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THE SUPER FIXED TARGET BEAUTY FACILITY AT THE SSC

The SFT Collaboration†

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ABSTRACT

The rationale for pursuing beauty physics at the SSC in a fixed target configuration is described. The increased beauty production cross section at the SSC, combined with high interaction rate capability of the proposed detector, results in 10^{10-11} produced $B\bar{B}$ events per year. The long decay length of the B hadrons ($\simeq$ 10 cm) allows direct observation of B decays in the high resolution silicon microstrip vertex detector. To optimize the operation of the proposed beauty spectrometer and the SSC, parasitic extraction of attendant or artificially generated large amplitude protons using crystal channeling is proposed and explored. The large sample of fully reconstructed B events allows detailed studies of various CP violating decays with requisite statistics to confront the standard model. The CP physics potential of the proposed experiment is evaluated and compared with alternative approaches, such as asymmetric e^+e^- B Factories and specialized hadron colliders.

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1. INTRODUCTION

Since its discovery in hadronic collisions in 1977,[1] the b quark has amassed a few surprises. For example, its lifetime[2] ($\tau_B \simeq 1 \times 10^{-12}$s) is $\simeq$ 3 times longer than that of a lepton about 1/3 its mass. The mixing of the B_d mesons is appreciable.[3] In the framework of the standard model, a rapid mixing of the strange beauty mesons (B_s) and sizable CP violation in the B system are anticipated.[4]

A beauty physics program aimed at understanding the origin of CP violation requires at least 10^9 produced $B\bar{B}$ events with high tagging and reconstruction efficiencies.[5] The 20 TeV proton beam at the SSC offers an excellent opportunity to pursue B physics with high statistics because of the higher beauty production cross section[6] and high momentum of the B hadrons in the lab frame, especially in a fixed target configuration. The main advantage of a fixed target beauty experiment at the SSC is its low proton consumption, hence allowing the experiment to be operated concurrently with the collider detectors. The projected interaction rate of 10^7/s for a 5% target consumes only about 2 x 10^8 protons/s ($\simeq$ 2 x 10^{-6}/s of the circulating beam). This depletion rate of protons is comparable to that of proton losses at the high luminosity interaction regions (IR), and hence will not be the dominant contributing factor to the lifetime of the stored beams. The Super Fixed Target (SFT) Collaboration proposes to utilize the halo protons created at the IR's by extracting them via crystal channeling. Nondestructive methods will be used to generate the halo protons if necessary. The produced B events will be studied by a large acceptance fixed target beauty spectrometer.

The SFT proposal[7] is a natural evolution of the ongoing E771 beauty experiment at Fermilab.[8] In section 2, the salient features of the E771 experiment are briefly described. Details of the SFT proposal, including the extraction scheme, crystal channeling techniques, and the beauty spectrometer, are discussed in section 3. In section 4, the physics capability of SFT in measuring CP violation in the decay mode, $B_d \to J/\psi + K_s$, is studied and compared with that of alternative approaches, such as asymmetric e^+e^- colliders[9] and specialized hadron colliders. [10]

2. E771

The E771 beauty experiment is based on the muon spectrometer located at the Proton-west High Intensity Lab at FNAL.[11] The spectrometer has been used by the E537 and E705 experiments for dimuon studies. To enhance its B physics capability, the spectrometer was upgraded with a total of about 20 planes of high resolution (25-100 μm pitch) silicon microstrip vertex detectors (SMVD). The main function of the SMVD is to precisely locate the incident proton and to reconstruct secondary vertices of B and D (charm) decays. Additional small spacing wire chambers with pad and strip readouts were added to aid charged particle tracking in the central region and triggering. The original dimuon trigger based on scintillators[12] has been supplemented by a muon detector consisting of 3 planes of Resistive Plate Counters (RPC) and associated trigger electronics. In conjunction with signals from the pad chambers, a single muon trigger, based on a minimum transvere momentum (p_t) requirement, is presently being installed and tested.[13] More detailed description of the experiment can be found elsewhere.[14]

