EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
CERN — A&B DEPARTMENT

AB-Note-2004-027-OP

OPERATION STATISTICS OF THE CERN ACCELERATORS COMPLEX FOR 2003

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Abstract

This report gives an overview of the performance of the different Accelerators (Linacs, PS Booster, PS, AD and SPS) of the CERN Accelerator Complex for 2003. It includes scheduled activities, beam availabilities, beam intensities and an analysis of faults and breakdowns by system and by beam.

MORE INFORATION by using the OP Statistics Tool:
http://eLogbook.web.cern.ch/eLogbook/statistics.php

and on the SPS HomePage:
http://ab-div-op-sps.web.cern.ch/ab-div-op-sps/SPSss.html

Geneva, Switzerland
26 March 2004

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INTRODUCTION

2003 was a year of extreme contrasts for the Operation of CERN's Particle Accelerators. There were several major breakdowns and technical problems, some of which delayed the start-up of the Accelerators and affected beam availability. These failures were clearly due to the reduced level of preventive maintenance that has been the policy at CERN for recent years. At the same time, some experimental faculties received record particle intensities with excellent beam availability.

The Complex was scheduled to restart early in April 2003 with full physics operation for ISOLDE, nTOF, AD, EAST, NORTH and WEST AREAS underway from early May. The various accelerator cold check-outs and hardware tests began as planned but, during these tests, two faulty main dipole magnets were found in the PS machine. These magnets had to be changed before PS Operation could start. There are four different kinds of main dipole magnet in the PS, with one spare for each kind. Fortunately, the two broken magnets were of different kinds and therefore spares were readily available. However this implied a three week delay to the start of the machines, whilst the magnets were changed. Eventually this delay was limited to two weeks or less for the different physics programs, thanks to some excellent work by the teams changing the magnets, who got the PS back fully operational in just over two weeks, and by juggling the start-up schedule.

A major breakdown of the electrical compensator for the SPS Main Power Supply, threatened to delay SPS Operation even more, since the spare compensator was not fully operational. Finally, the spare compensator was pressed into service for three weeks, against the advice of the suppliers, to enable the SPS to start-up to continue. The problems were far from over however as, during the EAST HALL start-up, one of the four power transformers for the PS slow extraction septum broke (a similar fault occurred last year). This limited the PS slow-extracted beam to the EAST HALL users to 20 GeV, instead of the usual 24 GeV, for the first ten weeks of operation. It was possible to partially compensate for the lower beam energy by increasing the spill length from 400 to 550 milliseconds inside the same 2.4 second cycle.

After this rather eventful and painful start-up, beam was eventually available as follows:

- ISOLDE on April 30th, 7 days later than originally scheduled
- SPS NORTH and WEST AREA beams on May 14th, as originally scheduled. (However, 10 days of SPS fixed target physics operation were cancelled as the SPS scrubbing run had to be rescheduled later in June)
- nTOF on May 19th, as originally scheduled
- EAST HALL Operation on May 19th, 14 days later than originally scheduled
- Antiprotons for AD users on June 9th, 11 days later than originally scheduled

As a result of these delays it was agreed by the CERN Research Board to extend the run by two weeks in order to recuperate the lost physics time.

During the last week of May the SPS began a week of operation with a 25 nanosecond bunch structure on the extracted beam for tests of LHC detector components. This was followed by the postponed "scrubbing" run with the LHC type beam. During this 10 day run numerous experiments were performed aimed at measuring the "cleaning" of the SPS vacuum chamber by the beam-induced electron cloud. There were also several tests done using a cold LHC style vacuum section inserted into the SPS. These test revealed a slower than expected vacuum "scrubbing" for the cold surface. During this run it was also noticed that the extraction kickers installed in the SPS for the LHC and CNGS beams were heating up rather quickly. Further studies showed that this was due to RF losses in the ferrites induced by the bunch structure of the LHC beam. Indeed this heating effect was found to be about four times larger than the maximum available cooling capacity and clearly limited the beam intensity that could be stored at top energy, where the bunches are shortest.

Throughout these tests the operation at the PS and PSB continued reasonably well, except for some cooling problems related to a faulty heat exchanger in the PS EAST HALL. This was corrected during the technical stop at the start of July. Early in June sparking at a High Voltage connector on the HRS front-end target station at ISOLDE, was discovered. In spite of several in-situ cleanings and interventions the HRS front-end was removed at the end of June and ISOLDE operations was forced to continue using only the GPS target station for the next three months. About half the scheduled HRS experiments could be rescheduled at the GPS, while the rest had to be either cancelled or postponed. This reduction in ISOLDE beam time was not completely lost. As it meant that more beam time was available in the PS cycles for the EAST HALL and nTOF users.

After the SPS "scrubbing" run, operation of the SPS NORTH experimental area was very painful. There were numerous problems with vacuum leaks, magnet and collimator problems. In addition, since the start-up, the controlled access system had proven very unreliable. This was particularly difficult as the number of Operators available in the PCR (SPS Control Room) had been reduced from three to two as part of a rationalisation of the available Operations manpower. By the end of June the access problems were reasonably "under control", but the remaining problems were making NORTH area operation almost impossible. The combination of high radioactivity, water from numerous water leaks and blocked drainage systems, with corrosive PVC insulation had led to extreme corrosion of numerous vacuum vessels in the NORTH area target zone. This corrosion caused repeated vacuum leaks and the beam availability for the NORTH area was very poor (<50%) during July and August. At the end of July it was decided to stop the piece-meal repairs and change all the corroded vacuum chambers, after a 5 day radiation cool-down period. Some vacuum vessels (e.g. collimator tanks) could not be changed and would still have to repaired in-situ in case of problems.

Early in July preparation had started at LINAC3 for the Heavy Ion run, using Indium ions instead of the usual Lead, and, by early August, Indium ions had been accelerated successively through the PSB and the PS ready for SPS operation, which started in September. At the beginning of August the PS switched back to a 24 GeV slow extraction for the EAST HALL beam as the septum power supply transformer had been repaired and re-installed.

In spite of the apparent large number of problems in many areas some beams were running very well. This was particularly true for the nTOF high intensity beam and the AD Operation in general. In fact the nTOF facility received almost twice as many protons in 2003 as in the same running time in 2002. The reliability and reproducibility of the AD machine was also somewhat better than in 2002, and record intensities of antiprotons were regularly achieved in the AD.

At the beginning of September the first of two LHC extraction tests took place. The aim of these tests was to test the LHC/CNGS beam extraction channel at the SPS using LHC type "pilot" beams. These tests were completely successful and the beam was extracted and transported 150m downstream of the extraction area to a beam dump. These test marked a major milestone in the SPS preparations for the LHC.

Throughout the summer there was a major effort in all the machines devoted to preparing a large number of MD beams for beam studies. For the LHC, these studies included: preparing the many types of different LHC pilot beams with different intensities and emittances in the PS Booster, preparing the LHC beam with a 75 nanosecond bunch spacing in the PS and preparing the ultimate intensity LHC beam in the SPS. Other, non-LHC, studies included: work on the resonant 5 turn extraction in the PS, tests of PS operation with an increased duty cycle (0.9 second repetition rate instead of the usual 1.2 seconds) and preparations for the high intensity CNGS beam. It is yet again worth noting that these studies, as well as the setting up of the new Indium Ion operation, were done in parallel with the scheduled physics programs. This is a due in no small part to the ingenuity of the Operations teams and the flexibility of the CERN Accelerator Complex.

The final seven weeks of the run were devoted to Indium Ion operation for the SPS North area users. In contrast with the proton operation for the North area, the beam availability was excellent and the beam stability and intensity also exceeded expectations. This was in spite of the fact that the Indium ion source at LINAC3 needed changing every 7 – 10 days. To minimise the effects on the physics users, these changes were carried out during dedicated machine study sessions or accelerator stops. At the PS the other experimental physics programs continued, during this time, with EAST HALL operation back at 24 GeV, nTOF operation using both dedicated and parasitic 20 GeV beam, AD antiproton physics and ISOLDE operation using both GPS and HRS front-end target stations. The new HRS target station was installed, tested and operational by the second week of September. However, there was a major worry three weeks before the end of the run, when a dipole magnet, which deflects the extracted beam to the South beam line in the PS EAST HALL, developed an earth fault. By increasing the level of the power supply interlock and by-passing the relevant magnet interlock, it was possible to continue operation to the end of the run, but many fingers were crossed in the EAST HALL for these last three weeks!!

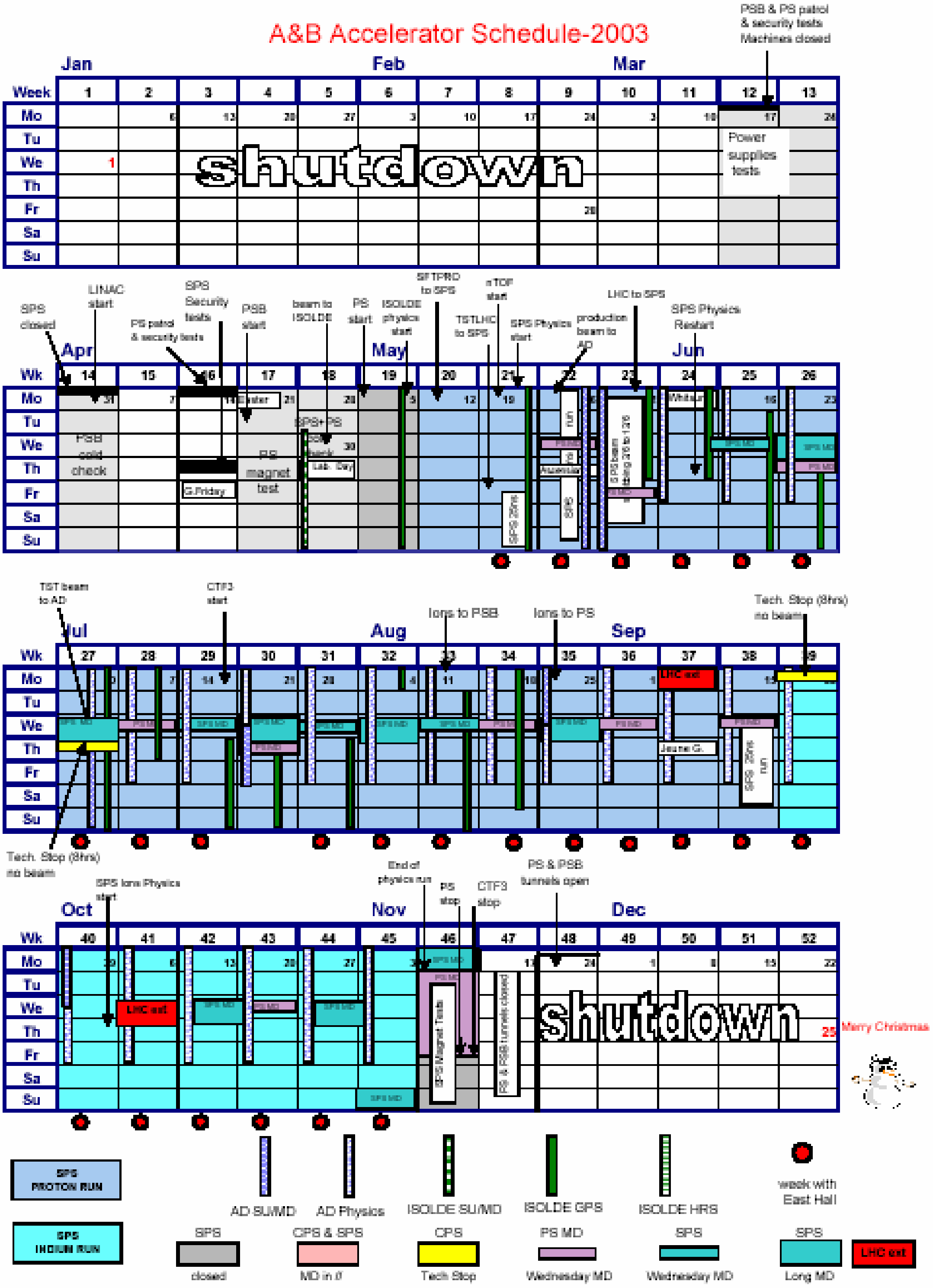
On the November 10th, according to the extended schedule, experimental physics operations stopped, but a number of dedicated beam tests were performed at the LINAC3, PSB and the PS during the following two weeks. Finally, by November 24th, all accelerator operation stopped at CERN for 2003.

AB-OP

1. 2003 schedule

sb./ed. 20.10.2003 Approved by Research Board 5.6.2003

A&B Accelerator Schedule-2003

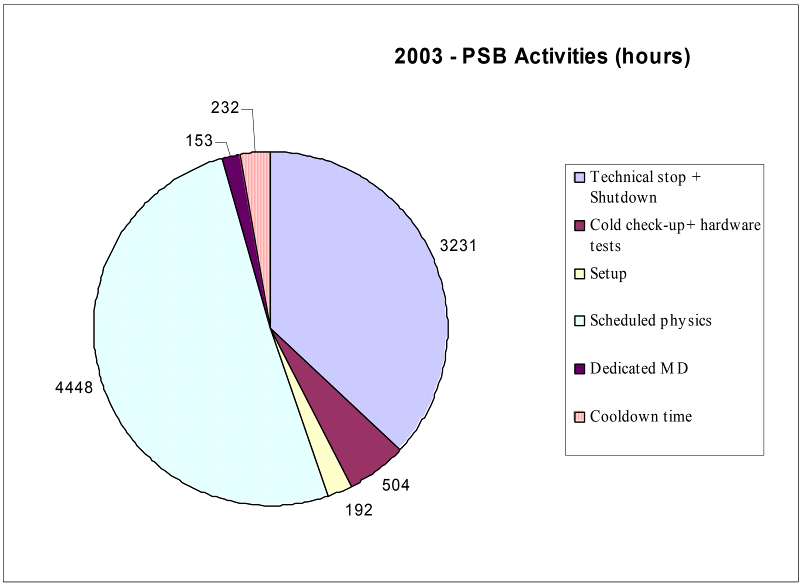


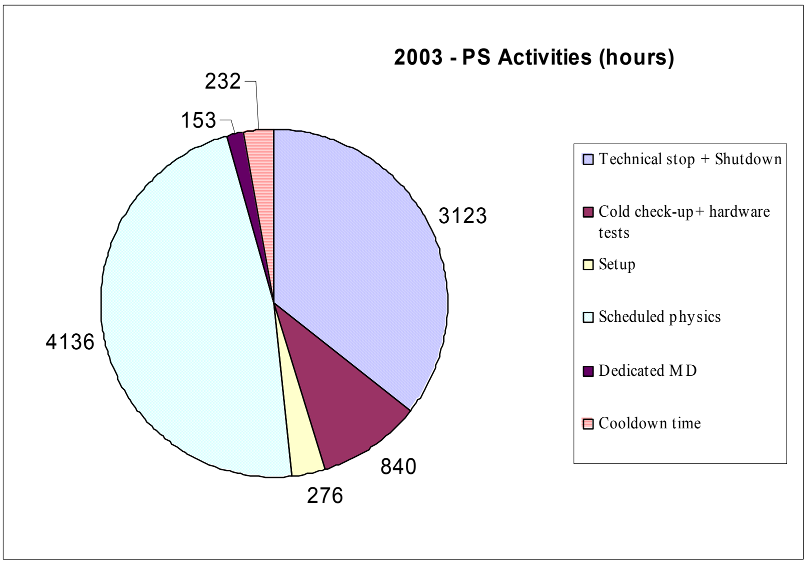
http://ab-div.web.cern.ch/ab-div/Schedules/Sched.html

