THE STATUS OF TURKIC ACCELERATOR COMPLEX PROPOSAL

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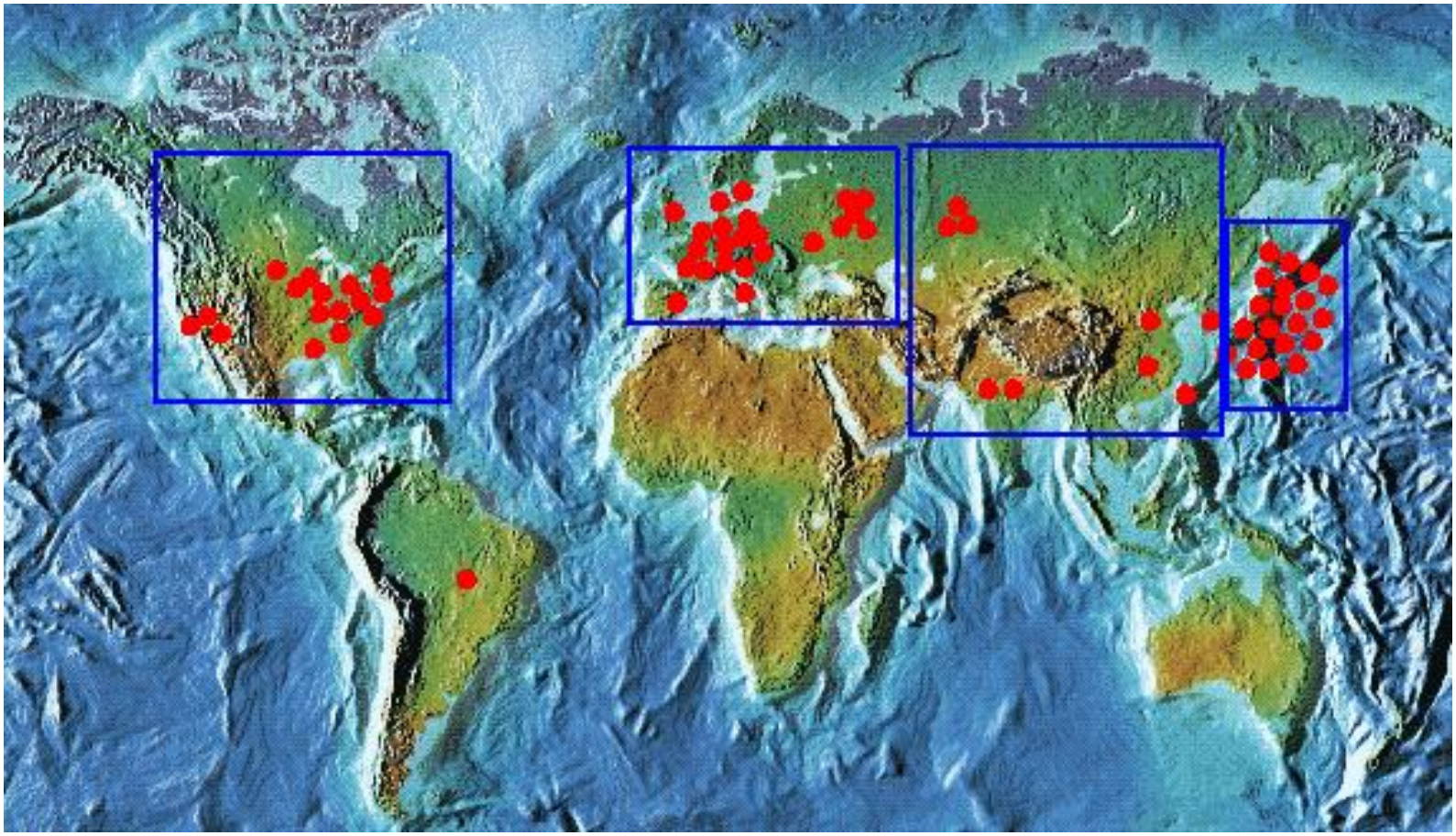
Introduction

- Accelerator technology ➲ a generic technology ➲ locomotive of the development in almost all fields of science and technology.
- Accelerator technology should become widespread all over the world.
- Existing situation: a large portion of the world (the South and Mid-East) is poor on the accelerator technology.

