WaferAnalysis

Why?
How to use it?
How does it work?
How to define cuts?

Why? The WaferAnalysis program

- Motivation :
  - Objective and fast analysis
  - More than 10000 values per wafer need automation
  - reusable for module test

- Goal:
  - Analyze every scan data
  - Automatically apply cuts and judge the scan results
  - Automatically create scan data/result plots
  - Automatically create distribution plots for wafers/modules
  - Give easy access to the cut settings

How to use it? Installation and Interface

- **Stand alone installer:**

http://icwiki.physik.uni-bonn.de/svn/USBpixI4/host/trunk/Applications/Pixel/WaferAnalysis/setup/WaferAnalysisSetup_Beta.exe

- Qmake project File, **VS2008 project file** (with release, debug built) in:

http://icwiki.physik.uni-bonn.de/svn/USBpixI4/host/trunk/Applications/Pixel/WaferAnalysis/

needs VS2008 professional or slight changes to the project for the .rc file

WaferAnalysis Interface I

Current wafer/ module name

Current wafer serial number

Settings file name

Cut file name/version

Save wafer distribution plots

Resets the final determined IC/module status

Start analysis

Chip number according to IBM scheme or module index

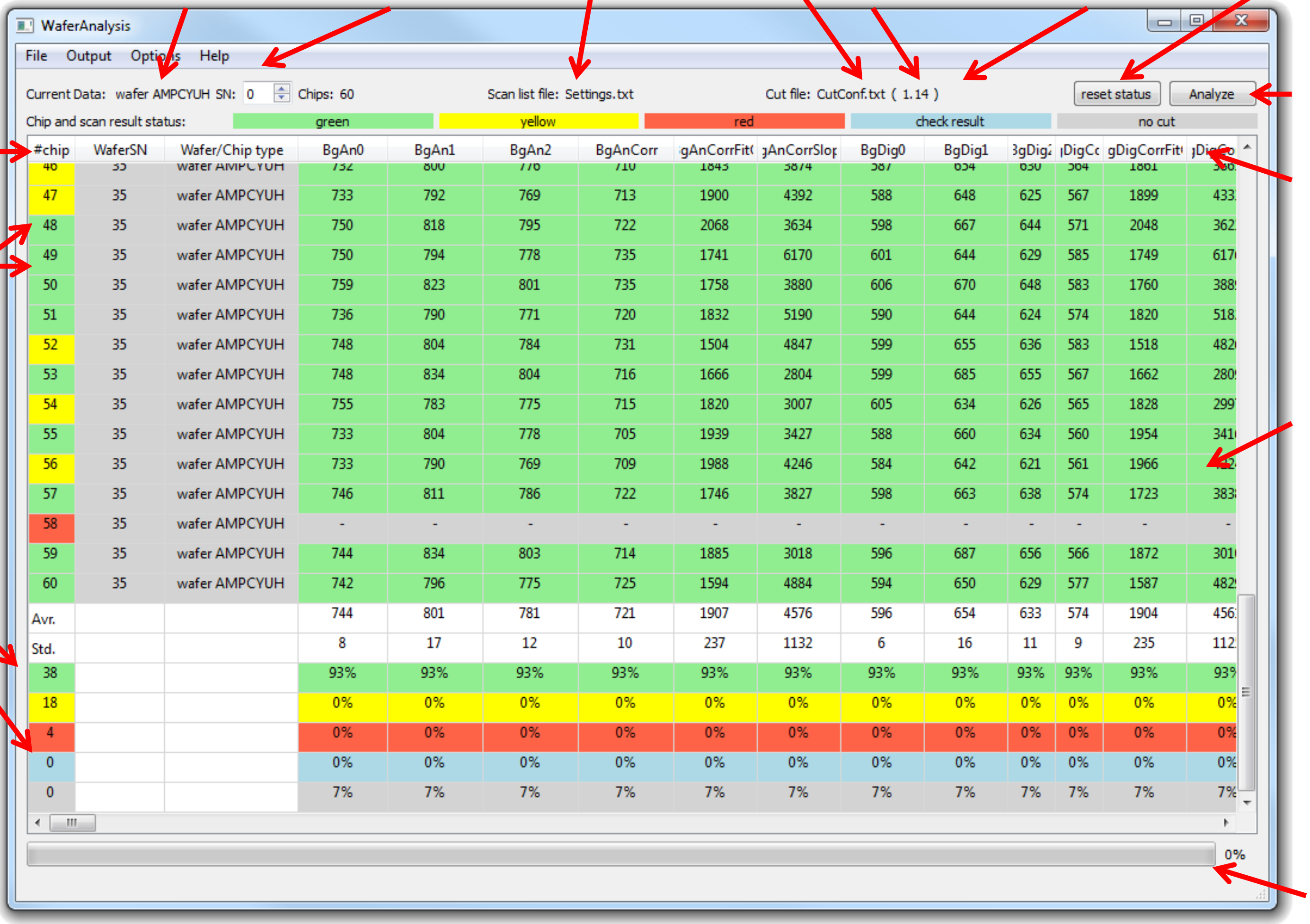
Color indicates chip status

Scan result name

Scan result value with a background color indicating the status (here: green)

Result statistics: Mean, RMS Percent of failing chips in each scan

Progress bar, one wafer takes ca. 10 min



Current Data: wafer AMPCYUH SN: 0 Chips: 60

Scan list file: Settings.txt

Cut file: CutConf.txt (1.14)

Chip and scan result status: green yellow red check result no cut

#chip	WaferSN	Wafer/Chip type	BgAn0	BgAn1	BgAn2	BgAnCorr	gAnCorrFit(	gAnCorrSlop	BgDig0	BgDig1	3gDig2	DigCc	gDigCorrFit	Dig.Co
46	35	wafer AMPCYUH	732	800	776	710	1843	3874	587	654	630	564	1861	566
47	35	wafer AMPCYUH	733	792	769	713	1900	4392	588	648	625	567	1899	433
48	35	wafer AMPCYUH	750	818	795	722	2068	3634	598	667	644	571	2048	362
49	35	wafer AMPCYUH	750	794	778	735	1741	6170	601	644	629	585	1749	617
50	35	wafer AMPCYUH	759	823	801	735	1758	3880	606	670	648	583	1760	388
51	35	wafer AMPCYUH	736	790	771	720	1832	5190	590	644	624	574	1820	518
52	35	wafer AMPCYUH	748	804	784	731	1504	4847	599	655	636	583	1518	482
53	35	wafer AMPCYUH	748	834	804	716	1666	2804	599	685	655	567	1662	280
54	35	wafer AMPCYUH	755	783	775	715	1820	3007	605	634	626	565	1828	299
55	35	wafer AMPCYUH	733	804	778	705	1939	3427	588	660	634	560	1954	341
56	35	wafer AMPCYUH	733	790	769	709	1988	4246	584	642	621	561	1966	[illegible]
57	35	wafer AMPCYUH	746	811	786	722	1746	3827	598	663	638	574	1723	383
58	35	wafer AMPCYUH	-	-	-	-	-	-	-	-	-	-	-	-
59	35	wafer AMPCYUH	744	834	803	714	1885	3018	596	687	656	566	1872	301
60	35	wafer AMPCYUH	742	796	775	725	1594	4884	594	650	629	577	1587	482
Avr.			744	801	781	721	1907	4576	596	654	633	574	1904	456
Std.			8	17	12	10	237	1132	6	16	11	9	235	112
38			93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93
18			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0			7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%

0%

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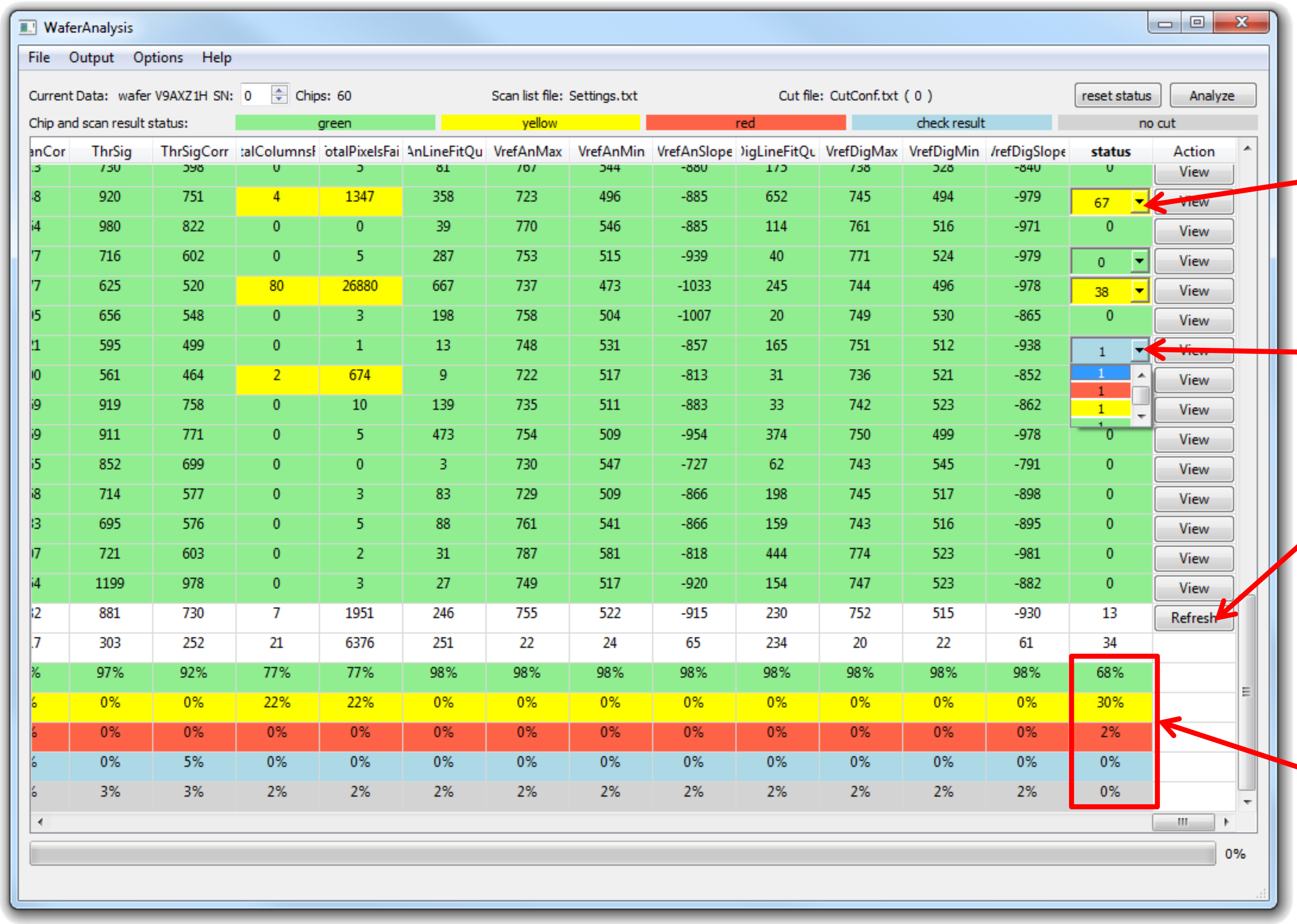
WaferAnalysis Interface II



Current Data: wafer V9AXZ1H SN: 0 Chips: 60 Scan list file: Settings.txt Cut file: CutConf.txt (0)

