

Table of Contents

| | |
|--|----------|
| Search for High-Mass Diphoton Resonances - Analysis Page..... | 1 |
| CADI Entry EXO-10-019..... | 1 |
| Documentation:..... | 1 |
| Recent Presentations..... | 1 |
| Earlier Results..... | 1 |
| Analysis Code..... | 2 |
| Tags..... | 2 |
| Event and Photon Selection..... | 3 |
| Scripts for CRAB jobs..... | 3 |
| Code/Scripts for Making Histograms..... | 4 |
| To-Do List for Next Re-Processing..... | 4 |
| Summary Plots..... | 4 |
| Data..... | 5 |
| Third Processing..... | 6 |
| Fourth Processing..... | 7 |
| Event displays..... | 7 |
| MC: RS Graviton Signal..... | 7 |
| MC: Background..... | 8 |
| Limit-setting & Sensitivity Studies..... | 9 |
| Other Useful Information..... | 9 |

Search for High-Mass Diphoton Resonances - Analysis Page

THIS PAGE IS OUTDATED. PLEASE GO TO: [ExoticaDiphotonResonance](#)

- **Conor Henderson, Toyoko Orimoto (CERN)**
- **Yousi Ma (Caltech)**
- **Sean Simon (UCSD)**

CADI Entry EXO-10-019

<http://cms.cern.ch/iCMS/analysisadmin/viewanalysis?id=410&field=id&value=410&name=Search%20for%20Randall-Sundrum%20Gravitons%20in%20the%20Diphoton%20Final%20State>

Documentation:

Analysis Note AN-10-405 & PAS EXO-10-019

http://cms.cern.ch/iCMS/jsp/db_notes/showNoteDetails.jsp?noteID=CMS%20AN-2010/405

| Tag | Date | Comments |
|---------------|-------------|-----------|
| toyoko_061210 | 06 Dec 2010 | Version 1 |

Instructions for checking out note:

- <https://twiki.cern.ch/twiki/bin/view/CMS/Exotica2010WinterResonances>

To make a tag:

- `svn copy svn+ssh://svn.cern.ch/repos/tdr2/notes/AN-10-405/trunk svn+ssh://svn.cern.ch/repos/tdr2/notes/AN-10-405/trunk`

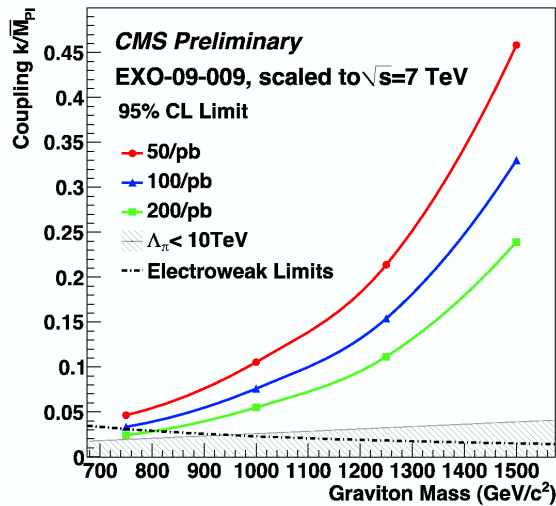
Recent Presentations

- Status report, Exotica Resonances, 12 Nov 2010
- Status report, Exotica Resonances, 3 Sept 2010
- First look at diphotons in data, Exotica Photons, 11 June 2010
- 7 TeV Scaling, Exotica, 09 March 2010
- Overview, Resonances Meeting, 06 November 2009

Earlier Results

- "Search for Randall-Sundrum Gravitons in the Diphoton Final State", Summer 2009
- "Search for Randall-Sundrum excitations of gravitons decaying into two photons for CMS at LHC", CMS NOTE-2006/051

Based on the earlier MC approved analysis EXO-09-009, our expected sensitivity after scaling to 7 TeV is shown here:



Previous publications from the Tevatron experiments on this topic:

- CDF publication with 5.4 pb-1 [↗](#)
- D0 publication with 5.4 pb-1 [↗](#)
- CDF publication with 1 pb-1 [↗](#)
- D0 publication with 1 pb-1 [↗](#)

