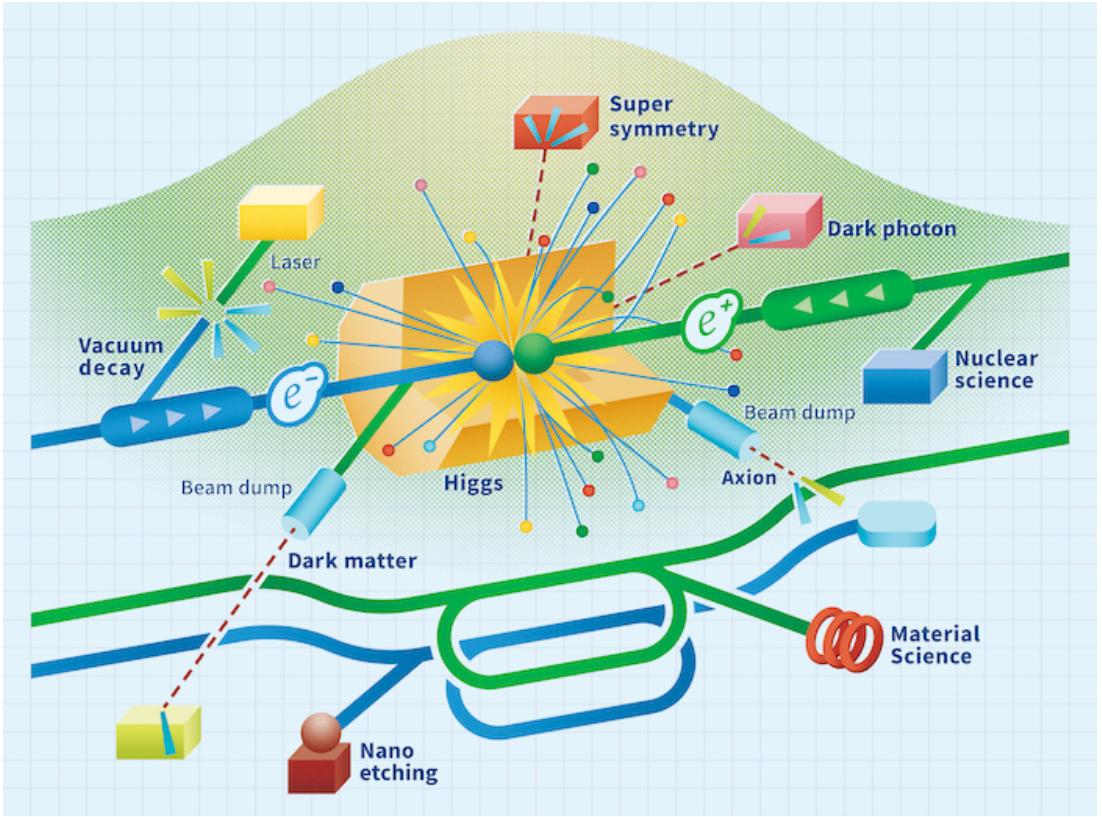
IDT-WG3 & LCVision

European Linear Collider Meeting
Dec 18, 2024

J.List



WG3 News

LCWS, EPPSU & ECFA

- LCWS2025 candidate weeks Oct 6-10 or **Oct 20-24**, host under investigation…
- Physics Preparatory Group sent a draft of physics & detector “benchmarks” they would like to receive results for by end of March
  - Thanks to all of you who participated in the short-notice discussion and helped to gather feed-back within the < 1 week deadline!
  - Muon Collider community echoed pretty much our comments, other colliders did not share their remarks
  - response from Karl so far “many thanks for sending us your feedback on the proposed first set of benchmarks. We very much appreciate your constrcutive input, we will discuss it and get back to you soon.”
- ECFA Higgs Factory Report in final editing
  - to be circulated to all contributors by the end of the week
  - many thanks also to the many contributors from this round, and of course from ILD & SiD

LCVision

Overview

- for EPPSU:
  - make a strong case for Linear Collider in general, based on physics arguments and attractive upgrade options
  - propose a Linear Collider Facility for CERN
  - generate broad, joint support across all Linear Collider concepts
  - think beyond the minimal ILC250 as discussed for Japan
- since summer
  - Coordination Group with representatives of LC concepts / technologies and national contacts
  - Expert Teams on upgrade options and implementation at CERN
  - Siting / CFS / costing for CERN under preparation
  - Core editing team started weekly meetings from November
  - Author teams for physics part in place, kick-off meeting last week
  - Draft begins to appear on overleaf
  - Agenda for LC Vision Community Event being finalized
- next year
  - full drafts of LCVision documents by end of January
  - incl 10-pager in EPPSU format plus longer archive document(s)
  - circulation for comments and supporter signature collection

Food for thought — Luminosity & Power Consumption of Linear Colliders

A bit of History

ILC Parameters Joint Working Group

- group of accelerator and particle physics experts
- charged to develop running scenarios for the ILC
- integrated luminosities kept fixed ever since!

	integrated luminosity with $\mathrm{sgn}(P(e^-),P(e^+)) =$			
	(-,+)	(+,-)	(-,-)	(+,+)
$\sqrt{s}$	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]
250 GeV	1350	450	100	100
350 GeV	135	45	10	10
500 GeV	1600	1600	400	400

	integrated luminosity with $\mathrm{sgn}(P(e^-),P(e^+)) =$			
	(-,+)	(+,-)	(-,-)	(+,+)
$\sqrt{s}$	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]	[fb^{-1}]
1 TeV	3200	3200	800	800
90 GeV	40	40	10	10
160 GeV	340	110	25	25

arXiv:1506.07830v1 [hep-ex] 25 Jun 2015

ILC-NOTE-2015-068
DESY 15-102
IHEP-AC-2015-002
KEK Preprint 2015-17
SLAC-PUB-16309
June 25, 2015

ILC Operating Scenarios

ILC Parameters Joint Working Group

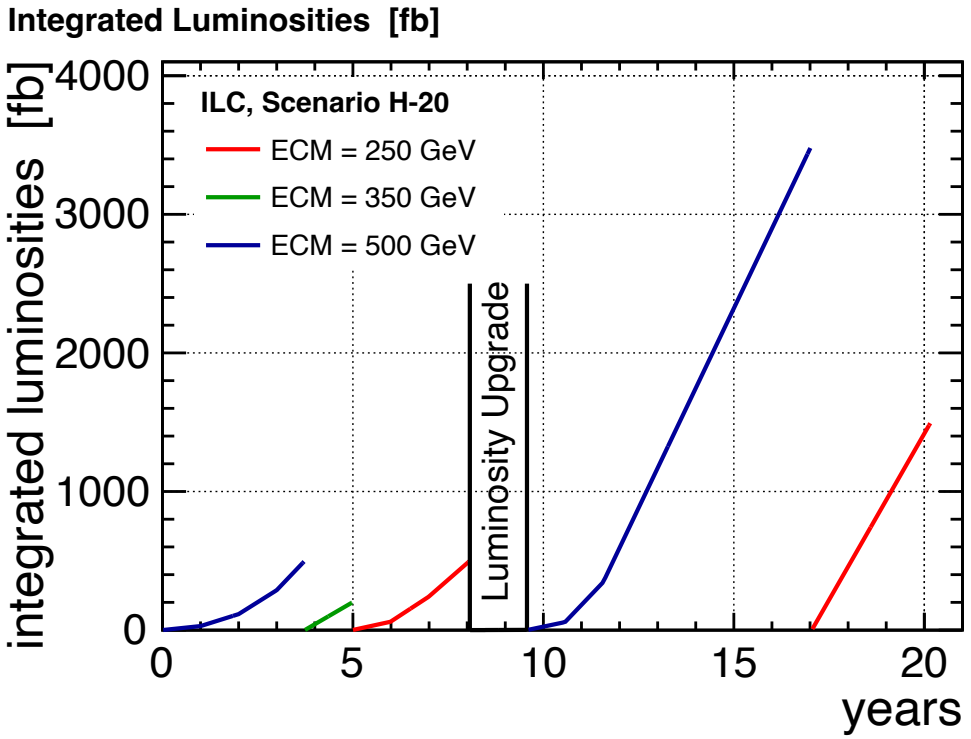
T. Barklow, J. Brau, K. Fujii, J. Gao, J. List, N. Walker, K. Yokoya

Abstract

The ILC Technical Design Report documents the design for the construction of a linear collider which can be operated at energies up to 500 GeV. This report summarizes the outcome of a study of possible running scenarios, including a realistic estimate of the real time accumulation of integrated luminosity based on ramp-up and upgrade processes. The evolution of the physics outcomes is emphasized, including running initially at 500 GeV, then at 350 GeV and 250 GeV. The running scenarios have been chosen to optimize the Higgs precision measurements and top physics while searching for evidence for signals beyond the standard model, including dark matter. In addition to the certain precision physics on the Higgs and top that is the main focus of this study, there are scientific motivations that indicate the possibility for discoveries of new particles in the upcoming operations of the LHC or the early operation of the ILC. Follow-up studies of such discoveries could alter the plan for the centre-of-mass collision energy of the ILC and expand the scientific impact of the ILC physics program. It is envisioned that a decision on a possible energy upgrade would be taken near the end of the twenty year period considered in this report.

