Running Scenarios for ILC500

Jenny List, Feb 5 2015

Outline

- Loose ends from last time
- new running scenarios

Loose ends (I)

- Higgs coupling fit:
  - meaning of label “with hadronic recoil”:
    hadronic recoil included at 250, 350 and 500 GeV
  - “model-independent” vs “ΣBR=1”
    => all fits shown last time were *unconstrained*,
    “ΣBR=1”-label was *wrong*

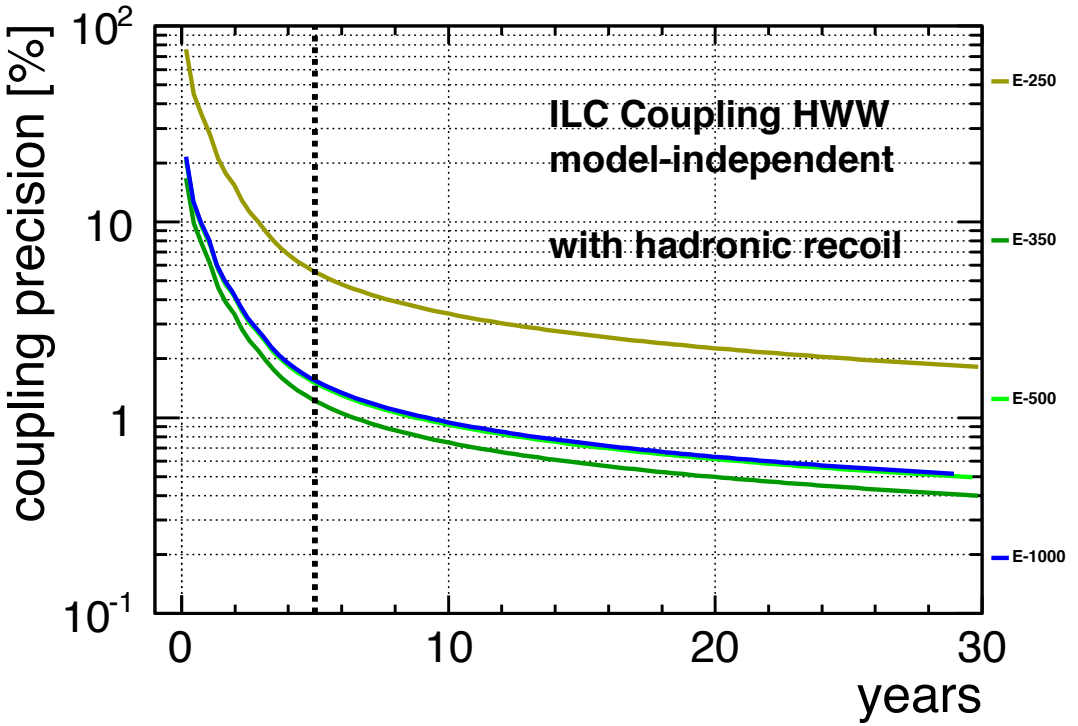
Higgs Couplings: Special Cases

HWW coupling:

- naively expect best performance at highest energy
- but **again** 350 GeV wins in fit since HZZ also contributes via ~~Σ(BR)=1~~ **better knowledge of BRs (eg H->bb) from sigma(ZH)xBR, followed by better HWW couping from sigma(nunuH)xBR**

Conclusion: extended 350 GeV run?

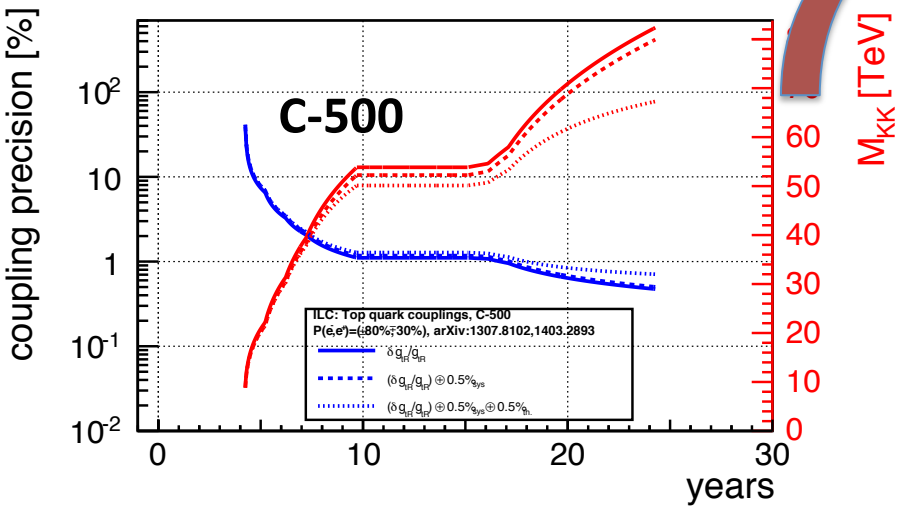
... it depends!

