

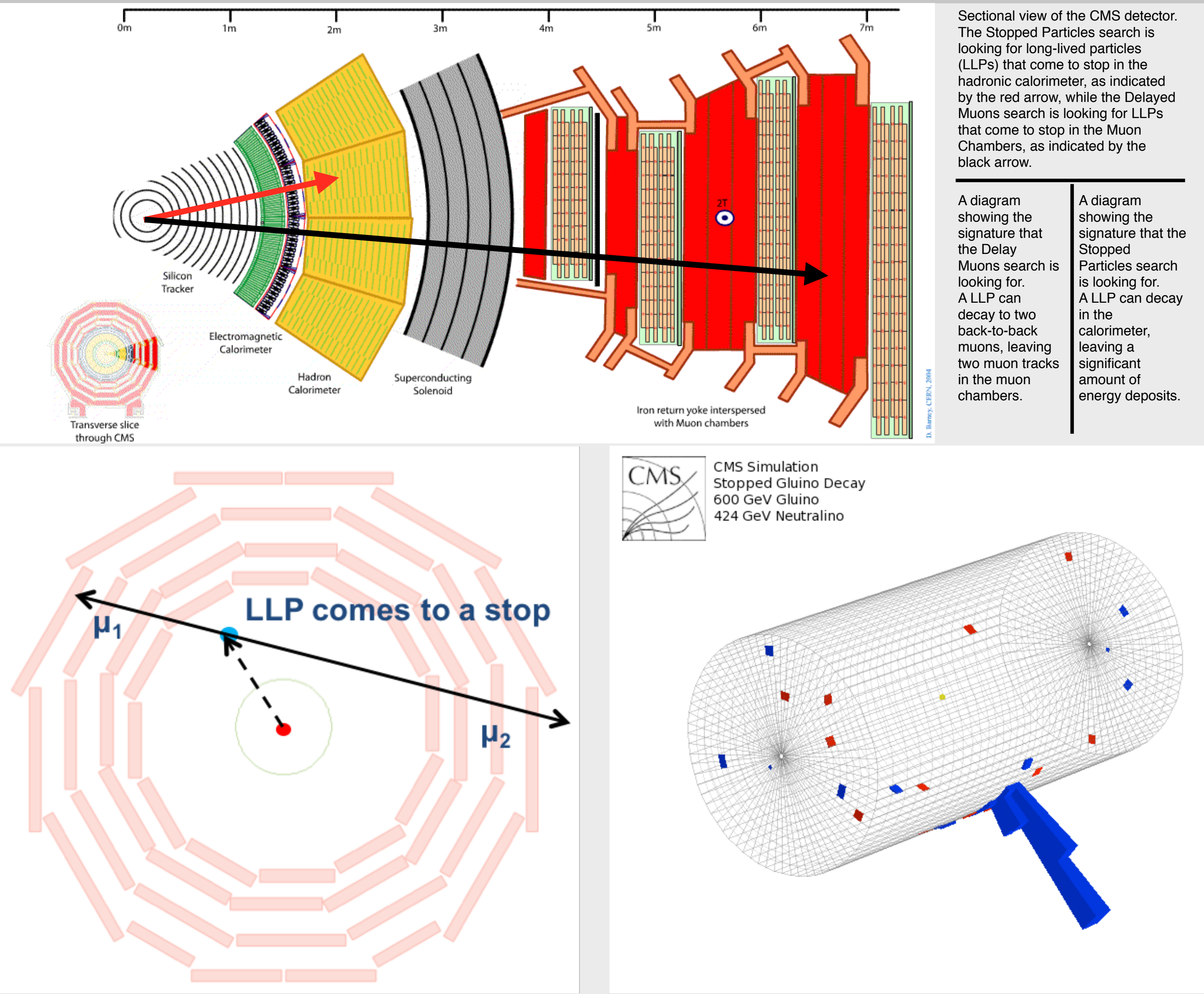
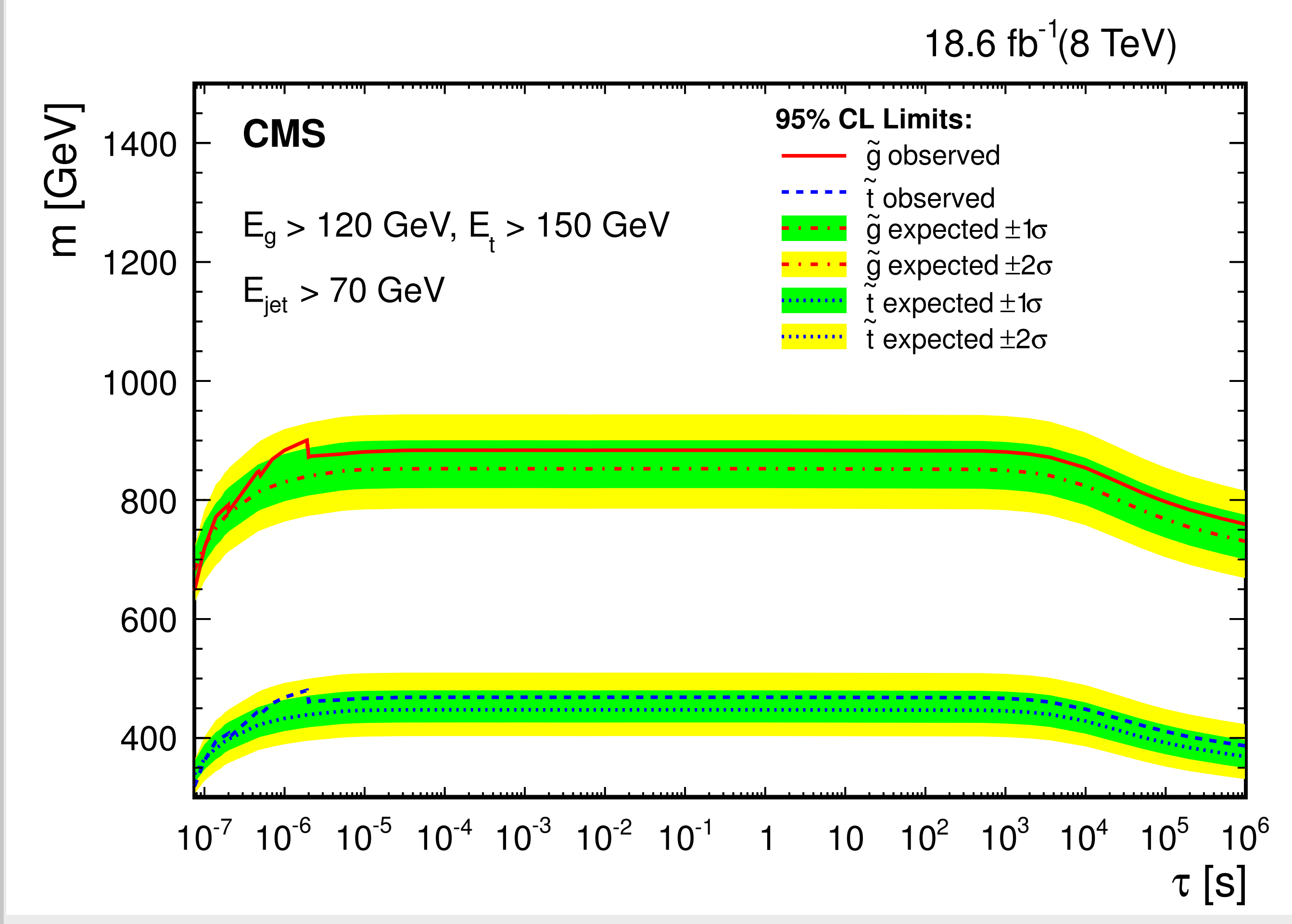
The Compact Muon Solenoid Experiment



