Single Run Scenario

2014/12/17

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What the Single Run Scenario is
and
What it is not

In my understanding
it is a set of end-point numbers
corresponding to

- ***i) Ecm: CM energy***
- ***ii) (Pe-,Pe+): beam polarization***
- ***iii) L: integrated luminosity***

to be used for physics studies

It does not have to be a single run sequence at least for the moment

Why?

Because the primary reason why we need the numbers is to quote the expected end-point ILC physics performances

The staging scenario was needed, however,

I) to reduce the initial cost by starting at 250GeV as recommended by JHEP

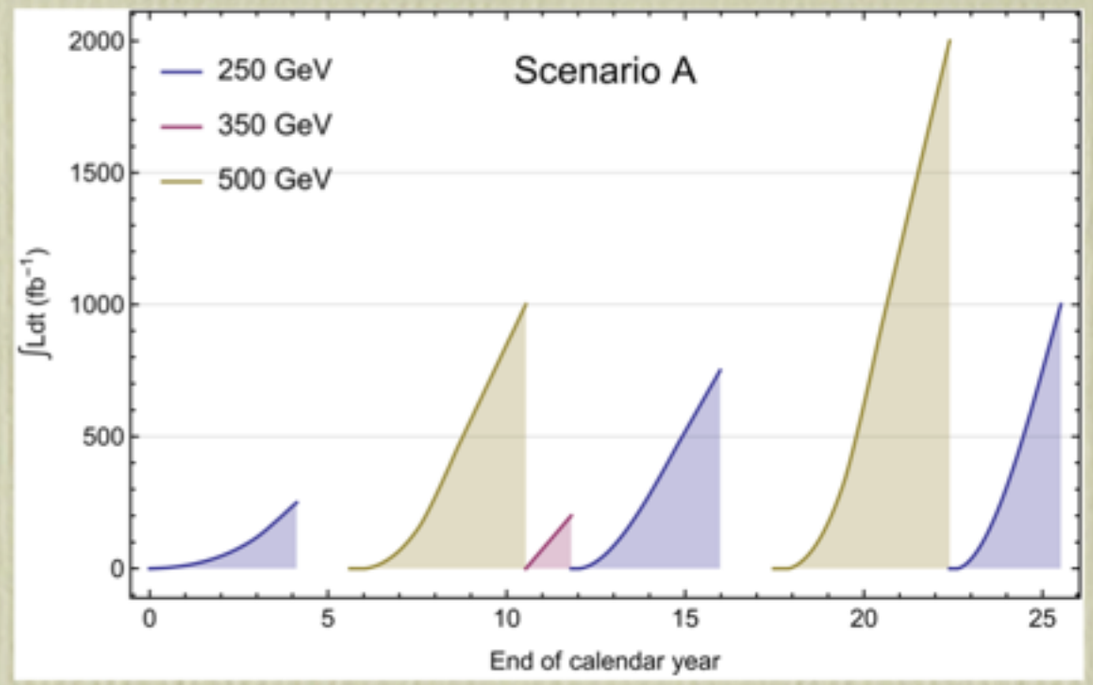
II) to estimate the total years of running at different energies and the total running cost

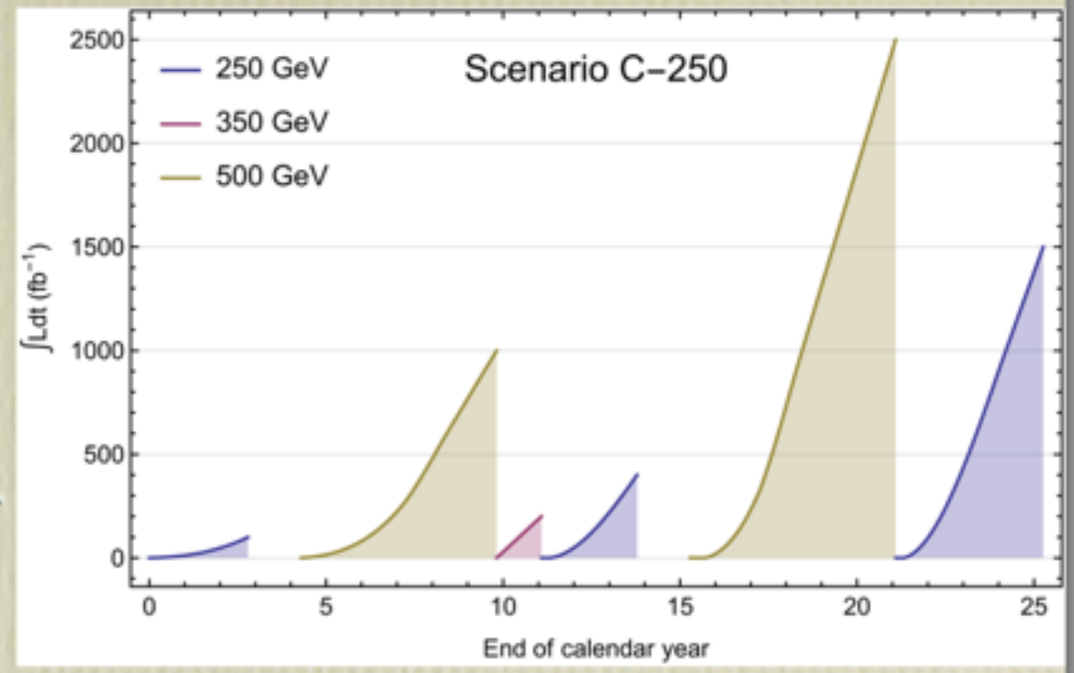
Actual run plan will strongly depend on possible new physics signals

