JOINT INSTITUTE FOR NUCLEAR RESEARCH

E1,9,13–92–98

Proceedings of the Workshop on JINR c-tau Factory

(29—31 May 1991, JINR, Dubna)

Dubna 1992

JINR STORAGE ACCELERATOR COMPLEX — C-TAU FACTORY

A.N.Sissakian

Joint Institute for Nuclear Research, Head Post Office, PO Box 79. Moscow, 101000, Russia

1. INTRODUCTION

Now a storage accelerator project is being studied in the JINR. This complex is expected to allow promising investigations in the Institute's traditional fields of elementary particles physics, nuclear physics, condensed matter physics, as well as applied investigations.

The new complex is supposed to be attractive for wide international cooperation.

The project discussed involves:

- a heavy-ion storage accelerator of energy up to 1 GeV/nucleon, which allows electron-nucleus collisions (K4-K10);
- a $c\tau$-factory with the total energy of colliding particles up to 5 GeV;
- a high resolution neutron source (HRNS);
- an 8-10 GeV positron (electron) storage ring (NK-10).

The heavy ion storage rings are to be employed in the experiments which are now impossible and which will allow significant progress in studying mechanisms of nuclear reactions, the nuclear structure, the nature of nuclear forces, in studying and using fine effects in atomic physics of heavy ions.

The scientific research programme for the $c\tau$-factory includes τ-lepton and τ-neutrino physics, charmonium spectroscopy, CP violation experiments, charmed baryon physics and meson spectroscopy.

The HRNS will make it possible to raise the level of investigation of parity violation in neutron-nucleus interactions, p and α decay channels of excited nuclei in reactions (n, p) and (n, α), γ-ray cascades in capture of resonance neutrons, etc.

The positron (electron) storage ring NK-10 will allow fundamental and applied research in nuclear physics, elementary particles physics, atomic and molecular physics, chemistry, condensed matter physics, biology, materials technology, X-ray lithography, etc.

The construction of the complex will have three stages. At the first stage (the desired deadline is 1994) the heavy ion storage rings and the high resolution neutron source are to be built. The second stage (can be finished in 1996-1997) is the construction of the $c\tau$-factory. The third stage (to be finished after 2000) involves the construction of a synchrotron light centre on the basis of the positron (electron) storage ring.

A layout of the storage accelerator complex is shown in **Fig.1**. The $c\tau$-factory is on the spare territory of the JINR, while NK-10 occupies some of the existing laboratory buildings. To meet the above deadlines with allowance for the current situation and the infrastructure available, there is an idea to assemble the common preinjector for the $c\tau$-factory and the NK-10 in the linear accelerator (LU) building. If so, both boosters and the $c\tau$-factory shall be moved to another place.

The idea of building in the JINR the storage accelerator complex for ions, electrons and positrons was put forward by Academician A.N.Skrinsky at the 66th session of the JINR Scientific Council in 1989. The JINR experts have optimized the layout of the complex. has been approved by the 67th session of the JINR Scientific Council, the international expert commission and the Committee of Plenipotentiaries of the JINR [1].

In this talk we consider possible experiments at the $c\tau$-factory, the acceleration concept of the $c\tau$-factory, and the scheme of a universal detector for studying e^+e^- annihilation in the $c\tau$-factory energy range.

2. Cτ-FACTORY PHYSICS PROGRAMME

The research programme for $c\tau$-factories has already been discussed in remarkable survey papers [2-15] and is practically ready. So we confine ourselves to a brief description of the problems to be solved.

The core of the experimental programme for $c\tau$-factories must be the study of properties of the second-generation quarks and the third-generation leptons through investigations in

- tau-lepton physics;
- charmed meson physics;
- charmonium physics;
- charmed baryon physics.

Fig.2 shows the behavior of the hadron production cross section as a function of the muon production cross section for the energies available at $c\tau$-factories. Remember that it is in this field that the most outstanding discoveries were made in the 1970s. The J/ψ particle and then a whole family of hadrons with hidden charm and a $c\bar{c}$ quark system were found. Then the third-generation lepton and the heavy τ-lepton were found. Charmed hadrons with a single c-quark, i.e. hadrons with open charm, were discovered. This is the energy region where the BEPC facility recently built in Beijing (China) operates. Nevertheless, the experimental statistics for this energy region is far from being rich because the existing colliders have low luminosity. So, one of the reasons for building $c\tau$-factories is to get higher luminosity. The luminosity of $c\tau$-factories is planned to be 200 times higher than that of the BEPC.

In **Table 1** there are the assumed production rates of events that can be studied at $c\tau$-factories. Undoubtedly, an essential increase in luminosity is important. However, proving the necessity of $c\tau$-factories we'd like to show that the investigations to be carried out at $c\tau$-factories are impossible, for example, at B-factories with the same luminosity.

In **Fig.3** there is the production cross section of $\tau^+\tau^-$ pairs as a function of the energy. It is well seen that the cross section at B-factory energies, though smaller than at $c\tau$-factory energies, is large enough to carry out serious investigation. As to the charmonium ($J/\psi, \psi', \psi''$,...), it is produced resonantly and therefore is a "privilege" of this energy region. Besides, the $c\tau$-factory allows one to study properties of τ-leptons and charmed baryons near their production threshold and thus to obtain high-quality informations at a uniquely sow background.