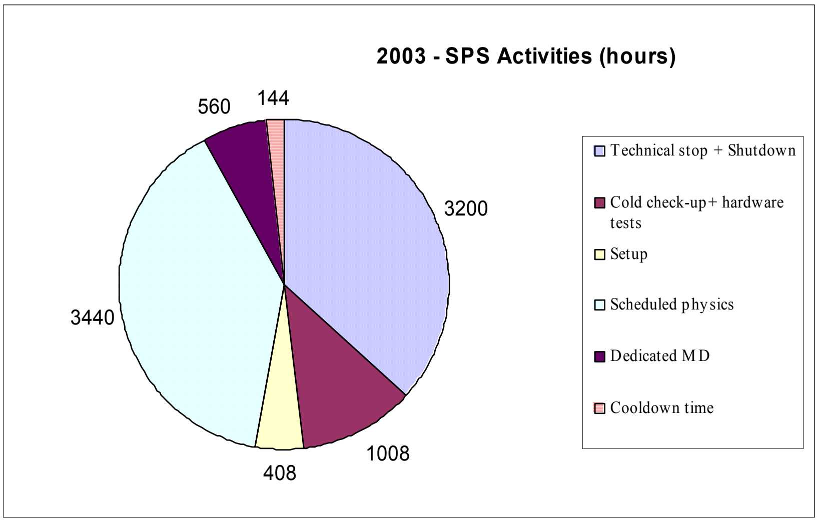
2 . Accelerator activities in hours

Annual Accelerator Activities in hours

	Technical stop + shutdown	Cold Checkup + hadware tests	Setup	Scheduled Physics	Dedicated MD	Cooldown time
PSB	3231 (hours)	504	192	4448	153	232
PS	3123 (hours)	840	276	4136	153	232
SPS	3200	1008	408	3440 * * proton + ions	560	144 ** ** magnet tests


2003 - PSB Activities (hours)
232
153
3231
4448
504
192
Technical stop + Shutdown
Cold check-up+ hardware tests
Setup
Scheduled physics
Dedicated MD
Cooldown time


2003 - PS Activities (hours)
232
153
3123
4136
840
276
Technical stop + Shutdown
Cold check-up+ hardware tests
Setup
Scheduled physics
Dedicated MD
Cooldown time


2003 - SPS Activities (hours)
560
144
3200
3440
1008
408
Technical stop + Shutdown
Cold check-up+ hardware tests
Setup
Scheduled physics
Dedicated MD
Cooldown time

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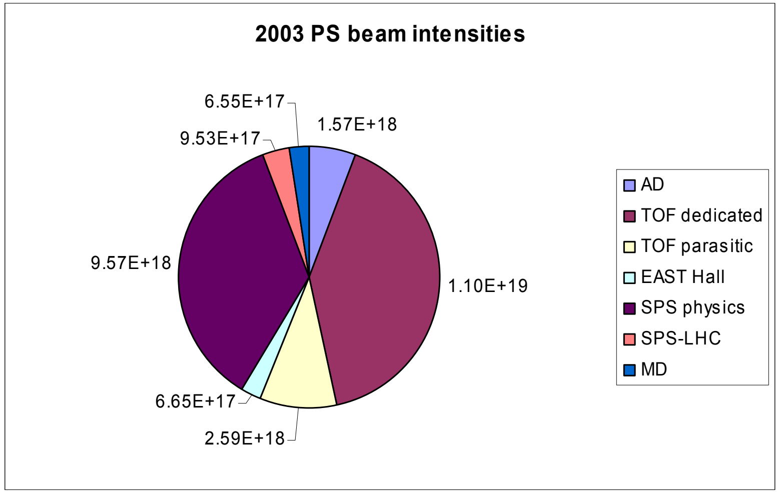
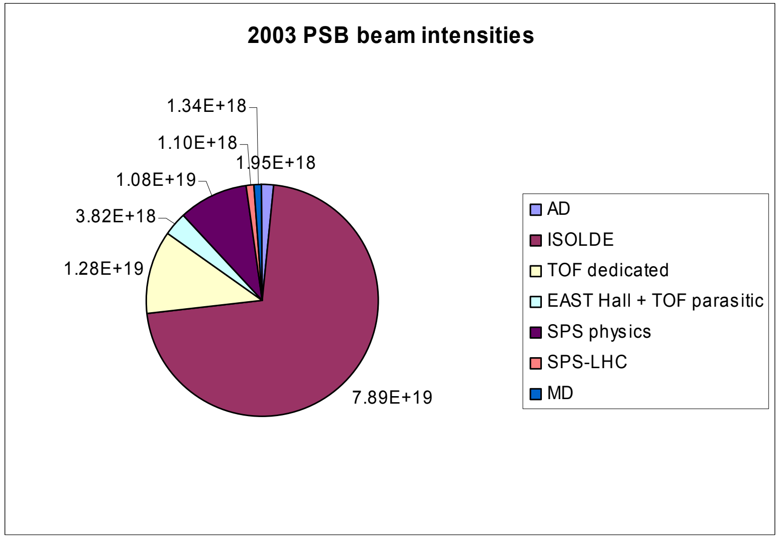
3. Total of Hadrons produced by PSB, PS and SPS (by Users)

2003 - PS beam Intensities	
AD	1.57×10^{18}
TOF dedicated	1.10×10^{19}
TOF parasitic	2.59×10^{18}
EAST Hall	6.65×10^{17}
SPS physics	9.57×10^{18}
SPS-LHC	9.53×10^{17}
MD	6.55×10^{17}
Indium In^{37+} charges	**9.84×10^{15}**



2003 - PSB beam intensities	
AD	1.95×10^{18}
ISOLDE	$7.89 \text{ X } 10^{19}$
TOF dedicated	1.28×10^{19}
EAST Hall + TOF parasitic	3.82×10^{18}
SPS physics	1.08×10^{19}
SPS-LHC	1.10×10^{18}
MD	1.34×10^{18}



2003 SPS beam intensities	
2003 - SPS protons delivered	
West area	0.96×10^{18}
North area	5.14×10^{18}
2003 - SPS ions delivered	
(In^{49+} charges)	
North area	4.2×10^{15}

Total of hadrons produced by PSB, PS, SPS

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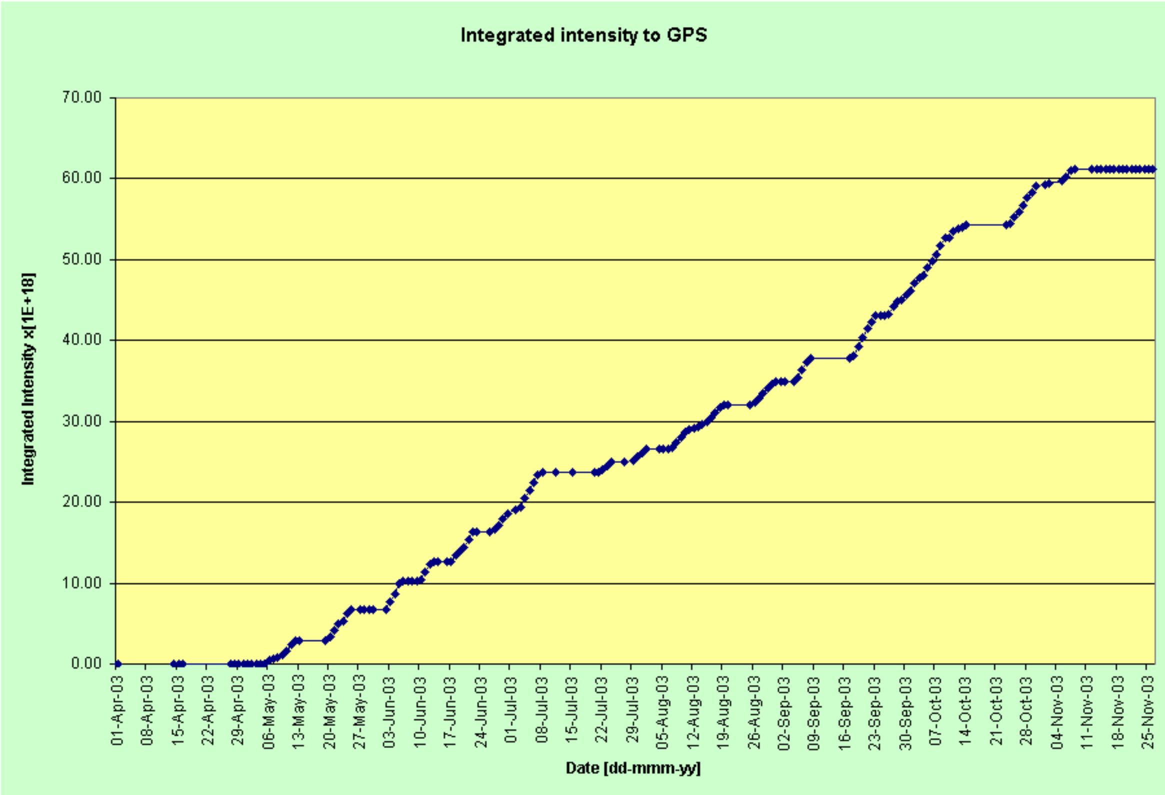
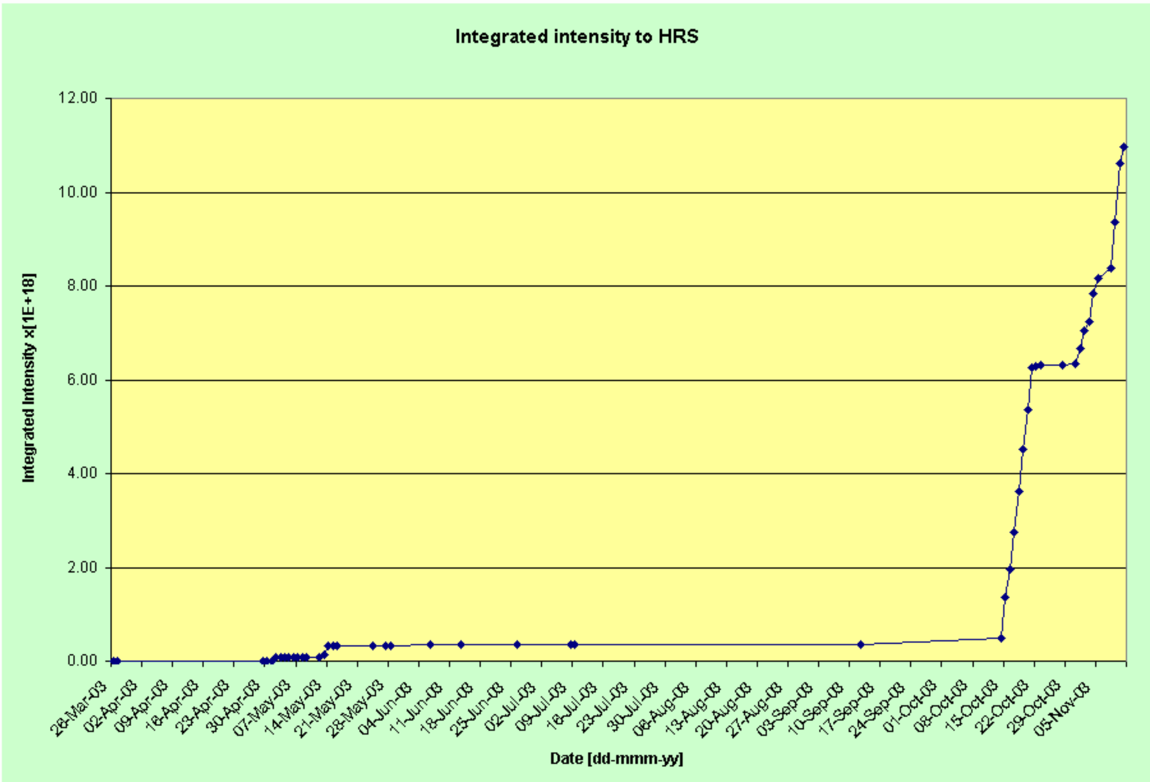
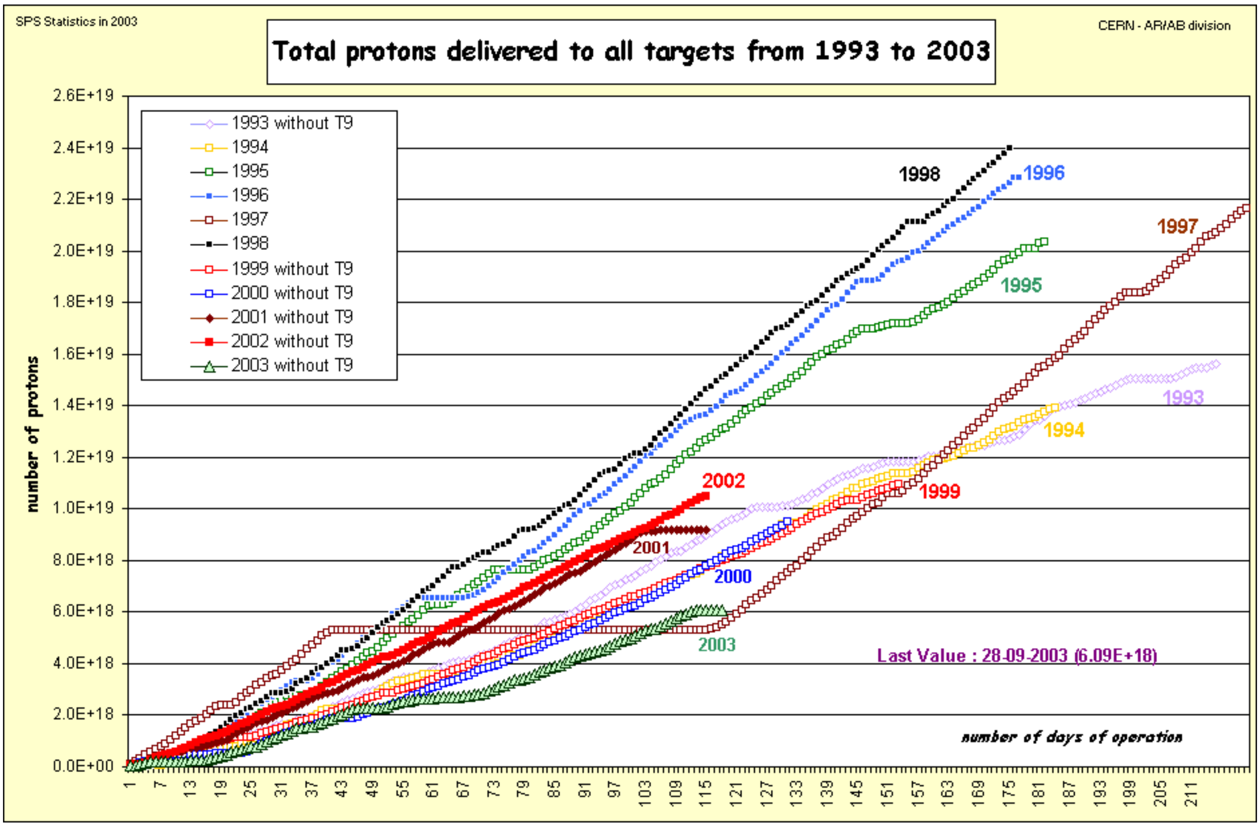
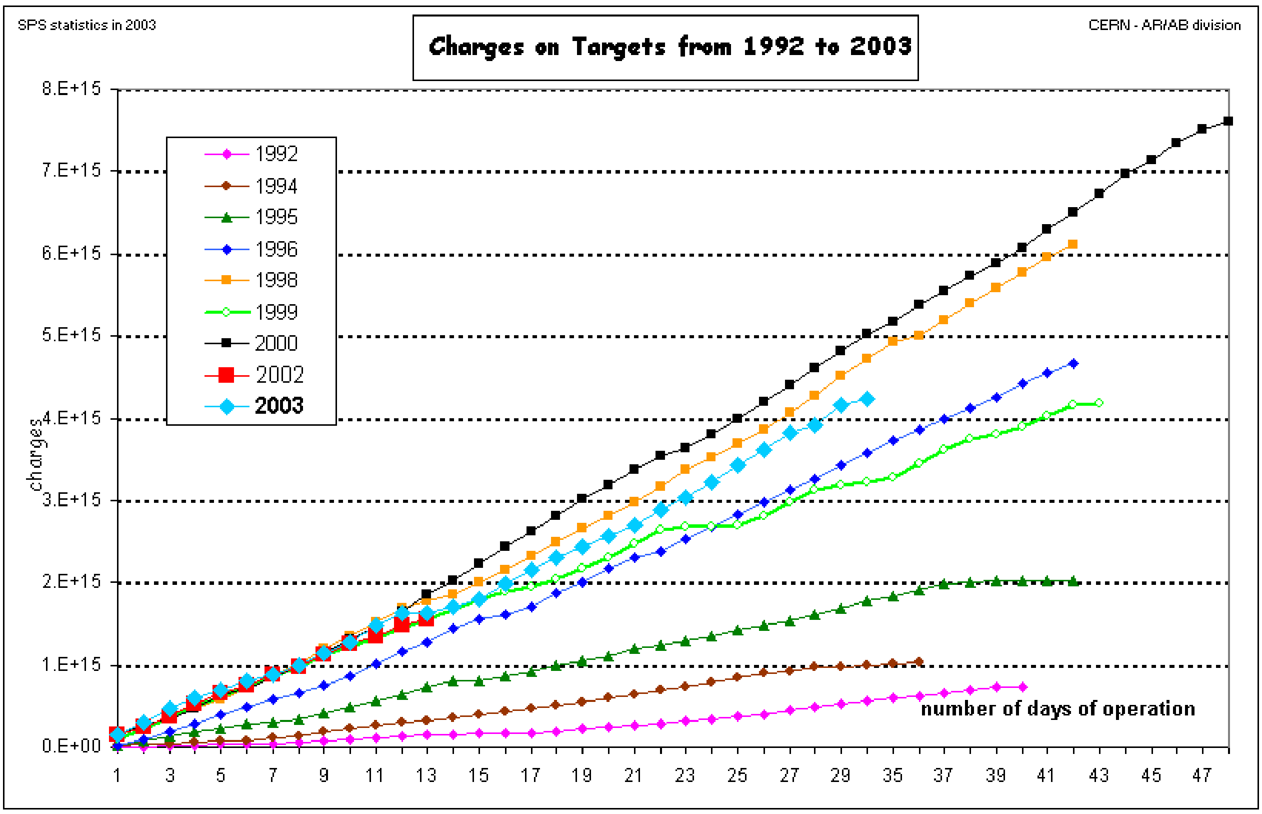
4. Integrated beam intensity for:

