DRIFT TUBE CHAMBER STATUS

F.Gasparini
May 14 /2002

SUMMARY

Construction of SL is now at nominal rate
Usual concern for availability of MINICRATES

Production of SL reached the nominal rate
Assembly of chambers behind schedule (recoverable)
Concern with Honeycomb plates
Assembly of Plates and beams on schedule
Some problem with small and non structural parts (cables,fittings..)
Delay in the production of R-Out and Trigger electronics
And MINICRATES
More room for installation in V 33
ISR Storage

Institution Board

IB chairs D.Reeder (M.Cerrada)

Technical Board (Steer.Comm.)

P.Managers	**F.Gasparini G.Mitselmakher**
I.B. Chairs	**D.Reeder M.Cerrada**
R.Manager	C.Peroni
Tech. Coords	**H.Reithler R.Loveless**
Task Coords.	**G.Iaselli** (rpc) T.Rodrigo (alignment)
	M.Cerrada (DT) C.Willmott (DT El.)
	A.Korytov (CSC) TY Ling (CSC El.)
	I.Golutvin (ME1/1)
	W.Ko (software) G.Wrochna (TRIDAS link)

BARREL **ENDCAPS**

Project leader

F.Gasparini
deputy A.Benvenuti

Tech.Coord.

H.Reithler

SPO

M.Cerrada	planning
H.Reithler	Safety
S.Maselli	QA&QC
D.Dattola	Integration
G.Bencze	Alignment
G.**Iaselli**	RPC

Resource Manager

C.Peroni

Finance Board

M.Cerrada	Spain
D.Rein	Germ.
G.Zumerle	Italy
R.Loveless	US
V.Karjavin	RDMS

BARREL
muon

Technical Board

Tech.coordin.	H.Reithler
DT chambers	M.Cerrada
DT electronics	C.Willmott
RPC	G.Iaselli
RPC electronics	A.Ranieri
Alignment	T.Rodrigo, G.Bencze
TRIDAS link	G.Wrochna
Software	U.Gasparini
Integration (detect.)	D.Dattola
(services)	H.Reithler

Drift Tubes Committee

H.Reithler	M.Cerrada
C.Peroni	M.Dalla Valle
T.Hebbeker	G.Zumerle
C.Willmott	A.Benvenuti

DT Sites responsibles:

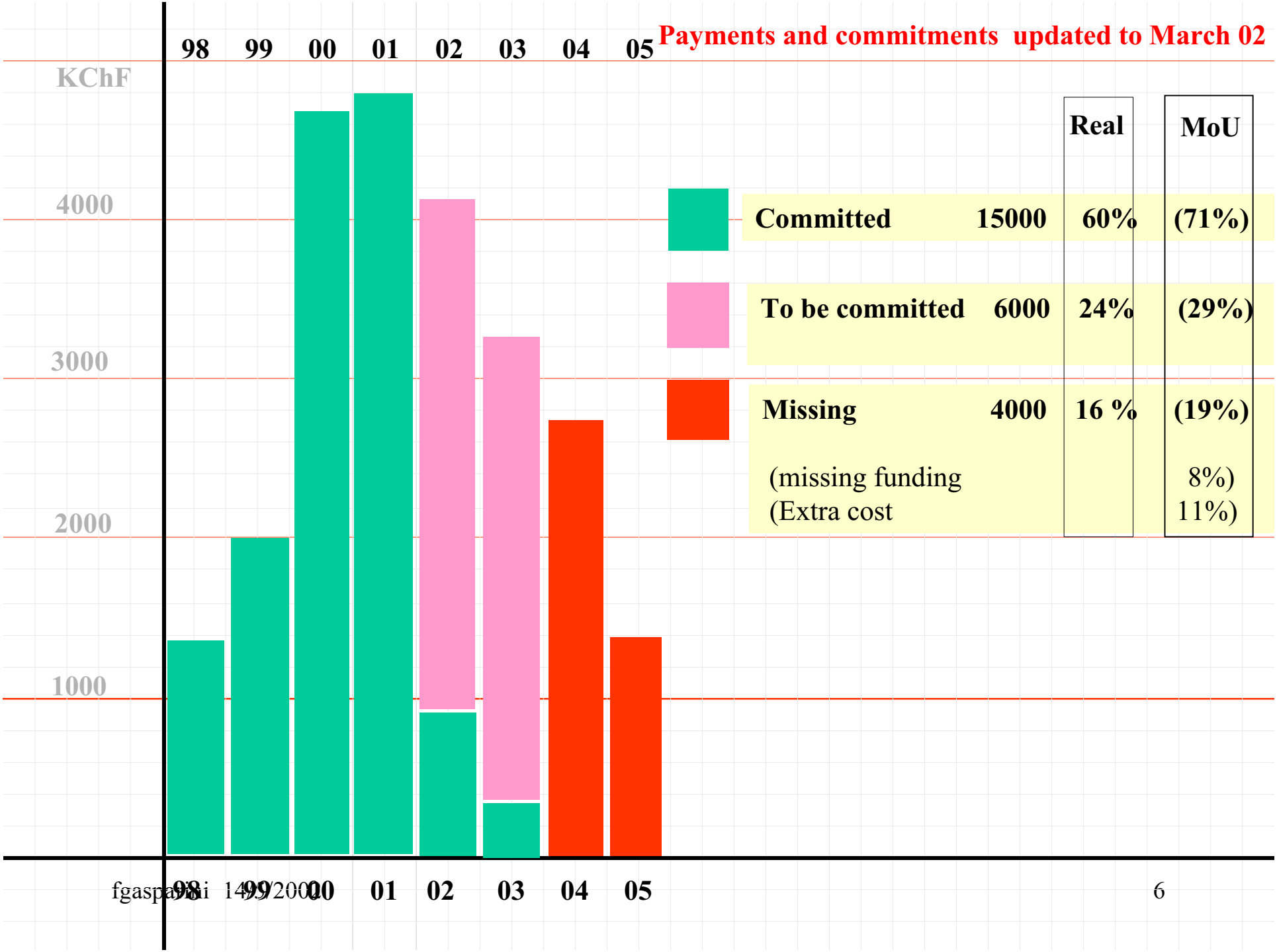
Aachen :	**H. Reithler**
CIEMAT:	**L.Romero**
PD-LNL :	**M.De Giorgi**
Torino:	**A.Staiano**
Dubna (DT plates):	**V.Kalagin/A.Staiano**
Protvino (DT I-Beams):	**V.Obratzov/A.Benvenuti**
ISR&CERN activity :	**A.Benvenuti**
IHEP Beijing:	**Shann Wenn/De Giorgi**

RPC Sites responsibles

Bari:	Iaselli
Peking U.	Y.Ye
Sophia	V.Genchev
Pavia	P.Vitulo

Test beam : **E.Conti**

BARREL
Muon


98 99 00 01 02 03 04 05
Payments and commitments updated to March 02
KChF
4000
3000
2000
1000
Real
MoU
Committed 15000 60% (71%)
To be committed 6000 24% (29%)
Missing 4000 16 % (19%)
(missing funding 8%)
(Extra cost 11%)
98 99 00 01 02 03 04 05

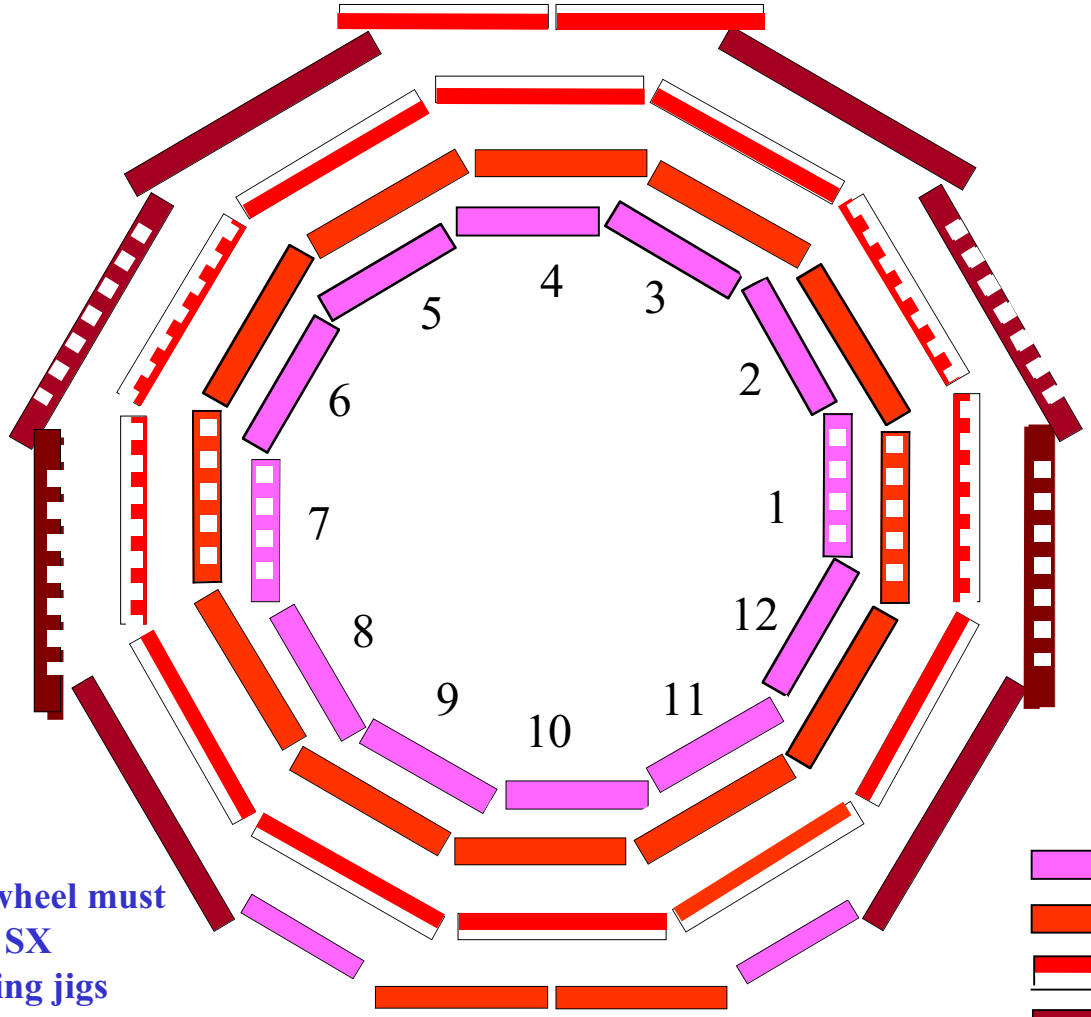
THE BARREL MU DRIFTCHAMBERS

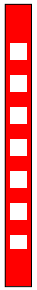
4 concentric stations
60 chambers each (MB4 70 ch.s)
680 SLs (MB1,2,3: 3 SL each,MB4 2 SL)
171.732 wires

Four assembly sites

Aachen	60 MB1 + 10 MB1/4	**(180+20 SL)**
CIEMAT	60 MB2 + 10 MB2/4	**(180+20 SL)**
Padova	60 MB3 + 10 MB3/4	**(180+20 SL)**
Torino	40 MB4 (with two tables)	(80 SL)

DT Chambers Production sharing





12 chambers/wheel must be installed in SX because of lifting jigs

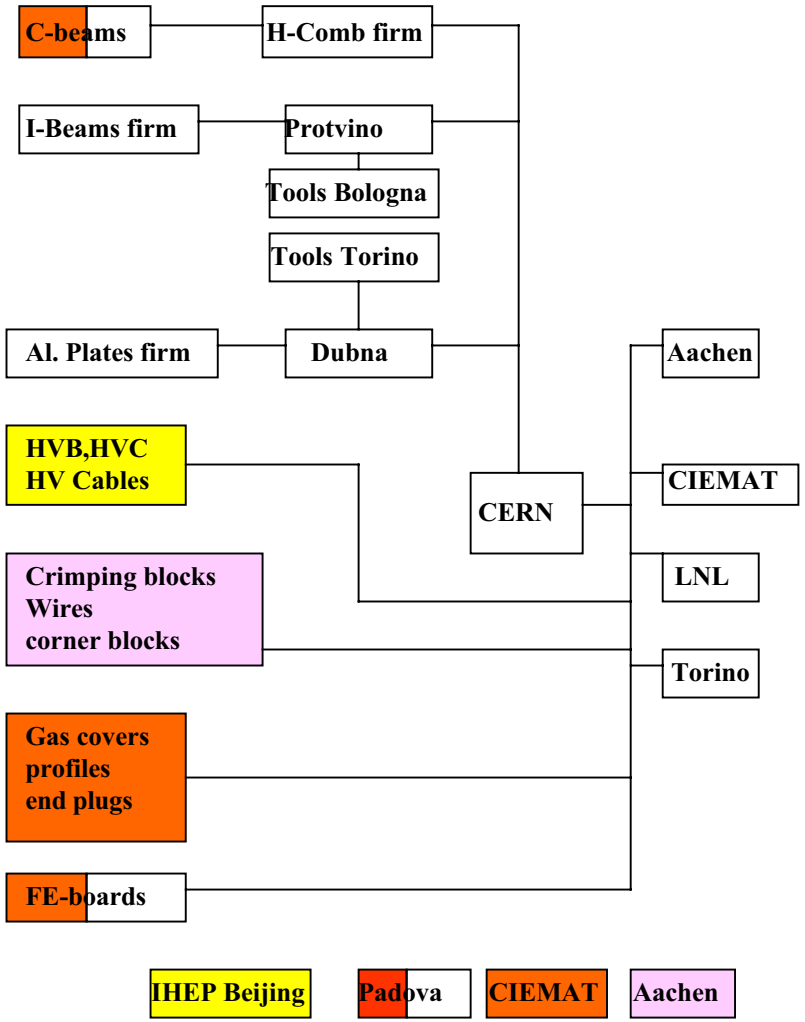
Aachen
Madrid
Padova
Torino

Parts needed to assemble end test one SL:

