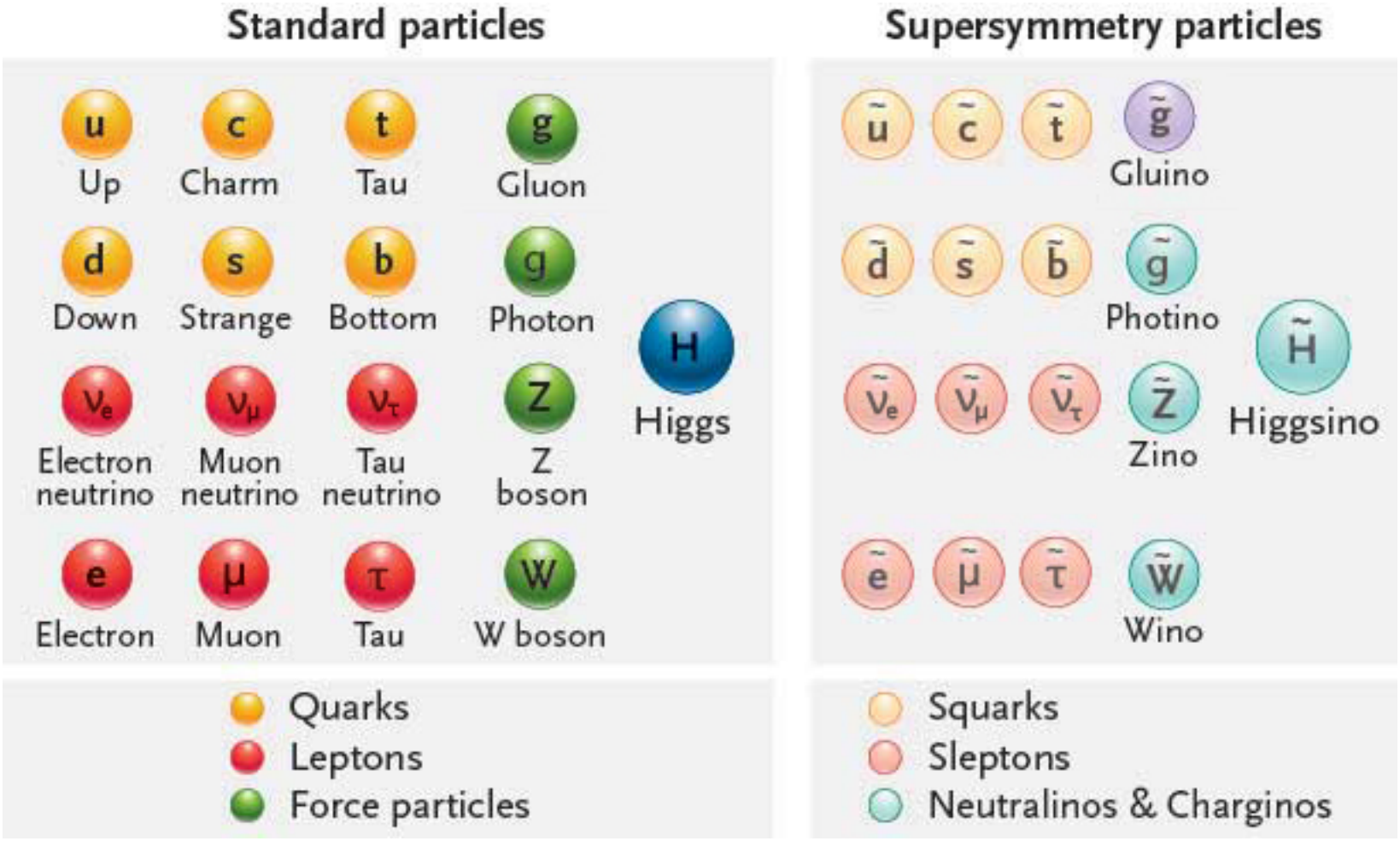
Search for a diphoton and $E_{\mathrm{T}}^{\mathrm{miss}}$ final state

QCD Background Estimation for Run II

Overview

- Basic ideas in Supersymmetry
- General Gauge Mediation (GGM) models
- Diphoton + $E_{\mathrm{T}}^{\mathrm{miss}}$ final state
- Expected background
- QCD background studies
  - Improve overlap removal criterion
  - Matrix Method

SUSY particles



- Each SM particle has SUSY partner (spin difference is ½)
- How about the mass?