Search for Stopped Particles/Delayed Muons proton-proton Collisions

Juliette Alimena, Chris Hill, Weifeng Ji, Wells Wulsin

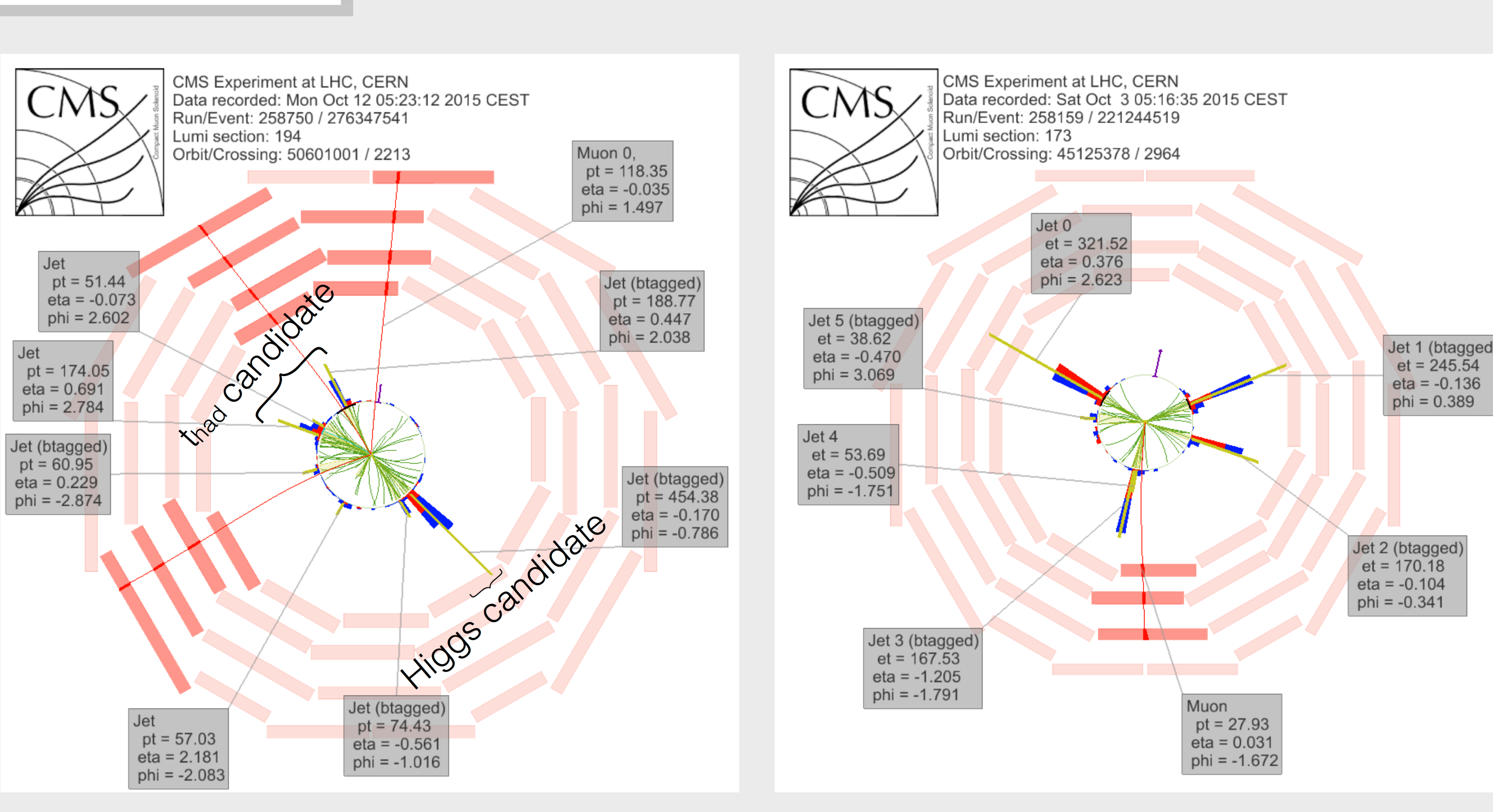
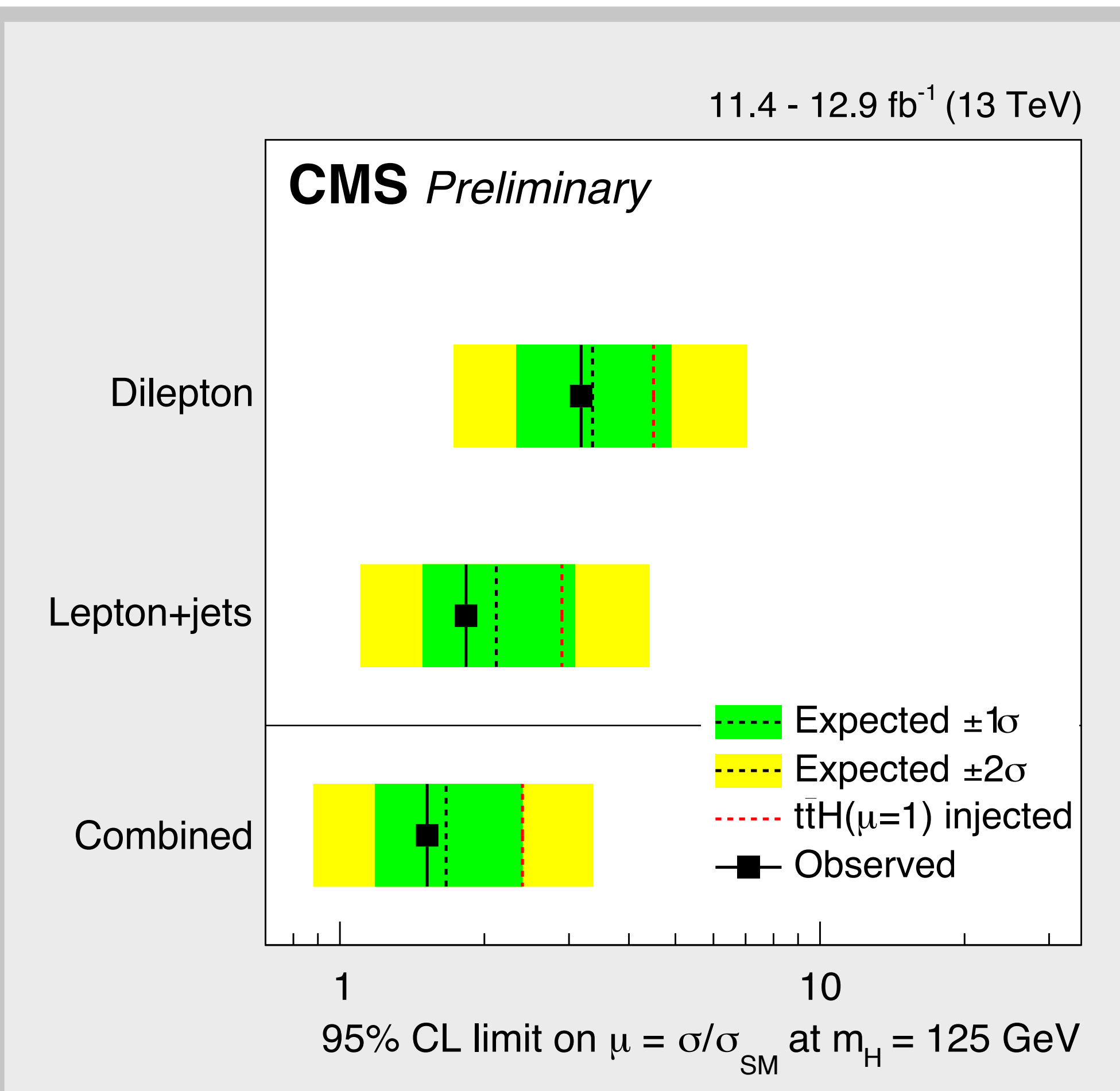
We are performing a search for long-lived particles that could have come to rest within the CMS detector, using the time intervals between LHC beam crossings. The existence of such particles could be deduced from observation of their decays via energy deposits in the CMS calorimeter or highly displaced muons in the CMS muon system, appearing at times that are well separated from any proton-proton collisions. Since we search for signs of these particles when there are no proton beams, the main backgrounds are not Standard Model processes from proton collisions, but rather muons from cosmic rays, instrumental noise, and muons from beam halo. The results are interpreted with models that predict long-lived gluinos and top squarks, and cross section limits are set for over 13 orders of magnitude in the mean proper lifetime of the stopped particle as one can see in the plot below.