1) Aluminium plates with field elecrodes
2) Aluminium beams with cathode electrodes
3) Hcomb Panels (that house services)
4) HV Boards in the gas volume
5) Amplifiers on boards in the gas volume

1) 3400 plates (2040 double sided,1360 single s.)
370.000 electrodes . Mass prod. in Dubna.
Tools designed and commissioned by INFN Torino (330 plates prepared in To)

2) 171.000 I-beams = 342.000 cathodes
mass prod. in IHEP Protvino.
Tools designed and commissioned by INFN Bo (13.000 beams assembled in Bo)



3) produced by Hexcel
4) boards assembled in IHEP Beijing tools and jigs from INFN Padova
5) boards and chips by INFN Padova

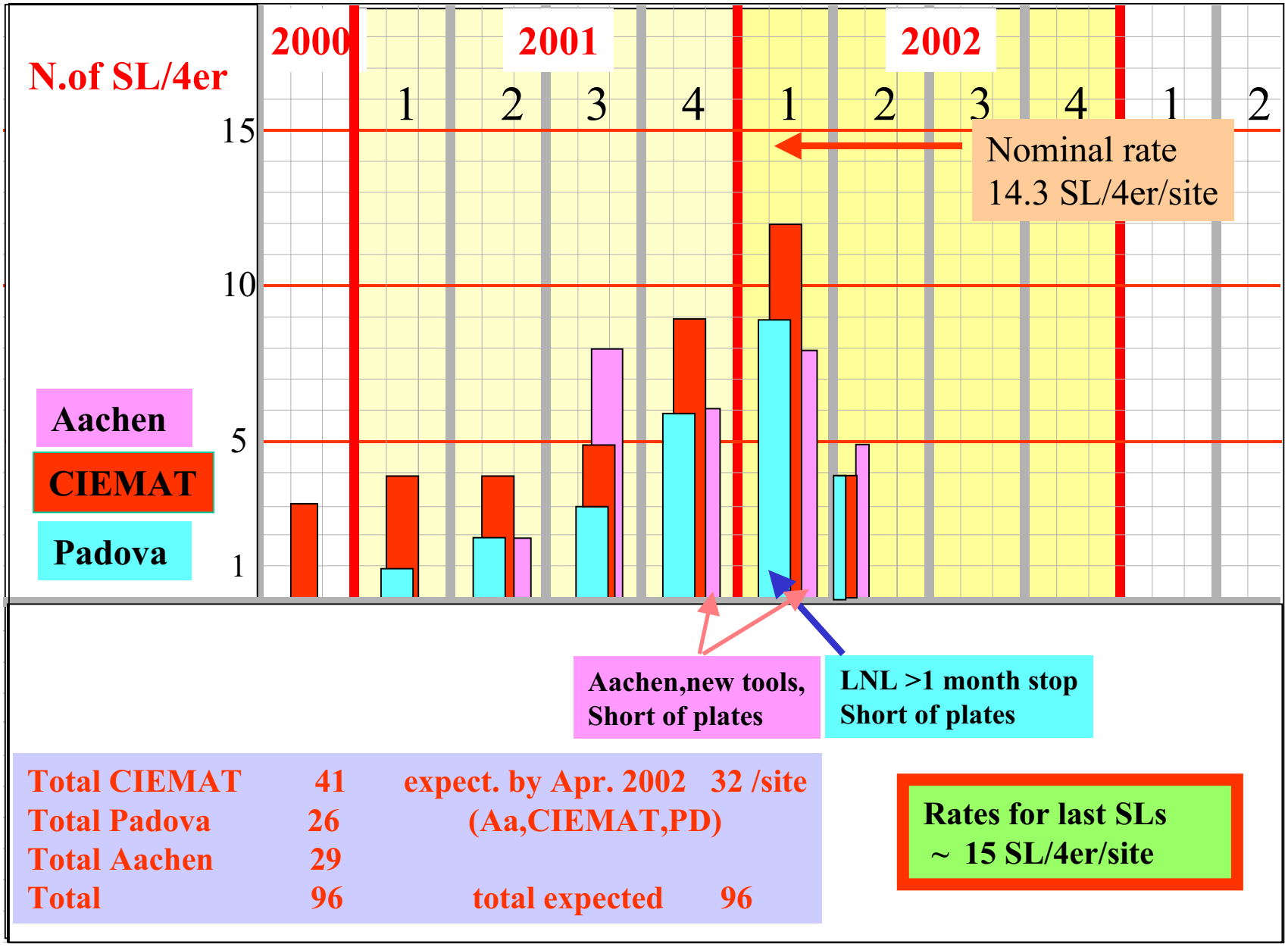
The nominal assembly rate:
(176 w.d./year : 9 d/SL)/12 months = 1.6 ch/month in average
14.3 SL/quarter/site
20 ch /year/site

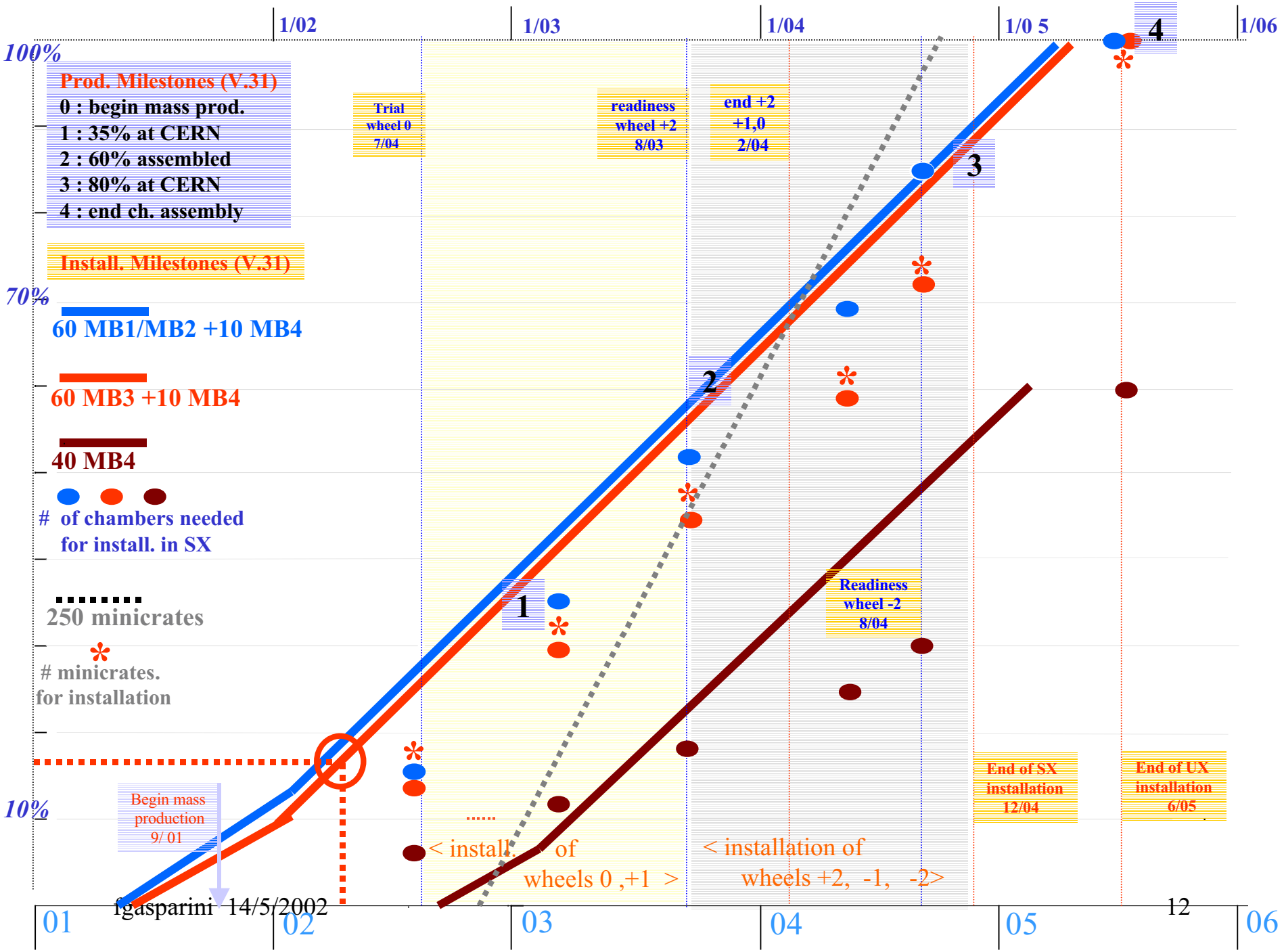
Last figure from CIEMAT 4 chambers/10 weeks (15.5 SL/quarter)
Testing time follows the same rate

In Padova the rate of 9 ~ 10 days per 3 SL is achieved for mechanical assembly and for SL training and testing.

Some problems for test in Aachen

Chamber assembly in Padova and Aachen behind schedule
for local problems solved by end of may (?) :
ch. assembly does not interfere with SL assembly


N.of SL/4er
2000
2001
2002
1
2
3
4
1
2
3
4
1
2
15
10
5
1
Nominal rate
14.3 SL/4er/site
Aachen
CIEMAT
Padova
Aachen,new tools,
Short of plates
LNL >1 month stop
Short of plates
Total CIEMAT 41
Total Padova 26
Total Aachen 29
Total 96
expect. by Apr. 2002 32 /site
(Aa,CIEMAT,PD)
total expected 96
Rates for last SLs
~ 15 SL/4er/site


1/02
1/03
1/04
1/0 5
1/06
100%
70%
10%
Prod. Milestones (V.31)
0 : begin mass prod.
1 : 35% at CERN
2 : 60% assembled
3 : 80% at CERN
4 : end ch. assembly
Install. Milestones (V.31)
60 MB1/MB2 +10 MB4
60 MB3 +10 MB4
40 MB4
# of chambers needed for install. in SX
250 minicrates
minicrates. for installation
Trial wheel 0 7/04
readiness wheel +2 8/03
end +2 +1,0 2/04
Readiness wheel -2 8/04
End of SX installation 12/04
End of UX installation 6/05
Begin mass production 9/ 01
< install. of wheels 0 ,+1 >
< installation of wheels +2, -1, -2>
1
2
3
4
01
02
03
04
05
06

DETAILS 1)

Expected May 14	SL (mech)	HV+FE	tested SL	cosmic test	chambers
Aachen	**29**	**24**	**16 (+3 problems)**	**4**	**2**
CIEMAT	**42**	**36**	**36**	**36**	**11**
Padova	**26**	**23**	**23**	**20**	**5**
Torino	**commissioning dec. 02**				

11 chambers at CERN ISR (from CIEMAT)

DETAILS 2)

Chambers **Honeycomb panel supply several months late (legal problems CERN<> HEXCEL)**

CIEMAT will be out of panels May 31st and Padova June 15th

Aachen is late with the tests (mainly HV problems,under investigation by experts (De Giorgi and Pegoraro)(solved?)) .This and the delayed commissioning of the complete set of tools for Ch. assembly are at the origin of the delay.

