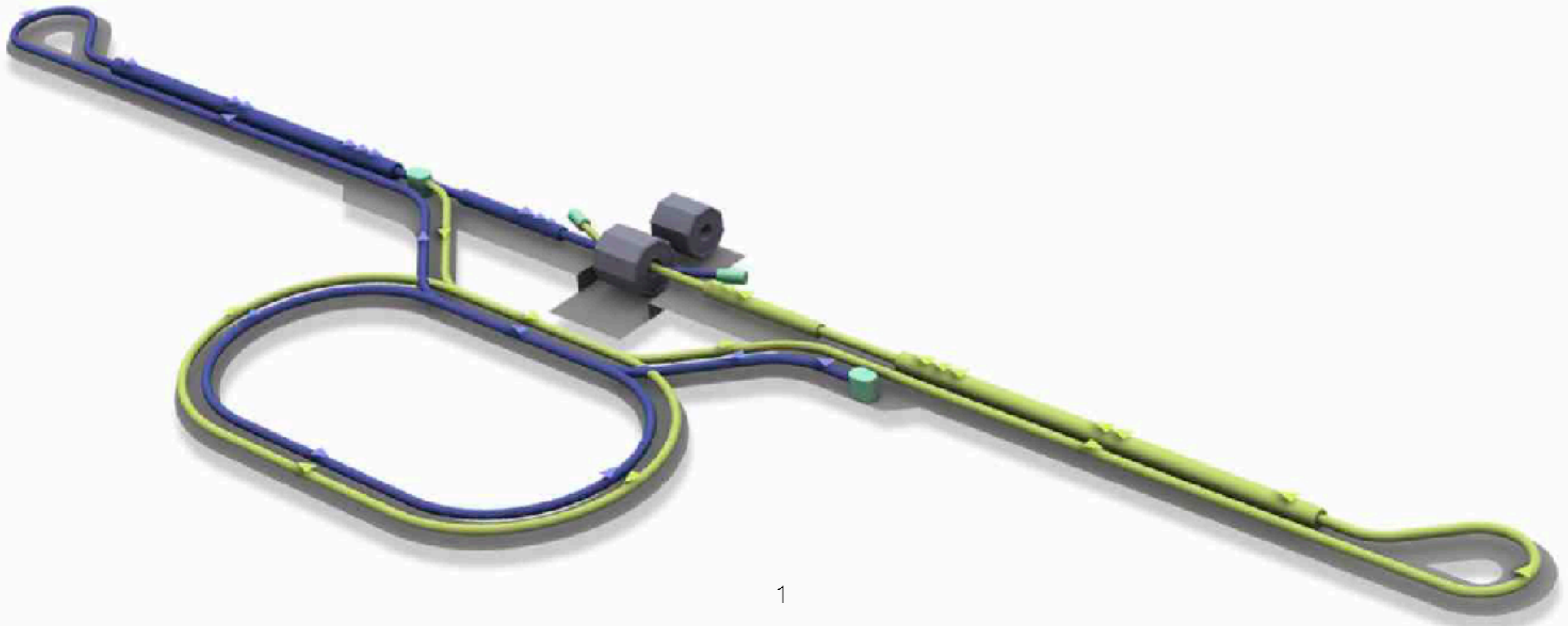


# ILC IDT WG3

## Physics & Detector

Hitoshi Murayama (Berkeley/Kavli IPMU)  
拡大高エネルギー委員会, Aug 21, 2021



# ILC

## physics vs technology

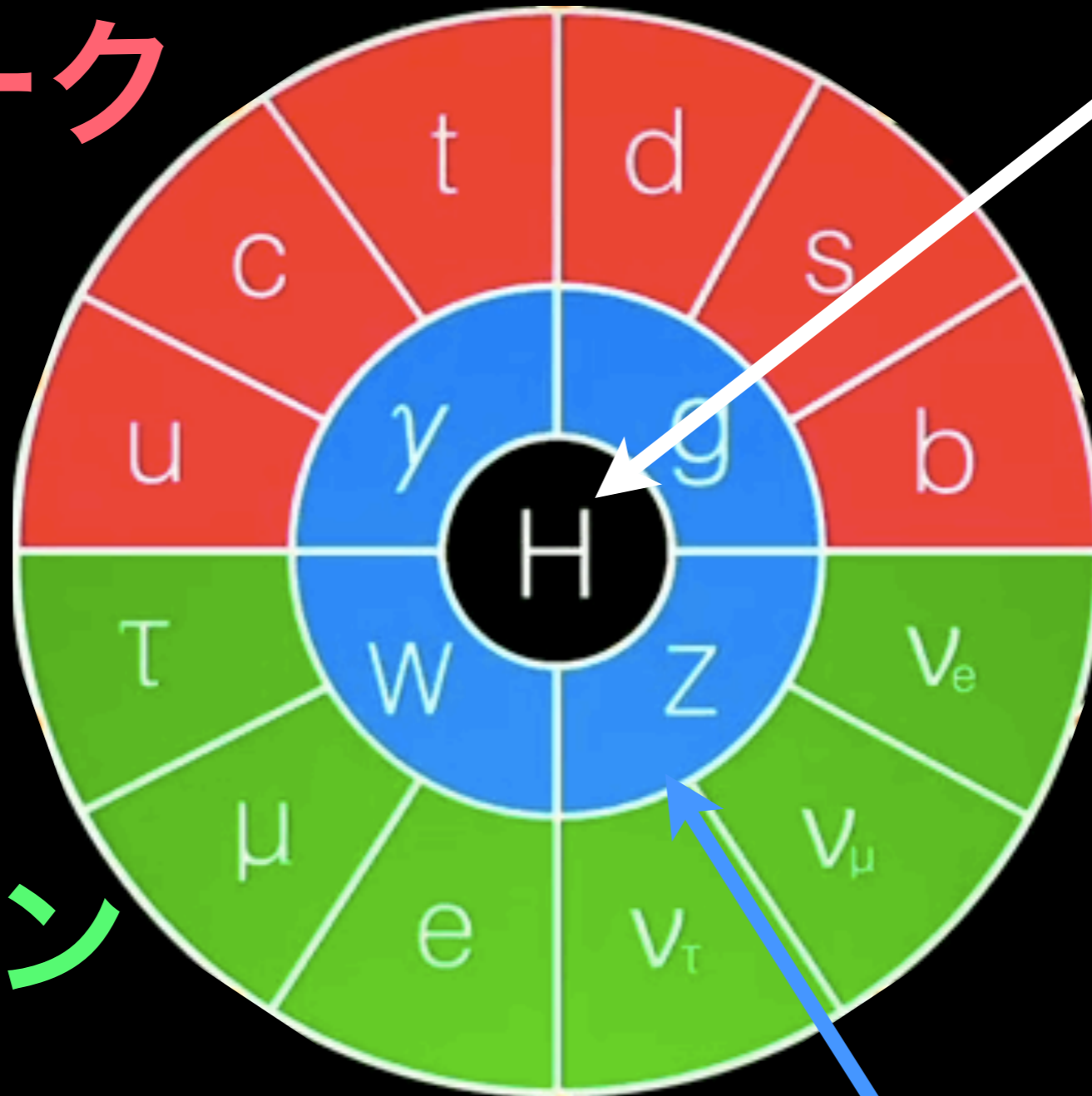
- We've known since 30's that TeV scale is important  $G_F \sim (300\text{GeV})^{-2}$ 
  - Fermi talked about globatron
  - didn't know what energy is sufficient for physics:  $\sqrt{s} = 1.5\text{--}3\text{TeV}$ ?
- We've known since 60's that we should go linear
  - mature design since Technical Design Report in 2013
  - extendable to higher energies
- Lots of technical progress since then
  - SCRF gradient, yield (European X-FEL  $\sim 0.1$  ILC)
  - low emittance
- Higgs discovery
  - now we now  $\sqrt{s} = 250\text{GeV}$  is already great physics
  - European Strategy: Higgs factory = highest priority
  - ILC the "only" realistic project right now
- "Pre-lab" four-year process incl. international negotiations
  - need to finalize engineering design
  - proposal submitted to MEXT, under review

