Experiment : AA Machine Acceptance after Horizontal Bumps

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1. The Idea

a) Start with a good machine i.e. with good closed orbits.

b) Make a bump with 3 or 4 quads where it is believed there are some limitations.

c) Measure acceptance before and after bumps with the same system.

2. Bump at QFW04

When all quads are in their reference positions (situation after the shutdown of January 1982), the horizontal closed orbit shows a bump of -12 mm in QFW04.

We moved 3 quads in order to reduce this distortion.

3. Bump at Septum

According to the geometry of the injection region (where $\alpha_p = 0$), we can deduce that a bump of -4 mm at the level of P.U. BLG23 and BLG02 should increase the horizontal acceptance.

Fig. 1 shows the closed orbit after this bump.

We then tried to optimize by adjusting the TRIM and we found that with a TRIM = -2,77 mm, we obtained a maximum in acceptance.

4. Bump at KPM9

We tried a bump in this region in order to check if the longitudinal acceptance is increased when the shutters are closed.

A bump of +4 mm gives +1,1 o/oo of gain in frequency, then $\sim 1{,}1\ 10^{-2}$ in $\Delta p/p$.

Fig. 2 shows the result after a trim adjustment. We can see the effect of the bump between QFW08 and QFW10. However, in the P.U. BLG14, the beam is at -3 mm (region where $\alpha_p = 0$). This situation implies that a correction of the orbit is required for this region.

5. Bump at Cooling Region

According to the previous results, we moved 4 quads in order to have the horizontal closed orbit in P.U. BLG 11 and 14 close to zero.

Fig. 3 shows the result.

6. Bump at QFW06

According to the HF cooling P.U. response and QFW06-P.U. readings, a big discrepancy appears. In order to put the stack closed orbit in the middle of HF cooling P.U., we put a bump of -15 mm in QFW06.

7. Effect of Current in QF0 and QDE (working point)

Fig. 4 shows the AA horizontal acceptance between the injection orbit and the stack orbit, from which we can see the best acceptance, which was obtained since the beginning.

However, Fig. 5 shows the horizontal acceptance across the whole chamber to be worse after a ΔQ_H variation.

The main field remains the same.

8. Acceptances according to β Values

Fig. 6 gives the theoretical horizontal and vertical acceptances for 3 different orbits (injection, central, stack).

The horizontal acceptance on the injection orbit is theoretically 92 π and we measure 86 π at 1846,07 kHz and 89 π at 1847,6 kHz.

We can say we have reached the theoretical value for the injection region within measurement accuracy. This is not the case for the central and stack orbits. However, the stack orbit acceptance is probably limited because we expect to have a cooled stack and it is not necessary to have 102 π in this region.

The theoretical vertical acceptance on injection orbit is 90 π and we measure 70 π. Probably there are some vertical restrictions remaining in the machine.

9. Conclusions

Fig. 7 gives all quads which have been moved and which affect the horizontal orbits and acceptances.

Fig. 8 gives the evolution of acceptance measurements according to different horizontal bumps.

a) It is necessary to find a good compromise between the horizontal acceptance on injection orbit, and the working point (Q values).

b) We have to explain the bump of -12 mm in QFW04 when all quads are in their reference positions.

c) We must also explain the necessity to have a bump of -15 mm in QFW06.

d) We must continue the experiments with bumps in the shutter regions.

e) We should find the vertical restrictions on the injection orbit.