To study τ-lepton physics, there are three optimal energy regions:

- near the $\tau^+\tau^-$ production threshold (E_{cm}=3.57 GeV) the number N_τ of the τ-lepton pairs expected is $\approx 4 \times 10^6$ per year;
- under the production threshold of the charmed $c\bar{c}$-quark pair (E_{cm} =3.67 GeV), here $N_\tau \approx 4 \times 10^6$ per year;

Table 1:

Type of PARTICLE	E_{cm} GeV	PRODUCTION FREQUENCY 1/S	EVENTS PER YEAR (10^7 s)
J/Ψ	3.10	1000	10^{10}
Ψ'	3.69	600	$6 \cdot 10^9$
$\tau^+\tau^-$	3.57	0.4	$4 \cdot 10^6$
$\tau^+\tau^-$	3.67	2	$2 \cdot 10^7$
$\tau^+\tau^-$	4.25	4	$4 \cdot 10^7$
D^+D^-	$\Psi''(3.77)$	2	$2 \cdot 10^7$
$D^o\overline{D^o}$	$\Psi''(3.77)$	3	$3 \cdot 10^7$
$D_s^+D_s^-$	4.03	0.7	$7 \cdot 10^6$
$D_sD_s^*$	4.14	1	10^7
$L = 10^{33}cm^{-2}s^{-1}$; $E_{cm} = 4$ GeV			

- near a local minimum in the production cross section for the $c\bar{c}$-quark pair (E_{cm}=4.25 GeV), at this energy the $\tau^+\tau^-$ production crossed section reaches its maximum and $N_\tau \approx 5.6 \times 10^7$ per year.

The work in these energy regions has the following advantages:

- at (E_{cm}=3.57 GeV) it is possible to calibrate the background by transition to point E_{cm}=3.55 GeV, where $\tau^+\tau^-$ pairs are not produced while the background does not practically charge and the systematic errors are greatly reduced;

- at E_{cm}=3.57 GeV and E_{cm}=3.67 GeV there are no background processes from decays of charmed mesons and charmonia ($E_{th}(\psi') = 3.69$ GeV, $E_{th}(D\bar{D})$=3.73 GeV);

- a typical feature of $c\tau$-factory experiments is a possibility of labelling τ-leptons. For example, when the accelerator energy is 3.57 GeV, which several MeV higher that the production threshold, $\tau^+\tau^-$ pairs are produced practically at rest in the lab frame, and products of their two-particle decays are almost monoenergetic and well distinguished kinematically from the products of multi-particle decays.

  Fig.4 shows the simulated momentum spectra of particles produced in the most probable decays of the τ-lepton at this energy. Isolating π-mesons with momentum about 800 MeV/c, one can isolate, label $\tau^+\tau^-$ productions events and, moreover, separate particle from different τ-leptons. It allows one to make the background extremely low and to carry out absolute normalization of the quantities measured [15];

- at the $c\tau$-factory energies the τ-lepton decay products have small momenta, which improves the efficiency of their detection. A small momentum spread (2.4%) for the products of for the products of two-particle τ decays creates good conditions for τ-neutrino mass measurement;

- a contribution of radiative corrections to $\tau^+\tau^-$ production is small. It is very important, for example, in precise measurement of electron energy specrtum in the decay $\tau \rightarrow e\bar{\nu}_e\nu_\tau$.

Together with high luminosity (L=$10^{33} cm^{-2}s^{-1}$) all the features allow one to deal with many physical problems with cannot be solved at the existing facilities.

- Cτ-FACTORIES CREATE UNIQUE POSSIBILITIES FOR PHYSICIST TO CARRY OUT HIGHLY PRECISE MEASUREMENTS UNDER GOOD BACKGROUND CONDITIONS AND NO OTHER ACCELERATORS CAN ALLOW SUCH POSSIBILITIES.

In **Table 2** there are examples of physical problems that can be solved at $c\tau$-factories.

3. Cτ-FACTORY ACCELERATION CONCEPT

The electron-positron collider ($c\tau$-factory) is expected to provide high luminosity (about 10^{33} cm^{-2} s^{-1}) in the energy range of colliding particles 1.5-2.5 GeV. Following recommendations [5,9], we plan the maximum luminosity at 2.2 GeV. The energies close to it are necessary for experiments on τ-lepton and τ-neutrino physics. The factory must also have high integral luminosity, i.e. high reliability of all facilities involved and high injector capacity. According to the universally accepted principle [3,9,13,17,18], the JINR factory design is based on conservative solutions, i.e. the high luminosity is obtained with systems, principles and devices tested in various scientific centres.

Now two versions of the $c\tau$-factory are examined: one is similar to that described in ref.[2,8,12,16,17], the other is based on the monochromatization scheme [19].

In the first version high luminosity is obtained by using:

- multi-bunch mode of storage device operation with separation of bunches after collision;
- minimum possible value of the vertical β-function at the collision point (about 1 cm) due to superconducting lenses (micro-beta insertions);
- higher number of particles stored, owing to thorough correction of the magnetic field and suppression of coherent instabilities using feed-back systems;
- magnetic structure that provides sufficiently large beam emittance.

