Topology-based approach to discovering new physics

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outline

- why a topology-based discovery plan is a good idea
- a detailed example: dijets
- theory models as templates for searches
- missing energy topologies
- your friendly neighborhood theorist
- critical mass@LPC

inclusive vs exclusive searches@LHC

- there are a very large number of exclusive channels@LHC

- eventually we must examine them all

  → develop global analysis tools

- even at startup, some exclusive channels will need immediate strong efforts, especially those critical for SM Higgs search:

$\mu^+\mu^-\mu^+\mu^-$	not so bad
$\gamma\gamma$	hard
jj $\tau\tau$	harder

Vista output

CDF Run II preliminary (927 pb^{-1})

Final State	Data	Background	Final State	Data	Background	Final State	Data	Background
3jτ+	71	113.7 ± 3.6	2e+j	13	9.8 ± 2.2	e+$\gamma\not{p}$	141	144.2 ± 6
5j	1661	1902.9 ± 50.8	2e+e-	12	4.8 ± 1.2	e+μ-$\not{p}$	54	42.6 ± 2.7
2jτ+	233	296.5 ± 5.6	2e+	23	36.1 ± 3.8	e+μ+$\not{p}$	13	10.9 ± 1.3
be+j	2207	2015.4 ± 28.7	2b $\Sigma p_T > 400$ GeV	327	335.8 ± 7	e+μ-	153	127.6 ± 4.2
3j $\Sigma p_T < 400$ GeV	35436	37294.6 ± 524.3	2b $\Sigma p_T < 400$ GeV	187	173.1 ± 7.1	e+j	386880	392614 ± 5031.8
e+3j$\not{p}$	1954	1751.6 ± 42	2b3j $\Sigma p_T < 400$ GeV	28	33.5 ± 5.5	e+j2γ	14	15.9 ± 2.9
be+2j	798	695.3 ± 13.3	2b2j $\Sigma p_T > 400$ GeV	355	326.3 ± 8.4	e+jτ+	79	79.3 ± 2.9
3j$\not{p}$ $\Sigma p_T > 400$ GeV	811	967.5 ± 38.4	2b2j $\Sigma p_T < 400$ GeV	56	80.2 ± 5	e+jτ-	162	148.8 ± 7.6
e+μ+	26	11.6 ± 1.5	2b2jγ	16	15.4 ± 3.6	e+j$\not{p}$	58648	57391.7 ± 661.6
e+γ	636	551.2 ± 11.2	2bγ	37	31.7 ± 4.8	e+j$\gamma\not{p}$	52	76.2 ± 9
e+3j	28656	27281.5 ± 405.2	2bj $\Sigma p_T > 400$ GeV	415	393.8 ± 9.1	e+jμ-$\not{p}$	22	13.1 ± 1.7
b5j	131	95 ± 4.7	2bj $\Sigma p_T < 400$ GeV	161	195.8 ± 8.3	e+jμ-	28	26.8 ± 2.3
j2τ+	50	85.6 ± 8.2	2bj$\not{p}$ $\Sigma p_T > 400$ GeV	28	23.2 ± 2.6	e+e-4j	103	113.5 ± 5.9
jτ+τ-	74	125 ± 13.6	2bjγ	25	24.7 ± 4.3	e+e-3j	456	473 ± 14.6
b$\not{p}$ $\Sigma p_T > 400$ GeV	10	29.5 ± 4.6	2be+2j$\not{p}$	15	12.3 ± 1.6	e+e-2j$\not{p}$	30	39 ± 4.6
e+jγ	286	369.4 ± 21.1	2be+2j	30	30.5 ± 2.5	e+e-2j	2149	2152 ± 40.1
e+j$\not{p}\tau$-	29	14.2 ± 1.8	2be+j	28	29.1 ± 2.8	e+e-τ+	14	11.1 ± 2
2j $\Sigma p_T < 400$ GeV	96502	92437.3 ± 1354.5	2be+	48	45.2 ± 3.7	e+e-$\not{p}$	491	487.9 ± 12
be+3j	356	298.6 ± 7.7	τ+τ-	498	428.5 ± 22.7	e+e-γ	127	132.3 ± 4.2
8j	11	6.1 ± 2.5	$\gamma\tau$+	177	204.4 ± 5.4	e+e-j	10726	10669.3 ± 123.5
7j	57	35.6 ± 4.9	$\gamma\not{p}$	1952	1945.8 ± 77.1	e+e-j$\not{p}$	157	144 ± 11.2
6j	335	298.4 ± 14.7	μ+τ+	18	19.8 ± 2.3	e+e-jγ	26	45.6 ± 4.7
4j $\Sigma p_T > 400$ GeV	39665	40898.8 ± 649.2	μ+τ-	151	179.1 ± 4.7	e+e-	58344	58575.6 ± 603.9
4j $\Sigma p_T < 400$ GeV	8241	8403.7 ± 144.7	μ+$\not{p}$	321351	320500 ± 3475.5	b6j	24	15.5 ± 2.3
4j2γ	38	57.5 ± 11	μ+$\not{p}\tau$-	22	25.8 ± 2.7	b4j $\Sigma p_T > 400$ GeV	13	9.2 ± 1.8
4jτ+	20	36.9 ± 2.4	μ+γ	269	285.5 ± 5.9	b4j $\Sigma p_T < 400$ GeV	464	499.2 ± 12.4
