Fundamental Concepts of Particle Accelerators
V: Future of the High Energy Accelerators
VI: References

Koji TAKATA

KEK

koji.takata@kek.jp
http://research.kek.jp/people/takata/home.html

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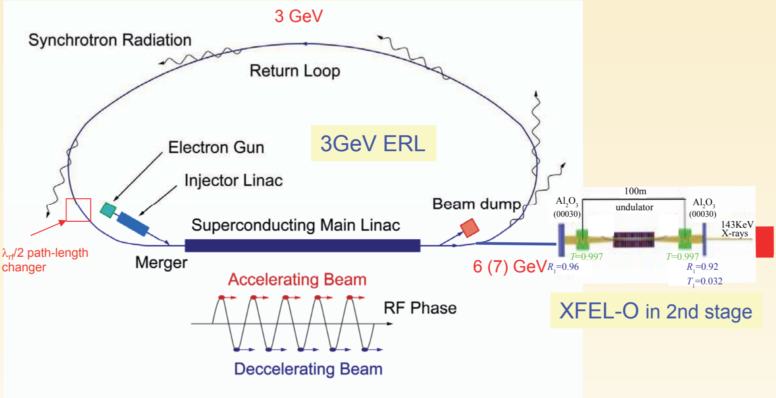
Contents

KEK-PF-ERL

- Linac: $1.3\,\mathrm{GHz}$ Superconducting type
- Ultrashort $(0.1\,\mathrm{ps} - 3\,\mathrm{ps})$ electron bunches are generated by the electron gun with a photo-cathode irradiated by laser pulses.



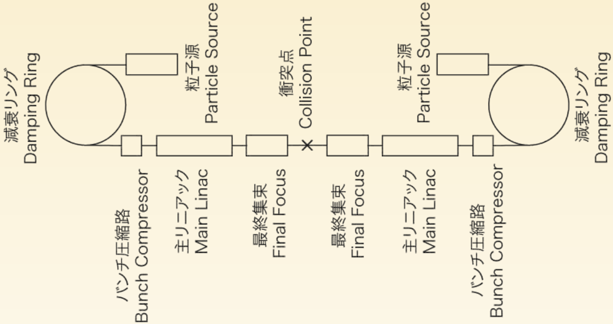
Basic Features

- The injection linac accelerates a train of ultrashort ($\sim \mathrm{ps}$) electron bunches to a few GeV. The bunches make just one turn around the ring emitting ultrashort SR lights and return back to the linac.
    - In the linac, they lose energy by emitting $1.3\,\mathrm{GHz}$ RF power, which contributes to the acceleration of the next train of electron bunches.
- The ultrashort SR lights are used for observation of fast transient phenomena in condensed matters.
    - In the conventional SR rings, the bunch length is too long ($\sim \mu\mathrm{s}$) due to the quantum nature of SR photons.

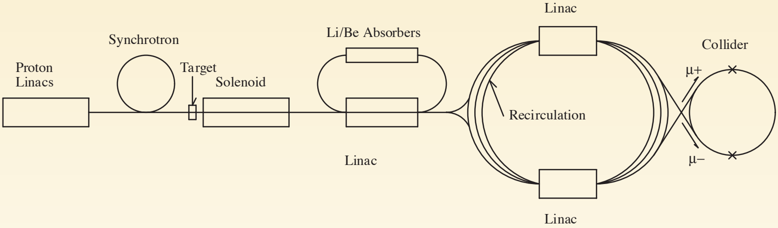
LC: e^+e^- Linear Collider

Basic Features of the Linear Collider

- Aiming at the center-of-mass energy around $1\,\mathrm{TeV}$ or higher. The main accelerator should be two linacs in the opposite direction because ring accelerators suffer from severe SR energy loss proportional to γ^4.
- The accelerator complex for electrons and that for positrons are almost the same except for the positron source.
- The beam emittance should be extremely small to achieve a moderate luminosity at the collision.



- Since the muon mass is 206.7 times larger than the electron and the γ^4 issue is greatly mitigated, a ring collider scheme is still acceptable, and its site scale becomes much smaller than that for a linear collider.
- The transverse emittance of the muon beam just after the target is so large that R&D of efficient beam-cooling system is the most critical issue.
- A continuous RF acceleration during the cooling is necessary to cope with the short life time of the muon: $\tau_\mu = 2.2\,\mu\mathrm{s}$.



cf. R. Palmer and R. Fernow: *An Overview of Muon Colliders*, Beam Dynamics Newsletter **55** (ICFA, Aug. 2011) p.22.

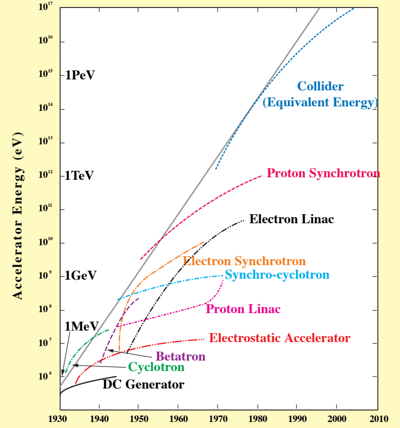
- Four possible ways to generate plasma waves (relativistic electron density waves)

Please see the figures on p.47 of *ref.*[*]

- At present, longitudinal gradients of the order of $\sim 200\,\mathrm{GeV/m}$ have been achieved in a length of a few mm.

[*] C. Joshi and T. Katsouleas, *Physics Today,* p.47, June 1980

Livingston Chart



- M. S. Livingston & J. P. Blewett: "Particle Accelerators, p.6", MacGraw Hill, 1962.
- For the colliders, the energy is converted to that for their equivalent fixed target system.
- Maximum energies ever achieved
  - Electron synchrotron: 2×100 GeV (2000, CERN LEP)
  - Proton synchrotron: 2×7 TeV (2010, CERN LHC) http://lhc.web.cern.ch/lhc/
- Target energy for ILC (International e^+e^- Linear Collider)

  2×500 GeV? (2025 or later?)

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  - A classical paper on the theory of the strong focusing
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