Padova was stopped by a broken LASER used for measurement of the planarity of the HC panels during the assembly of the ch. . This measurement is needed because of the bad planarity of the plates.
The new diode should be available this week

THE HONEYCOMB SAGA:

By contract planarity had to be better than 1mm/m
First samples OK
The planarity of the 30 panels of the preserie was worse than 1 mm
The contract was not signed yet : HEXCEL asks for an increase of the tolerance to 2 mm in order to sign the contract , new preserie of 30 planned by Nov. 01.
Delayed to Feb. 02 because of administrative problems

First 10 MB1 panels delivered in two batches (6 +4) ,the second one beginning of March.
The last 4 have 3 out 8 faces that exceed the 1 mm tolerance.

The 10 MB2 are done but a problem (mistake) was found in one of the first samples of the 10 MB3 : in some positions of the bottom face of the plates the HC was not glued to the Al skin. The side C s were all correctly glued.
The same defect was than found in 7 out if the 10 MB2 ,and next week HEXCEL people will check the 10 MB1 in Aachen.

The origin of the defect is understood (too large tolerance in the HC thickness, and the panels are recoverable…injecting glue from the opposite face……..
No figure is available for the planarity of the MB2 and MB3 panels……..but delivery is delayed by few weeks . CIEMAT will be out of panels May 31st and Padova June 15th

Dear colleagues,

after a problem has been spotted in the production of the honeycomb pane……Last Wednesday we visited the company to see the problem and to understand the outcome of the investigation. A summary of this meeting is:

1- PROBLEM: tolerances in honeycomb thicknes led to small areas remaining unglued between honeycomb and cover plate. This was discovered on an MB3 panel by routine Quality Control and then redone in detail for every panel available. It is affecting preferentially the bottom face of the panel.
The borders are always fine, especially the junction between honeycomb and lateral C-profiles, where forces are inserted, as visible on the attached photo of one dismantled panel.

2- EXTENSION: the problem was found on one of the first MB3 panels, then on 7 of the 10 MB2 panels. The zones affected are sometimes very small, although they may several square decimeters. For us the relevant aspects are that (a) such a failure can be reliably be localized by a simple test, and (b) the panel can be repaired and is thus not lost. One MB3 panel was dismantled for inspection, which confirmed the observations made from outside. The MB1 panels had also passed the routine QC, but wil be rechecked in detail next week.
The global planarity seems not to be affected by this problem.

3- ACTIONS TAKEN SO FAR (before our visit):
- Very detailed inspection of the 10 MB2 and of the 3 MB3 panels.
- Dismantle the worst panel to check that the conclusions from the observation from outside are correct.
- Produce a couple of sample panels to further confirm the conclusions about the origin of the problem.

4- NEXT ACTIONS:
- Repair the 10 panels affected (~ 2-3 weeks).
- Inspect again the 10 MB1 panels (next week).
- Adapt production/test to avoid such problems altogether.
- Finish the MB3 panels.
- Ship MB2 panels for arrival at Madrid on 31 May at latest (there are already 3 unaffected panels; all 10 will be shipped together if ready in time).
- Ship MB3 panels for arrival at Legnaro by 15 June at latest.

Note that the delivery deadlines above were given by the two labs and represent the limit of flexibility in their production. This revised schedule matches the expectation at Hexcel and we are confident that despite this additional delay the chamber assembly can proceed without damage.

With best regards,

Hans

DETAILS 3)
(concern: work load in the ISR storage)

in the sites during the chamber assembly one should install:

1) the RPC support pads (glued on one or two faces of chambers)
2) HV /LV cabling
3) Final gas and cooling fittings/piping

1) Pads will be available beginning of may ,chambers at ISR have no installed PADs (they must be glued at ISR on 11 ~ 15 chambers)

2) HV voltage cables will not be available before 6 ~ 8 months: delay due to unsolved integration problems .Conflicts in the Central Wheel between "Movable services" and DT HV patch panels . hopefully solved in May. But HV cables should be prepared in China…… (70 chambers will be cabled at ISR….)

3) General cooling and gas piping has been defined only recently (piping of many (how many?) chambers will be done at ISR

4) Minicrates will not be available before late spring 2003 and they will be installed and tested on the chambers at the ISR storage.

TEST PLANNED AT ISR:

Installation of Minicrates
Check for Gas tightness
HV test
Noise check
Search for dead channels

Measurement of relative position of Alignment forks wrt the reference blocks
This gives also the relative position of t he three Sl

(First measurements and commissioning of the bench in July)

Coupling with RPC
Test of cooling
Transportation to SX

IN SX

Gas tightness
Electronics functionality
(HV test)

Dubna 1) :

Tools shipped end of August 2001,
Unloaded in Dubna Sept 20
Begin commissioning of the plant mid Oct.
First usable plates mid November

A peak production of 8.6 plates/day was reached,

the average since November 29 is 4.6 plates/day

a steady rate of 5.5 plates/day was reached during the last month.

5.5 plates/day and **24 w.d./month** cover the need of four sites running at 2 ch/month

1 chamber/site >> 15 plates*3 +10 plates*2 = 65
two ch./month >> 130 plates/month (130 plates/month)/(5.5 plates/day) **= 24 w.d./month**
(The average number of faces per plate is 1.6, so 5.5 plates correspond to 8.8 faces/day).

New head April 22 >>> mid June

15 days of double shifts planned in July (to be made compatible with Dubna Holidays)

Dubna 2) :

Production and shipments from Dubna:

(Jan .16	2 ch	Aachen	done
Jan . 21	2 ch	CIEMAT)	done
Feb. 18	**4 ch**	**4LNL**	**done**
Feb. 26	**2 ch**	**2Aachen**	**done**
Mar. 4	**4 ch**	**4CIEMAT**	**done**
Apr. 3	**3 ch**	**3Aachen**	**done**
Apr.29	**9 ch**	**5 LNL, 4 CIEMAT**	**done**
May. 15	**3 ch**	**3 Aachen**	
Jun. 24	**10 ch**	**3 LNL,3 Aachen, 4 CIEMAT**	
Total	**35 ch**	**12 LNL, 11 Aachen, 12 CIEMAT**	

	TOTAL	Padova	Aachen	CIEMAT
Total	**35 ch**	**12**	**11**	**12**
Preseries	**22**	**6**	**6**	**10**
Total	**57**	**18 mid Oct**	**17 mid Sept**	**22 mid Oct**
By Dec. the	**sites could assemble:**			
	14 Ch.more	**4**	**6**	**4**
TOTAL end 2002	**71 Ch**	**22**	**23**	**26**

DUBNA 3) :

To cover the assembly of 14 chambers in the last part of the year 210 plates must be produced after mid June.

At a rate of 5.5 plates/day = 38 w.days = 1.6 months

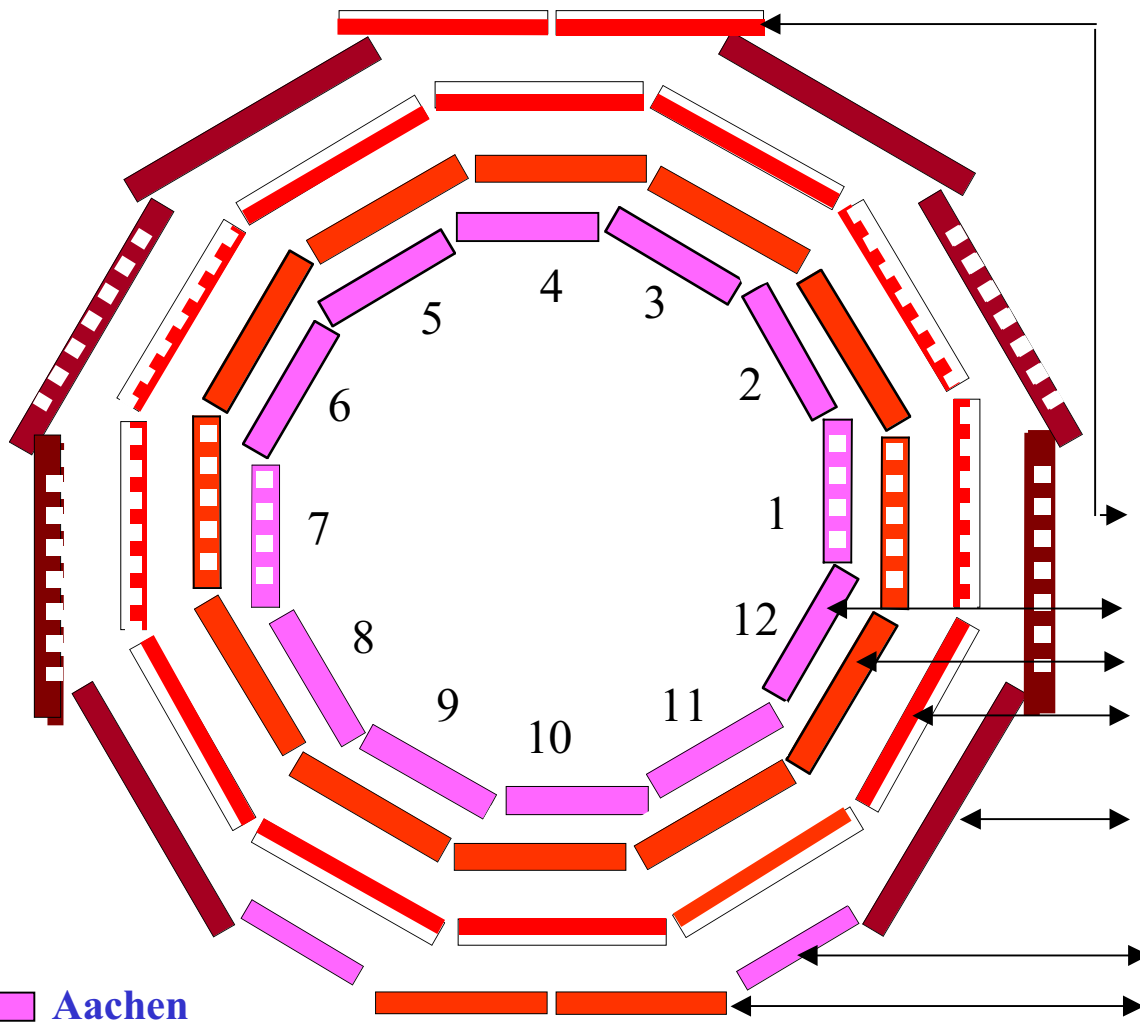
This production could be finished by beginning of September

Then Dubna will produce for chambers to be assembled in 2003

By the end of the year they should manage to prepare 396 plates and cover the need for three months of assembly at full speed.

beginning of September Dubna will be three months in advance.

I-Beams inventory



# I-beams	# chambers
580	X 10
632	X 60
716	X 60
812	X 60
732	X 40
400	X 10
484	X 10

TOTAL ~ 173.520 ~ 694/chamber

Aachen
Madrid
Padova
Torino

(694 X 4 sites) / 9 w.d. = 308 I-beams/day in average

PROTVINO

I-Beams production In Protvino:

production going smoothly with two tables at >= 320/day (nominal max. 360/day)

PLANNING to JULY

The Nr of THETA SL gives ~ the number of buildable chambers.

I-Beams available by end July cover the chamber production up to December 2002.

