LINEAR COLLIDER COLLABORATION

Designing the world's next great particle accelerator

Questions about ILC Staging Options

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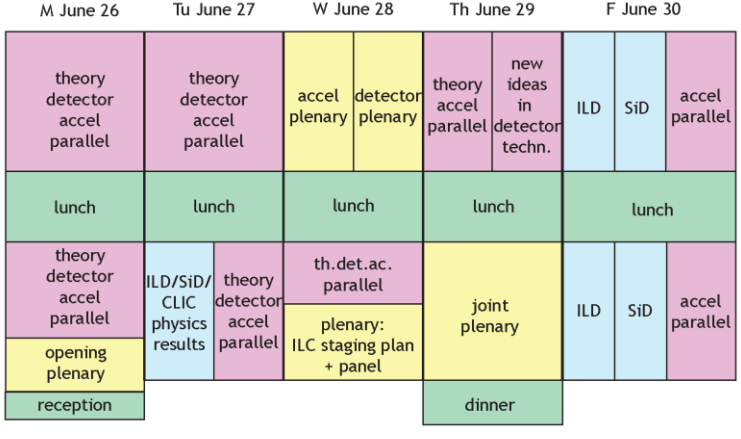
A short history of staging

- Heuer Panel in 2004 / 06: Set ILC Parameters:
  500GeV machine, with 1TeV upgrade option
- 2013: Higgs discovery -> 250GeV has a solid physics case: Zh production
- 2013: JAHEP statement: Start with 250GeV, extend to 500GeV
- 2013: ILC TDR was published, including a staging scenario similar to “option F”
- Circular shock: Could a circular ee collider beat the ILC?
- Morioka 2016: a 500GeV machine is too expensive, even with technology advances, but a 250GeV might be feasible / fundable
- **SLAC 2017: Settle on a staging plan**

Defining Staging: This Week and Beyond

- In this workshop:
  - Parallel sessions on Monday and Tuesday, plus Thursday
  - Separate accelerator and detector plenaries Wednesday morning
  - Plenary session on Wednesday afternoon
  - **Panel discussion on Wednesday afternoon**
- August 9: ICFA meeting at LP2017 (Guangzhou, China)
- Endorsement of a staging scenario by LCC / LCB

Plan of the AWLC 2017 Workshop



The Question

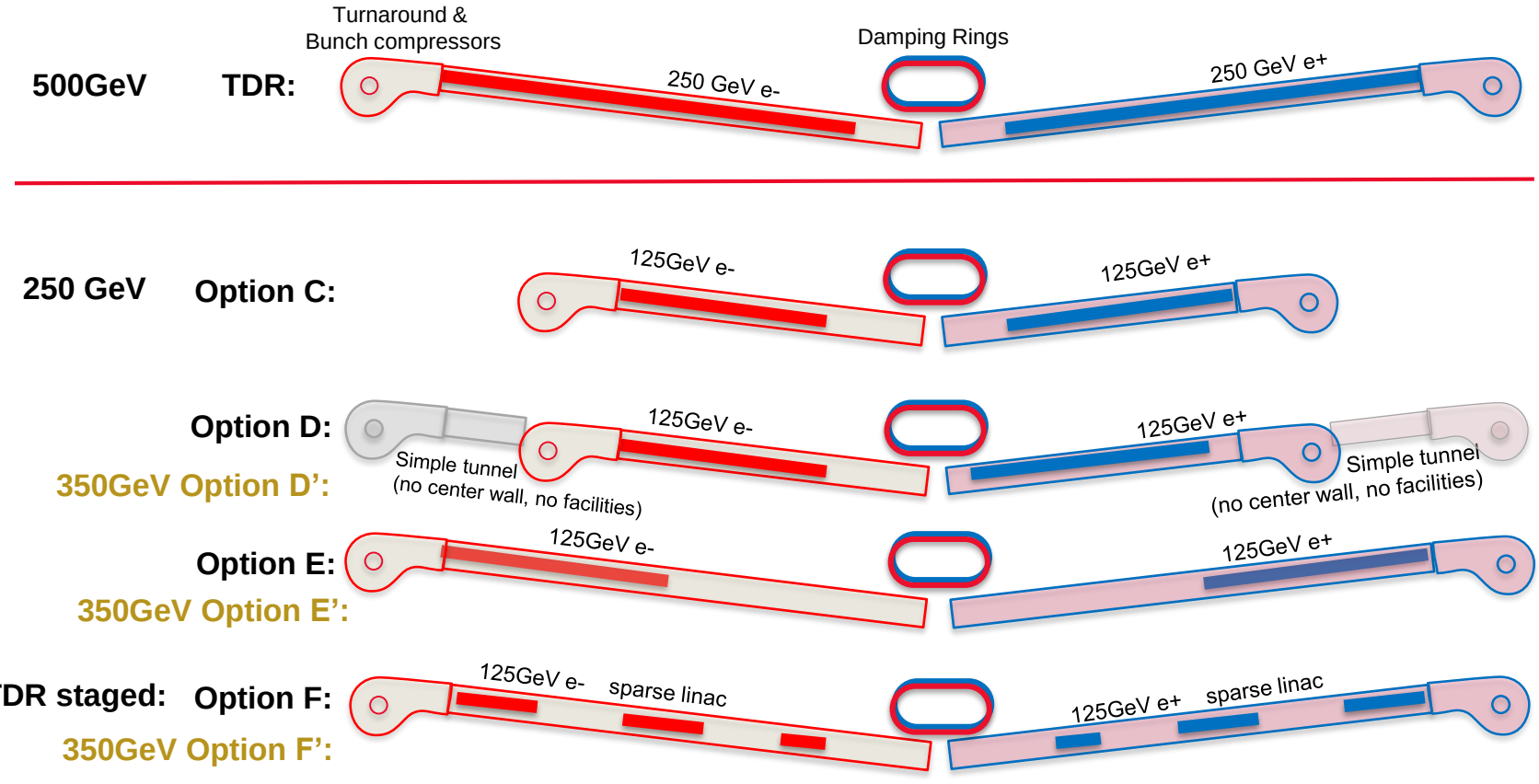
“What is the right ILC project that the international community wants to propose to ICFA, the Japanese government, and the international the funding agencies?”