Nevertheless we start from the studies done by the ILC parameters WG

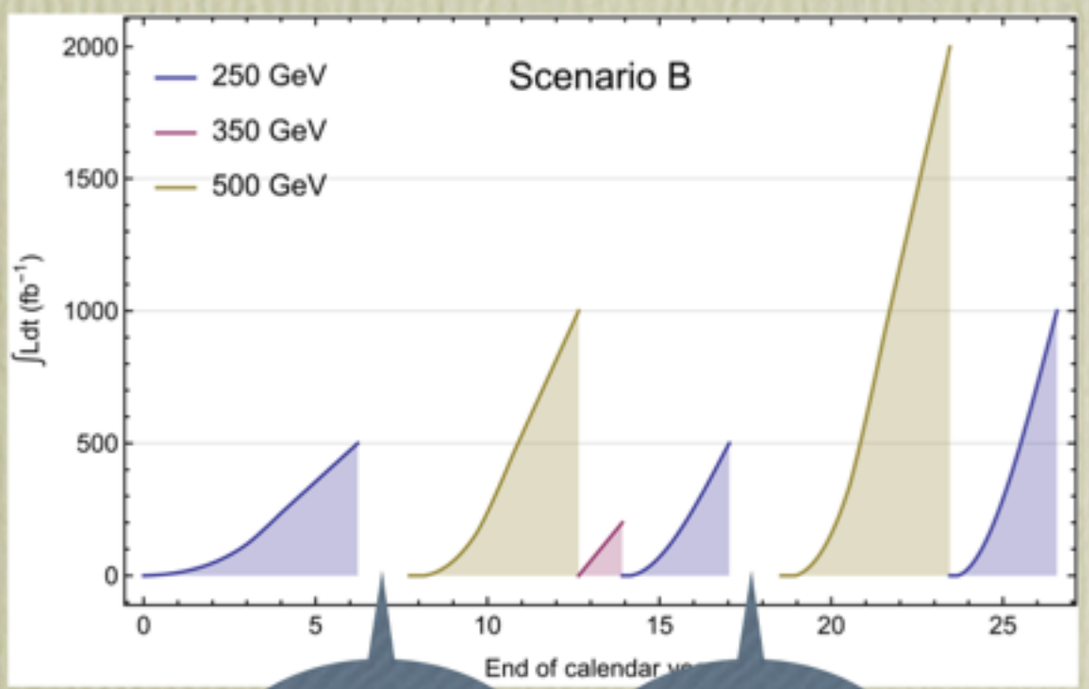
Parameters for ILC Staging

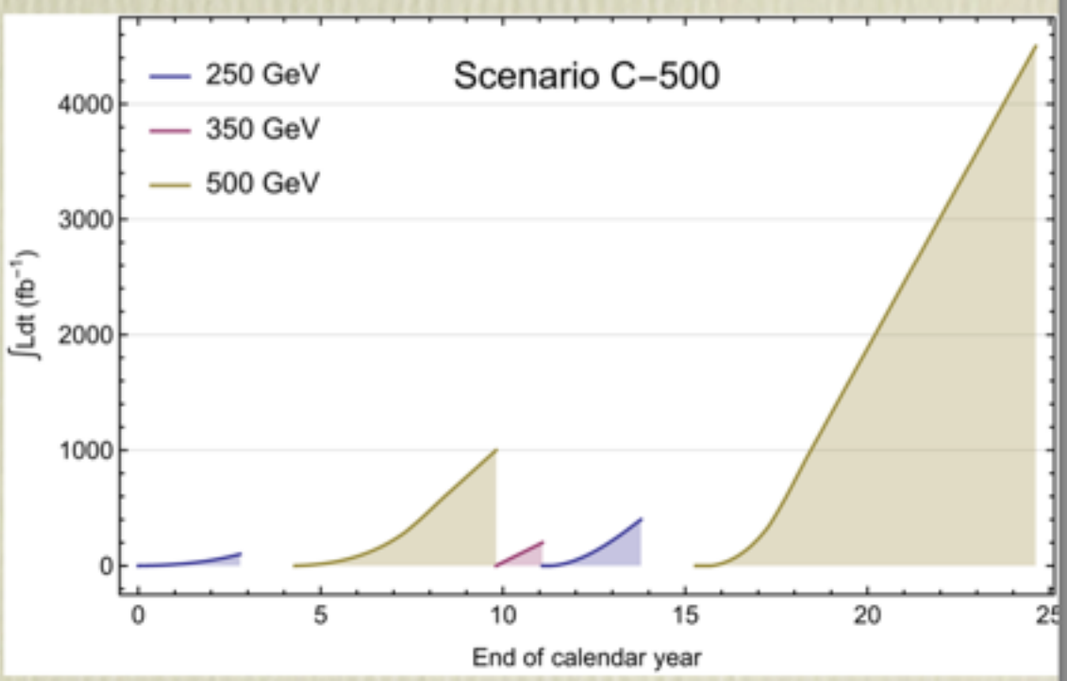
ILC Parameters Joint Working Group
(presented by Jim Brau)





