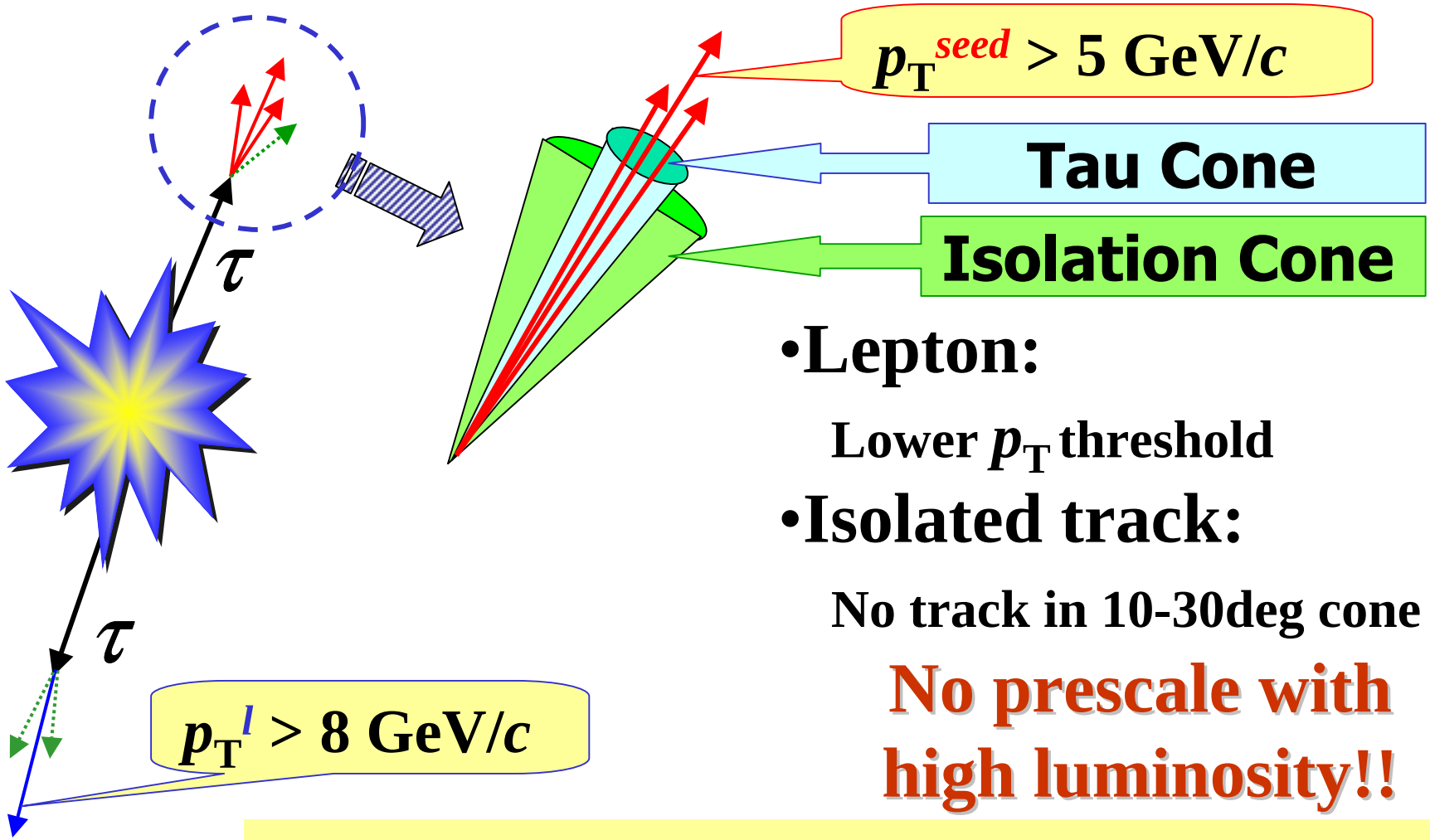
Run I vs. Run II

- $\int L dt$ (pb^{-1}) : **72** vs. **106**
- $\sqrt{s}$ (TeV) : **1.96** vs. **1.8**
- **New Trigger : Generic dilepton trigger including two taus in the final state for high luminosity**

Lepton[8GeV]+Track[5GeV] ***(w/o Prescale)***

vs. **Lepton[8GeV]** ***(w/ Prescale)***

Run II: Trigger



- **Lepton:**
  - Lower p_T threshold
- **Isolated track:**
  - No track in 10-30deg cone

No prescale with high luminosity!!

