USA SCT Barrel Module Assembly

SCT Week CERN
September 2003

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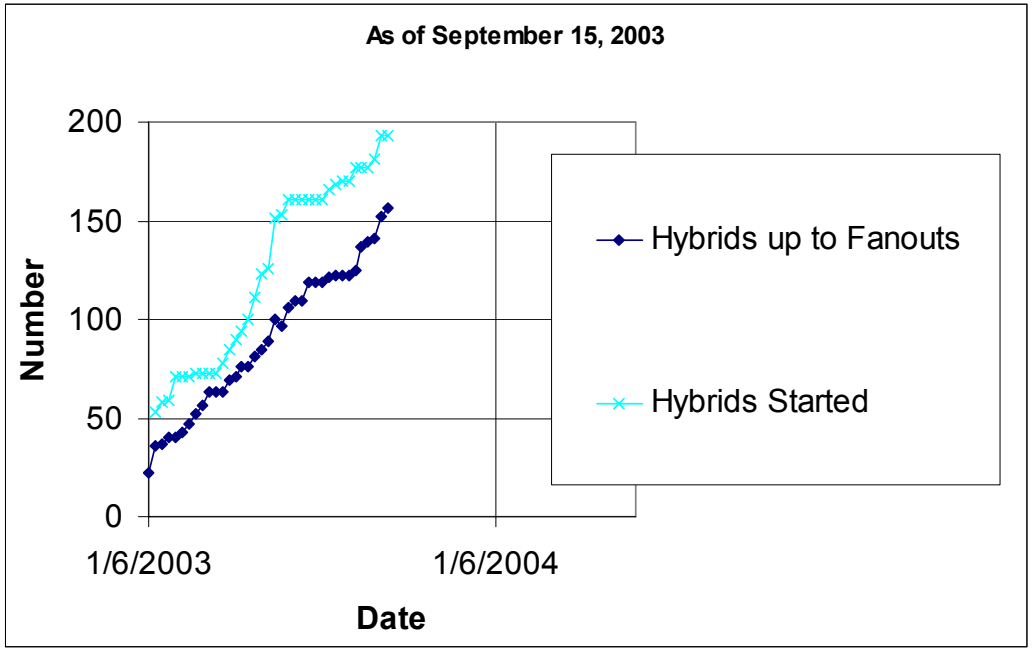
Lawrence Berkeley Lab

Technical Status

- Production started 9/02
- Qualification milestone passed 4/03
- Technical staff trained for production are in place, minimal cross training to spread expertise still underway
- 2 metrology systems in use
- 2 wirebonders in use (new H&K)
- Regularly building modules inside all specs
- Still experiencing occasional problems which require small adjustments to procedures
- Can just now align and glue 5 sides per day (2.5 modules) and complete 2 assemblies, ready for test, per day
- Full 483 deliverable should complete by 6/04

Hybrid Production

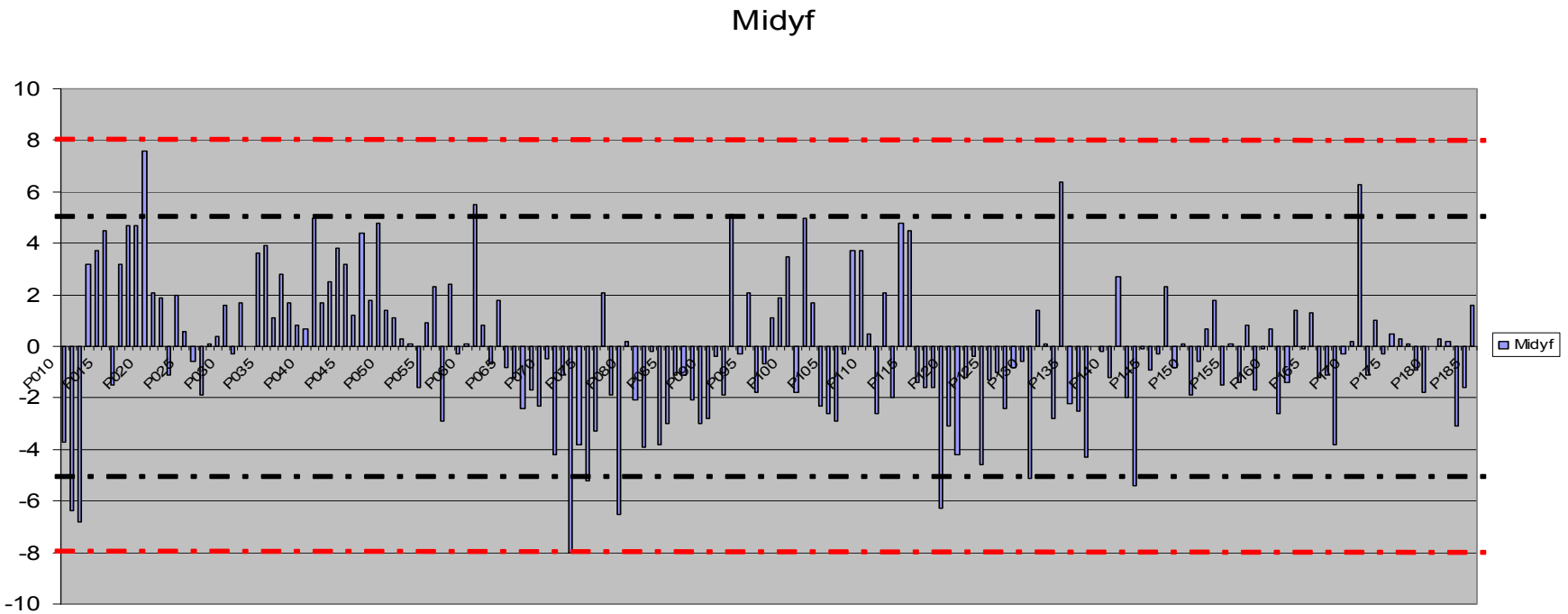
- Strongly coupled to deliveries, so far just in time for module assembly
- 193 (152) started (completed)
- Delivery rate increased in last weeks, not yet reflected in assembly
- But concern persists about fanout bonding with ongoing tests and evaluations which are time consuming.
- Recent pitch adapter damage, origin under study