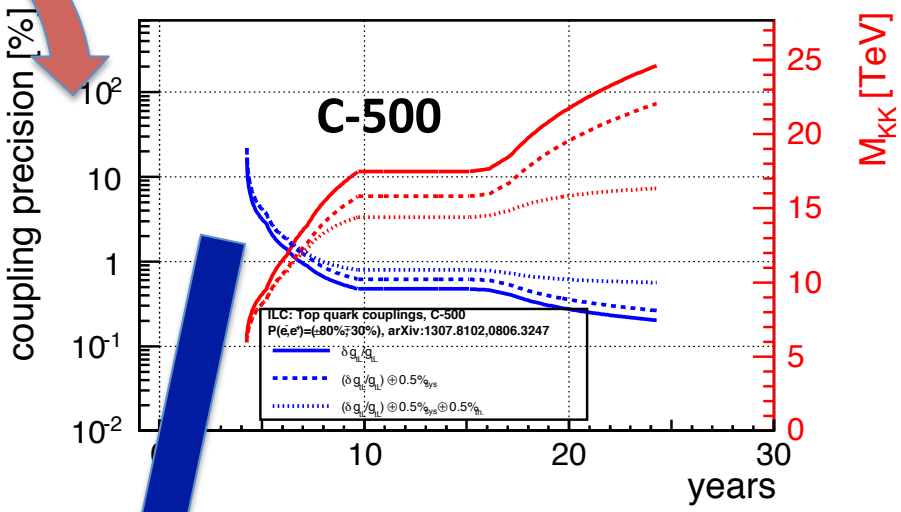


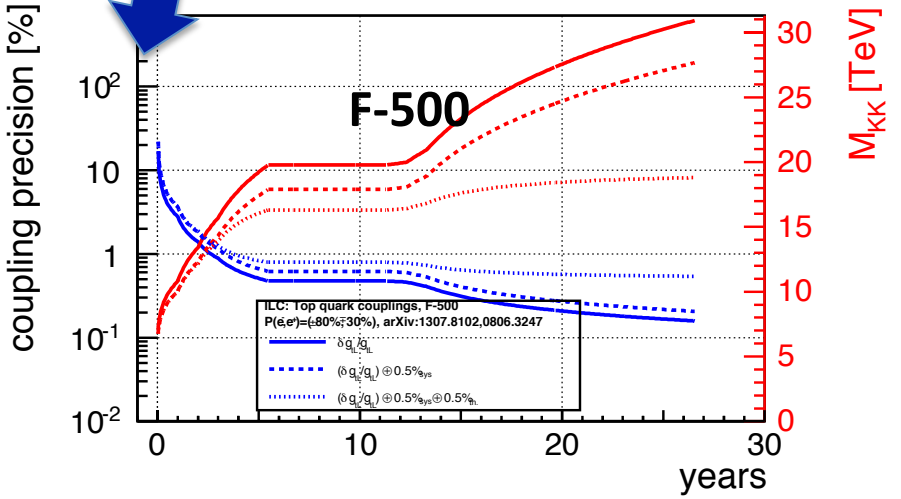
Loose ends (II)

- Interpretation of top coupling precision in extra-dimension / compositeness models
  - in staging report: used special model fine-tuned to describe $A_{FB}(b)$ measured at LEP
    => very strong limits on Kaluza-Klein mass scale up to 80 TeV => “untypical”
  - NEW: thanks to Roman Poeschl, can use more “typical” model (by Pomerol et al)
    => limits up to 20-30 TeV
    => still impressive enough

Top Couplings







in new, more typical model,
theory uncertainties limit
reach to < 20 TeV
but this is expected to improve

New Running Scenarios

Plan from two weeks ago:
Propose optimised running scenarios for ~3 different assumptions on the total life time (*before* 1 TeV upgrade)

- 10 years ?
- 15 years
- 20 years
- 25 years ?

Building blocks (c.f. January slides for details)

- "initial scouting run" @ 500 GeV -> min 4 years
  (to run one year at design luminosity)
- top threshold scan @ 350 GeV -> ~1.3 years
- ZH run @ 250 GeV or 350 GeV -> X years
- lumi upgrade installation -> 1.5 years
- post lumi-upgrade:
  - high statistics run @ 500 GeV
  - "Joker run": reserve some time for New Physics threshold scans, ultra-precise ZH run, 161 GeV, 90 GeV, ...

