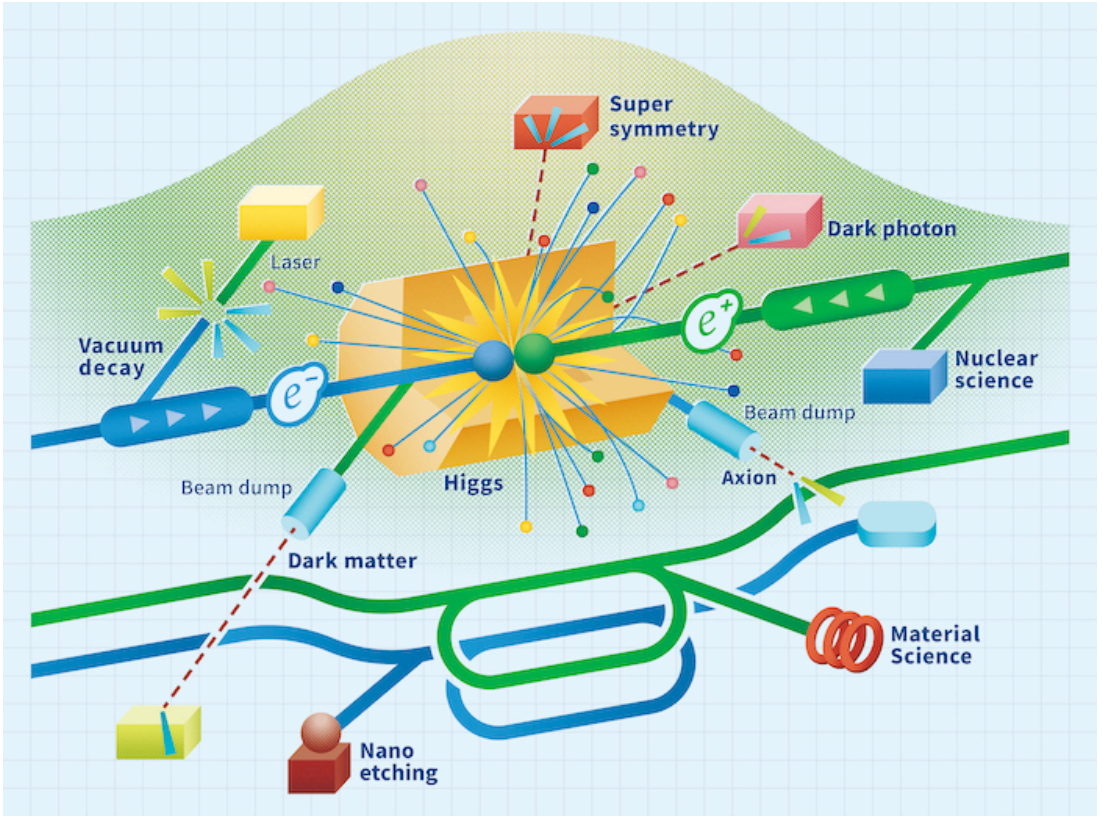
LCVision Update

ILD Monthly Meeting
Mar 4, 2025

M. Ishino, J. List, T. Nakada, M. Peskin,
R. Pöschl, A. Robson, S. Stapnes

Outline:

- Introduction: general reminder on LCVision
- the LC Vision “generic” / “long” document
- the LCF@CERN strategy submission
- next steps



Introduction

LCVision

Overview and links to more information

- LCVision originated from a bottom-up brain-storming in spring 2024
- Leading up to a first public presentation and discussion at LCWS2024, c.f.
  - https://newsline.linearcollider.org/2024/11/29/
  - https://agenda.linearcollider.org/event/10134/timetable

  => decision to develop this further into an EPPSU input
- LC Vision Community Event Jan 8-10 at CERN
  - see current newsline: https://newsline.linearcollider.org/
- Mailing list e.g. for announcement of document drafts:
  - sign-up for LCVision e-group: **http://simba3.web.cern.ch/simba3/SelfSubscription.aspx?groupName=LCVision-General**

- **NEW:**
  - LCVision talk collection (incl. sources): https://agenda.linearcollider.org/event/10617/
  - indico page for document drafts: https://agenda.linearcollider.org/event/10624/program

LCVision

Objectives

- make a strong case for Linear Colliders in general
  - based on physics arguments
    - capabilities at low energies (90-380GeV)
    - unique added-value at high energies (500GeV … 1 TeV … 3 TeV)
  - and attractive upgrade options
    - based on advanced / new technologies rather than tunnel length
  - independently of the exact implementation (acc. technology, site, …)
- propose a versatile Linear Collider Facility (LCF)
  - suited to host a long-term program, for instance at CERN
  - starting from an affordable and timely realizable baseline
  - building upon all the important R&D done for all the mature LC concepts
  - with scientifically and technologically exciting upgrade options
- aim for broad, joint support across all Linear Collider concepts

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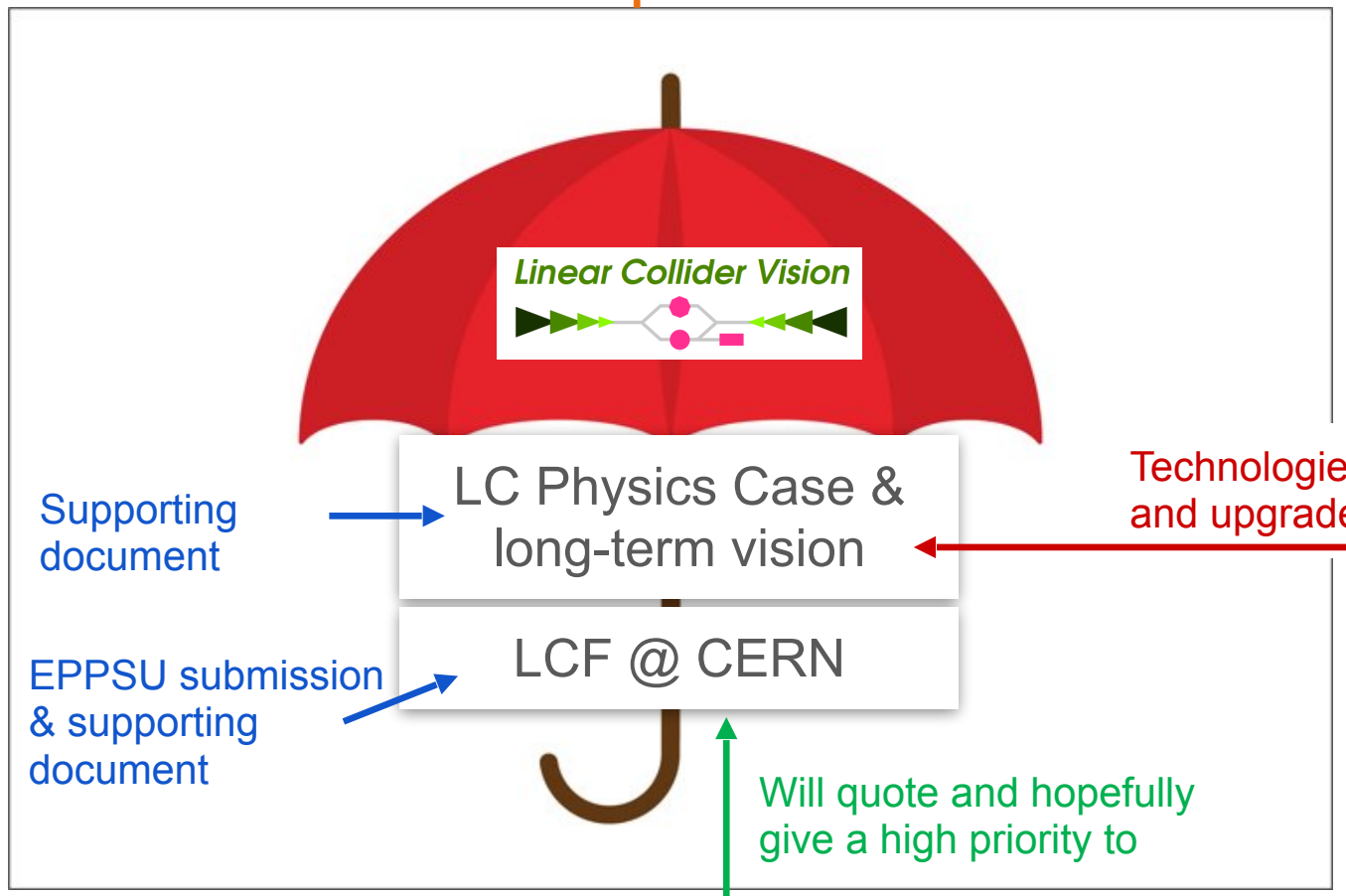
Contribute both the generic case and the LCF@CERN to the EPPSU