Analysis Code

The base directory for our analysis code package is:

<http://cmssw.cvs.cern.ch/cgi-bin/cmssw.cgi/UserCode/ExoDiPhoton/DiPhotonAnalysis/> [↗](#)

A simple filter to preselect events with at least two reco::Photons (with configurable pt cuts) is in: DiPhotonFilter/

The analysis code for running on data is in: ExoDiPhotonAnalyzer/. Likewise, the code for running on signal MC and background MC are in ExoDiPhotonSignalMCAnalyzer and ExoDiPhotonBkgAnalyzer, respectively. Common header classes are defined in CommonClasses.

The idea is that, for our current relatively small datasets, we basically would like to go directly from RECO to histograms. The output of the analyser is just a basic tree, with information on the two highest-pT reconstructed photons which pass our tight photon ID and spike-removal cuts. The final histograms are then filled directly from these trees.

Tags

| Tag | Date | Comments |
|---------------|-------------|---|
| Data_38X_v4 | 14 Jan 2011 | New implementation of fake handling (only different for events with more than two tight/fakeable objects) |
| MC_36X_V4 | 29 Nov 2010 | Should be same as Data_38X_v3, but labeled for MC processing (Toyoko) |
| Data_38X_v3 | 29 Nov 2010 | For study of vertex effect on M _{gg} , add some branches to our output ntuple |
| Data_38X_V2 | 22 Nov 2010 | CommonClasses and ExoDiPhotonAnalyser for main reprocessing - many additions |
| toyoko_181110 | | "Unofficial" tag before adding changes for reprocessing in 38X |

| Tag | Date | Comments |
|-------------|--------------|--|
| | 18 Nov 2010 | |
| MC_36X_V3 | 08 Nov 2010 | Included GEN level info for filtering out double-counted particles |
| MC_36X_V2 | 30 Sep 2010 | Updated to latest Photon ID (Conor) and photon trigger paths (Toyoko) |
| Data_36X_V1 | 10 Sept 2010 | Corresponding to first main data processing using this ntuple format |
| MC_35X_V1 | Aug 2010 | The contents of CommonClasses and ExoDiPhotonBkgAnalyzer corresponding to first round of background trees. |

Event and Photon Selection

Event Selection

For basic event selection, we use the standard 'Good Vertex' and 'No Scraping' filters, as detailed in the Collisions 2010 twiki and links within (Note that we use a data vtx z-range of $\pm 24\text{cm}$, following a Physics Operations email of 5 August 2010)

More details can be found below at: #Third_Processing

Kinematic Requirements

- Photons $p_T > 30\text{ GeV}$
- Photon $\eta < 2.5$
- Photon $\eta < 1.4442$ && Photon $\eta < 1.566$ (excluding EB-EE gap)

Photon ID

For Photon ID, we use the recommended E-Gamma Tight ID selection:

- Had/EM < 0.05
- ecal Iso (cone 0.4) $< 4.2 + 0.006 \cdot p_T$
- hcal Iso (cone 0.4) $< 2.2 + 0.0025 \cdot p_T$
- track Iso (cone of 0.4) $< 2.0 + 0.001 \cdot p_T$
- $\sigma_{\eta\eta} < 0.013$ (EB), < 0.030 (EE)
- require No Pixel Seed

Spike cleaning procedure:

Spikes are automatically cleaned in the 38X series and beyond.

- <https://twiki.cern.ch/twiki/bin/viewauth/CMS/SWGuideEgammaSpikeCleaning>

Scripts for CRAB jobs

We've written some scripts to ease launching many jobs (for instance, many MC samples) to the GRID. They have been committed to DiPhotonAnalysis/ExoDiPhotonBkgAnalyzer/test/. They are currently set up to run on `*/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO` MC, but can easily be adapted to run on other samples.