***physics and technology finally met each other!***

# 標準理論

クォーク

ヒッグス



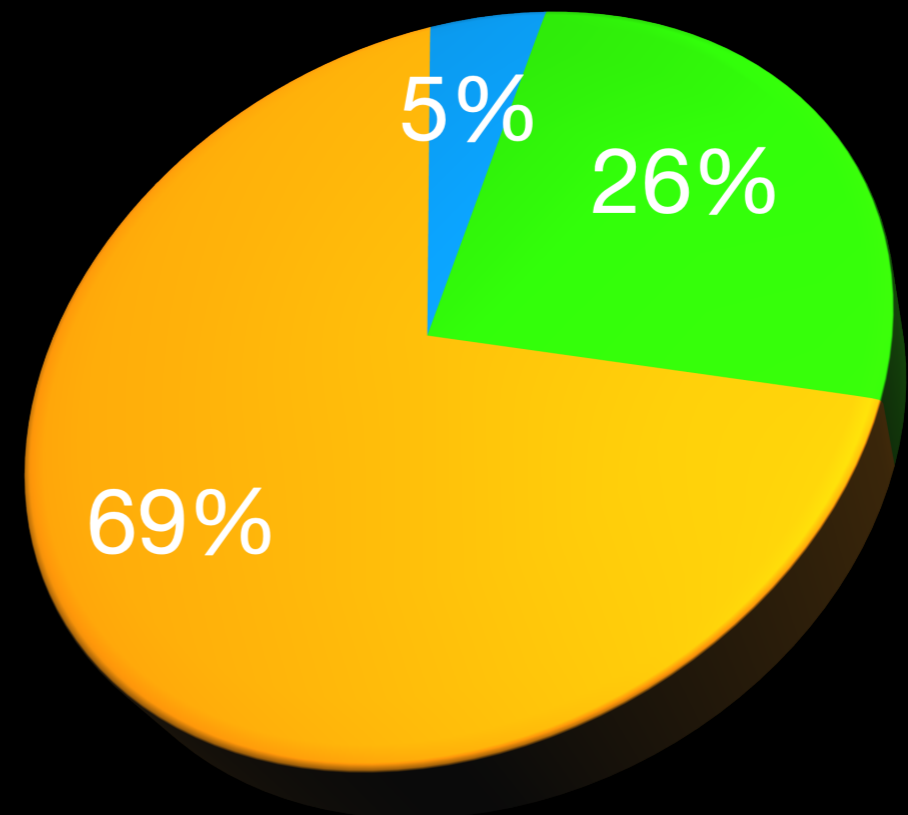
レプトン

力の粒子

# どう標準理論を超えるか？

- 標準理論では説明できない謎
  - ニュートリノの質量
  - ダークマター
  - ダークエネルギー
  - インフレーション
  - 消えた反物質
- 理論的な予想
  - ヒッグス粒子が突破口に

- 原子
- ダークマター
- ダークエネルギー



# History of Colliders

## lepton vs hadron

1. precision measurements of neutral current (*i.e.* polarized  $e+d$ ) predicted  $m_W, m_Z$
  2. UA1/UA2 discovered  $W/Z$  particles
  3. LEP/SLC nailed the gauge sector
- 
1. precision measurements of  $W$  and  $Z$  (*i.e.* LEP + Tevatron) predicted  $m_t$  and  $m_H$
  2. Tevatron discovered top, LHC discovered a Higgs particle
  3. ILC nails the top & Higgs sector
- 
1. precision measurements at ILC predicts ???

