High Intensity Protons in AGS Accelerator complex

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HB2008

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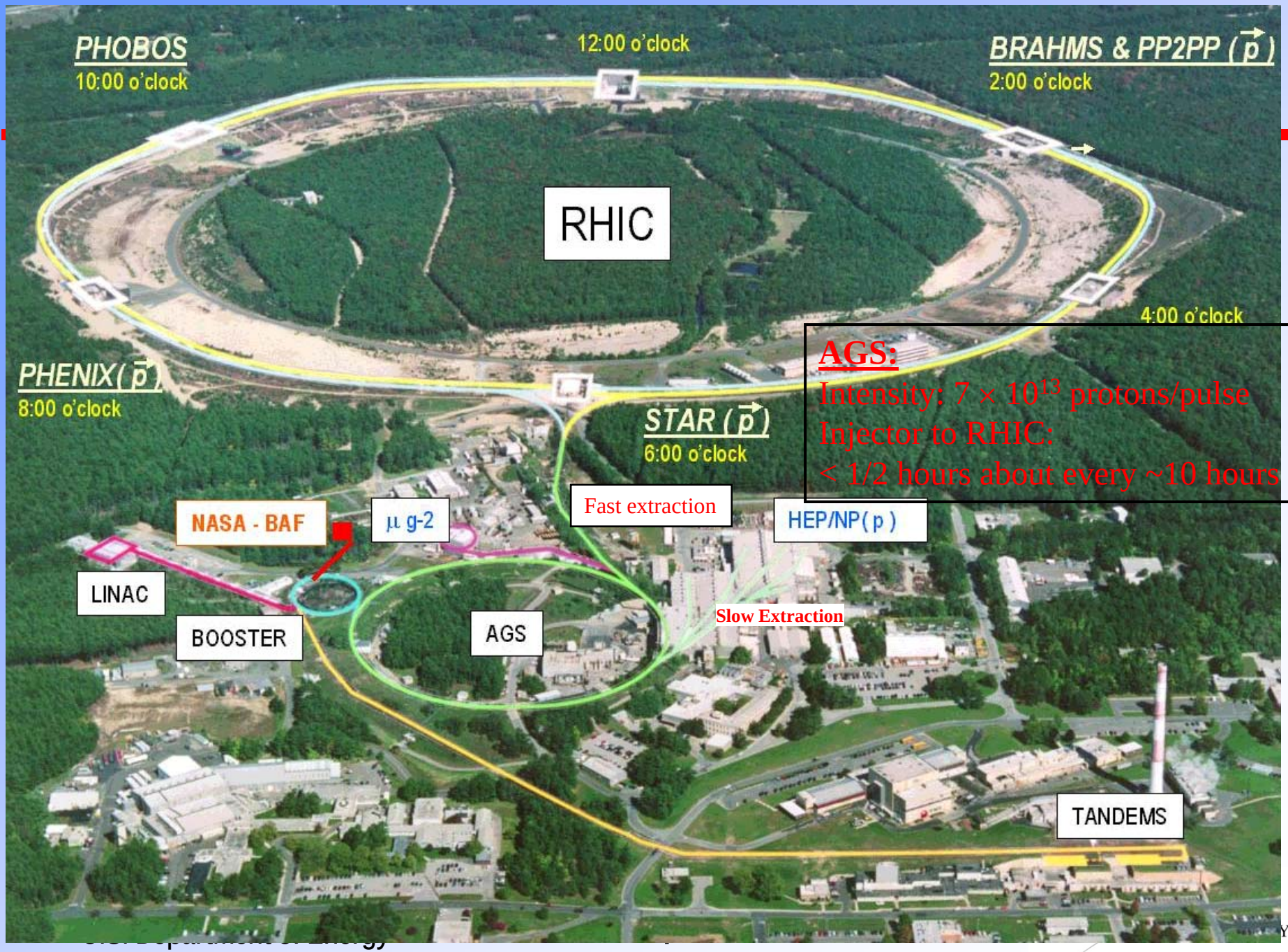
OUTLINES

- Introduction
- Linac, BLIP
- Booster
- AGS
- Conclusion

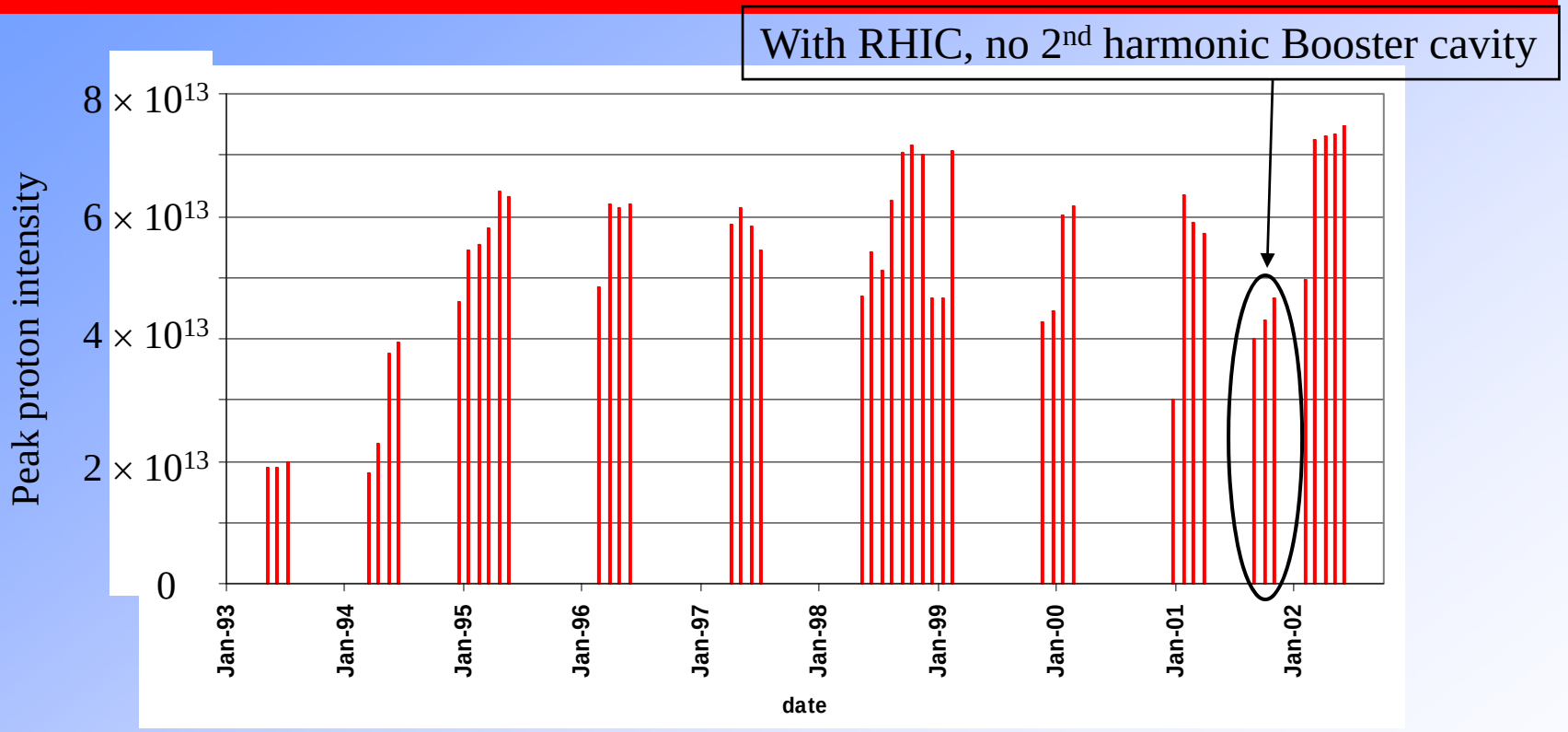
Acknowledgements

L.Ahrens,J, Alessi, P. Bergh, B. Briscoe, K. Brown, P. Cirnigliaro, V. LoDestro, R. Thomas

Note: This talk will cover only high intensity proton operations of Linac, Booster and AGS

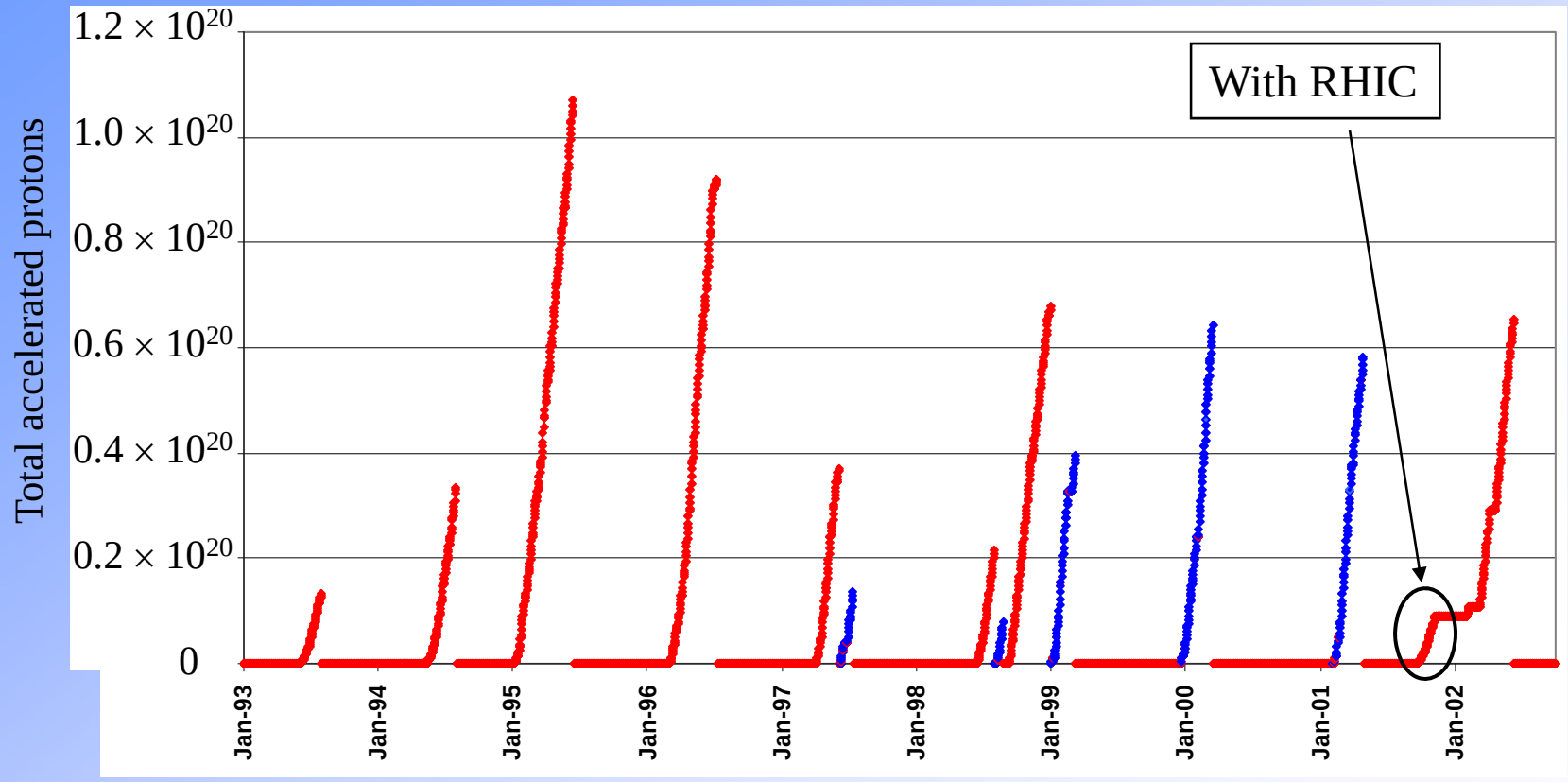

PHOBOS
10:00 o'clock
12:00 o'clock
BRAHMS & PP2PP (p)
2:00 o'clock
RHIC
4:00 o'clock
PHENIX (p)
8:00 o'clock
STAR (p)
6:00 o'clock
AGS:
Intensity: 7 × 10^13 protons/pulse
Injector to RHIC:
< 1/2 hours about every ~10 hours
Fast extraction
HEP/NP (p)
NASA - BAF
μ g-2
LINAC
BOOSTER
AGS
Slow Extraction
TANDEMS

AGS Peak Proton Intensities



World record proton synchrotron intensity!

Total Accelerated Protons at the AGS

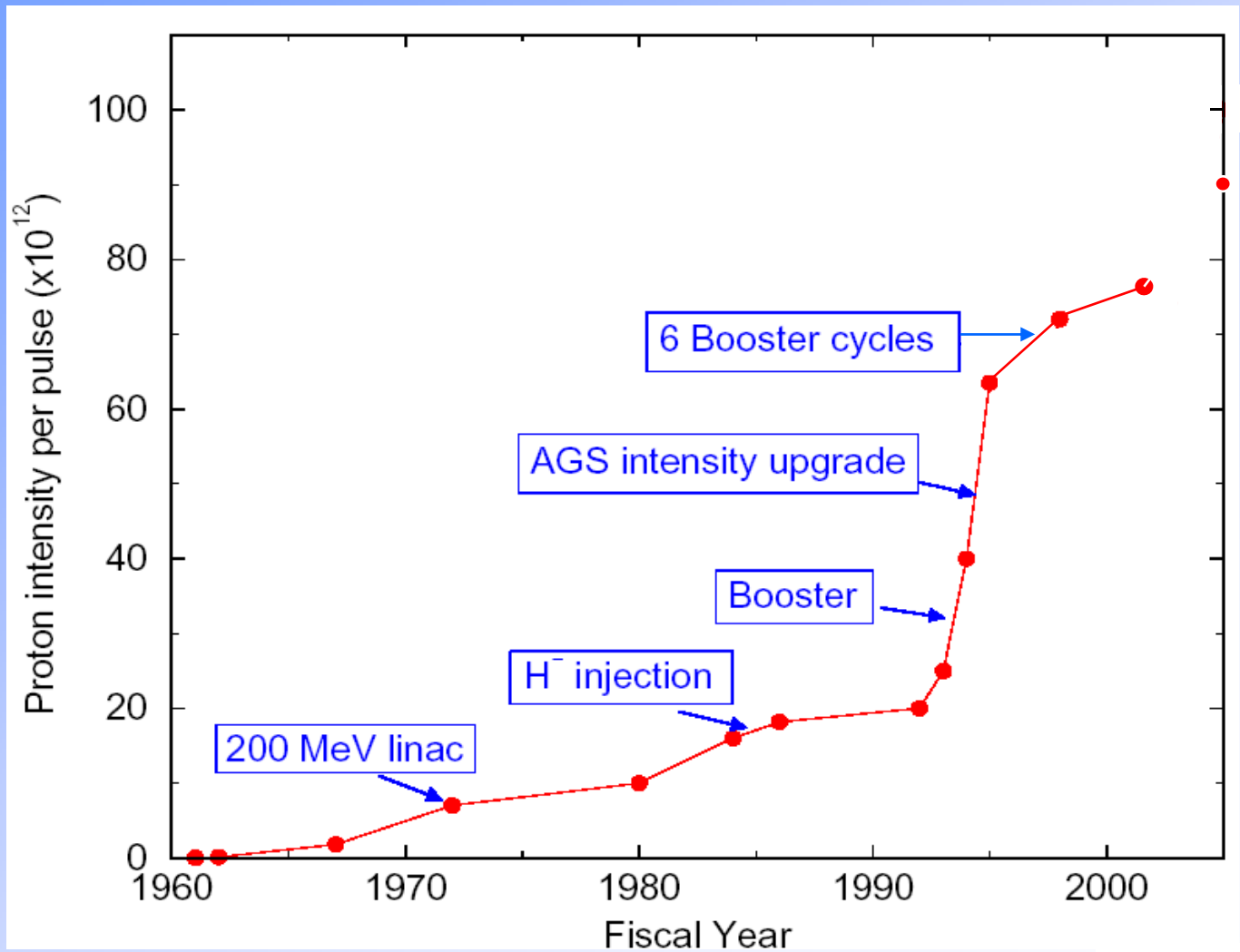


Slow extracted beam (Kaon decay)

Fast extracted beam (g-2)

Note: Lower total accelerated protons in later years due to much shorter running time

AGS Intensity History



LINAC Beam Parameters

Final Energy	200 MeV
Peak Current	30-40 mA
Repetition Rate	4 pulses/AGS pulse(7.5 Hz)
Pulse Length	0.350 ms (250 turns)
Trans. Emittance(n,rms)	2 pi mm mrad
Energy Spread	± 0.1 MeV (0.1 %, 95%)
Energy Jitter	± 0.1 MeV
Chopping	Slow + fast
Customers	BLIP, Booster