SR Sources around the world

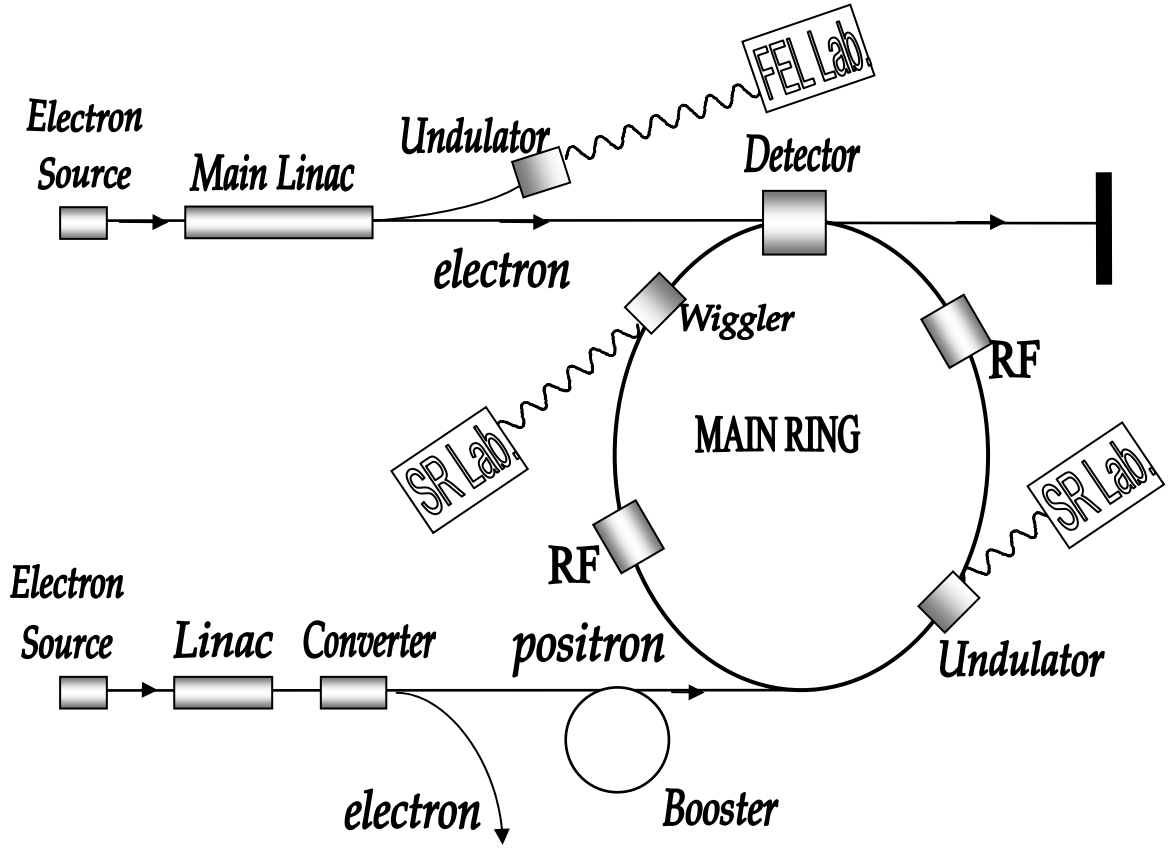


Projects in Middle East

- SESAME in Jordan (by UNESCO) } SR
- CANDLE in Armenia

- Turkic Accelerator Complex
  - light sources
  - particle physics experiments
  - proton and secondary beam applications

Turkic Accelerator Complex



- Schematic view of the TAC charm factory complex

Short chronology of the TAC project

- Approximately 10 years ago, linac-ring type charm-tau factory with synchrotron light source was proposed as a regional project for elementary particle physics.
  - S. Sultansoy, Turk. J. Phys. 17 (1993) 591; Turk. J. Phys. 19 (1995) 785.

- Starting from 1997, a small group from Ankara and Gazi Universities begins a feasibility study for the possible accelerator complex in Turkey with the support of Turkish State Planning Organization (DPT).
  - **http://bilge.science.ankara.edu.tr**

Short chronology of the TAC project (cont.)

