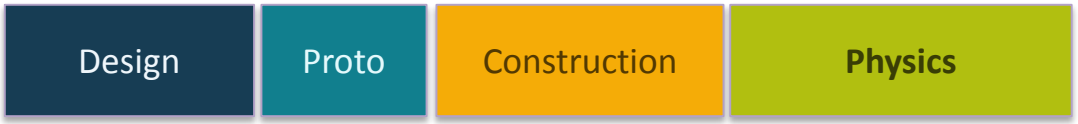
A few words on FCC-ee

100 TeV pp collider and High Luminosity 90-305 GeV e+e- collider form the core of the CERN FCC design study.

(from the CERN FCC brochure)

Future Colliders broad-brush planning



LHC

Top priority European Strategy (2013) and US P5 (2014) - ATLAS and CMS TDRs in 2016-2017

HL-LHC

Physics

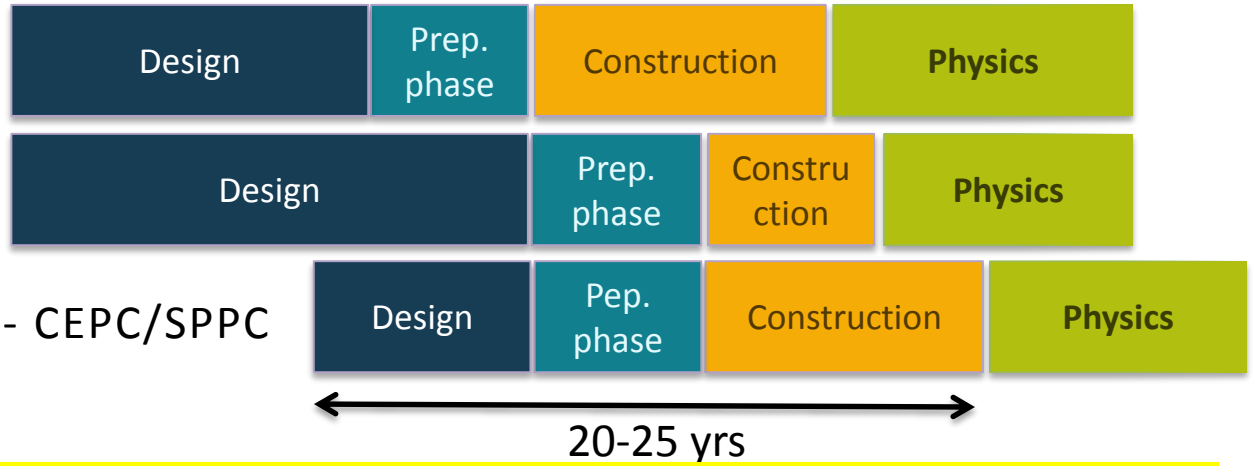
ATLAS - CMS

End of LHC Run 2 → 2019-20 recommendation from ES, others? US P5, Japan JAHEP, China