[Click here to see detailed instructions](#) [hide](#)

All of the scripts can be used like this:

```
./launchDiphoton.sh DiPhotonBox_Pt250toInf
```

launchDiphoton.sh: Given a sample name as above, will create a subdirectory of the same name and will submit jobs to GRID via CRAB.

statusDiphoton.sh: Will simply execute "crab -status" for the sample given.

checkDiphoton.sh: Similar to statusDiphoton.sh, but will check for number of jobs in "submitted", "scheduled", "running", "done" states. Once all jobs are DONE, will retrieve output with "crab -get"

mergeDiphoton.sh: Merges root output and log files, and then copies them to castor, in:
/castor/cern.ch/user/t/torimoto/physics/diphoton/ntuples/mc/

Code/Scripts for Making Histograms

We've also written some ROOT code and scripts for making plots. They have been committed to DiPhotonAnalysis/ExoDiPhotonBkgAnalyzer/test/plots/. They run on the files stored in /castor/cern.ch/user/t/torimoto/physics/diphoton/ntuples/mc/.

Click here to see detailed instructions [hide](#)

fTree.h, fTree.C: Simple ROOT class (adapted from the output of MakeClass from the diphoton TTree) which applies pT cut on the two photons and produces basic histograms (trigger, kinematics, isolation, spike rejection, etc). To compile, simply run in ROOT:

```
.L fTree.C++;
```

fTreeData.h, fTreeData.C: Same as fTree but with MC blocks commented out to run on Data.

make_diphoton_plots.C: Macro which uses fTree to run over ntuples and draw histograms.

plotDiphoton.sh: Script which runs the above macro (make_diphoton_plots.C) and creates nice webpages. Can be edited to run on data. To run: .

```
./plotDiphoton.sh DiPhotonBox_Pt250toInf
```

To-Do List for Next Re-Processing

- Ideas for further improvements:
 - ◆ save every RECO photon with $p_T > 30$ GeV ?
 - ◆ Utilize wider gap (from Sean's Photon ID optimization studies)
 - ◆ use E2/E9 for spike removal

Summary Plots

Data

- http://torimoto.web.cern.ch/torimoto/physics/diphoton/data/Data_38X_V3/data_33.9pb_onlyEB/
- http://torimoto.web.cern.ch/torimoto/physics/diphoton/data/Data_38X_V3/DataMC_33.9pb_onlyEB/

MC Background

- http://torimoto.web.cern.ch/torimoto/physics/diphoton/mc/MC_36X_V4/allMC_33.9pb_onlyEB/

NB: All plots have required the selection described above

Data

☒ Show Outdated Processing ☐ hide

Most Recent Edition

| Dataset | JSON file | Run range |
|----------------------------------|---|-----------|
| /EG/Run2010A-Sep17ReReco_v2/RECO | Cert_132440-146729_7TeV_StreamExpress_Collisions10_JSON.txt | All? |

First Processing

| | |
|--------------------------------|---|
| Dataset | /MinimumBias/Commissioning10-SD_EG-v9/RECO |
| JSON file | Cert_132440-135735_7TeV_StreamExpress_Collisions10_JSON.txt |
| Corresponding lumi | 7.49 nb-1 |
| ExoDiPhotonAnalyzer.cc version | v1.4 |
| Analyzer CMSSW version | CMSSW_3_5_6 |
| Ntuple location | /castor/cern.ch/user/c/chenders/DiPhotons/data/v1/ |
| Files | diphoton_tree_data_EG_SD_run135735.root |

This first processing did not use official spike-cleaning procedure. It only used a simple $e1/e3 \times 3 < 0.95$ requirement to reject spikes at the supercluster level.

Second Processing

This will be an update to use the official spike cleaning procedure, switch to CMSSW_3_6_X, and add more data.

- Spike-cleaned re-RECO in dbs:
 - ◆ in cms_dbs_ph_analysis_02
 - * /EG/yma-361pathc2_rereco__Run2010A-PromptReco-v2-d75f32b7c2df81b652d4a295489c0d32/US

Data processed in 363, using the official spike removal, then simple diphoton filter ($pt > 5, 5$), then reclustering, then ExoAnalyzer code:

Hadd'ed ntuples are being stored in castor, in

/castor/cern.ch/user/y/yma/RSGravitons/Sep2010

along with associated lumiSummary.json, and lumiCalc.txt (output of Lumi calc script)

| Run Number Range | Data set official name | Ntuple Info |
|------------------|--|---------------------------------|
| 132440-135735 | /MinimumBias/Commissioning10-SD_EG-Jun14thSkim_v1/RECO | /castor/cern.ch/user/y/yma/RSGr |

| Run Number Range | Data set official name | Ntuple Info |
|------------------|------------------------------------|---------------------------------|
| 136066-137028 | /EG/Run2010A-Jun14thReReco_v1/RECO | /castor/cern.ch/user/y/yma/RSGr |
| 139779-140159 | /EG/Run2010A-Jul16thReReco_v2/RECO | /castor/cern.ch/user/y/yma/RSGr |
| 138564-141961 | /EG/Run2010A-PromptReco-v4/RECO | /castor/cern.ch/user/y/yma/RSGr |
| 141961-144114 | /EG/Run2010A-PromptReco-v4/RECO | /castor/cern.ch/user/y/yma/RSGr |
| | | |

Third Processing

updated to 38X to use sept17re-RECO (spike cleaning included) and also to read Run2010B data (RECO's in 38X).

event selection includes:

```
process.primaryVertexFilter = cms.EDFilter("GoodVertexFilter", vertexCollection =
cms.InputTag('offlinePrimaryVertices'), minimumNDOF = cms.uint32(4), maxAbsZ = cms.double(24),
maxd0 = cms.double(2) )
```

```
process.noScraping = cms.EDFilter("FilterOutScraping", applyfilter = cms.untracked.bool(True), debugOn =
cms.untracked.bool(False), numtrack = cms.untracked.uint32(10), thresh = cms.untracked.double(0.25) )
```

```
process.diphotonFilter.ptMin_photon1 = 10.0
```

```
process.diphotonFilter.ptMin_photon2 = 10.0
```

| Run Number Range | Data set official name | Ntuple Info |
|------------------|-------------------------------------|---|
| 136035-144010 | /EG/Run2010A-Sep17ReReco-v2/RECO | /castor/cern.ch/user/y/yma/RSGravitons/Oct2010/diphoto |
| 136035-144114 | /EG/Run2010A-Sep17ReReco-v2/RECO | /castor/cern.ch/user/c/chenders/DiPhotons/data/v2/diphoto |
| 146428-147116 | /Photon/Run2010B-PromptReco-v2/RECO | /castor/cern.ch/user/y/yma/RSGravitons/Oct2010/diphoto |
| 147115-147454 | /Photon/Run2010B-PromptReco-v2/RECO | /castor/cern.ch/user/y/yma/RSGravitons/Oct2010/diphoto |
| 147757-148058 | /Photon/Run2010B-promptreco-v2/RECO | /castor/cern.ch/user/y/yma/RSGravitons/Oct2010/ |
| 148822-148864 | /Photon/Run2010B-promptreco-v2/RECO | /castor/cern.ch/user/y/yma/RSGravitons/Oct2010/ |
| 148952-149294 | /Photon/Run2010B-promptreco-v2/RECO | /castor/cern.ch/user/y/yma/RSGravitons/Nov2010 |

| Run Number Range | Data set official name | Ntuple Info |
|------------------|--|--|
| | /EG/Run2010A-Sep17ReReco-v2/RECO | www.hep.caltech.edu/~yma/RS2010/diphoton_tree_2010A.html |
| | /Photon/Run2010B-SuperCluster-Nov4Skim_v1/RECO | www.hep.caltech.edu/~yma/RS2010/diphoton_tree_2010B.html |

MC: RS Graviton Signal

| | |
|----------|--|
| Datasets | /RSGravToGG_kMpl001_M-250_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl001_M-500_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl001_M-750_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl001_M-1000_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl001_M-1250_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl001_M-1500_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl005_M-500_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl005_M-750_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl005_M-1000_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl005_M-1250_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl005_M-1500_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl005_M-1750_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl01_M-750_7TeV-pythia6/Spring10-5 |
| | /RSGravToGG_kMpl01_M-1000_7TeV-pythia6/Spring10 |

| | |
|--|--|
| | /RSGravToGG_kMpl01_M-1250_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl01_M-1500_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl01_M-1750_7TeV-pythia6/Spring10 |
| | /RSGravToGG_kMpl01_M-2000_7TeV-pythia6/Spring10 |
| Ntuple location | |
| first version | |
| /castor/cern.ch/user/c/chenders/DiPhotons/RSGravitons/v2 | |
| MC_36X_V2 | /castor/cern.ch/user/t/torimoto/physics/diphoton/ntuples/m |