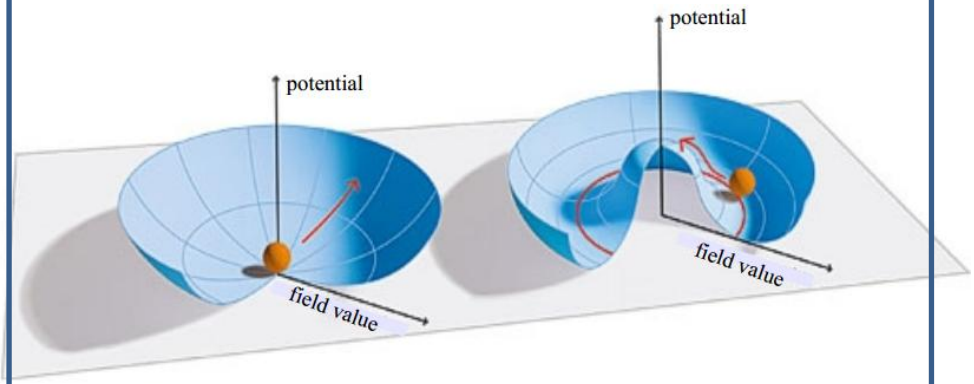
SUSY breaking

Super particles have not yet been observed

⇒ SUSY must be broken

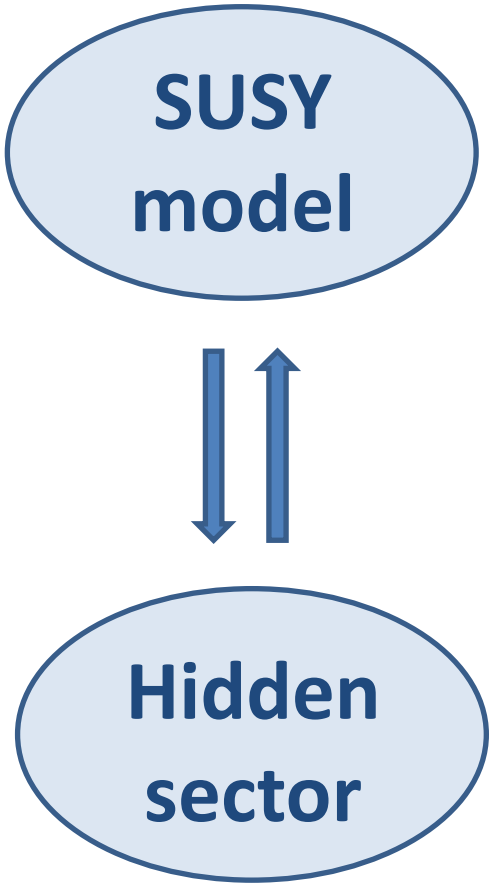
⇒ sparticles much heavier than SM partners

Breaking a lagrangian (Higgs like)

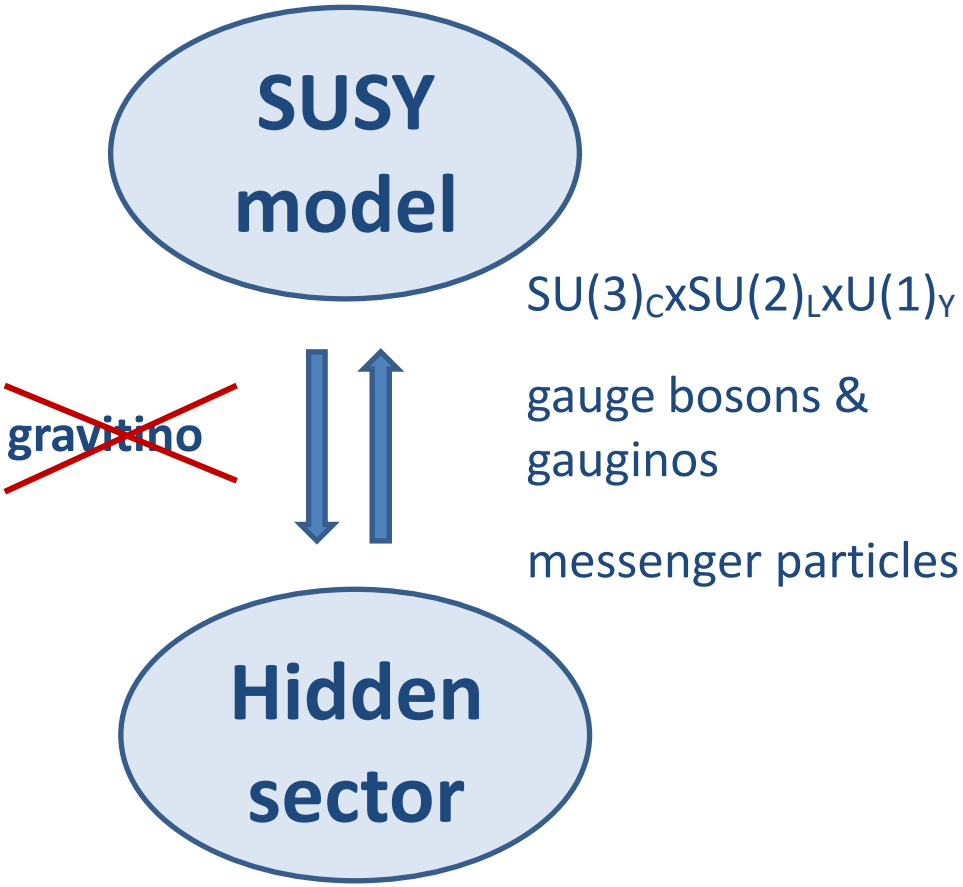


Symmetry is contained
VEV is no longer the origin

Breaking takes place in a "hidden sector"



GGM models



- sparticles decay in cascades into jets, leptons

AND finally into

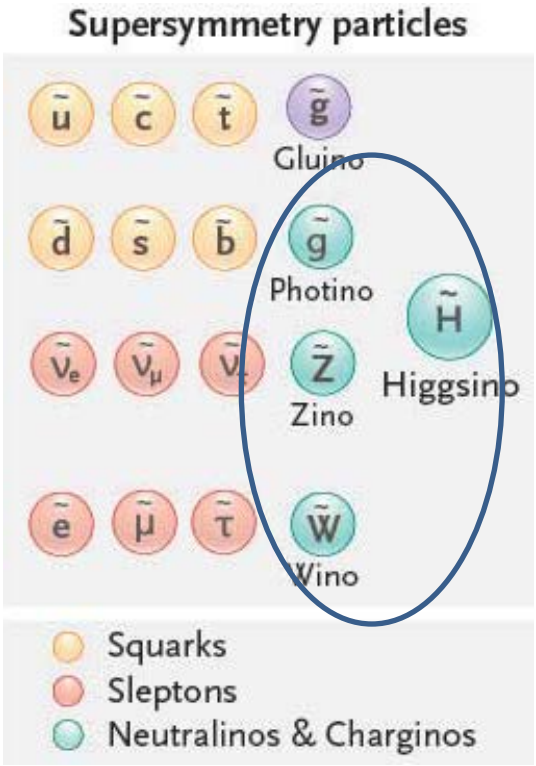
- the Lightest Supersymmetric Particle (LSP)

