5D2HDM

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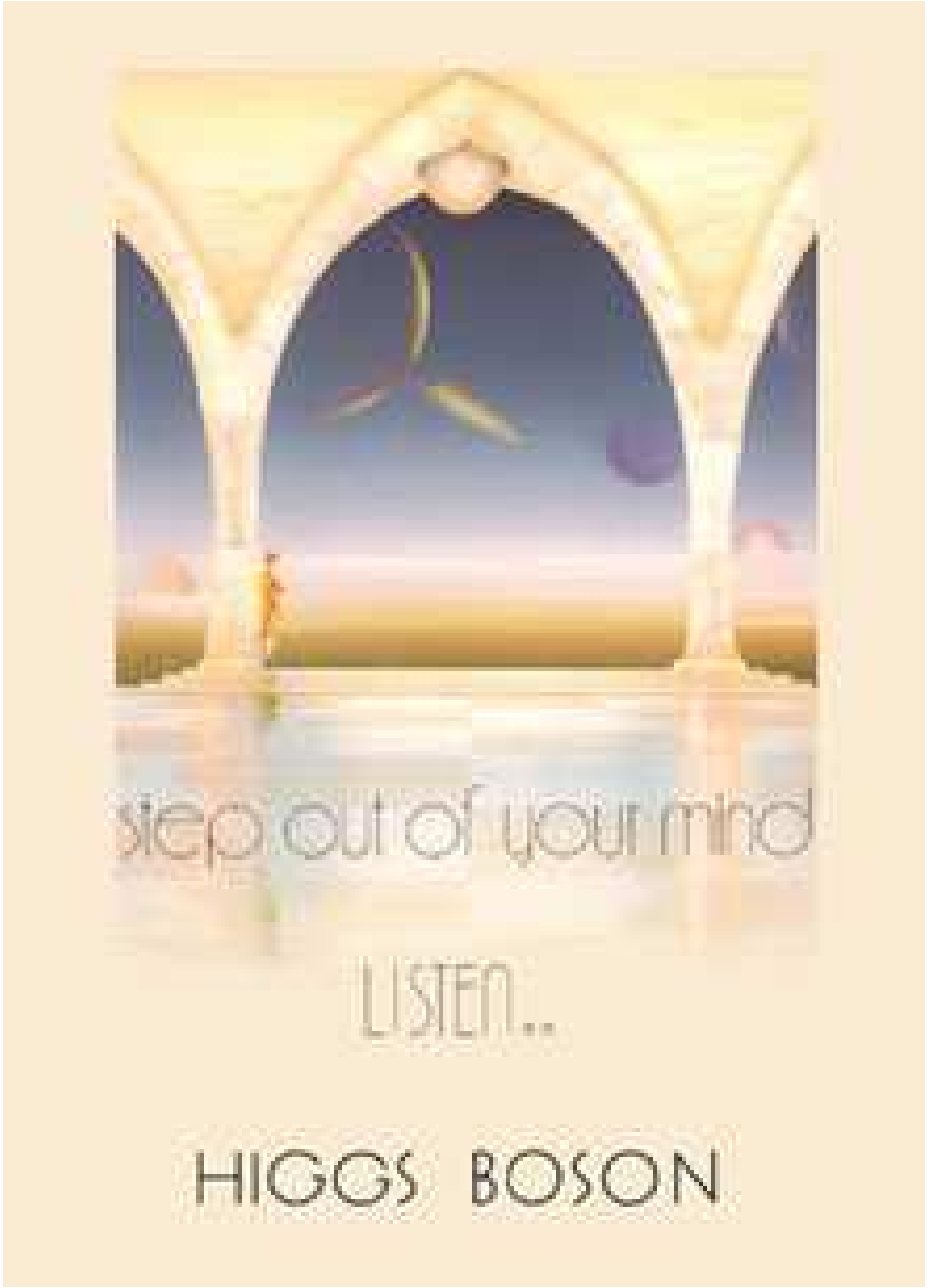
and