4j$\not{p}$ $\Sigma p_T > 400$ GeV	516	525.2 ± 34.5	μ+$\gamma\not{p}$	269	282.2 ± 6.6	b3j $\Sigma p_T > 400$ GeV	5354	5285 ± 72.4
4j$\gamma\not{p}$	28	53.8 ± 11	μ+μ-$\not{p}$	49	61.4 ± 3.5	b3j $\Sigma p_T < 400$ GeV	1639	1558.9 ± 24.1
4jγ	3693	3827.2 ± 112.1	μ+μ-γ	32	29.9 ± 2.6	b3j$\not{p}$ $\Sigma p_T > 400$ GeV	111	116.8 ± 11.2
4jμ+	576	568.2 ± 26.1	μ+μ-	10648	10845.6 ± 96	b3jγ	182	194.1 ± 8.8
4jμ+$\not{p}$	232	224.7 ± 8.5	j2γ	2196	2200.3 ± 35.2	b3jμ+$\not{p}$	37	34.1 ± 2
4jμ+μ-	17	20.1 ± 2.5	j2$\gamma\not{p}$	38	27.3 ± 3.2	b3jμ+	47	52.2 ± 3
3γ	13	24.2 ± 3	jτ+	563	585.7 ± 10.2	b2γ	15	14.6 ± 2.1
3j $\Sigma p_T > 400$ GeV	75894	75939.2 ± 1043.9	j$\not{p}$ $\Sigma p_T > 400$ GeV	4183	4209.1 ± 56.1	b2j $\Sigma p_T > 400$ GeV	8812	8576.2 ± 97.9
3j2γ	145	178.1 ± 7.4	jγ	49052	48743 ± 546.3	b2j $\Sigma p_T < 400$ GeV	4691	4646.2 ± 57.7
3j$\not{p}$ $\Sigma p_T < 400$ GeV	20	30.9 ± 14.4	j$\gamma\tau$+	106	104 ± 4.1	b2j$\not{p}$ $\Sigma p_T > 400$ GeV	198	209.2 ± 8.3
3j$\gamma\tau$+	13	11 ± 2	j$\gamma\not{p}$	913	965.2 ± 41.5	b2jγ	429	425.1 ± 13.1
3j$\gamma\not{p}$	83	102.9 ± 11.1	jμ+	33462	34026.7 ± 510.1	b2jμ+$\not{p}$	46	40.1 ± 2.7
3jγ	11424	11506.4 ± 190.6	jμ+τ-	29	37.5 ± 4.5	b2jμ+	56	60.6 ± 3.4
3jμ+$\not{p}$	1114	1118.7 ± 27.1	jμ+$\not{p}\tau$-	10	9.6 ± 2.1	bτ+	19	19.9 ± 2.2
3jμ+μ-	61	84.5 ± 9.2	jμ+$\not{p}$	45728	46316.4 ± 568.2	bγ	976	1034.8 ± 15.6
3jμ+	2132	2168.7 ± 64.2	jμ+$\gamma\not{p}$	78	69.8 ± 9.9	b$\gamma\not{p}$	18	16.7 ± 3.1
3bj $\Sigma p_T > 400$ GeV	14	9.3 ± 1.9	jμ+γ	70	98.4 ± 12.1	bμ+	303	263.5 ± 7.9
2τ+	316	290.8 ± 24.2	jμ+μ-	1977	2093.3 ± 74.7	bμ+$\not{p}$	204	218.1 ± 6.4
2$\gamma\not{p}$	161	176 ± 9.1	e+4j	7144	6661.9 ± 147.2	bj $\Sigma p_T > 400$ GeV	9060	9275.7 ± 87.8
2γ	8482	8349.1 ± 84.1	e+4j$\not{p}$	403	363 ± 9.9	bj $\Sigma p_T < 400$ GeV	7236	7030.8 ± 74
2j $\Sigma p_T > 400$ GeV	93408	92789.5 ± 1138.2	e+3jτ-	11	7.6 ± 1.6	bj2γ	13	17.6 ± 3.3
2j2γ	645	612.6 ± 18.8	e+3jγ	27	21.7 ± 3.4	bjτ+	13	12.9 ± 1.8
2jτ+τ-	15	25 ± 3.5	e+2γ	47	74.5 ± 5	bj$\not{p}$ $\Sigma p_T > 400$ GeV	53	60.4 ± 19.9
2j$\not{p}$ $\Sigma p_T > 400$ GeV	74	106 ± 7.8	e+2j	126665	122457 ± 1672.6	bjγ	937	989.4 ± 20.6
2j$\not{p}$ $\Sigma p_T < 400$ GeV	43	37.7 ± 100.2	e+2jτ-	53	37.3 ± 3.9	bj$\gamma\not{p}$	34	30.5 ± 4
2jγ	33684	33259.9 ± 397.6	e+2jτ+	20	24.7 ± 2.3	bjμ+$\not{p}$	104	112.6 ± 4.4
2j$\gamma\tau$+	48	41.4 ± 3.4	e+2j$\not{p}$	12451	12130.1 ± 159.4	bjμ+	173	141.4 ± 4.8
2j$\gamma\not{p}$	403	425.2 ± 29.7	e+2jγ	101	88.9 ± 6.1	be+3j$\not{p}$	68	52.2 ± 2.2
2jμ+$\not{p}$	7287	7320.5 ± 118.9	e+τ-	609	555.9 ± 10.2	be+2j$\not{p}$	87	65 ± 3.3
2jμ+$\gamma\not{p}$	13	12.6 ± 2.7	e+τ+	225	211.2 ± 4.7	be+$\not{p}$	330	347.2 ± 6.9
2jμ+γ	41	35.7 ± 6.1	e+$\not{p}$	476424	479572 ± 5361.2	be+j$\not{p}$	211	176.6 ± 5
2jμ+μ-	374	394.2 ± 24.8	e+$\not{p}\tau$-	48	35 ± 2.7	be+e-j	22	34.6 ± 2.6
2jμ+	9513	9362.3 ± 166.8	e+$\not{p}\tau$+	20	18.7 ± 1.9	be+e-	62	55 ± 3.1

inclusive vs exclusive searches@LHC

searches based on inclusive data samples
have many advantages for LHC first physics:

- allow SM calibrations that are more directly tied to putative signals; e.g. ttbar in jets+MET+0,1,2 leptons channels is both a background and a calibration for new physics
- increase signal acceptance
- decrease theoretical bias
- allow a larger # of analyses to happen sooner, by sharing the work of background estimation, understanding triggers, understanding effects of varying cuts, algorithms, turning off parts of the detector, etc

inclusive channels = topologies for this workshop

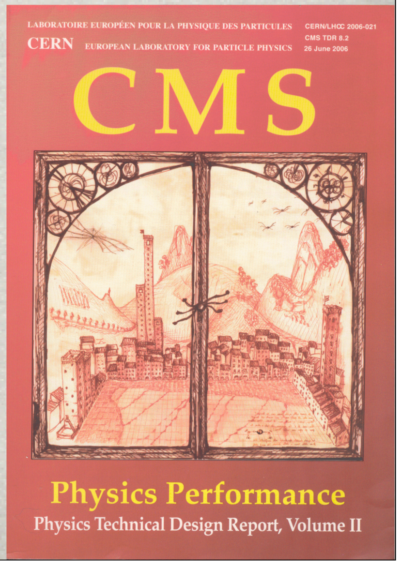
- dijets
- jets + MET
- lepton + jets + MET
- dilepton + jets + MET
- dileptons
- photons
- other*

*I added this one

a detailed example: dijets

why dijets?

- relatively simple (mostly bump hunting)
- well studied; e.g. full analysis in CMS PTDR, CMS notes by Rob Harris, Selda Esen, et al., talk by Marek Zielinski
- in pretty good shape

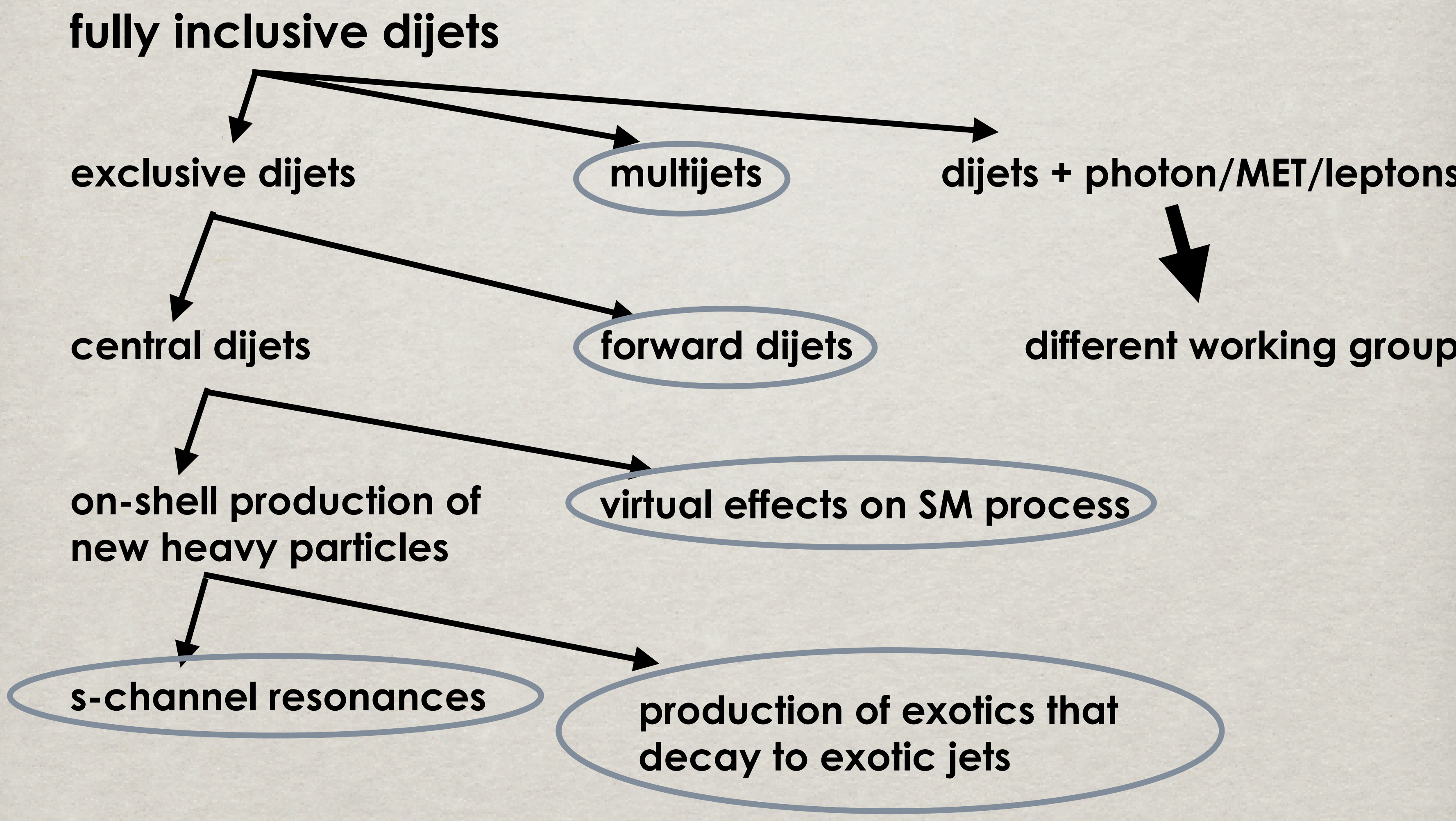


what are dijets?

as defined in this workshop,
what goes in the dijet topology?