Grand Total	Aachen Θ	Aachen Φ	CIEMAT Θ	CIEMAT Φ	Legnaro Θ	Legnaro Φ	Torino Φ
05-Nov-2001 18076	1459	2575	3528	4260	3413	2841	0
Nr. of SL	6	12	15	17	14	9	
30-Nov-2001 27191	2449	4375	3528	6960	3413	6466	0
Nr. of SL	10	21	15	28	14	22	
19-Apr-2002 38365	4247	7065	4430	9730	3413	9480	0
Nr. of SL	18	35	19	40	14	32	
30-May-2002 49640	5190	9853	5373	12559	4356	12309	0
Nr. of SL	22	49	23	51	18	42	
xx-July-2002 60956	6133	11739	6316	14445	7185	15138	0
Nr. of SL	26	58	27	59	30	52	

Cathodes Required per Super-Layer
Θ SL = 232; MB1 SL = 200; MB2 SL = 242; MB3 SL = 290

DT PLANNING

years	01	02	03	04	05
MB1/2/3	22	60	60	60	8
MB4		2	18	20	
SL	66	184	216	220	24

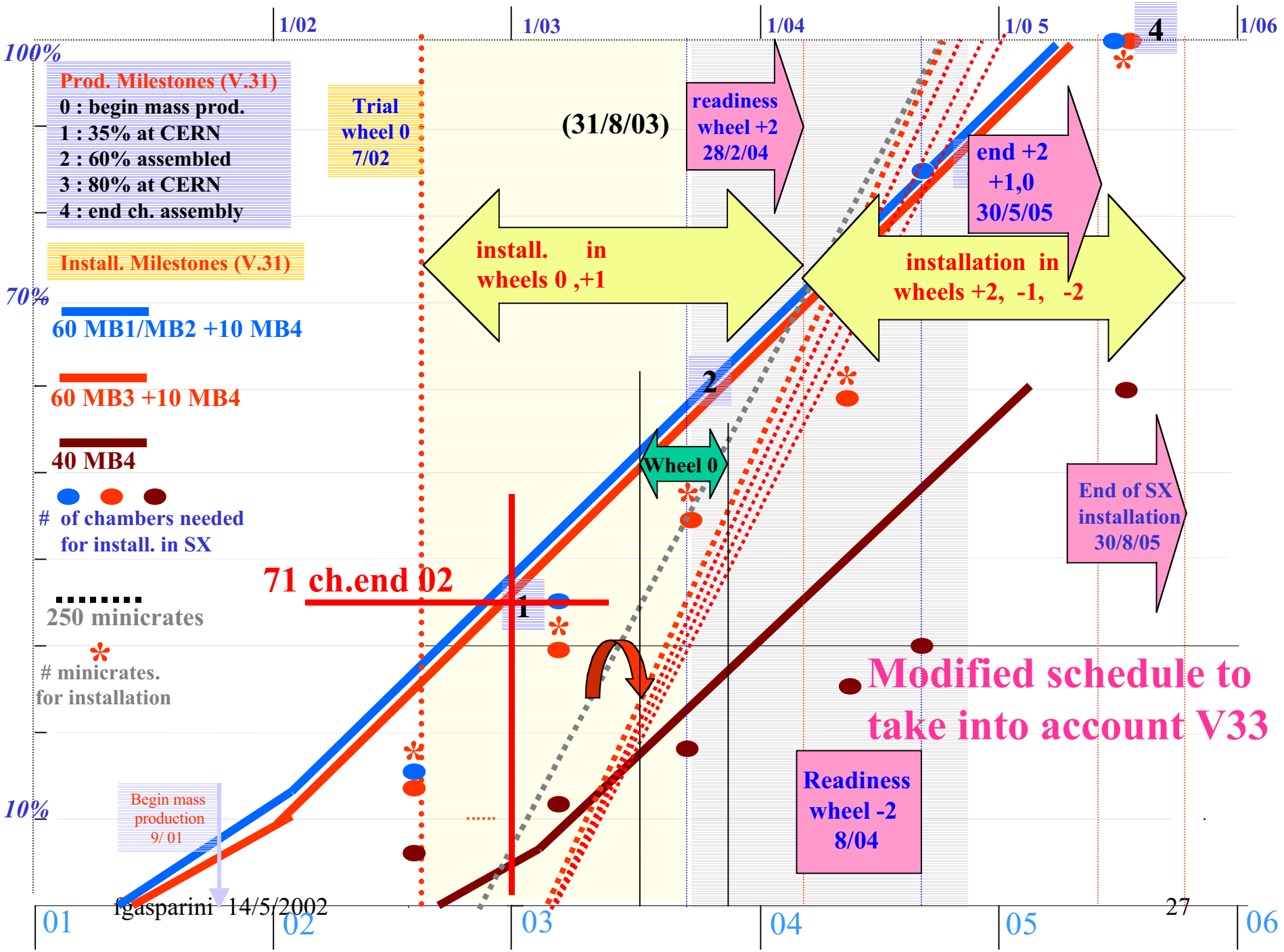
By end 2002 250 SL 84 chambers

EXPECTED by end 2002

SL 55 + 164 = **219**

Chambers 70
(27 Ciemat, 22 Aa, 23 LNL,1 To)

14 chambers behind schedule = 1.5 months
(4 assembly sites)


1/02
1/03
1/04
1/0 5
1/06
100%
70%
10%
Prod. Milestones (V.31)
0 : begin mass prod.
1 : 35% at CERN
2 : 60% assembled
3 : 80% at CERN
4 : end ch. assembly
Install. Milestones (V.31)
60 MB1/MB2 +10 MB4
60 MB3 +10 MB4
40 MB4
# of chambers needed for install. in SX
250 minicrates
minicrates. for installation
Trial wheel 0 7/02
(31/8/03)
readiness wheel +2 28/2/04
end +2 +1,0 30/5/05
install. in wheels 0 ,+1
installation in wheels +2, -1, -2
Wheel 0
End of SX installation 30/8/05
71 ch.end 02
Modified schedule to take into account V33
Readiness wheel -2 8/04
Begin mass production 9/ 01
1
2
4
01
02
03
04
05
06

Test and quality control:
Construction follows a QA/QC Book (includes Plates and I-Beams etc..)
Data are recorded in local files in the sites
(as an ex. Single wire position wrt reference block,tension etc..)

A “simple” sequence of data is made easily available to everybody to allow the cross check of the chamber quality .

Reference block position: position /SL (4 blocks)
Wire position : average value and sigma (FE +HV side)/SL
number of wires > 100 micron < 500 (should be none)
Wire tension: average value and sigma /SL
Gas Tightness : 1 number /SL (decay time at +50 mbar)
Wire Noise : average figure and sigma/SL at standard voltages (same wire gain)
number of cells > 200 and >1000Hz (or noise rate per wire)
Cosmics test: average cell efficiency/SL
average and sigma MT left and right /SL (precision of staggering)
Disconnected cells : list and reasons for disconnected cell

Results from Pressure Drop

QC requirement: τ >135 min

With two HV covers, time constant on average τ ~1500 min

In final conditions (FE+HV) τ = 1200 min

Pressure drop:

$$\tau = t / \ln\left(\frac{P_{i0} - P_a}{P_i - P_a}\right)$$

P_i = pressure at t=0

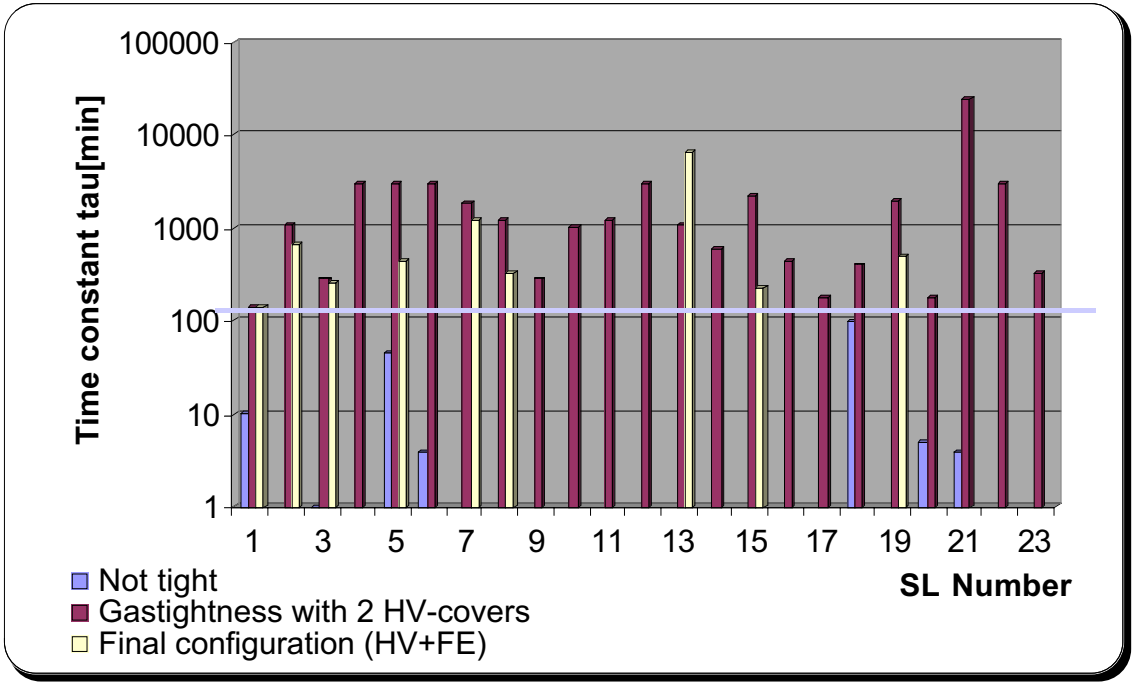
P_a = pressure after t>0

Our observations:

Recommended to first measure with two HV covers (check of FE-cover tightness during second measurement)

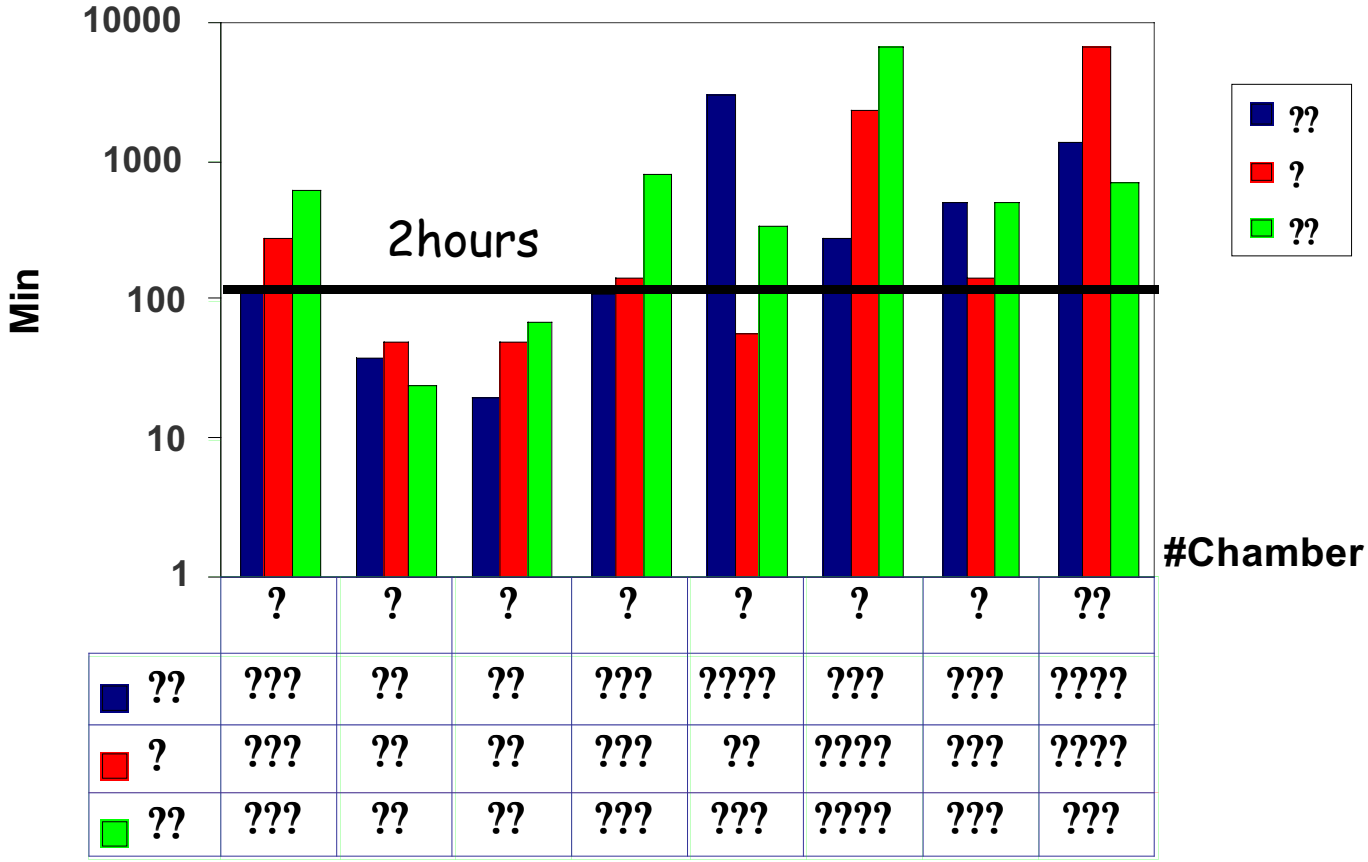
In case of leakage, τ<5 min

If additional sealing required, usual close to corner-blocks



GAS Tightness

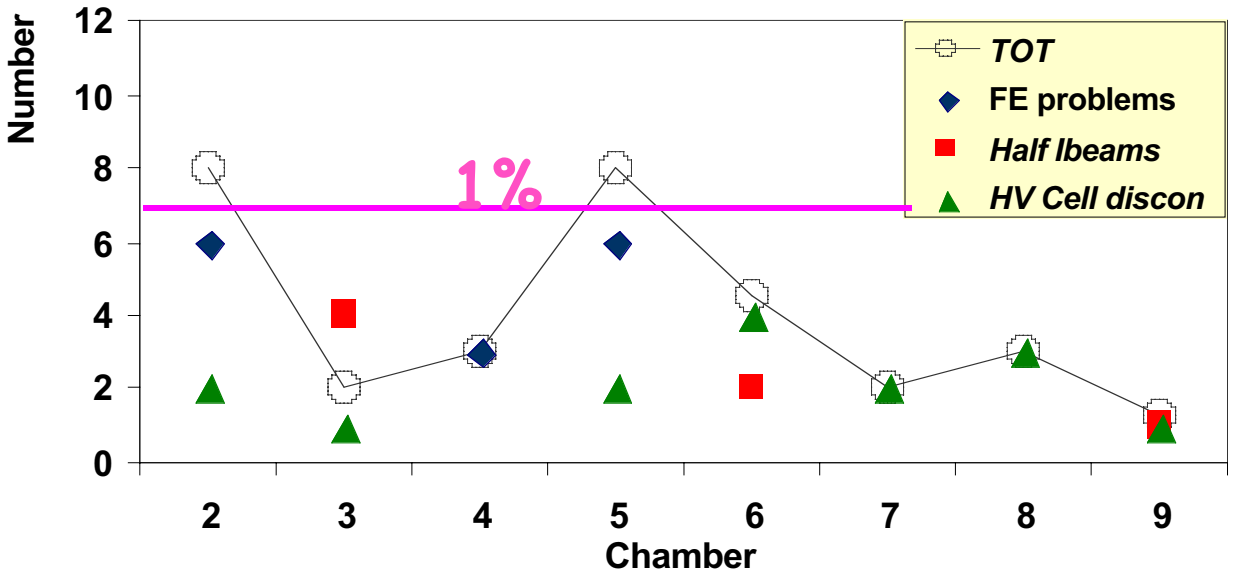
TIME CONSTANTS



	?	?	?	?	?	?	?	??
??	???	??	??	???	????	???	???	????
?	???	??	??	???	??	????	???	????
??	???	??	??	???	???	????	???	???