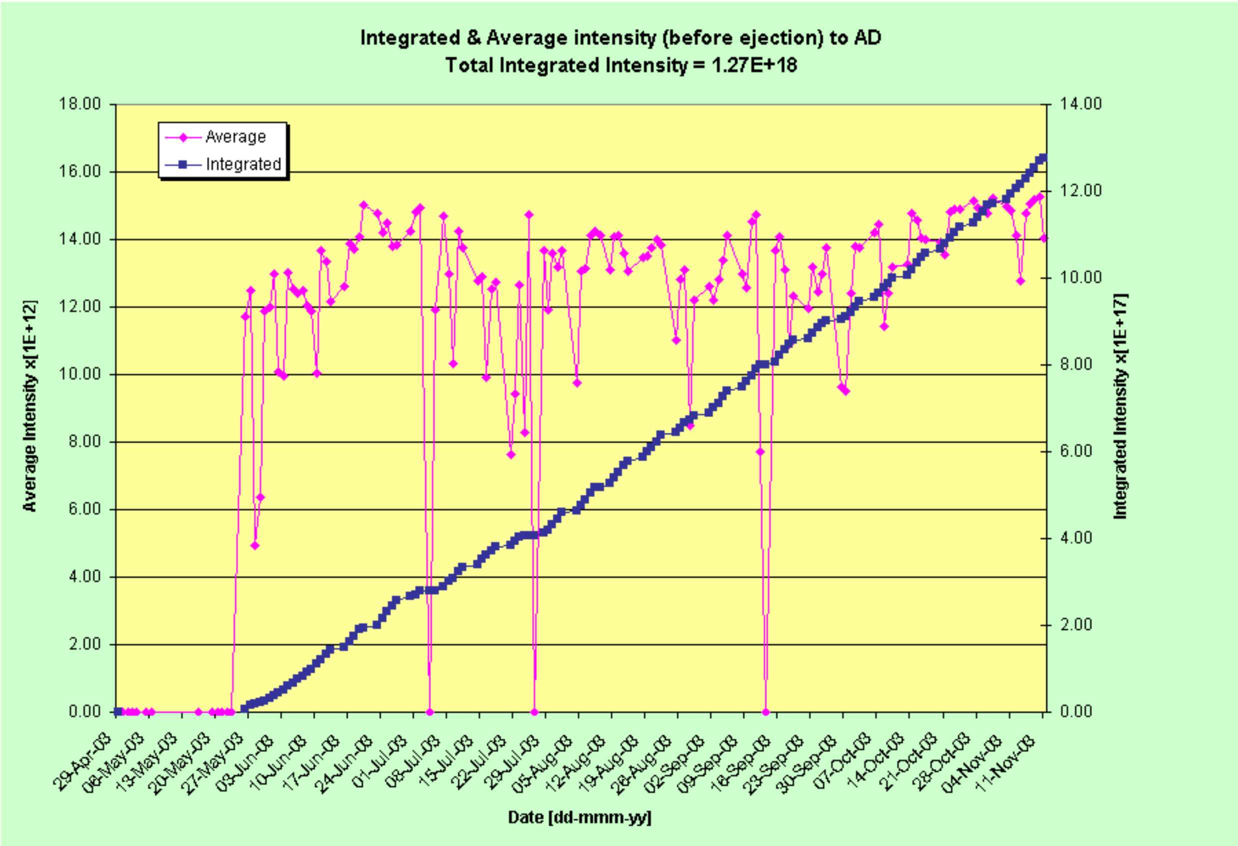
- ISOLDE GPS & HRS
- SPS protons & ions to North and West Areas
- EASTC
- EASTB
- nTOF
- AD (for pbar production)


Integrated intensity to GPS
Integrated Intensity x[1E+18]
Date [dd-mmm-yy]

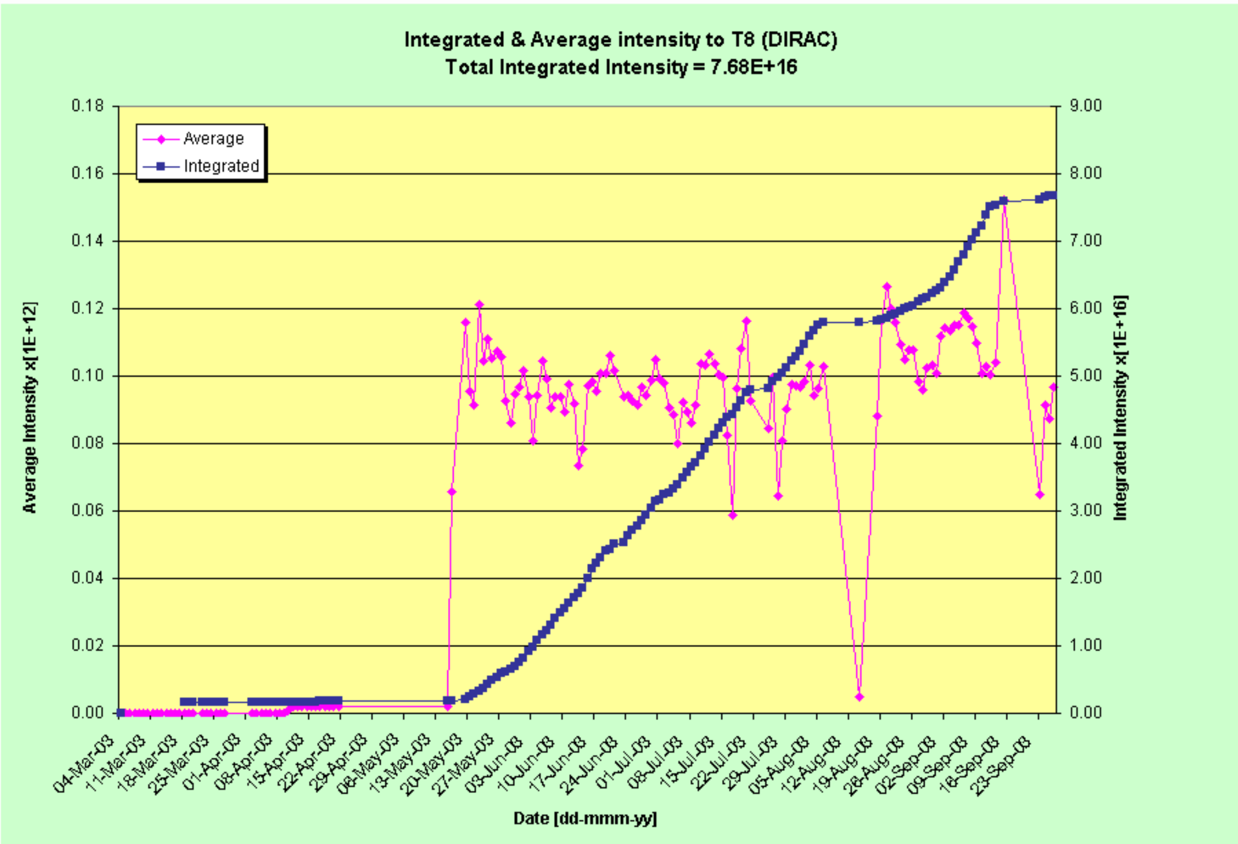

Integrated intensity to HRS
Integrated Intensity x[1E+18]
Date [dd-mmm-yy]


SPS Statistics in 2003
Total protons delivered to all targets from 1993 to 2003
CERN - AR/AB division
number of protons
number of days of operation
Last Value : 28-09-2003 (6.09E+18)
1993 without T9
1994
1995
1996
1997
1998
1999 without T9
2000 without T9
2001 without T9
2002 without T9
2003 without T9

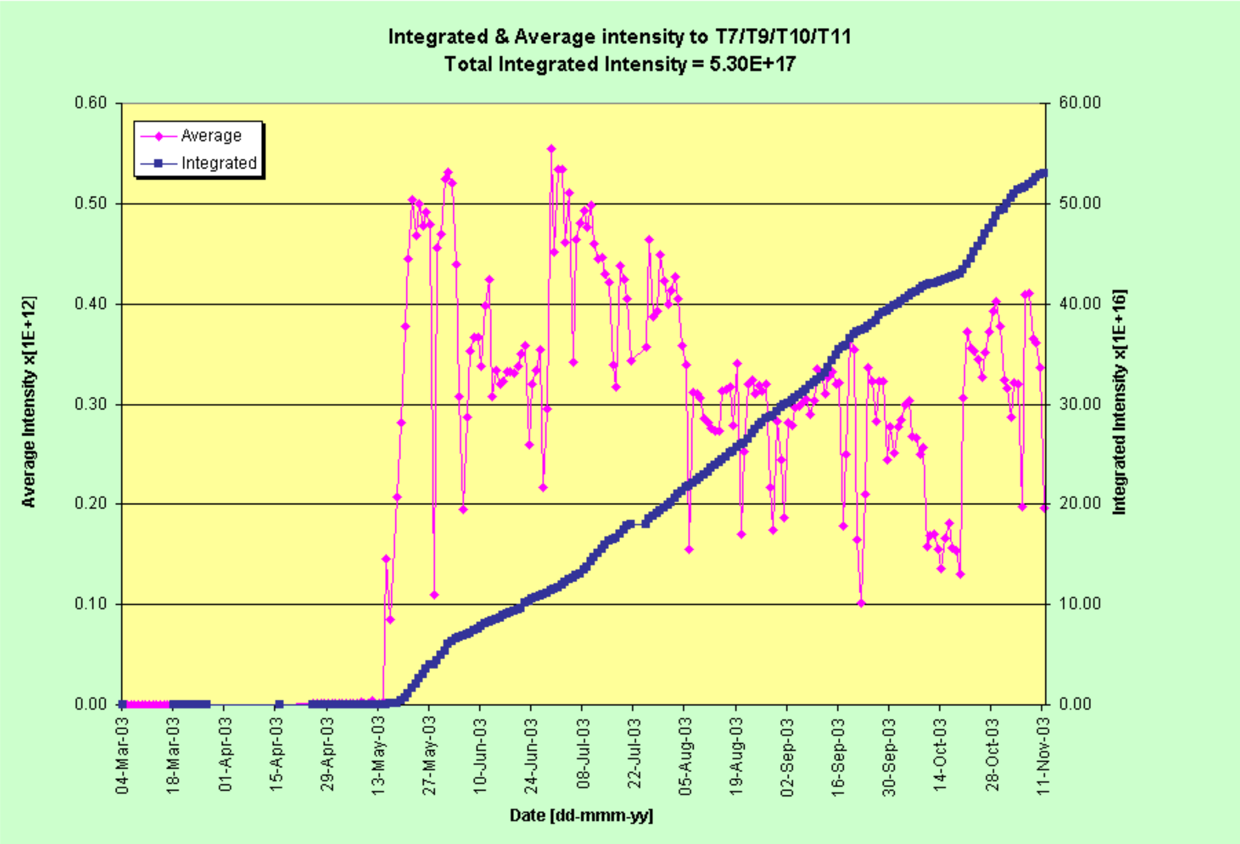

SPS statistics in 2003
Charges on Targets from 1992 to 2003
CERN - AR/AB division
charges
number of days of operation
1992
1994
1995
1996
1998
1999
2000
2002
2003