- dijets with photons and/or MET and/or 2 or more leptons belong to other topologies
- dijet + single lepton + no MET violates lepton number, so is (presumably) a detector background
- multijets belongs in dijets
- forward jets are a special case of dijets

what are dijets?



dijet resonances

- appear as a bump in the dijet invariant mass plot

- could also appear as a rise or dip in the tail, but I will ignore this

- what are the observables?

dijet resonance observables

- cross section times branching fraction: $\sigma \times \mathbf{\Gamma_{jj}}$
- mass
  - requires $\mathbf{E_T},\ \eta,\ \phi$ and "jet mass" to make a jet 4-vector and thus to make a dijet invariant mass
  - need jet corrections if you want extracted mass = physical mass
- width
  - for very broad resonances, hard to measure
  - for narrow resonances, masked by dijet mass resolution:

$$\frac{\sigma}{\mathbf{M}} \sim \mathbf{1.3}\sqrt{\frac{1\ \mathrm{GeV}}{\mathbf{M}}}$$

dijet resonance observables

since dijets are back-to-back, there are few kinematic observables:

- jet $\mathbf{E_T}$ distribution
- jet η distribution
  - a simple robust variable for central jets is

$$\mathbf{R}_\eta = \frac{\mathbf{N}_{\rm events}(\mathbf{0} < |\eta| < \mathbf{0.5})}{\mathbf{N}_{\rm events}(\mathbf{0.5} < |\eta| < \mathbf{1})}$$

$\mathbf{R}_\eta \simeq \mathbf{0.6}$ for QCD

- jet characteristics, e.g. jet charge, shape, b-tagging
  - not obvious how much of this can be reliably used at startup

bottom-up analysis of dijets?

- given these observables, why can't I just do a bottom-up analysis of any observed dijet resonance signal?

- such an analysis would begin by writing down the nearly model-independent general formula for resonance production at a hadron collider:

bottom-up analysis of dijets?

- near the resonant peak, ignoring interference effects, we can write

$$\mathbf{M^2 \frac{d\sigma}{dM^2} = \int dx_1 dx_2 \frac{\kappa^2 \hat{s}}{(\hat{s} - M_0)^2 + \Gamma^2 M_0^2}}$$

$$\mathbf{\times \sum_{i,j} Q_{i,j}^2 f_i(x_1) f_j(x_2) \left[\delta(\frac{M^2}{s} - x_1 x_2) + D_{ij} \left(\frac{M^2}{\hat{s}}, \alpha_s \right) \right]}$$

bottom-up analysis of dijets?

$$\mathbf{M^2 \frac{d\sigma}{dM^2} = \int dx_1 dx_2 \frac{\kappa^2 \hat{s}}{(\hat{s} - M_0)^2 + \Gamma^2 M_0^2}}$$

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- what are the possible parton initial states?
- what are possible color, weak and electric charges?
- what is the spin of the resonance?

table of possible initial parton states, spins and charges for a dijet resonance

initial partons	spin	electric charge	color charge	weak charge
qq	0, 1, 2, ...	4/3, 1/3, -2/3	3, 6	0, 1
qg	1/2, 3/2, ...	2/3, -1/3	3, 6, 15	1/2
gg	0, 1, 2, 3, ...	0	1, 8, 10, 27	0
$q\bar{q}$	0, 1, 2, ...	0, 1	1, 8	0, 1
bq, bg, $b\bar{q}$				

~ 100 possibilities!

failure of bottom-up analysis@LHC

- ignorance of parton initial state implies orders of magnitude uncertainty from pdfs

- this uncertainty is entangled with orders of magnitude uncertainty about couplings (strong, weak, em, other) and charges (note $\sigma \times \Gamma_{jj} \propto Q^4$)

- it helps if you can measure the width separately, since $\Gamma \propto \kappa M_0$, but in most cases width is too narrow to measure

theory models as templates for searches

- a wisely chosen spread of theory models makes this problem managable

- ~10 models can do the work of 100’s or 1000’s or ∞

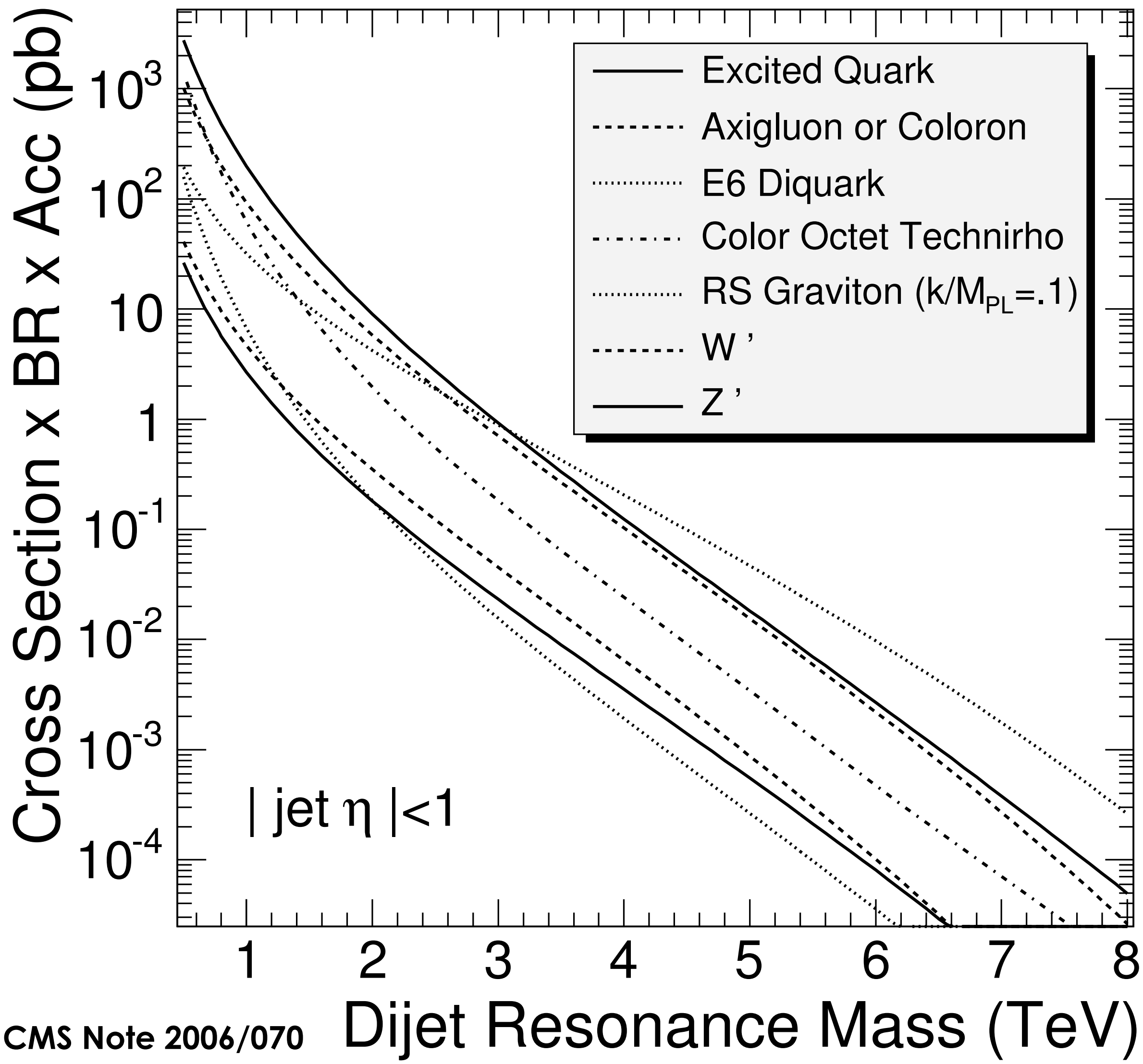
- don’t need to believe in any of them, though well-motivated examples are to be preferred