Reported by L. Rinolfi

CALCULATION OF CLOSED ORBIT DISTORTIONS FROM PU

DATE: 1982-03-10 TIME: 17:50:54 LAST CALIB.: 1982-03-09

DP/P (FROM FREQUENCY)= .01 E-3 MEAS. FREQ. = 1850.37 KHZ

DP/P (FROM PU AVERAGE)= .26 E-3 CORRES. FREQ. = 1850.32 KHZ

BLG AVERAGE= -1.74 mm Ip= -2.724E10

PU	HORIZONTAL PLANE				VERTICAL PLANE	
POSITION	READ.	R.THEO	R.MEAS	R.DIST	READ.	Z.DIST
BLG02	1.047	0	-3.8	-3.8	-.017	-.2
QFW04	-.007	-.1	.6	.8	.051	.9
QFW06	-.019	-.2	3.5	3.7	.041	.4
QFW08	-.021	-.2	4.7	4.9	-.048	-.6
QFW10	-.012	-.1	1.5	1.7	-.004	-.1
BLG11	-.153	0	1.5	1.5	-.039	-.6
BLG14	-.014	0	-1.4	-1.4	.017	.2
QFW16	-.024	-.1	3.1	3.3	-.034	-.5
QFW18	-.007	-.2	1.1	1.3	-.029	-.4
QFW20	-.019	-.2	3.4	3.6	.036	.4
QFW22	-.017	-.1	1.1	1.3	-.009	-.1
BLG23	.481	0	-3.2	-3.2	-.004	0

FIG 1 After bump at septum (−4mm)

CALCULATION OF CLOSED ORBIT DISTORTIONS FROM PU

DATE: 1982-03-11 TIME: 12:29:12 LAST CALIB.: 1982-03-09

DP/P (FROM FREQUENCY)= .06 E-3 MEAS. FREQ. = 1850.36 kHZ

DP/P (FROM PU AVERAGE)= .32 E-3 CORRES. FREQ. = 1850.31 kHZ

BLG AVERAGE= -2.75 mm Ip= -2.438E10

PU	HORIZONTAL PLANE				VERTICAL PLANE	
POSITION	READ.	R.THEO	R.MEAS	R.DIST	READ.	Z.DIST
BLG02	1.064	0	-4.6	-4.6	.002	0
QFW04	0	.1	-.3	-.5	.073	1.2
QFW06	-.026	.2	4.6	4.4	.043	.5
QFW08	-.024	.2	5.1	4.8	-.063	-.8
QFW10	-.031	.1	3.9	3.7	-.063	-1.1
BLG11	-.122	0	.8	.8	-.217	-3.3
BLG14	.046	0	-3.0	-3.0	-.205	-3.4
QFW16	-.017	.1	2.1	1.9	-.134	-2.0
QFW18	-.014	.2	2.2	2.0	-.026	-.4
QFW20	-.024	.2	4.2	3.9	.017	.2
QFW22	-.014	.1	.8	.6	-.017	-.2
BLG23	.510	0	-4.1	-4.1	-.007	-.1