Just the red = 7 years, plus reduced efficiency due to new ramp up

=> 10 years too short for lumi-upgrade!

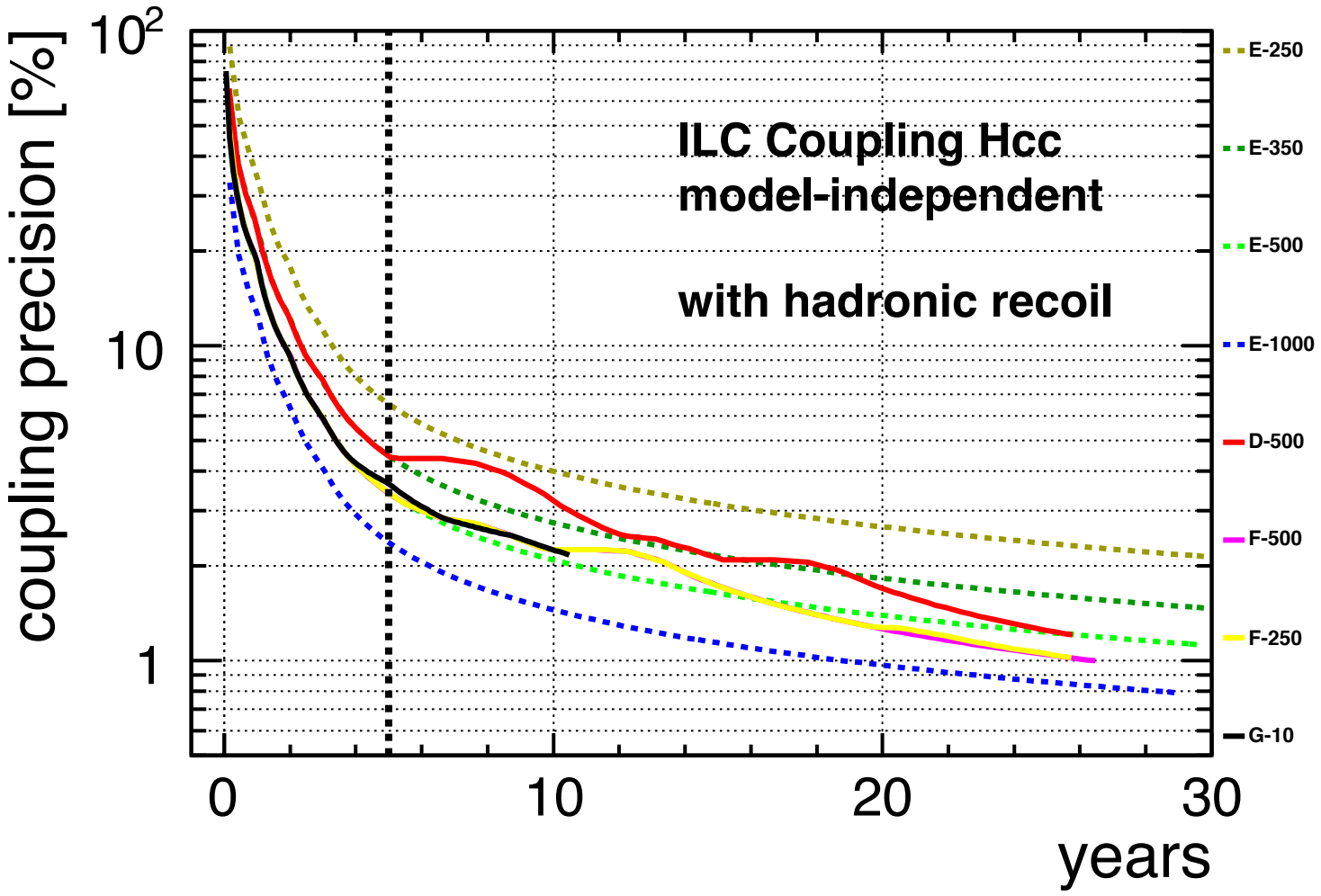
G-10: 10 years – w/o upgrade

- 500 fb-1 @ 500 GeV "scouting"
- 200 fb-1 @ 350 GeV "top threshold"
- 500 fb-1 @ 500 GeV "more 500"
- 250 fb-1 @ 250 GeV "ZH"
- 500 fb-1 @ 500 GeV "even more 500"