http://www.hep.anl.gov/Physics/Talks/2003/10_WIN03

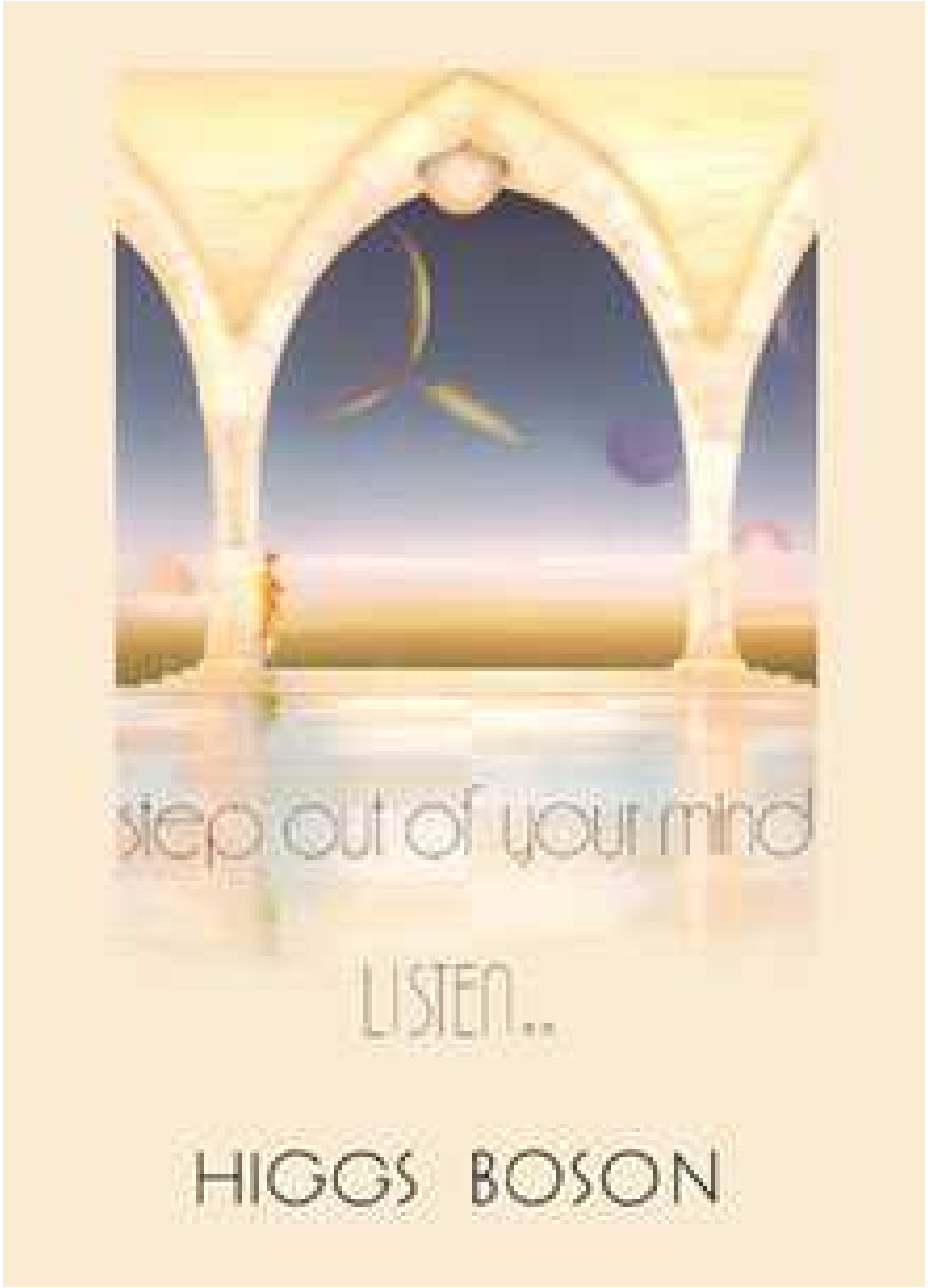


No one can tell me,
Nobody knows,
Where the wind comes from,
Where the wind goes.

But if I stopped holding
The string of my kite,
It would blow with the wind,
For a day and a night.

And then when I found it,
Wherever it blew,
I should know that the wind
Had been going there too.

