AGS Intensity Upgrades

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SAGENAP Review
March 12, 2002
NSF, Arlington, VA

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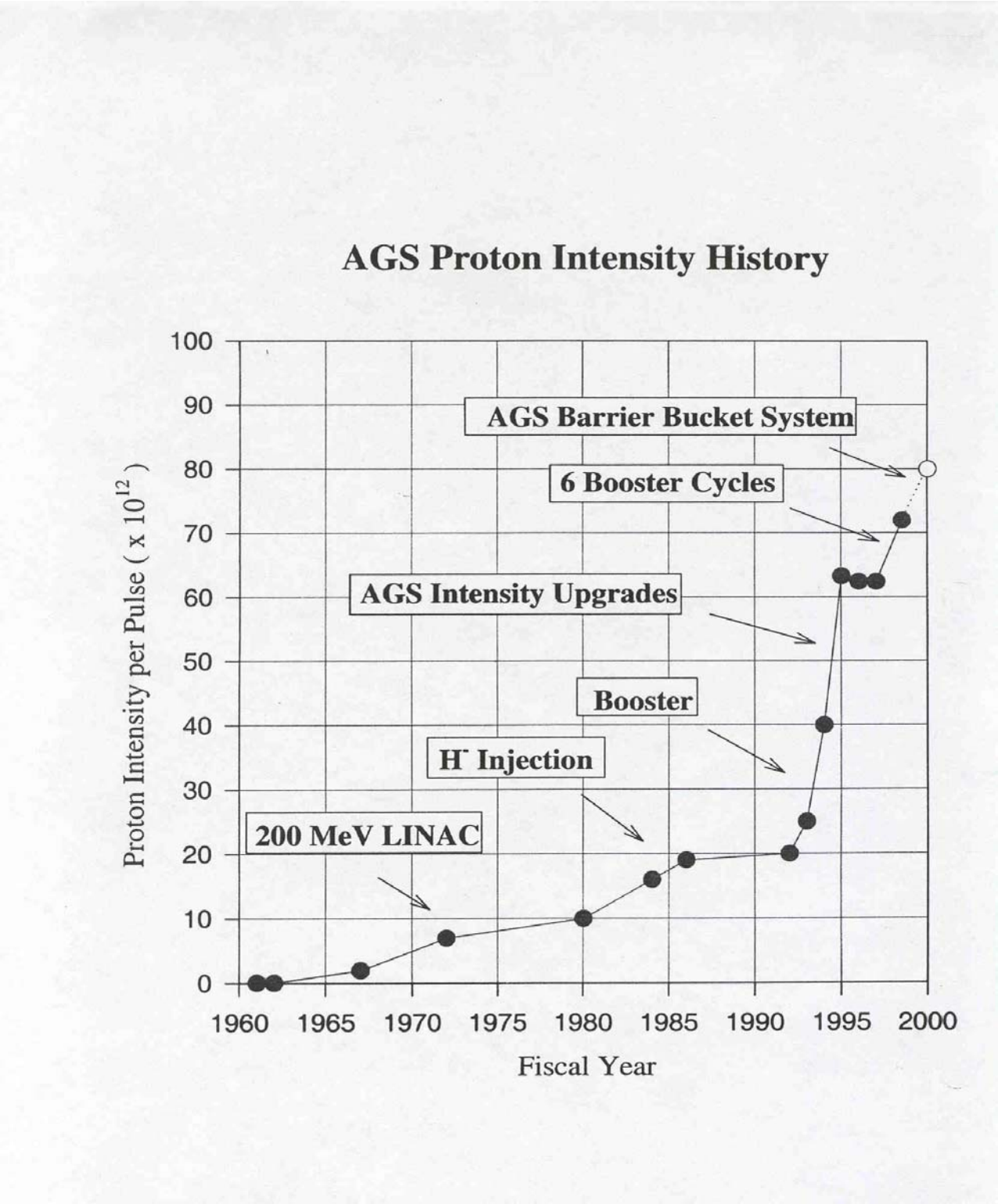