Chip and scan result status: 🟩 green 🟨 yellow 🟥 red 🟦 check result ⬜ no cut

ınCor	ThrSig	ThrSigCorr	ːalColumnsF	ʼotalPixelsFai	ʌnLineFitQu	VrefAnMax	VrefAnMin	VrefAnSlope	ʻigLineFitQu	VrefDigMax	VrefDigMin	/refDigSlope	status	Action
:3	730	598	0	5	81	767	544	-880	175	738	528	-840	0	View
:8	920	751	4	1347	358	723	496	-885	652	745	494	-979	67 ▾	View
;4	980	822	0	0	39	770	546	-885	114	761	516	-971	0	View
'7	716	602	0	5	287	753	515	-939	40	771	524	-979	0 ▾	View
'7	625	520	80	26880	667	737	473	-1033	245	744	496	-978	38 ▾	View
ı5	656	548	0	3	198	758	504	-1007	20	749	530	-865	0	View
'1	595	499	0	1	13	748	531	-857	165	751	512	-938	1 ▾	View
ı0	561	464	2	674	9	722	517	-813	31	736	521	-852	1 1	View
;9	919	758	0	10	139	735	511	-883	33	742	523	-862	1	View
;9	911	771	0	5	473	754	509	-954	374	750	499	-978	0	View
;5	852	699	0	0	3	730	547	-727	62	743	545	-791	0	View
;8	714	577	0	3	83	729	509	-866	198	745	517	-898	0	View
;3	695	576	0	5	88	761	541	-866	159	743	516	-895	0	View
ı7	721	603	0	2	31	787	581	-818	444	774	523	-981	0	View
;4	1199	978	0	3	27	749	517	-920	154	747	523	-882	0	View
;2	881	730	7	1951	246	755	522	-915	230	752	515	-930	13	Refresh
.7	303	252	21	6376	251	22	24	65	234	20	22	61	34	
%	97%	92%	77%	77%	98%	98%	98%	98%	98%	98%	98%	98%	68%	
ó	0%	0%	22%	22%	0%	0%	0%	0%	0%	0%	0%	0%	30%	
ó	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	
ó	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
ó	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	0%	

0%

Chip/module status, number say how many scan results failed to be green

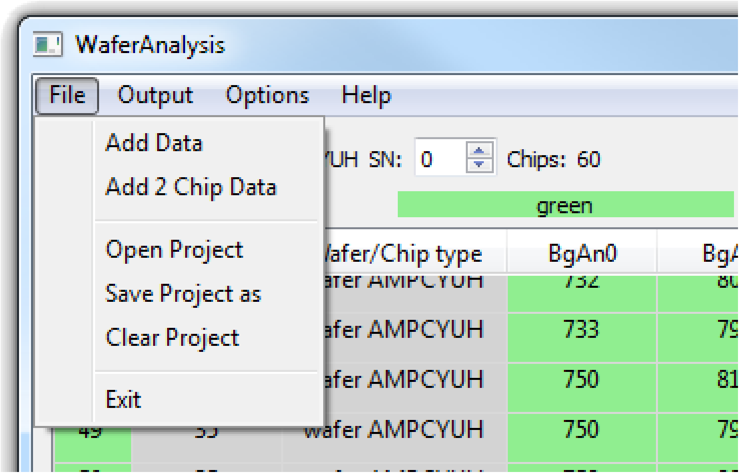
Blue Scan result values have to be checked and can be set manually

After scan result stati were changed press refresh to recalculate the statistics and redraw the table

Overall status statistic (**yield**)

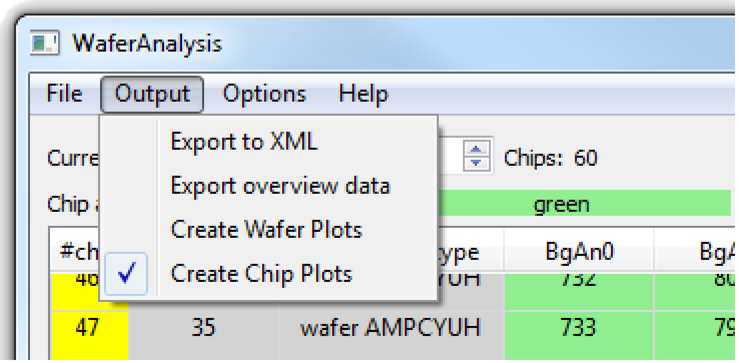
WaferAnalysis Interface (III: File)

- **Add Data**: Use to add a wafer data file (the other IC data files from the same wafer will be added automatically) or a single chip module file
- **Add 2 Chip Data**: Use to a double chip module file
- **Open Project:** opens a stored project file
- **Save Project:** Saves the actual project, don‘t forget the *.waprj suffix!
- **Clear Project:** resets the program to the status when it was started
- **Exit:** Well…



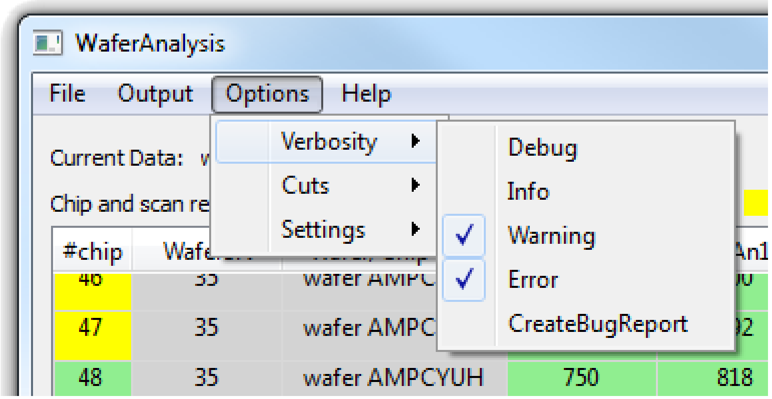
WaferAnalysis Interface (IV: Output)

- **Export to XML**: exports selected data to an xml file for the not existing IBL data base ☺ (ist totally useless)
- **Export Overview data:** Exports the Iref, Cap, SN, status data of one wafer into a text file for Fabian. Used for module production.
- **Create Wafer Plots:** Creates scan results distribution plots and wafer maps if more than one IC/module is loaded
- **Create Chip Plots:** Activate to automatically create a plot for each analysed scan

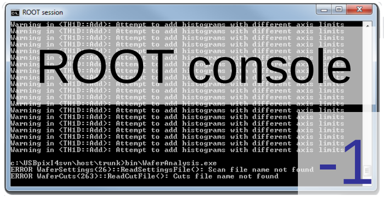


WaferAnalysis Interface (V: Options)

- **Verbosity**: changes the level how talkative the program is
  - *create debug report* writes every action into a text file stored in the exe folder
- **Cuts:**
  - *Open*: define the cut file used, otherwise cut file in the exe folder is used
  - Reload: read the cut file again and applies the IC cuts again, NOT the pixel/columns cuts (need new analysis)
- **Settings:**
  - *Open*: define the settings file used, otherwise settings file in the exe folder is used
  - Reload: read setting file again



The WaferAnalysis program I/O



ROOT session

```
Warning in <TH1D::Add>: Attempt to add histograms with different axis limits
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Warning in <TH1D::Add>: Attempt to add histograms with different axis limits

c:\USBpixI4svn\host\trunk>bin\WaferAnalysis.exe
ERROR WaferSettings(26)::ReadSettingsFile(): Scan file name not found
ERROR WaferCuts(263)::ReadCutFile(): Cuts file name not found
```
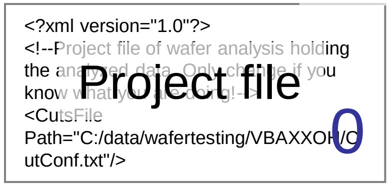

ROOT console

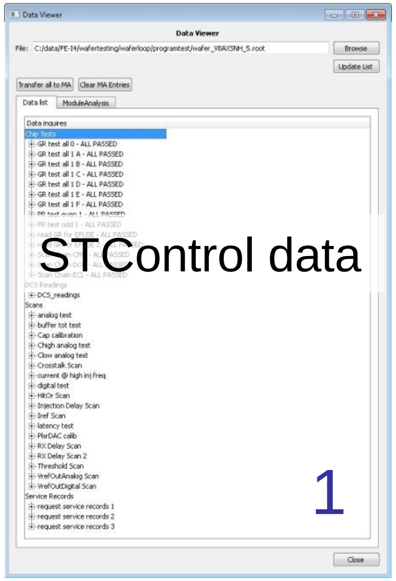
-1



```
<?xml version="1.0"?>
<!--Project file of wafer analysis holding the analyzed data. Only change if you know what you are doing!-->
<CutsFile Path="C:/data/wafertesting/VBAXXOH/CutConf.txt"/>
```

Project file

0



Data Viewer

Data Viewer

File: C:/data/FE-I4/wafertesting/waferloop/programtest/wafer_V8AX5NH_5.root

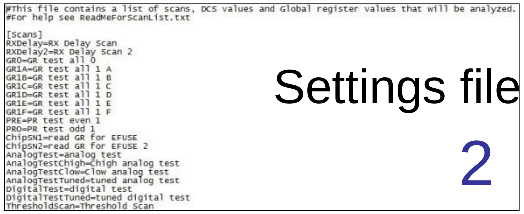
Data inquires

- Chip Tests
  - GR test all 0 - ALL PASSED
  - GR test all 1 A - ALL PASSED
  - GR test all 1 B - ALL PASSED
  - GR test all 1 C - ALL PASSED
  - GR test all 1 D - ALL PASSED
  - GR test all 1 E - ALL PASSED
  - GR test all 1 F - ALL PASSED
  - PR test even 1 - ALL PASSED
  - PR test odd 1 - ALL PASSED
  - read GR for EFUSE - ALL PASSED
  - read GR for EFUSE 2 - ALL PASSED
  - Scan Chain CMD - ALL PASSED
  - Scan Chain DOB - ALL PASSED
  - Scan Chain ECL - ALL PASSED
- DCS Readings
  - DCS_readings
- Scans
  - analog test
  - buffer tot test
  - Cap calibration
  - Chigh analog test
  - Clow analog test
  - Crosstalk Scan
  - current @ high inj freq
  - digital test
  - HitOr Scan
  - Injection Delay Scan
  - Iref Scan
  - latency test
  - PlsrDAC calib
  - RX Delay Scan
  - RX Delay Scan 2
  - Threshold Scan
  - VrefOutAnalog Scan
  - VrefOutDigital Scan
- Service Records
  - request service records 1
  - request service records 2
  - request service records 3

STControl data

1

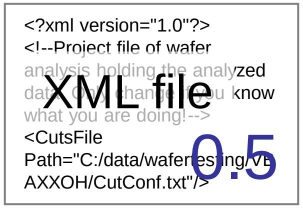
two files per chip
(scan data/cfg)



```
#This file contains a list of scans, DCS values and Global register values that will be analyzed.
#For help see ReadMeForScanList.txt

[Scans]
RXDelay=RX Delay Scan
RXDelay2=RX Delay Scan 2
GR0=GR test all 0
GR1A=GR test all 1 A
GR1B=GR test all 1 B
GR1C=GR test all 1 C
GR1D=GR test all 1 D
GR1E=GR test all 1 E
GR1F=GR test all 1 F
PRE=PR test even 1
PRO=PR test odd 1
ChipSN1=read GR for EFUSE
ChipSN2=read GR for EFUSE 2
AnalogTest=analog test
AnalogTestChigh=Chigh analog test
AnalogTestClow=Clow analog test
AnalogTestTuned=tuned analog test
DigitalTest=digital test
DigitalTestTuned=tuned digital test
ThresholdScan=Threshold Scan
```