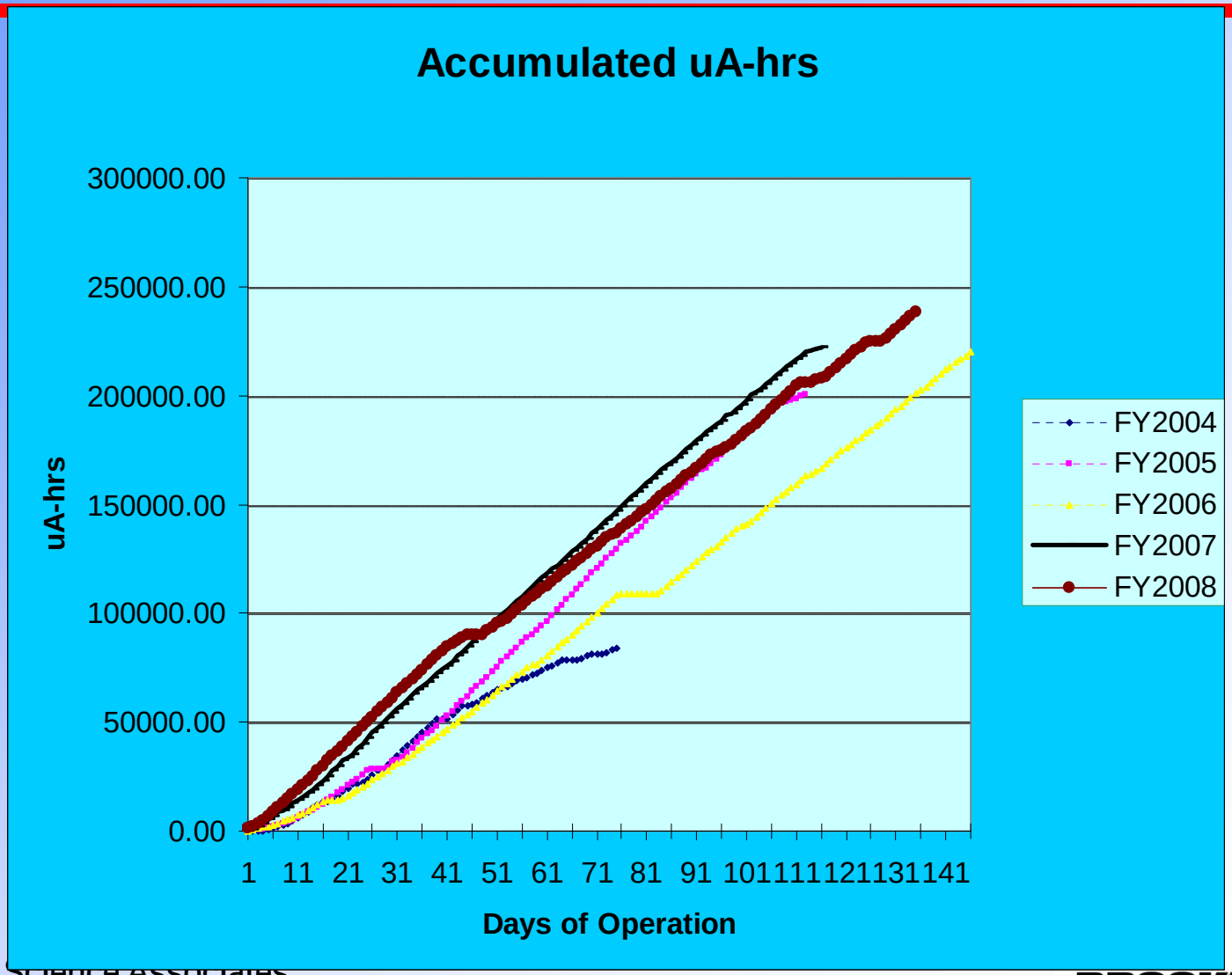
BNL 200 MeV Linac



General Parameter of BNL 200 MeV Linac

Preinjector Energy	0.75	MeV
Output Energy	200.3	MeV
Peak Beam Current	100	mA
Emittance (100mA at 200 MeV)	1	pi cm-mrad
Beam Pulse Length (max)	200	µsec
RF Pulse Length	400	µsec
Operating Frequncy	201.25	MHz
Number of Cavities	9	
Total Length of the Accelerator	144.8	meters
Numbers of unit cells	286	
Total Peak RF Excitation Power	22	MW
Pulse Repetition Rate (max)	10	pulse/sec

Beam Delivered to BLIP



Losses in 200 MeV Linac

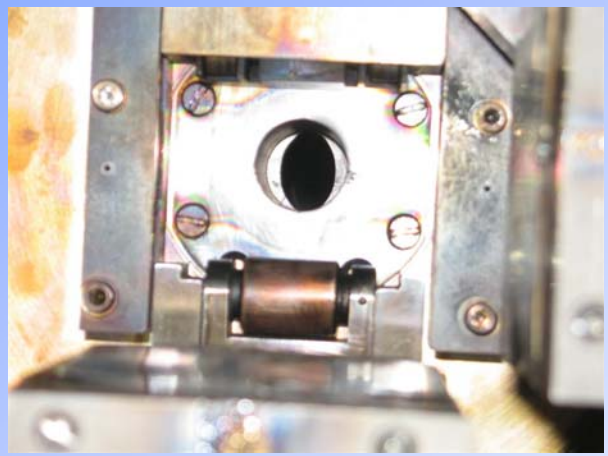
	Losses for 100 micro Amps (W/m)	Radiation (mrad/hr)
RFQ	2.8	0
MEBT	1.9	0
TANK 1	4.2	<1
TANK 2	1.0	<1
TANK 3	0.4	8.75
TANK 4	0.4	6.45
TANK 5	0.0	1.5
TANK 6	2.5	13.25
TANK 7	1.0	7.5
TANK 8	0	2.75
TANK 9	0	7.7
Average	1.4 w/m	

Protection systems

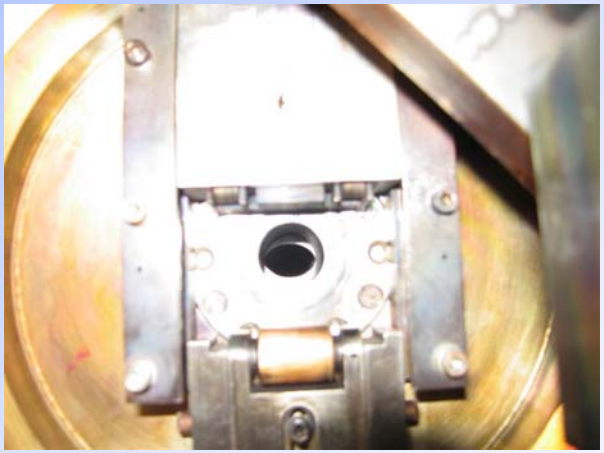
- Collimation :
  LEBT, Tank1, and BLIP Line
- BLM are reach back to Fast Chopper (FBI)
- Temperature monitor
- Harp out wire are reach back to Fast Chopper







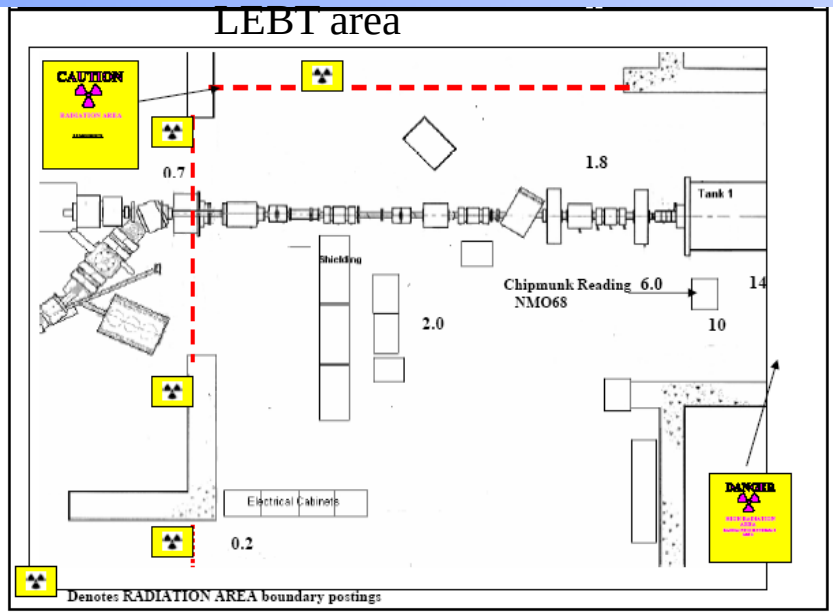
Tank 1 Collimator (P)



Tank1 Collimator (H-)

Radiological Survey of Linac

- LINAC energy for BLIP 117 MeV
  only first 5 tank, 6.67 Hz, 400 μs, ~40 mA
- Polarized proton 200 MeV
  0.5 Hz, 350 μs, ~ 250 μA



BNL RADIOLOGICAL SURVEY FORM

☐ ROUTINE N/A
☐ SPECIAL N/A
☒ RWP# CA-02

BLDG#: 930 LOCATION: LINAC Tank 1 - 9 DATE/TIME: 06-17-02 / 0900

MODEL	6112B	TENELEC	N/A	N/A	N/A	N/A
SERIAL#	25464	32831				
Cal Due Date	8-10-02	9-28-02				
Source Checked (Yes or No)	YES	YES				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
CONTACT	N/A	TIME	μCi/cc	%DAC
GENERAL AREA	25 mR/hr	N/A	N/A	N/A

LEGEND: O - SMEAR SURVEY LOCATION
□ - MASSLIN SURVEY LOCATION
Δ - AIR SAMPLE LOCATION
XXX Y X = CONTACT READING
ZZZ Z = READING @ 30 cm
Y = RADIATION TYPE

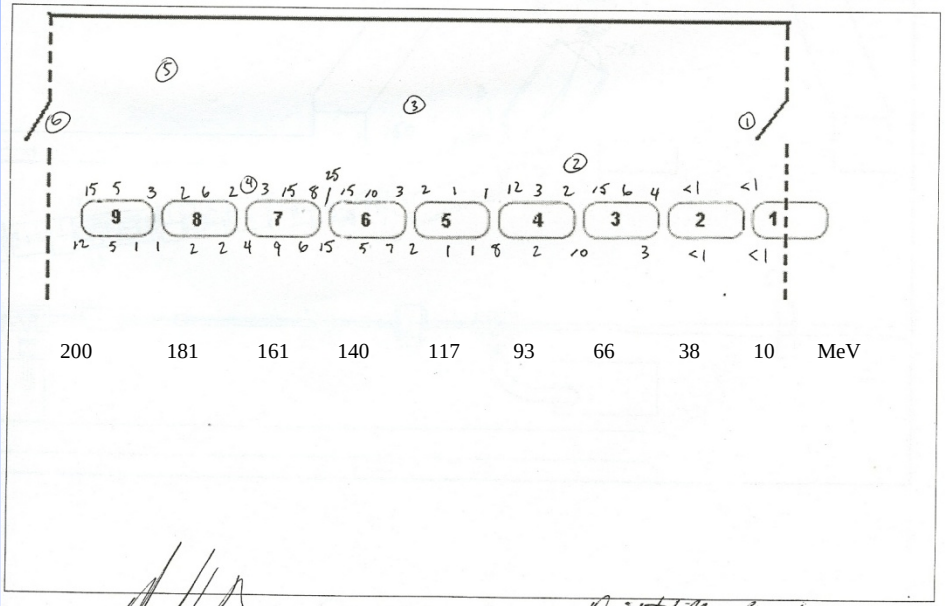
SMEAR SURVEY RESULTS (DPM/100 cm²)
³H Bkg 0

☒ MDA = ~~2.95~~ 13.95 dpm β⁻ = 38 dpm
☒ All Exposure Rates are in mR/hr at 30 cm (12 in.) unless otherwise noted
☒ See Attachment for smear survey results
BATCH # 3113
NOTE: ALL SMEARS < MDA α

1. FLOOR	<MDA	8. N/A	N/A	15. N/A	N/A	22. N/A	N/A		
2. FLOOR	<MDA	9.		16.		23.			
3. FLOOR	<MDA	10.		17.		24.			
4. FLOOR	<MDA	11.		18.		25.			
5. FLOOR	<MDA	12.		19.		26.			
6. FLOOR	<MDA	13.		20.		27.			
7. N/A	N/A	14.		21.		28.			

MASSLIN SURVEY RESULTS (DPM/LAS)

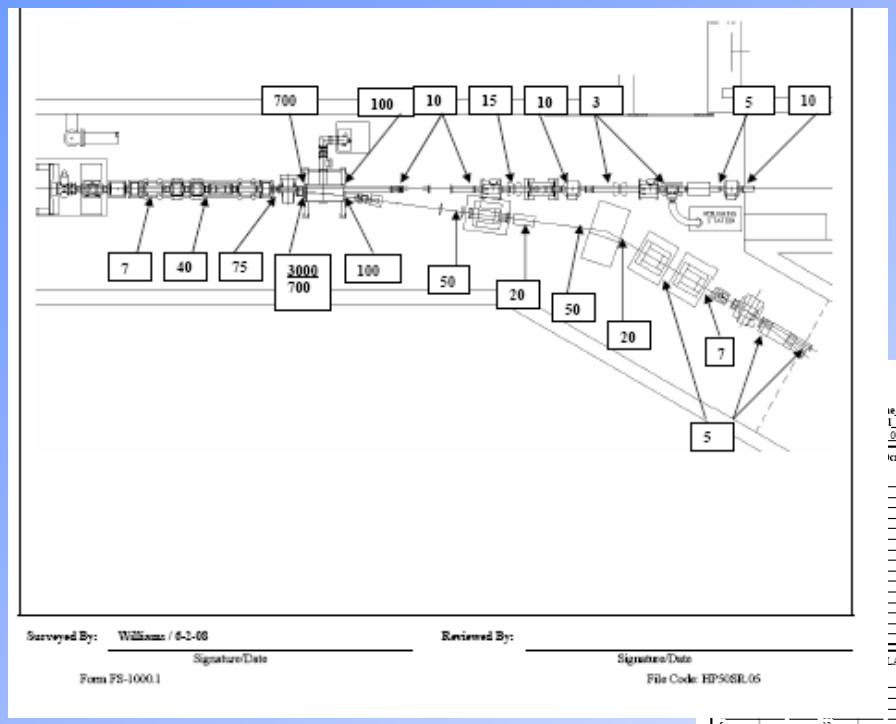
1. N/A	8. N/A		
2.	9.		
3.	10.		
4.	11.		
5.	12.		
6.	13.		
7.	14.		