ILC TDR in 2013 → Japan
MEXT creates ILC taskforce

CLIC CDR in 2012
Proj. Imp. Plan end 2018

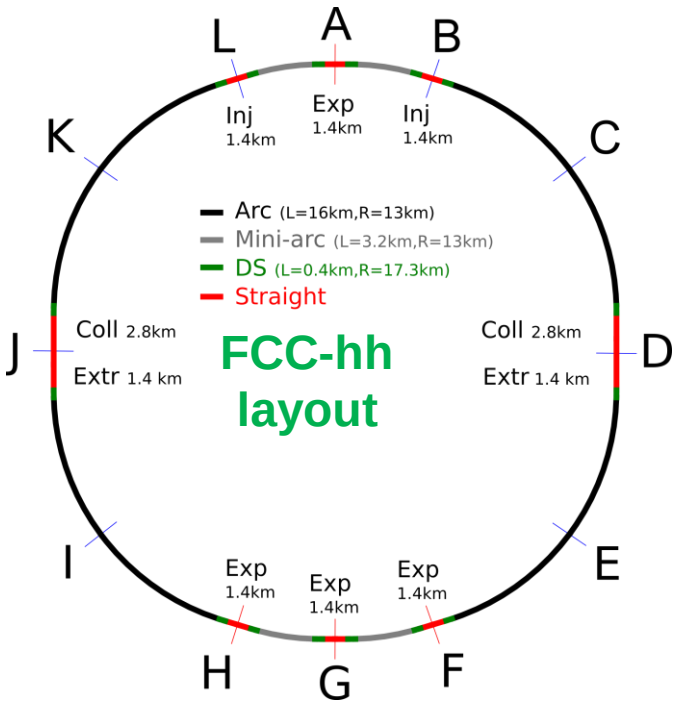
FCC-hh/ee CDR end 2018 - CEPC/SPPC

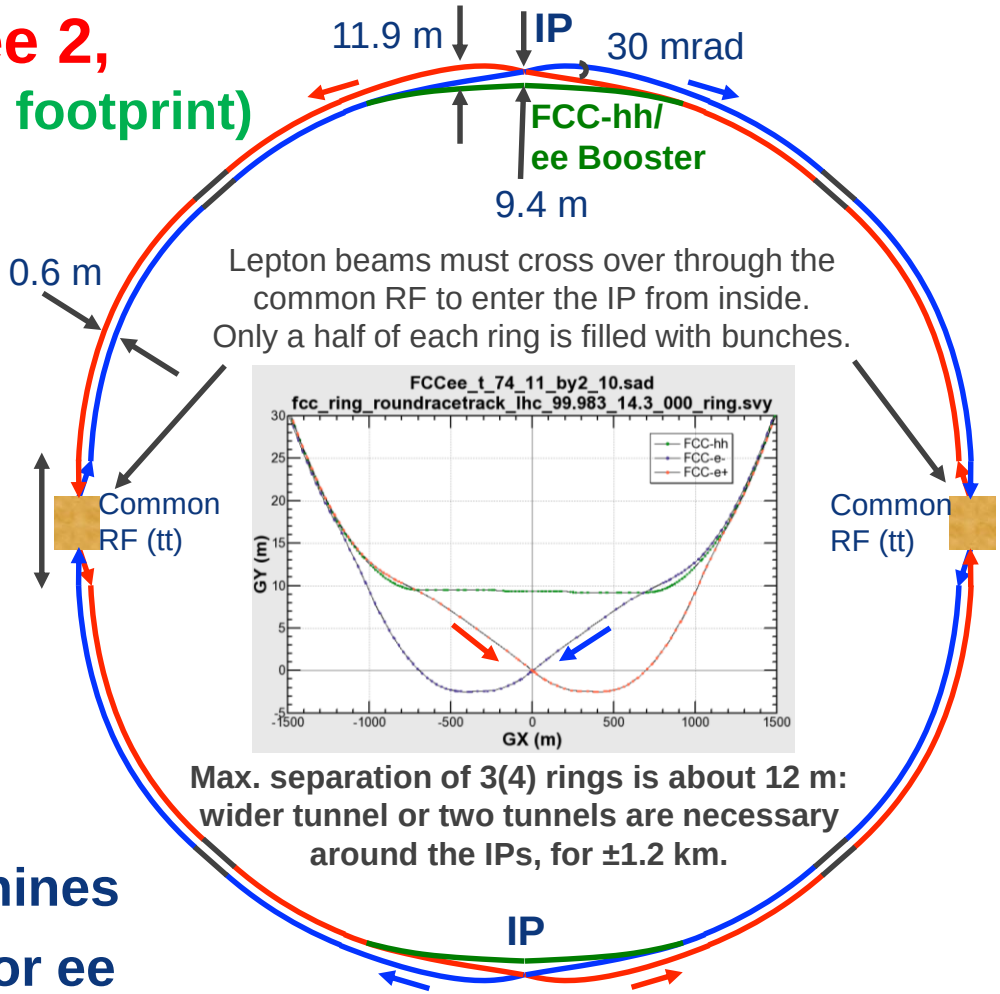


<u>Similar time scales.</u> Important bonus of circular colliders is the synergy with the pp colliders.

common layouts for hh & ee

FCC-ee 1, FCC-ee 2,
FCC-ee booster (FCC-hh footprint)





