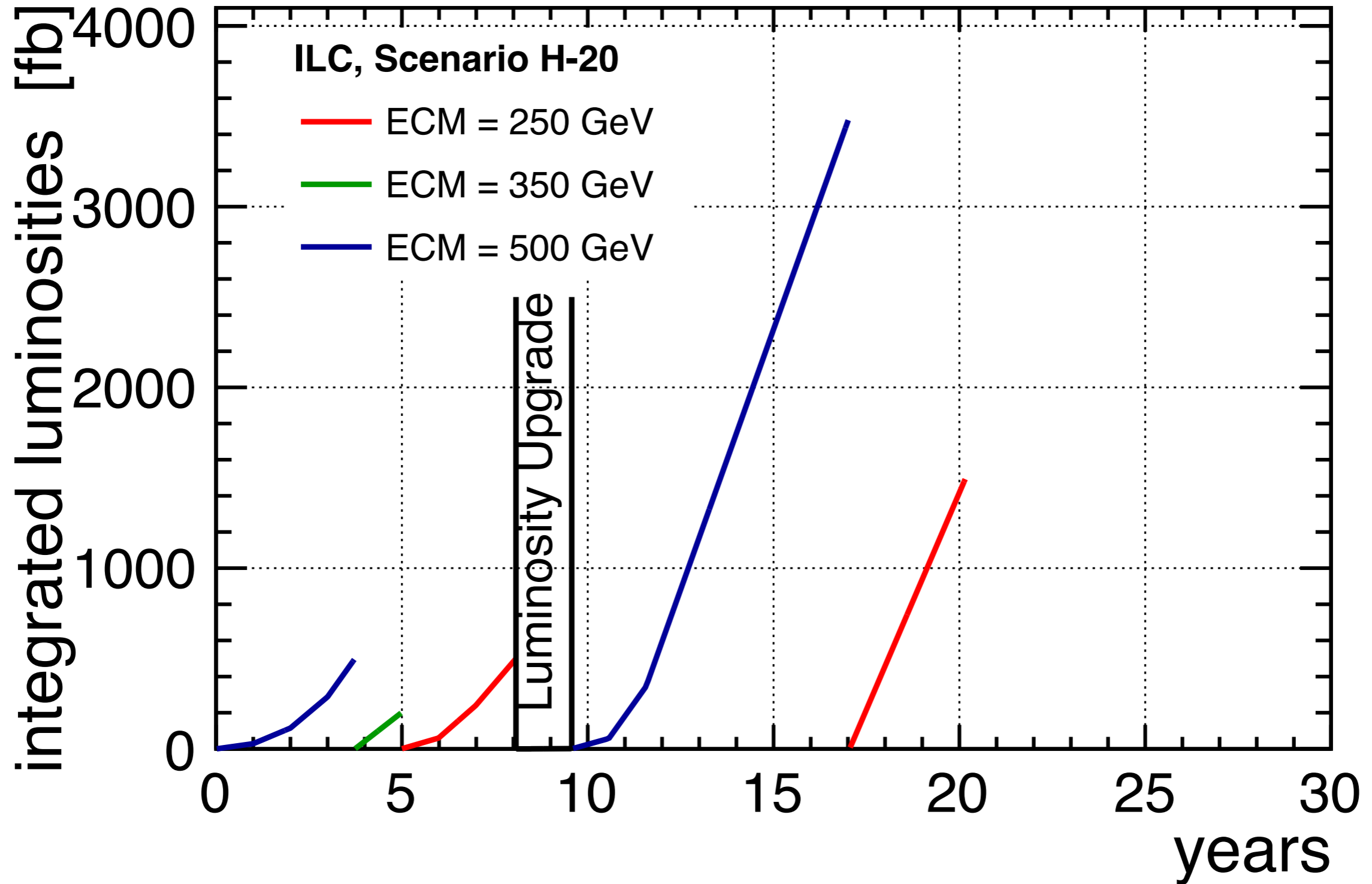


Integrated Luminosities [fb]



Update from the
Parameter Group

J. List, Jan 13 2017
ILC @ DESY General Project Meeting

Reminder: The Joint WG on ILC Beam Parameters

- “joint” between
 - accelerator physicists (Nick Walker, Kaoru Yokoya, Gie Gao)
 - and SiD (Jim Brau, Tim Barklow) and ILC (Keisuke Fujii, JL)
- first charge: (in 2014!) develop possible staged running scenarios starting at 250 GeV (did also 350 GeV)
=> LCC decided not to propose this from their side
- second charge: develop a 20-year program for the full 500 GeV machine
=> **H-20** (G-20, I-20) standard since summer 2015

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**LCWS 2016:
staging is back!
Like this?
Or more like that?**

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A first look - again - at starting 250 GeV

- boundary conditions
 - **goal is to save ~40% of the costs** (by staging, higher gradient, less CFS, ...)
 - 500 GeV tunnel from the start, put only half the cryo-modules, half the cryo-plants, half the klystrons, ...
 - => no 10-Hz operation at 250 GeV “for free”, since cavities run at full gradient and no “spare” cryo / RF !!!
- detailed installation scenarios (EDMS):

Implications of an Energy-Phased approach to the realization of the ILC

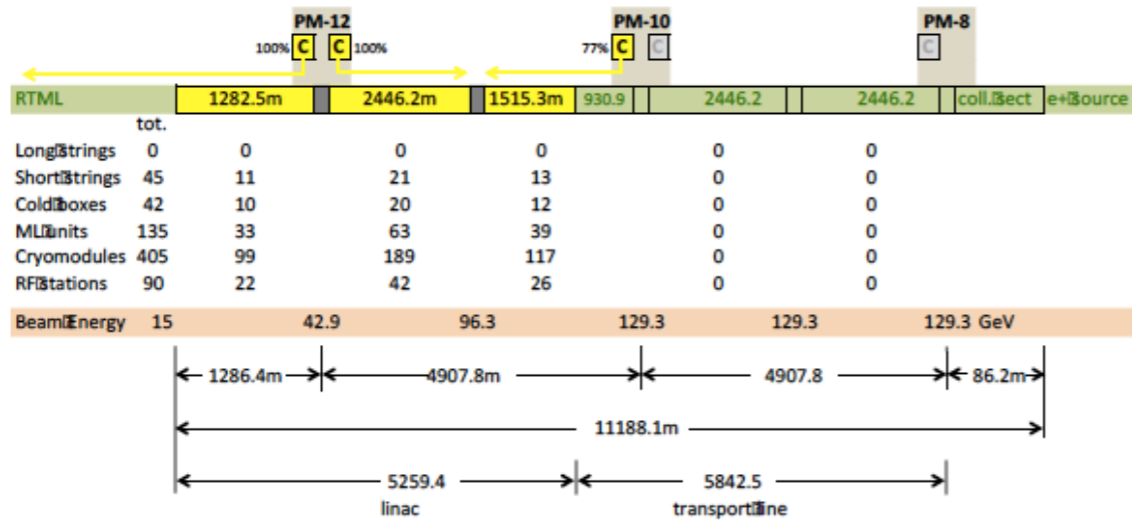
Prepared for: LCC Directorate

Prepared by: G. Dugan, M. Harrison, B. List, N. Walker

FINAL VERSION 26.02.2014

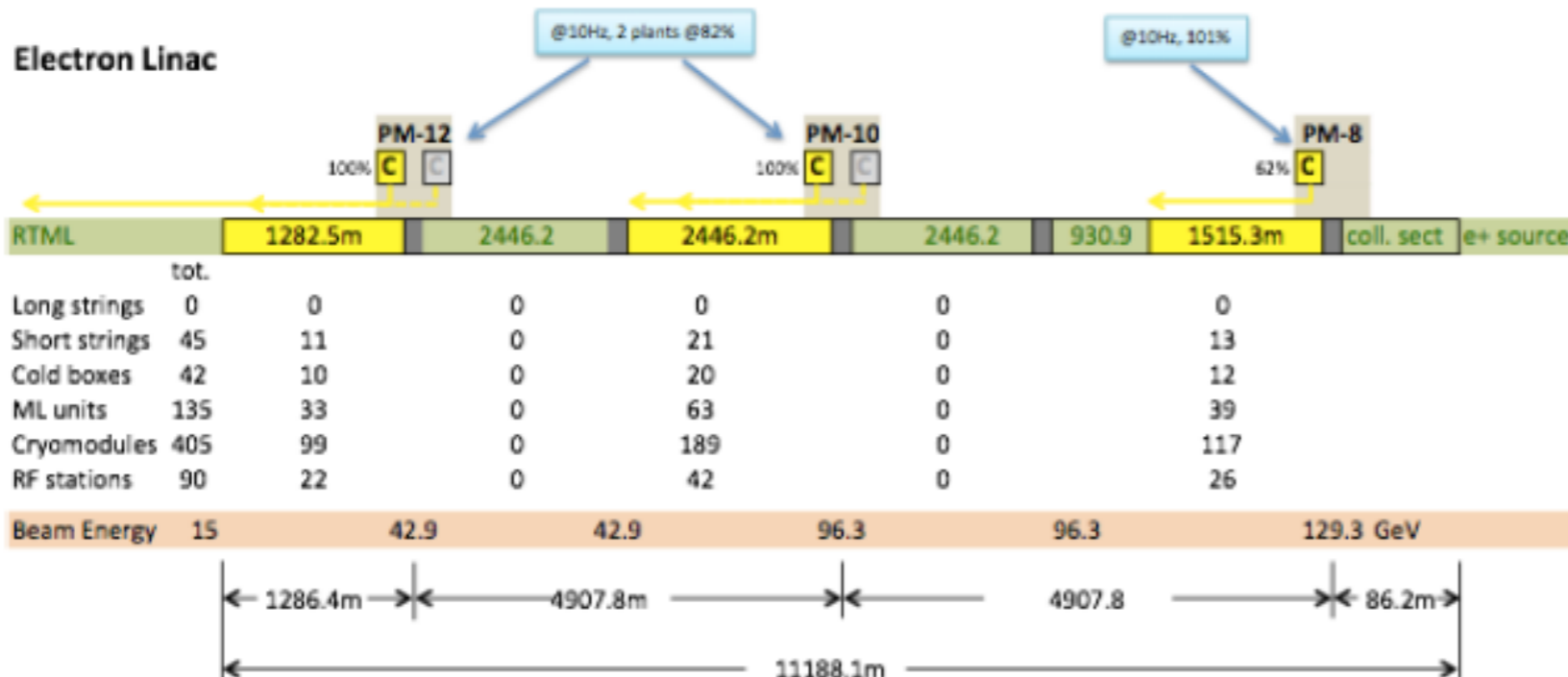
10 Hz at 250 GeV in a staged machine?

Electron Linac



would need to put extra cryoplant / klystrons where they are not needed later for 500 GeV :(

Electron Linac



“early” installation of cryo / RF needed for 500 GeV would allow 10 Hz operation

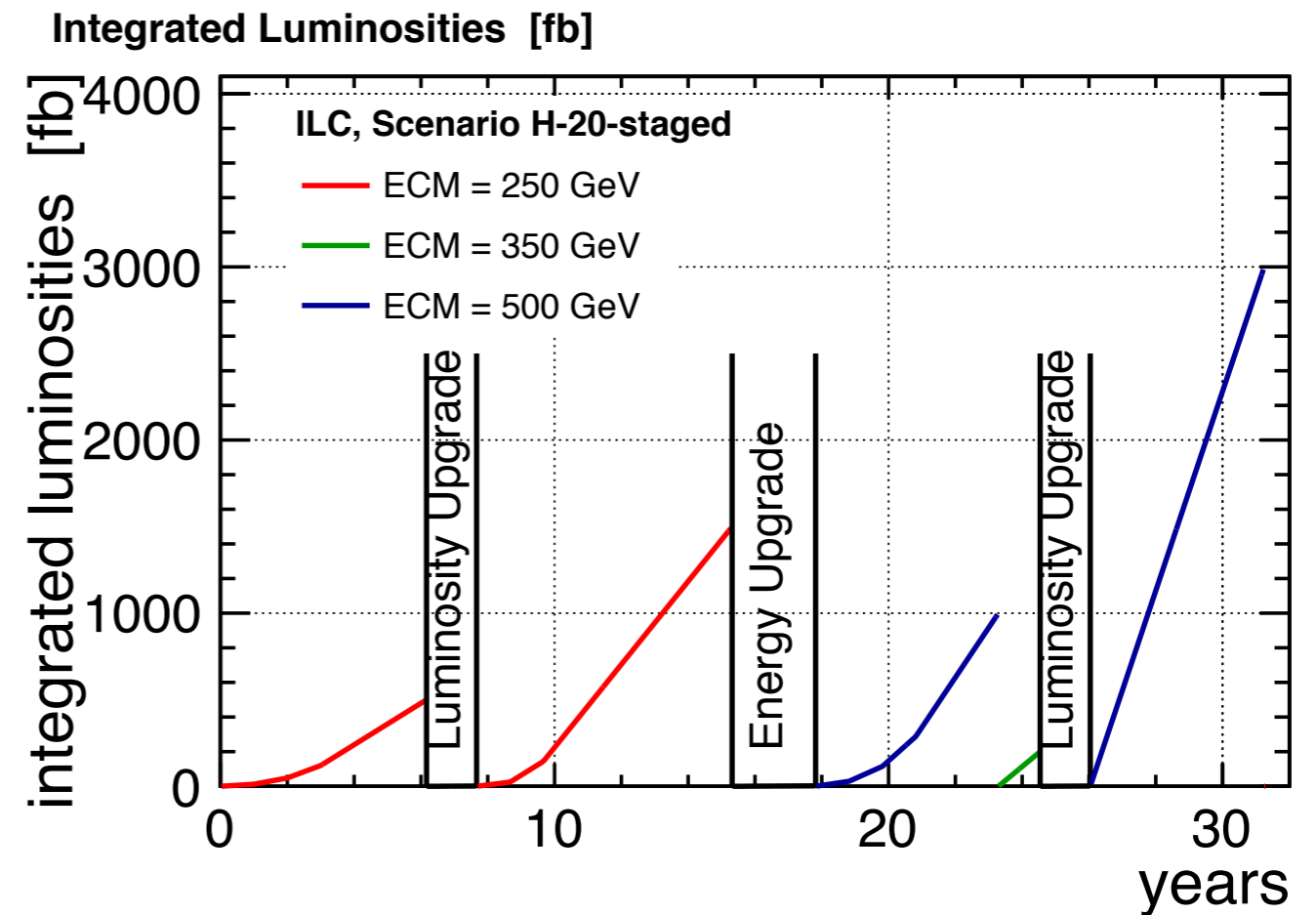
Another possibility for higher luminosity