After bump (+4mm) at KPM9

FIG. 2

CALCULATION OF CLOSED ORBIT DISTORTIONS FROM PU

DATE: 1982-03-11 TIME: 17:18:57 LAST CALIB.: 1982-03-11

DP/P (FROM FREQUENCY)= .04 E-3 MEAS. FREQ. = 1850.37 kHZ

DP/P (FROM PU AVERAGE)= .29 E-3 CORRES. FREQ. = 1850.31 kHZ

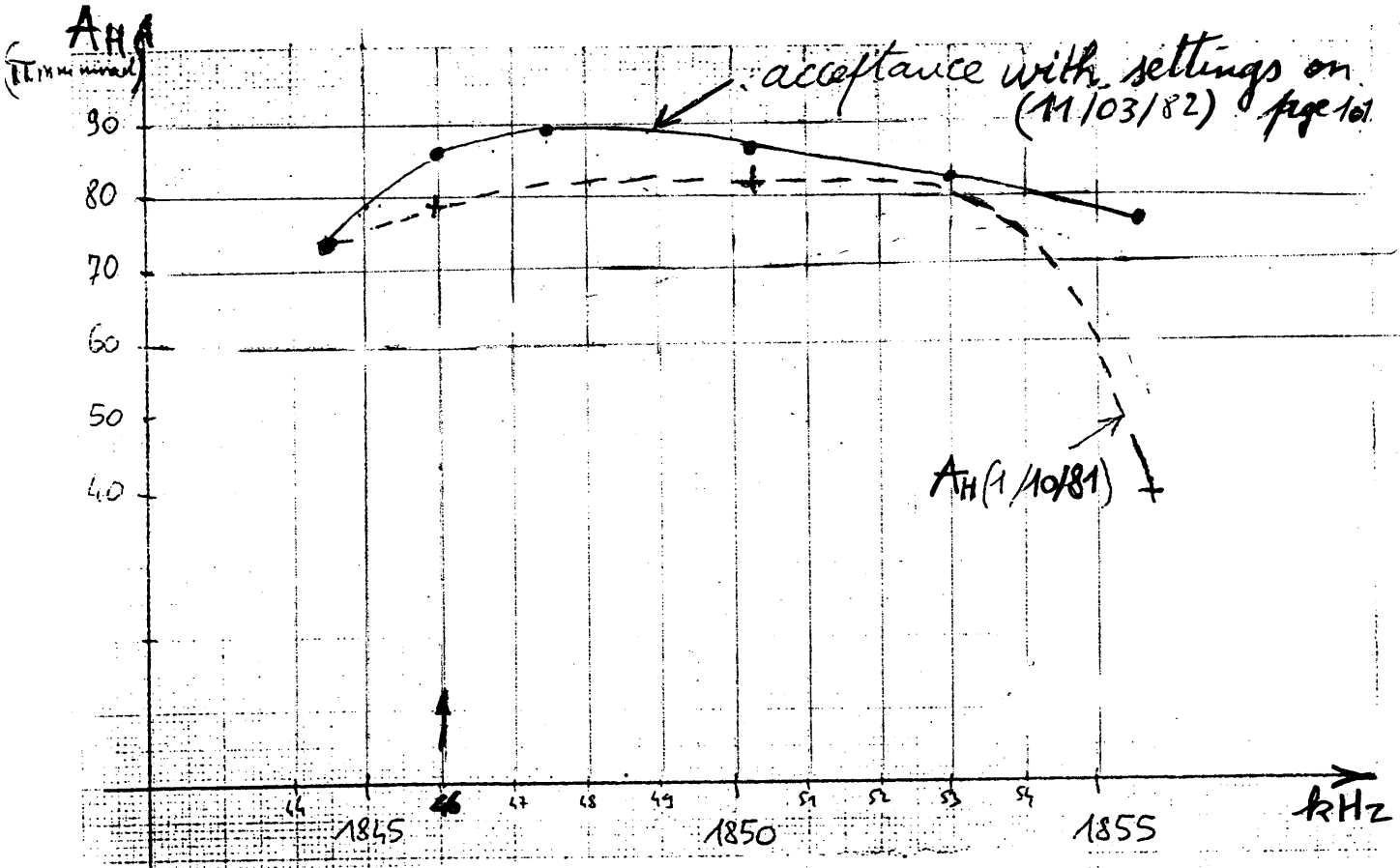
BLG AVERAGE= -3.07 mm Ip= -3.105E10

PU POSITION	HORIZONTAL PLANE				VERTICAL PLANE	
	READ.	R.THEO	R.MEAS	R.DIST	READ.	Z.DIST
BLG02	1.113	0	-7.2	-7.2	0	0
QFW04	0	0	-.3	-.4	.068	1.1
QFW06	-.021	0	3.9	3.8	.048	.6
QFW08	-.024	0	6.2	6.1	-.061	-.8
QFW10	-.031	0	3.9	3.9	-.061	-1.1
BLG11	-.083	0	0	0	-.214	-3.3
BLG14	-.056	0	-.3	-.3	-.210	-3.5
QFW16	-.012	0	1.5	1.4	-.134	-2.0
QFW18	-.007	0	1.1	1.0	-.026	-.4
QFW20	-.021	0	3.8	3.7	.026	.3
QFW22	-.012	0	.5	.5	-.017	-.2
BLG23	.537	0	-4.6	-4.6	-.004	0

After correction in cooling region

FIG. 3

FIG. 4



		REF.	REQUIRED
BHZ #DH	BH	1946.44	1946.44
BHZ #DT	H	7.65	7.65
QDO #QD	⋈	1062.14	1060.93
QFO #QF	◇	1471.86	1470.36
SMH #SM	SH	3909.8	3891.5
F4		100.0	50.0

(B)