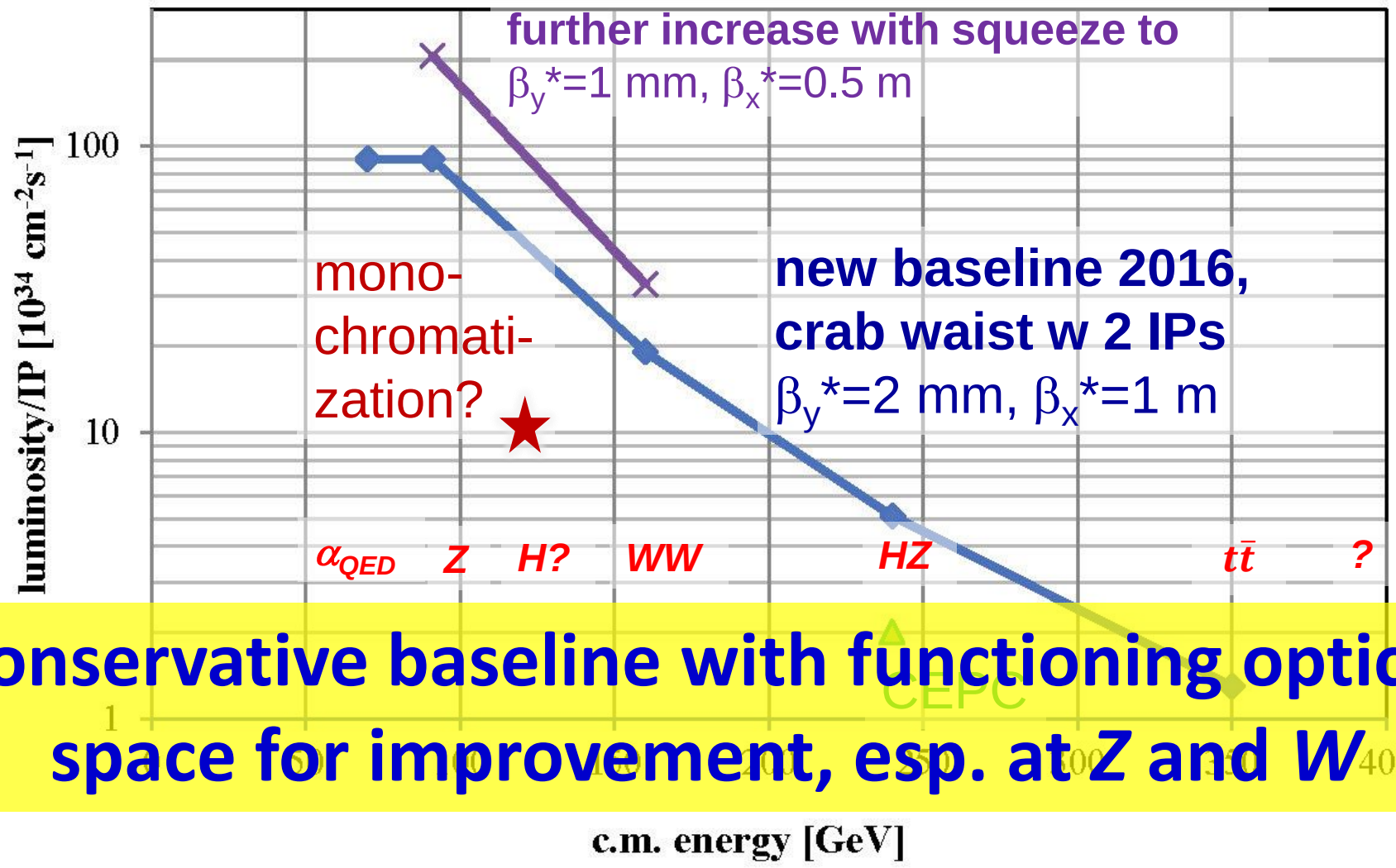
- 2 main IPs in A, G for both machines
- asymmetric IR optic/geometry for ee to limit synchrotron radiation to detector