Gas tightness is better in most recently built SL´s

Dead Channels



- Dead Channels < 1%
- Most of HV dead cells due to Sparking Strips.
- NO FE dead channels for the last 4 chambers.

The FE problems were mainly due to:

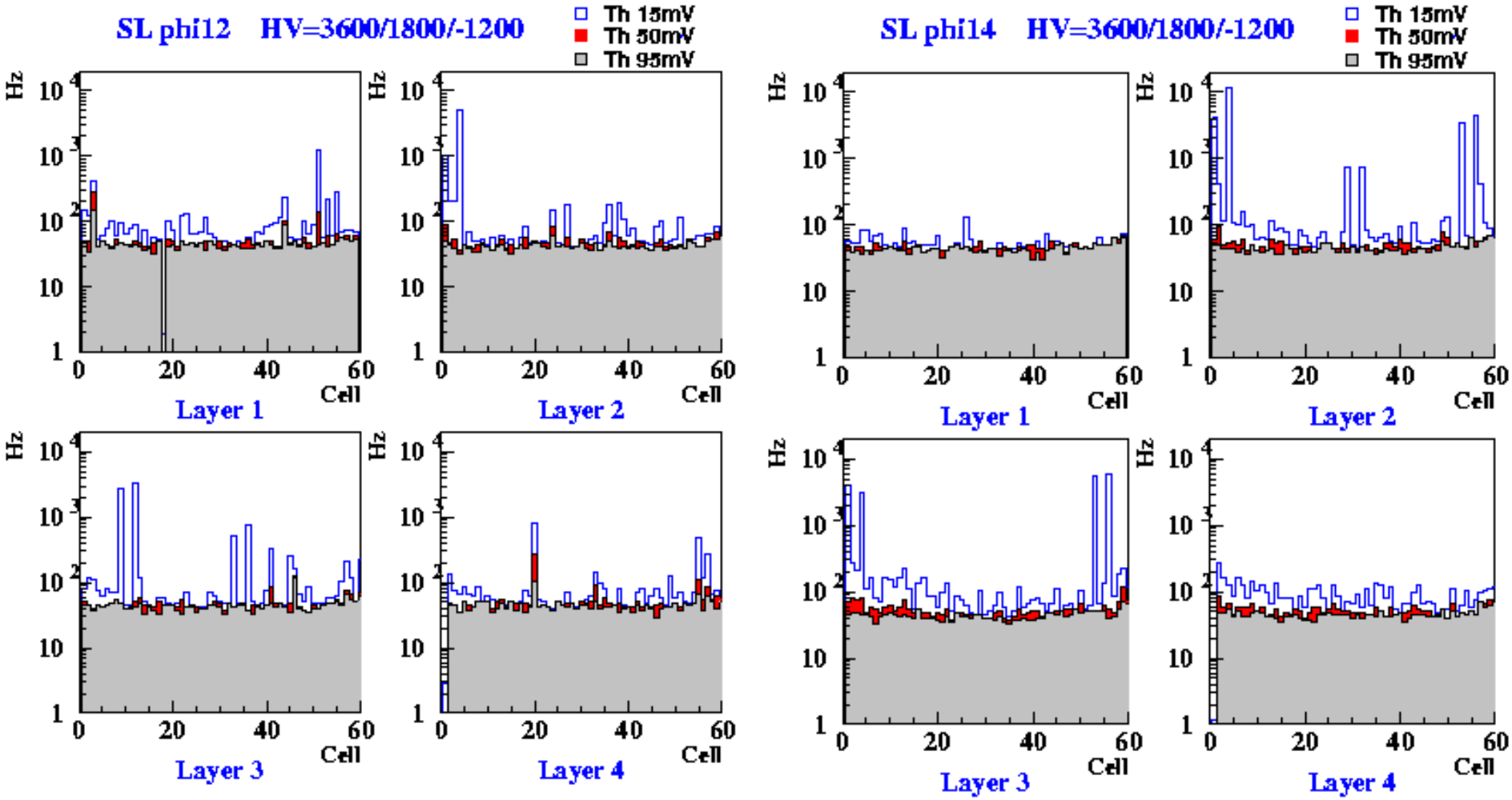
- Dead Channels on the blue connector

  Now we test them and on the last group the failure rate is 0%

- Some dead channels on the FE boards

  Now we have enough FE Boards to replace the bad ones

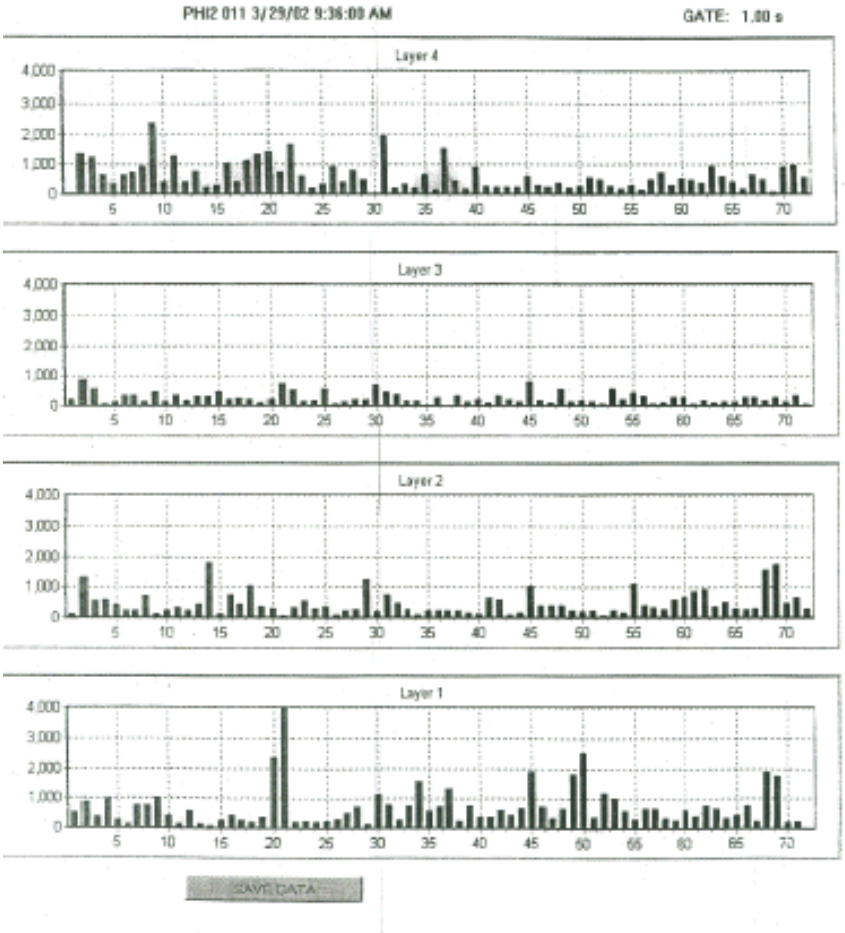
NOISE



At 15 mV ⇒

≤100Hz/cell

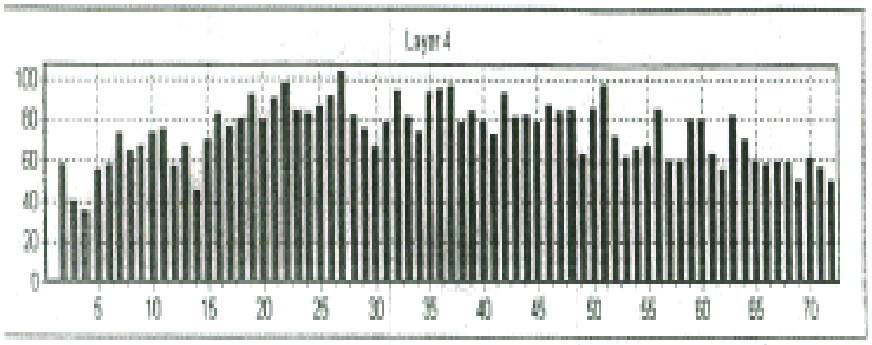
≤5 % Noisy Cells

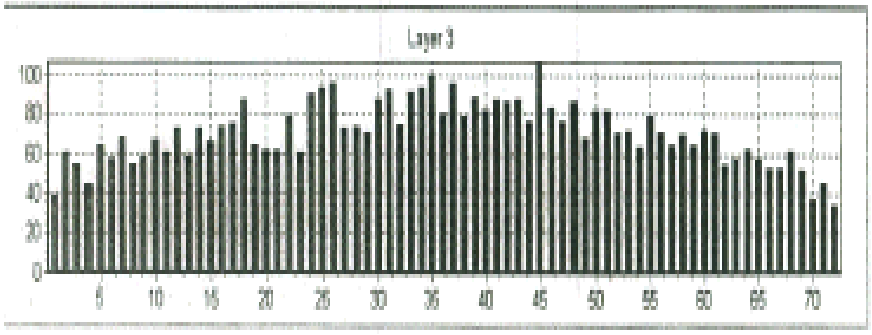