LC Vision Documents

and their relations to other EPPSU inputs



LCVision Organisation

Coordination Group & Expert Team Leaders

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 Murayama, 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"
Stefania Gori, Yasuhito Sakaki, Ivo Schulthess, Mihoko Nojiri

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, Ariel Schwartzman

LCVision Organisation

Document Writing - Core Editing Team, Physics Team & Expert Teams

Core Editing Team
Masaya Ishino, Jenny List, Tatsuya Nakada, Michael Peskin, Roman Poeschl, Aidan Robson, Steinar Stapnes

Higgs at 250 GeV
Dirk Zerwas, Caterina Vernieri, Kei Yagyu

Top from threshold to highest E
Marcel Vos, Gauthier Durieux, Ken Mimasu

EW from Z pole to highest E
Graham Wilson, Adrian Irles, Taikan Suehara

Direct BSM
Filip Zarnecki, Sabine Kraml, Sven Heinemeyer, Howard Baer, Natsumi Nagata

Higgs at high(est) E
Shinya Kanemura, Georg Weiglein, Johannes Braathen, Margarete Muehlleitner

ttH and VV
Juergen Reuter, Wolfgang Kilian, Jan Strube, Koji Tsumura

Global Interpretations
Junping Tian, Jorge de Blas

Alternative Collider Modes & Beyond-Collider
=> physics covered by respective expert teams

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=> more contributors welcome, please get in touch!

Behind the scenes

Work, work, work…

- Agreeing on LCF parameters => details in the following
  - length, # IRs, crossing angle(s)
  - SCRF specs
  - …
- Updated ILC cost estimate for EPPSU
  - review by international expert committee in December
  - final numbers for ILC250 in Japan:
    - 6.7 BILCU (= USD in 2024) for accelerator => basis for LCF@CERN accelerator costing
    - 196 BJPY for civil construction => for LCF@CERN replaced by CERN CFS costing
- Assess via consistent recipe by same experts for all CERN proposals
  - CFS design & costing: first prelimiary numbers (last Thu) turned out very consistent with escalated ILC@CERN costs from TDR :)
  - operation costs: recipe in final agreement stage…
  - environmental aspects => LDG Sustainability Group recipe, LCF will be included in LDG report tables

The LCVision “generic” document

A Linear Collider Vision for the Future of Particle Physics

Introduction, Operating Scenarios, Experimental Environment

ILC

	91 GeV	250 GeV	350 GeV	500 GeV	1000 GeV
$\int \mathscr{L}$ (ab^{-1})	0.1	2	0.2	4	8
beam polarization (e^-/e^+; %)	80/30	80/30	80/30	80/30	80/20
(–, -+, +-, ++) (%)	(10,40,40,10)	(5,45,45,5)	(5,68,22,5)	(10,40,40,10)	(10,40,40,10)

Table 1: Centre-of-mass energy, integrated luminosity and beam polarisation of the various stages of the straw-man ILC operating scenario.

CLIC

	380	1500	3000
$\int \mathscr{L}$ (ab^{-1})	2.2 (4.3)	4	5
beam polarization (e^-/e^+; %)	80/0	80/0	80/0
(-0, +0) (%)	(50,50)	(80,20)	(80,20)

Table 2: The updated baseline CLIC operation model (December 2024). Two options for 380 GeV-running are given, with 50 Hz and 100 Hz repetition rates, respectively. Running at $\sqrt{s} = 91$ GeV is an option.

LCF

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Table 3: Centre-of-mass energy, integrated luminosity and beam polarisation of the various stages of the straw-man LC Vision scenario.

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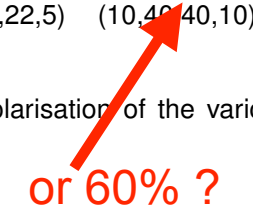

A Linear Collider Vision for the Future of Particle Physics

The Portal to New Physics

Higgs / EW at high(est) energies

Direct BSM

Photon Collider & Co

top from threshold to high(est) energies

Global interpretations

Beyond Collider

In corporate physics case studies for ***all*** linear colliders (dominated by ILD and CLICdp)

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ILD & LCF Highlight:
with 8 ab-1 at 550 GeV,
self-coupling precision = 10…11%

A Linear Collider Vision for the Future of Particle Physics

A Linear Collider Facility - Baseline and Roadmap

“ready to go”: SCRF drive-beam

Energy upgrades for initial SCRF machine

Luminosity upgrades

BDS: 2 IRs

Photon Collider & Co

A Linear Collider Vision for the Future of Particle Physics

Beyond Collider, Detectors, ….

Beyond Collider

Detectors

as of today:
447 references :)

A Linear Collider Vision for the Future of Particle Physics

Conclusion on long document status

- This will be a very interesting document, complementary to many past LC reports
- A lot of work done already by all authors, among them many from ILD
- as of today ~100 pages + 447 references
- => many, many thanks to all contributors!
- However, still a lot to do:
  - some sections (for good & noted reasons…) are behind
  - main editors have still a lot to do to make it coherent document
- arxiv identifier needed in time so that EPPSU submissions can quote it
- to be clarified:
  - will we need also a formal 10-page submission to the EPPSU with the long document as “back-up”?
  - when will draft be public?
- after March 31, submit to EPJ ST (agreed with EPJ ST editors)