Settings file

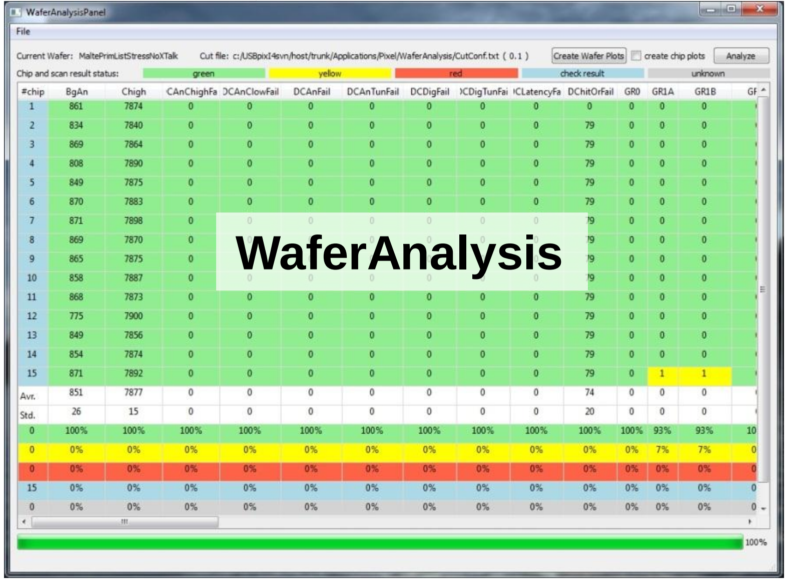
2



```
<?xml version="1.0"?>
<!--Project file of wafer analysis holding the analyzed data. Only change if you know what you are doing!-->
<CutsFile Path="C:/data/wafertesting/VBAXXOH/CutConf.txt"/>
```

XML file

0.5



WaferAnalysisPanel

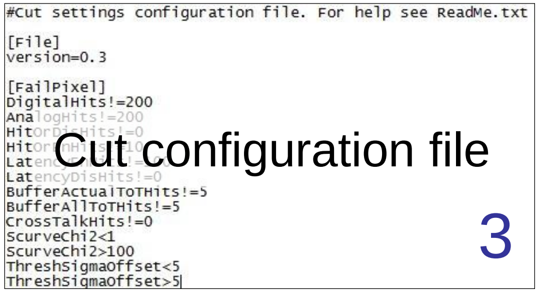
Current Wafer: MaltePrimListStressNoXTalk   Cut file: c:/USBpixI4svn/host/trunk/Applications/Pixel/WaferAnalysis/CutConf.txt (0.1)

Chip and scan result status: green | yellow | red | check result | unknown

#chip	BgAn	Chigh	CAnChighFa	DCAnClowFail	DCAnFail	DCAnTunFail	DCDigFail	DCDigTunFai	CLatencyFa	DChitOrFail	GR0	GR1A	GR1B	GF
1	861	7874	0	0	0	0	0	0	0	0	0	0	0	
2	834	7840	0	0	0	0	0	0	0	79	0	0	0	
3	869	7864	0	0	0	0	0	0	0	79	0	0	0	
4	808	7890	0	0	0	0	0	0	0	79	0	0	0	
5	849	7875	0	0	0	0	0	0	0	79	0	0	0	
6	870	7883	0	0	0	0	0	0	0	79	0	0	0	
7	871	7898	0	0	0	0	0	0	0	79	0	0	0	
8	869	7870	0	0	0	0	0	0	0	79	0	0	0	
9	865	7875	0	0	0	0	0	0	0	79	0	0	0	
10	858	7887	0	0	0	0	0	0	0	79	0	0	0	
11	868	7873	0	0	0	0	0	0	0	79	0	0	0	
12	775	7900	0	0	0	0	0	0	0	79	0	0	0	
13	849	7856	0	0	0	0	0	0	0	79	0	0	0	
14	854	7874	0	0	0	0	0	0	0	79	0	0	0	
15	871	7892	0	0	0	0	0	0	0	79	0	1	1	
Avr.	851	7877	0	0	0	0	0	0	0	74	0	0	0	
Std.	26	15	0	0	0	0	0	0	0	20	0	0	0	
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	93%	93%	10
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	7%	0
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0
15	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0

100%

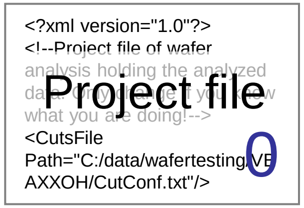
WaferAnalysis



```
#Cut settings configuration file. For help see ReadMe.txt

[File]
version=0.3

[FailPixel]
DigitalHits!=200
AnalogHits!=200
HitOrDisHits!=0
HitOrEnHits!=10
LatencyEnHits!=200
LatencyDisHits!=0
BufferActualToTHits!=5
BufferAllToTHits!=5
CrossTalkHits!=0
ScurveChi2<1
ScurveChi2>100
ThreshSigmaOffset<5
ThreshSigmaOffset>5
```

Cut configuration file

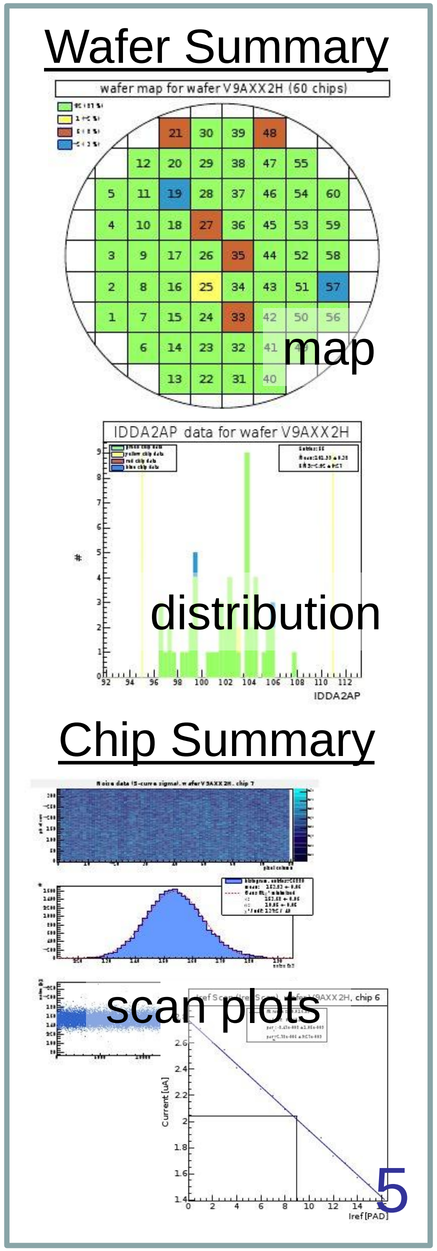
3



```
<?xml version="1.0"?>
<!--Project file of wafer analysis holding the analyzed data. Only change if you know what you are doing!-->
<CutsFile Path="C:/data/wafertesting/VBAXXOH/CutConf.txt"/>
```

Project file

0



Wafer Summary

map

distribution

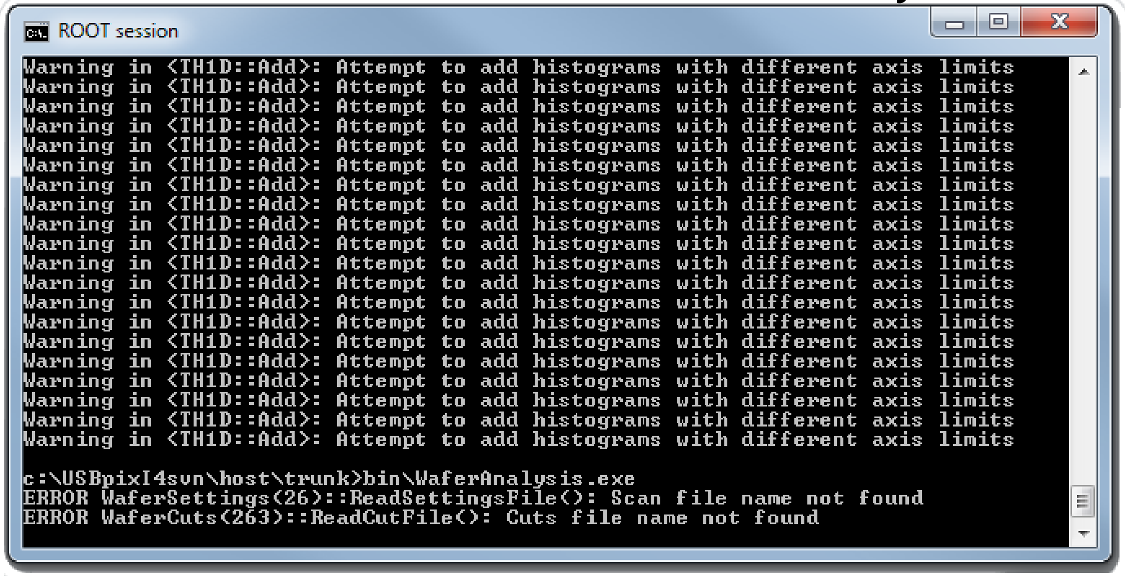
Chip Summary

scan plots

5

-1: ROOT console

- Is always open an additional window
- Shows (according to the verbosity setting): debug, info, warning, error messages
- Standard setting is: show warnings/errors
- The levels are choosen in a way that
  - **Warnings** are serious and can lead to a wrong judgement of the data!
  - **Errors** lead the program not to work in the intended way and have to be solved
  - **Infos** can have usefull additional but not necessary information
  - **Debug** will fill the console with in seconds and is only intended for program debug



```
Warning in <TH1D::Add>: Attempt to add histograms with different axis limits
Warning in <TH1D::Add>: Attempt to add histograms with different axis limits
Warning in <TH1D::Add>: Attempt to add histograms with different axis limits
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Warning in <TH1D::Add>: Attempt to add histograms with different axis limits
Warning in <TH1D::Add>: Attempt to add histograms with different axis limits

c:\USBpixI4svn\host\trunk>bin\WaferAnalysis.exe
ERROR WaferSettings(26)::ReadSettingsFile(): Scan file name not found
ERROR WaferCuts(263)::ReadCutFile(): Cuts file name not found
```

0: Project files

- One project file (*.waprj) stores the analyzed data in a human readable way
- XML format
- The data/settings/cut files should be in the same folder/subfolder!

```
<?xml version="1.0"?>
<!--Project file of wafer analysis holding the
analyzed data. Only change if you know what you are
doing!-->
<CutsFile Path="CutConf.txt"/>

<SettingsFile Path="Settings.txt"/>

<Wafer Index="0">
    <WaferInfo SerialNumber="7" WaferName="VBAXXOH"
Chips="60"
FileGroupName="C:/data/wafertesting/VBAXXOH/data/waf
er_VBAXXOH"/>
</Wafer>

<Chip Index="0">
    <ChipInfo ChipNr="1.000000" WaferSN="7.000000"/>
    <BgAn Value="791.261971" Status="green"/>
    <BgDig Value="640.864015" Status="green"/>
    <CapCalib Value="6560.559455" Status="green"/>
    <CapCalibLineFitQuality Value="6.073999"
Status="green"/>
    <CapCalibST Value="8441.355705" Status="green"/>
    <ChipSN2 Value="449.000000" Status="green"/>
    <ColAnChighFail Value="0.000000"
Status="green"/>
    <ColAnClowFail Value="0.000000" Status="green"/>
    <ColAnFail Value="0.000000" Status="green"/>
```