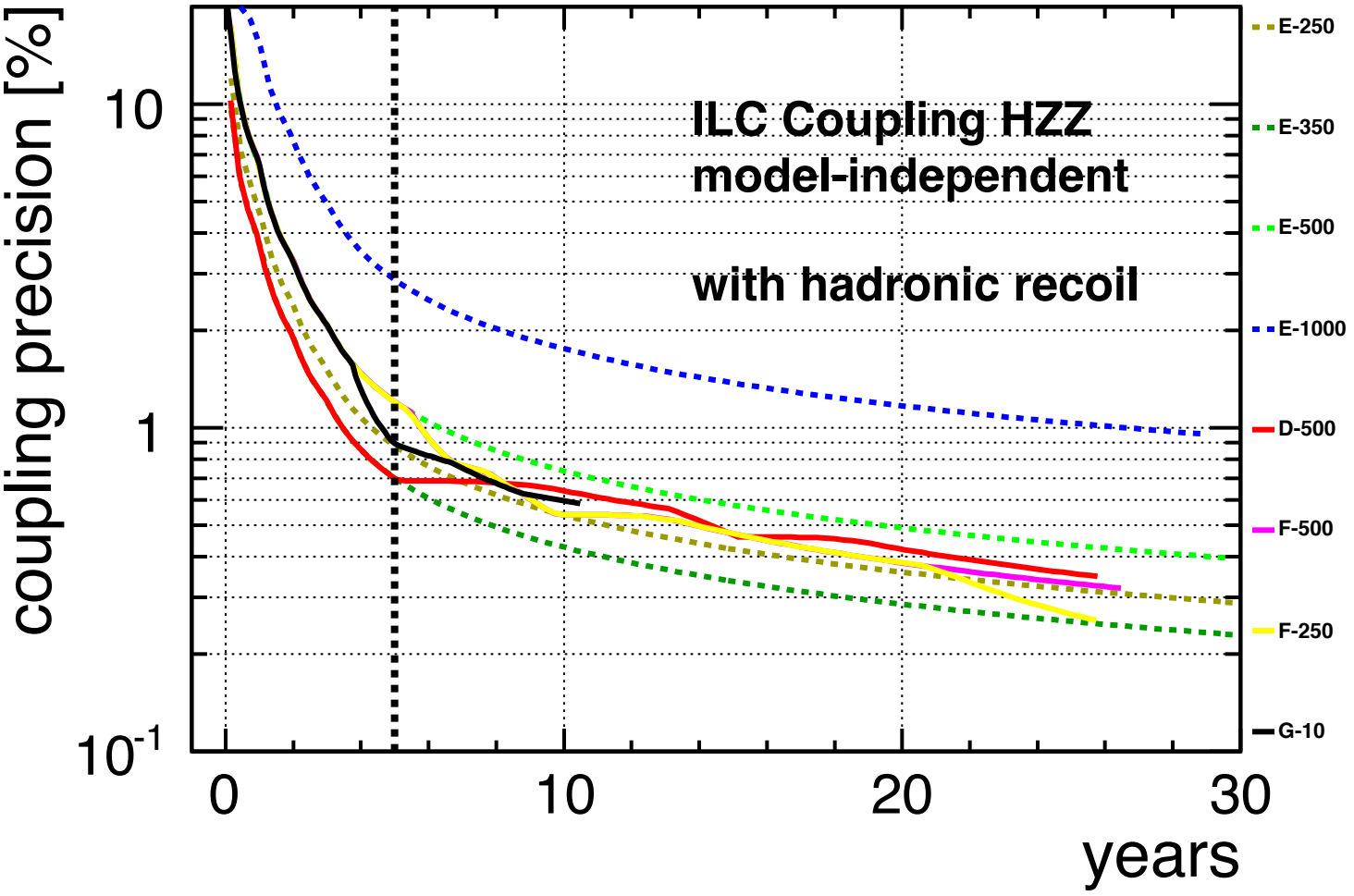
total: 10.5 years

no 10 Hz running, no lumi-upgrade:
additional installation / ramp-up time eats up gain in design luminosity if runs too short

Eg H->cc


coupling precision [%]
10^2
10
1
0
10
20
30
years
ILC Coupling Hcc
model-independent
with hadronic recoil
E-250
E-350
E-500
E-1000
D-500
F-500
F-250
G-10