The LCF@CERN Proposal

The LCF@CERN

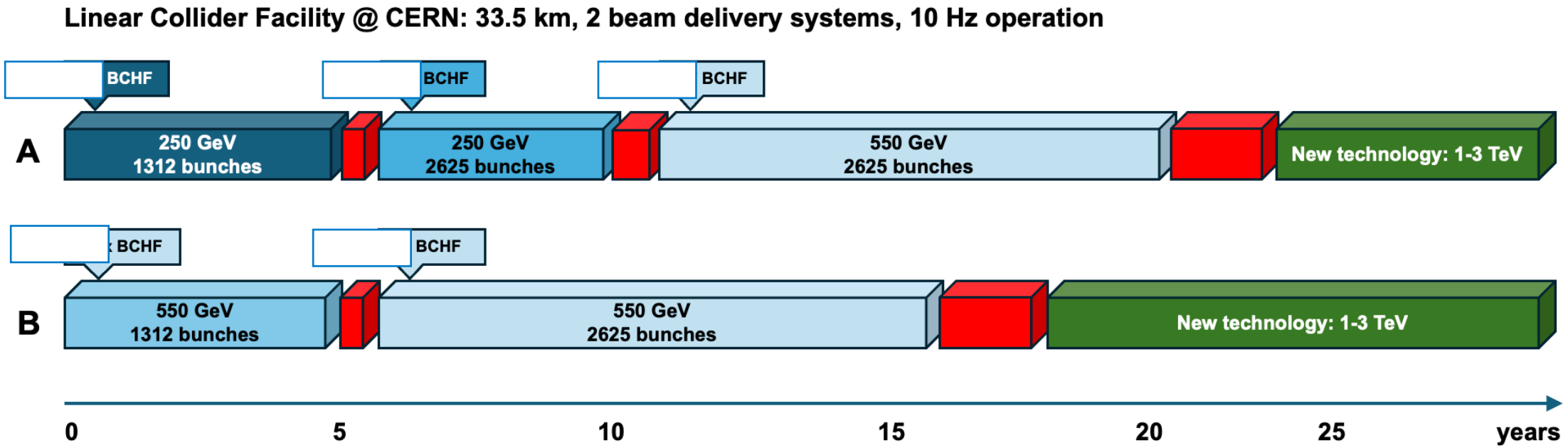
Basic Considerations

- Philosophy:
  - leverage all the excellent work done for ILC & CLIC in the past
    - reliable costing etc
    - “ready to build”
  - but modernize / push back on minimal machine to turn into attractive project for CERN
- SCRF technology (31.5 MV/m, Q_0=**2**E10)
  - successful construction & operation of Eu.XFEL, LCLS-II, construction of more (SHINE…)
    => no large-scale demonstrator step needed
  - lab experience and production capacities in industry globally
    => opportunity to take burden off CERN’s shoulders
  - choice for fastest implementation
- Scope project to be a flagship project for CERN
  - 2 interaction regions
  - higher luminosity
  - add-on facilities (Beyond Collider, R&D / irradiation facilities)
  - attaractive upgrade perspectives with advanced technologies
  - but stay affordable