K. Oide, D. Schulte, A. Bogomyagkov, B. Holzer, et al.

lepton collider parameters

parameter	FCC-ee					LEP2
physics working point	**Z**		**WW**	**ZH**	**tt_{bar}**	
energy/beam [GeV]	**45.6**		**80**	**120**	**175**	105
bunches/beam	30180	**91500**	**5260**	**780**	**81**	4
bunch spacing [ns]	7.5	**2.5**	**50**	**400**	**4000**	22000
bunch population [10^{11}]	1.0	**0.33**	**0.6**	**0.8**	**1.7**	4.2
beam current [mA]	1450	**1450**	**152**	**30**	**6.6**	3
luminosity/IP x $10^{34}cm^{-2}s^{-1}$	210	**90**	**19**	**5.1**	**1.3**	0.0012
energy loss/turn [GeV]	0.03	**0.03**	**0.33**	**1.67**	**7.55**	3.34
synchrotron power [MW]	**100**					22
RF voltage [GV]	0.4	**0.2**	**0.8**	**3.0**	**10**	3.5
rms cm *E* spread SR [%]	0.03	**0.03**	**0.05**	**0.07**	**0.10**	0.11
rms cm *E* spread SR+BS [%]	0.15	**0.06**	**0.07**	**0.08**	**0.12**	0.11

FCC-ee luminosity per IP

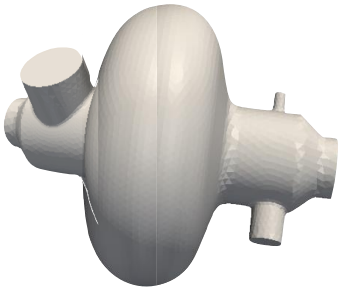


conservative baseline with functioning optics, space for improvement, esp. at *Z* and *W*

RF system R&D lines

400 MHz single-cell cavities preferred for hh and ee-Z (few MeV/m)

- Baseline Nb/Cu @4.5 K, development with synergies to HL-LHC, HE-LHC
- R&D: power coupling 1 MW/cell, HOM power handling (damper, cryomodule)



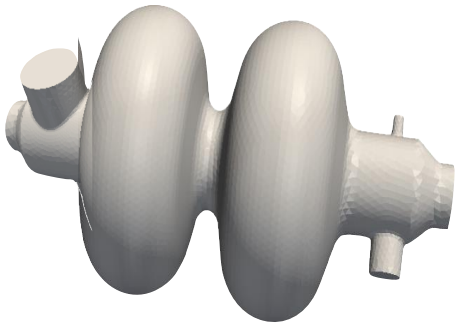
hh ≈ 16 cells per beam

Z ≈ 100 per beam (+ 100 for booster ring)

W ≈ 210 per beam (+ 210 for booster ring)

400 or 800 MHz multi-cell cavities preferred for ee-H, ee-tt and ee-W

- Baseline options 400 MHz Nb/Cu @4.5 K, ◄—► 800 MHz bulk Nb system @2K
- R&D: High Q_0 cavities, coating, long-term: Nb_3Sn like components



W ≈ 200 per beam (+ 200 for booster)

H ≈ 800 per beam (+ 800 for booster)

t ≈ common 2600 cells for both beams (+ 2600 for booster)

O. Brunner, A. Butterworth, R. Calaga

FCC-ee discovery potential

of course discovery depends on the goodwill of nature;
a few things that FCC-ee could do and discover (if they exist):

EXPLORE 10 TeV energy scale (and beyond) with Precision Measurements

~20-50 fold improved precision on many EW quantities
(equivalent to factor 5-7 in mass)

m_Z, m_W, m_{top} , $\sin^2\theta_w^{eff}$, R_b , $\alpha_{QED}(m_z)$, $\alpha_s(m_z)$, **Higgs and top couplings**

DISCOVER a violation of flavour conservation

- **ex FCNC** ($Z \longrightarrow \mu\tau$, $e\tau$) **in 5** 10^{12} **Z decays.**
  + flavour physics (10^{12} **bb events!)**

also see
M. Bicer et al.,
"First Look at the Physics Case of TLEP,"
JHEP01 (2014) 164