Time-development in 2015

ILC started still at 500 GeV, but initial luminosity had already been halved ("low power" option)

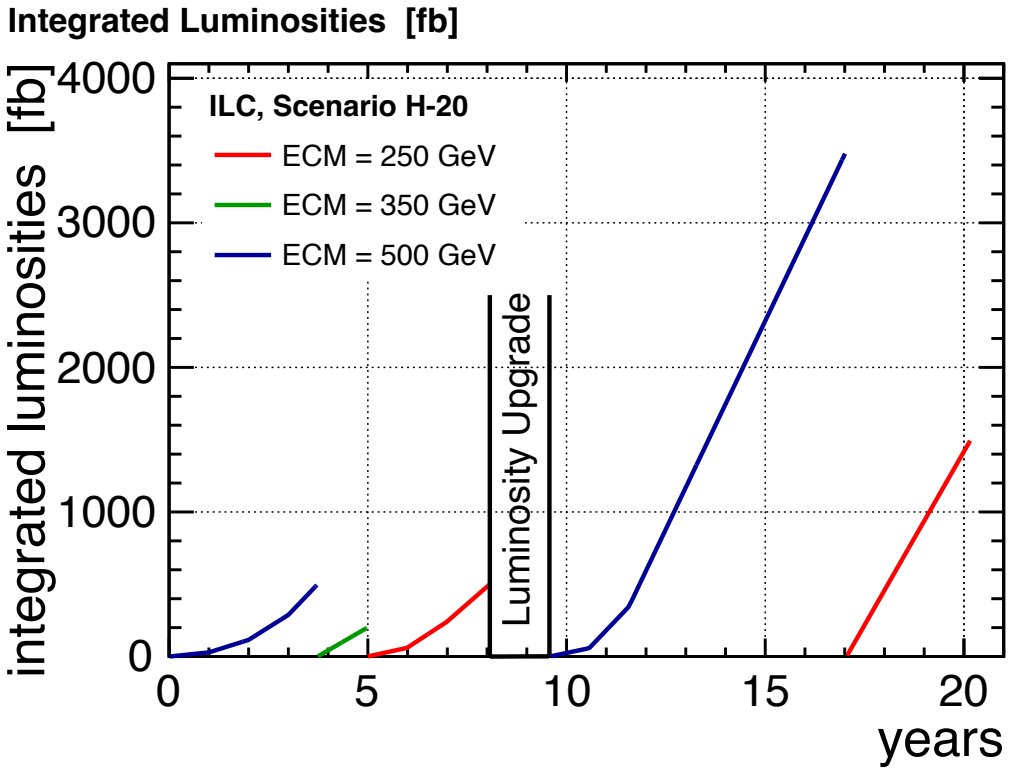


- **operation 1.6E7 s / year** (more than std CERN assumption)
- **start at 500 GeV**
  - initial peak lumi = 1.8E34 / s / cm2 (= 1315 bunches / train)
  - luminosity upgrade 3.6E34 / s / cm2 (= 2625 bunches / train)
- at lower energies
  - linac is operated at lower gradient
  - **use spare RF & cryogenic power to increase train repetition rate to 10 (7) Hz at 250 (350) GeV**
- **assume slow ramp-up to peak luminosity**
  - 0.1, 0.3, 0.6, 1.0 in years 1-4
  - 0.25, 0.75, 1.0 after first change to 10 Hz
  - 0.1, 0.5, 1.0 after lumi upgrade

Staged machine 2017

Start at 250 GeV: half the linac length, and also reduced RF & Cryo power

- **no 10 Hz operation possible in initial configuration**
- initial peak lumi 1.35E34 /s /cm2



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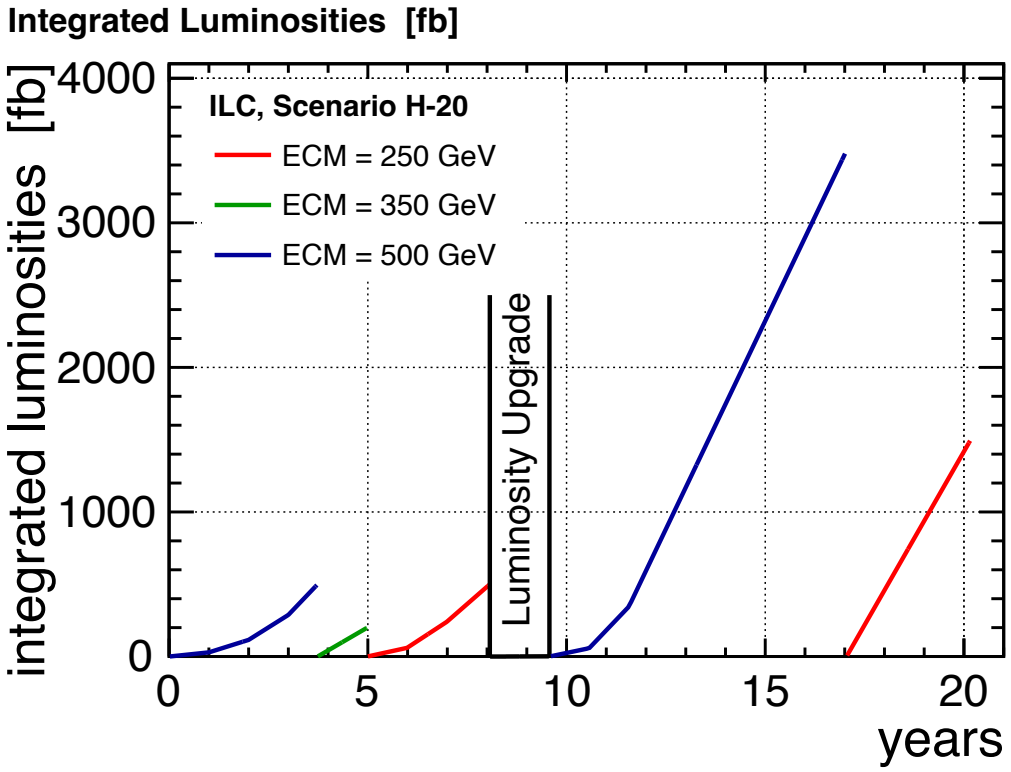
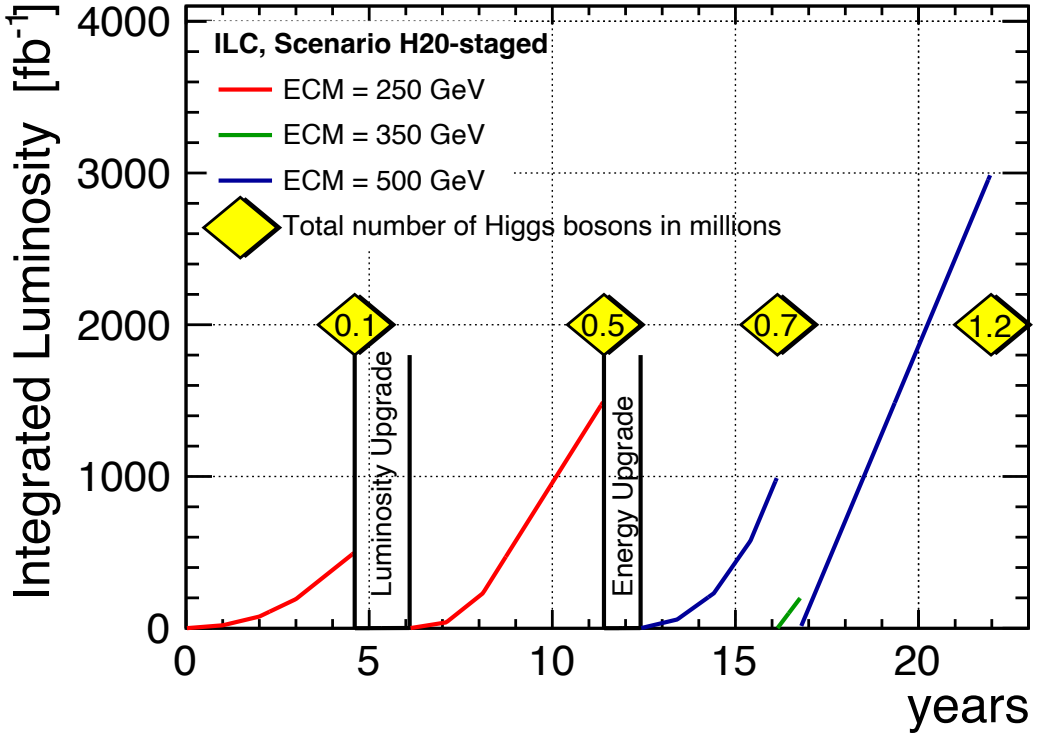
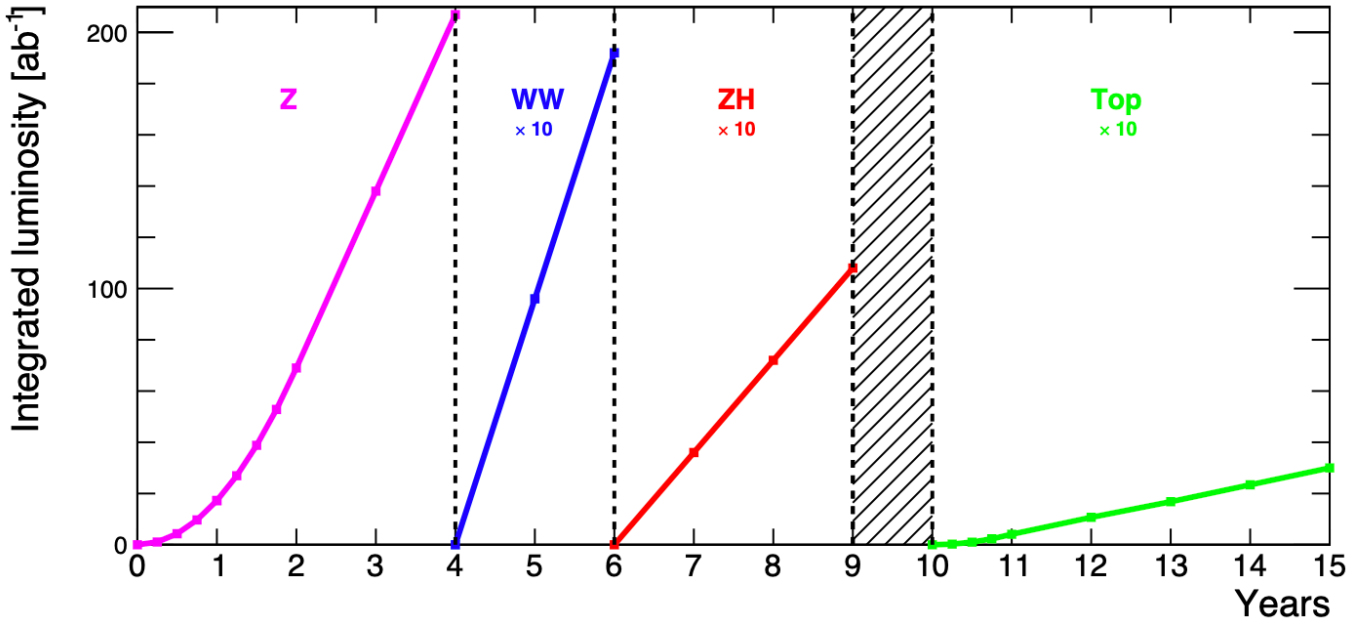