- The results of the study are published in

  A. K. Çiftçi et al., Turk. J. Phys. 24 (2000) 747

  and presented at EPACs

  Ö. Yavaş, A. K. Çiftçi, S. Sultansoy, EPAC 2000, p. 1008.

  A. K. Çiftçi et al., EPAC 2002, p. 1100.

- Starting from 2002, the conceptual design study of the TAC project has started with a relatively enlarged group (again with the DPT support). The results are published in

  S. Sultansoy et al., PAC 2005

Short chronology of the TAC project (cont.)

Present Status:

Turkish State Planning Organisation Project
(DPT2006K-120470)
2006-2010

9 Turkish universities
30 staff + 40 students

- TAC TDR
- Infrared FEL Lab

TAC Project includes

- Linac-ring type charm factory
- Synchrotron light source based on positron ring
- Free electron laser based on electron linac
- GeV scale proton accelerator
- TAC-Test Facility

TAC Particle Factory

- Considered:
  - linac-ring type ϕ factory,
  - **linac-ring type charm factory**,
  - linac-ring type τ factory
- $L = 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ can be achieved for all three options.

Synchrotron Light Source

- Is additional positron storage ring dedicated for production of synchrotron radiation necessary?
- Ring-ring collider: beam-beam tune shift restriction ➲large emittance ➲ high luminosity:

$$L = f_c \frac{4\pi\gamma_p\gamma_e\Delta Q_p\Delta Q_e\varepsilon_p}{r_0^2\beta_e^*}$$

SR in linac-ring type machines

- Luminosity independent of emittance

$$L = f_c \frac{\gamma_p \Delta Q_p N_p}{r_0 \beta_p^*}$$

- Chosen emittance (3 nm·rad) of the positron small enough ➲ a third generation light source (< 20 nm·rad)
- Number of insertion devices and beam lines of TAC SR Facility and their specifications depend on realization of SESAME and CANDLE projects as well as on user potential in our region.

Free Electron Laser

- Main linac of the TAC charm factory can be operated separately to obtain FEL.
- FEL operation is foreseen during the maintenance of the collider.
- With 1 GeV electron beam, wave length of SASE FEL photons is expected to be a few nm.
- Detailed studies for different electron beam energies were presented at national conferences.

Proton Accelerator

- TAC proton accelerator proposal consists of 100÷300 MeV energy linear pre-accelerator and 1÷5 GeV main ring.
- The average beam current values for these machines would be ~30 mA and ~0.3 mA, respectively.
- Proton beams from two different points of the synchrotron will be forwarded to neutron and muon regions, where a wide spectrum of applied research is planned.

Planned uses of proton accelerator

- Muon region
  - fundamental investigations
    - test of QED and
    - muonium-antimuonium oscillations...
  - applied investigations with μSR method
    - High-T_c superconductivity
    - phase transitions
    - impurities in semiconductors...
- Neutron region
  - applied physics
  - molecular biology
  - fundamental physics

TAC Test Facility

- Before building charm factory
  - to get experience on accelerator technology on smaller scale
  - to train young accelerator physicists

  we plan to build infrared free electron laser (IR FEL) on 20÷50 MeV e-linac until 2009.