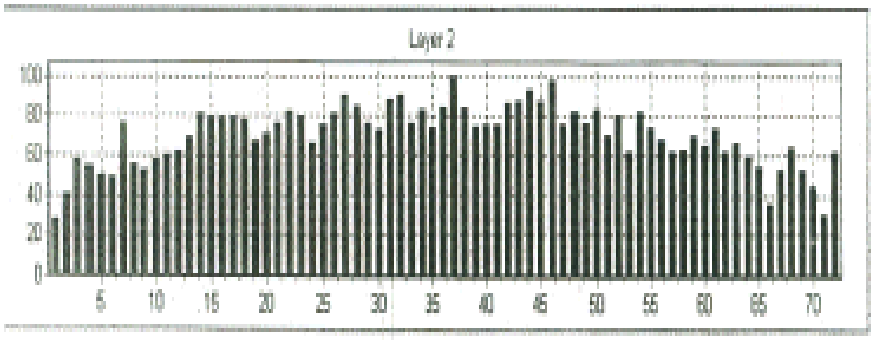
9011

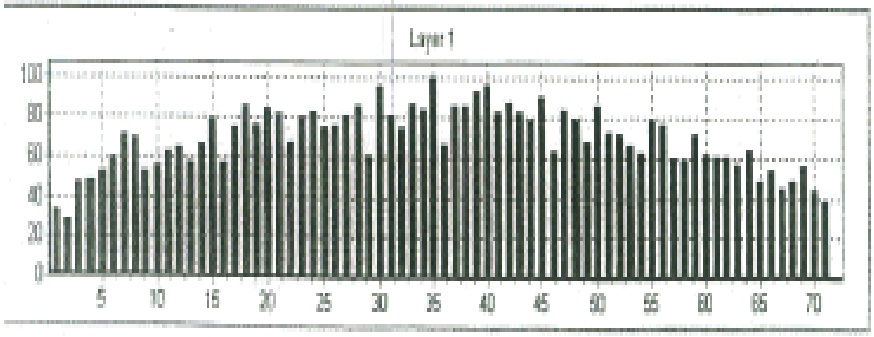
noise in Hz

still decreasing







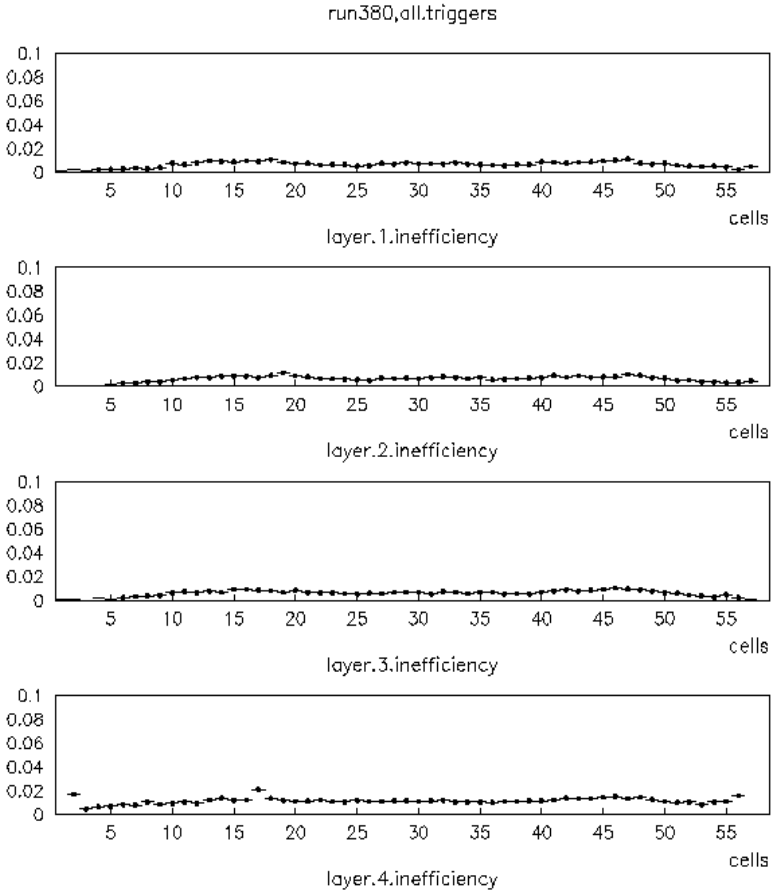


SAVE DATA

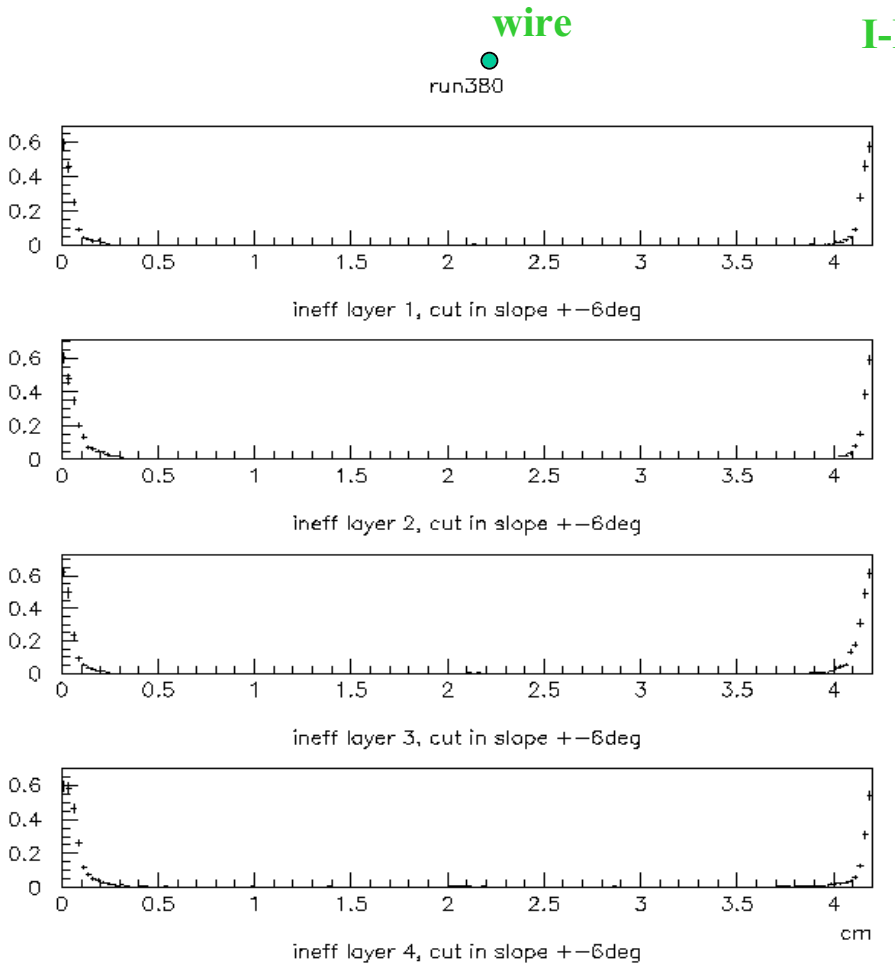
4011

cosmic ray occupa with counters

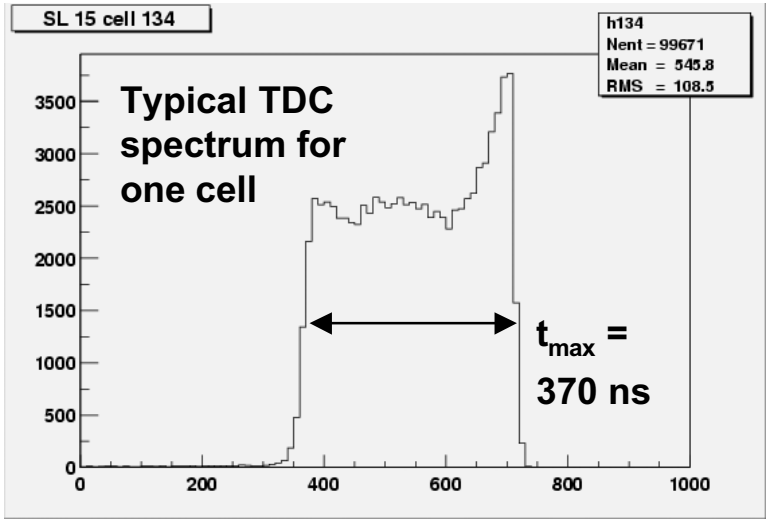
SL test in Legnaro : Cell inefficiency

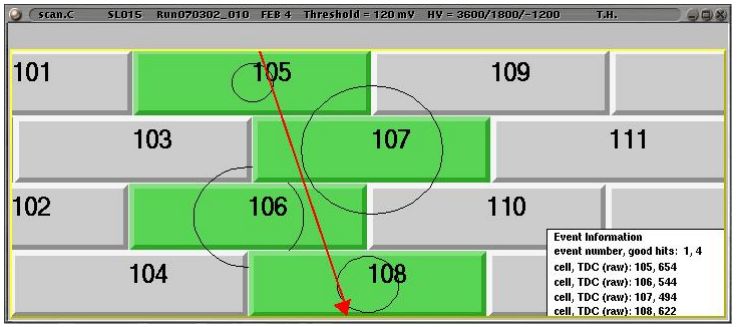


SL test in Legnaro : Ineff. is due to I-beams

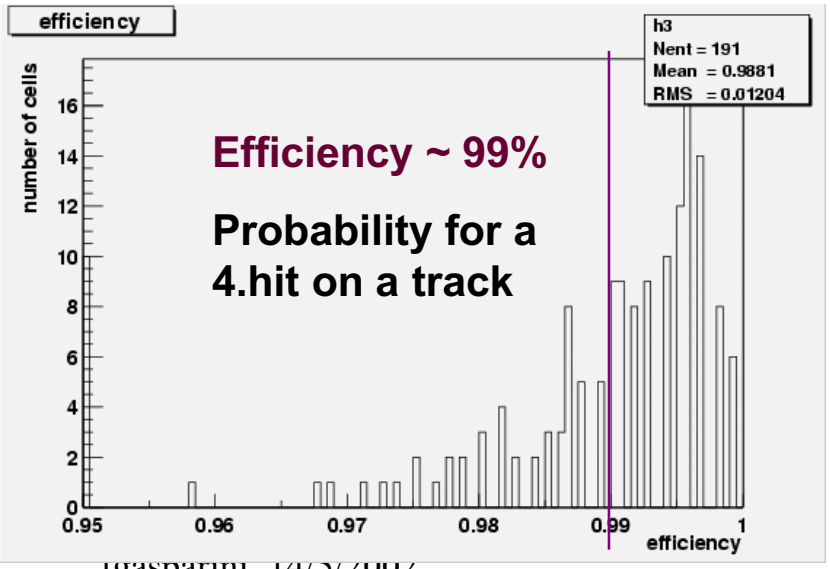


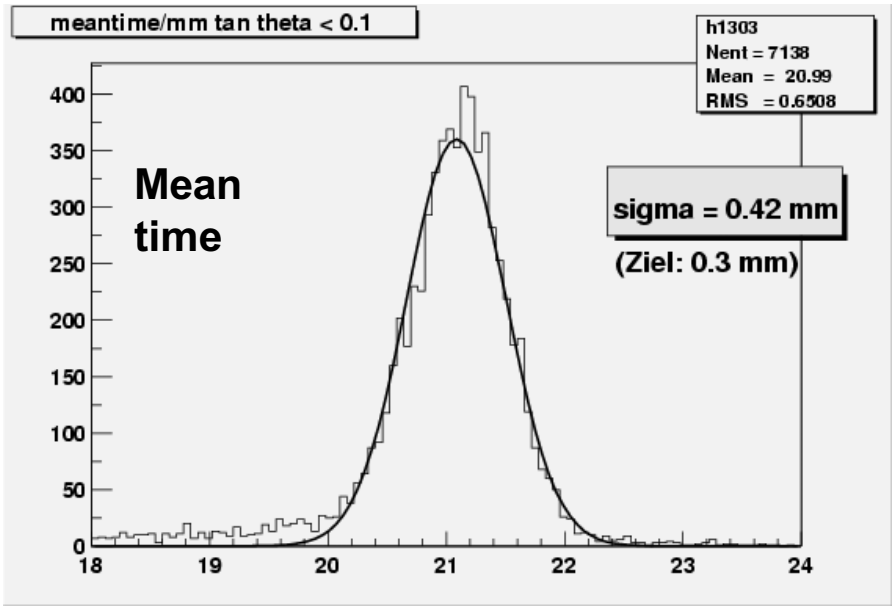
TDC spectrum and Mean time





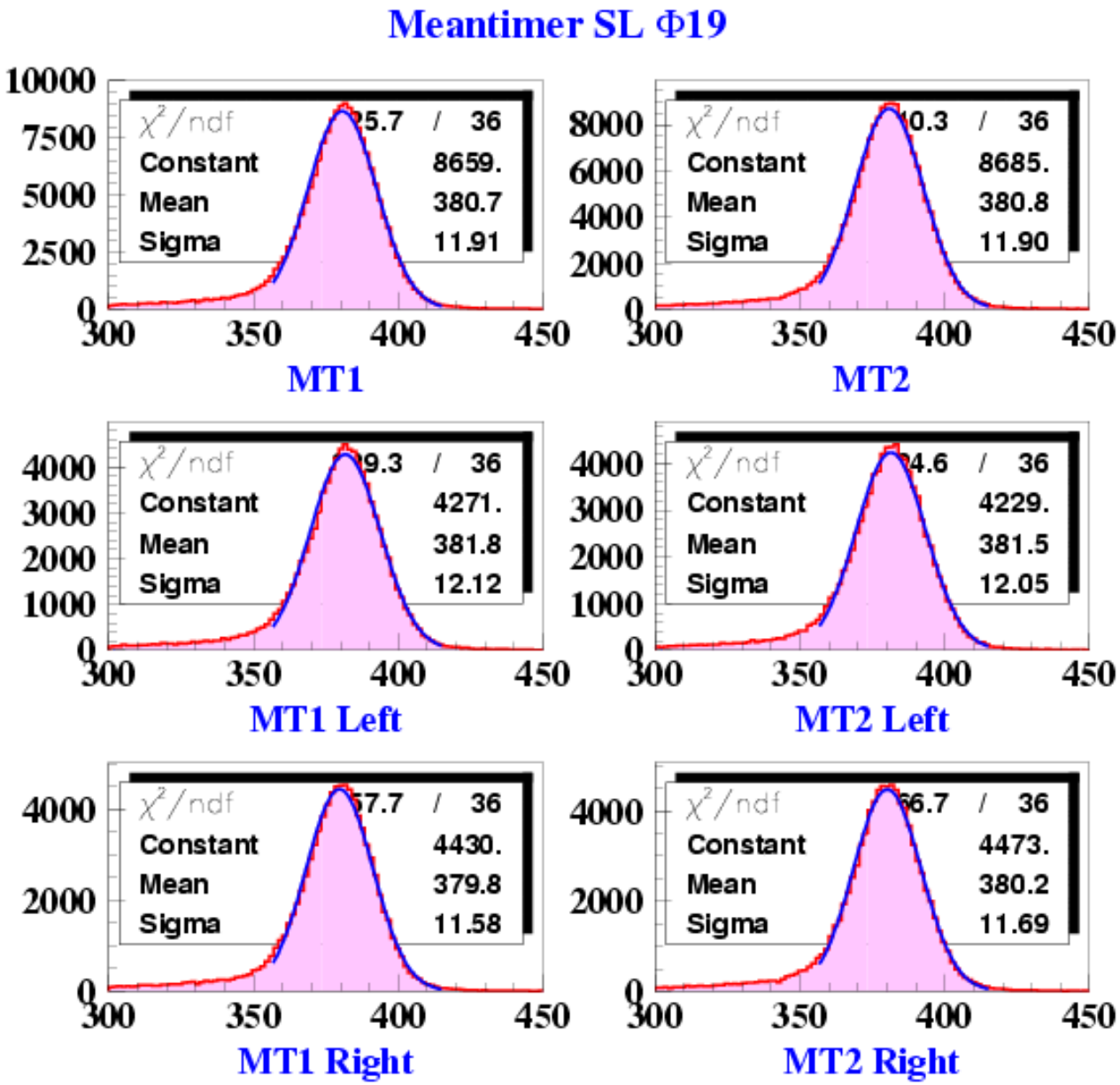
$$\text{Meantime} = \frac{1}{2}\left[dist(1) + dist(3)\right] + dist(2)$$