→ See Sasha Baroiant's talk (H13) for details.

Z Event Selection

- **Baseline selection: $e+\tau_h$**

  $E_T(e) > 10$ GeV

  $E_T(\tau_h) > 20$ GeV

- **Transverse mass cut to reduce *W+jets* events:**

  $+ M_T(l,\not{E}_T) < 25$ GeV/c^2

- **Vector Sum p_T cut to reduce QCD events**

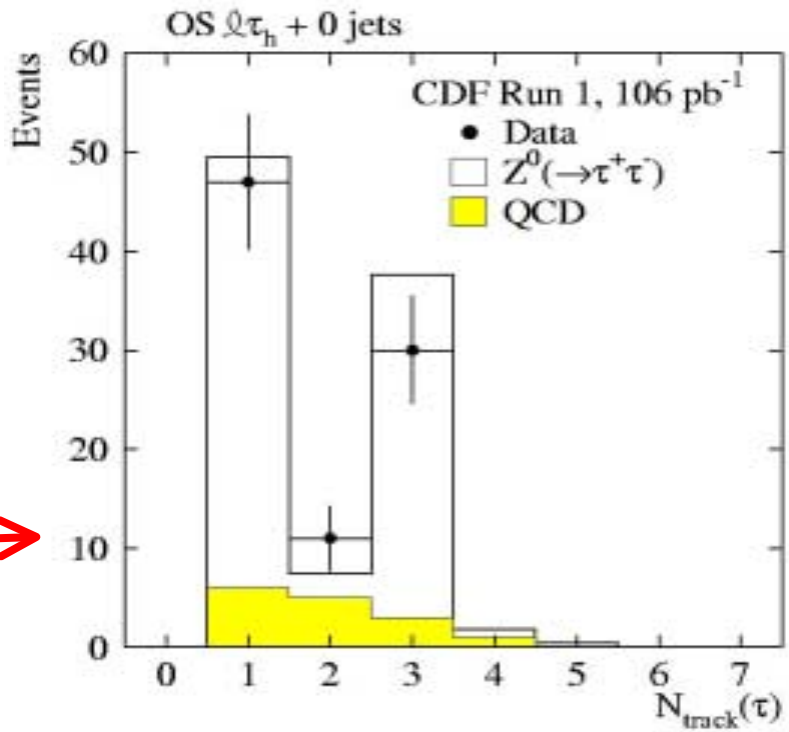
  $+ p_T(l,\not{E}_T) > 25$ GeV/c

- **Example: Run I**

  (l : 10 GeV, τ_h : 15 GeV)

(OS l τ_h + 0 jets)

CDF Run I Preliminary

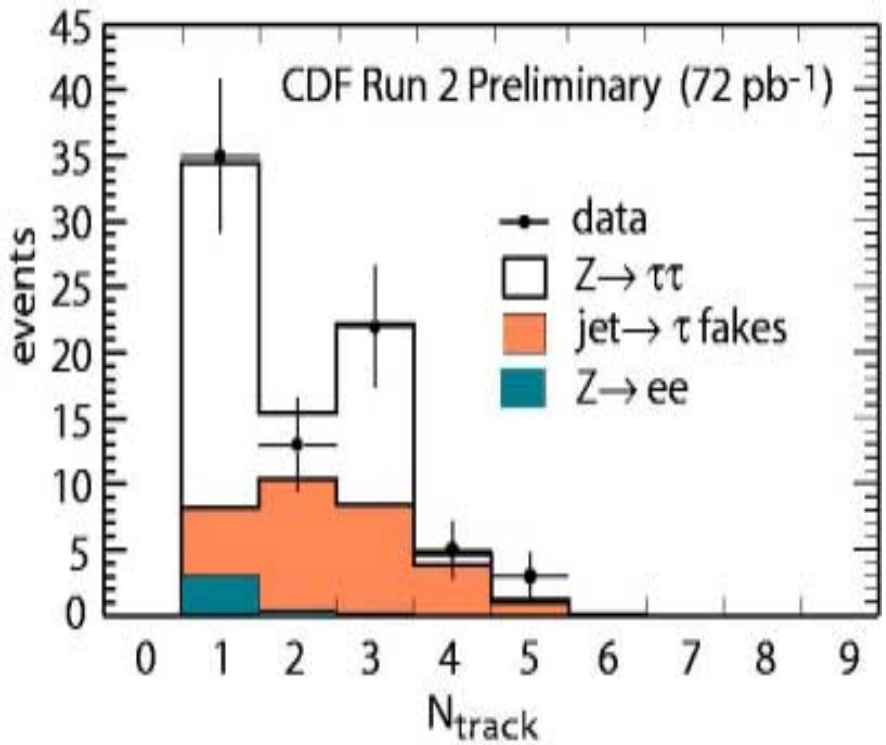


→ Yoshiyuki's talk (B12) for details.