Module Assembly and Test

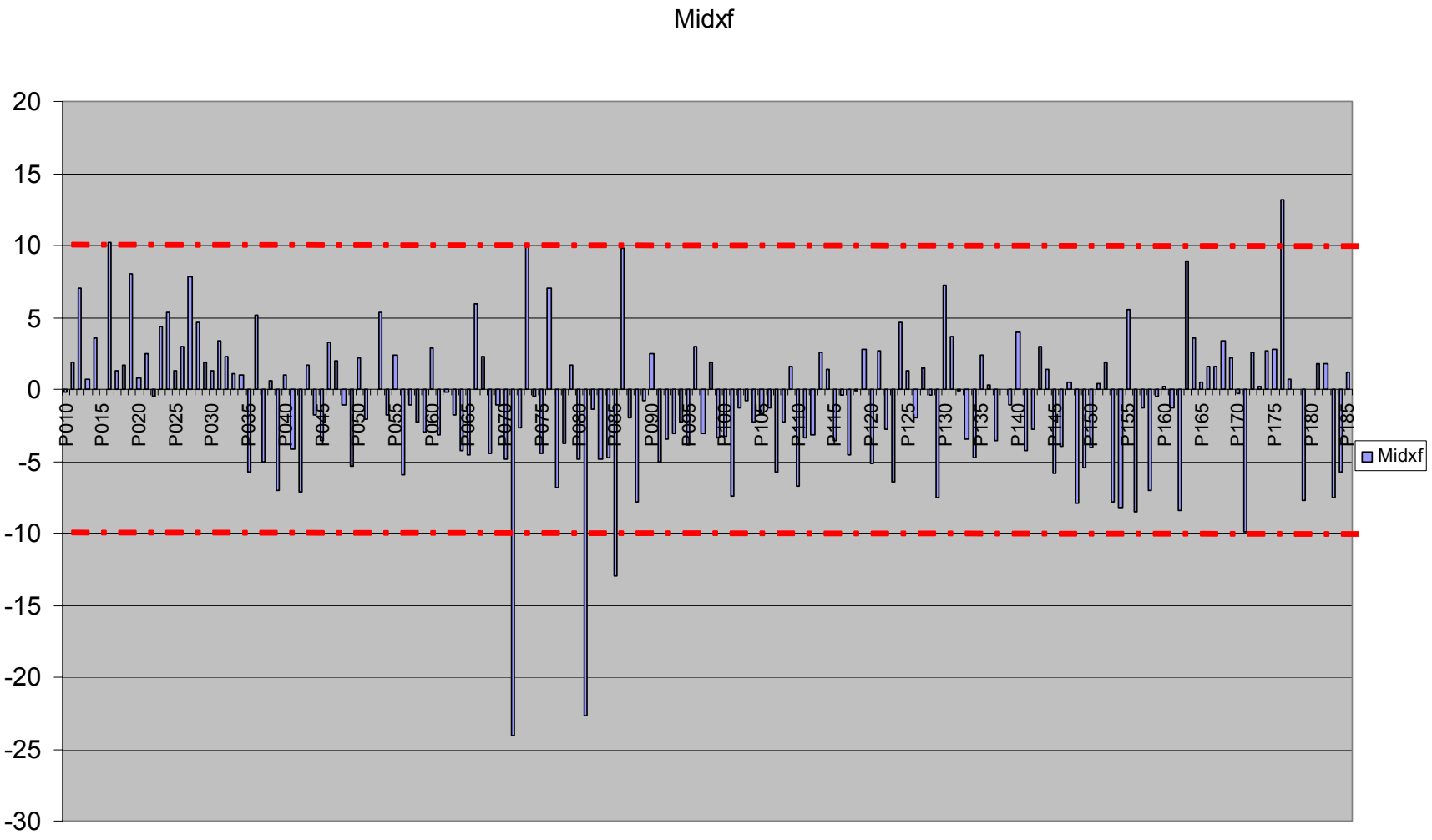
- What have been the key technical issues?
  - Metrology: meeting tightest specs on front to back alignment ("midyf") and stereo angle, monitoring drifts
  - Wire-bonding: lost channels and re-bonding- a fanout issue
  - Leakage currents: with strict re-bonding protocols achieve ~"sum of the 4 crystals"
  - Leakage currents – significant breakdown above 350V
  - Hybrid attachment: height parameter, fixture systematics

