EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE

CERN - PS DIVISION

PS/ PA/ Note 95-17 (PPC)

Minutes of the Topical PPC Meeting held on 27th June 1995

D. Manglunki

Geneva, Switzerland
8 August 1995

PS/PA Note 95-17 (PPC)
August 8th, 1995

Minutes of the Topical PPC meeting held on June 26th, 1995

Topic : PS-SPS Beam transmission at 13 (and 26) GeV/c

Present :

B. Allardyce, G. Arduini, B. Autin, J. Belleman, J. Boillot, M. Bouthéon, R. Cappi (Chairman), M. Chanel, V. Chohan, K. Cornelis, G. Cyvoct, G. Daems, D. Dekkers, A. Faugier, R. Garoby, G. Gelato, S. Hancock, H. Haseroth, C. Hill, T. Linnecar, D. Manglunki (Secretary), M. Martini, S. Maury, J.P. Riunaud, K. Schindl, H. Schönauer, D. Simon, E. Schulte, E. Shaposhnikova, C. Steinbach, H. Ullrich, E .Wildner.

1. Introduction (R. Cappi)

Welcome to the SL delegates (G. Arduini, K. Cornelis, A. Faugier, T. Linnecar and E. Shaposhnikova).

Two problems were to be addressed by the accelerators physicists in 1995 (see PPD minutes, PS/PA Note 95-03 (PPC)) :

LHC beam behaviour at 26GeV/c ;
Pb ion transmission between PS and SPS.

4 types of beam were prepared : 26, 20, 14 and 13 GeV/c, thanks to the new facilities of the new PS control system.

A big effort was made to improve the reliability and the calibration of the instrumentation (mainly the PS wire scanners and TT2 SEM grids and fils).

2. Summary of PS results (R. Cappi)

Dynamic and mechanical aperture measurements at 26 GeV/c showed the PS can extract a $\Delta p/p$ of $\pm 4.10^{-3}$ with an efficiency of 95%.

Transverse emittance measurements in the PS and in TT2 are in agreement, but the TT10 measurements are a factor ~2 bigger, or anyway show inconsistencies. An instrumentation error is not excluded. We still miss a comparison of SPS wire scanner (not yet working) with PS wire scanner measurements.

Very small longitudinal emittance ($\tau<5$ns, $\Delta p/p<10^{-3}$) bunches were produced at 26GeV/c for the study of microwave instabilities in the SPS.

3. Microwave instability in the SPS (T. Linnecar)

The foreseen behaviour of the LHC beam is based on extrapolations on existing beams. According to those extrapolations, the beam density is above the microwave instability treshhold. Experimental results are under analysis.

4. Emittance measurements in TT10 and data analysis (G. Arduini, M. Martini)

The PS and SPS teams agree on the definition of emittance ($\varepsilon=4\sigma^2/\beta$).
The precision of the emitttance measurements is estimated to be 10-20%.
TT10 momentum acceptance found to be $\Delta p/p = \pm 4.10^{-3}$.

PPC 26.6.95 1a

PS - SPS BEAM TRANSMISSION AT 13 (and 26) GeV/c

rep. by R. Cappi

1b

INTRODUCTION

AT PPD 95 WE MENTIONED TWO PROBLEMS TO BE STUDIED A.S.A.P. :

Participants

M. Arruat
C. Carter
C. Dutriat
R. Garoby
M. Martini
K. Priestnall
U. Raich
J.P. Riunaud
B. Vandorpe
R. Cappi
....

(1) LHC BEAM BEHAVIOR AT 26 GeV/c

(1a) DYNAMIC APERTURE PS → SPS

(1b) Long. μW IN SPS → T. LINNECAR

(2) P_b TRANSMISSION : PS → SPS → G. ARDUINI

20 GeV/c | 13 GeV/c equiv.

THE AIMS OF THIS MEETING IS TO REPORT THE PROGRESS DONE UP TO NOW, FOCUSSING IN PARTICULAR ON POINT (2) : THE MOST URGENT.

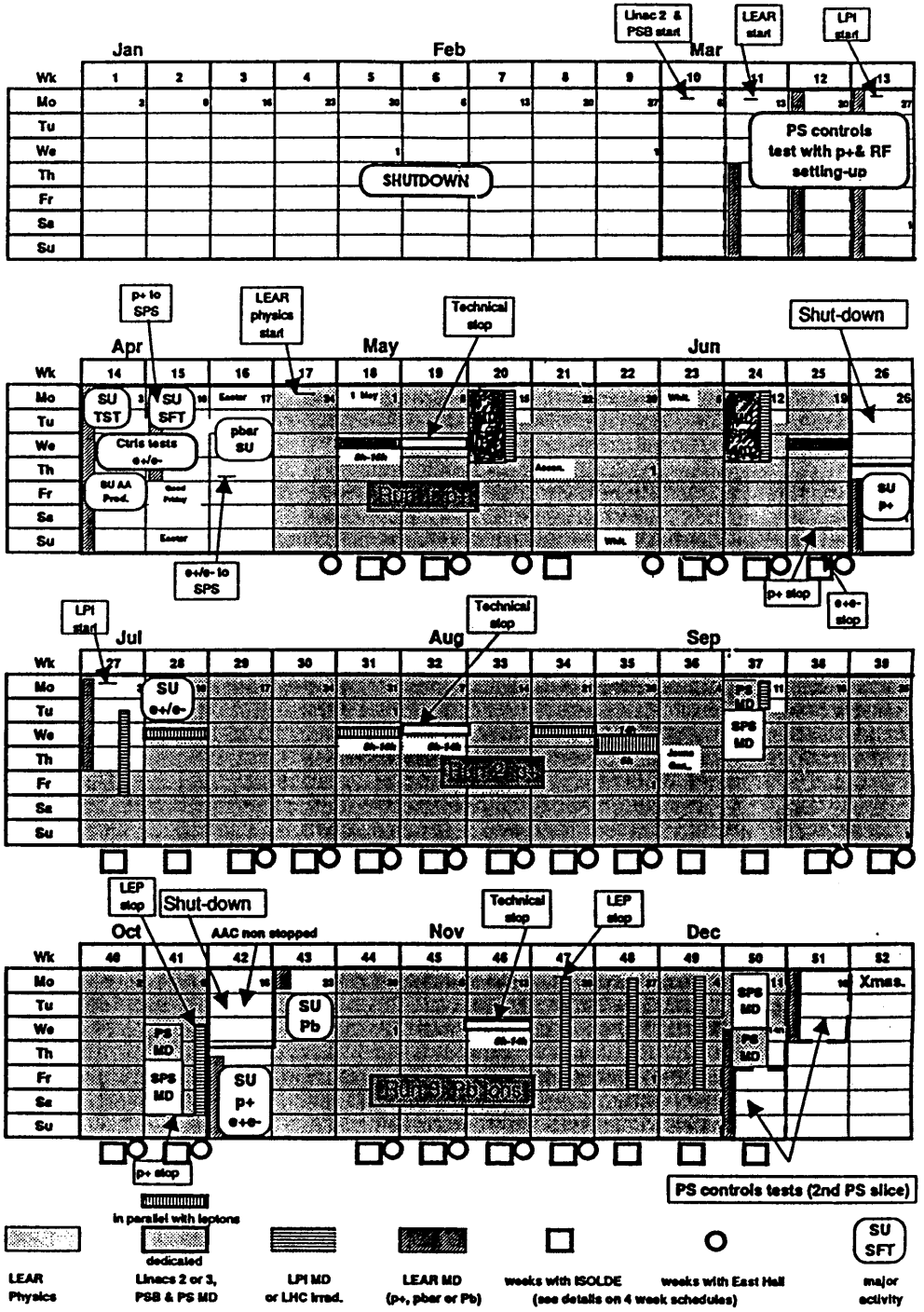
jb - 23 Feb 95
(rev-dd-08/06)

