

Pixel plans for first half of 2013

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Hamburg Pixel Upgrade meeting, 14.12.2012

- beam tests
- lab tests
- X-ray tests
- bump bonding
- module production

beam tests

- DESY test beam is booked to 103% in 2013.
- PRELIMINARY schedule circulates:
 - DESY shutdown in Summer of 2013 not confirmed yet
- CMS Pix has 5 slots in TB21 with Datura telescope:
 - Purdue FPIX sensor: p-stop design choice week 5: 28.1. - 3.2.
 - DESY irradiated sensors (CERN PS) week 6: 4.2 - 10.2.
 - PSI irradiated and 3D sensors (T. Rohe) week 12: 18.3. - 24.3.
 - KIT pixel sensors Easter week 13: 25.3. - 31.3.
 - DESY next version psi46dig week 21: 20.5. - 26.5.
- There are 4 weeks in April 2013 for ILC calo when Datura is free (parasitic mode might be possible)
- There are 4 weeks in June 2013 for ILC calo in TB22 where Aconite telescope is free

lab tests (DESY)

- Measure irradiated digital ROCs:
 - chip 202: 3 Mrad of 24 GeV protons Jan-Apr 2013
CERN PS Oct 2012
 - chip 203: 13 Mrad of 24 GeV protons CERN PS Oct 2012
 - chip 204: 30 Mrad of 23 MeV protons Ka Zyklotron Jan 2013
 - chip 214: 99 Mrad of 23 MeV protons Ka Zyklotron Jan 2013
- take new digital test board into operation Winter 2013
 - visit PSI, learn FPGA software Winter 2013
- take DESY cold box into operation 2013

X-ray (Uni HH)

- Got 2 single chip modules with psi46dig from PSI:
 - establish DAC and trim parameters Nov 2012
 - operate in X-ray box on-going
- CERN-irradiated single chip modules:
 - determine absolute gain calibration (ke/DAC) Winter 2013
- X-ray gain calibration at low temperature:
 - still an open issue (KIT studies on-going)
 - cooling and dry air set-up under preparation

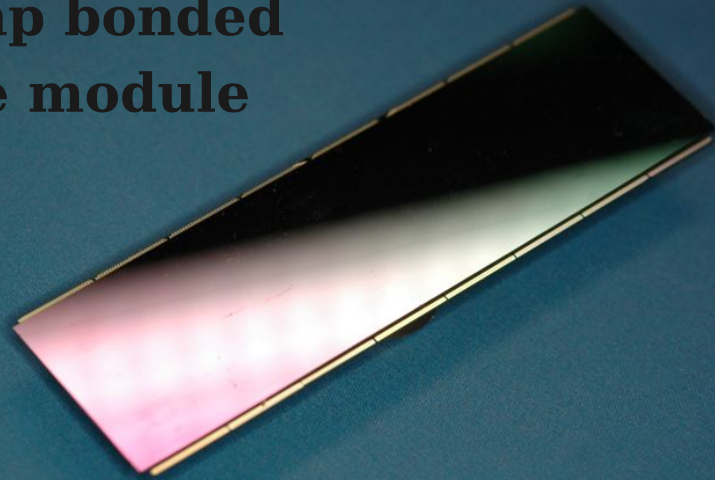
bump bonding

- UBM on 15 μm openings: VTT test structures PacTech, Jan 2013
- UBM on IBM wafer (old psi46v2), dice PacTech, Feb 2013
- UBM on CIS sensors, dice PacTech, Jan 2013
- place solder balls on CIS sensors PacTech, Feb 2013
- prepare class 1000 bump bond area at FEC, Jan-Feb 2013
- take Femto flip chip bonder into operation FEC, Feb 2013
- flip chip bond first bare modules FEC, Mar-Apr 2013
- bare module test with (old) probe card at FEC, Apr-May 2013
- take SB2 Jet into operation FEC, May 2013
- first in-house bump bonded bare module FEC, Jun 2013

