

Light Composite DM (and CDEX)

G. Cacciapaglia (IPNL)
project LightDM

FCPPL workshop
Marseille (France)

The teams (2018-)

France

G. Cacciapaglia (IPNL)
A. Deandrea (IPNL)
N. Bizot (IPNL)
S. Vatani (Master student)
+ ...

China

Wang Qing (Tsinghua U.)
Zhang Bin (Tsinghua U.)

Zhang Hong Hao (SYSU)
Cai Chengfeng (SYSU)
+3 students

New students will be involved from Fall 2018
both at IPNL and Sun-Yat Sen U.

Already 1 publication
in 2018:

- C.Cai, G.Cacciapaglia, H-H.Zhang, "Vacuum alignment in a composite 2HDM", arXiv:1805.07619

Is the search for New Physics over?

- No discovery @ LHC, no New Physics?
- No stone left unturned?
- Do we understand all New Physics models?

TeV

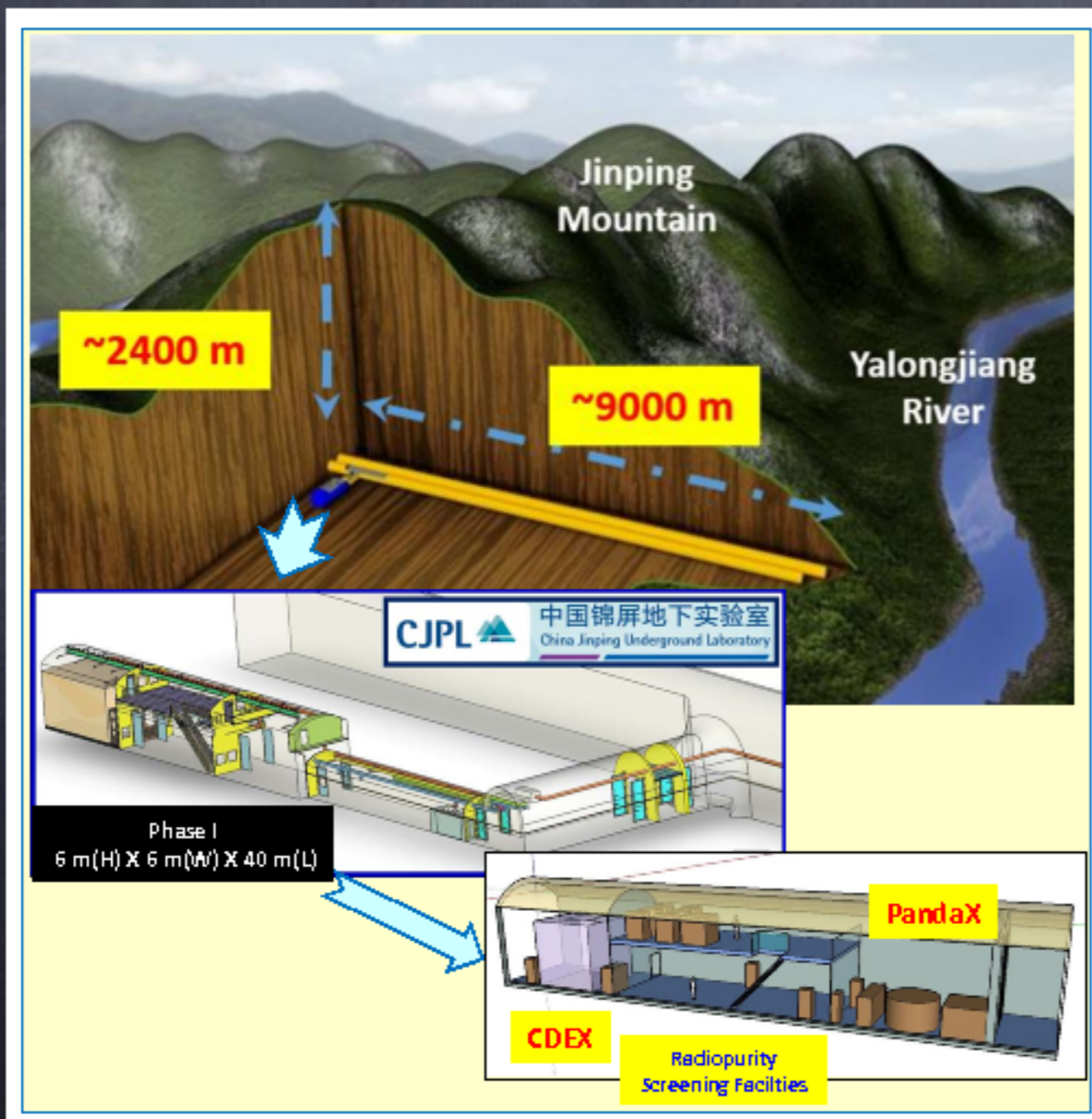


Tempting to look
at high scales...

New Physics may
be hiding at low
scales! (GeV)

Light and Dark

- Can Dark Matter be Light? (few GeV)