0.5: XML export

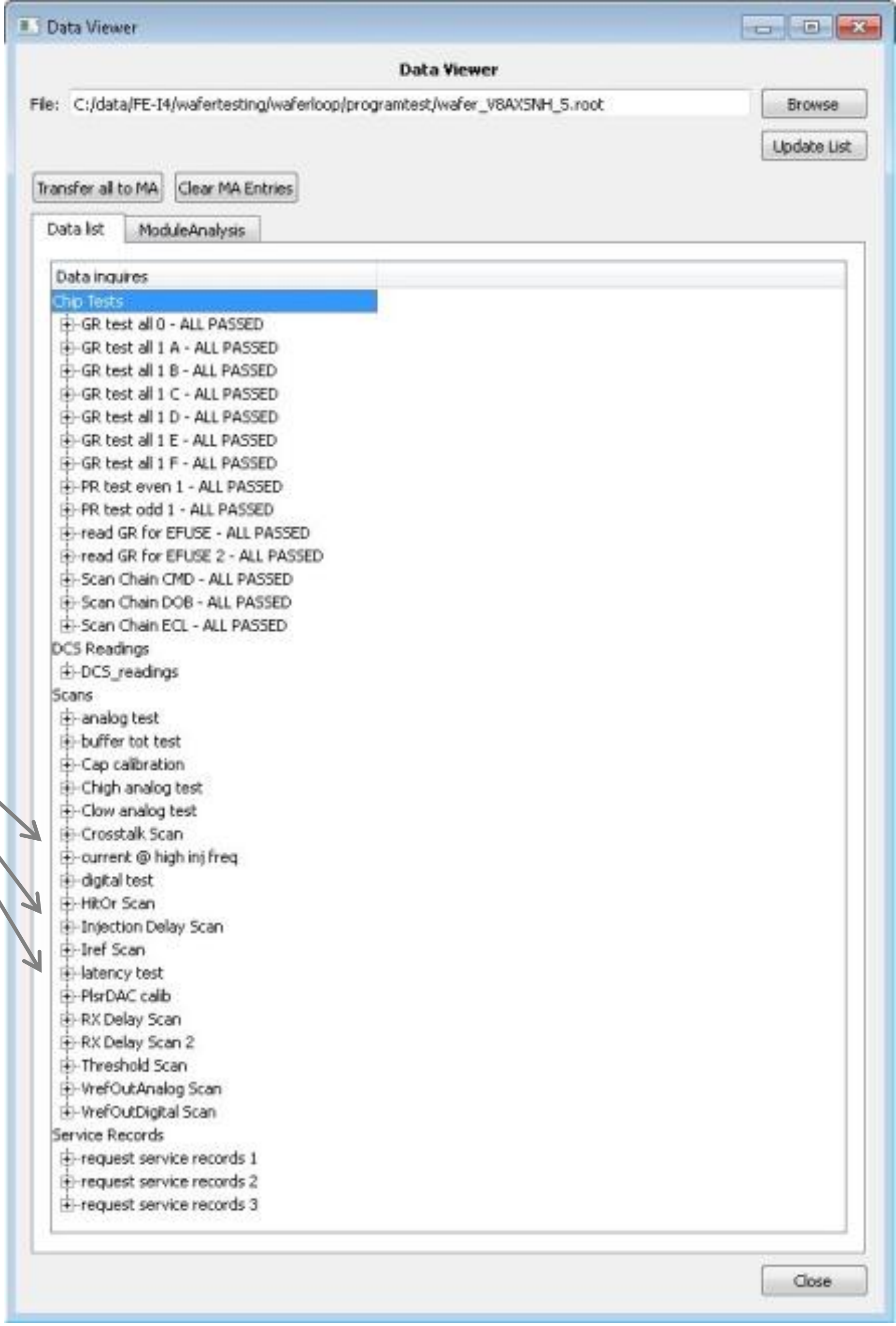
- For the IBL data base
- XML standard format
- The results to be exported can be set in the settings file in the section [XMLexport]
- **preview feature**, there won‘t be an IBL data base available in time…

```
<?xml version="1.0"?>

<!--Proof of concept FE-I4B wafer
testing XML for production data
base-->
-<Wafer> <WaferInfo SerialNumber="0"
WaferName="V4AXSSH"/>
<WaferStatistic RedChips="2"
YellowChips="4" GreenChips="54"/> -
<IC10> <SerialNumber ChipSN2=""/>
<DigitalCurrent
IDDA2CONF="111.377"/> <AnalogCurrent
IDDD2CONF="253.907"/> <RunAborted
RunAborted=""/> <Status status=""/>
</IC10> </Wafer>
```

1: STControl data

- ROOT DB format
- Two files per chip/module (scan data/cfg):
  - (wafer_)*name_chipNr*.root
  - (wafer_)*name_chipNr*.cfg.root
- Almost all data can be viewed with the WaferViewer (…/bin/WaferViewer.bat)
- Scan names; names are defined in the primitive list



File: C:/data/FE-I4/wafertesting/waferloop/programtest/wafer_V8AXSNH_5.root

Data inquires

Chip Tests
- GR test all 0 - ALL PASSED
- GR test all 1 A - ALL PASSED
- GR test all 1 B - ALL PASSED
- GR test all 1 C - ALL PASSED
- GR test all 1 D - ALL PASSED
- GR test all 1 E - ALL PASSED
- GR test all 1 F - ALL PASSED
- PR test even 1 - ALL PASSED
- PR test odd 1 - ALL PASSED
- read GR for EFUSE - ALL PASSED
- read GR for EFUSE 2 - ALL PASSED
- Scan Chain CMD - ALL PASSED
- Scan Chain DOB - ALL PASSED
- Scan Chain ECL - ALL PASSED

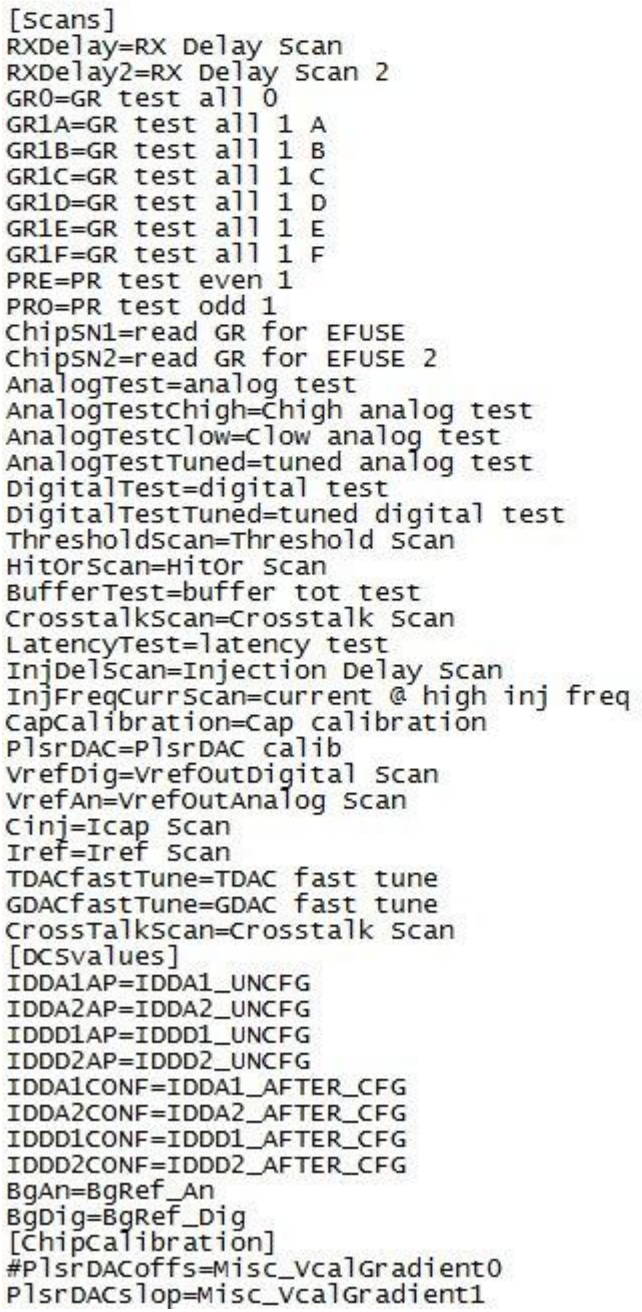
DCS Readings
- DCS_readings

Scans
- analog test
- buffer tot test
- Cap calibration
- Chigh analog test
- Clow analog test
- Crosstalk Scan
- current @ high inj freq
- digital test
- HitOr Scan
- Injection Delay Scan
- Iref Scan
- latency test
- PlsrDAC calib
- RX Delay Scan
- RX Delay Scan 2
- Threshold Scan
- VrefOutAnalog Scan
- VrefOutDigital Scan

Service Records
- request service records 1
- request service records 2
- request service records 3

2: Settings file

- Text file: ./Settings.txt
- Function:
  - Maps the STControl scan names to the WaferAnalysis scan names
  - Defines wich scans are analyzed!
  - Defines the post processing actions
  - … and much more (SEE README!)
- Has different sections sections
  - [Scans]: scan names
  - [DCScalues]: any single DCS measurement name
  - [ChipCalibration] e.g.:
    - PlsrDAC slope
    - Injection capacitance
  - [GlobalRegValues]:
    - Any global register name
  - …
- Read Me for more detailed informations: ./ReadMeForSettings.txt



```
[Scans]
RXDelay=RX Delay Scan
RXDelay2=RX Delay Scan 2
GR0=GR test all 0
GR1A=GR test all 1 A
GR1B=GR test all 1 B
GR1C=GR test all 1 C
GR1D=GR test all 1 D
GR1E=GR test all 1 E
GR1F=GR test all 1 F
PRE=PR test even 1
PRO=PR test odd 1
ChipSN1=read GR for EFUSE
ChipSN2=read GR for EFUSE 2
AnalogTest=analog test
AnalogTestChigh=Chigh analog test
AnalogTestClow=Clow analog test
AnalogTestTuned=tuned analog test
DigitalTest=digital test
DigitalTestTuned=tuned digital test
ThresholdScan=Threshold Scan
HitOrScan=HitOr Scan
BufferTest=buffer tot test
CrosstalkScan=Crosstalk Scan
LatencyTest=latency test
InjDelScan=Injection Delay Scan
InjFreqCurrScan=current @ high inj freq
CapCalibration=Cap calibration
PlsrDAC=PlsrDAC calib
VrefDig=VrefOutDigital Scan
VrefAn=VrefOutAnalog Scan
Cinj=Icap Scan
Iref=Iref Scan
TDACfastTune=TDAC fast tune
GDACfastTune=GDAC fast tune
CrossTalkScan=Crosstalk Scan
[DCSvalues]
IDDA1AP=IDDA1_UNCFG
IDDA2AP=IDDA2_UNCFG
IDDD1AP=IDDD1_UNCFG
IDDD2AP=IDDD2_UNCFG
IDDA1CONF=IDDA1_AFTER_CFG
IDDA2CONF=IDDA2_AFTER_CFG
IDDD1CONF=IDDD1_AFTER_CFG
IDDD2CONF=IDDD2_AFTER_CFG
BgAn=BgRef_An
BgDig=BgRef_Dig
[ChipCalibration]
#PlsrDACoffs=Misc_VcalGradient0
PlsrDACslop=Misc_VcalGradient1
```

README for settings file (part 1)

The Settings file contains different sections to set the wafer analysis program settings and options.

