ERL Report Nr. 1 - Not for publication June 9, 2021

The Development of Energy Recovery Linacs

Initial Findings and Activity Report for the LDG

The ERL Panel

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Contents

Figure 3: Draft table of contents of the about 250 pages paper in preparation describing the ERL developments and prospects [1]. A similar order of topics will be used for the shorter roadmap input, complemented by chapters on milestones, cost and options for the ERL future.

Very recent:
$e\gamma \rightarrow e\mu/\mu$
concept of
100 GeV eERL
with X ray FEL
as base for
muon collider
10pmrad emittance

arXiv:2106.03255
Curatolu, Serafini

ERL concepts now
for ep, e^+e^-, yy
+ muon colliders

A selection of past, present and proposed ERL facilties vs energy and current

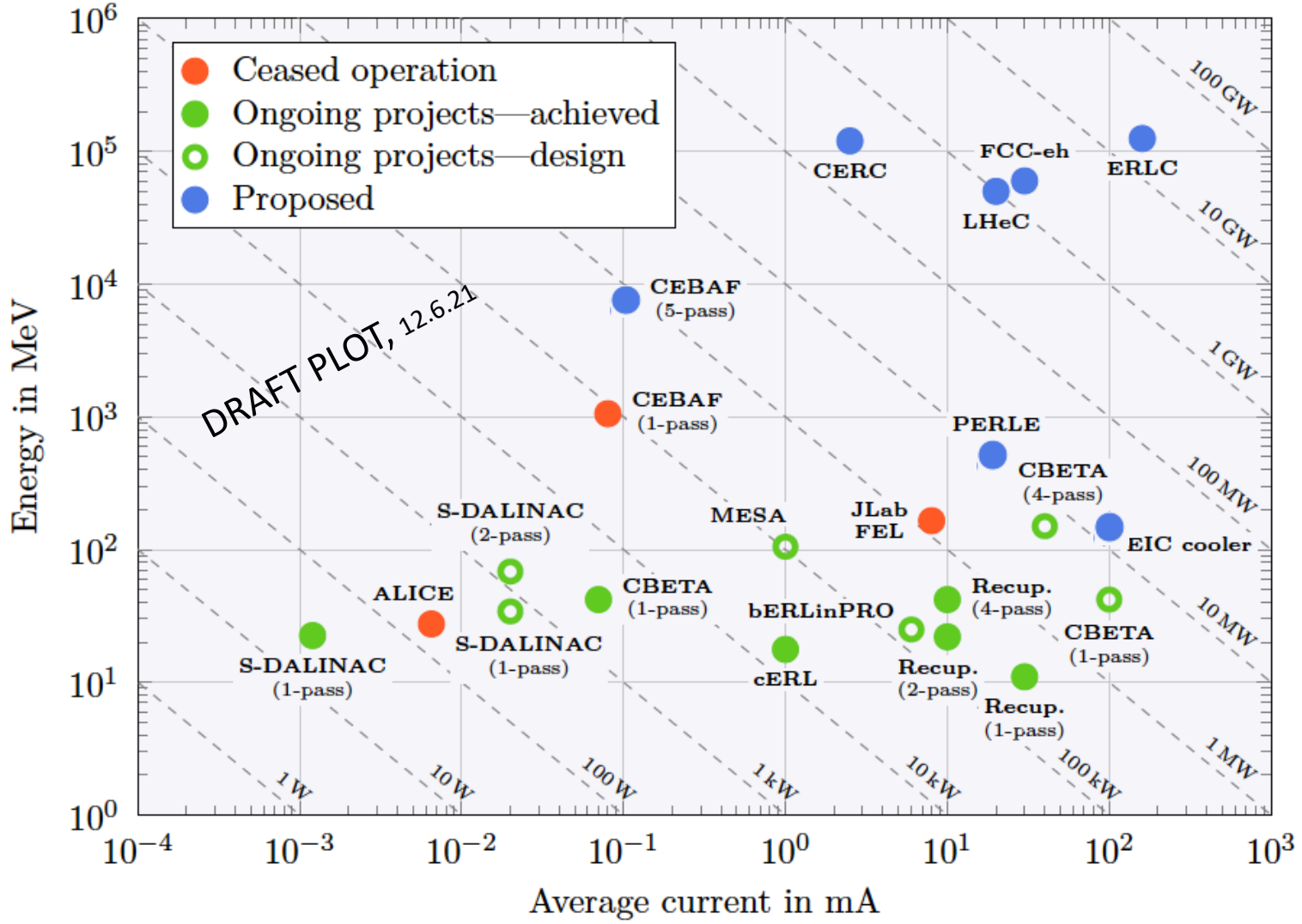

Figure 1: Electron energy vs current for ERL facilities, draft plot from long write-up [1].