# 窓

暗黒  
世界

$$\frac{1}{\Lambda^{n+2}} \mathcal{O}_n H^\dagger H$$

標準理論

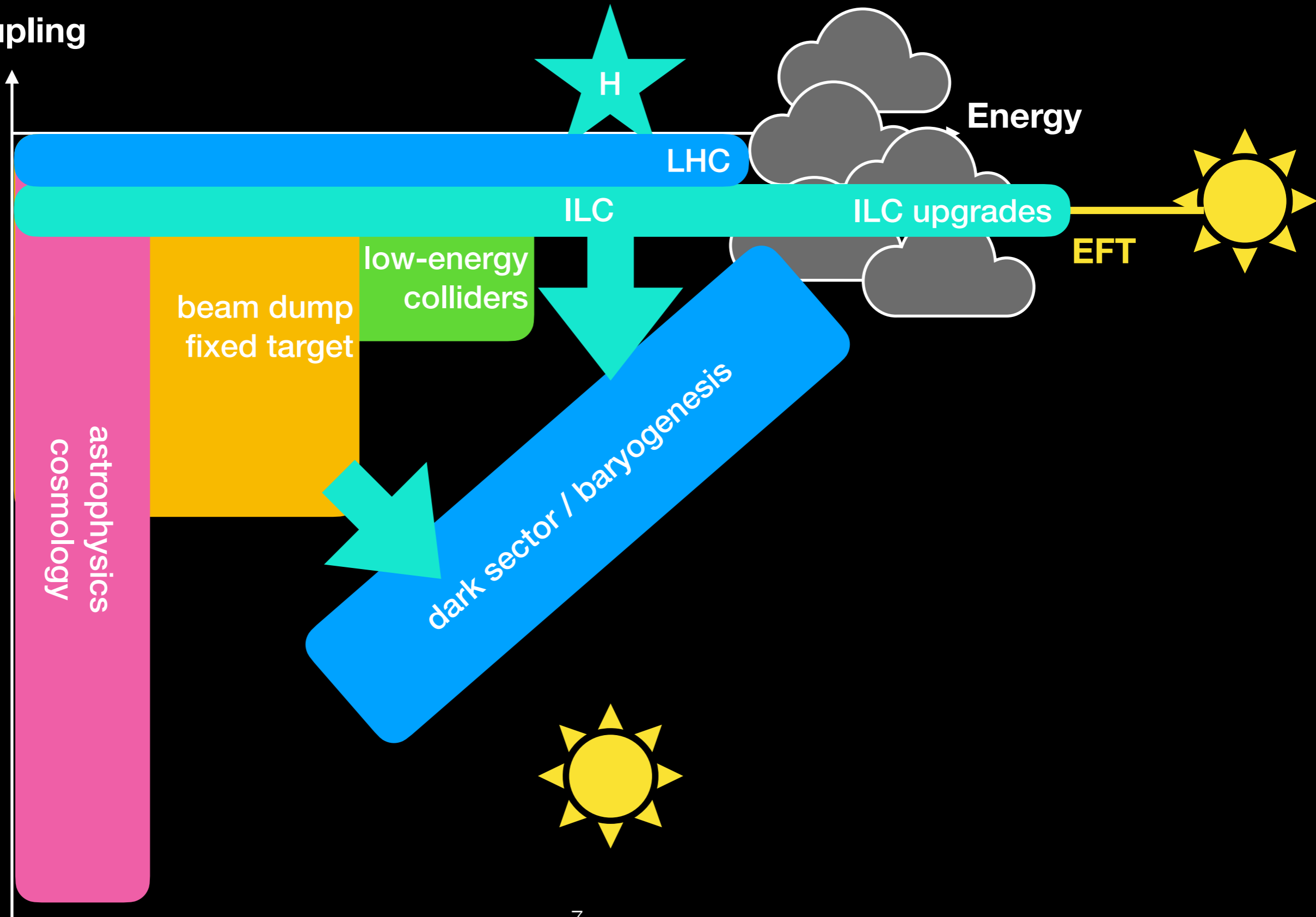
ヒッグス

物質粒子

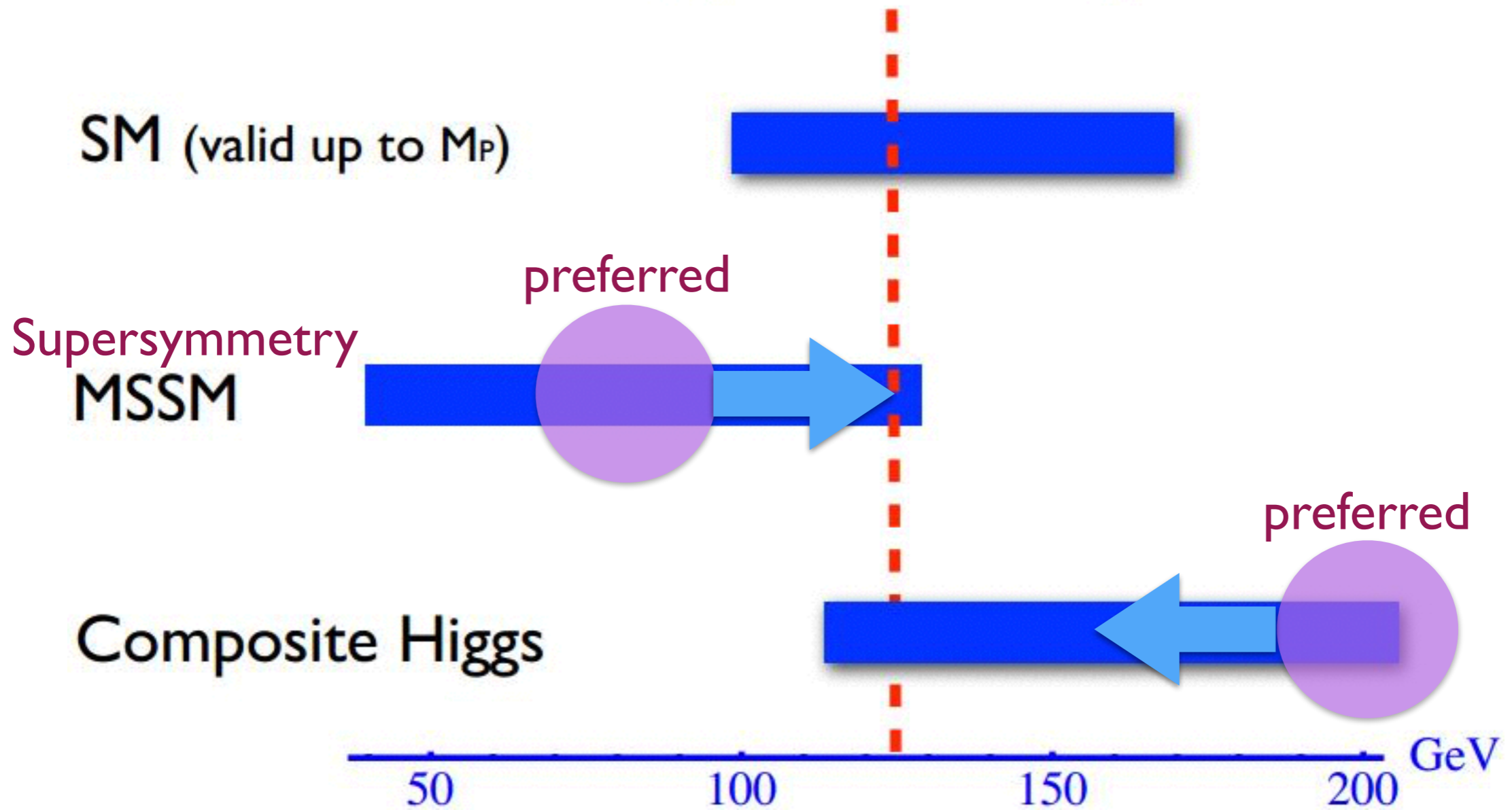
cf.  $\frac{1}{\Lambda^{n+4}} \mathcal{O}_n F_{\mu\nu} F^{\mu\nu}$