Metrology: Midyf history

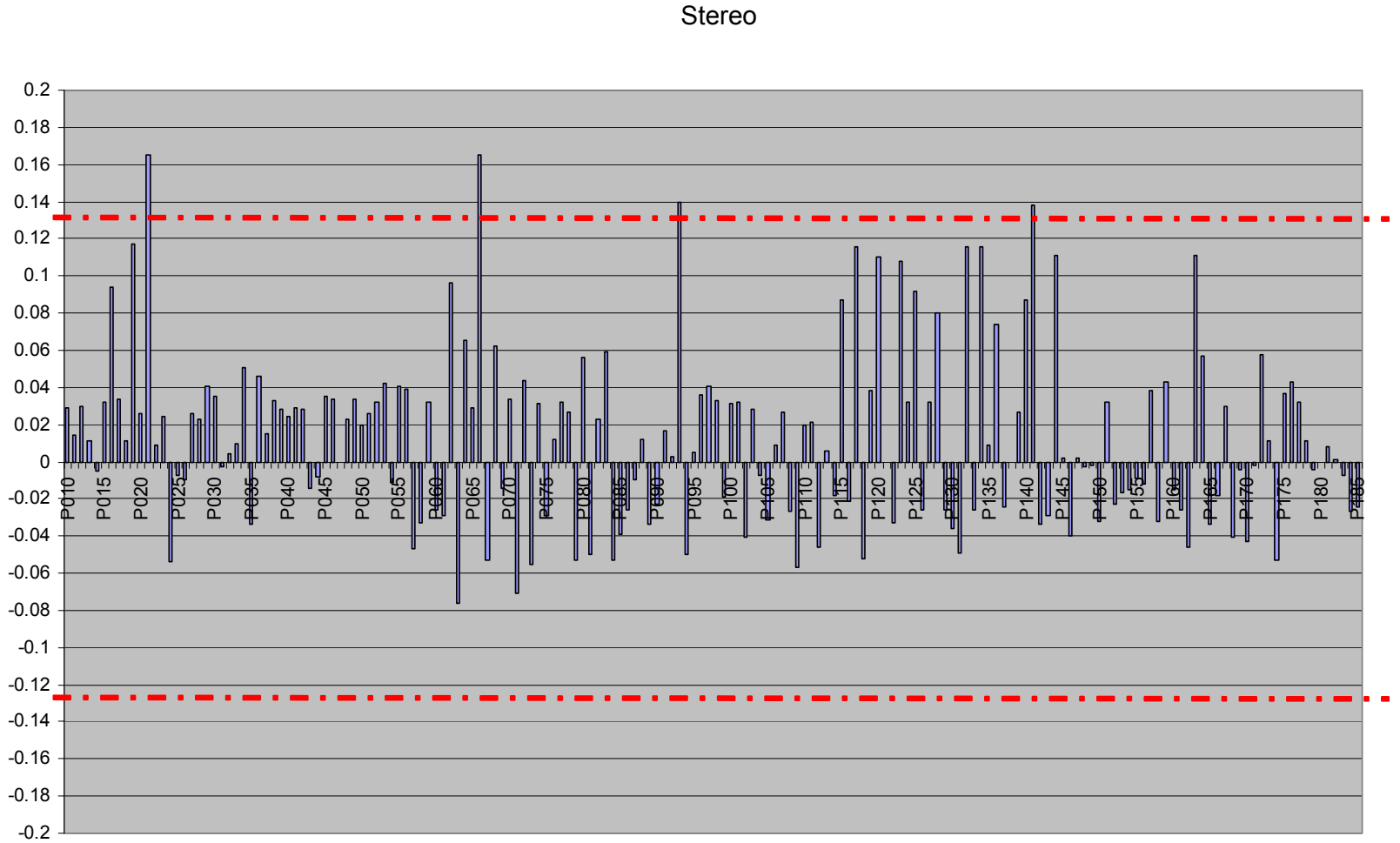


Plot shows history since 11/02

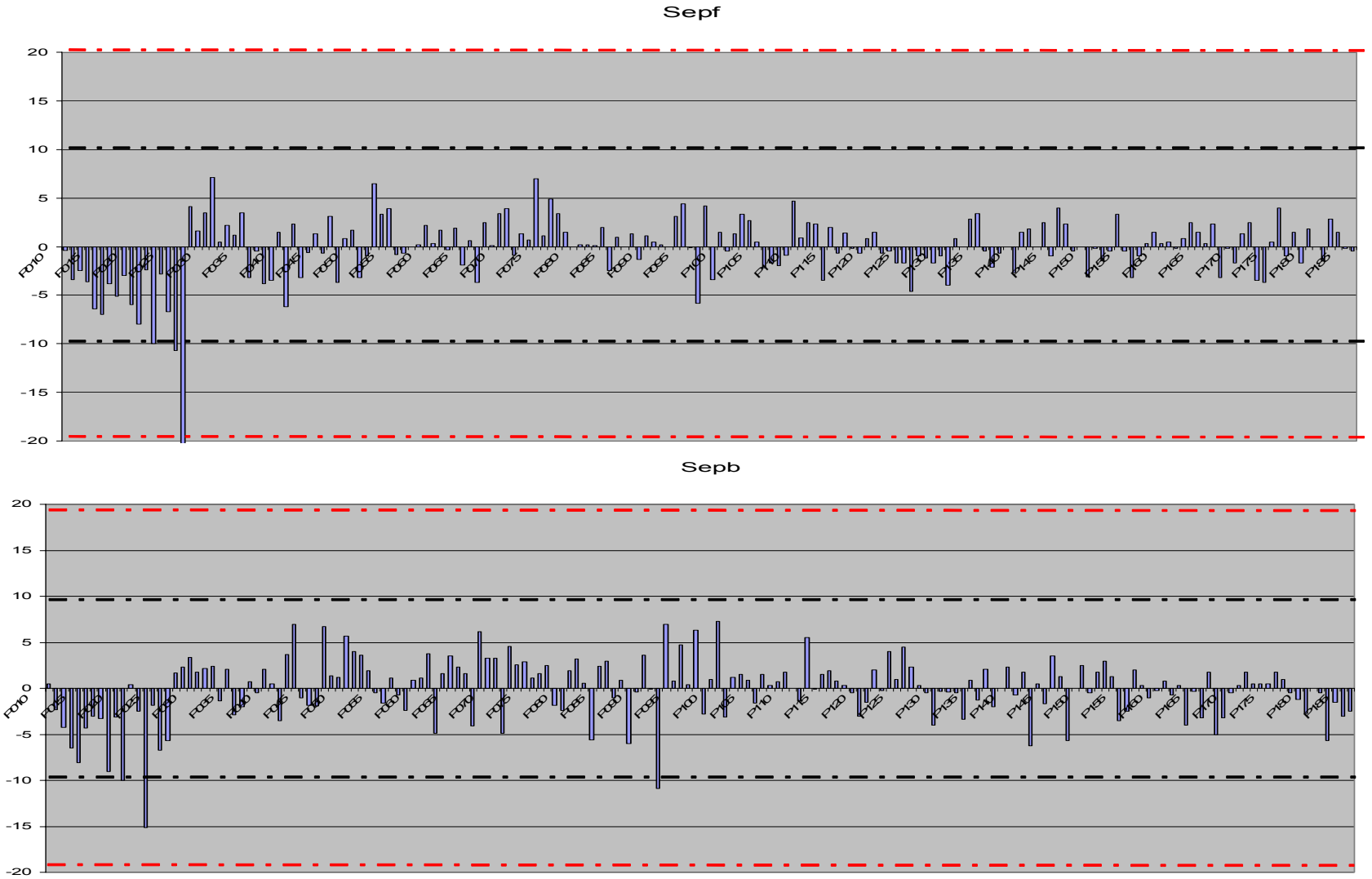
Midxf (10 μm)


Midxf
20
15
10
5
0
-5
-10
-15
-20
-25
-30
P010
P015
P020
P025
P030
P035
P040
P045
P050
P055
P060
P065
P070
P075
P080
P085
P090
P095
P100
P105
P110
P115
P120
P125
P130
P135
P140
P145
P150
P155
P160
P165
P170
P175
P180
P185
Midxf