The major upgrades were completed and final data taking is now in progress. E771 has operated up to 2 x 10^6 interactions per second during the test run in the summer of 1990. The experiment is expected to record $\simeq 10^{8-9}$ dimuon and $\simeq 10^8$ single-muon triggers during the 1991 run. The strategy for physics analysis is to identify dimuons from J/ψ decays which are not coming from the primary vertex, indicative of B production.[15] Low multiplicity all-charged B decay modes with a J/ψ in the final state will be searched for. About 100 fully reconstructed B events in these channels are expected. Dimuon events accompanied a D particle also signal B production and will be searched for. There will also be a large sample of single muon events, rich in B decays. These samples of B events will allow measurements of B production cross section, lifetimes of various B species, decay branching fractions, and mixings. An important measurement will be the mixing of the strange beauty mesons.[16]

3. THE SFT PROPOSAL

The proposal to pursue B physics at the SSC in a fixed target configuration (SSCII) was motivated by a higher beauty production cross section at the SSC and simpler vertex detection. The typical decay length of a B particle at SSCII is about 10 cm, which will span nominally 15 planes of SMVD in the proposed spectrometer. Compared to the collider configuration (SSCI), which has a roughly 10 times lower Lorentz boost factor and largely inaccessible primary decay volume (inside the beam pipe), the technical challenge for a fixed target experiment is less severe. The higher momentum of the B particles in SSCII also renders a straightforward implementation of a high p_t lepton trigger. The implicit requirement for a fixed target program at the SSC is its noninterfering operation with the collider program. The SFT collaboration proposes to use crystal channeling to extract the large amplitude (halo) protons. The method is clean, nondestructive, and may actually be beneficial to the collider program by removing the halo particles produced at the IR's.

3.1 Crystal channeling

It has been known for some time that high energy protons can be channeled along the interstitial space in a crystal with high efficiency.[17] A bent crystal placed close to the circulating SSC beam can serve as the first septum for a conventional extraction system.[18] The width of the non-channeling portion of the crystal near the surface and misalignment correspond to an effective 'septum width' of the order of 1.0μm which is small compared to the typical step size of the halo protons at the SSC. The low interaction probability of a proton in the crystal of a few percent keeps the process clean. The design parameters for crystal extraction at the SSC are listed in Table 1.

Table 1. The design paramters for crystal extraction at the SSC

Type of crystal	silicon
Dimensions of crystal	3 x 3 x 40 mm^3
Distance from beam orbit	1.0 mm (4 σ)
Bend angle	100 μrad
Momentum/radius of curvature	0.5 GeV/cm
Critical angle at 20 TeV	1.0 μrad
Projected beam divergence at SSC	0.3 μrad
Channeling efficiency (single pass)	65 %
Channeling efficiency (multi-pass)	85 %

The geometric acceptance of the crystal is determined by the critical angle which is about 1 μrad for 20 TeV protons in silicon. At the SSC, the projected divergence of the proton beam at a high dispersion region is about 0.3 μrad,[19] resulting in nearly 99% geometric acceptance. Similar arrangement at the LHC would suffer a larger acceptance loss due to anticipated higher beam divergence.[20] Dechanneling losses due to bending and finite atom size etc. appear to scale as p/r, the ratio of beam momentum to the radius of curvature of the bent.[21] Using the measured dechanneling fraction at low energy and extrapolating to the SSC according to the p/r scaling law, the expected dechanneling fraction at the SSC is about 35% for the first pass. Protons that failed to be channeled may be channeled subsequent passes. The overall channeling efficiency is expected to be near 85%.

A plausible extraction scheme is shown in Fig. 1 where the silicon crystal is positioned near a 3-point beam bump formed by 2 dipoles and a Lambertson magnet (a so-called 'dogleg' arrangement). The crystal is placed about 1 mm from the beam and bent upward from the orbit plane. The channeled protons are deflected by 20 mm in the 250 m run into the field-free region of the Lambertson magnet and thereby extracted from the circulating beam. The unchanneled protons are deflected by the Lambertson back to the orbit. To enhance the extraction efficiency, a high dispersion region is chosen so that the off-momentum protons are separated from the core by about 250 μm. These protons are placed well into the channeling region of the crystal.