Finding SUSY = Finding LSP

- In GGM: LSP is gravitino, $M(\tilde{G}) << 1keV$

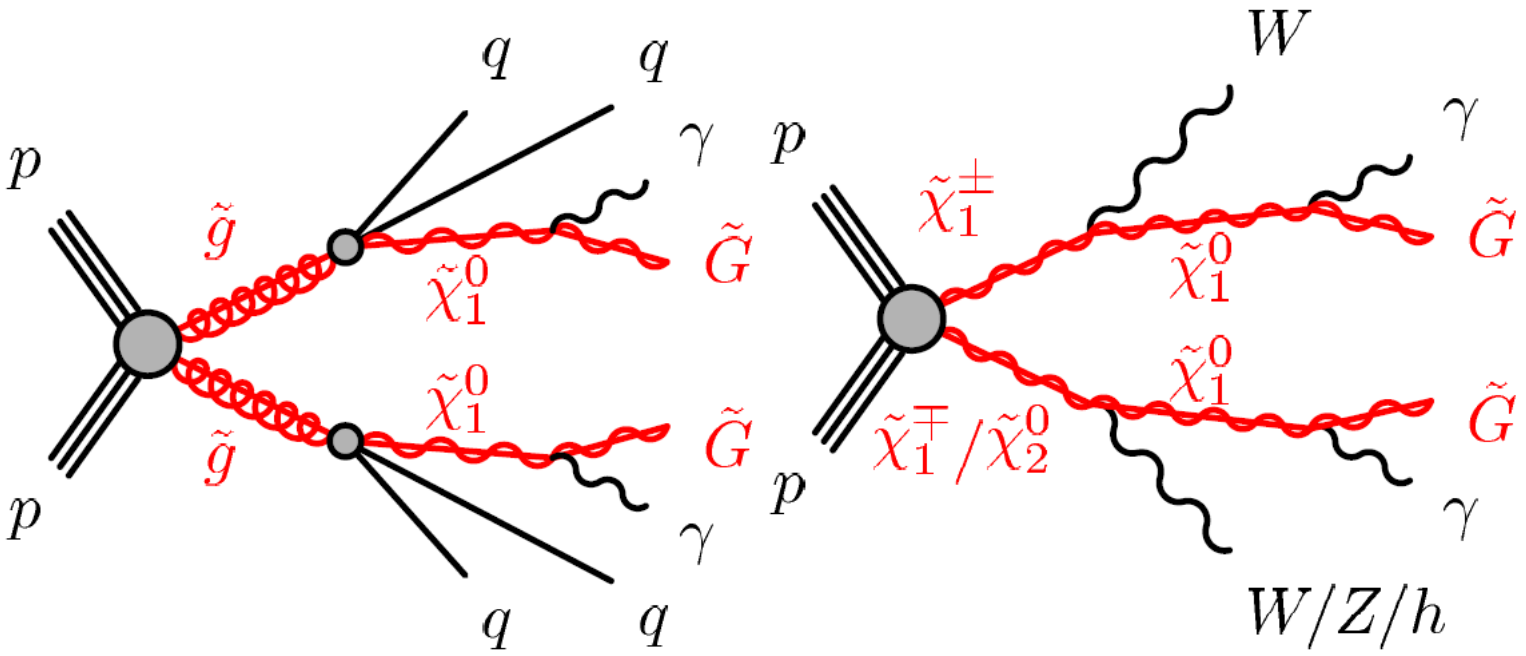
This model

- The mother particle of final decay, the **Next-to LSP** (NLSP) **defines signature**
- Cadidates: stau *(in German 'Stau' = 'traffic jam'),* neutralino
- Neutralino is mixture/superposition of gauginos (bino, wino, higgsinos)
- Decay into gamma, Z or higgs