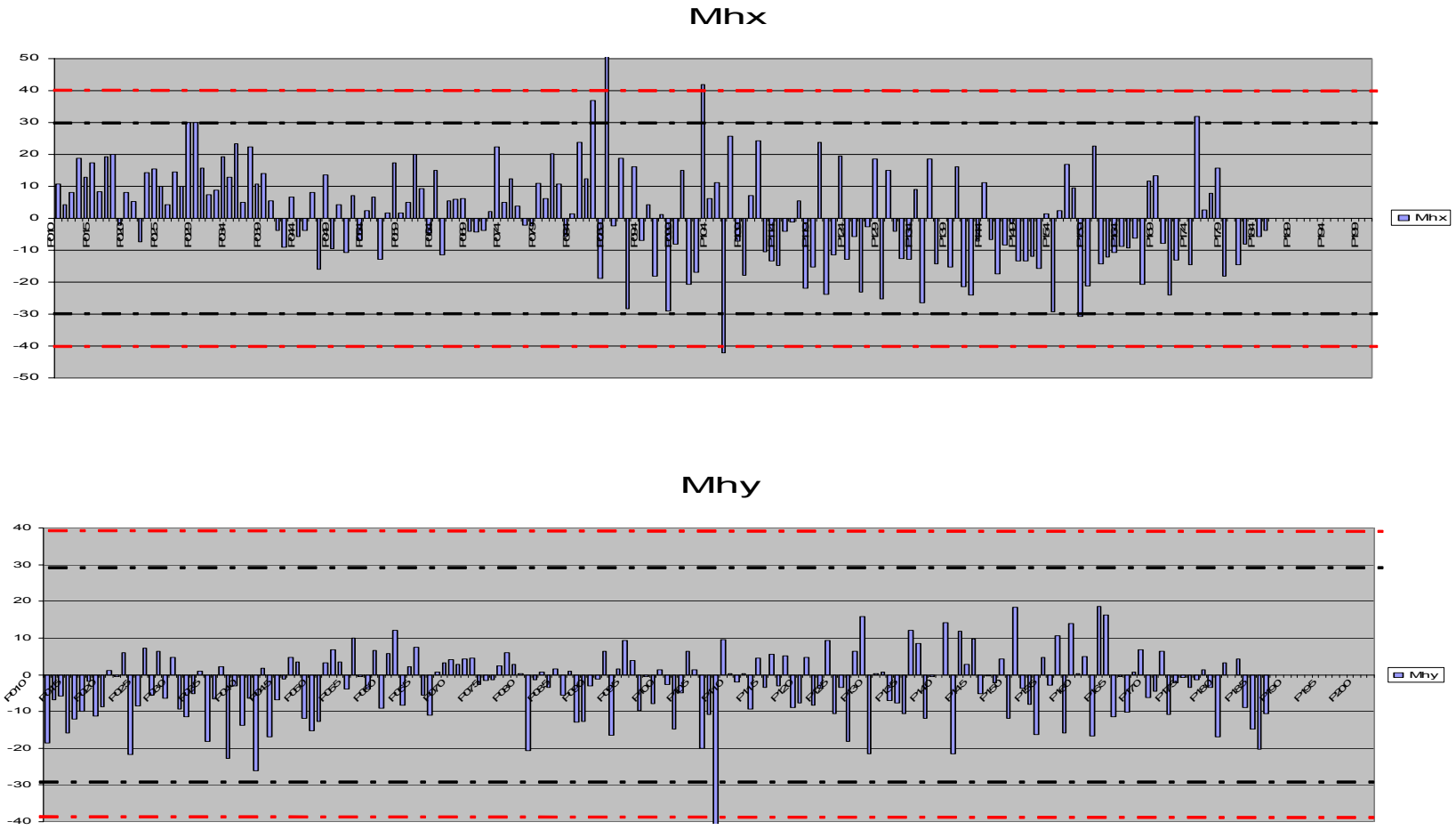
Stereo Angle (130 mrad)



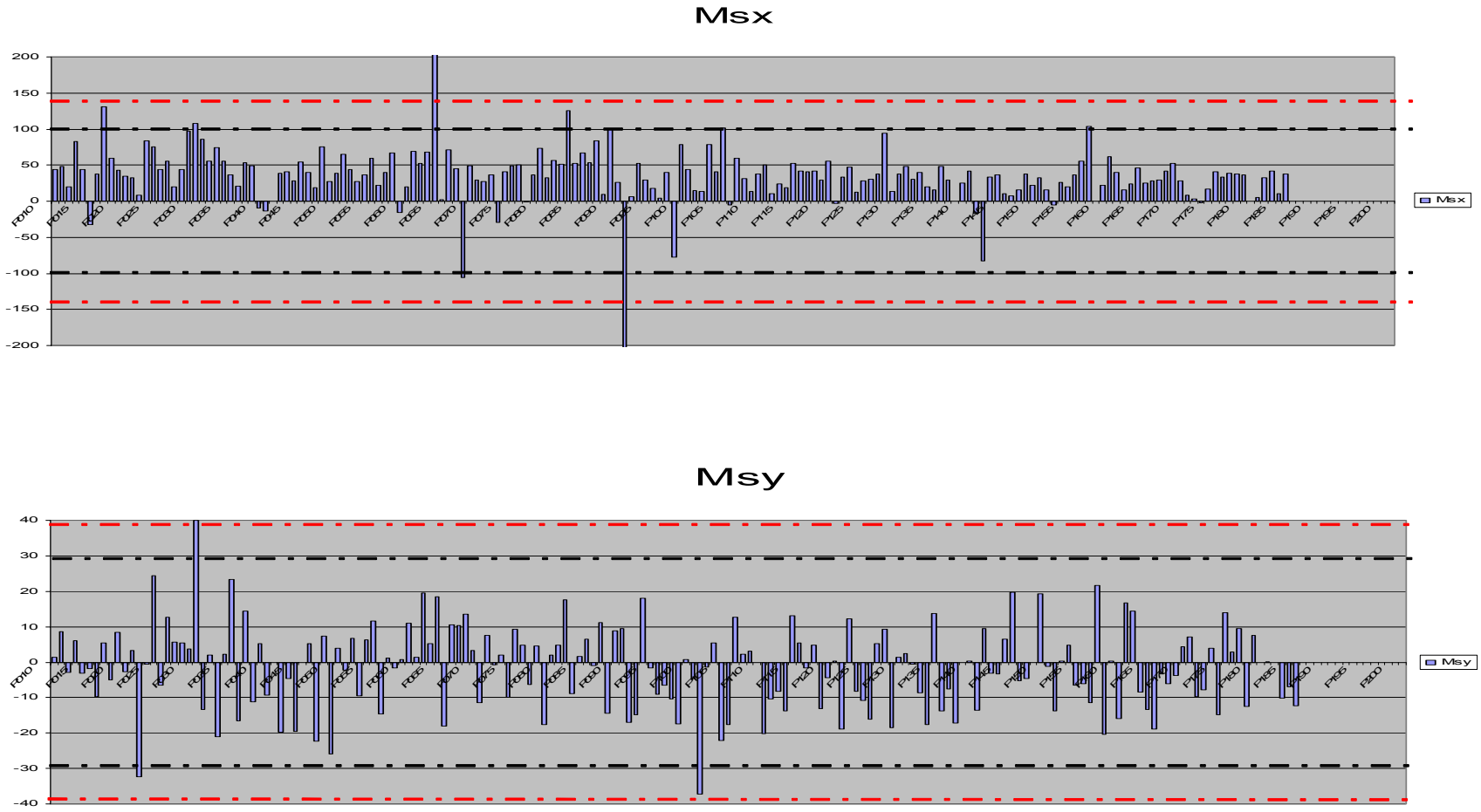
Sepf and Sepb (10 μm)