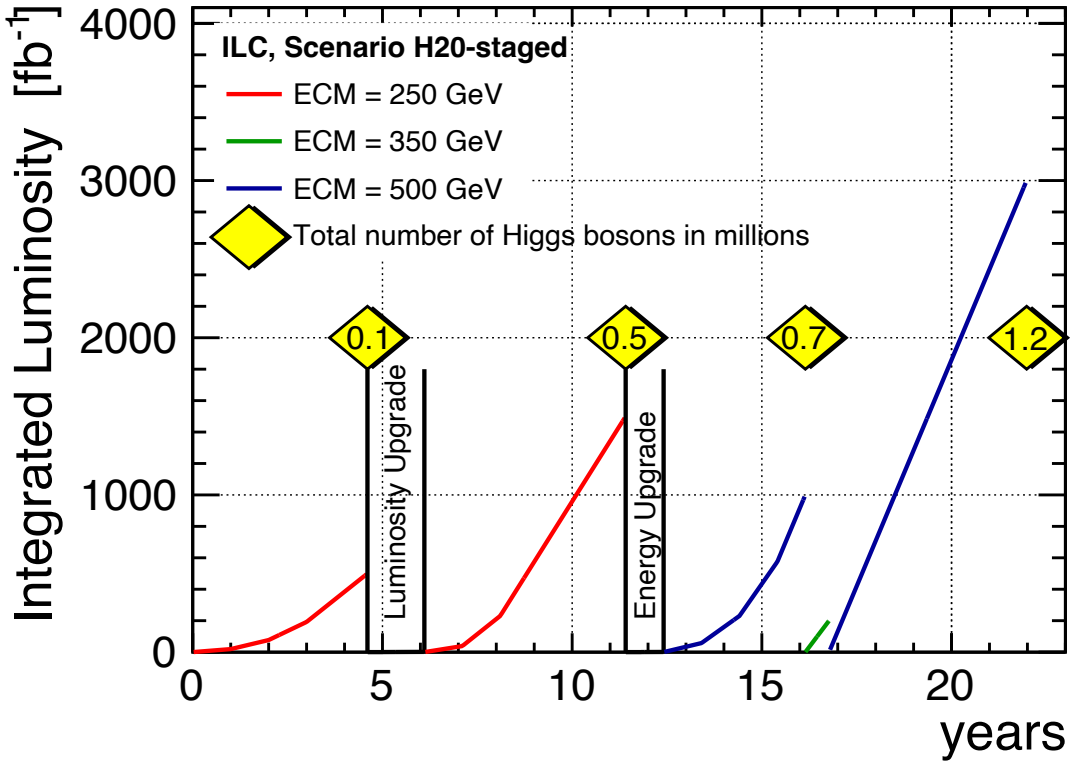
Running Scenarios

Luminosity, Power Consumption and all that

- typical criticism: “low luminosity of LCs requires much more time to do the Higgs program”
  - indeed, in std ILC250 run plan, **ZH run takes ~11 years, vs 3 years** in FCCee plan
  - **however: ILC250 starts with minimal power => let’s take a look!**