theory models as templates for searches

- choice of template models dictated by the observables and kinematics of the search channel, not by your local theorist's biases, the latest fad, "constraints" from other experiments, etc

- a well-chosen set of template models applied to inclusive searches is as close as you can get to a model-independent discovery strategy for CMS

model templates for dijet searches



CMS Note 2006/070

- excited quark
- axigluon or coloron
- E6 diquark
- techinrho
- RS graviton
- W'_{SSM}
- Z'_{SSM}

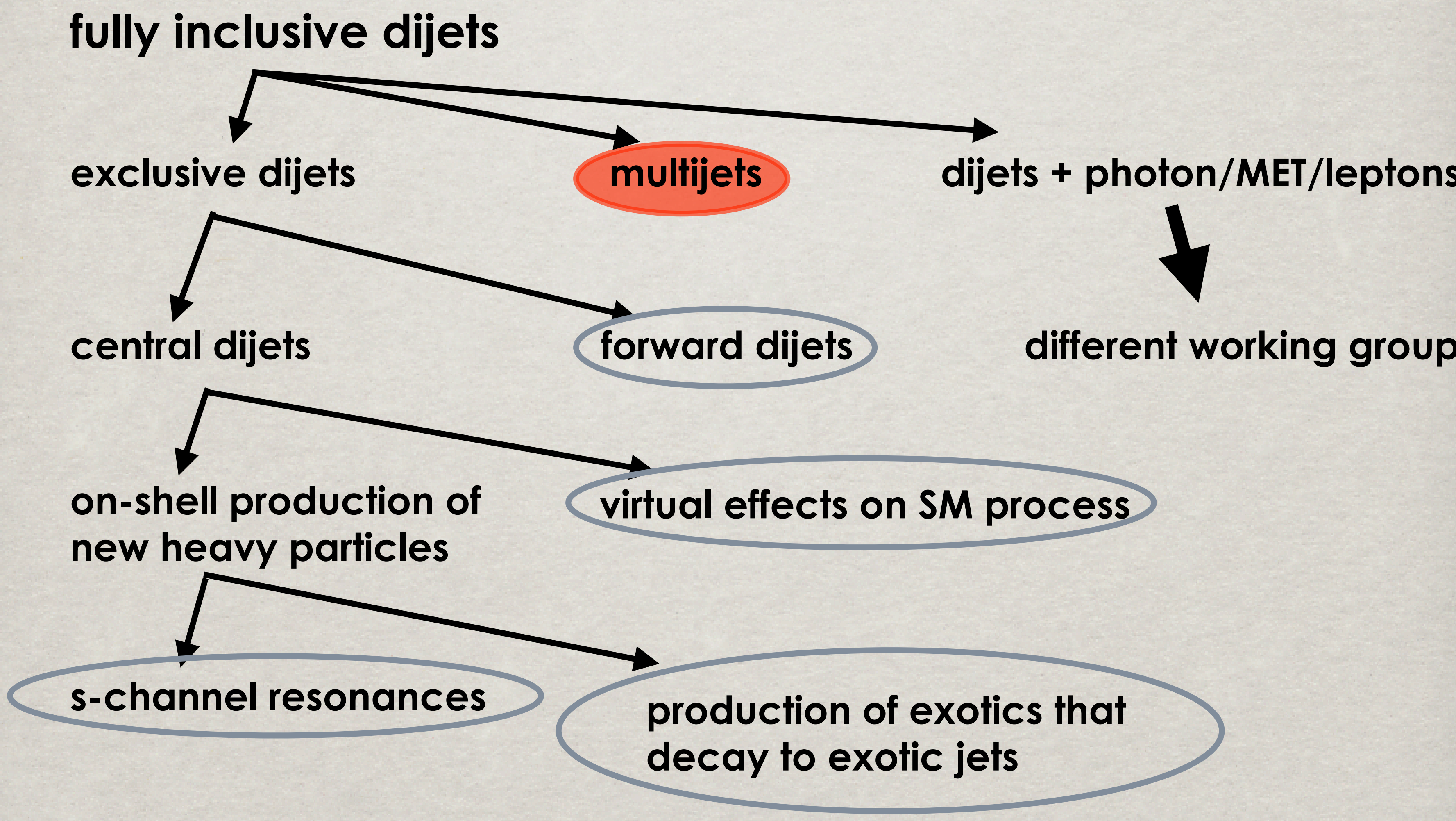
initial partons	spin	electric charge	color charge	weak charge
qq	0, 1, 2, ...	4/3, 1/3, -2/3	3, 6	0, 1
qg	1/2, 3/2, ...	2/3, -1/3	3, 6, 15	1/2
gg	0, 1, 2, 3, ...	0	1, 8, 10, 27	0
$q\bar{q}$	0, 1, 2, ...	0, 1	1, 8	0, 1
bq, bg, $b\bar{q}$				