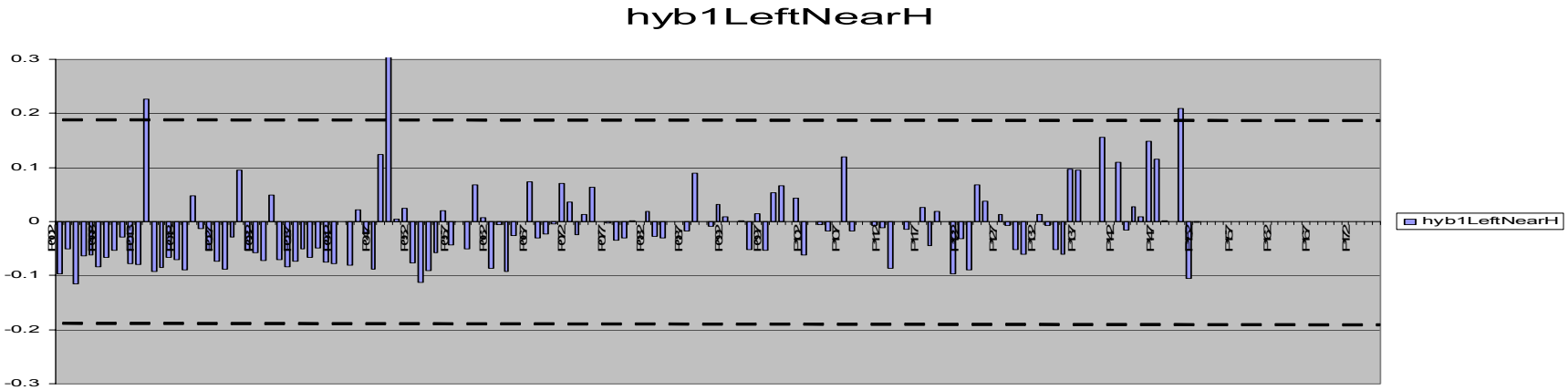
Hole

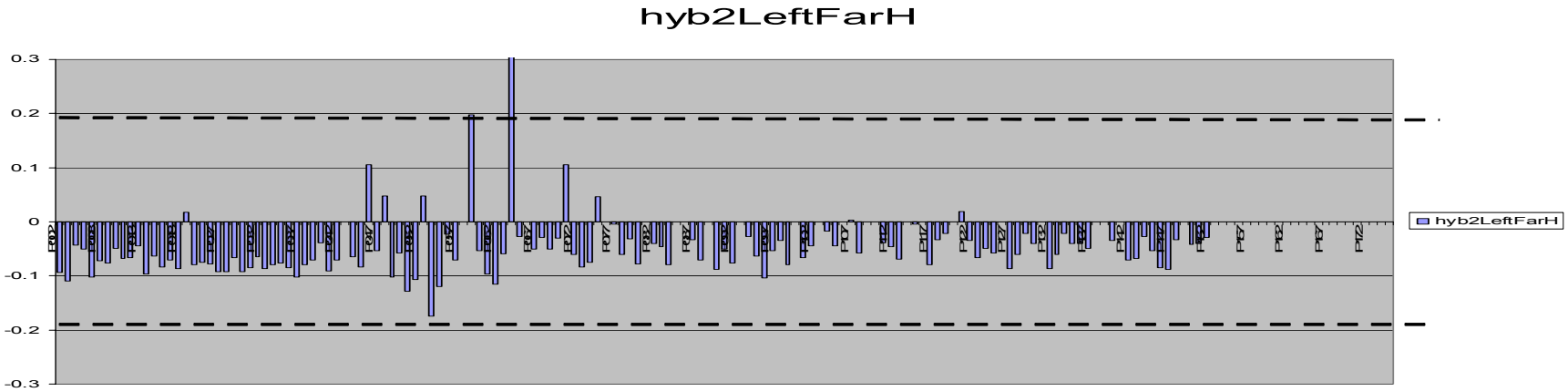

Mhx
50
40
30
20
10
0
-10
-20
-30
-40
-50
Mhx
Mhy
40
30
20
10
0
-10
-20
-30
-40
Mhy

