

Thomas Bergauer (HEPHY Vienna)

Belle II Vienna-Pisa meeting

25 April 2013





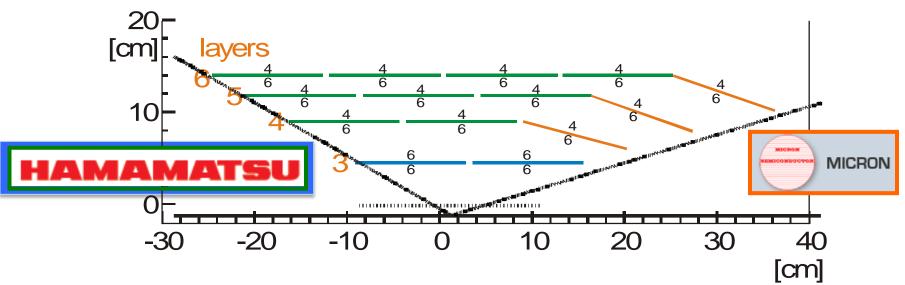
SENSOR CHARACTERISATION





Sensor Accounting

Two vendors, three layouts



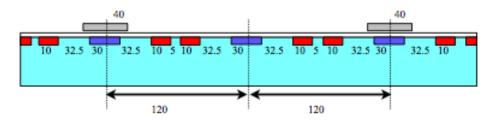
Layer	# of Ladders	Rect. Sensors [narrow]	Rect. Sensors [wide]	Wedge Sensors	APVs
6	16	0	64	16	800
5	12	0	36	12	480
4	10	0	20	10	300
3	7	14	0	0	168
Sum:	49	14	120	38	1748

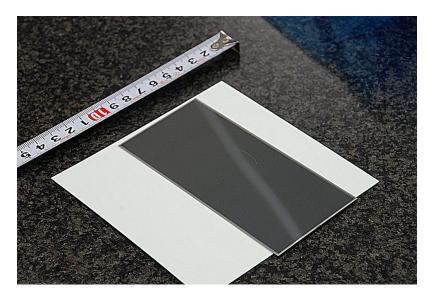


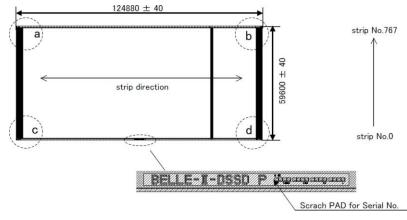


Rectangular Sensors from Hamamatsu

- HPK re-started production of DSSDs on 6" wafers
 - Old 4" production line was decommissioned
- We evaluated first batches
- Quality was constantly improving and is now at an acceptable level
- Technical details (layers 4,5,6):
 - Dimensions: 59.6 x 124.88 mm²
 - **p-side:** 768 strips, pitch: 75 μm
 - **n-side:** 512 strips, pitch: 240 μm



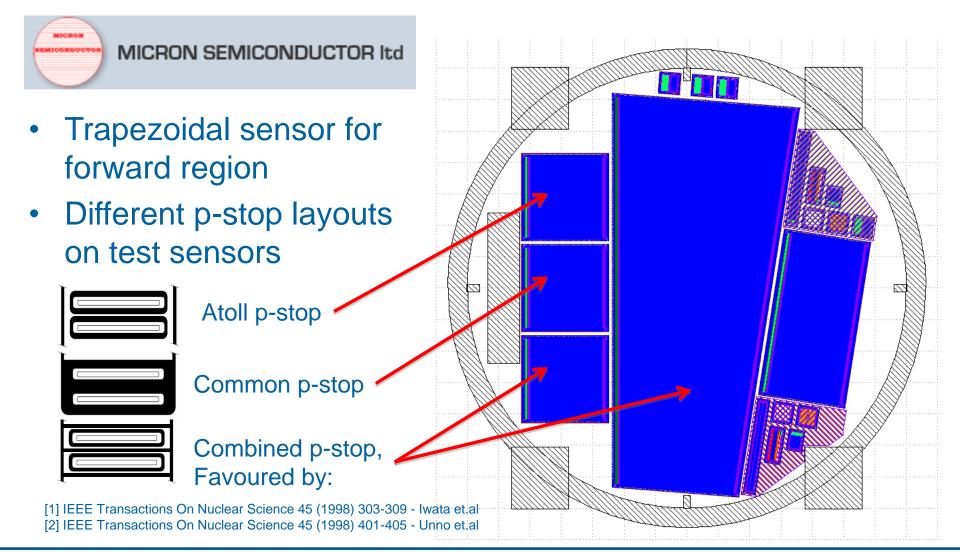








Trapezoidal Sensors from Micron







Modules for Beam Test 2010

- Read out by APV25 (CMS)
- Baby Module used to verify p-stop geometries:



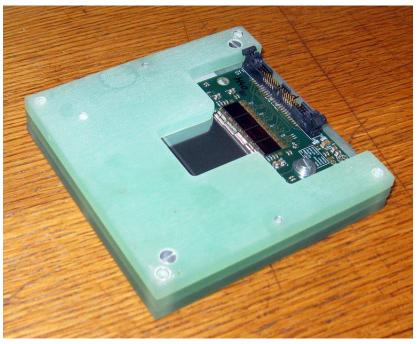
Atoll p-stop



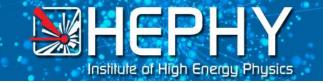
Common p-stop



Combined p-stop



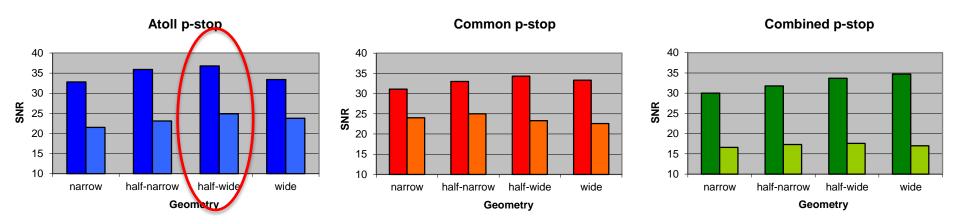
Baby Module





Signal-to-noise-ratios

- Test sensors have been Gamma-irradiated with Co-60 (70 Mrad)
- Tested before and after at CERN beam test (120 GeV hadrons)



- Dark colors: non-irradiated, Light colors: irradiated
- Atoll pattern (half-wide) performs best, both irradiated and nonirradiated
- Charge accumulation in non-implanted regions after irradiation

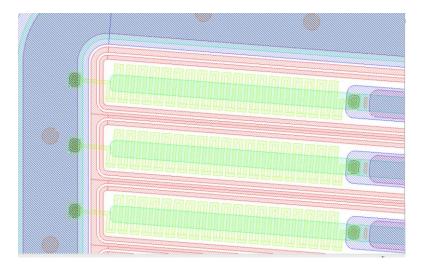


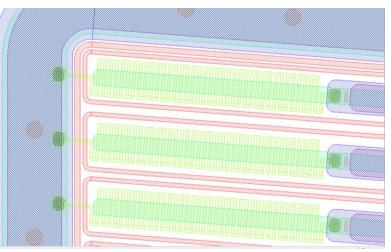


New prototype order with Atoll p-stop

- Three new masks ordered at Micron Semiconductor

 P-stop, metal, via
- P-stop: Atoll pattern (halfwide) [like HPK n-side]
- Three prototype detectors ordered in 2012
 - Delivery for spring 2012
 - beam test and irradiation summer/autumn 2012
- Order placed for mass production beginning 2013

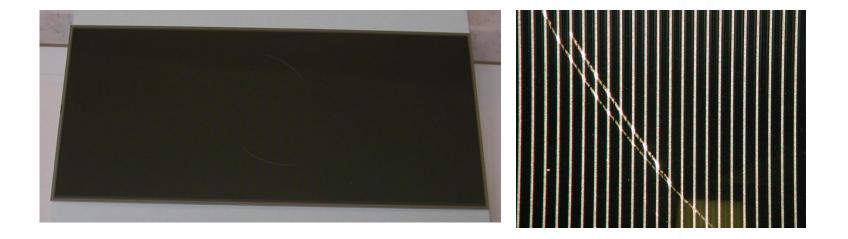




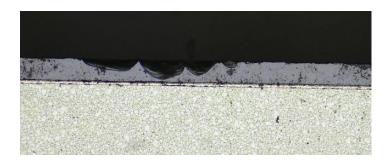




Optical inspection Scratches & Marks



- Round scratches
 - occur on every sensor
 - maybe due to automatic sensor handling?