note: no lumi ramp-up assumed apart from Z pole



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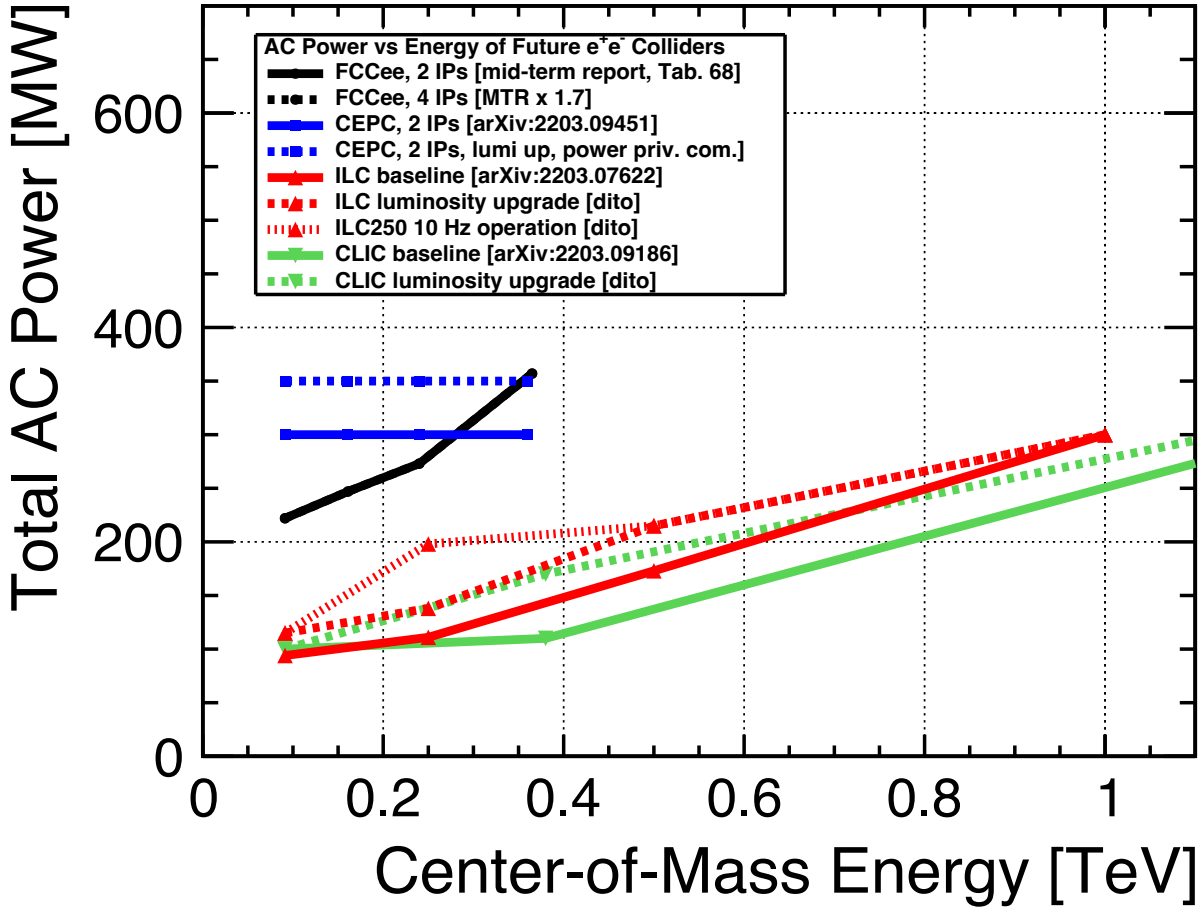
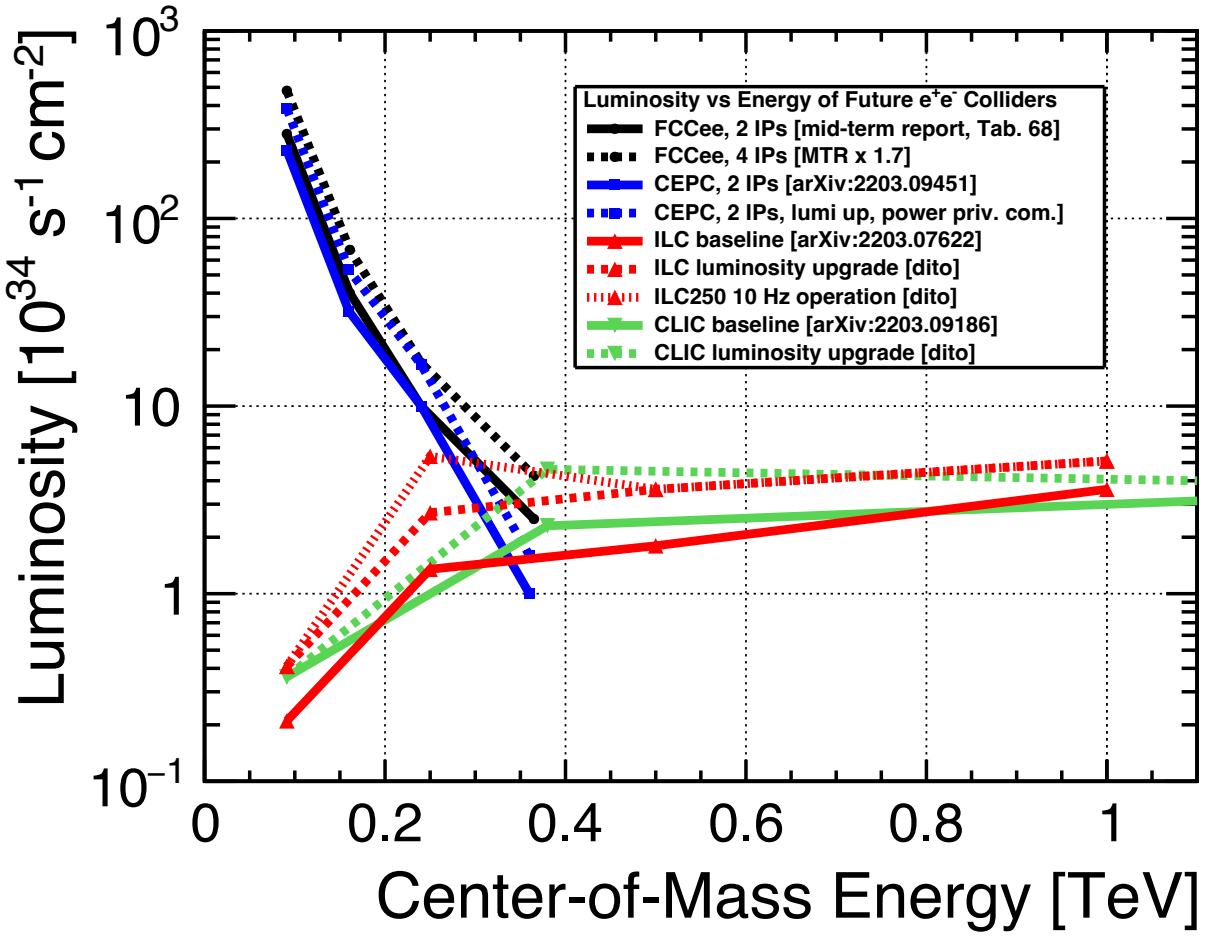
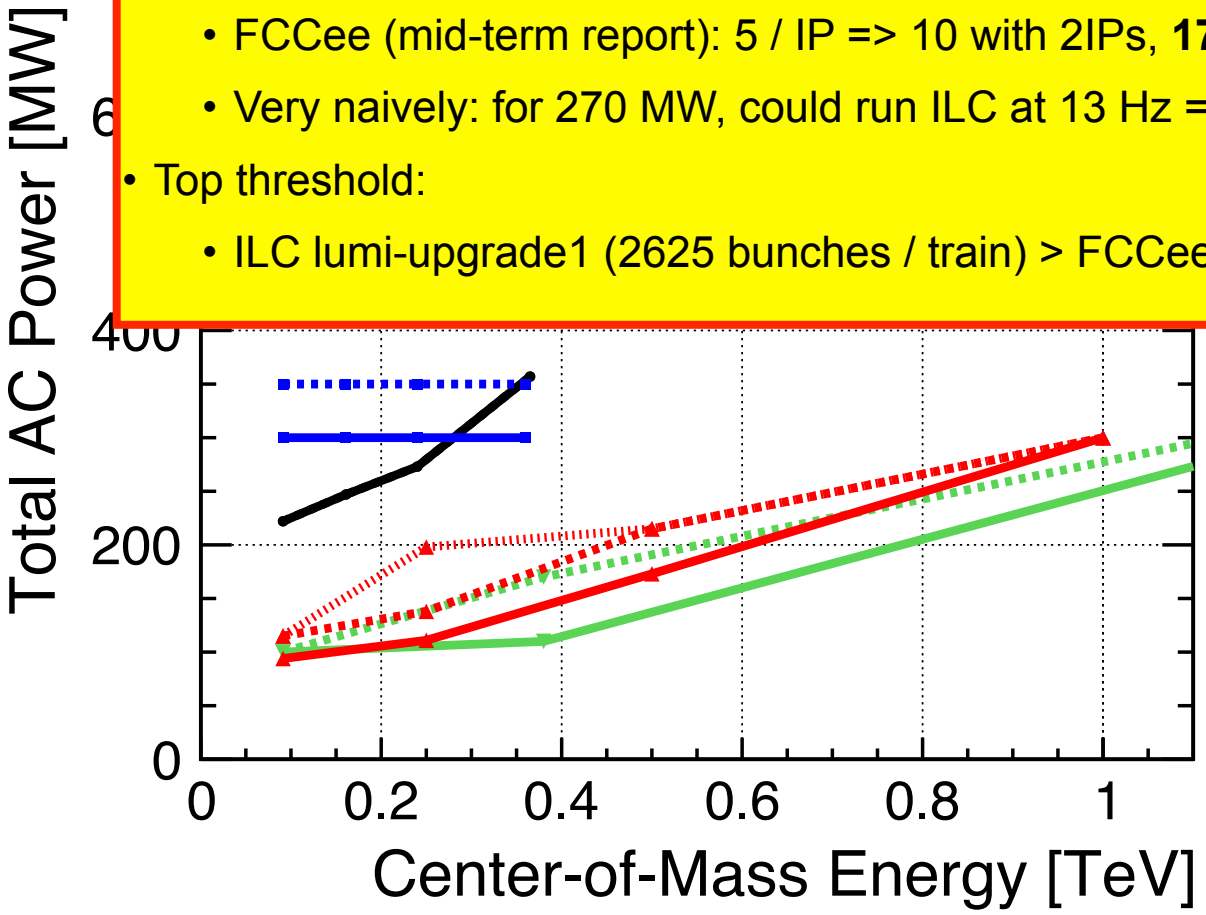


