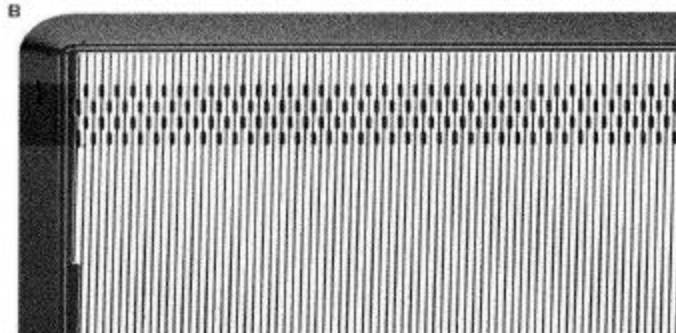


Production tests of silicon strip detectors of STAR SSD layer



Alberto TARCHINI
ALICE/STAR group of IReS (Strasbourg)

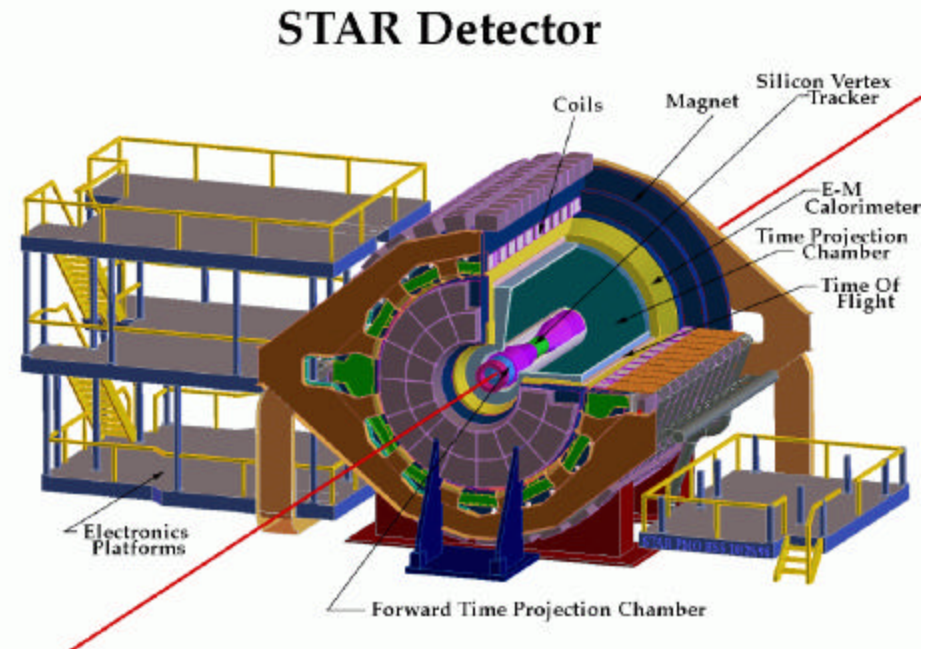
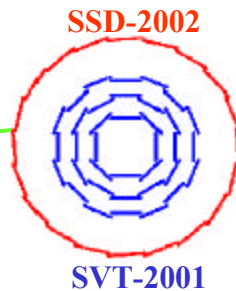
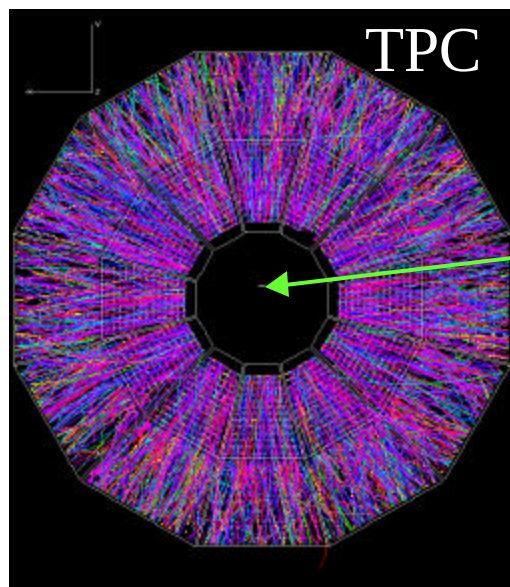
Contents

- STAR experiment
- SSD layer - SSD specifications
- Production outcome and detector delivery
- Quality assurance of produced detectors
- Instrumentation set-up and test results
- Database
- Additional measurements
- Some words about ITS ALICE SSD
- Conclusion

The STAR experiment

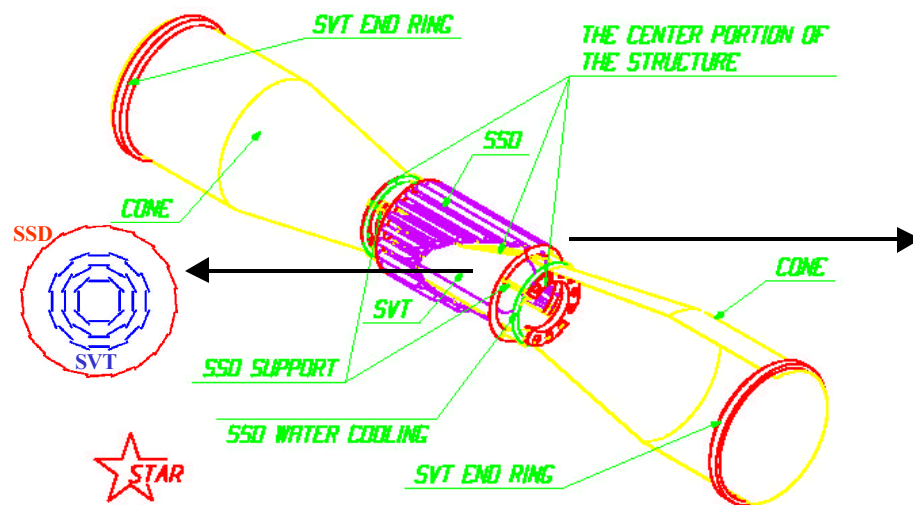
The **S**olenoidal **T**racker **A**t **R**HIC (**STAR**),
searching mainly for signatures of quark-gluon plasma,
is running at the **R**elativistic **H**eavy **I**on **C**ollider (**RHIC**)
at **B**rookhaven **N**ational **L**aboratory (**BNL**)