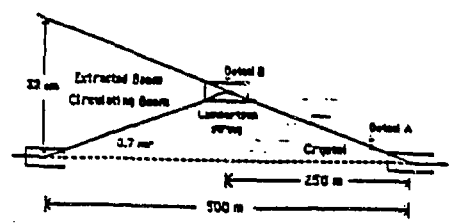

Figure 1. SFT Extraction Scheme at SSC

Beam-beam interactions at the IR's generate on the average 10^{6-7} off-momentum protons per second,[19] not quite sufficient for SFT consumption. Therefore, it is necessary to artificially generate more large amplitude protons. Several schemes to manipulate the halo protons have been proposed. The general idea is to heat up preferrentially protons at the edge of the phase space by filtered RF noise while the core is left intact. Monte Carlo studies have shown that such schemes are generally quite satisfactory.[22] More elaborate schemes, based on adding scatterers such as a gas jet or another crystal in front of the bent crystal, are presently being studied.

In order to demonstrate the technical feasibility of such schemes and to evaluate the alignment requirement, the SFT collaboration proposes to perform a test using the 1 TeV protons available at Fermilab.[23] The proposal is to install a similar crystal extraction system at the C0 region of the Tevatron main ring during the 1992 collider run. The parameters for the crystal extraction for this test were chosen to match those required at the SSC. During this test, particle detectors will be installed to analyse the extracted beam.

3.2 The SFT beauty spectrometer

A schematic of the proposed spectrometer is shown in Fig. 2. It assumes an open geometry proposed in

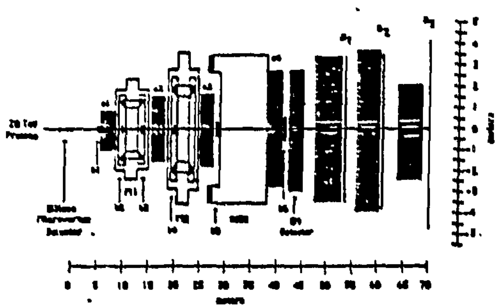

Figure 2. The SFT Beauty Spectrometer

recent design studies.[24] The vertex detector consists of 30 planes of 200 μm thick SMVD, interspersed with 850 μm Be foils, constituting a roughly 5 % target with about 15 % of a radiation length. Since there is an advantage in particle-antiparticle tagging by measuring the charge of the B particles in the same event for CP violation studies, the option to embed the vertex detectors in a magnetic field is being considered. A typical B traverses about 15 planes of SMVD before it decays. The vertex detector is followed by 30 planes of 50 μm SMVD, distributed over a longer distance, to intercept late B and D decays. The solid angle downstream of the vertex detectors will be covered by the more conventional charged particle tracking devices, small spacing PWC's and microstrip gas detectors (b_1-b_6) in the central region and wire chambers (straws or multiwire drift chambers)(c_1-c_6) outside the 20 mrad region. Several planes of high rate pad chambers (not shown in Fig. 2) will be deployed to assist pattern recognition and provide p_t measurements for trigger purposes. The pad chambers have to be constructed with minimal material to reduce scattering and secondary interactions. A double magnet system (M1 and M2) with the two magnets running in opposite polarities is chosen to keep the transverse dimensions of the detector small.

Particle identification will be crucial for B studies at the SSC. A Ring Imaging Cerenkov (RICH) counter is proposed for SFT. In the proposed scheme, Cerenkov light from the radiator which is 12 m of neon gas at atmospheric pressure is reflected by low-mass parabolic mirrors and detected by an array of multi-anode photomultiplier tubes (MAPMT). In order to achieve adequate K/π separation in the bulk of the momentum range, a pixel size of about 1 x 1 cm^2 for the MAPMT's is contemplated. For example, studies showed a pixel size of 7.5x7.5 mm^2 can provide at least 2 σ K/π separation up to 250 GeV/c. Over 90 % of π's and K's from B and D decays have momenta below 250 GeV/c.