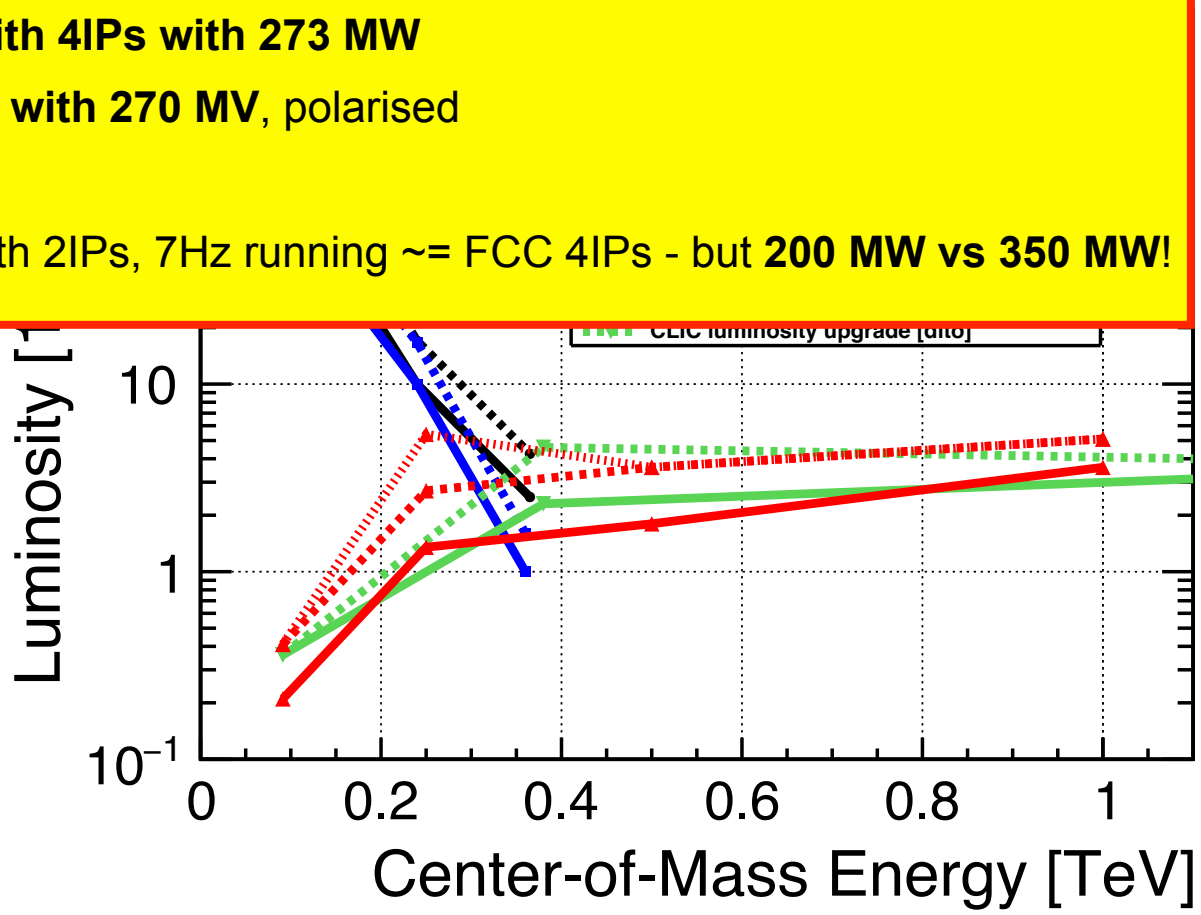


R

Lu

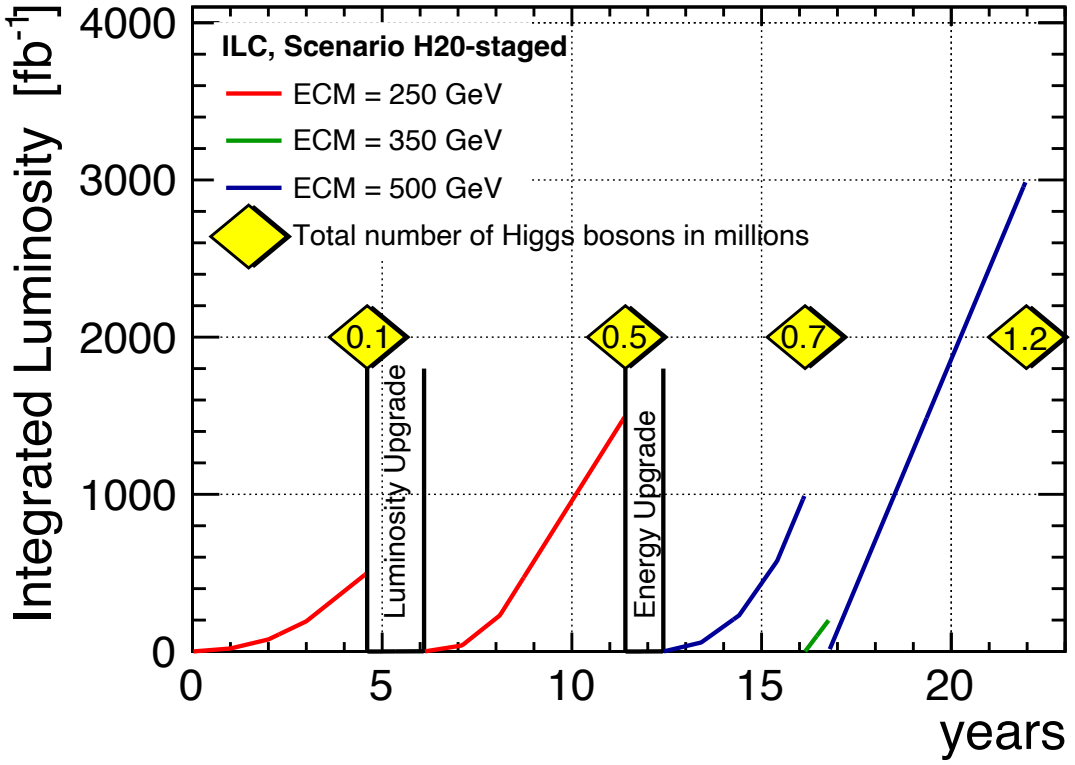
- Single-Higgs program at 240/250 GeV:
  - Linear Collider luminosity restricted by *self-assigned* power limit (all lumis in x10^34 s^-1 cm^-2)
    - 250 GeV ILC baseline lumi **1.35 => 2.7 => 5.4 with 200MW**
    - **less luminosity for *same* Higgs coupling precision due to polarised beams (2ab-1 pol ~= 5 ab-1 unpol)**
  - FCCee (mid-term report): 5 / IP => 10 with 2IPs, **17 with 4IPs with 273 MW**
  - Very naively: for 270 MW, could run ILC at 13 Hz => **7 with 270 MV**, polarised
- Top threshold:
  - ILC lumi-upgrade1 (2625 bunches / train) > FCCee with 2IPs, 7Hz running ~= FCC 4IPs - but **200 MW vs 350 MW**!





Cranking up ILC power

Full number of bunches per train from day-one “lumi upgrade” on previous page



Higgs run down to 6-7 years

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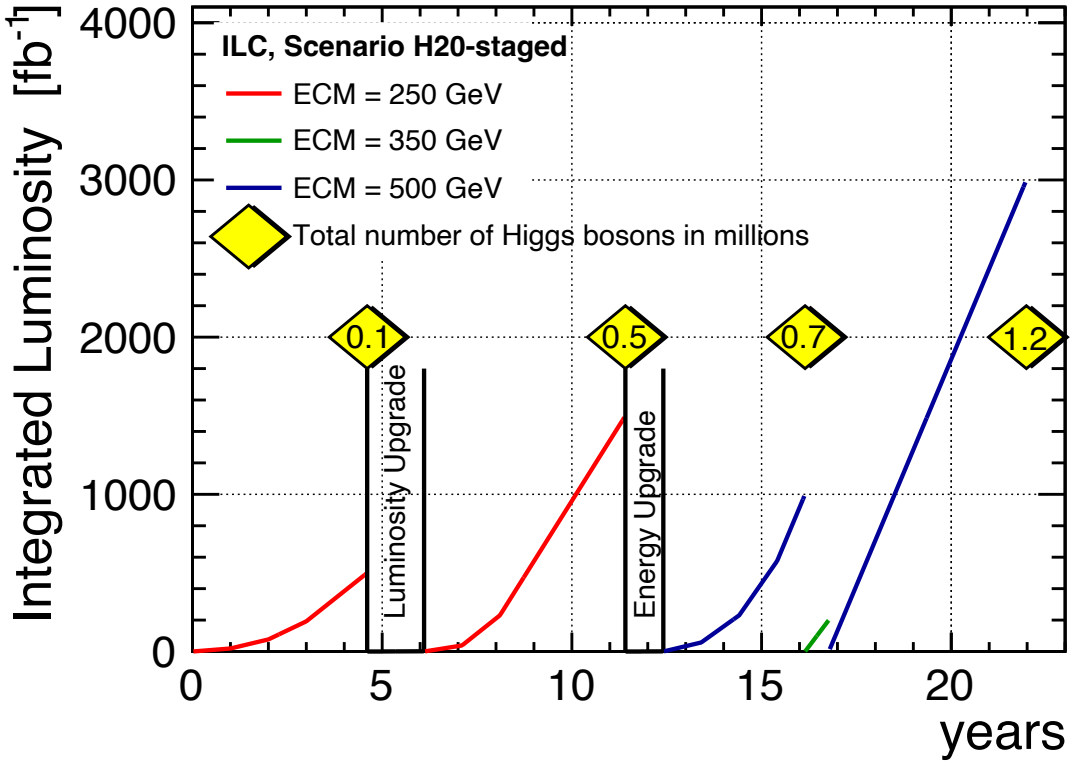
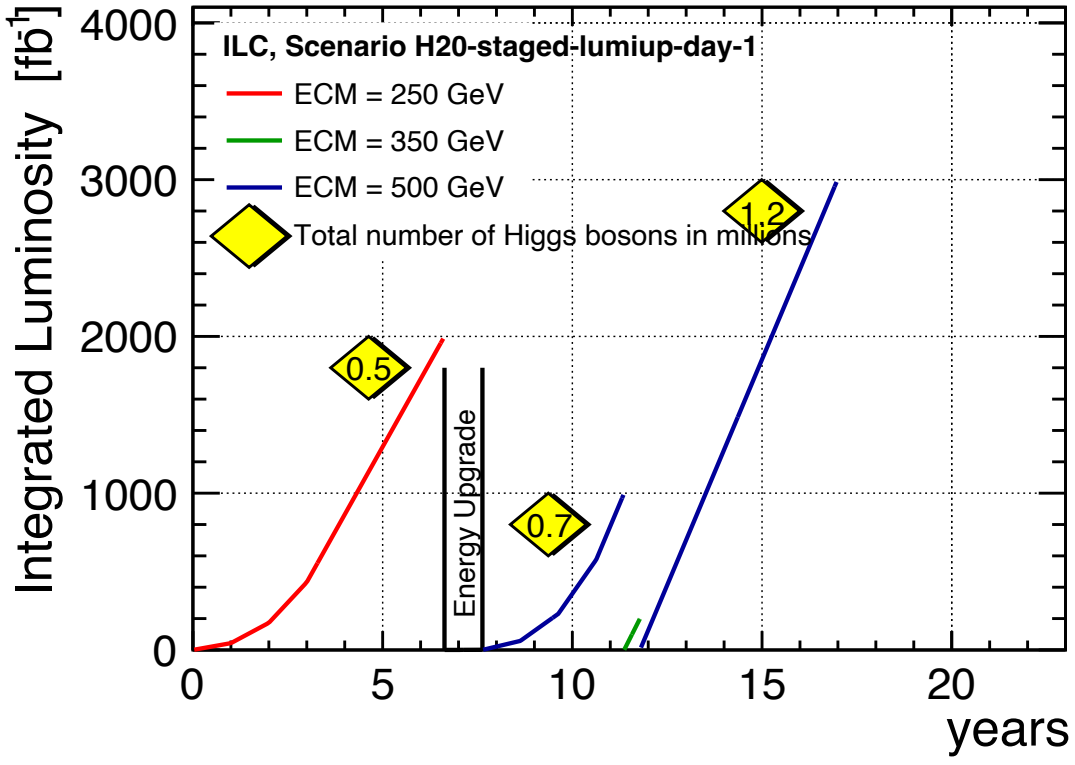
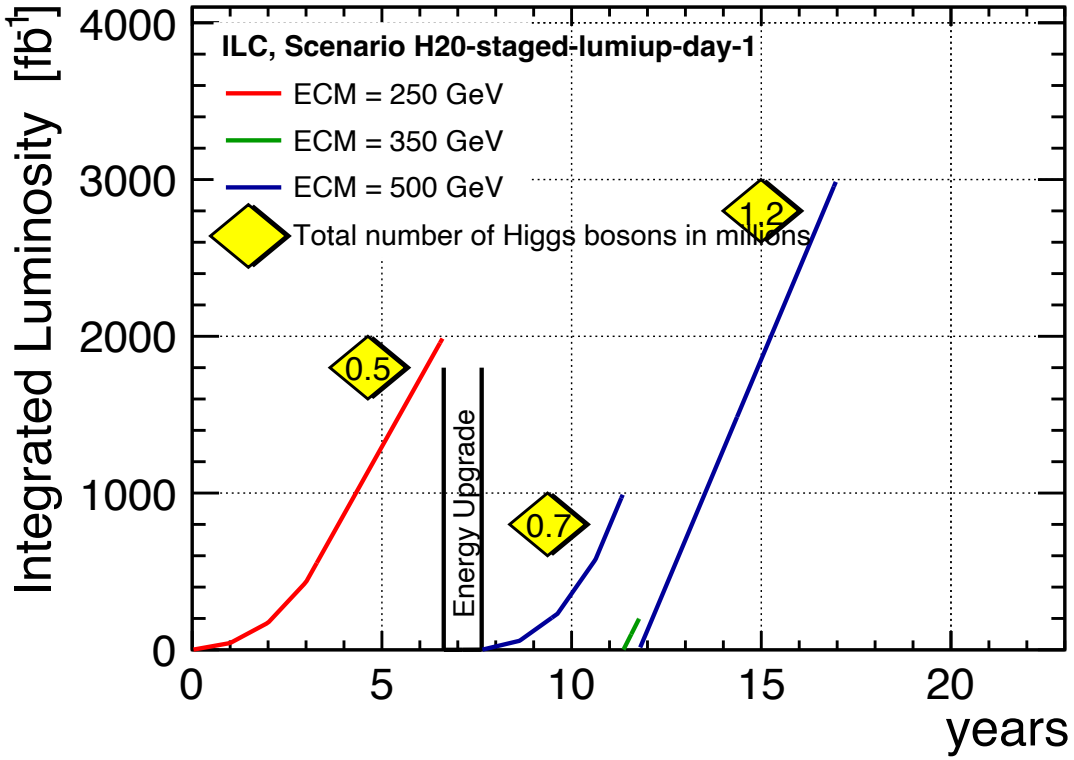