Early results on $t\bar{t}H$ with H to $b\bar{b}$ at 13 TeV

Sean Flowers, Tony Lefeld, Wuming Luo, Darren Puigh, Brian Winer

First results of the search for the associated production of a Higgs boson with a top quark-antiquark pair ($t\bar{t}H$) in proton-proton collisions at a center-of-mass energy of $\sqrt{s} = 13\text{TeV}$ are presented. Candidate $t\bar{t}H$ events are selected with criteria enhancing the lepton+jets or dileptonic decay channels of the $t\bar{t}$ system and the decay of the Higgs boson into a bottom quark-antiquark pair ($H \rightarrow b\bar{b}$). The result is presented in terms of the $t\bar{t}H$ signal strength modifier μ , the ratio of the observed $t\bar{t}H$ production cross section relative to the value expected for a 125 GeV standard model Higgs boson. A combined fit of multivariate discriminant templates in all categories to data results in an observed (expected) upper limit of $\mu < 1.5$ (1.7) at the 95% confidence level.

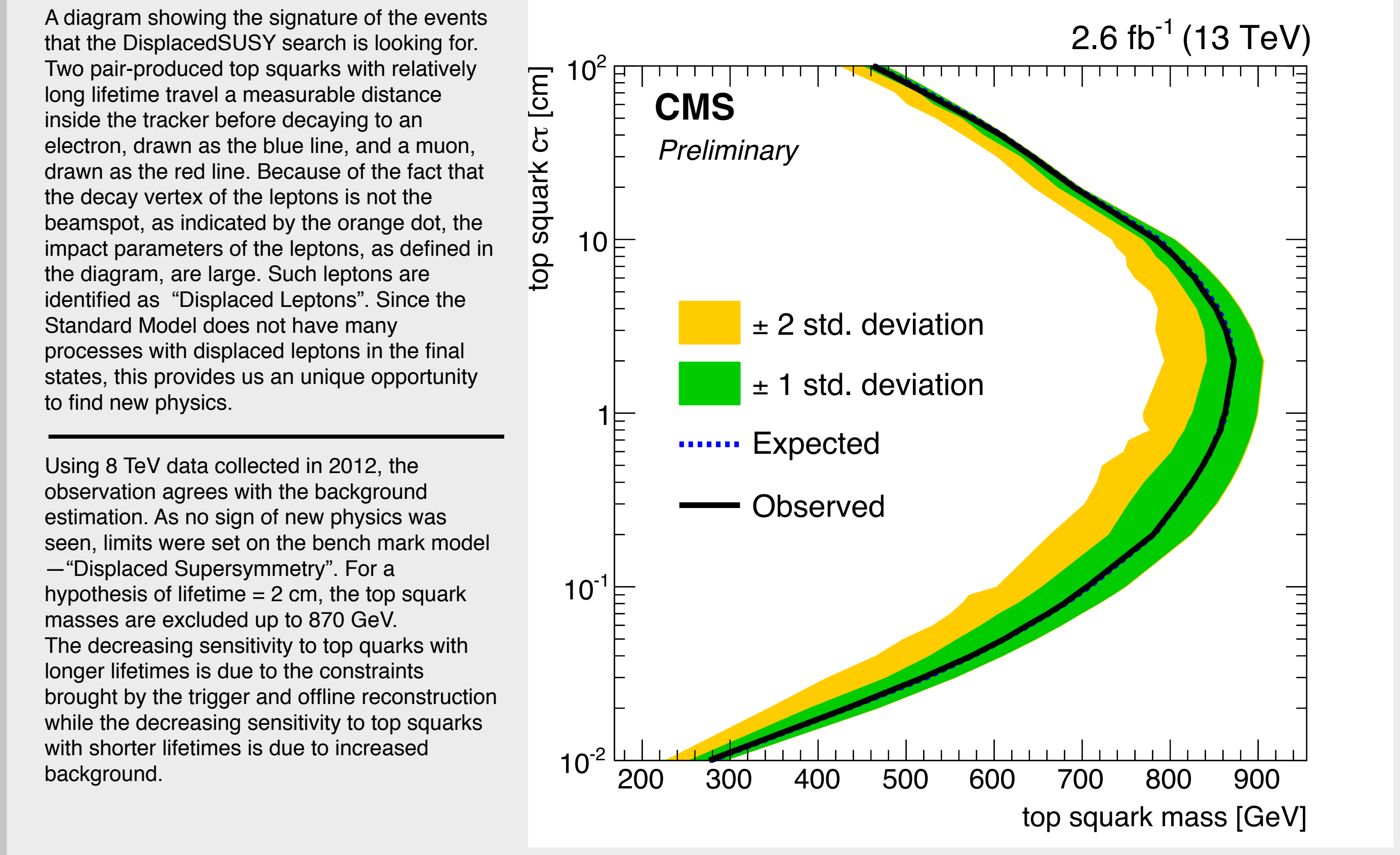
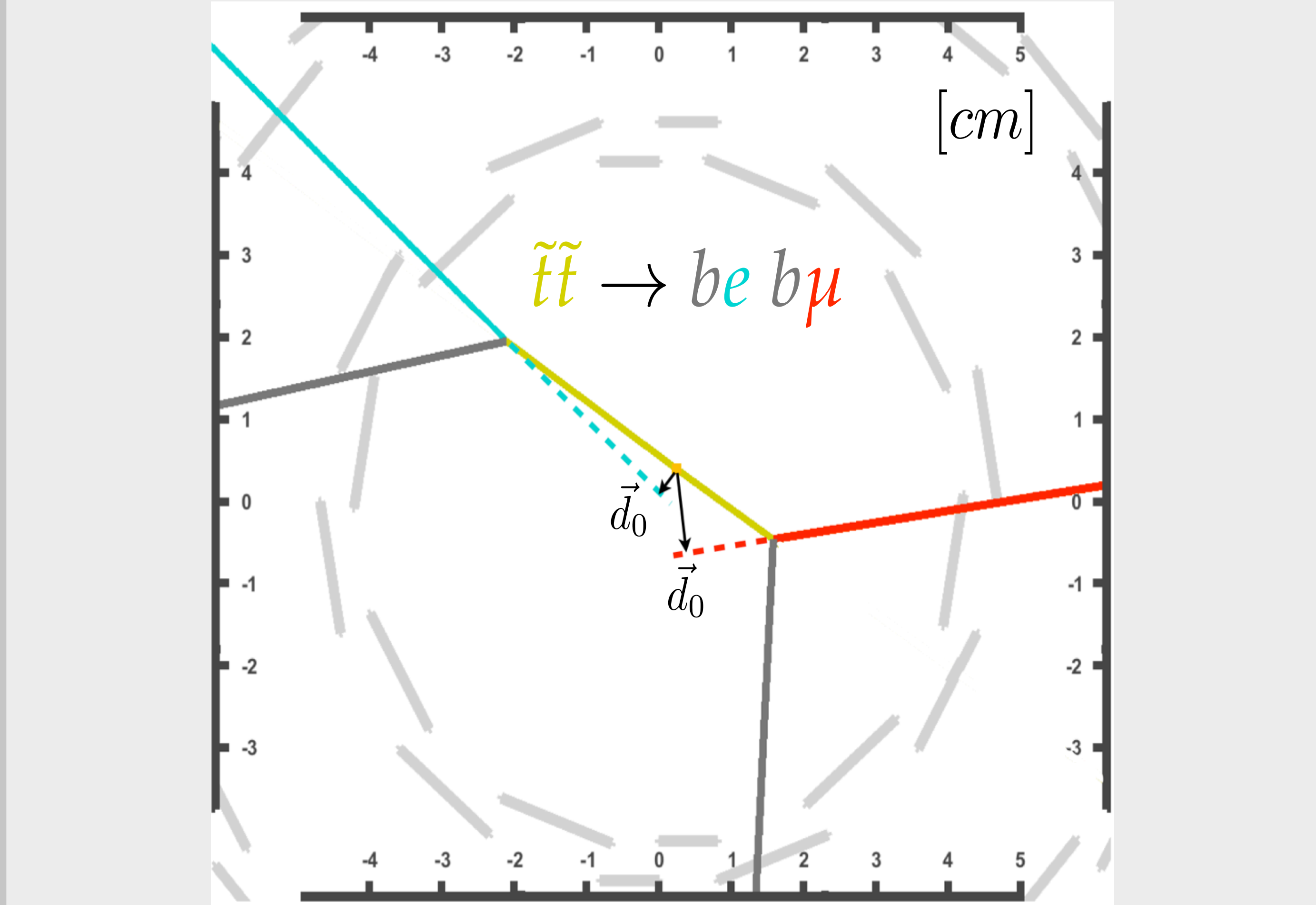