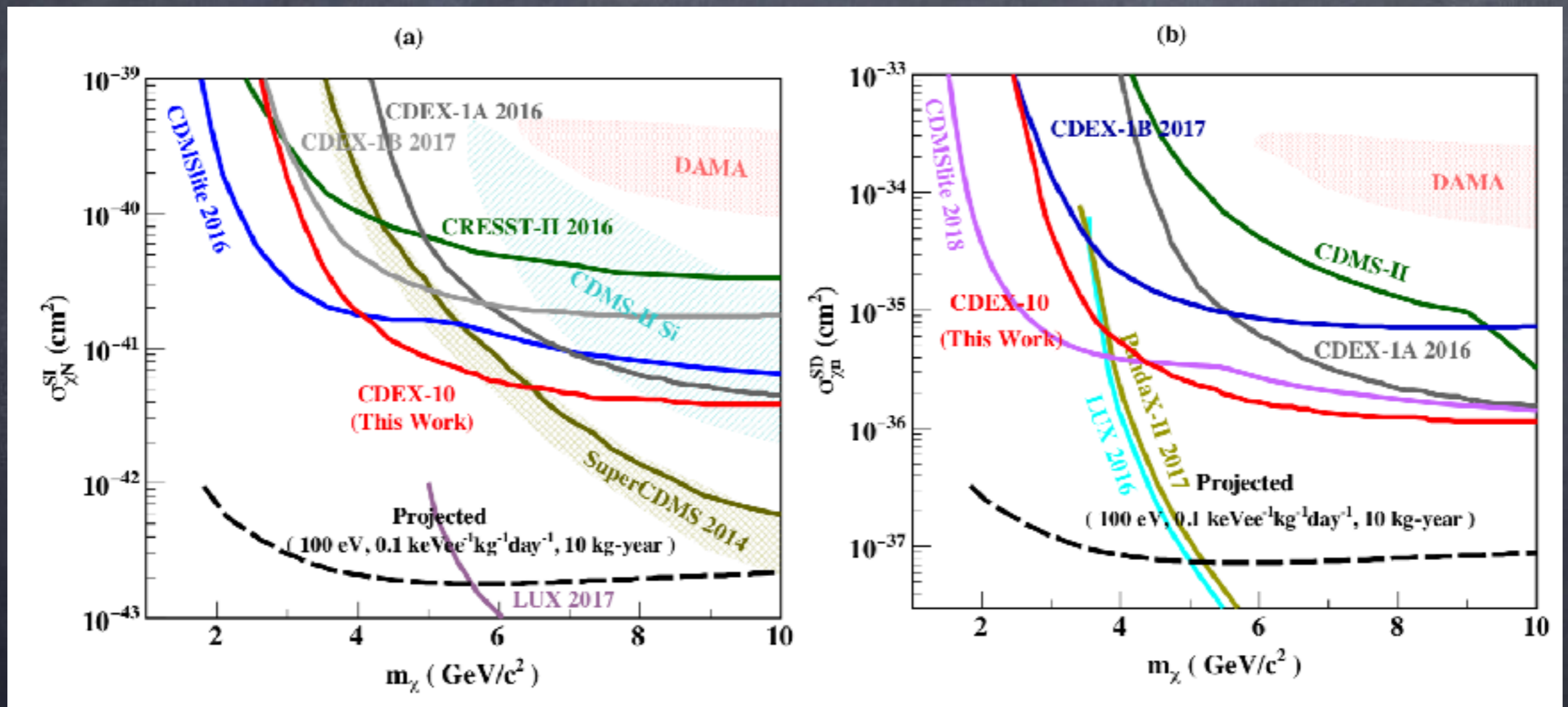


CDEX experiment
in China
is targeting DM
of mass of a few GeV

Main focus on
Lowering the