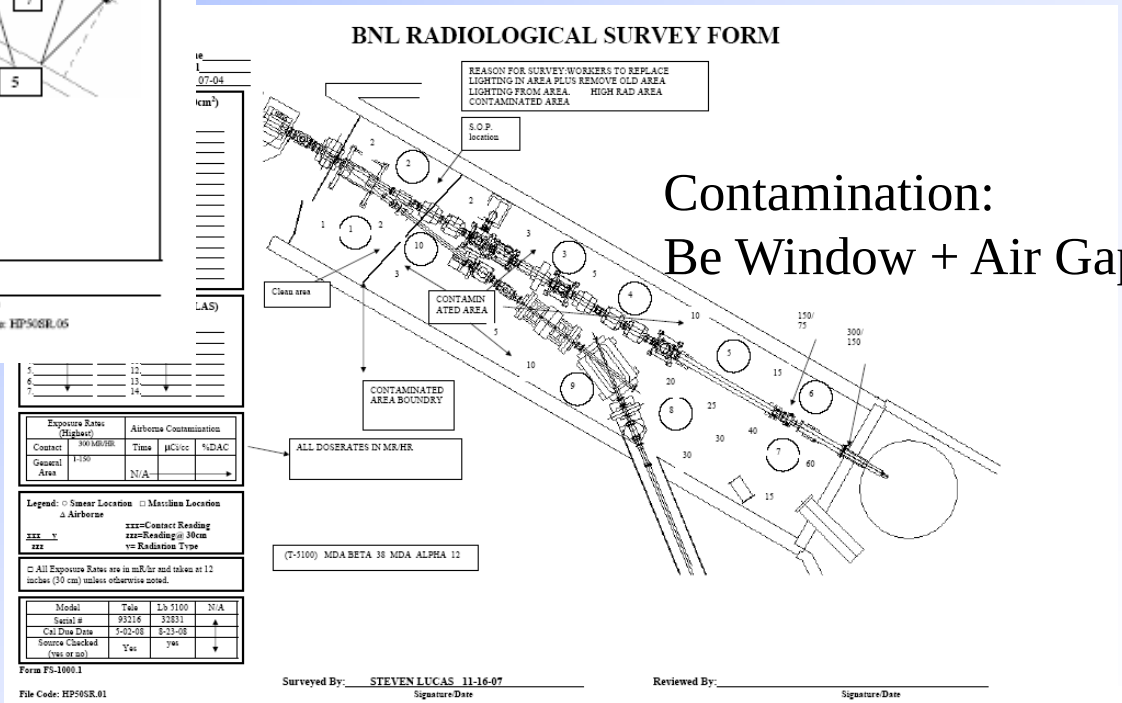


SURVEYED BY: 6-17-02
Signature/Date
REVIEWED BY: 6-17-02
Signature/Date

Form FS-1000.1 FS-SOP-1000, rev 1, attachment 8.2, page 11 File Code: HP50SR.01

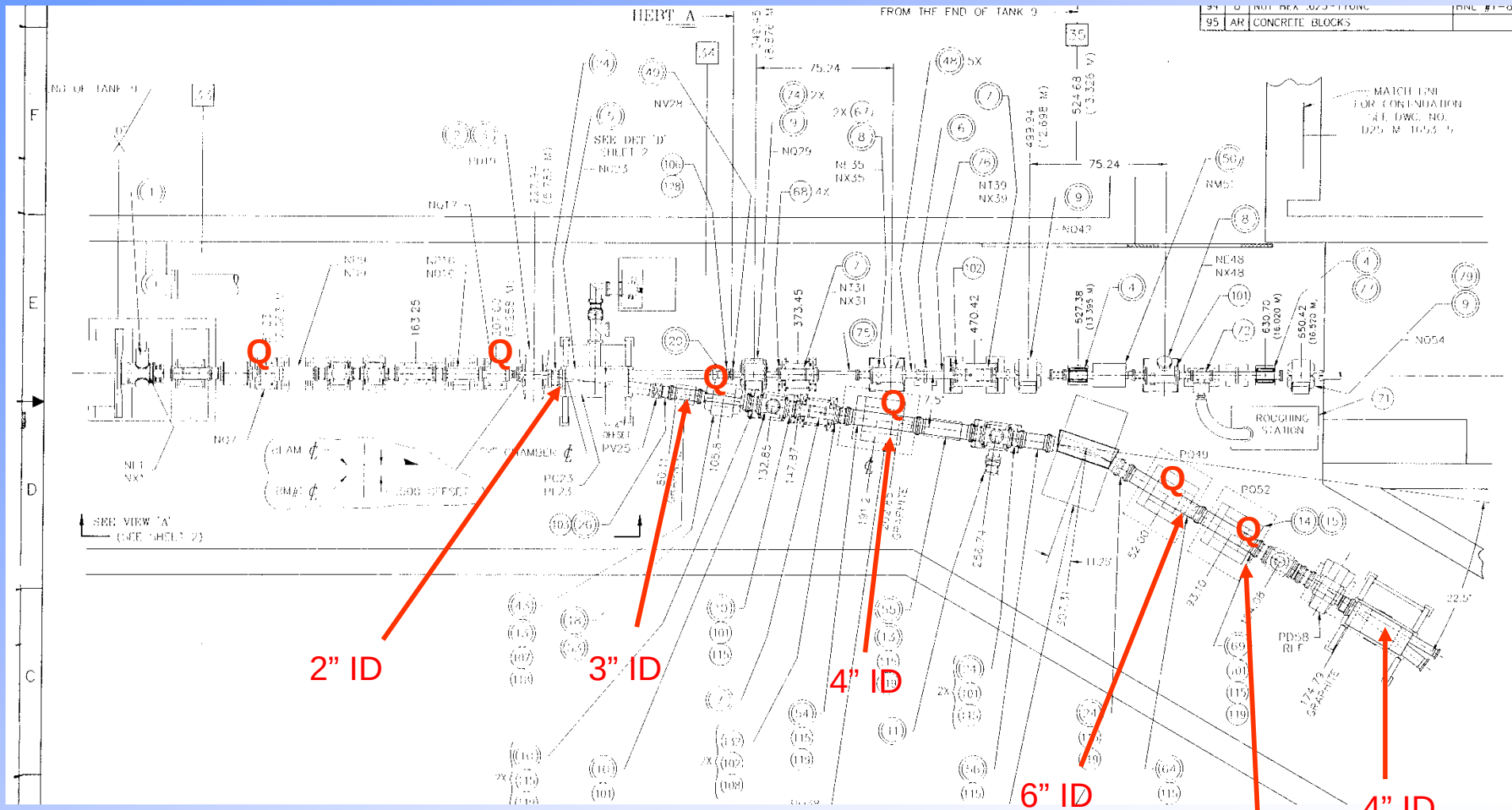
Radiological Survey of BLIP Line





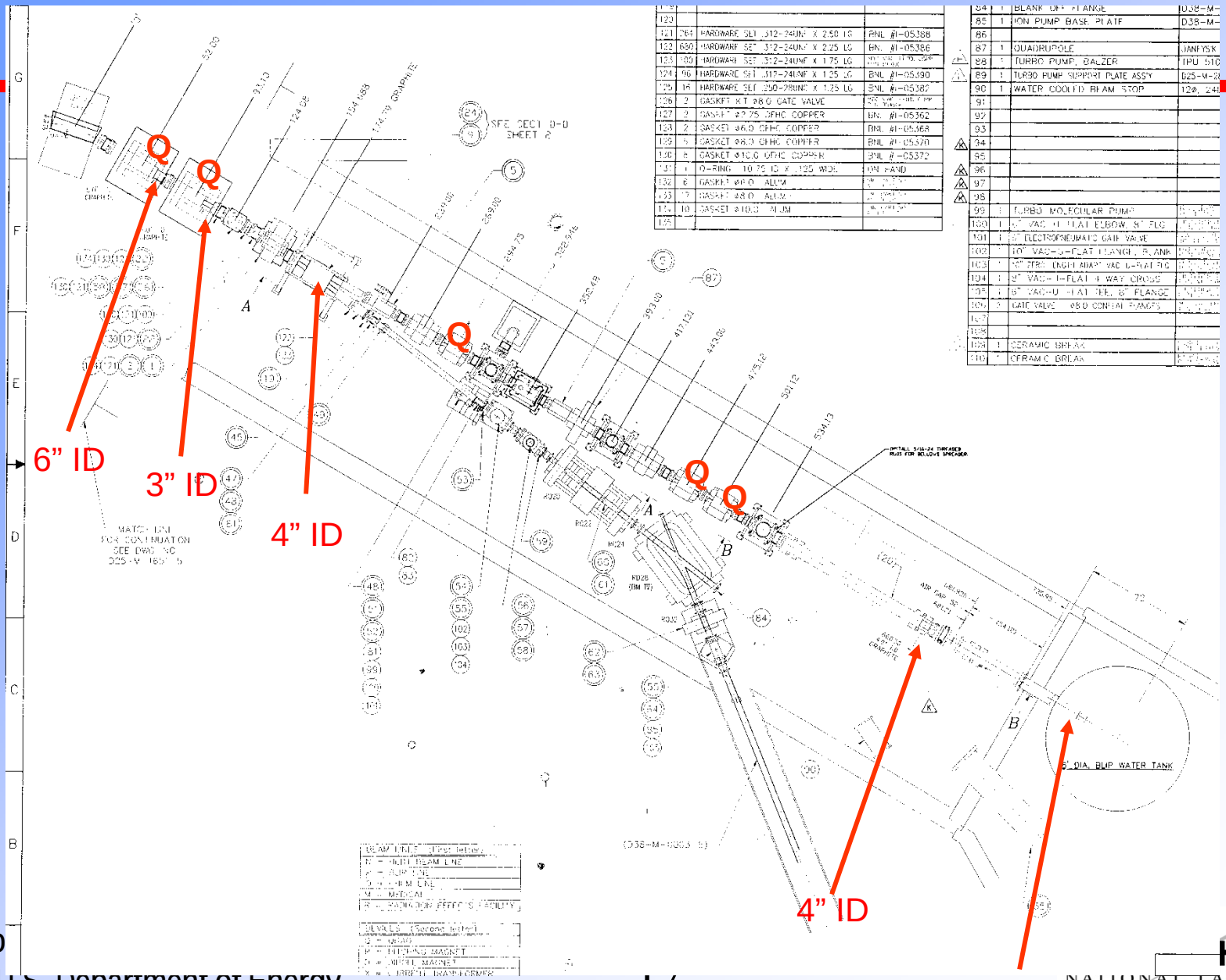
Contamination:
Be Window + Air Gap

Blip Flange Melt down: Graphite collimators BLIP Line



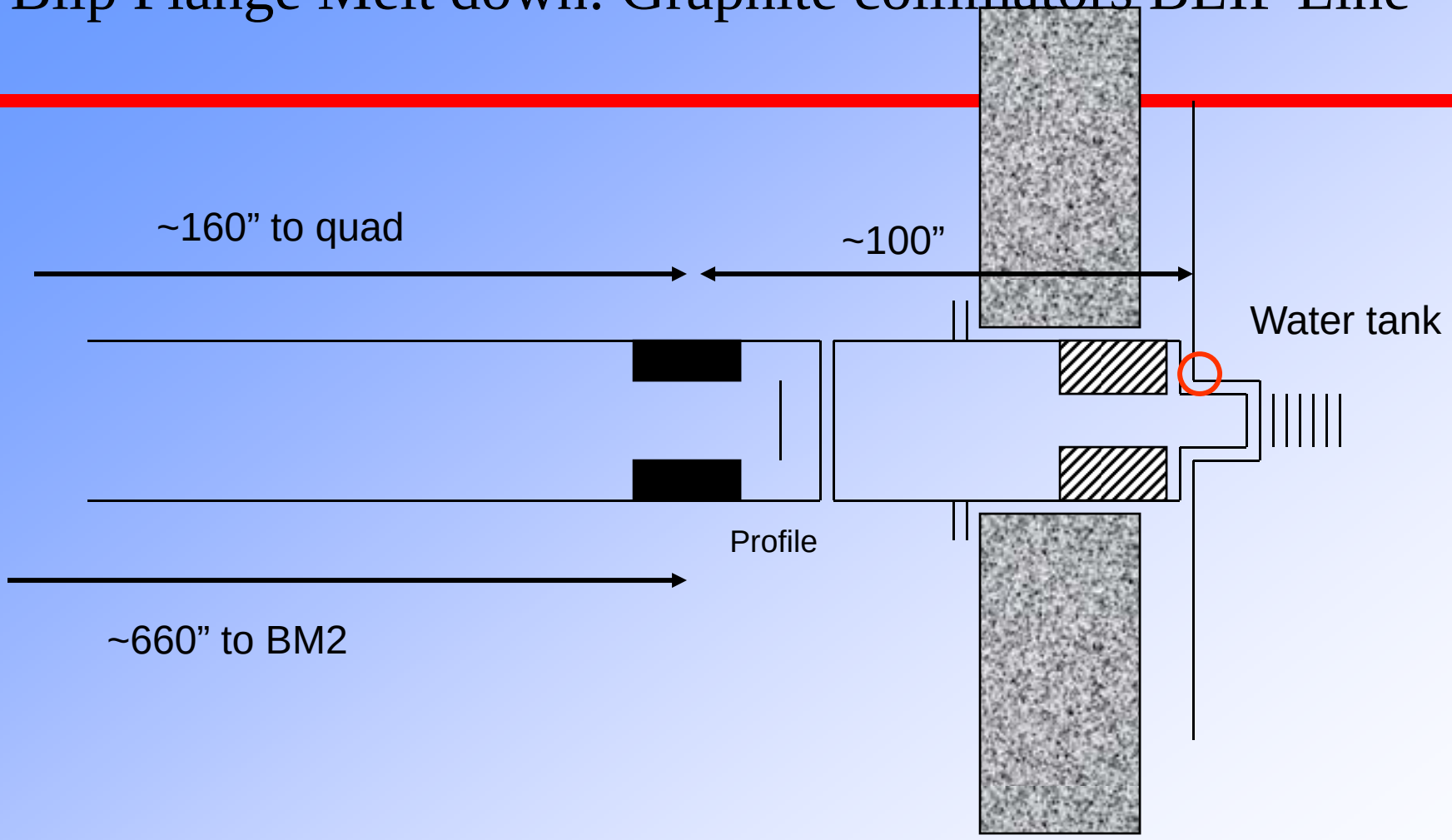
Graphite collimators

Blip Flange Melt down: Graphite collimators BLIP Line

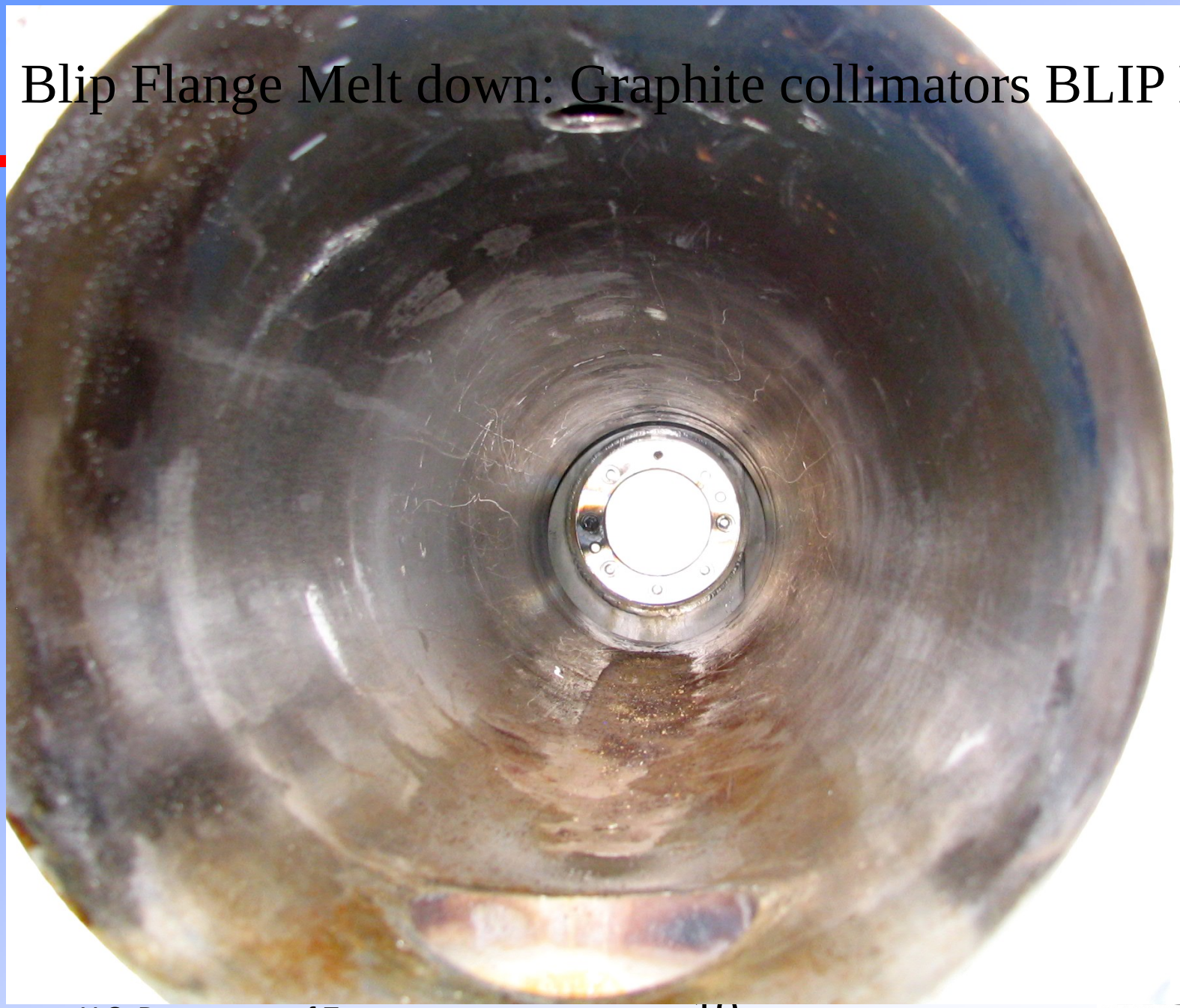


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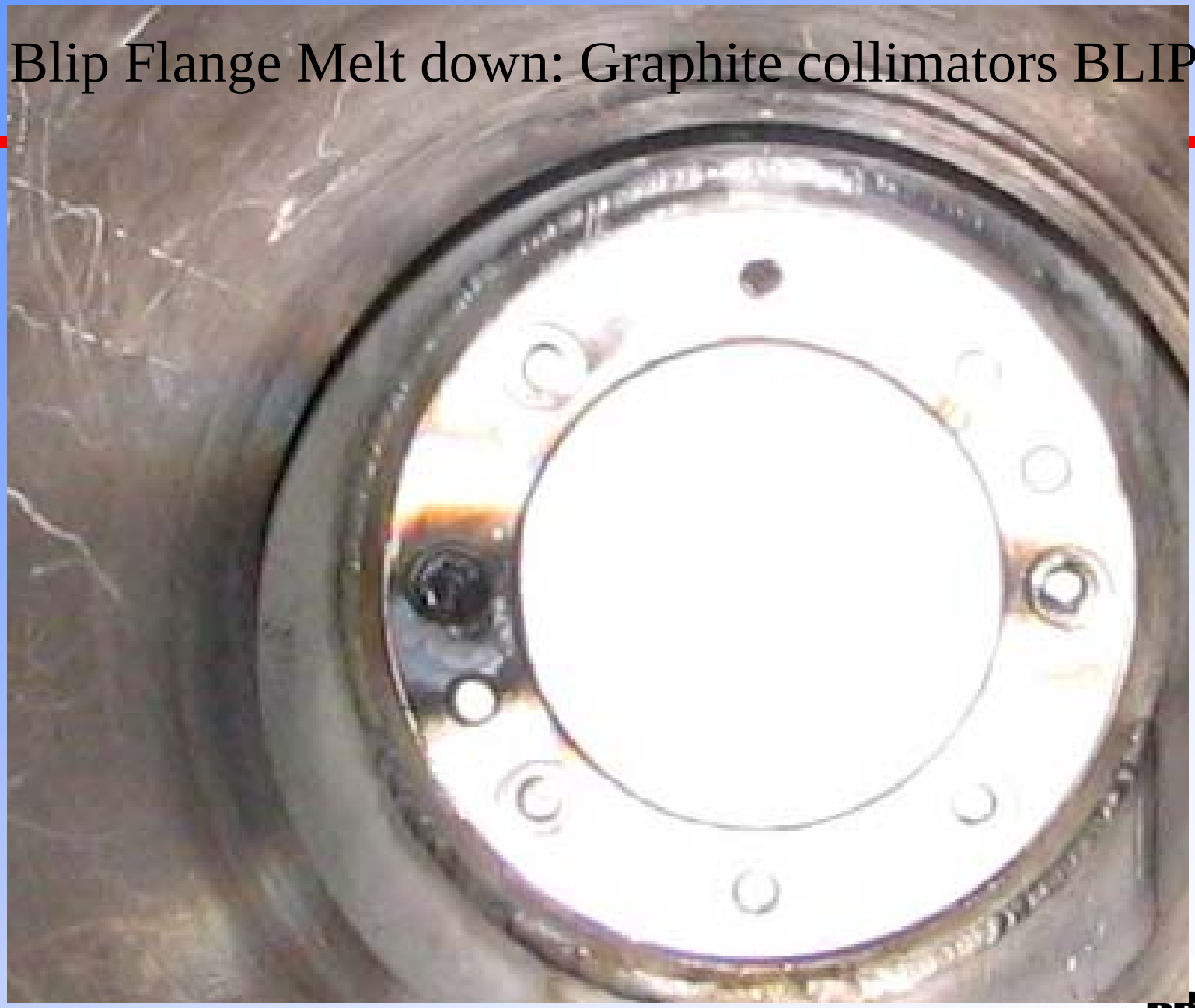
Blip Flange Melt down: Graphite collimators BLIP Line



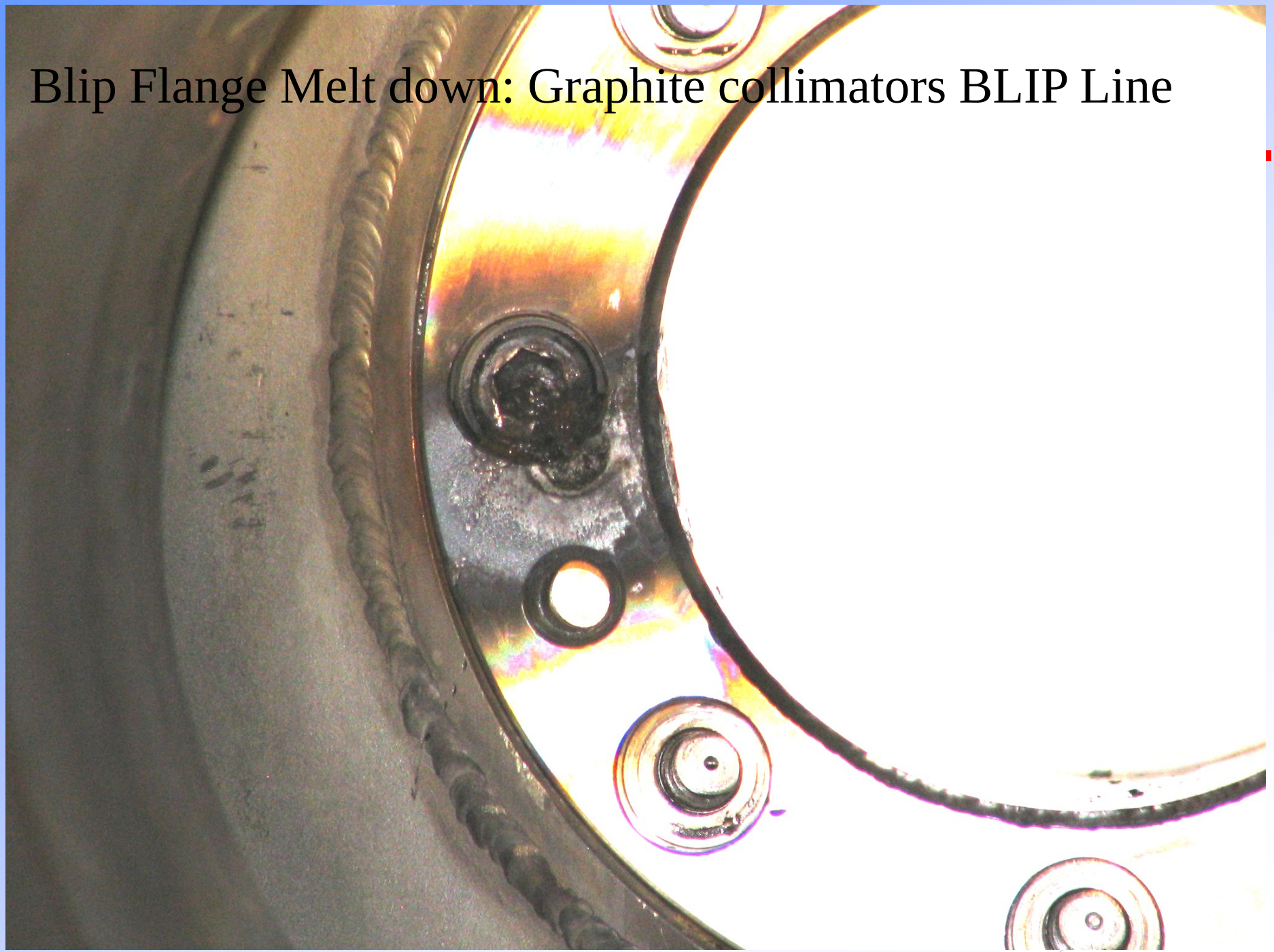
Blip Flange Melt down: Graphite collimators BLIP Line