# ILC++

Coupling

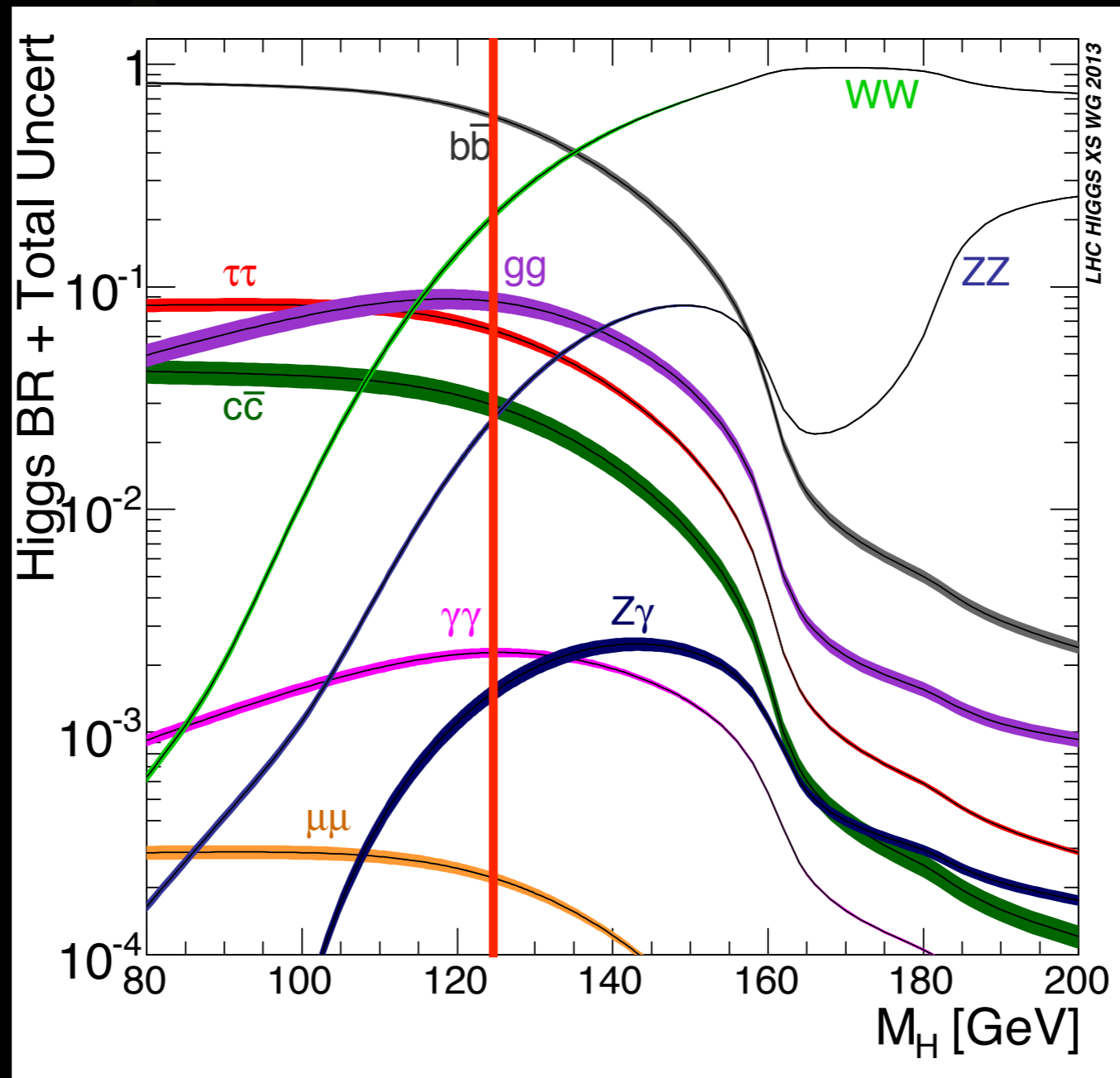


# Higgs mass range



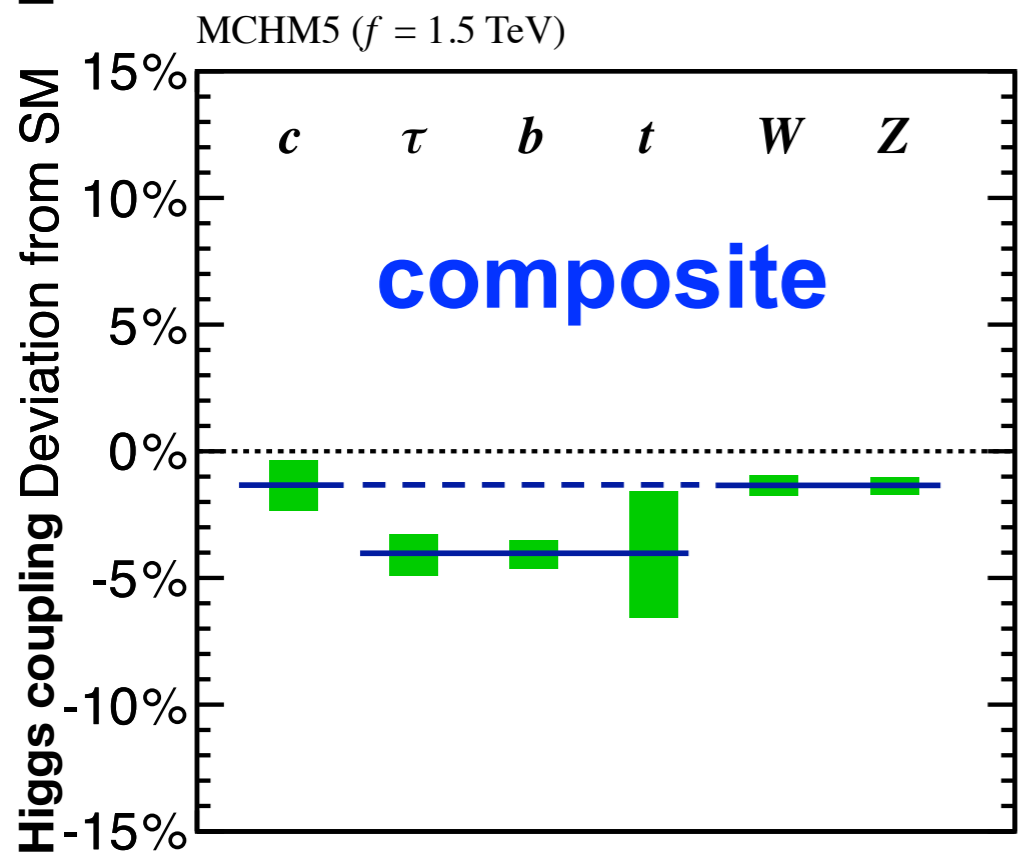
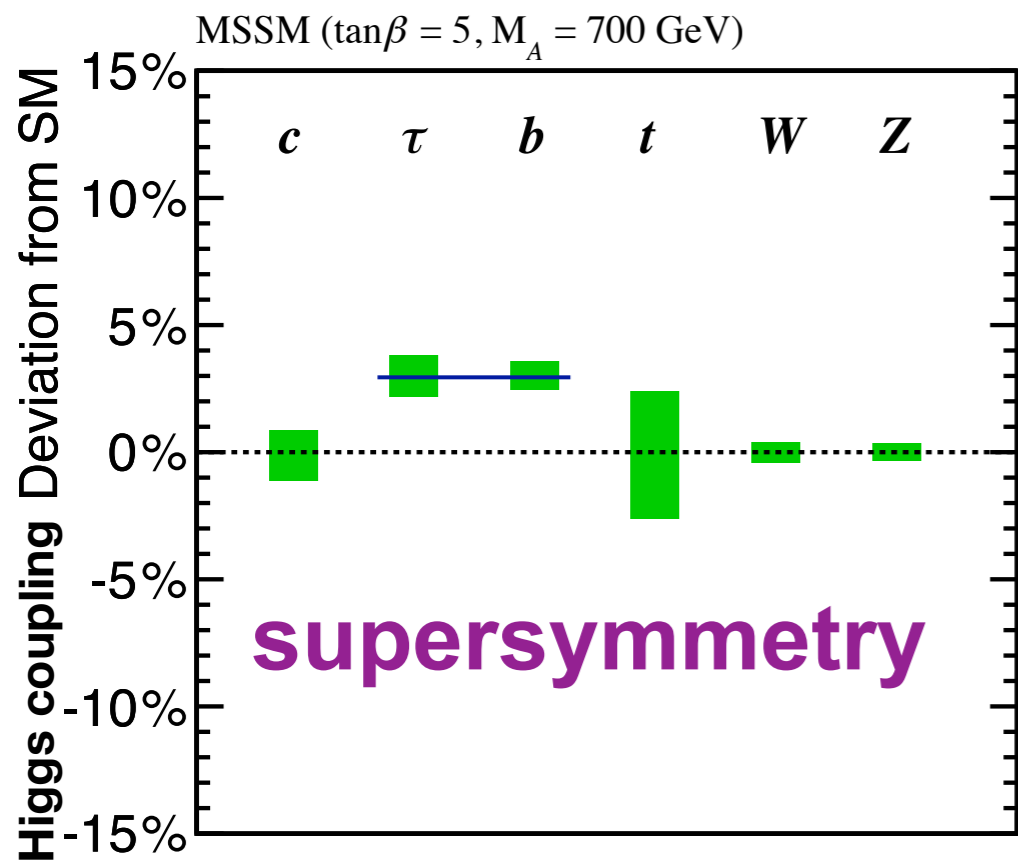


