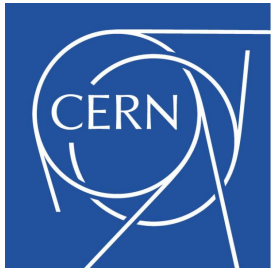
CERN THEORY RETREAT

Les Houches

Alessandro Vichi



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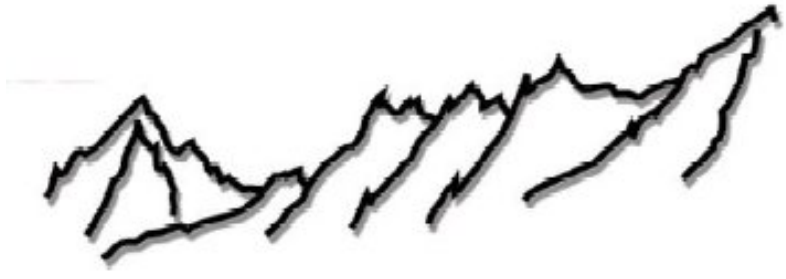

November 7, 2014

About me

- Undergrad in Pisa
- PhD in Lausanne with R.Rattazzi
- Postdoc at Berkeley
- Fellow at Cern since Oct 2014

Recent collaborators:

- S. El-Showk, M. Paulos, S.Rychkov, D. Poland, D. Simmons-Duffin
- M. Papucci, K. Zurek

Outline

1. BSM and the origin of conformal bootstrap

2. DM@colliders

A bit of history..

Nice example of how "wild" model building triggered the development of a new research line.

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2004: *Conformal Technicolor* Luty,Okui

	SM	Technicolor
▶ Flavor	✓	X
▶ Higgs field H is elementary $[H] \sim 1$		
▶ Yukawa couplings are the only marginal operators		
▶ all 4 fermion interactions are suppressed by the cut-off scale		
▶ Technicolor Higgs is a fermion condensate $[H^2] \sim 6$		
▶ Yukawa couplings are as irrelevant as the Higgs mass term		
▶ Hierarchy problem:	X	✓
▶ SM Higgs mass term is strongly relevant $[H^2] \sim 2$		
▶ Naturally of cut-off scale		

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Question: Can one build a CFT where $[H] \sim 1$ and $[H^2] \geq 4$?

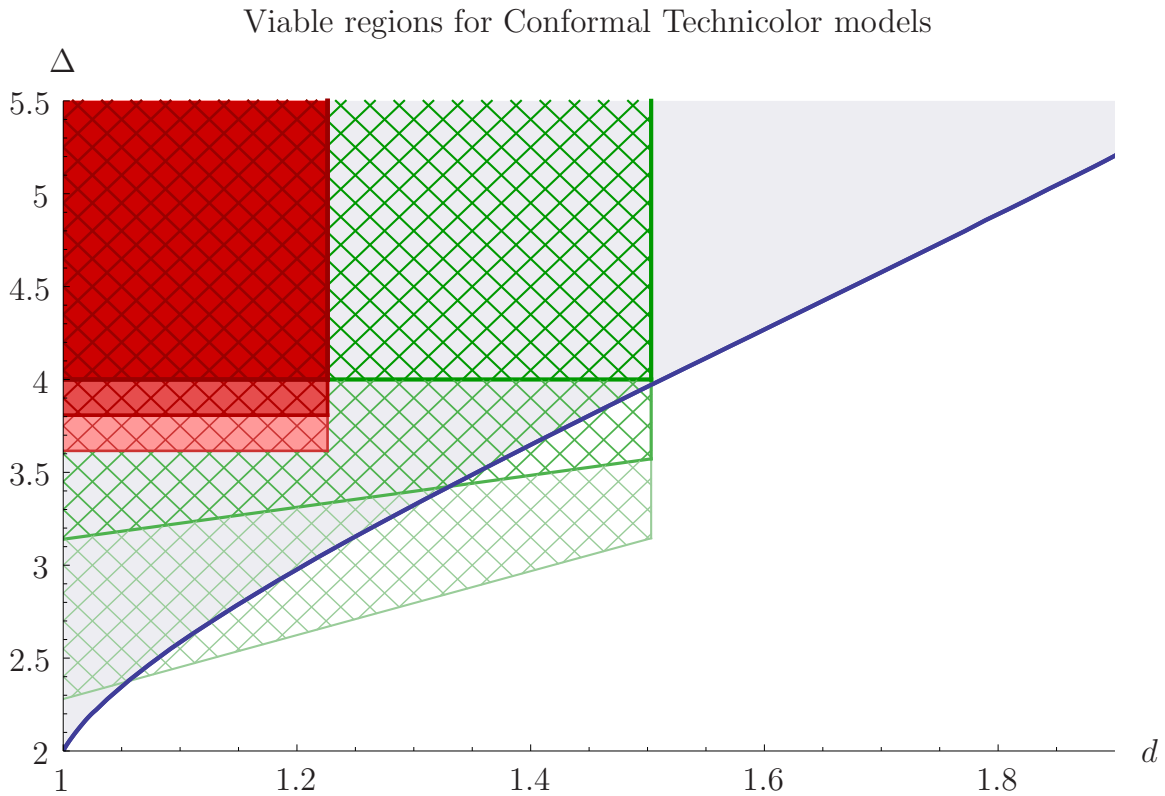
A bit of history..