Higgs run down to 6-7 years

Being honest: adjusting to CERN operation year = 1.2x10^7s

Old ILC assumption used to be 1.6x10^7 s / year



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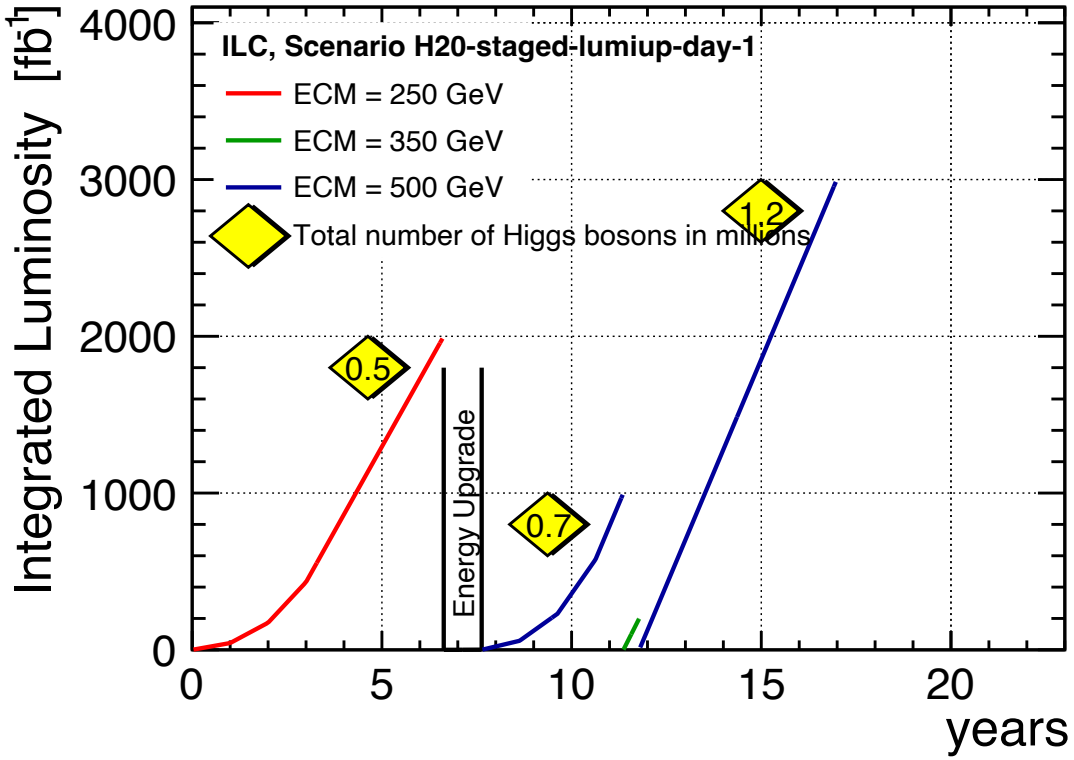
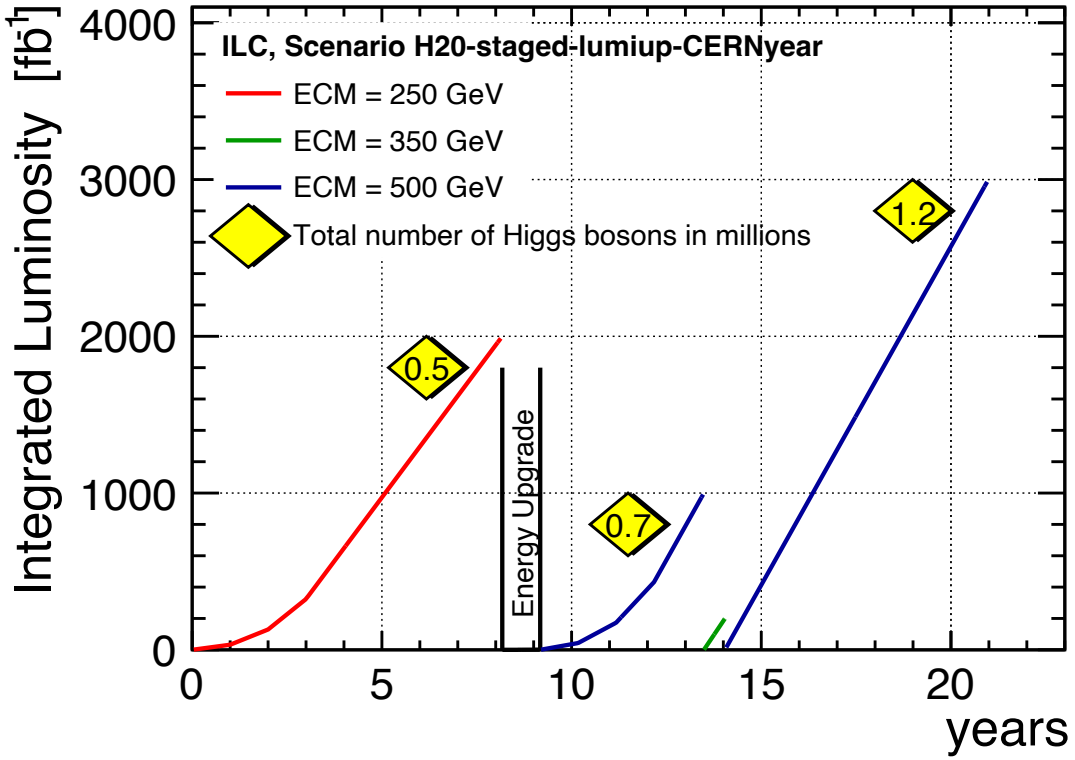
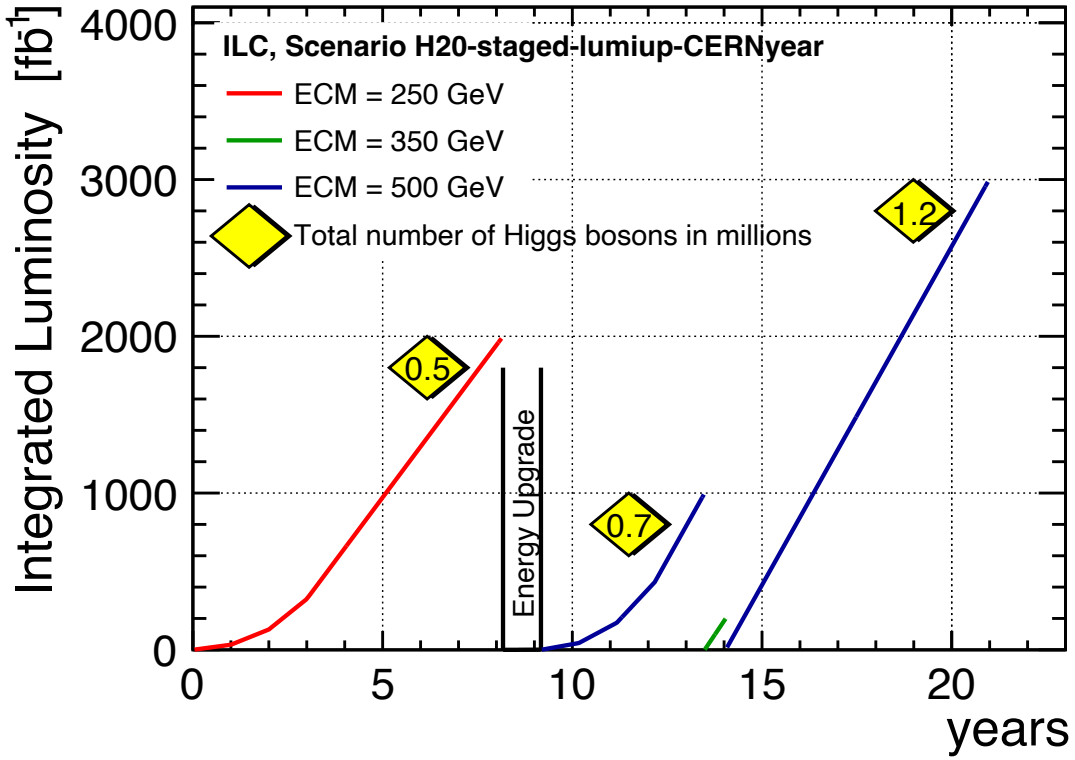




