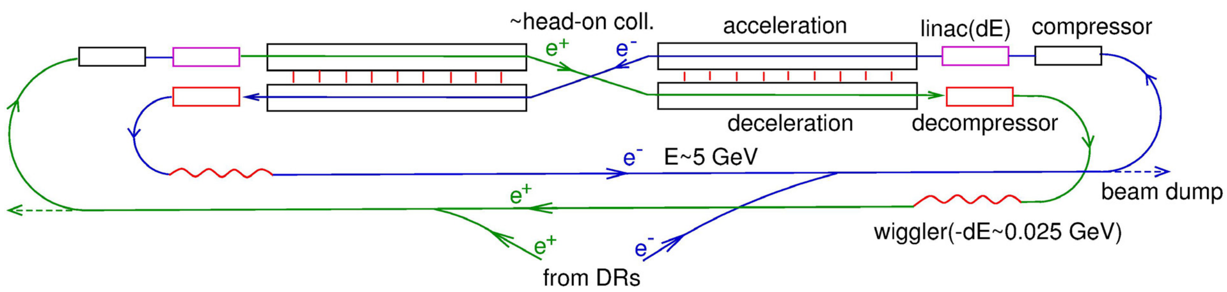


Twin Superconducting Energy Recovery Linear Collider (ERLC): An Ultra-High Luminosity e^+e^- and e^-e^- Higgs Factory

Валерий Тельнов

ИЯФ СО РАН

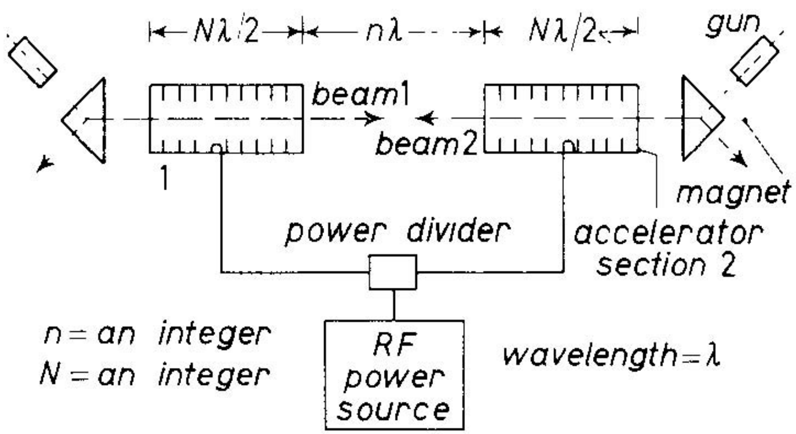
Секция ядерной физики РАН, Новосибирск, 10.03.2026

Contents

- Short history of e^+e^- linear colliders, the idea of SC LC with the energy recovery(1965,1971,1975)
- The idea of twin e^+e^- ERLC with the energy recovery (2021)
- Posiible parameter of e^+e^- ERLC
- The idea of twin e^-e^- ERLC, possible parameters
- Critical technologies and problems of ERLC, further work
- Conclusion

Short history of e+e− linear colliders

1) In 1965 M.Tigner published a paper in Nuovo Cim. 37, 1228 (1965). about using colliding linac beams as an alternative to storage rings for studying electron-electron collisions. He talks about the benefits of superconductivity and how to lower the operating power by using energy recovery. He considered machines in the few GeV energy range. This paper did not attract attention, there were no citations until 1979.



2) In 1971 A. Skrinsky at seminar in Morges spoke briefly about linear accelerators for reaching the hundred GeV region, necessity of 10 μm transverse beam sizes, conventional and superconducting LC with energy recovery were mentioned.

3) July 1973 – discovery of neutral currents (Gargamelle, CERN), that confirmed Weinberg-Salam model which predicted Z-boson with M_Z~100 GeV.
In 1975-76 B. Richter spent a sabbatical at CERN and worked out (together with C.Pelegrini, C.Rubbia) the scaling laws: Cost = C_0 +kE^2 for e+e- storage rings. As a result he published the paper NIM 136 (1976) 47, which opened the way to the construction of LEP.

4) At the end of 1975, Ugo Amaldi, inspired by the discussions at CERN, published a paper "A possible scheme to obtain e-e-, e+e- collisions at energies of hundred of GeV", where he proposed a superconducting linear collider with energy recovery.

A POSSIBLE SCHEME TO OBTAIN e^-e^- AND e^+e^- COLLISIONS AT ENERGIES OF HUNDREDS OF GeV

U. AMALDI
CERN, Geneva, Switzerland

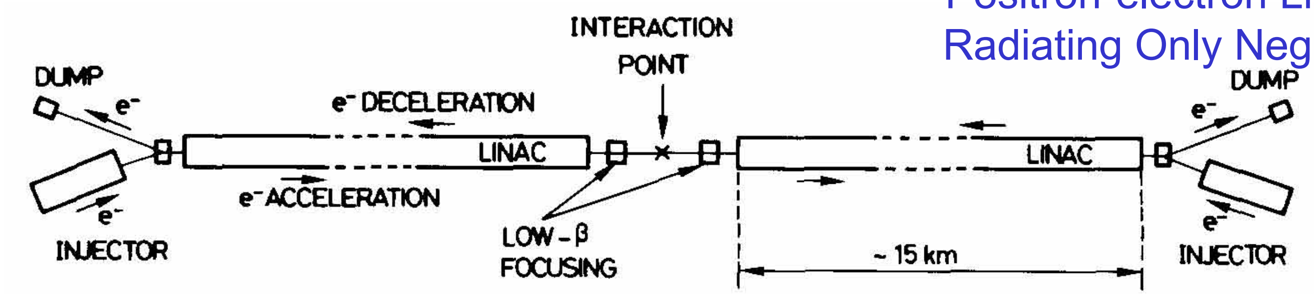
Received 18 December 1975

The very first paper on high energy LC:

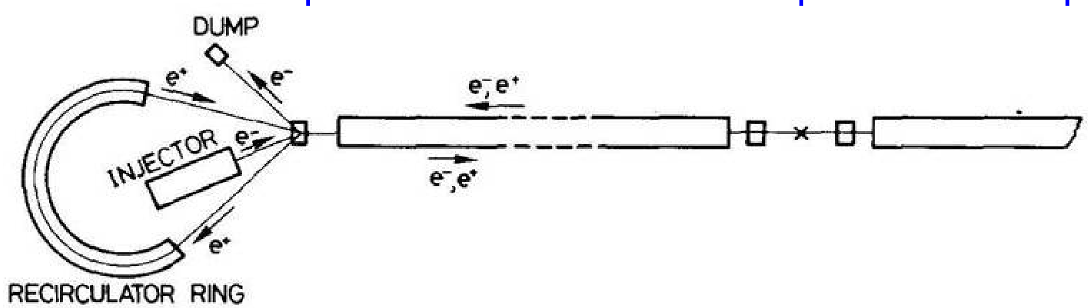
U. Amaldi, Phys. Lett. 61B (1976) 313 (March 29, 1976)
+ report U.Amaldi, H.Lengeler at Serpukhov meeting, May 1976

As a contribution to the discussion on very long term developments in the field of high energy physics, it is pointed out that it is possible to devise e^-e^- and e^+e^- colliding beam machines which are not affected by the large synchrotron losses typical of conventional storage rings. The scheme proposed here makes use of two collinear superconducting linacs which at the same time accelerate and recover the energy fed to the electron and positron beams.

Ugo called it "Peloron",
"Positron-electron Linear Oscillator Radiating Only Negligibly"



In this scheme the electron and positron bunches are dumped after one-pass energy recovery

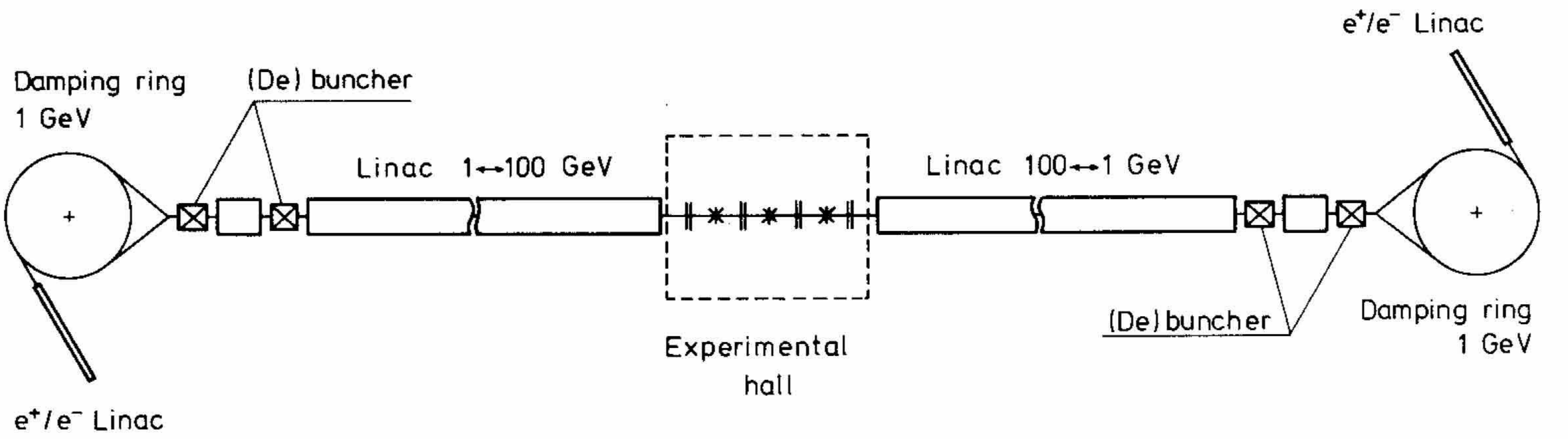


In this scheme the electron bunches are dumped after a single traversal while, to save positron current, the positrons are recirculated in a low energy ring.

B. Richter (1987): «Amaldi in *Physics Letters* in 1976 independently reinvented Tigner's scheme of superconducting electron linacs with energy recovery. He also considered e+e- colliders, but could not find a solution that satisfied him for the production of positrons in a sufficiently small phase space to make high luminosity electron-positron colliders a practicality».

More advanced “Peloron” scheme. Problems

H. Gerke and K. Steffen, Note on a 45 - 100 GeV electron swing colliding beam accelerator, DESY-PET 79/06 (1979).



Here bunchers-debanchers reduce the energy spread in damping rings.

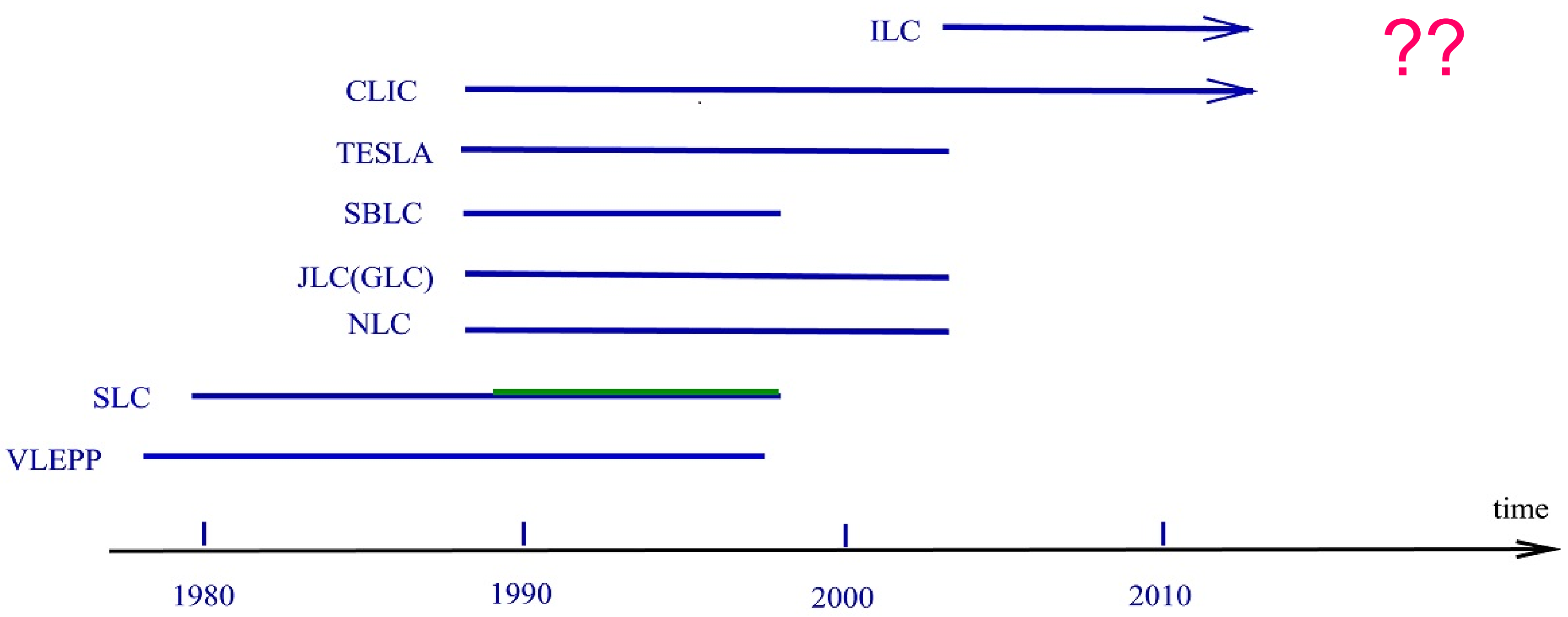
Problems: parasitic collisions in linacs do not allow a high collision rate. Only one bunch shoud be present at each moment in a half linac, that restricts the collision rate f~30 kHz. The luminosity, with account of duty cycle 1/30, is low enough.

As result $L=3.6\times10^{31}$ - not interesting

So, the main obstacle to LC with energy recovery is parasitic collisions in linacs!

Since 1980 linear colliders with the energy recovery were no longer considered, because one pass linear colliders allowed higher luminosity, up to $L\sim10^{34}$.

Linear colliders



The advantage of LC – no synch. radiation → higher accessible energies
The disadvantage of LC – beams are used only once → low energy efficiency

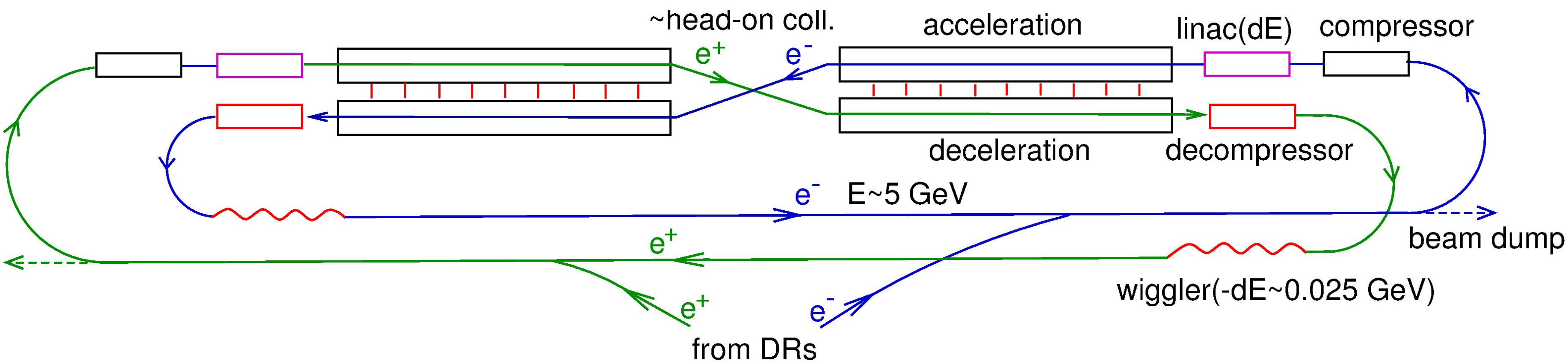
The ILC has not been approved yet, partly because the FCC-ee has almost one order higher luminosity at Higgs boson energies.

The idea of radically increasing the luminosity of linear colliders came to me in March 2021, and I spoke about it at LCWS 2021 (remotely).

A high-luminosity superconducting twin e+e- linear collider with energy recovery (ERLC)

V.I.Telnov, LCWS21

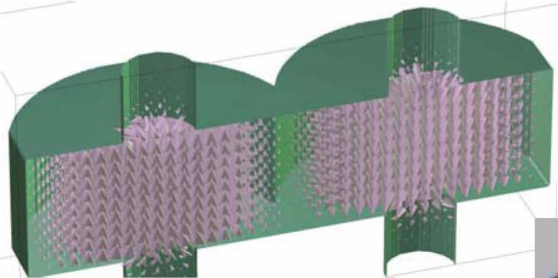
arXiv:2105.11015
JINST 16 (2021)12, P12025

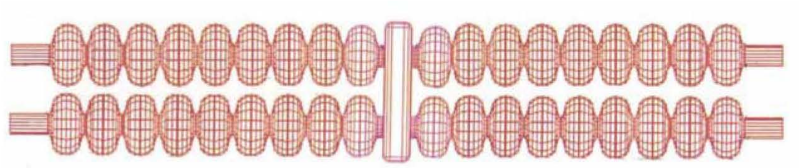


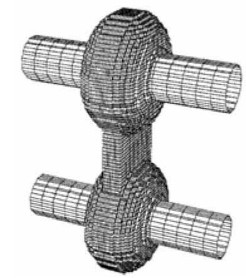
1) LC consists of two parallel SC linacs with coupled RF systems, so that the fields are equal at any time. One line is for acceleration, the other for deceleration.
2) Damping is provided by wigglers (no damping rings) at the “return” energy about E~5 GeV. The energy loss per turn dE/E~1/200. Damping is needed to reduce emittances and the energy spread to the level $\sigma_E/E \sim 2\cdot 10^{-3}$ arising from collisions.
3) It can work with a in the continuous mode or with a duty cycle, duration of one cycle tens of seconds, depending on SC technology.

The ERLC was reviewed in 2021 by an expert group (led by A. Hutton). It was found to be realistic project and was recommended for further study and development of the required technology, high T and Q superconducting cavities.

Dual/Twin cavities (before 2021)







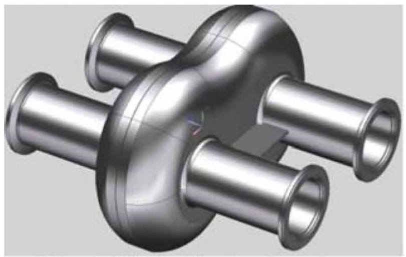


Figure 2: Single cell twin axis cavity.

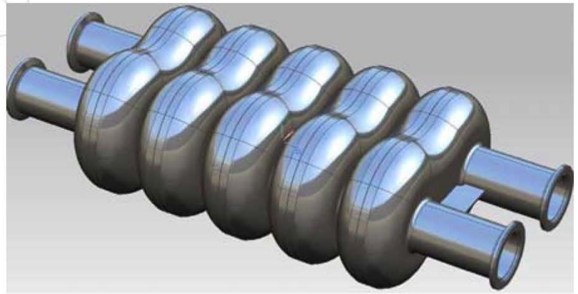
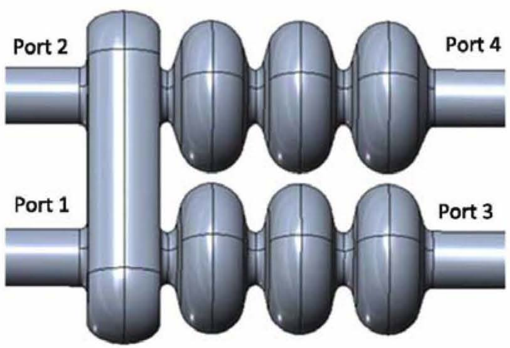
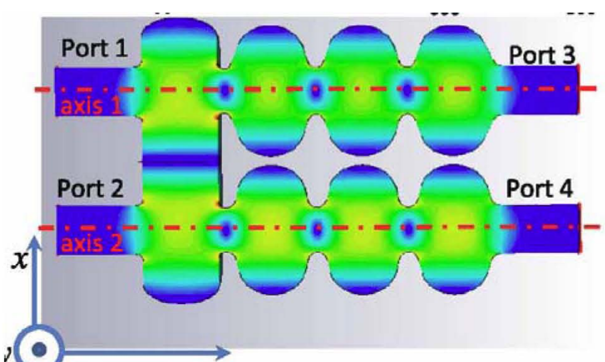
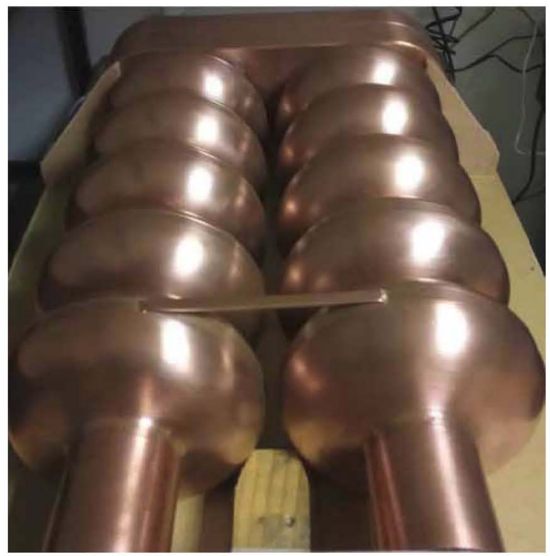


Figure 9: Multicell twin axis cavity.







Collision effects limiting luminosity

BI 1) Beam Instability (the turn shift) $\xi_y = \frac{N r_e \sigma_z}{2\pi\gamma\sigma_x\sigma_y} \le 0.1 \quad (\text{for } \beta_y \approx \sigma_z)$

MBS 2) Beam energy spread at the IP due to multiple beamstrahlung $\frac{N^3}{\sigma_x^3\sigma_z^2} < \frac{8\cdot10^{-3}}{r_e^5\gamma^2}\left(\frac{\sigma_E}{E_0}\right)^2 \frac{\delta E}{E}$

rel. energy loss in wigglers ~1/200

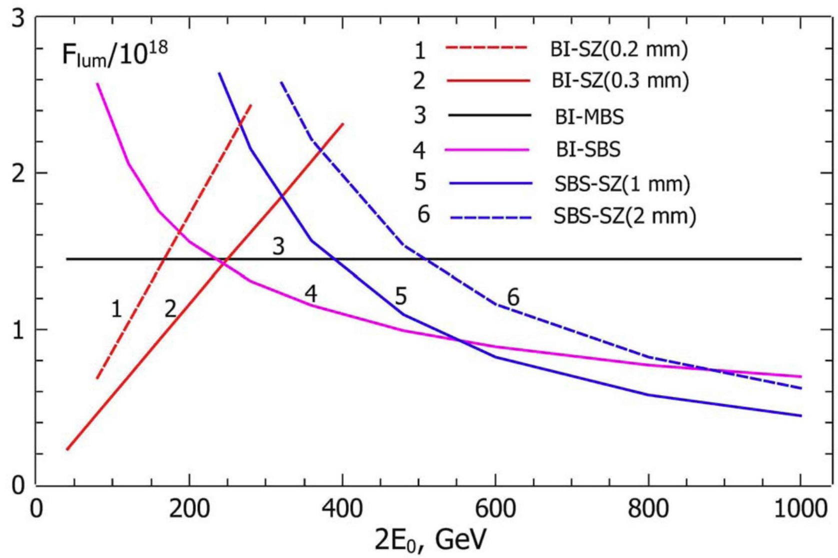
SBS 3) Beam life time due to tails in single beamstrahlung (>1.5×10[6] collisions, ~5 min) $\frac{N}{\sigma_x\sigma_z} < \frac{7.9}{\gamma^2 r_e^2 \Lambda}, \quad \Lambda \approx \ln\frac{120}{E_0/125},$

SZ 4) Bunch length $\sigma_{z,\min} < \sigma_z < \sigma_{z,\max}$

$$L = 0.3\times10^{18}\left(\frac{N/10^9}{d[\mathrm{m}]}\right)F(2E_0)\times DC,$$

DC - duty cycle

d – distance between bunches



$\xi_y = 0.1,$

$\varepsilon_{ny} = 3\cdot10^{-8}\,\mathrm{m}$

Power consideration for e+e-

Most of power consumption is connected with
1) RF power losses in SC cavities (depends on Q-value of cavities)
2) High order mode losses (HOM) (for one bunch $dE/dz \propto N^2/a^2$, a-iris radius)
(details in the article JINST 16 (2021)12, P12025)

Optimization N, dependence of L on accel. grad. G and Q

The total power (main contribution only) $P_{tot} = \left(k_1 + k_2 \frac{N^2}{d}\right) \times DC$

where the coefficients k_1 and k_2 describe the RF and HOM losses, both are proportional to the length of the collider (or E_0), d –distance between bunches. The luminosity in one collision with account of collision effects $L_1 \propto N$, then the total luminosity

$$L \propto \frac{N}{d} DC = \frac{N}{d} \left(\frac{P}{k_1 + k_2 N^2/d} \right)$$

The luminosity reach maximum at $L \propto \frac{P}{2\sqrt{k_1 k_2 d}}$ at $N = \sqrt{\frac{k_1 d}{k_2}}, \quad DC = \frac{P}{2k_1}.$

For fixed total power

1. $L \propto 1/\sqrt{d}$, so the distance between the bunches d should be as small as possible ($d = \lambda_{\rm RF}$ is the best);
2. $L \propto \sqrt{Q}$, because $k_1 \propto 1/Q$;
3. L does not depend on the acceleration gradient G. This is because the collider length is $l_c \propto 1/G$, so $k_2 \propto 1/G$, and the RF losses are $k_1 \propto G^2 \times l_c \propto G$. The result is $L = \text{const}$;
4. The optimal $N = \sqrt{k_1 d/k_2} \propto G\sqrt{d/Q}$, $DC \propto 1/G$.

In continues (CW) mode $P = k_1 + k_2 \frac{N^2}{d}, \quad L \propto \frac{N}{d},$

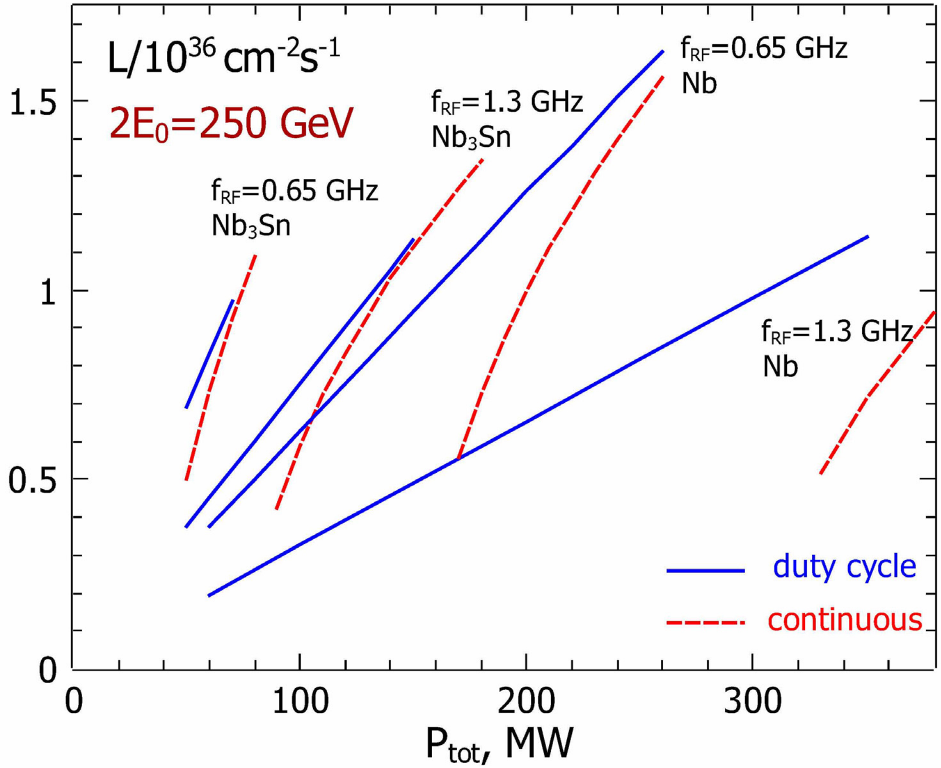
which gives $N = \sqrt{\frac{(P - k_1)d}{k_2}}, \qquad L \propto \sqrt{\frac{(P - k_1)}{k_2 d}}.$

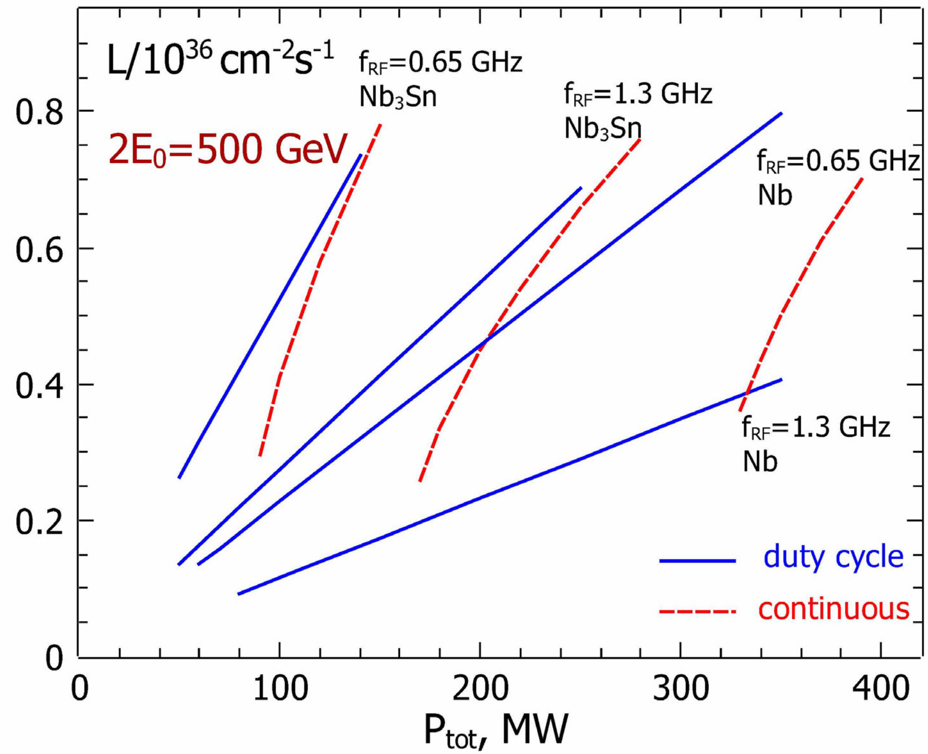
Continuous operation requires a large threshold power $P > k_1 \propto G$. However, at higher powers the behavior is similar to DC mode, where L/P does not depend on G and proportional to $Q^{1/2}$.

So, e+e- ERLC can work at high gradients !

Possible luminosities vs power (G=20 MeV/m)

V.Telnov, JINST 16 (2021)12, P12025





Luminosity can be two order of magnitude higher than at one pass ILC

Table 2. Parameters of e^+e^- linear colliders ERLC and ILC, $2E_0$ = 250 GeV.

	unit	ERLC pulsed Nb 1.8 K 1.3 GHz	ERLC pulsed Nb 1.8 K 0.65 GHz	ERLC contin. Nb_3Sn 4.5 K 1.3 GHz	ERLC contin. Nb_3Sn 4.5 K 0.65 GHz	ILC Nb 1.8 K 1.3 GHz
Energy $2E_0$	GeV	250	250	250	250	250
Luminosity $\mathcal{L}_{tot}$	10^{36} cm^{-2}s^{-1}	0.39	0.75	0.83	1.6	0.0135
P (wall) (collider)	MW	120	120	120	120	129(tot.)
Duty cycle, DC		0.19	0.37	1	1	n/a
Accel. gradient, G	MV/m	20	20	20	20	31.5
Cavity quality, Q	10^{10}	3	12	3	12	1
Length L_{act}/L_{tot}	km	12.5/30	12.5/30	12.5/30	12.5/30	8/20
N per bunch	10^9	1.13	2.26	0.46	1.77	20
Bunch distance	m	0.23	0.46	0.23	0.46	166
Rep. rate, f	Hz	$2.47 \cdot 10^8$	$2.37 \cdot 10^8$	$1.3 \cdot 10^9$	$6.5 \cdot 10^8$	6560
$\epsilon_{x,n}/\epsilon_{y,n}$	10^{-6} m	10/0.035	10/0.035	10/0.035	10/0.035	5/0.035
β_x^*/β_y at IP	cm	2.7/0.031	10.8/0.031	0.46/0.031	6.8/0.031	1.3/0.04
σ_x at IP	μm	1.05	2.1	0.43	1.66	0.52
σ_y at IP	nm	6.2	6.2	6.2	6.2	7.7
σ_z at IP	cm	0.03	0.03	0.03	0.03	0.03
$(\sigma_E/E_0)_{BS}$ at IP	%	0.2	0.2	0.2	0.2	~ 1

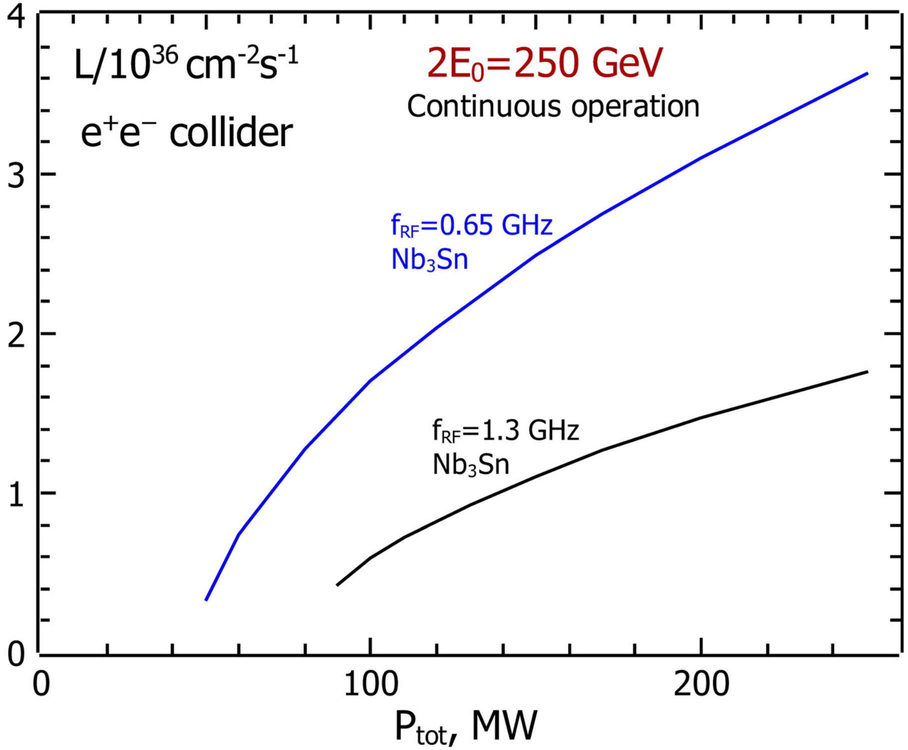
Table 3. Parameters of e^+e^- linear colliders ERLC and ILC, $2E_0$ = 500 GeV.

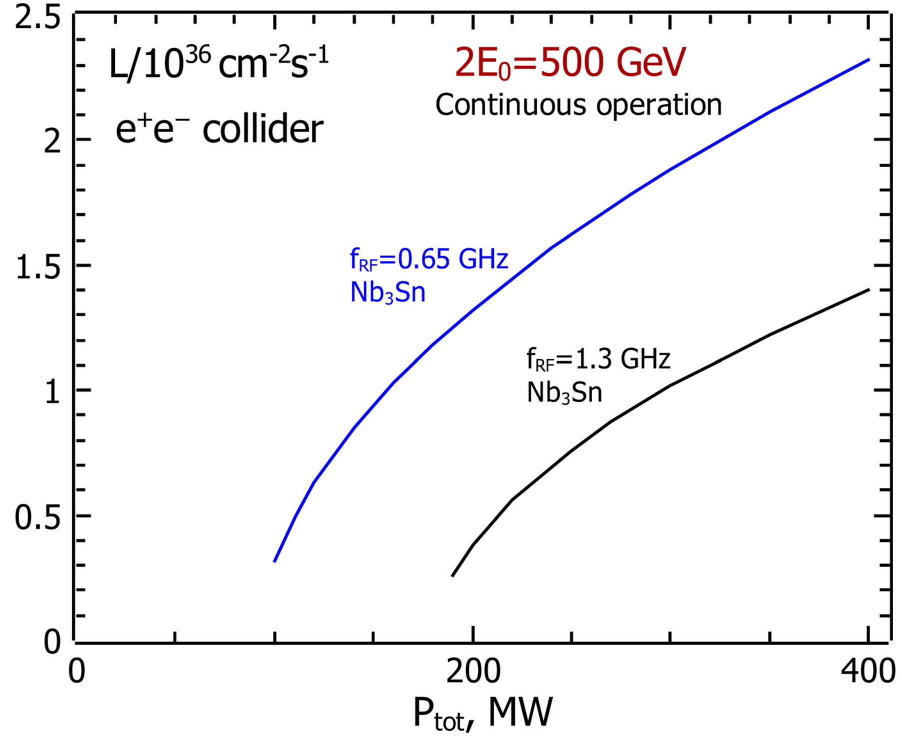
	unit	ERLC pulsed Nb 1.8 K 1.3 GHz	ERLC pulsed Nb 1.8 K 0.65 GHz	ERLC pulsed Nb_3Sn 4.5 K 1.3 GHz	ERLC contin. Nb_3Sn 4.5 K 0.65 GHz	ILC Nb 1.8 K 1.3 GHz
Energy $2E_0$	GeV	500	500	500	500	500
Luminosity $\mathcal{L}_{tot}$	10^{36} cm^{-2}s^{-1}	0.174	0.342	0.412	0.78	0.018
P (wall) (collider)	MW	150	150	150	150	163(tot)
Duty cycle, DC		0.121	0.237	0.47	1	n/a
Accel. gradient, G	MV/m	20	20	20	20	31.5
Cavity quality, Q	10^{10}	3	12	3	12	1
Length L_{act}/L_{tot}	km	25/50	25/50	25/50	25/50	16/31
N per bunch	10^9	1.13	2.26	0.685	1.23	20
Bunch distance	m	0.23	0.46	0.23	0.46	166
Rep. rate, f	Hz	$1.57 \cdot 10^8$	$1.54 \cdot 10^8$	$6.1 \cdot 10^8$	$6.5 \cdot 10^8$	6560
$\epsilon_{x,n}/\epsilon_{y,n}$	10^{-6} m	10/0.035	10/0.035	10/0.035	10/0.035	10/0.035
β_x^*/β_y at IP	cm	7.7/0.089	31/0.089	2.85/0.089	9.4/0.089	1.1/0.04
σ_x at IP	μm	1.26	2.5	0.76	1.38	0.47
σ_y at IP	nm	7.4	7.4	7.4	7.4	5.9
σ_z at IP	cm	0.089	0.089	0.089	0.089	0.03
$(\sigma_E/E_0)_{BS}$ at IP	%	0.1	0.1	0.1	0.1	~ 1

e+e- ERLC, update

V.Telnov
arXiv:2302.09758

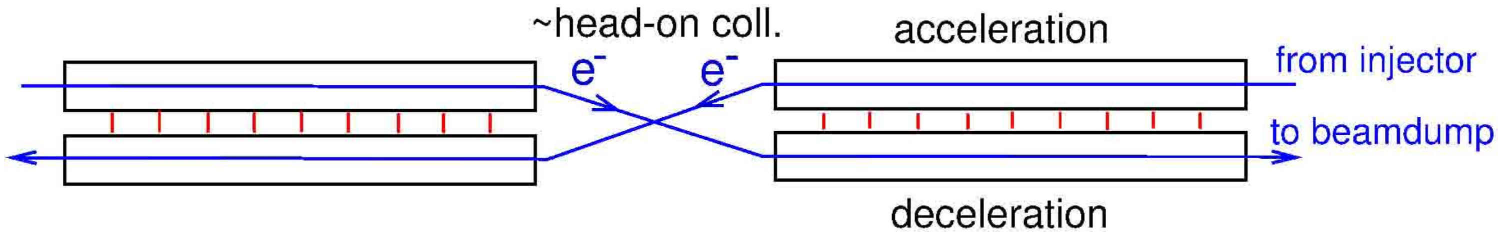
As was notice recently one can obtain higher accelerating gradients using traveling wave accelerating structures. According to V.Shemelin et al (PRAB 25, p. 021001, 2022) with the same aperture (same HOM losses) one can achieve 1.3 times higher G and 1.7 times lower RF heat losses (parameter k_1). In this case, one can work with G=40 MeV/m in continues mode with reasonable total power:





V.Telnov
arXiv:2302.09758

Twin e^-e^- LC with energy recovery

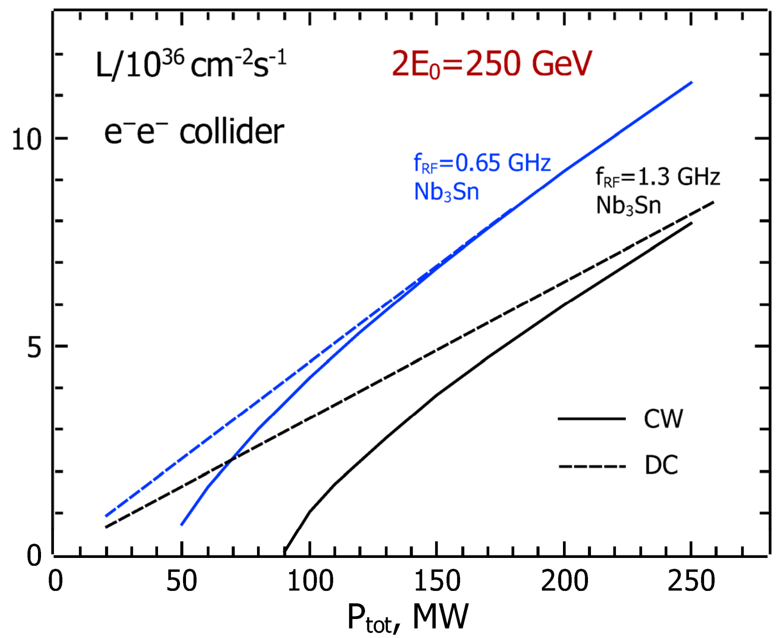


In this case the power is used for compensation of RF, HOM and beamstrahlung radiation at the IP,

$$\delta = \frac{\Delta E}{E_0} \approx \frac{5 r_e^3 N^2 \gamma}{6 \sigma_z \sigma_x^2}$$

which in optimum cases reach P_γ=10-30 MW ! Electric power needed for compensation of beamstralung losses $4P_\gamma$ was assumed.

For such e^-e^- collider $L^2 \propto P_\gamma N/(\varepsilon_{ny} E_0 d)$ and $L \propto Q^{1/4}$. See details in the paper.



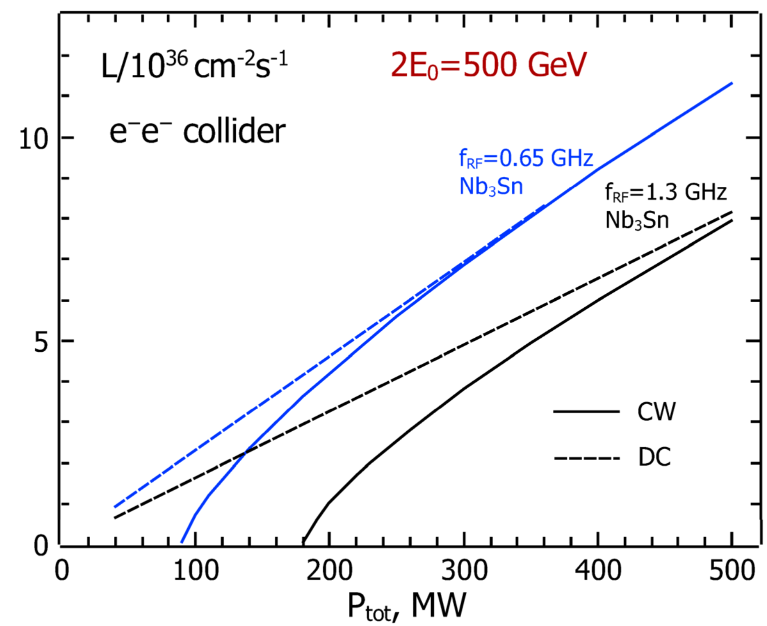


Table 1: Parameters of e^+e^- and e^-e^- linear colliders ERLC (Nb_3Sn), $2E_0 = 250$ GeV

	unit	e^+e^- 1.3 GHz	e^+e^- 0.65 GHz	e^-e^- 1.3 GHz	e^-e^- 0.65 GHz
Energy $2E_0$	GeV	250	250	250	250
Luminosity $\mathcal{L}_{\rm tot}$	$10^{36}\,\rm cm^{-2}s^{-1}$	1.1	2.5	3.8	7.8
P (wall) (collider)	MW	150	150	150	150
Accel. gradient, G	MV/m	40	40	40	40
Length $L_{\rm act}/L_{\rm tot}$	km	6.3/16	6.3/16	6.3/16	6.3/16
N per bunch	10^9	0.62	2.75	0.41	1.53
Bunch distance	m	0.23	0.46	0.23	0.46
Rep. rate, f	Hz	$1.3 \cdot 10^9$	$0.65 \cdot 10^9$	$1.3 \cdot 10^9$	$0.65 \cdot 10^9$
$\epsilon_{n,x}/\epsilon_{n,y}$	10^{-6} m	10/0.03	10/0.03	1/0.02	1/0.02
β_x^*/β_y at IP	cm	0.82/0.03	16.4/0.03	0.21/0.019	3/0.02
σ_x at IP	μm	0.58	2.6	0.092	0.35
σ_y at IP	nm	6.2	6.2	4	4.05
σ_z at IP	cm	0.031	0.031	0.019	0.02
$\Delta E/E$ at IP	10^{-4}	0.165	0.161	4.7	4.3
P_{rad} at IP	MW	0.53	1.16	10	17

Table 2: Parameters of e^+e^- and e^-e^- linear colliders ERLC (Nb_3Sn), $2E_0 = 500$ GeV

	unit	e^+e^- 1.3 GHz	e^+e^- 0.65 GHz	e^-e^- 1.3 GHz	e^-e^- 0.65 GHz
Energy $2E_0$	GeV	500	500	500	500
Luminosity $\mathcal{L}_{\rm tot}$	$10^{36}\,\rm cm^{-2}s^{-1}$	1.0	1.9	3.8	6.9
P (wall) (collider)	MW	300	300	300	300
Accel. gradient, G	MV/m	40	40	40	40
Length $L_{\rm act}/L_{\rm tot}$	km	12.5/30	12.5/30	12.5/30	12.5/30
N per bunch	10^9	0.81	2.97	0.41	1.53
Bunch distance	m	0.23	0.46	0.23	0.46
Rep. rate, f	Hz	$1.3 \cdot 10^9$	$0.65 \cdot 10^9$	$1.3 \cdot 10^9$	$0.65 \cdot 10^9$
$\epsilon_{n,x}/\epsilon_{n,y}$	10^{-6} m	10/0.03	10/0.03	1/0.02	1/0.02
β_x^*/β_y at IP	cm	4/0.09	55/0.09	0.41/0.039	6/0.04
σ_x at IP	μm	0.91	3.4	0.092	0.35
σ_y at IP	nm	7.4	7.4	4	4.05
σ_z at IP	cm	0.09	0.09	0.039	0.04
$\Delta E/E$ at IP	10^{-4}	0.078	0.076	4.5	4.3
P_{rad} at IP	MW	0.67	1.18	19.5	34

A Linear Collider Vision for the Future of Particle Physics

C. Balazs et al., arXiv:2503.19983, 31 March 2025

ERLC

V. Telnov, *A high-luminosity superconducting twin e+e- linear collider with energy recovery*, Journal of Instrumentation **16** (2021) P12025,

Basic idea The idea of ERLC (Energy Recovery Linear Collider) has been proposed by V. Telnov[513]. Fig. 60 shows the concept of ERLC. In the steady state the positron beam goes as follows. It is accelerated in the linac (a) and, after collision with the electron beam, it is decelerated in the linac (b) down to about 5 GeV. After the bunch length is decompressed in (c), the beam looses about 25 MeV of energy in the wiggler section (d). Then the beam is compressed in (e) and again accelerated in (a).

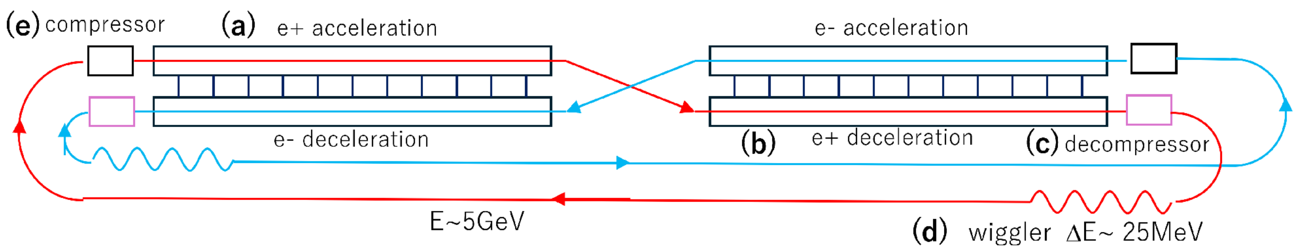


Figure 60: Schematic plot showing the concept of ERLC. Some systems such as injectors, beam dumps, etc. are omitted for simplicity.

K. Yokoya, *ILC Upgrade with Energy Recovery*, EPJ Web Conf. **315** (2024) 02016

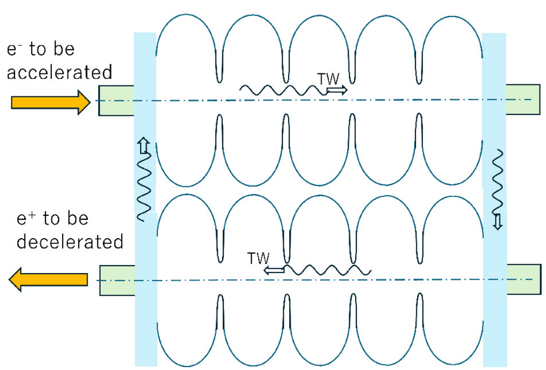


Figure 61: Concept of the twin axis cavity of TW type. There exists TW only in the clockwise direction in this figure. The upper cavity accelerates the electron beam going to the right and the lower cavity decelerates the positron beam going to the left.

The ERLC is considered now as a high luminosity upgrade of ILC (or instead of ILC?)

Critical technologies and problems of ERLC, further work

The ERLC is good idea, but there are many questions which need careful studies and technical developments:

1. Development of reliable SC cavities with a high working T and high Q, such as Nb_3Sn or better.
2. Development of twin/dual cavities.
3. Study of beam stability and HOM losses
4. Study of compressors-decompressors, they increase ε_x and determine the required damping loss. By now only energy spread was accounted.