Eg ZZH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10^{-1}
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20
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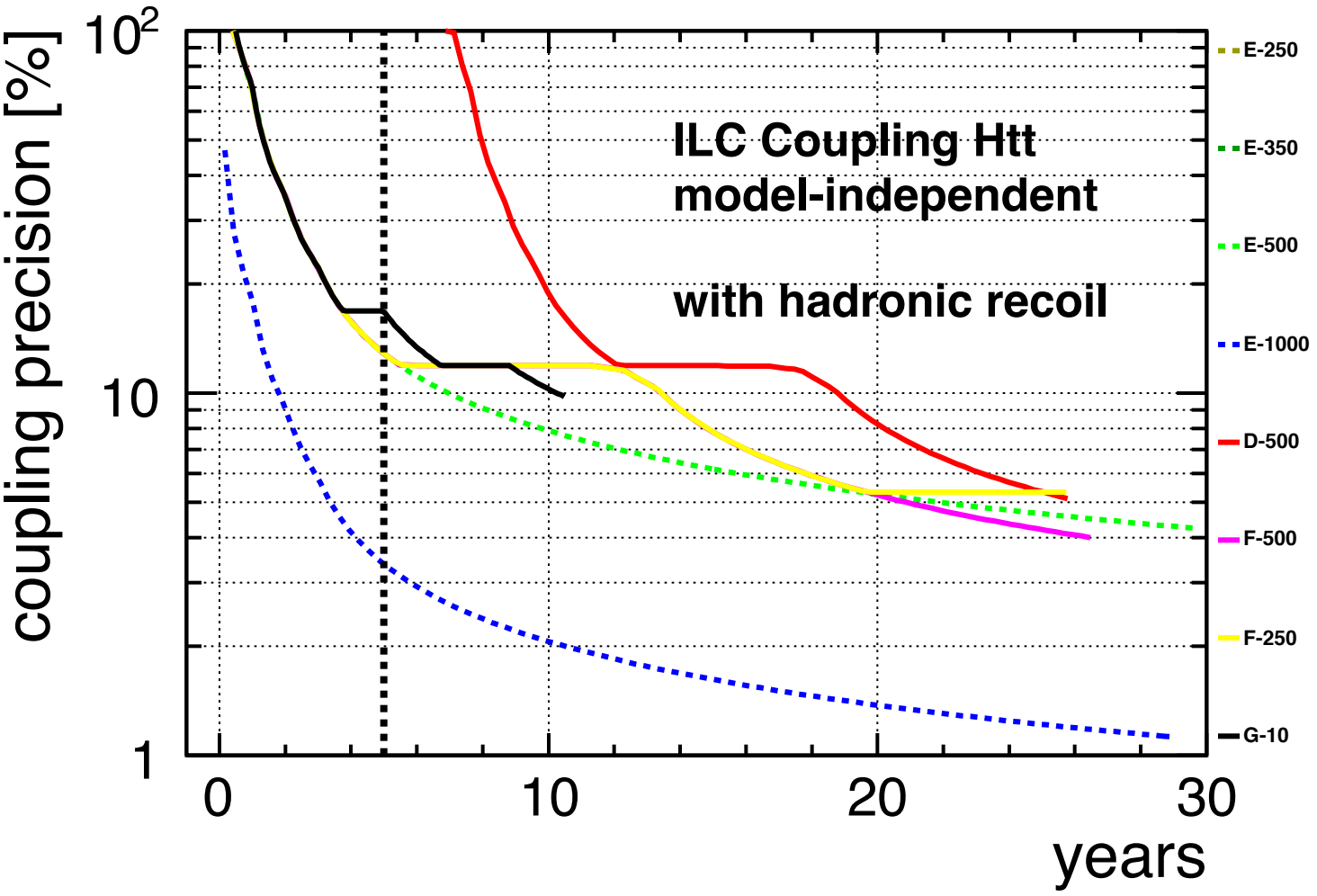
years
ILC Coupling HZZ
model-independent
with hadronic recoil
E-250
E-350
E-500
E-1000
D-500
F-500
F-250
G-10

Eg ttH


coupling precision [%]
10^2
10
1
0
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20
30
years
ILC Coupling Htt
model-independent
with hadronic recoil
E-250
E-350
E-500
E-1000
D-500
F-500
F-250
G-10