The name mapping sections are: [Scans] [DCSGraphAnaValues] [ChipCalibration] [GlobalRegValues] [PixCrtlSetting]
These sections contain a list of scans, DCS names, chip calibration, Global register names,
PixControler settings and Graph Analysis Value Names that will be analyzed.
It is possible to add any DCS name, chip calibration name, global register name, Graph Analysis Value and PixControler setting.
You just have to know the name used within the file (cfg or data) and define a name to use in the
Wafer probing program.
Example:
VthinAF=GlobalRegister_Vthin_AltFine (left side: your definition, right side: STControl value name)
You can also cut on this new defined value by writing it into the Cut file (here for example: VthinAF>100)
The scans cannot be defined this way (of cause) because the program has to analyze each scan
in a different way. Only the scans listed in the Scan list file are analyzed and you can not add new ones
without changing the program. To add new scans change the WaferAnalysis class.
As a check all scans (even if they do not require any analyzes) have to be listed in the Scan list file.
Otherwise the program will complain.
Example:
ThresholdScan=Threshold Scan
The left side of the scan definitions (here: ThresholdScan) should not be changed, otherwise
the scan is not recognized anymore!

The [AddToTotalCount] section:
Defines the pixel based scans (e.g. analog scan) to be added to the total failing pixel/column count. The name is the scan name
not the STControl scan name. For example:
AnalogTest=1 (enabled)
uncommenting, not mentioning or AnalogTest=0: scan results is not added to the total failing pixel/column count

README for settings file (part 2)

The [PostProcessing] section:

Defines the post processing that is done after all results are available. These post processing steps are:
- CheckForAbortRun: the data of the chip is checked that the run got not aborted due to abort conditions and adds an abort flag to the chip results
- TotalCount: activates the total pixel/failing count and add the results to the chip results
- CorrectVrefs: does the GND shift correction to the Vrefs (tunable and fixed)
- CalculateResult: calculates a new results from other results, only / and * as mathematical operators are supported so far
- CompareResults: compares two results and changes the state of one results if they are not the same in a given error range

The post processing steps can be activated via:
PostProcessingName=1

The [CorrectBandGaps] section:

Defines the BGvoltages and currents that are used for the ground shift correction. Syntax:
BandGapVoltageName=NameOfCurrent1:NameOfCurrent2:...
The current are summend up and the plot has a point (BandGapVoltageName, SumOfTheCurrents).
A new result is added with the old result name + "Corr" appendix.
For example:
BgAn0=IDDA1AP:IDDA2AP:IDDD1AP:IDDD2AP

The [CorrectTunVrefs] section:

Defines the BGvoltages that are used at the moment when the TunVref was measured. Then the mean difference of the measured BGvoltages to the corrected on is used to correct the tunable Vrefs values.
A new result is added with the old result name + "Corr" appendix.
Example:
VrefDigMin:BgDig1:BgAn1
(takes the mean difference of the difference BgDig1 to the corrected BgDig and the BgAn1 to the correctd BgAn.
This is then applied to the VrefDigMin)

README for settings file (part 3)

The [CapacitanceCorrection] section:
Defines values that are used for the formular to calculate the injection capacitance out of the measured slope of the Icap scan. The value are:
Offset=-1360.
Dividor=1.081
Voltage=1000

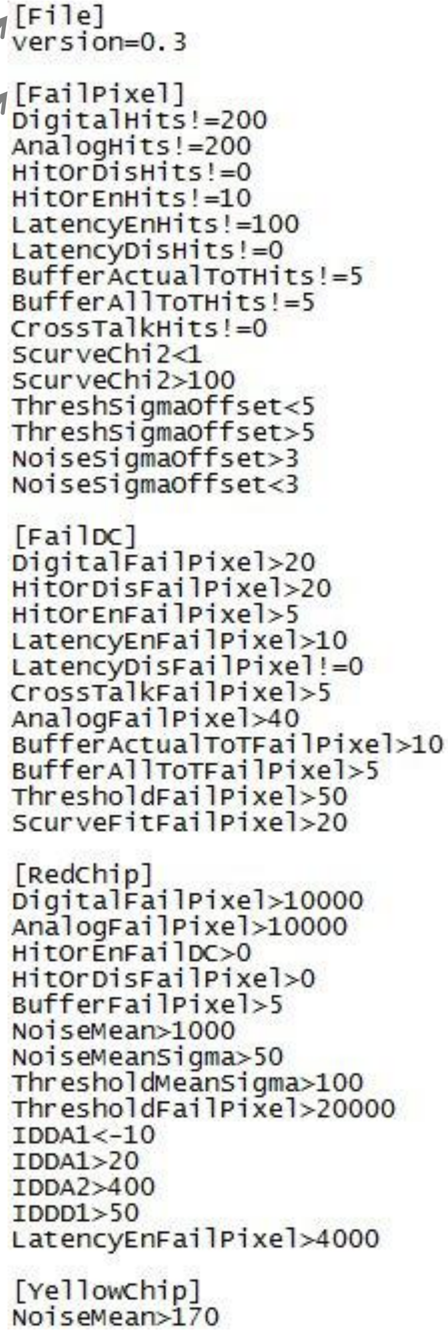
The [CompareResults] section:
Defines values that are compared with each other in a certain range and the resulting status if they do not match.
Syntax: ResultValueName1=ResultValueName2:AllowedDifferenceInPersentOfResult2:StatusIfTheValuesDontMatch.
Example: PlsrDACslopeST=PlsrDACslope:3:Blue (PlsrDACslopeST is marked blue if it more than 3% off from PlsrDACslope)

The [ZoomDistributionPlots] section:
Defines the names of the results that are plotted in addition to the normal distribution plot with a zoom on the green chips.

The [ExportToXML] section:
Defines the names of the results that are exported to a XML file for the IBL construction data base. The file format is not the final one! So far its only "proof of concept"

3: Cut Configuration

- Text file: ./CutConf.txt
- Defines the cuts with 3 operators: <, >, !=
- Equations are indepented (ORed)!
- Has 6 sections
  - [File]: defines cut file version
  - [FailPixel]: cuts to define a failing pixel for each scan
  - [FailColumn]: number of failing pixel in a Column to bring the Column to fail (for each scan)
  - [Blue-, Red-, Yellow-Chip]:
    - Cuts that trigger to define the chip state
- Read Me: ./ReadMeForCutConf.txt



```
[File]
version=0.3

[FailPixel]
DigitalHits!=200
AnalogHits!=200
HitOrDisHits!=0
HitOrEnHits!=10
LatencyEnHits!=100
LatencyDisHits!=0
BufferActualToTHits!=5
BufferAllToTHits!=5
CrossTalkHits!=0
ScurveChi2<1
ScurveChi2>100
ThreshSigmaOffset<5
ThreshSigmaOffset>5
NoiseSigmaOffset>3
NoiseSigmaOffset<3

[FailDC]
DigitalFailPixel>20
HitOrDisFailPixel>20
HitOrEnFailPixel>5
LatencyEnFailPixel>10
LatencyDisFailPixel!=0
CrossTalkFailPixel>5
AnalogFailPixel>40
BufferActualToTFailPixel>10
BufferAllToTFailPixel>5
ThresholdFailPixel>50
ScurveFitFailPixel>20

[RedChip]
DigitalFailPixel>10000
AnalogFailPixel>10000
HitOrEnFailDC>0
HitOrDisFailPixel>0
BufferFailPixel>5
NoiseMean>1000
NoiseMeanSigma>50
ThresholdMeanSigma>100
ThresholdFailPixel>20000
IDDA1<-10
IDDA1>20
IDDA2>400
IDDD1>50
LatencyEnFailPixel>4000

[YellowChip]
NoiseMean>170
```

README for CutConf file (part 1)

```
#All possible parameter cuts for all sections [section]
#are listed below. The formatting of a parameter equation is:
#parameter<value; parameter>value or parameter!=value.
#The != operator is equal to the combination of the < and the > operator.
#The cut triggers if the parameter equation is true (example: AnalogHits!=200).
#The section triggers if any cut has triggered (ORed).
#If [BlueChip],[RedChip] and [YellowChip] do not trigger the chip is automatically green.
#If a parameter is mentioned more than once only the last definition
#is taken into account. The [File] area is special and only accepts = operators.
#You can also cut on DCSs and Global register values that you define in Settings.txt to
#be analyzed. These cuts belong to the [...Chip] section, the color is freely selectable.
#Some scans are done more than once with different configurations (HV applied, tuned, ...).
#Thus a Scan identifier[SI] can be used to distinguish these scans. The Scan identifier adds a word
#(like: tuned) to the usual name. For example
#ThresholdScanUntuned, ThresholdScanTuned (the [SI] is Untuned/Tuned). The [SI] can be empty.
#
#There are some scans that are only done in module testing. The cuts for these scans are mentioned
#separately at the end of this file.
#
#For any suggestions: pohl@physik.uni-bonn.de

[File]
version=0.1(version of the file, PLEASE INCREASE IN CutConf.txt IF ANYTHING CHANGED THERE)

[FailPixel]
AnalogHits(number of hits in the analog test, usually 200)
DigitalHits(number of hits in the digital test, usually 200)
HitOrEnHits     (number of hits in the hit Or test with disabled hit or, usually 0)
HitOrDisHits    (number of hits in the hit Or test with enabled hit or, usually 10)
LatencyEnHits     (number of hits in the latency test that are enabled for every latency value, usually 100)
LatencyDisHits     (number of hits in the latency test that are disabled for every latency value, usually 0)
```

README for CutConf file (part 2)

CrossTalk[SI]Hits (number of hits in the cross talk scan, usually 0)
DisabledHits (number of hits in the disabled pixel scan, usually 0)
BufferActualToTHits (number off hits in the buffer test for the actual ToT, usually close to 5)
Scurve[SI]Chi2(chi square of the s curve fit in the threshold scan, take care: failed fits sometimes have a chi2 = -1,0)
Thresh[SI]SigmaOffset(distance between pixel threshold and mean threshold, distance = ThreshSigmaOffset * sigma of threshold distribution)
Noise[SI]SigmaOffset(distance between pixel noise and mean noise, distance = NoiseSigmaOffset * sigma of noise distribution)
ESLhits (number of hits in the check Event Size Limit test, usually either 1 (1/2 of the pixels of first DC) or 0 (others))