Higgs run ~8 years

200 MW (aka 10 Hz scheme) from day 1

Remember: FCCee uses 270-350 MW



Higgs run 5 years

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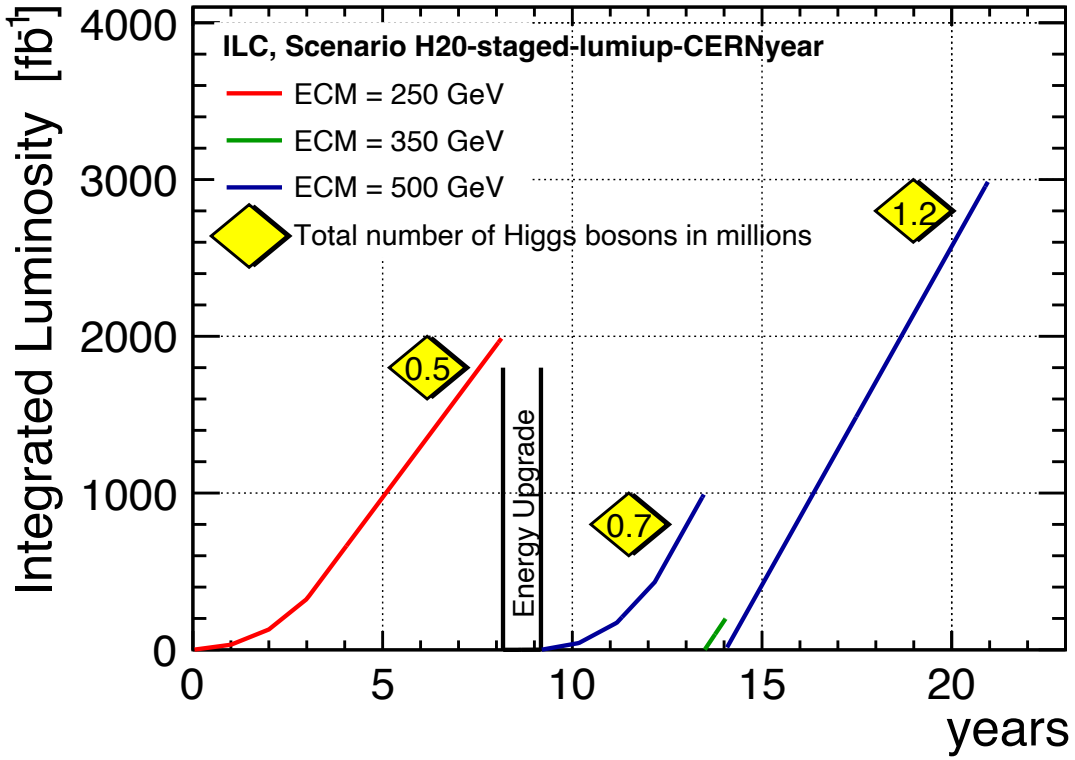
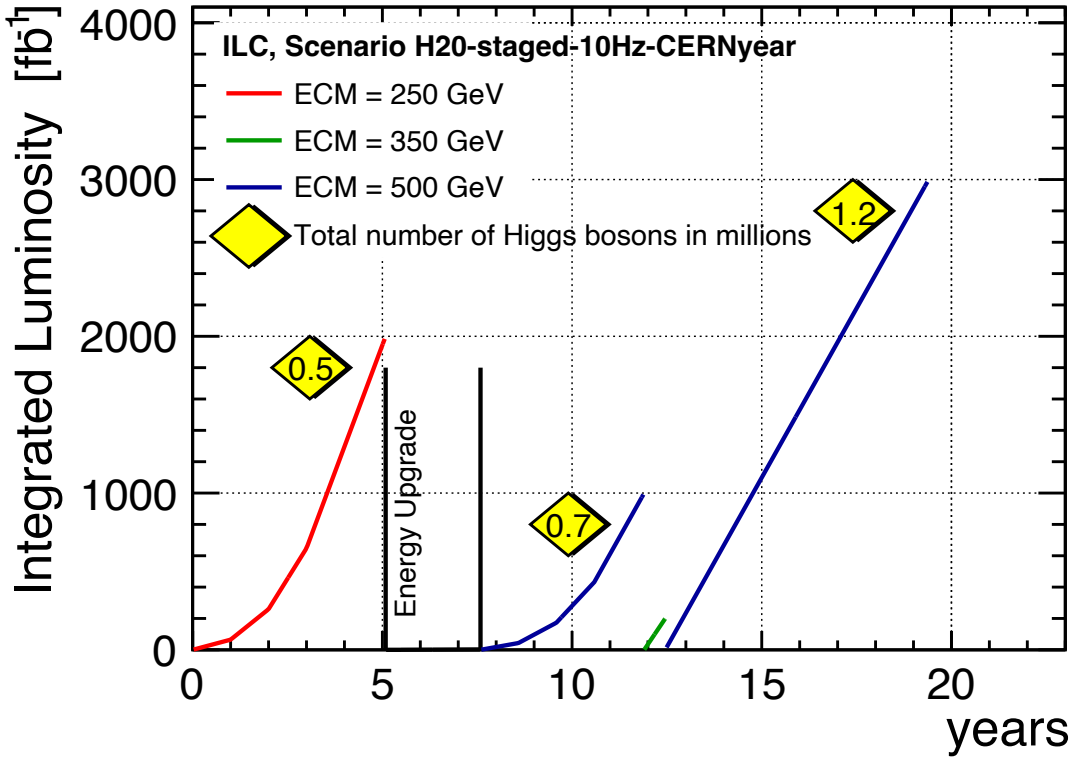
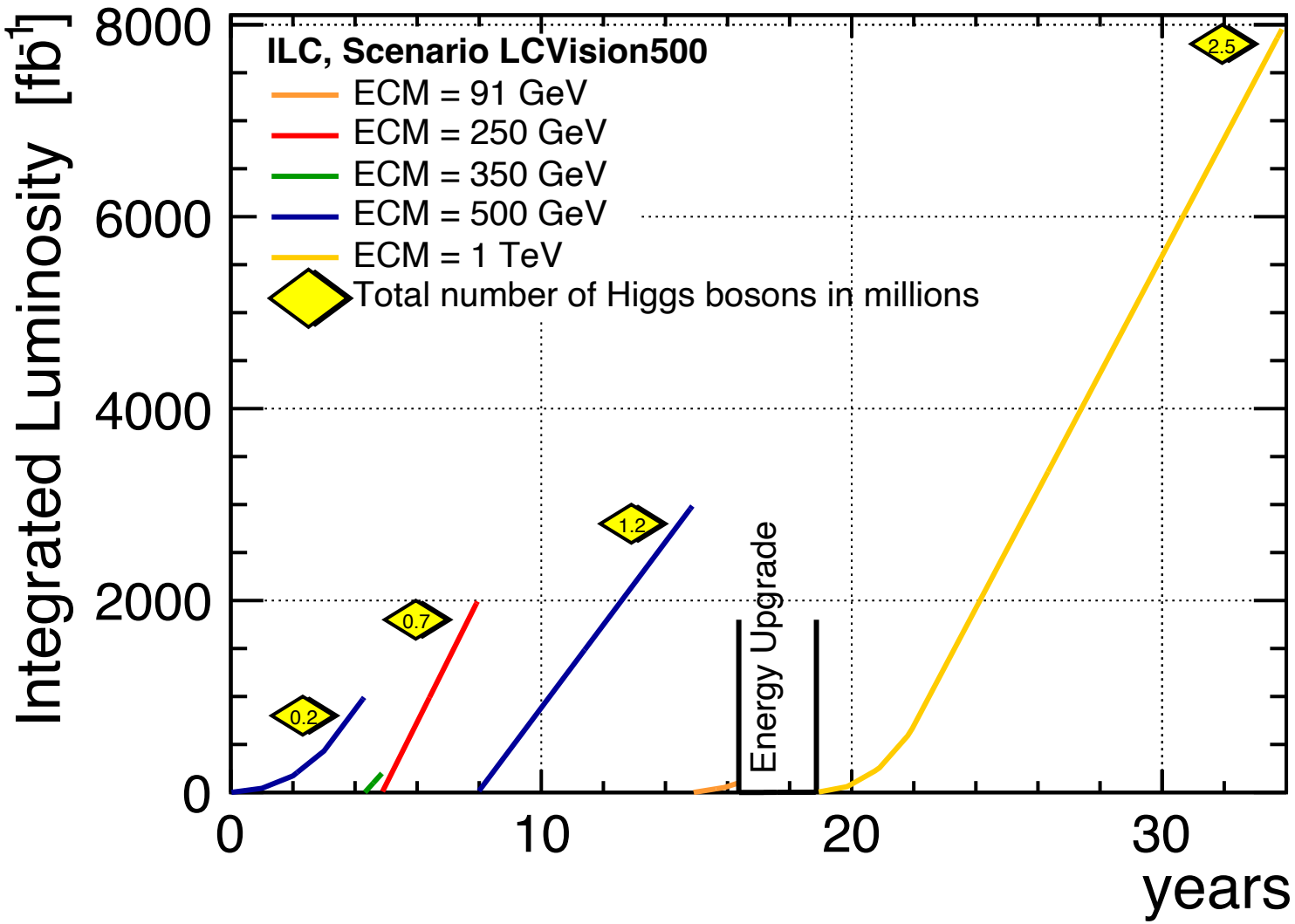