The schematic of the $c\tau$-factory with an injection complex and the main ring is shown in **Fig.5**. The injection complex consists of a preinjector and a fast booster synchrotron, where electrons and positrons are finally accelerated to the main ring storage energy. The preinjector is expected to be also used for initial acceleration of particles in the NK-10. It should be noted that the preinjector is actually HRNS, mentioned in the introduction before.

The basic parameters of the $c\tau$-factory are given in **Table 3**. The consideration of the τ-charm factory project in given in make detail in paper [20]. A group of JINR accelerator physicists is working in this problem and together with the group of State Building Design Institute is completing the main and important stage of projecting.

Table 2:

EXAMPLES OF PHYSICAL PROBLEM TO INVESTIGATE AT Cτ- FACTORY	
τ - LEPTON PHYSICS	
Cτ-factories are the best facilities for precision investigations of τ-lepton properties!	
1. Measurement of τ-lepton mass with accuracy	$\leq 0.2\mathrm{MeV}^2/\mathrm{c}$.
Current accuracy is	$3.2\mathrm{MeV}^2/\mathrm{c}$.
2. Measurement of τ-neutrino mass to level of	$\leq 4.0\mathrm{MeV}^2/\mathrm{c}$.
Current level is	$\leq 35\mathrm{MeV}^2/\mathrm{c}$.
3. Measurement of branching ratio with accuracy	$\leq 1\%$
Current accuracy is	(3-25)%
4. Search for rare τ -lepton decays at level of	$\approx 10^{-7}$
Current level is	$\approx 10^{-5}$
D - MESON PHYSICS	
1. Observation of pure lepton decays.	
2. Measurement of mixing matrix elements V_{cs} and V_{cd}.	
3. Search for rare D-meson decays at level of $\approx 10^{-7}$	.
J/Ψ and Ψ' - MESON PHYSICS	
1. Search for new states of the $c\bar{c}$-system.	
2. Search for glueballs in radiative decays.	
INVESTIGATION OF CHARMED BARYONS	
1. Spectroscopy of charmed baryons.	
2. Study of charmed baryon decay modes.	
3. Study of production mechanism of charmed baryons.	
"NEW" PHYSICS	
1. Search for second-class current effects.	
2. Search for supersymmetric gluinos and photinos.	
3. Search for manifestations of charged Higgs particles and leptoquarks.	

Table 3: $C\tau$-FACTORY PARAMETERS

Energy at maximum luminosity	GeV	2.2
Luminosity	$cm^{-2}\ s^{-1}$	$1.2 \cdot 10^{33}$
Lifetime	hours	2
Number of collision points		2
Perimeter	m	378
Turn radius	m	11.92
Orbit expansion coefficient		$3.43 \cdot 10^{-2}$
Horizontal emittance	m·rad	$4.11 \cdot 10^{-7}$
Vertical emittance	m·rad	$2.05 \cdot 10^{-8}$
Energy spread		$5.46 \cdot 10^{-4}$
Attenuation time of		
longitudinal oscillations	ms	16.0
transverse oscillations	ms	32
Operating frequency of RF system	mHz	500
Accelerating voltage	MV	16
Number of accelerating stations		2 x 4
Harmonic order		630
Number of bunch		30
Full current	mA	600
Particles per bunch		$1.58 \cdot 10^{11}$
Energy loss per revolution	MeV	174
SI power per unit length of chamber	kW/m	1.4
Tolerable wide-band impedance	Ohm	0.34
Beta-function at collision point		
horizontal	m	0.20
vertical	m	0.01
R.m.s. length of bunch	mm	7.12
Space charge parameter		0.04

The feasibility study carried out in 1990 shows that construction of the $c\tau$-factory on the territory of the JINR using its infrastructure will cost 130M roubles, 20.5M of them being spent for civil engineering and installation work.

Table 4 breaks down the estimated expenditure for the complex.

4. UNIVERSAL DETECTOR

To solve the above-mentioned problems one needs a universal 4π-detector. At present there are both operating installations and projects of universal 4π-detectors for colliding e^+e^--beams in close energy regions [2,5,9,24,25]. As mentioned above, the $c\tau$-factory investigations involve mainly precision experiments, which demands that the detector performance should satisfy strict requirements:

- precise ($\triangle P/P \approx 0.5\%$) measurement of momenta of charged particles and a possibility of reconstructing coordinates of secondary vertices of decays of charmed particles and τ-leptons with an accuracy of 10 μm;
- possibility of identifying e, μ, π, K, p with energies to ≈ 2 GeV/c;
- precise energy measurements for electrons and γ-quanta of the lowest possible energies in a calorimeter with a space resolution good enough for effective identification of π^o-mesons;
- maximum tightness of the detector.

A schematic view of the detector proposed for the $c\tau$-factory at the JINR is shown in **Fig.6**.

The tentative estimations of the detector cost at 1990 prices are shown in **Table 5**.

The detailed consideration of the detector project is given in paper [21] as well as is series of lectures at the present conference. If should be only noted that at present a group of JINR scientists in close collaboration with LNP (Novosibirsk) is working out the project of the detector. According to the tentative schedule given below, designing, manufacturing, assembly and adjustment of the detector can be done within five-six years after the financing begins.

