

Letter of Interest concerning group F08

What can we expect at an e^+e^- TeV collider from LHC indications for new heavy scalars ?

F. Richard June 2020

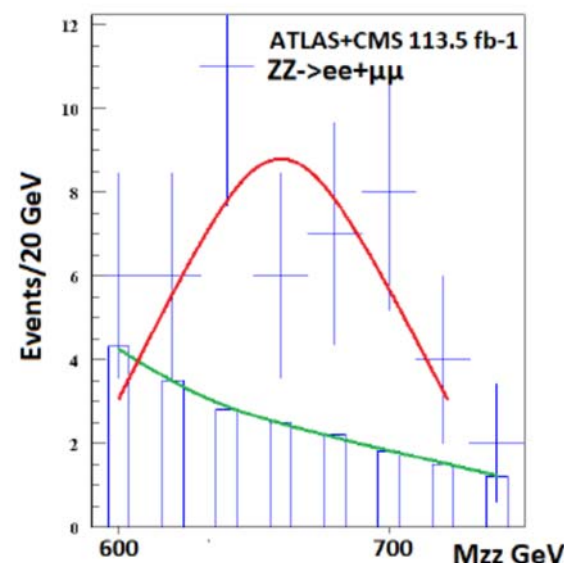


Introduction

- The general mood in HEP is that we should expect nothing new and be content with precision measurements
- In that case an e^+e^- collider reaching the top threshold is sufficient
- The selling argument for a Linear Collider is its **expandability in energy** to cope with unforeseen discoveries from LHC
- If these discoveries are to occur in the present machine, there should already be **some indications** in the present data (not yet fully analysed)
- I have decided to look into the LHC searches for new scalars and had **some surprises**
- I will therefore briefly summarize these findings and give a brief evaluation of the **rates and backgrounds at an e^+e^- LC**
- Two Arxiv papers already describe this work:
- <https://arxiv.org/abs/2001.04770>
- <https://arxiv.org/abs/2003.07112>

H(660) in 4 leptons

- Paolo Cea, a physicist from Bari, had a look at the data from CMS and ATLAS and found coincidental fluctuations at ~ 700 GeV
- I did the same and found the following combined result which indeed suggests a bump at 660 GeV with a ~ 100 GeV width (see figure)



- This indication is observed in ATLAS in ggF (tt coupling) and ZZ/WW fusion
- Not seen in tt (but ggF suggests there is coupling), nor in **WW** (2HDM !), weak hh indication
- The following table shows my findings as deduced from ATLAS and CMS data
- Intriguing missing modes ~50%
- **1 fb expected from e+e- → hZ at 1 TeV**

Channel	ZZ	hh	Missing	tt	gg
BR %	28	14	49	9	0.026
σ fb	160	80	280	50	0.15

A(400) in 4 independent channels

- A ttbar paper from CMS has claimed a 3.5 sd at ~400 GeV
- CMS took into account interference with the QCD background (major handicap of LHC)
- Signals were observed by ATLAS in tt, tt+b and in hZ + b
- **4 signals at ~3 sd, result in >5 sd when combined**
- Does not fit into **2HDM** which would predict ~zero for A->hZ

gAtt	tt %	miss %	hZ %	$\tau\tau$ %	bb %	gg %	σ A fb	Γ_{tot} GeV	Γ_{res}/M %
1	42	46	3.7	0.55	0.3	0.04	9000	28	7
0.9	52	40	6.5	0.7	0.35	0.04	7300	18.3	5
0.8	66	19	5.7	0.87	0.45	0.06	5700	11.4	3.5
0.7	86	5	7.5	1.1	0.56	0.07	4400	6.7	2.6

• Preferred solution gAtt~0.8

- **Predicts ee->hA(400) ~2 fb at 600 GeV**

Conclusions

- There is hope for LHC discoveries in a near future and one is eagerly awaiting for full analysis and professional data combinations
- Eager to see missing analyses and HL-LHC
- I am agnostic about interpretations (SUSY or its avatar 2HDM, compositeness) with some sympathy for the later
- I am working out the numbers for what concerns ILC in view of **Snowmass** (BSM physics) and prepare a 3d ArXiv paper