Higgs run 5 years

Dream a little dream…

Starting at 550 GeV



without lumi ramp-up (i.e. like FCCee assumption): Higgs run < 2 years

Conclusions on Running Scenarios

Some take-away messages

- for physics results, the combination of energy, integrated luminosity and beam polarisation counts
- for construction and operation costs, the total AC power counts
- power and instantaneous luminosity are strongly correlated
- Integrated luminosity depends on peak instantaneous luminosity and assumed operating efficiencies, learning curves etc pp
- the 11years the minimal ILC250 needs to collect the 250 GeV sample is driven by all the cost reductions applied to the orginal design
- **If we could build a 550 GeV machine right away, and the same AC power and the same operation assumptions as for FCC-ee, the same data set could be taken in < 2 years**
- **Would be awesome if we could find a way to pay for this!!! :)**

LCVision Community Event

status of agenda

- https://indico.cern.ch/e/lcvision2025

- registration closed on Sunday
  - ~150 registrants
  - **~60 thereof in person**
  - if you still want to register for zoom, let me know…

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Happy Linear Collider Holidays!

Any Questions?

LC Vision Overview

organisation

Chairs: J. List, S. Stapnes

Coordination Group

Halina Abrahmovic, Erik Adli, Ties Behnke, Ivanka Bosovic, Phil Burrows, Marcel Demarteau, Yuanning Gao, Carsten Hensel, Mark Hogan, Masaya Ishino, Daniel Jeans, Imad Laktineh, Andy Lankford, Benno List, Kajari Mazumar, Shin Michizono, Emmanuela Musumeci, Tatsuya Nakada, Mihoko Nojiri, Dimitris Ntounis, Jens Osterhoff, Ritchie Patterson, Aidan Robson, Daniel Schulte, Taikan Suehara, Geoffrey Taylor, Caterina Vernieri, Marcel Vos, Georg Weiglein, Filip Zarnecki, Jinlong Zhang, Patrick Koppenburg, Hitoshi Murayma, Laura Monaco, Jochen Schieck

Expert Team 1

"Physics-driven run plan and EPPSU documents"
Roman Poeschl, Michael Peskin

Expert Team 3

"SCRF upgrades"
Sergey Belomestnykh, Hiroshi Sakai, Marc Wenskat

Expert Team 5

"ERL upgrades"
Walid Kaabi, Vladimir Litvinenko, Kaoru Yokoya

Expert Team 7

"Beyond Collider"
Yasuhito Sakaki, Ivo Schulthess

Expert Team 2

"LCF@CERN"
Steinar Stapnes, Thomas Schörner

Expert Team 4

"C3/CLIC upgrades"
Angeles Faus-Golfe, Enrico Nanni

Expert Team 6

"Plasma upgrades"
Brian Foster, Spencer Gessner

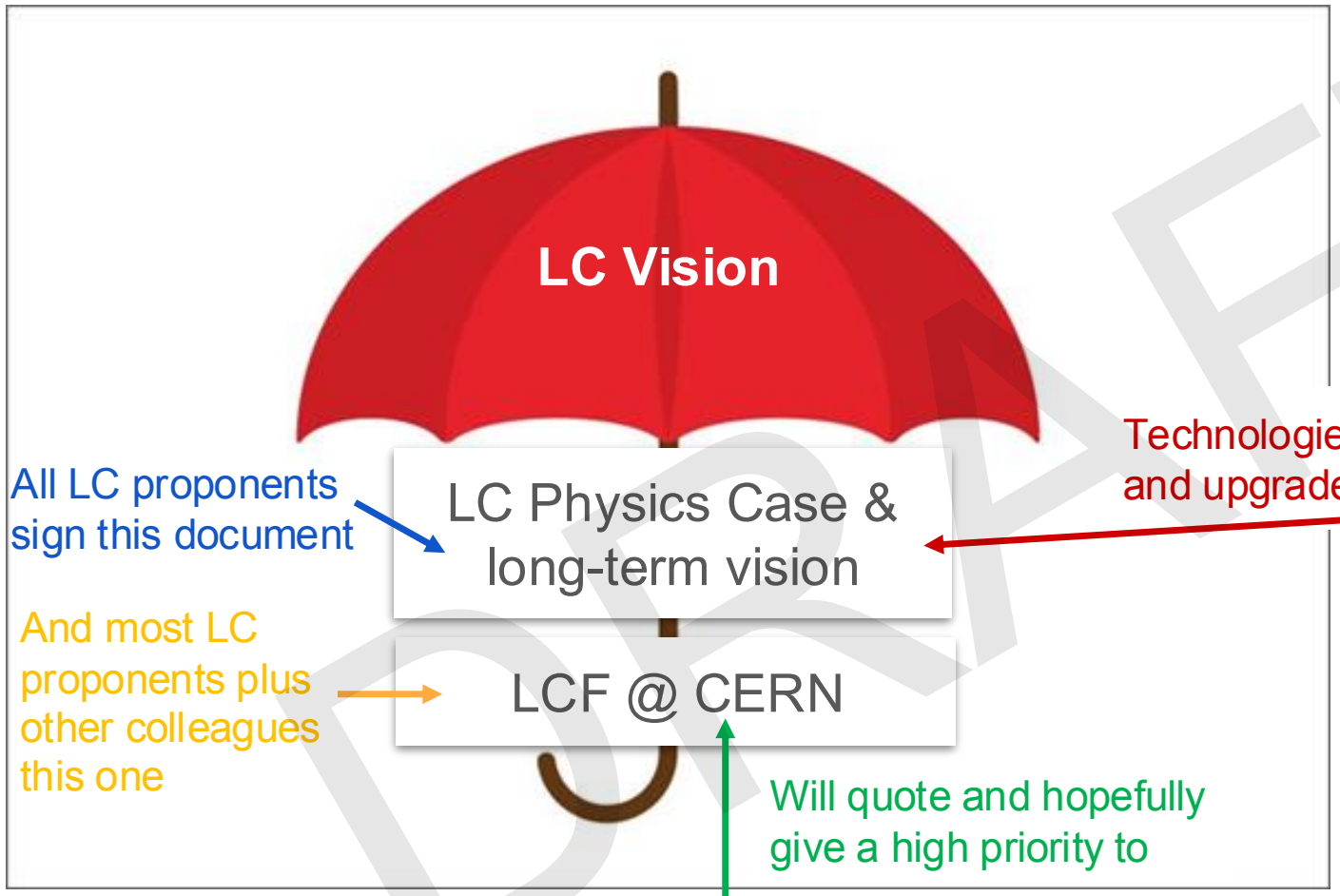
Expert Team 8

"Alternative Collider Modes"
Tim Barklow, Gudi Moortgat-Pick

LC Vision Documents

and their relations to other EPPSU inputs

idea: S. Gessner



- ILC in Japan (IDT)
- CLIC at CERN
- Advanced SCRF
- C^3
- ERLs
- HALHF
- 10 TeV Wakefield
- $\gamma\gamma$ / eγ collider
- Beyond Collider

DRAFT

Scenarios for Expert Teams

to get started

- **let's assume we start with a Linear Facility, with 2 Beam Delivery Systems (2 IRs), length**
  - **a) ~20 km** (e.g. 250 GeV SCRF — minimal cost)
  - **b) ~30 km** (e.g. 550 GeV SCRF — CEPC complementarity from day-one)
- **what could "your" technology offer as**
  - **i. decision-ready in < 5 years (e.g. 2-3 year targeted engineering effort after EPPSU adoption in early 2026)?**
    - ILC-like SCRF, CLIC-like drive-beam
    - alternative collider modes, beyond-collider facilities?
    - anything else?
  - **ii. as upgrade, decision-ready after the first years of data-taking of initial facility (e.g. 2045-2050)?**

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can WG3 MDI help here?

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Documents to be written

Overview - not listed: executive summaries as actual EPPSU inputs (10-pages) needed…

A. main, generic LC Vision document, "site agnostic" (100+ pages)

- **Linear Collider Physics Case**
  - capabilities at low energies (90-380GeV)
  - unique added-value at high energies (500GeV - 1 TeV, 3 TeV, x TeV)
- **Long-term upgrade / add-on opportunities**
  - physics motivation, community size
  - requirements on initial facility
  - required R&D, milestones for decision, timeline, cost

B. LinearColliderFacility @ CERN (~30 pages)

- concrete proposal for CERN => cite specific
- carefully understand scope, likely distinguish
  - "FCCee too expensive"
  - CEPC goes ahead
- crisp summary of physics opportunities
- 1-2 baseline configurations + portfolio of add-ons / upgrades

=> realistically, final cost <-> performance optimisation part of strategy process?

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WG3 Physics!

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