5. CONCLUSIONS

1. The $c\tau$-factory physics programme for the precision study of the properties of the τ-lepton and c-quark-containing particles near their production threshold is of current importance and aimed at studying the fundamental problems of particle physics. It cannot be implemented at the existing or planned facilities.

Table 4:

	Breakdown	Expenditure (in millions of roubles)
1.	**Injection complex**	
	Linac	20.0
	Cooler-accumulator	1.5
	Booster magnetic systems & power sup.	2.49
	Injection and extraction	1.9
	RF system of booster and cooler	4.0
	Beam transport channels	0.46
	Vacuum system	0.35
	Other equipment	0.4
		....
		31.1
2.	**Cτ-factory**	
	Wigglers, -insertions, separators	2.34
	Magnetic system and power supply	6.8
	RF system	$ 6.1m
	Injection	1.0
	Vacuum system	2.8
	Other equipment	0.76
		....
		13.7 + $ 6.1m
3.	**Auxiliary systems**	
	Diagnostics, checking, control	8.0
	SI channels	1.0
		....
		9.0
4.	**Capital outlays**	
	Civil engin. and installation work	20.5
	Other expenditure	9.9
		....
		30.4

TOTAL: 83.2 + $6.1m

Table 5:

	UNITS	Estimated cost (mlns of roubles)
1.	Luminosity monitor and front calorimeter	0.400
2.	Track system	
2.1	Vertex chamber	0.600
2.2	Central track system	4.800
3.	Particle identification system	
3.1	Aerogel-based Cherenkov detector	0.900
3.2	Flight time measurement system based scintil. counters	0.550
3.3	Flight time measurement system based on spark counters	0.450
4.	Gamma-quantum detector	10.500
5.	Superconducting solenoid	2.500
6.	Path system	4.000
7.	Trigger and data collection system	6.000
8.	Detector checking system	0.350
	Detector cost	**31.050**
10.	Methodical work (10%)	3.100
11.	Unexpected expenses (20%)	6.200
	Total cost of the detector	**40.350**

Table 6:

	Year after financing begins					
	1	2	3	4	5	6
Methodical work, modelling of units	*****	*****	**			
Civ.engin.& instal.						
• Designing	*****	****				
• Construction of						
-experim. hall		***	*****	*****	****	
-comput.centre bldg			****	*****	*****	**
Electronics						
-R&D work	*****	*****				
-prototipes		*****	*****			
-ordering and manufacturing			****	*****	*****	
Detector elements						
-designing	***	*****				
-simulation	**	*****	*****	***		
-manufacturing		***	*****	*****	*****	
-assembly, adjust.			***	*****	*****	

2. In general, the research programmes proposed now for high-intensity e^+e^- colliders (ϕ-, $c\tau$-, B-factories) complement one another and are likely to yield the best results if fulfilled together.

3. Implementation of this programme will take at least 10 years after putting into operation the above installations.

4. As the research programme is rather wide, it is reasonable to construct at least two installations of each type, which will also ensure the necessary confidence level of the data obtained.

5. Being a project of a perfect facility for modern particle physics, the $c\tau$-factory and universal detector project is relatively cheap and feasible for the JINR.

6. The significance of the project is far beyond the above-mentioned scientific reasons:

   - development and construction of this collider allows a new modern basic facility of world class in the JINR for particle physics research;
   - participating in this work based on the advanced technological experience many specialists (accelerator and other physicists, engineers, designers, workers) will improve their professional skills, which will raise the general level of the scientific research in the JINR;
   - new competitive basic facility will allow the JINR to remain attractive to the scientists of the member-states for another 10-15 years and to attract scientists of other research centres;
   - construction of the $c\tau$-factory in the JINR will allow many young specialists of the member-states to be trained according to the present-day requirements and will be helpful in replenishing the JINR staff with talented youth.

This report has been made of the bases of papers [1,15,20,21]. I am very thankful to doctors Chelkov G.A., Perelshtein A.A., professors Denisov Yu.N. and Vylov Ts.D. for the discussion and help in the preparation for the report.

After the Workshop and up to the moment the Scientific Works were published hard work on projecting and annotating of this suggestion had taken place. By March 1992 technical and economic substantiation of the project (TES) and the draft of the $c\tau$-factory had been completed. In December 1991 the JINR entered into an Agreement with INP (Novosibirsk) and ITEP (Moscow) of the $c\tau$-factory project collaboration. The first steps on the collaboration with LNS (Cornell University), LAL (France) and others have been taken.

In January-February 1992 an approbation of the conceptual cτ-factory project was organized. We received positive conclusions from SSC Lab, AUSTRON, TRUIMF, LNS (Cornell) and others.

As a result we satisfy ourselves that the interest to physics on the cτ-factories in only increasing. If is explained by "its big universality" compared to physics on B- and Φ-factories. Though nowhere in the world the decision of the construction of cτ-factories has been taken there exists the necessity of construction of at least two such factories to secure high luminosity in different experimental intervals, as is known the Spanish project is now being carefully studied. At the first stage of the project (1,5 years) it is reasonable (with scientific and economic considerations taken into account, in cooperation with INP (Novosibirsk)) to elaborate the injector of the cτ-factory as the common past of the complex. The preinjector of the factory is practicaly an HRNS (with insignificant exceptions), the possible start-up of which in 1993-1994 is of independent scientific interest. The decision on this part of the problem can be taken in the nearest future and important work will be started.