- at 250 GeV, beamstrahlung, pair background etc much lower than at 500 GeV
- could we afford to squeeze the beams harder for higher per-bunch-luminosity?
- very speculative:
 - not clear whether feasible from beam optics side
 - not clear what effect worse beam spectrum / higher pair background would have on physics performance

Nevertheless, some very speculative scenarios

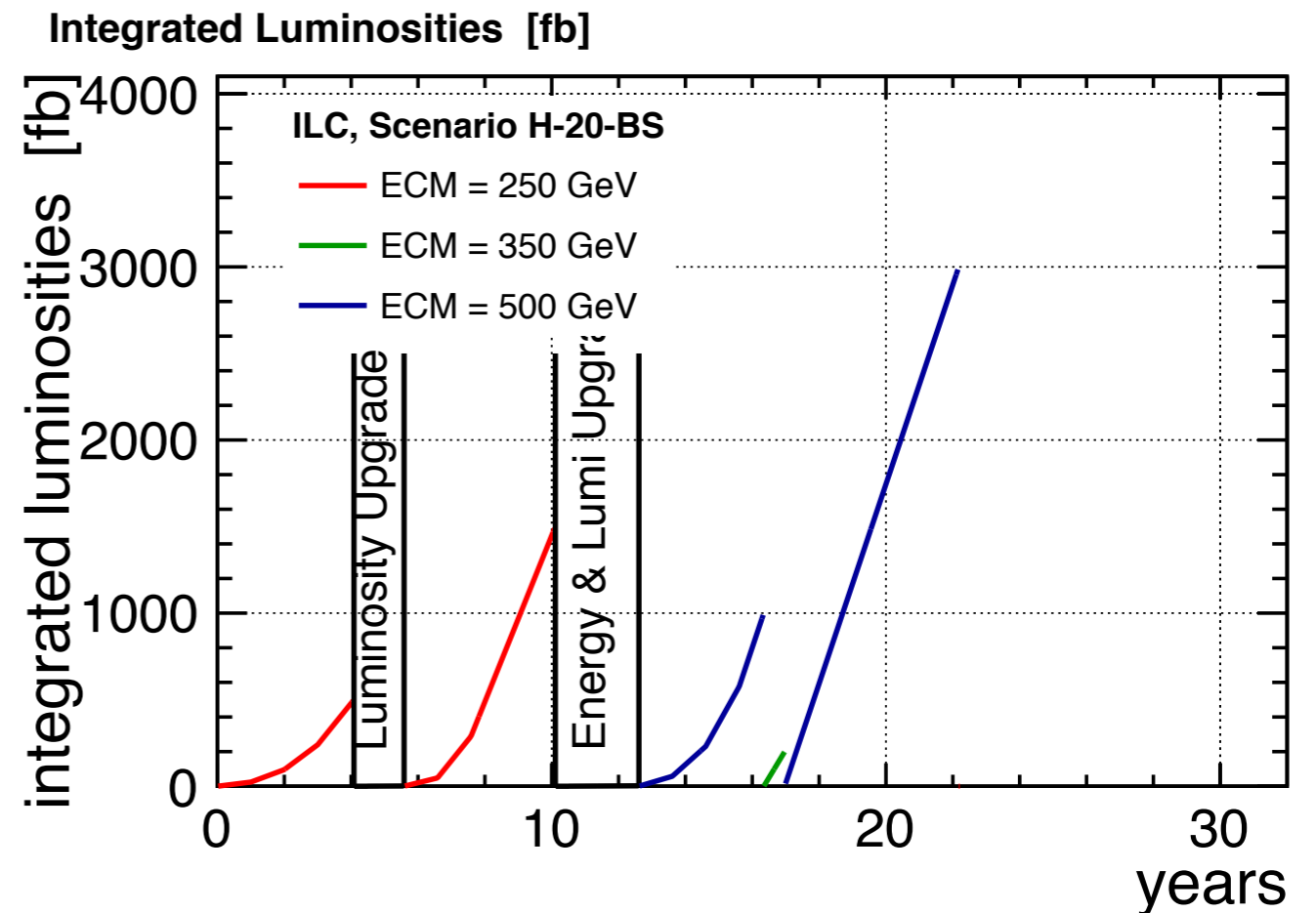
A rather pessimistic staged scenario: H-20-staged

- **final integrated luminosities = H20**
- all ramps etc analogous to H20
- assume start at TDR luminosity for staged machine
- **after 6 years** lumi upgrade (double number of bunches)
- **after 15 years** energy upgrade to 500 GeV, TDR lumi
- **after 25 years** lumi upgrade for 500 GeV
- no 10Hz running
- **takes 31 years to reach H20 performance**



A rather optimistic staged scenario: H-20-BS

- final integrated luminosities = H20
- all ramps etc analogous to H20
- **assume factor 2 higher lumi from day 1 by stronger focussing (=> beam strahlung!)**
- **after 4 years** lumi upgrade (double number of bunches)
- **after 10 years** energy upgrade to 500 GeV, **directly including lumi upgrade**
- no 10Hz running
- **takes 22 years to reach H20 performance**

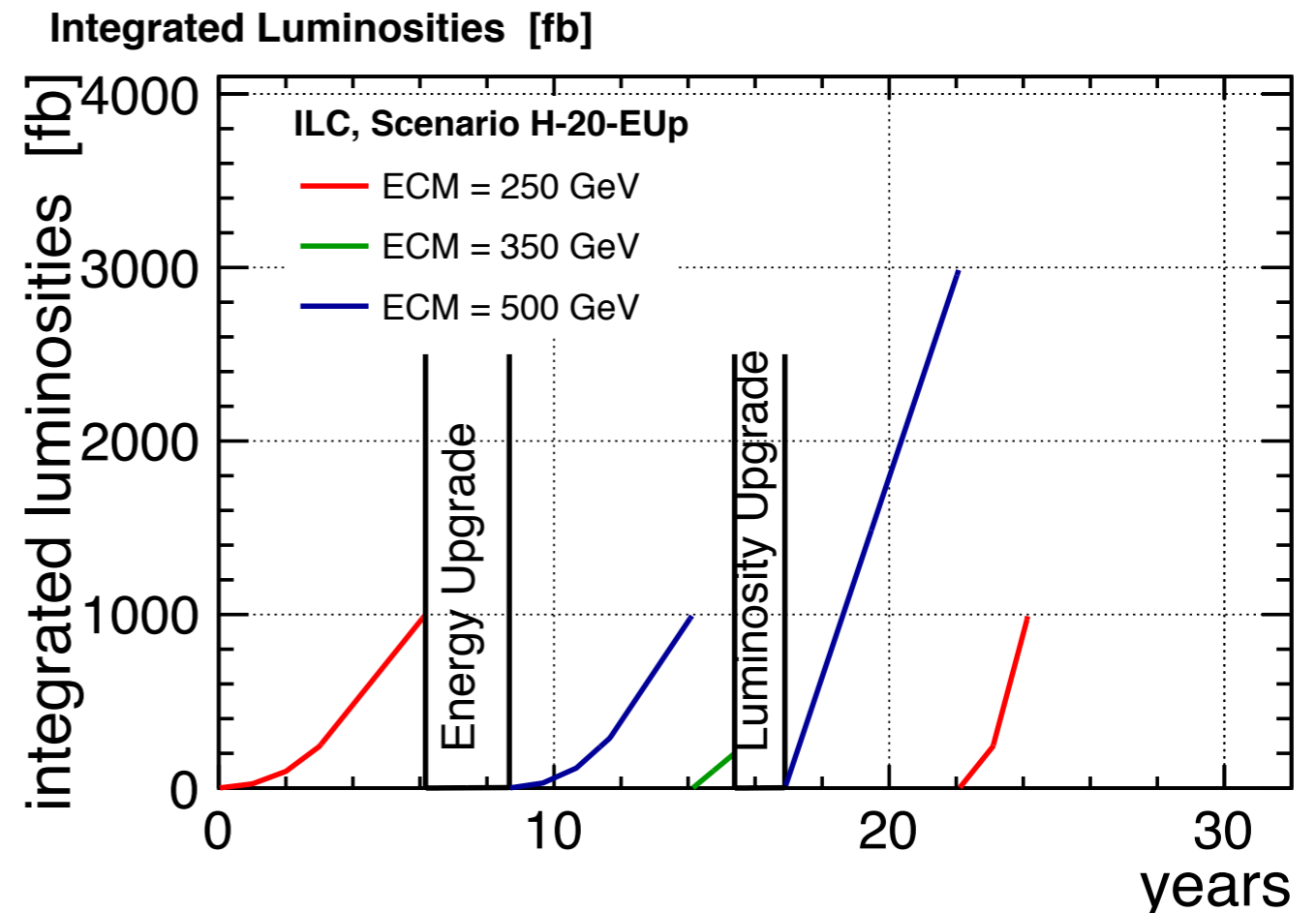


caveats:

- **seems unlikely that a factor 2 in lumi from day one can be achieved (beam optics)**

An other optimistic staged scenario: H-20-EUp

- final integrated luminosities = H20
- all ramps etc analogous to H20
- again factor 2 higher lumi from day 1 by stronger focussing
- **after 6 years energy upgrade to 500 GeV**
- **after 15 years** lumi upgrade (double number of bunches)
- **10Hz running** with (= 8x TDR lumi at 250 GeV!)
- **takes 24 years to reach H20 performance**

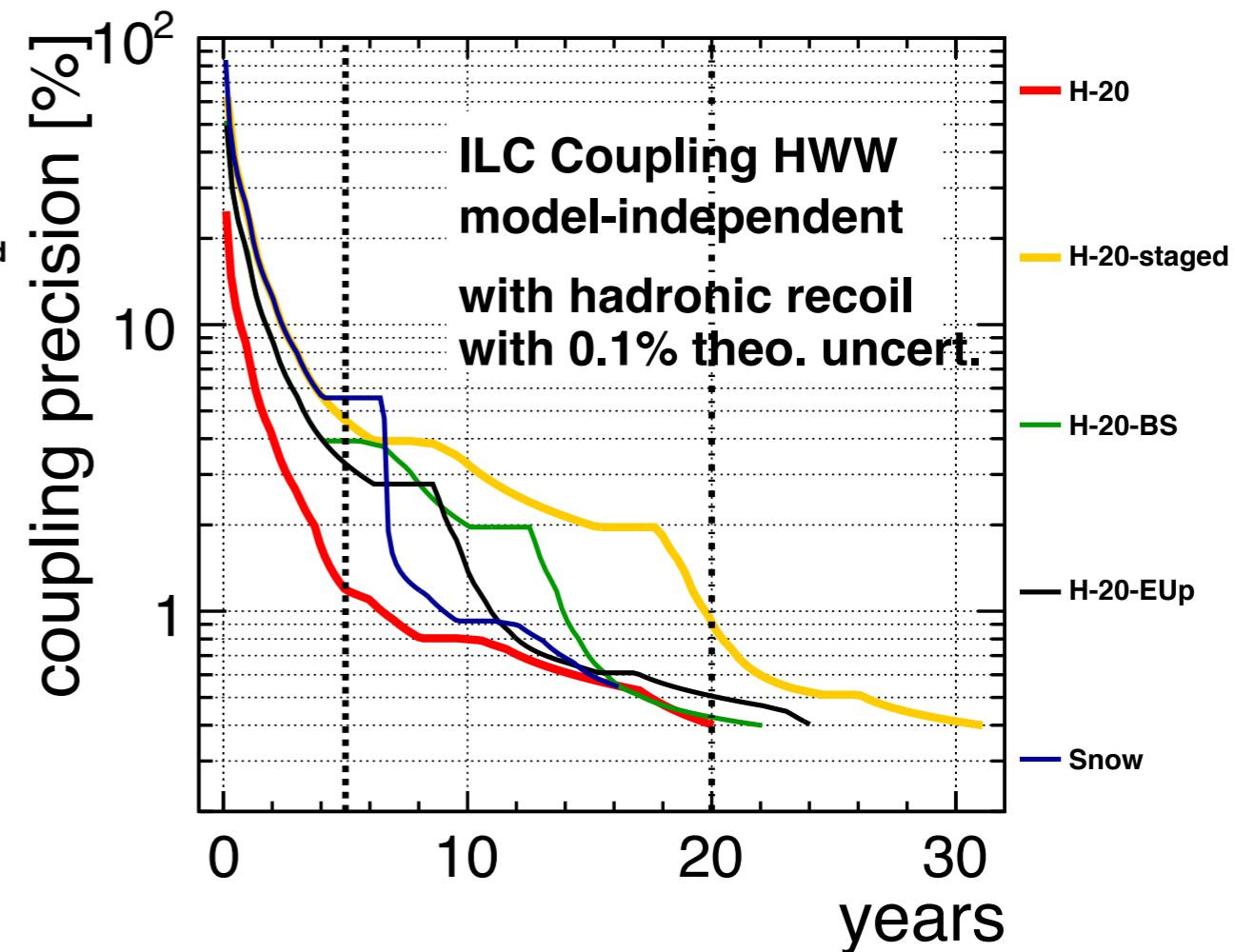
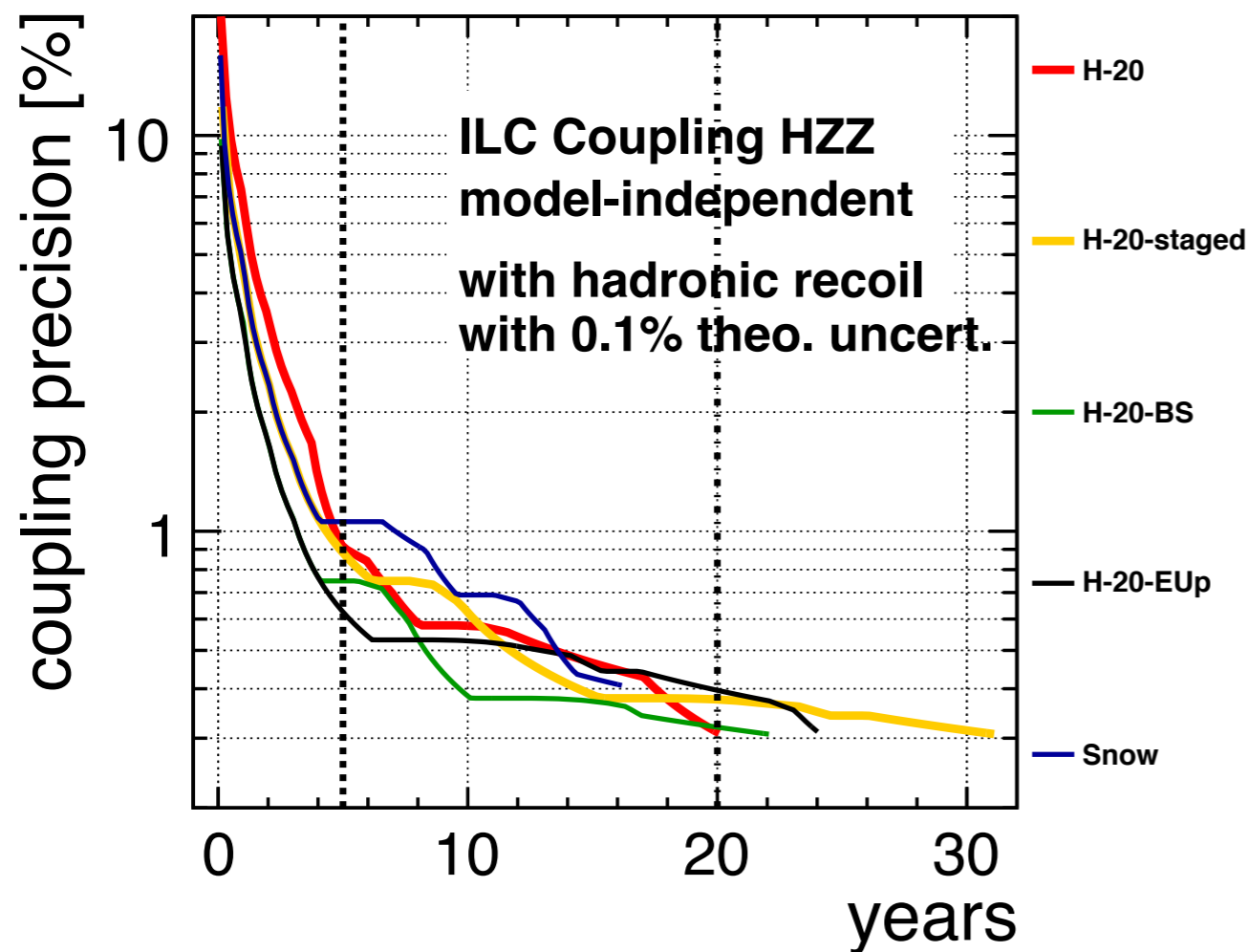