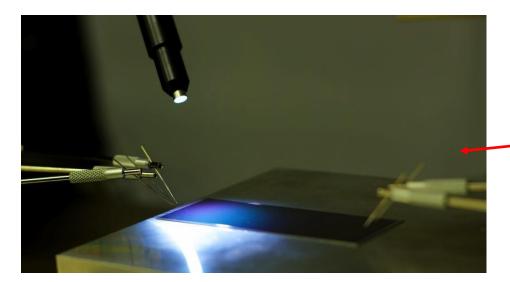


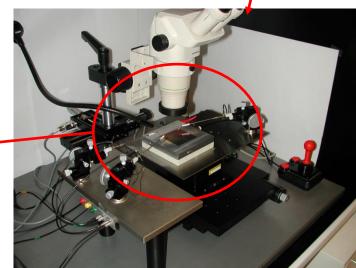


Strip-by-strip Test Setup

- Sensor in Light-tight Box
- Vacuum support jig is carrying the sensor
 - Mounted on movable table in X, Y and Z
- Needles to contact different structures on sensor
- What do we test?
 - Electrical parameters
 - strip failures





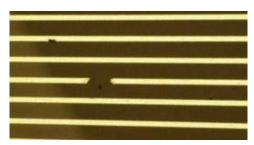






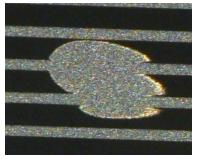
Common strip failures

Open Strip:

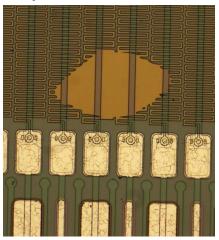


Open implant at via:

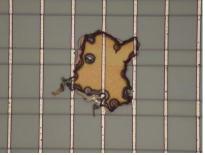
Shorted Strip:



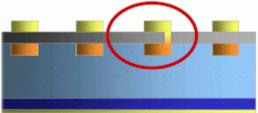
Open bias resistor:



Open implant:



"Pinhole" (short between implant and metal):

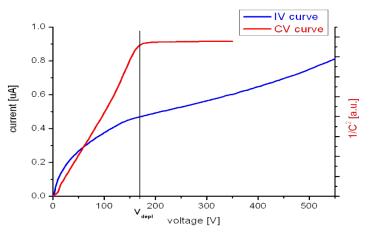


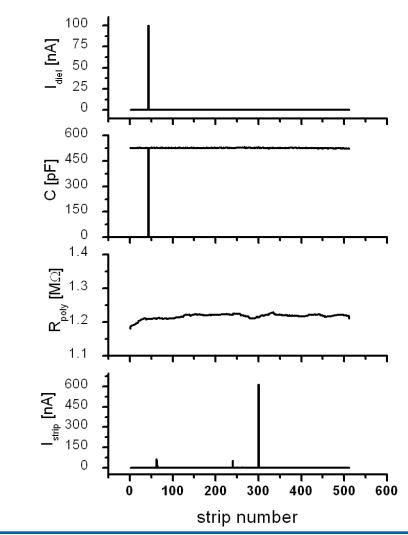




What do we test?

- Global parameters:
 - IV-Curve: Dark current, Breakthrough
 - CV-Curve: Depletion voltage, Total Capacitance
- Strip Parameters e.g.
 - strip leakage current I_{strip}
 - poly-silicon resistor R_{poly}
 - coupling capacitance C_{ac}
 - dielectric current I_{diel}