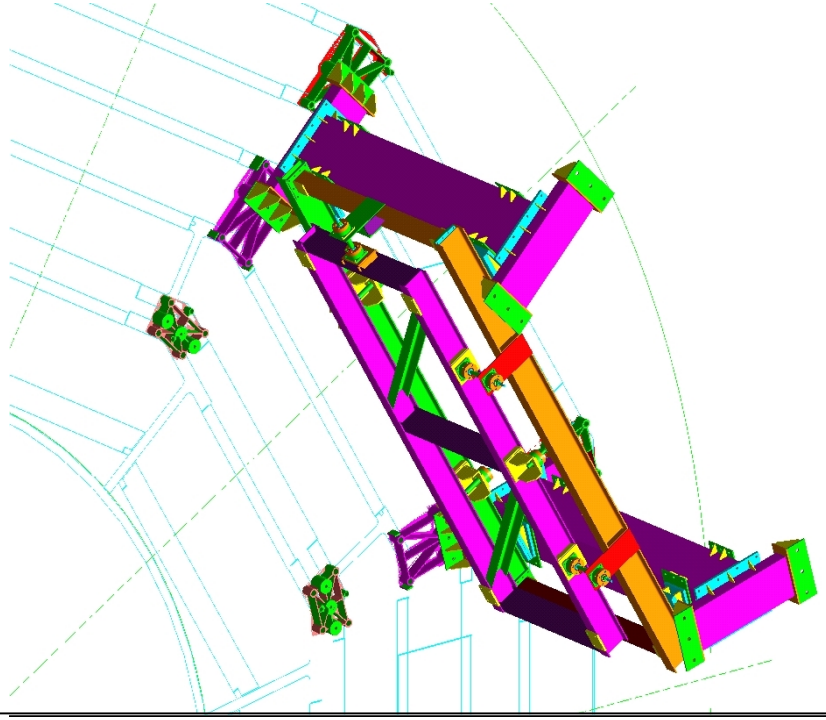




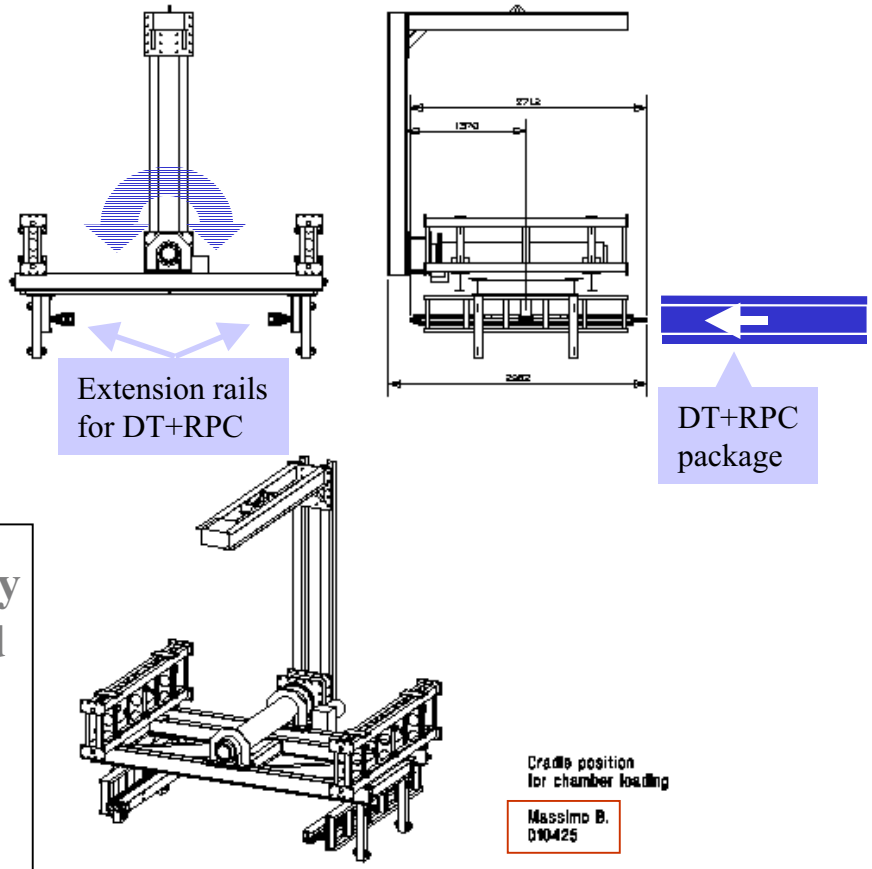
Meantimers(I)

Mean values are the same within ±1ns





DT installation tool



1 - Transport to CERN
2 - Test at ISR
3 - Alignment calibration
4 - Installation of RPC(s)
5 - Transport to P5
6 - Test at P5
7 - Insertion in YB
8 - Test in YB (gas,cooling,HV)

Several ancillary tools are needed that are under design or construction

Insertion test :0ne MB2 ch in Jul.~Aug. 02
Sector insertion : fall 2002

AIM OF INSTALLATION TESTS

SUMMER TEST: one chamber only

Understanding of the behaviour of the prototype of installation tool
And to have a credible estimate of the time needed for the installation

