ANKARA ÜNİVERSİTESİ ARAŞTIRMA DEKANLIĞI

CERN'İN 70. YILINDA TÜRKİYE-CERN İLİŞKİLERİ

VE ANKARA ÜNİVERSİTESİNİN ROLÜ

CERN LHeC PROJESİ

Türk ve CERN Fizikçilerinin Başlattığı Proje

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Hızlandırıcı Teknolojileri Enstitüsü
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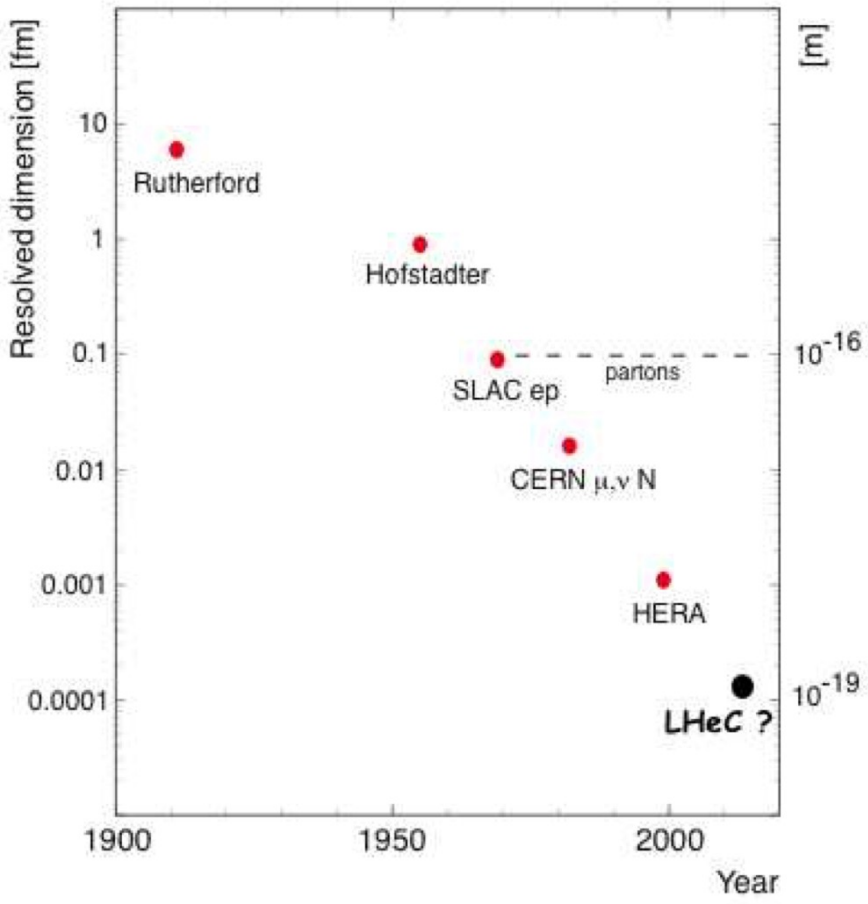
09.05.2024

İ Ç E R İ K

- Nükleon Yapısını Keşfetmek
- CERN LHeC Projesi
- CERN LHeC Projesi Başlangıç Toplantısı
- İlk ECFA-CERN LHeC Çalıştayı
- Türkiye'deki Çalışmalar
- Yorumlar

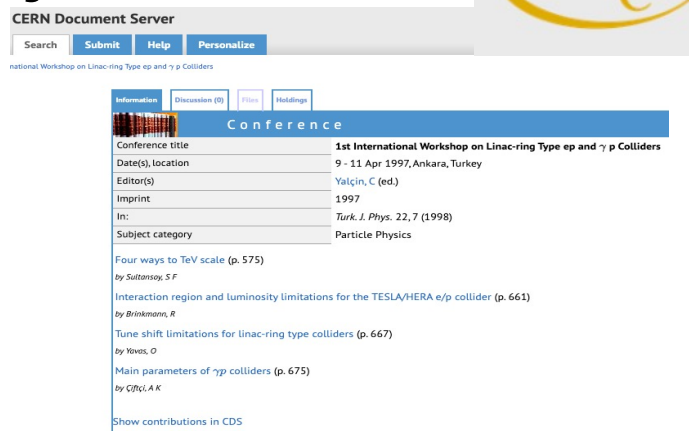
Nükleon Yapısını Keşfetmek

- Rutherford Deneyi: 1911 atomun yapısı
- Hofstadter Deneyi: 1954-1957 proton yük dağılımı
- SLAC ep: Proton partonic iç yapısı 10^{-16} m
- CERN mu $\nu_\mu N$: 1980's nötrino-çekirdek saçılması
- HERA: e-/e+ (27.5 GeV) p (920 GeV)
  $\chi \sim 10^{-4}\ Q^2 \sim 2 - 6\ GeV^2$
- LHeC: e- (50 GeV) p (7 TeV)
  $\chi \sim 10^{-6}\ Q^2 \sim 1\ GeV^2$



DIS deneylerinin çözünürlüğü 20. yüzyıldaki "kilometre taşları"
(**21. yüzyılda LHeC'de dahil olmak üzere**).

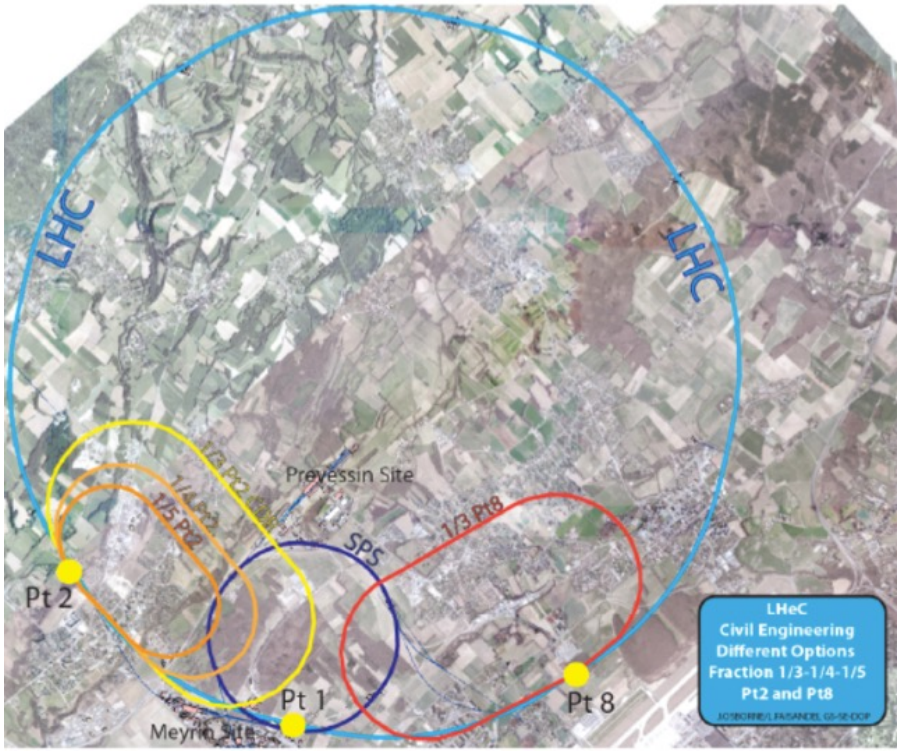
CERN LHeC Projesi



LHeC **L**arge **H**adron **e**lectron **C**ollider, önerisi CERN ve Türk araştırmacılar tarafından yapılan **elektronları protonlarla/iyonlarla** çarpıştırmak üzere tasarlanan bir makinedir.

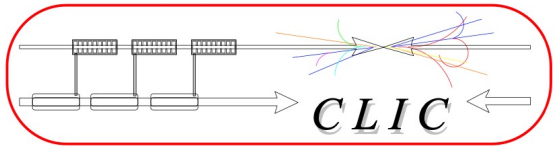
LHC'nin proton halkasına ek olarak kurulacak olan bir elektron demet hattı ile oluşturulacak bir çarpıştırıcıdır.

LHC için PDF'leri sağlayan HERA dan sonraki en yüksek kütle merkezi enerjili e-p çarpıştırıcısı olacaktır.



CERN LHeC Projesi Başlangıç Toplantısı

CERN – EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH



CLIC Note 613

Mini-Workshop on Machine and Physics Aspects of CLIC based future Collider Options

Editor: F. Tecker

CERN-OPEN-2004-026
20/09/2004

Abstract

A one-day workshop took place at CERN to discuss different possibilities for colliding CLIC beam with LHC beam, and to review the physics potential of CLIC and CLIC-LHC based colliders in detail. The options include e-p, e-A, γ-p, and γ-A collisions to study Quantum Chromo-Dynamics in a wide kinematical region and FEL based γ-A collisions for Nuclear Resonant Flourescence.
After a brief introduction to the various options and the related issues, the presentations of the workshop are collected in this note.

Table of Contents:

https://cds.cern.ch/record/798726/files/open-2004-026.pdf?version=1

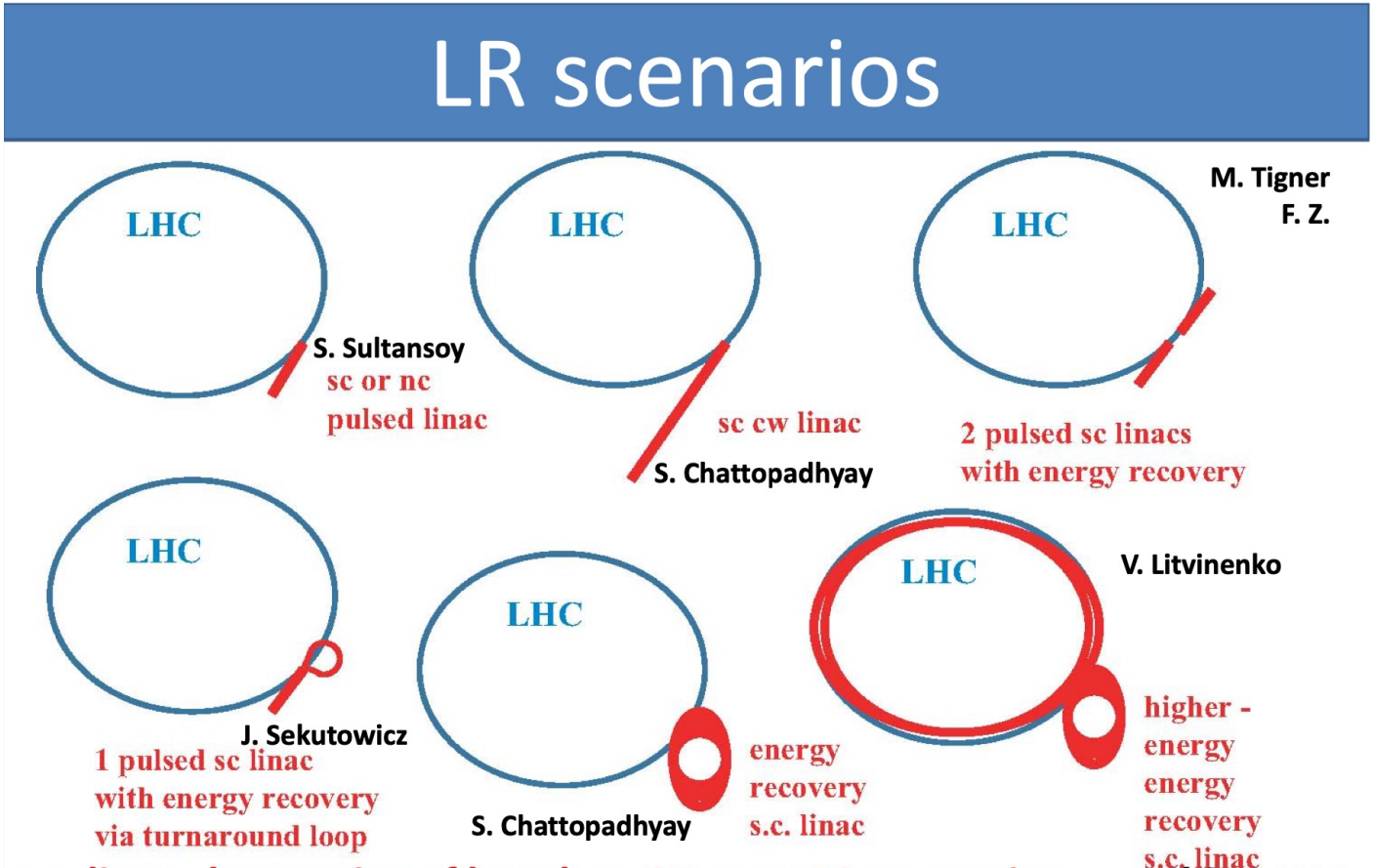
CERN LHeC Projesi
İlk ECFA-CERN LHeC Çalıştayı

CERN LHeC Projesi
İlk ECFA-CERN LHeC Çalıştayı

LR e-p motivation

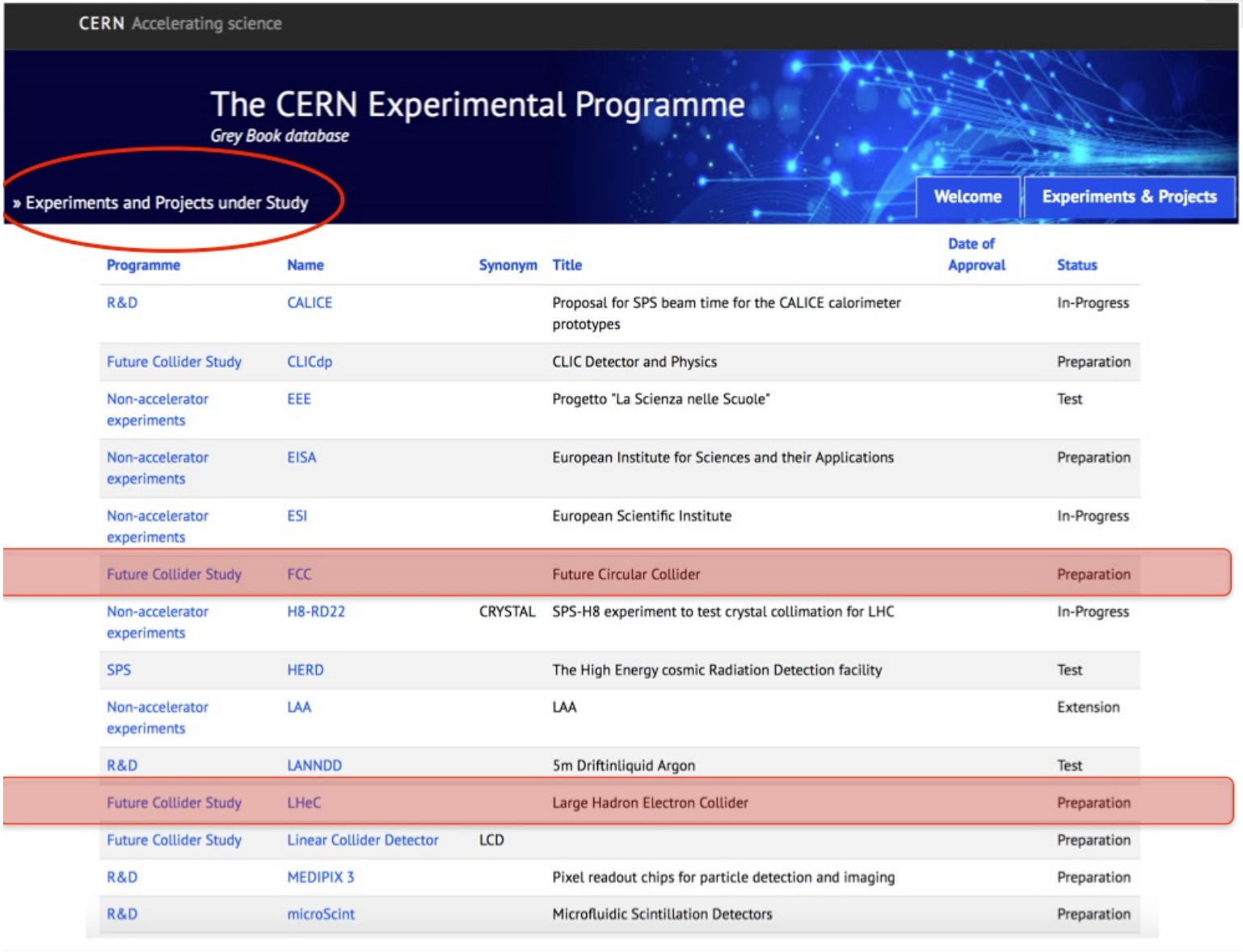
- colliding 7 TeV p's with 25-140 (-300) GeV e-'s:
  → extending LHC discovery reach
  → enabling LHC precision physics
- history: - Ankara workshop 1997, Turkish JP, 22, 7 (1998)
  -S. Sultansoy, Aachen 2003, EPJ C33: S1064 (2004)
  -D.Schulte,F.Zimmermann, EPAC'04 (CLIC-1/LHC p s-bunch)
  -H. Aksakal et al, NIM A576: 287 (2007) (CLIC & ILC vs LHC)
  - S. Chattopadhyay: ***cw!, ERL!*** (2007), A. Eide's report (2008)
  -V. Litvinenko, CERN AB Form 11 March 2008
  -F. Zimmermann et al, EPAC'08
  -J. Skrabacz' report (2008)
- e- linac offers several distinct advantages
  e.g.: separation from LHC, high beam quality, synergies

CERN LHeC Projesi
İlk ECFA-CERN LHeC Çalıştayı



s.c. linac , long trains of bunches, 25-ns or 50-ns spacing, matching LHC p beam (*PLACET: stable);* long pulse or cw → high luminosity; optional energy recovery → higher luminosity; 1.3 GHz (ILC) or 700 MHz (SPL)

CERN LHeC Projesi



CERN Accelerating science

The CERN Experimental Programme

Grey Book database

» Experiments and Projects under Study

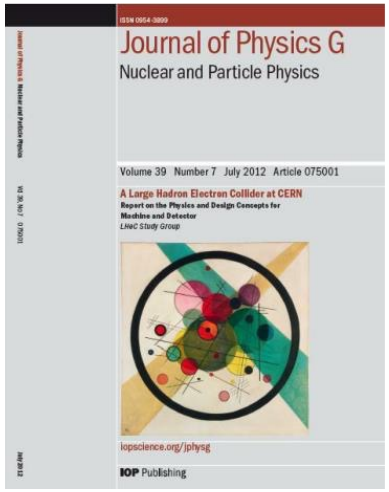
Welcome | Experiments & Projects

Programme	Name	Synonym	Title	Date of Approval	Status
R&D	CALICE		Proposal for SPS beam time for the CALICE calorimeter prototypes		In-Progress
Future Collider Study	CLICdp		CLIC Detector and Physics		Preparation
Non-accelerator experiments	EEE		Progetto "La Scienza nelle Scuole"		Test
Non-accelerator experiments	EISA		European Institute for Sciences and their Applications		Preparation
Non-accelerator experiments	ESI		European Scientific Institute		In-Progress
Future Collider Study	FCC		Future Circular Collider		Preparation
Non-accelerator experiments	H8-RD22	CRYSTAL	SPS-H8 experiment to test crystal collimation for LHC		In-Progress
SPS	HERD		The High Energy cosmic Radiation Detection facility		Test
Non-accelerator experiments	LAA		LAA		Extension
R&D	LANNDD		5m Driftinliquid Argon		Test
Future Collider Study	LHeC		Large Hadron Electron Collider		Preparation
Future Collider Study	Linear Collider Detector	LCD			Preparation
R&D	MEDIPIX 3		Pixel readout chips for particle detection and imaging		Preparation
R&D	microScint		Microfluidic Scintillation Detectors		Preparation

CERN LHeC Projesi

CDR

2012



630 sayfa

150 yazar, 80 enstitü

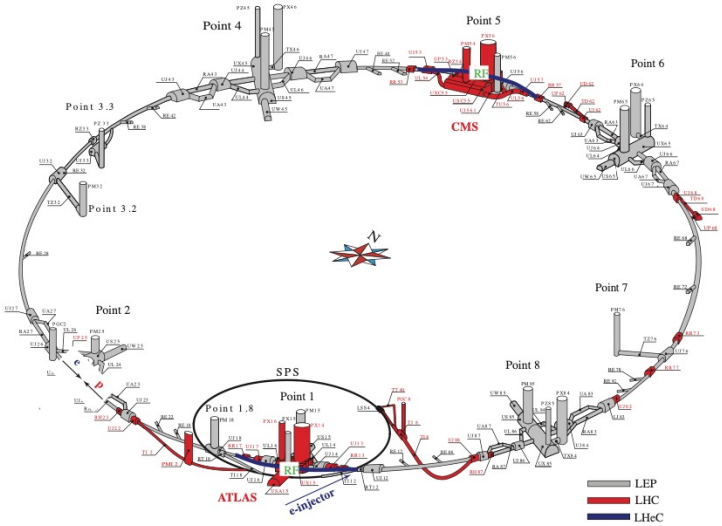
6 Türk üniversite
~25 Türk araştırmacı

Contents

CERN LHeC Projesi

Çarpıştırıcı Tasarımları

Halka-Halka

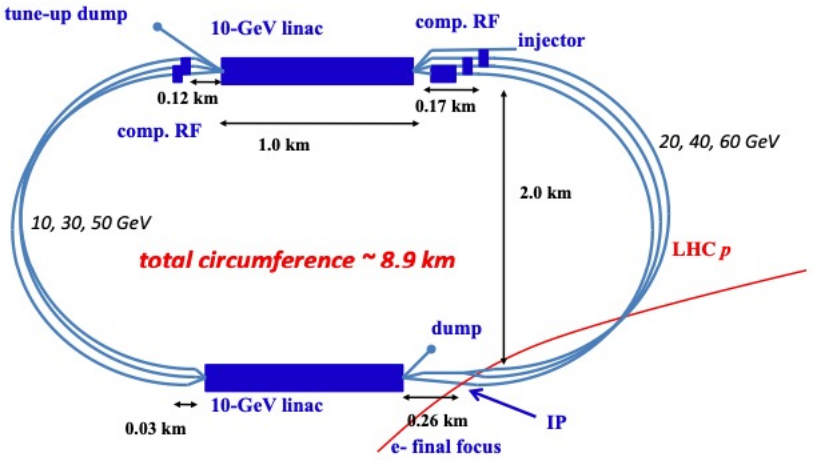


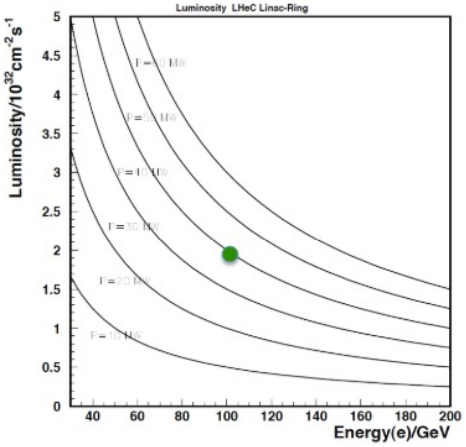
Detector Option		1°		10°	
Quantity	unit	electrons	protons	electrons	protons
Number of bunches		2808			
Particles/bunch N_b	10^{10}	1.96	17	1.96	17
Horiz. beta-function	m	0.4	4.0	0.18	1.8
Vert. beta-function	m	0.2	1.0	0.1	0.5
Horiz. emittance	nm	5.0	0.5	5.0	0.5
Vert. emittance	nm	2.5	0.5	2.5	0.5
Distance to IP	m	6.2	22	1.2	22
Crossing angle	mrad	1.0		1.0	
Synch. Rad. in IR	kW	51		33	
absolute Luminosity	$m^{-2}\,s^{-1}$	$8.54 * 10^{32}$		$1.8 * 10^{33}$	
Loss-Factor S		0.86		0.75	
effective Luminosity	$m^{-2}\,s^{-1}$	$7.33 * 10^{32}$		$1.34 * 10^{33}$	

Luminosity ~ 10^{33}

Doğrusal-Halka

SPL
ERL

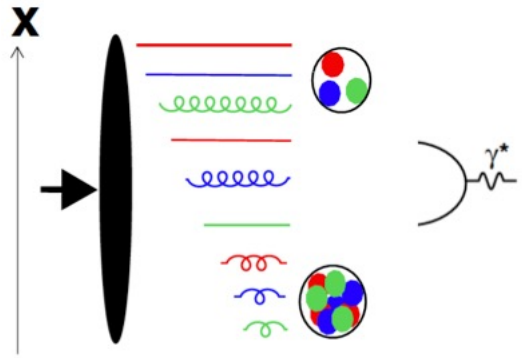




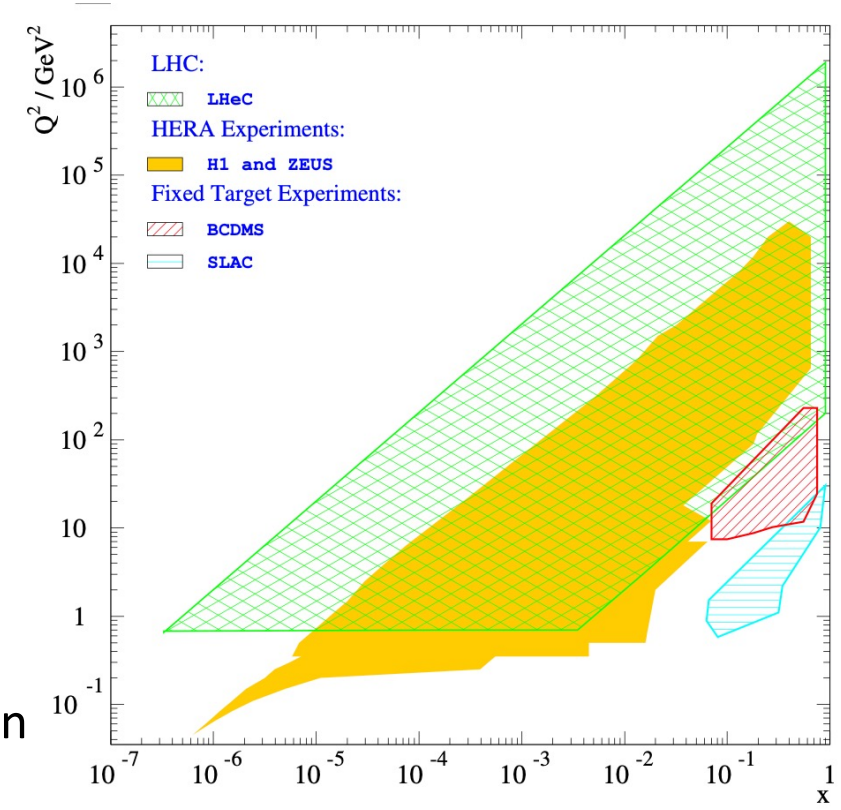
Luminosity ~ 2-3 x 10^{32}

CERN LHeC Projesi

QCD Explorer

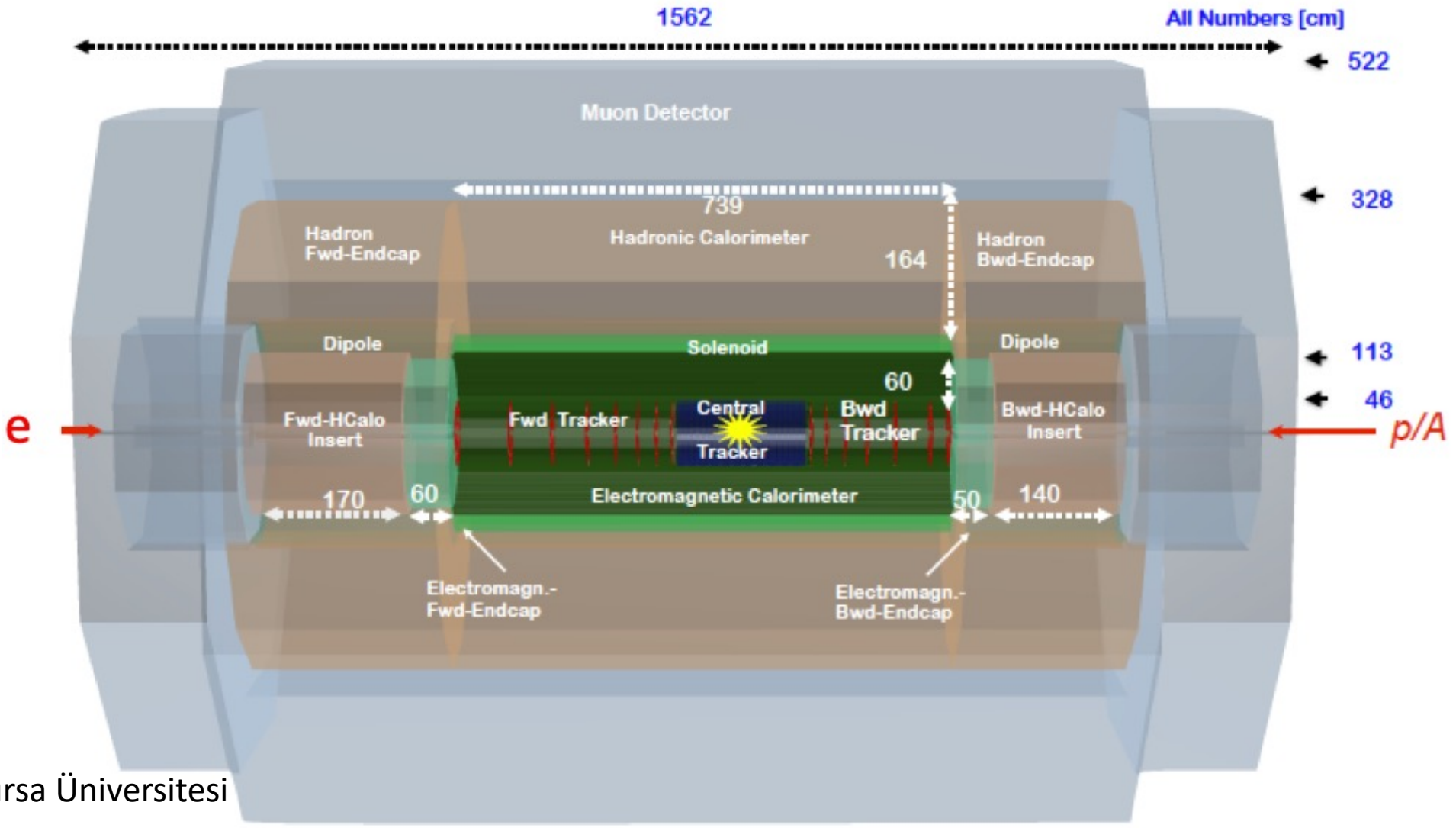


- Parton Dağılım Fonksiyonlarının (PDF) yüksek hassasiyette belirlenmesi
- Kuantum Renk Dinamiğinin temellerinin araştırılması
- Özellikle de $Q^2 \approx 1$ GeV^2'de 10^{-6}'ya kadar küçük x Björken bölgesinin araştırılması için yeterlidir.



CERN LHeC Projesi

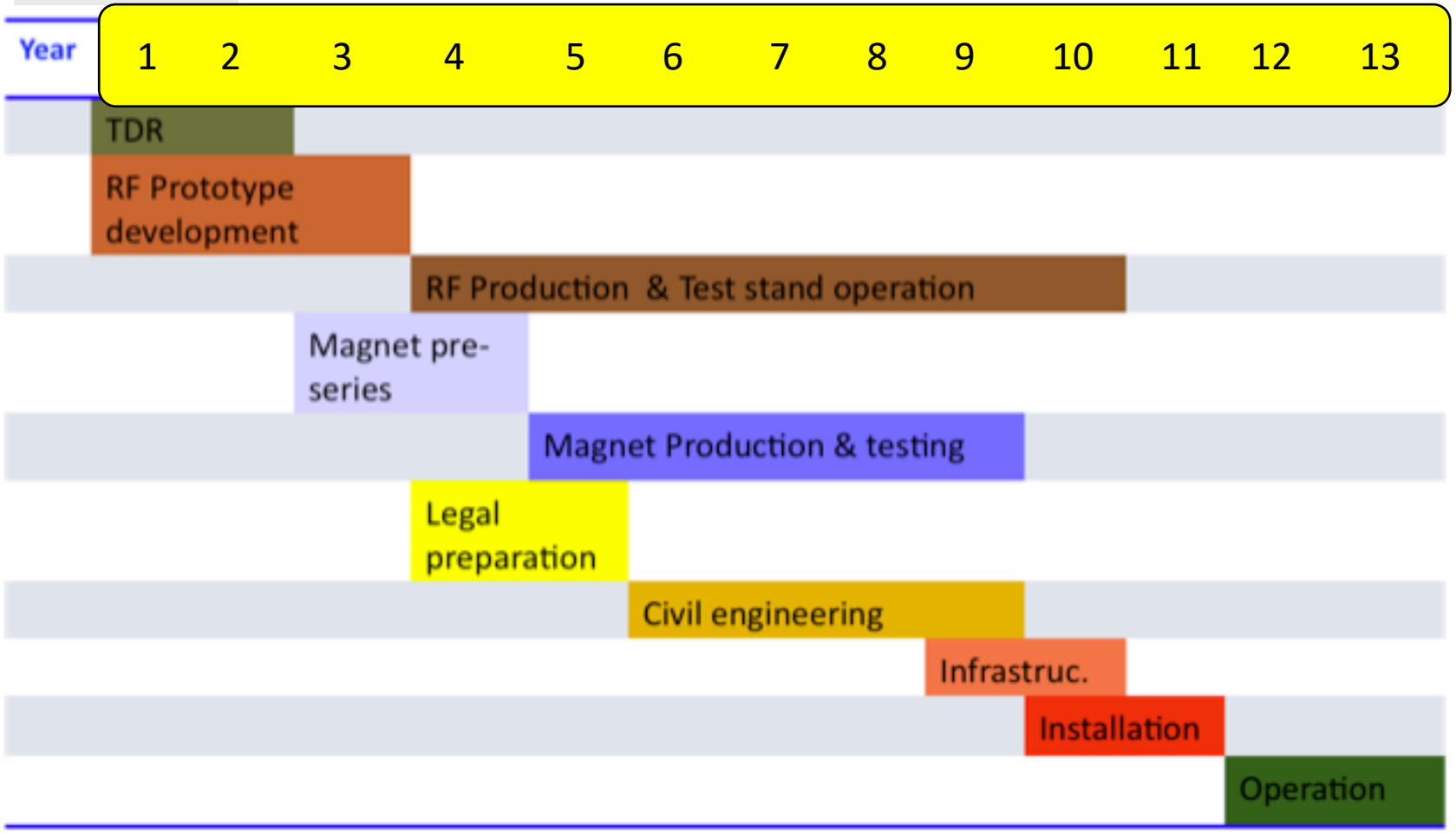
Algıç: 13.3 m uzunluk, 9 m çap



Bursa Üniversitesi

CERN LHeC Projesi

Timeline



Türkiyedeki Çalışmalar

Yayınlar

Probing the Anomalous FCNC Couplings at Large Hadron Electron Collider #2

I. Turk Cakir (CERN and Giresun U.), A. Yilmaz (Giresun U.), H. Denizli (Abant Izzet Baysal U.), A. Senol (Abant Izzet Baysal U.), H. Karadeniz (Giresun U.) et al. (May 15, 2017)

Published in: *Adv.High Energy Phys.* 2017 (2017) 1572053 • e-Print: 1705.05419 [hep-ph]

pdf DOI cite claim reference search 20 citations

Search for excited spin-3/2 neutrinos at LHeC #3

A. Ozansoy (Ankara U.), V. Arı (Ankara U.), V. Çetinkaya (Dumlupinar U.) (Jul 15, 2016)

Published in: *Adv.High Energy Phys.* 2016 (2016) 1739027 • e-Print: 1607.04437 [hep-ph]

pdf DOI cite claim reference search 8 citations

Search for anomalous $WW\gamma$ and WWZ couplings with polarized e-beam at the LHeC #4

I.T. Cakir (Istanbul Aydin U.), O. Cakir (Ankara U.), A. Senol (Kastamonu U.), A.T. Tasci (Kastamonu U.) (Jun 30, 2014)

Published in: *Acta Phys.Polon.B* 45 (2014) 10, 1947 • e-Print: 1406.7696 [hep-ph]

pdf DOI cite claim reference search 26 citations

Probing Anomalous HZZ Couplings at the LHeC #5

I.T. Cakir (Ankara U.), O. Cakir (Ankara U.), A. Senol (Abant Izzet Baysal U. and Kastamonu U.), A.T. Tasci (Kastamonu U.) (Apr 12, 2013)

Published in: *Mod.Phys.Lett.A* 28 (2013) 31, 1350142 • e-Print: 1304.3616 [hep-ph]

pdf DOI cite claim reference search 13 citations

Resonant Production of Sbottom via RPV Couplings at the LHeC #6

S. Kuday (Ankara U. and Istanbul Aydin U.) (Apr 8, 2013)

Published in: *J.Korean Phys.Soc.* 64 (2014) 1783-1787 • e-Print: 1304.2124 [hep-ph]

pdf DOI cite claim reference search 4 citations

Associated Production of Single Top Quark and W-boson Through Anomalous Couplings at LHeC based γp Colliders #7

I.T. Cakir (Ankara U.), A. Senol (Kastamonu U.), A.T. Tasci (Kastamonu U.) (Jan, 2013)

Published in: *Mod.Phys.Lett.A* 29 (2014) 1450021 • e-Print: 1301.2617 [hep-ph]

pdf DOI cite claim reference search 5 citations

Single Production of Fourth Family b' Quark at the Large Hadron electron Collider #11

O. Cakir (Ankara U.), V. Cetinkaya (Ankara U.) (Dec, 2009)

Published in: *Mod.Phys.Lett.A* 25 (2010) 2571-2577 • e-Print: 0912.2041 [hep-ph]

pdf DOI cite claim reference search 5 citations

Search for Scalar Diquarks at the LHeC Based Gamma-Proton Collider #12

M. Sahin (Ankara U.), O. Cakir (Ankara U.) (Nov, 2009)

Published in: *Balk.Phys.Lett.* 18 (2010) 024 • e-Print: 0911.0496 [hep-ph]

pdf cite claim reference search 2 citations

Anomalous Single Top Production at the Large Hadron electron Collider Based gamma p Collider #13

I.T. Cakir (CERN), O. Cakir (Ankara U.), S. Sultansoy (TOBB ETU, Ankara and Baku, Inst. Phys.) (Nov, 2009)

Published in: *Phys.Lett.B* 685 (2010) 170-173 • e-Print: 0911.4194 [hep-ph]

pdf DOI cite claim reference search 15 citations

Single Production of Fourth Family t-prime Quarks at LHeC #14

O. Cakir (Ankara U.), A. Senol (Kastamonu U.), A.T. Tasci (Kastamonu U.) (May, 2009)

Published in: *EPL* 88 (2009) 1, 11002 • e-Print: 0905.4347 [hep-ph]

pdf DOI cite claim reference search 24 citations

Türkiyedeki Çalışmalar

Yayınlar

The LHeC Project: e-Ring Revisited

Umit KAYA[1,2], Bora KETENOGLU[*2], Saleh SULTANSOY[1,3]

Abstract: Construction of a new 9 km long e-ring tangential to the Large Hadron Collider (LHC) has been proposed as an option for QCD-Explorer stage of the Large Hadron electron Collider (LHeC). It is shown that L=10^{33} $cm^{-2}s^{-1}$ can be achieved with 90 MW synchrotron radiation losses. This luminosity value, which coincides with basic version of ERL60⊗LHC, will be sufficient for precise determination of (Parton Distribution Function) PDFs for LHC, as well as exploration of QCD basics, especially small x Björken region up to 10^{-6} at $Q^2 \approx 1$ GeV^2. In addition, some comments on basic and upgraded versions of ERL60⊗LHC are presented as well. It is shown that upgraded ERL60⊗LHC version with L=10^{34} $cm^{-2}s^{-1}$ requires high wall plug power exceeding 160 MW.