(a) Best-fit values of the signal strength modifiers μ with their $\pm 1\sigma$ confidence intervals. (b) Median expected and observed 95% CL upper limits on μ . The expected limits are displayed together with $\pm 1\sigma$ and $\pm 2\sigma$ confidence intervals. Visualization of the detector signature of an event passing the single muon trigger, the lepton+jets boosted selection and the lepton+jets ≥ 6 jets, ≥ 4 b-tags selection. The properties of jets clustered with the anti-k algorithm are shown in the boxes. In addition, the candidates for the hadronically decaying top quark (t_{had}) and the Higgs boson as identified by the boosted event reconstruction are marked.

Search for Displaced Supersymmetry in Events with an Electron and a Muon with Large Impact Parameters

Jamie Antonelli, Chris Hill, Bingxuan Liu

Almost all searches at CMS for physics beyond the standard model assume that the new particle decays promptly and the decay products originate from the center of CMS. Our search explicitly targets decays of new long-lived particles decaying to electrons and muons. Our search could be sensitive to relatively obvious signals of new particles that would be missed by all previous searches at the LHC. The final search had less than one event of background expected. Since no events were seen in the data, we present our results as exclusions in the plane of the mass and lifetime of the proposed new particle. For some lifetimes, any particle lighter than 870 GeV is excluded.



Using 8 TeV data collected in 2012, the observation agrees with the background estimation. As no sign of new physics was seen, limits were set on the benchmark model — “Displaced Supersymmetry”. For a hypothesis of lifetime = 2 cm, the top squark masses are excluded up to 870 GeV. The decreasing sensitivity to top squarks with longer lifetimes is due to the constraints brought by the trigger and offline reconstruction while the decreasing sensitivity to top squarks with shorter lifetimes is due to increased background.