1c

1995 - P S COMPLEX SCHEDULE

Research Board 24 November 1994

START-UP REVISED (23.2.95)



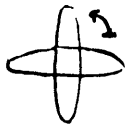
PREPARATION 1

PS-MD BEAMS :

		MOMENTUM	USER	Mag. cycle	Fast extr.
→	1	26 GeV/c	'MDLHC'	C	FE16S
	2	20 GeV/c	'MDPRO'	F	FE16I
→	3	13 GeV/c	'MDSPS'	H	FE16D
	4	14 GeV/c	'SFTPRO'	A	FE16

\+ ADIAB. V_{RF} REDUCTION TO OBTAIN SMALL $\Delta p/p \simeq \pm 0.3 \cdot 10^{-3}$

\+ BUNCH ROTATION TO OBTAIN 5 msec BUNCHES OR SMALL $\Delta p/p$



\+ "MINI-BUNCHES" TO OBTAIN SMALL $\tau_b < 5$ ms AND SMALL $\Delta p/p \simeq \pm 0.2 \cdot 10^{-3}$

\+ PRECISE CONTROL OF W.P. & $\xi_{x,y}$: NO MORE OCTUPOLES AT HIGH ENERGY (G. Arduini)

PREPARATION 2

A BIG EFFORT OF INSTRUMENTATION CHECK-UP

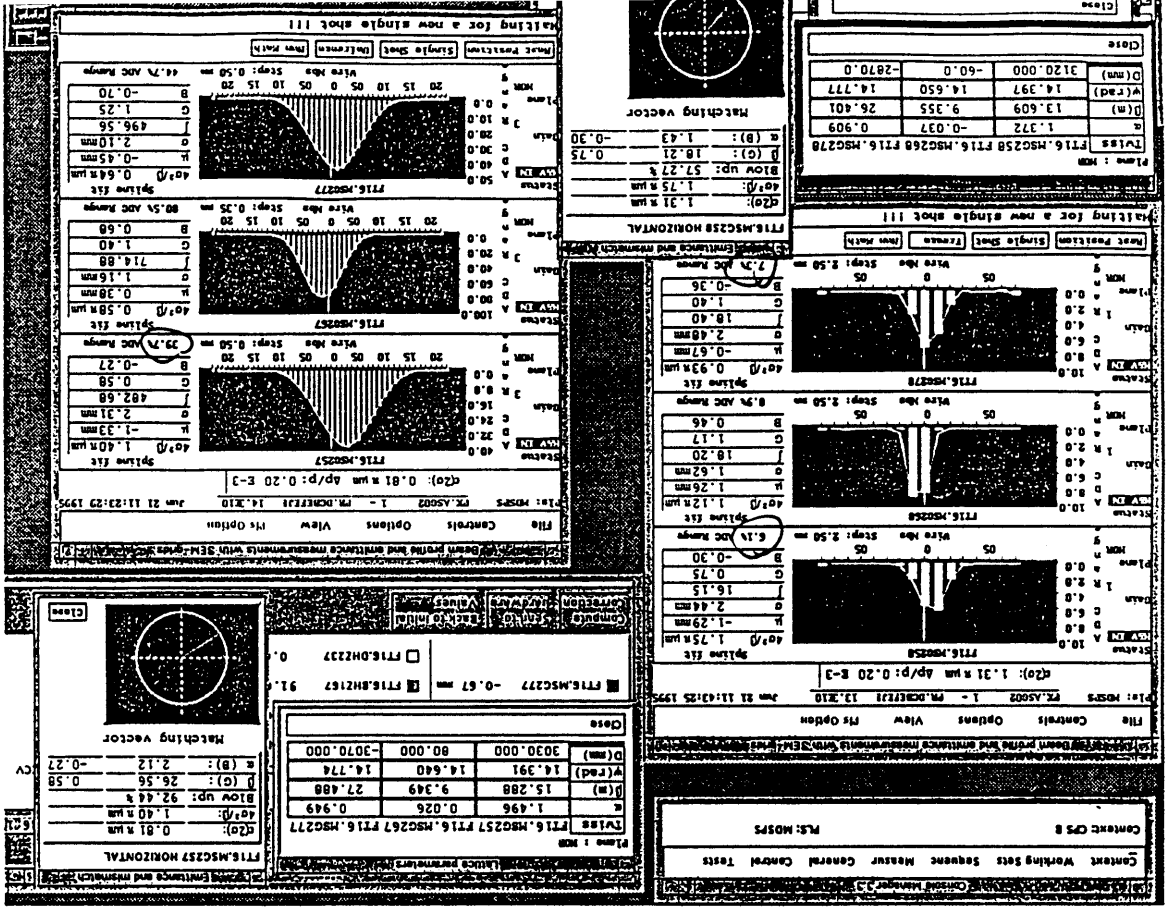
- WIRE SCANNERS (2xH, 2xV) ... NEW SOFT
- TT2 SEM grids
- TT2 SEM fils