Projected evolution of integrated luminosity with realistic ramp-up and upgrade timelines





Note
- time is in <u>calendar years</u>

Energy Upgrade

Lumi Upgrade

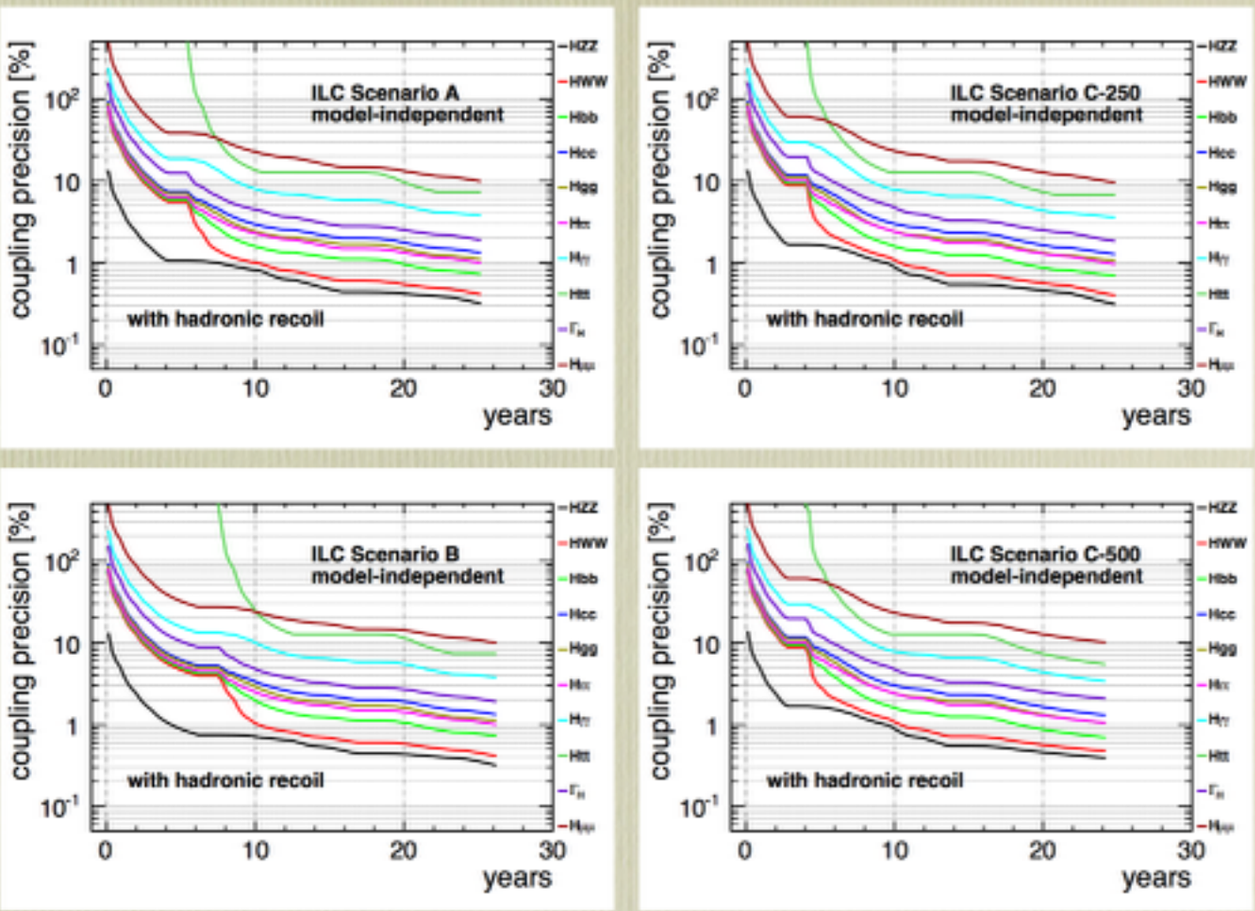
Summary of scenarios

	$\int \mathcal{L} dt$ [fb^{-1}]			
$\sqrt{s}$	A	B	C-250	C-500
250 GeV	2000	2000	2000	500
350 GeV	200	200	200	200
500 GeV	3000	3000	3500	5500