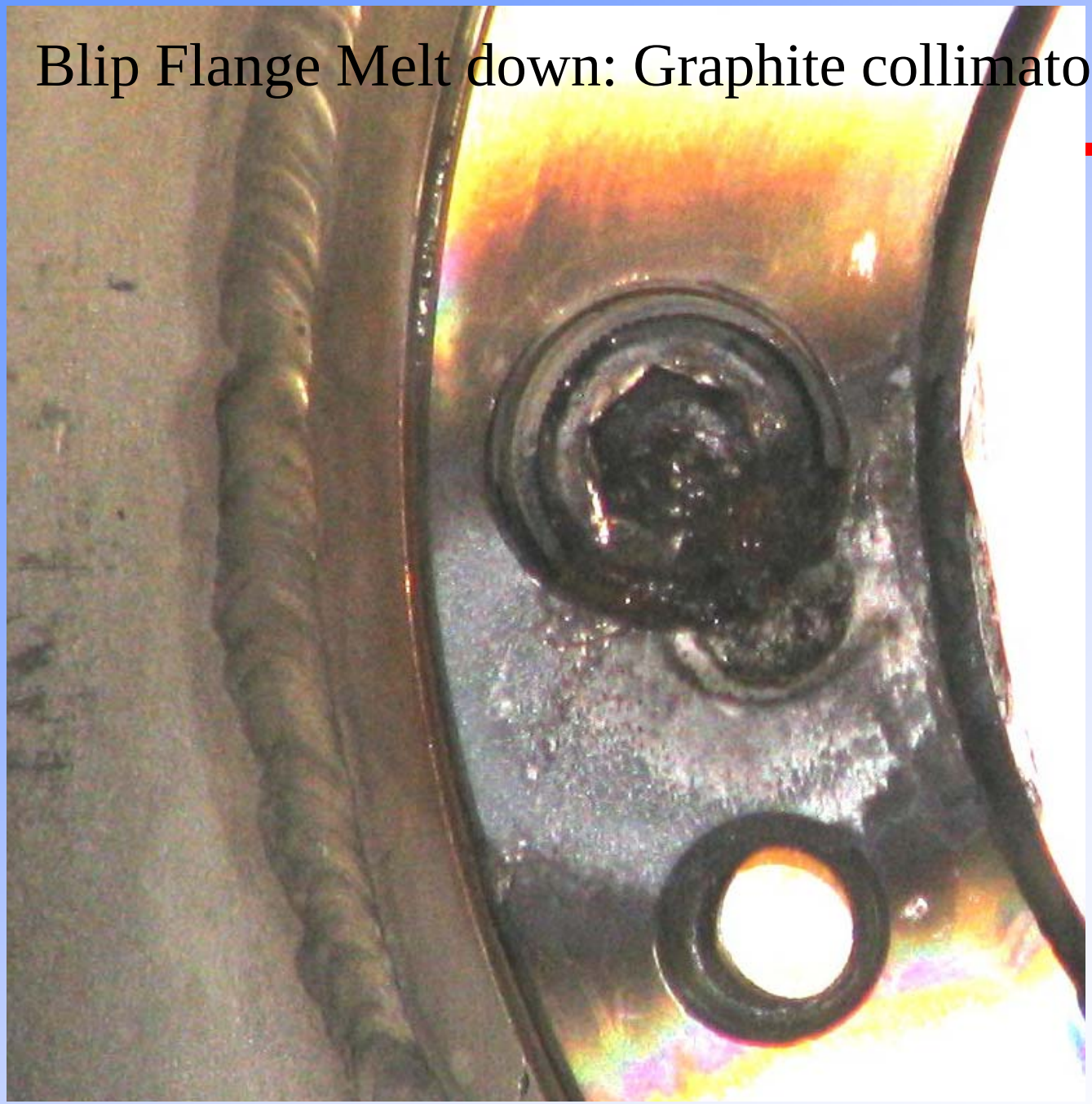
Blip Flange Melt down: Graphite collimators BLIP Line



Blip Flange Melt down: Graphite collimators BLIP Line



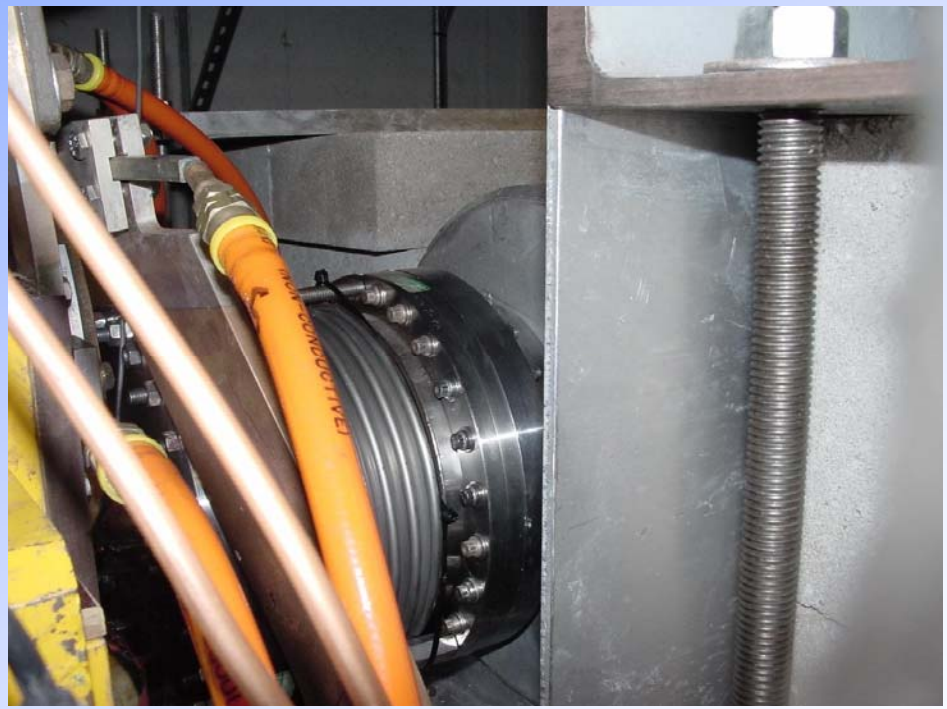
Blip Flange Melt down: Graphite collimators BLIP Line



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Shileding

- Shielding in dipoles



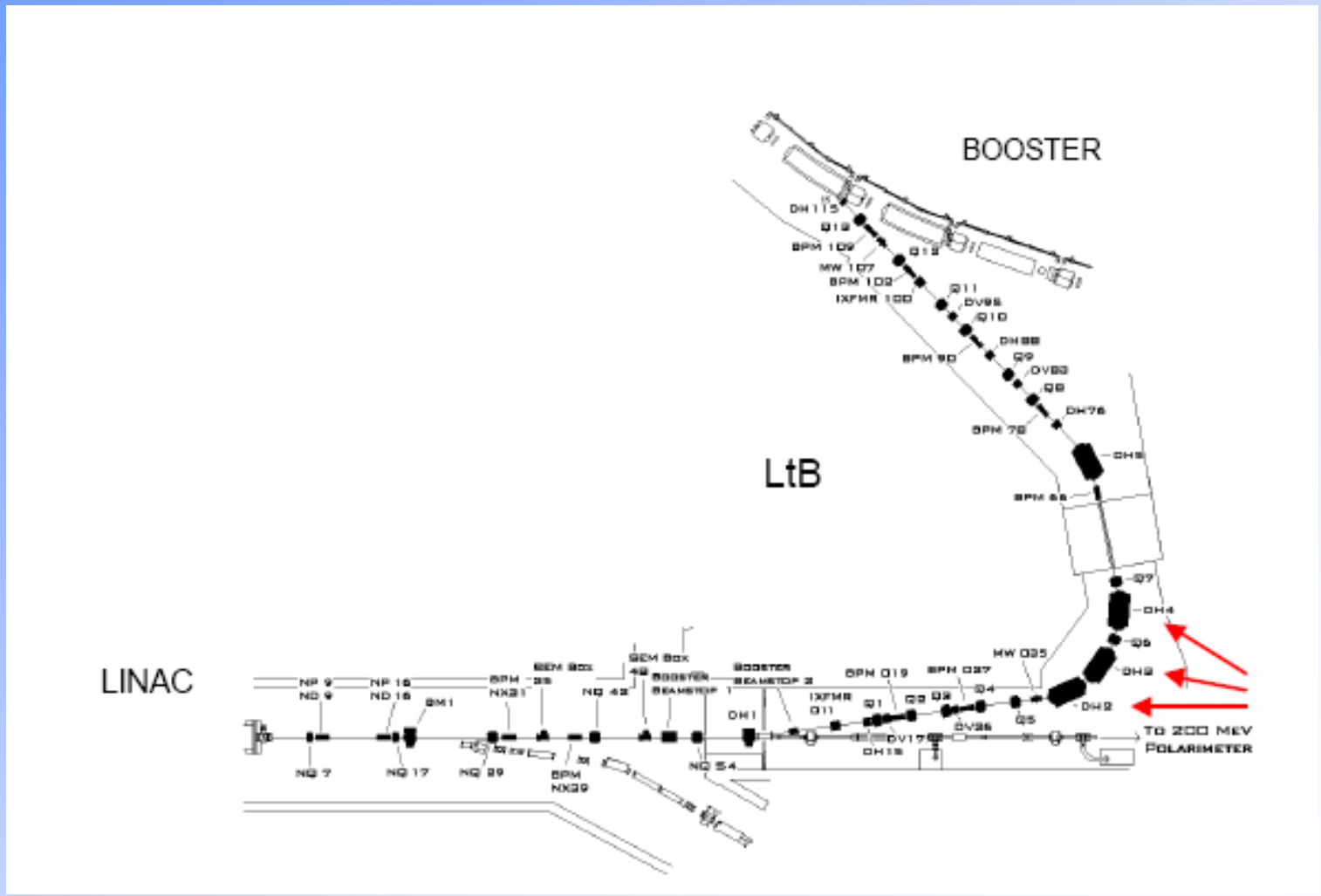


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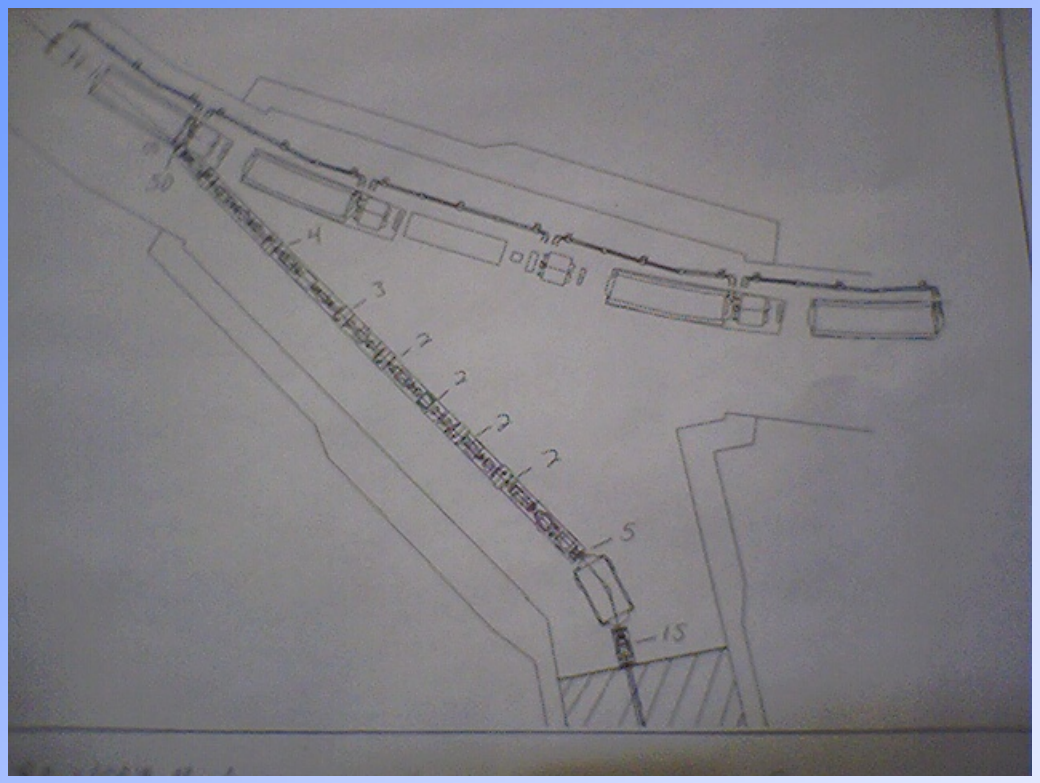
Linac to Booster Transfer Line (LTB)

- Transport to linac to booster
- Match into booster
- Measure Transverse Beam Quality
- No collimation
- No energy correction
- No buncher cavity
- No chopper in the LTB
- ~ 60 meter long
- 120 degrees bend
- Magnetic stripping of H^- not an issue

