

NewFEB: SBE Capability for the A-D Line

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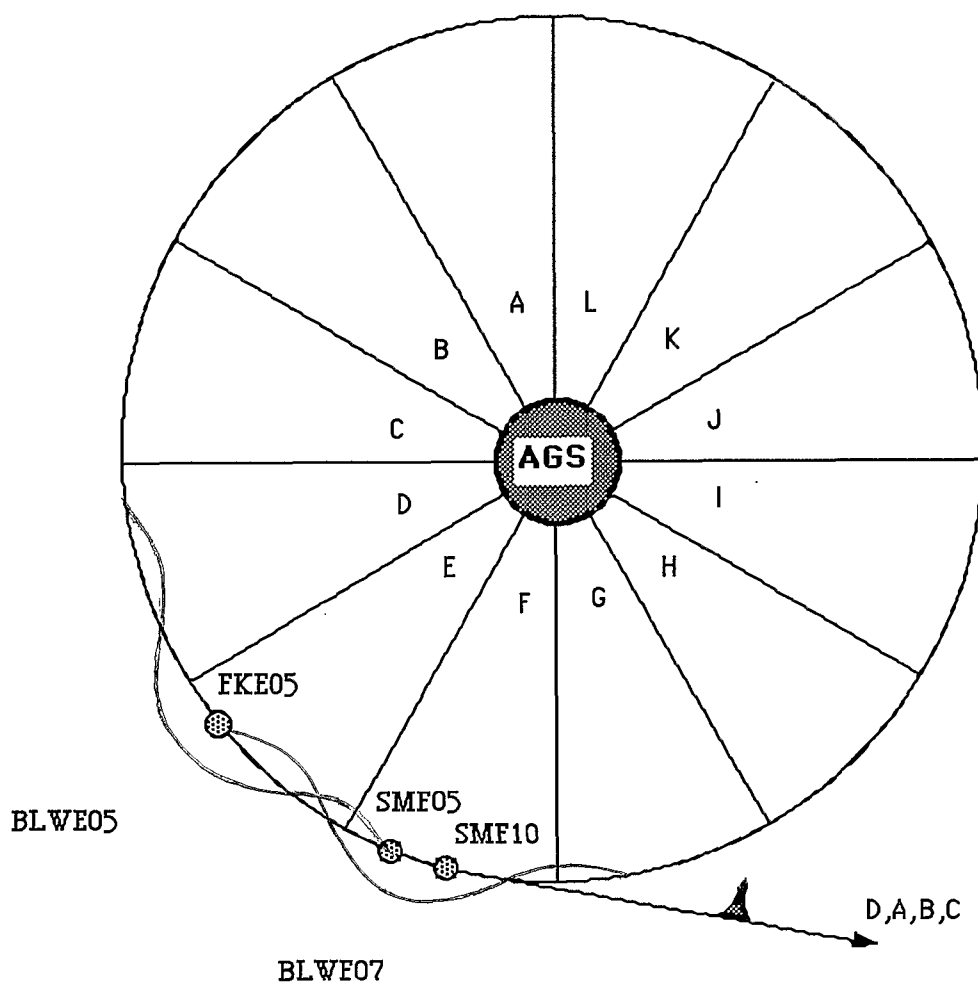
Introduction

The AGS new fast extraction [NewFEB] system is designed to perform single bunch multiple extraction [SBME] as often as ~10 ms up to 12 times per AGS cycle for the muon g-2 experiment and for RHIC injection. The proposed NewFEB system, described fully in the conceptual design report [1], will consist of a new fast multi-pulsing kicker with a limited aperture at straight section G10 and an improved ejector septum magnet at H10, together with local orbit bumps generated by powering backleg windings on the selected main magnets. Since the present FEB and SBE systems [2] will be no longer available in the near future, the capability of doing standard FEB (one-turn extraction) to the U line and SBE to the A-D line should not be lost.

In FY1994, Experiment 849 is scheduled to run a two-week experiment in the D-2 line that requires a single bunch proton beam to the D-target station. If it is successful, a new muonium-to-antimuonium conversion ($M \rightarrow \bar{M}$) experiment is likely to be proposed and will probably run in the D-line with single bunch extraction[SBE] in FY1995 and/or later [3]. This note describes the feasibility of performing SBE for the A-D line using the NewFEB extraction components.