2008: Conformal bootstrap is possible E.Tonni,R.Rattazzi,S.Rychkov,AV

2009: ... formal developments...

2010: ... formal developments...

2011: *Answer:* generically NO D.Poland,D.Simmons-Duffin,AV



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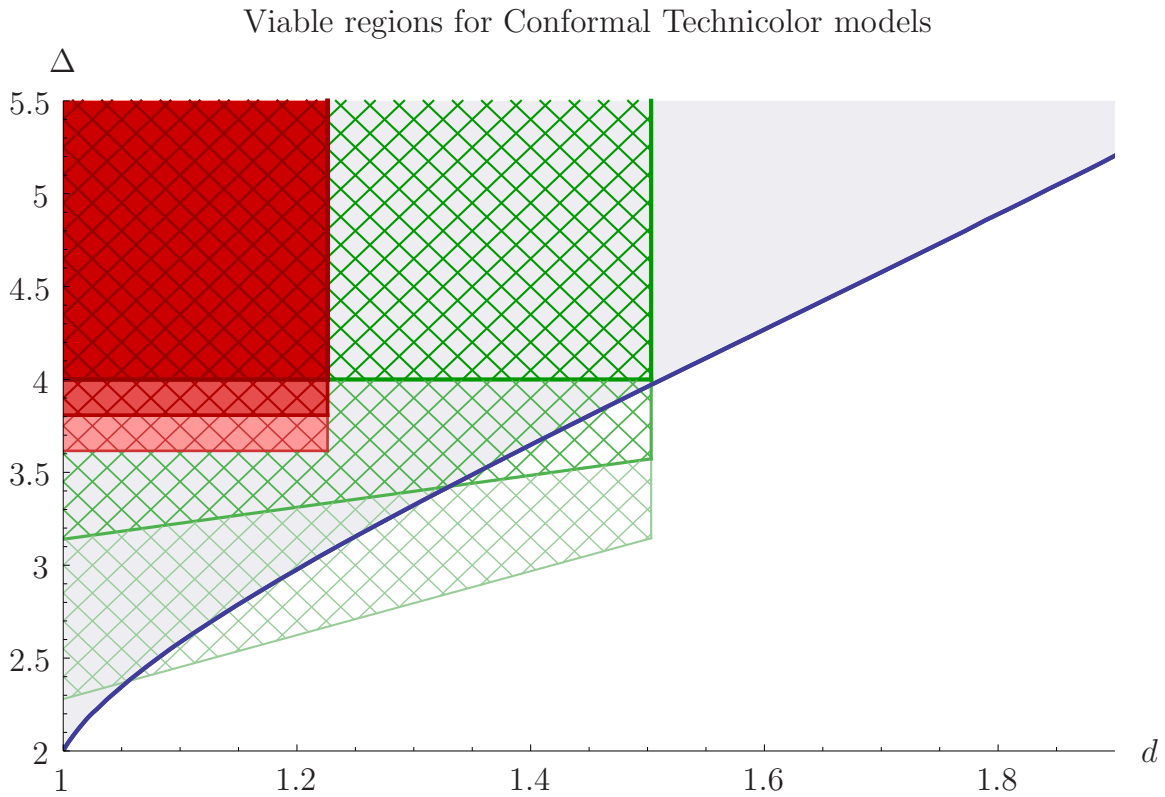
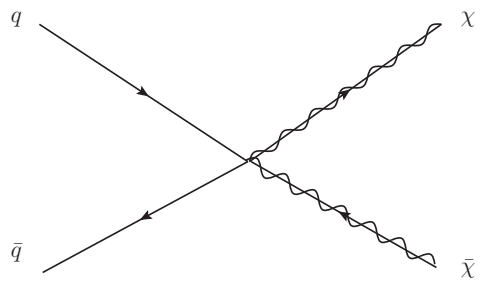