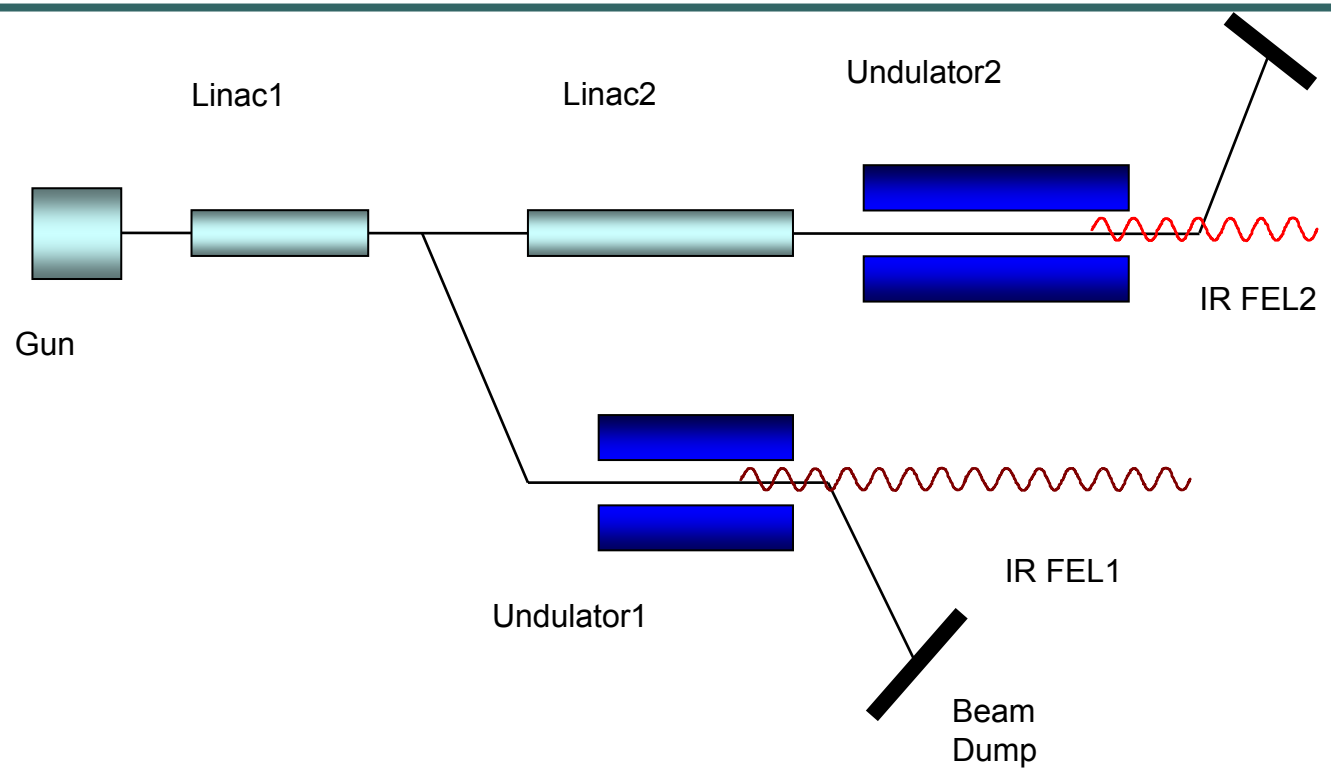
- IR FEL thought to work in oscillator mode.

{
- undulator strength parameter K=1
- vertical distance between magnet poles g=3 cm
}

⇩

{
- 10 MeV e-linac ➘ wavelength values of 15 μm (IR FEL1)
- 50 MeV e-linac ➘ wavelength values of 2 μm (IR FEL2)
}

Schematic view of the TAC Test Facility



Three experimental stations are planed to make research on biomedical subjects, semiconductor physics and photo chemical reactions.

Time Schedule

2006-2007:
- Completion of the conceptual design report
- Starting technical design study

2008:
- Installation of the TAC-TF linac

2009:
- Installation of the TAC-TF infra-red FEL and beam lines with the experimental stations
- Completion of the TAC technical design report

2010:
- Commissioning of TAC-TF
- **Governmental decision** on approval of TAC project

2015:
- **Completion of charm factory** and light source part of TAC project.

2017:
- Completion of proton accelerator and experimental stations

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 $\mathbf{10^{33}\ cm^{-2}s^{-1}}$, 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.

TAC Charm Factory

- Considered:
  - linac-ring type ϕ factory,
  - **linac-ring type charm factory**,
  - linac-ring type τ factory
- $L = 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ can be achieved for all three options.

Why Charm Factory?

- DAϕNE ϕ factory has nominal $L = 5 \times 10^{32} cm^{-2} s^{-1}$ and possible upgrades to higher luminosities are under consideration ➲ physics search potential for the ϕ factory will be essentially exhausted before TAC commissioning
- Success of B-factories L= 10^{34} $cm^{-2}s^{-1}$ $\rightarrow$ super B-factories with 10^{36} $cm^{-2}s^{-1}$ ➲ B-facory produces enough τ lepton to study.