[FailColumn]
AnalogFailPixel(number of pixel that pass the analog [FailPixel] criterion)
DigitalFailPixel(number of pixel that pass the digital [FailPixel] criterion)
HitOrEnFailPixel (number of pixel that pass the hit Or enable [FailPixel] criterions)
HitOrDisFailPixel (number of pixel that pass the hit Or disable [FailPixel] criterions)
LatencyEnFailPixel (number of enabled pixel that pass the enable latency [FailPixel] criterion)
LatencyDisFailPixel (number of disabled pixel that pass the disable latency [FailPixel] criterion)
BufferActualToTFailPixel (number of pixel that pass the buffer actual ToT [FailPixel] criterion)
BufferAllToTFailPixel (number of pixel that pass the buffer all ToT [FailPixel] criterion)
CrossTalk[SI]FailPixel (number of pixel that pass the cross talk scan [FailPixel] criterion)
DisabledFailPixel (number of pixel that pass the disabled pixel scan [FailPixel] criterion)
PixRegENABLEFailPixel>10 (total number of pixel that fail the pixel register tests for latch ENABLE)
PixRegCAP0FailPixel>10 (total number of pixel that fail the pixel register tests for latch CAP0)
PixRegCAP1FailPixel>10 (total number of pixel that fail the pixel register tests for latch CAP1)
PixRegILEAKFailPixel>10 (total number of pixel that fail the pixel register tests for latch ILEAK)
PixRegTDAC0FailPixel>10 (total number of pixel that fail the pixel register tests for latch TDAC0)
PixRegTDAC1FailPixel>10 (total number of pixel that fail the pixel register tests for latch TDAC1)
PixRegTDAC2FailPixel>10 (total number of pixel that fail the pixel register tests for latch TDAC2)
PixRegTDAC3FailPixel>10 (total number of pixel that fail the pixel register tests for latch TDAC3)
PixRegTDAC4FailPixel>10 (total number of pixel that fail the pixel register tests for latch TDAC4)
PixRegFDAC0FailPixel>10 (total number of pixel that fail the pixel register tests for latch FDAC0)
PixRegFDAC1FailPixel>10 (total number of pixel that fail the pixel register tests for latch FDAC1)
PixRegFDAC2FailPixel>10 (total number of pixel that fail the pixel register tests for latch FDAC2)
PixRegFDAC3FailPixel>10 (total number of pixel that fail the pixel register tests for latch FDAC3)

README for CutConf file (part 3)

[RedChip]
TotalPixelsFail (the total number of different pixels that fail the scans)
TotalColumnsFail(the total number of different columns that fail the scans)
Noise[SI]Mean(mean noise of the chip)
Noise[SI]Sigma(noise distribution gaus fit sigma of the chip)
Noise[SI]DistFitQuality(fit quality in chi2/ndf of the noise distribution fit)
Noise[SI]FailPixel (number of pixels that the noise [FailPixel] criterion)
Threshold[SI]Mean(mean threshold of the chip)
Threshold[SI]Sigma(threshold distribution gaus fit sigma of the chip)
Threshold[SI]DistFitQuality(fit quality in chi2/ndf of the threshold distribution fit)
Threshold[SI]FailPixel (number of pixels that the threshold [FailPixel] criterion)
Scurves[SI]Chi2Mean (mean chi2 of the chip for the s-curve fits)
Scurves[SI]Chi2Sigma (chi2 distribution gaus fit sigma of the chip)
AnalogFailPixel(number of pixel that pass the analog [FailPixel] criterion)
AnalogChighFailPixel (number of pixel that pass the analog [FailPixel] criterion)
AnalogClowFailPixel (number of pixel that pass the analog [FailPixel] criterion)
DigitalFailPixel(number of pixel that pass the digital [FailPixel] criterion)
HitOrEnFailPixel (number of pixel that pass the hit Or enable [FailPixel] criterions)
HitOrDisFailPixel (number of pixel that pass the hit Or disable [FailPixel] criterions)
HitOrEnFailColumn (total number of columns that pass the hit Or enable [FailColumn] criterion)
HitOrDisFailColumn (total number of columns that pass the hit Or enable [FailColumn] criterion)
LatencyEnFailPixel (number of enabled pixel that pass the enable latency [FailPixel] criterion)
LatencyDisFailPixel (number of disabled pixel that pass the disable latency [FailPixel] criterion)
LatencyFailColumn (total number of columns that pass the hit Or enable/disable [FailColumn] criterion)
BufferActualToTFailPixel (number of pixel that pass the buffer actual ToT [FailPixel] criterion)
BufferActToTFailColumn (total number of columns that pass the BufferActualToTFailPixel [FailColumn] criterion)
CrossTalk[SI]FailPixel (number of pixel that pass the cross talk test [FailPixel] criterion)
DisabledFailPixel (number of pixel that pass the disabled pixel scan [FailPixel] criterion)
DisabledFailColumns (total number of columns that pass the disabled pixel scan [FailPixel] criterion)
ScurveFitFailPixel(number of pixel that pass the scurve [FailPixel] criterion)
AnalogFailColumns(number of double columns that pass the analog [FailColumn] criterion)
DigitalFailColumns(number of double columns that pass the digital [FailColumn] criterion)

README for CutConf file (part 4)

HitOrFailD (number of pixel that pass the hit Or [FailColumn] criterion)

BufferFailColumns (number of double columns that pass the buffer test [FailColumn] criterion)

InjDelMinLVL1 (minimum mean LVL1 delay)

InjDelMaxLVL1 (maximum mean LVL1 delay)

InjDelMonotony (value describing the monotony, usually 0)

SRX_Y (the service record number for service record Y [0:31] and for the SR request X)

IDDA1(current consumption on analog 1 channel in mA)

IDDA2(current consumption on analog 2 channel in mA)

IDDD1(current consumption on digital 1 channel in mA)

IDDD2(current consumption on digital 2 channel in mA)

BgAnalog(voltage of the analog band gap reference mV)

BgDigital(voltage of the digital band gap reference mV)

PixelRegError(number of pixels with a pixel register error)

GlobalRegError(number of global register error)

RXvalley (distance in bins [1..25] with a delay value without communication errors)

VrefDigMin (minimum value measured for the digital voltage reference)

VrefDigMax (maximum value measured for the digital voltage reference)

VrefDigSlope (slope of the line fit for the Vref digital DAC transfer function, BE AWARE: in uV/DAC)

VrefDigLineFitQuality (chi2/nfd*1e6 for the line fit of the Vref digital DAC transfer function)

VrefAnMin (minimum value measured for the analog voltage reference)

VrefAnMax (maximum value measured for the analog voltage reference)

VrefAnSlope (slope of the line fit for the Vref analog DAC transfer function, BE AWARE: in uV/DAC)

VrefAnLineFitQuality (chi2/nfd*1e6 for the line fit of the Vref analog DAC transfer function)

Iref (best Iref value that can be set, BE AWARE: in nA)

IrefMin (minimum value measured for the current reference, BE AWARE: in nA)

IrefMax (maximum value measured for the current reference, BE AWARE: in nA)

IrefSlope (slope of the line fit for the Iref transfer function, BE AWARE: in nA/DAC)

IrefLineFitQuality (chi2/nfd*1e12 for the line fit of the Iref transfer function)

PlsrDACmin (minimum value measured for the PlsrDAC scan, BE AWARE: in mV)

PlsrDACmax (maximum value measured for the PlsrDAC scan, BE AWARE: in mV)

PlsrDACslope (slope of the line fit for the PlsrDAC transfer function, BE AWARE: in uV/DAC)

PlsrDACkink (kink of the PlsrDAC transfer function, BE AWARE: arbitrary unit)

PlsrDAClineFitQuality (chi2/nfd*1e6 for the line fit of the PlsrDAC transfer function)

README for CutConf file (part 5)

IcapSlope (slope of the line fit for the Icap data, BE AWARE: in nA/DAC)
IcapLineFitQuality (chi2/nfd*1e12 for the line fit of the Icap data)
OwnDefinedRegisterName (has to be defined in ScanList.txt)
OwnDefinedPixelCalibName (has to be defined in ScanList.txt, BE AWARE: the values read are multiplied by 1000)
HighFreqCurr (current consumption in the high trigger frequency scan)
SC_CMD (scan chain CMD, 0: fail, 1: pass, 2: no data)
SC_DOB (scan chain DOB, 0: fail, 1: pass, 2: no data)
SC_ECL (scan chain ECL, 0: fail, 1: pass, 2: no data)

[YellowChip]see [RedChip] parameters

[BlueChip]see [RedChip] parameters, but due to the fact that blue chip indicate analyzes issues only fit quality cuts and values that should not occure make sense here

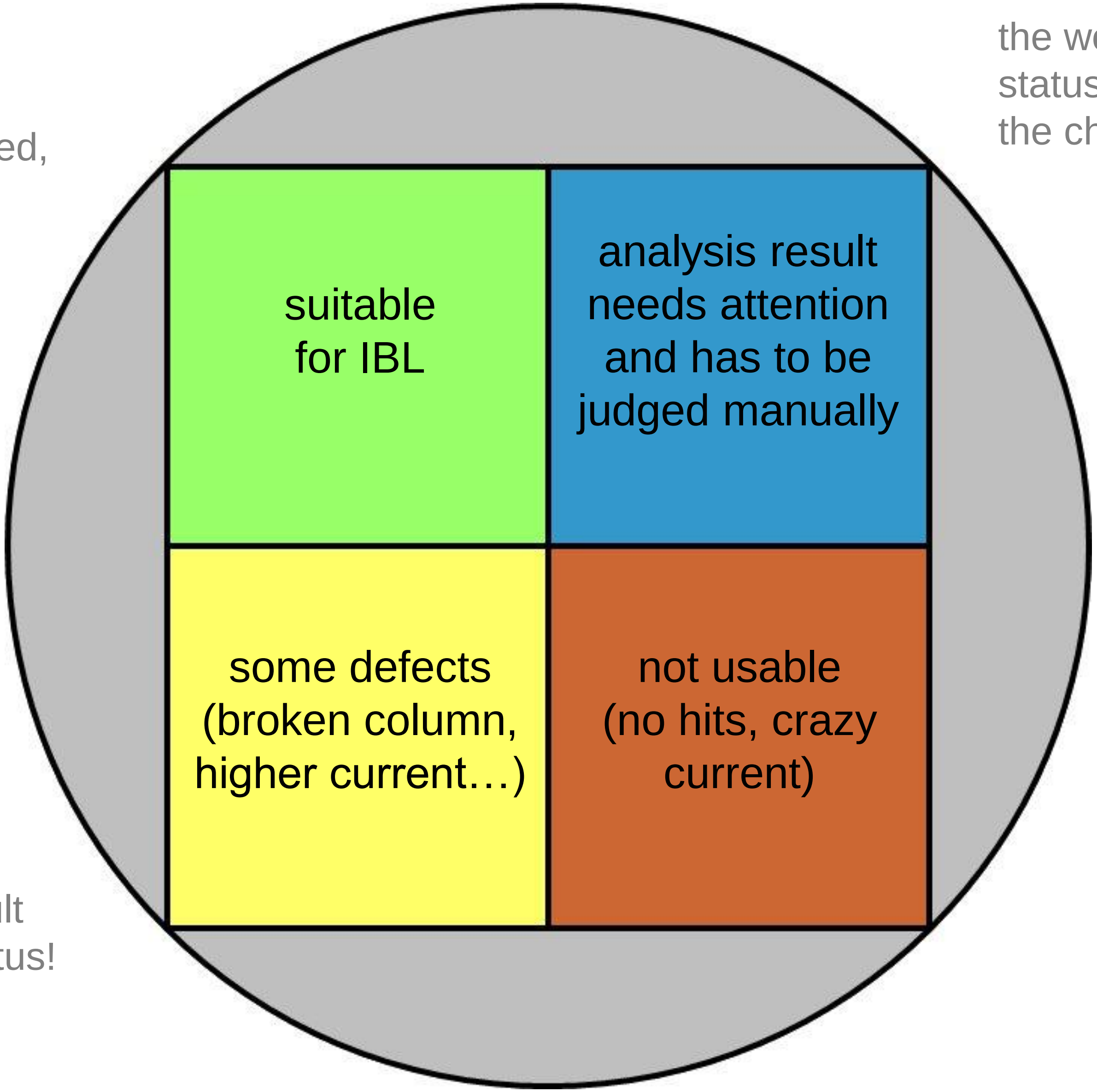
#cuts for module scans
[FailPixel]
BumpConNoiDiff (difference of the noise in e for two threshold scans with and without HV)
BumpConScurveChi2 (chi square of the s curve fit in the threshold scans, take care: failed fits sometimes have a chi2 = -1,0)
[FailColumn]
BumpConFailPixel (number of pixel that pass the bump connection noise difference [FailPixel] criterion)
[RedChip]
BumpConFailPixel (number of pixel that pass the bump connection noise difference [FailPixel] criterion)
BumpConFailColumn (total number of columns that pass the BumpConFailPixel [FailColumn] criterion)