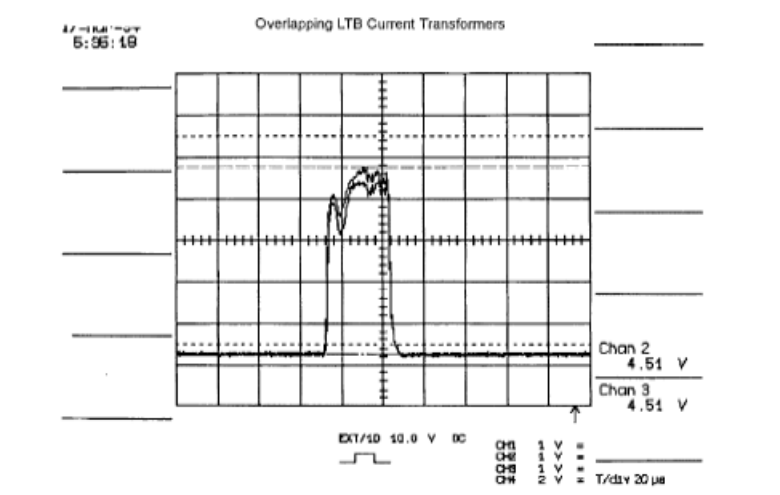
Transfer line layout



Losses in the LTB



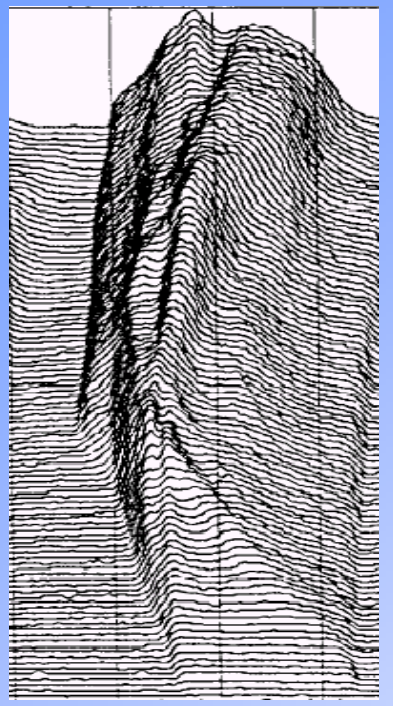
Transmission 90-95%



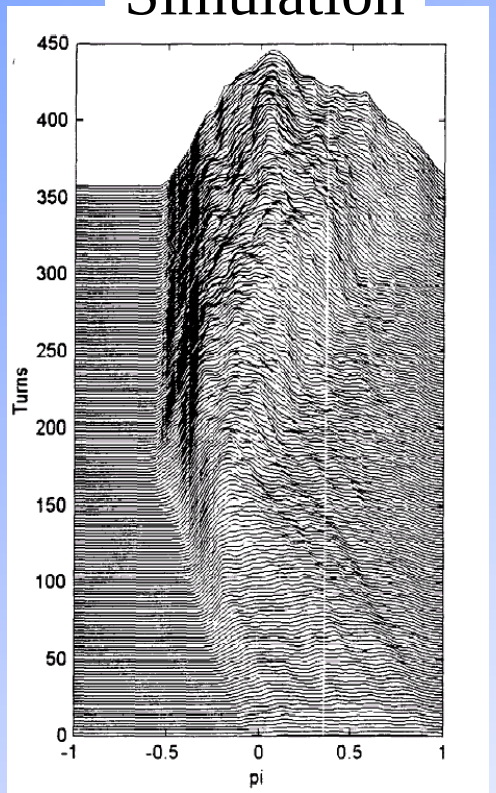
Current monitor XF011 , XF100

H^- injection into the Booster

Measurement



Simulation



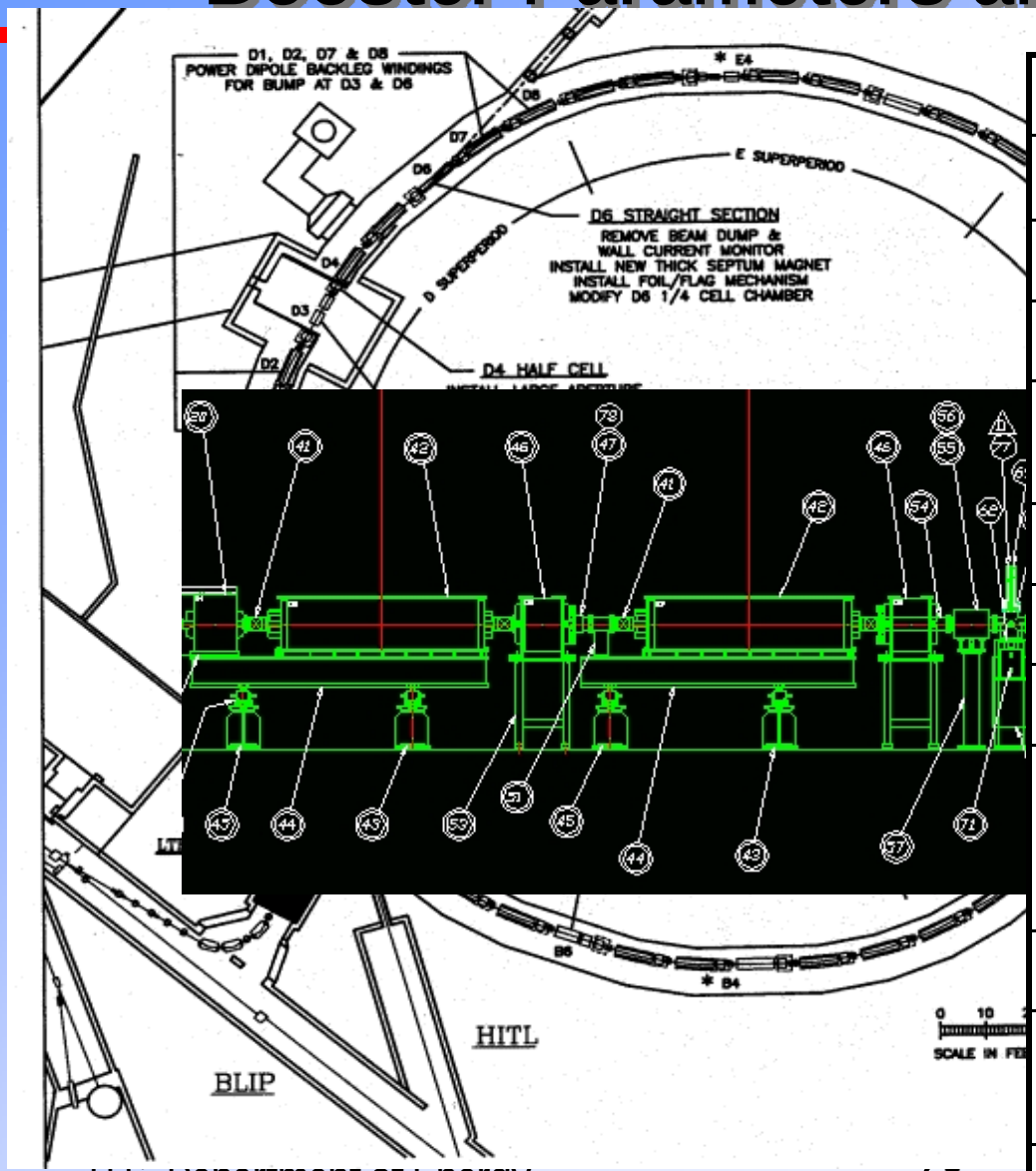
Injected:
31×10^{12} ppb
1.3 eVs

Circulating:
26×10^{12} ppb
3.0 eVs

Design Intensity 15 x 10^{12} ppb

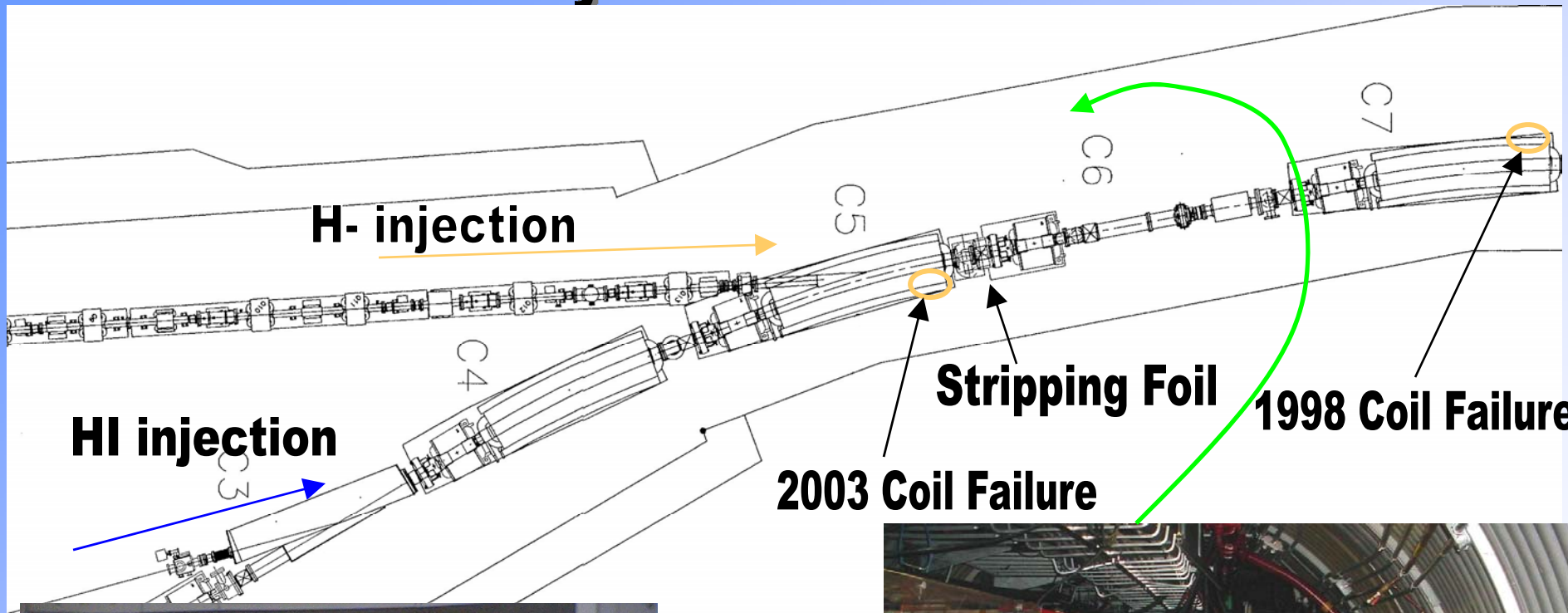
- 100 mA H^- magnetron source
- High B dot gives effective longitudinal phase space painting.
- Injection period is approx. equal to synchrotron period.
- Incoherent tune spread > 0.5

Booster Parameters and Performance

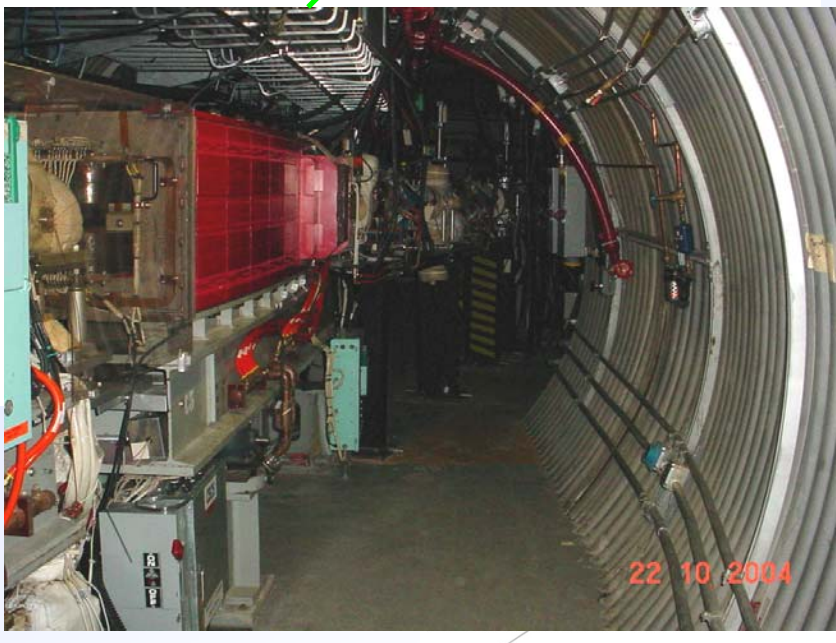


Parameter	Value
Circumference	201.78 (1/4 AGS) m
Ave. Radius	32.114 m
Magnetic Bend R	13.8656 m
Lattice Type	Separated Function, FODO
No. Superperiods	6
No. of Cells	24
Betatron Tunes,X,Y	4.82, 4.83
Vacuum Chamber	70 x 152 mm Dipoles 152 mm (circular) Quads
Max. Rigidity	17 Tm
Injection Rigidity	2.2 Tm (200 MeV protons)
Acceleration Rate	8.9 T/s (7.5 Hz)

Booster Injection



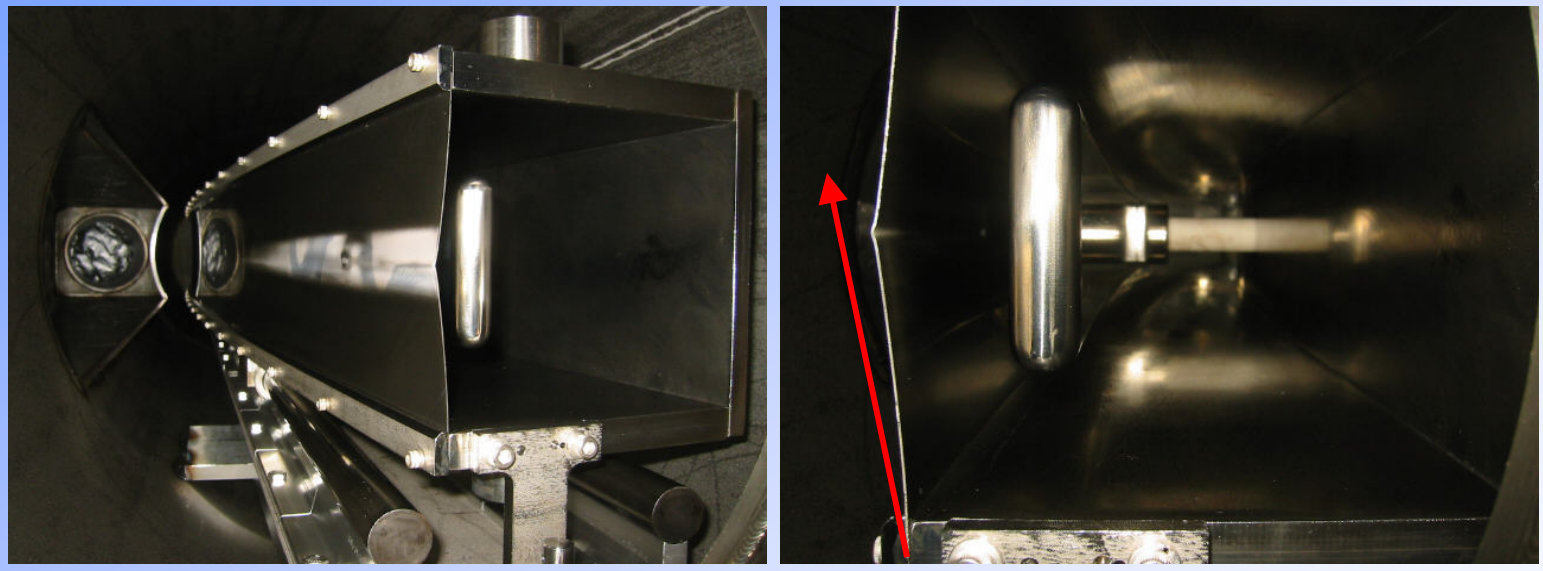
Septum Magnet	A	B	C	D	E	F
1	5	2	2	3	3	2
2	2	1	2	1	2	2
3	2	1	10	2	3	3
4	6	8	100	5	12	6
5	3	1	5	8	4	8
6	14	2	15	6	24	20
7	3	1	4	9	11	15
8	3	2	2	9	8	9



Booster Injection

- Reducing the risk of a C7 magnet failure
  - Thicker H- stripping foil. Will reduce H^0 to less than 0.3 %
    - 200 μgm = 0.4 %
    - 250 μgm = 0.09 %
    - Main Issue is emittance growth
  - Add Carbon Block absorber in Quad Upstream of C7, located to catch H^0
    - Main Issue is does this significantly reduce acceptance?
- Reducing the risk of a C5 magnet failure
  - Restrict acceptance of transfer line, to prevent beam scraping at entrance to C5 (collimation in transfer line)
    - assumes cause is beam scraping at or near the entrance
  - Add Carbon Block between vacuum chamber and coils on inside of C5 magnet, to diffuse and absorb lost particles.

C3 Inflector Protection



Inflector septum distortion. Should be perfectly flat. Presumed cause is high intensity protons scraping on the septum.

AGS Parameters and Performance

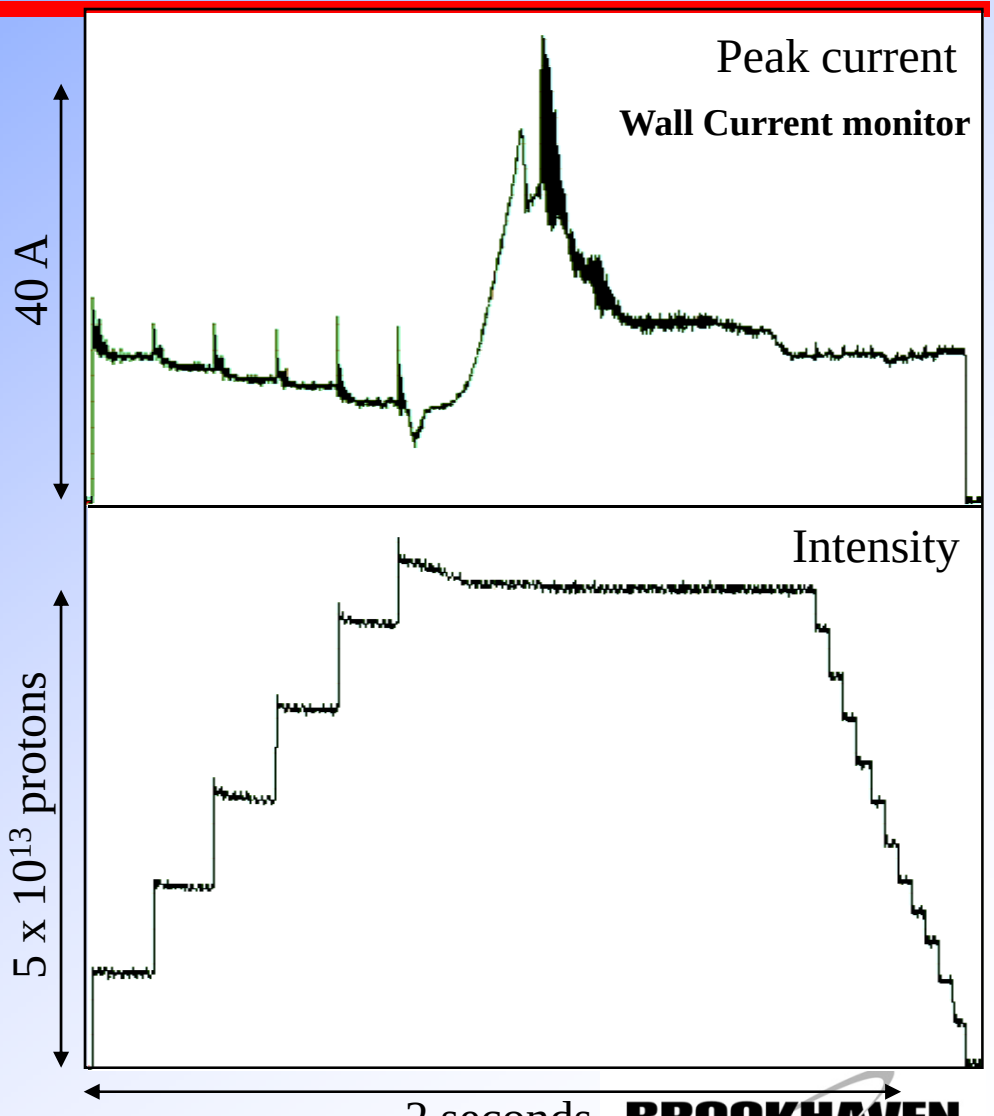




Parameter	Value
Circumference	807.091 m
Ave. Radius	128.453 m
Magnetic Bend R	85.3785 m
Lattice Type	Combined Function, FODO
No. Superperiods	12
Betatron Tunes,X,Y	8.72, 8.80
Vacuum Chamber	78 x 173 mm Dipoles
Max. Rigidity	110 Tm
Injection Rigidity	9.076 Tm (1.94 MeV protons)
Acceleration Rate (max)	2.5 T/s

AGS High Intensity Performance

- 6 single bunch transfers from Booster
- Peak intensity reached: 74 $\times$ 10^{12} ppp
- Bunch area: 3 eVs at injection
  10 eVs at extraction
- Intensity for FEB ops: 60 $\times$ 10^{12} ppp
- Strong space charge effects during accumulation in AGS
- 2nd order transition energy jump limits available momentum aperture.
- Chromatic mismatch at transition causes emittance dilution

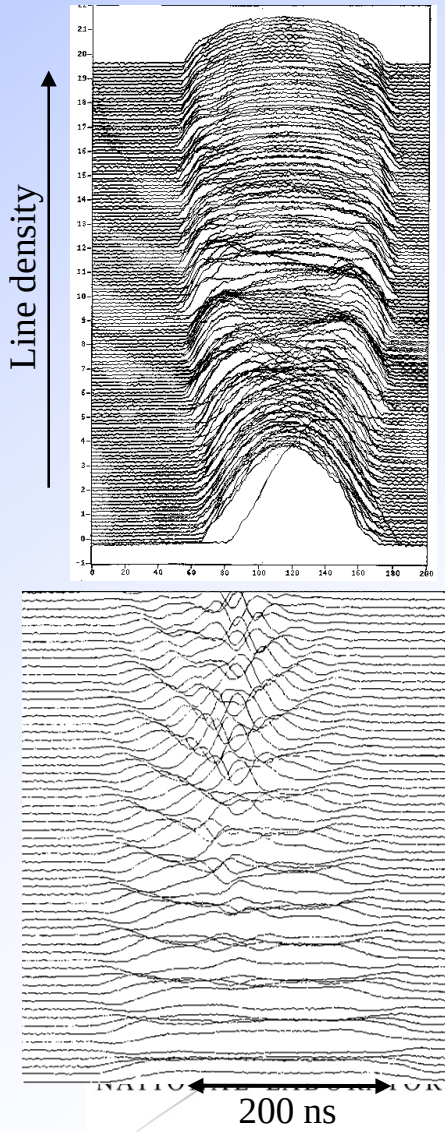


High intensity bunch-to-bucket transfer

- Incoherent tune spread ~ 0.3
  → significant effects during beam accumulation

- Longitudinal emittance dilution at AGS injection through mismatch followed by smoothing with high frequency (93 MHz) cavity.
- Needed to avoid excessive space charge tune spread and coupled bunch instabilities.