The LCF@CERN

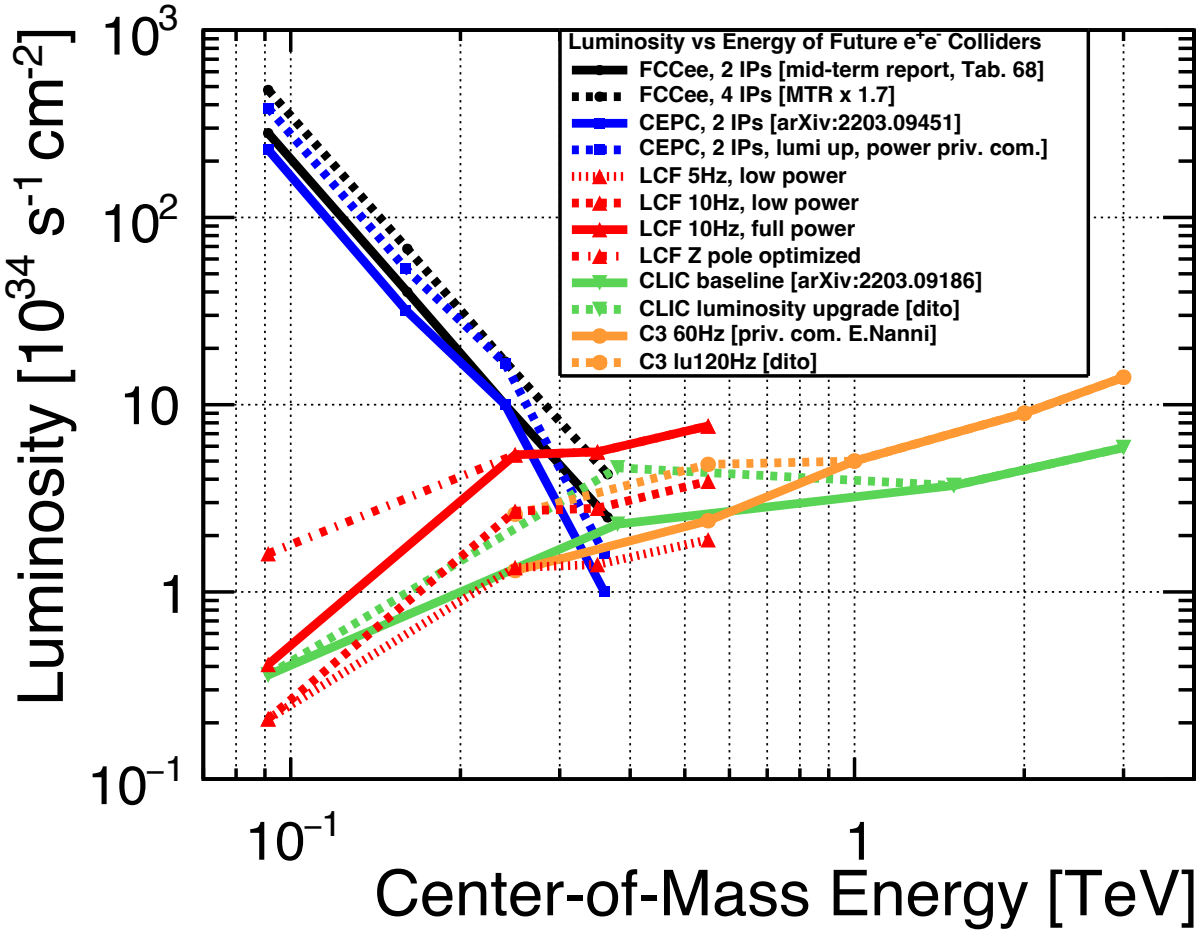
The proposal

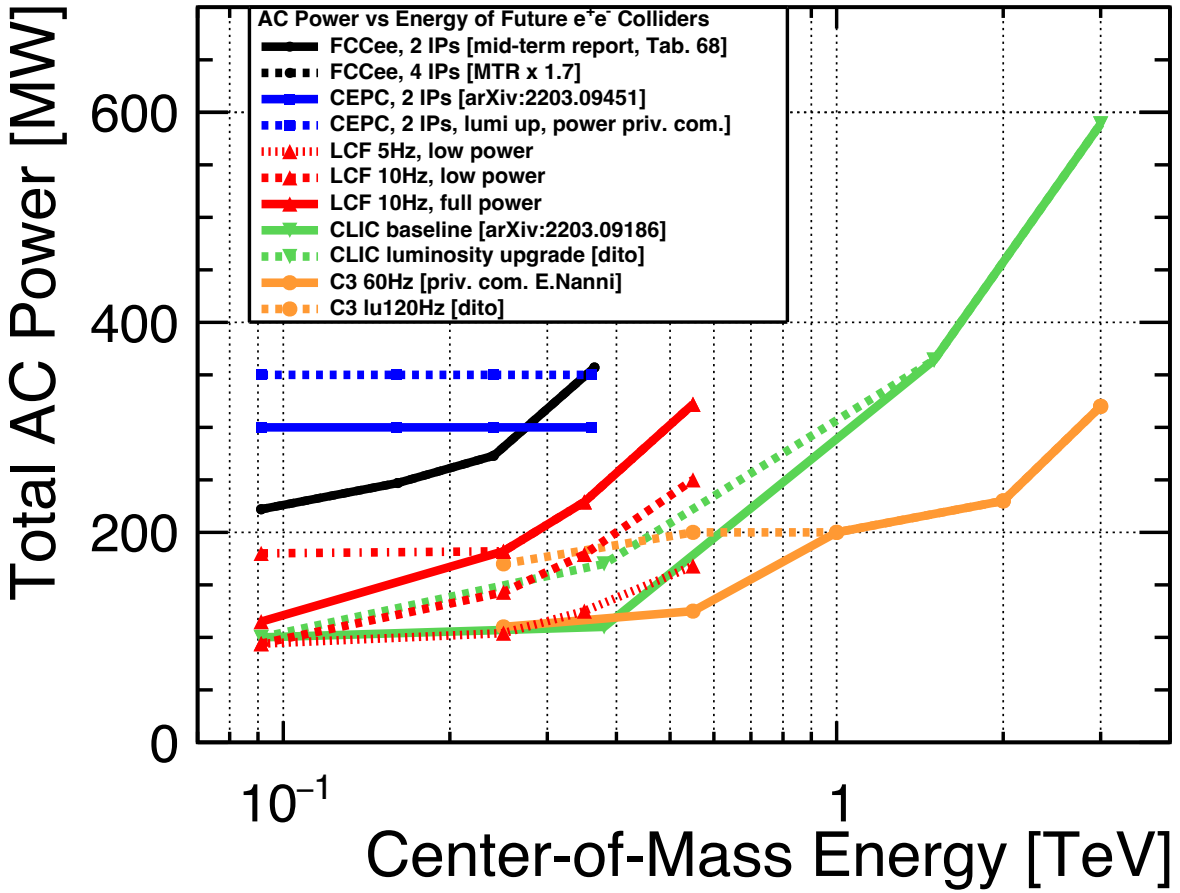
- a 33.5km facility => enough to reach 550 GeV even with 31.5MV/m
- operate at 10 Hz (due to higher Q0, power increase is not prohibitive…)
- with 2 IRs
- undulator source ;)
- scenarios:



Lumi, Power & all that

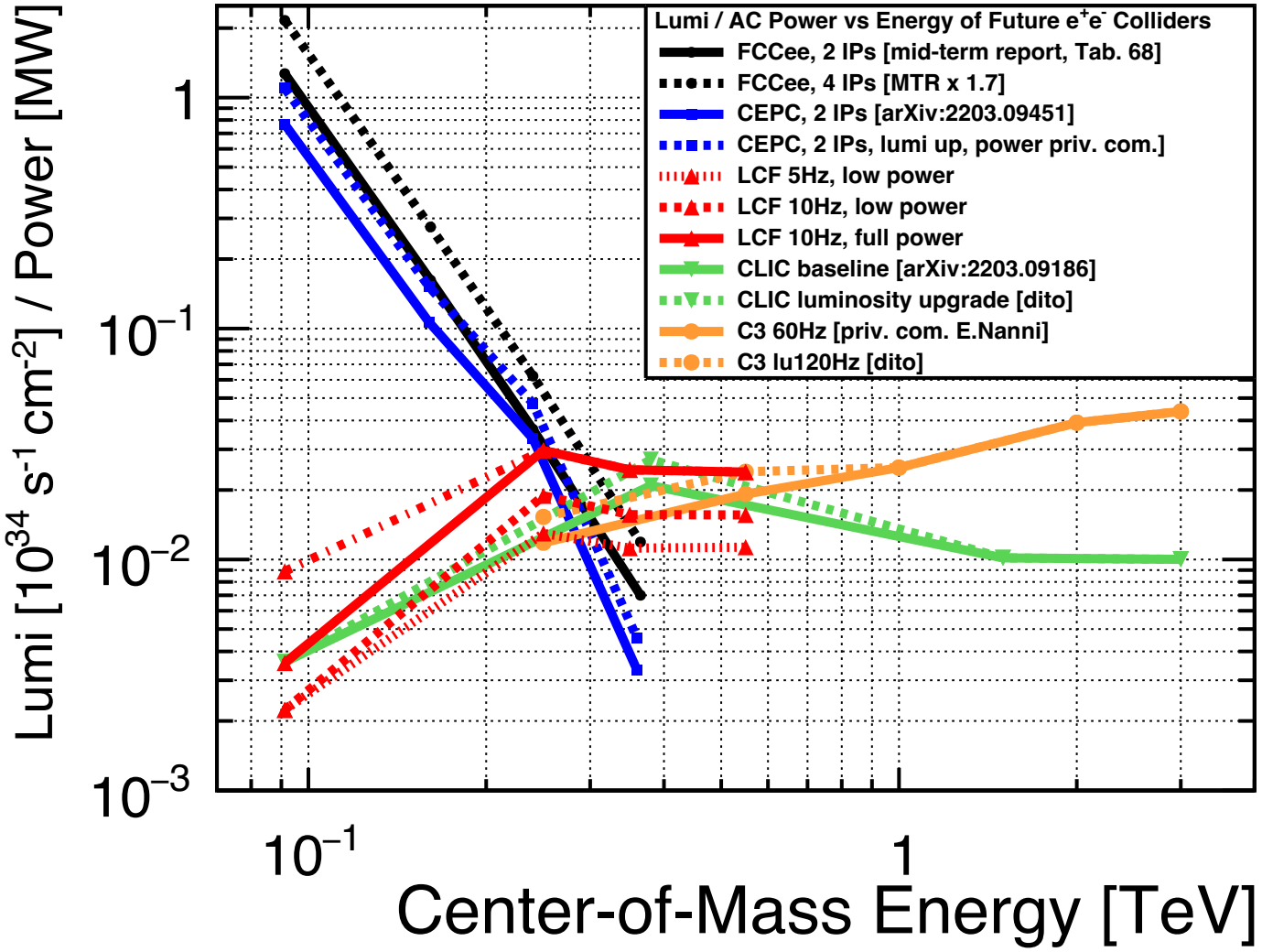
LCF et al





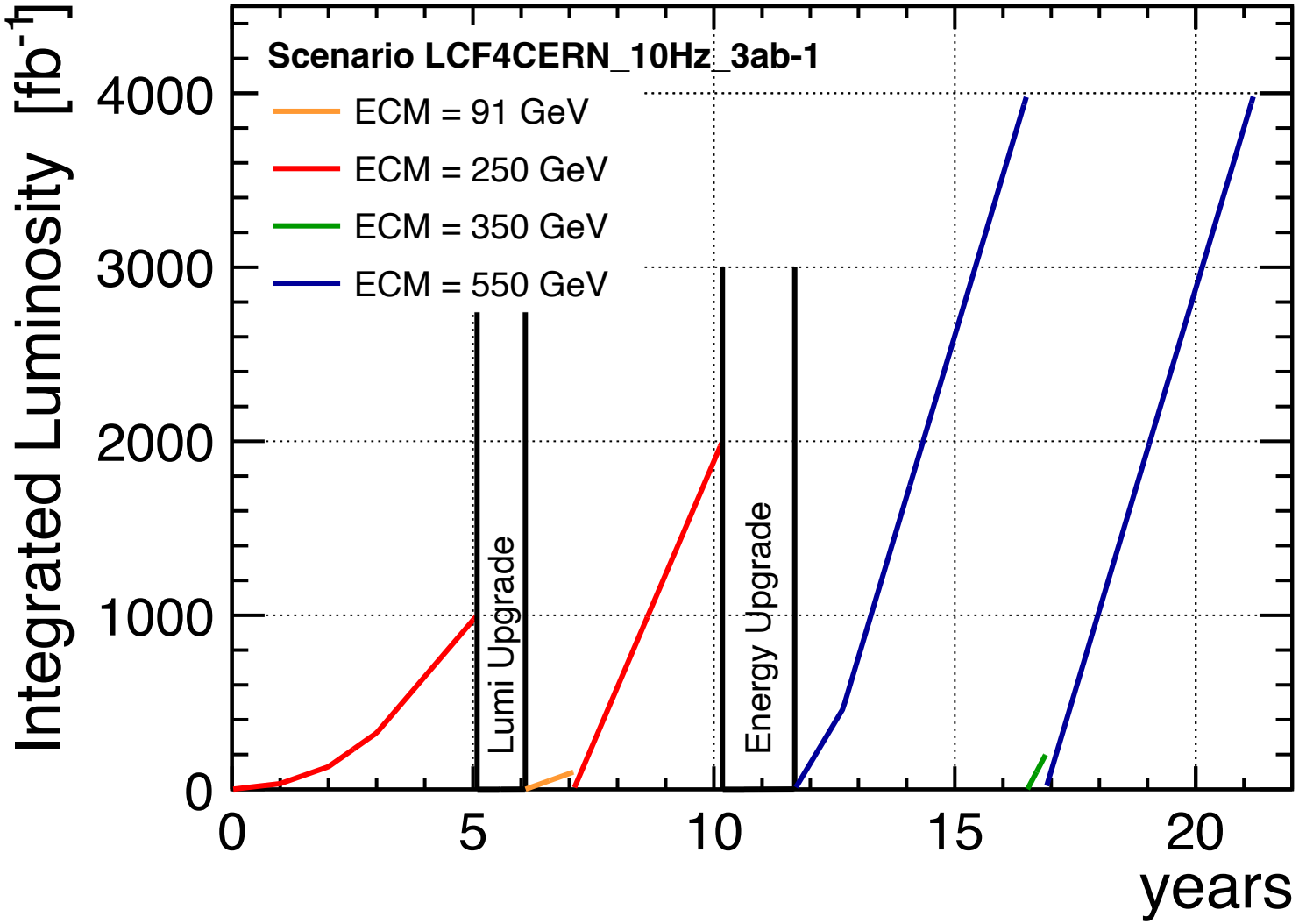
Lumi per Power

LCF et al



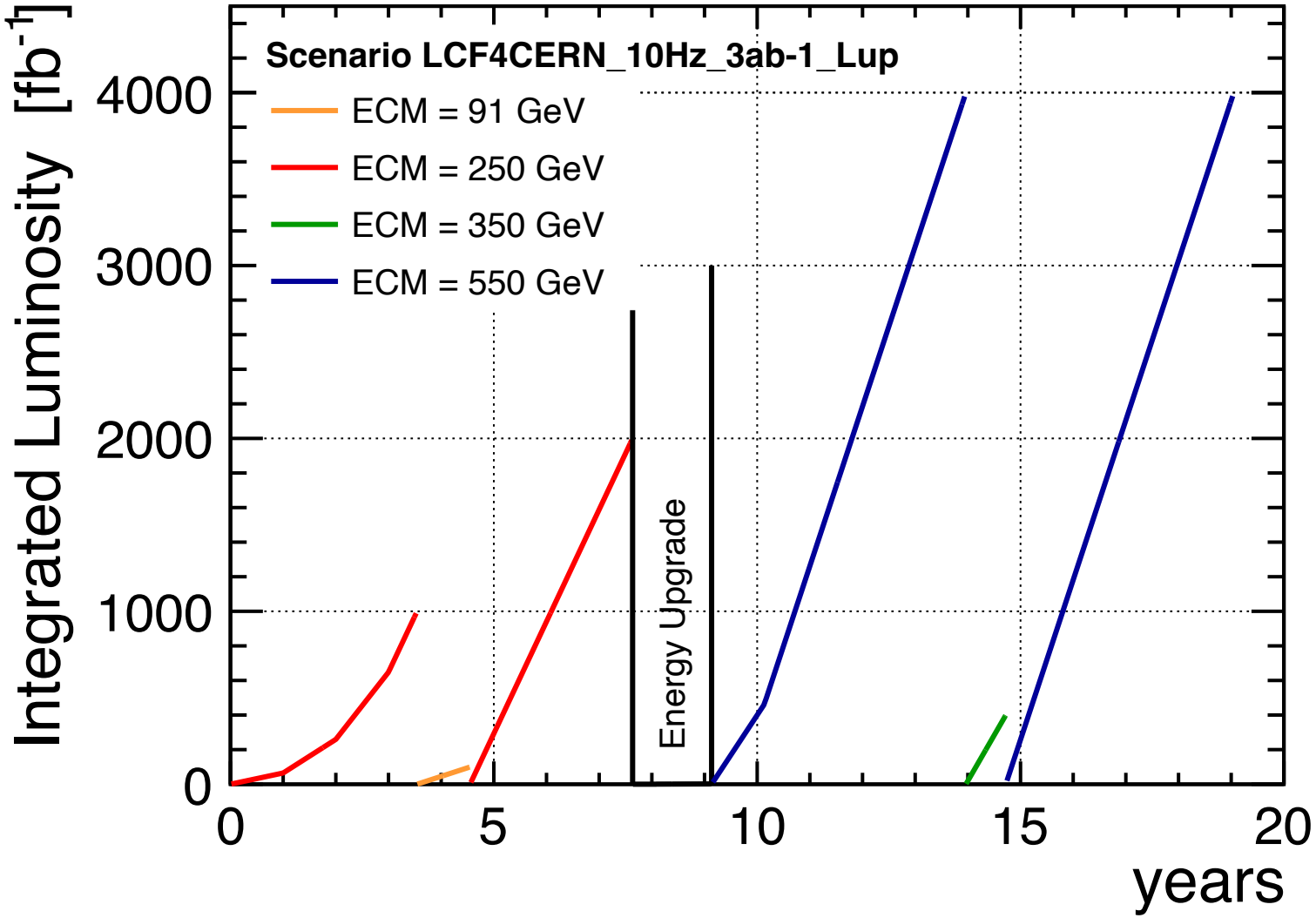
Running Scenarios

baseline ?