detection thresholds!

Light and Dark

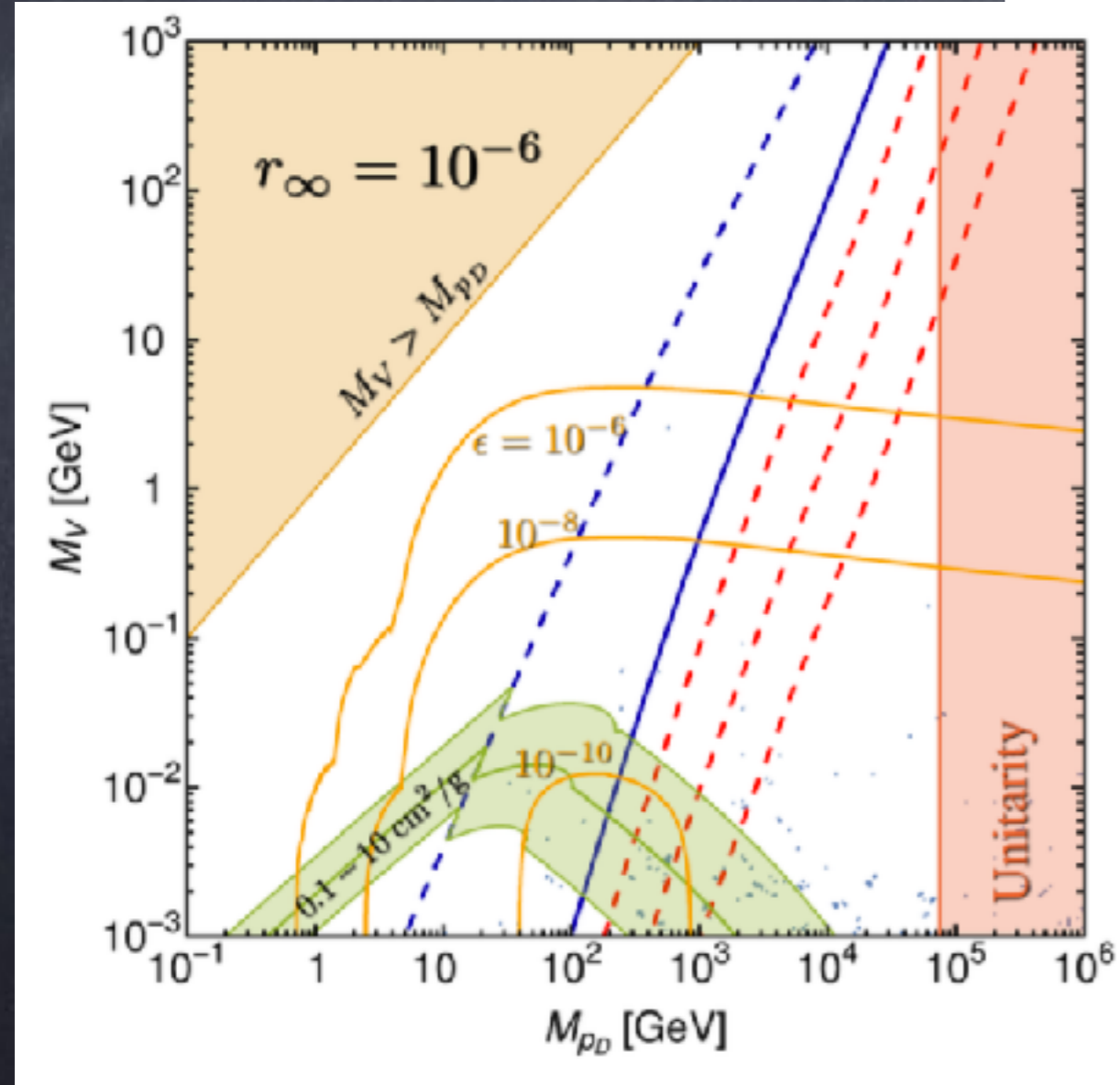
- Can Dark Matter be Light? (few GeV)