While the cτ-factory and detector projects are developed to select a more reliable version, we shall continue to unite the European and world collaborators and determine their contribution.. Also, a detailed technical examination of the project will be organized to reduce its price (in particular through the use of the available buildings, facilities and ready projects). It will take us 1 to 1.5 years to do this. At present it cannot be realized owing to economic difficulties. But we expect this problem to have been settled by the end of 1993.

The construction of the cτ-factory during the following ≈5 years is not only possible and interesting for physicists but also necessary for the JINR's prestige in the world scientific community.

Short-term plans can certainly be based on the collaboration with another accelerator centre while the long-term programme is sure to involve the construction of our own attractive scientific basis.

At present and in the future young JINR scientists must know the prospects of the institute, otherwise JINR will not be a competent partner of world institutes for nuclear physics.

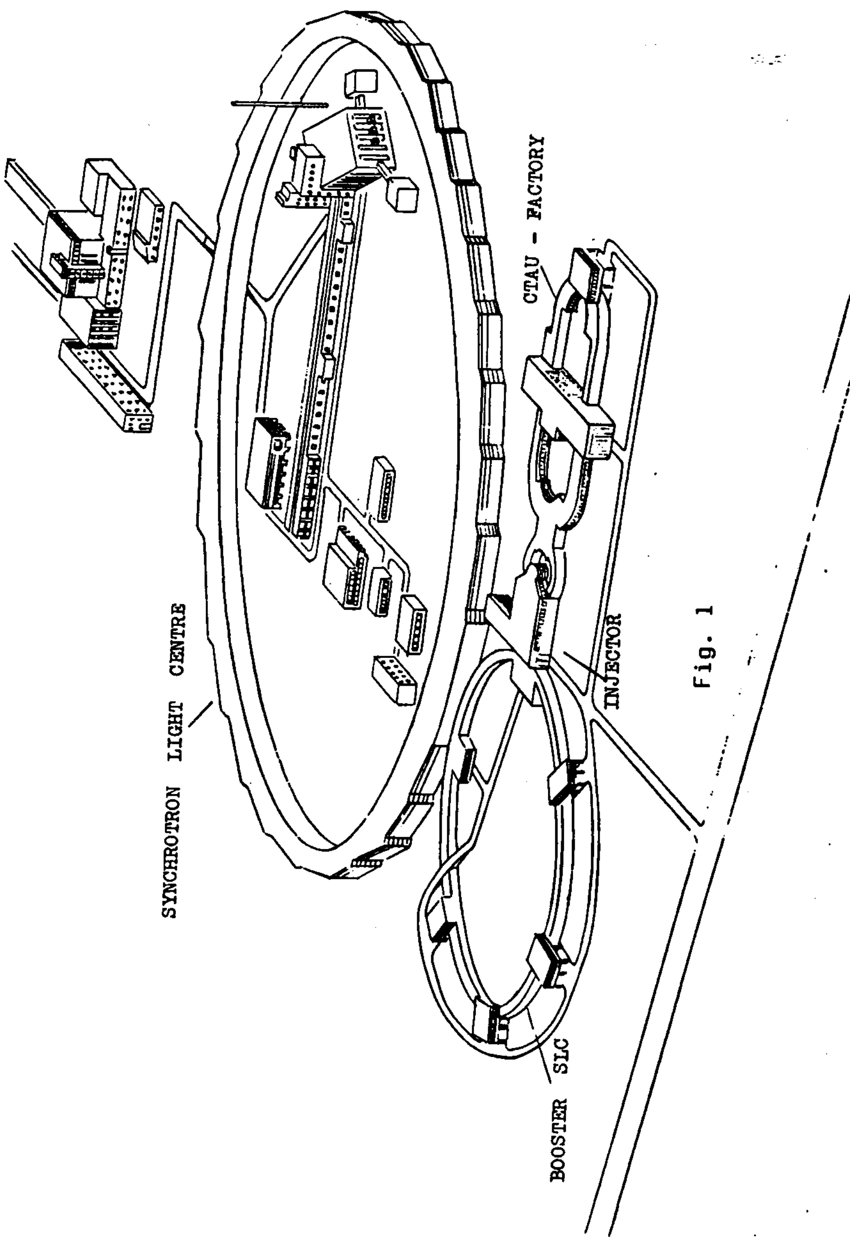
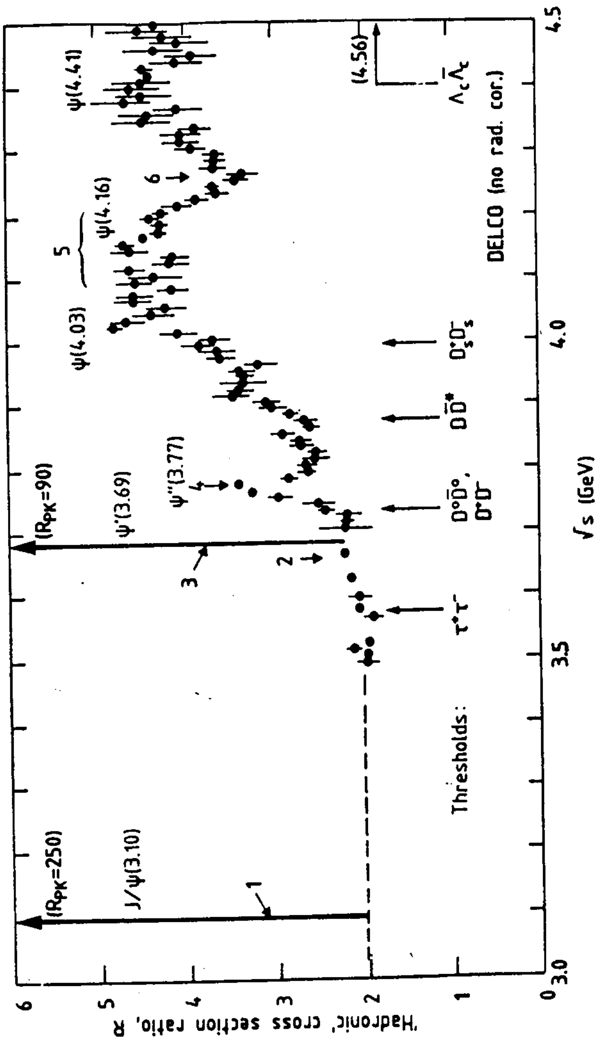