bare module testing

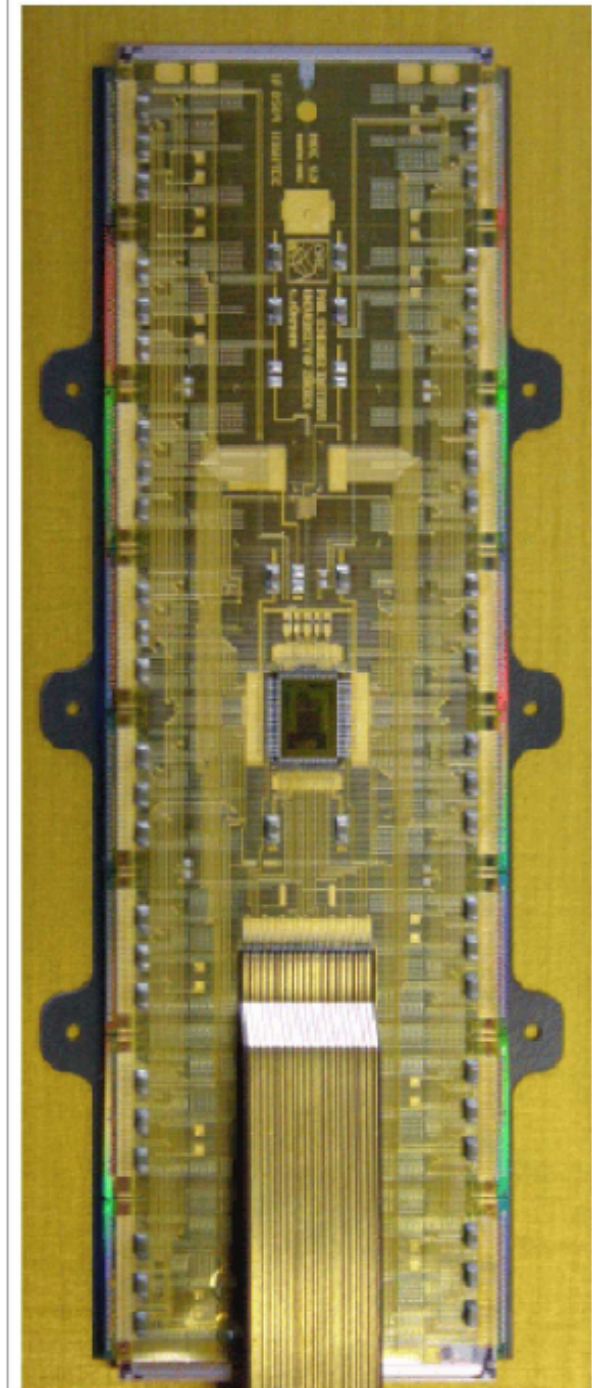
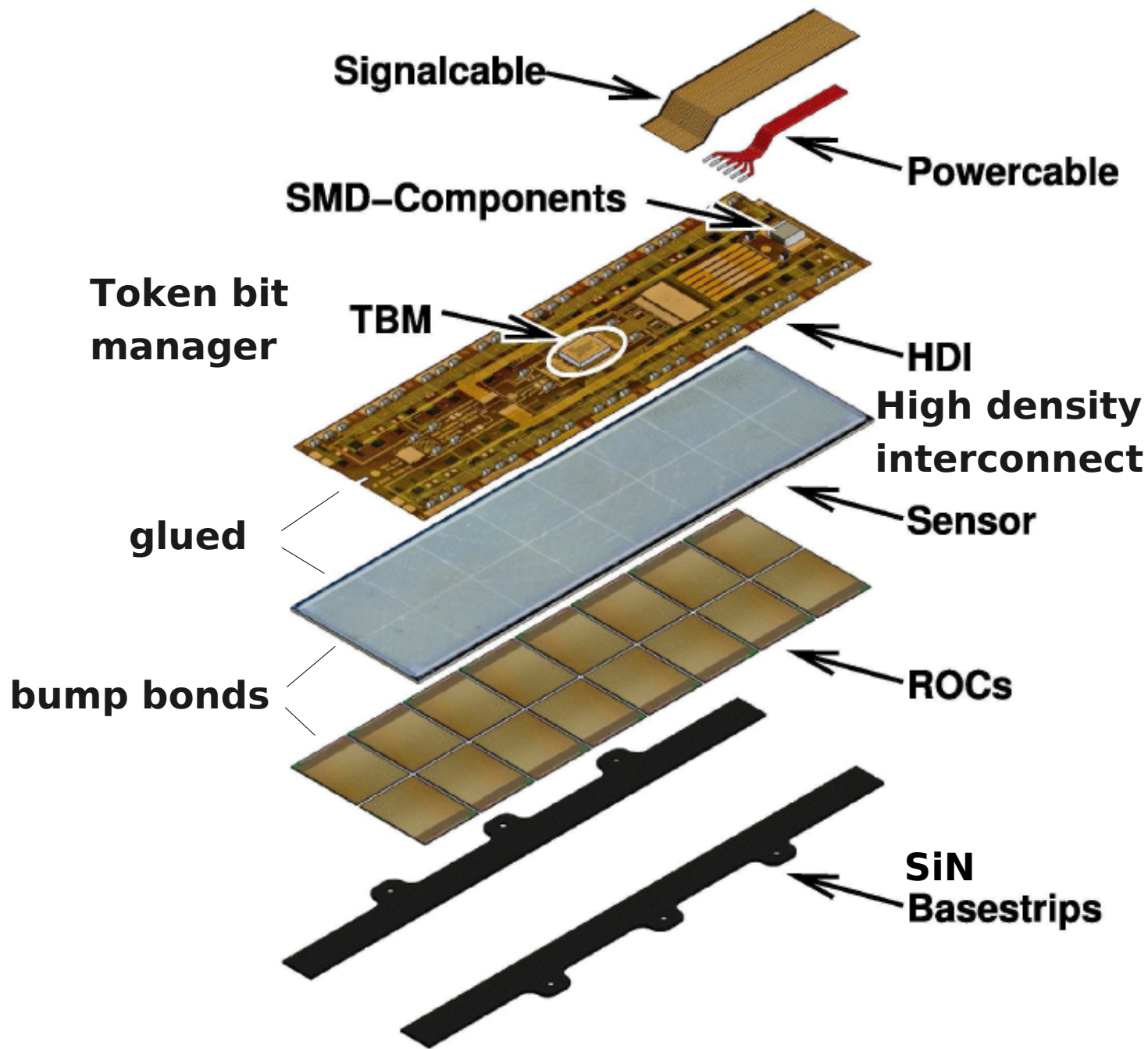