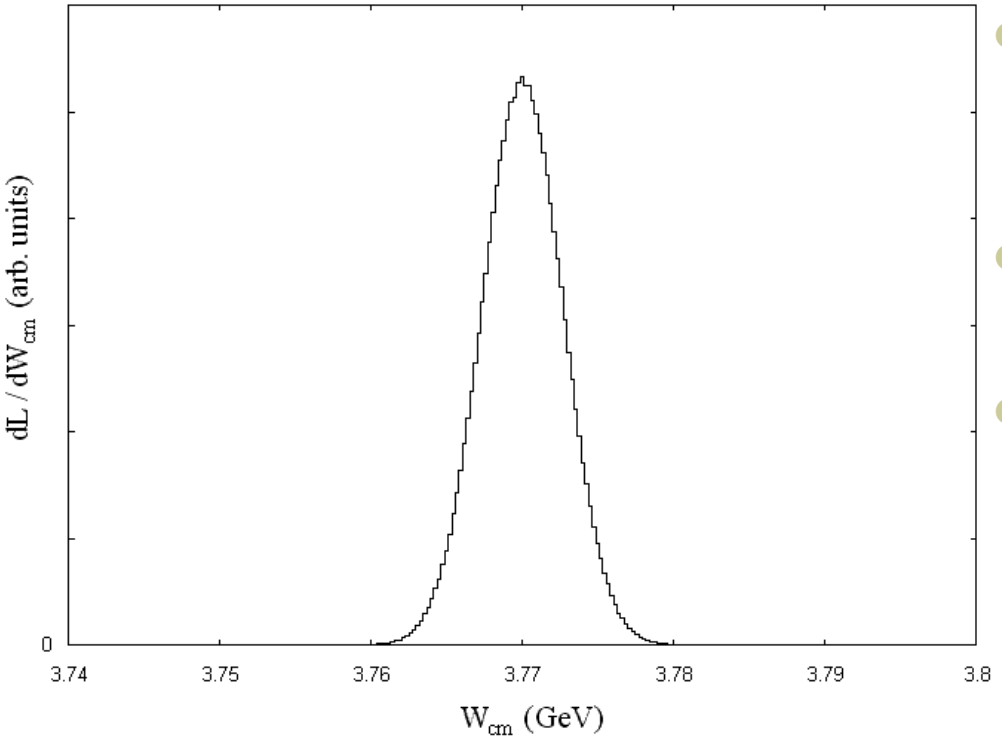
Why Charm Factory? (cont.)

- Existing CLEO-c ($L=10^{32}$ $cm^{-2}s^{-1}$)
- BEP charm factory proposal ($L=10^{33}$ $cm^{-2}s^{-1}$)
- TAC charm factory ($L=10^{34}$ $cm^{-2}s^{-1}$), planned to work in mid 2010's, will contribute charm physics greatly.
  - In the case of K and B mesons, possible new physics manifests itself as a deviation from standard model background, whereas for D mesons this background is negligible.

Tentative parameters of TAC charm factory

Parameter	**e^--linac**	**e^+-ring**
Energy, GeV	1.00	3.56
Particles per bunch, 10^{10}	0.55	11.00
β function at IP, cm	0.45	0.45
Normalized emittance, μm·rad	6.17	22.00
Bunch length, cm	0.10	0.45
Transverse size at IP, μm	3.76	3.76
Beam-beam tune shift	-	0.056
Collision frequency, MHz	30	
Luminosity (H_D·L)	$1.4\ 10^{34}$ $cm^{-2}s^{-1}$	