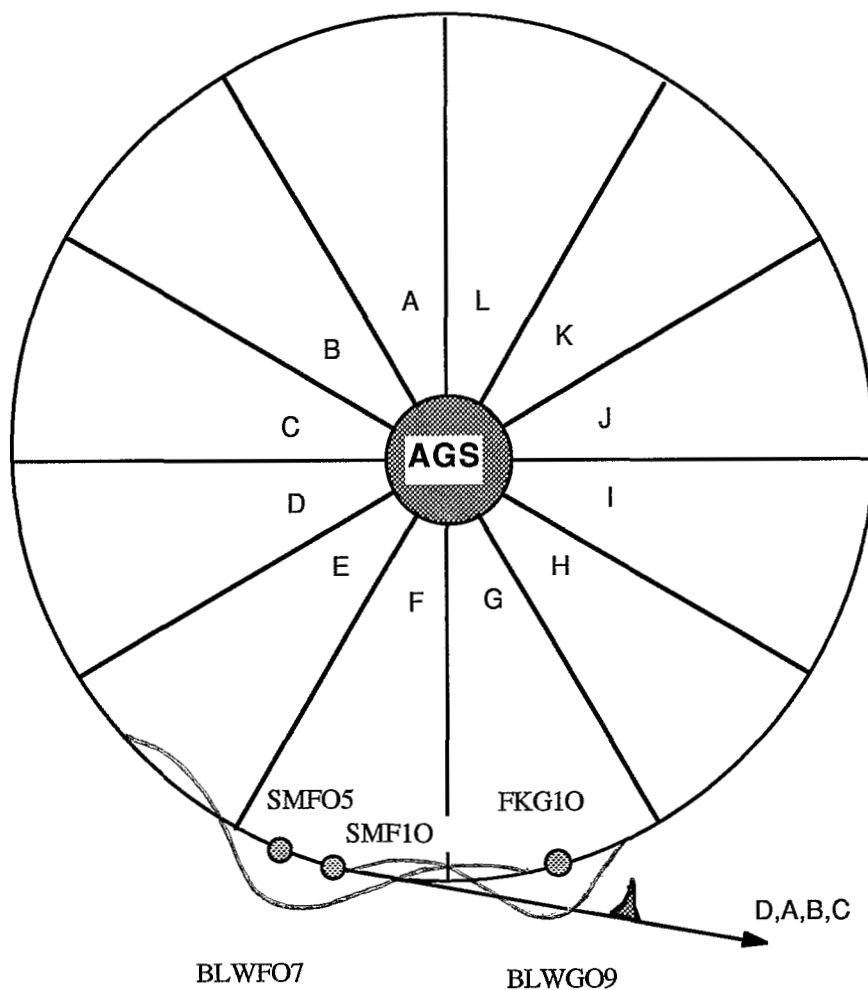
The Present SBE System

The present SBE system consists of a fast kicker at E05 [FKE05] and a local orbit bump [BLWE05] coupled with the SEB extraction system (thin septum magnet [SMF05] and thick septum magnet [SMF10] with a $3/2 \lambda$ bump [BLWF07]) [2]. This system became operational in 1983 for Experiment 745 on the QCD test in the D-line, which required a single bunch of ~ 40 ns long at $p=22$ GeV/c, and is currently used to deliver SBE beam for the detector test of the g-2 experiment. FKE05 gives ~ 0.9 mrad kick to one of 12 bunches without disturbing the remaining bunches. SMF05 and SMF10 provide additional ~ 1.2 and ~ 15 mrad deflection, respectively, to extract the bunch from the ring to the A-D line. However, this system will no longer be available in the near future due to the AIP program. The schematic layout of the present SBE operation is shown in the following figure.



SBE for the A-D line

To perform SBE for the A-D line without the SBE system implies that we have to use FKG10 as a substitute for FKE05. One of the bunches has to be kicked by FKG10 and make almost a full turn around the ring, then enter into SMF05 without scraping the limited aperture in the beam pipe. In the following figure, we show the location of required elements of SBE operation for the A-D line; (1) BLWGO9 (first half of BLWGH, 1λ bump) to produce a local orbit bump, which brings the circulating beam into the aperture of FKG10, (2) FKG10, (3) BLWFO7 (4) SMH05, (5) SMH10.