Cut scheme of WaferAnalysis

Color definition, chip states

The final chip status is: green, yellow, red, NOT blue

the worst result status defines the chip status



suitable for IBL

analysis result needs attention and has to be judged manually

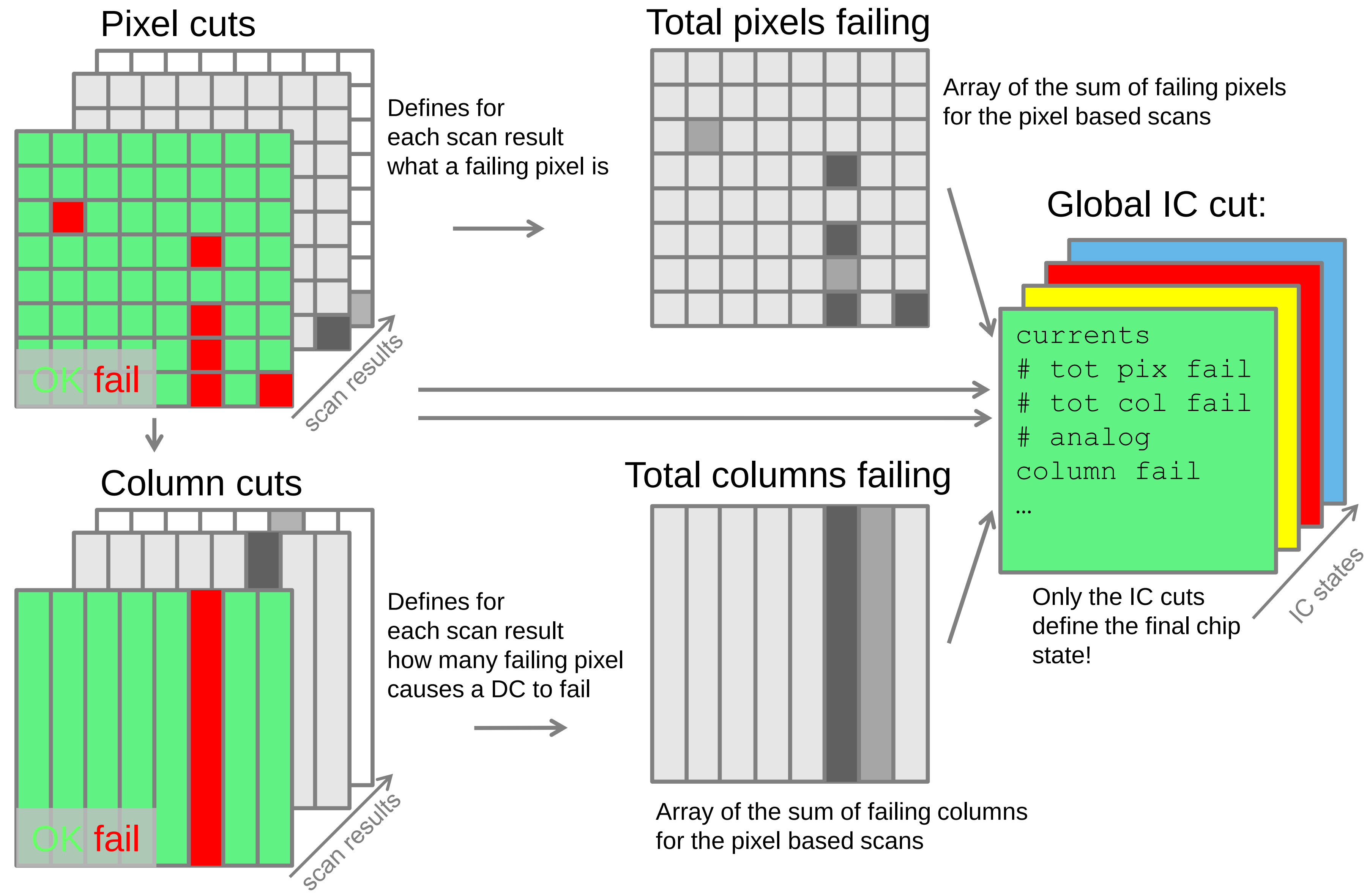
some defects (broken column, higher current…)

not usable (no hits, crazy current)

Each scan result has its own status! Blue is allowed here

Cut scheme of WaferAnalysis

pixel, column and global IC cuts



Defines for each scan result what a failing pixel is

Array of the sum of failing pixels for the pixel based scans

Defines for each scan result how many failing pixel causes a DC to fail

Array of the sum of failing columns for the pixel based scans

Only the IC cuts define the final chip state!

Cut scheme of WaferAnalysis

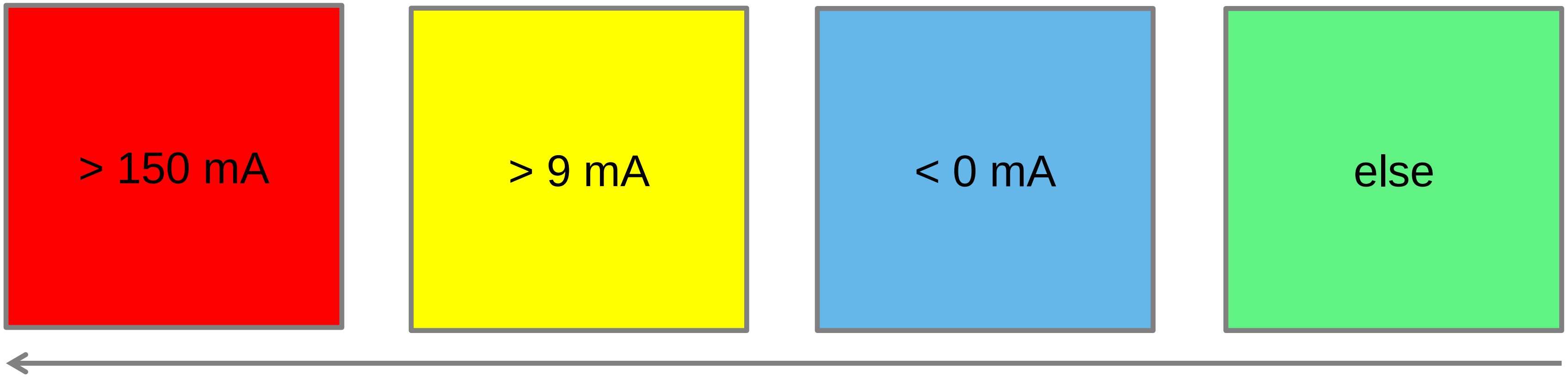
IC cuts

Defines the valid value range for each scan result and for the IC status: blue, red, yellow

IC cuts on results of the following scans:

- powering: current consumption, reference current, reference voltages
- global register, scan chain, service records, PlsrDAC, injection capacitance
- injection delay scan, threshold scan (noise, threshold)
- #total pixel failing, #total columns failing
- #pixel failing for some scans, #columns failing in some scans