looks pretty good

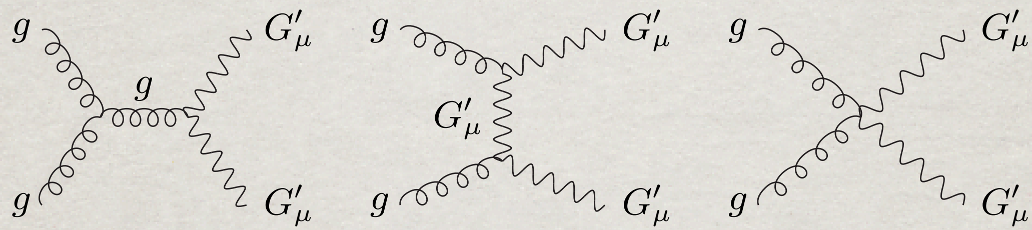
model templates for discriminating signals

- we need to study not only our sensitivity to signals but also our ability to discriminate between different possible origins of the same signal
- this means developing model templates that intentionally resemble in each other in a given channel
- it means developing robust discriminating observables, such as the dijet ratio R_η
- model templates allow us to study the correlations between signals in different channels: e.g. dijets versus dileptons and diphotons

what else?


fully inclusive dijets
exclusive dijets
multijets
dijets + photon/MET/leptons
central dijets
forward dijets
different working group
on-shell production of new heavy particles
virtual effects on SM process
s-channel resonances
production of exotics that decay to exotic jets

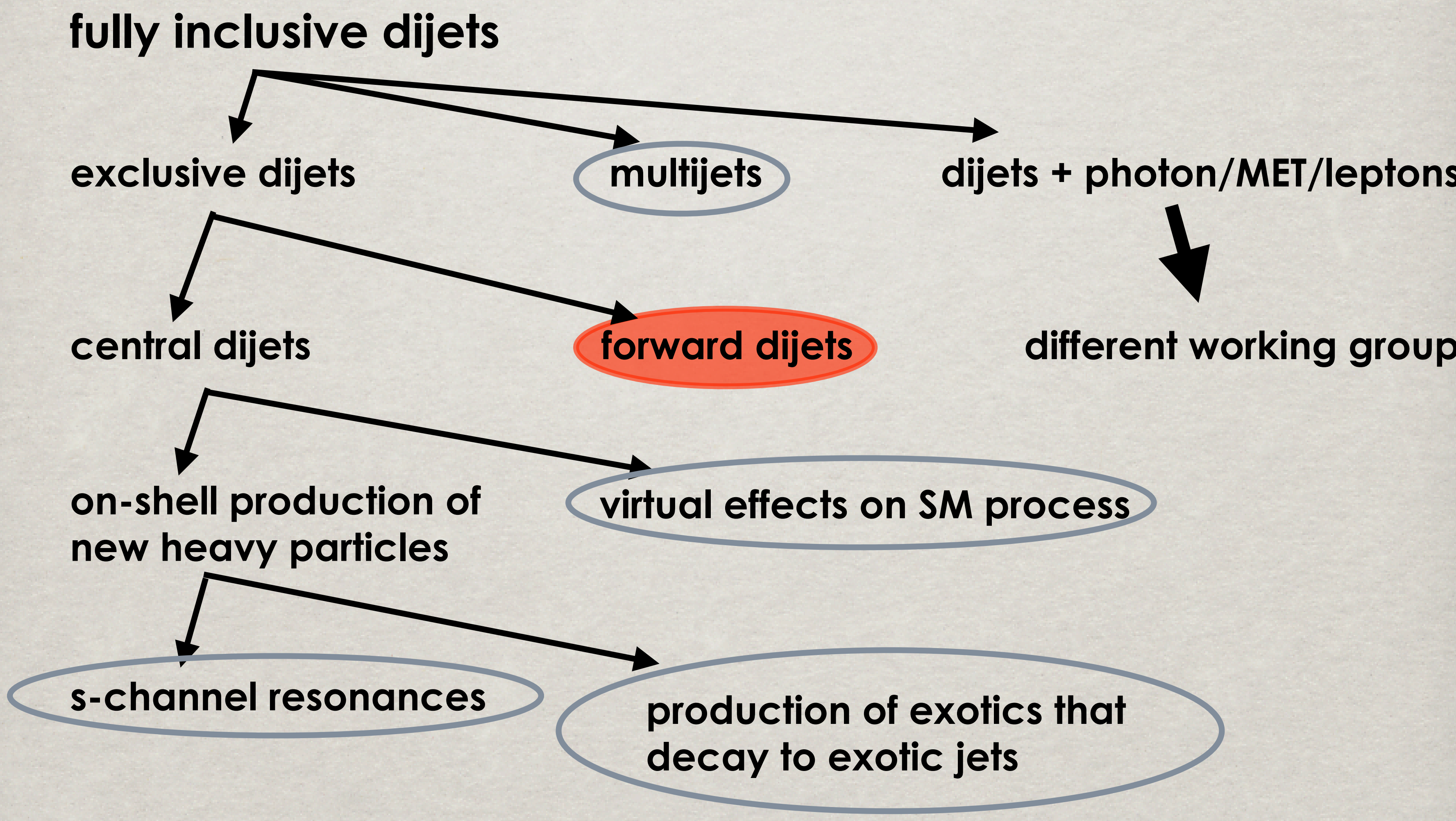
new physics in multijets at startup?