- For 13×10^{12} ppb: coherent space charge tune shift varies along bunch: $0 \rightarrow \sim 0.1$ at bunch center
- Dipole mismatch difficult to damp
- Quadrupole mismatch can cause halo



Booster & AGS Performance

Imposed limits to lost beam power for ALARA.
AGS SEB operation, 5.4 s AGS cycle time, 6 Booster cycles.
Achieved 19.6 Tp/sec, Booster Late & 13.7 Tp/second, AGS Late.

Table 1: SEB 10 Pulse Ave. Data (best performance)

* 1 Tp = $1x10^{12}$ protons

	Intensity (Tp/cycle) *	Efficiency (%)	Beam Loss (Tp/cycle)	ALARA (Tp/cycle)	Loss (kW)	Loss/m (W/m)
Linac	177	-	-	-	-	
Booster Injected	125	71	52	54	0.31	1.5
Booster Extracted	106	86	18	18	0.5	2.5
AGS Injected	78	74	28	31.5	1.62	2.0**
Transition	76	98	2	3	0.26	0.3
After Transition	73	95	3	4.5	0.63	0.8
AGS Late	73	100	0	1.5	0	0

** assumed lost in AGS

Booster & AGS Performance

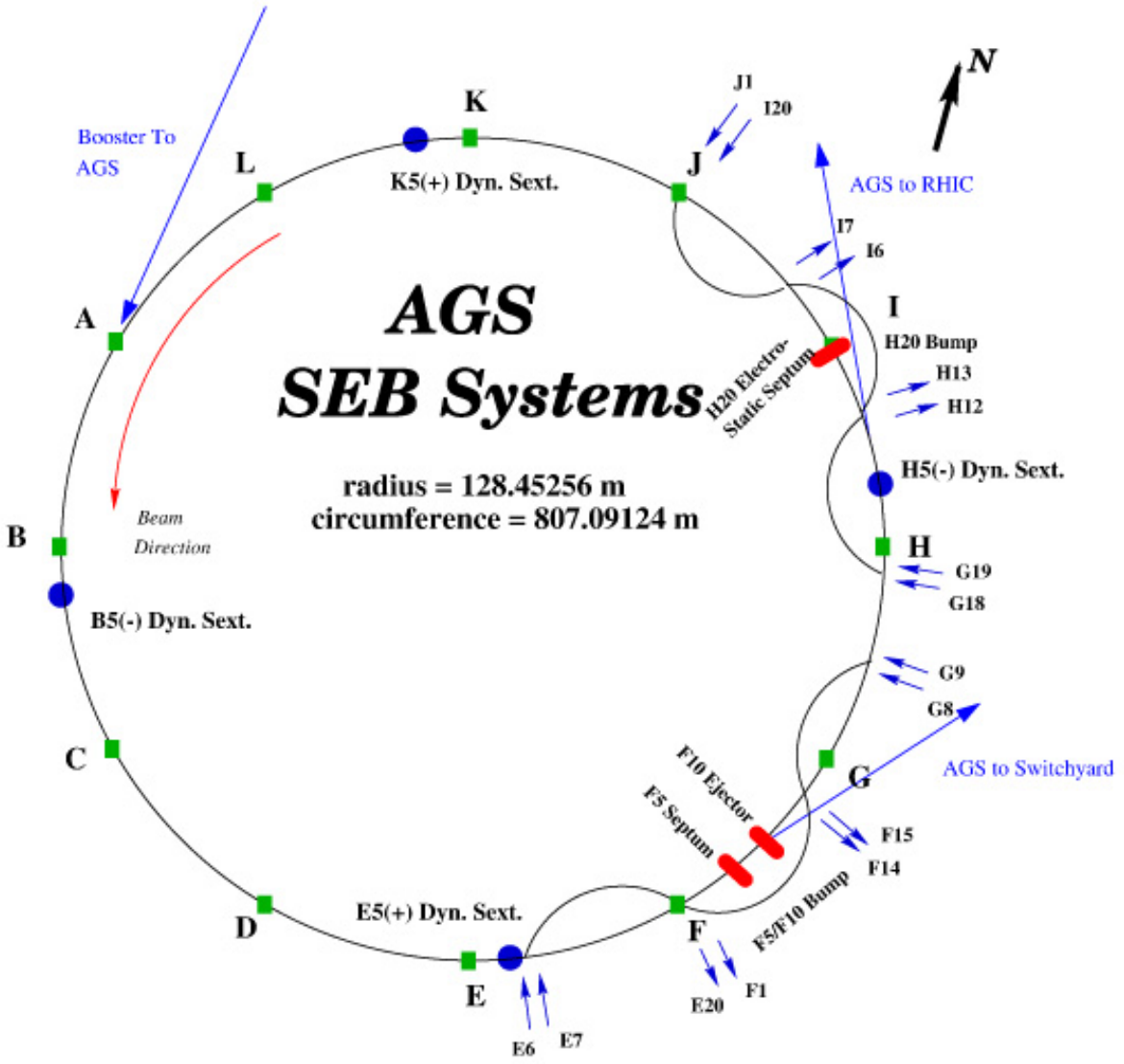
Imposed limits to lost beam power for ALARA.
AGS FEB operation, 2.77 s cycle AGS cycle time, 6 Booster cycles
Achieved 30 Tp/sec, Booster Late & 22 Tp/sec, AGS Late

Table 2: FEB 10 Pulse Ave. Data (best performance, not sustainable operation)

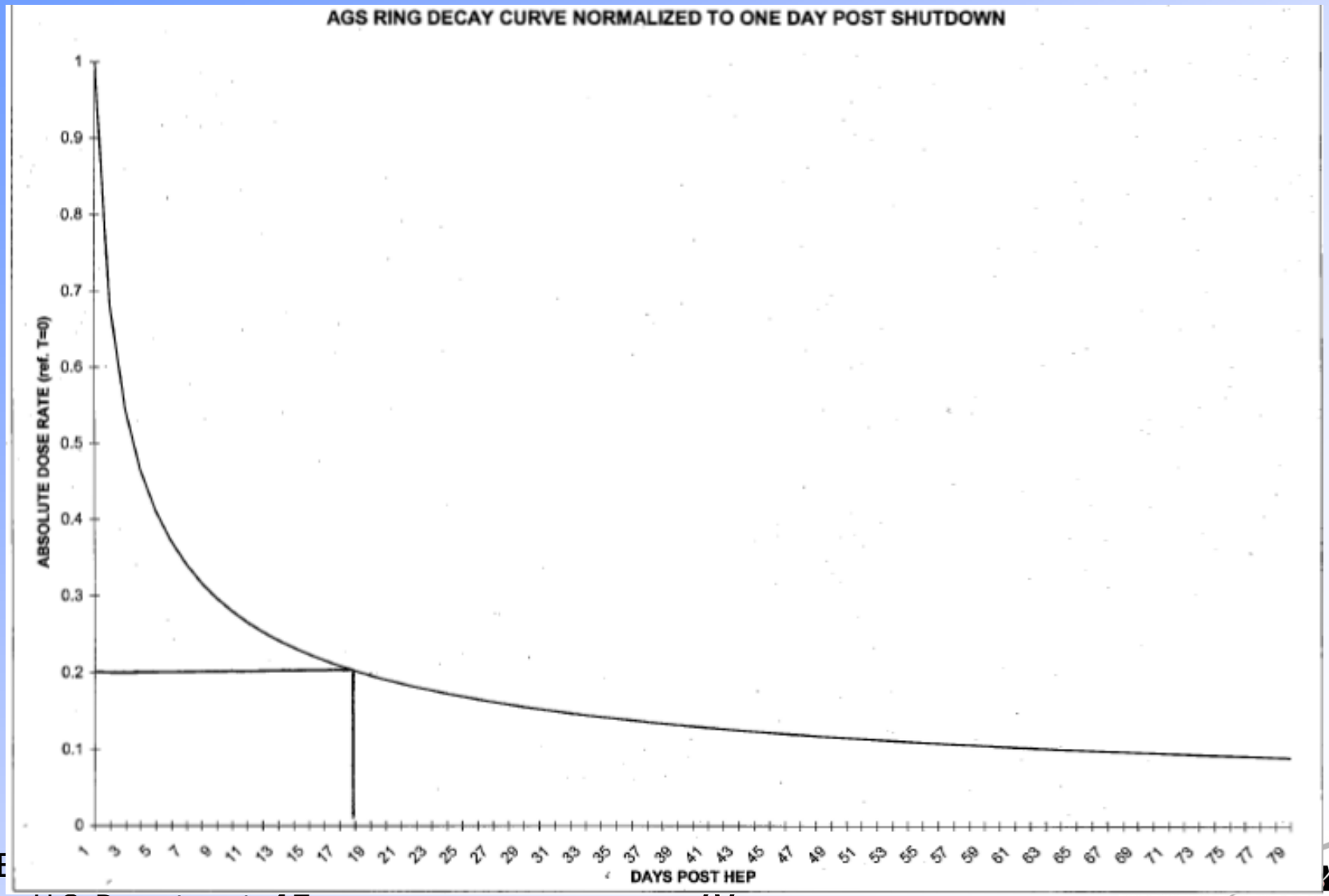
	Intensity (Tp/cycle)	Efficiency (%)	Beam Loss (Tp/cycle)	ALARA (Tp/cycle)	Loss (kW)	Loss/m (W/m)
Linac	115	-	-	-	-	-
Booster Injected	89	77	27	27.7	0.31	1.5
Booster Extracted	83	93	6	9.2	0.33	1.6
AGS Injected	66	78	18	16.3	2.0	2.5**
Before Transition	62.3	94	3.7	1.5	0.9	1.1
After Transition	61.6	99	0.6	2.3	0.2	0.2
AGS Late	61.4	99.5	0.3	0.8	0.25	0.3

** assumed lost in AGS

AGS Slow Extraction



AGS Ring Decay Curve



Radiological Servey of AGS

Survey taken Tuesday @ 4 pm ; g-2 (55 Tp) off Monday @ 5 am ; single bunch acc, up to 10 Tp intermittenty until Tuesday @ 10 am ; very low density of cycles over the last 8 hours.

AGS Main Ring diation Survey Form

Survey Date: 3-9-99 Time: 1545 - 1655 Reason for Survey: Routine/Special

Beam Off Date: 3-9-99 Time: 1600 RWP No. N/A

Instrument: Model No. 6112B - TELE Serial No. 35732

Surveyor(s): 1. D. Stillwell 2. K. Bobud Reviewed by/Date: Charles Schaefer 3/9/99

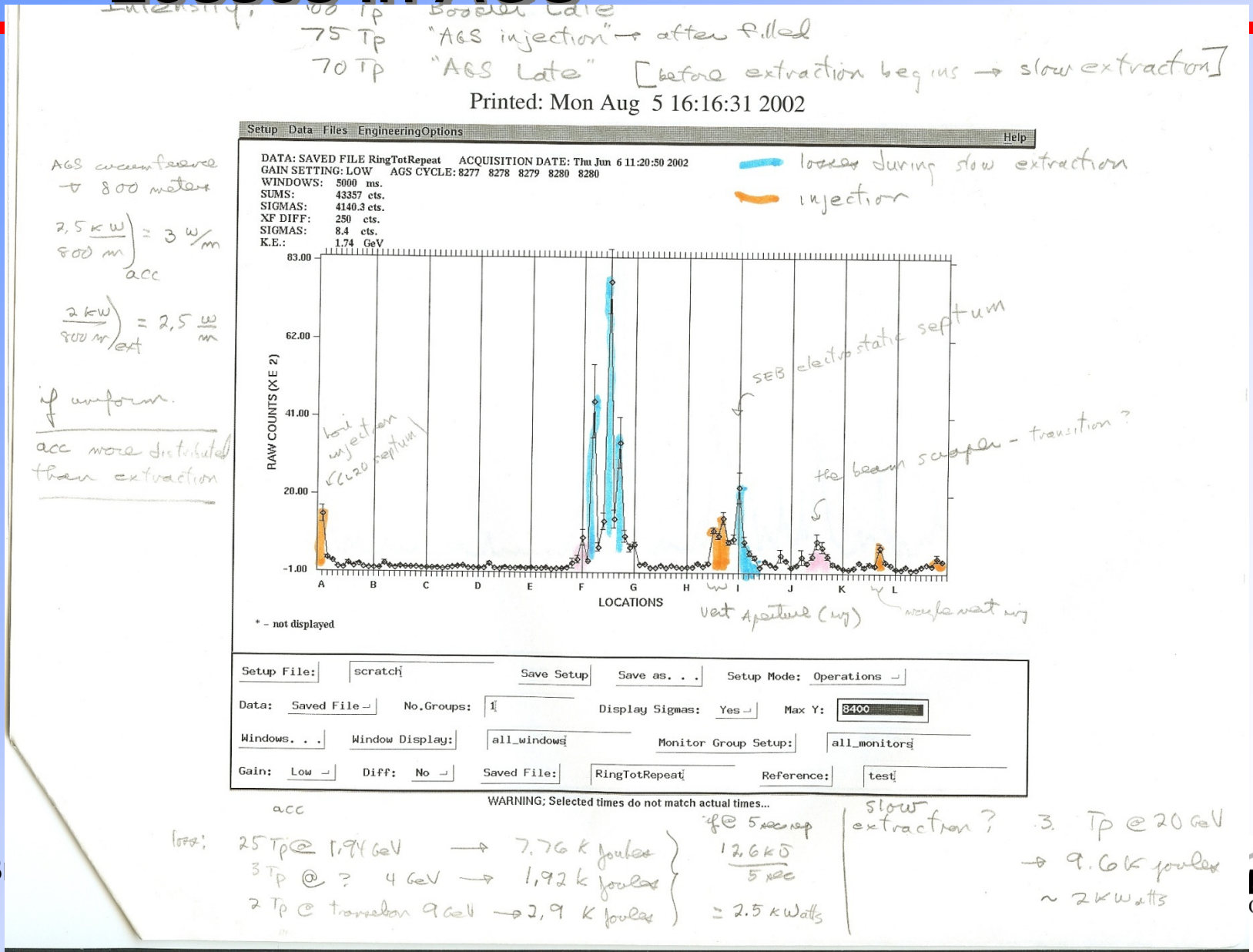
SS-AGS-1000 Rev. 0 Page 4 of 5 Attchmnt 8.1

Readings are in mr/hr at 12 inches at downstream end of magnet.

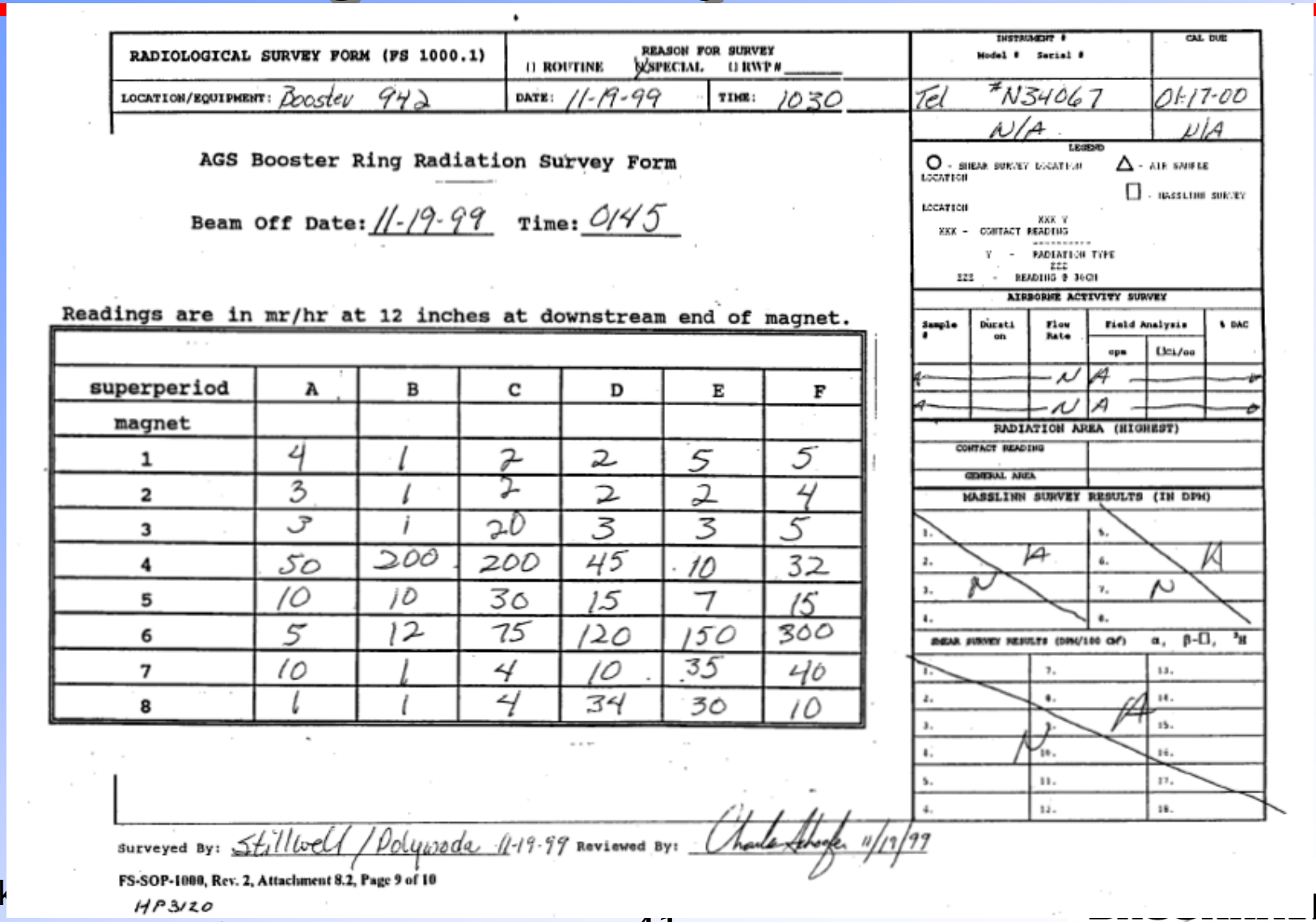
	A		B		C		D		E		F		G		H		I		J		K		L	
PERIOD	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN
MAGNET																								
1	2000		60		3		6		500		1300		110		18		110		28		18		7	
2	1600		15		5		4		175		800		75		16		125		42		12		10	
3	1300		12		45		2		105		400		26		10		50		400		12		12	
4	550		35		12		2		55		500		40		10		45		75		8		10	
5	90		50		20		6		65		1800		95		32		150		50		75		500	
6	175		17		12		2		110		600		30		14		55		80		15		90	
7	60		12		7		2		28		325		25		8		28		42		12		45	
8	70		22		6		1		20		150		18		12		18		16		6		50	
9	55		30		9		1		20		175		45		125		16		12		4		250	
10	75		6		2		17		10		2000		1000		850		2		50		2		80	
11	70		35		40		40		20		900		200		1300		26		18		60		100	
12	75		18		20		8		10		350		90		400		12		15		15		35	
13	150		25		50		6		9		350		90		500		20		50		15		35	
14	75		17		25		10		10		310		80		200		10		35		18		35	
15	125		15		22		32		23		/		175		600		90		200		80		40	
16	80		9		15		12		20		110		50		200		40		60		22		40	
17	60		17		30		20		50		175		75		350		200		45		30		175	
18	45		14		18		16		75		150		90		180		80		30		25		/	
19	22		8		11		8		90		100		42		80		60		26		14		250	
20	8		4		4		200		4000		175		20		225		26		12		5		4500	