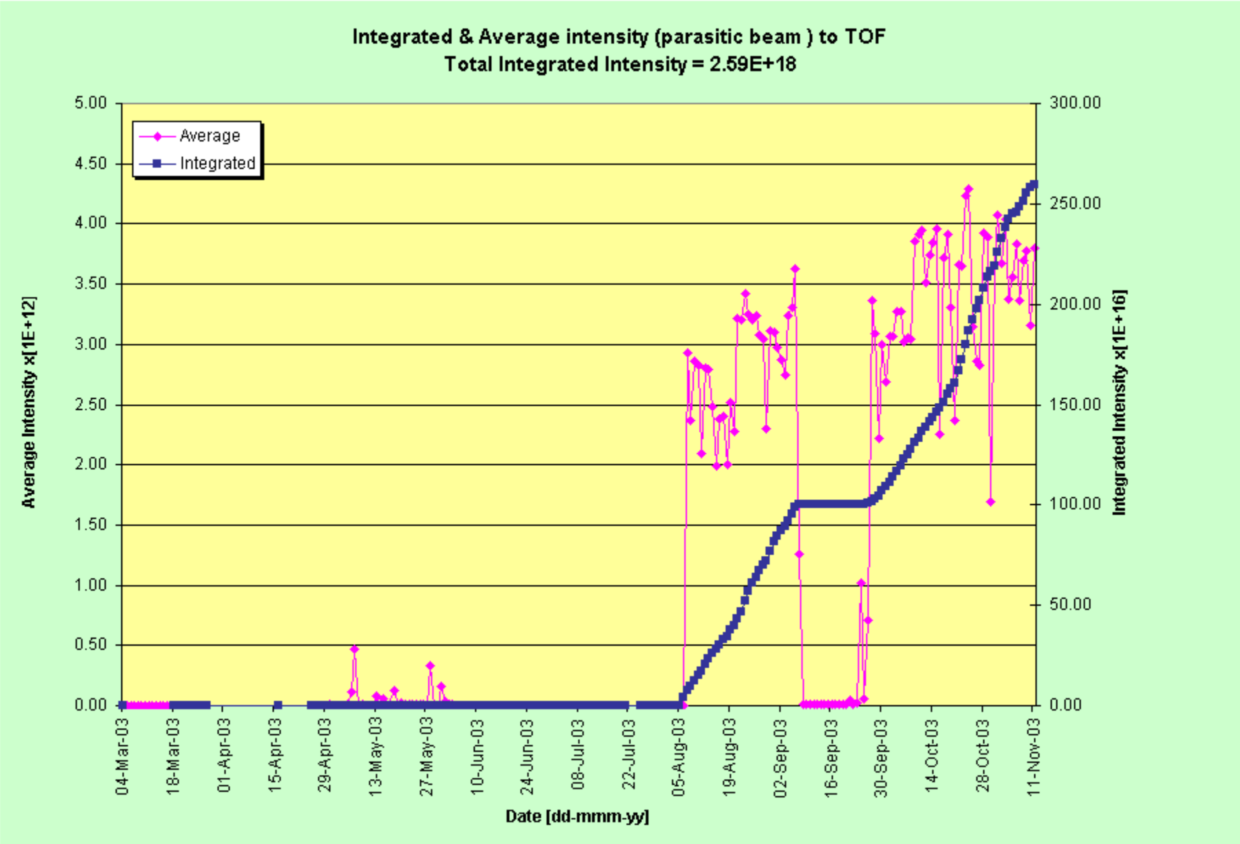
Integrated & Average intensity (before ejection) to AD
Total Integrated Intensity = 1.27E+18
Average
Integrated
Average Intensity x[1E+12]
Integrated Intensity x[1E+17]
Date [dd-mmm-yy]



Integrated & Average intensity to T8 (DIRAC)
Total Integrated Intensity = 7.68E+16
Average
Integrated
Average Intensity x[1E+12]
Integrated Intensity x[1E+16]
Date [dd-mmm-yy]



Integrated & Average intensity to T7/T9/T10/T11
Total Integrated Intensity = 5.30E+17
Average
Integrated
Average Intensity x[1E+12]
Integrated Intensity x[1E+16]
Date [dd-mmm-yy]
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.00
10.00
20.00
30.00
40.00
50.00
60.00
04-Mar-03
18-Mar-03
01-Apr-03
15-Apr-03
29-Apr-03
13-May-03
27-May-03
10-Jun-03
24-Jun-03
08-Jul-03
22-Jul-03
05-Aug-03
19-Aug-03
02-Sep-03
16-Sep-03
30-Sep-03
14-Oct-03
28-Oct-03
11-Nov-03



Integrated & Average intensity (parasitic beam) to TOF
Total Integrated Intensity = 2.59E+18
Average
Integrated
Average Intensity x[1E+12]
Integrated Intensity x[1E+16]
Date [dd-mmm-yy]
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
04-Mar-03
18-Mar-03
01-Apr-03
15-Apr-03
29-Apr-03
13-May-03
27-May-03
10-Jun-03
24-Jun-03
08-Jul-03
22-Jul-03
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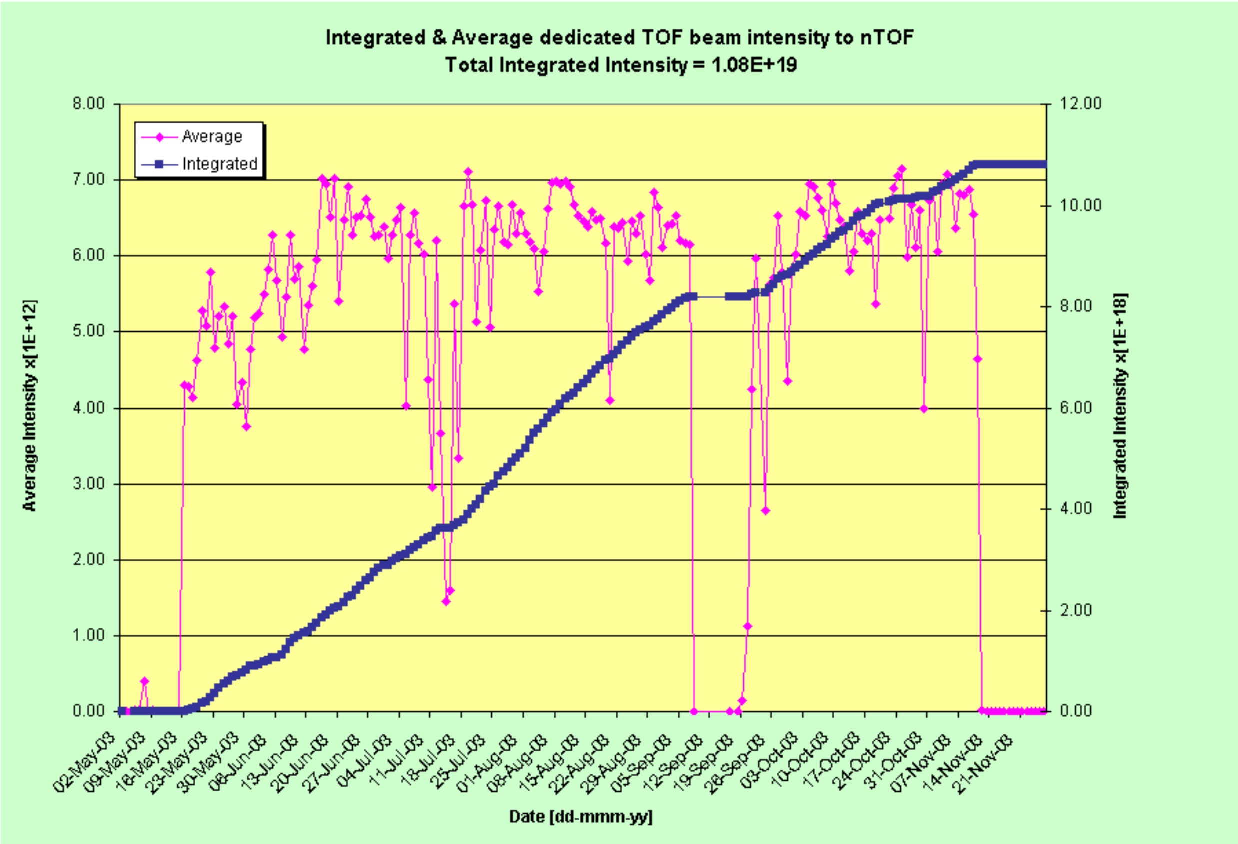
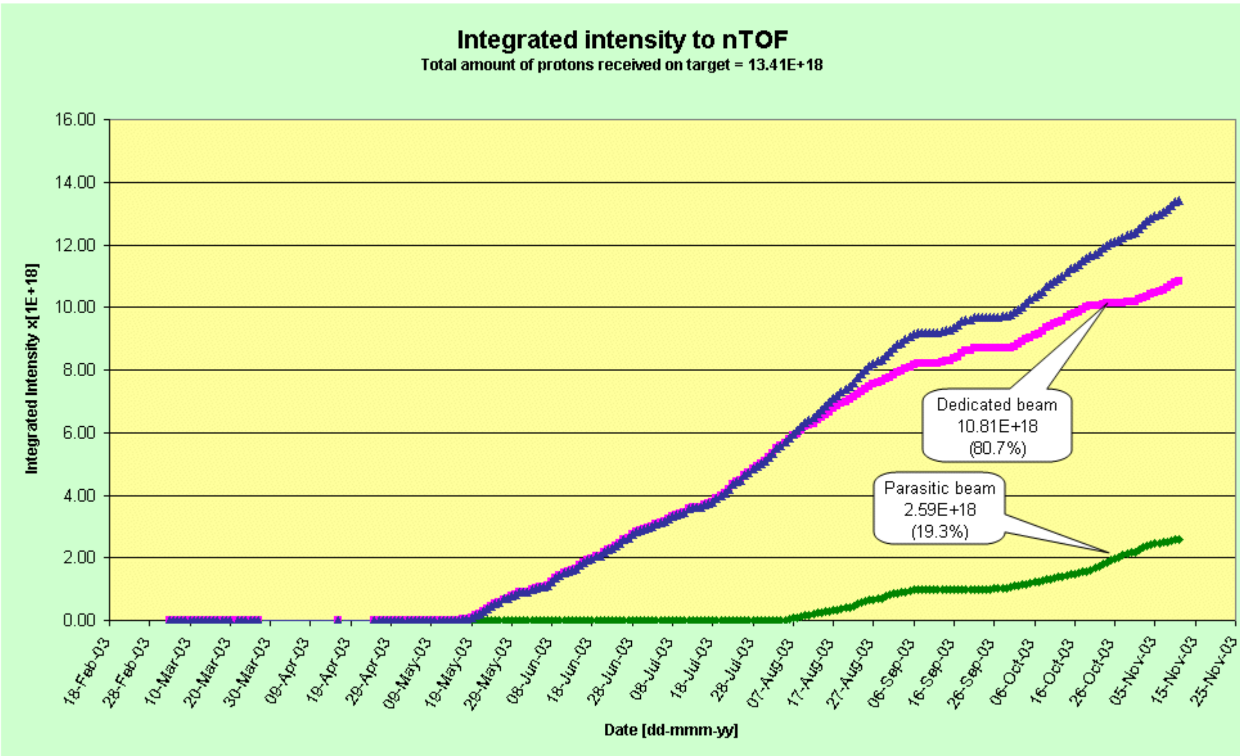
02-Sep-03
16-Sep-03
30-Sep-03
14-Oct-03
28-Oct-03
11-Nov-03



Integrated & Average dedicated TOF beam intensity to nTOF
Total Integrated Intensity = 1.08E+19
Average
Integrated
Average Intensity x[1E+12]
Integrated Intensity x[1E+18]
Date [dd-mmm-yy]



Integrated intensity to nTOF
Total amount of protons received on target = 13.41E+18
Dedicated beam
10.81E+18
(80.7%)
Parasitic beam
2.59E+18
(19.3%)
Integrated Intensity x[1E+18]
Date [dd-mmm-yy]

5. Annual beam availabilities (LIN, PSB, PS faults) :

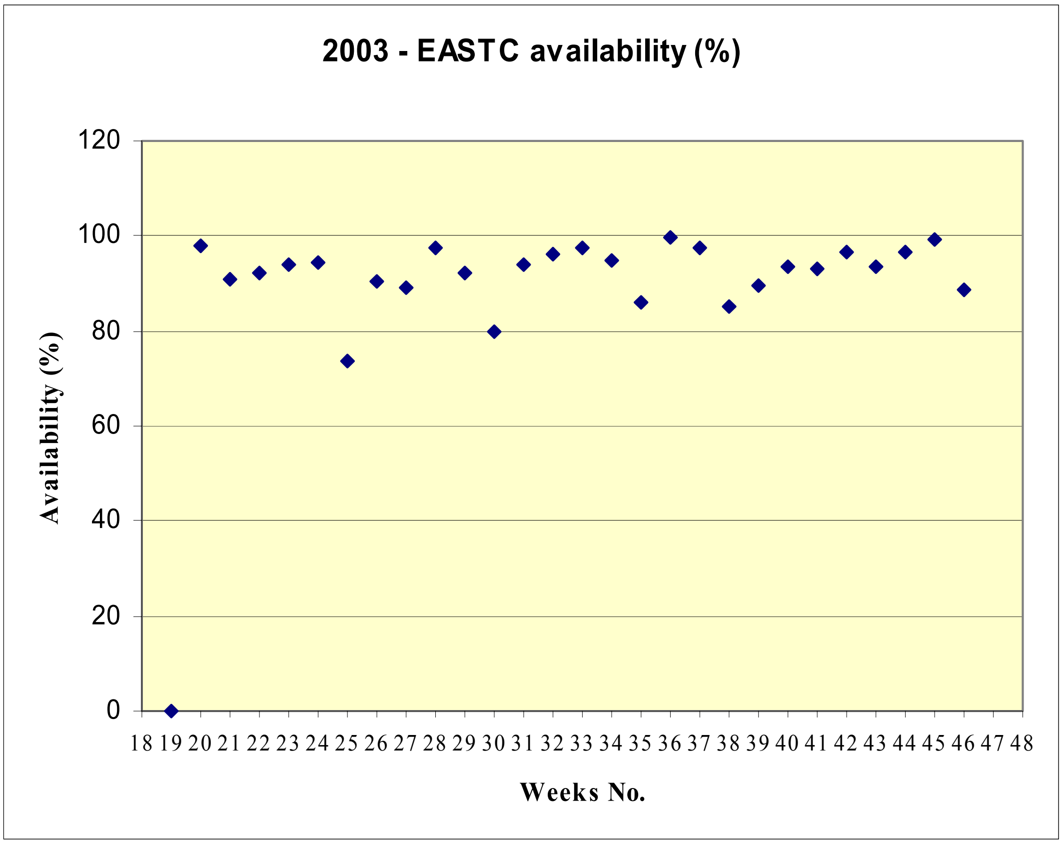
- ISOLDE GPS & HRS
- EASTC
- EASTB
- nTOF
- AD (for pbar production)
- SPS protons & ions to North and West Areas

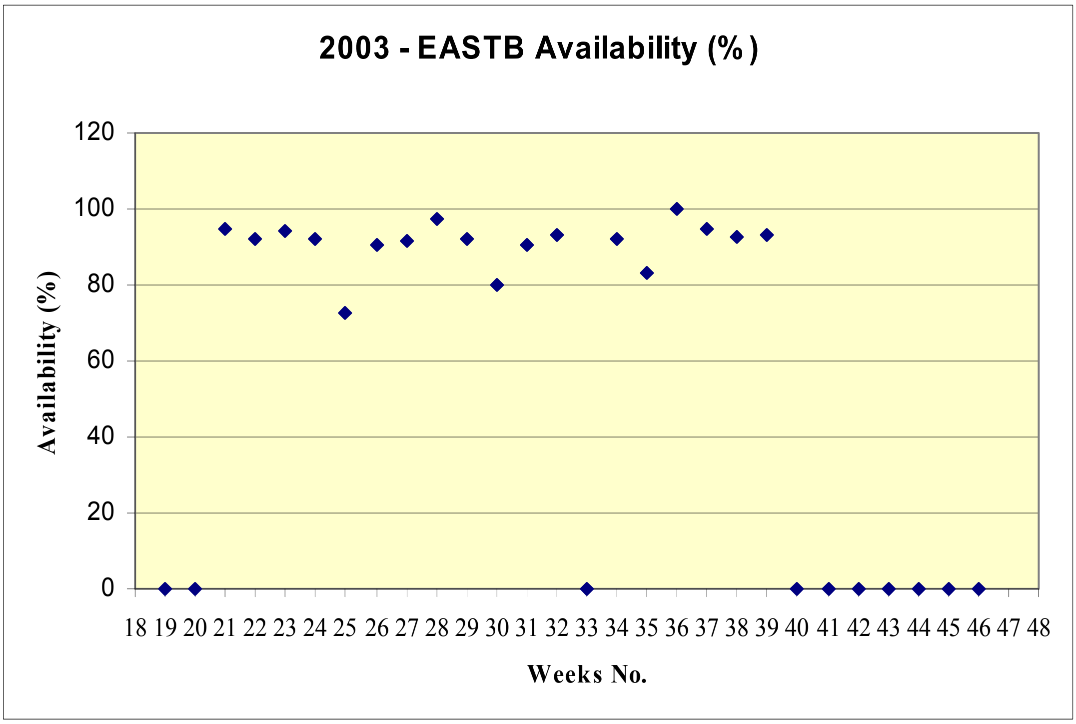
Annual Accelerator Operation Beam Availabilities