Slot

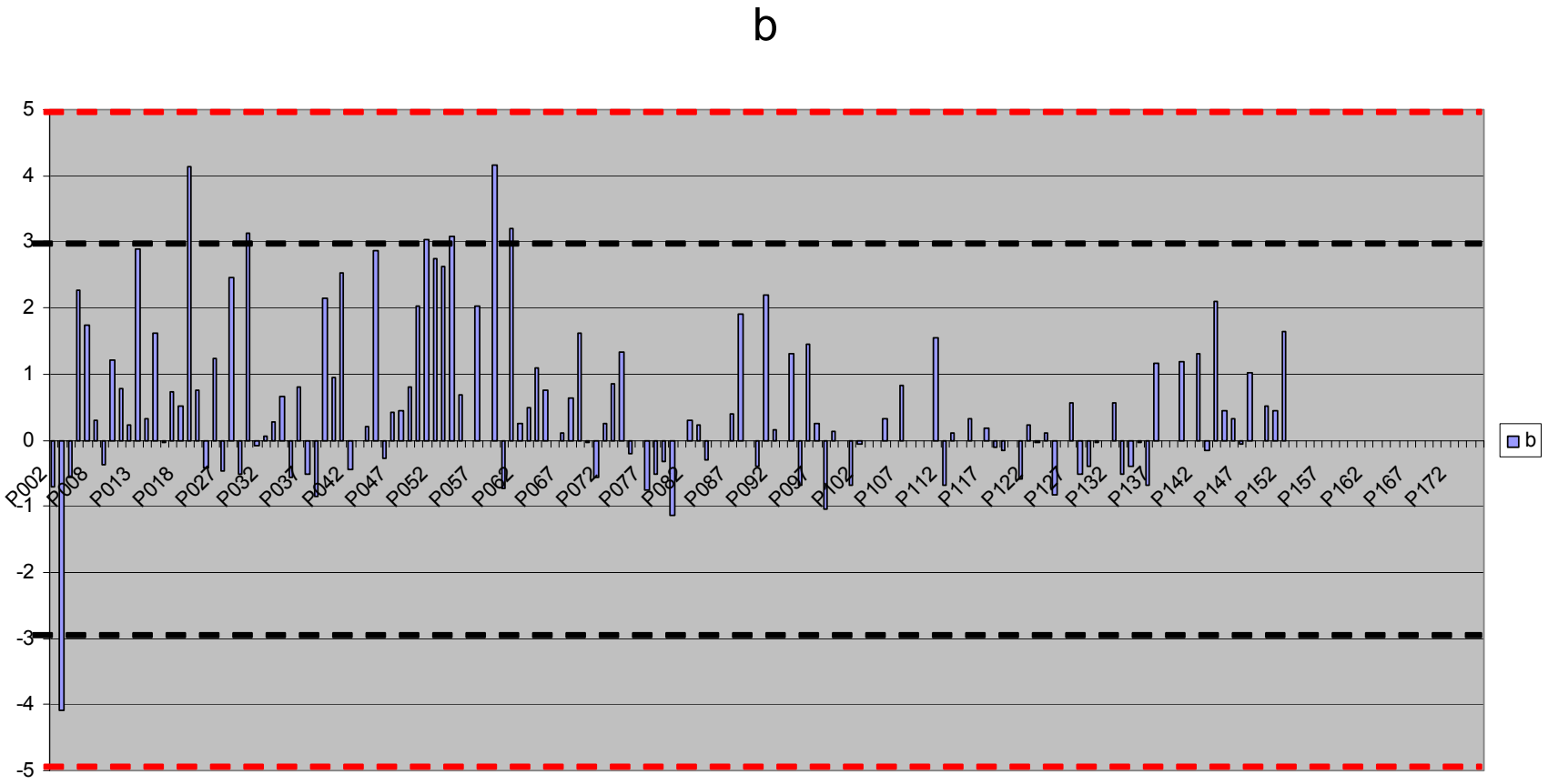

Msx
200
150
100
50
0
-50
-100
-150
-200
Msx
Msy
40
30
20
10
0
-10
-20
-30
-40
Msy