# dream case for experiments



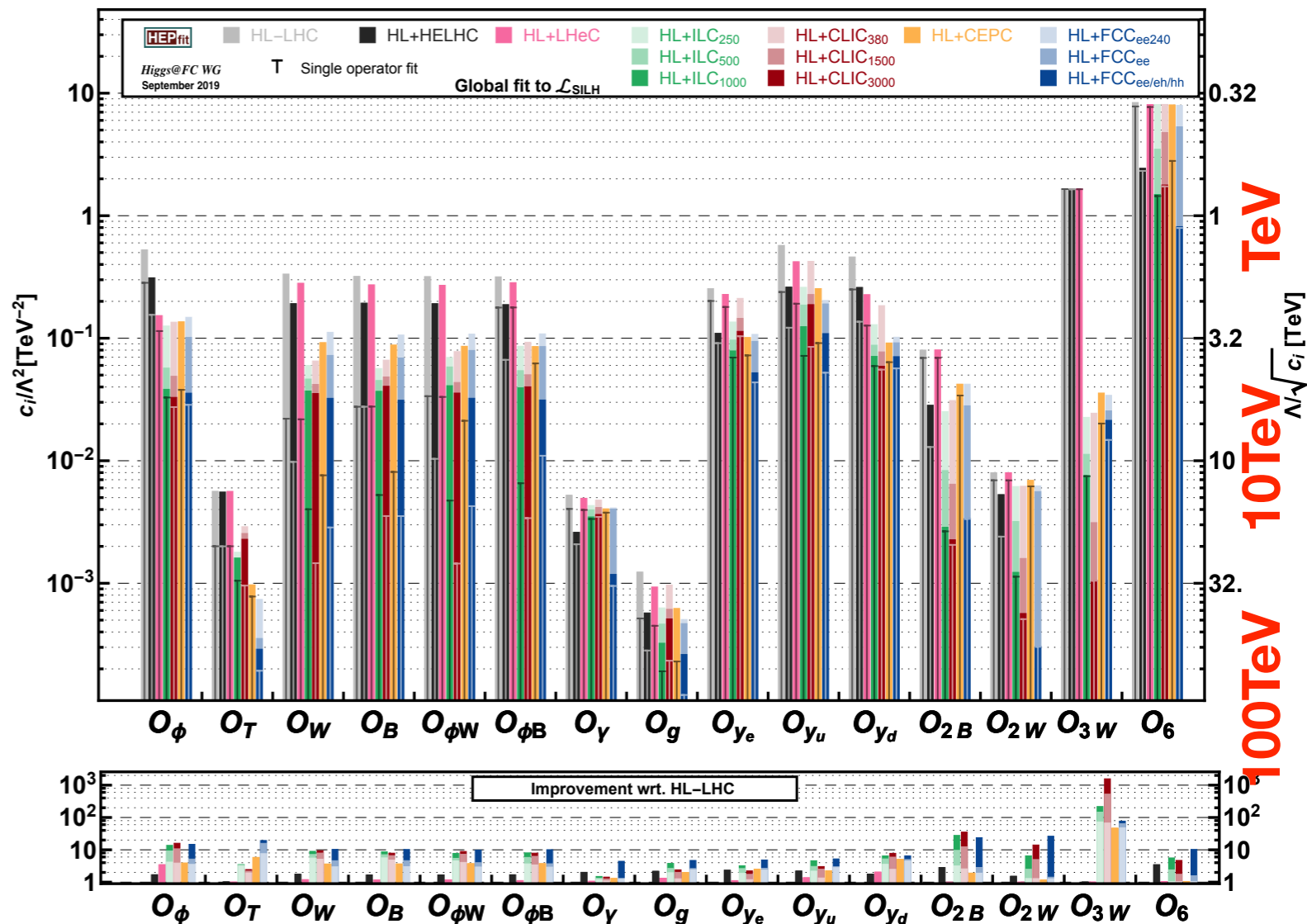
*stupid not<sup>o</sup>to do this!*

# What is Higgs boson really?



# What is the next energy scale?

x10 HL-LHC

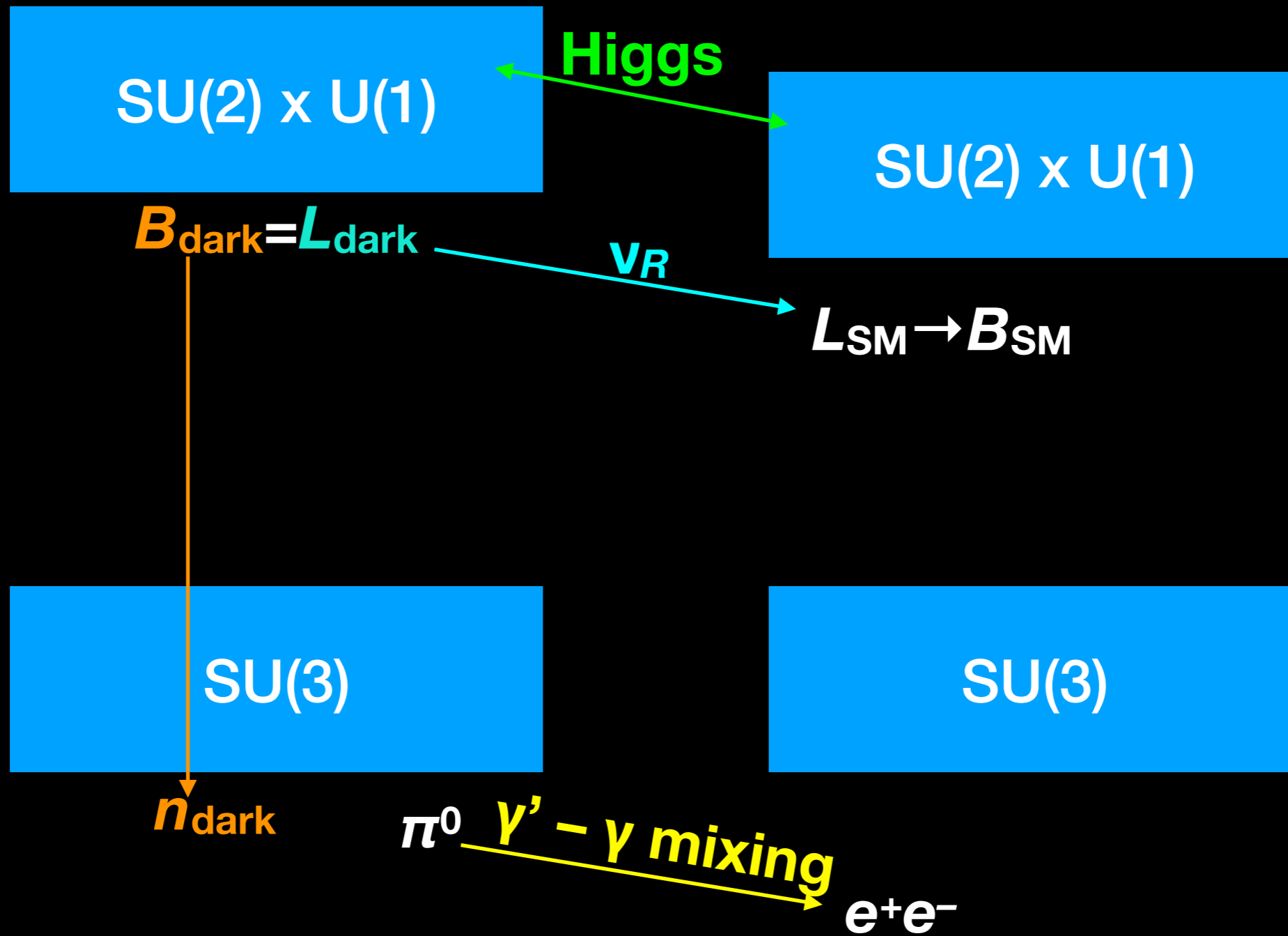


2000fb<sup>-1</sup>@250GeV  
200fb<sup>-1</sup>@350GeV  
4000fb<sup>-1</sup>@500GeV

