Chapter 1

Event Selection

In keeping with the phenomenology described in Sec. **??**, the candidate GGM events selected in this search consist of two high-E_T photons and a significant momentum imbalance transverse to the beam, indicating the production of an escaping gravitino. This momentum imbalance is usually referred to as *missing transverse energy* and is denoted by the symbol $\not\!\!E_T$.

However, in order to use real CMS data (as opposed to simulation) to derive predictions for the backgrounds to the search, *control samples* distinct from the *candidate* two-photon sample must be collected. These samples consist of different numerical combinations of photons, electrons, and jets, and are explained in more detail in Chapter **??**. Since this search is performed in the high-$\not\!\!E_T$ tail of the $\not\!\!E_T$ distribution, where adequate detector simulation is very difficult, it is advantageous to use *data-driven* background estimates, which capture the true detector response, over numbers derived from simulation.

In the following sections, the reconstruction of photons, electrons, jets, and $\not\!\!E_T$ is explained. Sec. 1.1 begins with an explanation of the high level reconstruction. It is followed by Sec. 1.2, which describes the triggers used to collect the candidate and control samples. Finally, the chapter concludes with a measurement of the photon

identification efficiency in Sec. 1.3.

1.1 Object Reconstruction

This section describes the *offline* object reconstruction, i.e. the reconstruction of particle objects from events that have already been triggered and written to permanent storage, as opposed to the building of trigger objects explained in Secs. **??** and 1.2.

1.1.1 Photons

1.1.2 Electrons

1.1.3 Jets and Missing Transverse Energy

1.2 HLT

From the objects described in Sec. 1.1, four samples of events are formed:

- $\gamma\gamma$ candidate sample, in which the two highest E_T objects are photons,
- $e\gamma$ control sample, in which the two highest E_T objects are one electron and one photon,
- ee control sample, in which the two highest E_T objects are electrons, and
- ff control sample, in which the two highest E_T objects are fakes.

The high level triggers used to select the four samples, by run range, are listed in Table 1.1. No trigger is prescaled.

Each piece of the HLT path name is defined as follows.

Table 1.1: HLT paths triggered by the $\gamma\gamma$, $e\gamma$, ee, and ff samples, by run range. No triggers are prescaled.

Run range	$\gamma\gamma$	$e\gamma$	ee	ff
160404-161215	Photon26_ IsoVL_ Photon18	Photon26_ IsoVL_ Photon18	Photon26_ IsoVL_ Photon18	Photon26_ IsoVL_ Photon18
161216-166346	Photon36_ CaloIdL_ Photon22_ CaloIdL	Photon36_ CaloIdL_ Photon22_ CaloIdL	Photon36_ CaloIdL_ Photon22_ CaloIdL	Photon36_ CaloIdL_ Photon22_ CaloIdL
166347-180252	Photon36_ CaloIdL_ IsoVL_ Photon22_ CaloIdL_ IsoVL	Photon36_ CaloIdL_ IsoVL_ Photon22_ CaloIdL_ IsoVL	Photon36_ CaloIdL_ IsoVL_ Photon22_ CaloIdL_ IsoVL Photon36_ CaloIdL_ IsoVL_ Photon22_ R9Id Photon36_ R9Id_ Photon22_ CaloIdL_ IsoVL Photon36_ R9Id_ Photon22_ R9Id	Photon36_ CaloIdL_ IsoVL_ Photon22_ CaloIdL_ IsoVL Photon36_ CaloIdL_ IsoVL_ Photon22_ R9Id Photon36_ R9Id_ Photon22_ CaloIdL_ IsoVL Photon36_ R9Id_ Photon22_ R9Id

- "Photon": Energy deposit in the ECAL that fired an L1 trigger (cf. Sec. **??**). For Photon26_IsoVL_Photon18, the L1 seed E_T threshold is 12 GeV, while for all other triggers in Table 1.1 it is 20 GeV.

- Integer following the word "Photon": E_T threshold in GeV for offline reconstructed photon, using the full photon reconstruction of Sec. 1.1.1 minus the laser calibrations and assuming the primary vertex at (0, 0, 0).

- "CaloIdL": For EB photons, $H/E < 0.15$ and $\sigma_{i\eta i\eta} < 0.014$.

- "IsoVL": $I_{\mathrm{ECAL}} < 0.012E_T + 6$ GeV, $I_{\mathrm{HCAL}} < 0.005E_T + 4$ GeV, and $I_{\mathrm{track}} < 0.002E_T + 4$ GeV.

- "R9Id": $R9 > 0.8$.

In addition, the versions of HLT_Photon26_IsoVL_Photon18 and Photon36_CaloIdL_Photon22_CaloIdL that were active during runs 160404-163268 included a cut $E_{\mathrm{max}}/E_{5\times5} < 0.98$ for spike rejection. E_{max} is the energy in the highest energy crystal of the EM cluster and $E_{5\times5}$ is the energy in the 5×5 crystal matrix around the seed crystal. All information about the evolution of the CMS HLT settings can be found in the HLT configuration browser at `http://j2eeps.cern.ch/cms-project-confdb-hltdev/browser/`.

As an example of the naming convention just described, the HLT path Photon36_CaloIdL_IsoVL_Photon22_R9Id is fired if one photon is found with $E_T > 36$ GeV passing the CaloIdL and IsoVL requirements, and another is found with $E_T > 22$ GeV passing the R9Id requirement.

1.3 Photon Identification Efficiency

Lorum ipsum fuck Republicans.