A large fraction of B decays contain one or more π_o or γ in the final state. For example, large fraction of B's are expected to be produced as B^*'s which will decay radiatively to B's and π_o's or γ's. Full reconstruction of these events is essential. The high interaction rate and hostile radiation level at SFT call for a highly segmented and radiation hard electromagnetic calorimeter. The SFT Collaboration proposes to build a fine grained lead/scintillating-fiber (SCIFI) electromagnetic calorimeter. This choice was based on the radiation hardness, ease of fabrication, and short radiation length of SCIFI, even though other technologies, such as lead fluoride crystals and silicon, are not ruled out. For the SCIFI scheme, the signal will also be readout by MAPMT's.

A muon system similar to the one presently used at E771 is proposed for SFT. Three planes of RPC's(μ_1-μ_3), each located behind about 30 interaction lengths of steel, will furnish primary signals for muon triggering. The trigger scheme used at E771 will be applicable to SFT as well. That is, a triple coincidence of aligned pad signals from the RPC's defines a muon track. When combined with signals from the pad chambers located upstream of the magnet, the p_t of the muon track can be determined. A trigger based on a p_t threshold for the muon can be implemented.[13]

The two main trigger schemes envisioned for SFT are based on high p_t muons and event topology (secondary vertices, one or more high p_t track) respectively.

The higher B production cross section at the SSC (a few x 10^{-4} per hadronic event) alleviated the rejection requirement for the first level trigger. A single muon trigger scheme analogous to the one presently used at E771 will have a trigger rate of about 1 kHz, which can be comfortably handled by CAMAC and FASTBUS without further reduction. Trigger schemes based on secondary vertices have been developed and tested at CERN[25] and can be implemented at SFT. The event topology trigger will complement the muon trigger to obtain B events without missing neutrinos associated with semileptonic B decays.

4. PHYSICS CAPABILITIES

SFT operating at the SSC will produce over 10^{10} $B\bar{B}$ events/year. This will allow detailed studies of CP violating effects of the B system. There will be ample statistics for many decay channels which are expected to exhibit substantial CP noninvariance. These measurments will in general over-constraint the CKM model of CP violation.[26] For the purpose of comparison, the sensitivity of SFT to the CP violating parameter of the decay, $B_d(\bar{B}_d) \rightarrow J/\psi + K_s$, is estimated. The B decay vertex distributions are given by[27]

$$\frac{dN_\pm}{dt} \propto e^{-t/\tau_B}[1 \pm \lambda sin(x_d t/\tau_B)],$$

where the decay time t is measured in the rest frame of the decay B meson and λ is the CP violating parameter for this decay. λ is related to one of the three CP violating phases in the CKM matrix. Based on the current experimental constraint on the CKM matrix elements, its value is expected to lie in the range 0.05-0.5.[28] The + (-) sign is for a B_d ($\bar{B}_d$) parent. $x_d \simeq 0.73$ is the B_d mixing parameter.[3] The tagging is done by measuring the charge of the other B in the same event. Only charged B tagging will be assumed for this analysis. This eliminates the dilution effects due to occasional wrong tagging by neutral B's. The value of λ can be determined by fitting the observed decay vertex distributions for B_d and $\bar{B}_d$ parents to their respective distributions. The sensitivity to λ will be limited by the number of fully reconstructed tagged events. An estimate is made for SFT, assuming an interaction rate of 10^7/s for 10^7 s/year. The calculation takes into account losses due to branching fractions, geometric acceptance, and reconstruction inefficiencies, as shown in Table 2. About 1,500 events of each kind are expected. The largest uncertainty comes from the production cross section calculation.[6] A conservative value of 10^{-4} $B\bar{B}$ event per hadronic interaction was assumed. A naive statistical analysis suggests the smallest value of λ that can be measured with confidence (3σ) is $\simeq 0.05$. To have comparable sensitivity in an asymmetric e^+e^- collider, 3 years of running at an average luminosity of 3 x 10^{33} $cm^{-2}s^{-1}$ is needed.[9]

Similar sensitivity for CP violation effects in the B_s is expected at SFT. To measure CP violating angles involving B_s mesons in an e^+e^- machine, it has to operate at $\Upsilon(5S)$ which has about 10 times lower cross section. In hadroproduction, the fraction of B_s production is about 40% per $B\bar{B}$ event.