- heavy color octet particles may be produced only in pairs, not as single resonances
- each decays back to two jets
- thus the signature is a di-dijet resonance in multijets
- this looks promising even at startup, but hasn't been studied

contact: Bogdan Dobrescu, KC Kong, Rakhi Mahbubani

what else?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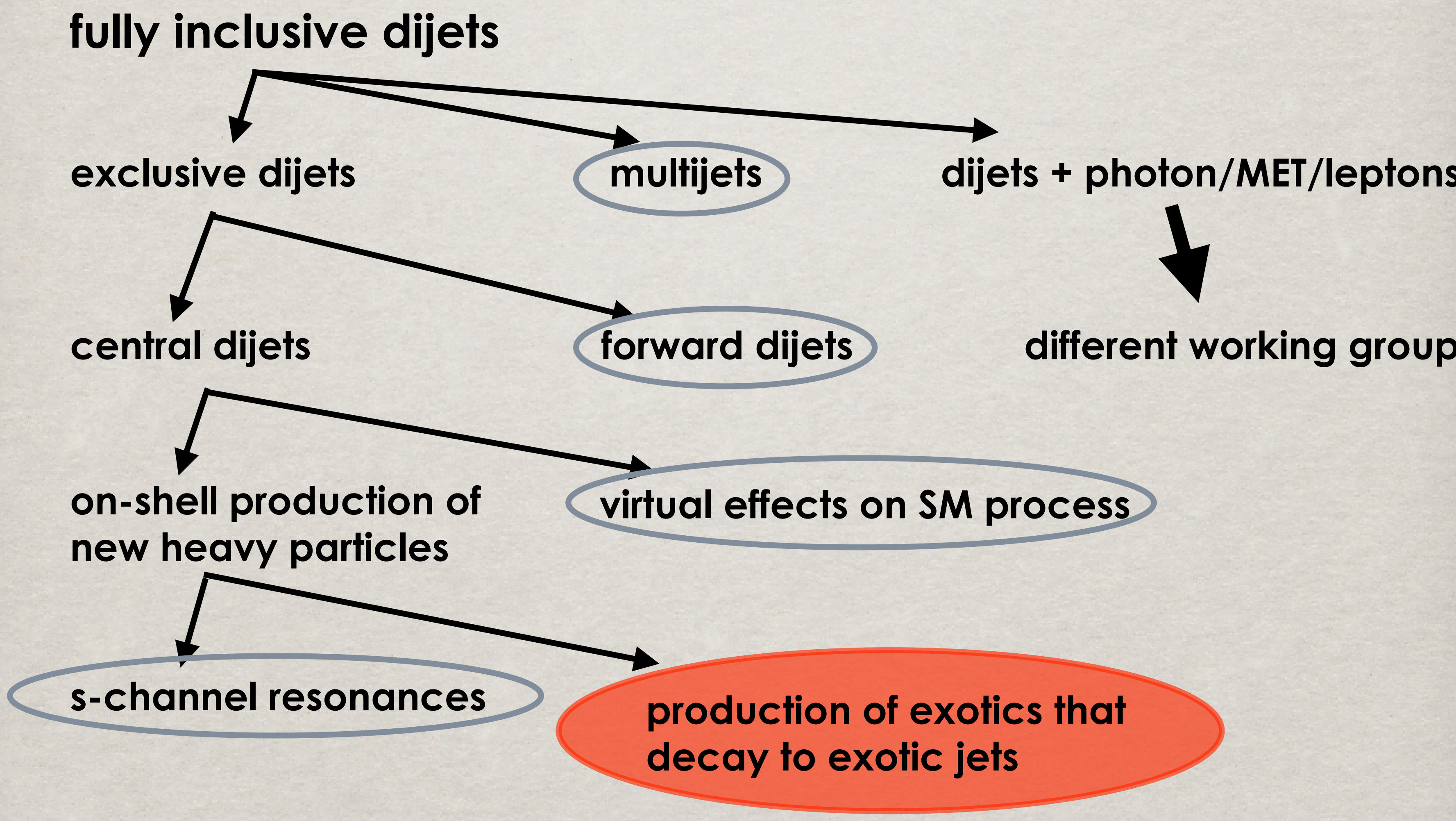
forward dijets

- important for Higgs production via vector boson fusion
- in SUSY models with extended Higgs sectors, the lightest Higgses often decay almost 100% invisibly, to neutralinos
- thus the signature is forward dijets + MET
- the MET may be hard to reconstruct, or hard to distinguish from MET in SM backgrounds
- there is a 2004 CMS internal note, but needs more study

contact: Csaba Balazs, Marcela Carena, Carlos Wagner

what else?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pair production of exotics that produce exotic jets

- one or more jets in the dijet final state may not be a standard jet, e.g.
- topjets: an energetic top decay that reconstructs as a single jet
- superjets: b-tagged jets that have extra leptons, because e.g. at the parton level they are really bbar, bW, or bZ
- fat jets, skinny jets, ...

inclusive channels = topologies for this workshop

- dijets
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- dilepton + jets + MET
- dileptons
- photons
- other*

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missing energy topologies

- all hadronic jets + missing transverse energy
- single lepton + jets + MET
- same sign or opposite sign dilepton + jets + MET

from a theory point of view these channels have a large overlap, but it makes sense to separate them experimentally because they have different triggers etc.

Why are they interesting?
it is an observational fact that dark matter exists

the most conservative theoretical assumptions then point to a weakly interacting massive particle as a major component of dark matter

this implies missing energy signals at the LHC

missing energy topologies

from a theory point of view, classify missing energy signals according to what kind of weakly interacting particle is observed as MET:

- neutrinos, from top, W, Z decays of SM, or W_R -> lepton + nu_R, or sphaleron decays
- spin 0, e.g. the extra polarization of the photon in 6d Universal Extra Dimensions (6d UED)
- spin 1/2, e.g. neutralino of SUSY
- spin 1, e.g. new heavy partners of the photon or hypercharge gauge boson, as in 5d Universal Extra Dimensions (5d UED) or Little Higgs with T Parity (LHTP)
- spin 3/2, e.g. gravitino of SUSY
- spin 2, e.g. Kaluza-Klein gravitons from large extra dimensions

missing energy topologies

from a phenomenological point of view, classify missing energy signals according to how many WIMPS + other objects are produced