Run II Results (i)

After Baseline(e / τ_h), M_T, p_T cuts

Tau track multiplicity

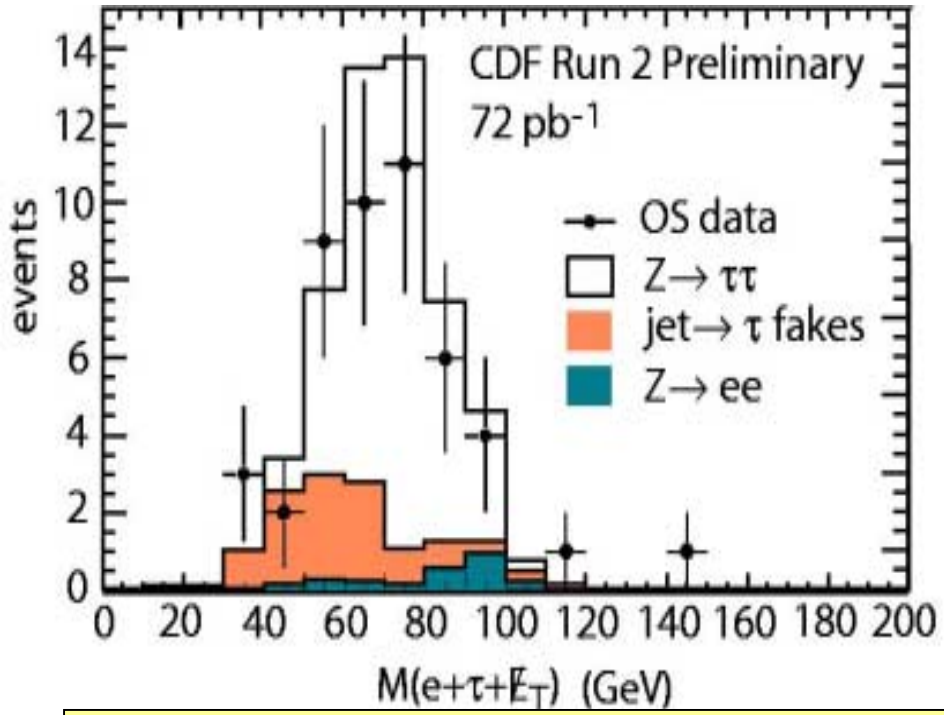


- Data : 78 evts
- $Z \rightarrow \tau_e \tau_h$ (fit): 46±15 evts
  (MC predicts 43 evts)
- QCD (fit): 28±14 evts
- $Z \rightarrow ee$ (fix): 3.7 evts

Run II Results (ii)

After Baseline(e / τ_h), M_T, p_T cuts, OS

Mass (OS data)