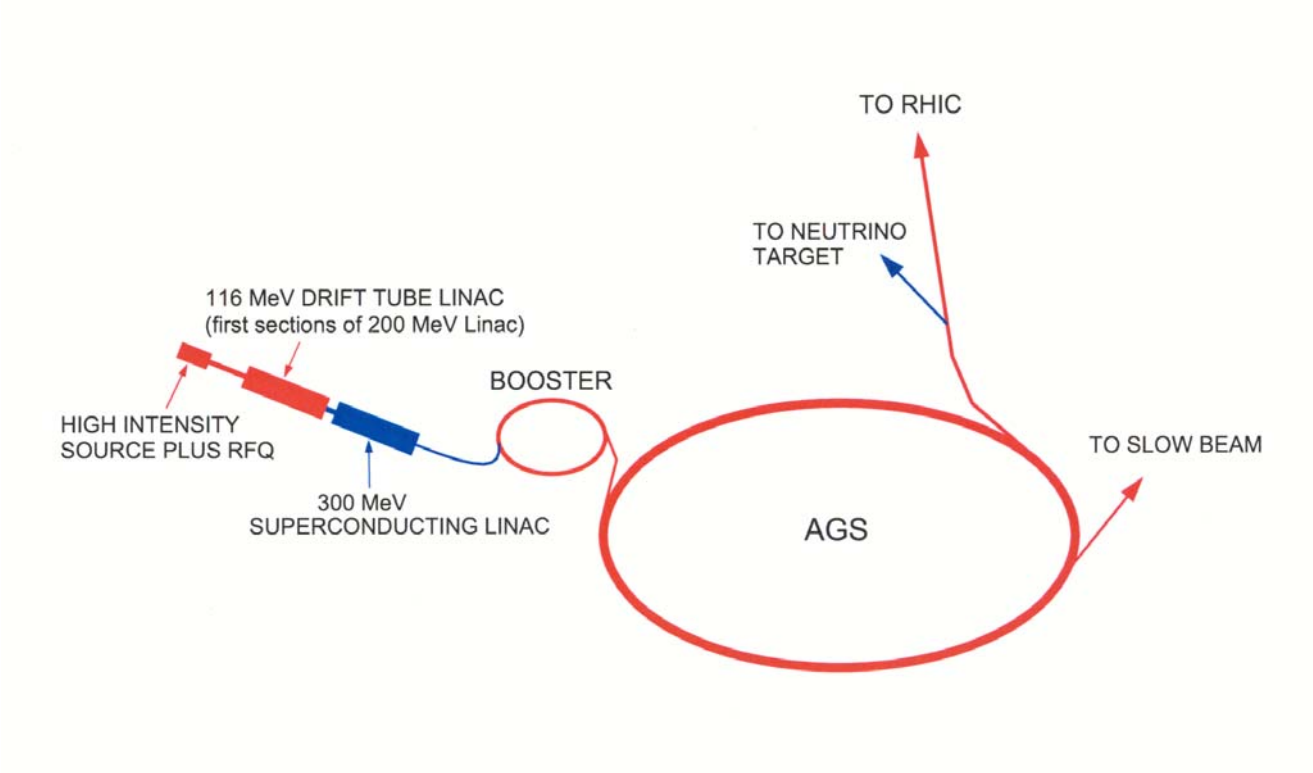
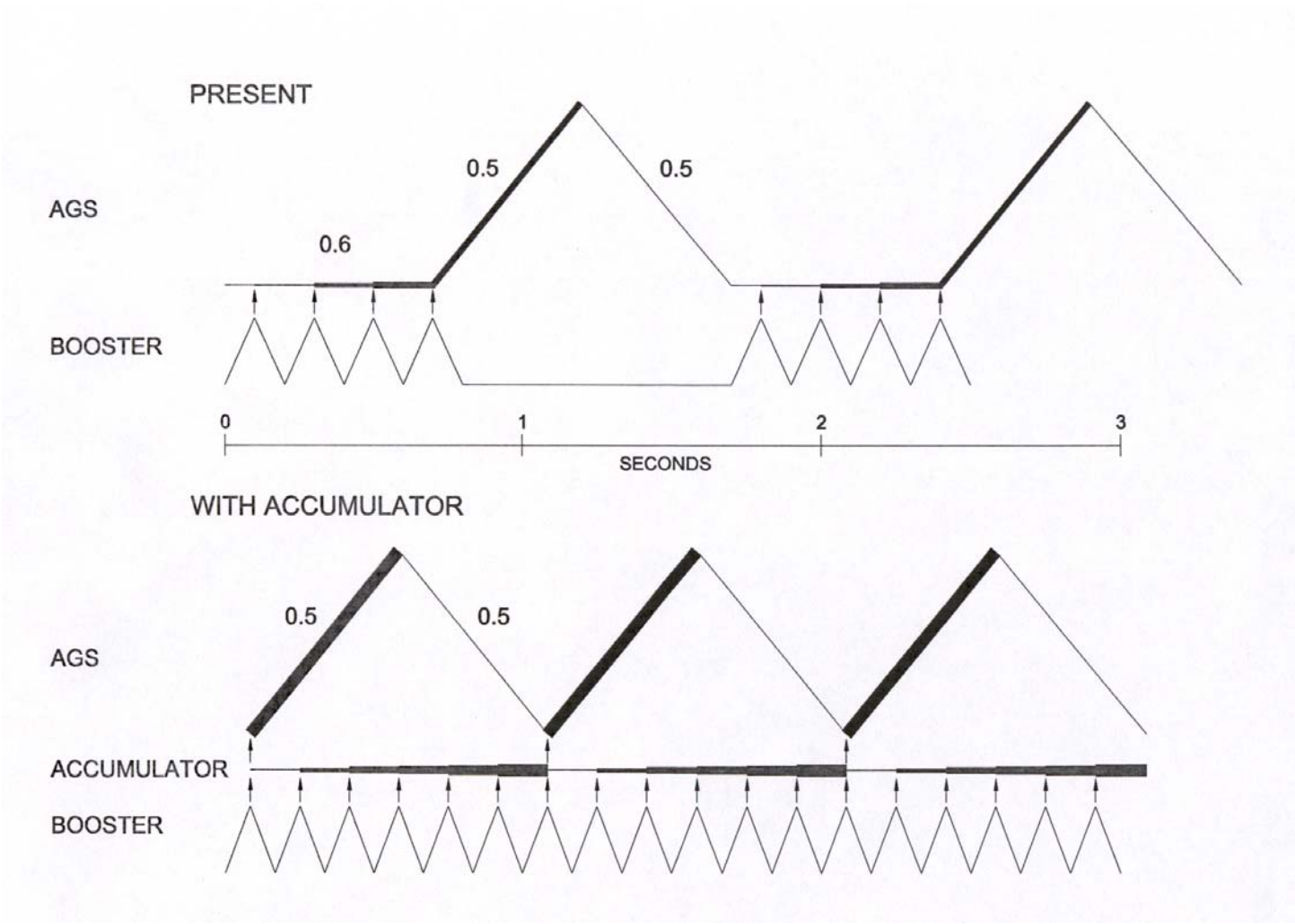
AGS Proton Intensity Evolution