Au+Au collision @ 130A GeV



Radiation < 10krad

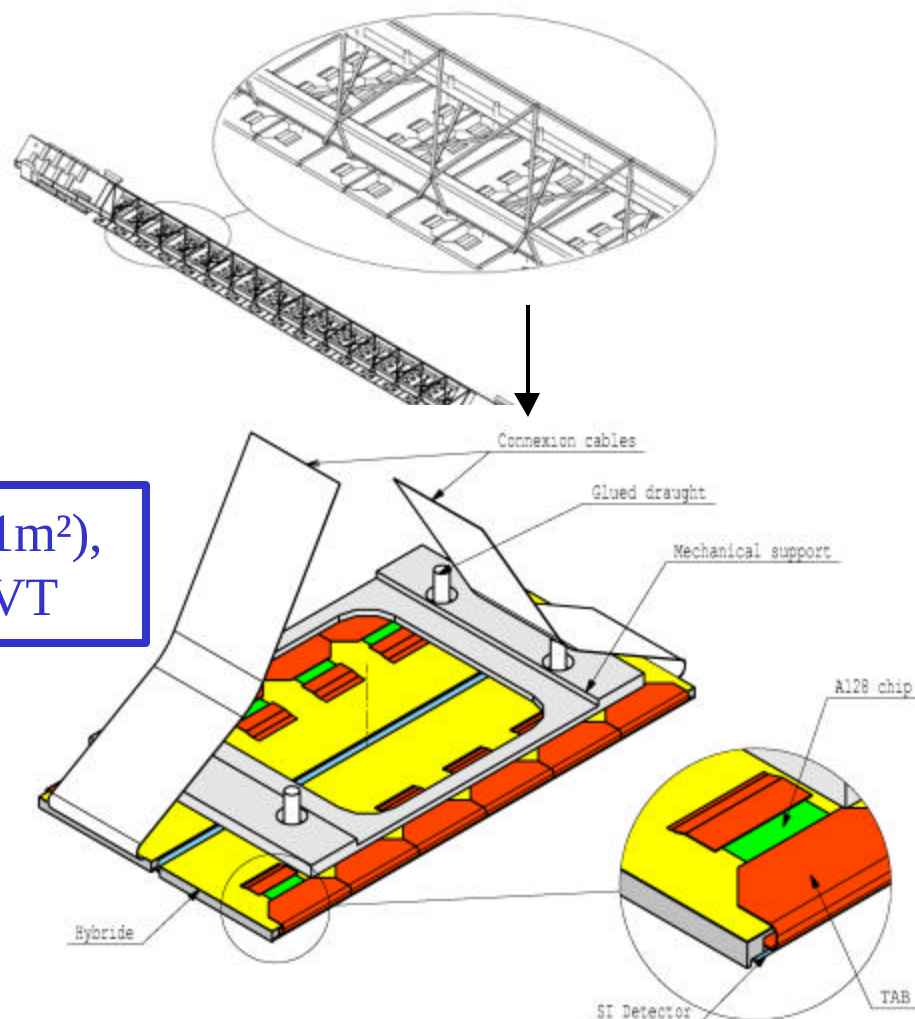
STAR SSD layer



The SSD is composed of **320 detectors** (1m²), placed on 20 ladders, will surround the SVT

Three laboratories are in charged of the conception and construction:

- IReS (Strasbourg)
- SUBATECH (Nantes)
- Warsaw Institute of Technology



Double sided Silicon Strip Detector (SSD) main specifications

General specification:

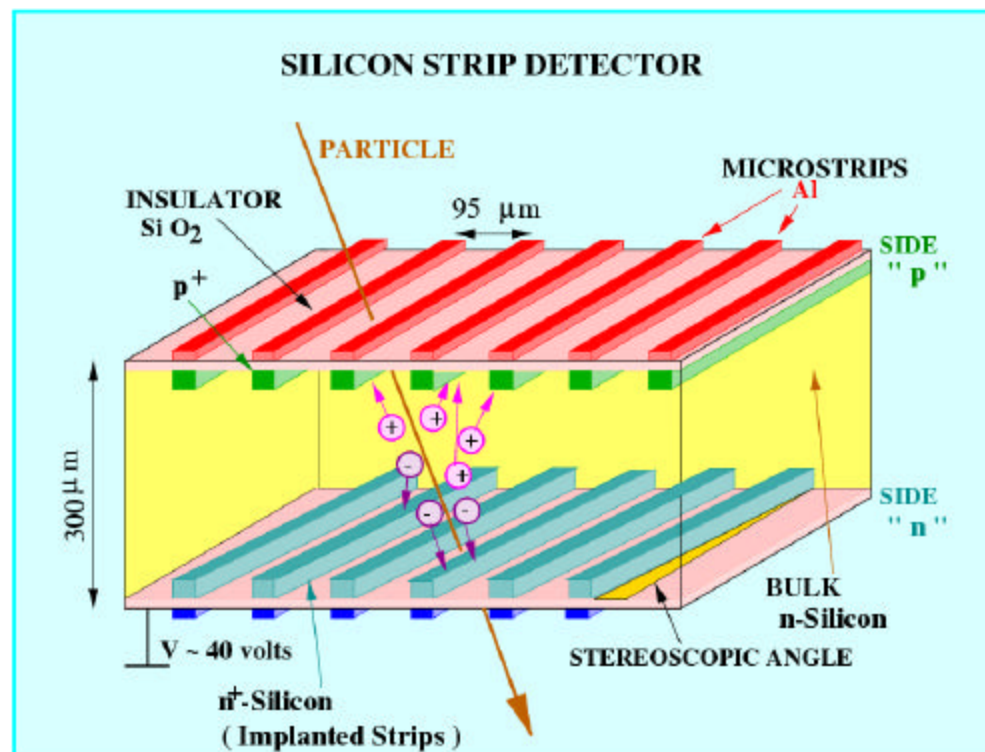
- N-type silicon substrate
- Strips: p⁺ one side, n⁺ opposite side
- Strips biasing: punch-through

Geometric specification:

- Size: 42x75 mm²
- Thickness: 300μm
- 768 strips per side - AC coupled
- Pitch: 95μm
- Strip width: 30μm
- Stereo angle: 35mrad

Electrical specification:

- Depletion voltage $\leq 55V$
- Bias/guard currents $\leq 2/5\mu A$



Acceptance criteria:

- Has to meet geometrical and electrical specification
- Bad strips ≤ 10 strips/side (1.3%)

STAR SSD production outcome

400 detectors separated in two lots of 200 were ordered at EURISYS MESURES, in July.-99