caveats:

- seems unlikely that a factor 2 in lumi from day one can be achieved (beam optics)
- how early can an energy upgrade come?

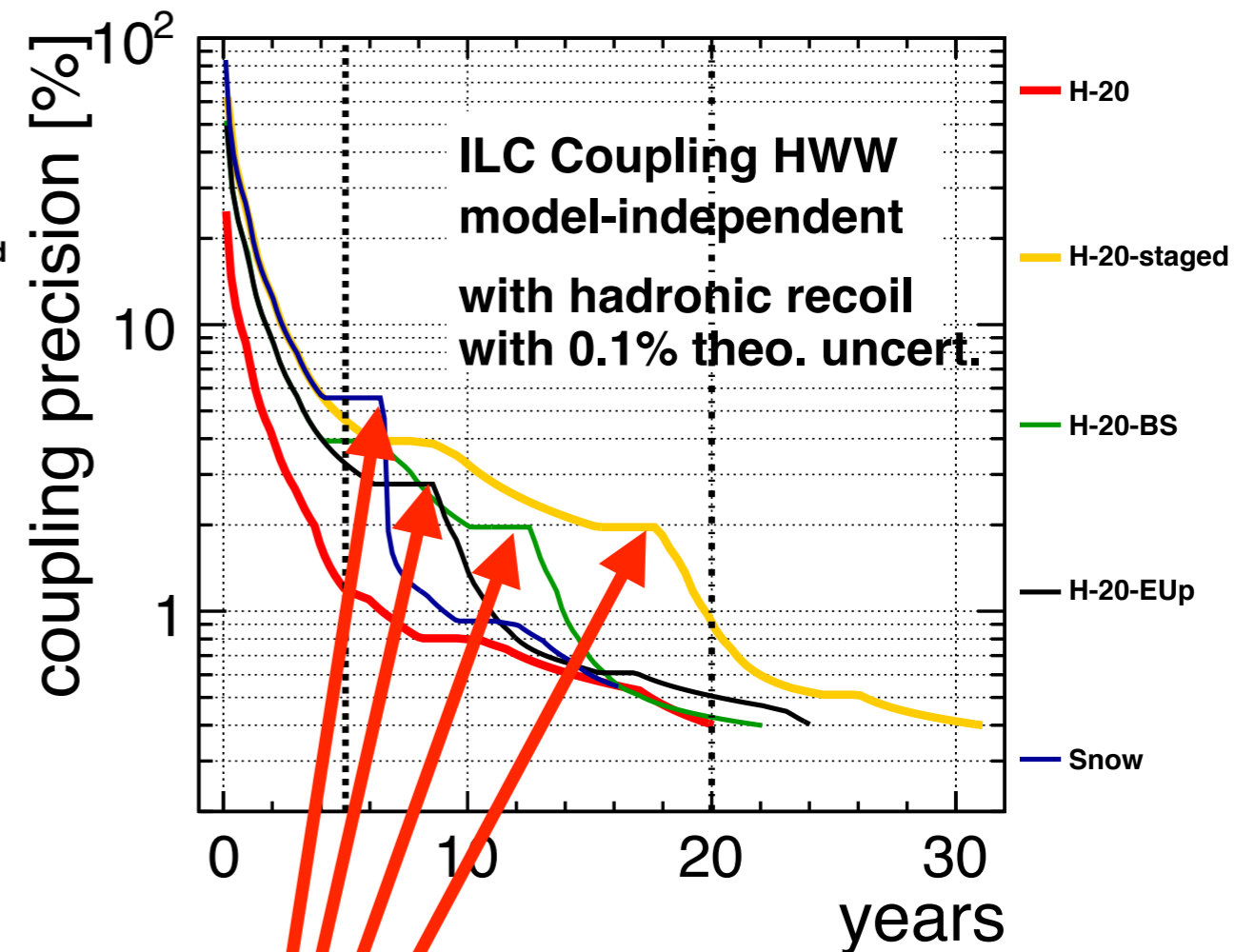
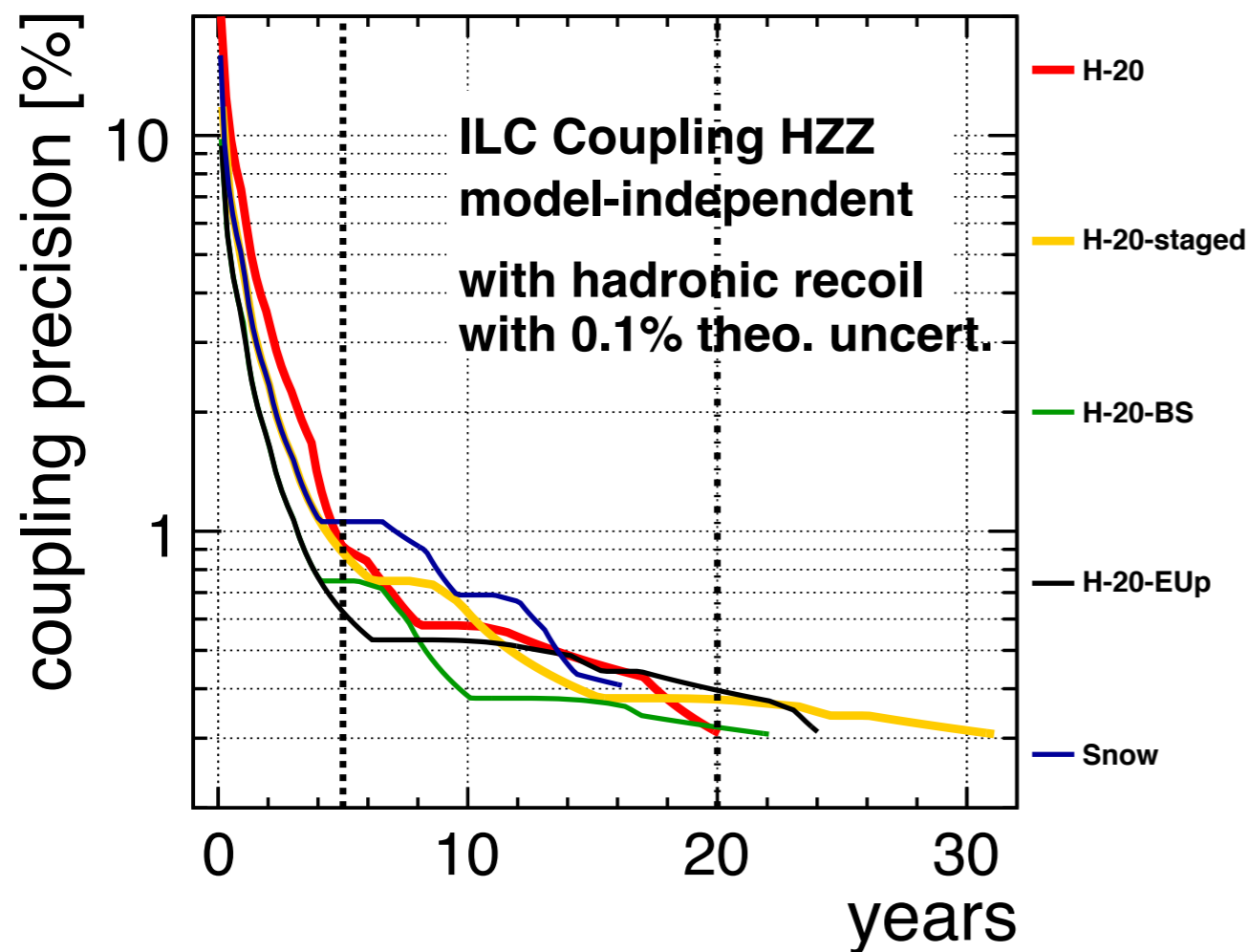
Some physics performance for these scenarios
— Higgs —