SYNCHROTRON LIGHT CENTRE
CTAU - FACTORY
INJECTOR
BOOSTER SLC

Fig. 1



'Hadronic' cross section ratio, R
√s (GeV)
3.0
3.5
4.0
4.5
(R_PK=250)
J/ψ(3.10)
(R_PK=90)
ψ'(3.69)
ψ''(3.77)
ψ(4.03)
ψ(4.16)
ψ(4.41)
Thresholds:
τ⁺τ⁻
D°D̄°, D⁺D⁻
DD̄*
D_sD̄_s
Λ_cΛ̄_c
(4.56)
DELCO (no rad. cor.)

Fig. 2

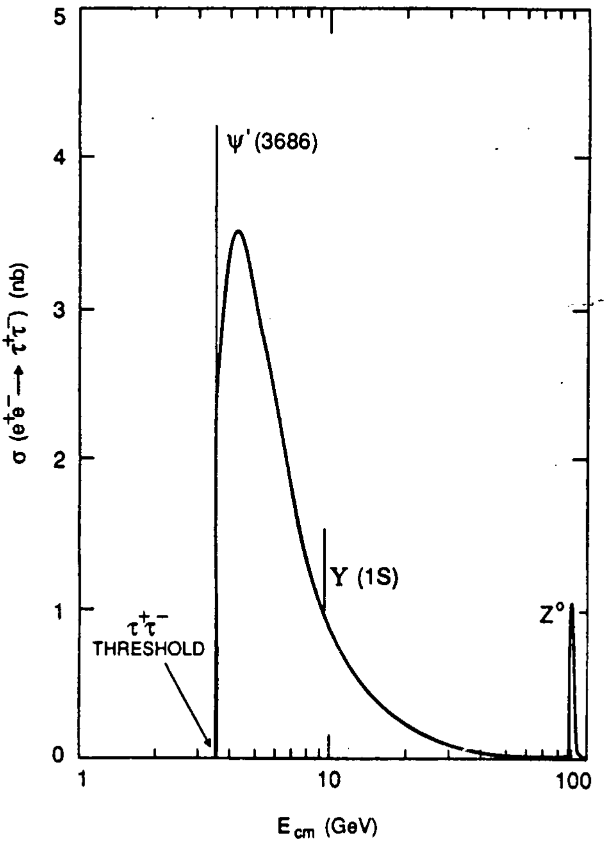


Figure 3: The $\tau^+\tau^-$ cross section, $\sigma(e^+e^- \to \tau^+\tau^-)$, in the range $2\,m_\tau \le E_{cm} \le 100$ GeV.