} CROSS CHECK IMPROVEMENTS IN : ELECTRONICS, CALIBRATION SOFTWARE

$\frac{D}{\lambda, y}$ MEASUREMENTS

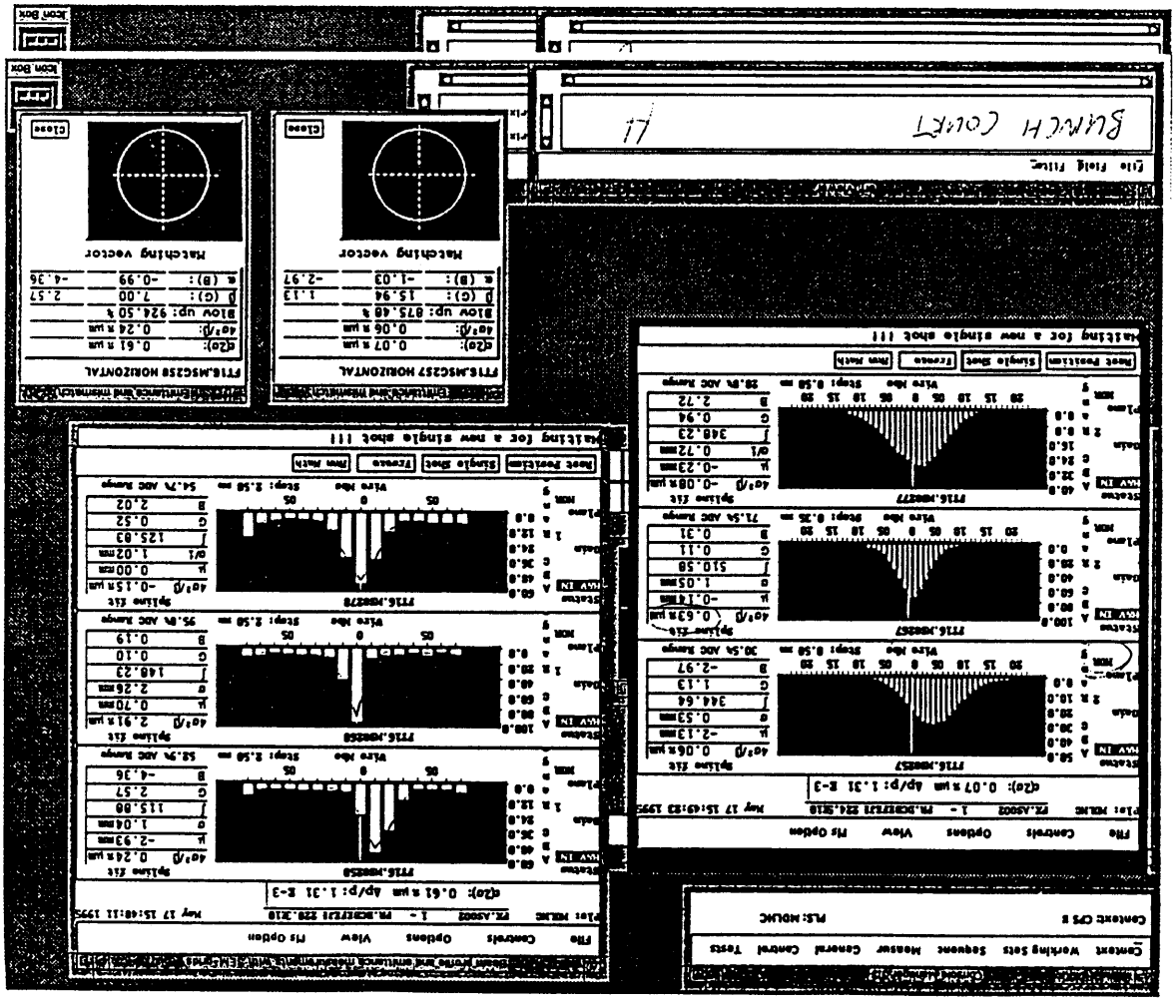
- TT2 TRANSFO'S CALIBRATION CHECKS

3c



... AN EXAMPLE OF BAD SIGNAL PROCESSING AND/OR LOW RESOLUTION ...

4



Par exemple : MESURES DE DISPERSION A 14 et 13 GeV/c

Mesures de Dispersion aux Sem-grids et Sem-Fils
14 GeV/c

Eta: -0.02253

Positions [mm]

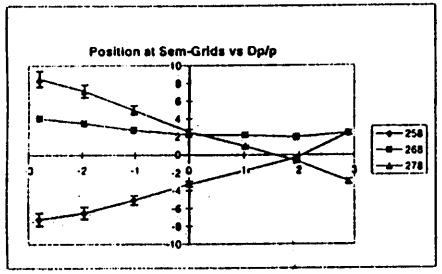
Dp/p [1E-3]	Frev [KHz]	Sem-Grids 258	268	278	Sem-Fils 257	267	277	Dp/p calc [1E-3]
-3	476.105	-7.22	4.09	8.52	-6.90	3.41	8.50	-2.80
-2	476.096	-6.52	3.52	7.13	-5.90	2.84	7.21	-1.96
-1	476.086	-5.10	2.73	4.99	-4.53	2.05	5.01	-1.03
0	476.075	-3.28	2.24	2.56	-2.65	1.81	2.77	0.00
1	476.064	-1.78	2.17	0.96	-1.04	1.81	1.20	1.03
2	476.054	-0.35	1.99	-0.68	0.52	1.94	-0.26	1.96
3	476.044	2.43	2.42	-2.96	3.44	2.38	-2.70	2.89

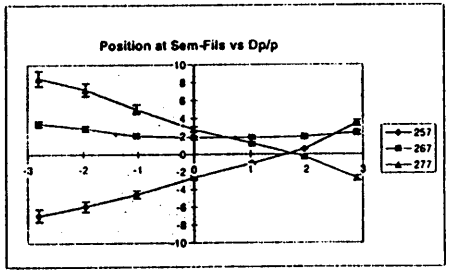
Dx [m] (computed at each point)

Sem-Grids 258	268	278	Sem-Fils 257	267	277
1.41	-0.66	-2.13	1.52	-0.57	-2.05
1.65	-0.65	-2.33	1.66	-0.53	-2.27
1.77	-0.48	-2.37	1.83	-0.23	-2.18
1.46	-0.07	-1.56	1.57	0.00	-1.53
1.50	-0.13	-1.65	1.62	0.07	-1.55
1.98	0.06	-1.91	2.11	0.20	-1.89

Dx [mm] (fitting from all points)

1.66	-0.32	-2.01	1.76	-0.19	-1.94





Mesures de Dispersion aux Sem-grids et Sem-Fils
13 GeV/c

Eta: -0.02182

Positions [mm]

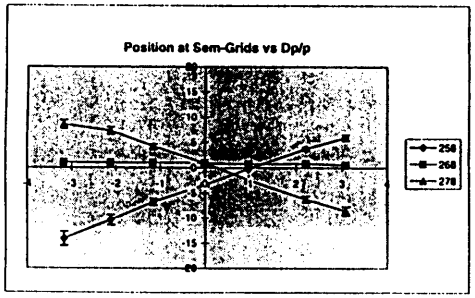
Dp/p esti [1E-3]	Frev [KHz]	Sem-Grids 258	268	278	Sem-Fils 257	267	277	Dp/p calc [1E-3]
-3	475.933	-14.12	1.06	8.53				-3.18
-2	475.922	-10.40	0.92	7.27	-8.42	0.21	7.72	-2.12
-1	475.912	-6.78	0.97	4.24	-6.39	0.29	4.72	-1.16
0	475.900	-3.37	0.94	0.94	-2.93	0.28	1.06	0.00
1	475.890	-0.20	0.74	-2.41	0.47	0.34	-2.27	0.96
2	475.877	3.70	0.84	-5.22	4.32	0.57	-5.81	2.21
3	475.868	5.95	0.58	-8.54	6.92	0.59	-8.08	3.08

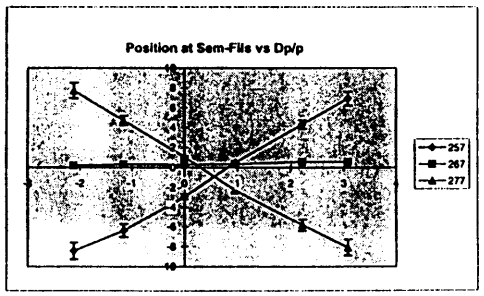
Dx [m] (computed at each point)