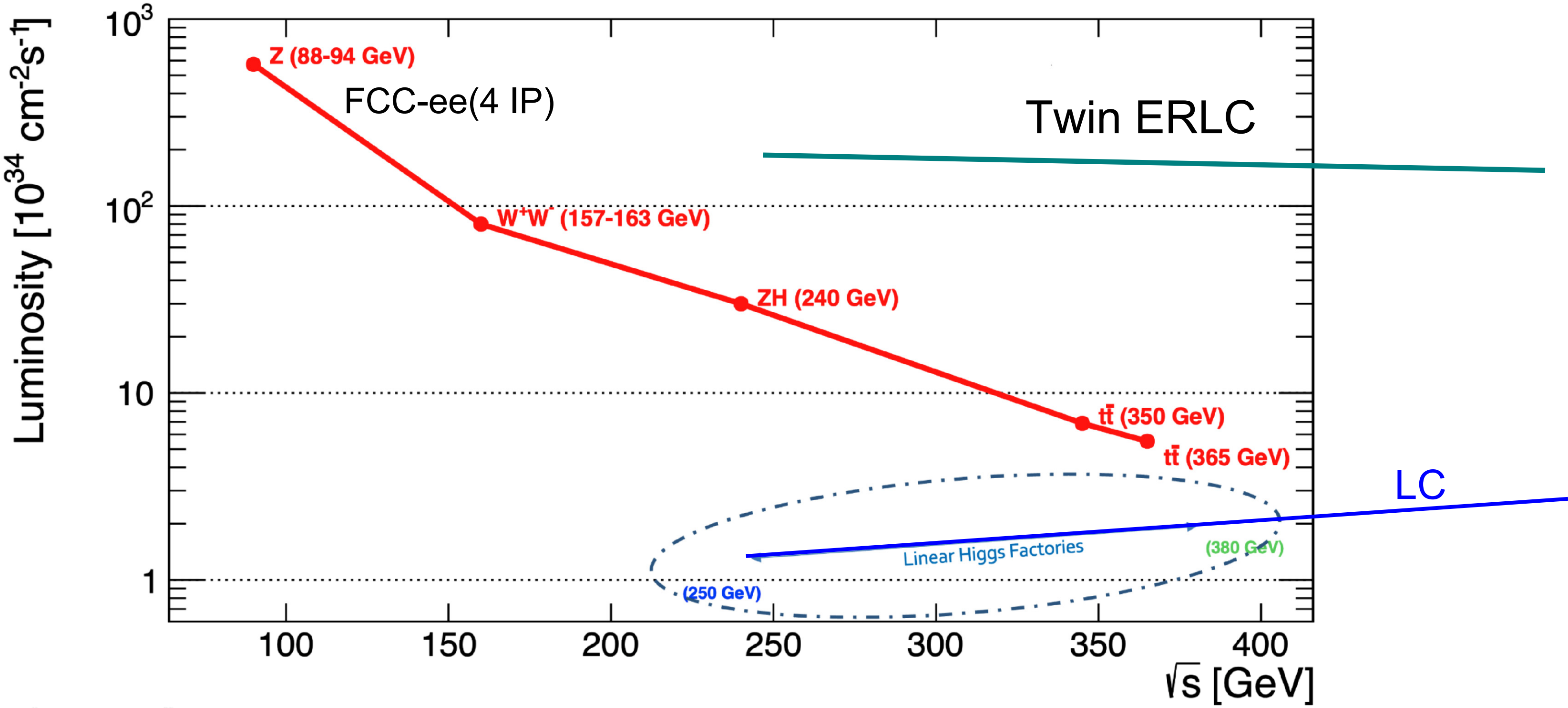
This is very exciting work for experts and young scientists, since the ERLC is an ideal collider for achieving the high luminosity, which is necessary for detailed study of the Higgs boson.

e^+e^- Higgs factories

$2E_0$=250 GeV, $e^+e^- \rightarrow ZH$, $\sigma \approx 3\cdot10^{-37}$ cm^2

$2E_0$=500+ GeV, $e^+e^- \rightarrow t^+t^-H$, ZHH (Higgs self-coupling), $\sigma \approx 1.5\cdot10^{-40}$ cm^2

from FCC-feasibility study,2025



The ERLC is undoubtedly is the superior candidate for a Higgs factory !

Conclusion (abstract)

Twin Superconducting Energy Recovery Linear Collider (ERLC): An Ultra-High Luminosity e^+e^- and e^-e^- Higgs Factory

The primary disadvantage of linear colliders is their inherent energy inefficiency: after a single collision, the bunches are directed into a beam dump. Although the use of superconducting energy recovery linacs (ERL) was proposed half a century ago to address this issue, it was realized by 1980 that the concept suffered from a fundamental flaw: the unacceptable interaction of accelerating and decelerating beams within the same linac. The resulting requirement of having only one bunch in a long linac leads to a low collision frequency, yielding a luminosity significantly lower than that of single-pass colliders (such as ILC or CLIC).

In 2021, the author proposed a twin superconducting collider concept, where accelerating and decelerating beams travel in parallel linacs coupled via RF fields. This configuration enables full energy exchange while avoiding beam-beam interactions within the accelerating structures. Consequently, the advantages of superconducting ERLs are fully realized. The luminosity is primarily limited by the power required for heat removal due to RF cavity losses (quality factor) and higher-order mode (HOM) losses in the accelerating structures, as well as by beam-beam effects.

Two configurations are considered:

1. An e^+e^-(or e^-e^-) ERL collider with continuous or pulsed (duty cycle) bunch operation. In this scheme, bunches are accelerated, collided, decelerated to ~5 GeV, and then recirculated through turnaround arcs, compressors, decompressors, and damping wigglers for re-injection.
2. An e^-e^- ERL collider with single-pass use of low-emittance electrons, which offers a simplified technical design and allows for higher luminosity per collision.

At a total power consumption of 150–300 MW and center-of-mass energies of $2E_0$=250–500 GeV, the attanable luminosity reaches $(1-2)10^{36}$ cm^{-2}s^{-1} for the first scheme and $(3-7)10^{36}$ cm^{-2}s^{-1} for the second. These values are two orders of magnitude higher than those of the ILC and an order of magnitude higher than FCC-ee (at $2E_0$=250 GeV, where 500 GeV operation is unfeasible for ring colliders). Given its capability for operation at 500 GeV, which is essential for Higgs self-coupling measurements, and its ultra-high luminosity, the ERLC is undoubtedly the superior candidate for a Higgs factory

Experts and enthusiasts, join this work!

Conclusion (abstract)

Сдвоенный сверхпроводящий линейный коллайдер с рекуперацией энергии (ERLC): e^+e^- и e^-e^- хиггсовская фабрика сверхвысокой светимости.

Основным недостатком линейных коллайдеров является низкая энергоэффективность: после однократного столкновения пучки направляются в поглотитель (beam dump). Идея использования сверхпроводящих линаков с рекуперацией энергии (ERL) для решения этой проблемы была предложена еще полвека назад. Однако к 1980 году стало ясно, что реализация этой схемы невозможна из-за паразитных столкновений ускоряемых и замедляемых пучков в линаке. Ограничение «один сгусток на линак» ведет к низкой частоте столкновений, из-за чего достижимая светимость оказывается ниже, чем в проектах с однократным использованием пучков (ILC, CLIC).

В 2021 году автором была предложена концепция сдвоенного сверхпроводящего коллайдера, в котором ускоряемые и замедляемые пучки движутся в параллельных линаках, связанных по ВЧ-полю. Такая схема обеспечивает эффективный обмен энергией между пучками и нет прямого столкновения пучков. В этом случае преимущества сверхпроводящих коллайдеров с рекуперации реализуются в полной мере, а светимость ограничивается в основном потребляемой мощностью на отвод тепла из-за RF (добротность) и HOM потерь в ускоряющих структурах и эффектами встречи.

В докладе рассматриваются две схемы:

1. e^+e^- (или e^-e^-) коллайдер с рекуперацией энергии в режиме непрерывной или импульсной (duty cycle) работы с пучком. Пучки ускоряются, сталкиваются, замедляются до энергии ~5 ГэВ, после чего проходят через поворотные арки, системы компрессии и вигглеры-затухатели для повторной инжекции.
2. e^-e^- коллайдер с однократным использованием электронов из источника с малым эмиттансом. Данная схема технически проще и позволяет достичь более высокой светимости в одном столкновении.

При полной потребляемой мощности 150–300 МВт и энергии $2E_0$=250–500 ГэВ достижимая светимость составляет $(1\text{-}2)10^{36}$ cm^{-2}s^{-1} для первой схемы и $(3\text{-}7)10^{36}$ cm^{-2}s^{-1} для второй. Это на два порядка выше, чем в ILC и на порядок, чем в FCC-ee (на энергии 250 ГэВ). Учитывая возможность работы на энергии 500 ГэВ, необходимой для измерения самодействия бозона Хиггса (self-coupling), и сверхвысокую светимость, проект ERLC, несомненно, является лучшим вариантом хиггсовской фабрики.