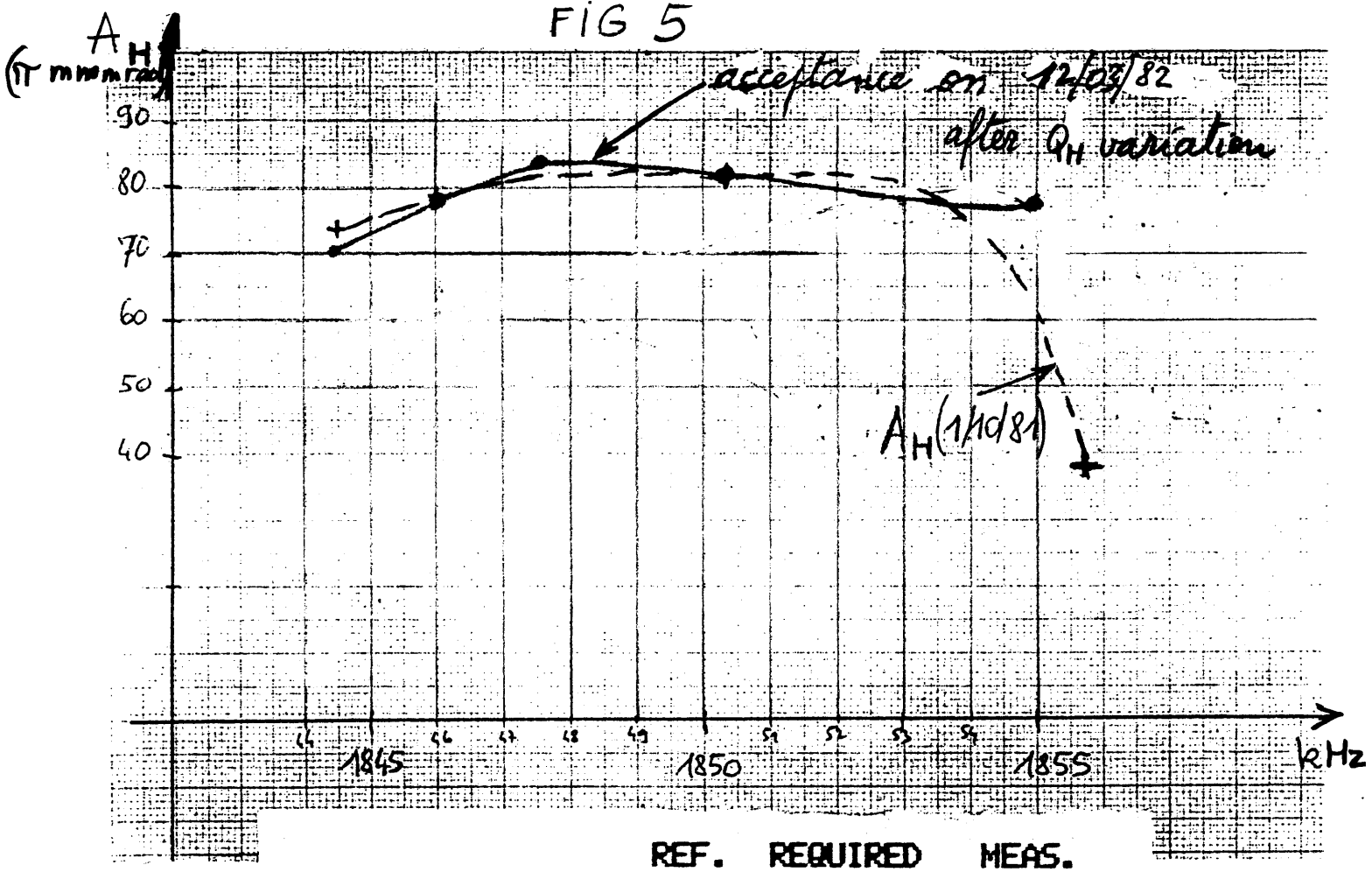
P (FROM FR = 1850.37 k

P (FROM PU AVERAGE)= .24 E-3 CORRES. FREQ. = 1850.32 k

BLG AVERAGE= -2.66 mm Ip= -1.135E10

PU POSITION	HORIZONTAL PLANE				VERTICAL PLANE	
	READ.	R.THEO	R.MEAS	R.DIST	READ.	Z.DIST
BLG02	1.082	0	-5.4	-5.4	.012	.1
QFW04	.007	0	-1.3	-1.3	.080	1.4
QFW06	-.021	0	3.5	3.5	.043	.5
QFW08	-.024	0	5.5	5.5	-.078	-1.0
QFW10	-.024	0	2.7	2.7	-.070	-1.2
BLG11	-.078	0	-.1	-.1	-.212	-3.3
BLG14	-.039	0	-.7	-.7	-.190	-3.2
QFW16	-.012	0	1.5	1.5	-.127	-1.8
QFW18	-.012	0	1.9	1.9	-.036	-.6
QFW20	-.019	0	3.0	3.0	.007	0
QFW22	-.009	0	.3	.3	-.009	-.1
					0	0