Model-independent : HZZ and HWW



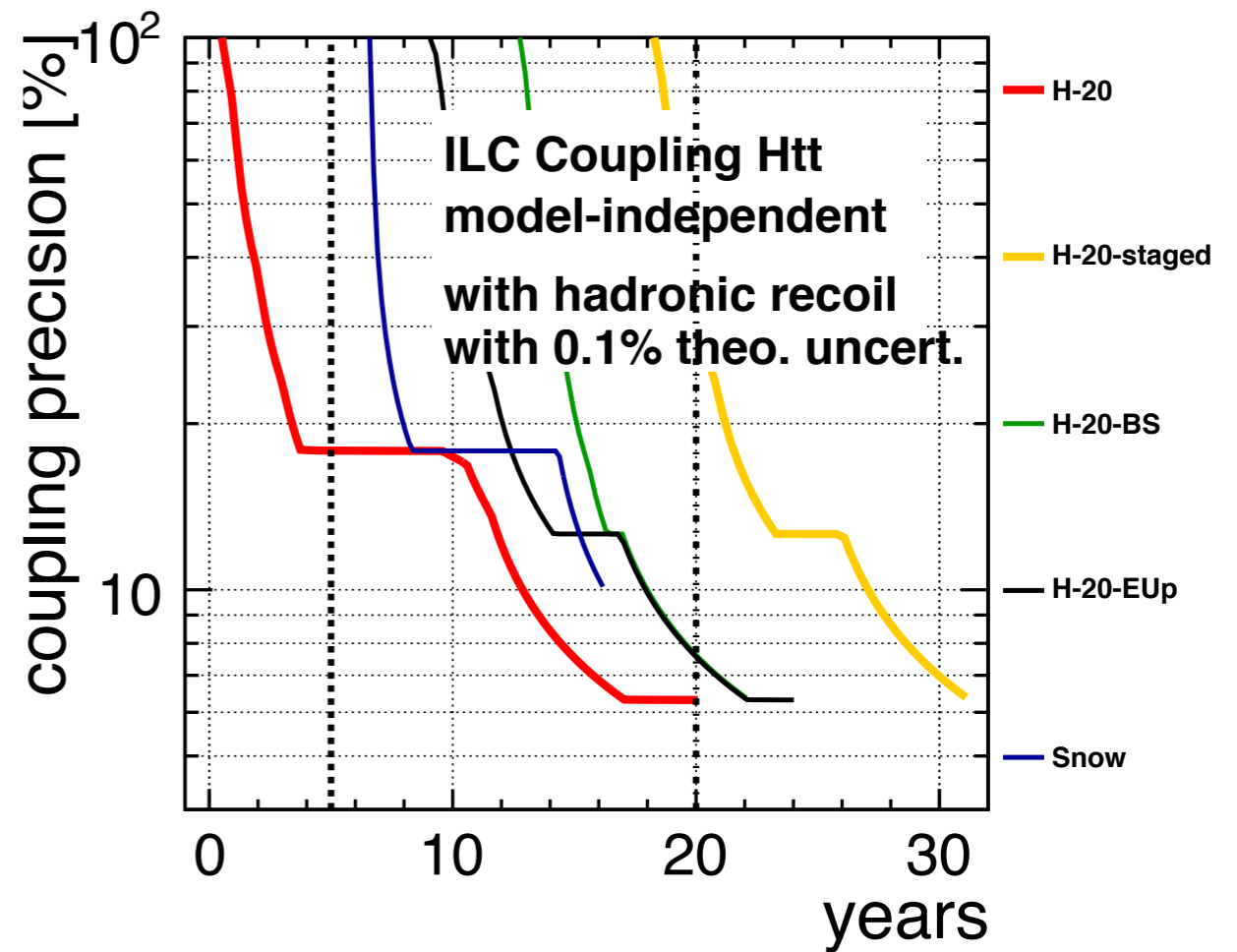
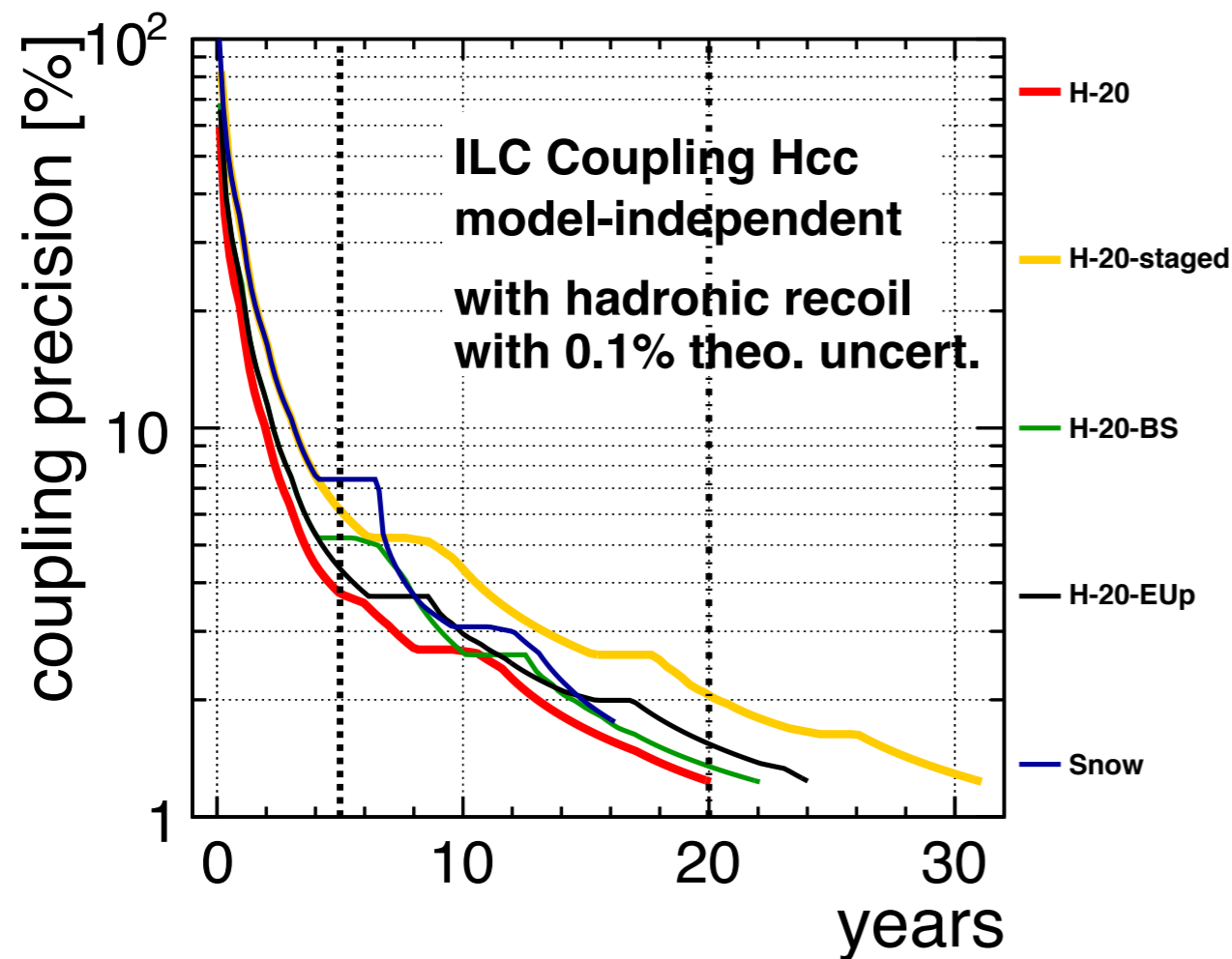
- as expected, start at 250 GeV is ok for HZZ, even better if lumi is high from beginning
- HWW starts only to be fun once we run at 500 GeV....

Model-independent : HZZ and HWW



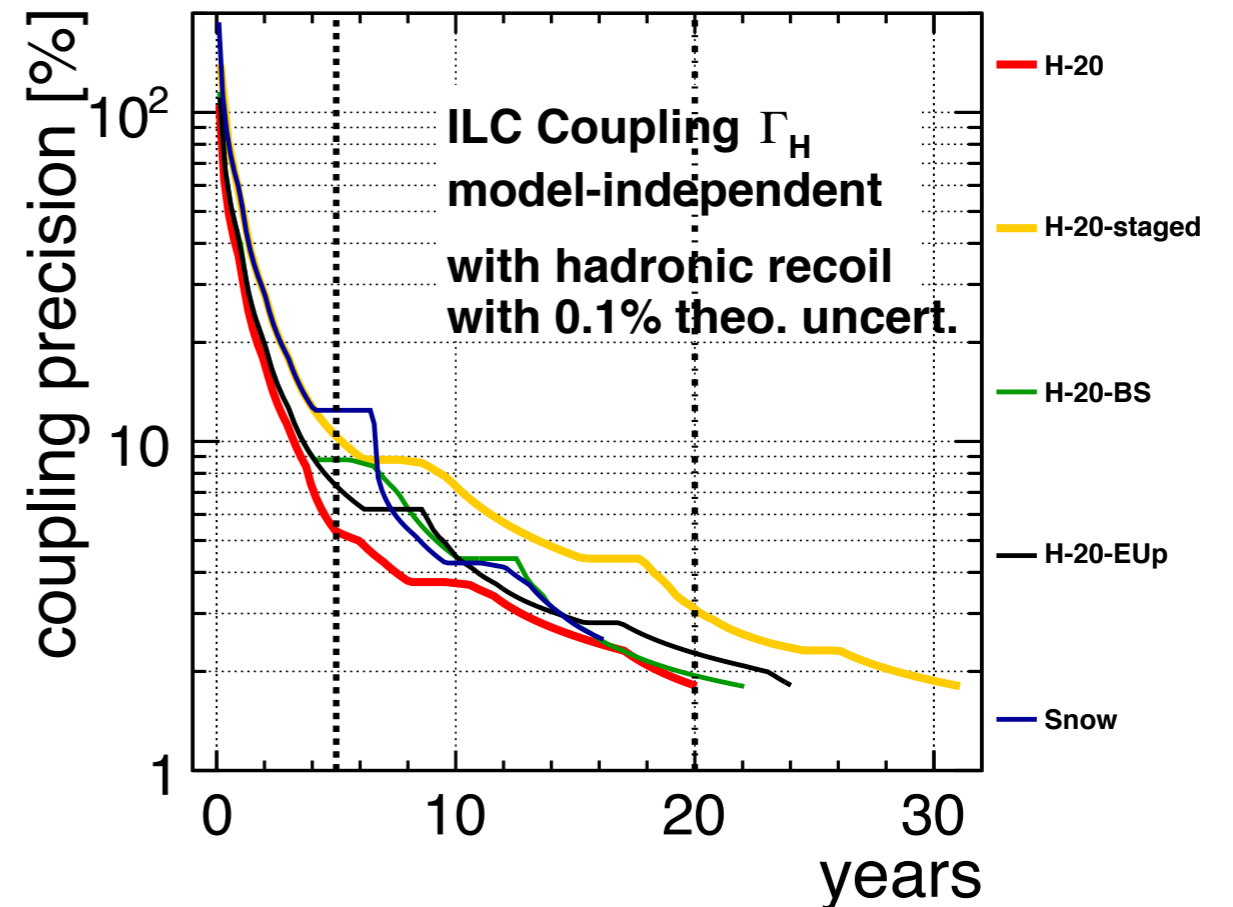
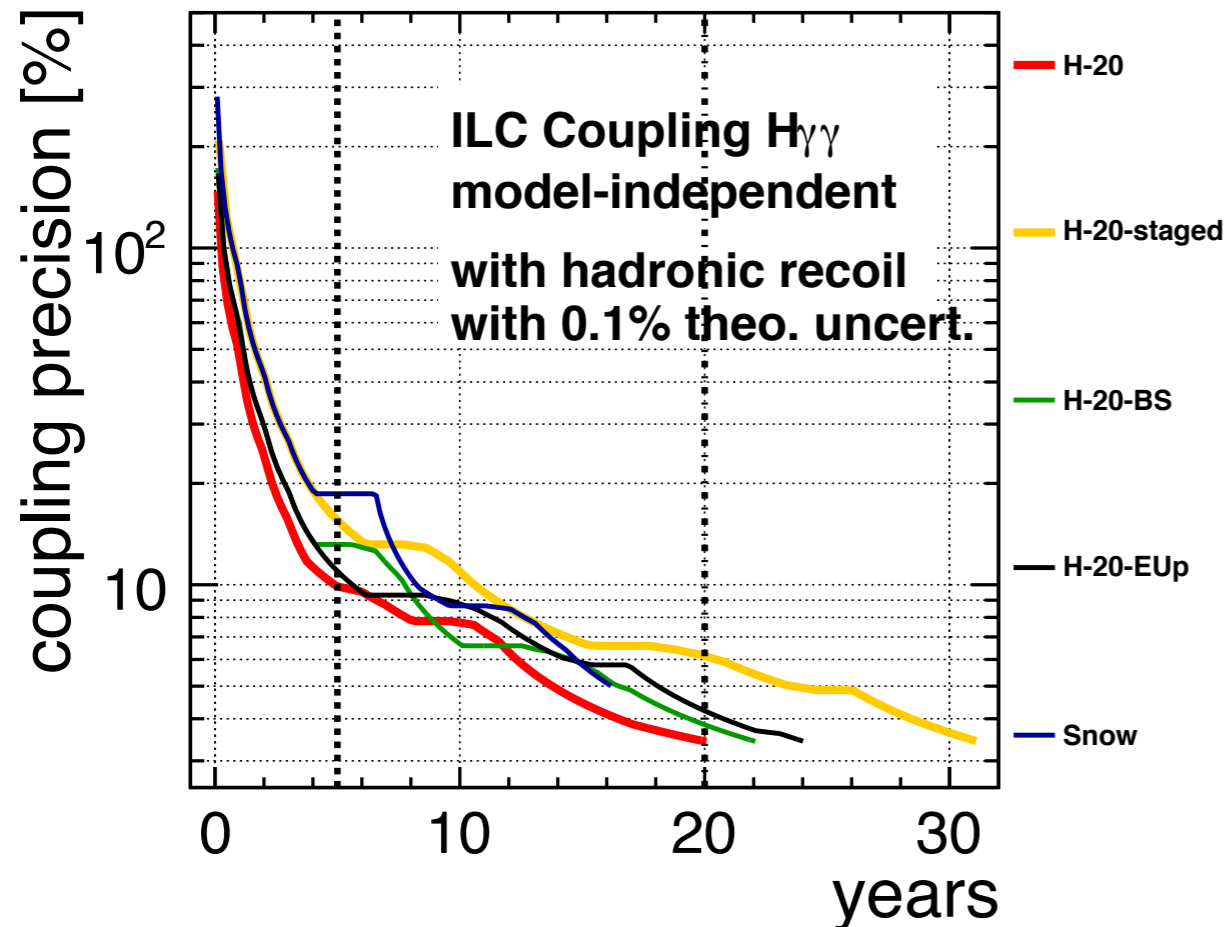
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Model-independent : Hcc and Htt



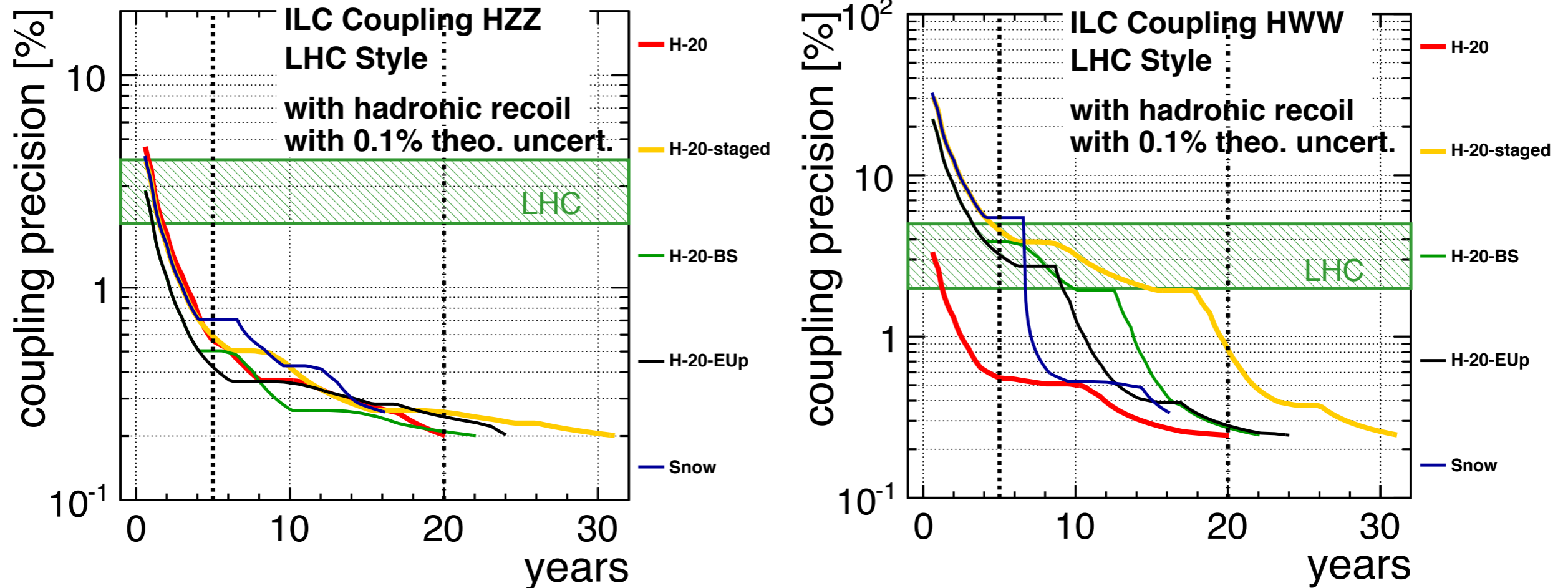
**no measurement of top-Yukawa coupling
before running at 500 GeV**