440 delivered: tested and sorted according to quality criteria by IReS

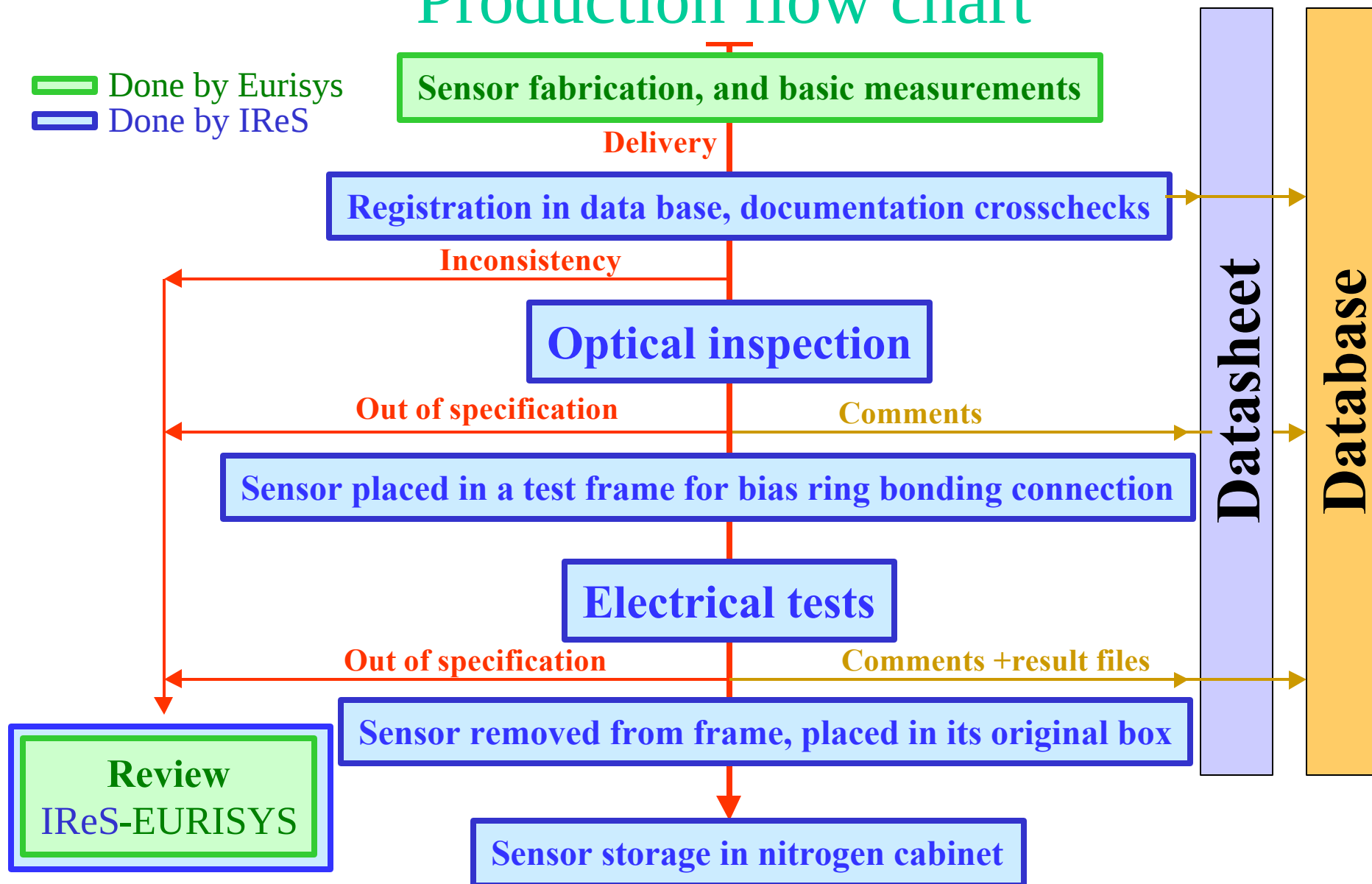
Detector delivery

Number of ssd	delivery
14	oct.-99
26	nov.-99
115	jan.-00
45	feb.-00
120	mar.-00
60	may-00
60	jun.-00

Production outcome

Quality	Nb detectors	Quality criteria	Specification
1	284	Bad strips <4	yes (very good)
2	82	Bad strips/side < 10	yes (good)
3	22	Bad strips/side > 10	no (some are usable)
4	18	Ibias>2 μ A or Iguard>5 μ A	no (some are usable)
5	28	Bad mechanical or electrical	no (very bad)
6	6	Depletion voltage > 55V	no
1,2,3,4,5,6	440		

Production flow chart

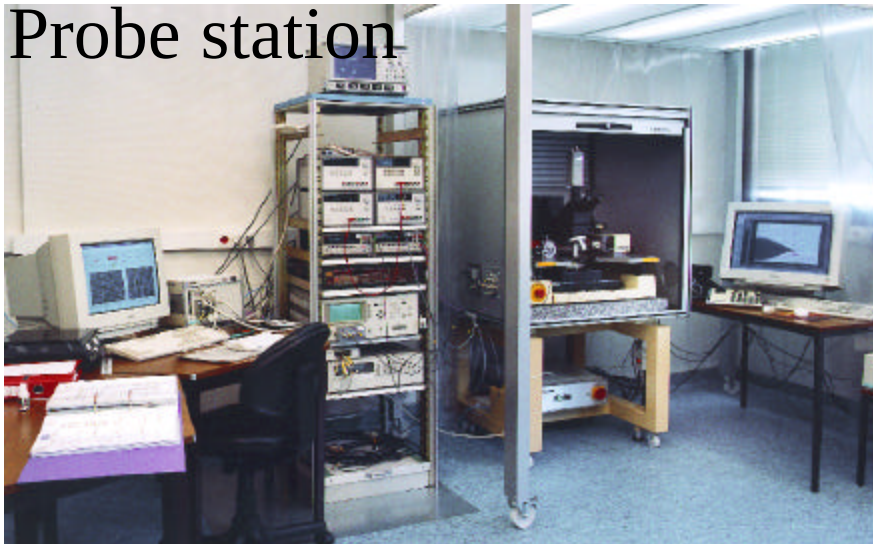


Instrumentation and testing clean room

Optical inspection



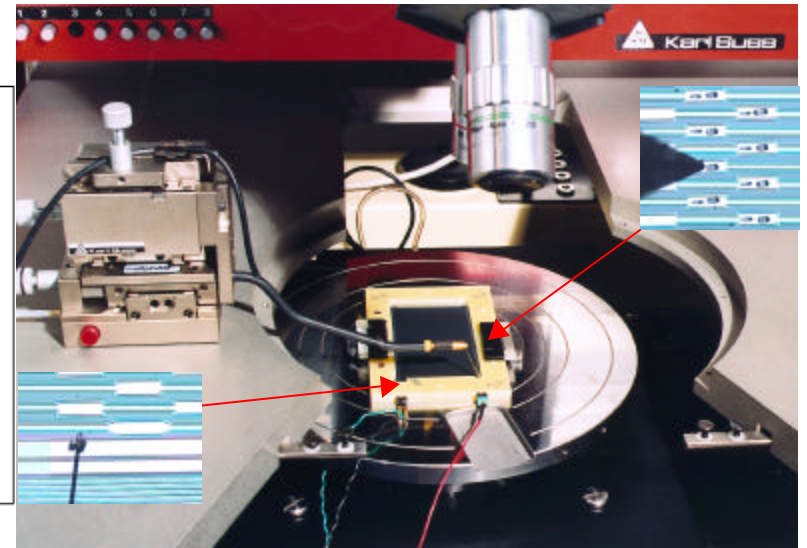
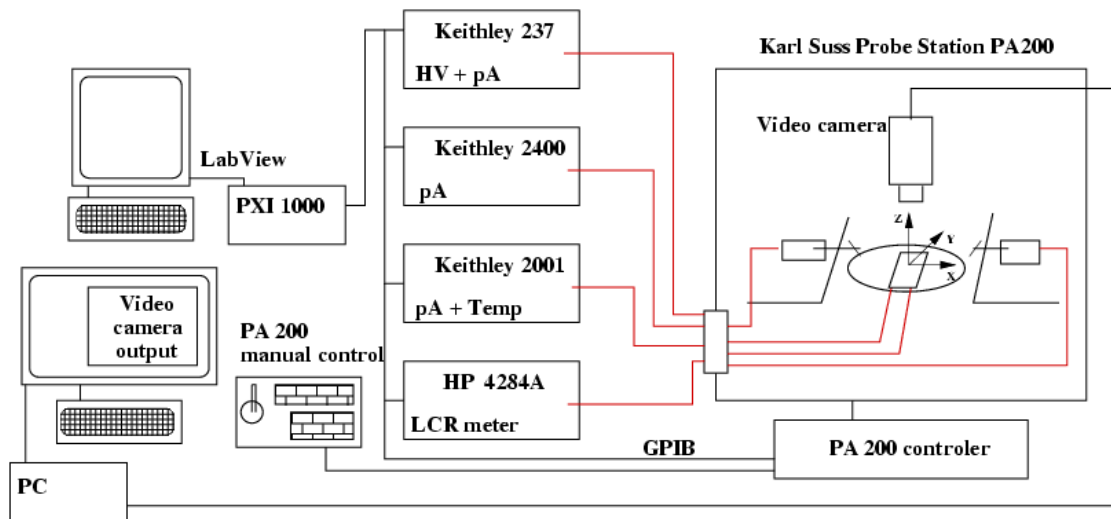
Probe station