Table 1: Proposed total target integrated luminosities for $\sqrt{s} = 250, 350, 500\,\text{GeV}$.

	total run time *before*		
	500 GeV	Lumi upgrade	TeV upgrade
Scenario	[years]	[years]	[years]
A	4.1	16.0	25.5
B	6.2	17.1	26.6
C-250	2.8	13.8	25.3
C-500	2.8	13.8	24.6

Table 5: Cumulative running times for the four scenarios, including ramp-up and installation of upgrades. Not included: calibration and physics runs at Z pole and WW-threshold or scanning of new physics thresholds.



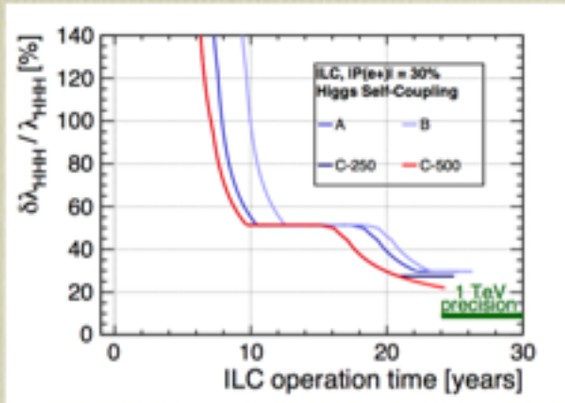
Higgs self-coupling

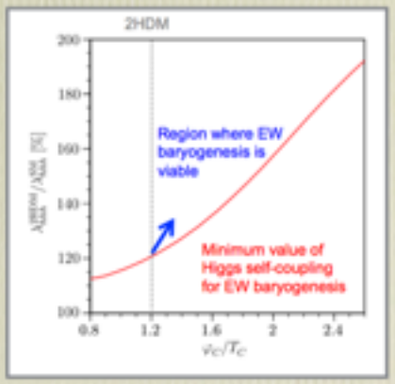
$\sqrt{s} \gtrsim 450$ GeV

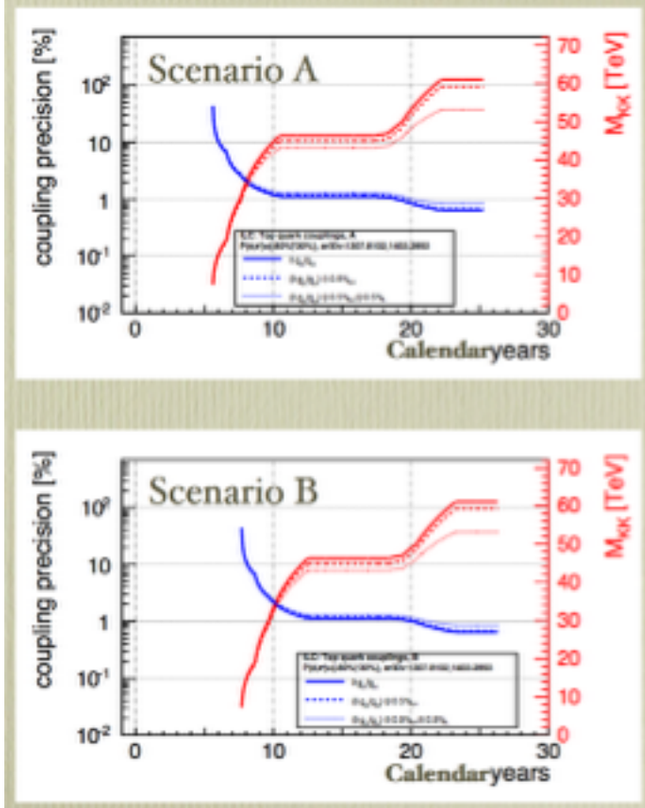
~20% precision (5σ SM) achieved at end of C-500 run

This precision is sufficient to <u>begin</u> testing BSM models, such as the EW baryogenesis model shown in Fig (arXiv:1211.5883)