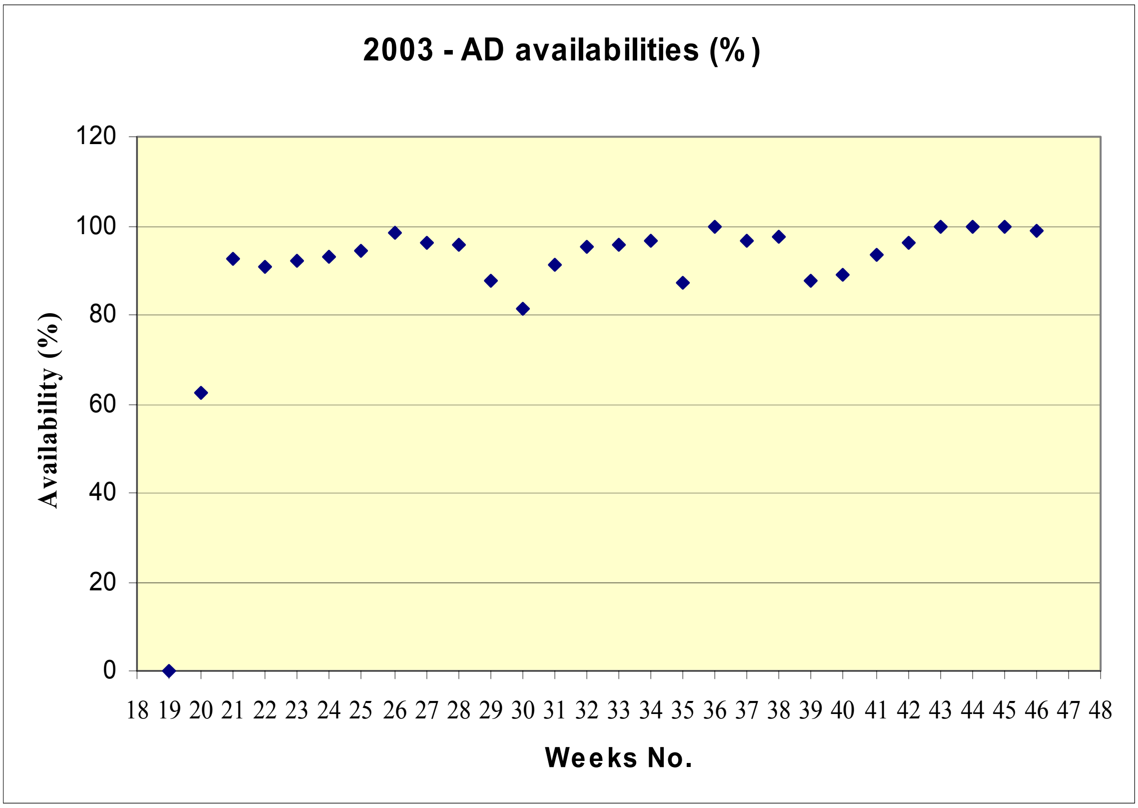
	ISOLDE GPS	ISOLDE HRS	EASTC	EASTB	TOF	AD	SFTPRO	SFTION
PSB	95.08%	98.17%	97.20%	96.77%	96.94%	97.03%	96.21%	94.76%
PS	none	none	92.61%	90.98%	93.03%	93.95%	93.20%	91.19%
AD	none	none	none	none	none	89.81%	none	none
SPS					North Area		72.60%	89.77%
					West Area		83.73%	none

6. Weekly beam availabilities (LIN, PSB, PS & AD faults) :

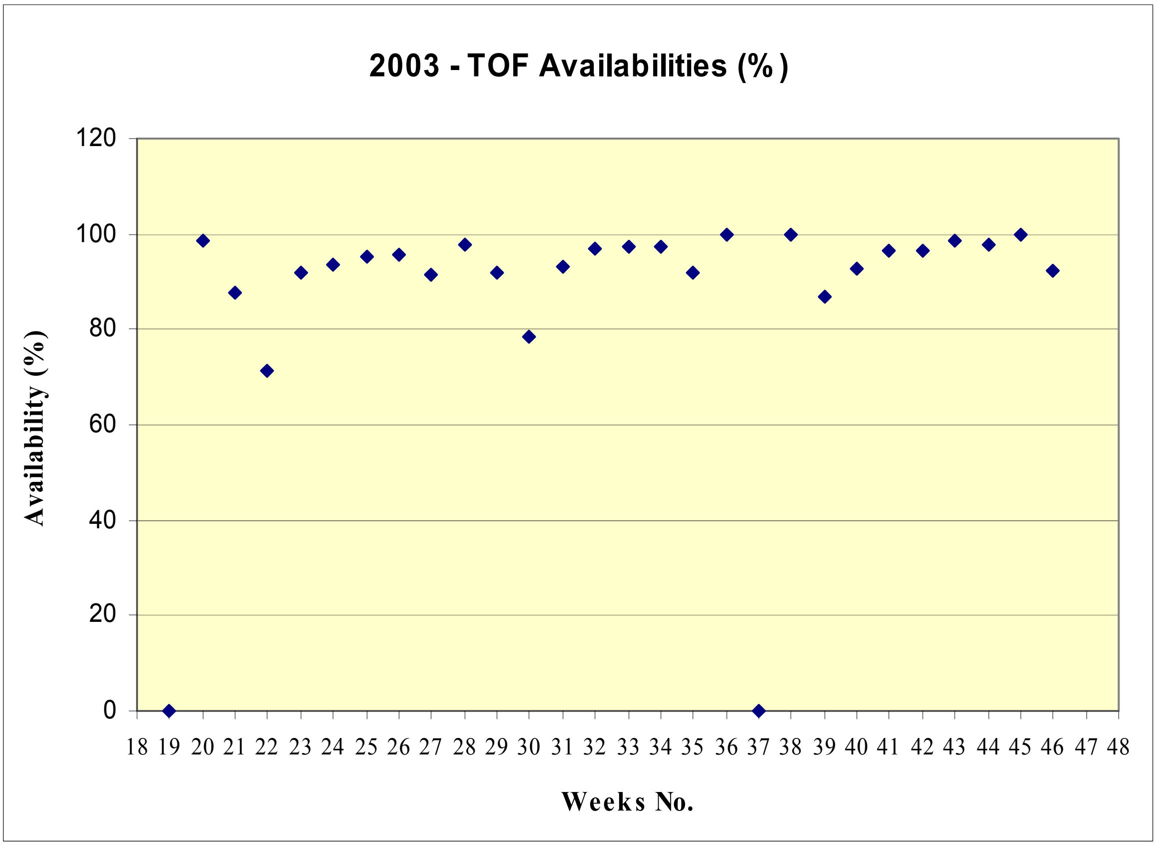
- ISOLDE GPS & HRS
- EASTC
- EASTB
- nTOF
- AD (for pbar production)


2003 - EASTC availability (%)
Availability (%)
120
100
80
60
40
20
0
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Weeks No.

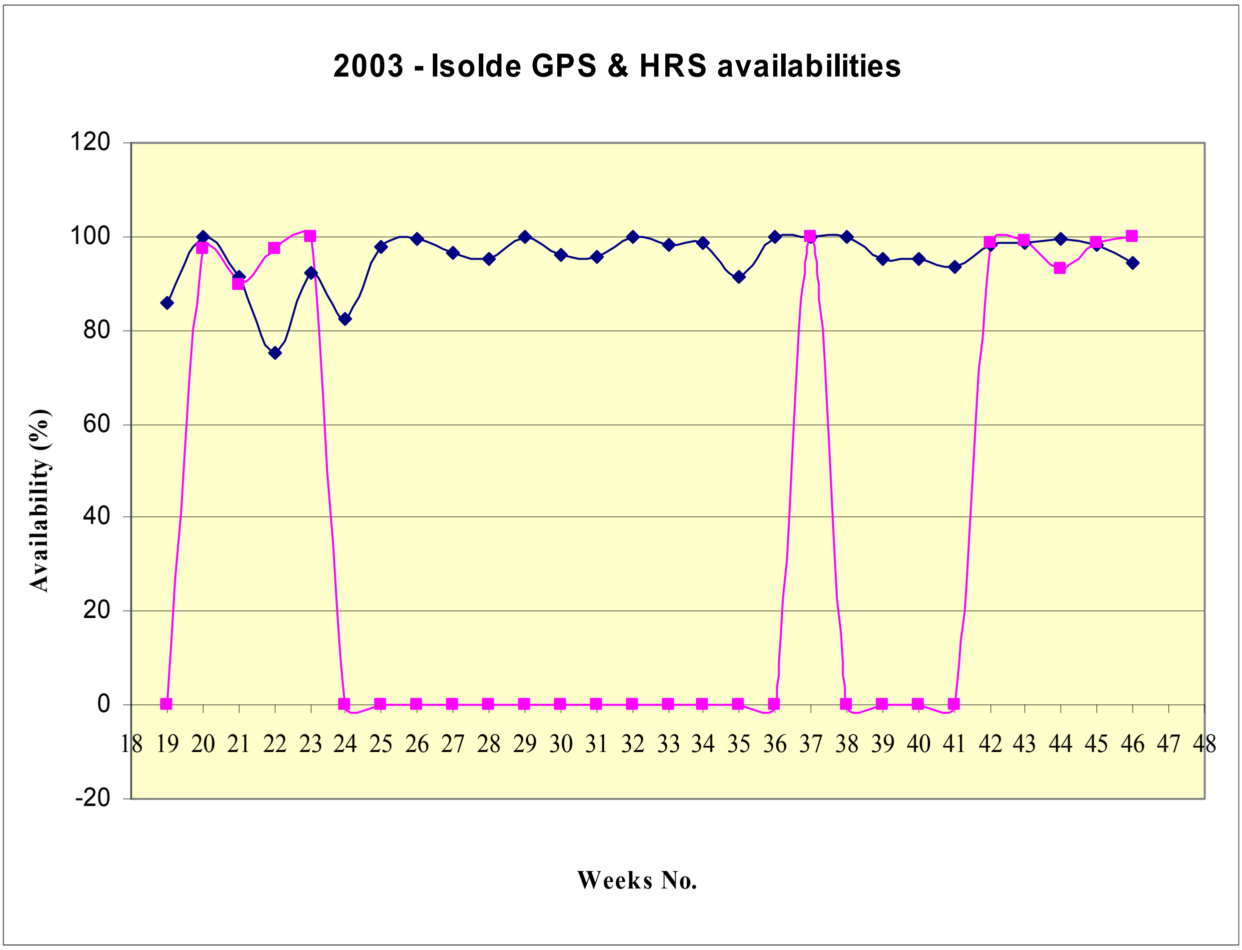

2003 - EASTB Availability (%)
Availability (%)
120
100
80
60
40
20
0
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Weeks No.



2003 - AD availabilities (%)
120
100
80
60
40
20
0
Availability (%)
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Weeks No.



2003 - TOF Availabilities (%)
120
100
80
60
40
20
0
Availability (%)
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Weeks No.


2003 - Isolde GPS & HRS availabilities
Availability (%)
120
100
80
60
40
20
0
-20
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Weeks No.

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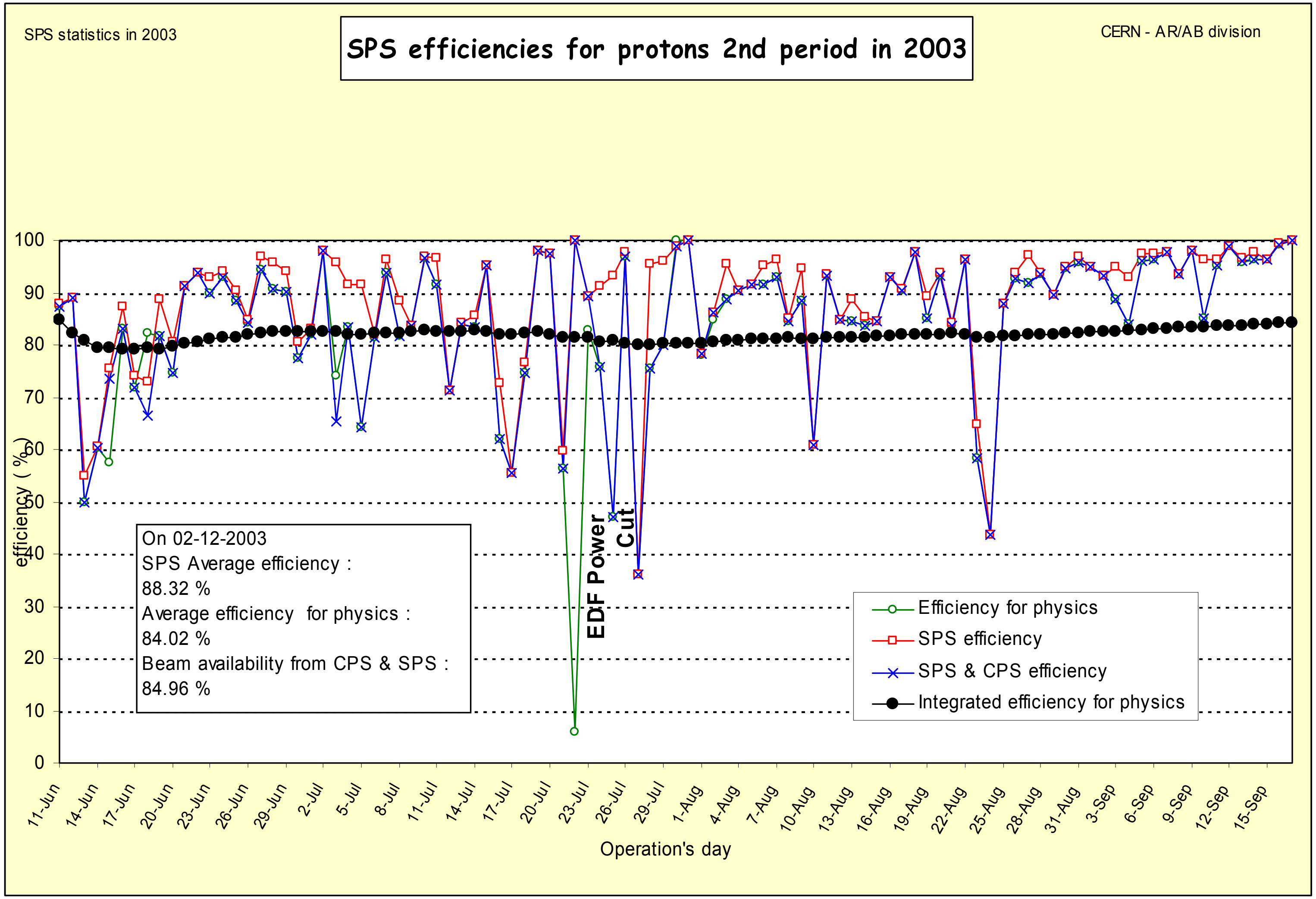
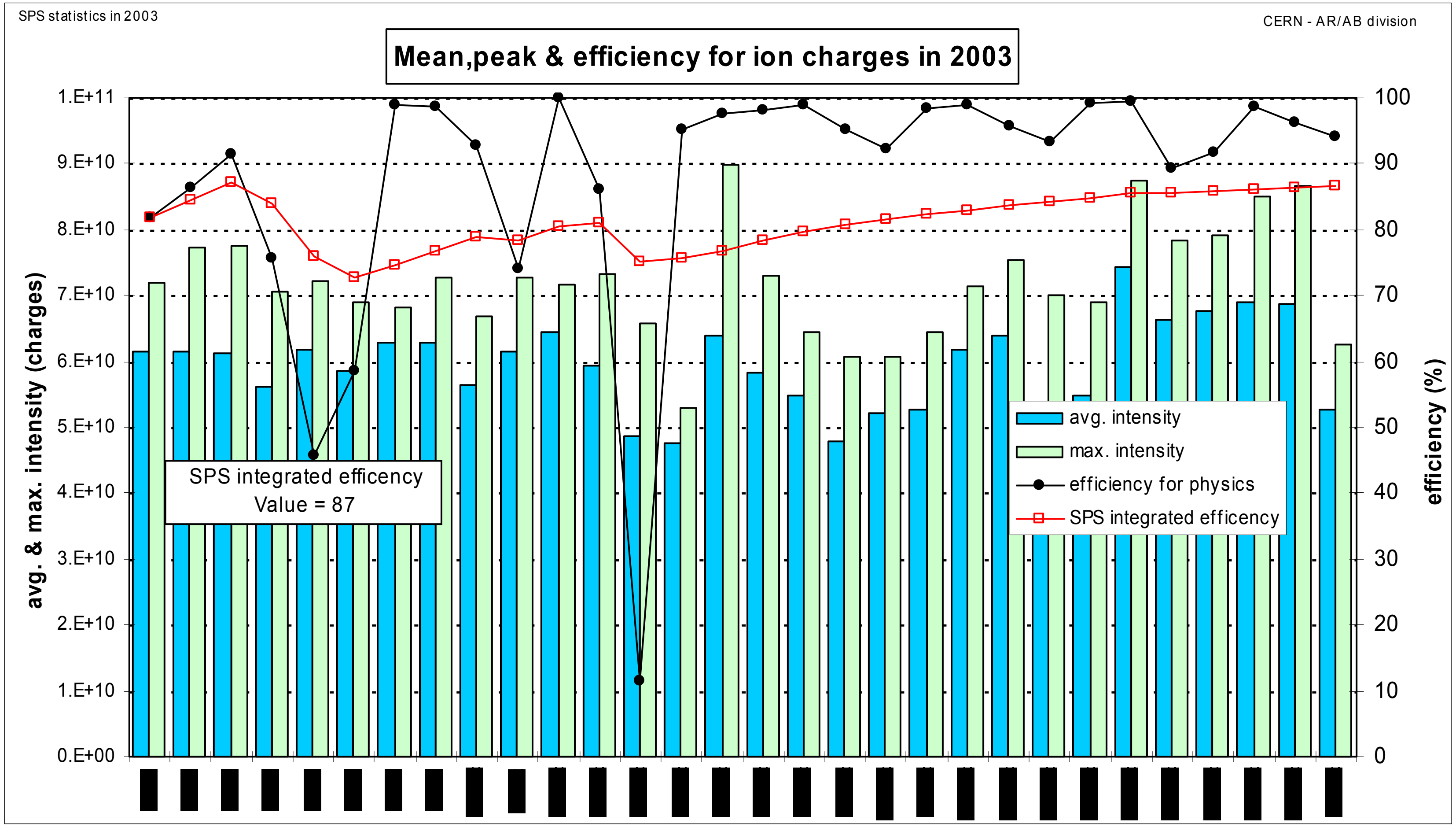
7. SPS daily efficiencies (protons & ions)