# baryogenesis + DM

dark sector

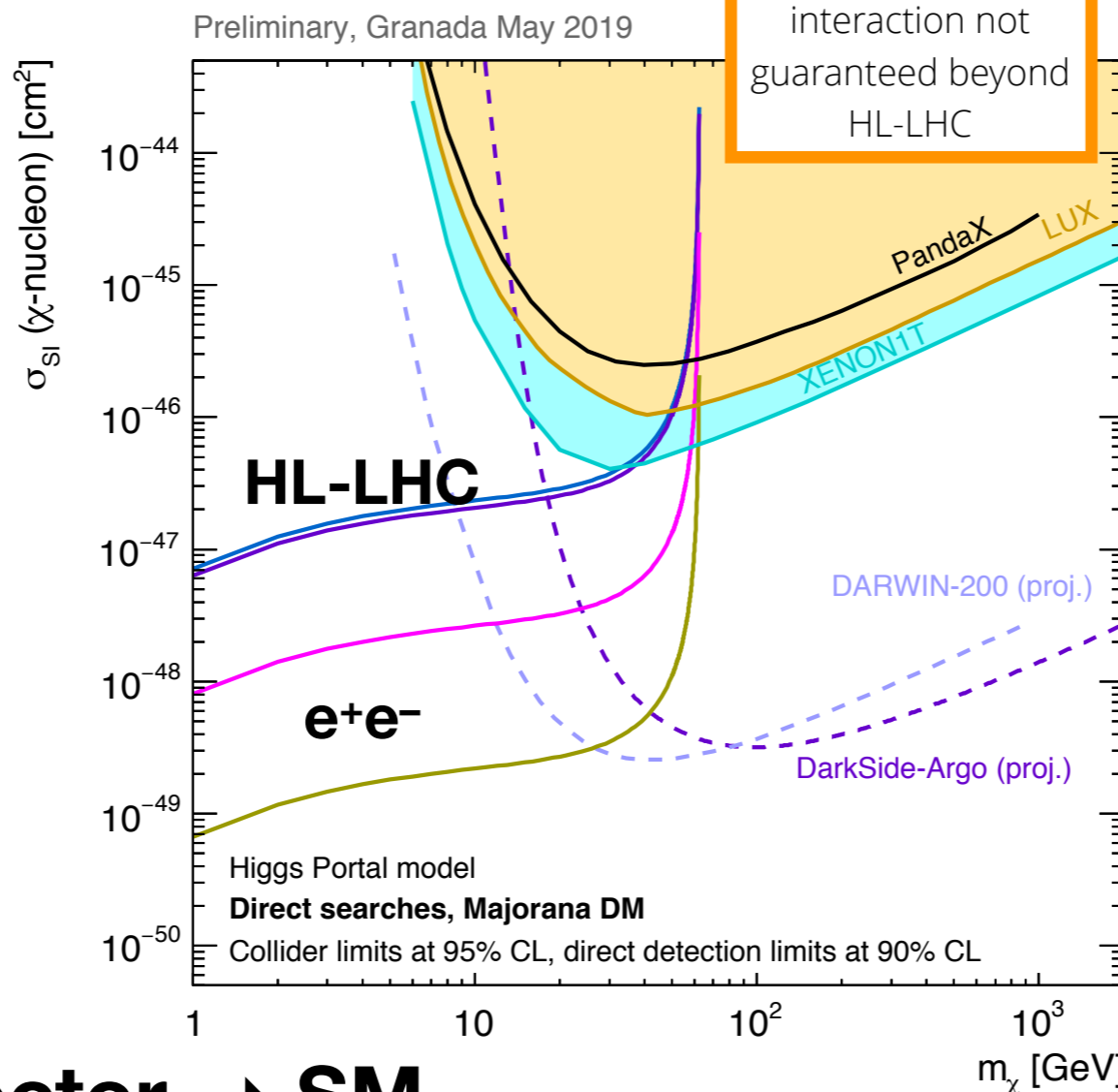
SM



# direct detection limits

## Higgs decay to dark matter

x10 HL-LHC



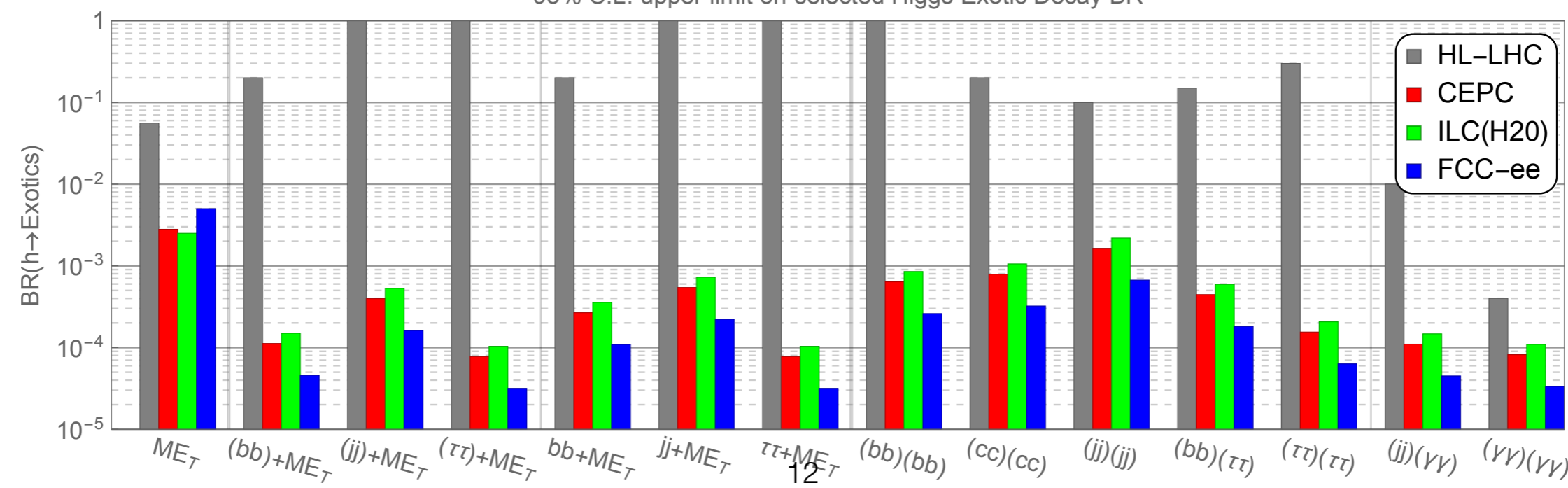
Caveat: EFT validity in Higgs-DM interaction not guaranteed beyond HL-LHC

x1000-10000 HL-LHC

## Higgs → dark sector → SM

95% C.L. upper limit on selected Higgs Exotic Decay BR

## exotic Higgs decays



**SiD**

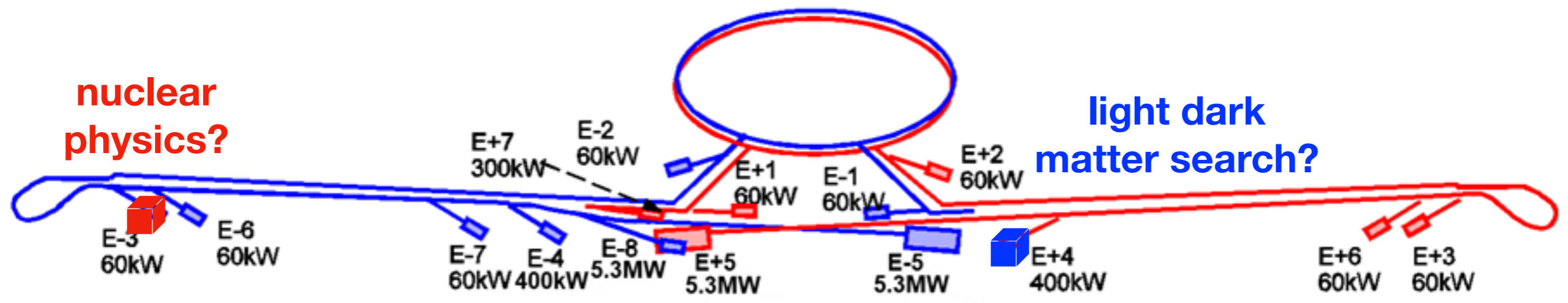
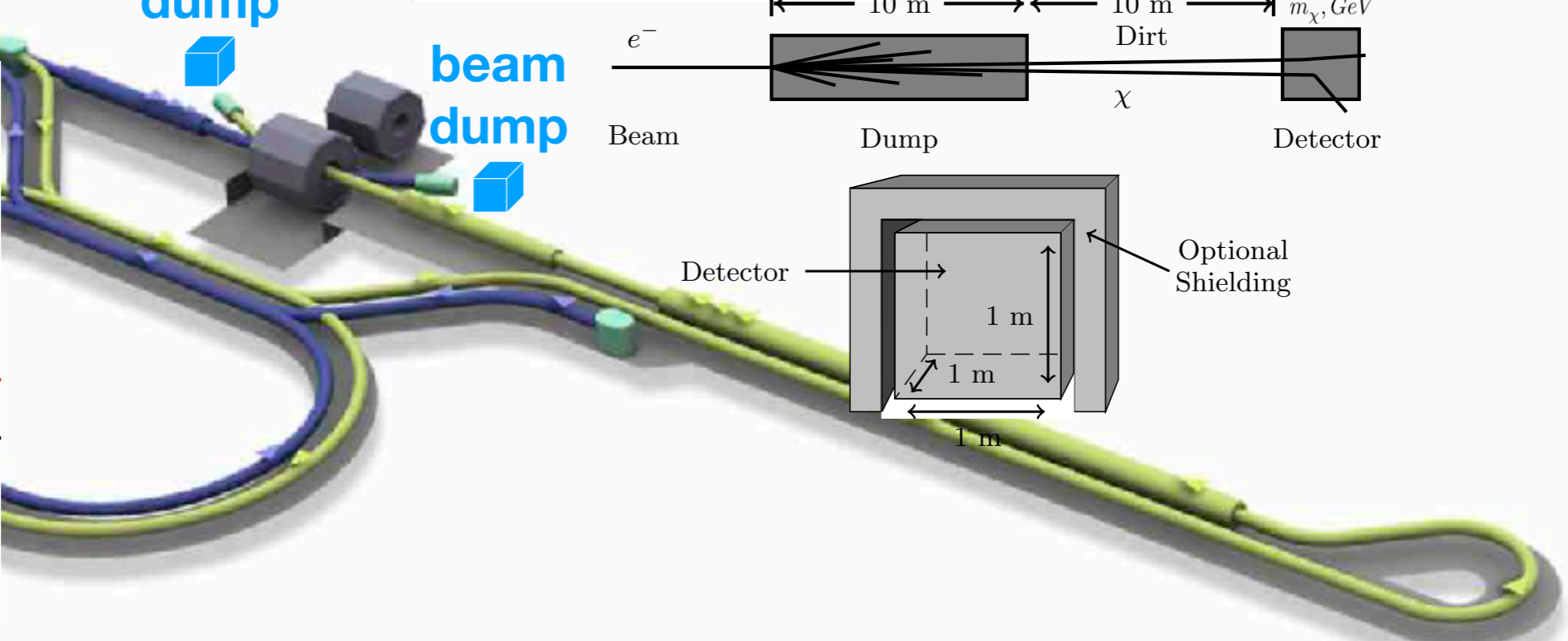
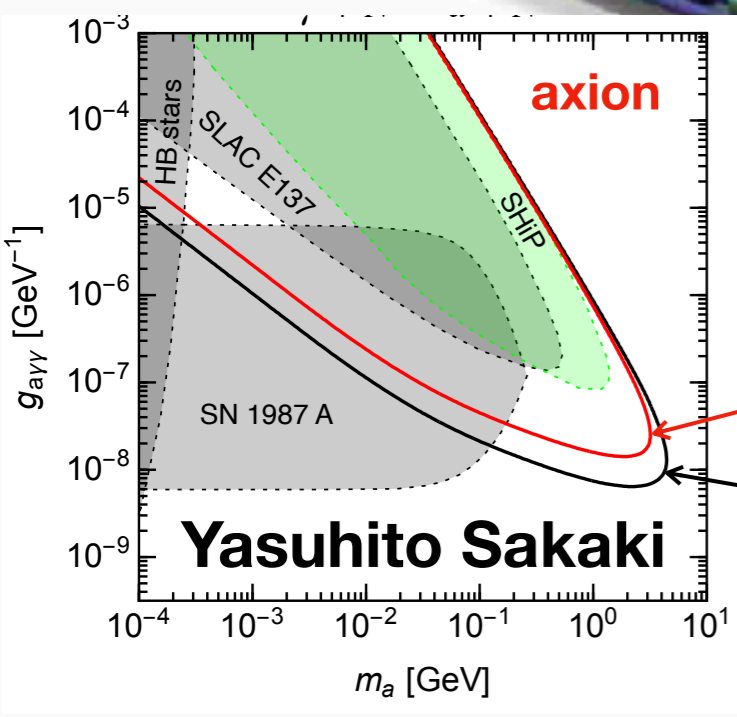
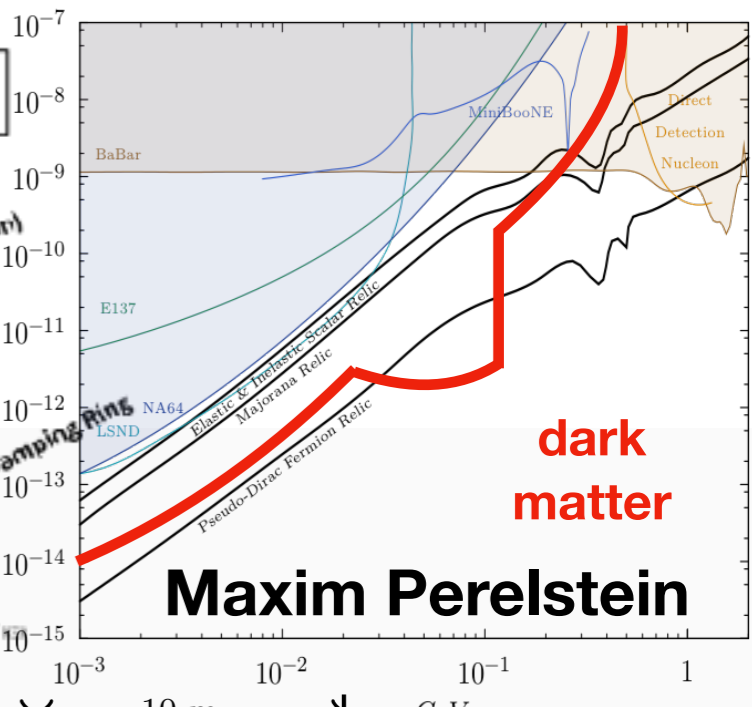
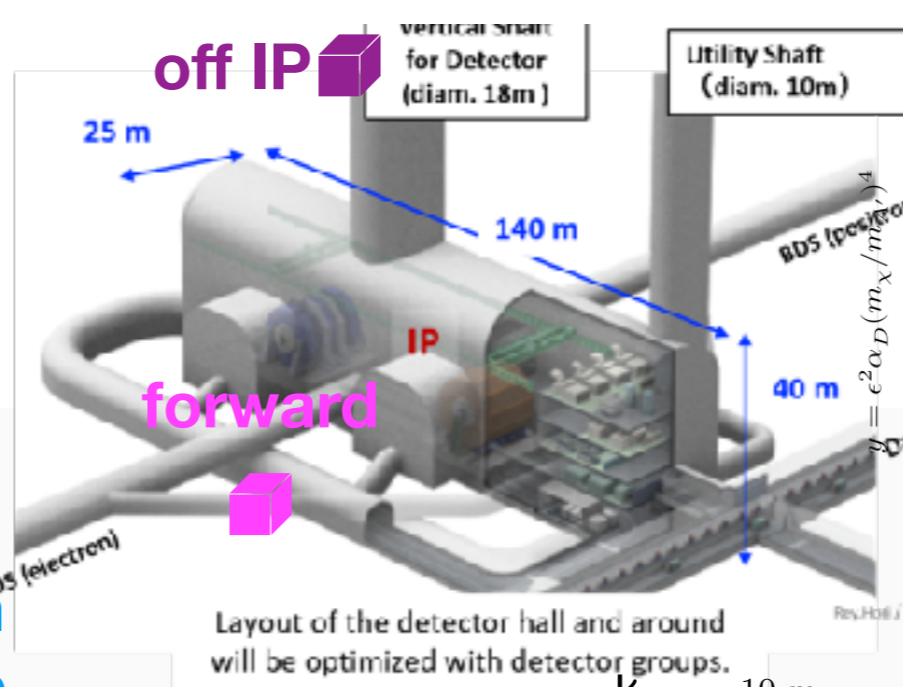
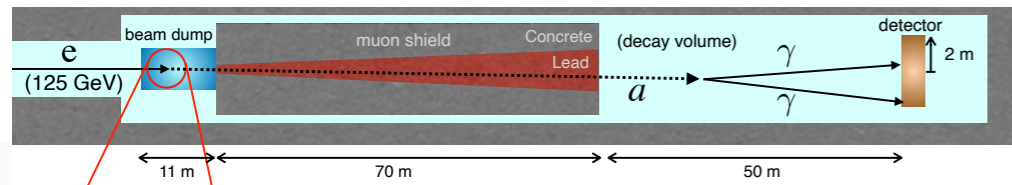
**Marcel Stanitzki**