AGS with SCL Addition



AGS Injection Modes

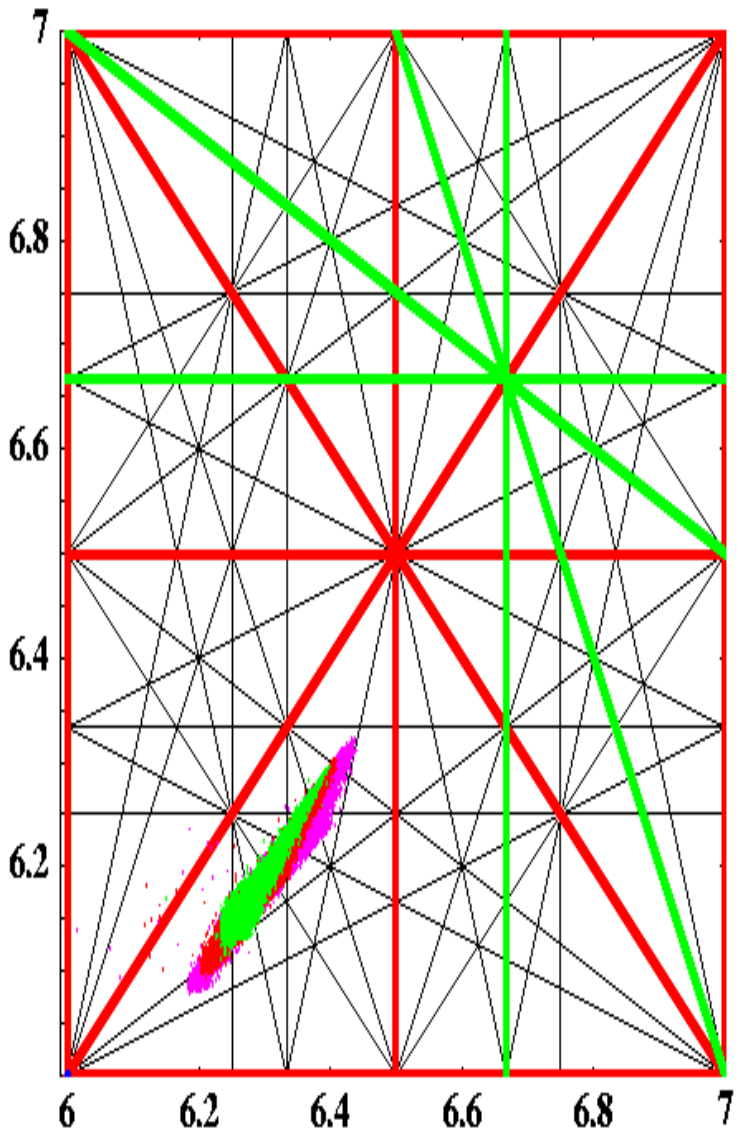


Incoherent and Coherent Space Charge Limit

$$\Delta Q_{inc} = \frac{3 r_p N}{2\beta\gamma^2 \varepsilon_N B_f}$$

	E (MeV)	N (10^{12})	Qx/Qy	ΔQ_{inc}	ΔQ_{exp}	ΔQ_{coh}
KEK-B	40	2.5	2.17/2.3	0.17	0.23	0.27
FNAL-B	400	8	6.7/6.8	0.2	0.4	0.32
ISIS	70	25	3.7/4.2	0.25	0.4	0.4
CERN-PS	1000	28	6.22/6.22	0.22	0.27	0.29