ERL Features:

Very high luminosity through high electron current and small preserved injector emittance. Economic use of power $P_o/(1-\eta)$ through recovery in multiple linac passing (recirculator or head-on). Non-radiative beam dump at injection energy. → orders of magnitude improved performance at same or reduced power, **a new era for accelerator, HEP, NP and applications**

"The ERL concept is well proven and the technology is well developed. Many demonstrator facilities exist worldwide with increasing sophistication. It needs a facility comprising all essential features simultaneously: high-current, multi-pass, optimised cavities and cryo-modules and a physics quality beam eventually for experiments". (Bob Rimmer)

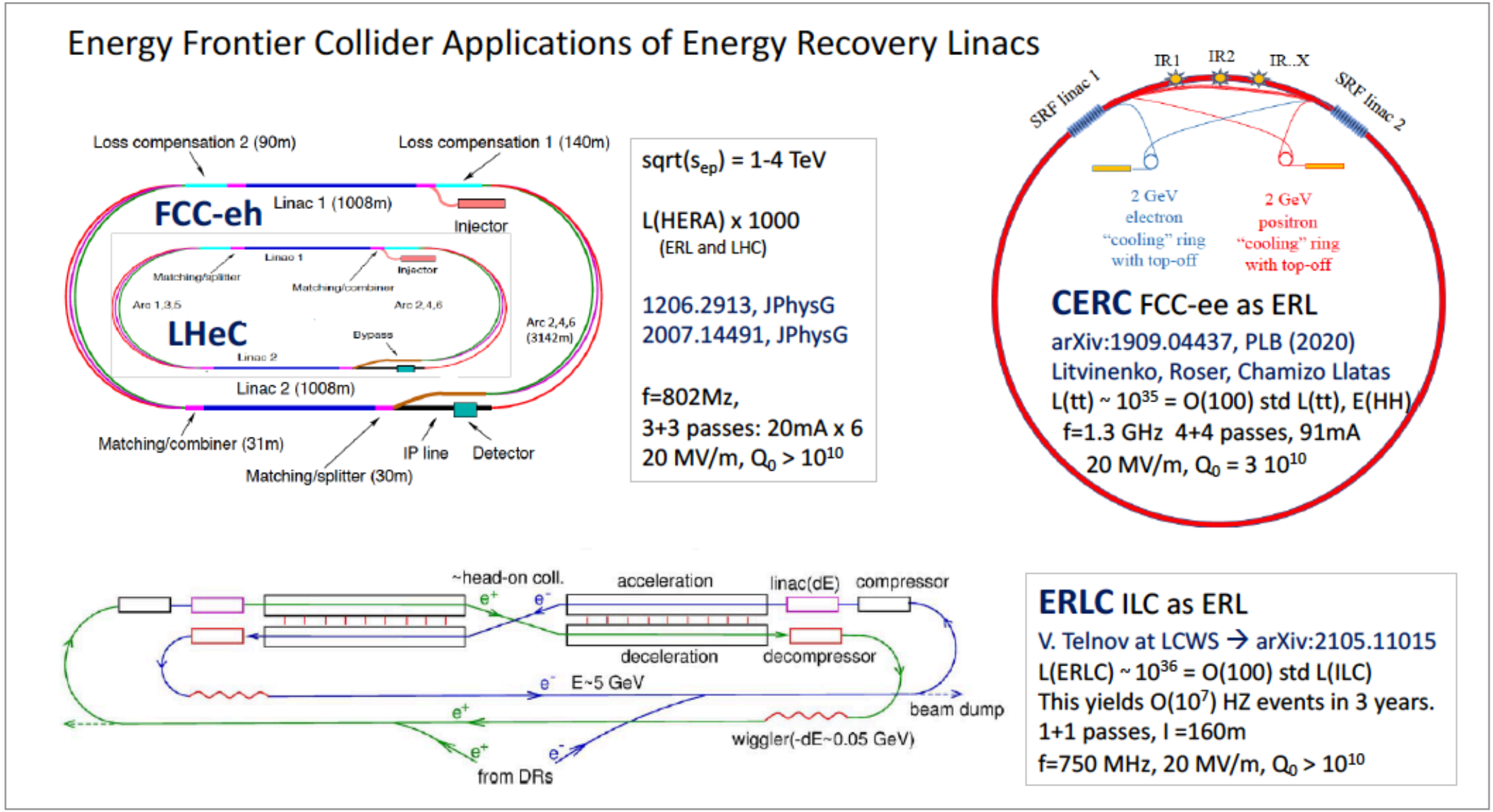

Figure 2: Sketch of possible future colliders based on ERLs: left top: LHeC and FCC-eh; right top: CERC; bottom: ERLC. For more information see the arXiv references displayed.