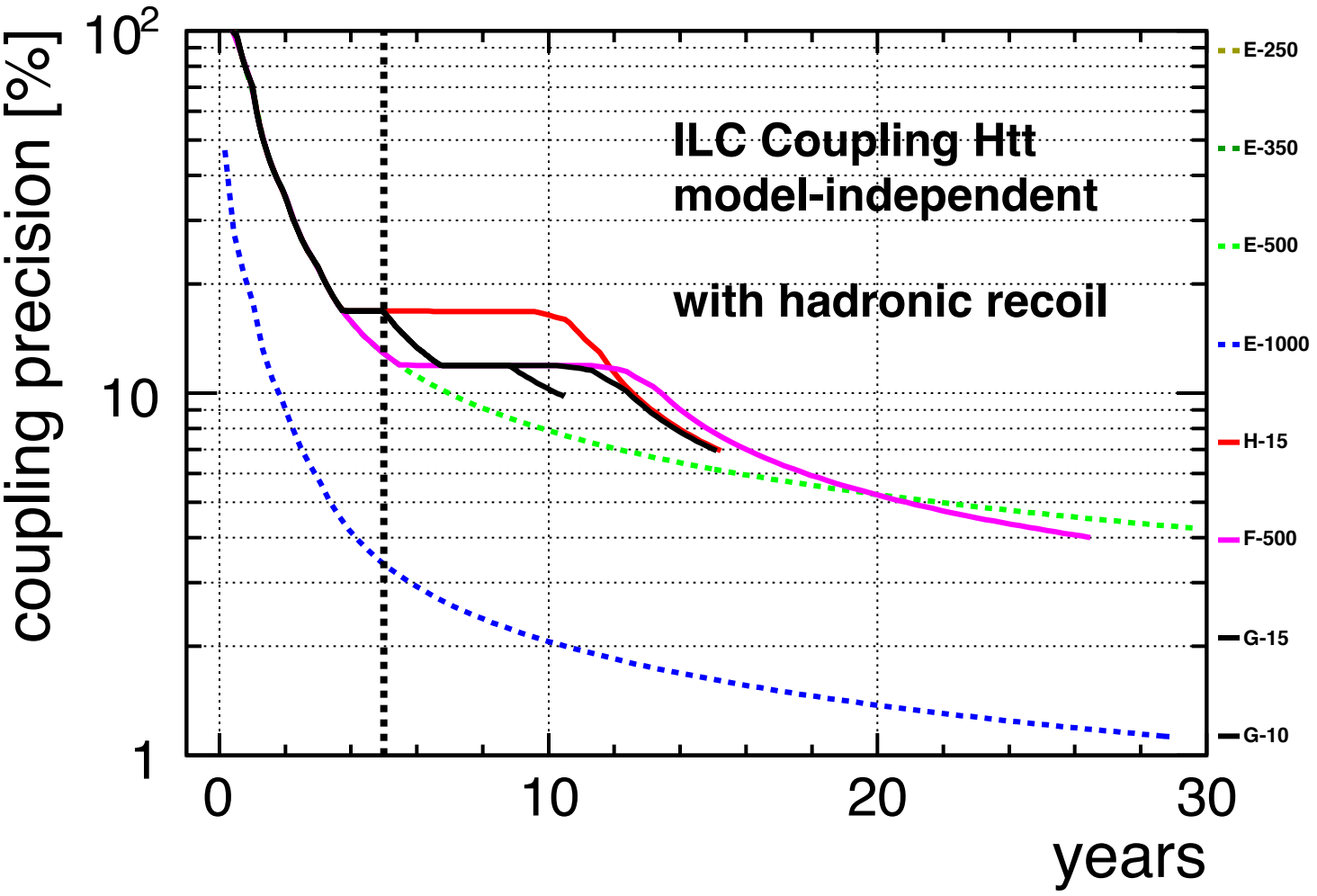
G-15: 15 years, with lumi-upgrade

- 500 fb-1 @ 500 GeV "scouting"
- 200 fb-1 @ 350 GeV "top threshold"
- 500 fb-1 @ 500 GeV "more 500"
- 250 fb-1 @ 250 GeV "ZH"
- lumi-upgrade
- 2000 fb-1 @ 500 GeV "lumi-up 500"