Today conformal bootstrap is an established research line, as presented yesterday

MET searches

- Indirect evidence of DM: worth exploring at colliders
- Stable particles are a common feature of many BSM scenarios
- Common approach until recently: let's be agnostic
- Parametrize our ignorance with an EFT description of SM-DM interactions



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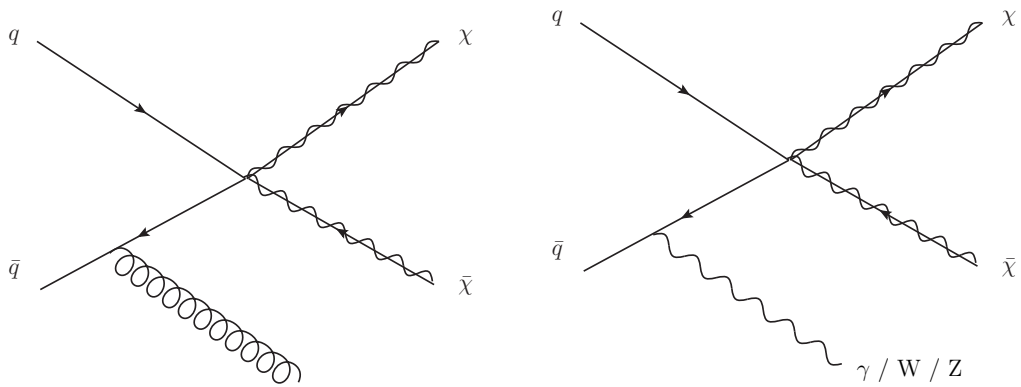
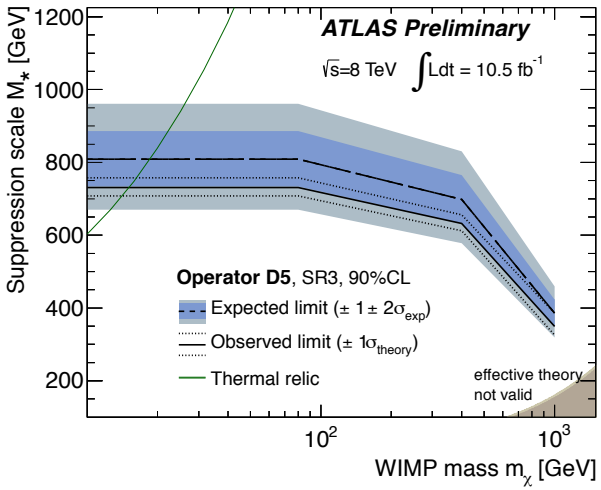


- Dress EFT interaction with SM gauge bosons
- Look for mono-jet, mono-photon, mono-W/Z

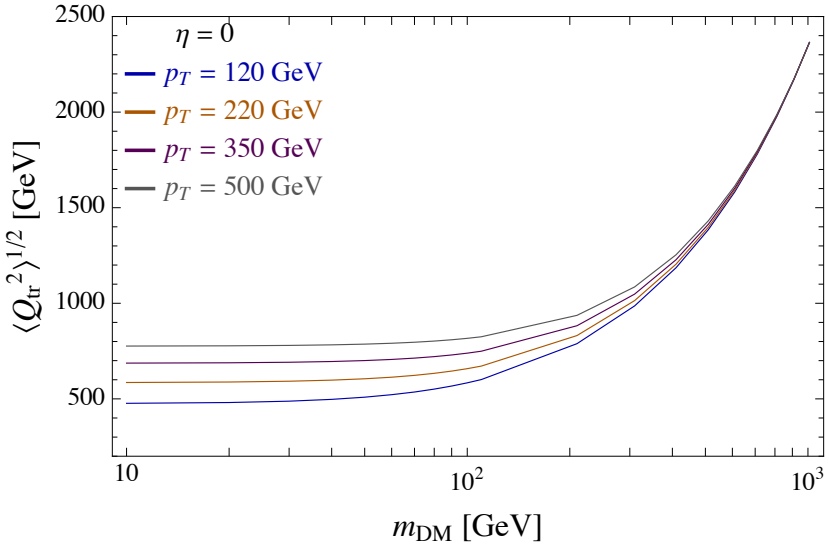
EFT not valid @ LHC: finally understood

- Expansion in Q_T^2/Λ^2
- Q^2 distribution at LHC8:



- At LHC, corrections to EFT are $\sim O(1)$.
- Need to go beyond...