CDEX collab., 1802.09016

Inspired by 1712.08489

$$\mathcal{L} = \frac{1}{2}M_V V_\mu V^\mu - \frac{1}{4}F_{D\mu\nu}F_D^{\mu\nu} - \frac{\epsilon}{2c_w}F_{D\mu\nu}F_Y^{\mu\nu} + \bar{p}_D(i\not{D} - M_{pD})p_D + \bar{e}_D(i\not{D} - m_{eD})e_D,$$



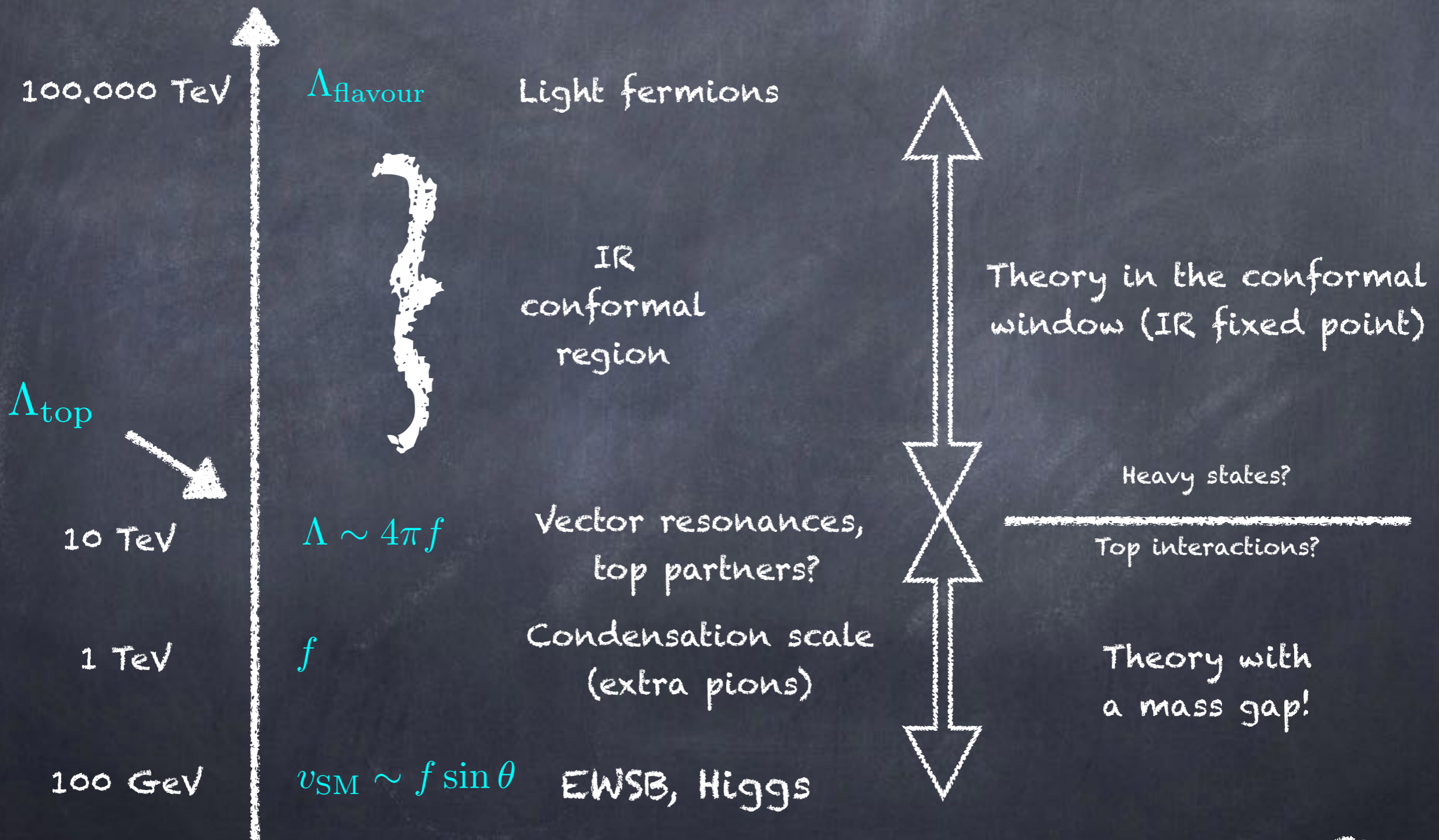
How well can CDEX constrain this model?