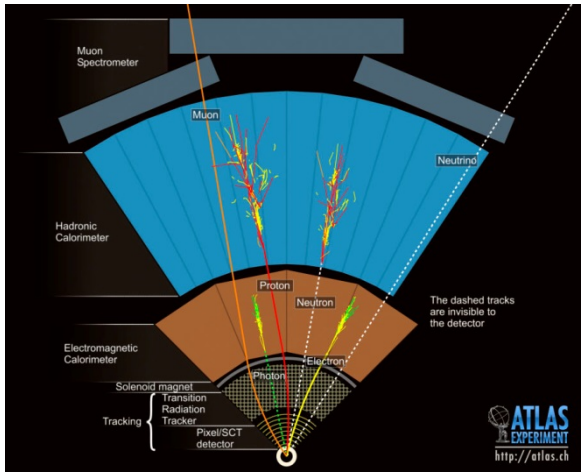
Expected signature

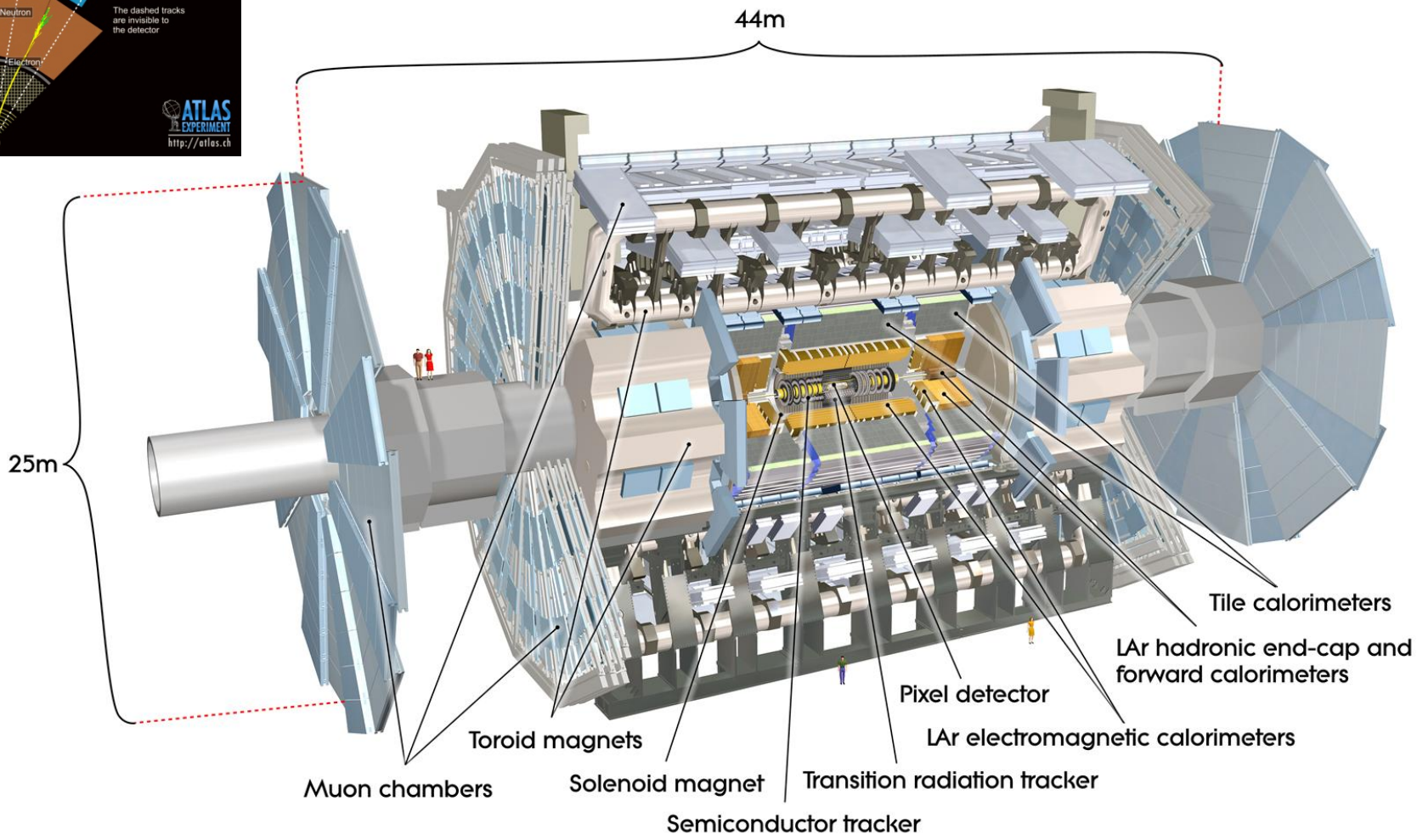
- Diphoton + E_T^{miss} final state



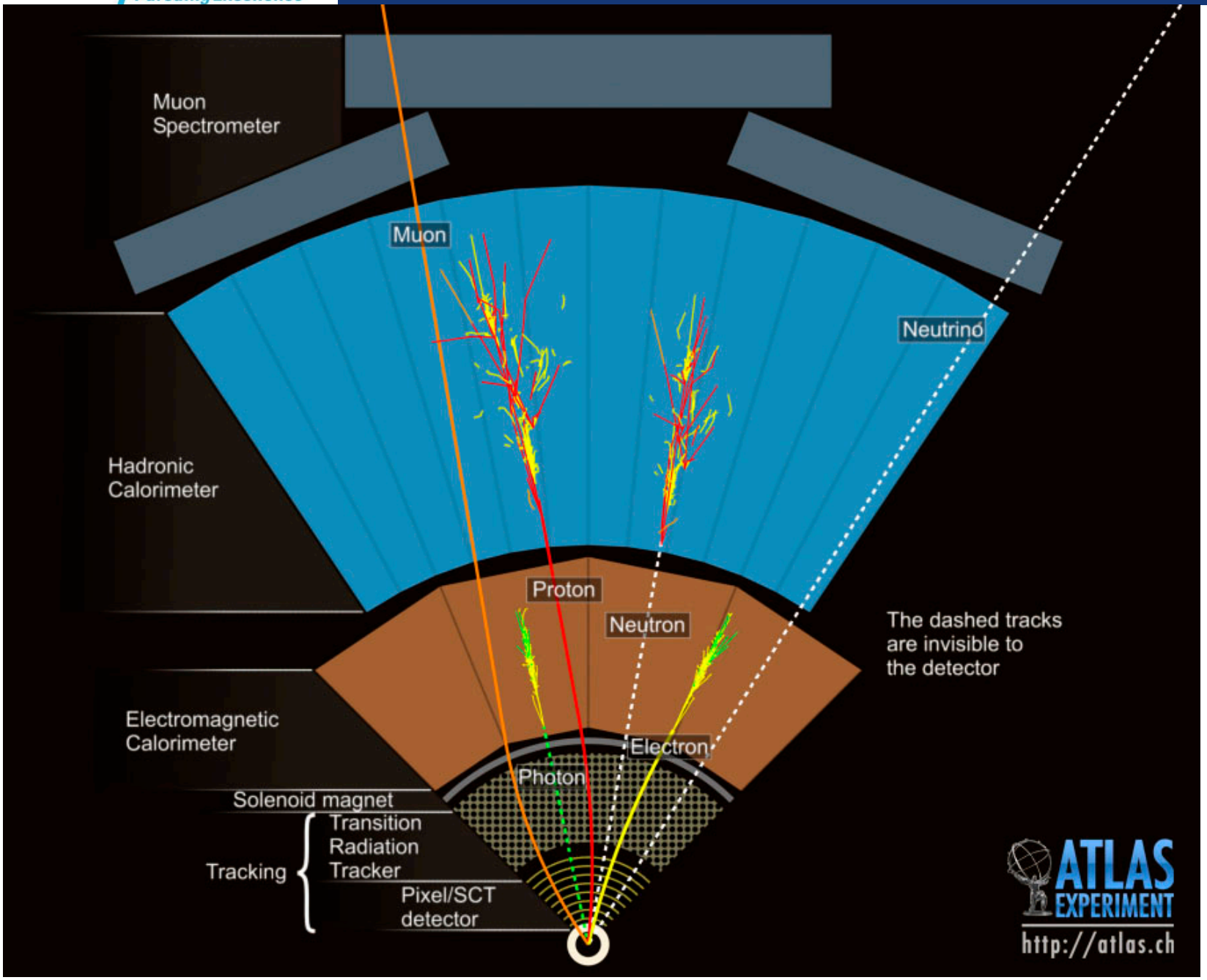
- NNLSP strong wino production
- High mass scale
- NNLSP electro-weak wino production
- Lower production X_{sec}