Professors: Stan Durkin, Chris Hill, Brian Winer
 Postdoctoral Researchers: Juliette Alimena, Jamie Antonelli, Brian Francis, Wuming Luo
 PHD Students: Sean Flowers, Andrew Hart, Weifeng Ji, Tony Lefeld

Scan for the links to the papers/public webpages:

Stopped Particles Analysis Paper
 EPJ C (2015) 76:151

$t\bar{t}H$ Analysis
 Public Webpage

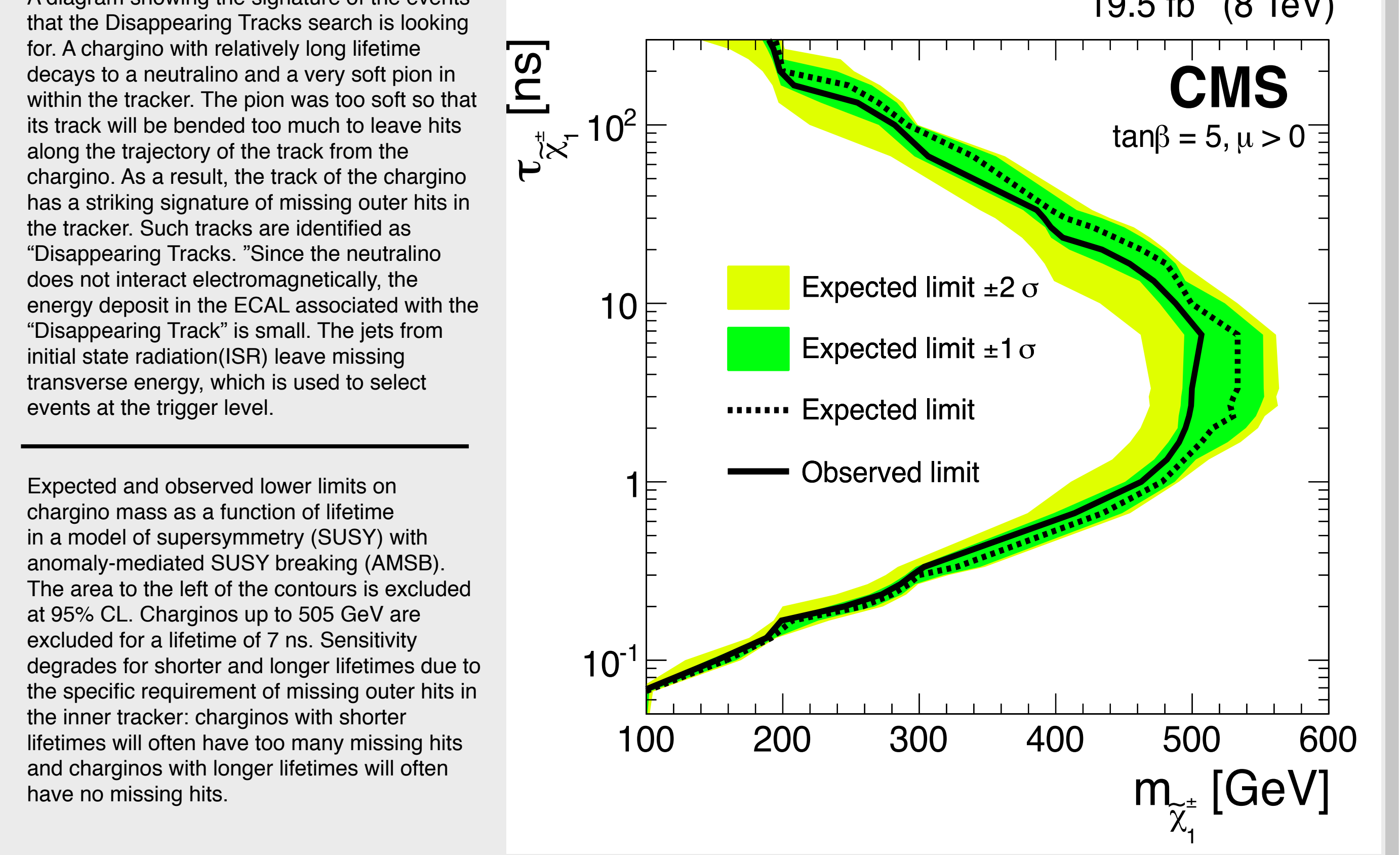
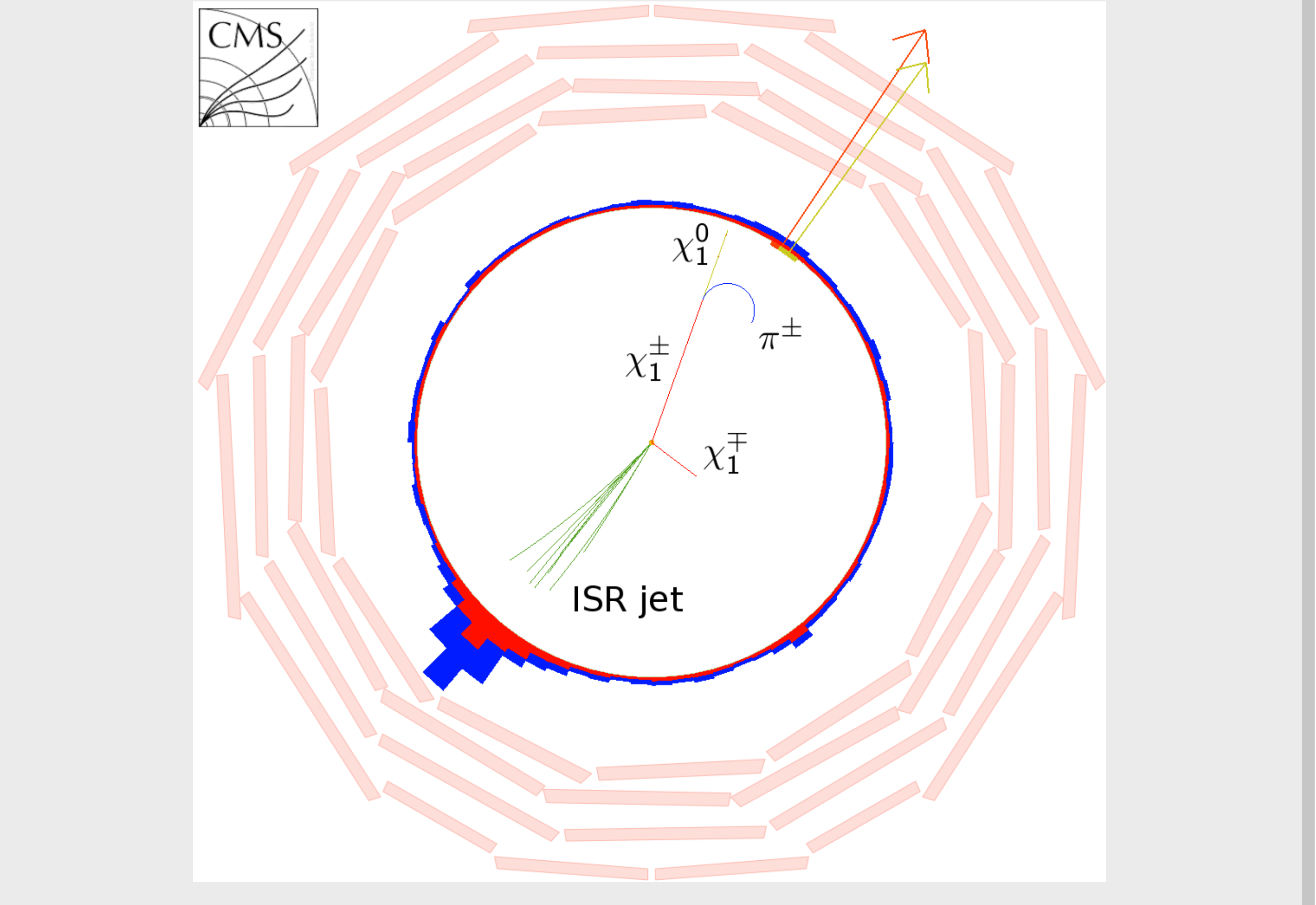
Displaced SUSY Analysis
 Public Webpage