The required kick by FKG10 is given by

$$\theta_K = \delta x'(G10) = \delta x(F05) / \{ \sqrt{\beta(F05)\beta(G10)} \cdot \sin(\delta\mu) \}$$

where $\delta\mu$ is the betatron phase advance from G10 to F05, $\delta x(F05)$ is the displacement needed between the circulating beam and the kicked bunch at F05, β 's are beta functions. Assuming that

$\epsilon_h^*(95\%) = 50 \pi$ mm-mrad	! horizontal normalized beam emittance
$(dp/p)_{\max} = \pm 0.2 \%$! maximum beam momentum spread
$p = 25$ GeV/c	! beam momentum
$Q_h = 8.7$! horizontal machine tune

and ~ 0.8 mm septum thickness of SMF05 and 2 mm clearance at both sides of the septum, we have

$$\begin{aligned} \theta_K &= 23.0 / \{ 18.5 \cdot \sin(-0.206 \cdot 2\pi) \} \\ &= -1.3 \text{ mrad} \end{aligned}$$

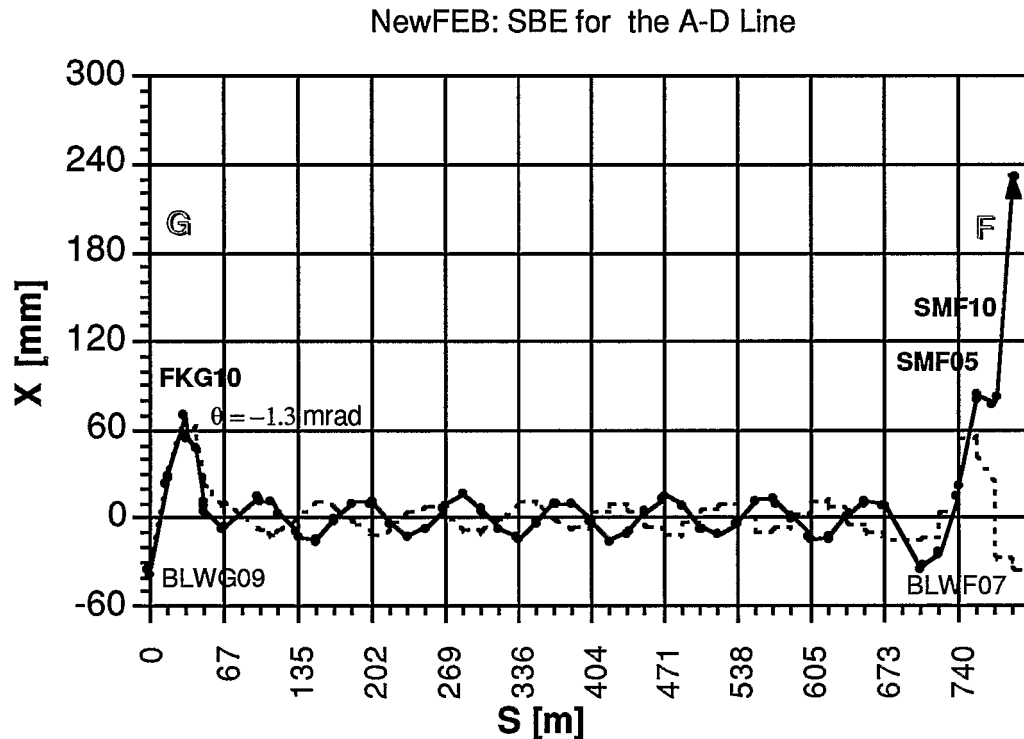
This value corresponds to -0.11 T-m and is well below the design maximum strength of -0.20 T-m for FKG10.

MAD Simulation

A MAD [4] simulation was performed with a model of AGS that includes only quadrupolar and sextupolar components of the main combined function magnets and the extraction components. First, MAD was run to obtain the desired closed orbit at FKG10 and SMF05 with BLWG09 and BLWF07. Then, the particle with initial conditions at the beginning of straight section G10 is traced through the lattice and receives appropriate kicks by FKG10, SMF05 and SMF10. The results with the parameters

BLWG09	KICK = 2.0 (4.0) mrad/pair
BLWF07	KICK = 2.0 mrad/pair
FKG10	KICK = -1.3 mrad
SMF05	KICK = 1.0 mrad
SMF10	KICK = 18.5 mrad

are shown in the following figure. The bunch kicked by FKG10 can make almost a full turn and jump the septum of SMF05 without hitting the vacuum chamber wall. However, the residual perturbation of the closed orbit outside the BLWG09(1λ) and BLWF07($3/2\lambda$) local bumps is relatively large compared to two standard $3/2\lambda$ bumps. The MAD results also show that the required kick of FKG10 is ~ -1.1 mrad, less than $\sim 20\%$ of the rough calculation value.



Conclusion

It is feasible to perform single bunch (even multiple) extraction [SBE] to the A-D line using the NewFEB fast kicker at G10 [FKG10] and its associated bump [BLWG09] though the orbit perturbation caused by BLWG09 and BLWF07 is relatively large compared to the two standard $3/2 \lambda$ bumps.

References

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