ATLAS Detector



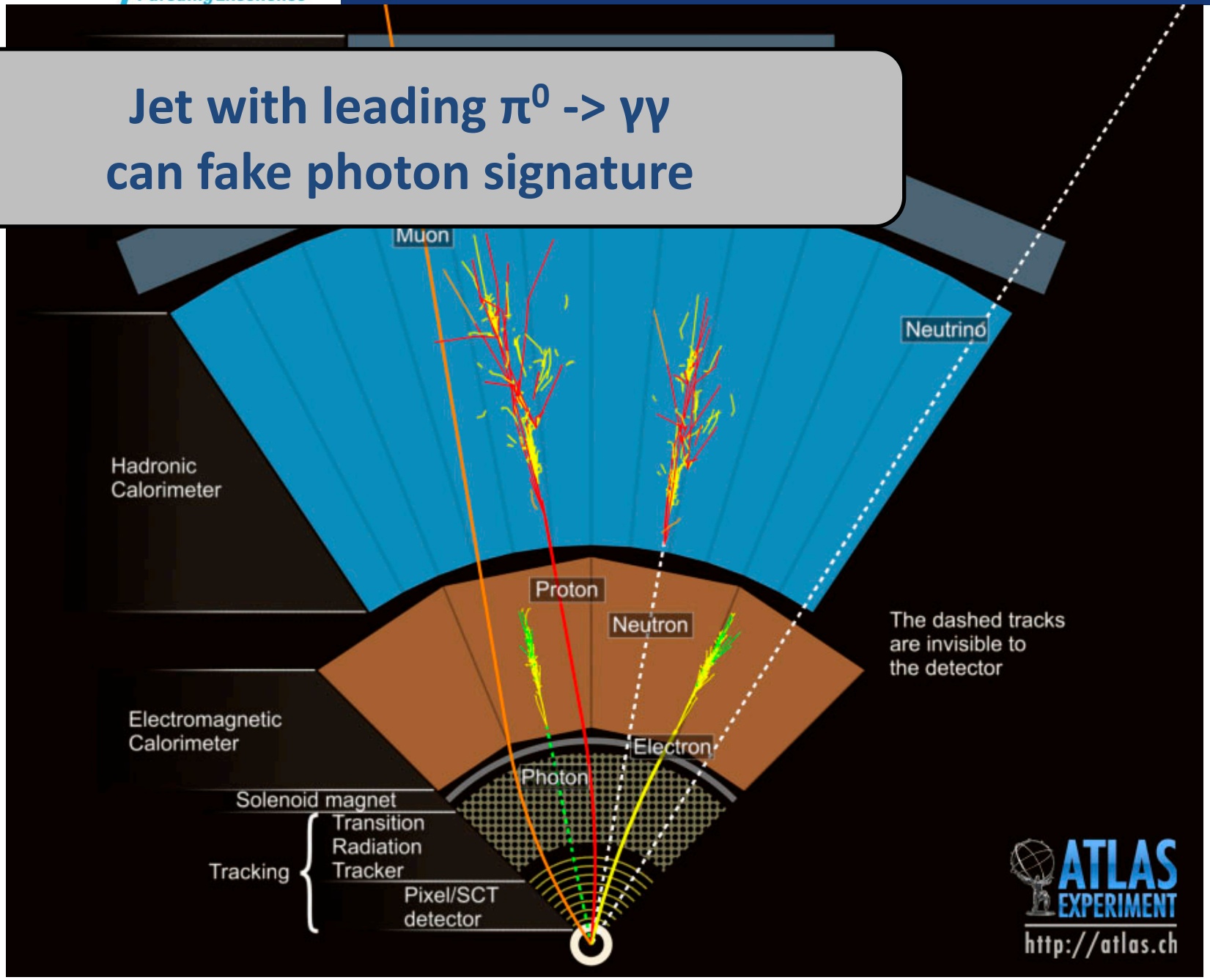


Particle signatures



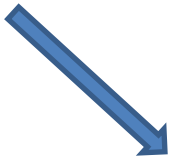
Particle signatures

Jet with leading π^0 -> $\gamma\gamma$ can fake photon signature



Expected background

- 2 categories
  - Instrumental E_T^{miss} /QCD background
  - Genuine E_T^{miss} /real E_T^{miss}



- EW component
  - One gamma + mis-identified electron
- "irreducible" component
  - 2 gamma + W/Z events with neutrinos

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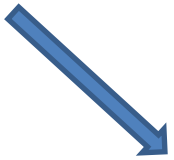

- EW component
  - One gamma + mis-identified electron
- "irreducible" component
  - 2 gamma + W/Z events with neutrinos

EW and irreducible component

Processes expected to contribute to the EW background include:

- $W + \gamma$ production, with $W \to l\nu$; especially $W \to e\nu$;
- $Z + \gamma$ production, with $Z \to \tau^+\tau^-$;
- $t\bar{t}\gamma$ production, with semileptonic t decay; especially $t \to be\nu$.

The IR backgrounds are expected to arise from

- $W + \gamma + \gamma$ production;
- $Z + \gamma + \gamma$ production.

QCD background

Processes expected to contribute to the QCD background include:

- SM diphoton production;
- Photon + jet production;
- Multijet production;
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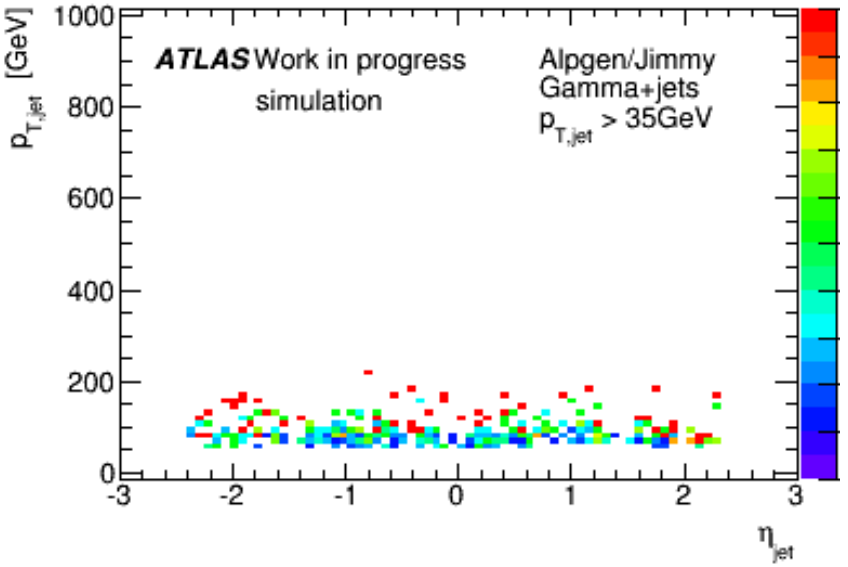
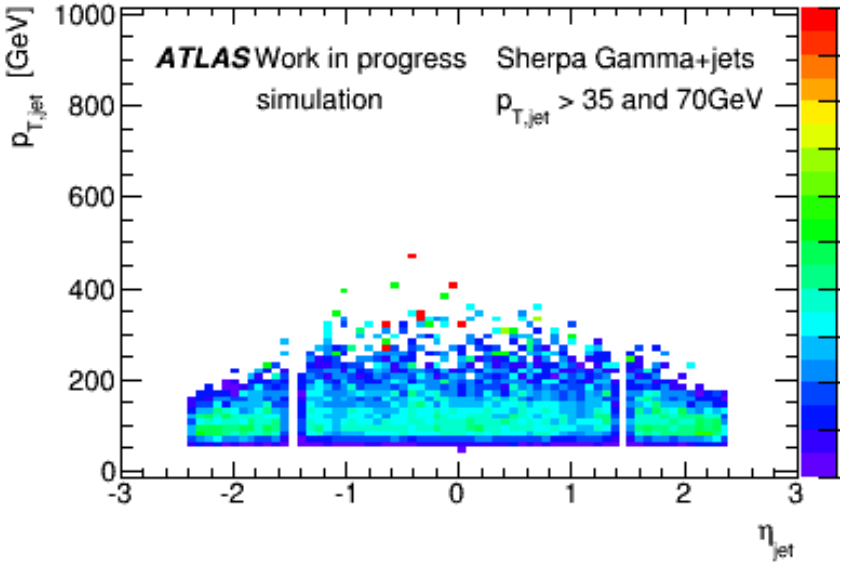
lost statistics, but process was minor background