Nitrogen cabinet



Testing setup

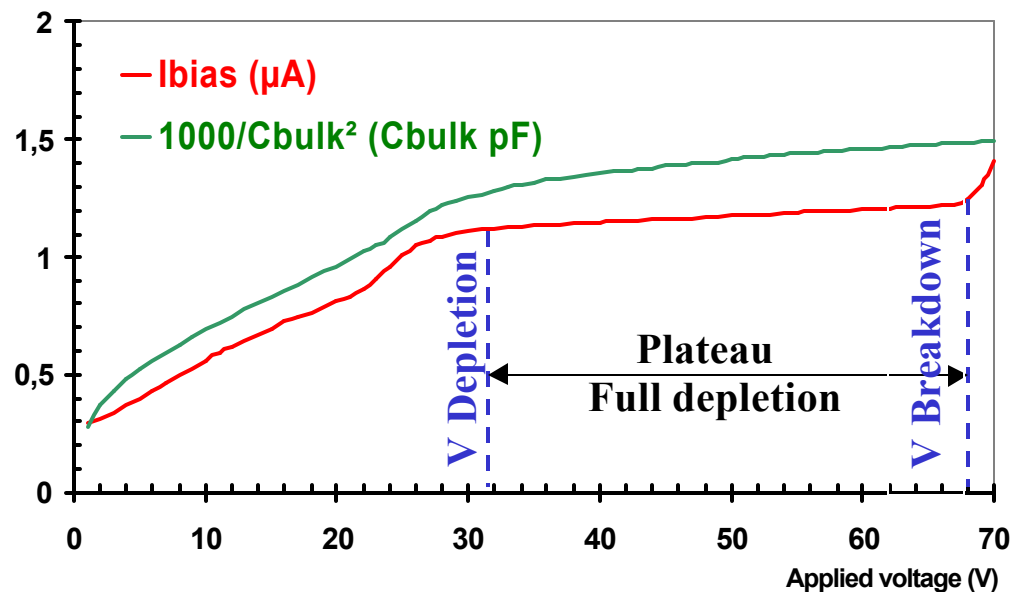


Production tests and measurements

Detector test name	Measurement	Characteristics	Occurrence	Time
1st test: Leakage current	I_{total} , I_{bias} , I_{guard} as a function of applied voltage	V depletion V breakdown	Systematic	3min
Bulk capacitance	C_{bulk} as a function of applied voltage	V depletion	facultative	3min
Inter-strip capacitance	$C_{\text{inter-strip}}$ as a function of applied voltage	V depletion	facultative	5min
2nd test: Strip coupling capacitor	Coupling capacitance, AC strip leakage current	Nb pin-holes, strips metal short, interrupted strips	Systematic	40 min per side
3rd test: Current stability	I_{total} , I_{bias} , I_{guard} at operating voltage as a function of time	Current values when stabilized	Systematic	Variable

1st test: depletion and breakdown voltage

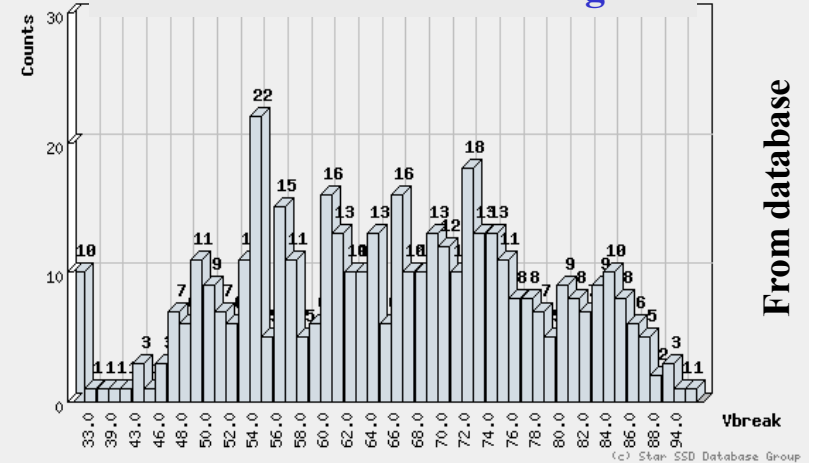
$I_{bias}=F(V)$ used for breakdown and depletion voltage determination (crosscheck with C_{bulk})



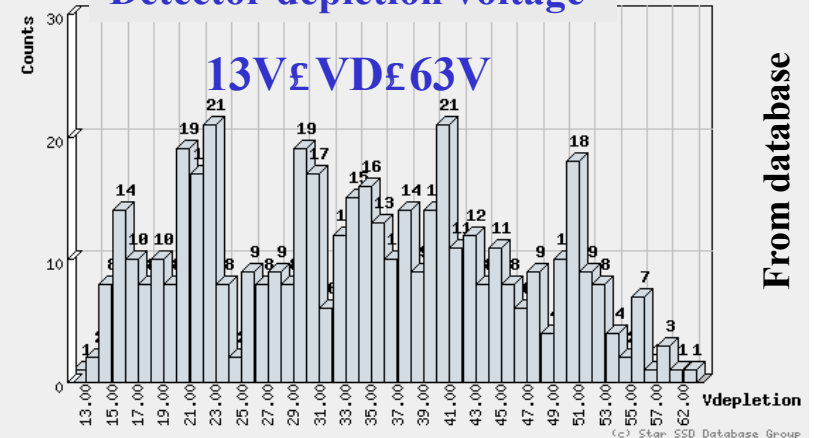
Plateau of accepted detectors:
 $28V \leq V \leq 43V$