Such a proposal needs:

- A compelling physics case that convinces politics, the scientific community at large, and the HEP community
- A credible operation and upgrade scenario over roughly 25 years that delivers this physics case
- An initial machine configuration that fits this scenario and is affordable

- The question about the initial machine configuration cannot be answered before one has considered
  - what kind of operating scenario would make sense afterwards,
  - how that affects the physics capabilities,
  - and which upgrade decisions have to be made.

Options for the Initial Configuration



What are the upgrade paths?

Ramp-up period of 3 years with increasing luminosity is always exciting. Scientific return normally justifies operating costs for max 5 years at constant conditions.
-> Maximum period without upgrades is ~8 years.

The basic possibilities:

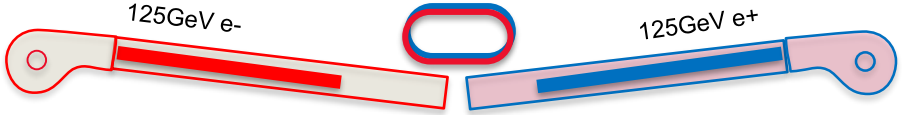
- More energy
- More luminosity
- (More polarization) – I will ignore this for now

Energy upgrade(s):

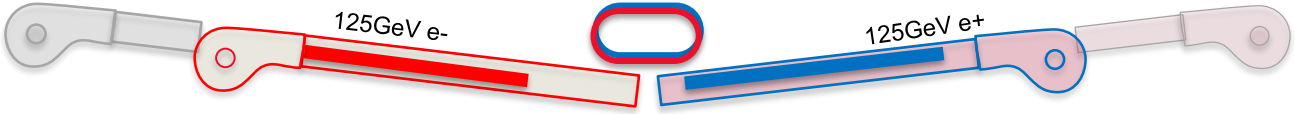
- are the only way to overcome the kinematic thresholds:
  need 350GeV for tt, 500GeV+ for tth and Zhh
- always require more cryomodules, which may come piecewise
- Tunnel digging requires long lead time and approval from Japan
- may proceed in big steps (250->500) or more gradually – depending on the initial configuration!

New Tunnel / Turnaround = Big Change

Option C:

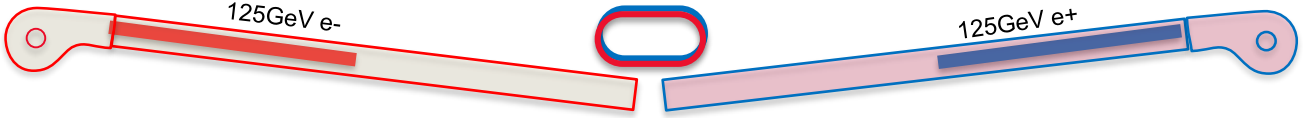


Option D:

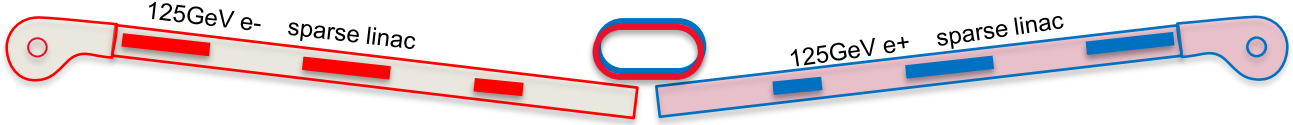


Gradual

Option E:



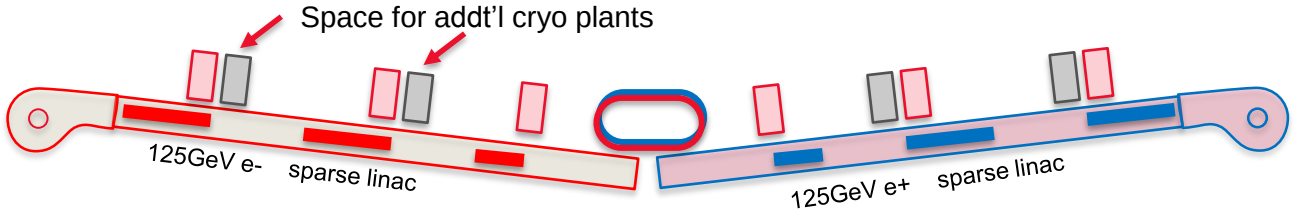
Option F:



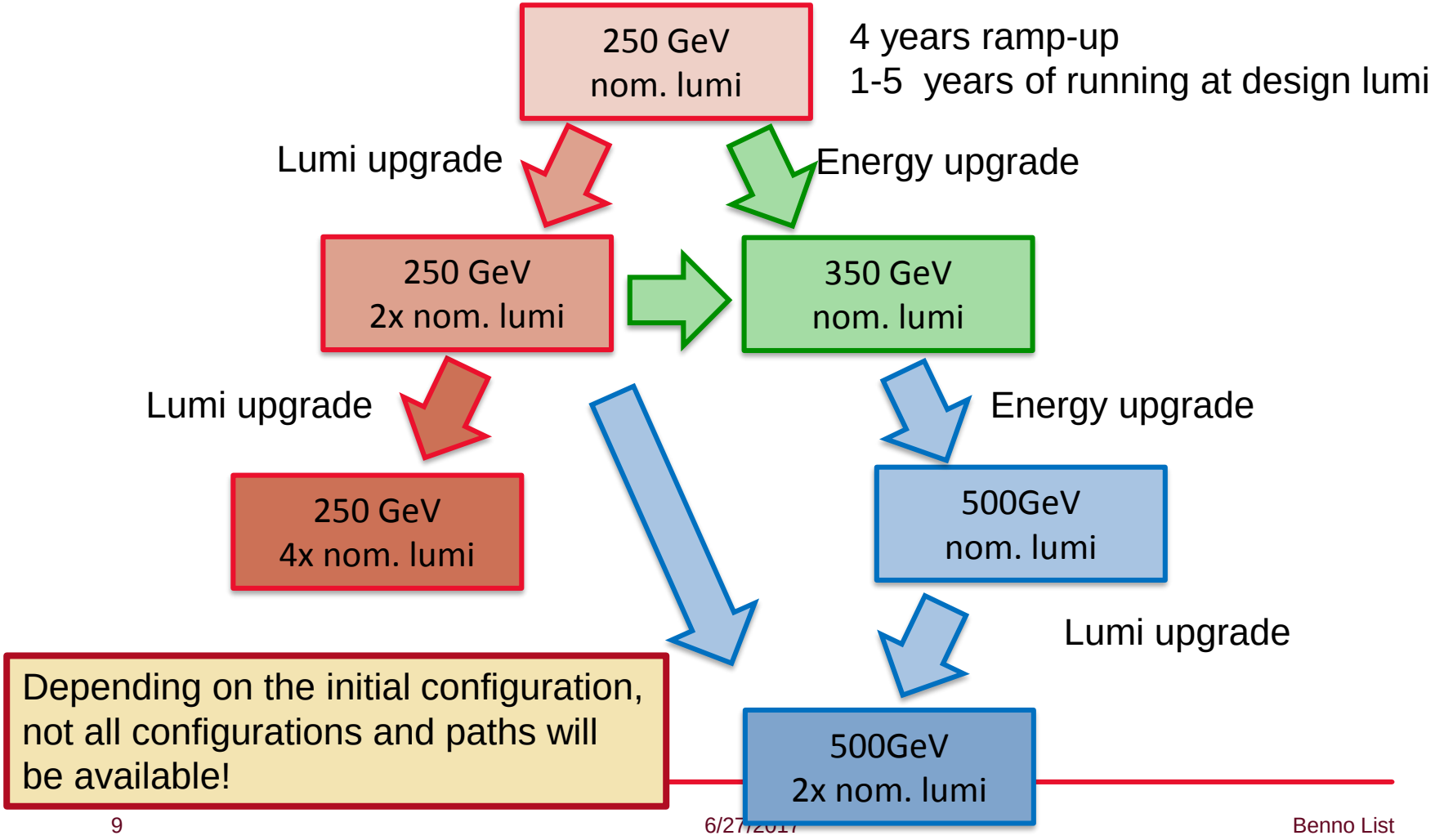
Luminosity upgrade(s)