- just a pair of WIMPS + nothing, e.g. direct neutralino pair production; no trigger! need forward jet tagging or something
- a single weakly interacting particle recoiling against a SM particle, e.g. graviton + monojet from large extra dimensions; ZH associated production
- pair production of new heavy particles with 2-body decays to a WIMP and a SM particle, e.g. top partners in LHTP models
- pair production of new heavy particles with cascade decays to WIMPs and SM particles, e.g. gluinos in SUSY
- production of new heavy particles that decay to tops, W, Z, e.g. excited quarks decaying to q + W; radions decaying to WW; ttbar resonances

how do we develop appropriate model templates for missing energy topologies?

two examples:

- pair production of new heavy particles with cascade decays to WIMPs and SM particles

- production of new heavy particles that decay to tops, W, Z

pair production of new heavy particles with cascade decays to WIMPs and SM particles

CMS already has a set of model templates based on minimal SUGRA

Point	$M(\tilde{q})$	$M(\tilde{g})$	$\tilde{g}\tilde{g}$	$\tilde{g}\tilde{q}$	$\tilde{q}\bar{\tilde{q}}$	$\tilde{q}\tilde{q}$	Total
LM1	558.61	611.32	10.55 (6.489)	28.56 (24.18)	8.851 (6.369)	6.901 (6.238)	54.86 (43.28)
LM2	778.86	833.87	1.443 (0.829)	4.950 (3.980)	1.405 (1.013)	1.608 (1.447)	9.41 (7.27)
LM3	625.65	602.15	12.12 (7.098)	23.99 (19.42)	4.811 (3.583)	4.554 (4.098)	45.47 (34.20)
LM4	660.54	695.05	4.756 (2.839)	13.26 (10.91)	3.631 (2.598)	3.459 (3.082)	25.11 (19.43)
LM5	809.66	858.37	1.185 (0.675)	4.089 (3.264)	1.123 (0.809)	1.352 (1.213)	7.75 (5.96)
LM6	859.93	939.79	0.629 (0.352)	2.560 (2.031)	0.768 (0.559)	0.986 (0.896)	4.94 (3.84)
LM7	3004.3	677.65	6.749 (3.796)	0.042 (0.028)	0.000 (0.000)	0.000 (0.000)	6.79 (3.82)
LM8	820.46	745.14	3.241 (1.780)	6.530 (5.021)	1.030 (0.778)	1.385 (1.230)	12.19 (8.81)
LM9	1480.6	506.92	36.97 (21.44)	2.729 (1.762)	0.018 (0.015)	0.074 (0.063)	39.79 (23.28)
LM10	3132.8	1294.8	0.071 (0.037)	0.005 (0.004)	0.000 (0.000)	0.000 (0.000)	0.076 (0.041)
HM1	1721.4	1885.9	0.002 (0.001)	0.018 (0.016)	0.005 (0.005)	0.020 (0.021)	0.045 (0.043)
HM2	1655.8	1785.4	0.003 (0.002)	0.027 (0.024)	0.008 (0.007)	0.027 (0.028)	0.065 (0.061)
HM3	1762.1	1804.4	0.003 (0.002)	0.021 (0.018)	0.005 (0.004)	0.018 (0.019)	0.047 (0.043)

- a good start, covering most of the relevant kinematic range, parton initial states, and lepton multiplicities in the cascade final states
- although these models are as good or better as any theory models around, keep in mind that we are only using them as templates

two generic questions:

- what important templates are missing? Don’t count variations whose signals fall into other topologies (e.g. GMSB SUSY signature belong to “photons” or “other”)
- what can we say about CMS ability to distinguish among theory models that produce similar signatures?

what important templates are missing?

MSUGRA limitations come from fixed relations between masses of gluino, charginos and neutralinos

- models with less missing energy, e.g. hidden valley models

- models which are more like the background, e.g. SUSY with light stops

- models with larger numbers of leptons, e.g. 6d UED

can CMS distinguish between models with similar signatures?

To answer this question, need to develop and simulate new templates based on theories that have missing energy cascade signatures similar to SUSY:

- Little Higgs with T parity (Jay Hubisz)

- 5d Universal Extra Dimensions (Bogdan Dobrescu, KC Kong)

- 6d Universal Extra Dimensions (Rakhi Mahbubani, Bogdan Dobrescu, KC Kong)

production of new heavy particles that decay to tops, W ,Z

These are cases where the missing energy is from neutrinos, so we expect backgrounds to be a problem

partial classification:

- **new heavy quarks: Q' decays to jet + W or jet +Z**
- **Higgs-like: e.g. radions that decay to WW or ZZ**
- **top-enriched: e.g. ttbar resonances, W' decaying mostly to tb, charged Higgs decaying to tb, t' decaying to tZ or tW**

pair production of new heavy particles that decay to tops, W ,Z

Questions:

- what is a reasonable set of model templates?
- can we simulate them at CMS?
- what scenarios can be distinguished from background?
- given a signal, can we discriminate between models?

inclusive channels = topologies for this workshop

- dijets
- jets + MET
- lepton + jets + MET
- dilepton + jets + MET
- dileptons
- photons
- other*

*I added this one

your friendly neighborhood theorist

- FNAL+CMS theorists have unsurpassed expertise in SM collider physics, including NLO production, shower algorithms, parton-shower matching, and underlying event description.

- We are 2/3 of the high priesthood of Pythia, we own MCFM, and are experts in MadGraph, Sherpa, CalcHEP, Alpgen,...

- In addition, we have >10 theorists who make models, write event generators for these models, and are highly motivated to work with CMS experimenters

critical mass @ LPC

- We have the critical mass of people to develop complete sets of model templates for the various inclusive channels, and develop robust methods to discriminate between models

- Theorists can provide the event generators and data samples in HepMC format, suitable for CMS studies with CMSSW or FastSim

- And they can help with validation, interpretation, and ideas for how to discriminate between models

- With Daniel Elvira, we are exploring how to create a suitable forum where theorists can interface with CMS experimenters to launch joint projects