Accepted and rejected detectors

Detector breakdown voltage



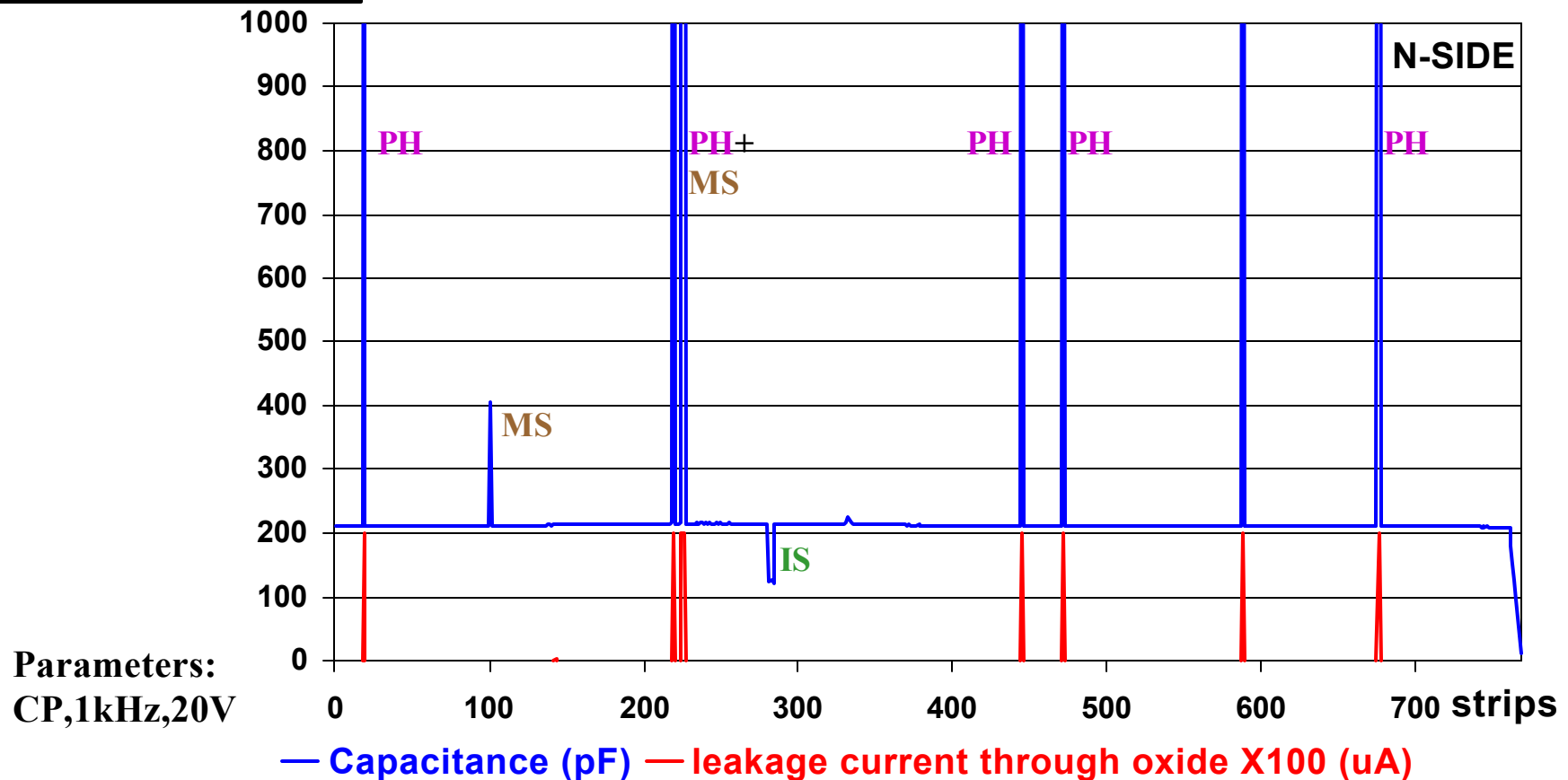
Detector depletion voltage



2nd test: strip coupling capacitors

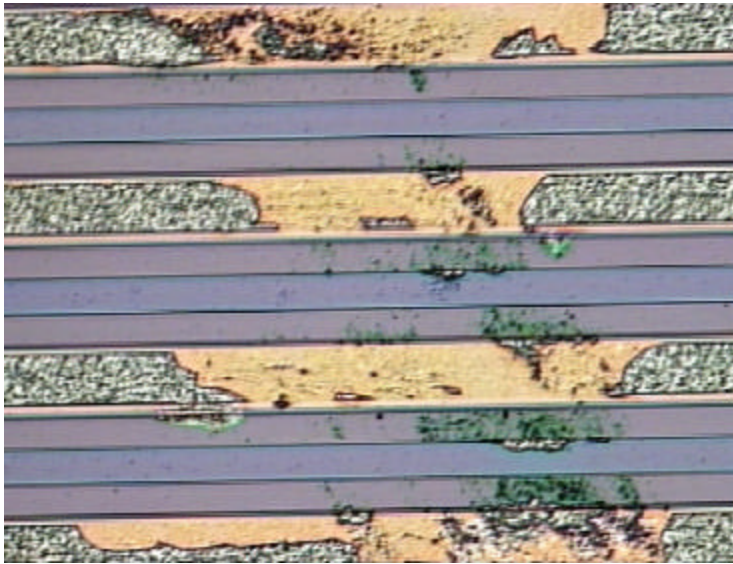
PH:pinhole
MS:metal short
IS:interrupted strip

Strips: - coupling capacitance
- leakage current through oxide
measurement for strip capacitor defect determination