AGS-B	200	15	4.8/4.9	0.35	0.5	0.48
AGS-B	400	20	4.8/4.9	0.21		
AGS	1900	60	8.8/8.9	0.25		
AGS	2500	100	8.8/8.9	0.3		

Avoiding Nonlinear Resonances



Example of tune space region free from structure resonances.

Tune foot-print of 2MW beam:

Green – space-charge spread

Red – space-charge and dp/p=0.7% spread

Pink – space-charge and dp/p=1% spread

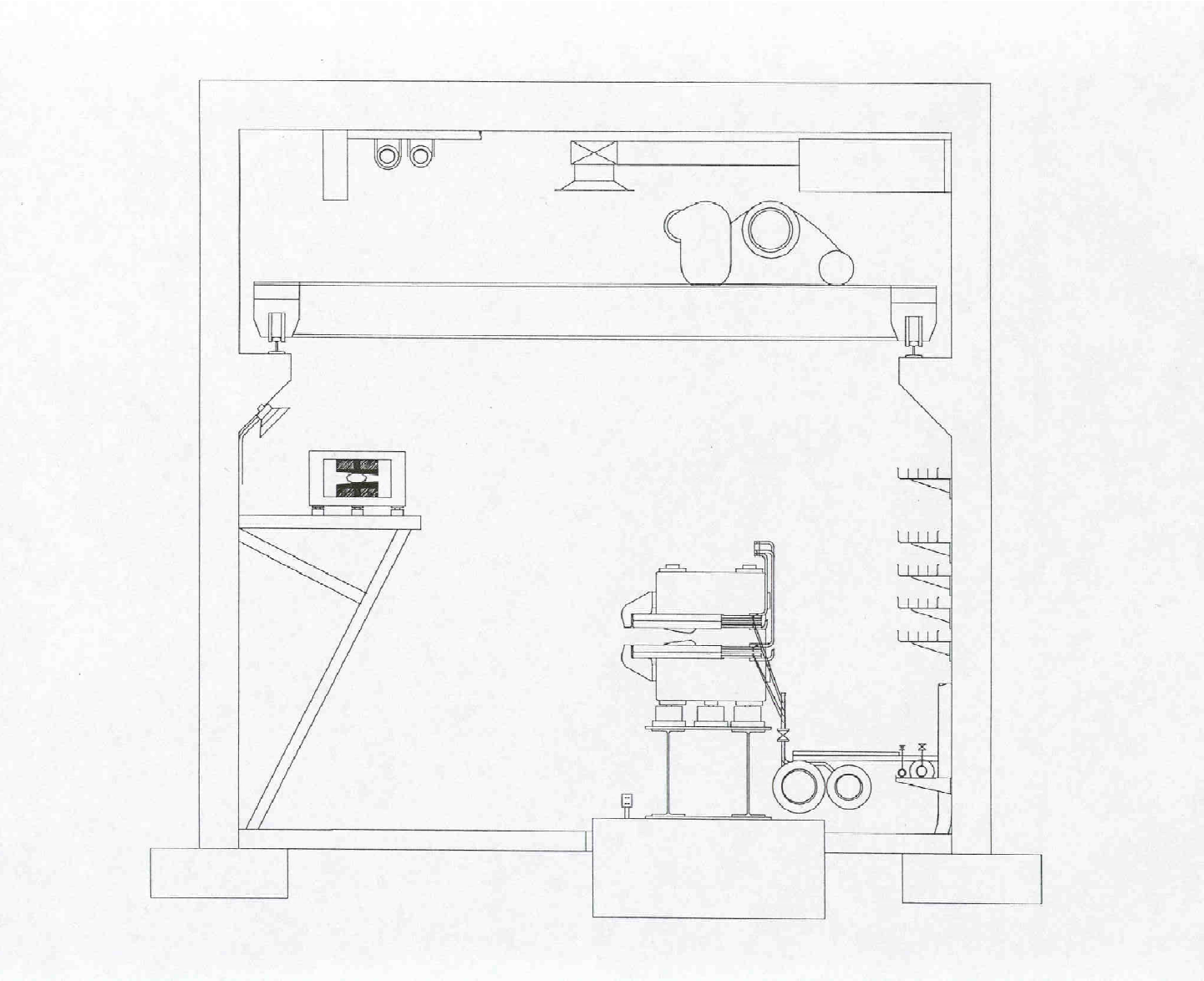
AGS Intensity Upgrades (I)