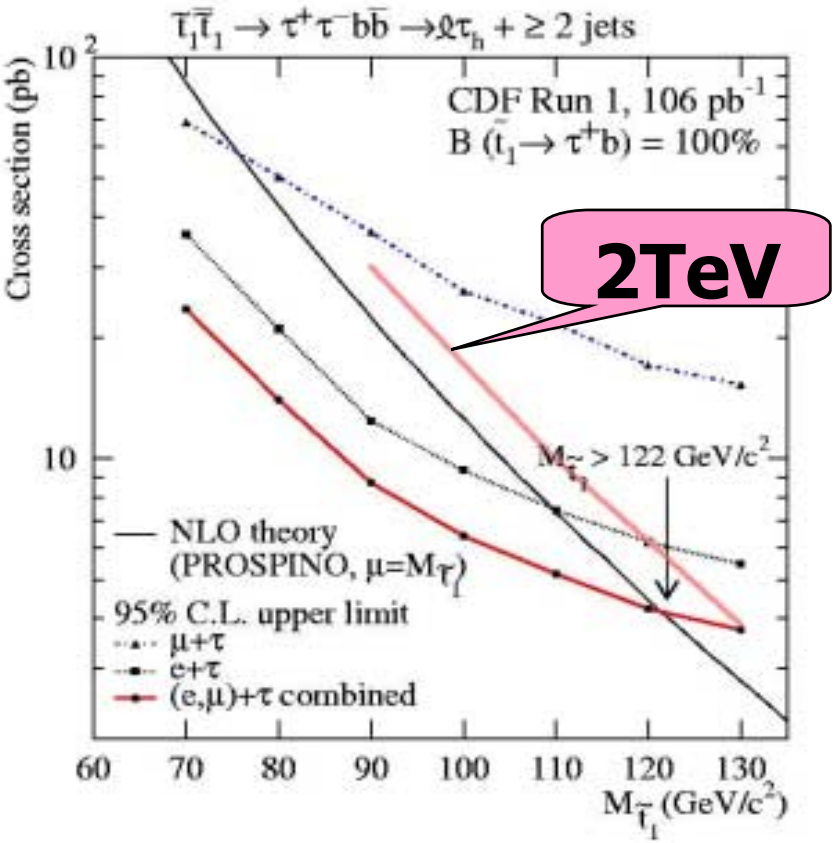


- Data : 47 evts
- $Z \rightarrow \tau_e \tau_h$ (fix): 39 evts
- QCD (fit): 11±6 evts
- $Z \rightarrow ee$ (fix): 2.8 evts

We are finalizing the *Z* analysis (including μ channel)

Run II Prospect

CDF Run I Preliminary



$$\sigma_{\text{limit1}} \times \varepsilon_1 \times L_1 = \sigma_{\text{limit2}} \times \varepsilon_2 \times L_2$$

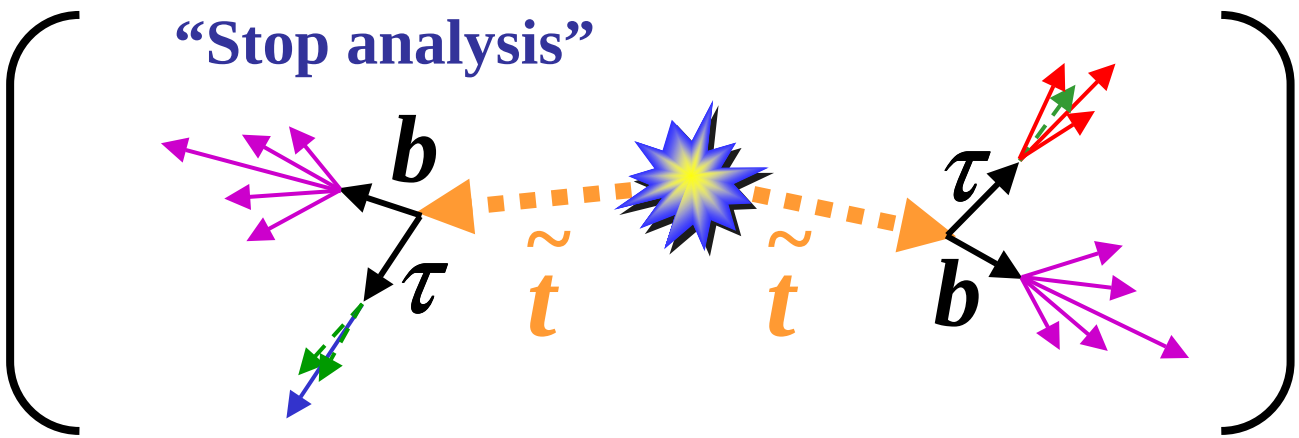
$$\Rightarrow \frac{\sigma_{\text{limit2}}}{\sigma_{\text{limit1}}} = \frac{\varepsilon_1 \times L_1}{\varepsilon_2 \times L_2}$$

$$\approx \frac{1.0}{1.0-(0.5\times 0.5)} \times \frac{110\,\text{pb}^{-1}}{2\,\text{fb}^{-1}}$$

$$\approx \frac{1}{14}$$

Mass Limit :
122 → ~180 GeV/c²

Assumption : No observation, same efficiency, same background level with 1 *b*-tag ($\varepsilon_{b\text{-tag}}$=50%).

Summary

- **STATUS:** a clear $Z \rightarrow \tau_e \tau_h$ signal in the data sample taken by a new lepton+track trigger in Run II. [The trigger is designed to detect all dilepton final states (except $\tau_h \tau_h$).]
- **FINAL GOAL:** search for new physics with di-τ final state. One of them is: