Linak-Halka Tipli Çarpıştırıcılar: Işınlık ve Fizik

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TOBB ETÜ Fen-Edebiyat Fakültesi Fizik Birimi
Azerbaycan Elmler Akademiyası Fizika İnstitutu
TAEK-CERN Bilim Komitesi üyesi

1. Prologue: Rutherfod ve Mehmet Akif
2. Linak-Halka Tipli Çarpıştırcılar
3. LHeC/QCD-E
4. TAC Super-Charm Fabrikası
5. Epilogue: Şehitler Ölmez…

Ek 1: Türkiye'nin CERN Serüveni

Ek 2: ICFA Seminer 2011'de TAC projesi

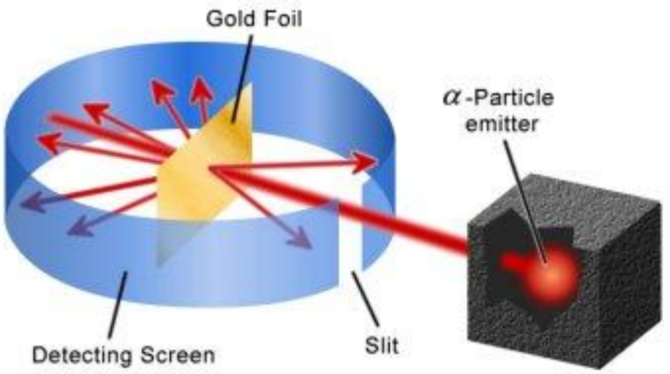
Prologue: Rutherfod ve Mehmet Akif

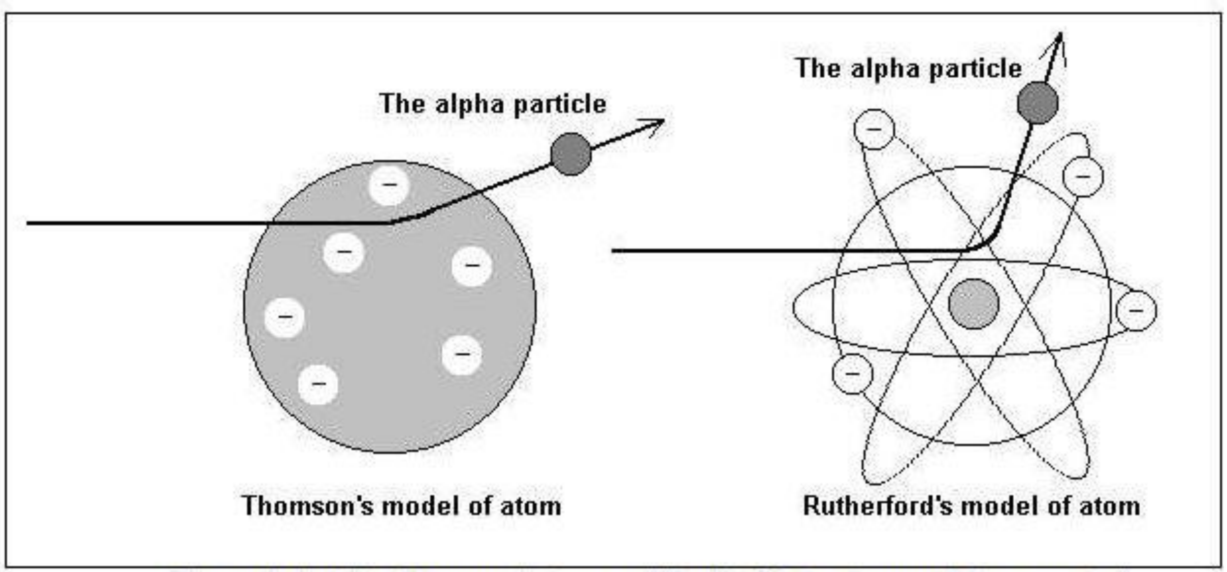
Modern Bilimin Doğuşu

- 1895: Elektronun keşfi
- 1897: Radyoaktivite
- 1911: Atom Çekirdeği
- …

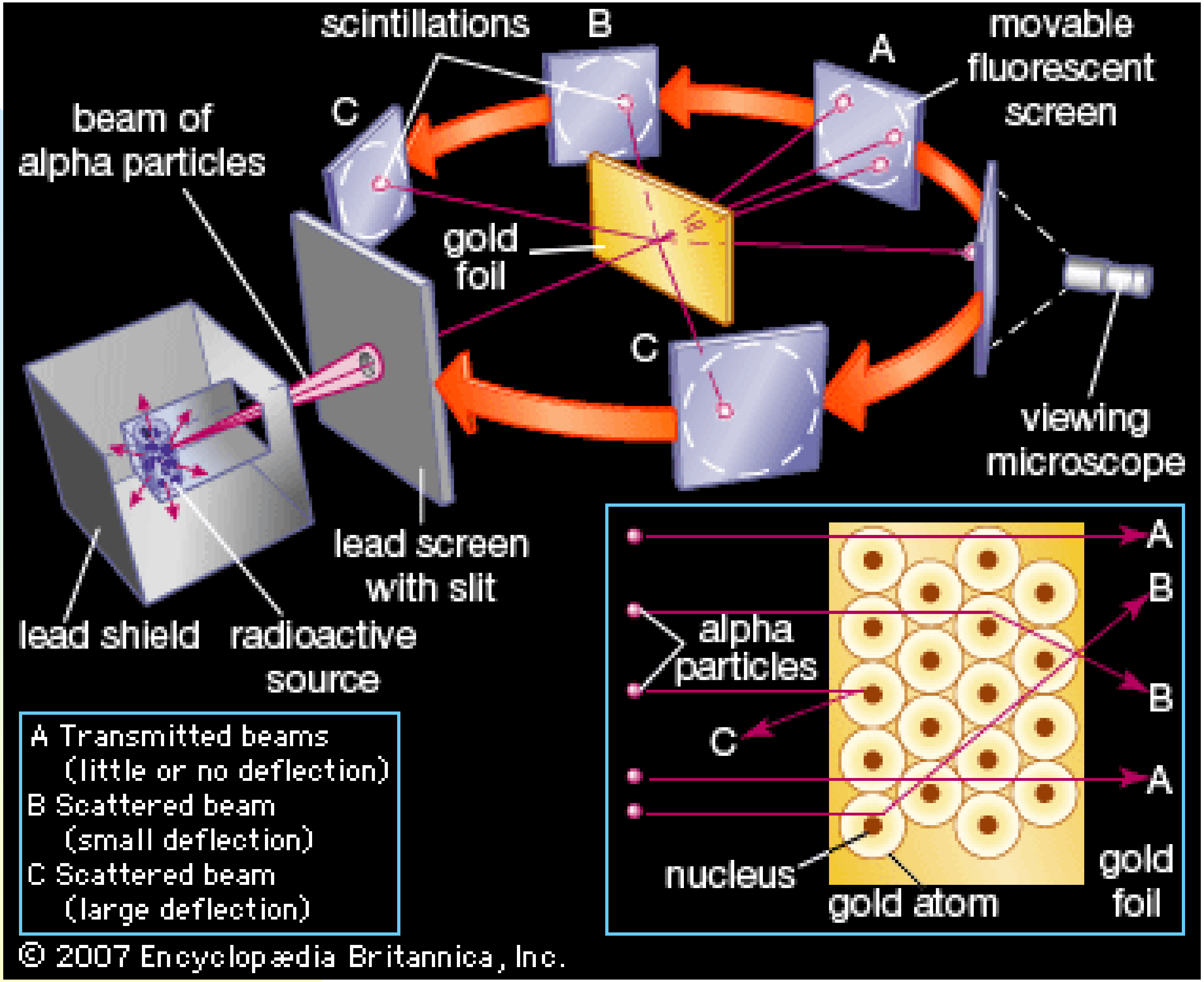
Yaşamımızı değiştiren deney

Rutherford Deneyi (1911)





The models of the Thomson's atom and Rurtherford's atom; and the expected aberrations of alpha particle in both cases.


scintillations
B
A
movable fluorescent screen
C
beam of alpha particles
gold foil
C
viewing microscope
lead screen with slit
lead shield
radioactive source
A Transmitted beams (little or no deflection)
B Scattered beam (small deflection)
C Scattered beam (large deflection)
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A
B
alpha particles
B
C
A
nucleus
gold atom
gold foil

Sen geçenlerde demiştin ki:

"Yazık hala biz,
Dünkü ilmin bile biganesiyiz, cahiliyiz,
İşte fıkdanı bu ihmal edilen ma'rifetin,
Nesli bir acze düşürmüş ki, bugün, memleketin,
Bir yığın kuvveti var, hem ne tabi'i de, henüz,
Biz o kuvvetlere eller gibi hakim değiliz!

Yarının ilmi nedir, halbuki? Gayet müdhiş:
"Maddenin kudret-i zerriyesi" uğraştığı iş,
O yaman kudrete hakim olabilsem diyerek,
Sarf edip durmada birçok kafa binlerce emek,
Onu bir buldu mu, artık bu zemin: Başka zemin,
Çünkü bir damla kömürden edecekler te'min,
Öyle milyonla değil, na-mütenahi kudret!...

Mehmet Akif ERSOY, 18 Eylül 1919

Safahat, 6.bölüm

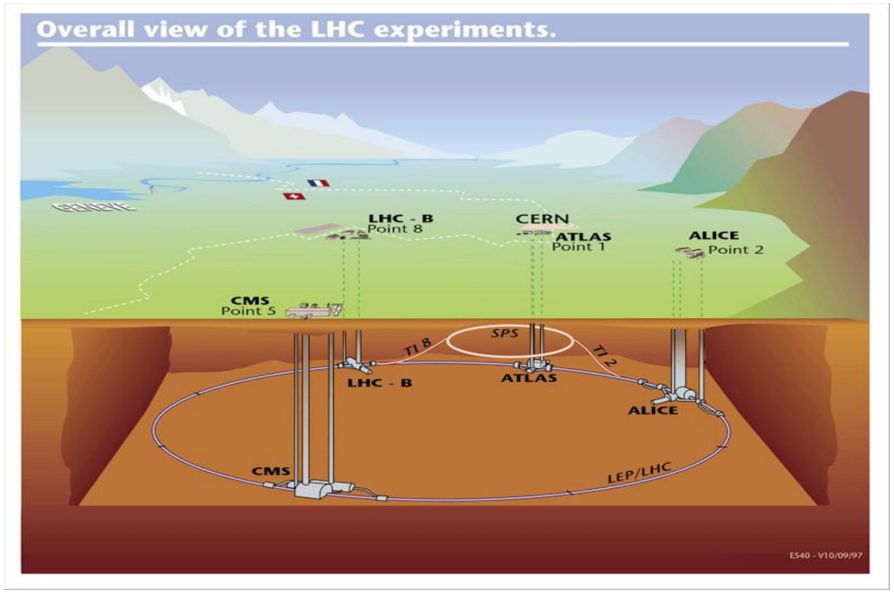
Bugün “Maddenin kudret-i zerriyesi” CERN’de araştırılıyor

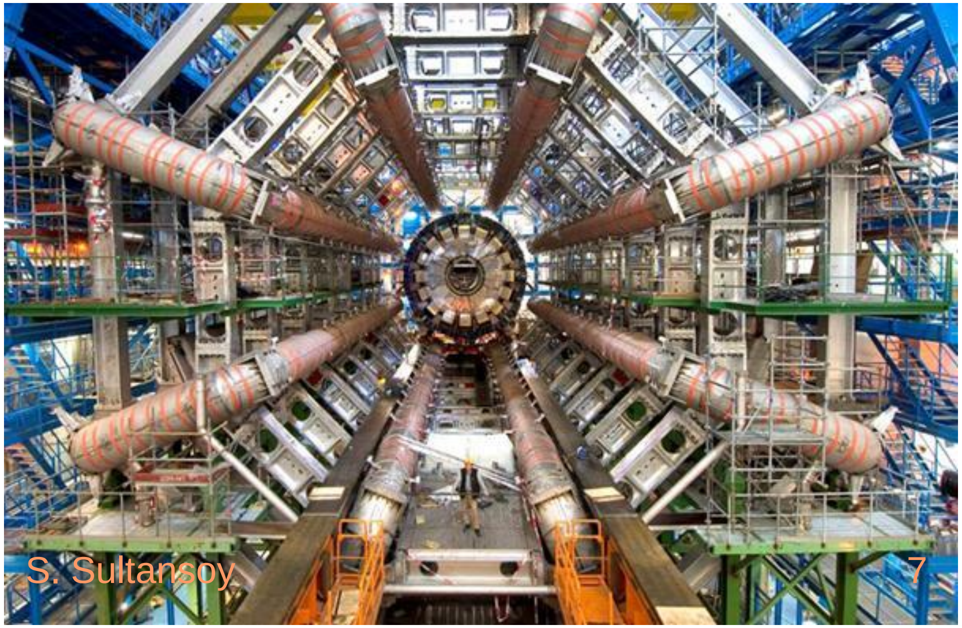
Tablo: Maddenin yapısı ile ilgili son 150 yıldaki gelişmeler ve önümüzdeki yıllar için öngörü

Aşamalar	1870’ler-1930’lar	1950’ler-1970’ler	1970’ler-2020’ler
Temel Öğe enflasyonu	Kimyasal elementler	Hadronlar	Kuarklar, leptonlar
Sistematik	Periyodik tablo	Sekizli Yol	Çeşni demokrasisi ?
Tasdiklenen öngörüler	Yeni elementler	Yeni Hadronlar	Dördüncü aile ?
Açıklayıcı deney	Rutherford	SLAC	LHC
Yapı taşları	Proton, nötron, elektron	Kuarklar	Preonlar ?
Enerji skalası	MeV	GeV	TeV
Teknolojiye etkisi	İstisnai	Yan etki	İstisnai ?

Ö. Etişken, “1911’den 2011’e Rutherford’dan 100 yıllık hediye”,
TÜBİTAK Bilim ve Teknik 529 (2011) 40-45

1911 (Rutherford) → 2011 (CERN LHC)





UPHUK1: 2001, Ankara, TAEK
UPHUK2: 2004, Ankara, ATO
UPHUK3: 2007, Bodrum, TFD
UPHUK4: 2010, Bodrum, TFD

TAC projesi: 1993 ilk makale, 1997-2000 1.DPT projesi, 2002-2005 2.DPT projesi, 2006-2009(→2013) 3.DPT projesi, 2014-2023 TAC'ın kurulması

Three Main Areas of Applications

- Fundamental Research in Particle and Nuclear Physics

  Example: Standard Model of electro-weak and strong interactions (analog of the electro-magnetic unification)

- Analysis of Physical, Chemical and Biological Objects

  Example: Human Genome (impossible without SR and SN sources)

- Modification of the Physical, Chemical and Biological Properties of Matter

  Example: ion implantation (cornestone of modern micro-electronics)

+ Energy Amplifier (ADS): Thorium as Fuel – Green Nuclear Energy

DOE Office of Science Statement

U.S. Department of Energy
Office of Science

Accelerator Technology for the Nation

Summary

Accelerators underpin every activity of the Office of Science and, increasingly, of the entire scientific enterprise. From biology to medicine, from materials to metallurgy, from elementary particles to the cosmos, accelerators provide the microscopic information that forms the basis for scientific understanding and applications. The combination of ground and satellite based observatories and particle accelerators will advance our understanding of our world, our galaxy, our universe, and ourselves.

Essentially all we know today and will learn in the future about the fundamental nature of matter is derived from probing it with directed

Ever since Ernest Rutherford discovered the atomic nucleus in 1911 by bombarding atoms with beams of alpha particles obtained from


THE 10 DOE OFFICE OF SCIENCE NATIONAL LABORATORIES
AMES LABORATORY
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ARGONNE NATIONAL LABORATORY ☼HL
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PACIFIC NORTHWEST NATIONAL LABORATORY
FERMI NATIONAL ACCELERATOR LABORATORY ☼HL
PRINCETON PLASMA PHYSICS LABORATORY
THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY ☼HL
SLAC NATIONAL ACCELERATOR LABORATORY ☼HL

AB ve TÜRKİYE

Avrupa Birliği ortalaması göz önünde tutularak, 65 milyon nüfuslu Türkiye'de, Yüksek Enerji Fiziğinin ana alanlarında olması gereken ve mevcut doktoralı eleman sayısı Tablo 1'de verilmiştir (S. Sultansoy, UPHUK-1, Ekim 2001, TAEK)

	Gereken, 1995	Mevcut, 1995	Gereken, 2010
Fenomenoloji+Teorik YEF	~250	~50	~300
Deneysel YEF+Dedektör Fiziği	~450	~30	~600
Hızlandırıcı Fizikçisi	~200	~0	~300

Tablo 1. *Avrupa standartları göz önünde tutularak 90'lı yıllarda Türkiye'de YEF'in ana alanlarında çalışması gereken Doktoralı eleman sayısı, gerçek sayılar ve 2010 yılında gereken sayıların tahmini.*

2. Linak-Halka Tipli Çarpıştırcılar

Classification of colliders

1. Colliding particles
- hadrons
- leptons
- lepton-hadron

2. Collider schemes
- ring-ring
- linear
- linac-ring

The ring-ring colliders are the most advanced ones from technology point of view and are widely used around the (developed) world.

The linear (linac-linac) colliders are less familiar; however, a lot of experience is gained through Standard Linear Collider (SLC) operation and ILC/CLIC related workout.

The linac-ring colliders require more R&D.

Linac-ring type colliders: two directions*

Lepton-hadron and photon-hadron colliders:

UNK+VLEPP (Mid 1980's) → THERA (End 1990's) → LHeC → Energy Frontier / QCD Explorer

THERA (End 1990's) → eRHIC/EIC/ELIC

Factories:

B-factory (Grosse-Wiesmann) → c-τ-factory → Super-Charm factory (TAC project)

c-τ-factory → ϕ-factory (Ankara group)

* For details and ref's see: A. Akay, H. Karadeniz and S. Sultansoy, Review of Linac-Ring-Type Collider Proposals, Int. J. Mod. Phys. A 25 (2010) 4589

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REVIEW OF LINAC–RING-TYPE COLLIDER PROPOSALS

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There are three possible types of particle colliders schemes: familiar (well-known) ring–ring colliders, less familiar but sufficiently advanced linear colliders, and less familiar and less advanced linac–ring-type colliders. The aim of this paper is twofold: to present a possibly complete list of papers on linac–ring-type collider proposals and to emphasize the role of linac–ring-type machines for future HEP research.

1. Introduction

Experiments in high energy physics today deal with three kinds of devices, namely, the fixed target experiments (using both accelerator and cosmic rays), the collider experiments and the rest (which include underground detectors and so on).

Collider experiments can be classified by the types of accelerator and colliding beams. There are three possible types of accelerator: ring–ring, linac–linac and linac–ring colliders, and three types of colliders of different beams: hadron, lepton and lepton–hadron colliders. With regard to energy frontiers, ring–ring-type corresponds to hadron collisions, linac–linac-type corresponds to lepton collisions and linac–ring-type corresponds to lepton–hadron collisions (see Table 1 and Fig. 1). The ring–ring colliders are the most advanced ones from technology point of view and are widely used around the (developed) world. The linear (linac–linac) colliders are less familiar; however, a lot of experience is gained through Standard Linear Collider (SLC) operation and ILC/CLIC related workout.

Forty years ago, John Rees[2] proposed a collision of 20 GeV SLAC electron

4590 *A. N. Akay, H. Karadeniz & S. Sultansoy*

Table 1. Energy frontiers: past and future.[1]

Colliders	Hadron	Lepton	Lepton–Hadron
1990's	Tevatron	SLC/LEP	HERA
$\sqrt{s}$ (TeV)	2	0.1/0.2	0.3
$L(10^{31}\ \mathrm{cm}^{-2}\mathrm{s}^{-1})$	1	0.1/1	1
2010's	LHC	"NLC"	"NLC"–LHC
$\sqrt{s}$ (TeV)	14	0.5	3.7
$L(10^{31}\ \mathrm{cm}^{-2}\mathrm{s}^{-1})$	10^3	10^3	1–10
2020's	VLHC	CLIC	"CLIC"–VLHC
$\sqrt{s}$ (TeV)	200	3	34
$L(10^{31}\ \mathrm{cm}^{-2}\mathrm{s}^{-1})$	10^3	10^3	10–100

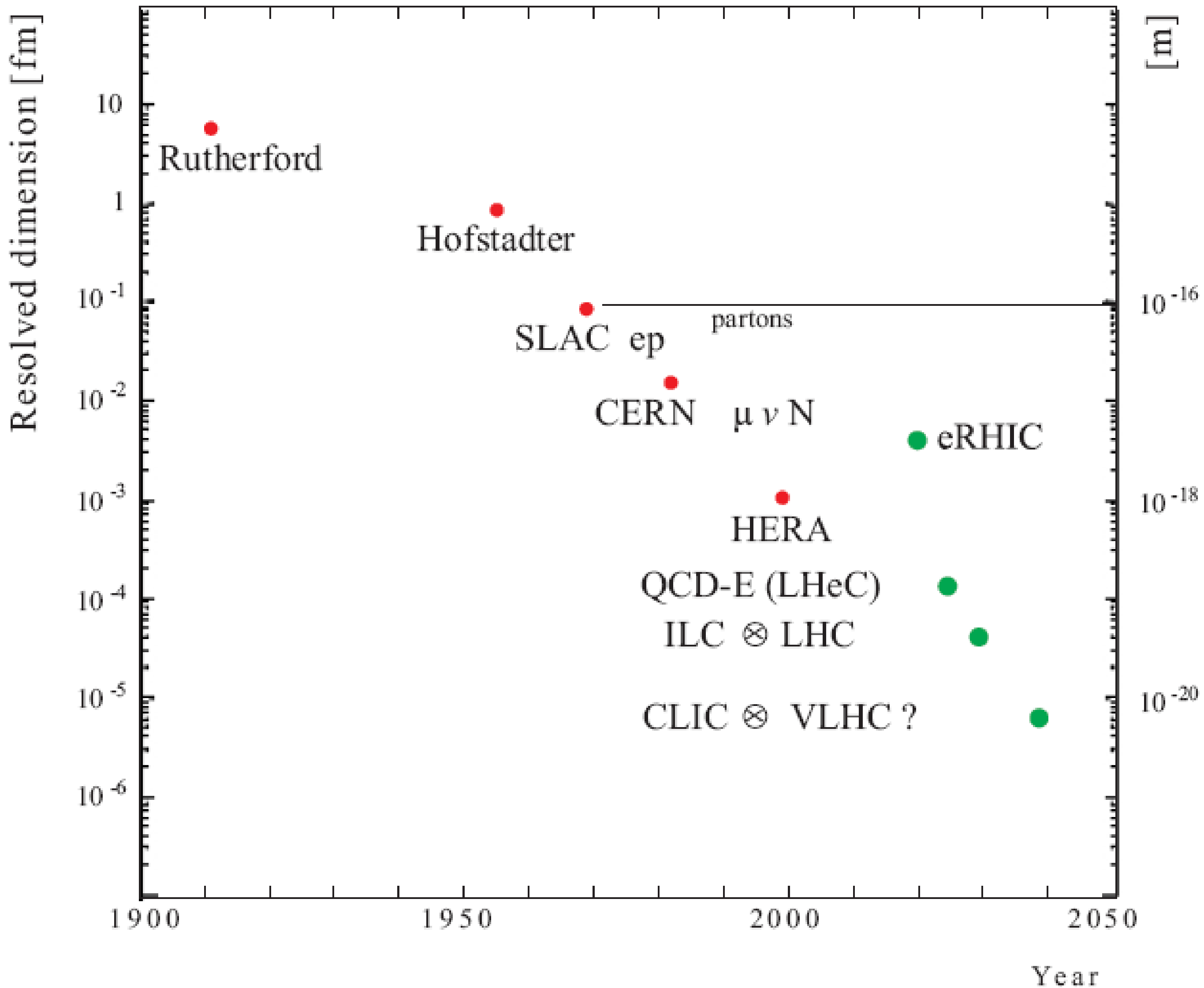

Fig. 1. The development of the resolution power of the experiments exploring the inner structure of matter over time from Rutherford experiment to CLIC ⊗ VLHC.

Forty years ago, John Rees[2] proposed a collision of 20 GeV SLAC electron beam with 3 GeV stored positrons in order to handle 15.5 GeV center-of-mass energy electron–positron collisions with a luminosity of 5×10^{29} $cm^{-2}s^{-1}$. Two years later, this proposal was reconsidered in Ref. 3 keeping in mind 2 GeV stored electrons (or positrons) which corresponds to 12.6 GeV center-of-mass energy with

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a luminosity of 2.4×10^{29} $cm^{-2}s^{-1}$. Both proposals were considered as possible upgrades for SLAC accelerator.[4] In the subsequent 15 years, only one paper on this subject was published.[5] The purpose was to choose a linear collider option for SLAC upgrade: the SLC construction began in 1983 and completed in 1989. In 1979, linac–ring scheme was considered merely as an alternative to SSC-based ring–ring-type of 140 GeV+20 TeV electron–proton collider (Ref. 6; see also Ref. 7).

The idea was reborn in mid-1980's when it was proposed to combine linear electron–positron and ring-type proton colliders to realize additional TeV scale lepton–hadron collider option. Namely, it was proposed to construct VLEPP tangentially to UNK.[8] This scheme would provide an opportunity to handle TeV scale γp colliders too.[9] This line went on by THERA, EIC/EPIC and QCD-E/LHeC projects (for references see the corresponding sections below). An important stage in this direction was made at the International Workshop held in Ankara in 1997.[10] Reviews on the subject can be found in Refs. 11–15 and 1.

Another line deals with particle factories (Fig. 2): in 1988 Grosse-Wiesmann proposed linac–ring-type B-factory.[16–19] In 1993, linac–ring-type charm-tau factory was proposed as the regional project for Turkey and abroad.[20] The last stage of this line is represented by Super Charm Factory as part of the Turkic Accelerator Complex (TAC) Project.[21]

The present review is organized as follows. In Sec. 2, the main parameters of linac–ring-type lepton–hadron collider proposals are considered, namely, UNK + VLEPP, THERA, eRHIC, EIC, QCD Explorer (LHeC linac–ring option) and energy frontier. Photon–hadron colliders which would be constructed on the base of these colliders are considered in Sec. 3. Section 4 is devoted to proposals of linac–ring-type particle factory. Finally, in Sec. 5 some concluding remarks and recommendations are presented.

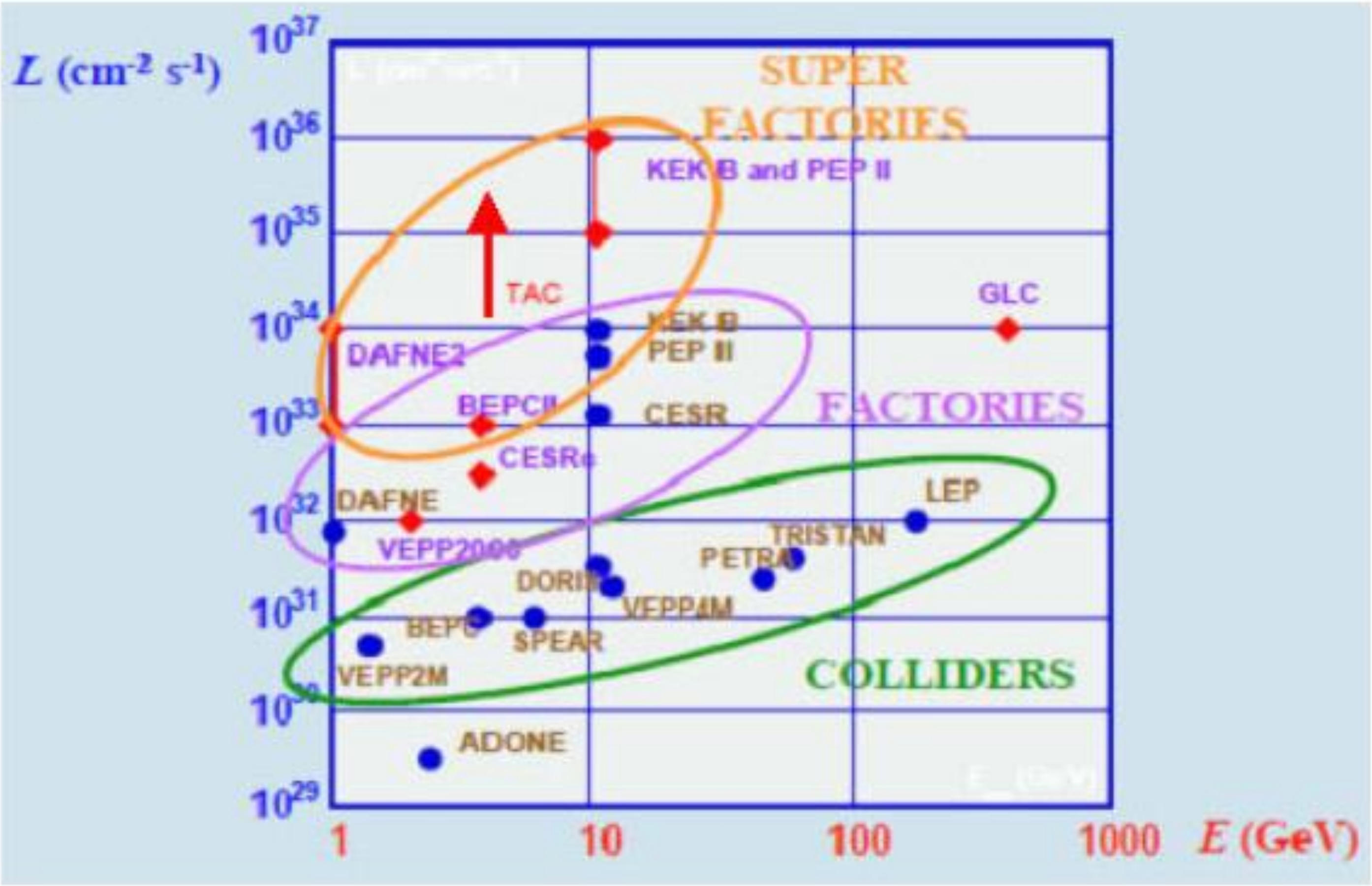


Fig. 2. Past, present and future e^+e^- colliders.

2.1. *UNK+VLEPP (IHEP, Protvino)*

In 1980's there were two projects of energy frontier collider in the former USSR, namely, $\sqrt{s} = 6$ TeV proton–proton collider UNK and $\sqrt{s} = 2$ TeV linear electron–positron collider VLEPP. The construction of the first one started at IHEP (Protvino, Moscow region), and the second one was planned at BINP (Novosibirsk). In mid-1980's, the construction of VLEPP tangential to UNK was proposed in order to provide additional opportunity to handle energy frontier ep (Ref. 8) and γp (Ref. 9) colliders.

In the following we give a brief summary of luminosity estimations. More details can be found in Ref. 11. Two possible versions of placing VLEPP and UNK are shown in Fig. 3. Two options of ep and γp collisions were considered for the UNK+VLEPP: on extracted proton beam (Fig. 4(a)) or in proton ring (Fig. 4(b)). It was shown that $L = 10^{30}$ cm^{-2}s^{-1} and $L = 6 \times 10^{30}$ cm^{-2}s^{-1} were achievable for the first and second options, respectively.

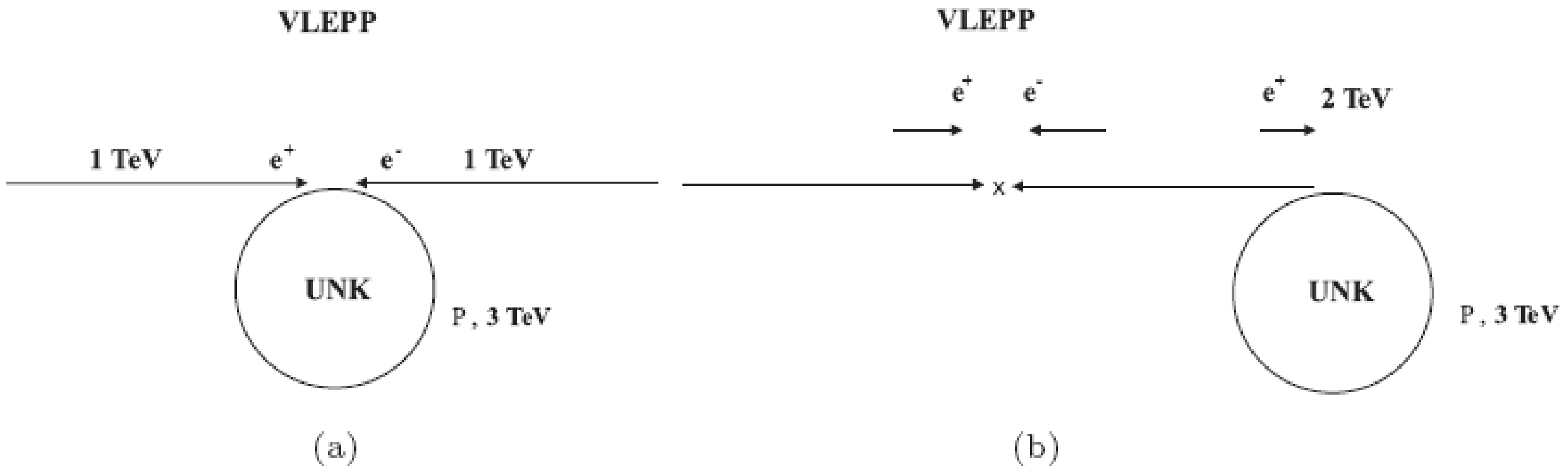


Fig. 3. (a) Symmetric version of ep (γp) collider; (b) asymmetric version.[11]

Note that this consideration was the main scientific reason for moving VLEPP from Novosibirsk to Protvino. Unfortunately, in the final design, VLEPP placement was chosen to cross the UNK ring, instead of tangential placement. Obviously, this choice eliminated ep and γp options (clear indication of the collapse of Eastern Block).

Table 3. THERA beam energies and luminosities.

Option	E_e, GeV	E_p, GeV	$\sqrt{s}$, TeV	L, 10^{30} cm^{-2}s^{-1}
1	250	1000	1	4
2	500	500	1	25
3	800	800	1.6	16

2.2. *THERA (DESY)*

THERA activity has been initiated since 1996 by B. Wiik and S. Sultansoy.[25] A lot of work was down in 1999–2000 during the preparation of TESLA TDR, which include THERA[26] as inseparable part together with photon collider and fixed target options. Moreover, THERA provided the main scientific reason for moving TESLA from Zeuthen to Hamburg. Results of this two-year study are published in the THERA book.[27] Concerning the beam energies and corresponding luminosities, three alternatives were analyzed (see Table 3).

2.3. *EIC (USA)*

The Electron-Ion Collider (EIC) is a new proposal of facility to collide high-energy electrons with nuclei and polarized protons/light nuclei (see Refs. 30 and 31 and references therein). Two broad classes of goals for the future EIC are reflected in two physics working groups (WG) of the EIC collaboration: the eA WG concentrates on exploring the (strong) gluon fields in nuclei, and the ep WG focuses on the precision imaging of quarks and gluons in the nucleon.

The original design of the EIC involves two concepts: eRHIC on the base of RHIC (see Fig. 5), where an additional energy recovering linac has to be added, and ELIC at Jefferson Lab (see Fig. 6), which requires a construction of a new hadron facility to be used with the existing CEBAF. The eRHIC concept allows for larger $\sqrt{s} = 60$–90 GeV and smaller luminosity $L \approx 10^{33}$ cm^{-2}s^{-1}, while the ELIC concept corresponds to smaller $\sqrt{s} \leq 60$ GeV and larger luminosity $L \approx 10^{35}$ cm^{-2}s^{-1}.

For more details please refer to the web pages in Refs. 33–35.

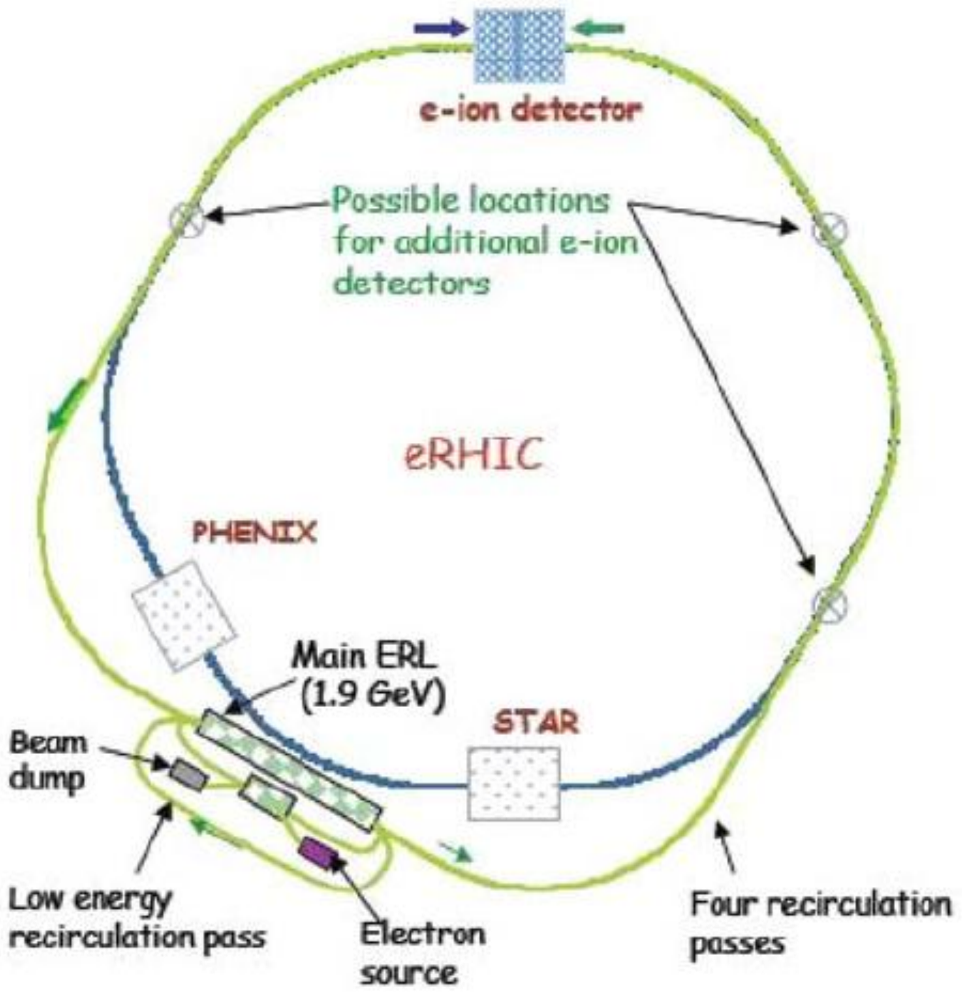


Fig. 5. ERL-based eRHIC design.[32]

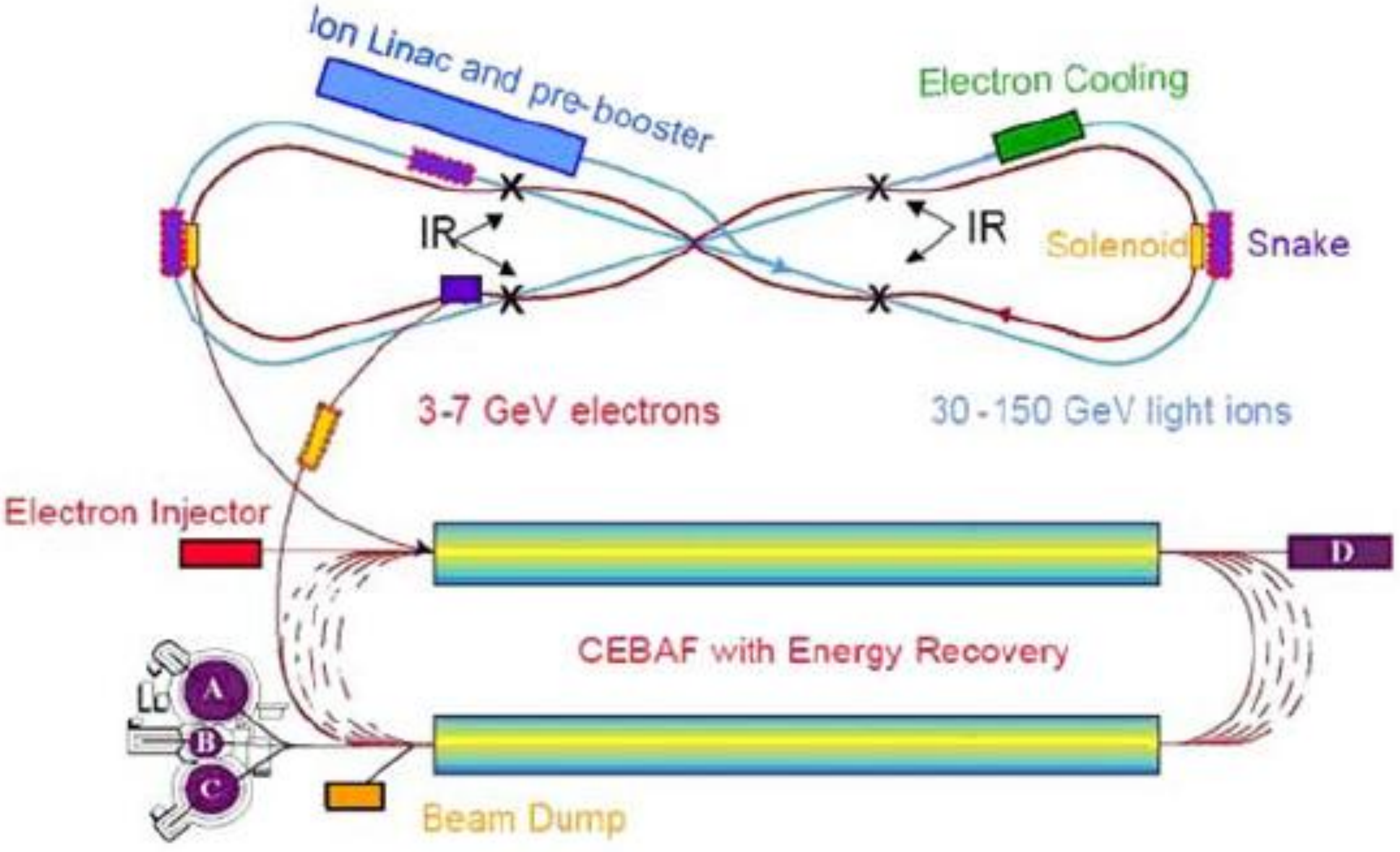


Fig. 6. Schematic layout of ELIC at Jefferson Laboratory.[35]

2.4. *QCD Explorer (LHeC linac–ring option, CERN)*

QCD Explorer means to construct a moderate energy electron linac (50–100 GeV) tangentially to LHC ring. This construction will provide opportunity to utilize highest energy hadron beams for lepton–hadron collisions. QCD Explorer has two main goals:

(i) to get more precise data on PDF's which will be necessary for adequate interpretation for future LHC data;
(ii) to enlighten fundamentals of QCD.

For this purpose, the technologies for electron–positron colliders, which have developed up to now can be used or new technologies can be created.

2.4.1. *CLIC based*

In this case, the main problem occurred due to the large different beam structure: bunch spacing of LHC is 25 ns as compared to 0.6 ns at CLIC, resulting a ratio of 1/40. This problem can be solved by changing beam structure of the LHC or CLIC or both. Superbunch option was proposed for LHC based *ep* collider in Refs. 36 and 37 and $L = 10^{31}$ cm^{-2}s^{-1} can be handled in this way.

2.4.2. *ILC (TESLA) based*

This option has advantages over CLIC; bunch spacing is larger so that it is more suitable for matching with LHC hadron beam. Estimations show that $L = 10^{32}$ cm^{-2}s^{-1} can be handled.[38,39]

2.4.3. *Special e-linac*

In the last two years, this option was preferred because of pulsed mode, CW mode and energy recovery linac. Figure 7 shows different scenarios for the LHC based linac–ring-type *ep* collider. Luminosity up to 3×10^{32} cm^{-2}s^{-1} could be achieved with pulsed or CW linacs.[40] If energy recovery is used, the luminosity gain depends on recovery efficiency. Ninety percent recovery efficiency results in $L = 3 \times 10^{33}$ cm^{-2}s^{-1} (if recovery reaches 98% luminosity exceeds 10^{34} cm^{-2}s^{-1}).

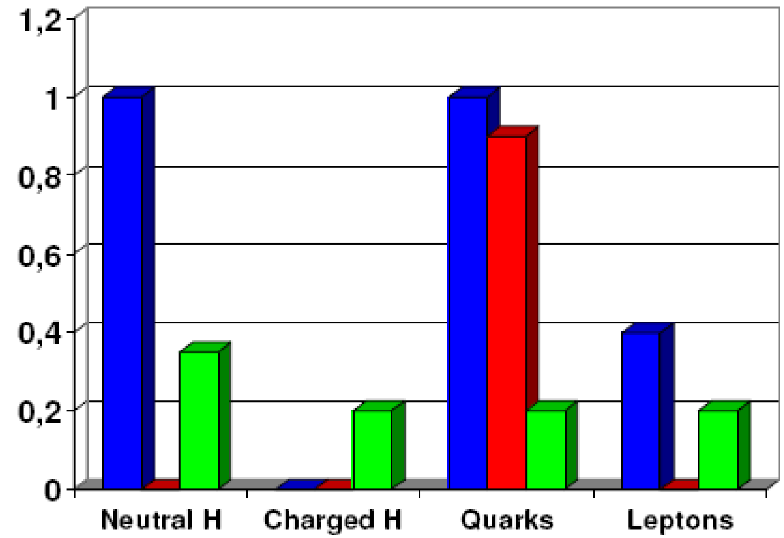
2.5. *Energy frontier (CERN)*

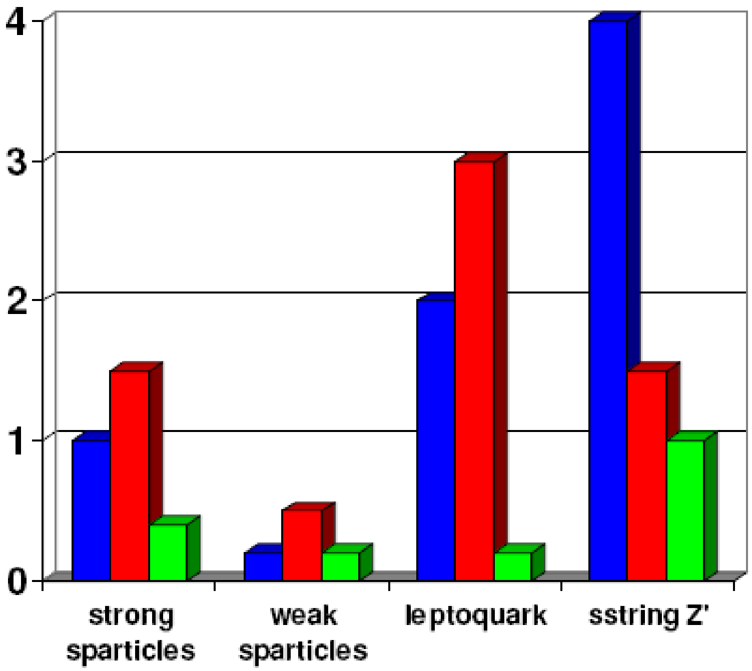
If $E_c \geq 500$ GeV, LHC based ep colliders are named as energy frontier. These high energies are inconvenient to use energy recovery. Nevertheless, $L = 10^{32}$ cm^{-2}s^{-1} seems to be achievable with pulsed linac.[41] It is useful to compare physics search potential of three colliders which can be considered as energy frontiers in foreseen future. Namely,

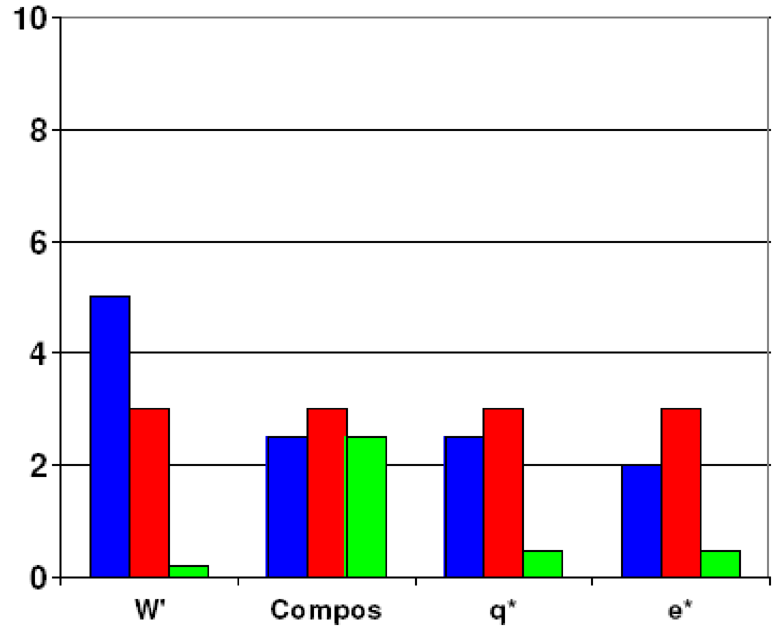
(i) $\sqrt{s} = 14$ TeV pp collider with $L = 10^{34}$ cm^{-2}s^{-1} (LHC);
(ii) $\sqrt{s} = 0.5$ TeV e^+e^- collider with $L = 10^{34}$ cm^{-2}s^{-1} (ILC);
(iii) $\sqrt{s} = 3.7$ TeV ep collider with $L = 10^{32}$ cm^{-2}s^{-1} ("ILC" $\times$ LHC).

Rough estimations[14] show that the total capacity of ep and γp options for BSM physics (SUSY, compositeness, etc.) research essentially exceeds that of 0.5 TeV linear collider.

Discovery limits in TeV
(rescaled from U. Amaldi 87)







S. Sultansoy 01.09.2009, Divonne 9

3. Photon–Hadron Colliders

In 1980's, the idea of using high energy photon beams, obtained by Compton backscattering of laser light off a beam of high energy electrons, was considered for γe and $\gamma\gamma$ colliders (see review Ref. 43 and references therein). Then the same method was proposed for constructing γp colliders on the base of linac–ring-type ep machines in Ref. 9. Rough estimations of the main parameters of γp collisions are given in Ref. 11. The dependence of these parameters on the distance between conversion region (CR) and interaction point (IP) was analyzed in Ref. 42, where some design problems were considered.

It should be noted that γp colliders are unique feature of linac–ring ep colliders and could not be constructed on the base of standard ring–ring-type ep machines (for arguments see Refs. 11 and 42).

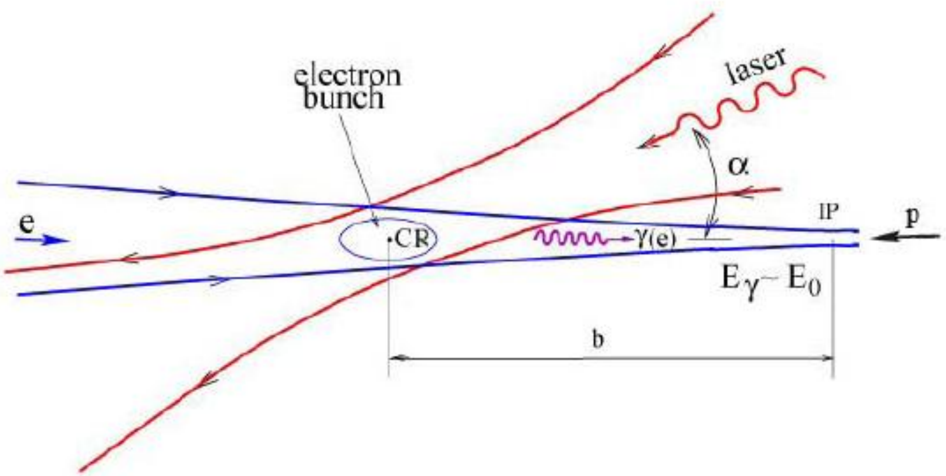


Fig. 8. Schematic view of γp collider.

Bu projelerin Türk Dünyasına Katkısı

- **UNK+VLEPP**

  Fizika İnstitutu 1.No'lu Devlet AR-GE Programına katıldı

  (maalesef, YerPHI benzerinin Azerbaycan'da kurulma imkanı engellendi)

- **Linac-HERA**

  DESY Ankara Üniversitesi ile İşbirliği Anlaşması imzaladı

  (maalesef, bu Anlaşmanın sağladığı imkanlar yeterince kullanılmadı)

- **Linac-LHC**

  Türk fizikçileri CLIC ve LHeC projelerine katıldı

  (Uluslar arası CTF3 projesi AÜ ile CERN'in imzalarıyla resmen başladı!)

- **LR Charm-Tau**

  Turkic Accelerator Complex (TAC) projesinin temel taşı

  (maalesef, Super-Charm ve Proton Hızlandırıcısı kısımları ihmal ediliyor)

+ Türk bilim insanlarının **EPAC, PAC, IPAC, ECFA ve ICFA** 'ya katılımı

EPS-HEP 2003 Konferansında ve PAC 2005'te Çağrılı konuşmalar,

ICFA 2002 "Future Perspectives in HEP" seminerinin kapanış oturumunda "Turkish comments on …" sunumu (**E. Arik, S. Sultansoy**, e-Print: hep-ph/0302012)

BOUN-HEP-2003-01
GU-HEP-2003-01
17 January 2003

Turkish Comments on "Future Perspectives in HEP"

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Abstract

These comments were prepared during the ICFA Seminar on "Future Persrectives in High Energy Physics" held at CERN (8-11 October 2002) and partially presented at the Panel and General Discussion on Interregional Collaboration for Future Facilities (10 October). Comments include arguments favoring the existence of the fourth SM family and new level of compositness. Then, the possible role of the linac-ring type colliders for future HEP research is discussed emphasizing TeV scale lepton-hadron and photon-hadron colliders. This preprint presents prepared transparencies and some illuminating remarks with corresponding references.

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ICFA Seminar, CERN, 10 Oct 2002

TURKISH COMMENTS ON

"Future Perspectives in HEP"

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[2] Gazi Univ., Ankara, TÜRKİYE

[3] Institute of Physics, Baku, Azerbaycan

1. *Periodic Table of Elementary Particles*
2. *Flavour Democracy → the Fourth SM Family*
3. *SUSY vs Compositness → SUSY at pre(pre)onic level*
4. *TeV scale lepton-hadron and photon-hadron colliders*
5. *Linac-Ring type factories: TAC Project*

2

3. LHeC/QCD-E

☼ The LHeC: Deep Inelastic Electron-Nucleon Scattering at the LHC
Webpage: http://www.ep.ph.bham.ac.uk/exp/LHeC/

☼ 1st ECFA-CERN LHeC Workshop (1-3 Sep 2008)
http://indico.cern.ch/getFile.py/access?resId=8&materialId=1&confId=31463

☼ 2nd CERN-ECFA-NuPECC Workshop on the LHeC (1-3 Sep 2009)
http://indico.cern.ch/conferenceDisplay.py?confId=59304

☼ 3rd CERN-ECFA-NuPECC Workshop on the LHeC (12-13 Nov 2010)
http://indico.cern.ch/conferenceDisplay.py?confId=105142

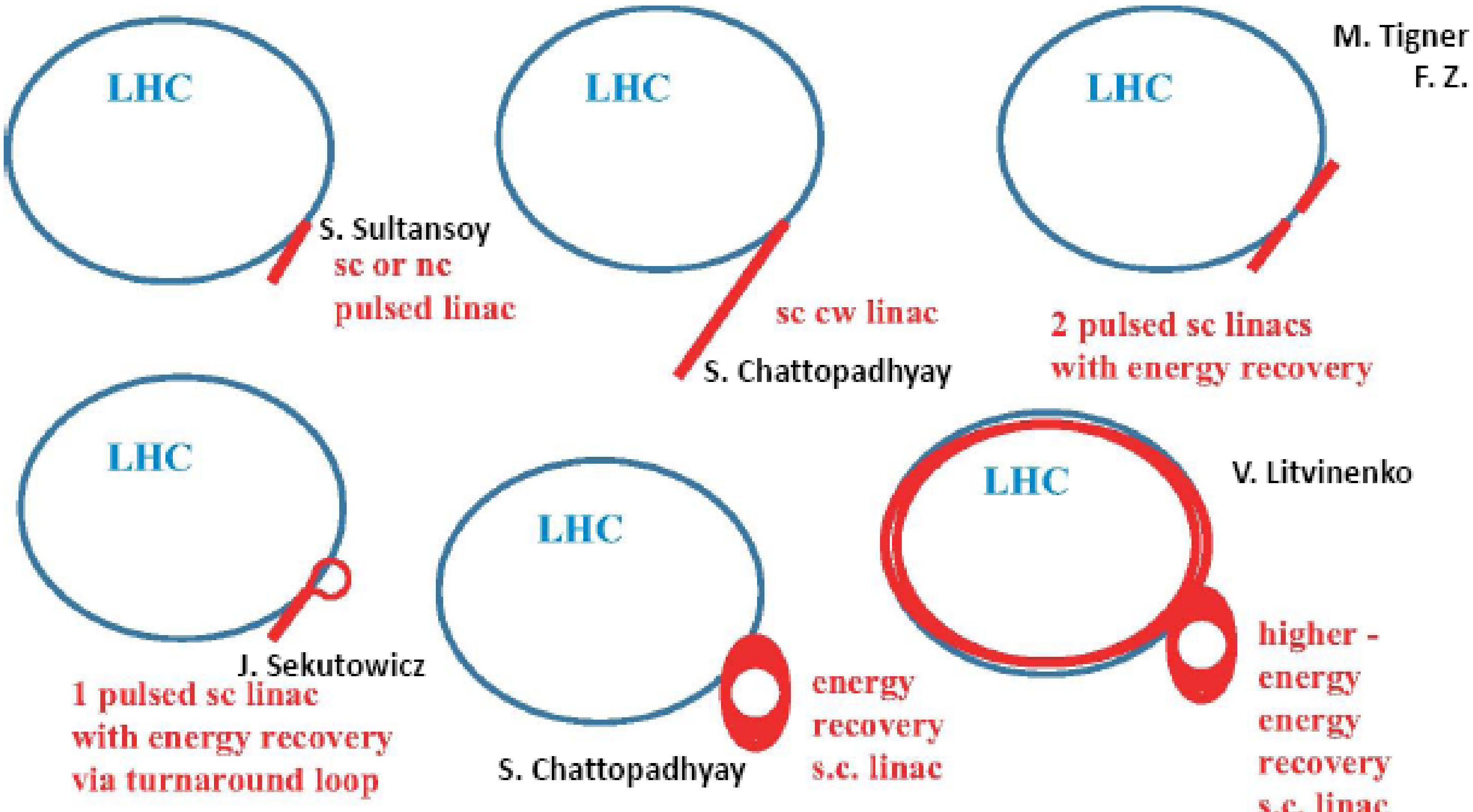
(F. Zimmermann, 1st ECFA-CERN LHeC Workshop, 02.09.2008)

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

(F. Zimmermann, 1st ECFA-CERN LHeC Workshop, 02.09.2008)

LR scenarios



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)

DRAFT 1.0
Geneva, August 5, 2011
CERN report
ECFA report
NuPECC report
LHeC-Note-2011-001 GEN

A Large Hadron Electron Collider at CERN

Report on the Physics and Design Concepts for Machine and Detector

LHeC Study Group

THIS IS THE VERSION FOR REFEREEING, NOT FOR DISTRIBUTION

Abstract

The physics programme and the design are described of a new electron-hadron collider, the LHeC, in which electrons of 60 to possibly 140 GeV collide with LHC protons of 7000 GeV. With an *ep* design luminosity of about $10^{33}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$, the Large Hadron Electron Collider exceeds the integrated luminosity collected at HERA by two orders of magnitude and the kinematic range by a factor of twenty in the four-momentum squared, Q^2, and in the inverse Bjorken x. The physics programme is devoted to an exploration of the energy frontier, complementing the LHC and its discovery potential for physics beyond the Standard Model with high precision deep inelastic scattering (DIS) measurements. These are projected to solve a variety of fundamental questions in strong and electroweak interactions. The LHeC thus becomes the world's cleanest high resolution microscope, designed to continue the path of deep inelastic lepton-hadron scattering into unknown areas of physics and kinematics. The physics programme also includes electron-ion (eA) scattering into a $(Q^2,\ 1/x)$ range extended by four orders of magnitude as compared to previous lepton-nucleus DIS experiments. The LHeC may be realised either as a ring-ring or as a linac-ring collider. Optics and beam dynamics studies are presented for both versions, along with technical design considerations on the interaction region, magnets, cryogenics, RF, civil engineering and further components. A design study is also presented of a detector suitable to perform high precision DIS measurements in a wide range of acceptance using state-of-the art detector technology, which is modular and of limited size enabling its fast installation. The detector includes tagging devices for electron, photon, proton and neutron detection near to the beampipe. The LHeC is designed to be built and operated while the LHC runs. It is a major opportunity for progress in particle physics and further exploits the investment made in the LHC.

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Türk fizikçiler üç ana kısmın (hızlandırıcı, detektör ve fizik) hepsinde etkin konumdadır !

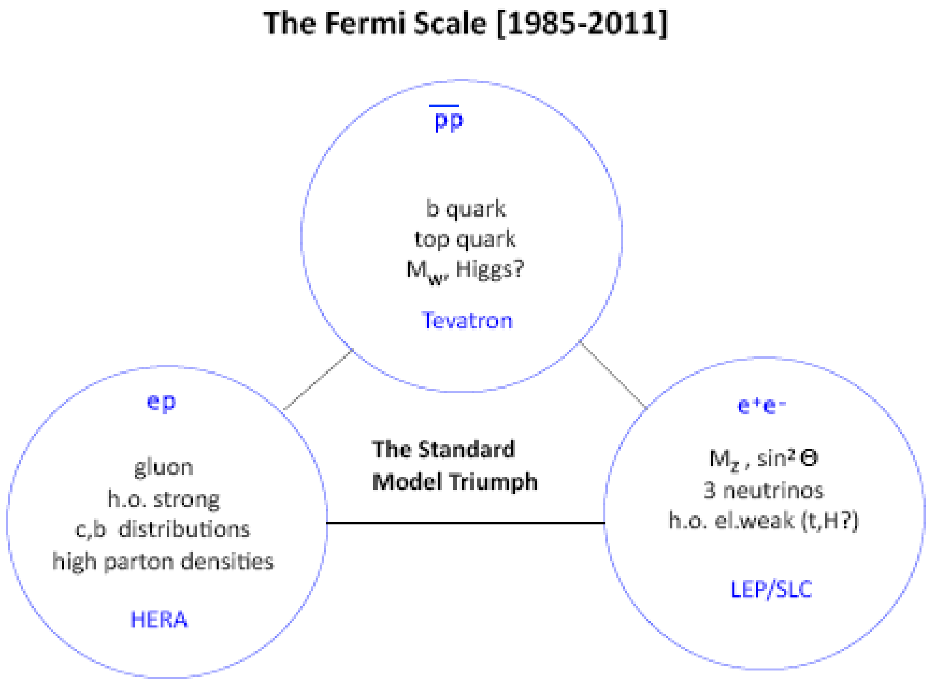


Figure 1.2: Key results of the exploration of the Fermi energy scale in $p\overline{p}$ (top), deep inelastic (bottom left) and e^+e^- scattering (bottom right) with the energy frontier colliders, the Tevatron, HERA and the SLC/LEP, respectively. These and further important results established the Standard Model of particle physics with six types of quarks and leptons in three families, and the development of higher order precision calculations used for the prediction of the top quark and the Higgs mass, based mainly on e^+e^- scattering results, and for the understanding of the partonic contents of the proton to NNLO pQCD, based mainly on the results from HERA and previous DIS fixed target experiments.

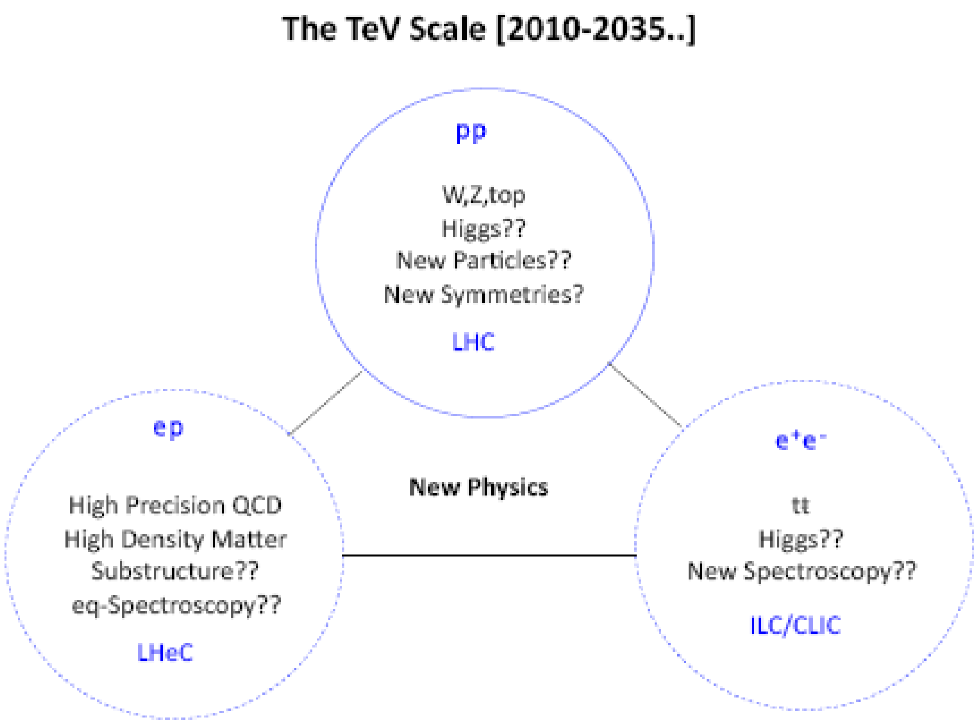


Figure 1.3: The exploration of the TeV energy scale has begun with the LHC. The present document describes one of its compliments, a new TeV scale ep and eA collider, while intense work is continuing on the developement of concepts for new e^+e^- and possibly $\mu^+\mu^-$ colliders. While each of the new machines has exciting standard model programmes to pursue with higher precision and range, physics beyond the SM has been elusive at the moment this report is released and $1\,\mathrm{fb}^{-1}$ of 7 TeV cms LHC data have been analysed within a very short time for the EPS11 conference at Grenoble.

4. TAC Super-Charm Fabrikası

Detayları bir sonraki sunumda Prof. Dr. Ömer Yavaş anlatacaktır.

Ben geçen sene ECFA'ya yaptığım sunumdan bazı slaytları göstermekle yetiniyorum

ECFA EUROPEAN COMMITTEE FOR FUTURE ACCELERATORS

EIGHTY-EIGHTH PLENARY ECFA MEETING

25-26 November 2010, CERN

THE CORNESTONE OF THE TAC PROJECT: LINAC-RING TYPE SUPER-CHARM FACTORY

Saleh Sultansoy

TOBB ETÜ, Ankara

Institute of Physics, Baku

Birth of TAC

Region means: Mid East + Balkans + Caucasus + Central Asia

Doğa – Tr. J. of Physics
17 (1993), 591 – 597.

Regional Project for Elementary Particle Physics Linac-Ring Type c-τ-Factory *

Saleh F. SULTANSOY
Institute of Physics, Academy of Sciences, Baku-AZERBAIJAN

Received 25.1.1993

Abstract

Linac-ring type e^+e^- collider with $\sqrt{s} = 3 - 5$ GeV is proposed as the regional project for elementary particle physics. It is shown that modern accelerator technology makes it possible to achieve luminosity $\mathcal{L} = 10^{34} cm^{-2}S^{-1}$. The possible physical goals of this machine in investigation of charmed particles, τ-lepton and ν_τ properties is briefly discussed.

1. Introduction

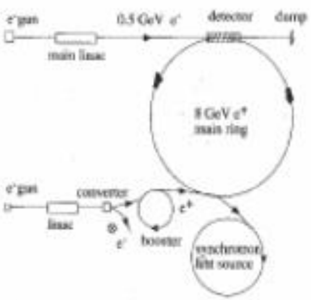


Figure 1. The proposed scheme for linac-ring c-τ-factory

Table 1. Basic parameters of linac-ring c-τ-factory

Parameters	e^--linac		e^+-ring
Energy (GeV)	0.5		8.0
$\sqrt{s}$ (GeV)		4	
Radius (m)	-		100
Length (m)	50		-
Particles per bunch, n (10^{10})	0.1		10
Collision rate, f_c (MHz)		30	
Bunches per ring, k	-		60
Current, I (mA)	5		500
Energy loss/turn, ΔE (MeV)	-		3.6
Power (MW)	2.5		> 1.7
Beam size at IP, $\sigma_{x,y}(\mu m)$	1		1
$\beta_{x,y}$ at IP (cm)	-		0.25
Bunch length, σ_z (cm)	0.1		0.2
Luminosity, $\mathcal{L}(cm^{-2}S^{-1})$		$2.4 \cdot 10^{34}$	

d) Synchrotron radiation. There are two possibilities: 1)to use the main positron ring as the source of synchrotron radiation; 2) to construct a new ring for this purpose. Let

c–τ–factory proposals in 1990's

- Ring–Ring: Spain (1991), JINR and BINP (1994)

$$L = 10^{33} cm^{-2} s^{-1}$$

- Linac–Ring: Ankara group (1993)

$$L = 10^{34} cm^{-2} s^{-1}$$

Before Crab–Waist scheme (2006) LR seemed to provide about 10 times higher Lumi.

S. SULTANSOY 25.11.2010 CERN 7

ICFA Statement on a Tau Charm Factory 31 January 1996

ICFA has noted that several intensive workshops have been held on the physics potential of a tau-charm factory. This collider is intended to operate at a luminosity of 10^{33} $cm^{-2}s^{-1}$, one hundred times the luminosity of the Beijing Electron-Positron Collider. The conclusion of these workshops is that a tau-charm factory can address issues concerning the tau, charmed particles, and light quark spectroscopy in a unique manner. Many of the issues can only be addressed by a tau-charm factory and cannot be fully addressed by B factories now under construction, or by high energy fixed target experiments.

There has been strong interest in a tau-charm factory by physicists from all regions of the world. Physicists from two nations, China and Russia, are seriously developing plans to construct such a facility. ICFA is pleased to note that the Chinese government has awarded funds of 5 million Yuan to the Institute of High Energy Physics in Beijing for the purpose of designing a tau-charm factory.

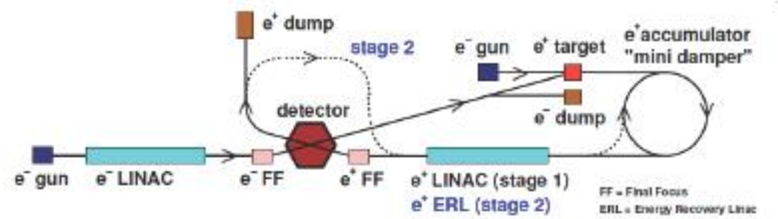
ICFA Statement on a Tau Charm Factory 31 January 1996 (cont.)

ICFA is pleased that international workshops on a tau-charm factory have been held over the past several years and that there are plans to hold additional ones in the future. In addition, the ICFA Beam Dynamics Panel is in the process of establishing a subpanel to assist in identifying and solving the beam dynamics issues associated with a tau-charm factory. ICFA supports the planning that must be done in advance of the construction of such a facility, and supports its construction, since there is ample justification for one such facility.

ICFA looks forward to the day when a tau-charm factory can begin operation, and encourages exploitation open to an international team in accordance with the existing ICFA Guidelines for Utilization of Major Regional Experimental facilities for High Energy Particle Physics.

BEPC II srarted in 2008

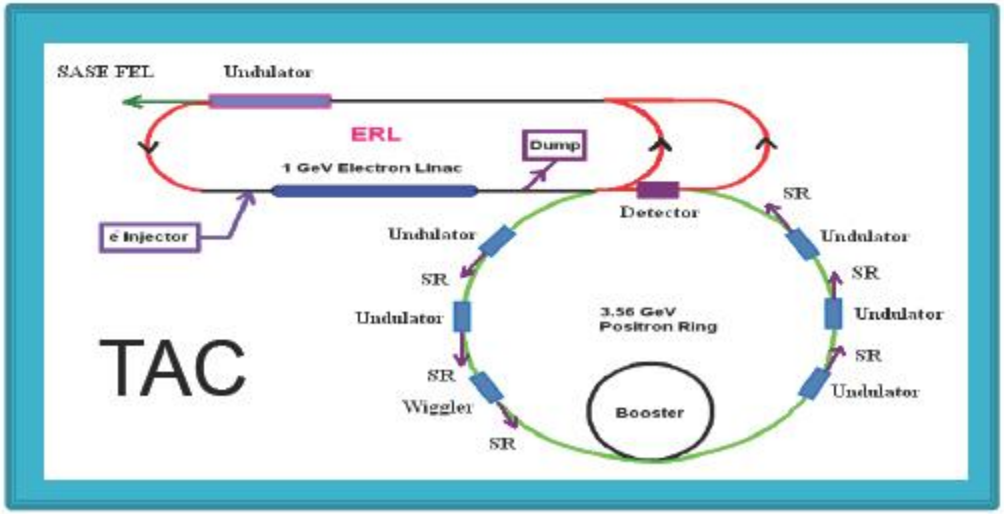
c–τ–factory proposals 2010



A. Schöning / Nuclear Physics B (Proc. Suppl.) 169 (2007) 387–392

All three proposals promise

$$L = 10^{35} cm^{-2} s^{-1}$$



25.11.2010 CERN 10

Tentative parameter list for TAC Super-C Factory

Positron ring	
Positron beam energy (GeV)	**3.56**
Number of positrons per bunch (10^{11})	2
Beta functions at IP β_x / β_y (mm)	80/5
Normalized emittances ε_x^N / ε_y^N (μm)	110/0.36
σ_x / σ_y (μm)	36/0.5
σ_z (mm)	5
Beam-beam tune shift	0.012/0.13
Energy loss / turn (MeV)	0.7
Number of buches, n_b	300
Revolution frequency (MHz)	0.5
Circumference, C (m)	600
Beam current (A)	4.8

Electron ERL	
Electron beam energy (GeV)	**1**
Number of electrons per bunch (10^{10})	2
Beta functions at IP β_x / β_y (mm)	80/5
Normalized emittances ε_x^N / ε_y^N (μm)	31/0.1
σ_x / σ_y (μm)	36/0.5
σ_z (mm)	5
Disruption Dx/Dy	0.33/60
Beam current (A)	0.48
Collider Parameters	
Crossing angle (mrad)	34
Collision frequency (MHz)	150
Luminosty	$1.4 \cdot 10^{35}$

Studies for reducing Dy are continuing

Further Lumi increase could be achieved by:
- increasing collision frequency
- shortening electron bunches with subsequent use of "dynamic focusing" (Brinkmann-Dohlus, DESY-M-95-11 (1995))

S. SULTANSOY 25.11.2010 CERN 11

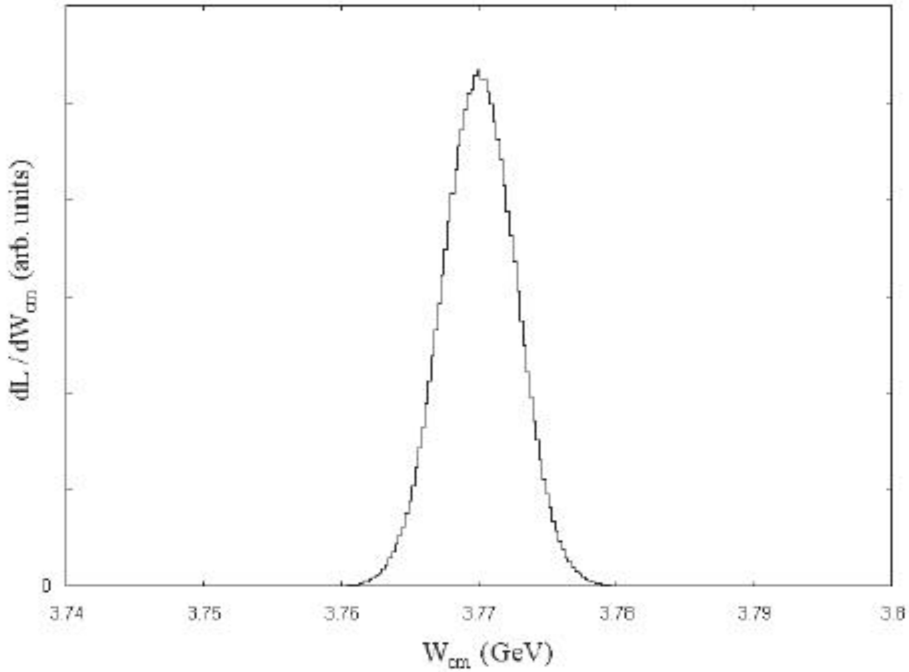
Physics at Super-Charm Factory

- τ option is weak.
  SuperB vs Super-c-τ: 2.5 times lower σ, but 10 times higher L
- Basic operation at $\Psi(3S)$
- Energy asymmetry is essential for time-dependent CPV analysis
  - Boost examples from *B*-factories are:
  - KEKB, the boost is $\beta\gamma = 0.43$.
  - PEP-II, used a slightly larger boost $\beta\gamma = 0.55$.

In TAC/PF, the boost is $\beta\gamma = 0.68$.

S. SULTANSOY 25.11.2010 CERN 12

Luminosity spectrum for the TAC charm factory.



- Center of mass energy spread < $\Gamma_{\Psi(3S)} \approx 24$ MeV.
- $\Psi(3S)$ is about 10^{10} per working year (10^7 s)
- D^+D^- and D^0D^0 decay modes are dominant channels for $\Psi(3S)$ decays.

S. SULTANSOY 25.11.2010 CERN 13

Outlook

For Charm Factory

Benchmark physics processes should be reviewed for a factory with asymmetrical beam energies.

Various synergy options within the TAC project should be evaluated.

- TAC SR (same e+ ring vs dedicated ring, sharing infrastructure)
- TAC FEL (time, infrastructure, expertise etc... sharing)

International collaborations with similar projects will be mutually beneficial:

- LHeC LR option, eRHIC LR option

For TAC in general

1 GeV SNS (based on TAC PA) is mandatory.

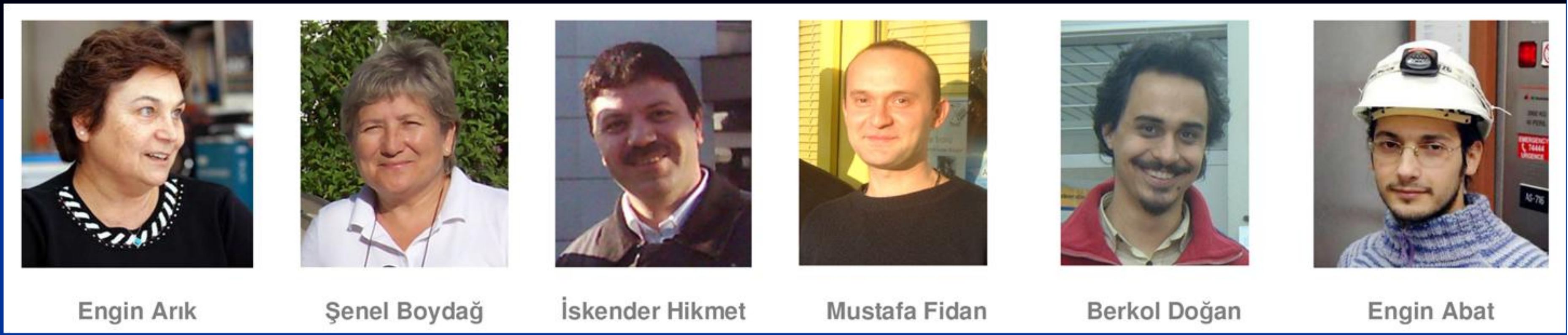
ADS studies (based on TAC PA) should be intensified.

Strong international cooperation opportunities should be seized.

We are seeking ECFA support for LR type colliders in general and for TAC project in particular.

Epilogue: Bayrakları Bayrak yapan …

30.11.2007 tarihinde Isparta'daki uçak kazasında kaybettiğimiz
Bilim Şehitlerimiz



Saygıyla ve rahmetle anıyoruz…

… Bu dünyada kimse kalmaz, giderim.

Yaşamını Türkiye'nin kalkınmasına adamış ve ülkemizin CERN üyeliği sürecini başlatan bilim şehidimiz

Prof. Dr. Engin Arık (1948-2007)

Son Söz Yerine

Hızlandırıcı teknolojisinde "muasır medeniyet düzeyeni yakalayabilmek" için:

✡ GeV mertebeli proton hızlandırıcısına

✡ GeV mertebeli elektron hızlandırıcısına

sahip olmalıyız

Ülkemizin **CERN üyeliği** Hızlandırıcı, Detektör ve Bilişim teknolojilerinde en yüksek düzeye ulaşmamızı sağlayacaktır.

"**Türk kültürünü muasır medeniyet seviyesi üzerine çıkarmamız**" için ise muhakkak en ileri düzey bir Parçacık Çarpıştırıcısı kurmalıyız.

Japonya örneğinde olduğu gibi Ulusal Hızlandırıcı Teknolojileri ve Uygulamaları Kurumunun oluşturulması tüm bunları gerçekleştirmemiz için gereken altyapının en etkin şekilde geliştirilmesi imkan sağlayacaktır.

Ek 1: Türkiye'nin CERN serüveni

- ✡ 1954: CERN 12 Avrupa ülkesi tarafından kuruldu. Maalesef, kurucu ülkeler arasında Türkiye yoktu

- ✡ 1960'lar: CERN Konseyi Türkiye'ye üyelik önerdi. Maalesef, bu öneriye olumlu cevap verilmedi. Rahmetli Prof. Dr. Erdal İNÖNÜ Hocamız 2001 yılında TÜBA'nın İstanbul'da CERN ile ilgili düzenlediği toplantıda bu olumsuz cevaptan dolayı kendisini affetmediğini söyledi.

- ✡ 1980'ler: Rahmeti Prof. Dr. Ahmet Yüksel ÖZEMRE Hocamızın başkanlığında Türk Bilim heyeti CERN'ü ziyaret ederek Türkiye'nin üyelik sürecini başlatmak istedi. Maalesef, **Hocamızın TAEK başkanlığından ayrılmasıyla bu süreç durdu.**

- ✡ 1997 yılında Nobel ödülü sahibi Prof. Dr. Carlo RUBBİA Hızlandırıcı Sürümlü Sistem (ADS) ile ilgili dokümanları Prof. Dr. Saleh SULTANSOY'a verdi. Bu dokümanlar Türk bilim insanları tarafından incelendi ve 1998 yılında TAEK'e konuyla ilgili Bilgi Notu iletildi.

- ✡ 2001: Rahmetli Prof. Dr. Engin ARIK, Prof. Dr. Metin ARIK, Prof. Dr. Ayla ÇELİKEL ve Prof. Dr. Saleh SULTANSOY TÜBA üzerinden ülkemizin CERN üyeliği sürecini başlattı

✡ 2001-2002 yıllarında TÜBA CERN ile ilgili toplantılar düzenledi. **Mart 2002'de TÜBA başkanının evinin kapısında bomba patlatıldı.**

✡ 2002: CERN Genel Direktör Yardımcısı Prof. Dr. R. CASHMORE başkanlığında bir heyet Türkiye'yi ziyaret etti. Bu ziyaret sırasında DPT müsteşarlığı Türkiye'nin CERN üyeliği konusunda olumlu görüş bildirmesine rağmen TÜBİTAK yönetimi süreci bloke etti

✡ 2002: 27 Temmuz tarihli Hürriyet gazetesinde Rahmetli Prof. Dr. Engin ARIK ile "Kurtarıcının adı Toryum" başlıklı musahibe yayınlandı. Bu musahibe de Türkiye'nin CERN üyeliğinin önemi net bir şekilde vurgulandı

✡ 2005: Mayıs ayında 15 Türk bilim insanının toplantısında hazırlanan Bilgi Notu TFD başkanı Prof. Dr. Baki AKKUŞ'un üst yazısıyla Sayın Başbakanımız Recep Tayyip ERDOĞAN'a iletildi. Bunun sonucunda TAEK Türkiye'nin CERN üyeliği konusunda kurum olarak görevlendirildi

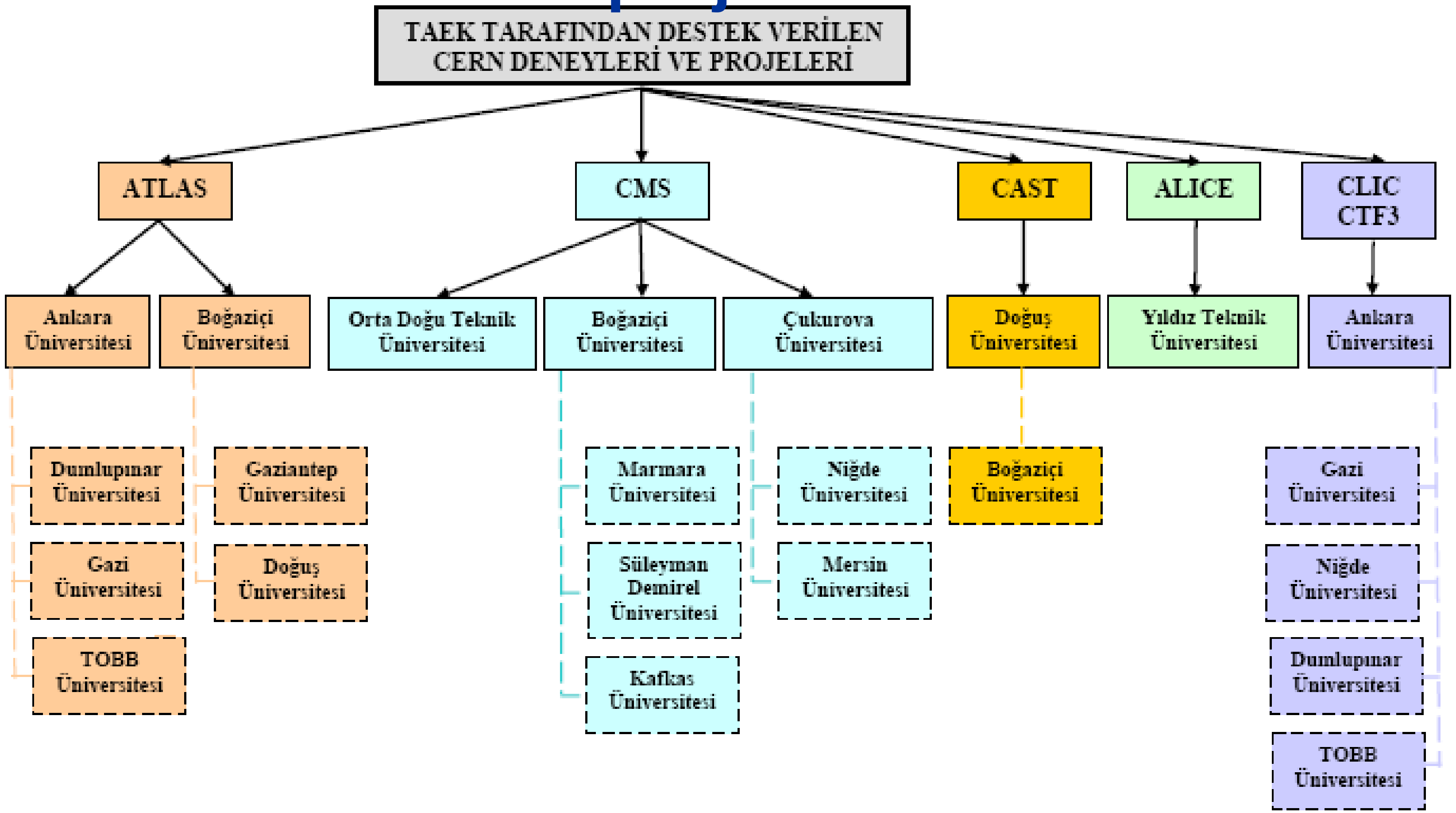
✡ 2006: 12 Türk bilim insanından oluşan TAEK-CERN Bilim Komitesi kuruldu

✡ **30 Kasım 2007: Prof. Dr. Engin ARIK ve TAC grubu üyesi beş bilim insanımız uçak kazasında şehit oldu**

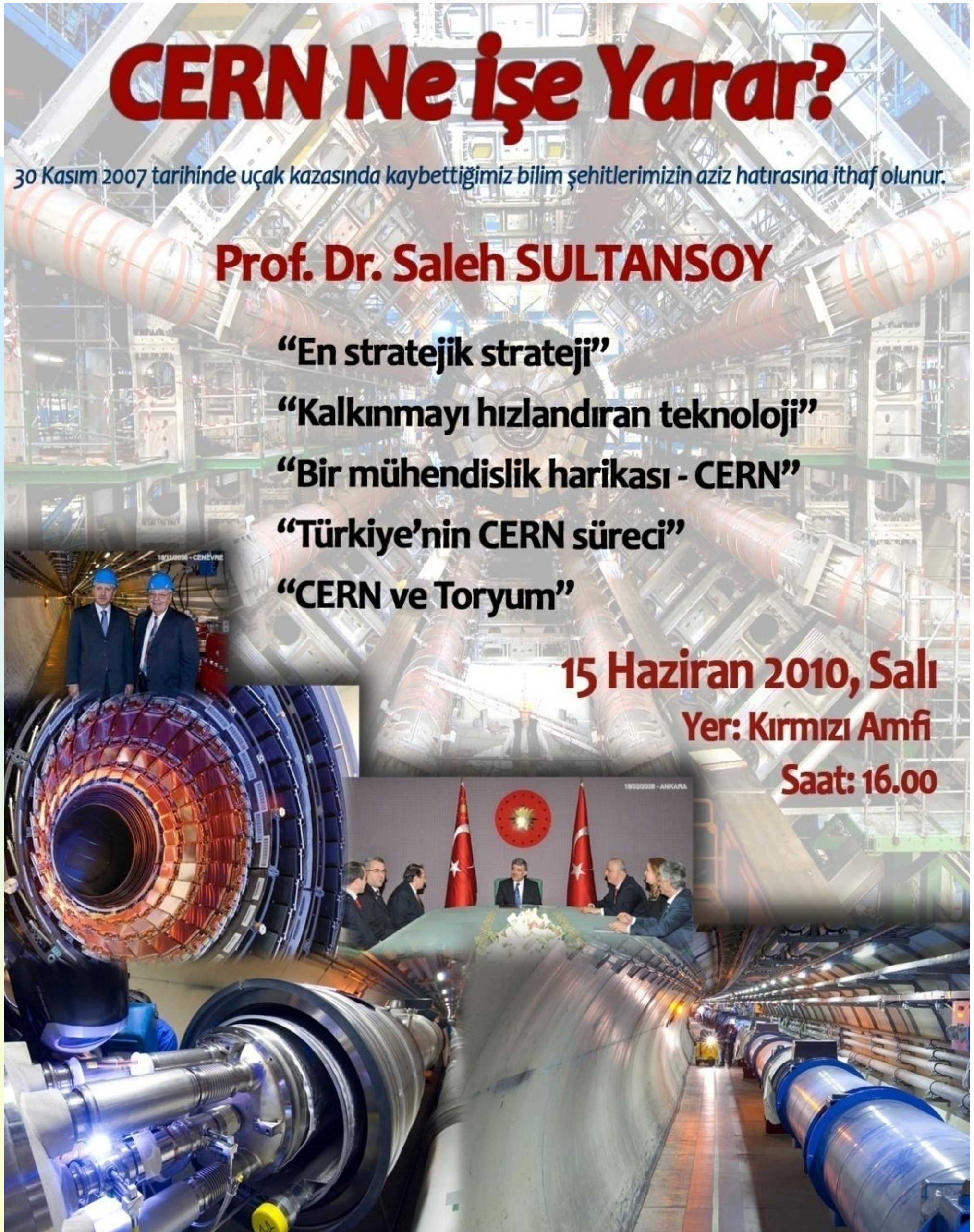
✡ 18 Şubat 2008: Cumhurbaşkanımız Sayın Abdullah GÜL TAC üyelerinden oluşan 6 kişilik TFD heyetini kabul etti. Yaklaşık bir saat süren görüşmede Sayın Cumhurbaşkanımız Türkiye'nin CERN üyeliği sürecine ve TAC projesine tam destek verdiğini açıkladı

✡ 18 Kasım 2008: Başbakanımız Sayın Recep Tayip ERDOĞAN CERN'ü ziyaret etti

TAEK'in desteklediği CERN projeleri



Yeni CERN projesi LHeC (2008 - ??) ile ilgili TOBB ETÜ yürütücülüğünde yeni TAEK projesi kabul edildi (2008-2011).



Bu sunumu yapmamım nedeni:

“Birileri” CERN Komisyonun Temmuz 2010’da planladığı Türkiye ziyaretini erteletmeye kalkıştı…

AKP Genel Başkan Yardımcısı Sayın Reha DENEMEÇ’in sunuma katılması bu “birilerine” iyi bir mesaj oldu !

- ✡ 2009: Türkiye CERN üyeliğine resmen başvurdu. Bizimle birlikte Güney Kıbrıs, İsrail, Sırbistan ve Hırvatistan CERN üyeliğine başvuruda bulundu. CERN Konseyi bu başvuruları incelemek için bir Komisyon kurdu

- ✡ Mayıs-Temmuz 2010: kurulan Komisyonun 5 ülkeyi ziyaret etti

- ✡ Eylül 2010: Komisyon hazırladığı raporu CERN Konseyine iletti

- ✡ Aralık 2010: CERN Konseyi 5 ülkenin üyelik süreci ile ilgili görüşmelerin başlatılmasına onay verdi

- ✡ Nisan 2011: İsrail hükümeti CERN ile üyelik işlemlerinin başlatılması kararını aldı

- ✡ Ekim 2011: İsrail'in başvurusu üzerine CERN Konseyi iki yıllık üyelik sürecinin başlatılmasını karara aldı. **İsrail 2013 yılında tam üye olacak !**

- ✡ Aralık 2011: Sırbistan'ın başvurusu üzerine CERN Konseyi iki yıllık üyelik sürecinin başlatılmasını karara aldı.

- ✡ Güney Kıbrıs bizden önce CERN üyesi olursa veto hakkına sahip olacak !

Ek 2: ICFA Seminer 2011’de TAC projesi

Particle Physics: European Region

ICFA Seminar

Geneva, Switzerland, 3-5 October 2011

T. Nakada

EPFL-LPHE

Lausanne, Switzerland

ECFA Chair and Scientific Secretariat for Strategy Session of CERN Council

Facilities for Flavour and Precisions

- Established national laboratories with accelerators still used for "flavour physics" experiments:
  - Germany DESY: search for axion like particle, $\sigma_{e^+p}/\sigma_{e^-p}$
  - Italy INFN Frascati National Laboratory
  - Russia Budker Institute of Nuclear Physics
    Institute for High Energy Physics
  - Switzerland Paul Scherrer Institute
- Emerging new organization
  - Italy **Cabibbo Laboratory**: Italian Consortium to construct SuperB Factory at the University of Rome Tor Vergata (INFN, Tor Vergata, Ministry, … discussion of governance on going)
  - Turkey Turkish Accelerator Center: Construction of accelerator complex with a possible inclusion of Tau-Charm Factory

European Strategy for Particle Physics

9. A variety of important research lines are at the interface between particle and nuclear physics requiring dedicated experiments; *Council will seek to work with NuPECC in areas of mutual interest, and maintain the capability to perform fixed target experiments at CERN*.

CERN Geneva laboratory offers facilities for
-Nuclear physics: ISOLDE, n-Tof,..
-Low energy antiproton (AD)
-Fixed target @ PS and SPS (QCD and Flavour)

CERN-ECFA Study Group for LHeC (ep collider with LHC proton) CDR almost ready

European Strategy Update

- Originally foreseen in 2011, delayed due to the LHC delay but now work started (Kickoff meeting at the ECFA-EPS joint session of Europephysics HEP conference, July 2011)
  - Draft for the updated strategy will be produced by the European Strategy Group (CERN member states, observer states, etc.)
  - Scientific inputs are prepared by the Preparatory Group (ECFA, CERN SPC, CERN GE-lab, American and Asian regions,…)
- Both groups are chaired by Scientific Secretary for ESS of CERN Council
- Timeline approved by the Council
  - Open Symposium for community input, September 2012
  - Strategy Group meeting for drafting, January 2013
  - Council discussion, March 2013
  - Presentation to EU Council of ministers, May/June 2013

10th ICFA Seminar on Future Perspectives in High-Energy Physics 2011
Science Driving facilities for particle physics

Future Opportunities for Heavy Flavor Physics Experiments

Toru Iijima

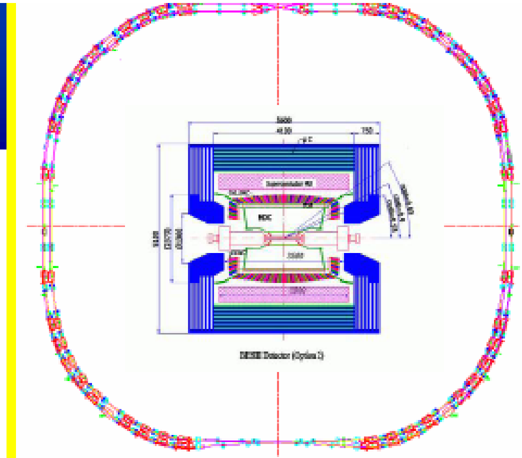
Kobayashi-Maskawa Institute

Nagoya University

October 5, 2011

BEPC II Plan

Hesheng Cheng
@ ECFA2010 meeting



On-going upgrade

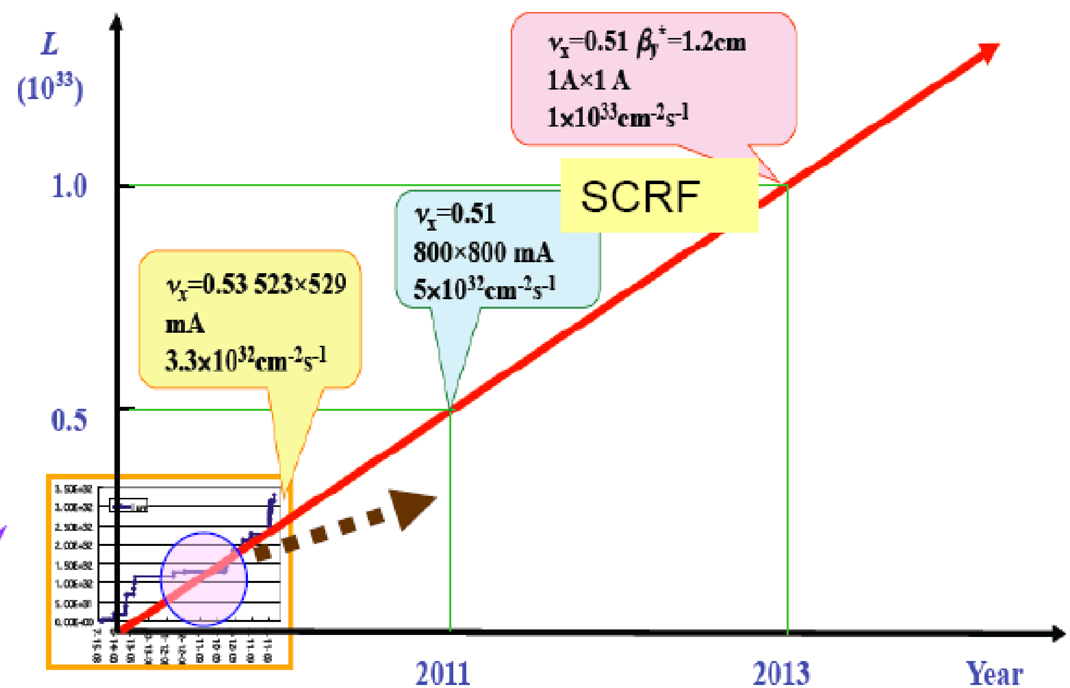
- To increase single bunch current in collision
- To enhance beam-beam parameter towards 0.04
- To move horizontal tune to 0.51
- To increase colliding bunch number and pattern
- Squeeze β_y^*

Long-term upgrades

(under discussion)

- Increasing beam energy? (2.3GeV now)
- Crab-waist for higher luminosity
- Collision with polarized beam
  - •Physics requirements
  - •e- beam plaization? location for rotators ?

BEPCII luminosity plan

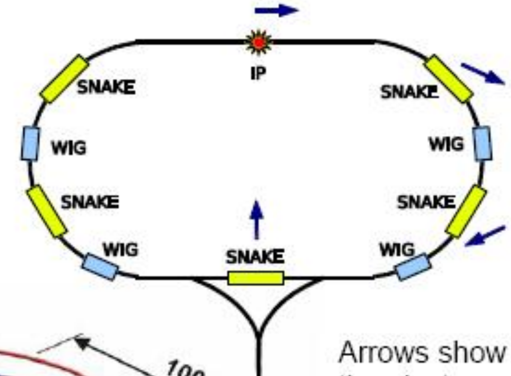


Super Charm Tau Factory at BINP

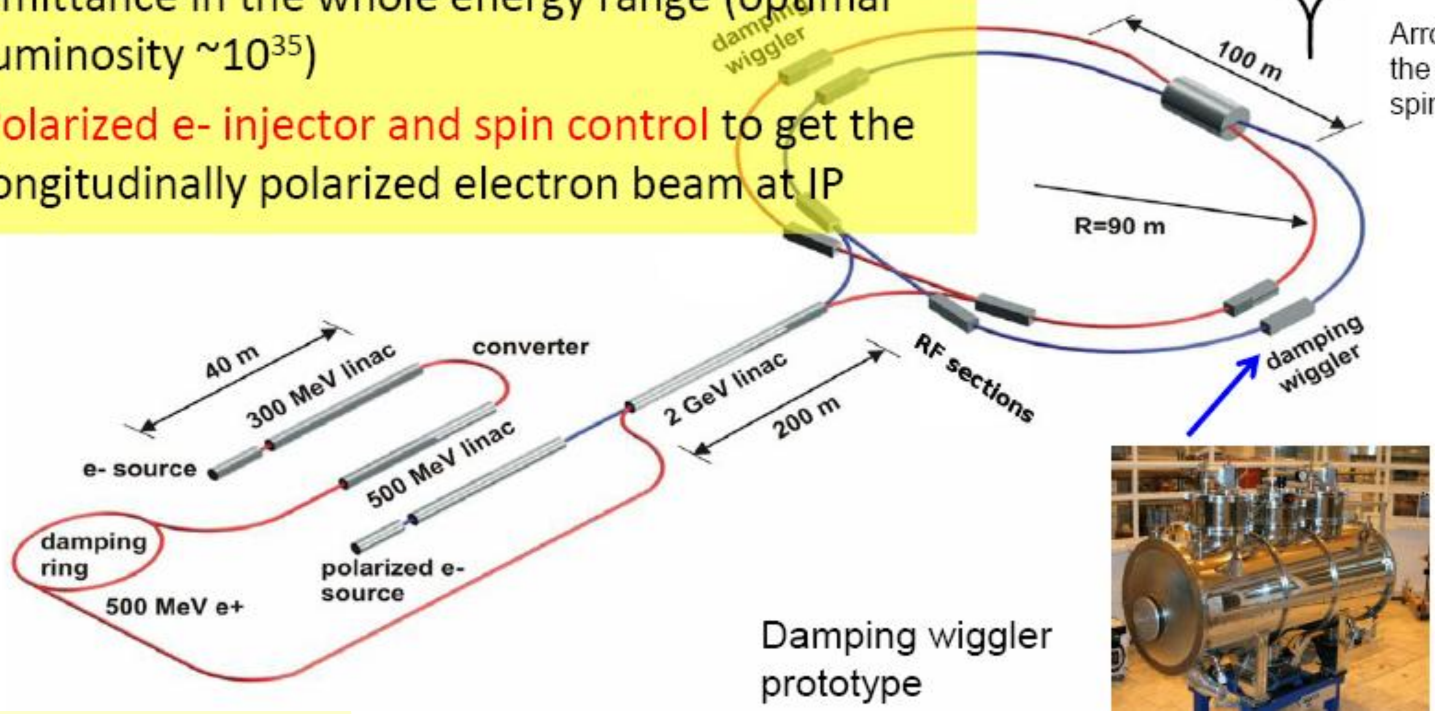
E_{beam} = 1.0 - 2.5 GeV : L_{peak} = 10^{35} $cm^{-2}s^{-1}$ (2 GeV): Polarized e^- beam

Main features:

- Two rings with a single interaction point
- Nano Beams + Crab waist collision
- SC wigglers to keep the same damping and emittance in the whole energy range (optimal luminosity ~10^{35})
- Polarized e- injector and spin control to get the longitudinally polarized electron beam at IP



Arrows show the electrons spin direction



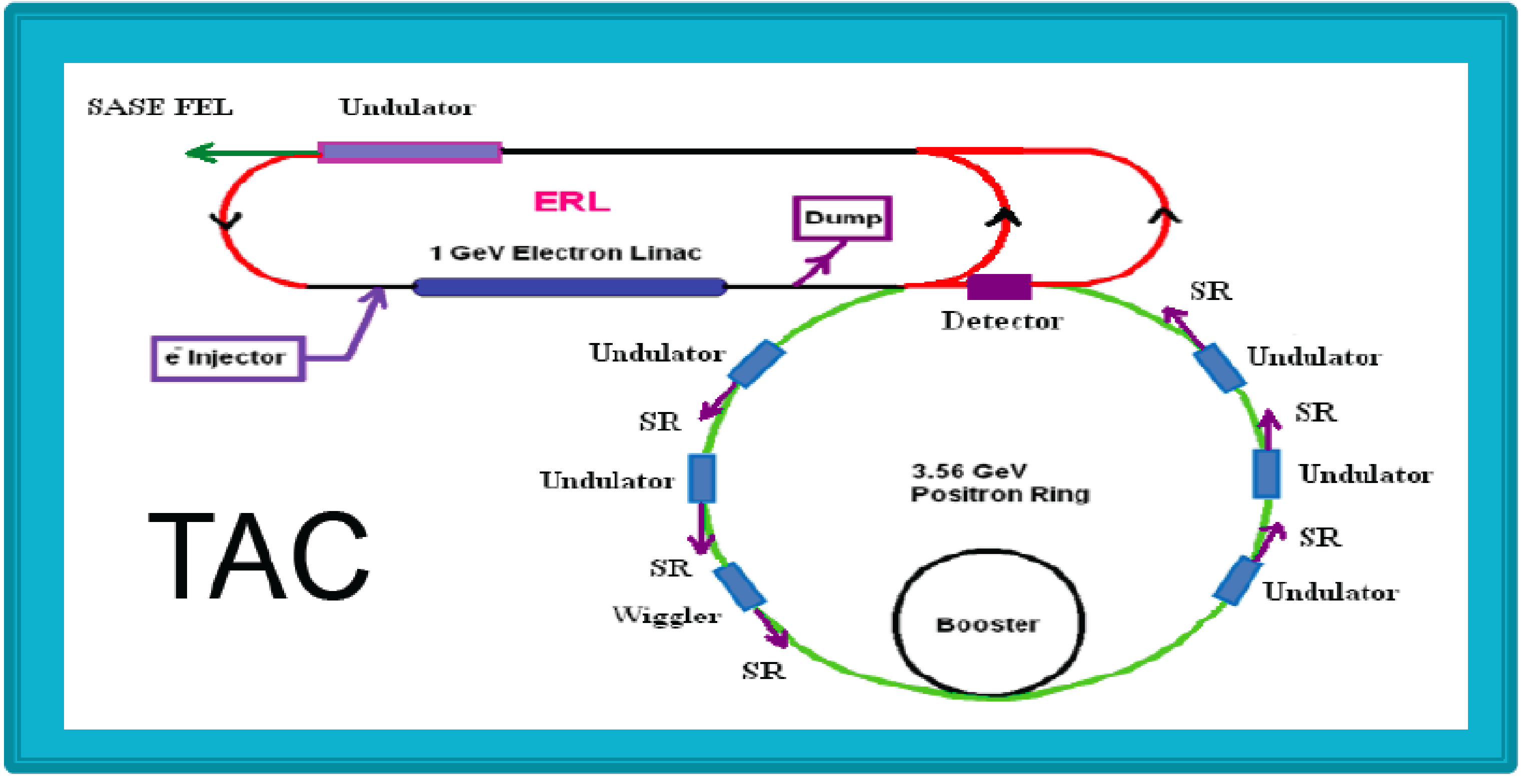
Damping wiggler prototype

29

Linac-Ring Type c-τ Factory

- An option of the Turkish Accelerator Center (TAC).
- Positron ring (3.56 GeV) + Electron ERL (1 GeV) ➡ $\beta\gamma = 0.68$
- $L_{peak} = 1.4 \times 10^{35} cm^{-2}s^{-1}$.

(Saleh Sultansoy @ ECFA2010 meeting)



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