	Now	400 MeV Linac	2.5 GeV Accumulator (in AGS Tunnel)	
Linac Energy (MeV)	200	400	**200**	**400**
Booster Intensity (ppp)	1.5×10^{13}	2.0×10^{13}	$\mathbf{1.5 \times 10^{13}}$	$\mathbf{2.0 \times 10^{13}}$
Booster Energy (GeV)	1.8	1.8	**2.5**	**2.5**
Booster Cycles (GeV)	4	4	**6**	**6**
AGS Energy (GeV)	24	28	**28**	**28**
AGS Intensity (Tp/sec)	36	48	**90**	**120**
AGS Rep Rate (Hz)	0.6	0.6	**1.0**	**1.0**
AGS Current (μA)	5.6	7.7	**14**	**19**
AGS Intensity (ppp)	6×10^{13}	8×10^{13}	$\mathbf{9 \times 10^{13}}$	$\mathbf{12 \times 10^{14}}$
AGS Power (kW)	140	215	**350**	**470**

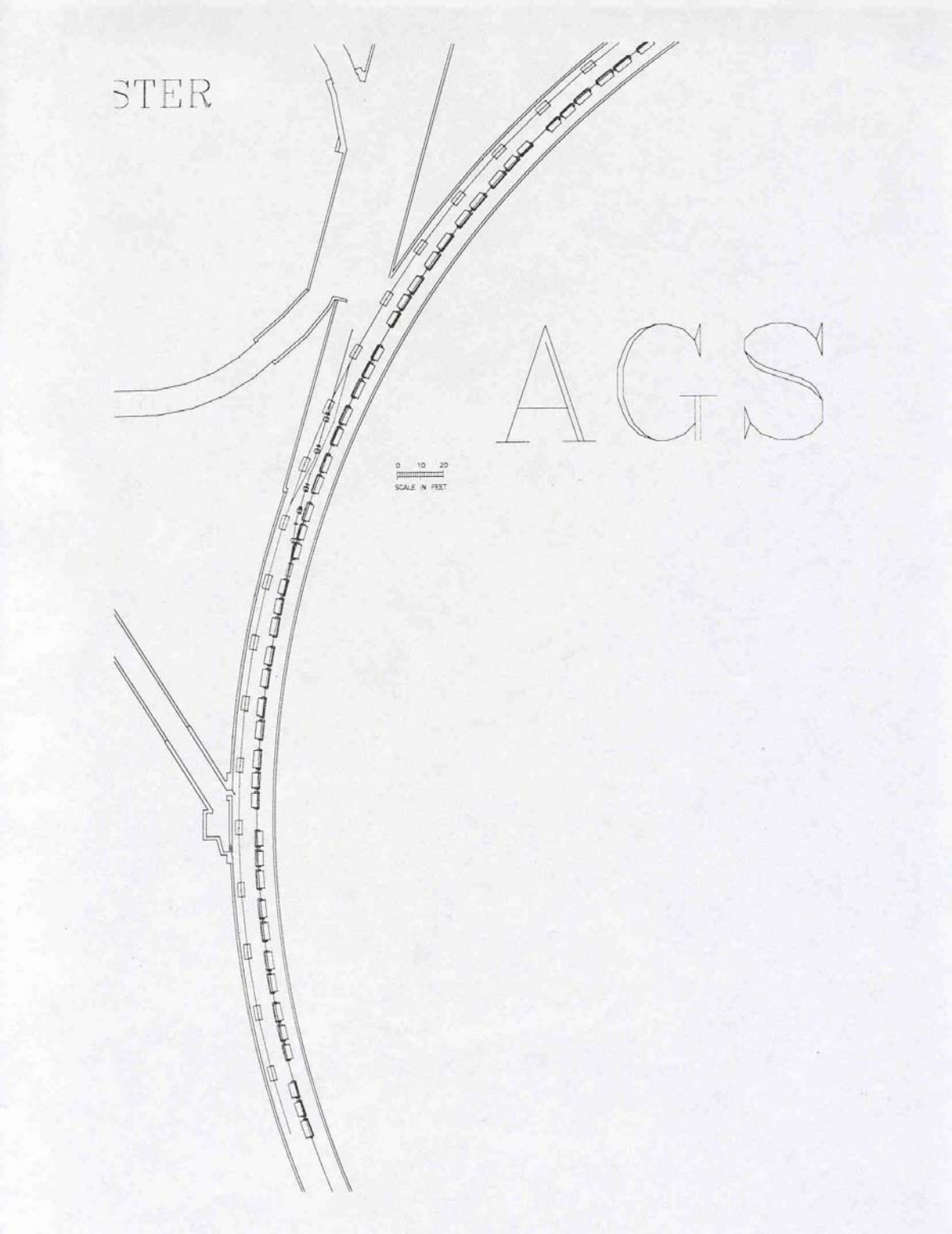
Accumulator Parameters

Max. Kinetic Beam Energy	2.5 GeV
Rigidity	13 Tm
Circumference	819.07 m
Number of Superperiods	25
Number of FODO Cells	50
Number of (Combined-Function) Dipoles	100
Dipoles Length / Field	3.25 m / 0.25 T
Length of FODO Cell	16.45 m
Length of straight sections	8.22 m
Phase Advance per FODO Cell	72 degrees
Vacuum Chamber x / y	150 mm / 75 mm
Acceptance Geometric x / y	234 / 58 π mm mrad
Acceptance Normalized @ 2.5 GeV x / y	744 / 184 π mm mrad
Space Charge limit:	
(100 π mm mrad, $\Delta\nu$ = 0.3, 2.5 GeV, debunched)	3.5×10^{14} ppp
Betatron Tunes x / y	10.3 / 10.5
Chromaticities x / y	-11.7 / -12.7
Beta Max. x / y	24.7 m / 24.3 m
Beta Min. x / y	7.8 m / 7.5 m
Dispersion Max.	1.8 m
Transition Gamma	9.6

AGS Tunnel with Accumulator Ring



AGS Tunnel with AR



Summary of Preliminary Cost Estimate

Phase-I (AGS at 1 Hz)		
300 MeV SRF (116 -> 400)	$	35 M
2.5 GeV AGS Accumulator Ring	$	25 M
AGS Injection at 2.5 GeV	$	5 M
Initial 65 M$ (for 0.47 MW)		
Phase-II (AGS at 2.5 Hz)		
AGS power supply	$	32.0 M
AGS rf upgrade	$	8.6 M
Booster Power Supply	$	5.5 M
AGS Collimation and Shielding	$	8.0 M
Additional 54.1 M$ (for 1 MW)		

Associated Accelerator Improvements

1. AGS injection improvements

2. AGS machine improvements
   - Resonace corrections
   - RF feedbacks
   - Transition crossing
   - Beam collimation and shielding

3. AGS extraction and Beam Transport to Target