SPS statistics in 2003
SPS efficiencies for protons 2nd period in 2003
CERN - AR/AB division
efficiency (%)
Operation's day
EDF Power Cut
On 02-12-2003
SPS Average efficiency :
88.32 %
Average efficiency for physics :
84.02 %
Beam availability from CPS & SPS :
84.96 %
Efficiency for physics
SPS efficiency
SPS & CPS efficiency
Integrated efficiency for physics


SPS statistics in 2003
CERN - AR/AB division
Mean,peak & efficiency for ion charges in 2003
avg. & max. intensity (charges)
efficiency (%)
1.E+11
9.E+10
8.E+10
7.E+10
6.E+10
5.E+10
4.E+10
3.E+10
2.E+10
1.E+10
0.E+00
100
90
80
70
60
50
40
30
20
10
0
SPS integrated efficency
Value = 87
avg. intensity
max. intensity
efficiency for physics
SPS integrated efficency

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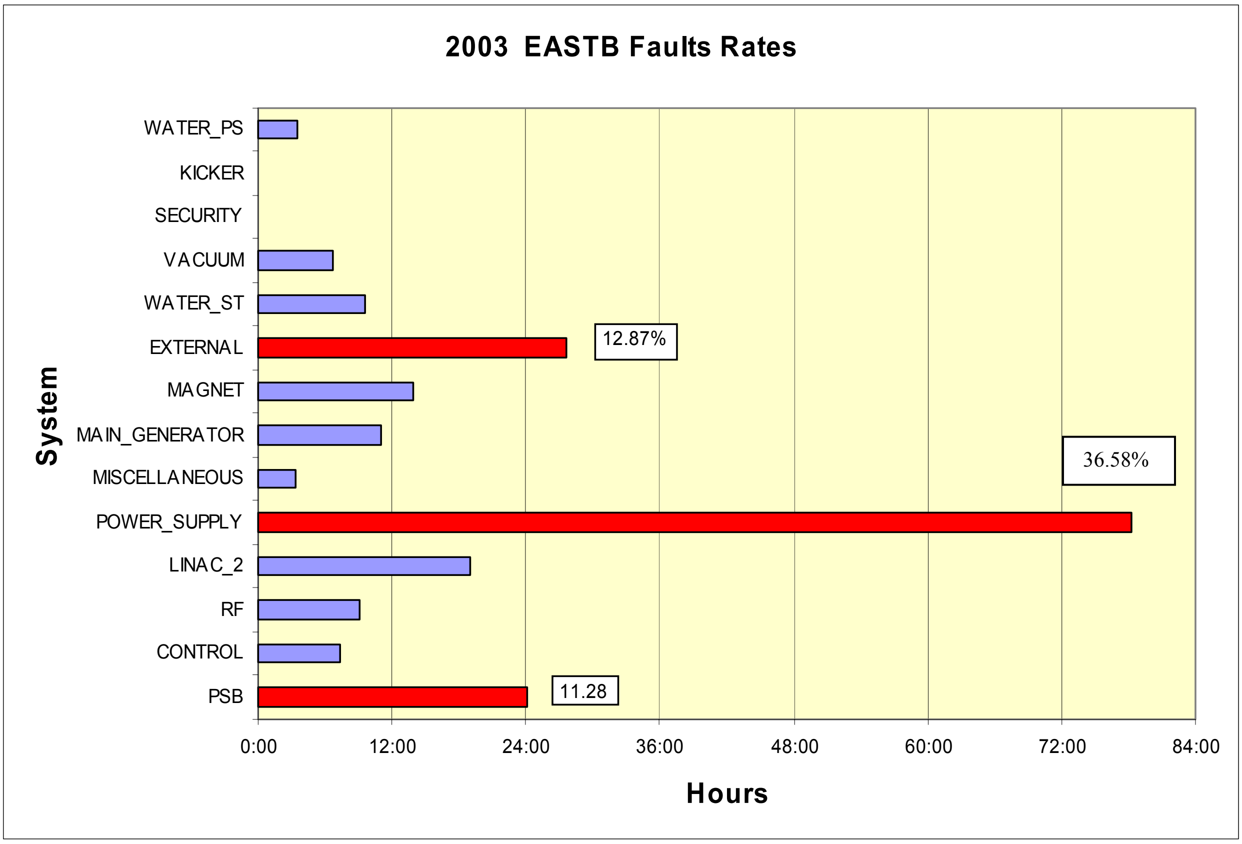
8. Fault analysis (breakdowns by category) for :

- PSB
- PS
- AD
- ISOLDE GPS & HRS
- TOF
- SPS (protons & ions)

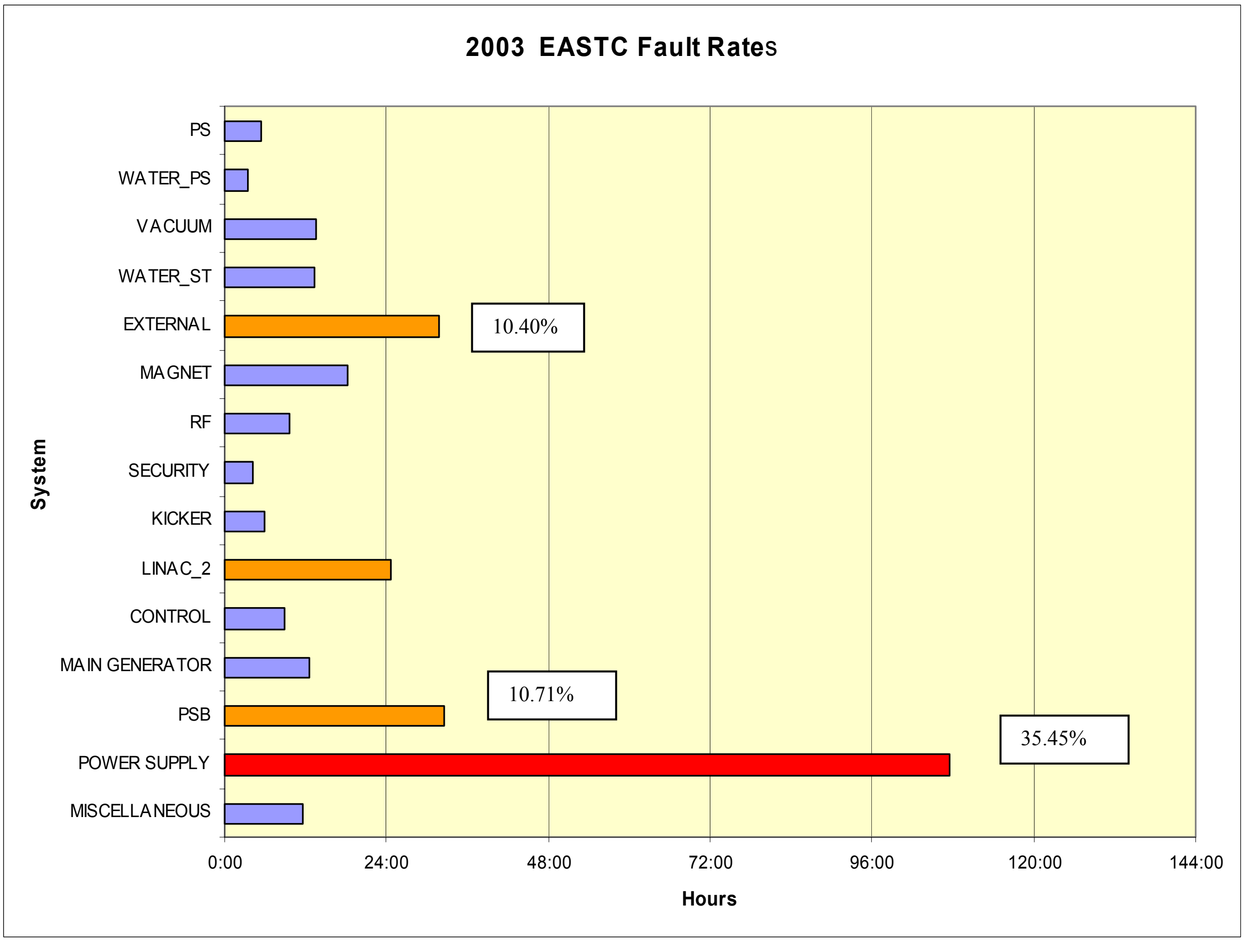
2003 - EASTB ANNUAL FAULT RATES

Faults Groups	active	percentage
PSB	24:09:16	11.28
CONTROL	7:20:10	3.43
RF	9:06:48	4.26
LINAC_2	19:03:38	8.9
POWER_SUPPLY	78:19:49	36.58
MISCELLANEOUS	3:25:13	1.6
MAIN_GENERATOR	10:56:50	5.11
MAGNET	13:54:57	6.5
EXTERNAL	27:33:35	12.87
WATER_ST	9:38:26	4.5
VACUUM	6:45:00	3.15
SECURITY	0:11:00	0.09
KICKER	0:12:58	0.1
WATER_PS	3:30:00	1.63



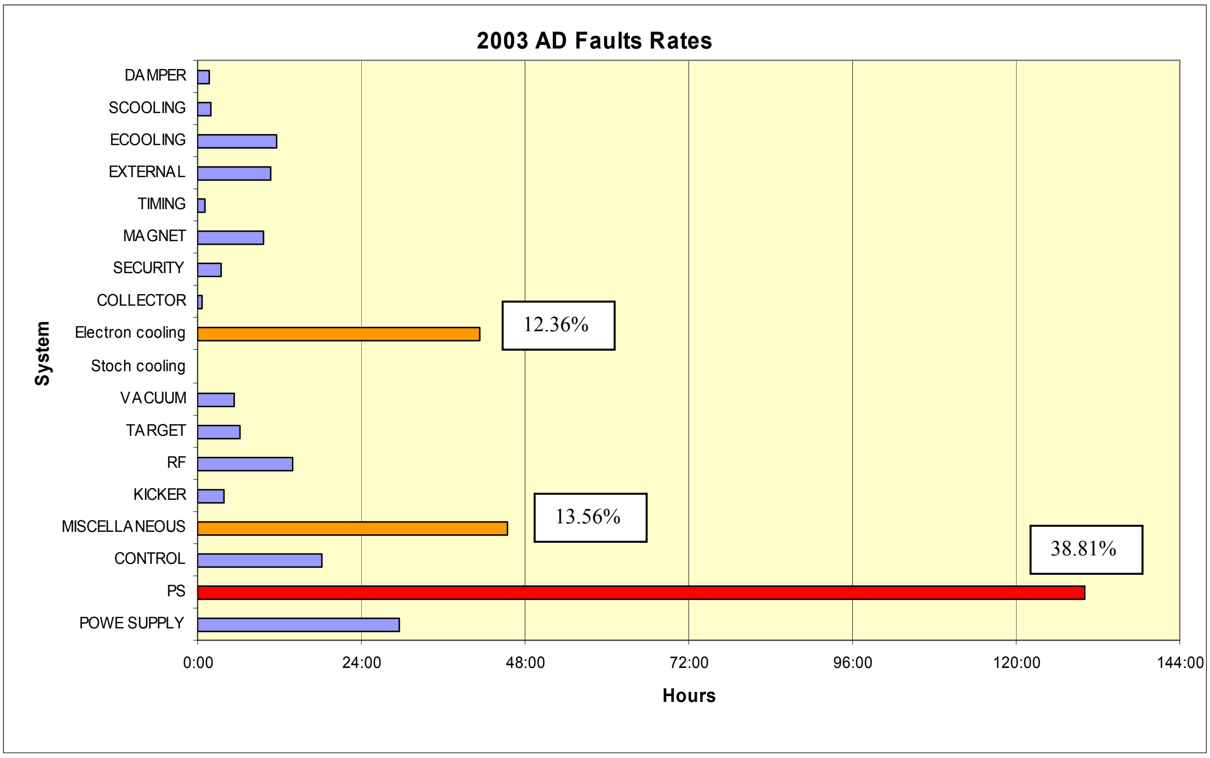
2003 - EASTC ANNUAL FAULT RATES

Faults Groups	active	percentage
MISCELLANEOUS	11:42:43	3.86
POWER SUPPLY	107:31:27	35.45
PSB	32:29:42	10.71
MAIN GENERATOR	12:30:55	4.13
CONTROL	8:59:47	2.97
LINAC_2	24:44:58	8.16
KICKER	5:59:07	1.97
SECURITY	4:09:04	1.37
RF	9:36:05	3.17
MAGNET	18:09:39	5.99
EXTERNAL	31:48:28	10.49
WATER_ST	13:12:39	4.36
VACUUM	13:29:05	4.45
WATER_PS	3:30:00	1.15
PS	5:24:04	1.78