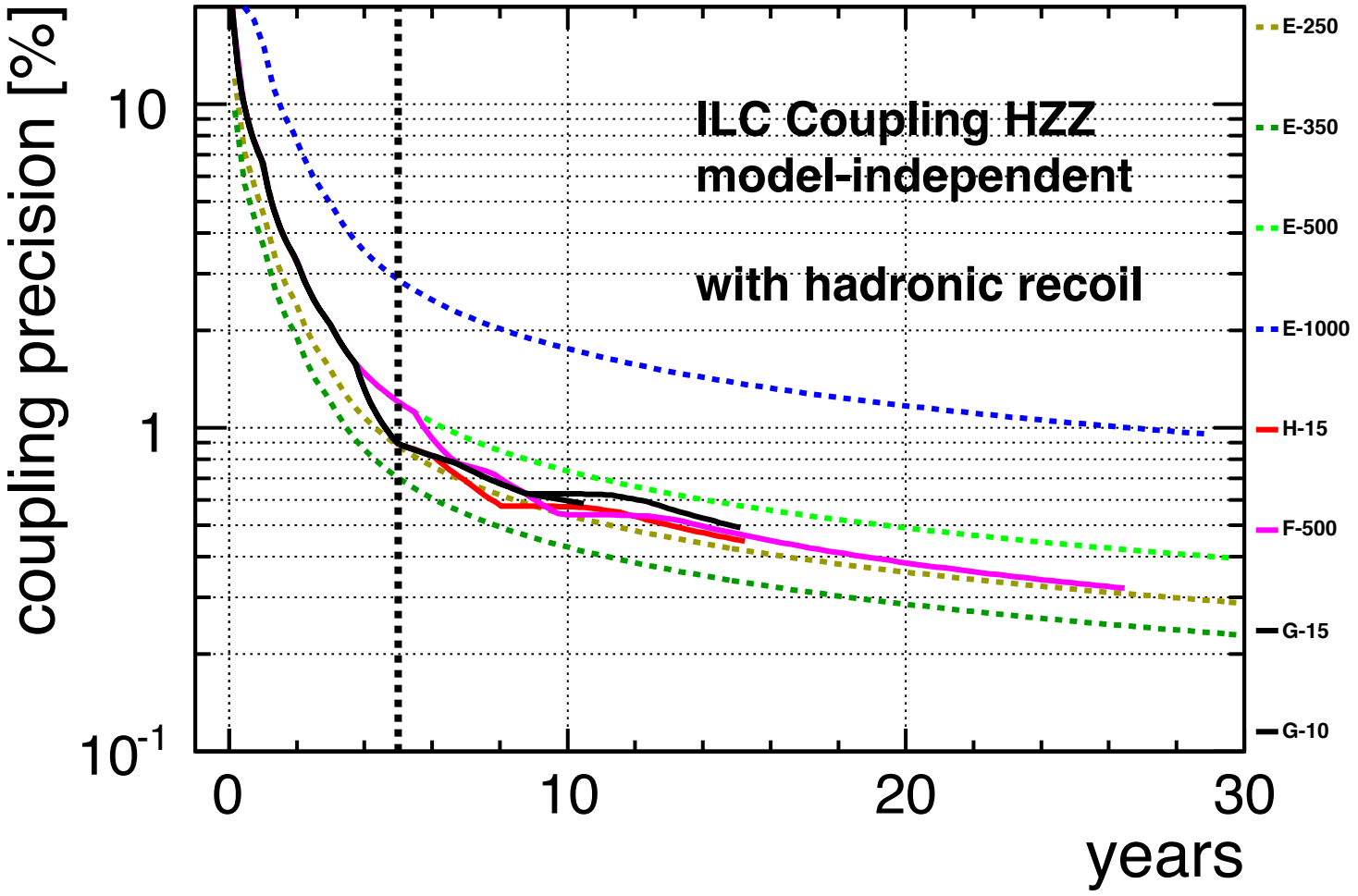
total: 15.2 years

final performance: a bit better than G-10
=> 15 years just enough to start to profit from lumi-upgrade, in particular for ttH:

ttH


coupling precision [%]
10^2
10
1
0
10
20
30
years
ILC Coupling Htt
model-independent
with hadronic recoil
E-250
E-350
E-500
E-1000
H-15
F-500
G-15
G-10

ZZH


coupling precision [%]
10
1
10^{-1}
0
10
20
30
years
ILC Coupling HZZ
model-independent
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E-250
E-350
E-500
E-1000
H-15
F-500
G-15
G-10

20 /25 years ?

- F-500 is a good candidate!
- can include some “joker time”

Conclusions?

- none yet from my side
- caveat: only plotted Higgs stuff sofar – top couplings, WIMPs, ZHH etc still missing
- comments from you?

inital run at 500(+x) GeV

1ab^{-1} with f_P(+-,-+,++,--) = (0.4,0.4,0.1,0.1)

- exclude / discover NP with M<250 GeV
- optimal results for 5 years running for
  - most Higgs couplings
  - ew top couplings
  - anom. gauge couplings
  - m_W, m_H from kinematic reconstruction

? y

tt threshold scan

200fb^{-1} at 350 GeV

- ultimate m_t
- QCD for ttH

1y

ZH run

1-2 ab^{-1} at250/ 350 GeV

- g_{HZZ}, H->inv.

? y

?y

discoveries at LHC and/or ILC

scan thresholds (~100fb^{-1} each) & high stat. 500 GeV

- precision BSM program
- model discrimination
- prediction of heavier states -> incentive for early energy upgrade?

more 500(+x) GeV data

~4-5ab-1 with f_P= (0.4,0.4,0.1,0.1)

- more precision ZHH, ttH et al
- increased Dark Matter sensitivity

? years

m_H from kinematic reconstruction not sufficient?

~3ab^{-1} at 250 GeV

- m_H from recoil

?y

m_W from kinematic reconstruction not sufficient?

~500fb^{-1} at 161 GeV

- m_W from threshold scan

?y

nothing new anywhere?