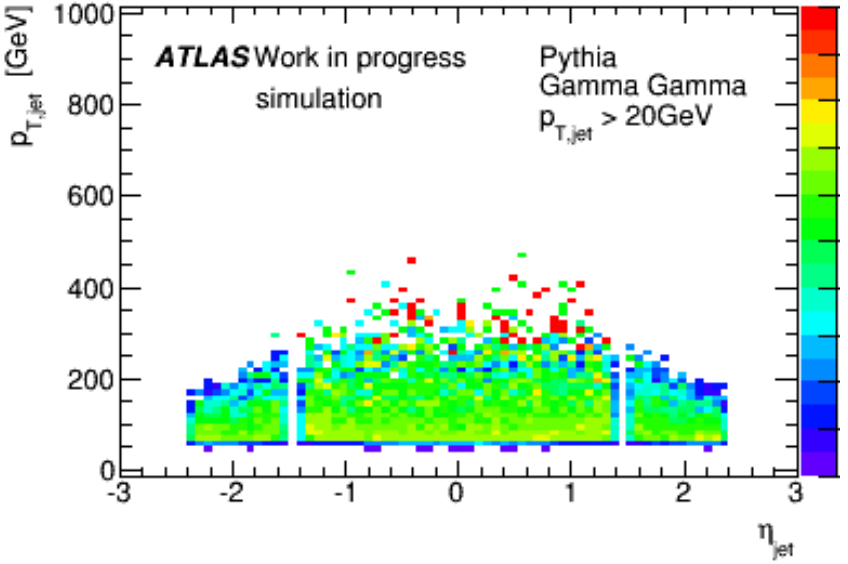
Improvement needed for Run II

Jet – photon overlap efficiency

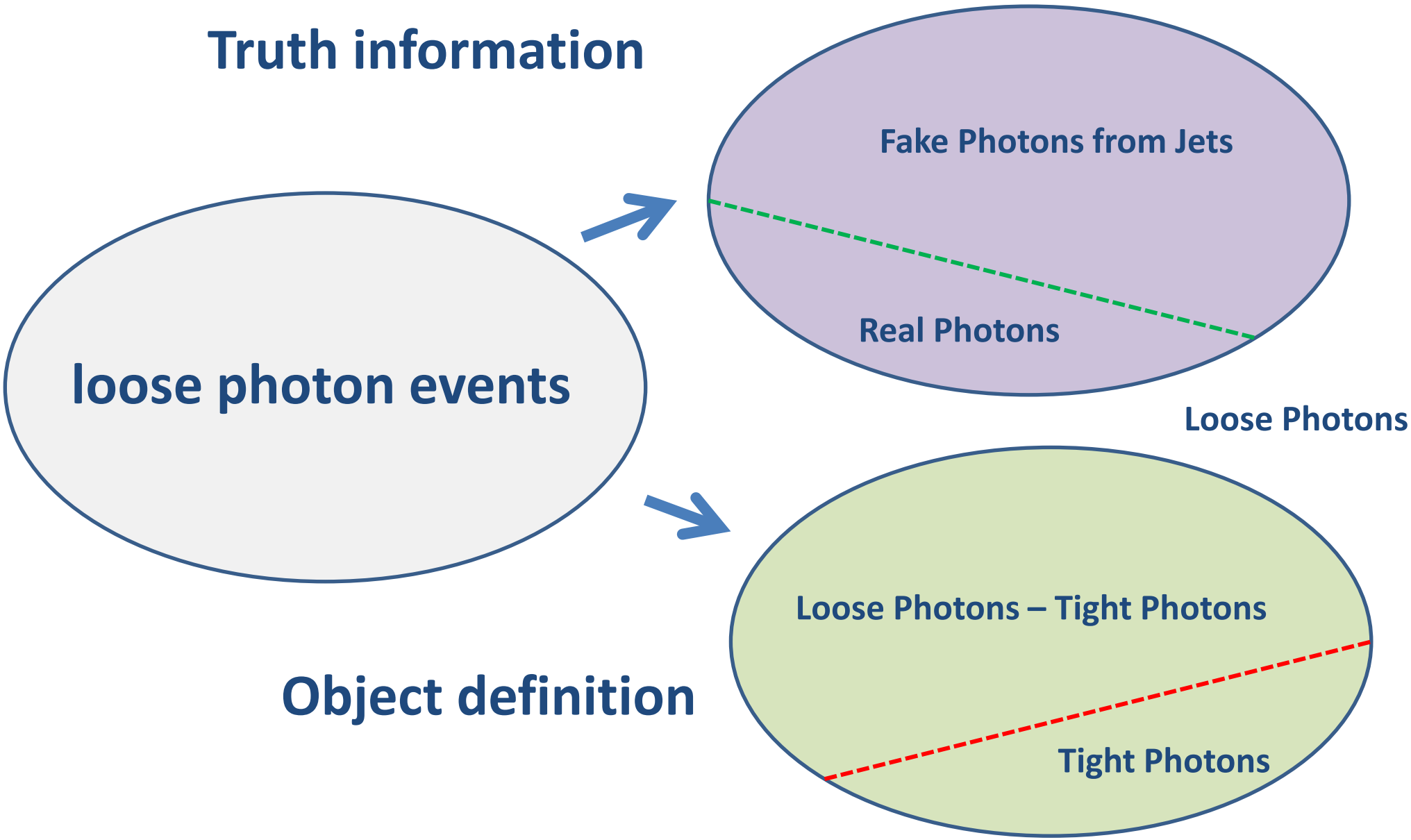
- In jet loop check overlap with photons
- **$\varepsilon = N_{isOverlap}/N_{noOverlapiij}$**
- Goal: add weight to jets in areas most likely faking jets
- Instead of simple rejection