Example: analog current after power up



> 150 mA

> 9 mA

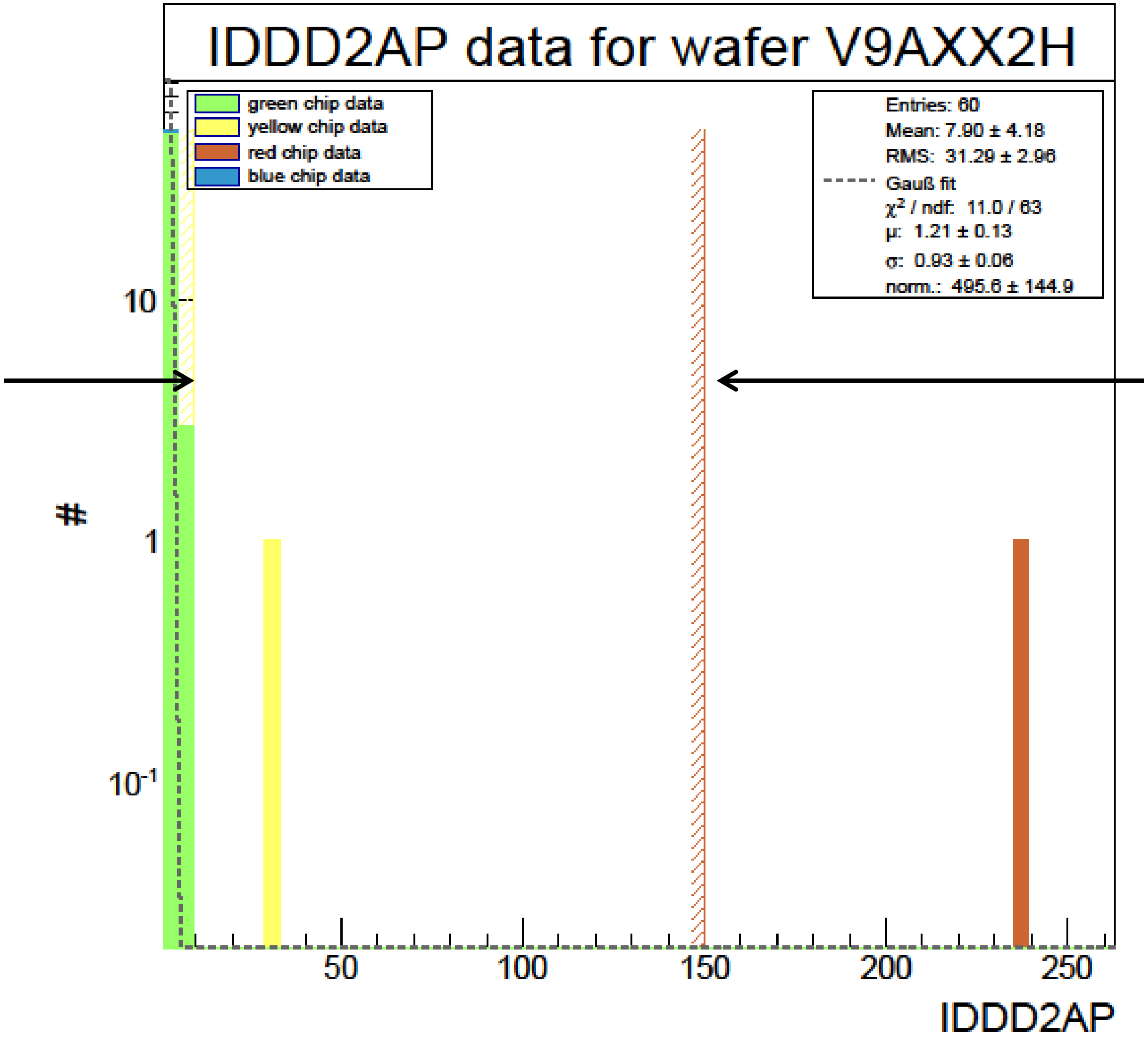
< 0 mA

else

cut order, values from cut file version 0.8

Cut scheme of WaferAnalysis

Global IC cuts example: analog current after power up



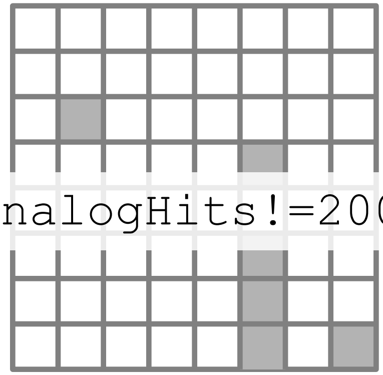
> 9 mA

> 150 mA

Cut scheme of WaferAnalysis

Pix/col based cuts example: Analog Scan

Pixel cuts

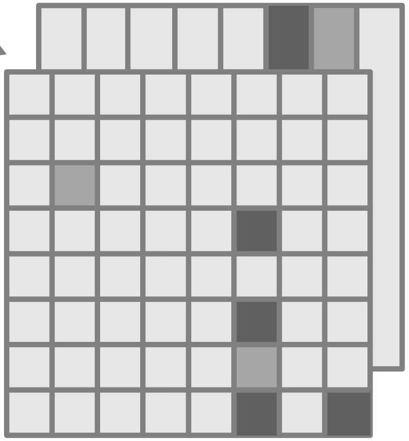


`AnalogHits!=200`

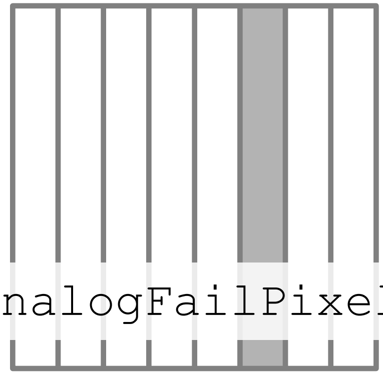
Defines here:
what is a analog
scan failing pixel

add to

Total pix/col failing



Column cuts



`AnalogFailPixel>20`

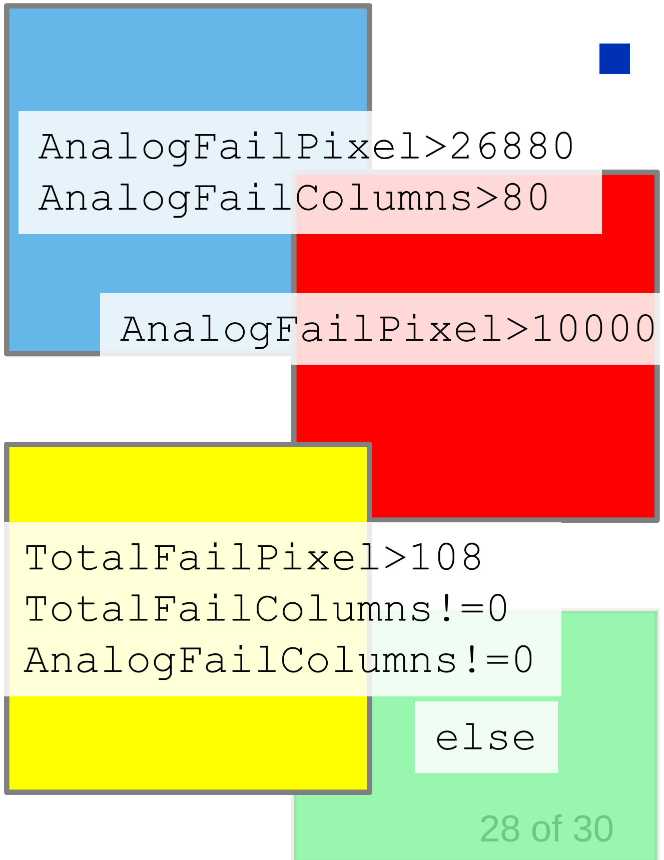
add to

Defines here:
How many pixel in one column have to fail the analog scan to let the DC fail

Global IC cuts

Defines here for the analog scan result and the blue, red, yellow IC states:
- how many pixels can fail in the analog test
- how many columns can fail in the analog test

And defines the total cuts



```
AnalogFailPixel>26880
AnalogFailColumns>80
```

```
AnalogFailPixel>10000
```

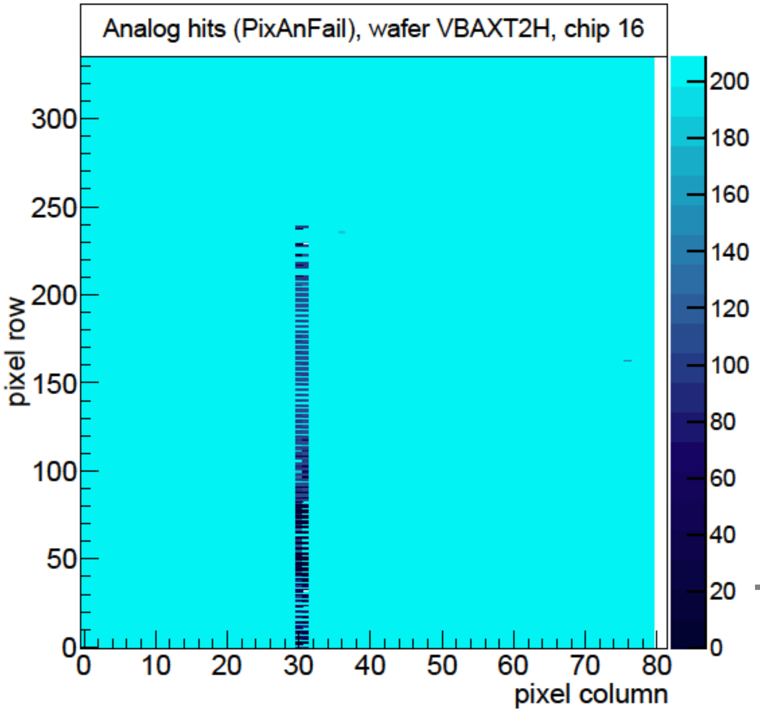
```
TotalFailPixel>108
TotalFailColumns!=0
AnalogFailColumns!=0
```

```
else
```

Cut scheme of WaferAnalysis

Pixel based cuts example: Analog Scan

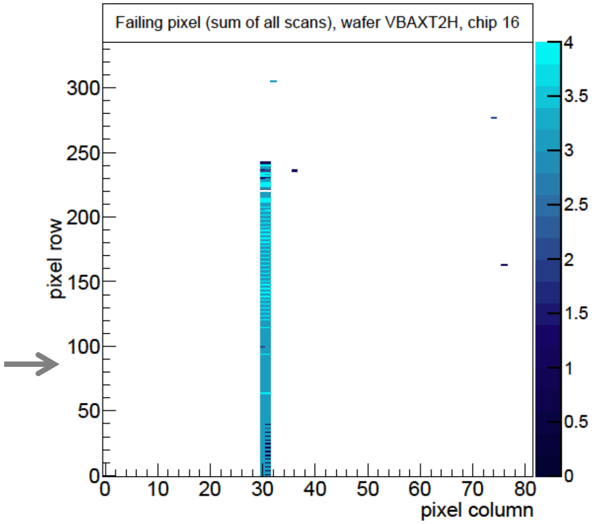
Pixel cuts

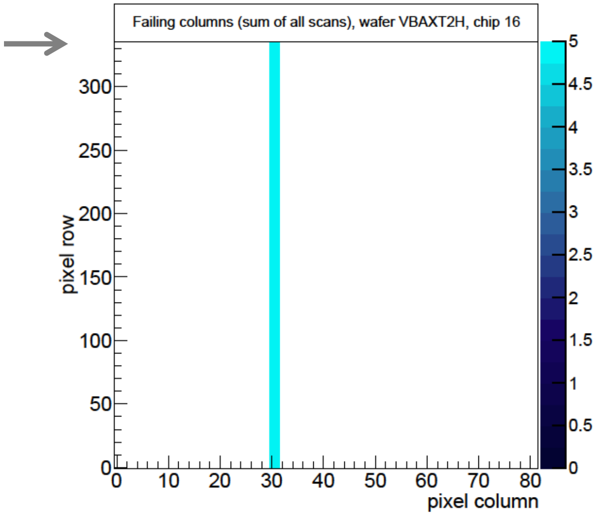


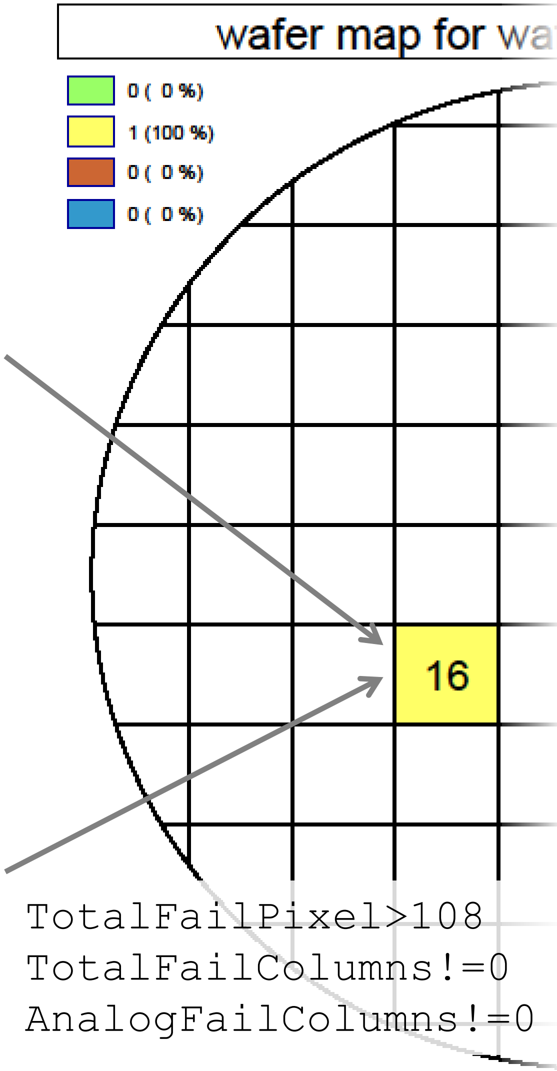
```
AnalogHits!=200
→466 analog failing pixels

Analog failing pixels > 20
→ 2 analog failing columns
```

Total pix/col failing







```
TotalFailPixel>108
TotalFailColumns!=0
AnalogFailColumns!=0
```

Please report all bugs to: pohl@physik.uni-bonn.de