Effects of Hybrid Mounting

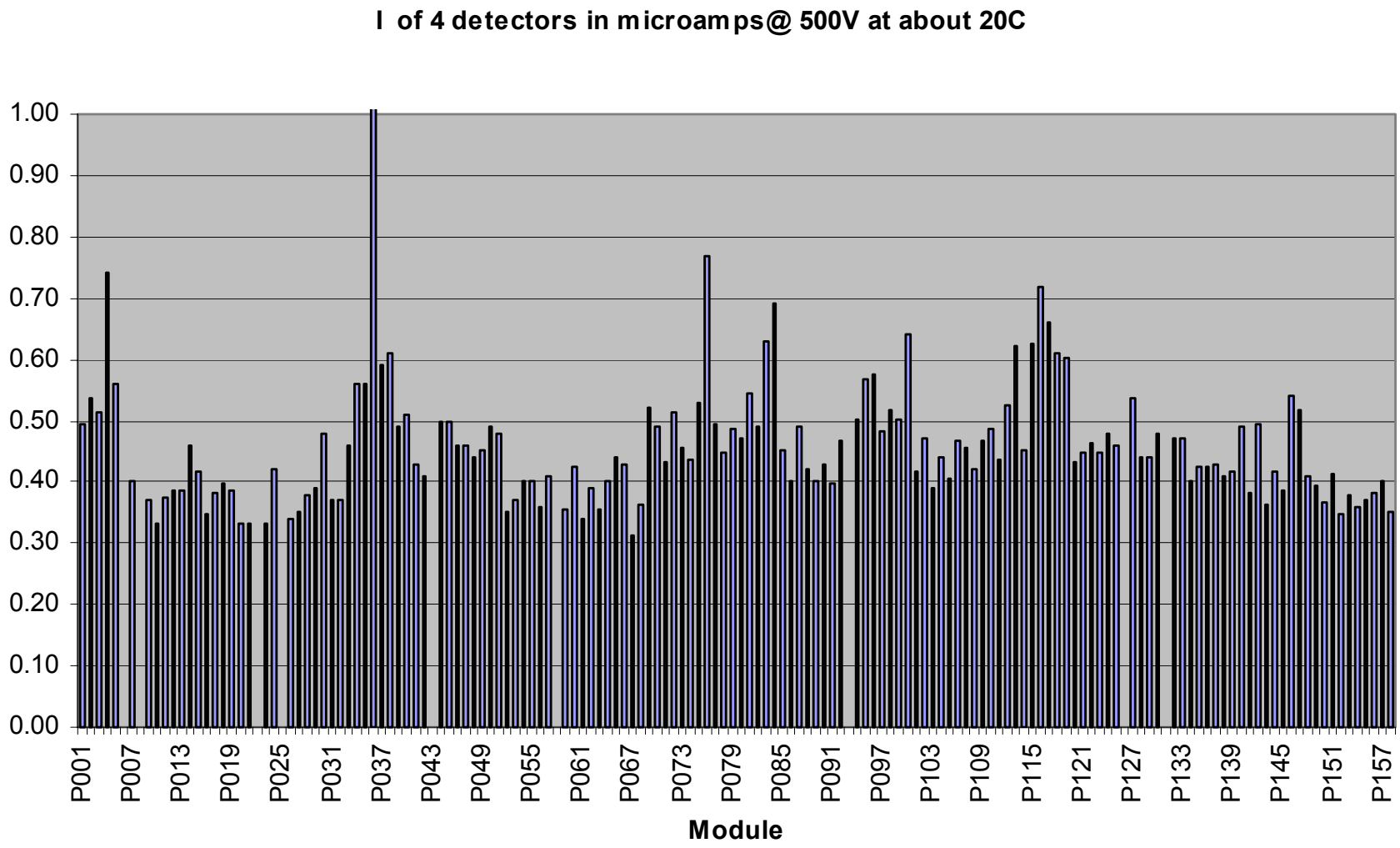




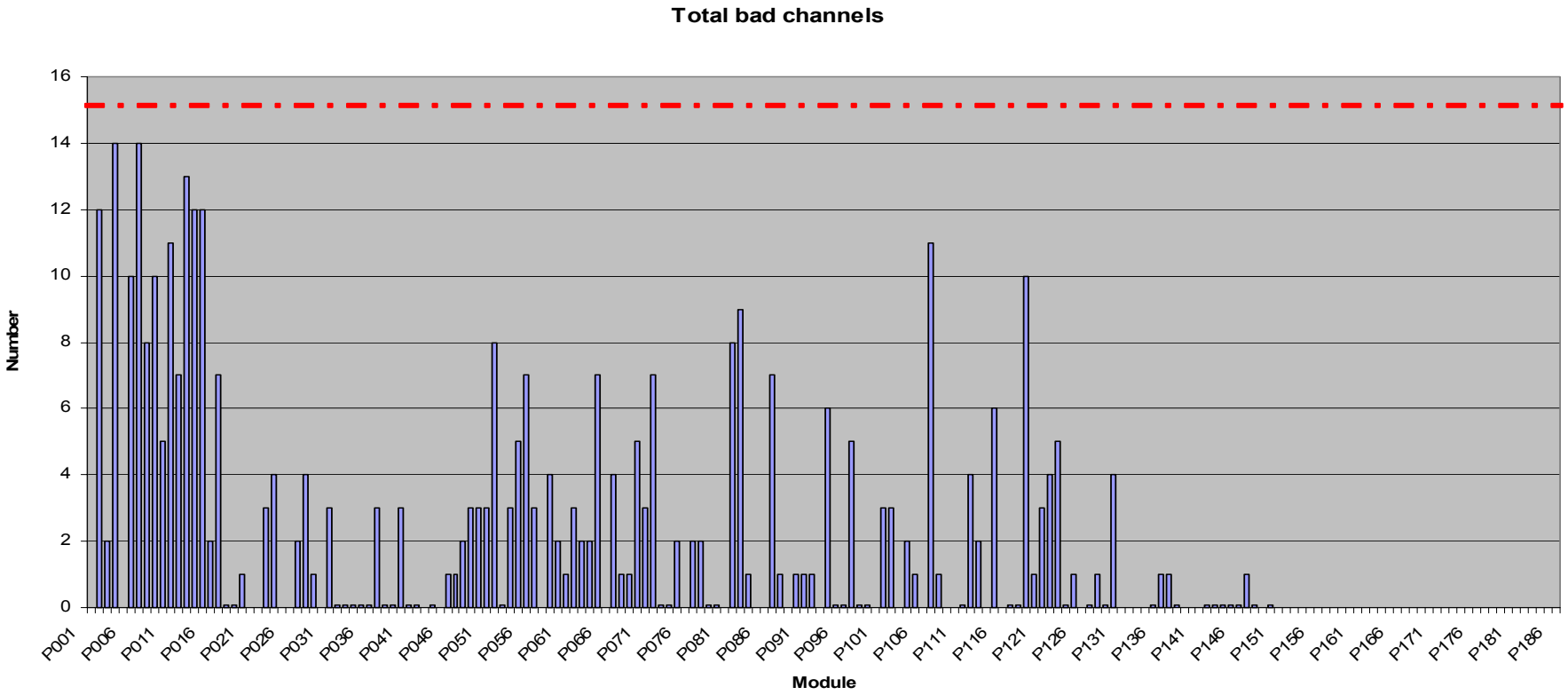
b


b
5
4
3
2
1
0
-1
-2
-3
-4
-5
P002
P008
P013
P018
P027
P032
P037
P042
P047
P052
P057
P062
P067
P072
P077
P082
P087
P092
P097
P102
P107
P112
P117
P122
P127
P132
P137
P142
P147
P152
P157
P162
P167
P172
b

Leakage Current of 4 Wafers



Bad Channels per Module



Leakage Current

- About 7% of individual detectors show breakdown above 350V after 4 wafer assembly.
- Except for a few, these exhibit rapid training/conditioning in seconds to few minutes after 500V.
- About 15% of modules also show breakdown above 350V just after wire bonding.
- Again most of these, but not all, exhibit rapid training/conditioning to stable, low currents.
- Correlation between breakdown at 4-wafer stage and after wire bonding to hybrid is only about 50%.

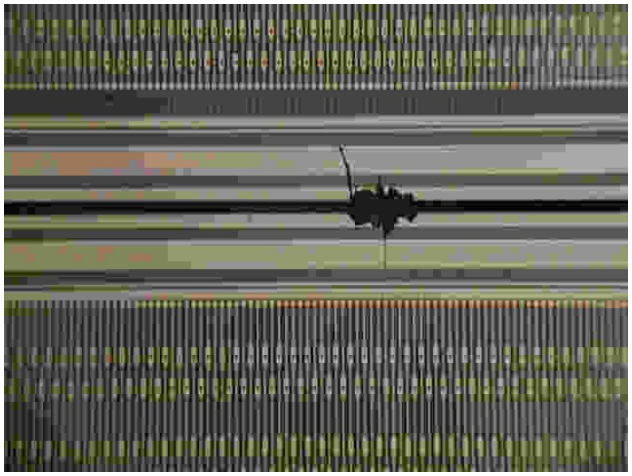
Module Categories

- We both classify modules as they are in the pipeline(as we go) and after tests are complete(or if they go to Hold, Fail, Rework). The yields are given for both all modules started and those completed tested/classified
- As of September 15.
- Modules started: 186. “Pipeline yield”
  - Modules Good finished or in pipeline:107(58%)
  - Modules Good+Pass finished or in pipeline:144(77%)
  - Modules Good+Pass+Hold finished or in pipeline:176(95%)
  - Modules Good+Pass+Hold+Rework finished or in pipeline:181(97%)
- Modules classified(tests done + Hold, Fail, Rework): 153. “Classified yield”
  - Modules Good: 78(51%)
  - Modules Good+Pass: 111(73%)
  - Modules Good+Pass+Hold: 143(93%)
  - Modules Good+Pass+Hold+Rework: 148(97%)
- Assembled modules with all tests done: 117

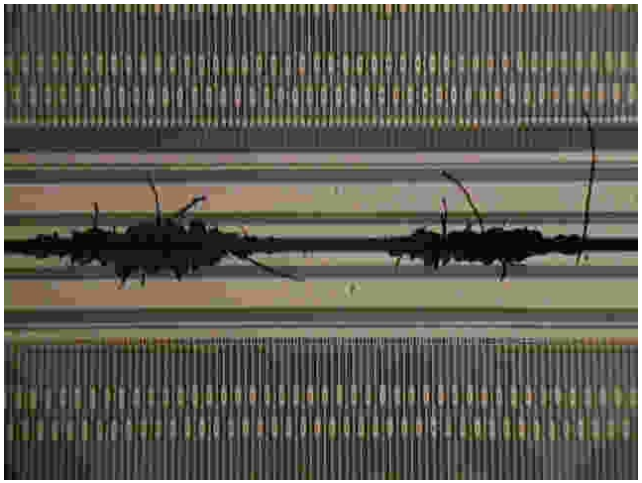
Hold Categories

- Metrology: 13 with parameters outside PASS
  - Module thickness – one case
  - Stereo: 0.168, 0.165, 0.165,0.135,0.138
  - Sepf -23
  - Midxf: -24,-23,-13
  - Mhx: 59, 42, -42
  - This problem is largely solved, hold rate much lower in last 50 modules
- Leakage current: 12
  - These need more study. Under real experiment conditions?
- Glue leakage: 7
  - 4 only in gap or minimal
  - 3 with glue on surface but not on pads
  - This problem has been solved. Last module with problem was P116 and we are now in P190s.