**ILD**

**Ties Behnke**

Cover: Paj-Hor

**optimizations?**  
**new technologies?**  
**new concepts?**



off IP  
forward

beam dump

beam dump

light dark matter search?

nuclear physics?

E+6 60kW  
E+3 60kW

E-3 60kW  
E-6 60kW

E-7 60kW  
E-4 400kW

E-8 5.3MW  
E-5 5.3MW

E-1 60kW  
E-5 5.3MW

E-2 60kW  
E+4 400kW

E+7 300kW  
E+1 60kW  
E-1 60kW  
E+2 60kW

Yasuhito Sakaki

Maxim Perelstein

# higher energies

- main reason to go linear: extendable!

- 350GeV:  $t\bar{t}$  threshold

- 400GeV: open top

- 550GeV:  $t\bar{t}H$

- 1TeV: Higgs self coupling, vector boson scattering

- multi TeV: SUSY, extra dim,  $Z'$ , ....

ILC Nb	35-50MV/m	0.5–1.5TeV
ILC Nb <sub>3</sub> Sn	120MV/m	4TeV
CLIC	100MV/m	3TeV
PWF DLA	1GV/m	30TeV

# WG3 Organisation and mandates

Chair: Hitoshi Murayama (Berkeley/Tokyo)

Deputies: Jenny List (DESY) and Claude Vallée (Marseille)

## Coordinator and Deputy coordinator(s)

### Steering Group

Subgroup conveners, Coordinator and Deputy Coordinator(s)

Kiyotomo Kawagoe (Kyushu), Alain Bellerive (Carleton),  
Ivanka Božović Jelisavčić (Belgrade)

### Speaker's bureau

Andy White (UT Arlington), Ties Behnke (DESY), Yuanning Gao (Peking), Frank Simon (MPP), Jim Brau (Oregon), Keisuke Fujii (KEK), Phil Burrows (Oxford), Francesco Forti (INFN),  
Filip Zarnecki (Warsaw), Patty McBride (Fermilab), Mihoko Nojiri (KEK), CERN member, Timothy Nelson (SLAC), Kajari Mazumdar (Mumbai), Phillip Urquijo (Melbourne), Dmitri Denisov (Brookhaven)

#### Interface with machine

Coordinate the interactions between the accelerator and facility infrastructure planning and the needs of the experiments

Karsten Buesser (DESY), Yasuhiro Sugimoto (KEK), Roman Poeschl (Orsay), US

#### Detector and technology R&D

Provide a forum for discussion and coordination of the detector and technology R&D for the future experimental programme

Marcel Vos (Valencia), Katja Krueger (DESY)  
Petra Merkel (Fermilab), David Miller (Chicago)

#### Software and computing

Promote and provide coordination of the software development and computing planning

Frank Gaede (DESY), Jan Strube (PNNL)  
Daniel Jeans (KEK)

#### Physics potential and opportunity

Encourage and develop ideas for exploiting the physics potential of the ILC collider and by use of the beams available for more specialised experiments

Michael Peskin (SLAC), Junping Tian (Tokyo)  
Aidan Robson (Glasgow)

## Open to anybody interested!

<https://linearcollider.org/team/>



# Regular ILC Software tutorials

grow and educate the community and newcomers

- organising a series of monthly seminars tutorials
- **Wednesdays**
  - **06:30 PDT / 15:30 CEST / 22:30 JST**
  - 60~90 minutes
- first one will be on **June 23**:
  - DELPHES ILC card (Filip Zarnecki)
  - “make your first ILC Higgs plot” (Jenny List)
- second one on **July 21**:
  - Introduction to iLCSoft (Thomas Madlener)
- future candidates: SGV, LCFIPlus, PandoraPFA, ddsim/DD4hep,...
- what do you want to see covered ?
  - send your suggestions to:  
**[ilc-swc-coreATml.post.kek.jp](mailto:ilc-swc-coreATml.post.kek.jp)**