A.A.Milne



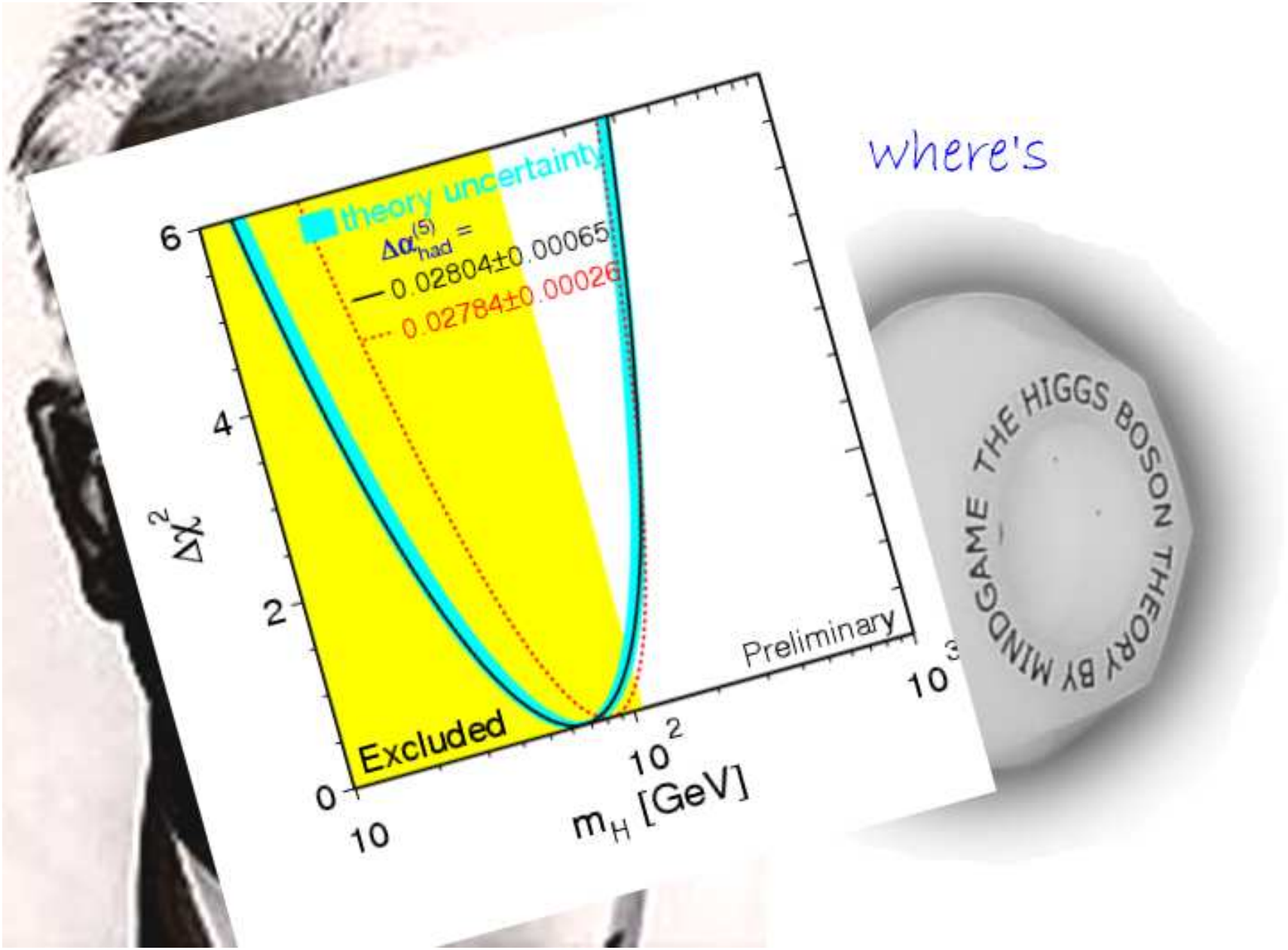
Outline

- No one can tell me
- Where the Higgs comes from
- Where the Higgs goes
- How do I know?