What is the effect of more general photon/dark photon mixing?

See 0904.2047

(by Wang Wing, Zhang Ying)

Composite scenario



Composite scenario: SU(6)/Sp(6)

1805.07619

$$\frac{1}{2} \begin{pmatrix} -\left(\frac{1}{\sqrt{2}}\eta_1 + \frac{1}{\sqrt{6}}\eta_2\right)\sigma^2 & \overset{\text{Higgs doublets}}{H_1} & H_2 \\ -H_1^T & -\left(\frac{1}{\sqrt{2}}\eta_1 - \frac{1}{\sqrt{6}}\eta_2\right)\sigma^2 & G \\ -H_2^T & \underset{\text{bunch of singlets}}{-G^T} & -\sqrt{\frac{2}{3}}\eta_2\sigma^2 \end{pmatrix}$$

14 pseudo-Goldstones!

Composite scenario: SU(6)/Sp(6)

1805.07619

$$\frac{1}{2} \begin{pmatrix} -\left(\frac{1}{\sqrt{2}}\eta_1 + \frac{1}{\sqrt{6}}\eta_2\right)\sigma^2 & H_1 & H_2 \\ -H_1^T & -\left(\frac{1}{\sqrt{2}}\eta_1 - \frac{1}{\sqrt{6}}\eta_2\right)\sigma^2 & G \\ -H_2^T & -G^T & -\sqrt{\frac{2}{3}}\eta_2\sigma^2 \end{pmatrix}$$

Higgs doublets
H₁ H₂
G
bunch of singlets

Two possible vacuum misalignments:

3 directions,
the 2 Higgses
plus a singlet

Composite scenario: SU(6)/Sp(6)

1805.07619

$$\frac{1}{2} \begin{pmatrix} -\left(\frac{1}{\sqrt{2}}\eta_1 + \frac{1}{\sqrt{6}}\eta_2\right)\sigma^2 & \text{Higgs doublets } H_1 & H_2 \\ -H_1^T & -\left(\frac{1}{\sqrt{2}}\eta_1 - \frac{1}{\sqrt{6}}\eta_2\right)\sigma^2 & \text{Stable! } G \\ -H_2^T & \text{bunch of singlets } -G^T & -\sqrt{\frac{2}{3}}\eta_2\sigma^2 \end{pmatrix}$$

Two possible vacuum misalignments:

3 directions,
the 2 Higgses
plus a singlet

OR

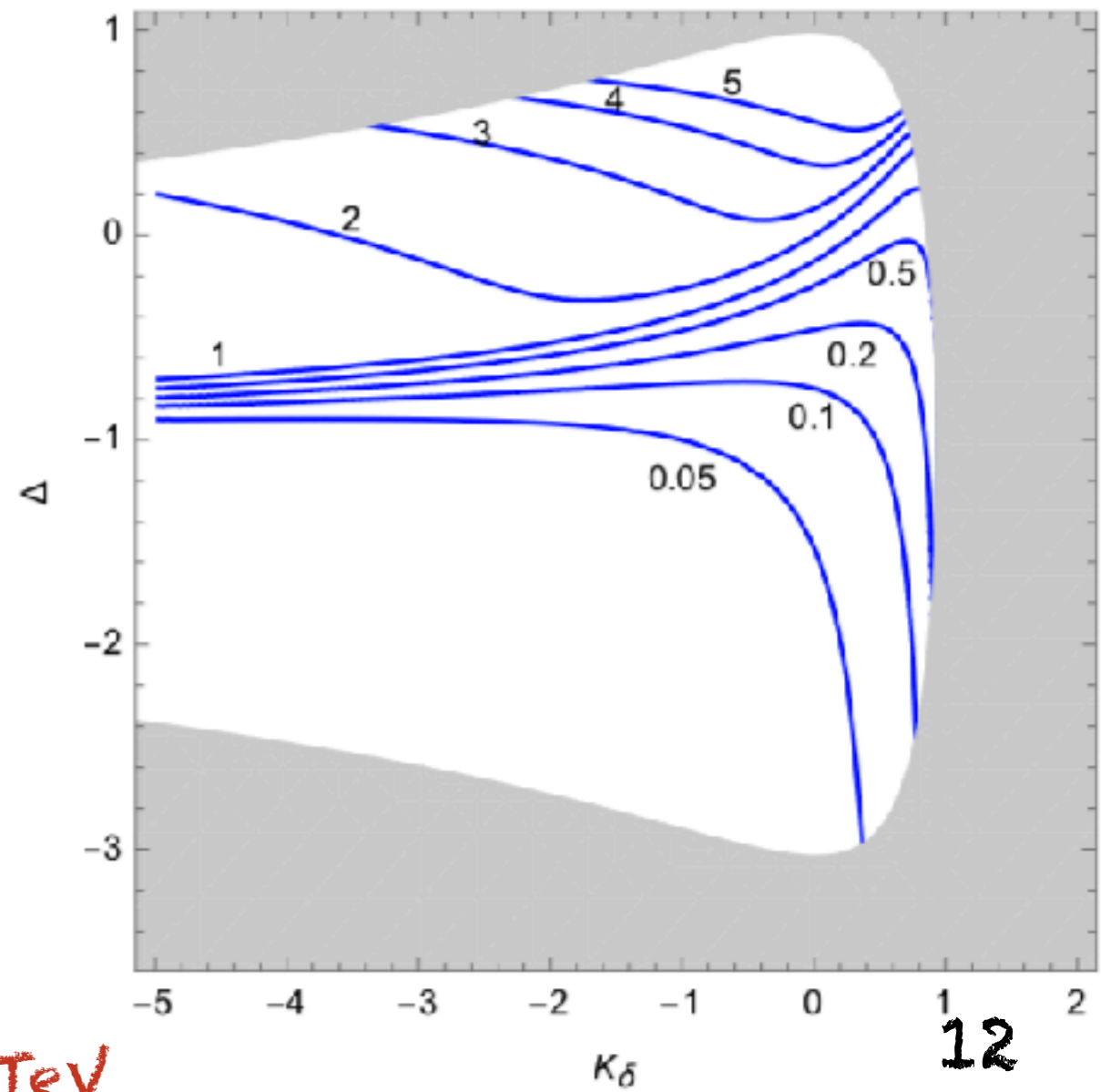
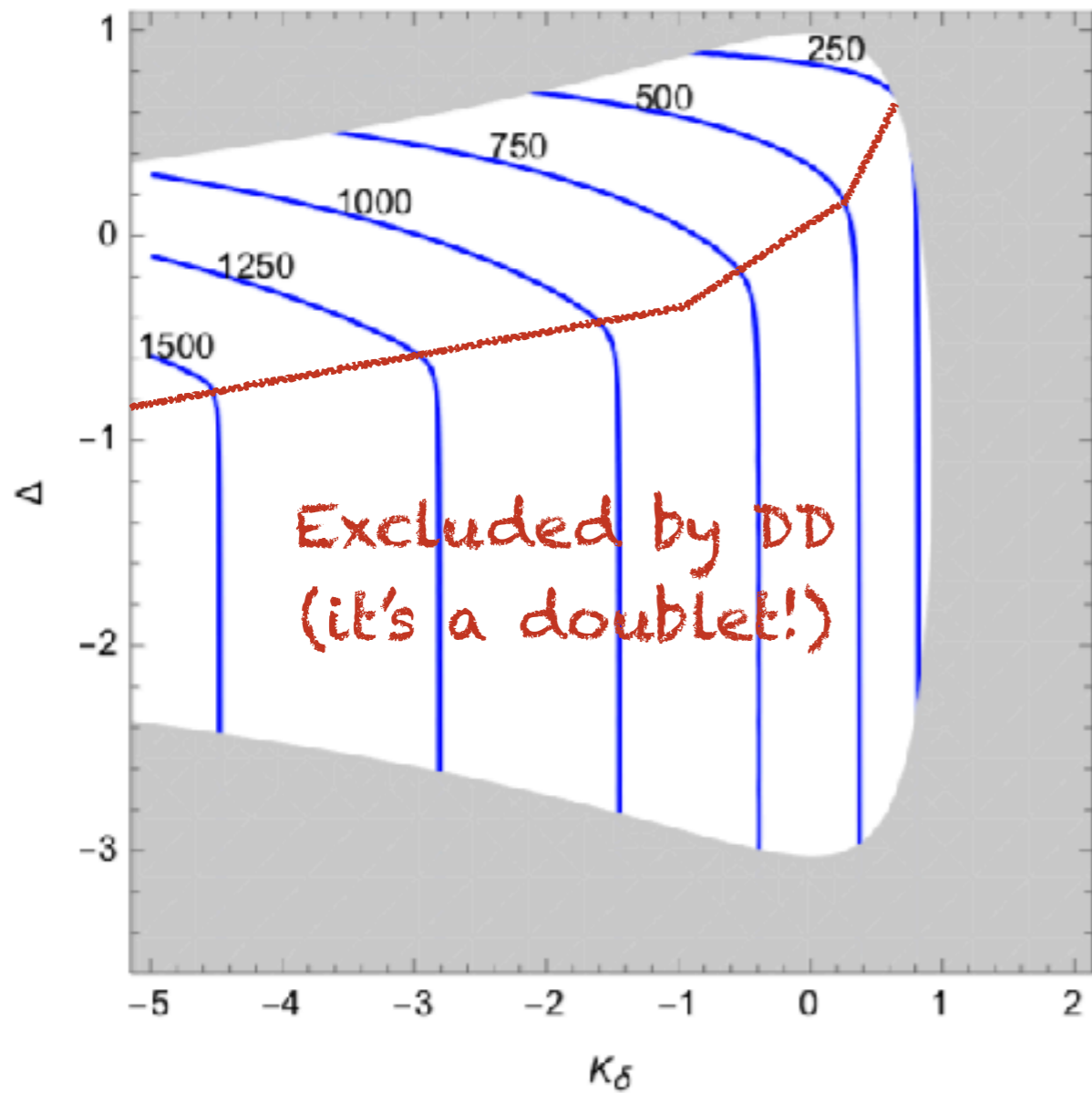
Only one Higgs!

DM-U(1) preserved!

U(1)DM VACUUM

DM mass (GeV)

Splitting from charged



U(1)DM vacuum: Open questions

- Can the DM be much lighter? (explore other sources of top mass)
- Can a gauged U(1) be added?
- How small is the relic abundance?
- Direct-detection impact from CDEX + self-interactions.