1 TeV running will bring precision to ~10%

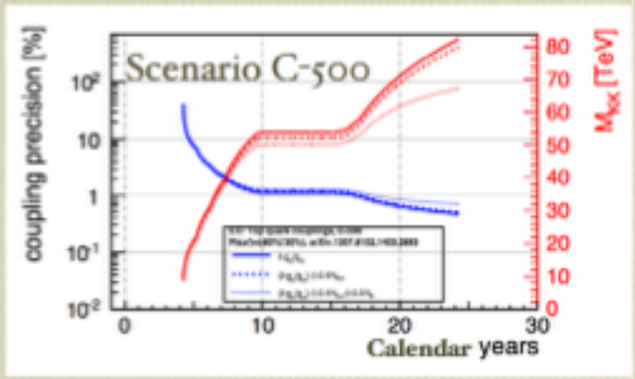






Top RH coupling & sensitivity of KK mass scale in extra dimension model

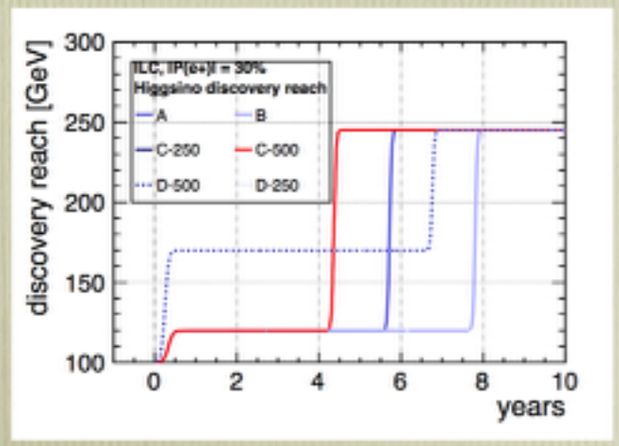
F. Richard, arXiv:1403.2893

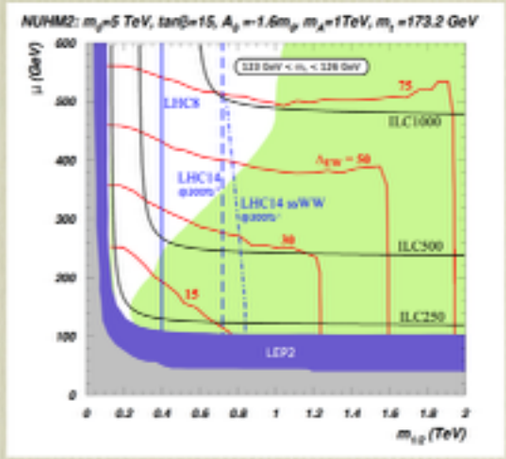


Note - the choice of this benchmark point is under recent discussion in the Physics Working Group

Discoveries

- The ILC physics program could be significantly enhanced by discoveries with the LHC or the early ILC running
- Early higher energy running increases the probability for this to happen early at the ILC
- Example: Higgsino





Accuracies in First 5 Years

	HL-LHC	ILC Scenario B	ILC Scenario D-500
$\sqrt{s}$ (GeV)	1400	250	350
L (fb^{-1})	3000	360	470
$\gamma\gamma$	2-5 %	14.8 %	10.9 %
gg	3-5 %	4.8 %	2.9 %
WW	2-5 %	3.9 %	0.63 %
ZZ	2-4 %	0.63 %	0.49 %
$t\bar{t}$ ($c\bar{c}$)	7-10 %	5.3 %	3.7 %
$b\bar{b}$	4-7 %	3.8 %	1.3 %
$\tau^+\tau^-$	2-5 %	4.3 %	2.4 %
$\Gamma_T(h)$	5-8 %	7.3 %	2.1 %

Table 7: Expected accuracies $\Delta g_i/g_i$ of Higgs boson couplings for the end of the HL-LHC program and for the first five years of ILC running assuming either Scenario B or Scenario D-500. The couplings are derived from a seven parameter fit of $g_g, g_\gamma, g_W, g_Z, g_b, g_t, g_\tau$ using the model dependent constraints described in Section 10.3.7 of the first report of the LHC Higgs Cross Section Working Group [26]. The HL-LHC coupling errors are taken from the 2013 Snowmass Higgs Working Group Report [15].

Conclusions of draft sent to LCB/LCC

All Scenarios assume a single E-upgrade to ~500GeV:

- ***The optimal scenario starting from 250 GeV is C-500, which spends the largest fraction of its lifetime operating at the highest possible energy. This scenario optimizes the possibility of discoveries of new physics while making the earliest measurements of the important Higgs properties.***

- ***A significant improvement in the earliest physics reach can be achieved if the first phase of the collider is at 350 GeV, rather than 250 GeV. This would optimize the Higgs measurements as well as open up measurements of the top mass and electroweak couplings.***

- ***The physics impact of the ILC is significantly improved if the maximum energy of the ~500 GeV ILC is stretched to ~550 GeV where the top Yukawa precision is more than a factor of two times better than at 500 GeV.***

Future investigations should include the following:

- ***The reduction in physics which would result if the assumed 30% position polarization were reduced to zero (effect of no e+ polarization).***

- ***The importance of the Z-pole calibration referred to in Section 7***

- ***The capability of ILC detectors to operate with 10 Hertz collisions.***

Next steps

- Comments on DRAFT from Physics WG **Done!**
- Meet in Tokyo on September 4 **Done!**
- Present updated DRAFT to LCC & LCB **Done!**
- Respond to LCC/LCB comments **Done!**
- Prepare DRAFT for comment at LCWS14 **Done!**
  - plenary session **Done!**
- Finish report by ICFA Seminar

Recommendation from Lynn

1. *Build the 500 GeV machine from the beginning*
2. *Energy staging, if necessary, with this 500 GeV machine*

The ILC parameters WG is waiting for inputs from the LCB

Possible Questions?