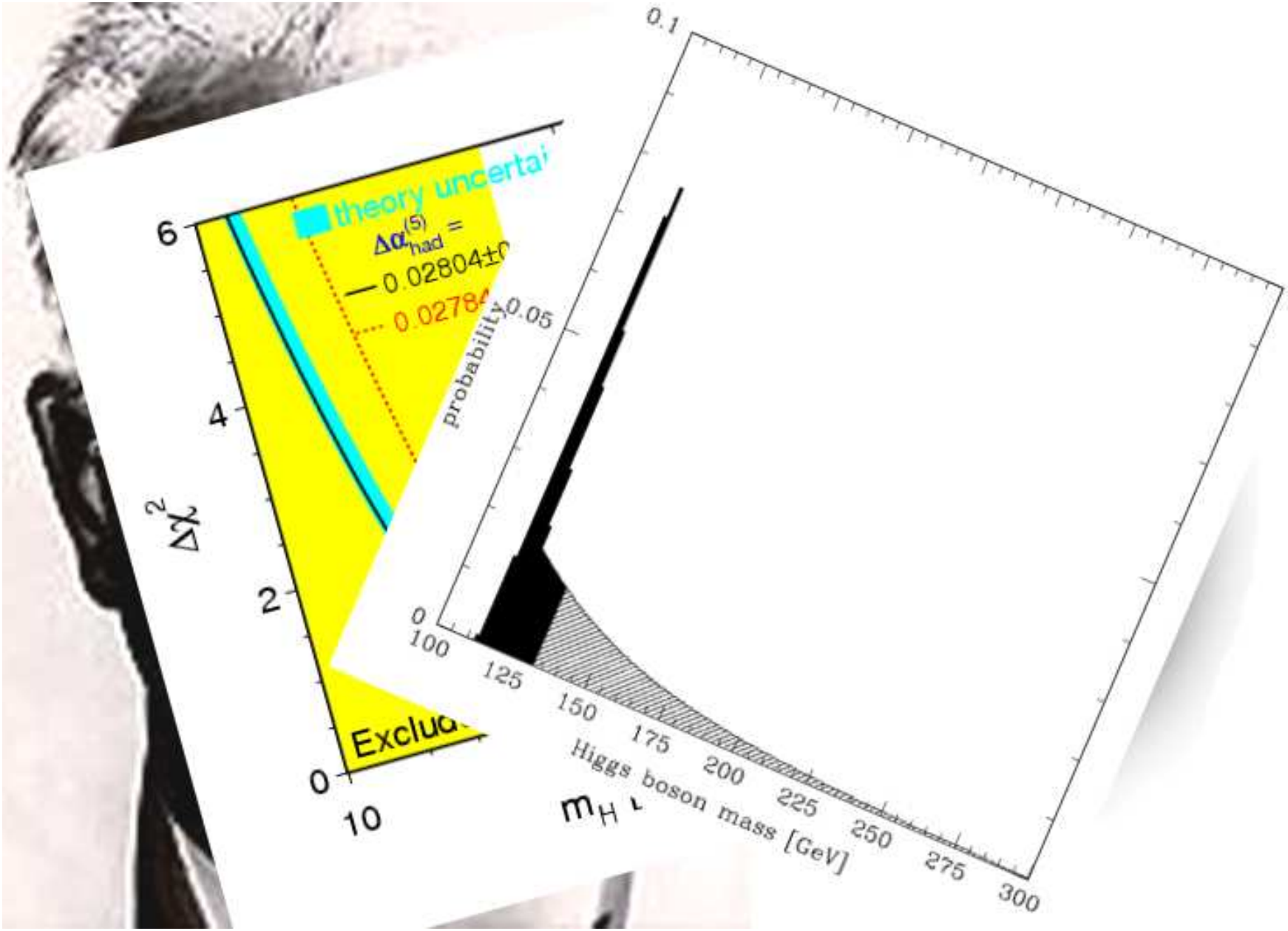
No one can tell me

where's

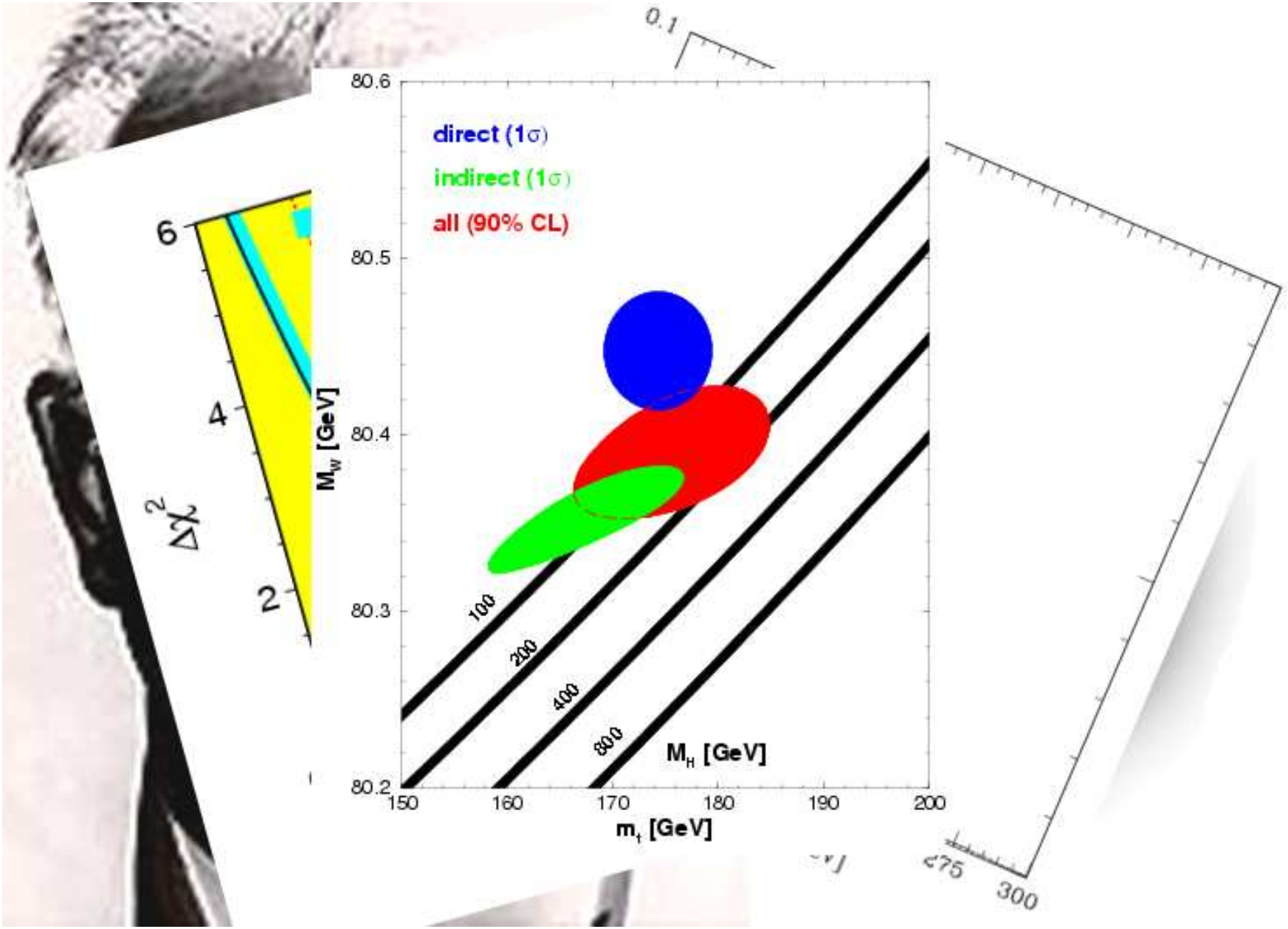
The Higgs hide and seek



The Higgs hide and seek



The Higgs hide and seek



Where the Higgs comes from

What if ...

... the lightest Higgs boson is, indeed, quite light ($m_h \sim 90$-150 GeV), but it's production rate at LEP (Tevatron) is suppressed by new physics

— Suppression of Higgs production/decay rates are typical in XD models

- $e^+ e^- \to Z^{0*} \to Z^0 h$ in TeV^{-1} size XDs:

  KK excitations of Z^0 interfere destructively with SM amplitude for $s < M_n^2$:

$$F_{KK}(s) = 2\sum_{n=1}^{N} \frac{s - M_Z^2}{s - M_n^2} = RA(s)(\pi \cot(RA(s)\pi) - H_{N-RA(s)} + H_{N+RA(s)}) - 1\,,$$

  leading to (substantially) suppressed production rates for $s < M_1^2$

Where the Higgs goes

- assume one TeV-size XD Dienes,Dudas,Ghergetta('99), Masip,Pomarol (`00)

visible brane	bulk
SM matter	SM gauge