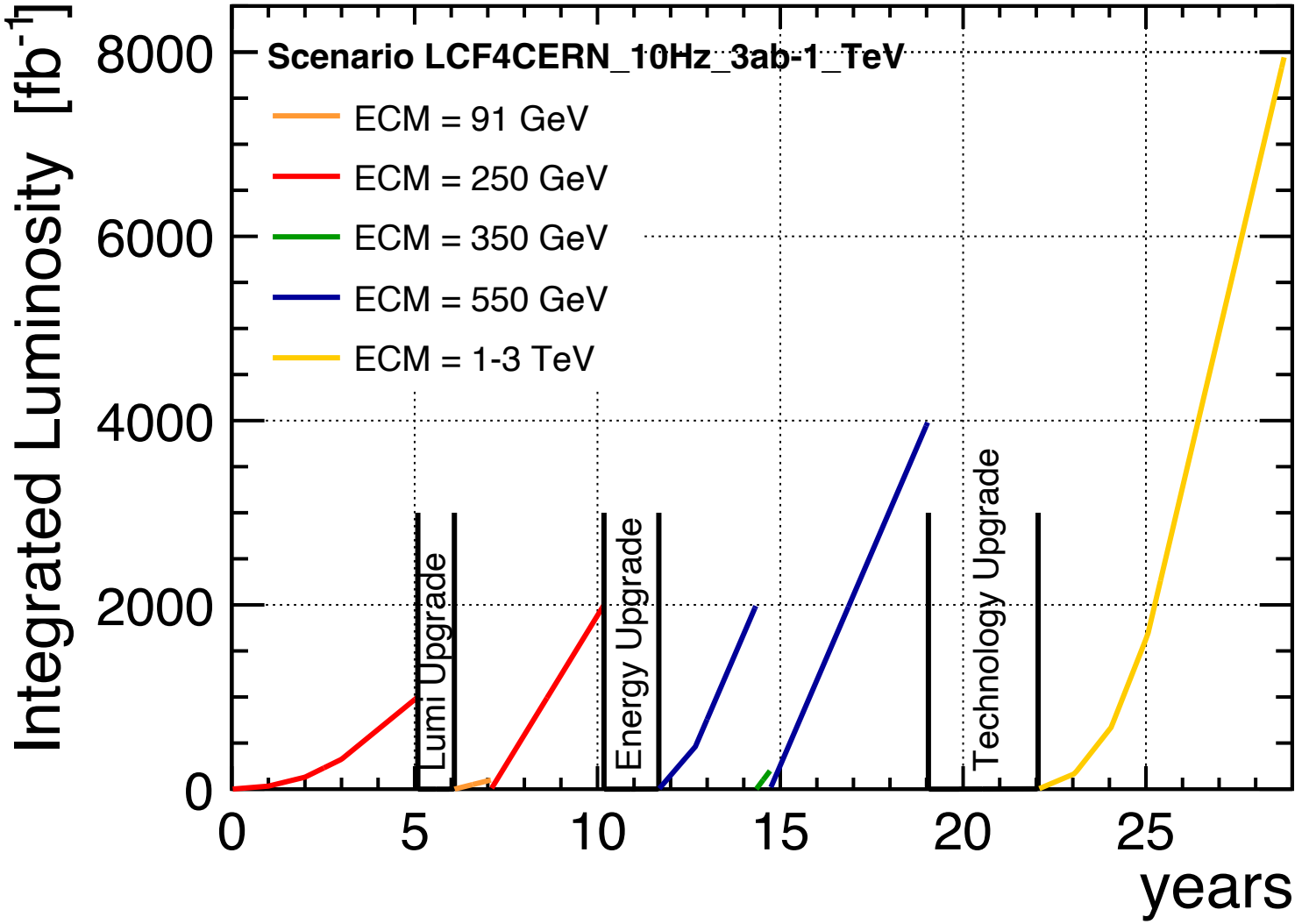
Running Scenarios

start with full power



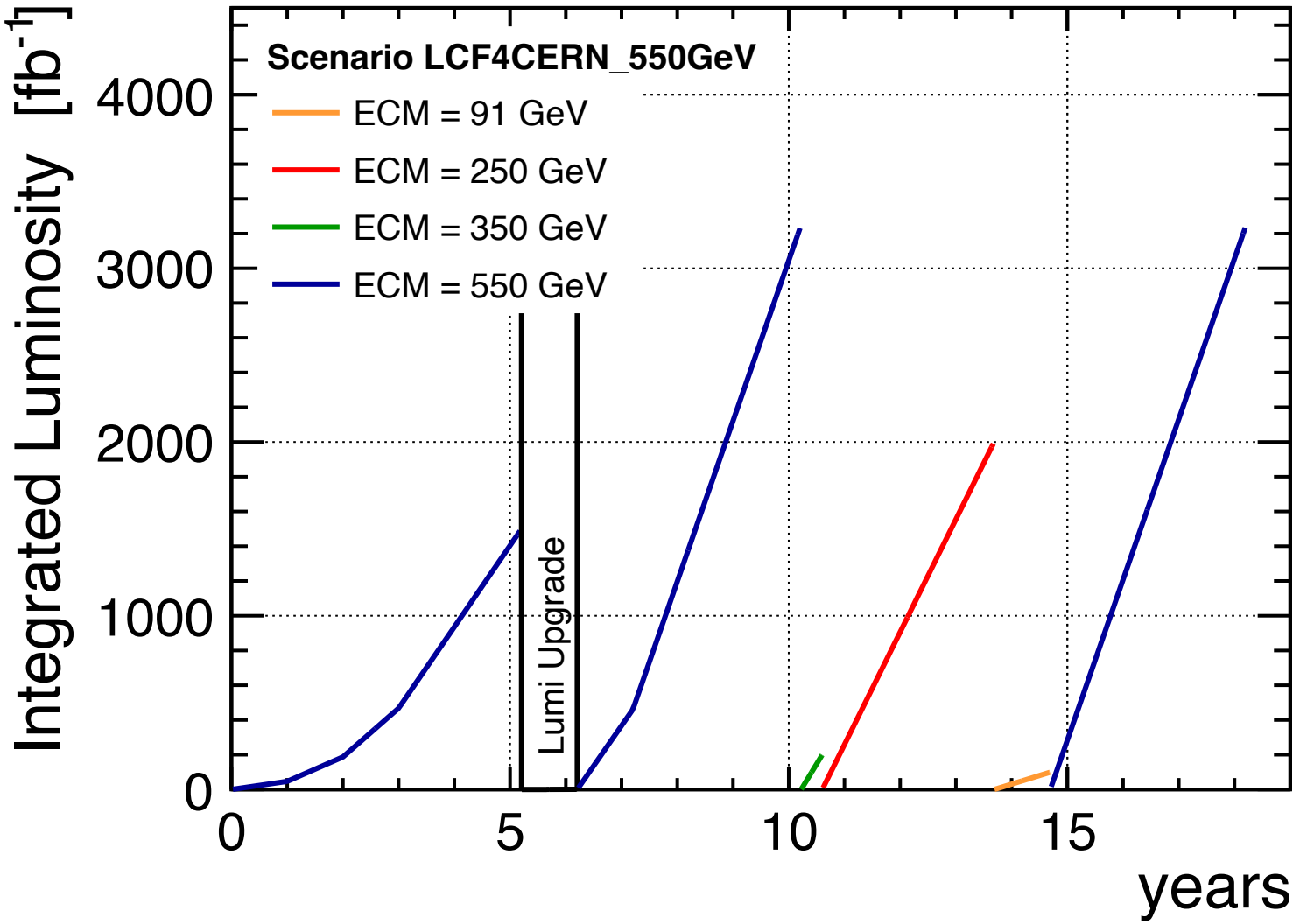
Running Scenarios