MC: Background

Locations of ntuples: /castor/cern.ch/user/t/torimoto/physics/diphoton/ntuples/mc/

[Background MC Samples](#) [hide](#)

| DiPhoton Born & Box | |
|---------------------|---|
| | /DiPhotonBorn_Pt10to25/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /DiPhotonBorn_Pt25to250/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /DiPhotonBorn_Pt250toInf/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /DiPhotonBox_Pt10to25/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /DiPhotonBox_Pt25to250/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /DiPhotonBox_Pt250toInf/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| PhotonJet | |
| | /PhotonJet_Pt0to15/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt15to20/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt20to30/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt30to50/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt50to80/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt80to120/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt120to170/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt170to300/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /PhotonJet_Pt300to500/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| QCD DiJet | |
| | /QCDDiJet_Pt80to120/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt800to1000/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt600to800/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt50to80/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt470to600/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt380to470/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt30to50/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt300to380/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt3000to3500/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt2600to3000/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt230to300/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt2200to2600/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt20to30/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt1800to2200/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt170to230/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt15to20/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt1400to1800/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |

| DiPhoton Born & Box | |
|---------------------|---|
| | /QCDDiJet_Pt120to170/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt1000to1400/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| | /QCDDiJet_Pt0to15/Spring10-START3X_V26_S09-v1/GEN-SIM-RECO |
| DrellYan | |
| | /DYToEE_M-20_7TeV-powheg-pythia6/Spring10-START3X_V26-v1/GEN-SIM-RECO |
| | /DYToEE_M-120_7TeV-pythia6/Spring10-START3X_V26-v2/GEN-SIM-RECO |
| | /DYToEE_M-200_7TeV-pythia6/Spring10-START3X_V26-v2/GEN-SIM-RECO |
| | /DYToEE_M-500_7TeV-pythia6/Spring10-START3X_V26-v2/GEN-SIM-RECO |
| | /DYToEE_M-800_7TeV-pythia6/Spring10-START3X_V26-v2/GEN-SIM-RECO |

Limit-setting & Sensitivity Studies

We use the CMS Exotica supported package (ExoSt) for producing limits:
<https://twiki.cern.ch/twiki/bin/view/CMS/ExoSt>

We also use the "95 percent Confidence Level Limit Calculator" from the Exotica group.

Other Useful Information

Spring2010 MC Twiki: <https://twiki.cern.ch/twiki/bin/viewauth/CMS/ProductionReProcessingSpring10>

Fall2010 MC Links:

- Requests: <https://twiki.cern.ch/twiki/bin/view/CMS/ProductionFall2010>
- Status: <http://vdutta.web.cern.ch/vdutta/Fall10ProductionRECOglobal.html>
- Status: <http://ceballos.web.cern.ch/ceballos/production/Fall10ProductionRECOglobal.html>

EventNumberFilter: for selecting individual events, given a run

- [EventNumberFilter.cc](#)
- [eventNumberFilter_cfi.py](#)
- To check out code:

```
cvs co -d CaloOnlineTools/EventNumberFilter/ UserCode/CCEcal/CRUZET2/CaloOnlineTool
```

EventDisplays: Fireworks & iSpy/Iguana

- [More Info Here](#)
- [Example iSpy config file](#)

-- ConorHenderson - 03-Jun-2010

- [RS_evt1.pdf](#): event display, EB only
- [RS_evt2.pdf](#): event display #2, EB only
- [RS_evt3.pdf](#): event display #3, EB only

This topic: Main > DiPhotonResonanceAnalysis
 Topic revision: r59 - 2011-05-01 - ToyokoOrimoto



Copyright &© 2008-2024 by the contributing authors. All material on this collaboration platform is the property of the contributing authors.
or Ideas, requests, problems regarding TWiki? use [Discourse](#) or [Send feedback](#)