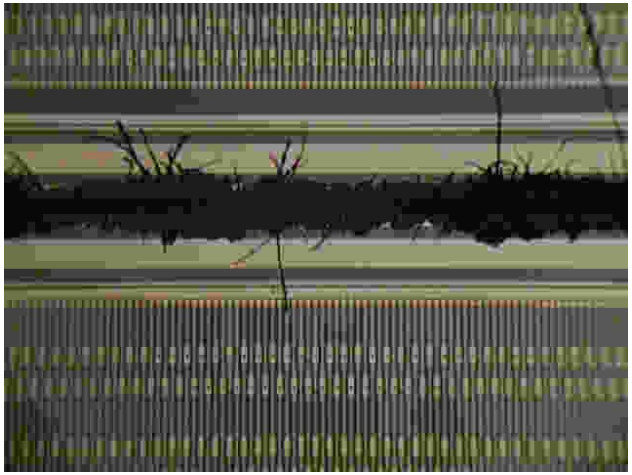
Glue Leakage on Surface



Minimal glue on surface



6 spots like these

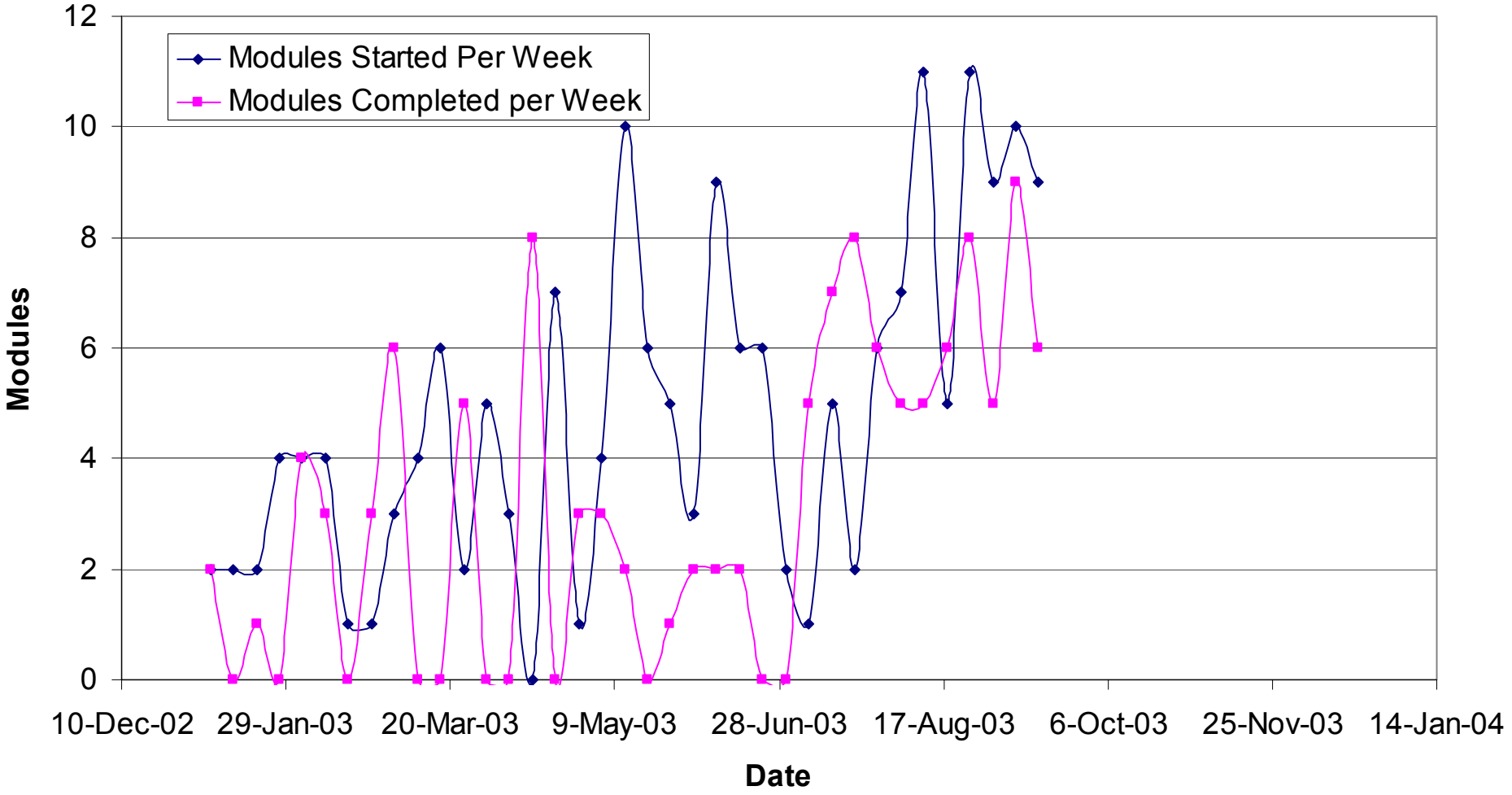


~50% of gap covered like this

Fail and Rework Categories

- Metrology: 2
  - Completely off due to wrong DIMS file
  - Vacuum failure during cure
- Broken: 3
  - Accidents
- Reworks: 5
  - 3 are hybrids too high
    - Have fixed one so far with hot wire to cut glue under foot
    - Expect to repair others eventually
  - 2 are bond damage
    - Expect to repair with some add'n bad channel or leakage

Modules per week



Production Model

- Based upon deliverable of 483 modules
- Based upon current rate, increasing to >2/day later in the project
- Include measured delay between assembly and test completion
- Project ends 6/04