Evaluation of ERL concepts for FCC-ee [CERC] and the ILC [ERLC]

Vladimir Litvinenko+ https://doi.org/10.1016/j.physletb.2020.135394 ;
Valery Telnov, https://arxiv.org/abs/2105.11015

The e^+e^- ERL Sub-Panel

The Sub-Panel should evaluate the technical and financial implications of the two novel concepts compared to the FCC-ee and ILC projects:

What are the technical advances, specifically in luminosity?

What are the technical solutions + obstacles requiring R&D?

How much time would that additionally require?

What is the rough cost implication (to about 10%)

Dates for the sub-Panel

Kick-off meeting held June 9, 2021

Completion by September 3, 2021

Deliverable:

A short report (~20 pages) detailing the conclusions of the evaluation, which should be agreed and supported by the entire sub-Panel and published as Appendix B to the full Panel report.

Methodology: Sessions with proponents to begin with. Sessions open to other ERL panel members

Procedure agreed with the proponents

Valeri Telnov and Vladimir Litvinenko, Tomas Roser

Sub-Panel members

Chris Adolphsen (SLAC) Reinhard Brinkmann (DESY)

Oliver Brüning (CERN) Andrew Hutton (JLab) – Chair

Sergei Nagaitsev (Fermilab) Max Klein (Liverpool)

Peter Williams (STFC) Akira Yamamoto (KEK)

Kaoru Yokoya (KEK) Frank Zimmermann (CERN)

Chair: Bettina Kuske (HBZ, Berlin)

13:00 **Welcome by the Lab Directors Group** 10m
Prof. Dave Newbold (STFC R.Appleton Laboratory)

13:10 **Introduction** 10m
Max Klein (University of Liverpool)

13:20 **ERL Facilities** 25m
Andrew Hutton (Jefferson Laboratory)

13:45 **High Current Electron Sources** 15m
Boris Militsyn (STFC)

14:00 **SRF Developments for ERLs** 25m
Robert Alan Rimmer (Jefferson Laboratory)

14:25 **ERL Prospects for High Energy Colliders** 25m
Oliver Bruning (CERN)

14:50 **Coffee/tea Break** 10m

Chair: Olga Tanaka (KEK)

15:00 **Low Energy Physics with ERLs** 20m
Jan Bernauer (Stony Brook University)

15:20 **Industrial ERL Applications** 20m
Peter Williams (Daresbury Laboratory)

15:40 **Energy Recovery and Sustainability** 20m
Erk Jensen (CERN)

Chairs: Andrew Hutton and Max Klein

16:00 **Discussion** 55m

ERL Symposium

Friday 4.6. 1-5pm CEST

https://indico.cern.ch/event/1040671/

An initial observation (not only) by the panel:
ERLs are more than an appealing technology:

They (cor)respond to **A NEW ERA** in particle and several other fields of physics, industry, accelerators .. in a world that cannot proceed without renewed care for our planet.

Energy Recovery Linacs are novel technologies with far reaching impacts on science + society.

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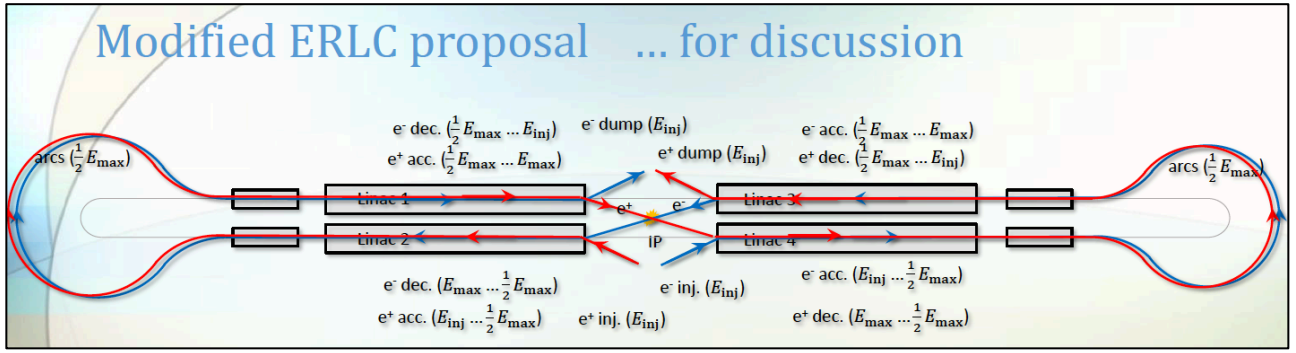

The symposium was an important event for information, consultation and formation of a more coherent R&D ERL effort.