Model-**in**dependent : $H\gamma\gamma$ and Γ_{tot}



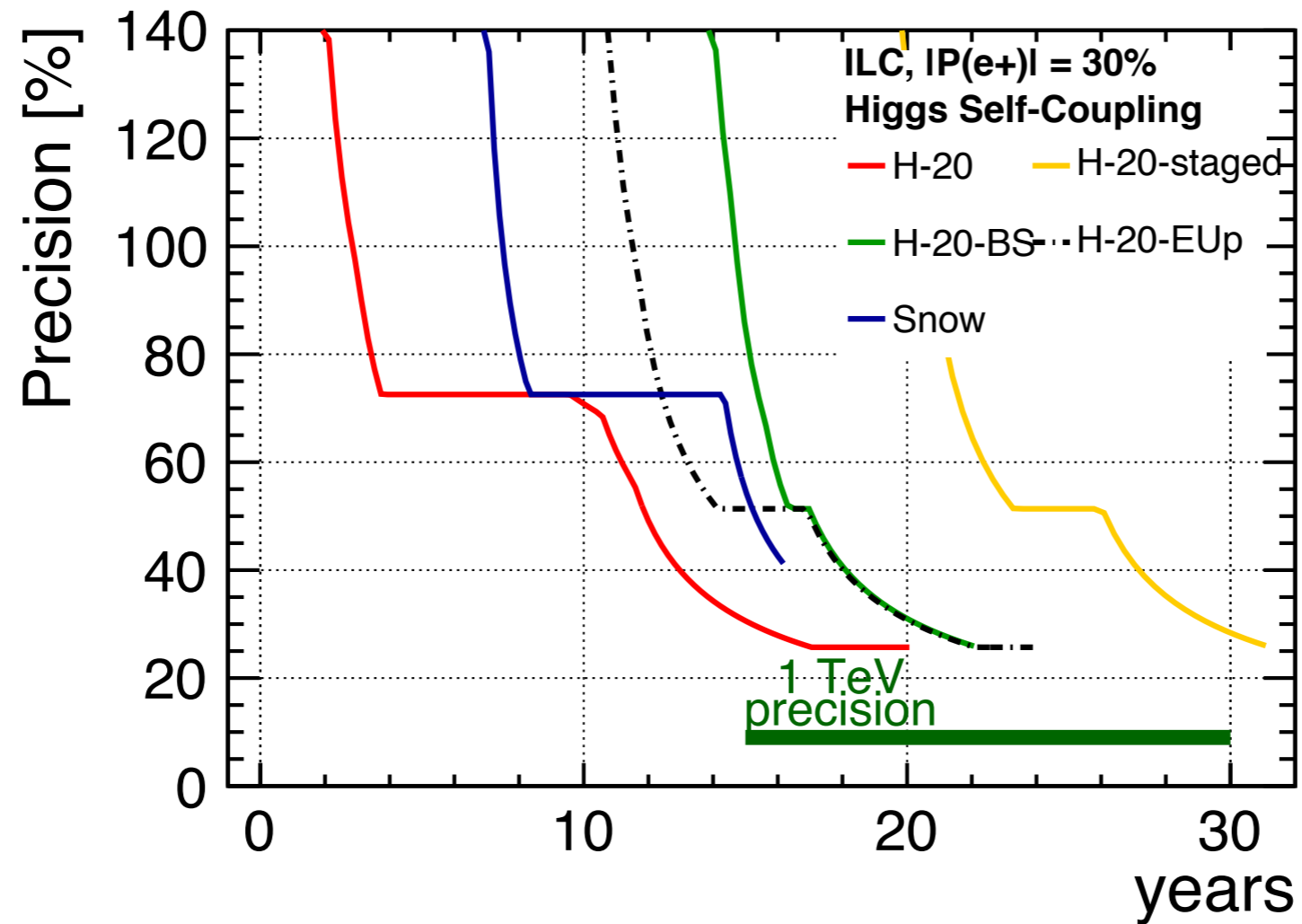
Higher lumi helps to recover early performance

Model-dependent : HZZ and HWW



- “LHC” is range between CMS “optimistic” and “pessimistic” projections
- HWW needs 500 GeV to improve beyond LHC in model-dependent interpretation

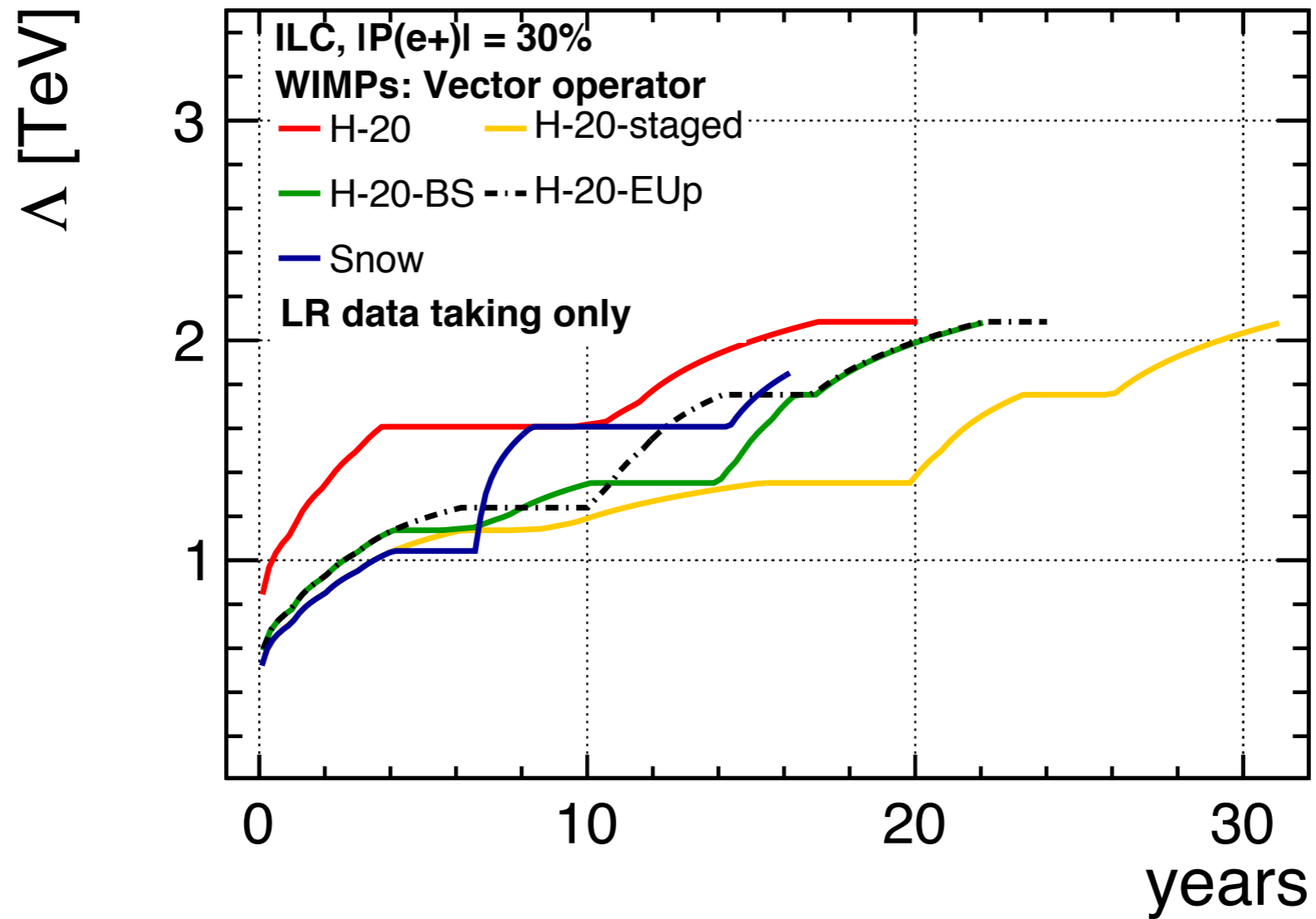
Higgs Self-Coupling



[not quite: plan to convert into signal significance for ZHH production]

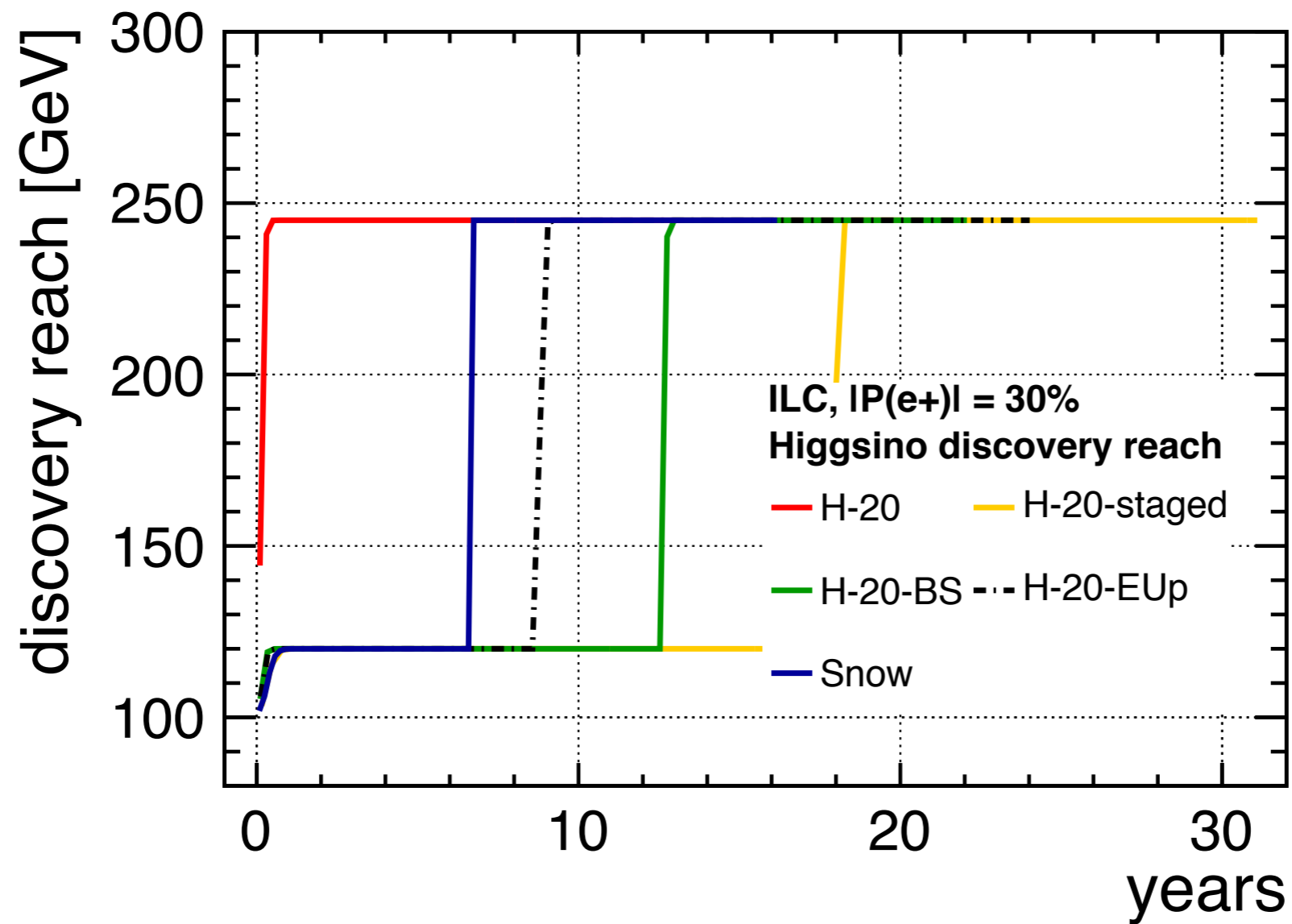
Some physics performance for these scenarios
— BSM —

WIMP discovery reach



without words....

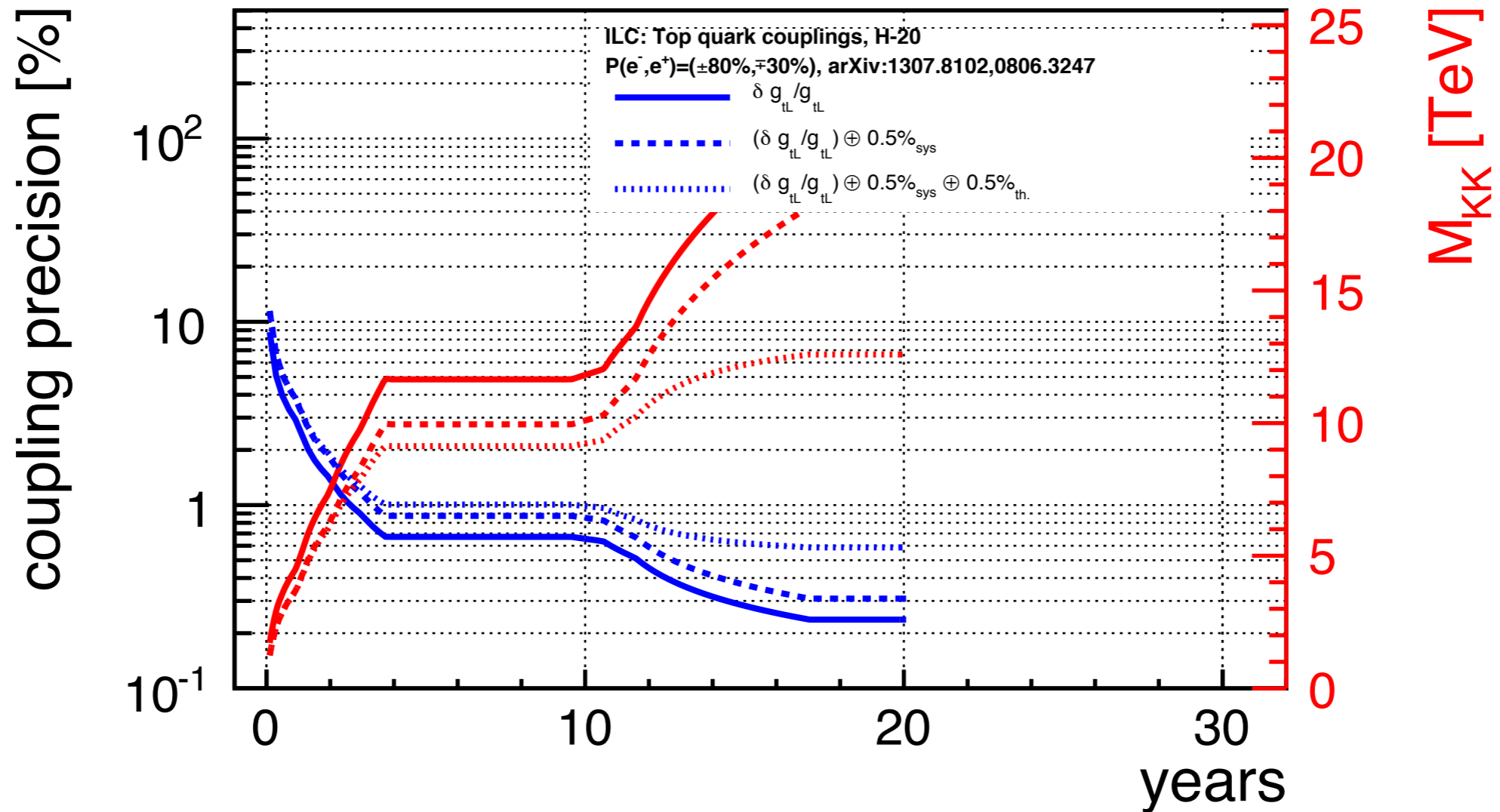
Higgsino discovery reach



without words....