Higgs doublet: Φ_u	Higgs doublet: Φ_d

$$\mathcal{L}^5 = -\frac{1}{4}\left(F^a_{MN}\right)^2 - \frac{1}{4}\left(B_{MN}\right)^2 + \left|D_M\Phi_d\right|^2 + \left|D_\mu\Phi_u\right|^2\delta(x^5)\,,$$

$$\Phi_u = \frac{1}{\sqrt{2}}\begin{pmatrix}\Phi_u^{0*}\\ \Phi_u^-\end{pmatrix} = \frac{1}{\sqrt{2}}\begin{pmatrix}v_u + h\cos\alpha + H\sin\alpha + i\cos\beta A\\ \cos\beta H^-\end{pmatrix}\,,$$

$$\Phi_d^{(0)} = \frac{1}{\sqrt{2}}\begin{pmatrix}\Phi_d^+\\ \Phi_d^0\end{pmatrix} = \frac{1}{\sqrt{2}}\begin{pmatrix}\sin\beta H^+\\ v_d - h\sin\alpha + H\cos\alpha + i\sin\beta A\end{pmatrix}\,,$$

— Calculate $Z^0 h$ (Wh) production at LEP (Tevatron)

$$\sigma(e^+e^- \to Zh) = \sigma_{SM}\left[\sin(\beta-\alpha) + 2\cos\alpha\sin\beta F_{KK}\right]^2\,,$$

$$F_{KK} = 2\sum_{n=1}^{\infty}\frac{s - M_Z^2}{s - M_n^2} = \pi R A(s)\left[\cot(\pi R A(s)) - 1\right]\,,$$

- observe threefold suppression: α, β, F_{KK}

The string of my kite ...