FIG 5



			REF.	REQUIRED	MEAS.	
BHZ #DH	BH		1946.44	1946.44	1946.65	
BHZ #DT	H		7.65	7.65	7.63	
QDO #QD			1062.14	1062.14	1062.24	
QFO #QF			1471.86	1471.86	1472.18	
SMH #SM	SM		3909.8	3892.5	3892.8	
P (F4			100.0	100.0	99.9	: 1850.37 k
P (					(A)	: 1850.31 k

BLG AVERAGE= -2.43 mm Ip= -1.085E10

PU POSITION	HORIZONTAL PLANE				VERTICAL PLANE	
	READ.	R.THEO	R.MEAS	R.DIST	READ.	Z.DIST
BLG02	1.074	0	-5.3	-5.3	.004	0
QFW04	.002	.1	-.6	-.8	.075	1.2
QFW06	-.024	.1	4.3	4.1	.039	.4
QFW08	-.019	.1	5.3	5.2	-.075	-1.0
QFW10	-.024	.1	3.0	2.9	-.065	-1.1
BLG11	-.092	0	.1	.1	-.214	-3.3
BLG14	-.046	0	-.5	-.5	-.197	-3.3
QFW16	-.014	.1	1.8	1.7	-.129	-1.9
QFW18	-.014	.1	2.2	2.1	-.036	-.5
QFW20	-.019	.1	3.4	3.3	.009	.1
QFW22	-.012	.1	.5	.4	-.012	-.1
BLG23	.512	0	-3.8	-3.8	0	0

AA machine acceptance according to β values

	β_H	$x_{scraper}$	f	A_H
A_H central	8,04	28,35	1850,37	100
A_H inject.	8,76	-	1846,07	92
A_H stack	7,9	-	1854,89	102

	β_V	$x_{scrap.}$	f	A_V
A_V central	8,57	29,3	1850,37	100
A_V inject.	9,5	-	1846,07	90
A_V stack	7,7	-	1854,89	111

FIG. 6

QUADS DISPLACED IN HORIZONTAL PLANE

(A) Orbit correction

①	QFW 04	2,09 mm	outs.
	QFW 08	2,6 "	"
	QFW 20	2,35 "	ins.
②	QFW 06	1,4 "	outs.
	QFW 20	0,8 "	ins.
	QFN 24	1,1 "	outs.
③	QFN 02	1,1 "	"
	QFW 20	0,7 "	"

(B) Bump – 4 mm at septum

④	QFN 02	0,7 mm	ins.
	QFW 04	1,5 "	"
	QFW 22	1,8 "	"
	QFN 24	0,1 "	"

FIG 7

(C) Bump + 4 mm at KPMG

(5)	QFW 08	1,4 mm	outs.
	QDN 09	1,2 "	"
	QFW 10	1,4 "	ins.
	QDN 11	3,7 "	"

(D) Orbit correction in cooling region

(6)	QDN 11	1,1 mm	outs.
	QFN 12	1,6 "	"
	QFN 14	2,3 "	ins.
	QDN 15	4,17 "	"

(E) Bump − 15 mm at QFW 06

(7)	QFW 04	5,5 mm	ins.
	QFW 06	4,06 "	outs.
	QFW 08	5,6 "	ins.

FIG 7

Acceptances evolution

	A_H inject. orbit 1846,07	A_H central orbit 1850,37
All quads at zero + first correction	67	73
second "	-	78
fluid "	-	75
After bump (- 4 mm) at septum	75	80
TRIM adjustement = - 2,7 mm	83	81,5
After bump at KPM9 + correction at cooling region	86	86,4

(at 1847,6 kHz, we got 89 π)

FIG. 8