Disappearing Tracks Analysis Paper
 10.1007/JHEP01(2015)096

Search for Disappearing Tracks in proton-proton Collisions

Jessica Brinson, Brian Francis, Andrew Hart, Chris Hill, Wells Wulsin

We search for long-lived charged particles that disappear in the detector with missing hits in inner tracker, missing calorimeter energy and missing hits in muon system. The signature is striking as the standard model has no such phenomenon. It is realized in models of supersymmetry with nearly degenerate chargino and neutralino. Observation in run 1 agreed very well with background estimates and no sign of new physics was seen. Lower limits were placed on the mass of a long-lived chargino as a function of the lifetime. Charginos with mass less than 505 GeV and lifetime of 7 ns were excluded. The search using the 13 TeV data collected in 2015 and 2016 is ongoing.



Expected and observed lower limits on chargino mass as a function of lifetime in a model of supersymmetry (SUSY) with anomaly-mediated SUSY breaking (AMSB). The area to the left of the contours is excluded at 95% CL. Charginos up to 505 GeV are excluded for a lifetime of 7 ns. Sensitivity degrades for shorter and longer lifetimes due to the specific requirement of missing outer hits in the inner tracker: charginos with shorter lifetimes will often have too many missing hits and charginos with longer lifetimes will often have no missing hits.

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