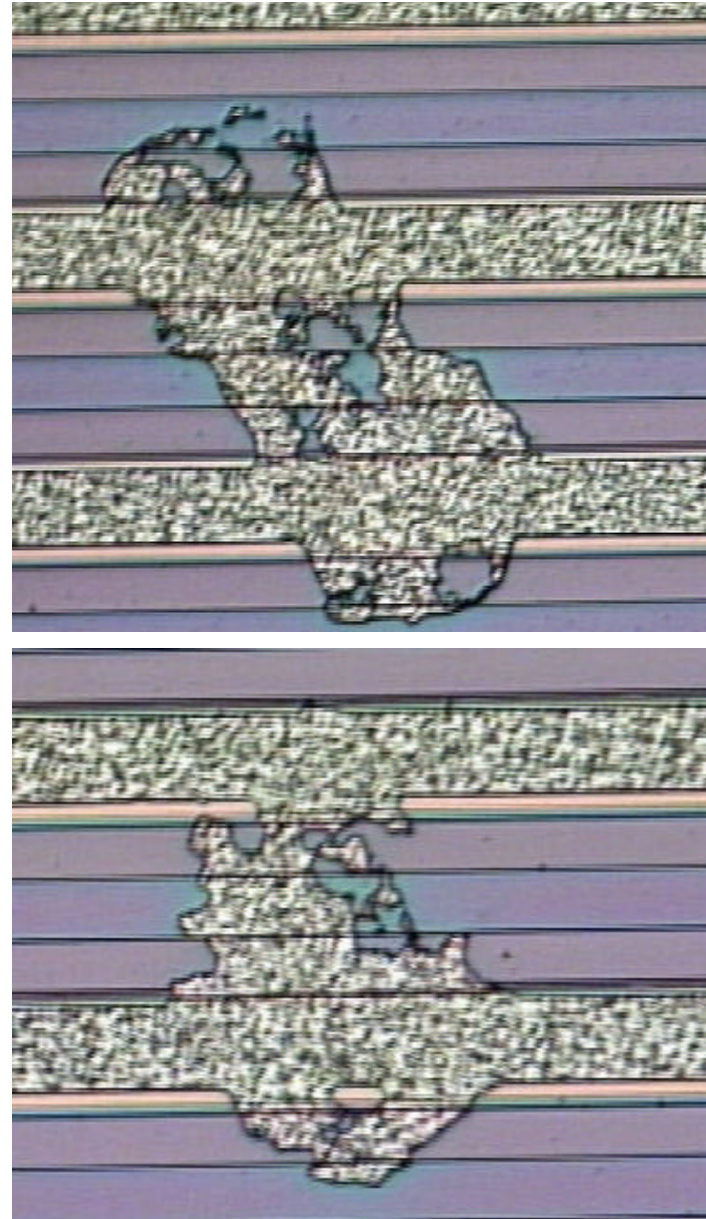


Different types of metal strip defect

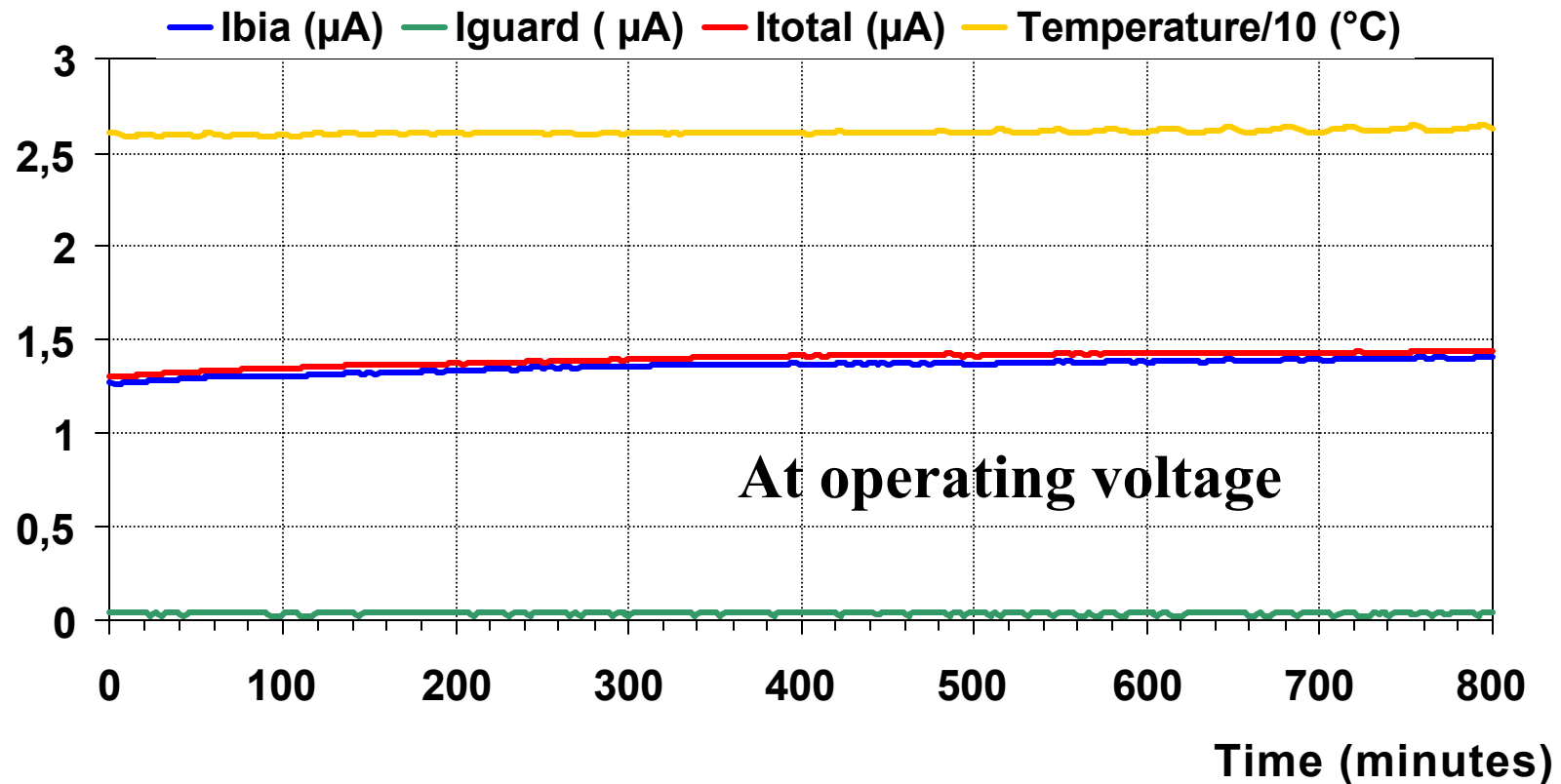
Metal strip interruption



Metal short between two strips

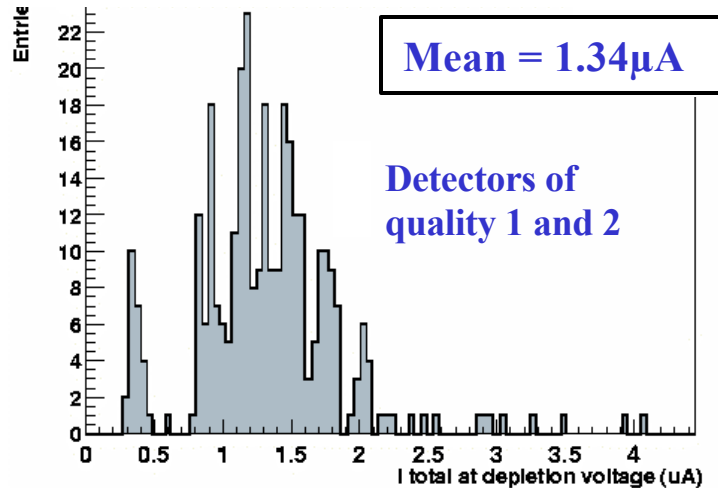


3rd test: leakage current stability

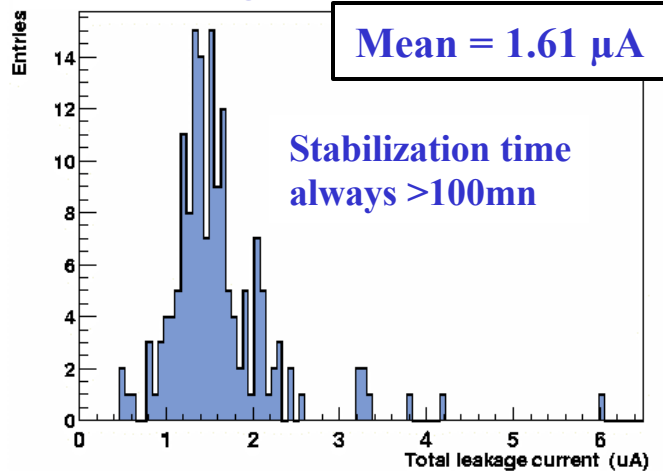


Production test results: dead strips and leakage current

Total leakage current at depletion voltage



Total leakage current after stabilization

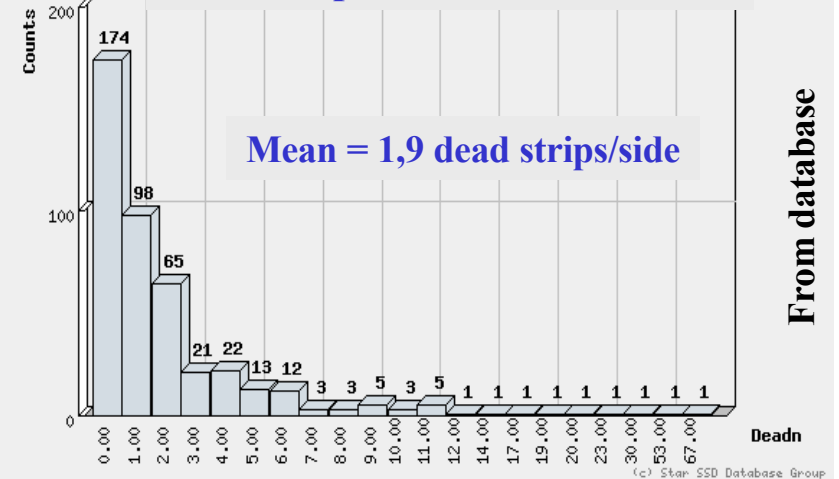


Done with accepted and rejected detectors

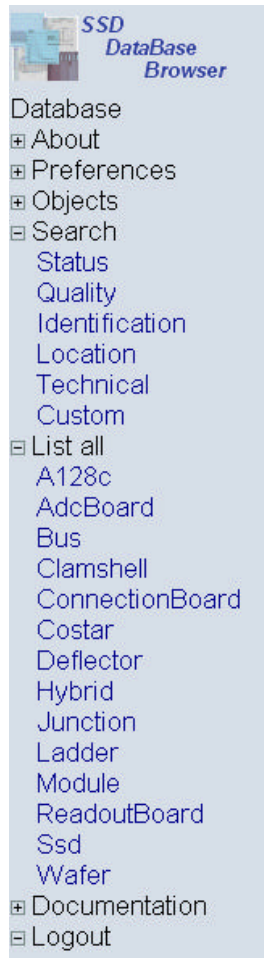
Dead strips on p-side/detector



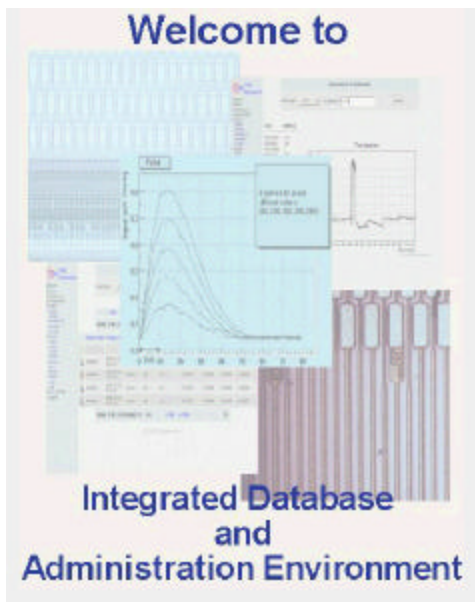
Dead strips on n-side /detector



Database