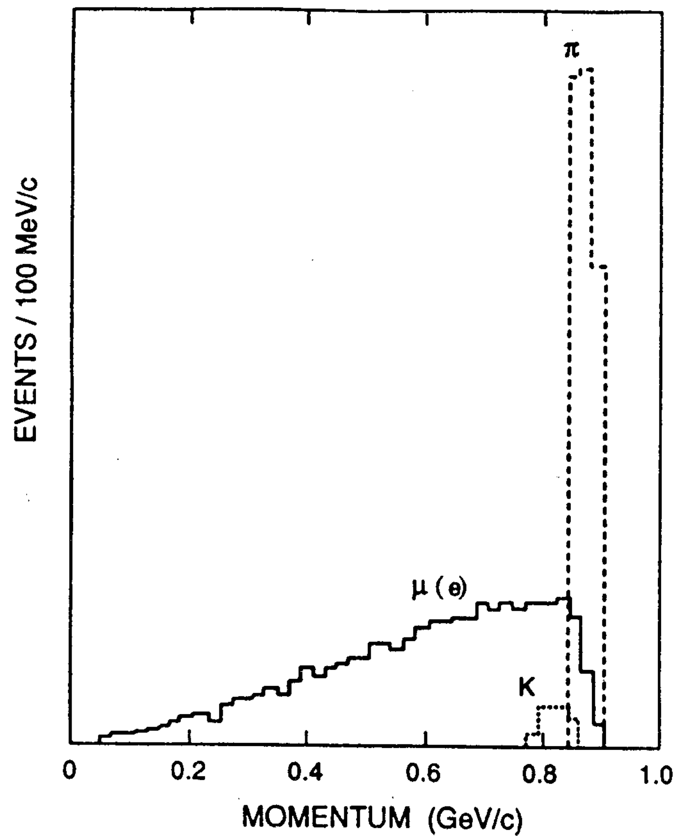
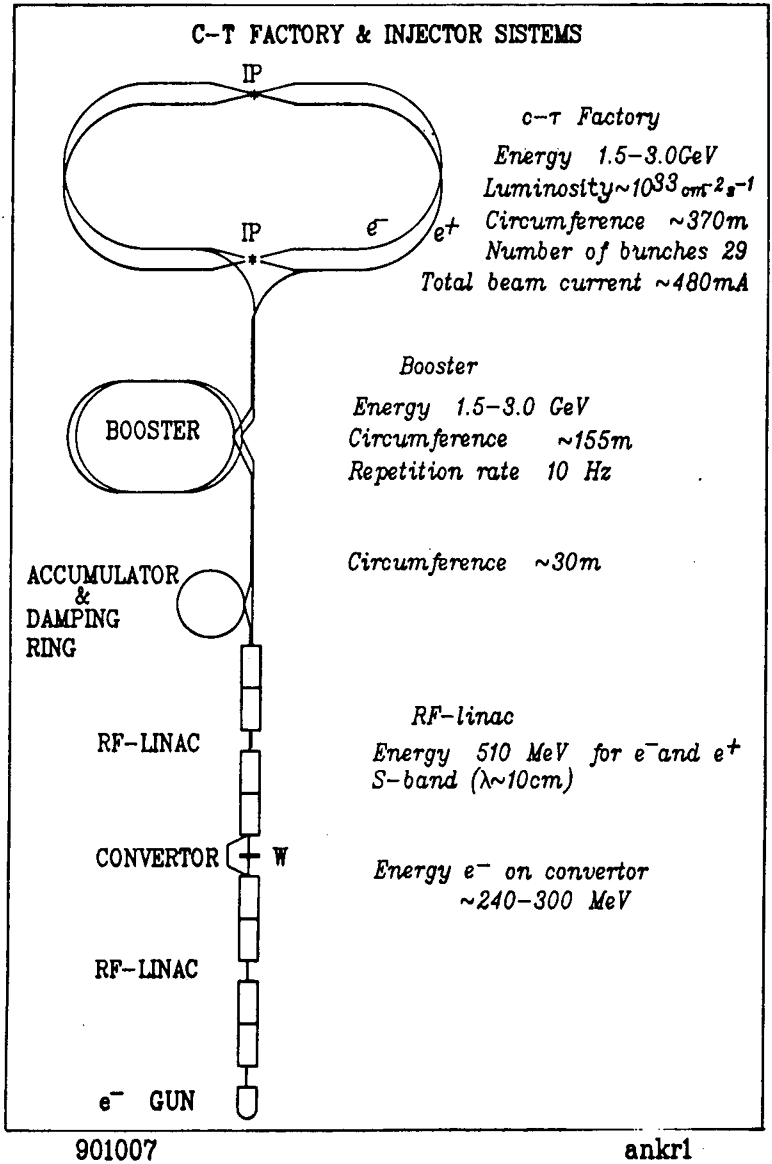


Figure 4: The momentum spectra from single-charged-particle $\tau^{\pm}$ decays at $E_{beam} = 1.785$ GeV.



C–T FACTORY & INJECTOR SISTEMS
IP
IP
e⁻
e+
c–τ Factory
Energy 1.5–3.0GeV
Luminosity~10^33 cm^-2 s^-1
Circumference ~370m
Number of bunches 29
Total beam current ~480mA
Booster
BOOSTER
Energy 1.5–3.0 GeV
Circumference ~155m
Repetition rate 10 Hz
ACCUMULATOR
&
DAMPING
RING
Circumference ~30m
RF–LINAC
RF–linac
Energy 510 MeV for e⁻ and e+
S–band (λ~10cm)
CONVERTOR
W
Energy e⁻ on convertor
~240–300 MeV
RF–LINAC
e⁻ GUN
901007
ankr1

Fig. 5.