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Losses in AGS



Radiological Survey Booster



RADIOLOGICAL SURVEY FORM (FS 1000.1)

REASON FOR SURVEY: ( ) ROUTINE (X) SPECIAL ( ) RWP #

LOCATION/EQUIPMENT: Booster 942 | DATE: 11-19-99 | TIME: 1030

INSTRUMENT # Model # Serial # | CAL DUE

Tel #N34067 | 01-17-00

N/A | N/A

AGS Booster Ring Radiation Survey Form

Beam Off Date: 11-19-99 Time: 0145

Readings are in mr/hr at 12 inches at downstream end of magnet.

superperiod	A	B	C	D	E	F
magnet						
1	4	1	2	2	5	5
2	3	1	2	2	2	4
3	3	1	20	3	3	5
4	50	200	200	45	10	32
5	10	10	30	15	7	15
6	5	12	75	120	150	300
7	10	1	4	10	35	40
8	1	1	4	34	30	10

LEGEND

O - SWEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION

☐ - HASSLINN SURVEY LOCATION

XXX Y

XXX - CONTACT READING

Y - RADIATION TYPE

ZZZ - READING @ 30CM

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis dpm/cc	% DAC
		N A			
		N A			

RADIATION AREA (HIGHEST)

CONTACT READING

GENERAL AREA

HASSLINN SURVEY RESULTS (IN DPM)

1.			5.		
2.		A	6.		A
3.		N	7.		N
4.			8.		

SWEAR SURVEY RESULTS (DPM/100 CM²) α, β-□, ³H

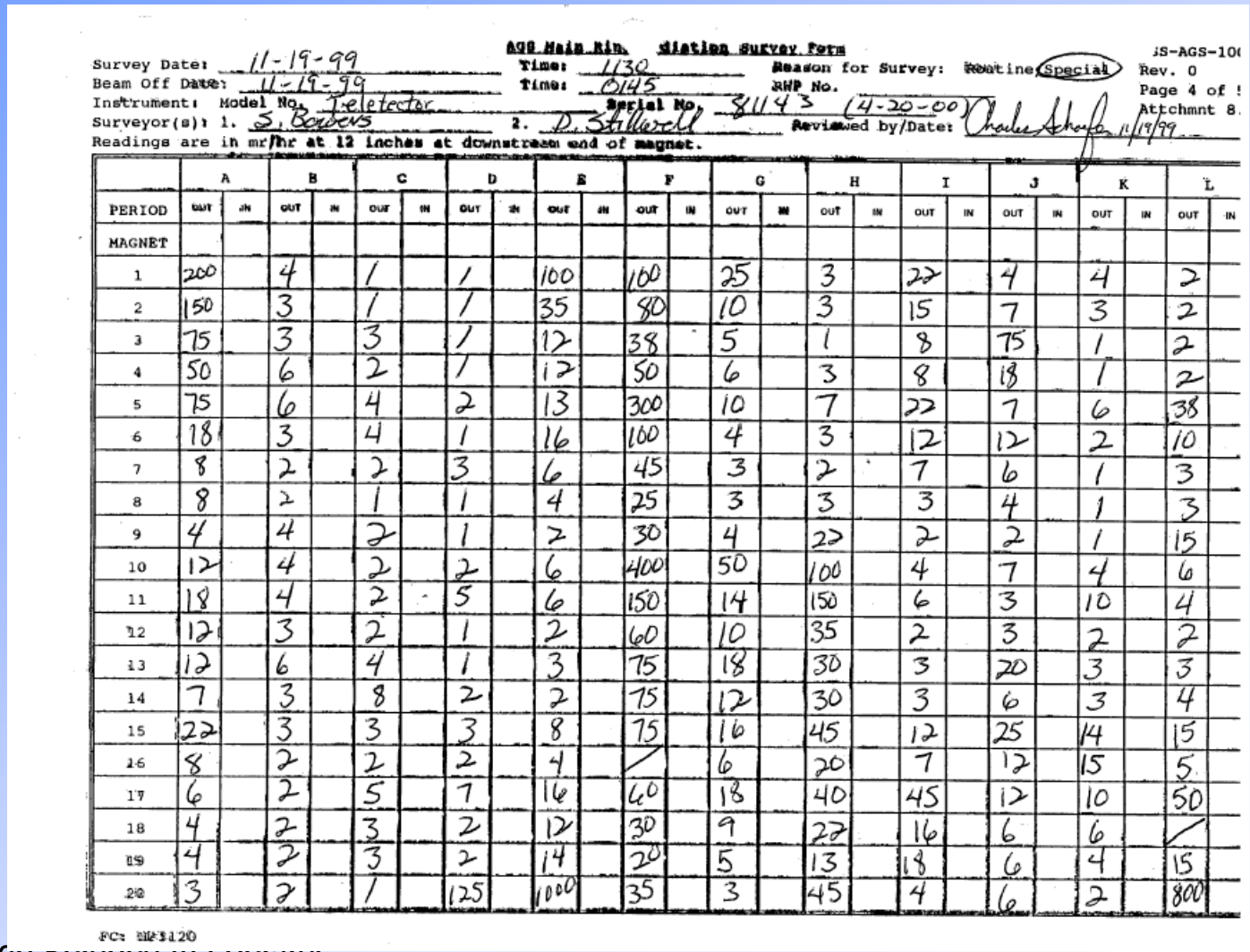
1.			7.		13.
2.			8.		14.
3.			9.	A	15.
4.		N	10.		16.
5.			11.		17.
6.			12.		18.

Surveyed By: Stillwell / Polywoda 11-19-99 Reviewed By: Charles Schaefer 11/19/99

FS-SOP-1000, Rev. 2, Attachment 8.2, Page 9 of 10

HP3/20

Radiological survey AGS



AGS Main Rin. diation Survey Form

Survey Date: 11-19-99 Time: 1130 Reason for Survey: Routine Special

Beam Off Date: 11-19-99 Time: 0145 RWP No.

Instrument: Model No. Teletector Serial No. 81143 (4-20-00)

Surveyor(s): 1. S. Bordens 2. D. Stillwell Reviewed by/Date: Charles Schaefer 11/19/99

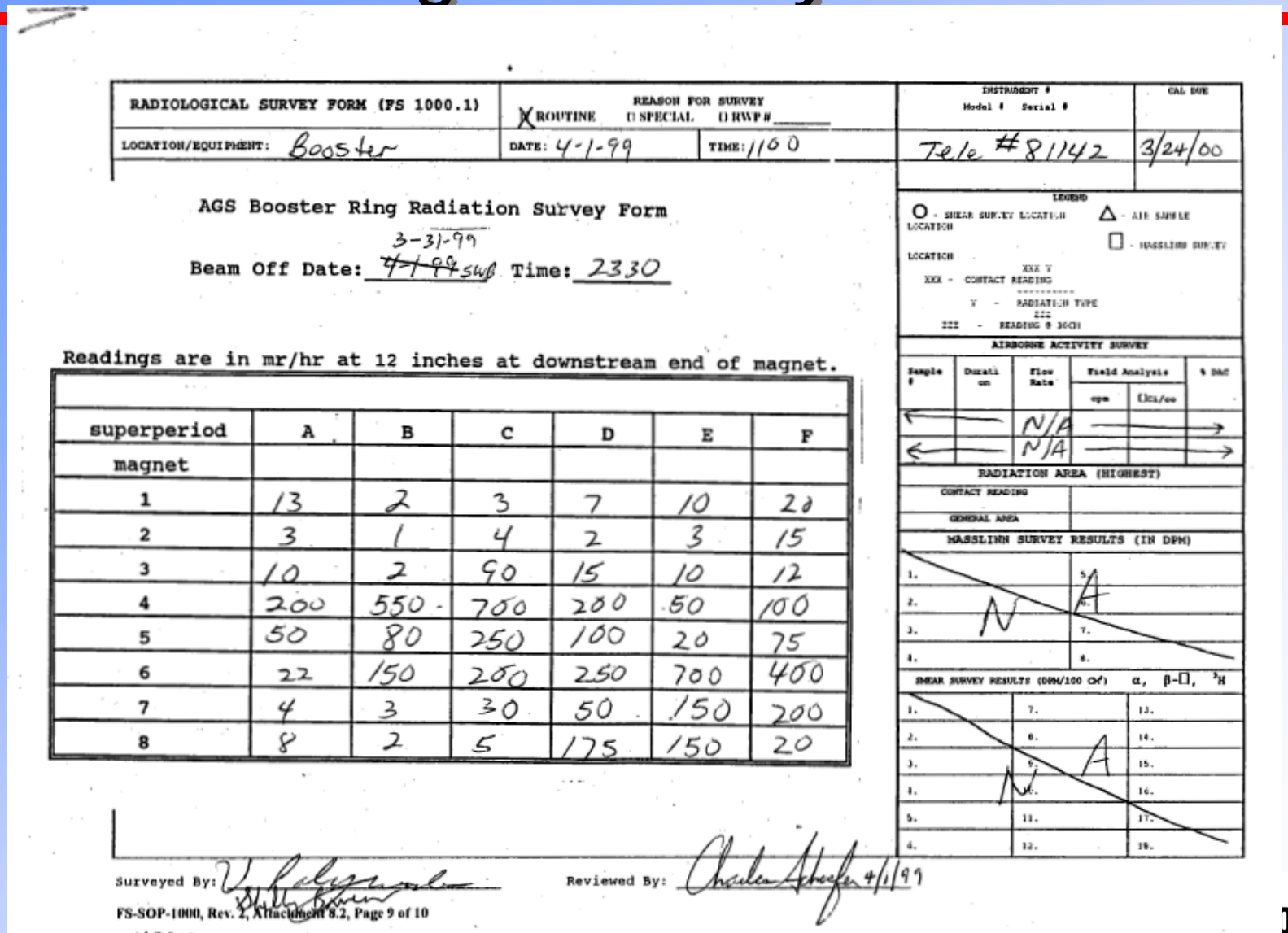
Readings are in mr/hr at 12 inches at downstream end of magnet.

JS-AGS-10(
Rev. 0
Page 4 of !
Attchmnt 8.

	A		B		C		D		E		F		G		H		I		J		K		L	
PERIOD	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN
MAGNET																								
1	200		4		1		1		100		100		25		3		22		4		4		2	
2	150		3		1		1		35		80		10		3		15		7		3		2	
3	75		3		3		1		12		38		5		1		8		75		1		2	
4	50		6		2		1		12		50		6		3		8		18		1		2	
5	75		6		4		2		13		300		10		7		22		7		6		38	
6	18		3		4		1		16		100		4		3		12		12		2		10	
7	8		2		2		3		6		45		3		2		7		6		1		3	
8	8		2		1		1		4		25		3		3		3		4		1		3	
9	4		4		2		1		2		30		4		22		2		2		1		15	
10	12		4		2		2		6		400		50		100		4		7		4		6	
11	18		4		2		5		6		150		14		150		6		3		10		4	
12	12		3		2		1		2		60		10		35		2		3		2		2	
13	12		6		4		1		3		75		18		30		3		20		3		3	
14	7		3		8		2		2		75		12		30		3		6		3		4	
15	22		3		3		3		8		75		16		45		12		25		14		15	
16	8		2		2		2		4		/		6		20		7		12		15		5	
17	6		2		5		7		16		40		18		40		45		12		10		50	
18	4		2		3		2		12		30		9		22		16		6		6		/	
19	4		2		3		2		14		20		5		13		18		6		4		15	
20	3		2		1		125		1000		35		3		45		4		6		2		800	

FC: EM3120

Radiological Survey Booster



RADIOLOGICAL SURVEY FORM (FS 1000.1)

REASON FOR SURVEY: [X] ROUTINE [ ] SPECIAL [ ] RWP #

LOCATION/EQUIPMENT: Booster

DATE: 4-1-99 TIME: 1100

INSTRUMENT # Model # Serial #: Tele #81142

CAL DUE: 3/24/00

AGS Booster Ring Radiation Survey Form

Beam Off Date: 3-31-99 ~~4-1-99~~ SWB Time: 2330

Readings are in mr/hr at 12 inches at downstream end of magnet.

superperiod	A	B	C	D	E	F
magnet						
1	13	2	3	7	10	20
2	3	1	4	2	3	15
3	10	2	90	15	10	12
4	200	550	700	200	50	100
5	50	80	250	100	20	75
6	22	150	200	250	700	400
7	4	3	30	50	150	200
8	8	2	5	175	150	20

LEGEND
O - SHEAR SURVEY LOCATION
Δ - AIR SAMPLE LOCATION
□ - HASSLINN SURVEY LOCATION
XXX Y
XXX - CONTACT READING
Y - RADIATION TYPE
ZZZ - READING @ 30CM

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis [illegible]	% DAC
←		N/A	→		
←		N/A	→		

RADIATION AREA (HIGHEST)

CONTACT READING

GENERAL AREA

HASSLINN SURVEY RESULTS (IN DPM)

1.		5.	A
2.	N	6.	
3.		7.	
4.		8.	

SHEAR SURVEY RESULTS (DPM/100 cm²) α, β-□, ³H

1.		7.	13.
2.		8.	14.
3.		9.	A 15.
4.	N	10.	16.
5.		11.	17.
6.		12.	18.

Surveyed By: [signature] Reviewed By: [signature] 4/1/99

FS-SOP-1000, Rev. 2, Attachment 8.2, Page 9 of 10

HP3x10

Radiological Survey AGS

AGS Main Ring diation Survey Form

AGS-AGS-100 Rev. 0 Page 4 of 5 Attchmnt 8.

Survey Date: 4-1-99 Time: 1630 Reason for Survey: Routine/Special

Beam Off Date: 3-31-99 Time: 2345 RWP No. N/A

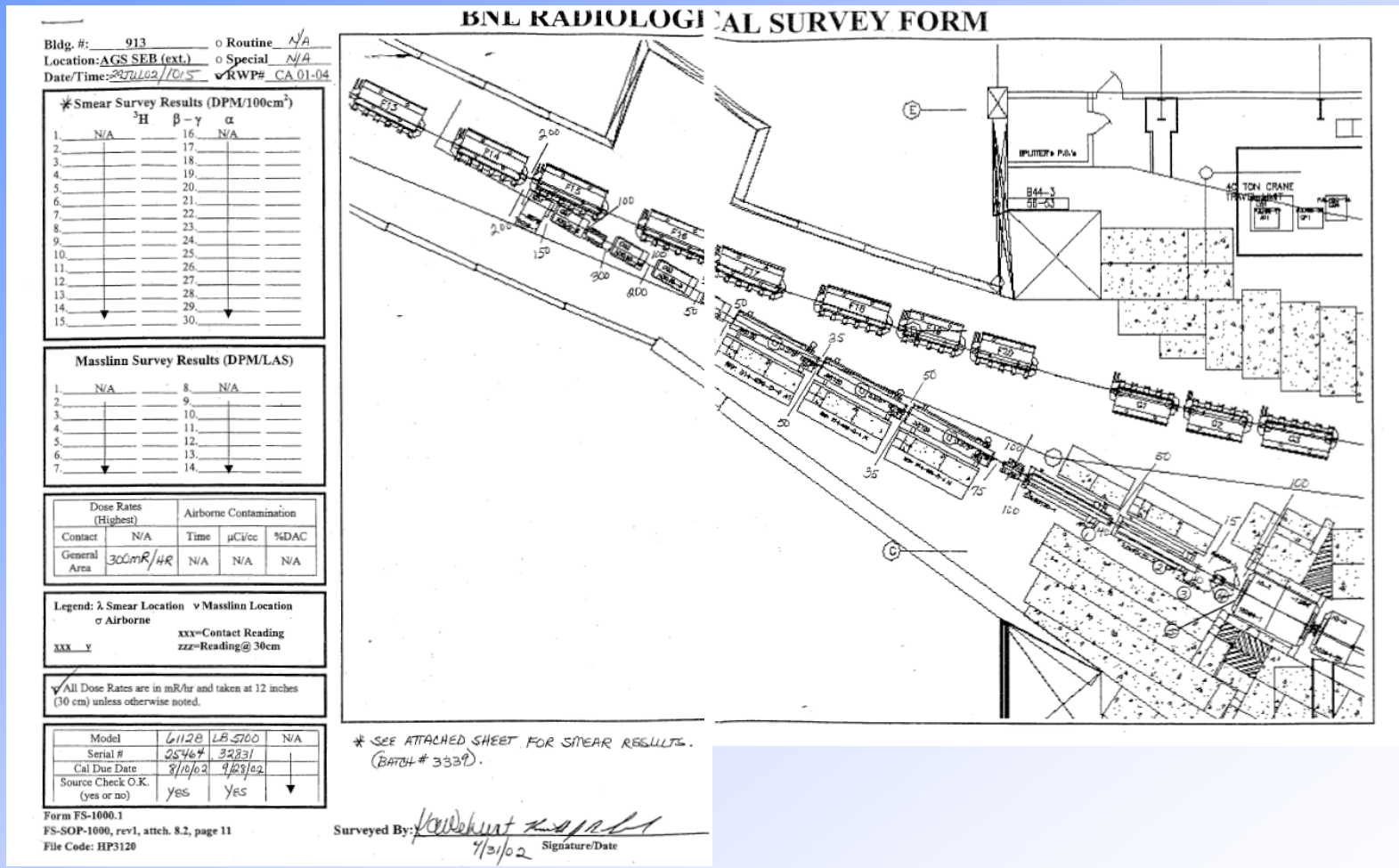
Instrument: Model No. TELETECTOR Serial No. 35732 CAL Due 11-14-99

Surveyor(s): 1. DAVE STILLWELL 2. KEN BOLAND Reviewed by/Date: Charles Schaefer 4/1/99

Readings are in mr/hr at 12 inches at downstream end of magnet.