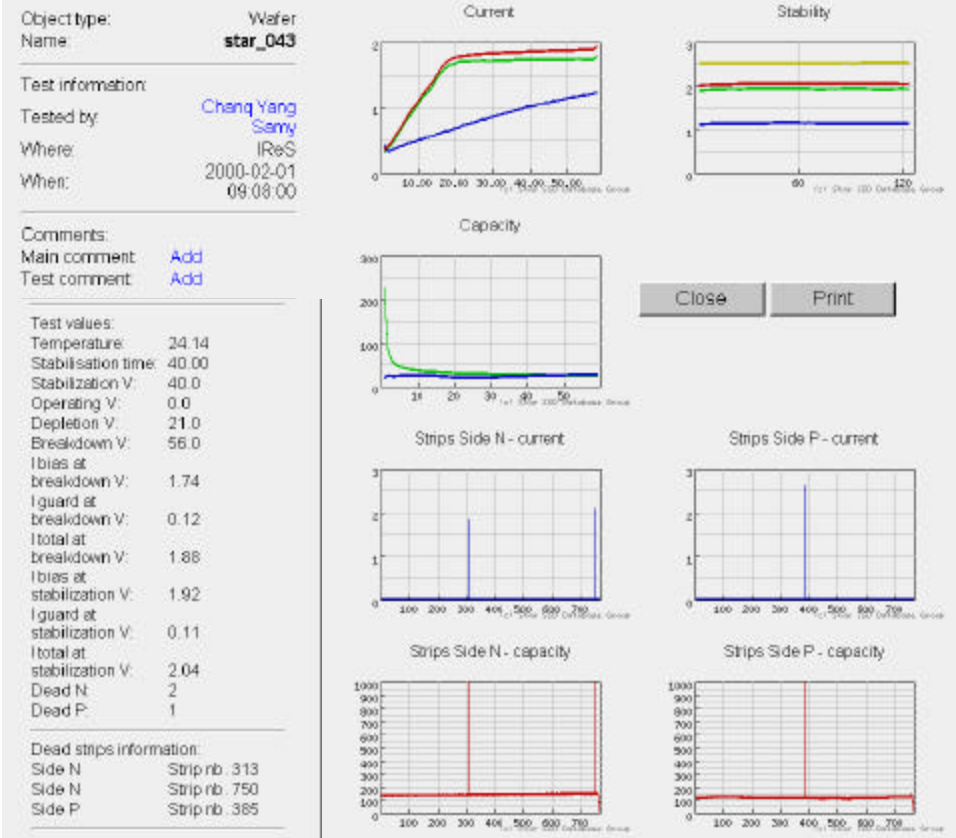


Search detectors using criteria



Database:
the best way to ...

Show test results of a detector

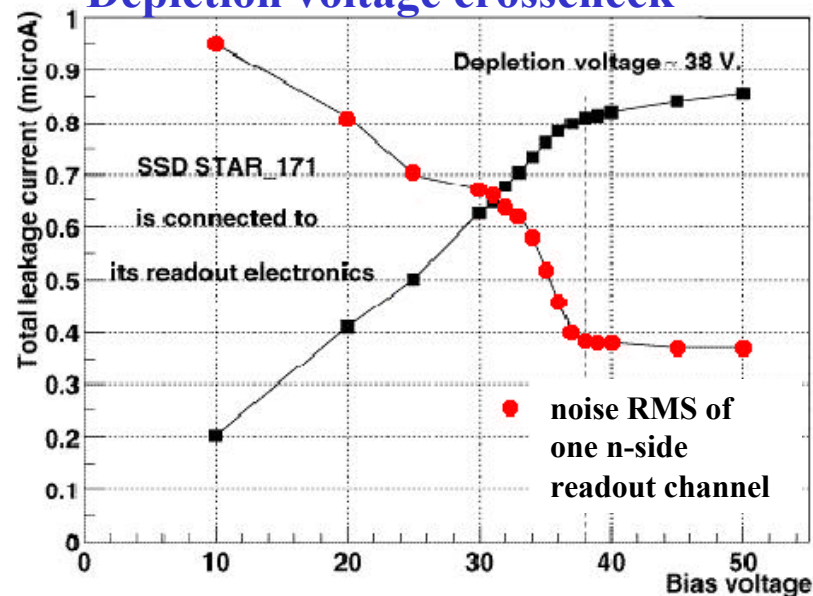


Store and visualize all data Address: <http://wwwstar-sbg.in2p3.fr/>

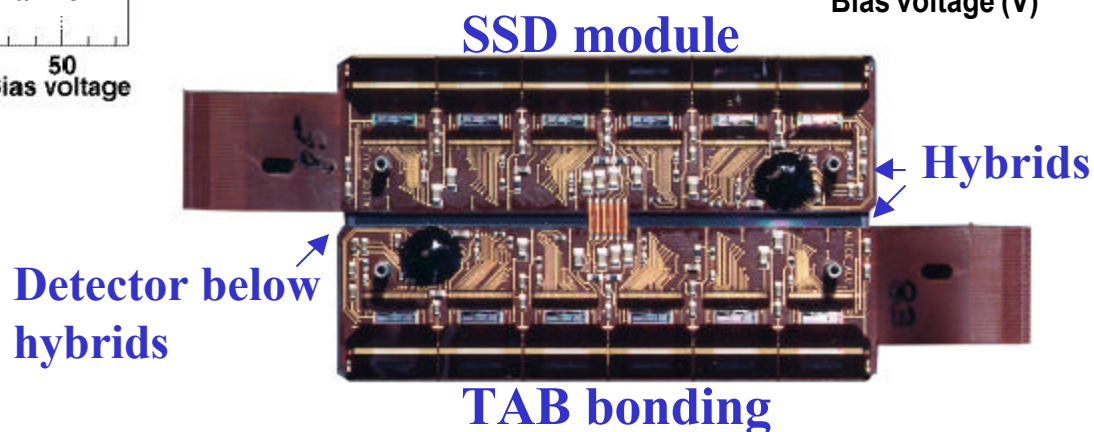
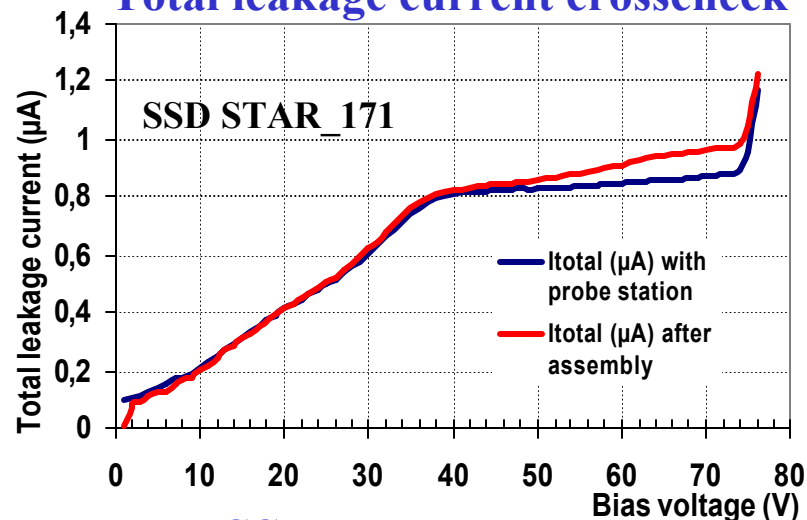
Number of hits: 440 (Displaying: 41 - 60)										<< First	<< Prev	Next >>	Last >>				
		Name	Type	Location	Tested	Accepted	Assembled	Destroyed	JTAG	Quality	Comment	DepletionV	BreakDownV	OperatingV	StabV	IBatBreakV	IGatBr
		star_041	wafer	IReS	yes	na	no	no	na	2	Add	16.0	54.0	0.0	40.0	1.84	
		star_042	wafer	IReS	yes	na	no	no	na	4	I bias too high...	20.0	57.0	0.0	40.0	4.71	