Can we forget about the staging from 250GeV that has been presented to the MEXT physics WG?

Is the total years (25 years or more without energy upgrade) of running acceptable?

Possible Strategies

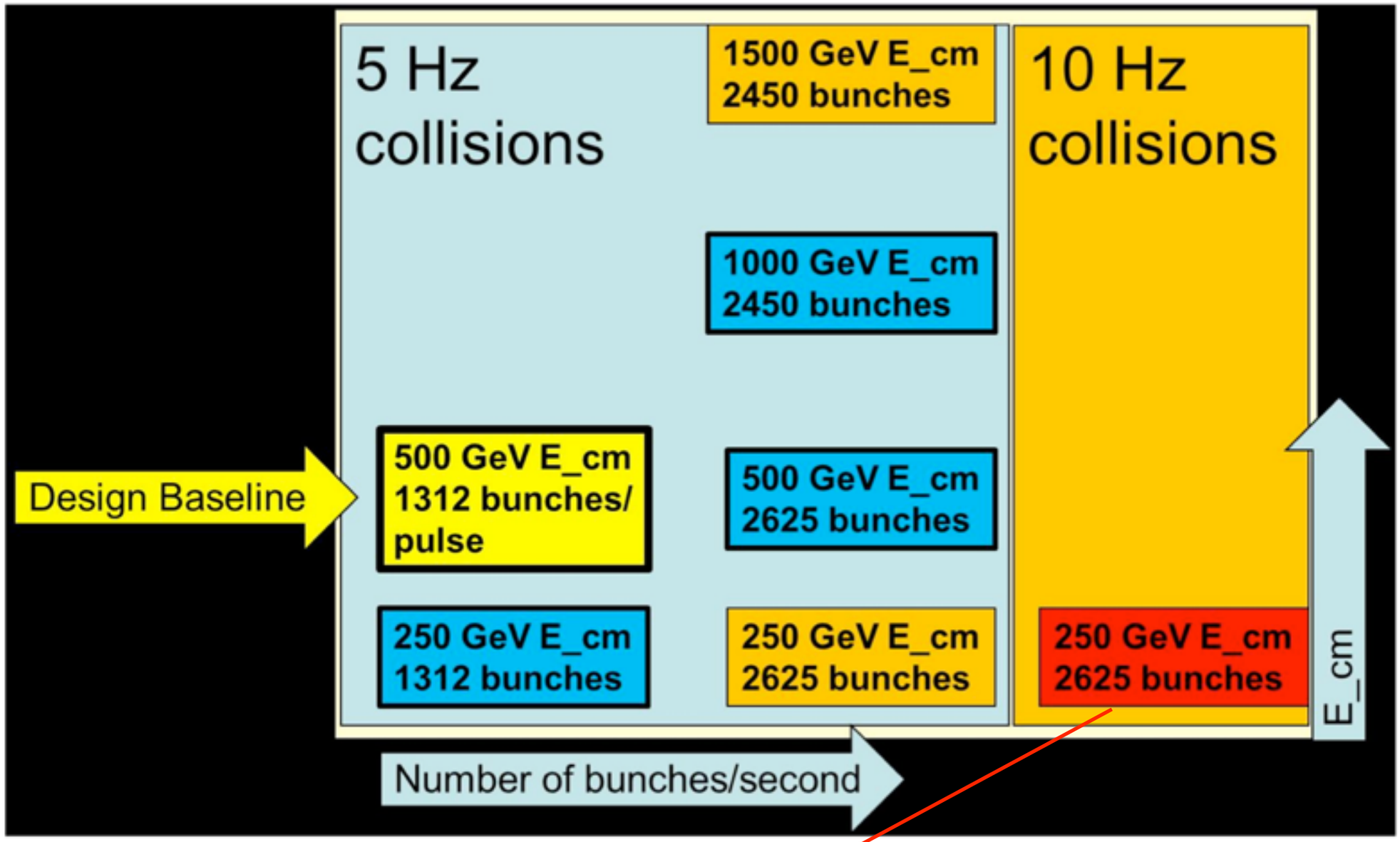
1. *Use C500 as it is*
2. *Use the Snowmass values*
3. *Readjust C500, taking into account the total number of years before the 1TeV upgrade*

In any case we had better keep some level of consistency with the Snowmass values

Other Questions or Comments from Our Side?