shorten 550 GeV to go to TeV range earlier



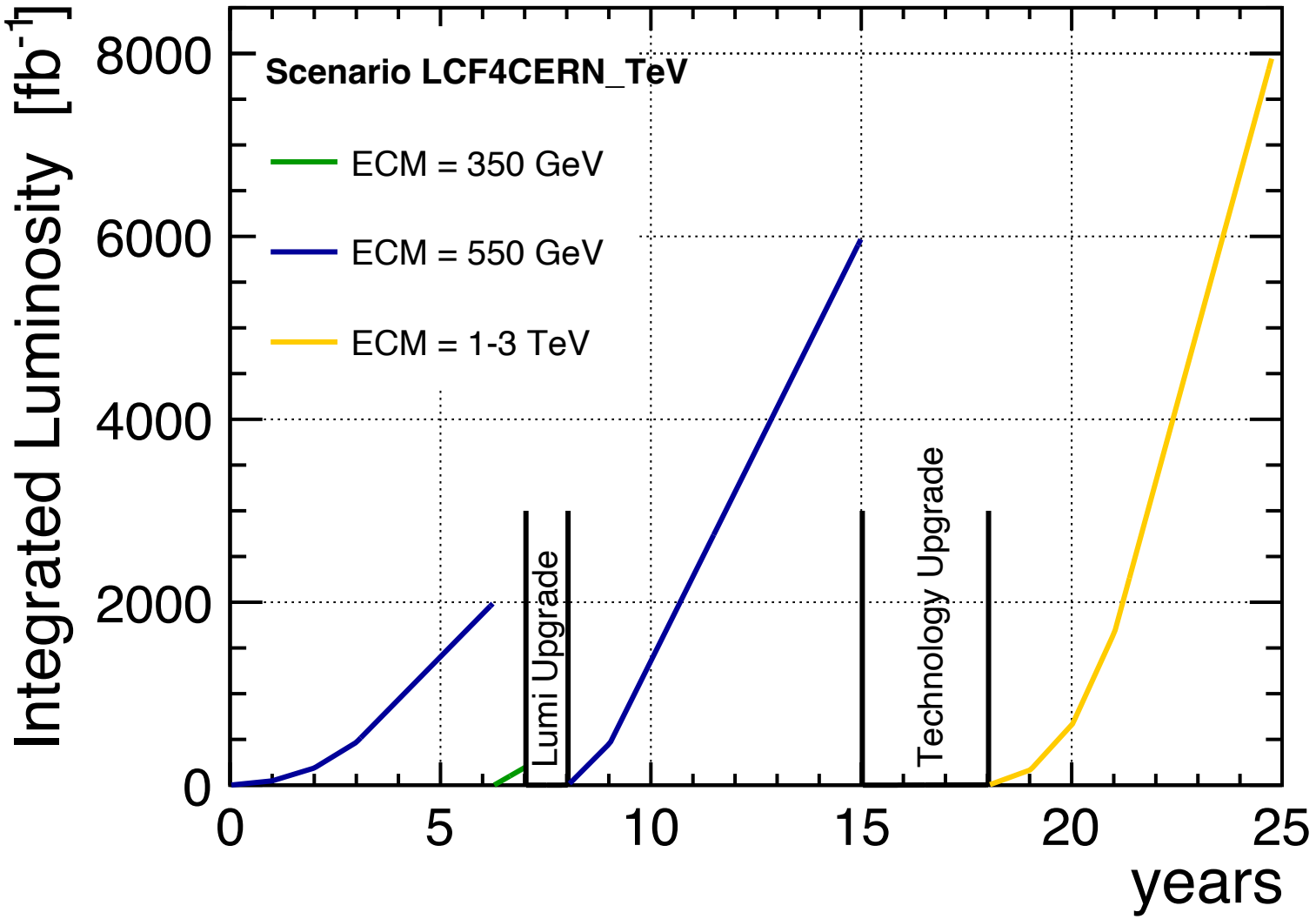
Running Scenarios

start with 550 GeV - cross-check CEPC with polarised data ?