Table 2. The expected number of fully reconstructed $B_d(\bar{B}_d) \rightarrow J/\psi + K_s$ events tagged by a charged B produced in the same event.

$B\bar{B}$ produced	1.0 x 10^{10}
Hadronization to B_d	0.8
Branching ratios to $\mu\mu\pi\pi$ final state	
$B_d \rightarrow J/\psi + K_s$	5.0 x 10^{-4}
$J/\psi \rightarrow \mu\mu$	0.07
$K_s \rightarrow \pi\pi$	0.69
Acceptance/efficiency	
$\mu\mu$ Trigger	0.33
K_s Acceptance	0.42
Track reconstruction	0.90
Tagging efficiency	
Acceptance of the other B	0.65
Hadronization to B_u	0.40
Charge Determination	0.50
Number of reconstructed tagged events	3.1 x 10^3

5. NEAR FUTURE ACTIVITIES

In view of the encouraging recommendations of the SSC PAC to incorporate B physics in the initial program of the SSC, preferrably with a fixed target experiment,[29] the SFT collaboration is actively working toward a realistic extraction scheme and detector, both to be ready at the turn-on of the machine. A proposal to perform crystal extraction test at the Tevatron in 1992 has been submitted to FNAL.[23] A 3-year R&D proposal, starting FY92, for the various detector components of SFT has been submitted to the SSC lab.[30] The goal is to start R&D of critical detector components as early as 1992 and have prototypes tested by 1994. In the meantime, we have also started simulation studies of the detector for more detailed design and optimization. The full evaluation of its B physics potential is also underway.

6. CONCLUSIONS

Techniques for doing B physics in fixed target environment have finally matured. Very soon, these experiments can begin to capitalize on the larger B production cross section in hadronic interactions, and contribute to the understanding of the b quark. E771 is a leading B physics experiment at FNAL based on a dimuon trigger and good vertex detection. With a projected interaction rate of 2 x 10^6/s or higher, as many as 100 fully reconstructed B events are expected in the 1991 run. Rapid progress is anticipated in the next few years. The SSC can play a significant role in the continuation of B physics and has pledged to incorporate B phyiscs in its initial program. The SFT proposal to perform B physics in a fixed target configuration at the SSC has the unique feature of noninterfering concurrent operation with the colliders and holds promise for high statistics, so desperately needed for CP violation studies. Rigorous R&D efforts in the crystal extraction technique and some critical detector components need to start as soon as possible.