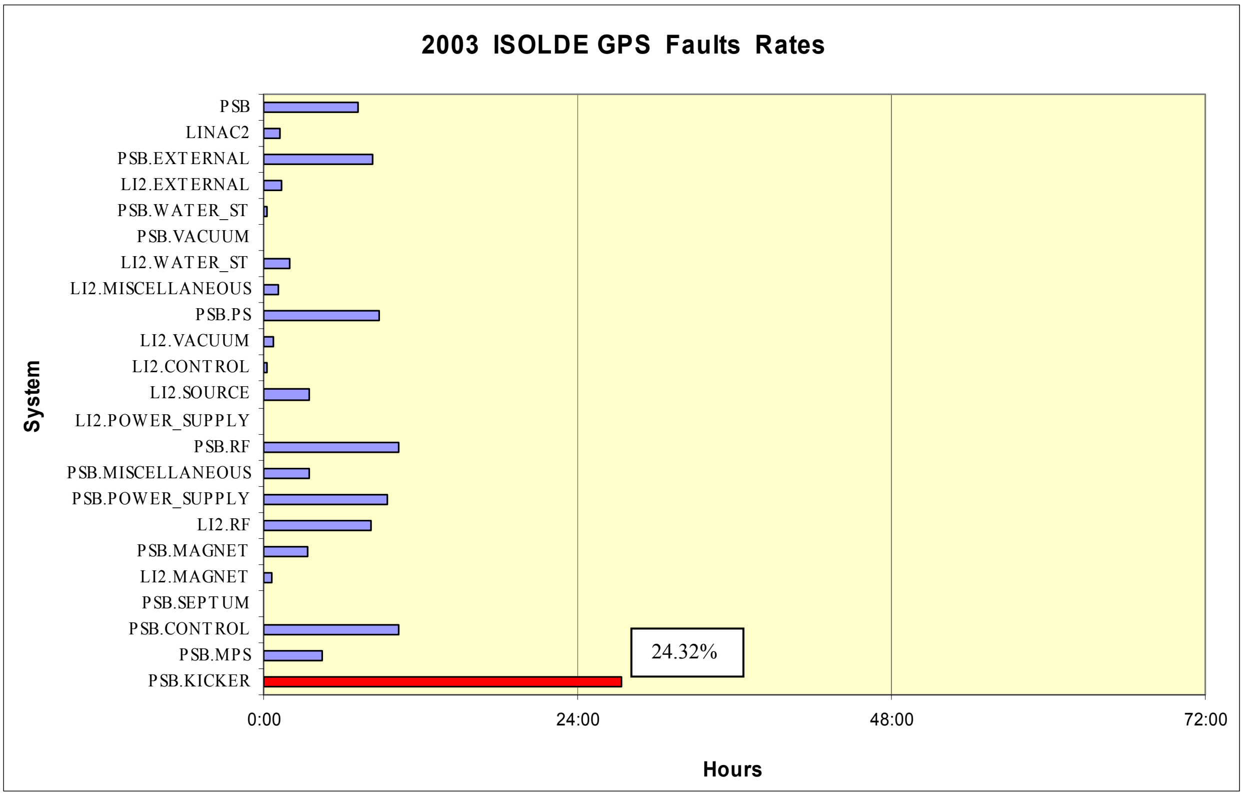


2003 - AD Annual Fault Rates

Faults Groups	active	percentage (%)
POWE SUPPLY	29:40:33	8.85
PS	130:07:00	38.81
CONTROL	18:11:58	5.43
MISCELLANEOUS	45:27:58	13.56
KICKER	3:55:18	1.17
RF	13:54:31	4.15
TARGET	6:08:12	1.83
VACUUM	5:26:34	1.62
Stoch cooling	0:11:00	0.05
Electron cooling	41:27:00	12.36
COLLECTOR	0:36:00	0.18
SECURITY	3:23:45	1.01
MAGNET	9:38:00	2.87
TIMING	1:03:41	0.32
EXTERNAL	10:45:17	3.21
ECOOLING	11:35:59	3.46
SCOOLING	1:57:01	0.58
DAMPER	1:45:00	0.52

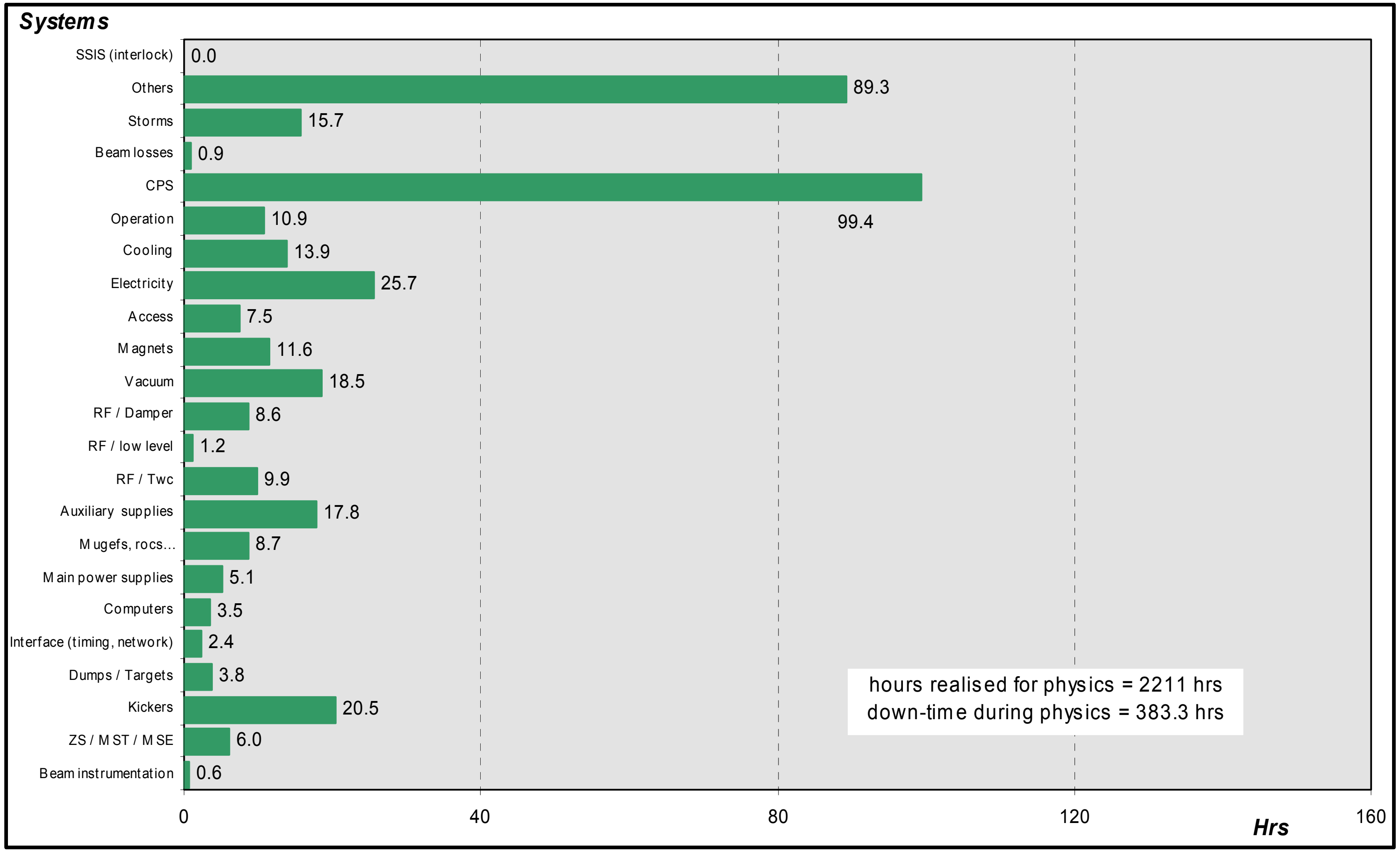


Faults Groups	active	percentage
PSB.KICKER	27:22:29	24.32
PSB.MPS	4:25:00	3.92
PSB.CONTROL	10:16:00	9.12
PSB.SEPTUM	0:05:00	0.07
LI2.MAGNET	0:36:00	0.53
PSB.MAGNET	3:22:48	3
LI2.RF	8:09:29	7.25
PSB.POWER_SUPPLY	9:29:31	8.43
PSB.MISCELLANEOUS	3:30:52	3.12
PSB.RF	10:19:00	9.17
LI2.POWER_SUPPLY	0:04:00	0.06
LI2.SOURCE	3:30:00	3.11
LI2.CONTROL	0:15:00	0.22
LI2.VACUUM	0:47:39	0.71
PSB.PS	8:48:40	7.83
LI2.MISCELLANEOUS	1:09:00	1.02
LI2.WATER_ST	1:56:00	1.72
PSB.VACUUM	0:03:00	0.04
PSB.WATER_ST	0:15:00	0.22
LI2.EXTERNAL	1:24:20	1.25
PSB.EXTERNAL	8:20:06	7.41
LINAC2	1:12:04	1.07
PSB	7:12:09	6.4



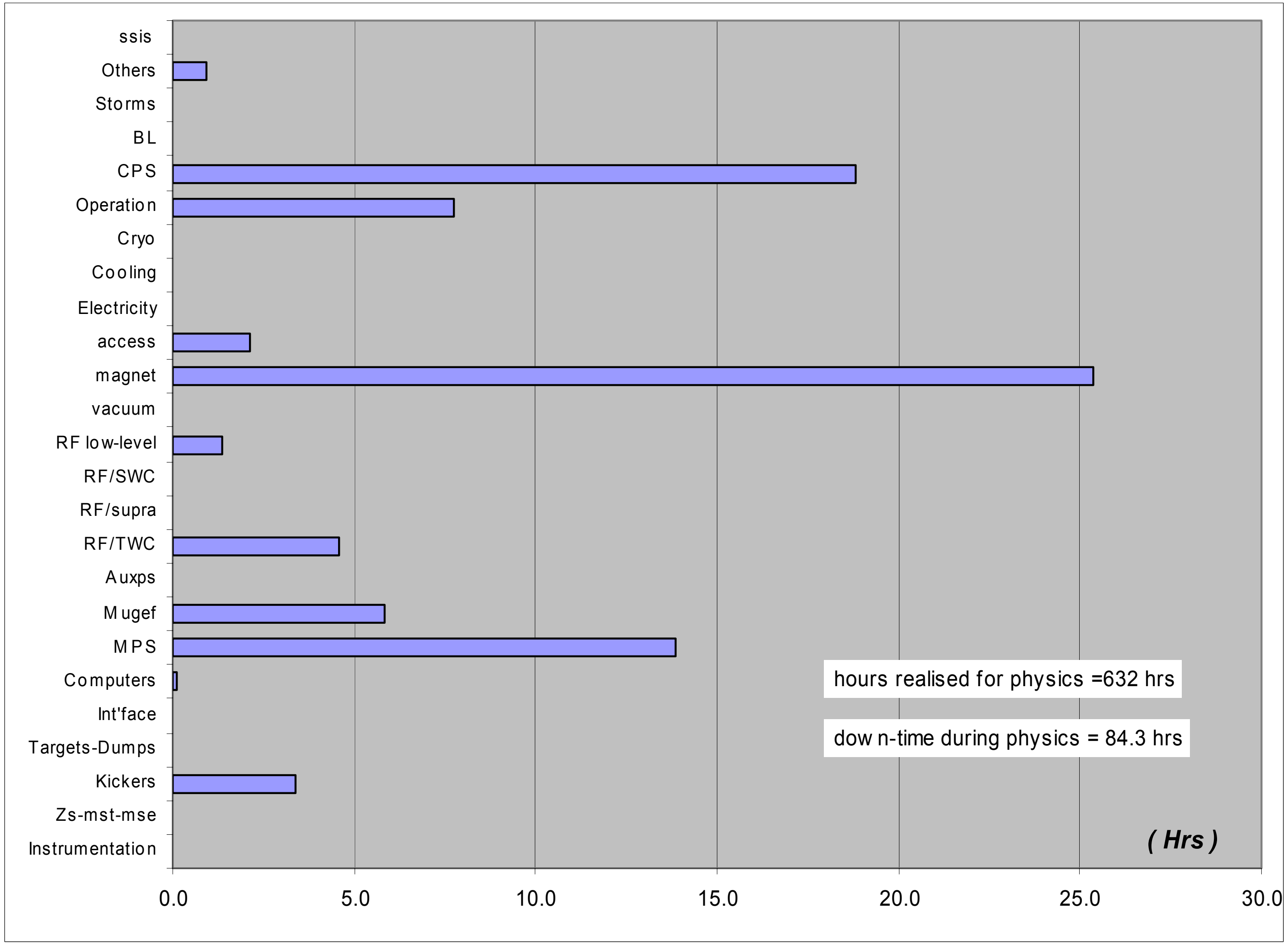
2003 Fixed targets down-time

Systems :	per 1a	per 2a	per 2b	per 2c	per 2d	per 2e	**Total** (hrs)	Total (%)
Beam instrumentation	0.0	0.4	0.0	0.2	0.0	0.0	**0.6**	0.2
ZS / MST / MSE	1.8	2.3	1.4	0.2	0.2	0.2	**6.0**	1.6
Kickers	5.1	0.1	3.0	7.3	0.1	4.9	**20.5**	5.4
Dumps / Targets	0.0	0.0	3.8	0.0	0.0	0.1	**3.8**	1.0
Interface (timing, network)	0.0	1.8	0.0	0.0	0.6	0.0	**2.4**	0.6
Computers	2.2	0.6	0.0	0.1	0.3	0.3	**3.5**	0.9
Main power supplies	0.0	2.1	1.1	0.0	1.9	0.0	**5.1**	1.3
Mugefs, rocs…	1.3	1.7	3.4	1.2	1.2	0.0	**8.7**	2.3
Auxiliary supplies	1.0	4.8	0.5	5.2	6.3	0.0	**17.8**	4.7
RF / Twc	0.1	2.6	0.0	1.9	3.8	1.4	**9.9**	2.6
RF / low level	0.0	0.0	0.1	1.0	0.0	0.2	**1.2**	0.3
RF / Damper	0.0	0.0	0.0	0.0	8.6	0.0	**8.6**	2.3
Vacuum	0.2	9.8	2.1	0.5	5.1	0.7	**18.5**	4.9
Magnets	7.8	1.3	2.4	0.0	0.0	0.0	**11.6**	3.0
Access	2.3	1.3	2.4	0.1	0.3	1.1	**7.5**	2.0
Electricity	0.0	0.0	10.7	0.5	14.4	0.0	**25.7**	6.7
Cooling	0.0	12.1	0.7	0.0	1.1	0.0	**13.9**	3.6
Operation	1.8	3.3	1.4	1.2	2.2	1.0	**10.9**	2.9
CPS	18.7	15.8	20.7	28.9	8.8	6.5	**99.4**	26.1
Beam losses	0.1	0.8	0.0	0.0	0.0	0.0	**0.9**	0.2
Storms	0.0	0.6	0.0	14.0	1.1	0.0	**15.7**	4.1
Others	10.4	14.3	17.8	16.6	11.5	18.6	**89.3**	23.4
SSIS (interlock)	0.0	0.0	0.0	0.0	0.0	0	**0.0**	0.0
	52.6	**75.8**	**71.5**	**78.9**	**67.4**	**35.1**	**381.4**	100.0