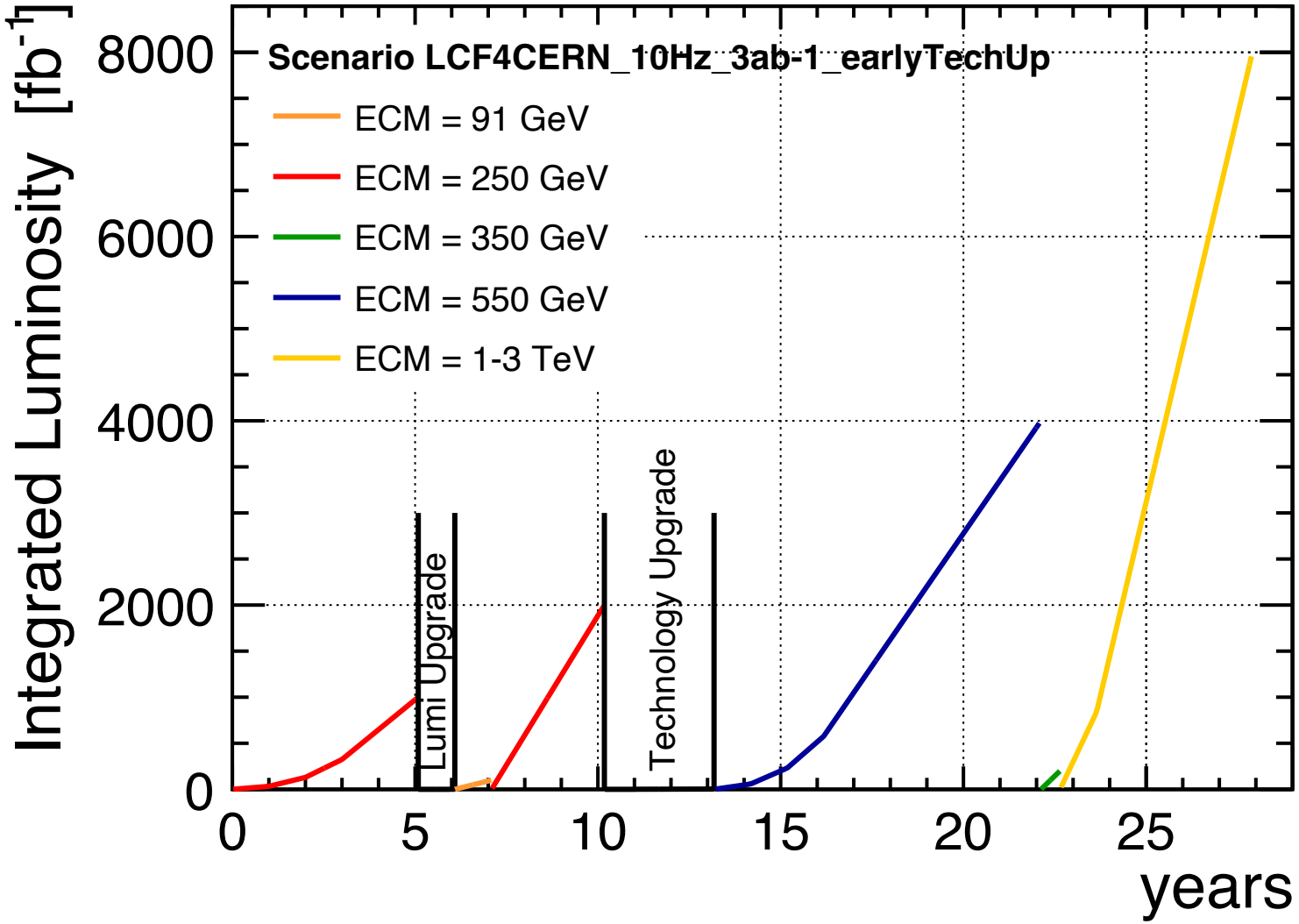
Running Scenarios

start with 550 GeV - or go to TeV range earlier



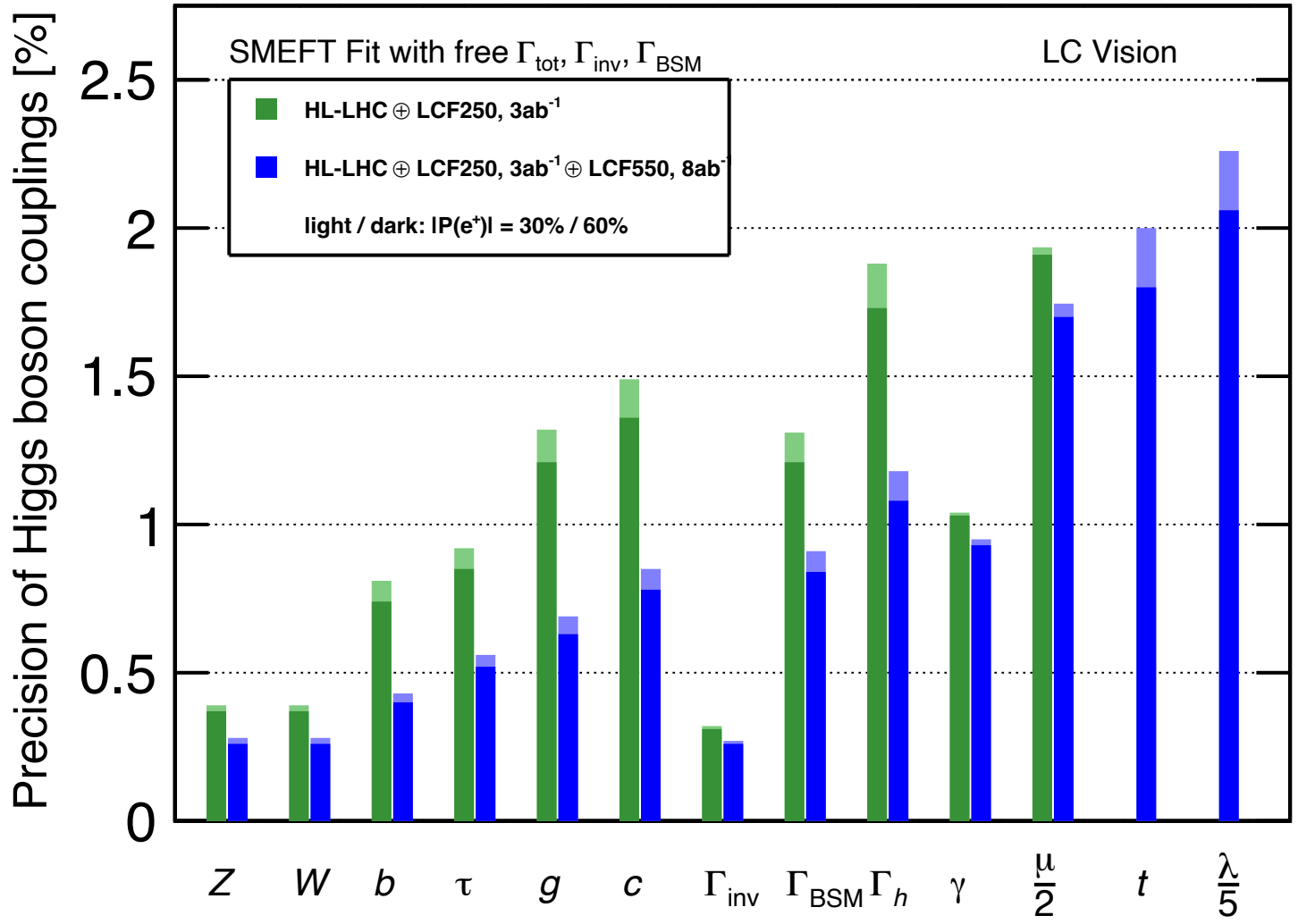
Running Scenarios

Early Technology upgrade



Higgs Coupling Precisions

3ab-1 @ 250 GeV + 8ab-1 @ 550 GeV



What we ask from the EPPSU

as first concrete step

- a “small” preparatory study, ideally starting directly in 2027
  - 3..5 years ????
  - 75…150 MCHF ????
- **An engineering design** of the LCF facility including the collider, the injectors, and all technical infrastructures that are required to construct and operate them will prepared. This includes updated cost, power and risk assessments. A number of technical studies are foreseen during the engineering design phase, optimising the LCF technologies and design, and preparing industrial productions:
  - SCRF industrialisation for a design based on more ambitious goals for cavity quality factors (Q_0) and power (klystron) efficiency, with higher repetition rate and hence cryogenic needs than foreseen in the ILC TDR design.
  - A detailed study of the Interaction Region for two experiments, including re-optimised Beam Delivery Systems.
  - Detailed studies of the Cryogenics system and Infrastructure Systems (e.g. cooling and ventilation, electrical, access and safety systems, transport and installation) adapting them to standard solutions used by CERN and industry.
  - Studies of the implications for Civil Engineering and the equipment used in the initial SCRF based facility, in order to allow collider upgrades in the future, and to accommodate the beyond the collider physics described in "ref section above".
  - Design and parameter optimization of the entire machine including further nanobeam studies.
- **Detector and Collaborations** need to be prepared and set up, building on the experience of the numerous detector concepts for Higgs factories, but also embracing new ideas.
- ….

Next Steps

Next steps

Count down for March 31

- LCF@CERN:
  - 10-pager (actual strategy submission): well advanced, draft is circulating to LCVision Coordination Group, discussion meeting tonight
    => public draft on the weekend?
  - back-up document (addendum to submission with more technical details, supporter list etc): well advanced, converging quickly
- LC Vision “long document”:
  - v1 needs to go to the arxiv in 3 weeks => obtain identifier for quoting by EPPSU submissions
  - schedule for circulation / comments / revisions very tight
  - circulate v0 (with some sections missing) to Coordination Group and selected individuals on Friday
  - tbd tonight at Coord. Group meeting:
    - do ~weekly updates, always including comments until a few days before, e.g.:
      - v0 March 7
      - v0.1 March 13 (incl comments until March 11) = first public version?
      - v0.2 March 19 (incl comments until March 17)
      - v1 (arxiv) March 25 (incl comments until and author list snapshot of March 22)
  - v2 shortly after March 31 …
  - submission to EPJ ST

Any Questions?