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REFERENCES

1. S. W. Herb *et al.*, Phys. Rev. Lett. **39**, (1977) 252.
2. MAC Collaboration, E. Fernandez *et al.*, Phys. Rev. Lett. **51**, (1983) 1022 and MARK II Collaboration, N. S. Lockyer *et al.*, Phys. Rev. Lett. **51**, (1983) 1316.
3. ARGUS Collaboration, H. Albrecht *et al.*, Phys. Lett. **192B**, (1987) 245.
4. See, e.g., I. Bigi, *Beauty Decays-10 Years from Now*, Proceedings of Workshop on a 20 TeV Fixed Target Beauty Facility at the SSC, Fermilab, November, 1989.
5. See, e.g., B. Cox, *Experimental Possibilities for Observation of CP Violation in B Decay*, Proceedings of the International Symposium on Production and Decays of Heavy Flavors, SLAC, July, 1988.
6. See, e.g., K. Ellis, *Bottom Production*, Proceedings of Workshop on a 20 TeV Fixed Target Beauty Facility at the SSC, Fermilab, November, 1989.
7. SFT Collaboration, B. Cox *et al.*, *An Expression of Interest in a Super Fixed Target Beauty Facility (SFT) at the Superconducting Super Collider*, SSC-EOI-014, May, 1990.
8. E771 Collaboration, B. Cox *et al.*, *A Proposal to study beauty production and other heavy quark physics associated with dimuon production in 800-925 GeV/c pp interactions*, Fermilab proposal no. 771, April, 1986.
9. *An Asymmetric B Factory Based on PEP*, Conceptual Design Report, SLAC-372 etc., Feb, 1991.
10. BCD Collaboration, H. Castro *et al.*,*An Expression of Interest for a Bottom Collider Detector at the SSC*, SSC-EOI-008, May, 1990.
11. E. Anassontzis *et al.*, NIM, **A242**, (1986) 215.
12. H. Areti *et al.*, NIM **A212**, (1983) 135.
13. W. Selove, *The Single Muon Trigger for E771*, Penn Preprint UPR-161E.
14. E771 Collaboration, G. Introzzi *et al.*, *B Physics at FNAL E771*, this volume.
15. B. Cox and D. E. Wagoner, *The J/ψ Trigger-Tag for Study of Weak Beauty Decays at the SSC*, Proceedings of the 1986 summer study on the physics of the Supercollider, Snowmass, (1986) 83.
16. K. Lau, *Prospect for Observing $B_s\bar{B}_s$ Mixing at E771*, UH preprint, UH-771-001, August, 1991.
17. V. V. Avdeichikov *et al.*, JINR comm. 1-84, Dubna (1984). English translation : Fermilab FN-429 (1986) and A. A. Asseev *et al.*, IHEP Preprint 89-57, Serpukhov (1989).
18. E. Tsyganov, Fermilab TM-682, (1976).
19. *Superconducting Super Collider*, Conceptual Design Report, SSC-SR-2020, March 1986.
20. Costantini, *The LHB Project: B Physics at LHC with an Extracted Beam*, this volume.
21. See, e.g., R. A. Carrigan and J. A. Ellison, eds, *Relativistic Channeling*, (Plenum, 1987).
22. J. A. Ellison *et al.*, *Effect of RF Noise on the SSC Beam*, Proceedings of the 1991 Conference on Accelerator Physics, San Francisco and S. Peggs, *Proton Mining -Dual Frequency Amplitude Modulation*, Fermilab AP Note 91-001 (1991).
23. C. T. Murphy *et al.*, *Proposal for a test of low intensity extraction from the Tevatron using channeling in a bent crystal*, Fermilab proposal no P-853, June, 1991.
24. H. Brown et al., *Report of the Super Fixed Target Beauty Facility Working Group on Progress Towards the SFT at the SSC*, Proceedings of the 1990 Summer Study on the Physics of the SSC, 1991.
25. L. Rossi *et al.*, *Proposal for a test of an impact parameter trigger aimed at a high statistics heavy quark study*, CERN/SPSC 85-62, SPSC/P218, October, 1985.
26. N. Cabibbo, Phys. Rev. Lett. **10**, (1963) 531 and M. Kobayashi and T. Maskawa, Prog. Theor. Phys. **49**,(1973) 652.
27. I. I. Bigi and A. I. Sanda, Nucl. Phys. **B193**, (1981) 85 and **B281**, (1987) 41.
28. See, e.g., J. Rosner and I. Dunietz, Phys. Rev. **34**, (1986) 1404.
29. The following is an excerpt from the SSC July 1990 PAC Summary of the Meeting and Recommendations,"*it would be desirable to incorporate B-physics into the initial SSC program ..For the initial SSC program, a fixed-target experiment may prove a better choice (than a collider detector).*"
30. SFT Collaboration, H. C. Ballagh *et al.*, *A proposal for R&D leading to the Super Fixed Target B Physics Facility*, submitted to SSCL, July, 1991.