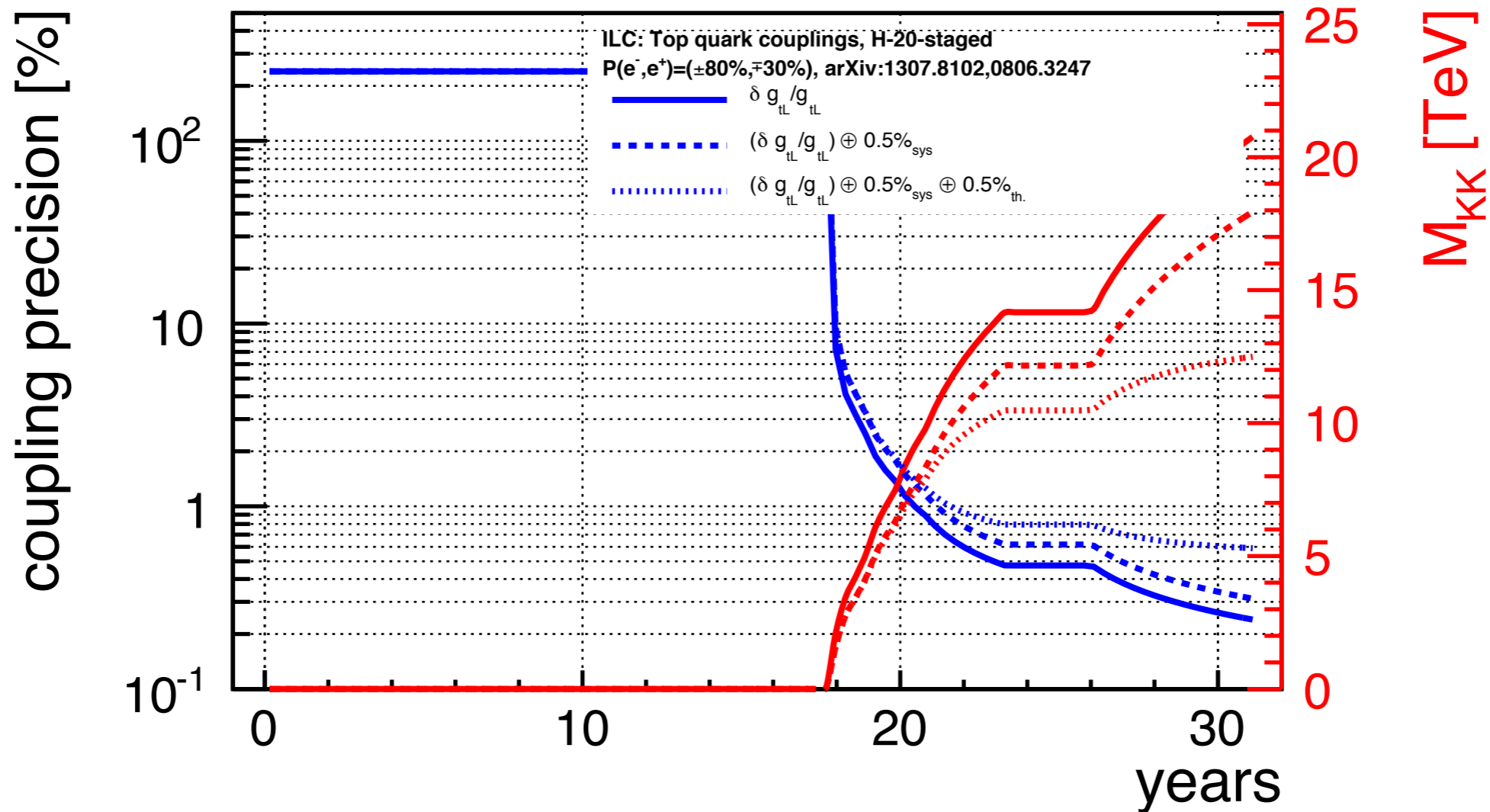
Some physics performance for these scenarios
— Top —

Top electroweak couplings and KK discovery



H-20 (new x axis)

Top electroweak couplings and KK discovery



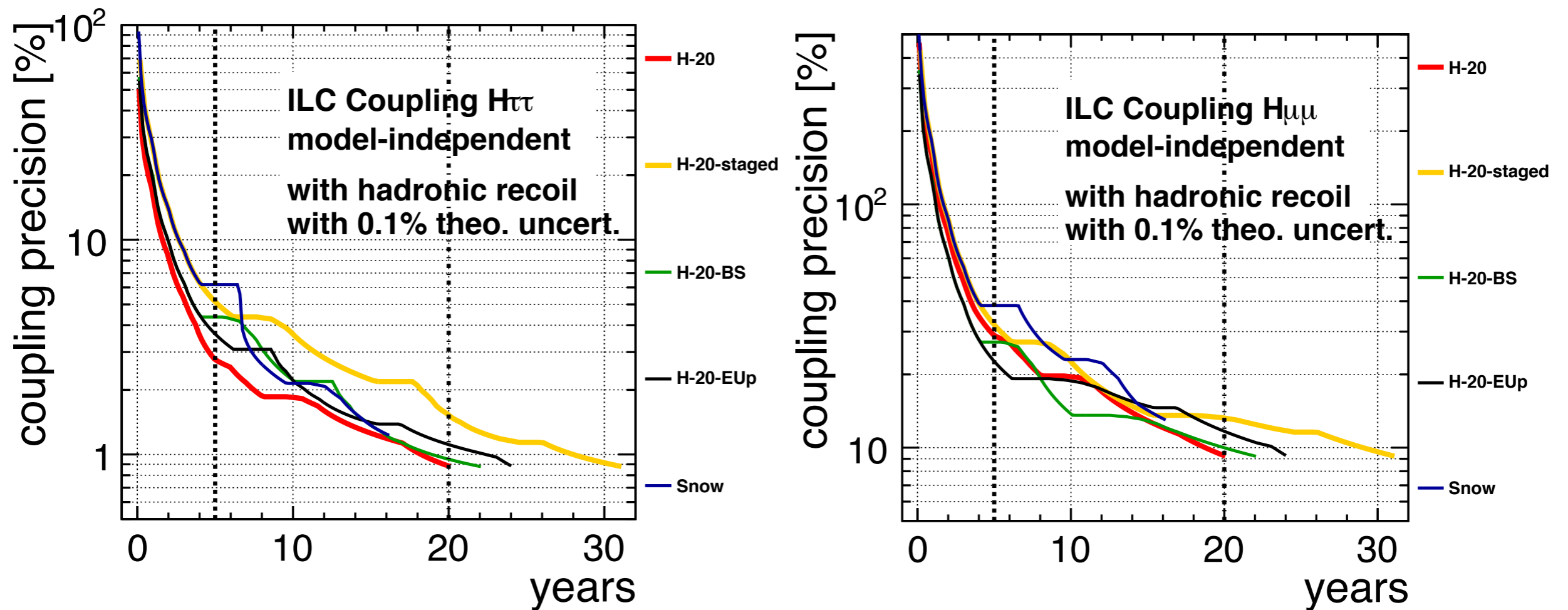
H-20-staged

Conclusions ? — Some personal ideas

- we have been stressing 500 GeV in the past for a reason
- it is very hard to make an appealing physics case with 250 GeV *alone*
- even with higher lumi.....
- we can only try to sell the 250 GeV physics case together with a timely upgrade to 500 GeV
- more information on the tolerable spending profile is crucial for making a realistic scenario

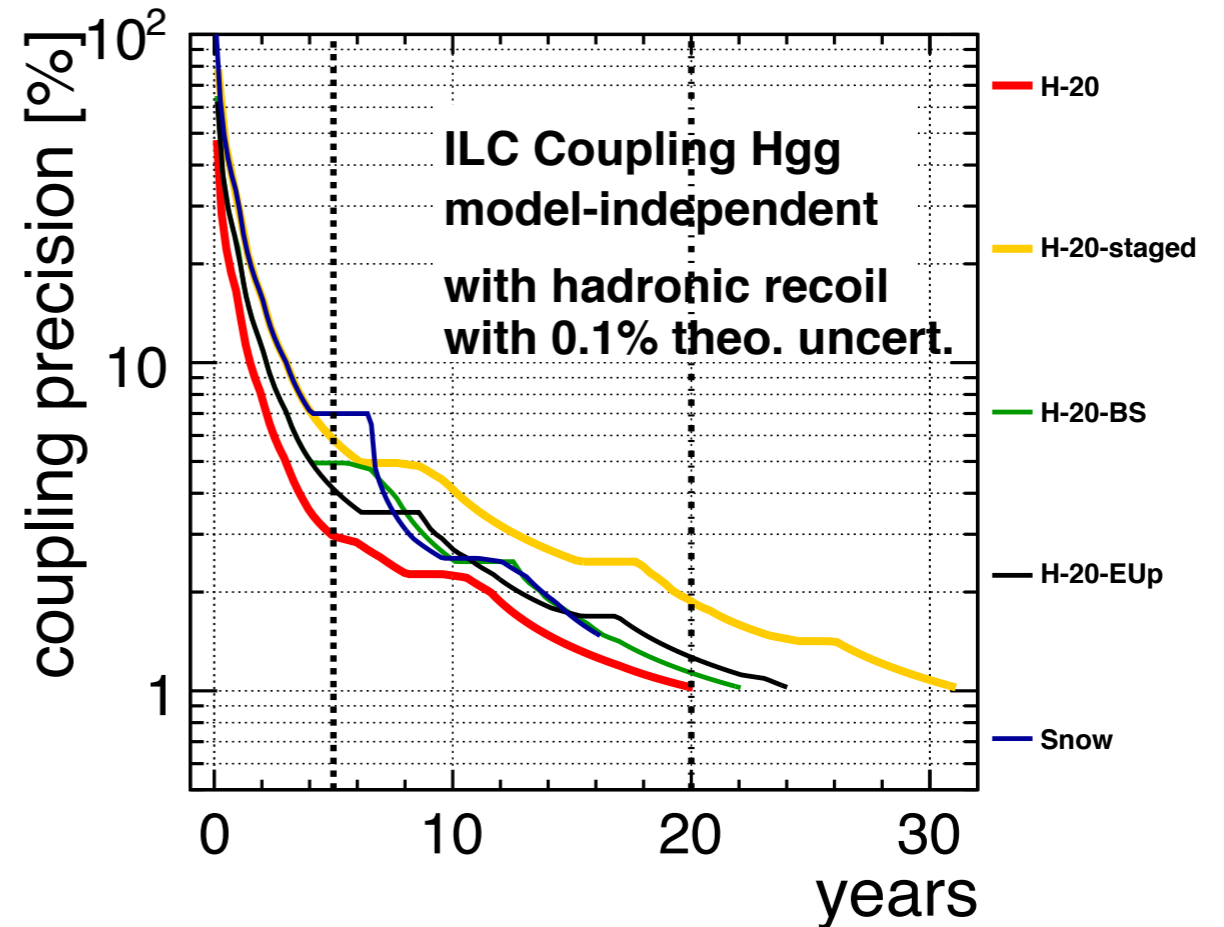
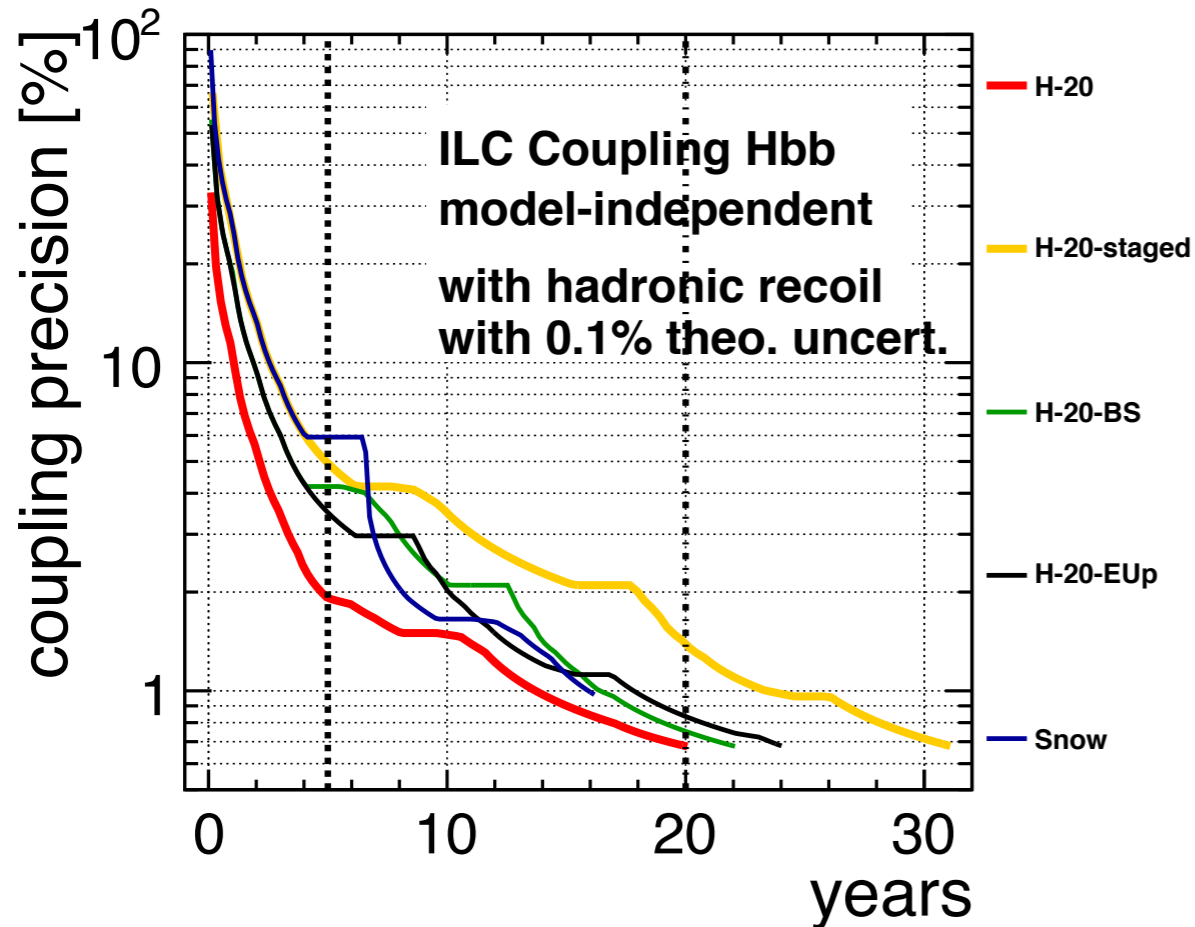
Backup