	A		B		C		D		E		F		G		H		I		J		K		L	
PERIOD	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN
MAGNET																								
1	1200		9		2		3		350		450		75		13		60		16		9		3	
2	650		9		2		3		120		300		35		8		55		20		8		4	
3	300		4		7		1		70		125		19		3		23		150		3		7	
4	300		22		4		2		38		200		25		5		25		35		4		5	
5	200		21		8		5		40		1100		45		18		75		30		26		150	
6	55		8		4		1		75		300		15		7		26		35		7		32	
7	28		6		3		2		16		200		7		4		15		16		6		10	
8	37		13		2		1		11		105		5		6		7		10		2		12	
9	22		14		4		1		7		90		15		90		8		6		2		80	
10	35		16		6		4		17		1500		250		200		14		25		11		25	
11	46		19		17		22		14		600		60		700		18		16		30		24	
12	35		12		9		5		6		200		40		150		6		7		5		9	
13	55		25		27		3		8		110		45		90		12		45		8		10	
14	25		14		9		4		10		150		30		75		6		18		9		14	
15	60		12		15		15		20		250		55		200		50		75		48		21	
16	27		5		9		6		12		/		22		80		24		35		14		19	
17	20		9		13		12		23		105		37		130		105		20		14		90	
18	16		8		10		10		38		80		24		60		50		20		15		/	
19	12		5		6		5		35		65		14		40		45		21		9		80	
20	11		7		3		400		1800		100		10		125		25		14		3		2000	

Radiological Survey Switch Yard



BNL RADIOLOGICAL SURVEY FORM

Bldg. #: 913 ○ Routine N/A
Location: AGS SEB (ext.) ○ Special N/A
Date/Time: 29JUL02/1015 ✓RWP# CA 01-04

✳Smear Survey Results (DPM/100cm²)

	^{3}H	β−γ	α		^{3}H	β−γ	α
1.	N/A			16.	N/A		
2.				17.			
3.				18.			
4.				19.			
5.				20.			
6.				21.			
7.				22.			
8.				23.			
9.				24.			
10.				25.			
11.				26.			
12.				27.			
13.				28.			
14.				29.			
15.				30.			

Masslinn Survey Results (DPM/LAS)

1.	N/A	8.	N/A
2.		9.	
3.		10.	
4.		11.	
5.		12.	
6.		13.	
7.		14.	

Dose Rates (Highest)		Airborne Contamination		
Contact	N/A	Time	µCi/cc	%DAC
General Area	300mR/HR	N/A	N/A	N/A

Legend: λ Smear Location ν Masslinn Location
σ Airborne
xxx=Contact Reading
zzz=Reading@ 30cm
xxx ν

✓All Dose Rates are in mR/hr and taken at 12 inches (30 cm) unless otherwise noted.

Model	61128	LB 5700	N/A
Serial #	25464	32831	
Cal Due Date	8/10/02	9/23/02	
Source Check O.K. (yes or no)	yes	Yes	

Form FS-1000.1
FS-SOP-1000, rev1, attch. 8.2, page 11
File Code: HP3120

✳ SEE ATTACHED SHEET FOR SMEAR RESULTS. (BATCH # 3339).

Surveyed By: [signature] 4/3/02 Signature/Date

Losses in Booster and AGS

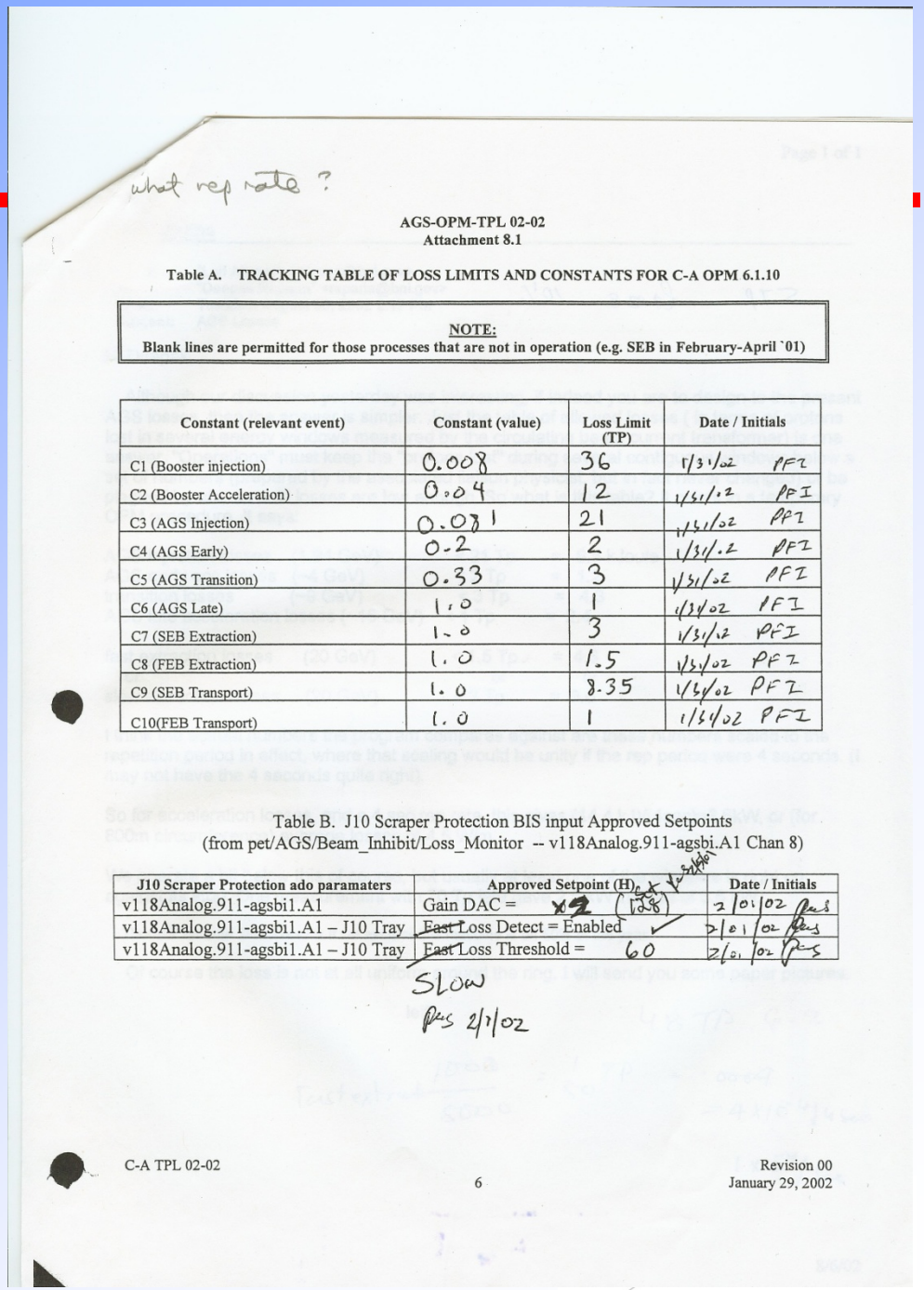
- No component damage in AGS
- Magnet C7 and extraction septum F6 lost due to radiation in Booster
- Hands-on-maintenance in GAS and Booster
- Ground water not a concern

Loss Limits

- Imposed limits for ALARA
- This loss limits were ad-hoc (achieved by experts)
- The peak intensities were not loss limited

ALARA Design Policy

- ALARA triggers Operations procedures to bound losses
- Beam current transformers and loss monitors with alarm limits
- Long-term monitoring for integrated beam loss Residual radiation surveys
- Soil coupon monitors (i.e., small containers filled with sand)
- Shielded storage area for component storage and repair
- Modular concrete and steel shielding
- Caps over soil if > 5% of the Drinking Water Standard



what rep rate ?

AGS-OPM-TPL 02-02
Attachment 8.1

Table A. TRACKING TABLE OF LOSS LIMITS AND CONSTANTS FOR C-A OPM 6.1.10

NOTE:
Blank lines are permitted for those processes that are not in operation (e.g. SEB in February-April `01)

Constant (relevant event)	Constant (value)	Loss Limit (TP)	Date / Initials
C1 (Booster injection)	0.008	36	1/31/02 PFI
C2 (Booster Acceleration)	0.04	12	1/31/02 PFI
C3 (AGS Injection)	0.031	21	1/31/02 PFI
C4 (AGS Early)	0.2	2	1/31/02 PFI
C5 (AGS Transition)	0.33	3	1/31/02 PFI
C6 (AGS Late)	1.0	1	1/31/02 PFI
C7 (SEB Extraction)	1.0	3	1/31/02 PFI
C8 (FEB Extraction)	1.0	1.5	1/31/02 PFI
C9 (SEB Transport)	1.0	8.35	1/31/02 PFI
C10(FEB Transport)	1.0	1	1/31/02 PFI

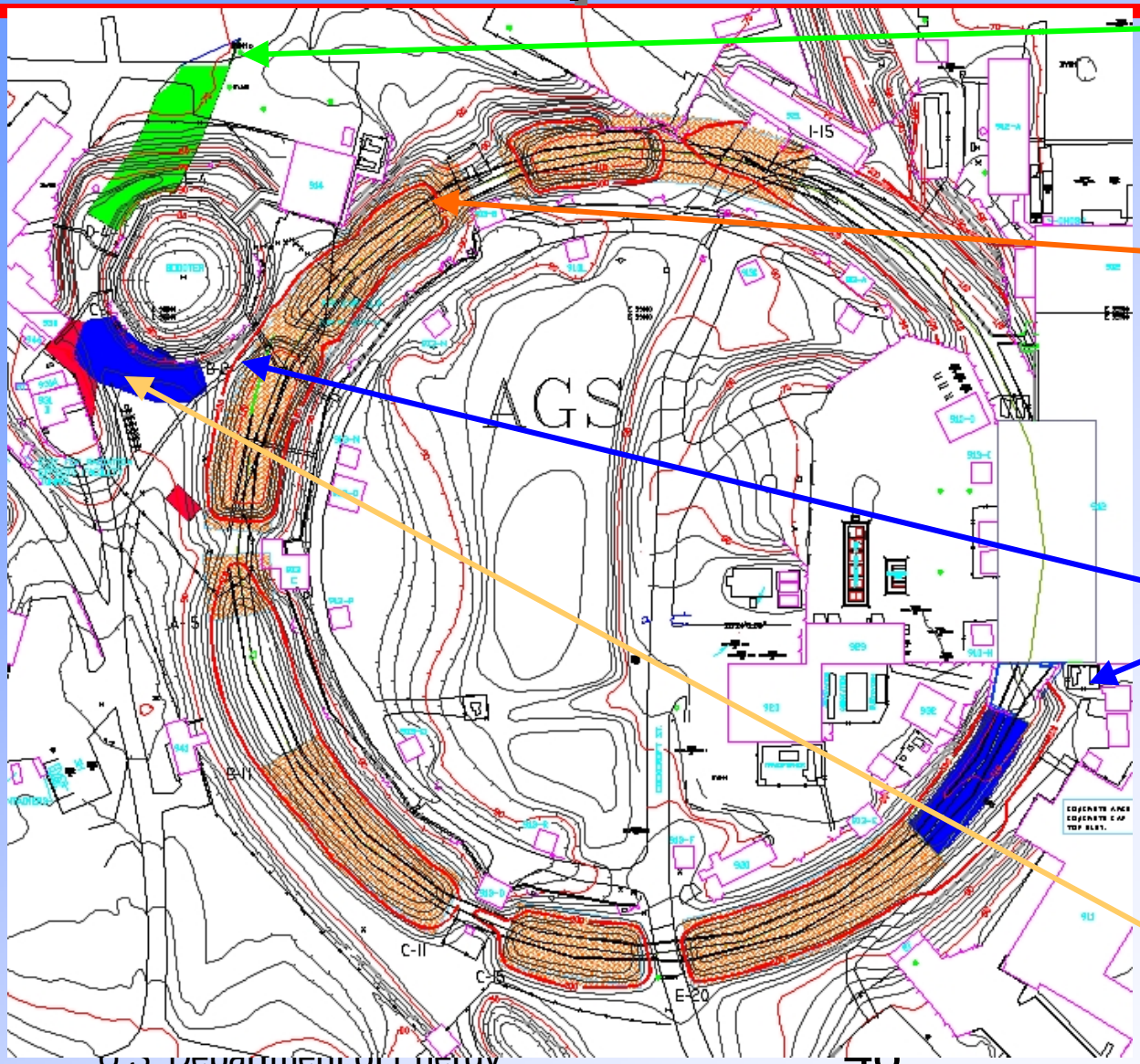
Table B. J10 Scraper Protection BIS input Approved Setpoints
(from pet/AGS/Beam_Inhibit/Loss_Monitor -- v118Analog.911-agsbi.A1 Chan 8)

J10 Scraper Protection ado paramaters	Approved Setpoint (H)	Date / Initials
v118Analog.911-agsbi1.A1	Gain DAC = x2 (538)	2/01/02 Pas
v118Analog.911-agsbi1.A1 – J10 Tray	~~Fast~~ Loss Detect = Enabled ✓	2/01/02 Pas
v118Analog.911-agsbi1.A1 – J10 Tray	~~Fast~~ Loss Threshold = 60	2/01/02 Pas

SLOW
Pas 2/1/02

C-A TPL 02-02 6 Revision 00 January 29, 2002

Shield Caps



Liner Cover over NSRL.

Concrete/Soil mix over area's of AGS tunnel.

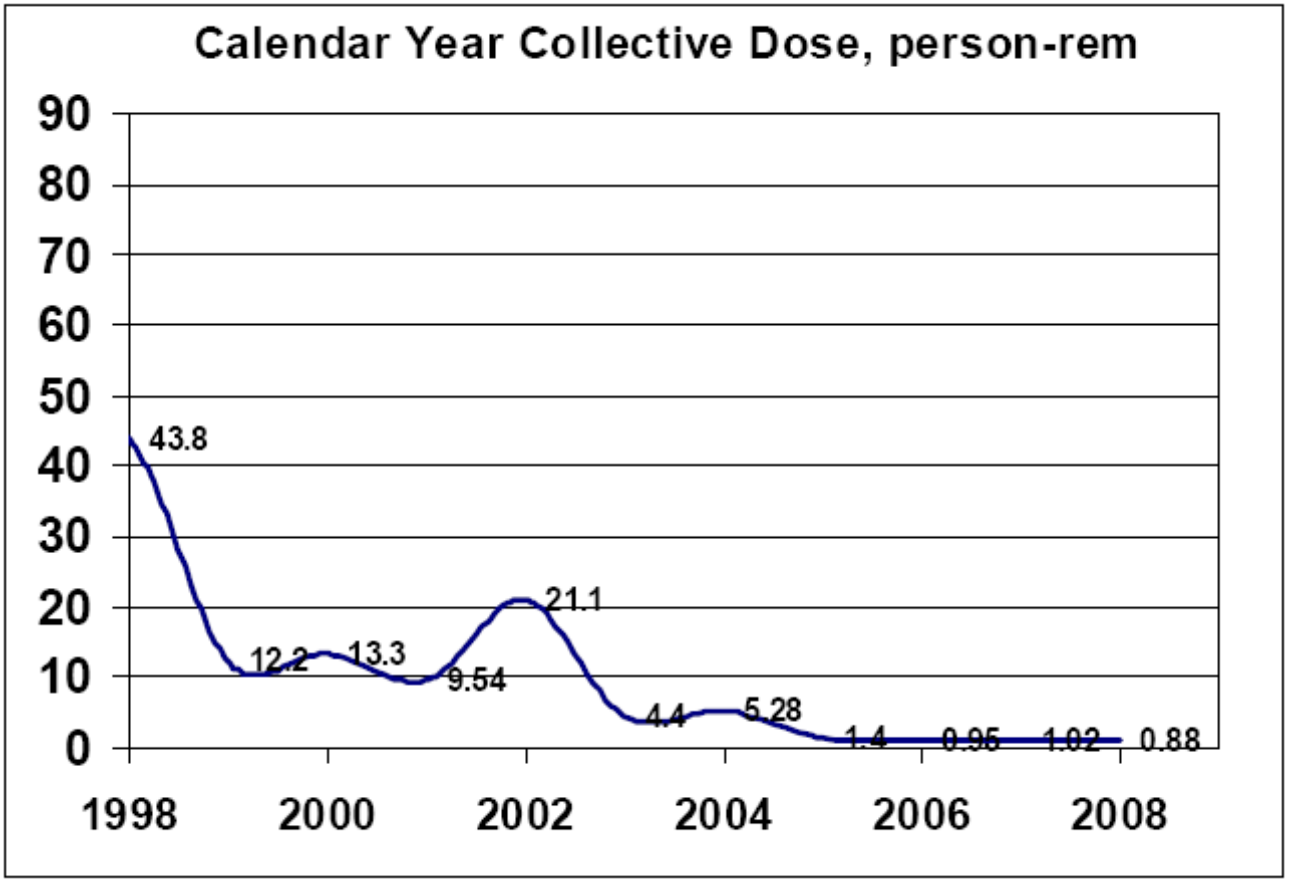
Existing Concrete Shield Cap

Area's to be covered with Concrete, outside RSVP project

BROOKHAVEN NATIONAL LABORATORY

Collective Dose

The Maximum individual dose:
2000 - 565mrem
2001 – 366mrem
2002- 865mrem



Conclusions

- Linac, Booster and AGS surpass design intensities
- Linac intensity is NOT limited by by losses
- Booster and AGS peak intensity were NOT limited by losses