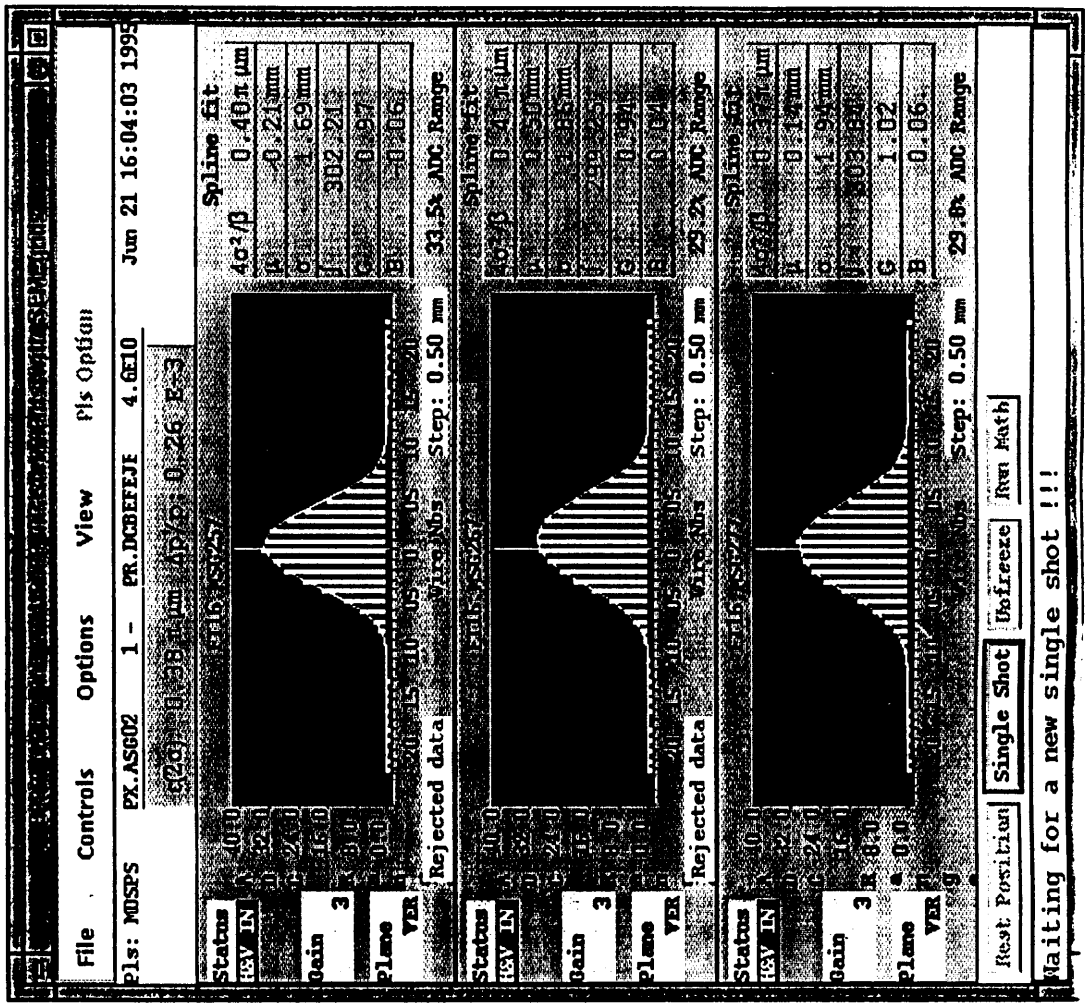
Sem-Grids 258	268	278	Sem-Fils 257	267	277
3.38	-0.04	-2.39	-0.92	0.09	0.33
3.32	0.01	-2.99	2.59	0.03	-3.14
2.95	-0.03	-2.86	2.99	-0.01	-3.17
3.29	-0.21	-3.48	3.53	0.06	-3.46
3.19	-0.05	-3.23	3.27	0.13	-3.10
3.02	-0.12	-3.08	3.20	0.10	-2.97

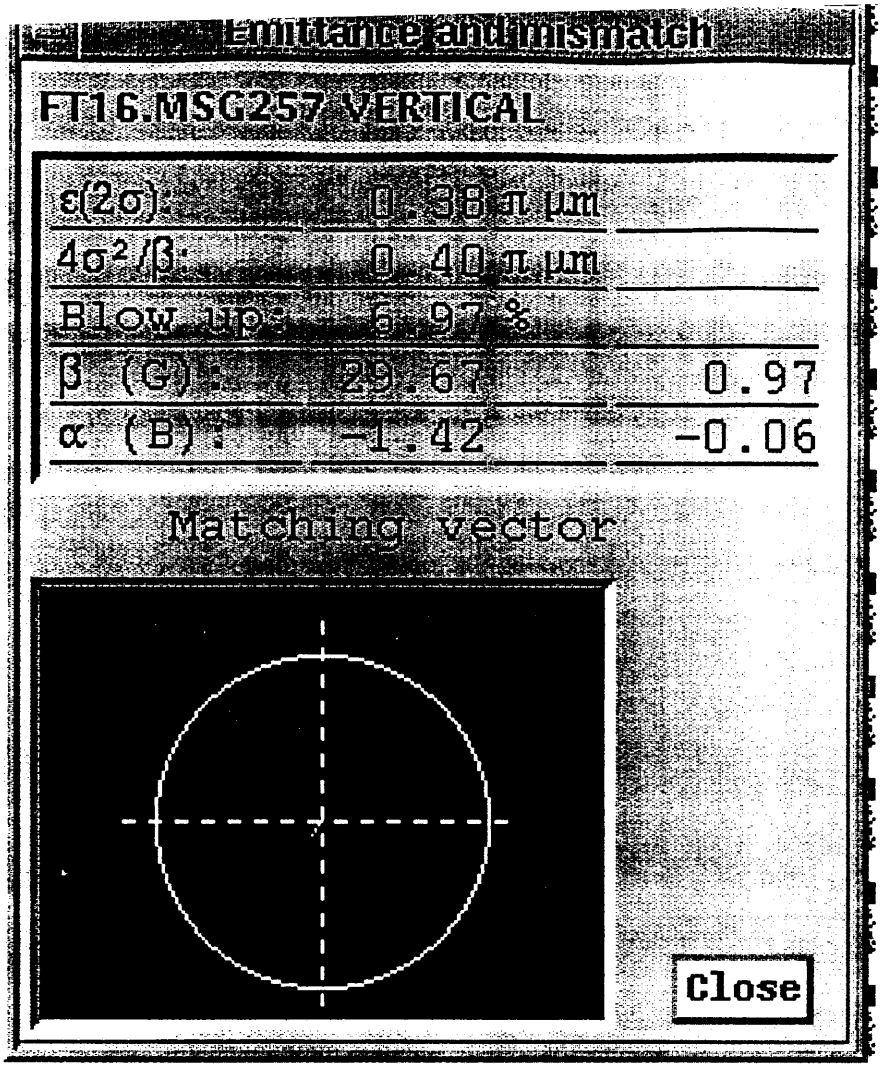
Dx [mm] (fitting from all points)

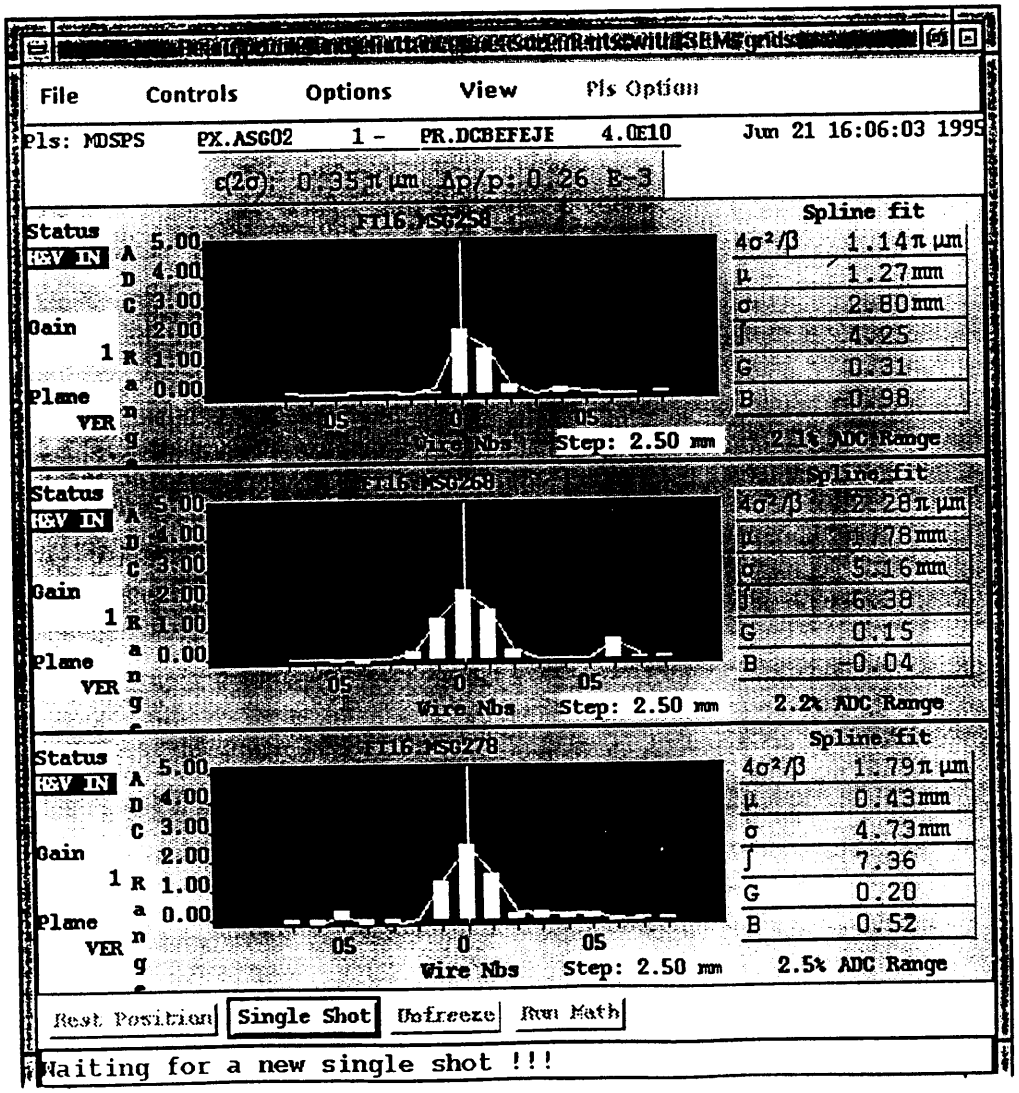
3.21	-0.06	-2.67	3.03	0.08	-3.07








Emittance and mismatch
FT16.MSG257 VERTICAL
ε(2σ): 0.38 π µm
4σ²/β: 0.40 π µm
Blow up: 6.97 %
β (G): 29.67 0.97
α (B): -1.42 -0.06
Matching vector
Close


File
Controls
Options
View
Pls Option
Pls: MDSPS
PX.ASG02 1 - PR.DCBEFEJE 4.0E10
Jun 21 16:06:03 1995
ε(2σ): 0.35 π µm Δp/p: 0.26 E-3
FT16.YS0258
Status
H&V IN
Gain
1
Plane
VER
Spline fit
4σ²/β 1.14 π µm
μ 1.27 mm
σ 2.80 mm
∫ 4.25
G 0.31
B -0.98
2.1% ADC Range
Wire Nbs
Step: 2.50 mm
FT16.YS0260
4σ²/β 1.28 π µm
σ 5.16 mm
G 0.15
B -0.04
2.2% ADC Range
FT16.YS0278
4σ²/β 1.79 π µm
μ 0.43 mm
σ 4.73 mm
∫ 7.36
G 0.20
B 0.52
2.5% ADC Range
Rest Position
Single Shot
Defreeze
Run Math
Waiting for a new single shot !!!

RESULTS ON

(1a) 26 GeV/c DYNAMIC APERTURE MEASUREMENTS

1) DYN. AP. IN THE PS RING

$$\frac{\Delta P}{P} \simeq \pm 4 \cdot 10^{-3}$$

2) MECH. AP. AT EXTRACTION, TRANSF. LINE AND SPS

$$\eta_{extr} > 95\% \quad \text{FOR} \quad \frac{\Delta P}{P} \leq \pm 4 \cdot 10^{-3}$$

3) $\varepsilon_{x,y}$ MEASUREMENTS $\quad \varepsilon_x = \frac{(2\sigma_x)^2}{\beta_x}$

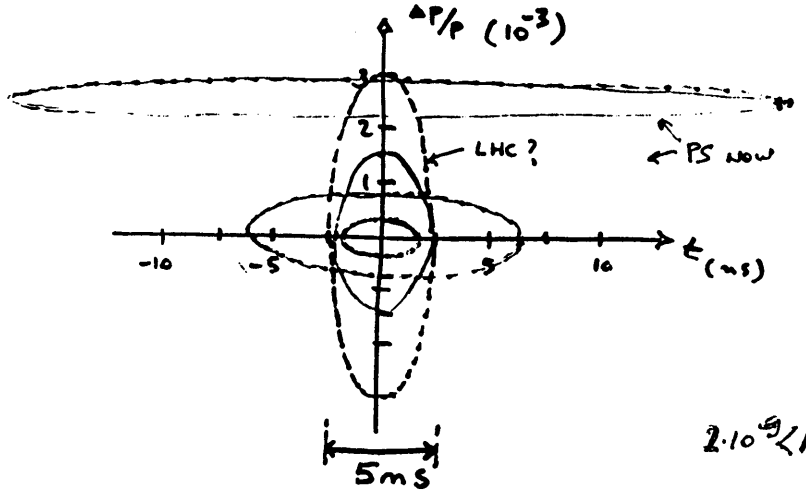
	W.S	TT2	TT10
ε_x π mm mrad	0.5 ±10%	0.5 ±10%	1.25 ±5%
ε_y π mm mrad	0.25 ±10%	0.22 ±10%	0.43 ?

4) MISMATCH ???

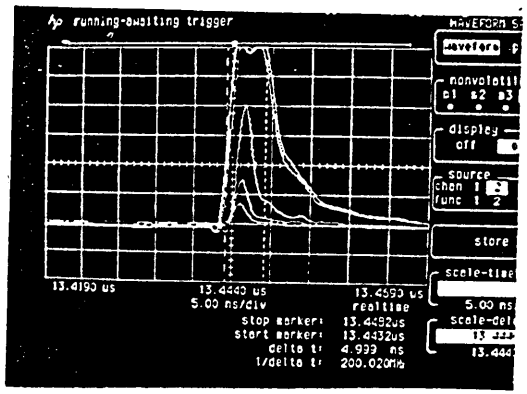
(1b) 26 GeV/c $\ell\mu W$ INSTABILITIES IN SPS

FOR STABILITY:

$$\frac{\Delta P}{P} > \sqrt{\frac{z}{n} \cdot k}$$



$2 \cdot 10^{9} < N_b < 6 \cdot 10^{10}$!!



Various Extracted bunch shapes

--- SEE TREVOR LINNECAR

RESULTS ON

(2) P_b TRANSMISSION BETWEEN PS & SPS AT 13 GeV/c p. equiv.

— MEASUREMENTS WITH P BEAM —

MINI BUNCHES :

	ε_L (eVs)	τ_b (ns)	$\Delta p/p$ (10^{-3})	N_L (10^{10} p/b)
NORMAL B.	0.3	14	± 1	6
MINI-B.	0.03	4.5	± 0.3	0.5

$\varepsilon_{x,y}$ MEASUREMENTS ($\varepsilon_x = \frac{(2\sigma_x)^2}{\beta_x}$)

	WS	TT2	TT10
ε_x π mm mrad	1 ± 10%	0.95 ± 10%	2.3 ± 20% ?
ε_y π mm mrad	0.5 ± 10%	0.5 ± 10%	0.9 ± 30% ?

... SEE G. ARDUINI

CONCLUSIONS

- CONCERNING 26 GeV/c LHC BEAM :
  - PS & SPS DYN. AP. : $\Delta p/p = \pm 4 \cdot 10^{-3}$
  - TRANSMISSION ~ 100 %
  - $\varepsilon_{x,y}$ TT10 / $\varepsilon_{x,y}$ TT2 ≈ 2 (IN BOTH PLANES) INCONSISTENT
  - MATCHING ? NEED TO MEASURE SPS WS / PS WS
  - ℓ μW ... SEE T.L. CONCLUSIONS

- CONCERNING 13 GeV/c BEAM (P_b)
  - $\varepsilon_{x,y}$ TT2 / $\varepsilon_{x,y}$ WS = 1 : CONSISTENT
  - TRANSMISSION ~ 100 % ... LOW INTENSITY P_b ?!
  - $\varepsilon_{x,y}$ "blow-up's" MEASURED IN 94 WERE PROBABLY WRONG (BOTH IN PS & SPS)
  - MEASUREMENTS AT 20 GeV/c WILL BE COMPLETED IN JULY.
  - MISSING : SPS-WS / PS-WS

1994 Graukt . for measu... V=200kV, ... rotation, ... P_b^{53+}

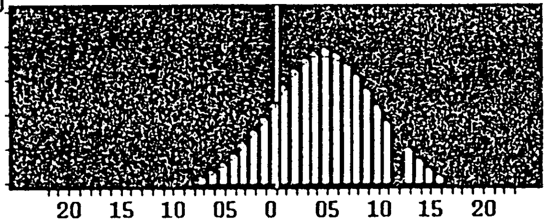
Beam profile and emittance measurements with SEM-grids

File   Controls   Options   View   Pls Option

Pls: SFT   PX.ASG02   50 -   FT16.TFA128   0.0-   Dec 7 16:32:5

ε(2σ): 0.48 π μm   Δp/p: 1.00 E-3   ... SPS

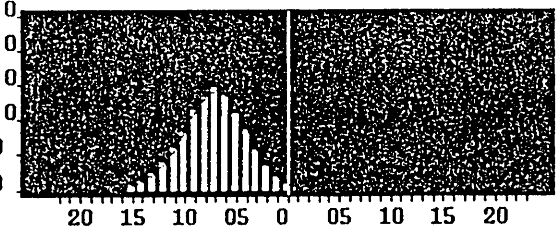
FT16.MSG257 — Status: H&V IN; Gain 2; Plane HOR; ADC Range



Rejected data   Wire Nbs   Step: 0.50 mm   7.9% ADC Ra

Spline fi	
4σ²/β	0.56
μ	2.39
σ	1.58
∫	90.21
G	0.86
B	0.56

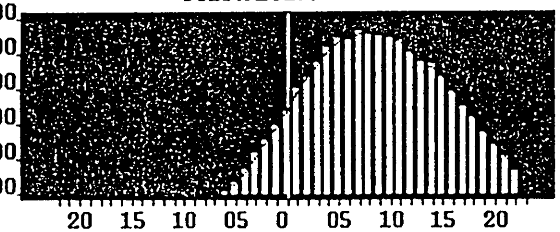
FT16.MSG267 — Status: H&V IN; Gain 2; Plane HOR; ADC Range



Wire Nbs   Step: 0.35 mm   23.1% ADC Ra

Spline fi	
4σ²/β	0.60
μ	-2.50
σ	1.03
∫	168.92
G	0.80
B	-0.52

FT16.MSG277 — Status: H&V IN; Gain 2; Plane HOR; ADC Range



Wire Nbs   Step: 0.50 mm   4.6% ADC Ra

Spline f	
4σ²/β	0.86
μ	4.33
σ	2.44
∫	80.31
G	0.56
B	0.14

Rest Position   Single Shot   Freeze   Run Math

New measurement :read semgrid data

V=200kV $4\sigma_t = 6.8$ ns ⇒ $\varepsilon_\ell = 42$ meV/u $\frac{dp}{p} = .8 \cdot 10^{-3}$

V = 20kV   11.2   "   37   " $.4 \cdot 10^{-3}$

1994 P_b^{53+}

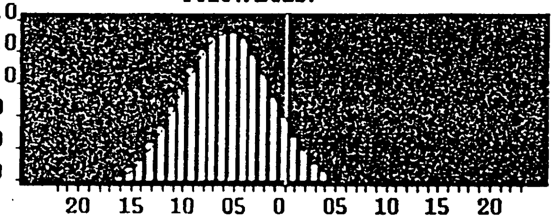
Beam profile and emittance measurements with SEM-grids

File   Controls   Options   View   Pls Option

Pls: SFT   PX.ASG02   50 -   FT16.TFA128   0.0-   Dec 7 16:16:10

ε(2σ) 0.43 π μm   Δp/p: 0.50 E-3

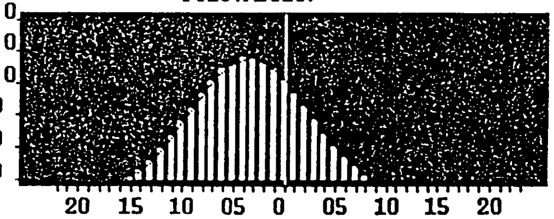
FT16.MSG257 — Status: H&V IN; Gain 3; Plane VER; ADC Range



Rejected data   Wire Nbs   Step: 0.50 mm   18.4% ADC Ran

Spline fit	
4σ²/β	0.55π
μ	-2.86mm
σ	1.95mm
∫	193.05
G	0.78
B	-0.02

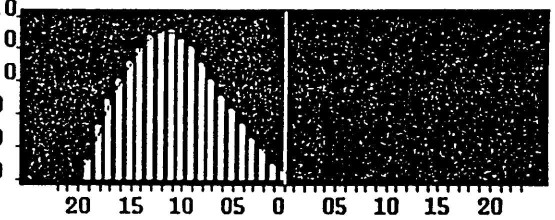
FT16.MSG267 — Status: H&V IN; Gain 3; Plane VER; ADC Range



Wire Nbs   Step: 0.50 mm   15.1% ADC Ran

Spline fit	
4σ²/β	0.46π
μ	-1.69m
σ	2.32m
∫	190.95
G	0.93
B	0.24

FT16.MSG277 — Status: H&V IN; Gain 3; Plane VER; ADC Range



Wire Nbs   Step: 0.50 mm   18.1% ADC Ra

Spline fi	
4σ²/β	0.36
μ	-5.40
σ	2.11
∫	209.91
G	1.21
B	0.19

Rest Position   Single Shot   Freeze   Run Math

Waiting for new measurement timing !!!

MD 14/6/95
26 GeV - NOPHASEX

- 20 bunches (5 ns long) - 4×10^9 ppb - $\Delta p/p = 0.12 \times 10^{-3}$ off-line analysis

TT10: $\varepsilon_H = 0.91\ \pi$ mm mrad PS: 0.50 π mm mrad
$\varepsilon_V = 0.26\ \pi$ mm mrad 0.22 π mm mrad

Blow-up factors: 1.01 and 1.07 - small spread of the emittance values calculated from the "theoretical" β function at the grids

on line TT10 measurement: $\varepsilon_H = 1.84\ \pi$ mm mrad
$\varepsilon_v = 0.32\ \pi$ mm mrad

- 20 bunches (26 ns long) - 10^{10} ppb - $\Delta p/p = 0.3 \times 10^{-3}$

TT10: $\varepsilon_H = 1.2\ \pi$ mm mrad PS: 0.5 π mm mrad
$\varepsilon_V = 0.5\ \pi$ mm mrad 0.3 π mm mrad

Blow-up factors: 1.03 and 1.11

on line TT10 measurement: $\varepsilon_H = 1.76\ \pi$ mm mrad
$\varepsilon_v = 0.51\ \pi$ mm mrad

During this MD session the momentum acceptance of the TT10 liner was measured both with "short" and "long" bunches:

TT10 momentum acceptance $\Delta p/p > +/- 4 \times 10^{-3}$

At $\Delta p/p = - 5 \times 10^{-3}$ no beam in TT10

MD 21/6/95

13 GeV - NOPHASEX

- 15 bunches (5 ns long) - 4×10^9 ppb - $\Delta p/p = 0.26 \times 10^{-3}$ off-line analysis

TT10: $\varepsilon_H = 0.86\ \pi$ mm mrad PS: 0.8 π mm mrad
$\varepsilon_V = 0.47\ \pi$ mm mrad 0.36 π mm mrad

Blow-up factors: 1.99 and 1.17

on line TT10 measurement: $\varepsilon_H = 1.66\ \pi$ mm mrad
$\varepsilon_V = 0.59\ \pi$ mm mrad

Preliminary results of the TT10 emittance measurements at 13 and 26 GeV

MD 17/5/95

- 3 pairs of SEM grids in TT10 (1027 - 1028 - 1029 -136, 106 and 75 m from the SPS injection point) 15 wires - 2.5 mm pitch

- on - line analysis of the grid data (Nodal program)

- off - line analysis of the raw data (noise measurement in the absence of beam, noise subtraction, gaussian fit, MAD calculation of the phase advance for PHASEX and NOPHASEX optics)

Gaussian fit: $\exp(-(x-\mu)^2/2\sigma^2)$

$\varepsilon = 4\sigma^2/\beta$

$\Delta p/p$ given at 2σ

Estimated error of the emittance measurement: 10 - 20 %

26 GeV - NOPHASEX
Only on-line analysis

- 20 bunches (5 ns long) - 10^{11} ppb - $\Delta p/p = 0.6 \times 10^{-3}$

TT10: $\varepsilon_H = 1.76\ \pi$ mm mrad PS: 0.6 π mm mrad
$\varepsilon_V = 0.61\ \pi$ mm mrad 0.3 π mm mrad

- Single bunch (5 ns long) - 8 - 9 x10^{10} ppb - $\Delta p/p = 1.3 \times 10^{-3}$

TT10: $\varepsilon_H = 1.92\ \pi$ mm mrad PS: 0.6 π mm mrad
$\varepsilon_V = 0.38\ \pi$ mm mrad 0.3 π mm mrad

- Single bunch (30 ns long) - 8-9 x10^{10} ppb - $\Delta p/p = 0.3 \times 10^{-3}$

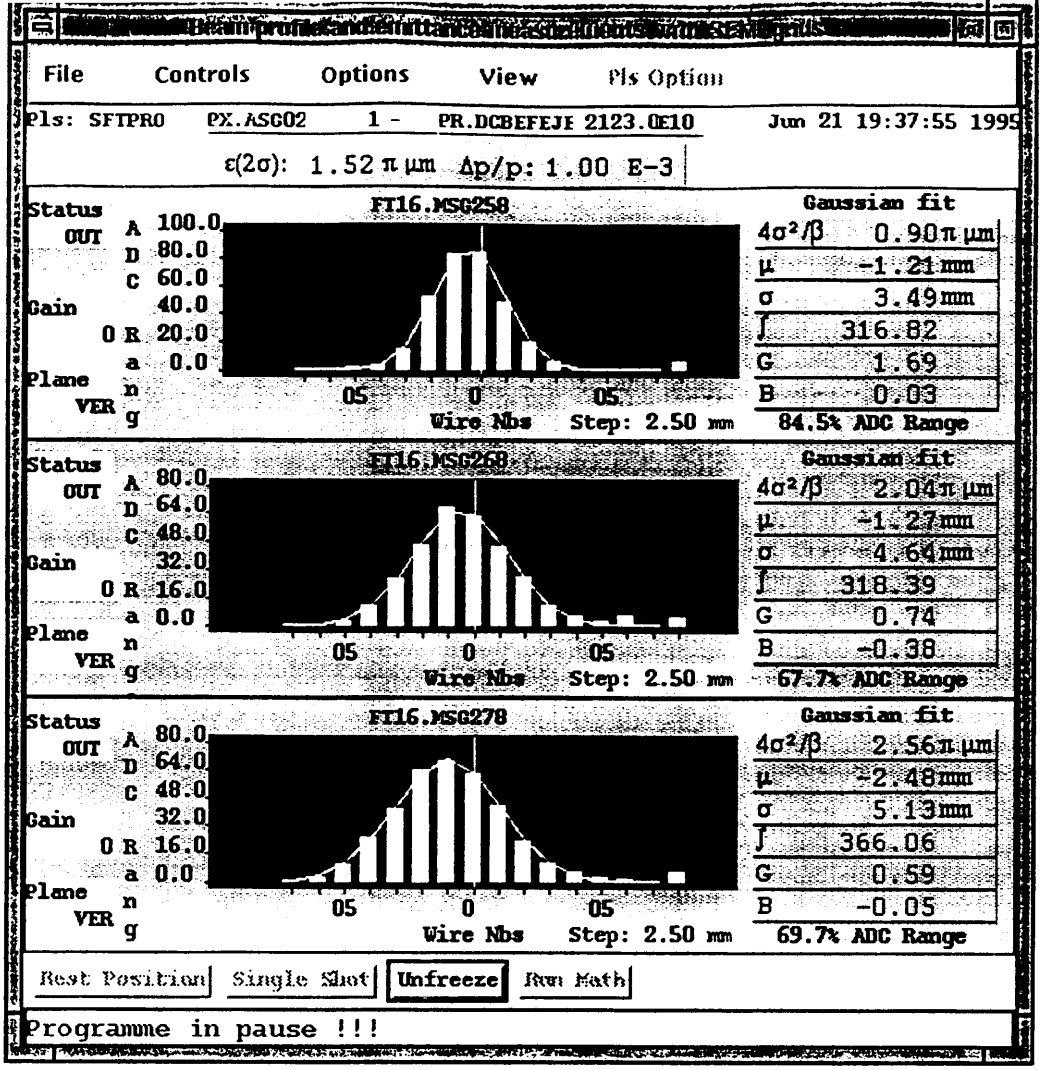
TT10: $\varepsilon_H = 1.16\ \pi$ mm mrad PS: 0.54 π mm mrad
$\varepsilon_V = 0.2\ \pi$ mm mrad 0.3 π mm mrad

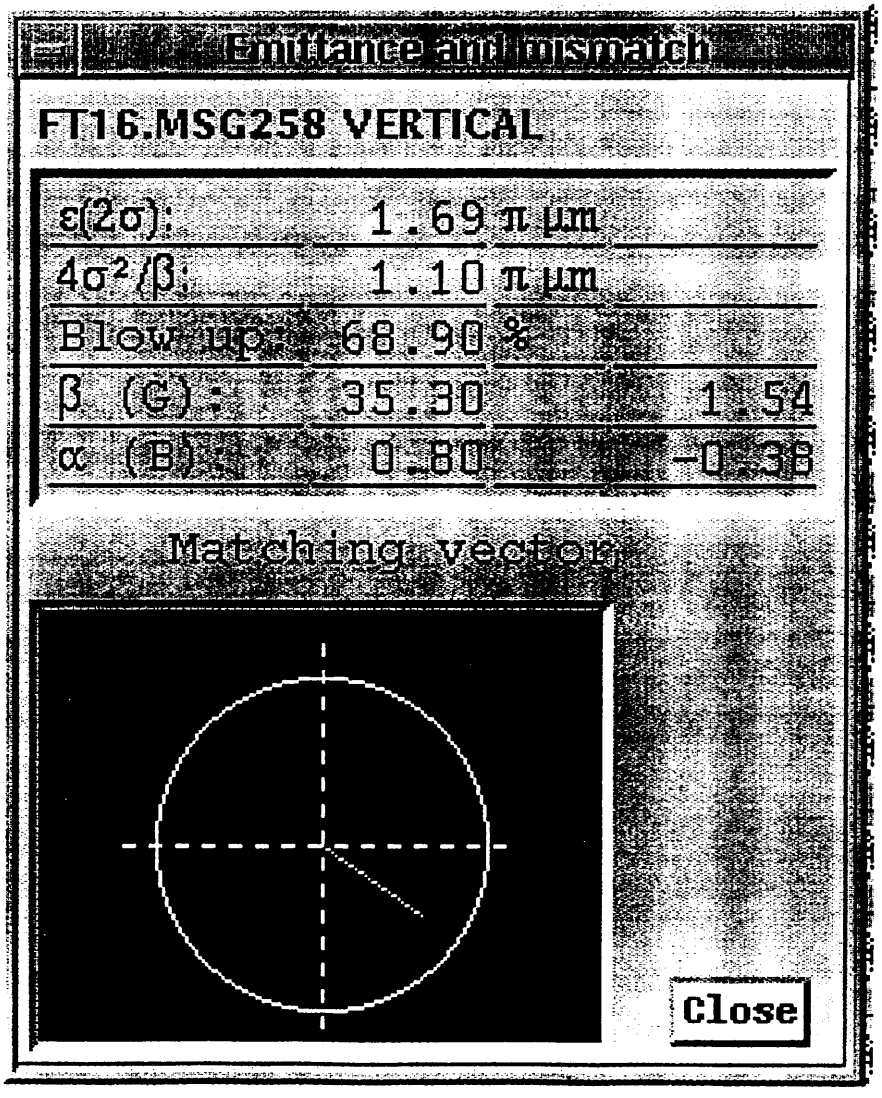
TT10 emittance: measurement of 06/06/95 - filename PS1

BATCH 1						
	BSG1027		BSG1028		BSG1029	
	H	V	H	V	H	V
	19	18	42	7	15	11
	47	21	105	9	31	53
	119	29	234	45	95	204
	259	66	425	232	325	505
	460	303	622	549	735	857
	660	1051	784	941	1168	1303
	938	1685	886	1385	1381	1426
	938	1729	918	1275	1381	1272
	976	991	856	926	1109	887
	931	418	743	576	673	477
	802	116	592	238	275	229
	607	25	397	108	97	121
	388	7	218	52	31	59
	207	6	99	24	13	23
	94	6	40	9	7	10
	114	114	92	93	98	115
μ [mm]	1.95701790	-1.14704037	-0.15945983	-0.97200435	-1.37609005	-2.19275188
σ [mm]	6.52212238	3.86446667	6.68917751	4.88399315	4.93852234	5.33293724
$4\sigma^2/\beta$ [mm mrad]	3.54638958	1.09951019	3.73038864	2.25900269	1.84311295	2.76850986

BATCH 2						
	BSG1027		BSG1028		BSG1029	
	H	V	H	V	H	V
	11	18	22	7	16	24
	23	22	58	19	34	141
	59	29	144	127	358	415
	145	62	303	404	358	832
	303	285	505	756	787	1198
	503	1030	693	1245	1212	1450
	716	1687	836	1395	1413	1264
	866	1728	915	1028	1356	954
	966	973	900	720	1037	536
	984	404	825	344	583	252
	905	111	695	145	221	127
	743	24	501	66	76	65
	527	7	299	30	26	29
	314	6	144	13	13	12
	156	6	60	7	7	7
	127	113	93	96	105	126
μ [mm]	3.63903809	-1.14596367	1.17644882	-2.45123672	-2.10384083	-4.18423176
σ [mm]	6.37330151	3.83920383	6.56793404	4.85678577	5.17168903	5.27653885
$4\sigma^2/\beta$ [mm mrad]	3.38639355	1.08518124	3.59638596	2.23390484	2.02126217	2.71026230
β [m]	47.979	54.330	52.880	42.237	52.930	41.091
α	-1.469	1.605	1.337	-1.083	-1.313	1.071
ϕ [2π]	3.103	2.927	3.169	3.085	3.307	3.167
D [m]	-4.342	-0.100	-4.120	-0.058	-1.498	-0.015

	BATCH 1		BATCH 2	
	H	V	H	V
Calculated emittance [π mm.mrad]	2.344	1.747	2.456	1.717
Calculated β [m]	72.57	34.19	66.15	34.34
Calculated α	-2.314	1.021	-2.100	1.011


File
Controls
Options
View
Pls Option
Pls: SFTPRO
PX.ASC02
1 -
PR.DCBEFEJE 2123.0E10
Jun 21 19:37:55 1995
ε(2σ): 1.52 π µm
Δp/p: 1.00 E-3
FT16.MSG258
Gaussian fit
4σ²/β 0.90π µm
µ -1.21mm
σ 3.49mm
∫ 316.82
G 1.69
B 0.03
84.5% ADC Range
FT16.MSG268
Gaussian fit
4σ²/β 2.04π µm
µ -1.27mm
σ 4.64mm
∫ 318.39
G 0.74
B -0.38
67.7% ADC Range
FT16.MSG278
Gaussian fit
4σ²/β 2.56π µm
µ -2.48mm
σ 5.13mm
∫ 366.06
G 0.59
B -0.05
69.7% ADC Range
Status
OUT
Gain
Plane
VER
Wire Nbs
Step: 2.50 mm
Rest Position
Single Shot
Unfreeze
Run Math
Programme in pause !!!


Emittance and mismatch
FT16.MSG258 VERTICAL
ε(2σ): 1.69 π µm
4σ²/β: 1.10 π µm
Blow up: 68.90 %
β (G): 35.30 1.54
α (B): 0.80 -0.38
Matching vector
Close

Distribution list

V. Agoritsas	PS
B.W. Allardyce	PS
G. Arduini	SL
B. Autin	PS
S. Baird	PS
J. Belleman	PS
J. Boillot	PS
J. Bosser	PS
M. Bouthéon	PS
E. Brouzet	SL
H. Braun	PS
R. Cappi	PS
J. Clendenin	PS
F. Caspers	PS
M. Chanel	PS
V. Chohan	PS
K. Cornelis	SL
G. Cyvoct	PS
G. Daems	PS
D. Dekkers	PS
J.P. Delahaye	PS
G. De Rijk	SL
D. Dumollard	PS
L. Durieu	PS
T. Eriksson	PS
J. Evans	PS
A. Faugier	SL
B. Frammery	PS
G. Fraser	DSU
R. Garoby	PS
G. Gelato	PS
R. Giannini	PS
M. Giovannozzi	PS
J. Gonzalez	PS
J. Gruber	PS
S. Hancock	PS
H. Haseroth	PS
J.Y. Hémery	PS
A. Hilaire	SL
Ch. Hill	PS
K. Hübner	DG
E. Jensen	PS
S. Johnston	PS
K.H. Kissler	SL
P. Lefèvre	PS
R. Ley	PS
M. Lindroos	PS
T. Linnecar	SL
J. Madsen	PS
D. Manglunki	PS
M. Martini	PS
S. Maury	PS
G. Metral	PS
C. Metzger	PS
D. Moehl	PS
H. Mulder	PS
F. Pedersen	PS
F. Perriollat	PS
J.P. Potier	PS
U. Raich	PS
N. Rasmussen	PS
J. Riche	PS
J.P. Riunaud	PS
K. Schindl	PS
G. Schneider	PS
H. Schönauer	PS
E. Schulte	PS
E. Shaposhnikova	SL
T.R. Sherwood	PS
D. Simon	PS
C. Steinbach	PS
E. Tanke	PS
G. Tranquille	PS
H. Ullrich	PS
H. Umstatter	PS
B. Vandorpe	PS
F. Varenne	PS
L. Vos	SL
M. Vretenar	PS
D. Warner	PS
E. Wildner-Malandain	PS
D. J. Williams	PS