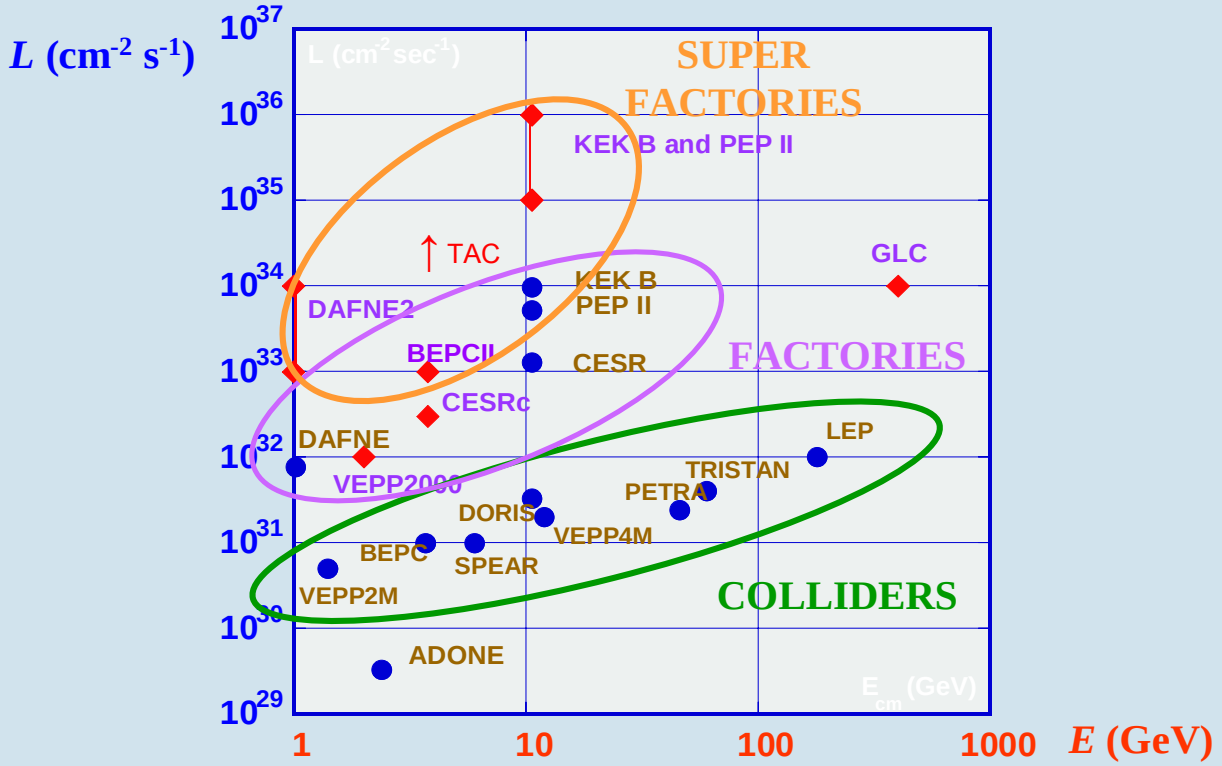
Luminosity spectrum for the TAC charm factory.



- Center of mass energy spread < $\Gamma_{\Psi(3S)} \approx 24$ MeV.
- $\Psi(3S)$ is about 10^9 per working year
- D^+D^- and D^0D^0 decay modes are dominant channels for $\Psi(3S)$ decays.

from D. Asner “Status of BES” (TAC is added)

e^+-e^- Colliders: Past, Present and Future



Ultimate luminosity for TAC

L ~ 10^{34} $cm^{-2}s^{-1}$ within existing (conservative) technologies and limitations

Possible improvements:

- ERL (to avoid linac beam power limitation) — factor 5÷10
- "dynamical focusing" — factor 3÷5
- Crab-crossing (to avoid ΔQ) — factor 3÷5

→ L= (0.5÷2.5)10^{36} $cm^{-2}s^{-1}$ Super Charm ??

Super Factories: B, Charm and Tau

Standard (ring-ring) type

L (10^{34} $cm^{-2}s^{-1}$)	S-KEK-B	ILC-inspired	Linear	Linac-Ring
B	80	100 ?	??	??
Charm	??	??	??	1 (→100 ?)
Tau	??	??	??	??

For each type of B-factory, the same technology will give opportunity to achieve at least 1/3 of B luminosity for Charm and Tau cases.

Outlook

1) Identification of benchmark processes for each super factory type

2) Comparative study of the benchmark processes at different facilities, including LHC-B, J-PARC etc

For Charm case priority should be given to D^0 -D^0(bar) oscillations and rare D decays which are highly suppressed within the 3 family SM. Observation of such prosesses will be direct evidence for New Physics.