DISCOVER dark matter as «invisible decay» of H or Z

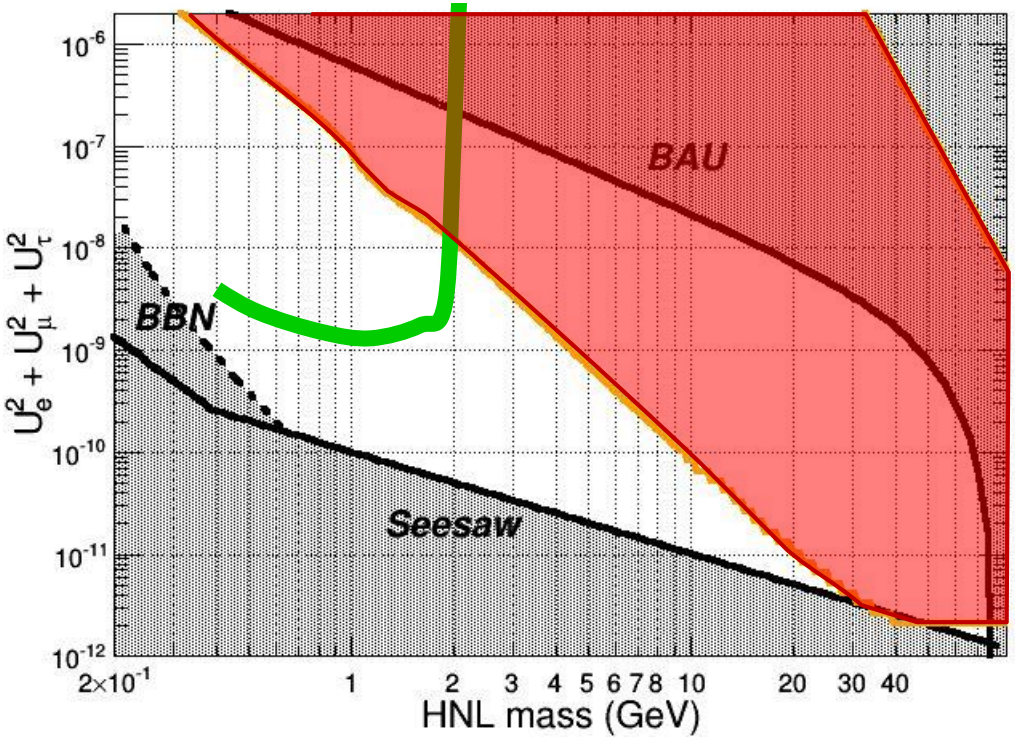
DISCOVER very weakly coupled particle in 5-100 GeV energy scale
such as: right-handed neutrinos, dark photons etc…

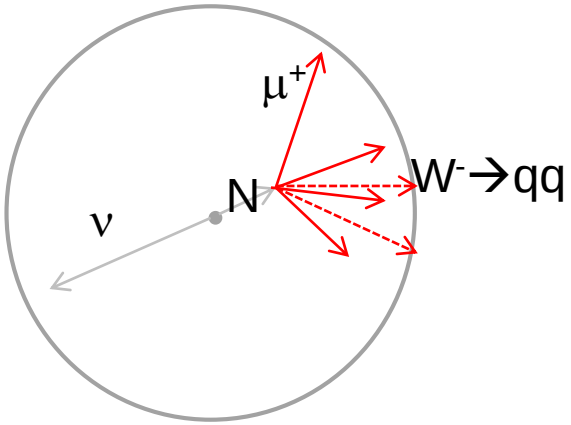
…..

FCC-ee expected sensitivity to heavy RH neutrinos

SHIP

FCC-ee expected sensitivity to Heavy RH neutrino





$N_Z = 10^{13}$ $100\mu m$ <L<5m

region of interest

FCC-ee sensitivity

NB: very large detector caverns for FCC-hh may allow for very large FCC-ee detector (R=15 m?) leading to improved reach at lower masses

Blondel, Graverini, Serra, Shaposhnikov

Summary

- FCC-ee combines several new concepts invented and successfully demonstrated during the last 20 years
- FCC-ee offers extremely high luminosities in the energy range from *Z* to ttbar; combined w. precise energy calibration at *Z* & *W*
- FCC-ee may serve as spring board for the FCC-hh 100 TeV pp collider, bringing a large tunnel, infastructure, cryogenics, time, addt'l physics motivations + performance goals for FCC-hh
- FCC-ee technology is ready; ongoing R&D aims at further increasing efficiency, making FCC-ee a truly „green accelerator"
- optics fulfils all requirements, matched to FCC-hh footprint, baseline luminosity performance is predicted with confidence
- FCC-ee would provide superb discovery potential & a great first step towards 100 TeV; FCC-ee/hh = powerful combination at EF