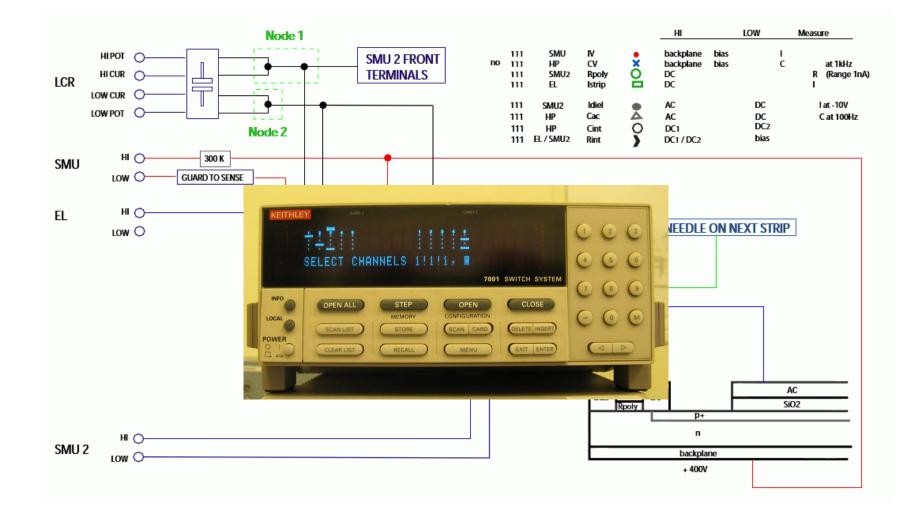








Switching Scheme



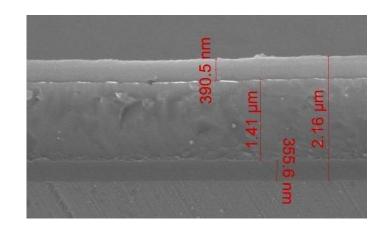


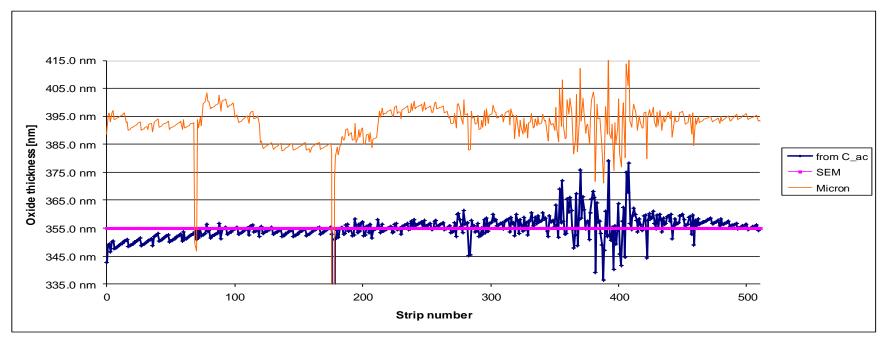


Measurement validation

Direct measurement of oxide thickness by electron microscopy

SEM result: 355 nm average from C_ac measurement: 354 nm Vendor average: 391.8 nm