Systems
SSIS (interlock)
Others
Storms
Beam losses
CPS
Operation
Cooling
Electricity
Access
Magnets
Vacuum
RF / Damper
RF / low level
RF / Twc
Auxiliary supplies
Mugefs, rocs...
Main power supplies
Computers
Interface (timing, network)
Dumps / Targets
Kickers
ZS / MST / MSE
Beam instrumentation
0.0
89.3
15.7
0.9
99.4
10.9
13.9
25.7
7.5
11.6
18.5
8.6
1.2
9.9
17.8
8.7
5.1
3.5
2.4
3.8
20.5
6.0
0.6
hours realised for physics = 2211 hrs
down-time during physics = 383.3 hrs
0
40
80
120
160
Hrs

Faults & down-time during lead ions physics period

	1992	1994	1995	1996	1998	1999	2000	2002	2003
Instrumentation	20.4	0.5		0.7	0.5	0.5	0.0	0.0	0.0
Zs-mst-mse	9.8	3.6	2.1	3.0	3.1	0.0	5.1	0.7	0.0
Kickers	7.9	0.7	1.0	1.2	2.8	1.1	5.4	0.4	3.4
Targets-Dumps				0.0	0.2	0.0	0.2	0.0	0.1
Int'face				0.0	6.8	0.0	2.7	0.0	0.0
Computers	14.6	1.3	3.8	0.9	3.0	1.5	0.7	0.1	0.1
MPS	23.8	0.1		0.6	10.8	3.6	1.5	0.4	13.9
Mugef	0.2	0.2		0.6	0.8	0.2	0.2	0.0	5.8
Auxps	47.7	1.7	5.4	1.5	7.4	0.1	1.2	0.0	0.0
RF/TWC	9.1	2.2	1.1	0.8	5.2	0.1	0.2	1.3	4.6
RF/supra	0.6	1.6		4.6	0.0	0.0	0.2	0.0	0.0
RF/SWC	2.8			2.8	0.2	0.1	1.3	0.0	0.0
RF low-level		0.9	10.7	2.1	0.2	0.8	3.0	0.0	1.4
vacuum				1.2	2.1	0.0	0.0	0.0	0.0
magnet				0.0	0.5	16.1	0.1	0.0	25.4
access	6.1		1.3	0.5	4.0	0.1	0.4	0.3	2.1
Electricity	6.7	0.1	0.8	0.5	15.9	5.4	33.5	0.0	0.0
Cooling	13.0		0.8					0.0	0.0
Cryo					3.5	9.4	0.9	0.0	0.0
Operation		6.0	7.7	0.1	12.8	4.4	5.5	1.1	7.8
CPS	138.0	42.4	42.1	5.2	105.9	51.1	37.1	17.6	18.8
BL	9.8	26.2	18.8	53.9	0.3	0.0	0.2	0.2	0.1
Storms				15.1	1.2	0.0	0.0	0.5	0.0
Others	1.5	0.5	15.1	0.1	89.6	112.8	3.3	1.2	0.9
ssis				6.4	1.4	1.1	1.5	0.2	0.0
total	311.8	87.9	110.7	101.6	278.1	208.4	104.1	23.9	84.3


ssis
Others
Storms
BL
CPS
Operation
Cryo
Cooling
Electricity
access
magnet
vacuum
RF low-level
RF/SWC
RF/supra
RF/TWC
Auxps
Mugef
MPS
Computers
Int'face
Targets-Dumps
Kickers
Zs-mst-mse
Instrumentation
hours realised for physics =632 hrs
down-time during physics = 84.3 hrs
(Hrs)
0.0
5.0
10.0
15.0
20.0
25.0
30.0

AB-OP

9. Historic comparing 2003 with previous years

- PSB & PS intensity evolution
- SPS intensity evolution (protons & ions)

Historic comparing 2003 with previous years

1. Fixed Target proton Phyiscs - SPS

See following pages (A. Rey)

2. Fixed Target proton Physics ISOLDE

Year	PSB
1997	8.55×10^{19}
1998	7.69×10^{19}
1999	5.53×10^{19}
2000	8.73×10^{19}
2001	8.56×10^{19}
2002	8.76×10^{19}
2003	7.85×10^{19}

3. Fixed Target proton Physics - EAST Hall (A+B+C)

Year	PS
1997	5.18×10^{17}
1998	3.82×10^{17}
1999	7.32×10^{17}
2000	8.18×10^{17}
2001	1.435×10^{18}
2002	7.33×10^{17}
2003	6.65×10^{17}

4.. Fixed Target proton Physics - TOF

Year	PS
1997	none
1998	none
1999	none
2000	7.59×10^{16}
2001	3.39×10^{18}
2002	7.14×10^{18}
2003	1.36×10^{19}

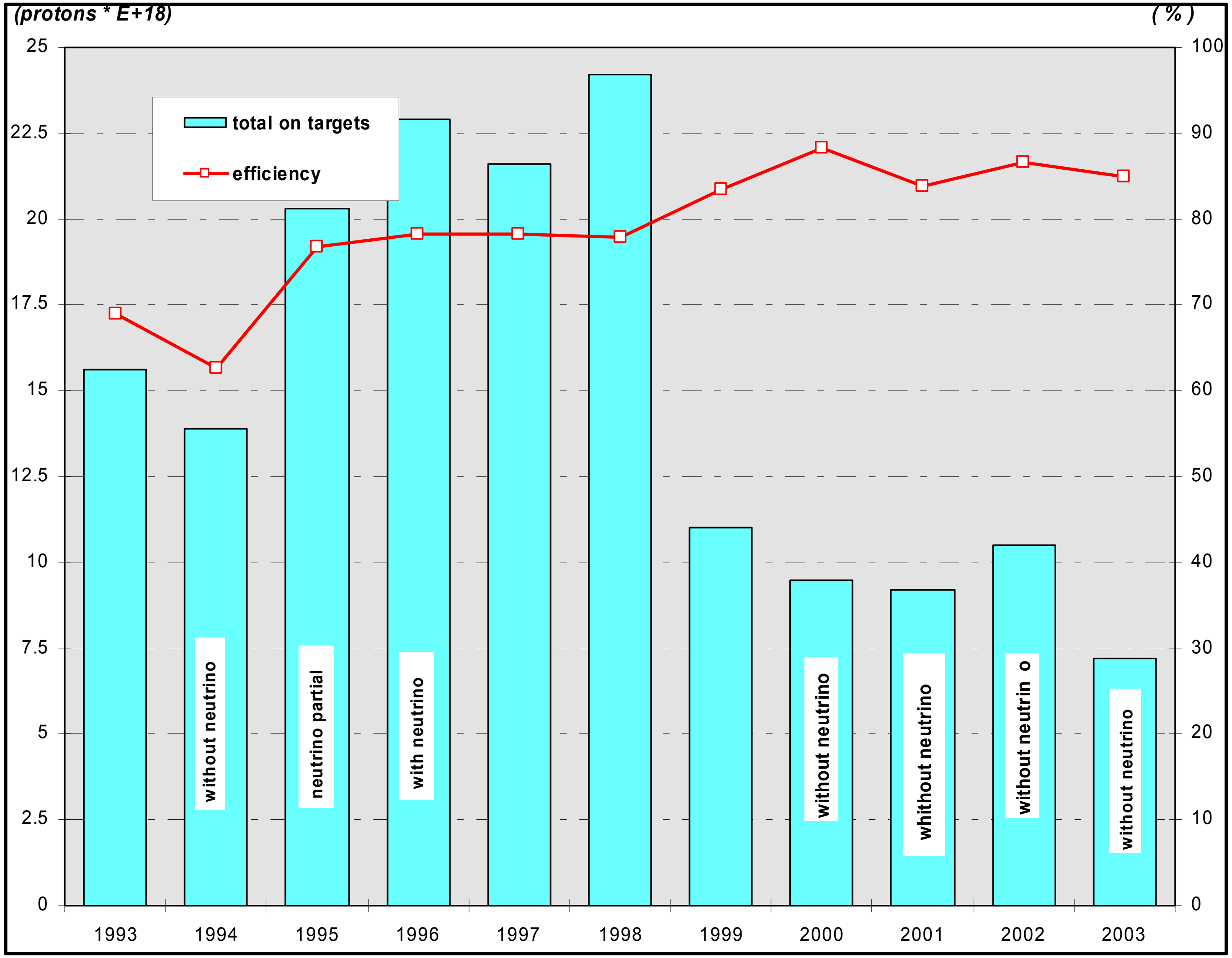
5. Protons for AD

Year	PS
1997	none
1998	none
1999	9.34×10^{17}
2000	2.12×10^{18}
2001	1.86×10^{18}
2002	1.47×10^{18}
2003	1.57×10^{18}

Comparative tables and diagrams from 1993 to 2003

Machine performances

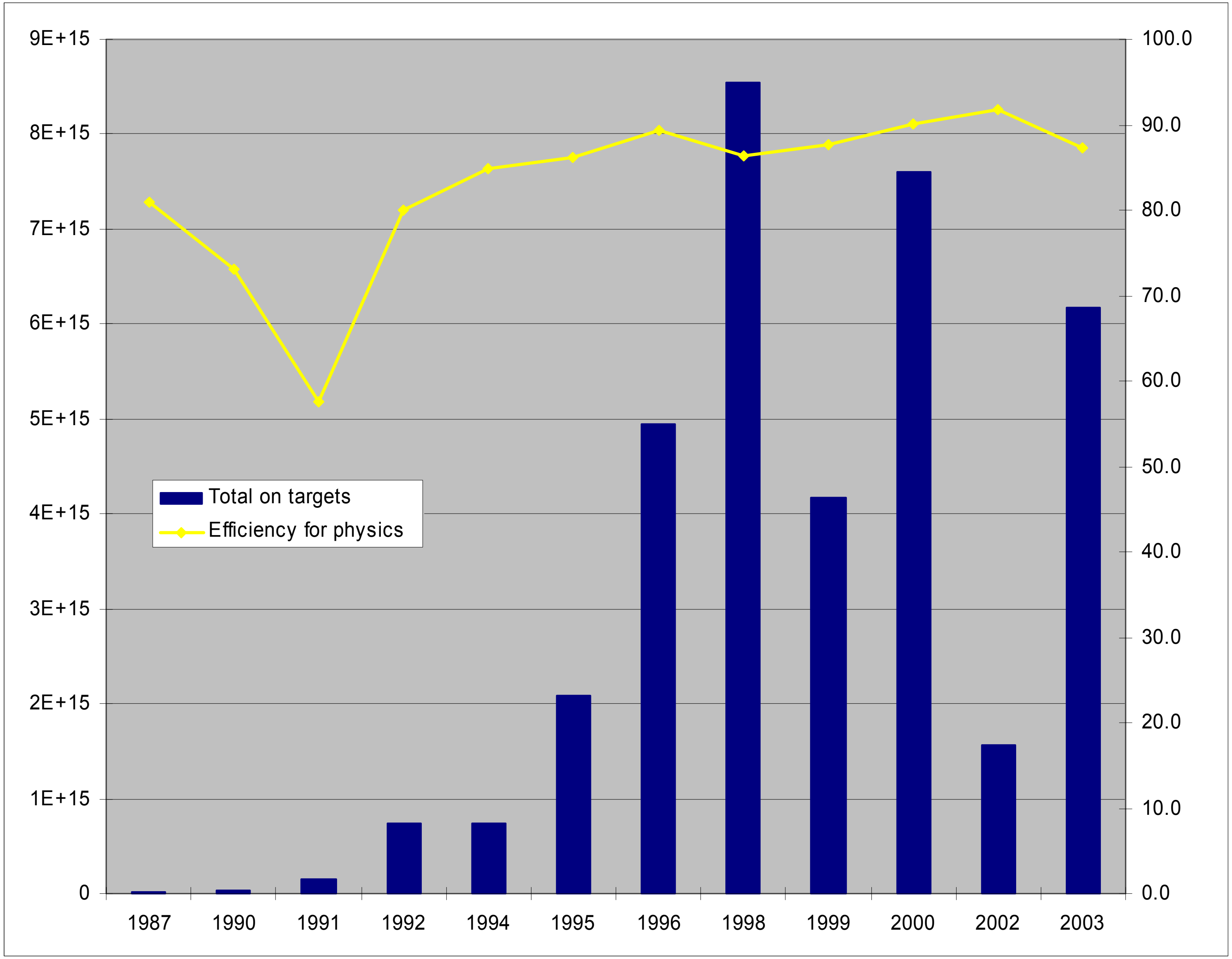
		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total scheduled hours of operation	(hrs)	5459	4387	4407	4280	4076	4315	4270	4030	3128	3394	2976
Total scheduled hours of physics	(hrs)	4635	3779	3588	3706	3293	3791	3415	2896	2508	2537	2601
Efficiency for physics	(%)	69	62.7	76.8	78.3	78.3	77.9	83.5	88.3	83.9	86.7	85
Total number of protons delivered to targets	(10^18)	15.6	13.9	20.3	22.9	21.6	24.2	11.0	9.5	9.2	10.5	7.2
Average protons accelerated per pulse (400GeV)	(10^13)	1.67	2.5	3.35	3.58	3.76	3.52	1.82	1.88	2.51	2.52	1.55
Average protons on targets / schedule day of physics	(10^17)	0.69	0.87	1.37	1.48	1.58	1.50	0.76	0.79	0.89	0.99	0.8
Cycle length(s)	(sec)	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	16.8	16.8	16.8


(protons * E+18)
(%)
25
22.5
20
17.5
15
12.5
10
7.5
5
2.5
0
100
90
80
70
60
50
40
30
20
10
0
total on targets
efficiency
without neutrino
neutrino partial
with neutrino
without neutrino
whithout neutrino
without neutrin o
without neutrino
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003

SPS Performance summary from 1987 to 2003 during ions period

		1987 sulphur	1990 ->	1991 ->	1992 ->	1994 lead	1995 lead	1996 lead	1998 lead	1999 lead	2000 lead	2002 lead	2003 Indium
Total scheduled hours of operation	**(hrs)**	524	862	1098	1189	1078	1300	1130	1756	1126	1200	600	792
Total scheduled hours of physics	**(hrs)**	414	670	984	842	726	919	946	1415	916	1034	292	632
Efficiency for physics	**(%)**	81.0	73.0	57.6	80	87*	86.1 *	89.3	86.4*	87.6*	89.9	91.8	87.8
Peak intensity at peak energy	**(10^9)**	0.1	3.2	4.5	16.9	25.0	39.0	61.4	87.6	90.0	89.0	69.6	87.3
Average no. of charges accelerated per pulse at peak energy	**(10^9)**	0.2	0.4	1.6	9.1	13.3	23.8	45.5	58.4	56.9	61.7	51.0	60.4
Average number of charges delivered to all targets per sched. day of physics	**(10^12)**	0.7	1.2	3.8	21.0	24.5	54.6	125.3	145.0	109.0	176.0	129.0	167.0
Total number of charges delivered to targets	**(10^14)**	0.1	0.3	1.5	7.4	7.4	20.9	49.4	85.5	41.7	76.0	15.6	61.7
Cycle length	**(s)**	14.4	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2

*** Without critical days**


9E+15
8E+15
7E+15
6E+15
5E+15
4E+15
3E+15
2E+15
1E+15
0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Total on targets
Efficiency for physics
1987
1990
1991
1992
1994
1995
1996
1998
1999
2000
2002
2003