Additional measurements: crosscheck of characteristics before and after detector assembly

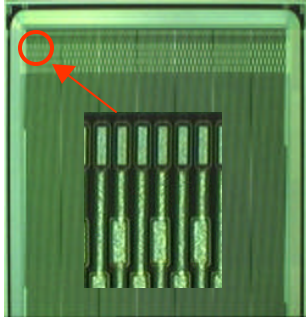
Depletion voltage crosscheck



Total leakage current crosscheck

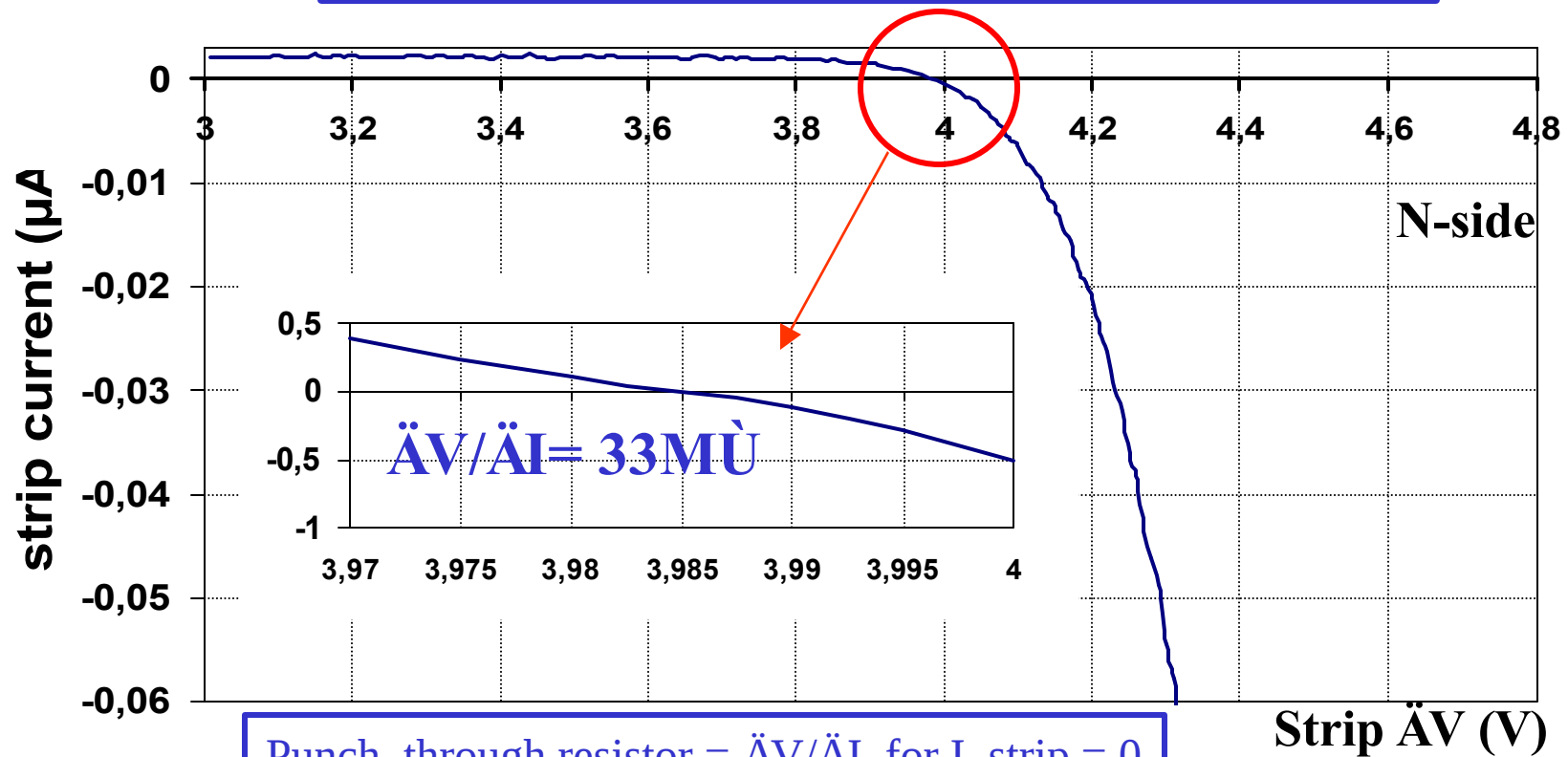


Test structure



Additional measurements: done on test structures

Punch_through resistor measurement at operating voltage using strip **DC pads** of a test structure

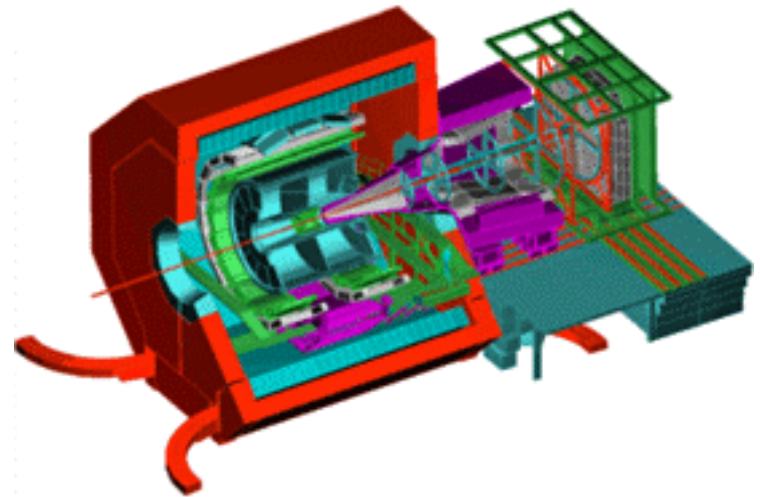


Some words about ITS ALICE SSD layers

Layer 5 and 6 of ALICE ITS are composed of **1698 detectors** very similar to the star SSD (5.4m^2).

The laboratories in charged of the conception and construction:

- INFN(Trieste)
- Institute of Technology (Warsaw)
- IReS (Strasbourg),
- SUBATECH (Nantes)
- Utrecht University/ NIKHEF
- Ukraine (Kharkof and Kiev)



1800 detectors will be **ordered** in **July 2001**.

The **pre-series** should arrive at CERN in **December 2001** for characterization.

Conclusions

STAR SSD are **produced, tested and sorted in quality groups**

The production of modules has started and the **characteristic crosscheck** of the detectors **does not show any problems**

Production **database** is **operational**

We already started to focus on **Alice SSD tests** which will be **carried out** at least **in two labs**.

The **hardware, software, organization** and the **experience gain from STAR SSD production tests** **will be used** like a base for **ALICE**