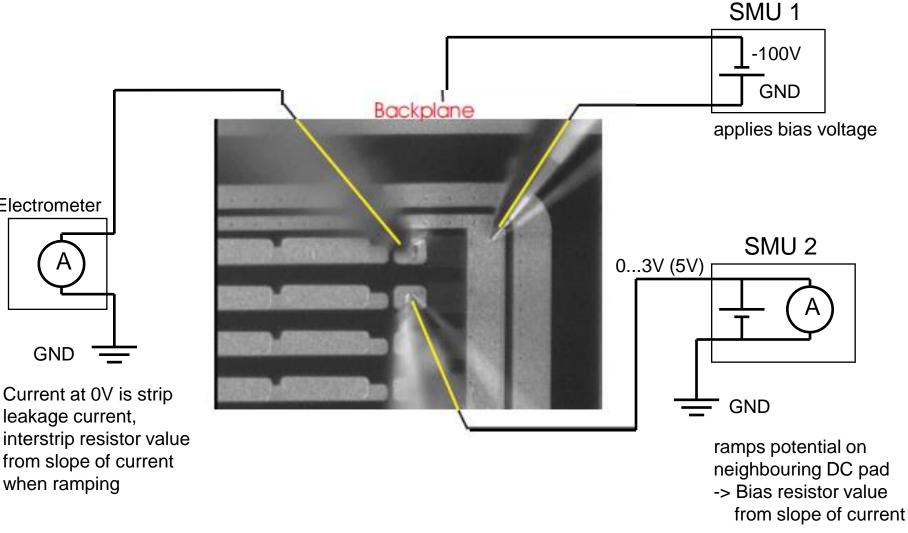




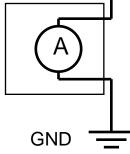




Measurement of the inter-strip resistance



Electrometer



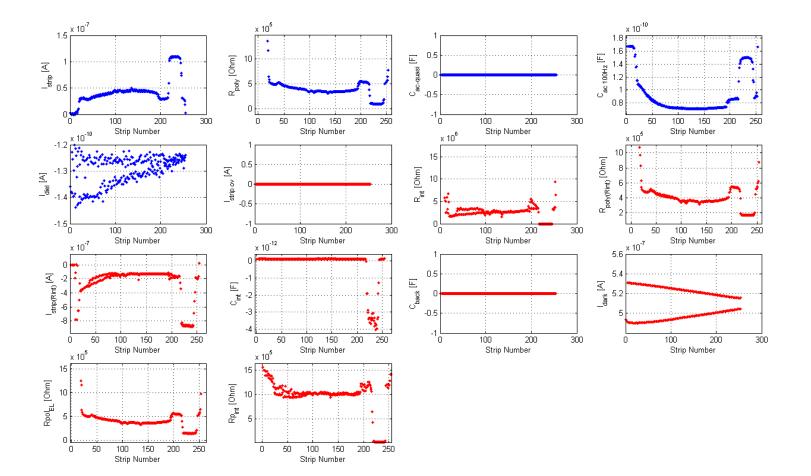
from slope of current when ramping

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Full Strip-by-strip results







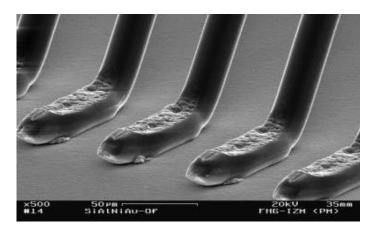
METROLOGY DURING LADDER ASSEMBLY





Wire bonding

- Ultrasonic welding
 technique
- 25 micron bond wire of Al-Si-1%
- Thin Wedge usually used for 17.5um wire
- Pull-tests to verify bond quality









Mechanical parameters

- Measurement of
 - Mechanical precision of CF ribs
 - Alignment of sensors w.r.t hybrid
 Using 3D mechanical measurement system
- Coordinate measurement machine (CMM)







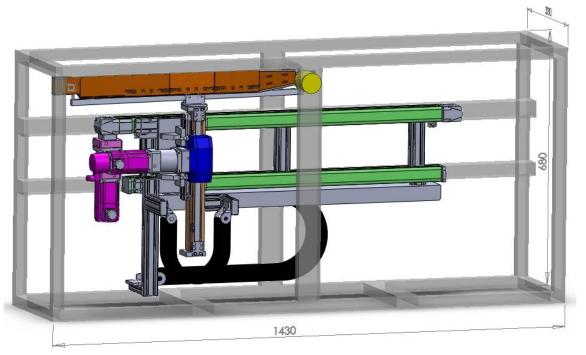
LADDER TESTING





Box with motorized XZ Table

Setup built for automatized ladder tests in Vienna



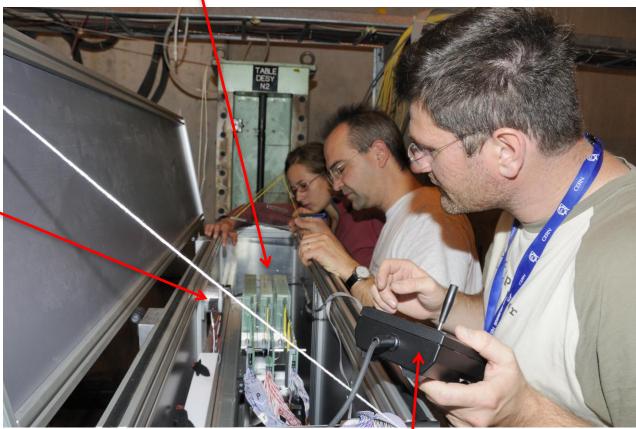
- Motorized stages remotely controllable via TCP/IP
- HPK mini-PMT with Scintillator for triggering





The setup

DUTs on x-z-table



Joystick for moving the x-y-table

(one of many interfaces for user error...)

Scintillator and photomultiplier for trigger











LADDER AGING AND BURN-IN





Climate Chamber

Key parameters:

- Volume 350l
- Space for 5 ladders
- Temperature range -40 up to +200 degC
- Rel. Humidity 0 to 95%
- Order placed mid March
- Will be delivered in June this year

Will be used for:

- Burn-in tests at elevated temperature
 - 60-80 degC
 - For durability checks of design (on pre-production ladders)
- Thermal cycling
 - To verify proper function of every single ladder







How to store metrology data?

CONSTRUCTION DATABASE





Belle II construction database

- Aim is to keep track of each (expensive) component:
 - Sensors
 - Hybrids
 - Modules
 - Ladders
- => Logistics: Registration, Shipments, Assembly
- Add measurement results





Key features

- User access system (benefit of CakePHP framework)
 - Authentication
 - User/Group permissions
- Logistics Module [already implemented]
 - Registration: "Add item"
 - View Inventory of one or all "locations"
 - Location is e.g. HEPHY, KEK, IPMU,...
- Measurement module [not yet implemented]
 - Store measurement results
 - Retrieve data with nice-looking plots
- Administration Module [already implemented]
 - Add/change/remove users and groups
 - Add new "locations", "item types",...