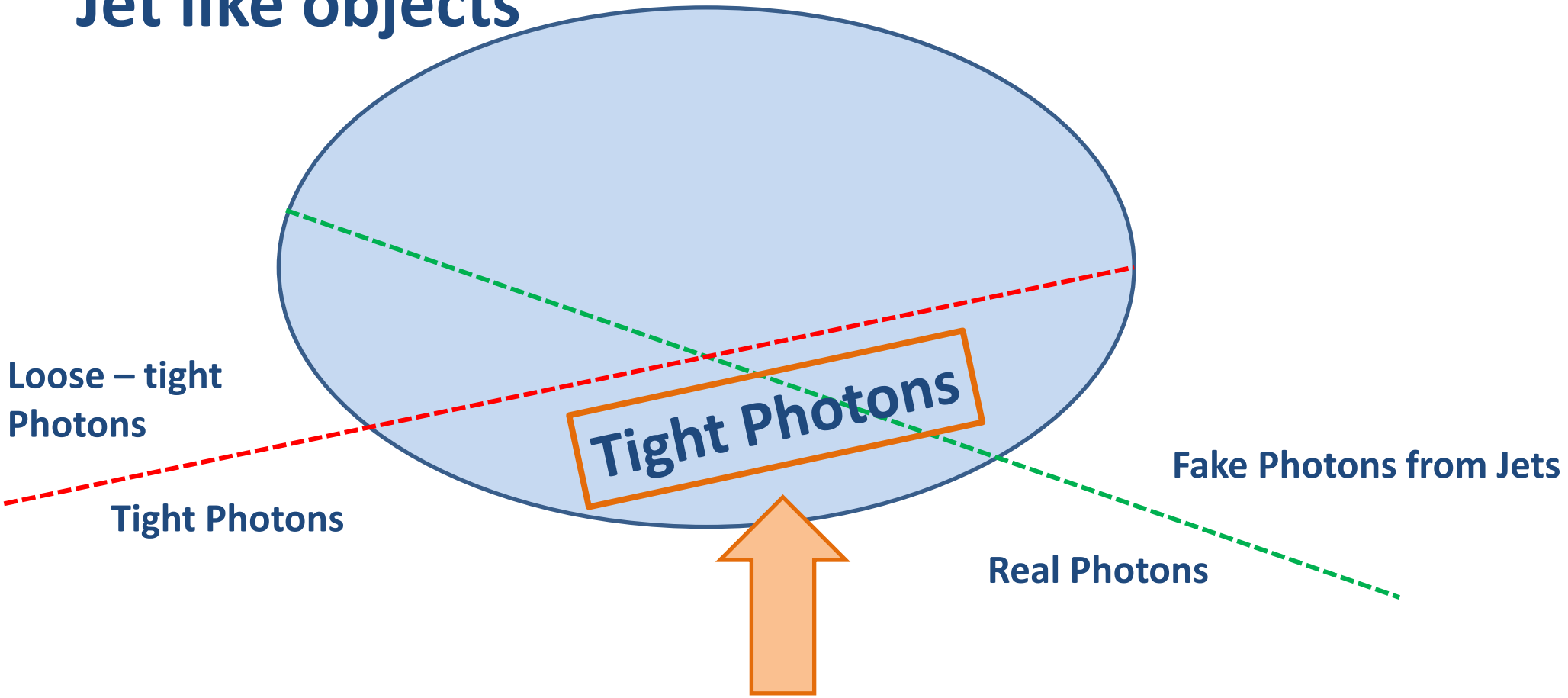


QCD background sample



QCD background sample

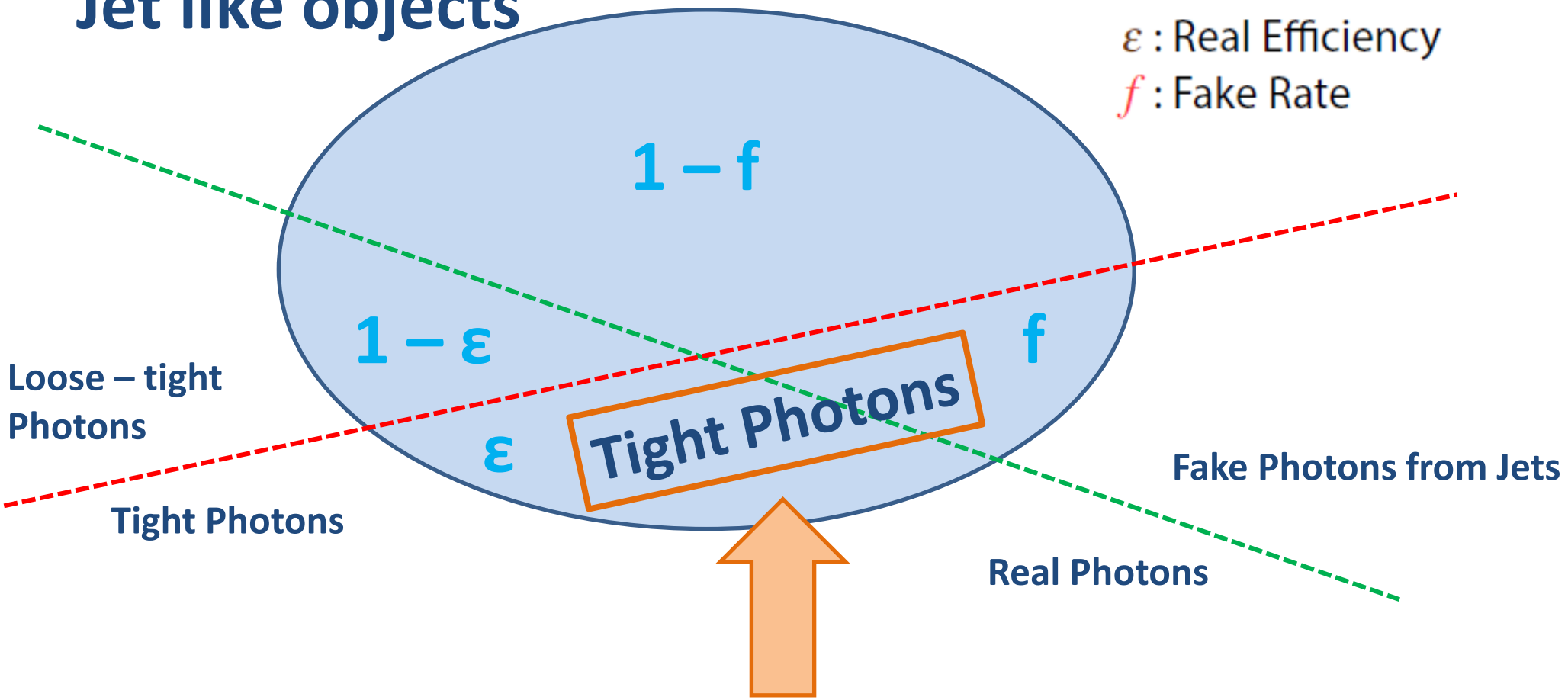
Jet like objects



Matrix Method Principle

Jet like objects

ε : Real Efficiency
f : Fake Rate



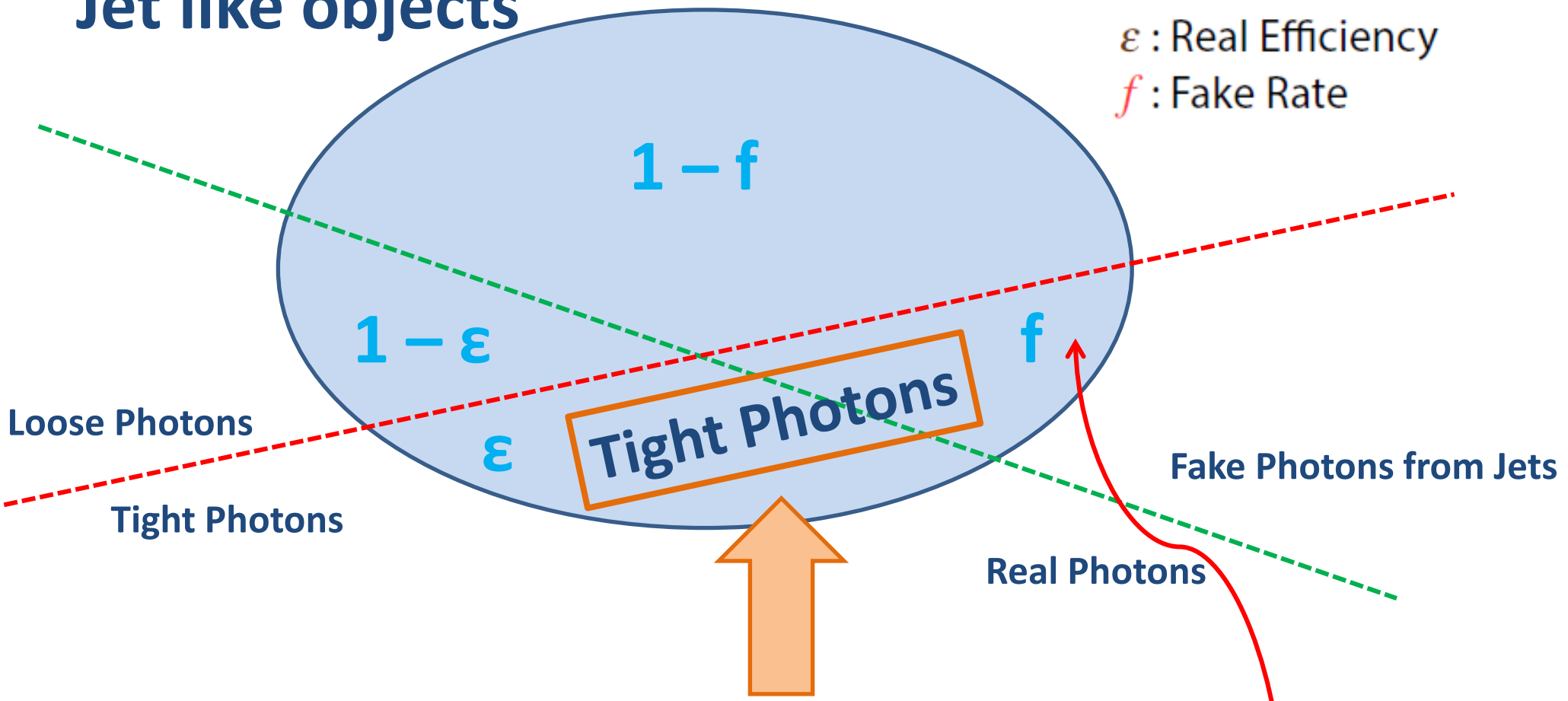
Used for Analysis

Matrix Method

$$\begin{pmatrix} N_{\text{tight}} \\ N_{l-t} \end{pmatrix} = \begin{pmatrix} \varepsilon & f \\ 1-\varepsilon & 1-f \end{pmatrix} \begin{pmatrix} N_{\text{Real}} \\ N_{\text{Fake}} \end{pmatrix}$$

Matrix Method Principle

Jet like objects



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invert matrix

f x N_{fake}

Summary

- Expect increasing contribution from QCD background in LHC Run II
- Contribution from Jets faking Photons needs to be properly modeled
- QCD background studies
  - Improve overlap removal criterion
  - Matrix Method