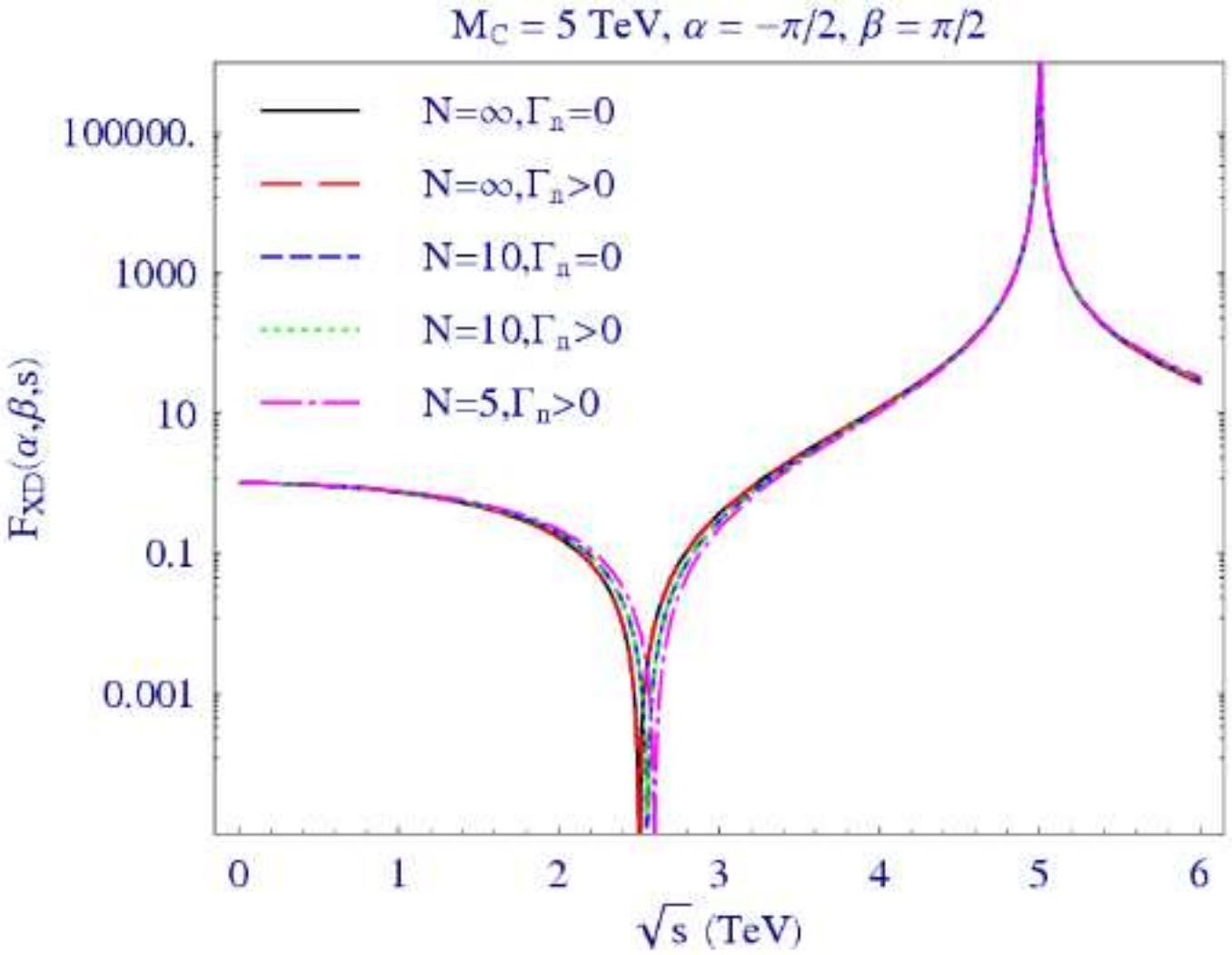


FIG. 1: The extra dimensional contribution F_{XD} to $e^+e^- \to Zh$, as the function of the cent mass energy $\sqrt{s}$ for various other parameter values.

And then when I found it ...