User access system

- Individual user accounts
- Linked to location, e.g. user Bergi=HEPHY

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Update AROs	view	Inherit :	 Inherit ‡ 	
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	1	bernhard	administrators	2012-04-04 14:20:23	2012-07-20 18:04:53	View	Edit	Delete
List	2	user	users	2012-04-04 14:20:32	2012-07-19 12:36:54	View	Edit	Delete
Users	5	admin	administrators	2012-07-19 12:36:35	2012-07-19 12:37:14	View	Edit	Delete
Groups	6	kek	users	2012-07-20 14:00:58	2012-07-20 14:13:18	View	Edit	Delete
	7	IPMU	users	2012-07-20 14:14:01	2012-07-20 14:25:13	View	Edit	Delete
	8	Bergi	administrators	2012-07-20 14:25:29	2012-07-20 14:25:44	View	Edit	Delete





Logistics Module

To view and search for inventory.

Works only if

- Each new component is entered
 - "Add item" page
- Shipments are entered
 "Transfer" page
- Assembly steps are followed in the db
 - "Assembly" page

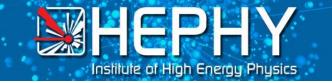
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	1571	B2HPK_10938-9239_47	Sensor Large Rectangular	HEPHY	****	<u>HPK</u>	Belle-II	Edit	Delete
Measurements History	1569	<u>HPK-100up-192ch-</u> DSSD-04	Baby Sensor HPK baby	<u>HEPHY</u>	****	НРК	<u>Belle-II</u>	Edit	Delete
Transfers	1568	<u>HPK-100up-192ch-</u> DSSD-03	Baby Sensor HPK baby	HEPHY	****	НРК	<u>Belle-II</u>	Edit	Delete
Administration	1567	HPK-100up-192ch- DSSD-02	Baby Sensor HPK baby	<u>HEPHY</u>	****	НРК	<u>Belle-II</u>	Edit	Delete
Item Subtypes	1566	<u>HPK-100up-192ch-</u> DSSD-01	Baby Sensor HPK baby	<u>HEPHY</u>	****	НРК	<u>Belle-II</u>	Edit	Delete
Locations	1565	B2HPK_10938-0404_59	Sensor Large Rectangular	HEPHY	****	<u>HPK</u>	<u>Belle-II</u>	Edit	Delete
Projects	1564	B2HPK_10938-0404_58	Sensor Large Rectangular	HEPHY	****	<u>HPK</u>	<u>Belle-II</u>	Edit	Delete
States	1563	B2HPK_10938-0404_57	Sensor Large Rectangular	HEPHY	****	НРК	<u>Belle-II</u>	Edit	Delete
Manufacturers	1562	B2HPK_10938-0404_56	Sensor Large Rectangular	HEPHY	****	<u>HPK</u>	<u>Belle-II</u>	Edit	Delete
Deliverers	1561	B2HPK_10938-0404_55	Sensor Large Rectangular	HEPHY	****	<u>HPK</u>	Belle-II	Edit	Delete
Denverers	1560	B2HPK_10938-0404_54	Sensor Large Rectangular	HEPHY	****	<u>HPK</u>	<u>Belle-II</u>	Edit	Delete
	1559	B2HPK_10938-0404_52	Sensor Large Rectangular	HEPHY	****	HPK	Belle-II	Edit	Delete
	1558	B2HPK_10938-0404_53	Sensor Large Rectangular	HEPHY	****	НРК	<u>Belle-II</u>	Edit	Delete
	Page 1	of 4, showing 15 records ou	t of 60 total, starting on record	d 1, ending o	on 15				





Measurement module: not yet implemented

- Upload measurement results as ASCII files directly to web server (HTTP POST command).
- Can be done
 - directly from measurement software (e.g. Labview)
 - Manually
- Uploaded ASCII files will be parsed at server side and data will be put into database
- Query module will allow to retrieve data (e.g. position of non-working strips) and nice-looking plots (e.g. IV curve on sensor)





Summary

- Sensor tests well defined
 - Fraction of full strip-by-strip scan not yet defined (rely on tests done by vendor)
- Metrology during ladder assembly via CMM
- Climate chamber to be commissioned for burn-in and thermal cycling
- Web-based logistics database for SVD has been implemented at http://www.hephy.at/hephydb







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