Backup

ILC Stages and Upgrades



Snowmass ILC Higgs White Paper (arXiv: 1310.0763)

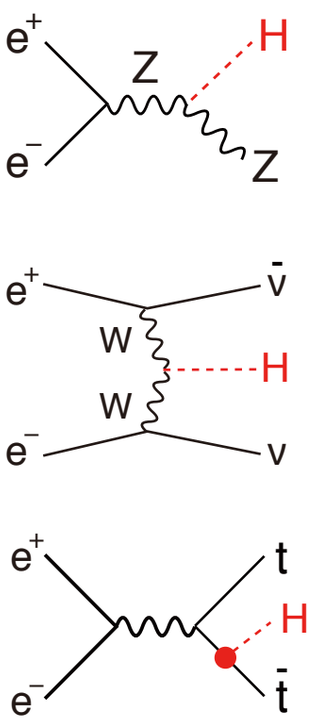
x4 upgrade @250GeV

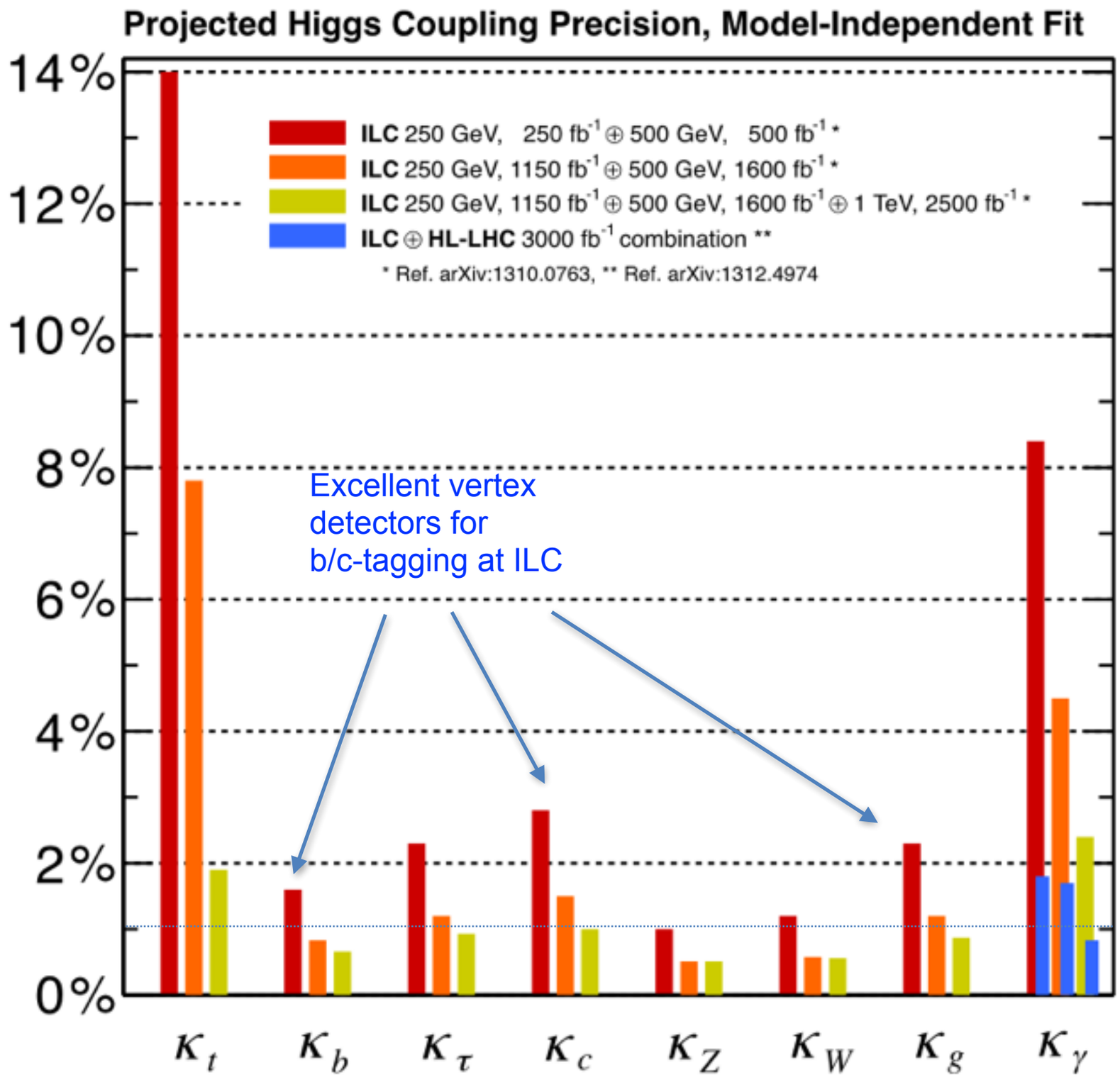
Blue: upgrade described in TDR

The current ILC design is rather conservative!