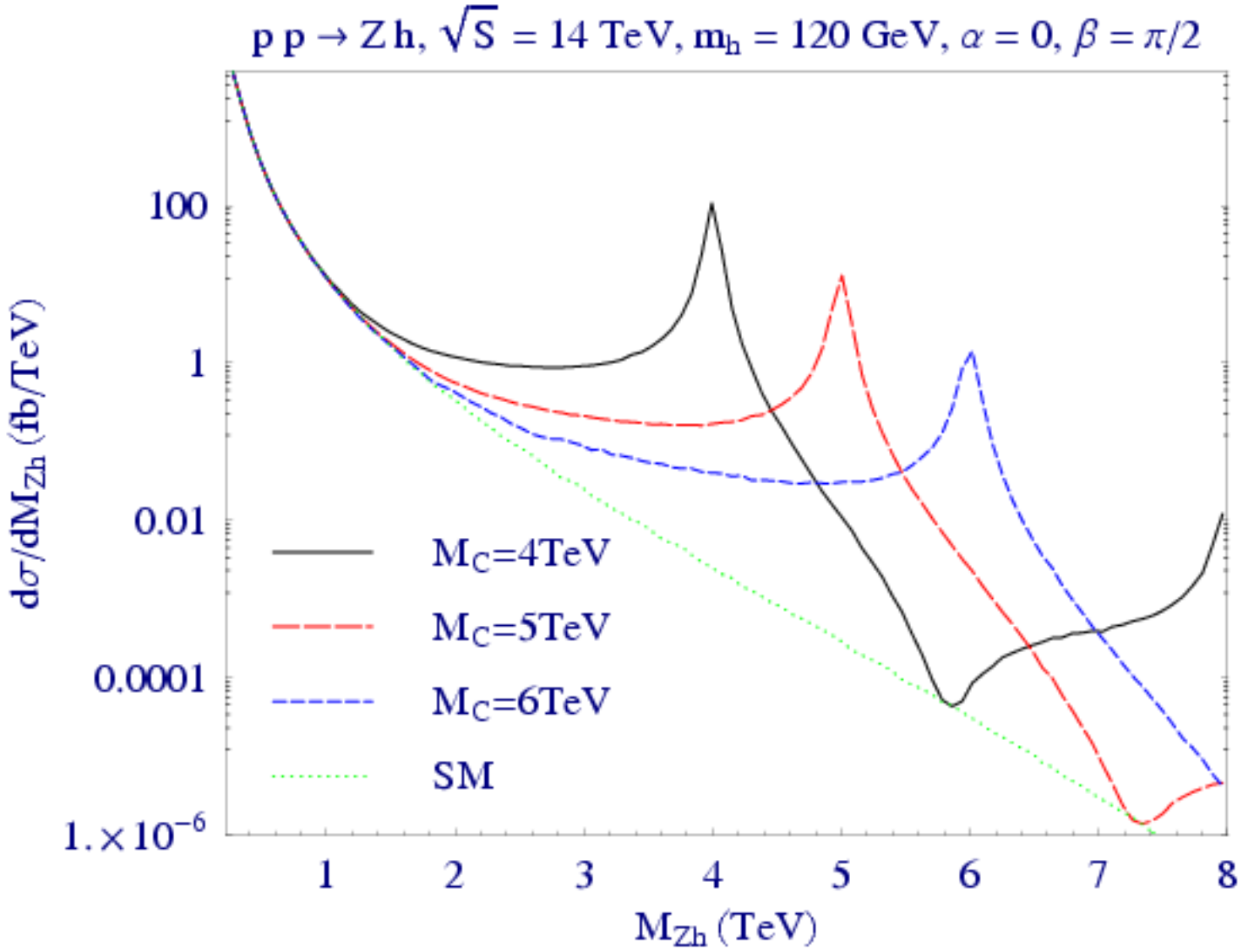


FIG. 3: Higgs production cross section in association with a Z boson at the LHC as a function of the compactification scale for selected values of the mixing parameters.

I should know that ...