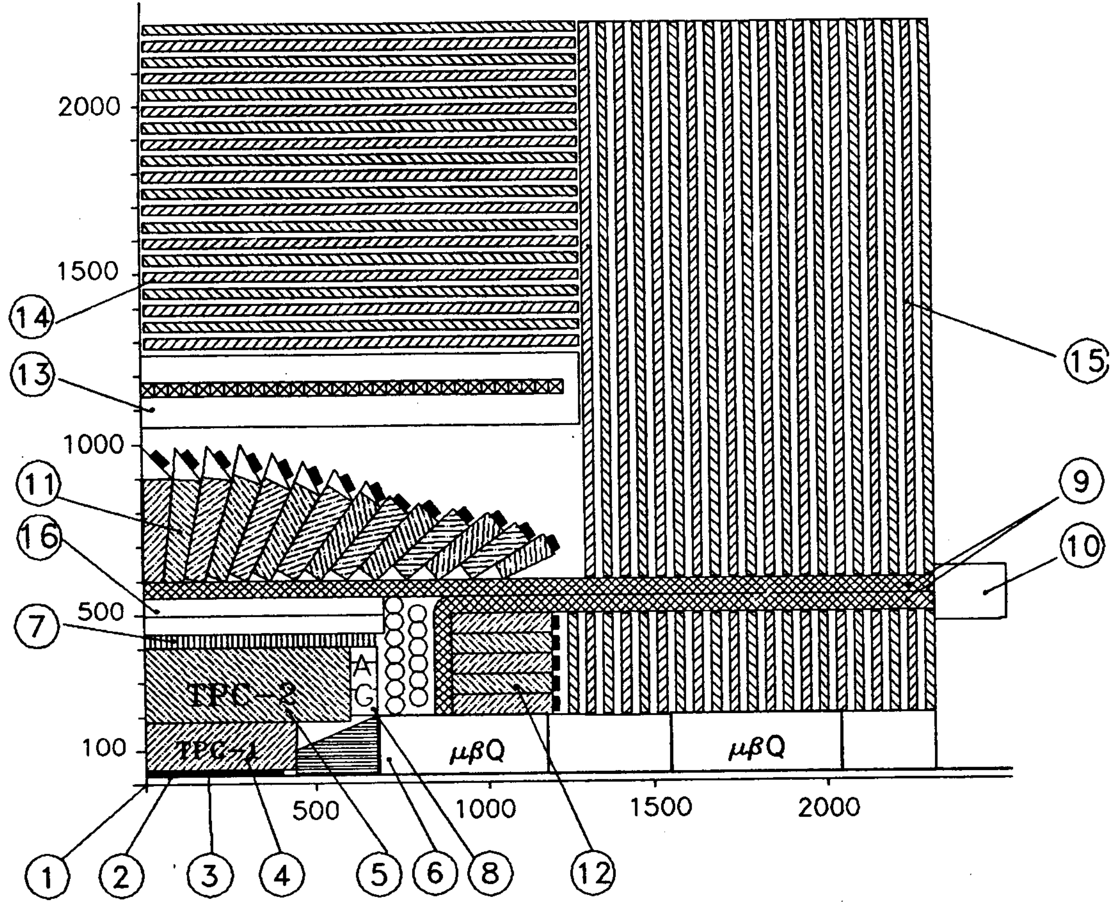

2000
1500
1000
500
100
500
1000
1500
2000
TPC-1
TPC-2
A
G
μβQ
μβQ
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Fig. 6

References

1. A.N.Sissakian. Suggestion on the ion, electron and positron storage complex in JINR, Preprint JINR, B1-9-90-283, Dubna, 1990.

2. Proceedings of the Tau-Charm factory workshop. SLAC 23-27 May 1989, SLAC-Report-343, 1989.

3. J.Kirkby. Preprint CERN-EP/87-210, 1987; Preprint CERN EP/89-54, 1989; Preprint CERN-ER/89-140, 1989.

4. J.M.Jowett. Preprint CERN LEP-TH/87-56, 1987.

5. M.L.Perl. Preprint SLAC-PUB-4675 (T/E), 1988.

6. M.B.Voloshin, M.V.Danilov and Yu.M.Zaytzev, Preprint ITEP 56-89, Moscow, 1989.

7. M.L.Perl. SLAC-PUB-4971 (T/E), 1989.

8. A.N.Skrinsky. Proc. Les Rencontres de Physique de la Vallee D'Aoste, 1989.

9. R.H.Shindler. SLAC-PUB-4996 (T/E), 1989.

10. J.J.Gomes-Cadenas, C.A.Heusch and A.Seiden. Particle World, 1, 10, 1989.

11. J.Kirkby. Particle World, 1, 27, 1989.

12. M.Regler. AUSTRON, RECFA-Meeting, 19. April 1990.

13. B.Barish et al. Preprint SLAC-PUB-5053, 1989. Preprint SLAC-PUB-5180 (E), 1990.

14. S.M.Bilenky. JINR NEWS, N 2, 1990, c. 11.

15. G.A.Chelkov. Proc. International School Low Energy Weak Interasction, Dubna, Sept.1990.D4,6-91-60,p.464

16. J.Kirkby. In Proceedings of the Tau Charm Workshop, SLAC, California, 23-27 May, eds. W. T. Kirn and M.L.Perl, SLAC-REPORT-343, 1989.

17. J.Gonishon et. al., Orsay report, LAL/RT 90-05, 1990.

18. Y.Baconnier e.a., Preprint CERN/AC/90-07, 1990.

19. Yu.Alexakhin, M.B.Voloshin, I.A.Golutvin et al. Preprint ITEP, 67-90, 1990.

20. V.S.Alexandrov et al. JINR E9-91-178, Dubna, 1991.

21. A C-Tau factory of the JINR Starage accelerator complex. Edited by V.A.Bednyakov et al. Dubna, 1991, Report JINR 11-5461.