GigaZ: ~100fb^{-1} at 91 GeV

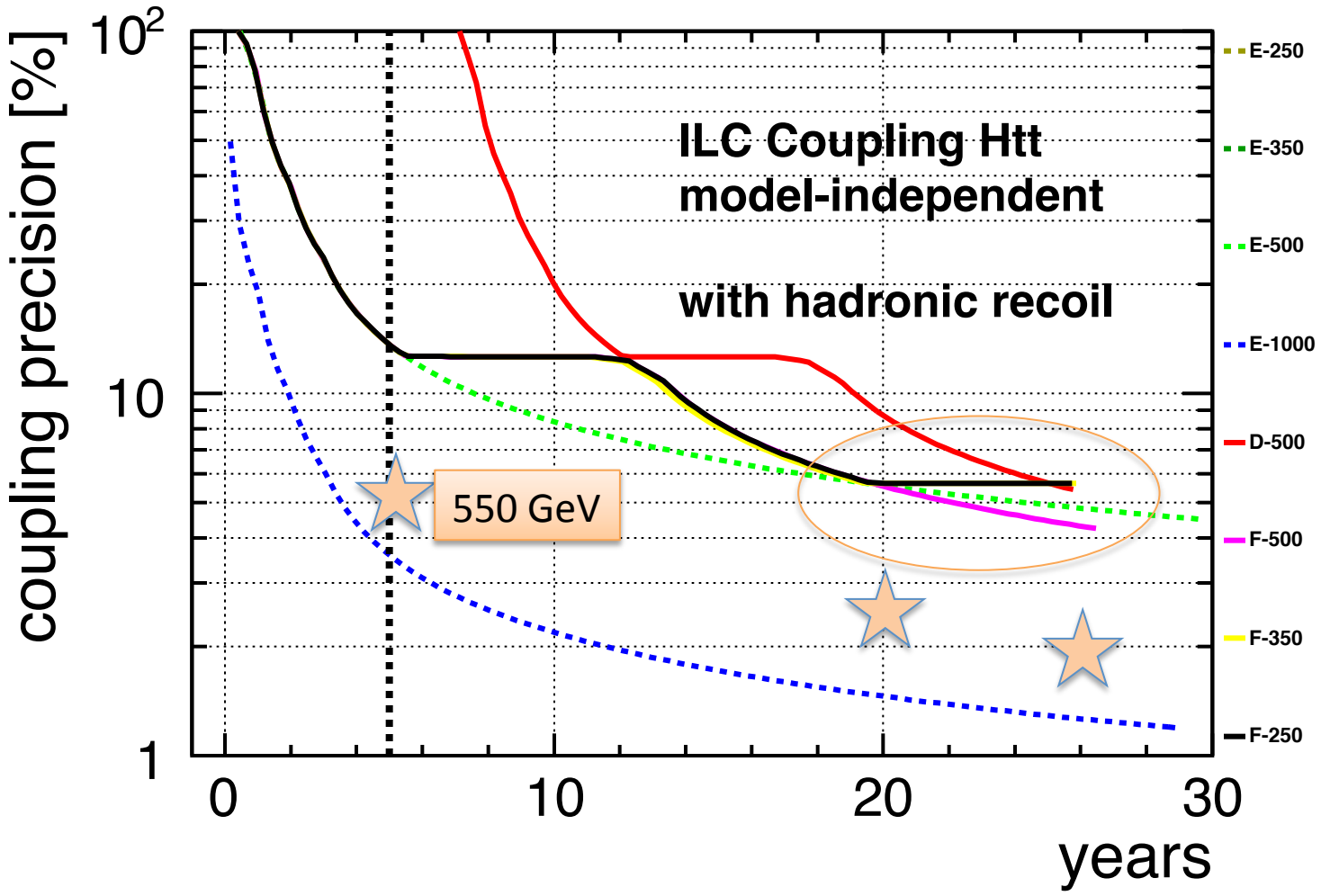
- ultimate M_Z
- ultimate $\sin\theta_{eff}$

?y

Some Running Scenarios

(Not considering: Zpole, WW, New Physics, 1 TeV)

- F-250
  - baseline: 1ab^{-1}@ 500 GeV, 200fb^{-1} @ 350 GeV, 500fb^{-1} @250 GeV (10Hz)
  - **lumi-up: 4ab^{-1} @ 500 GeV, 2.5 ab^{-1} @ 250 GeV (10 Hz)**
- F-350
  - baseline: 1ab^{-1}@ 500 GeV, 700fb^{-1} @ 350 GeV (7Hz)
  - **lumi-up: 4ab^{-1} @ 500 GeV, 2.5 ab^{-1} @ 350 GeV (7Hz)**
- F-500
  - baseline: 1ab^{-1}@ 500 GeV, 200fb^{-1} @ 350 GeV, 500fb^{-1} @250 GeV (10Hz)
  - **lumi-up: 8ab^{-1} @ 500 GeV**



F500 slightly prefered, but small effect compared to increase in ECM!