- **“Full power”:** TDR has only 1312 bunches per pulse, go back to 2625 bunches add more RF power and a 3rd damping ring: factor 2
  -> needs ~1.5 years of shutdown, plus ~2 years re-comissioning
- **“10Hz”:** increase repetition rate from 5 to 10Hz -> factor 2
  - run a high-energy machine at reduced energy but higher repetition rate
  - special to option F: add more cryogenic power to increase repetition rate even at full energy. – may fit into a regular shutdown
- total luminosity increase at 250GeV may be factor 2 to 4, depending on the initial configuration and upgrade paths

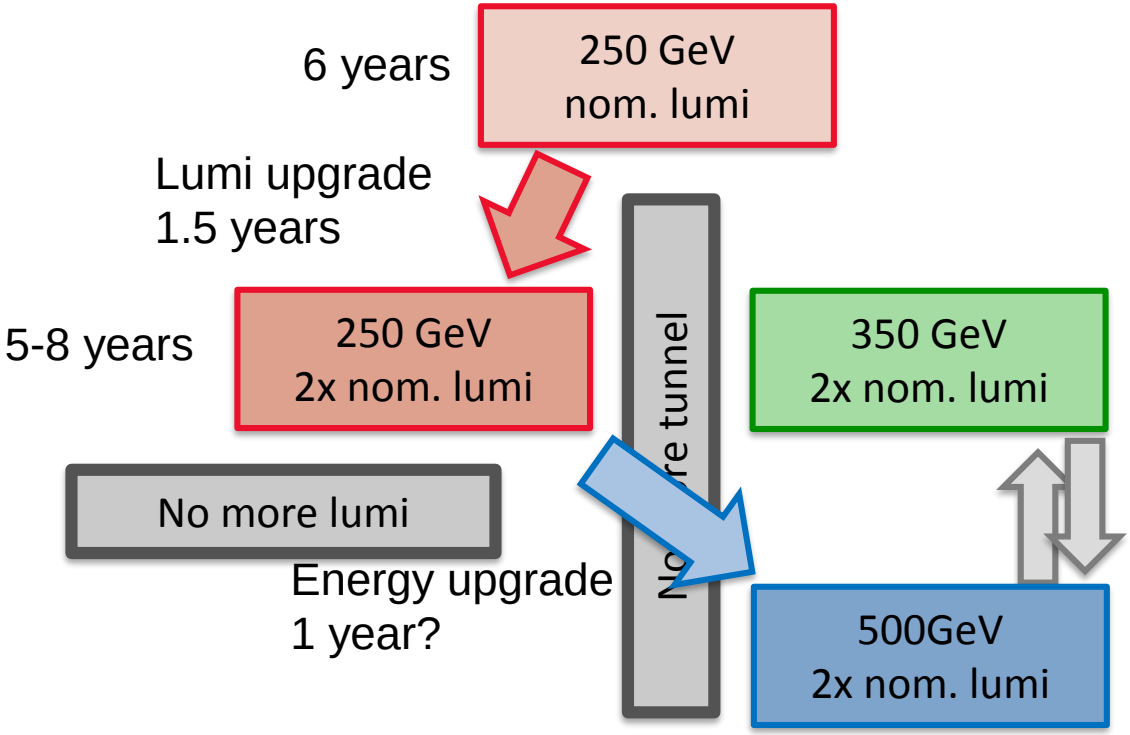
Option F:



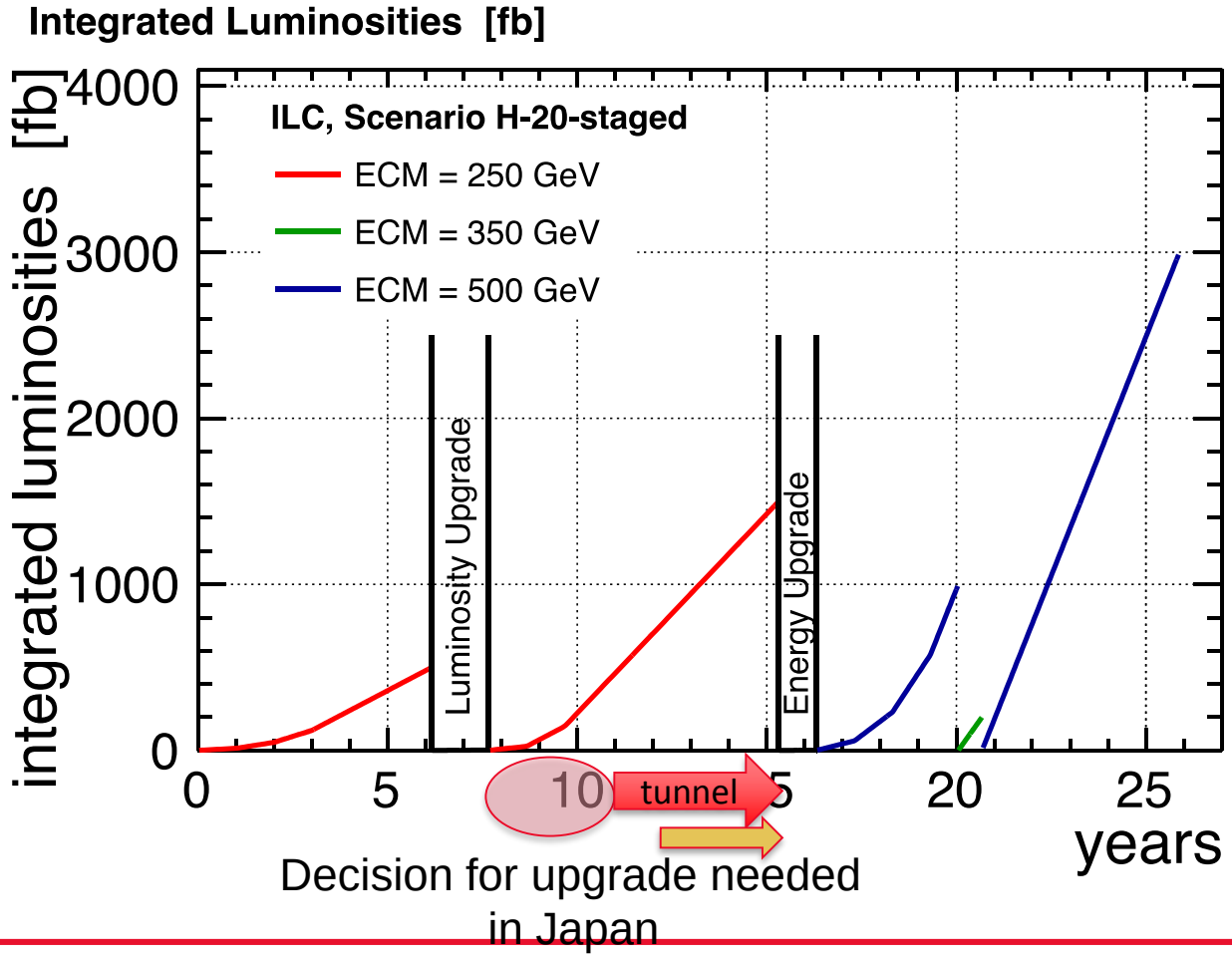
Upgrade Options and Paths



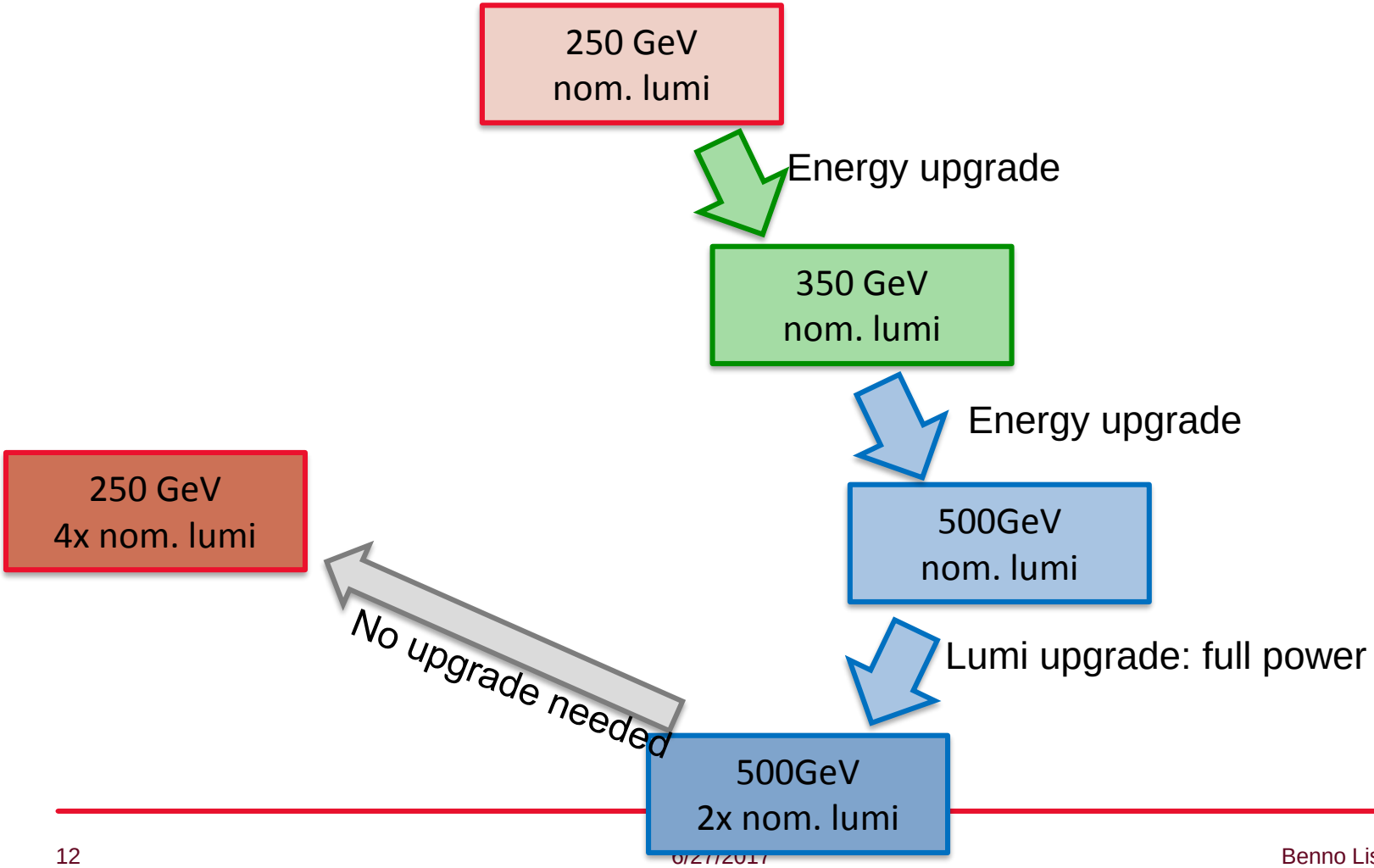
A possible Scenario for Options C, D



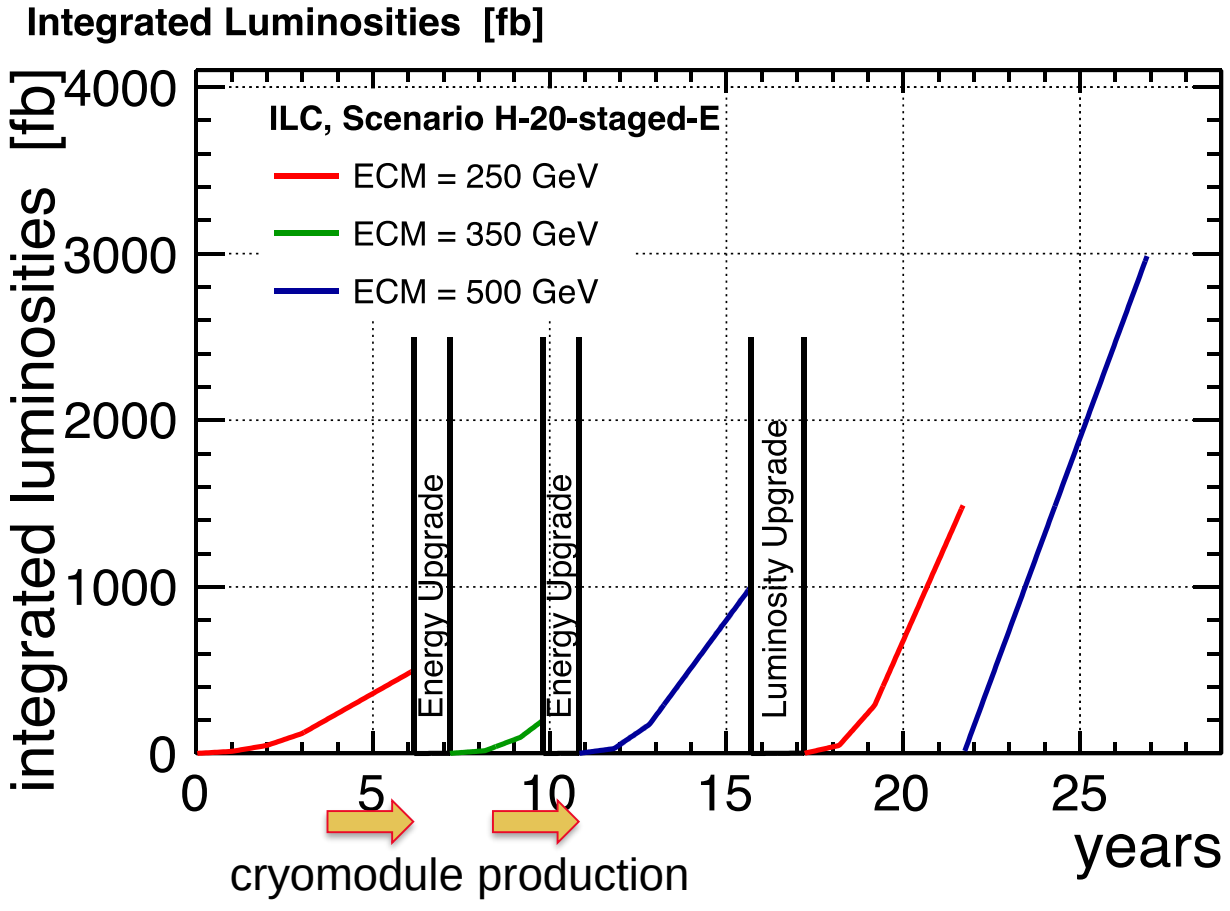
Scenario: Long 250 GeV run



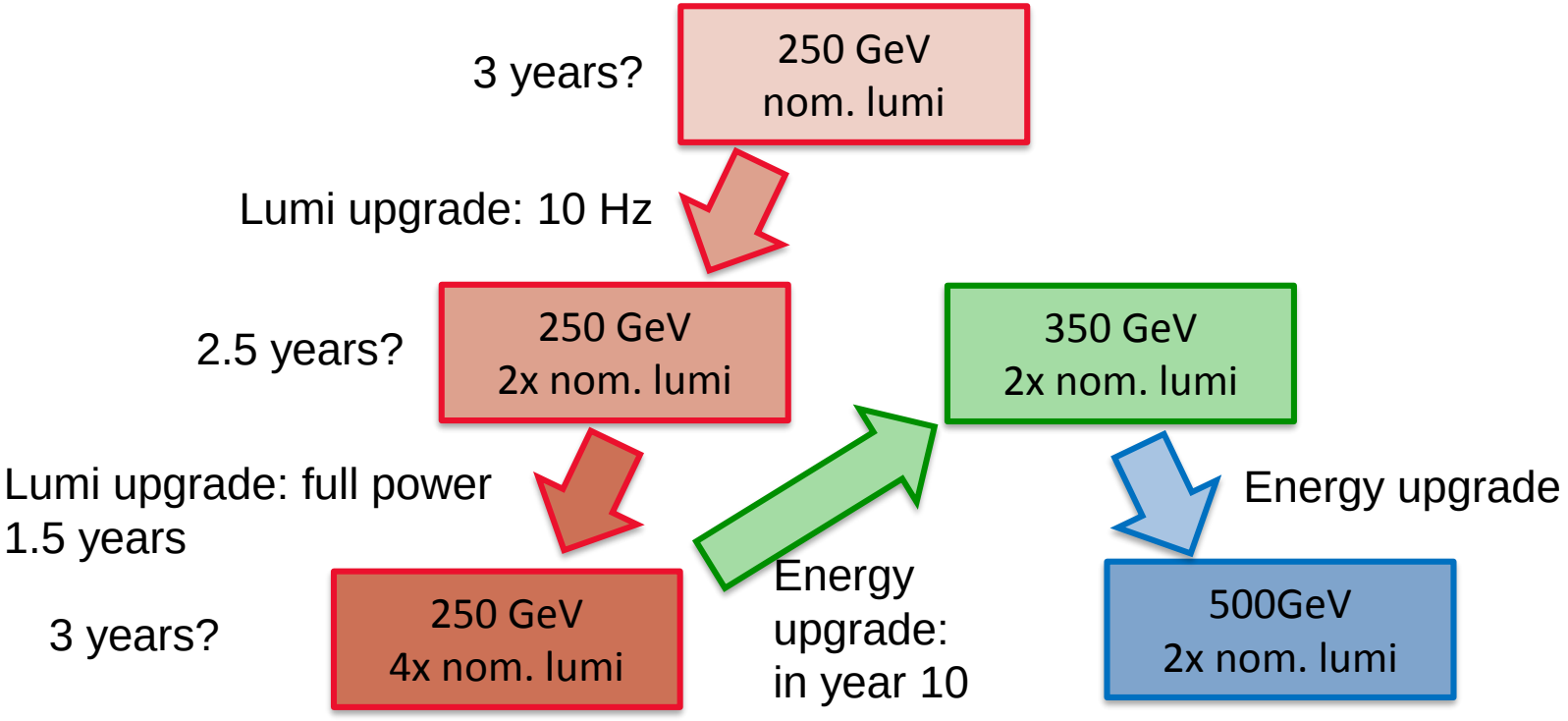
Upgrade Path: Option E, F: Energy first



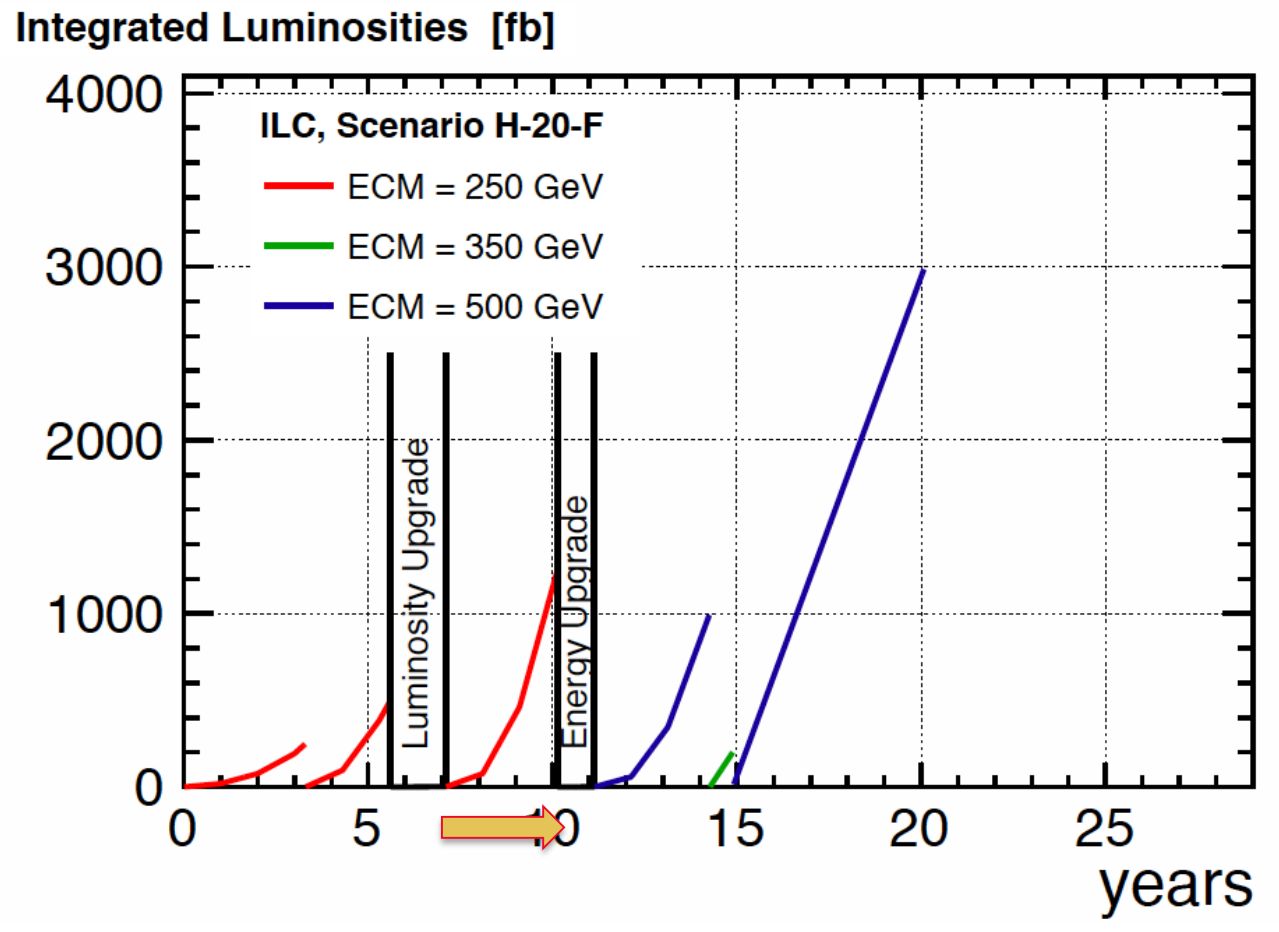
Scenario: Energy Upgrade First



Upgrade Path: Option F, Lumi first



Scenario for Option F: 2 lumi upgrades



Questions to the Workshop and the Panel

- Which of these physics topics are necessary and sufficient for a compelling physics case that can prevail against the competition from other big science projects (not necessarily limited to HEP)?