Model-independent : $H\tau\tau$ and $H\mu\mu$



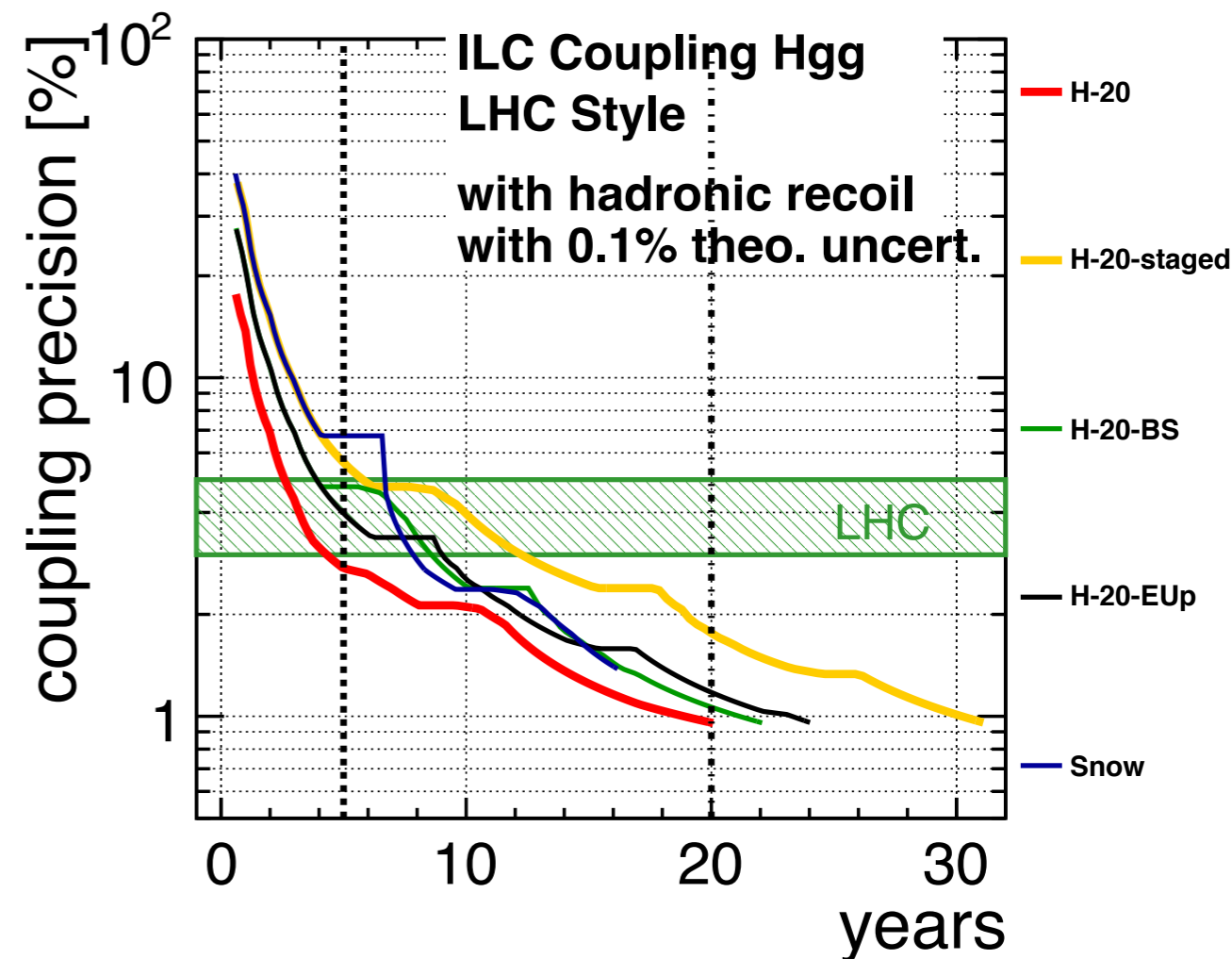
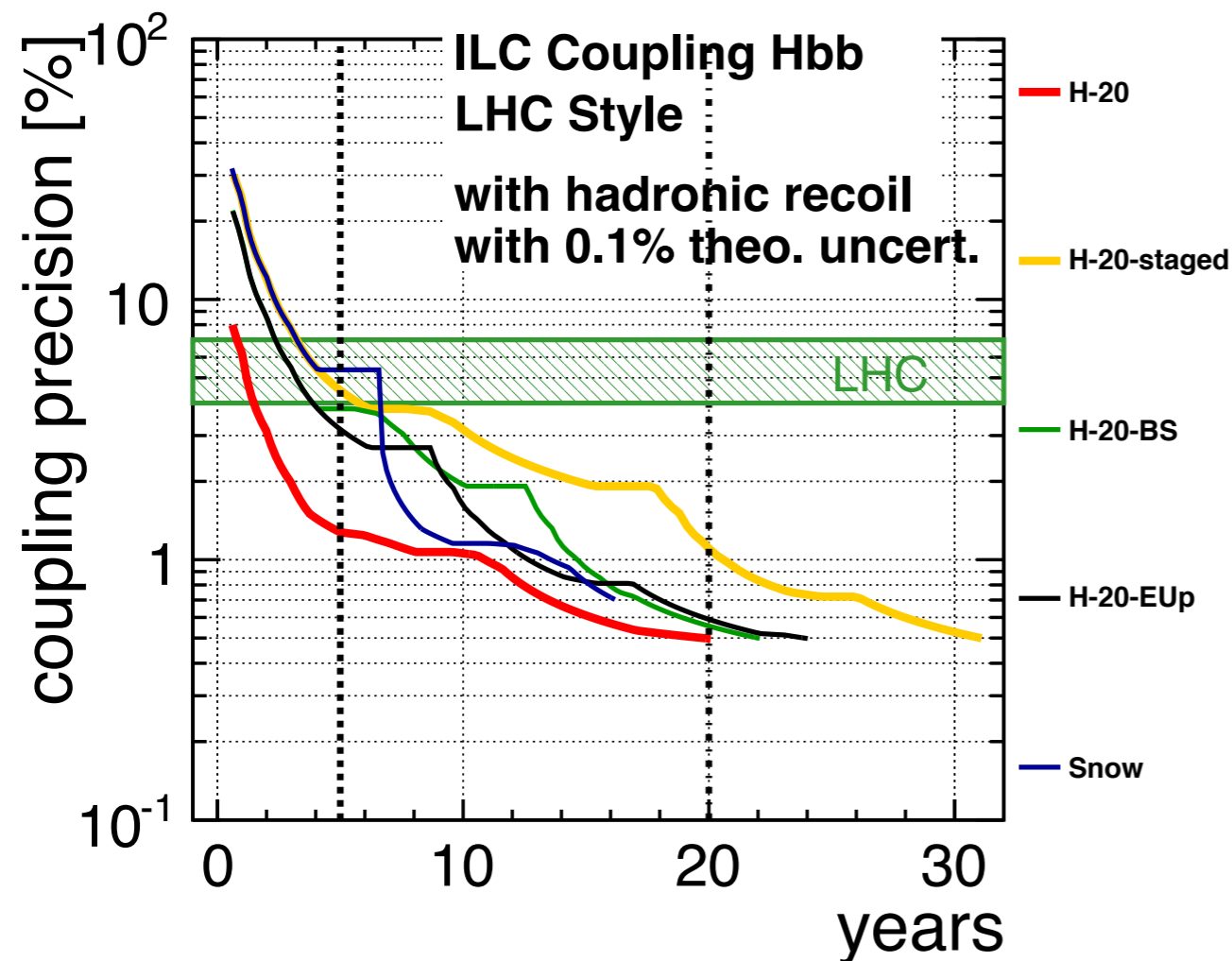
**$H\mu\mu$ only cares about luminosity
(caveat: based on extrapolated results from 1 TeV,
ILD update for 500 GeV underway)**

Model-**in**dependent : Hbb and Hgg



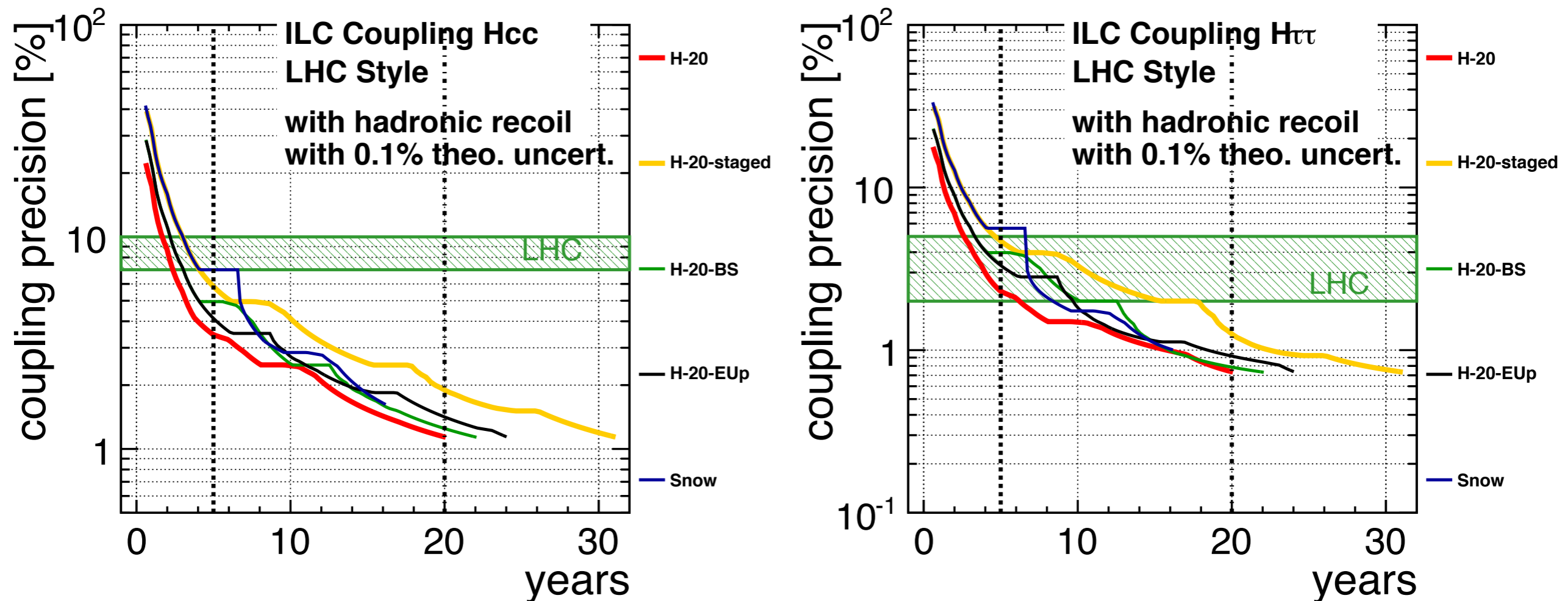
- early performance worse...
- ... catches up when reaching 500 GeV