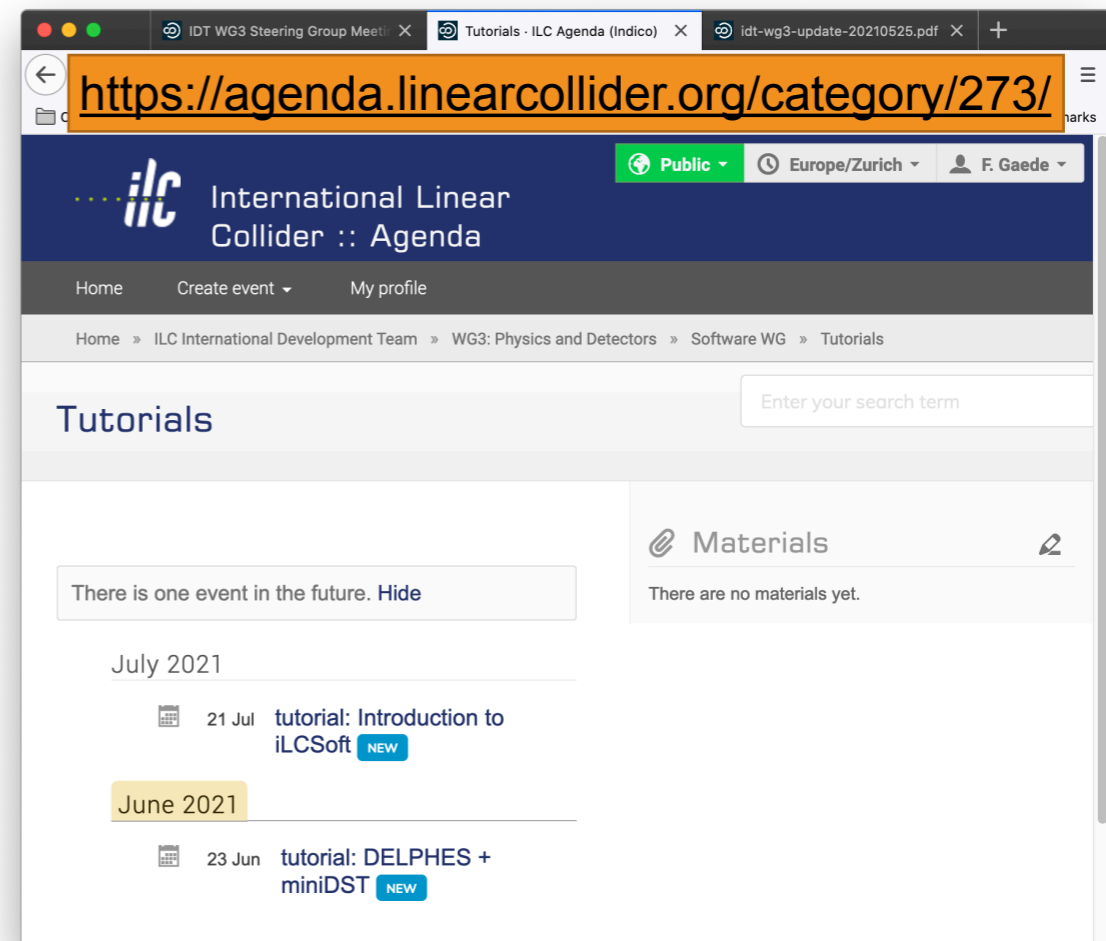


Table 1

## • Upcoming Tutorials:

• Aug 18th, LCFIPlus: <https://agenda.linearcollider.org/event/9318/>

• Sep 15th, SGV fast simulation: <https://agenda.linearcollider.org/event/9319/>

# Future open scientific meetings



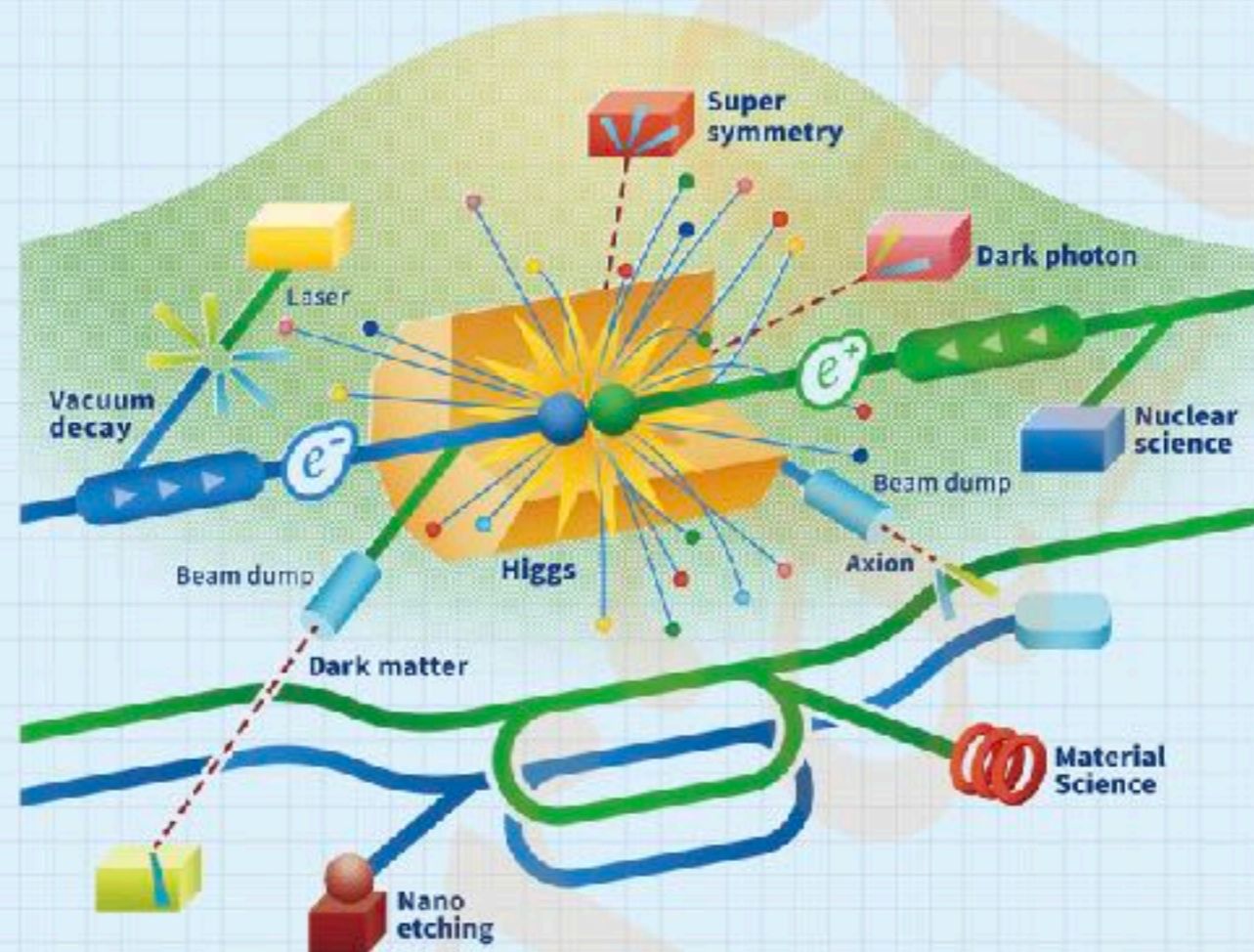
- ◆ Initially: regular monthly open scientific meetings, each organised by 2–3 Topical Groups – frequency will increase gradually as more people join. Schedule:

- **Thursday 17<sup>th</sup> June**, 3pm CEST
- **Thursday 15<sup>th</sup> July**, 3pm CEST
- **Thursday 12<sup>th</sup> August**, 3pm CEST
- **Thursday 16<sup>th</sup> September**, 3pm CEST

Global Interpretations and BSM talks including: Status update on EFT fits  
Connecting UV models to EFTs

- ◆ All listed on indico (linked from main WG3 Physics webpage)  
<https://agenda.linearcollider.org/category/266/>
- ◆ Sign-up for mailing lists, overall WG3 and topical lists:  
<https://agenda.linearcollider.org/event/9154/>

# ILCX2021 ILC Workshop on Potential Experiments



26-29 October 2021, Tsukuba, Japan

#### International Advisory Committee

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 (BNL, the Netherlands)  
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 Rika Takahashi (KEK)  
 Tomohiko Tanabe (Keio Univ., U.)



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**FOR IDT WG3**

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