Probing small x(g) region with the LHeC based gamma-p colliders

U. Kaya (TOBB ETU, Ankara), S. Sultansoy (TOBB ETU, Ankara), G. Unel (UC, Irvine)
Nov, 2012

Why QCD Explorer stage of the LHeC should have high(est) priority

S.A. Çetin (Dogus U., Kadikoy), S. Sultansoy (TOBB ETU, Ankara and Baku, Inst. Phys.), G. Ünel (UC, Irvine)
May 23, 2013

Sensitivity physics expected to the measurement of the quartic $WW\gamma\gamma$ couplings at the LHeC and the FCC-he

E. Gürkanli (Sinop U.), V. Ari (Ankara U.), A. Gutiérrez-Rodríguez (Zacatecas U.), M.A. Hernández-Ruíz (Zacatecas U.), M. Koksal (Cumhuriyet U.)
Mar 14, 2020

Resonant Production of Color Octet Electron at the Lhec

M. Sahin (TOBB ETU, Ankara), S. Sultansoy (TOBB ETU, Ankara and Baku, Inst. Phys.), S. Turkoz (Ankara U.)
Jan, 2010

Anomalous quartic $W^+W^-\gamma\gamma$ couplings in e^-p collisions at the LHeC and the FCC-he

V. Ari (Ankara U.), E. Gurkanli (Sinop U.), A. Gutiérrez-Rodríguez (Zacatecas U.), M.A. Hernández-Ruíz (Zacatecas U.), M. Köksal (Cumhuriyet U.)
Nov 10, 2019

Search for excited spin-3/2 neutrinos at LHeC

A. Ozansoy (Ankara U.), V. Arı (Ankara U.), V. Çetinkaya (Dumlupinar U.)
Jul 15, 2016

Analysis of the anomalous quartic WWWW couplings at the LHeC and the FCC-he

E. Gurkanli (Sinop U.), V. Ari (Cumhuriyet U.), A.A. Billur (Cumhuriyet U.), M. Köksal (Cumhuriyet U.)
Apr 15, 2019

Study on the anomalous quartic $W^+W^-\gamma\gamma$ couplings of electroweak bosons in e^-p collisions at the LHeC and the FCC-he

A. Gutiérrez-Rodríguez (Zacatecas U.), M.A. Hernández-Ruíz (Zacatecas U.), E. Gurkanli (Sinop U.), V. Ari (Ankara U.), M. Köksal (Cumhuriyet U.)
May 23, 2020

Türk araştırmacılar LHeC'te fizik, hızlandırıcı ve algıç konularında etkin rol oynuyorlar

Türkiyedeki Çalışmalar

TENMAK (TAEK) Projeler

- TAEK Proje 2008-2011

Yürütücü: Saleh Sultansoy

LİNAK-LHC BAZINDA ep, γp, eA ve γA ÇARPIŞTIRICILARI

- TAEK Proje 2016-2019

Yürütücü: Zafer Nergiz

LHeC İÇİN DEDEKTÖR VE HIZLANDIRICI ÇALIŞMALARI

Ankara Üniversitesi'nden LHeC'e katkı verenler

- İlkay Türk Çakır
- Orhan Çakır
- Sinan Kuday
- Volkan Arı
- Aysuhan Ozansoy
- Bora Ketenoğlu
- Ümit Kaya

Yorumlar

- En son ECFA 2022 kış toplantısında LHeC'ten söz edilmiş.
- 2026 yılında LHeC'in kurulması ile ilgili karar verilecektir.
- ERL60⊗LHC, yaklaşık 90 MW güç tüketimiyle 10^{33} luminosity sağlayabilecek.
- 10^{34} luminosity elde etmek için bohçadaki elektron sayısı 4 kat arttırılıyor fakat bu durumda 100 MW ile sınırlandırılmasına karar verilen güç tüketimi yaklaşık 160 MW'a çıkıyor.
- QCD explorer için, alternatif olarak (Türk araştırmacıların önerisi) 9 km yeni elektron halkasıyla, 90 MW güç tüketimiyle elektron-proton çarpıştırıcısı inşaa edilebilir.
- Sonrasında aynı halka ile muLHC kurularak kütle merkezi enerjisi 7 kat arttırılabilir.

ECFA
European Committee for Future Accelerators

2022

10th ECFA Newsletter

Similar to the inclusive FCC-ee/eh/hh programme, the ep/eA LHeC programme has the potential to empower the (HL-)LHC physics programme of ATLAS and CMS in a unique way and allow a deeper exploration of the EW/Higgs/top/strong physics sectors of the Standard Model beyond what can be achieved with the proton–proton collisions at the (HL-)LHC. In many cases, adding the LHeC data to the HL-LHC data would result in significant improvements in precision Higgs physics similar to those expected when moving from the LHC to the HL-LHC.

Yorumlar

A Letters Journal Exploring the Frontiers of Physics

April 2022

EPL, **138** (2022) 24002
doi: 10.1209/0295-5075/ac4f98

www.epljournal.org

Luminosity and physics considerations on HL-LHC– and HE-LHC–based μp colliders

Umit Kaya[1], Bora Ketenoglu[2(a)], Saleh Sultansoy[3] and Frank Zimmermann[4]

[1] *Institute of Science, Istinye University - Istanbul, Turkey*
[2] *Department of Engineering Physics, Ankara University - Ankara, Turkey*
[3] *Department of Materials Science and Nanotechnology Engineering, TOBB University of Economics and Technology Ankara, Turkey*
[4] *CERN - Geneva, Switzerland*

received 22 December 2021; accepted in final form 27 January 2022
published online 19 May 2022

Abstract – Construction of the future muon collider tangential to the Large Hadron Collider will give opportunity to realize μp collisions at multi-TeV center-of-mass energies. Using the nominal parameters of high-luminosity and high-energy upgrades of the LHC, as well as the design parameters of muon colliders, it is shown that $L_{\mu p}$ of the order of 10^{33} cm^{-2}s^{-1} is achievable for different options with $\sqrt{s_{\mu p}}$ from 4.58 TeV to 12.7 TeV. Certainly, the proposed μp colliders have a huge potential for clarifying QCD basics and searches for new physics.