Model-dependent : Hbb and Hgg



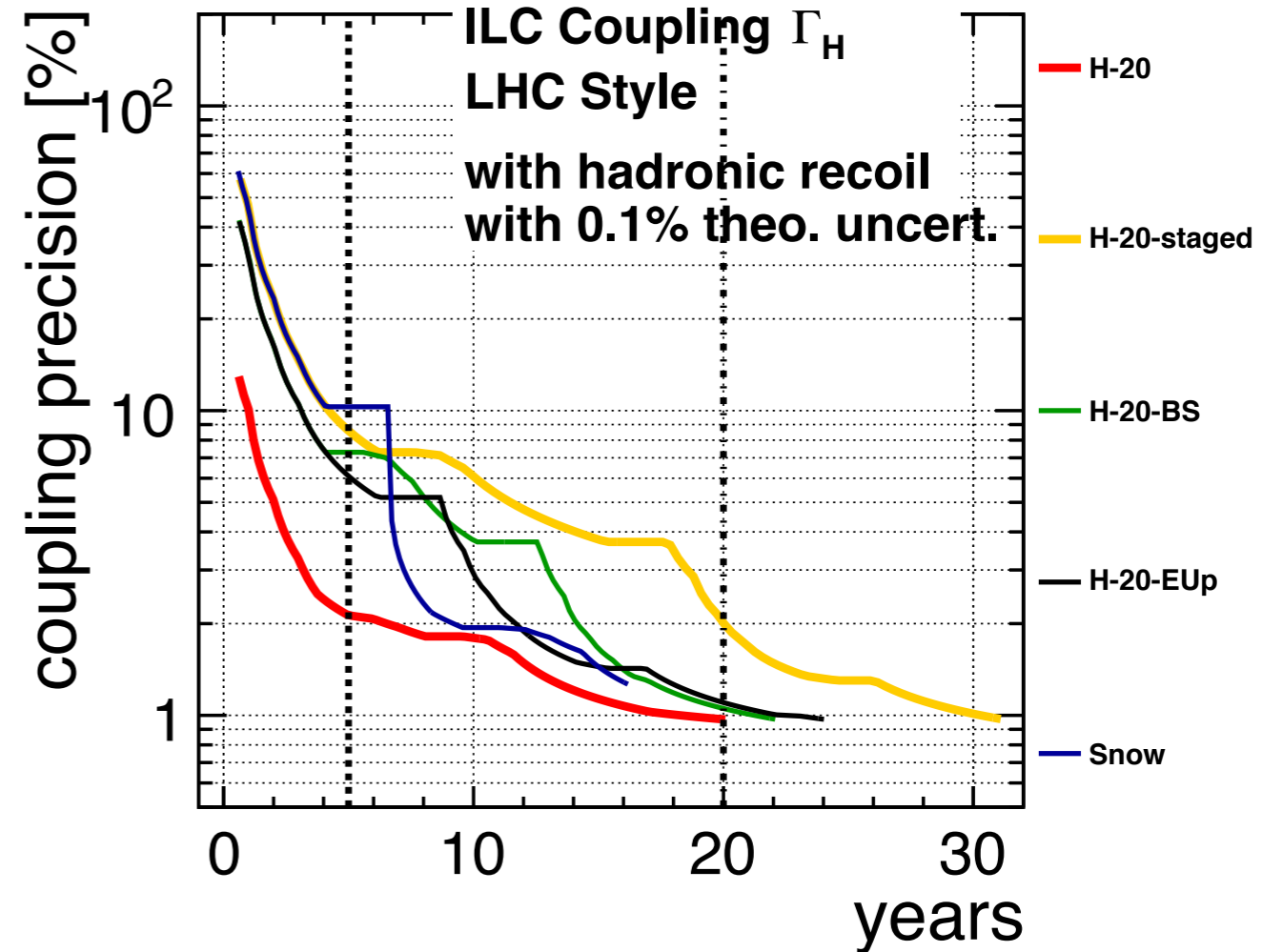
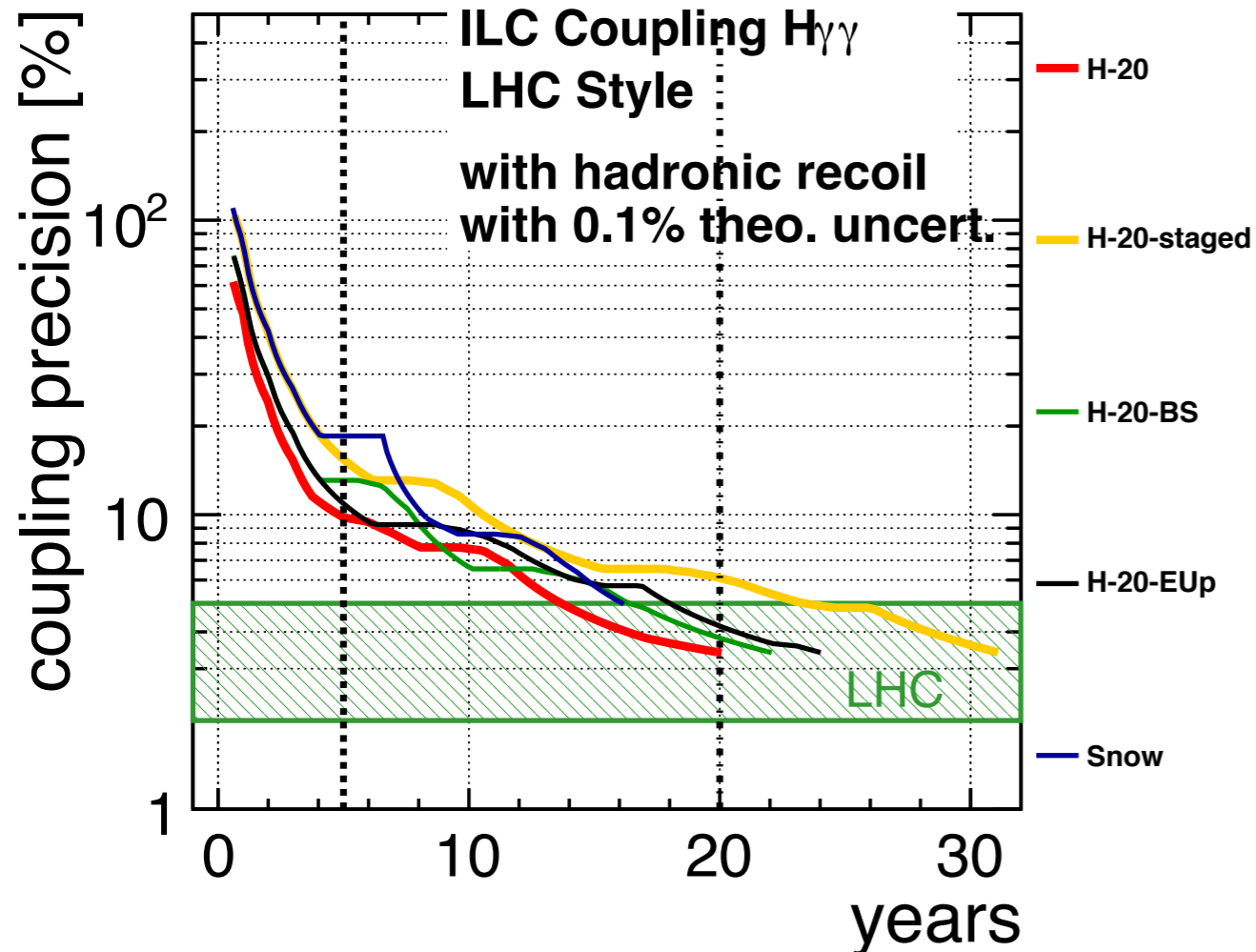
- don't forget the qualitative differences, eg:
 - Hgg at LHC from production
 - Hgg at ILC from decay

Model-dependent : H_{cc}/tt and $H_{\tau\tau}/\mu\mu$



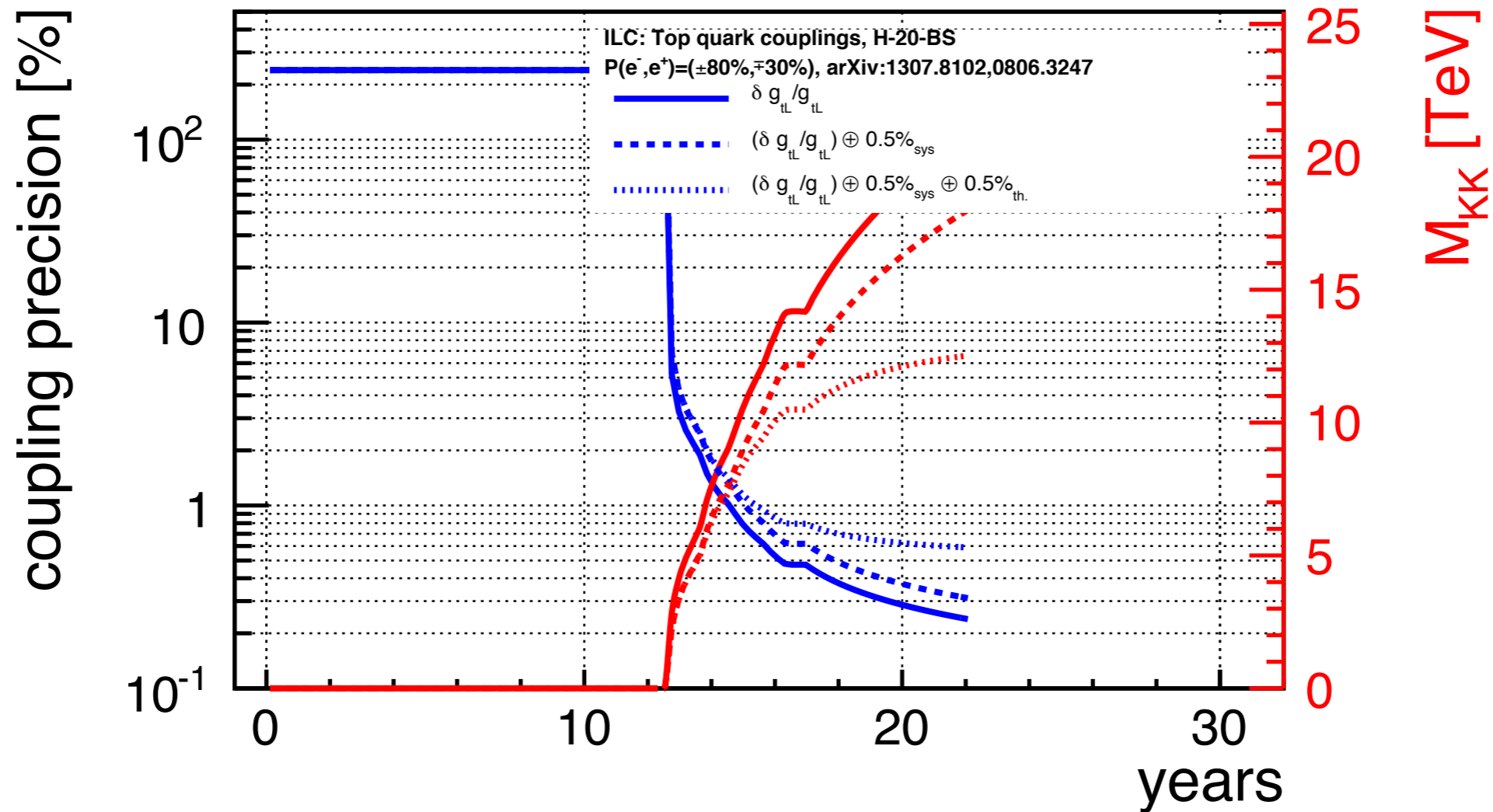
- H_{cc} from LHC easy to superseed in any scenario
- $H_{\tau\tau}$ from LHC takes between 6 and 18 years, depending on energy upgrade to 500 GeV

Model-dependent : $H\gamma\gamma$ and Γ_{tot}



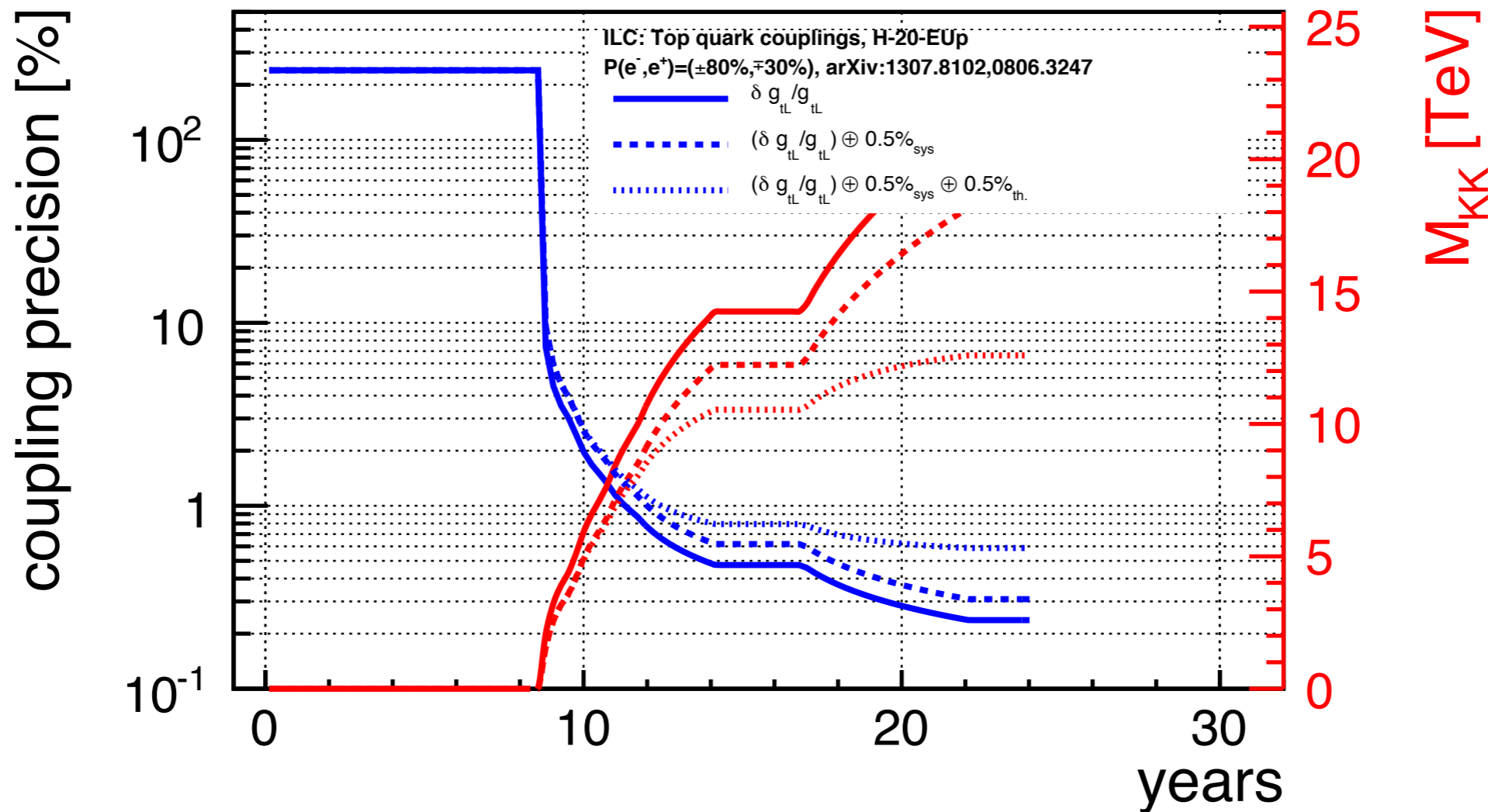
- $H\gamma\gamma$ needs combination with LHC anyway
- Γ_{tot} needs 500 GeV (not accessible at LHC!)
(in constrained fit dominated by HWW, while in model-independent case, $H \rightarrow \text{inv.}$ plays a larger role!)

Top electroweak couplings and KK discovery



H-20-BS

Top electroweak couplings and KK discovery



H-20-EUp