Higgs Couplings

Model-independent coupling determination, impossible at LHC



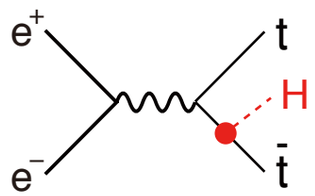


All of major Higgs decay modes accessible at ILC!

500 GeV already excellent except for K_t and K_γ

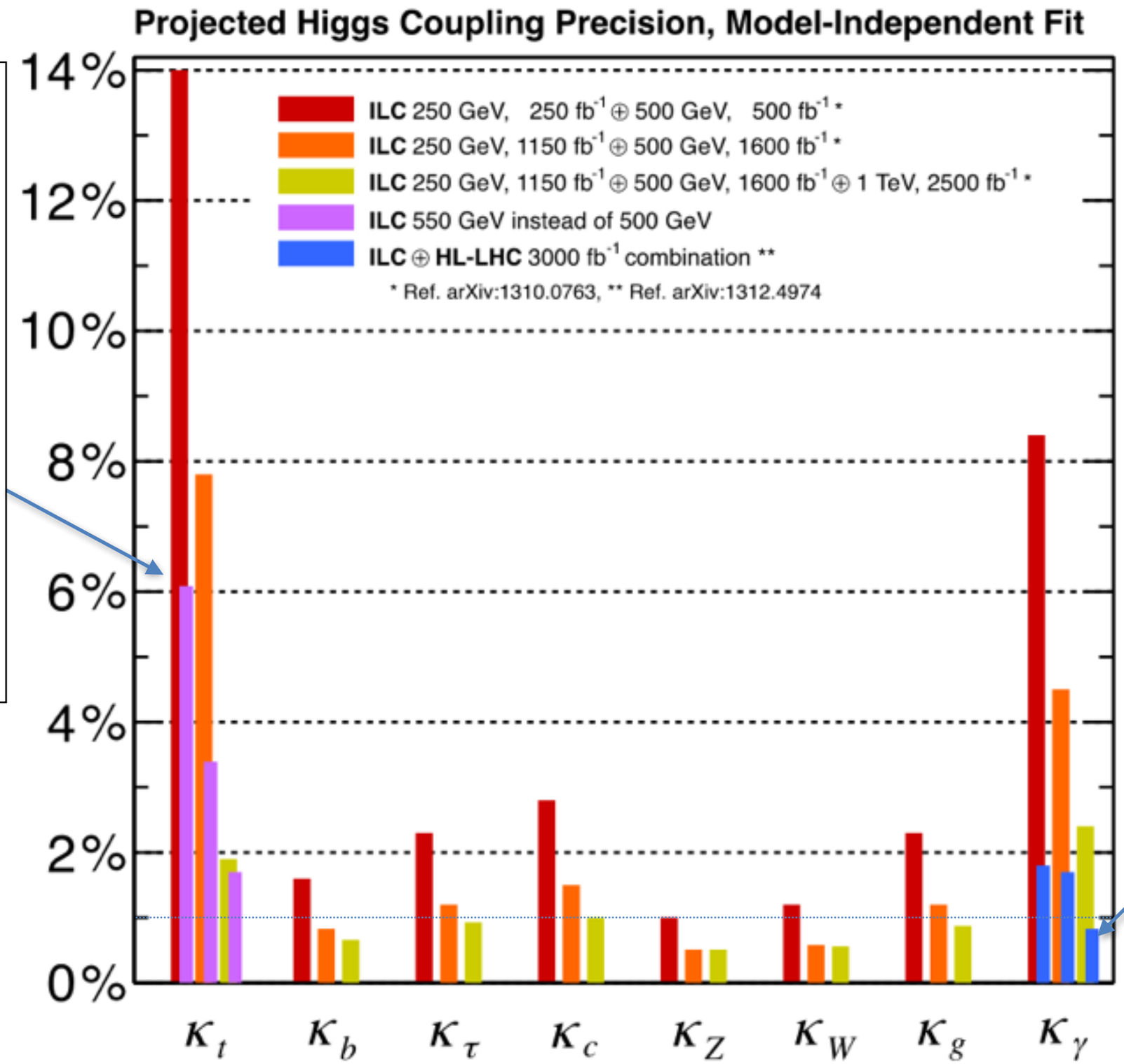
Higgs Couplings

Model-independent coupling determination, impossible at LHC



Top Yukawa improves by going to 550 GeV

Near threshold → a factor of 4 enhancement of σ_{tth} by going from 500GeV to 550 GeV



LHC can precisely measure
$BR(h\to\gamma\gamma)$ / $BR(h\to ZZ^*)$ = $(K_\gamma / K_Z)^2$

ILC can precisely measure ***K_Z***

Better hγγ with LHC/ILC synergy

~1% or better precision for most couplings!