  - Higgs precision physics at 250GeV based on ee->Zh
  - Top precision physics at 350GeV
  - Higgs physics at 500GeV: tth coupling, higgs self coupling, WW->Zh
  - Discovery potential for direct production of new particles
- Which upgrade / operational scenario offers a physics program that is attractive throughout the project lifetime?
- Can a staged ILC attract the necessary support from the international community?
- Is option C still a staged version of what ICFA ordered from the GDE in 2005?
- Do we need a strong commitment to 500GeV, as demonstrated by an empty tunnel [how empty?], or are we willing to wait and hope that an energy extension with a new tunnel might involve a larger step, e.g. to 800GeV?

Questions, cont'd

Accelerators:

- How confident are we that the ILC can be built for the cost estimated in the TDR?
- What are the prospects to increase the cryomodule gradient performance in the next year, at constant cost per module?
- How does the reduced volume of cryomodules to be built for a staged machine affect the cost?
- What is needed to convince labs to keep their SRF production facilities operational for an energy upgrade?

Concerning politics:

- How far do we have to get the price tag so that it is fundable?
- Which number is most relevant - initial cost, cost for a 'full' machine, operating cost (for a given physics result)?
- How long is the grace period after completion of the 250GeV stage before an large (500GeV) energy upgrade could be submitted for approval?

Summary

- The physics case must convince not only the ILC community or the HEP community, it competes against many other big science projects
- We want to propose:
  - An initial 250GeV stage with an acceptable cost to be funded
  - + A path for future upgrades, to have a complete physics case
- Physics case, operating scenarios and initial configuration of the ILC are tightly coupled