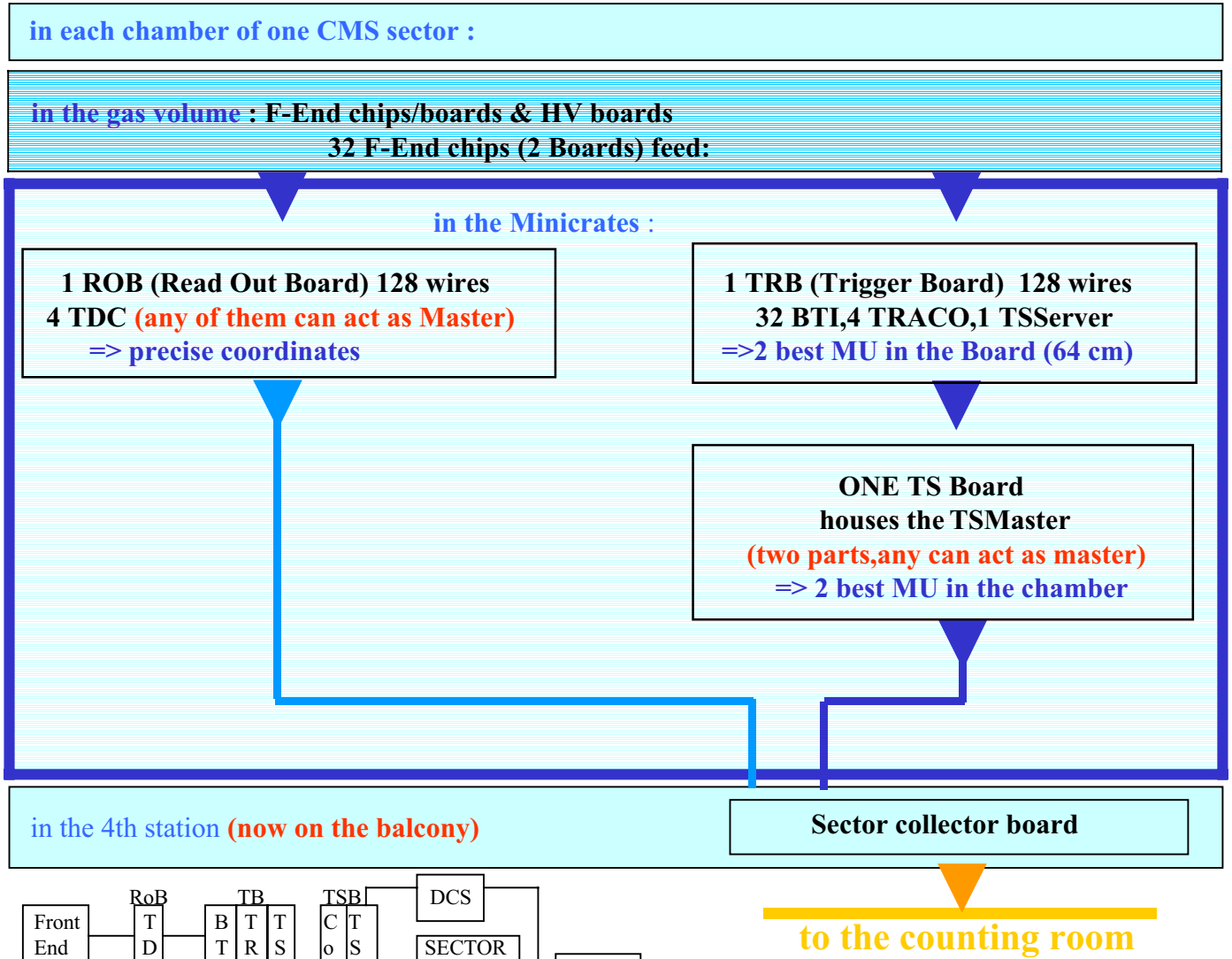
FALL 02 test

Installation of a full sector
Cabling and piping

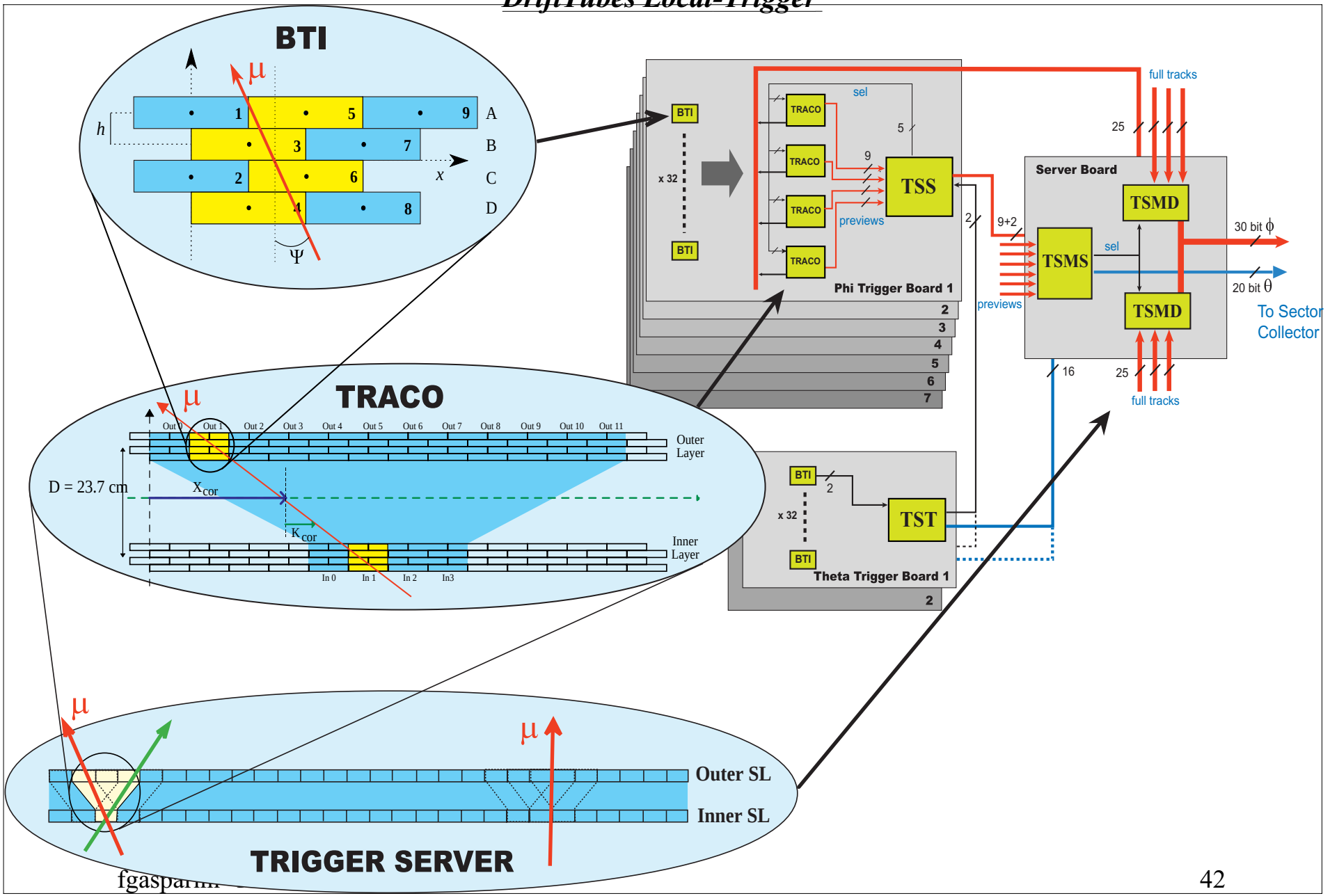
However there will be no minicrate available at the time
This would imply that chambers should be taken away, and back to ISR waiting for availability of full electronics

To be understood

3) electronics:
electronics is sitting on the chambers



DriftTubes Local-Trigger



STATUS OF ASICS AND BOARDS 1)

BTI:
all available (55.000)

BTI modules:
tender closed ,contract signed 6 May 2002(tender closed at CERN in August 2001) production : 50 samples July, 300 October
Hope to have 1000/month starting in December
(12.500 modules)

TRACO:
10 samples positively tested in January 2002 ,full lot (5500) ordered in February IN PRODUCTION

Trigger Boards:
call for tender in Apr. 9. Approval from INFN June/July.
Preserie (50 =~ 7 Minicrates) in Dec 2002
First batch (200) by April 2003, then 200 boards/month
end Prod. Beginning 2004 (1500 boards)

For first installation >= 38 Minicrates are needed
And mass assembly can begin only in April 2003.

STATUS OF ASICS AND BOARDS 2)

TSS:
production in April 2002

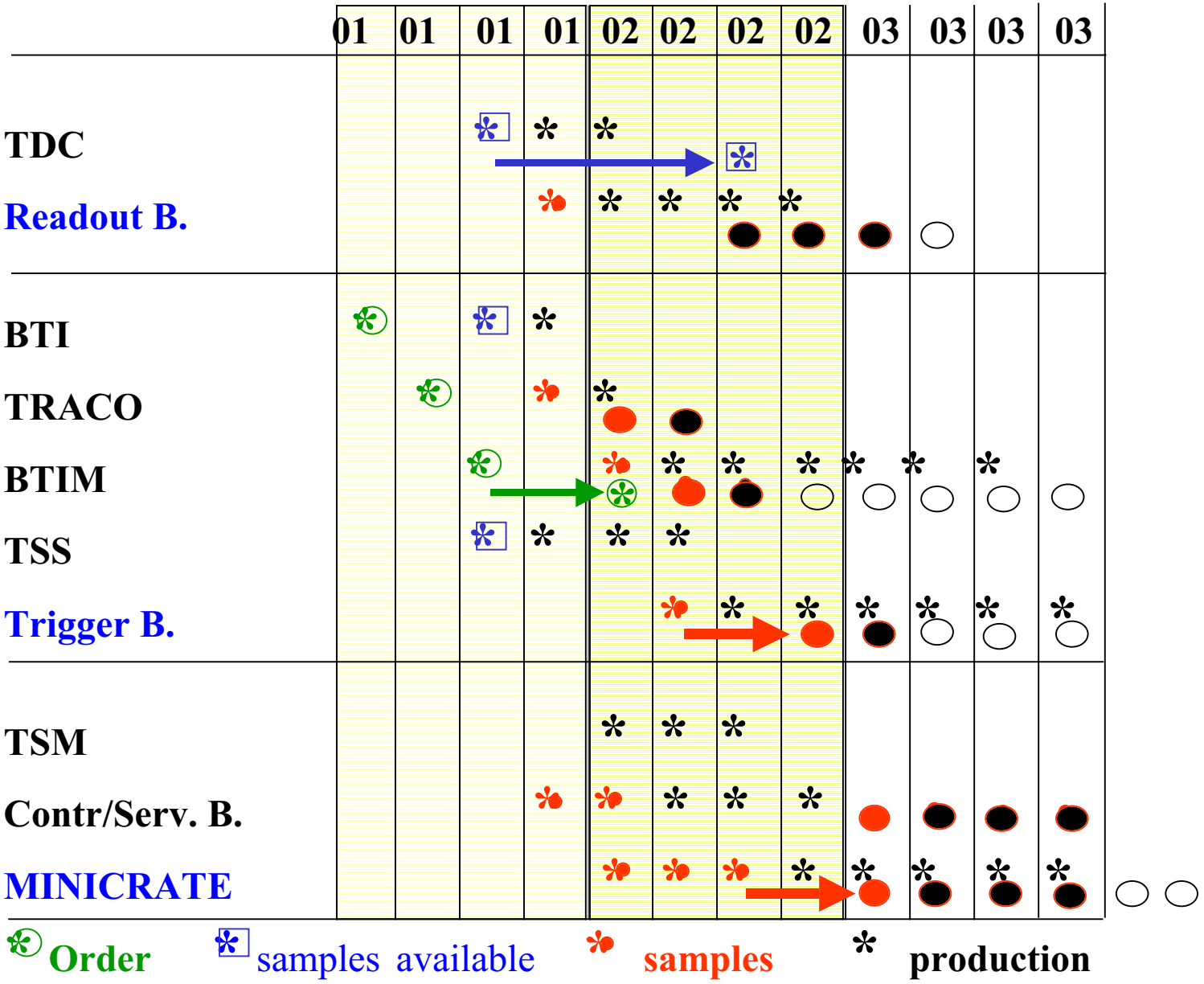
TDC (CERN MIC):
chips from the engineering run available,irradiation test with 60 MeV protons in Louvain passed,
mass production (5500 chips) delayed because of problems in the voltage regulator
New eng.run in Sept. Mass production Dec ~ Jan.

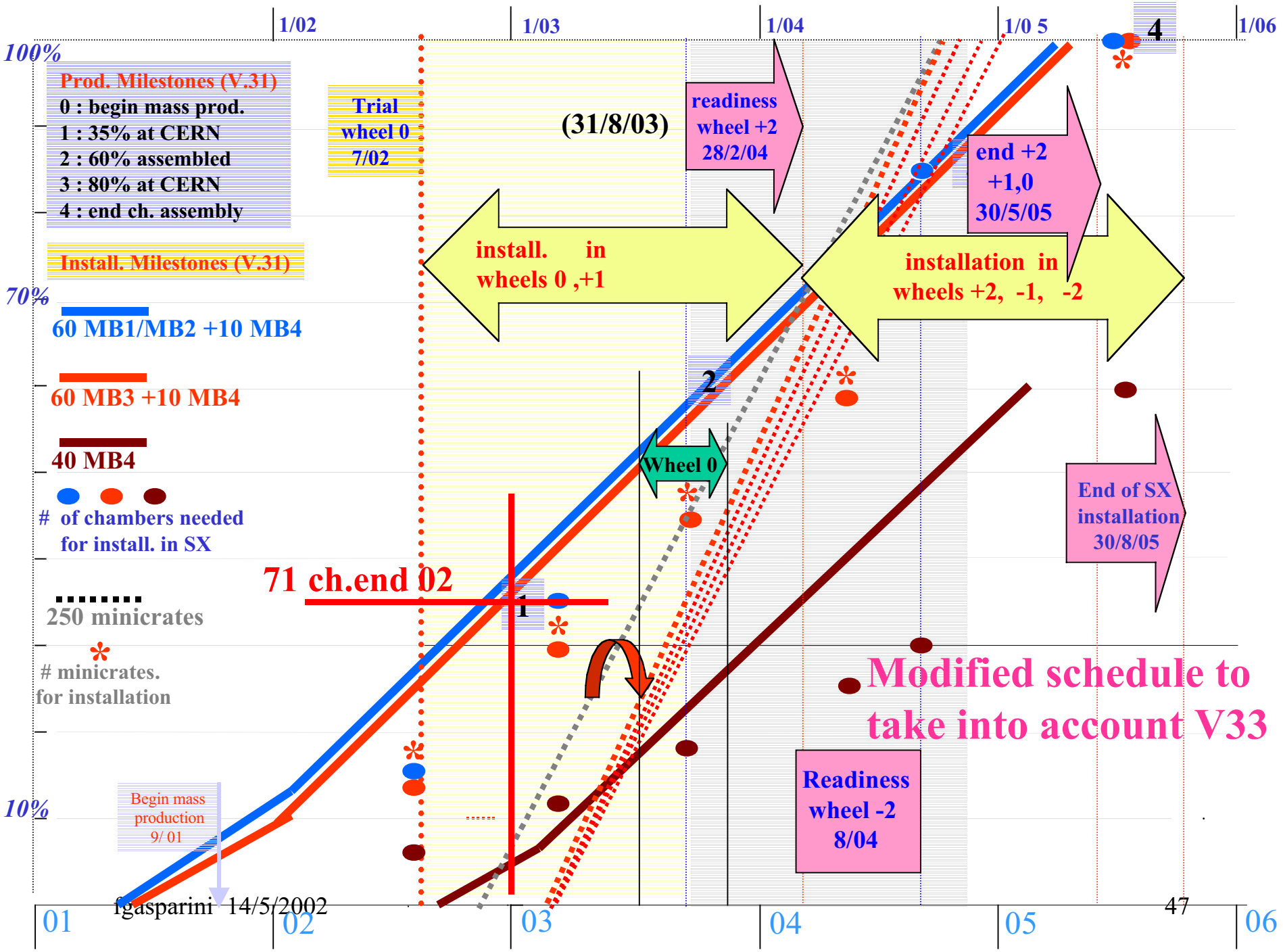
R-out Boards :
30 samples produced and tested ,
full lot of 1500 will be produced in fall 2002 (after eng.run) and 2003.

Control/Server Boards :
One per MINCRATE . The Jitter of the TTC regulator (CERN) is too large for a safe operation of the ASICS. It should be improved :new chips available by Jan. 2003.
No final CSBoard available before March 2003

	01	01	01	01	02	02	02	02	03	03	03	03
TDC			✻	*	*							
Readout B.				★	*	*	*	*				
BTI	✻		✻	*								
TRACO		✻		★	*							
BTIM			✻		★	*	*	*	*	*	*	*
TSS			✻	*	*	*						
Trigger B.						★	*	*	*	*	*	*
TSM					*	*	*					
Contr/Serv. B.				★	★	*	*	*				
MINICRATE					★	★	★	*	*	*	*	*

✻ Order ✻ samples available ★ samples * production


01 01 01 01 02 02 02 02 03 03 03 03
TDC
Readout B.
BTI
TRACO
BTIM
TSS
Trigger B.
TSM
Contr/Serv. B.
MINICRATE
Order
samples available
samples
production


1/02
1/03
1/04
1/0 5
1/06
100%
70%
10%
Prod. Milestones (V.31)
0 : begin mass prod.
1 : 35% at CERN
2 : 60% assembled
3 : 80% at CERN
4 : end ch. assembly
Install. Milestones (V.31)
60 MB1/MB2 +10 MB4
60 MB3 +10 MB4
40 MB4
# of chambers needed for install. in SX
250 minicrates
minicrates. for installation
Trial wheel 0 7/02
(31/8/03)
readiness wheel +2 28/2/04
end +2 +1,0 30/5/05
install. in wheels 0 ,+1
installation in wheels +2, -1, -2
Wheel 0
End of SX installation 30/8/05
71 ch.end 02
Modified schedule to take into account V33
Readiness wheel -2 8/04
Begin mass production 9/ 01
4
2
1
01
02
03
04
05
06