- EFT exclusion limit:



Simplified models: t-channel example

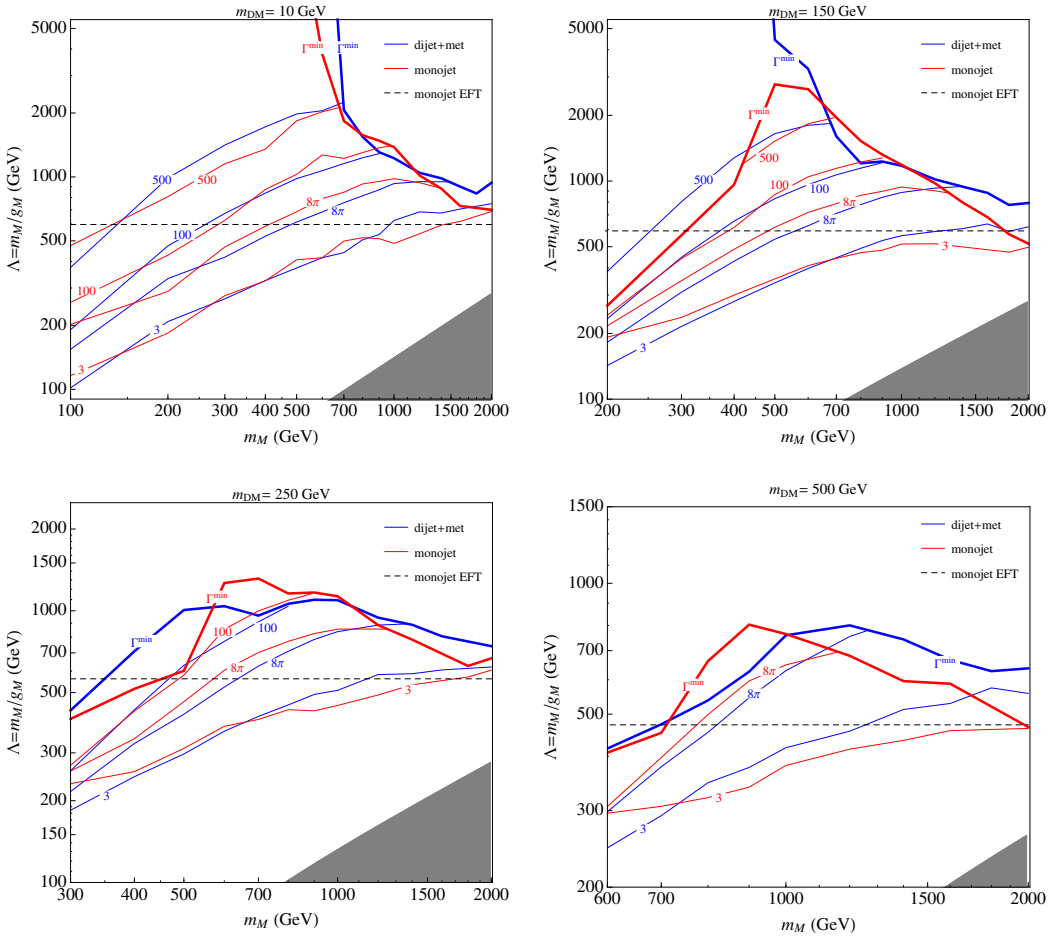
- Consider simplified models: stable particle(s) + mediator(s)
- EX: squarks + a fermion

$$\mathcal{L} = \mathcal{L}_{SM} + g_M \sum_{i=1,2} \left(\widetilde{Q}_L^i \bar{Q}_L^i + \tilde{u}_R^i \bar{u}_R^i + \tilde{d}_R^i \bar{d}_R^i \right) \chi + \text{mass terms} + c.c.$$

Why consider only monojet searches? List all possible allowed final states:

- Monojet, monophoton,....
- jets+ missing energy
- Dijets (in the case of a Z' or a higgs like mediator)
- .....

Searches comparison



M.Papucci, AV, K.Zurek

Dijets+met:

- ATLAS-CONF-2013-047
- ATLAS-CONF-2012-109
- CMS-PAS-SUS-13-012
- CMS-PAS-SUS-12-028
- ATLAS-CONF-2012-033
- CMS-PAS-SUS-11-022
- CMS-PAS-SUS-12-011

Monojet:

- ATLAS-CONF-2013-068
- CMS-PAS-SUS-12-048
- ATLAS-CONF-2012-147
- ATLAS-CONF-2011-096
- CMS-PAS-SUS-11-059

Ongoing projects (on the BSM side)

- A roadmap for simplified models with missing energy at LHC@14Tev w/ M.Papucci, K.Zurek, S.P. Liew
- Minimal dark matter @100Tev (beyond Higgsino, Wino)