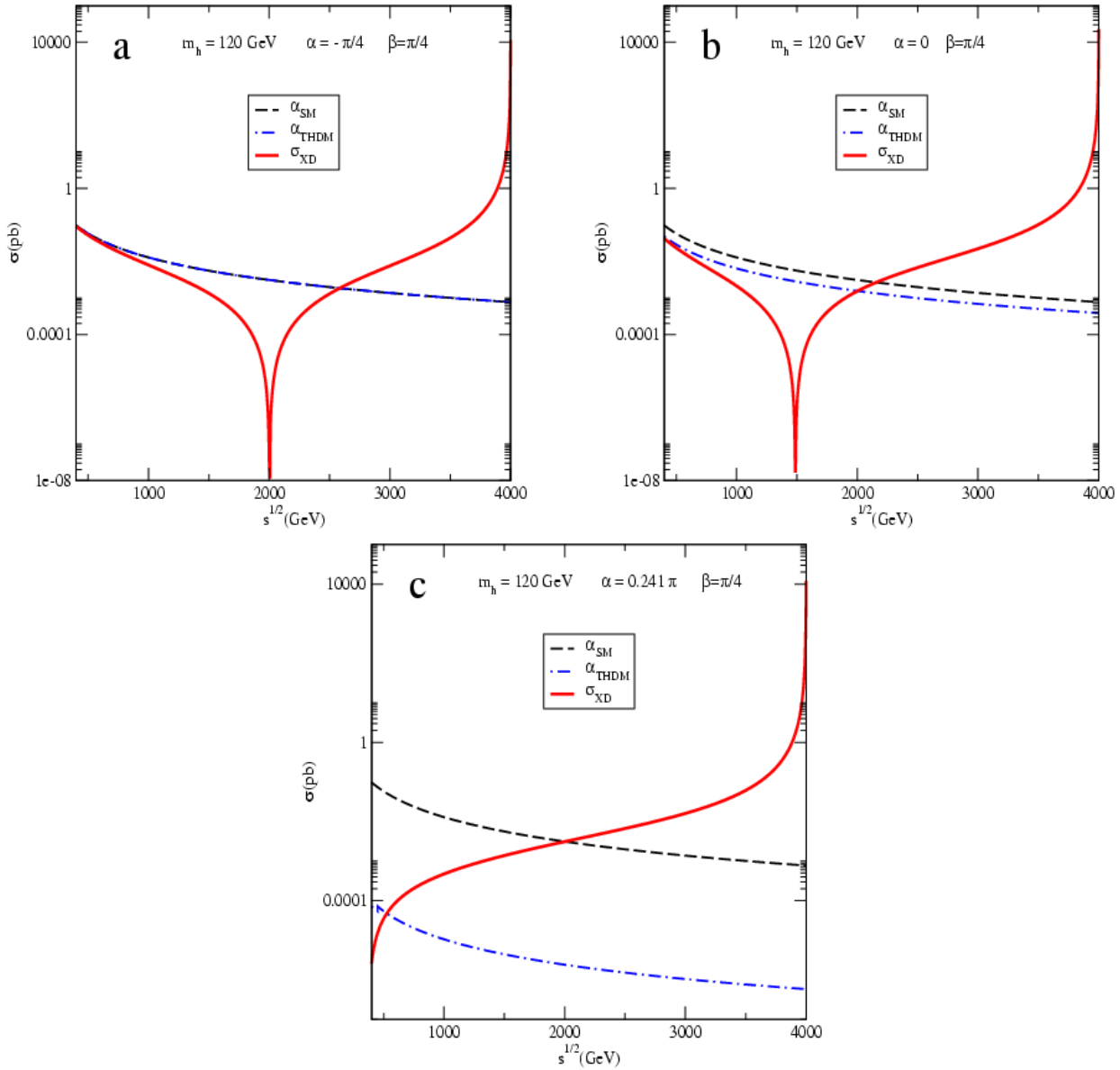


FIG. 1: SM, THDM and XD cross sections for $e^+e^- \to Zh$. Each plot corresponds to a different set of values for α and β all with $m_h = 120$ GeV and with a compactification scale $M_c = 4$ TeV.

The wind had been going there, too

- if Z^0 in bulk ⇒ $\sigma(Z^0 h)$ suppressed @ LEP/Tev/LC, enhanced @ LHC/CLIC
- if h in bulk ⇒ enhanced $\sigma(Z^0 h)$ @ LHC/CLIC can determine its location

— Model and analysis to be extended

- theory: brane-kinetic terms and/or warp

  Are brane kinetic terms (BKTs) describe the same physics as the "mixing"?

  Is it straightforward to warp this?

- phenomenology:

  Special cases? (SM, 2HDM, 5DSM, Higgs in bulk/on brane ...);

  Other processes ($gg \to h$, ...), decays ($h \to b\bar{b}$, $h \to gg$, ...)?

  What's the new phenomenology induced by BKTs?

- experiment:

  In what para-region can the peak be observed at LHC/CLIC?

  Can we measure α and β (Higgs location) independently?