**bump bonded
bare module**

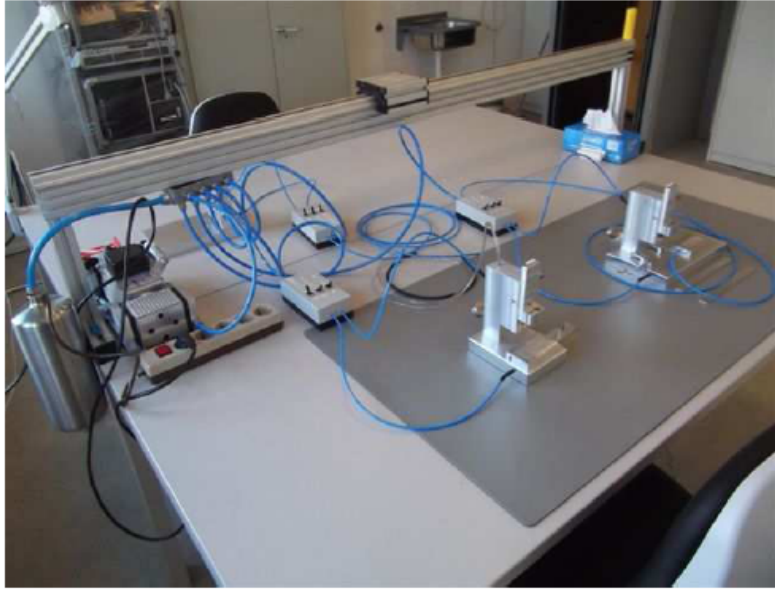


**PA300 probe station:
35 needles contact one ROC
connect to test board
run pixel tests
run bump bond test**

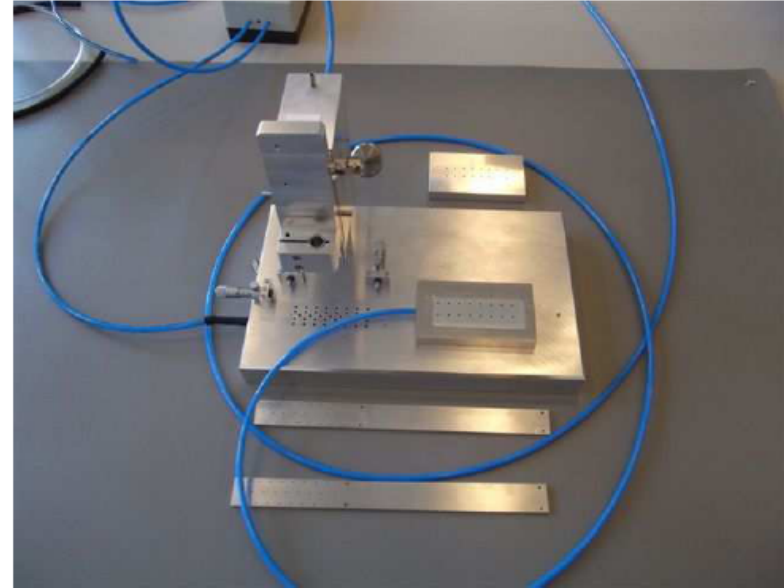
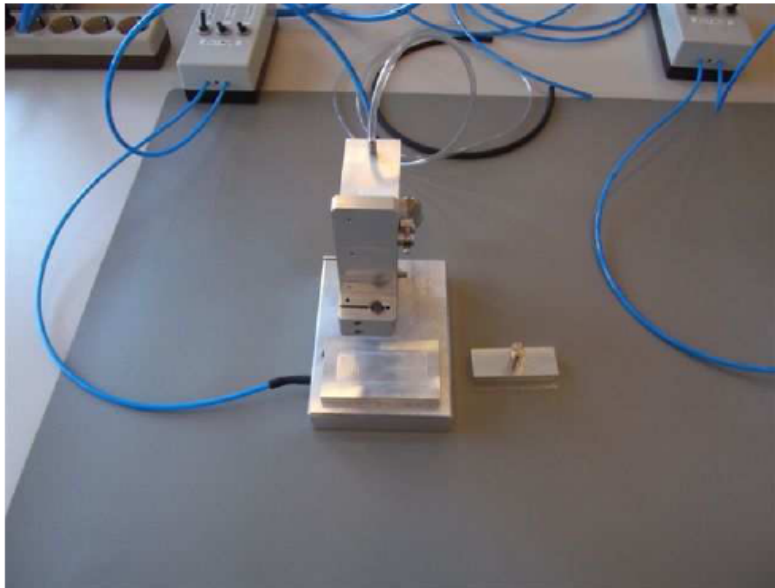
CMS barrel pixel module



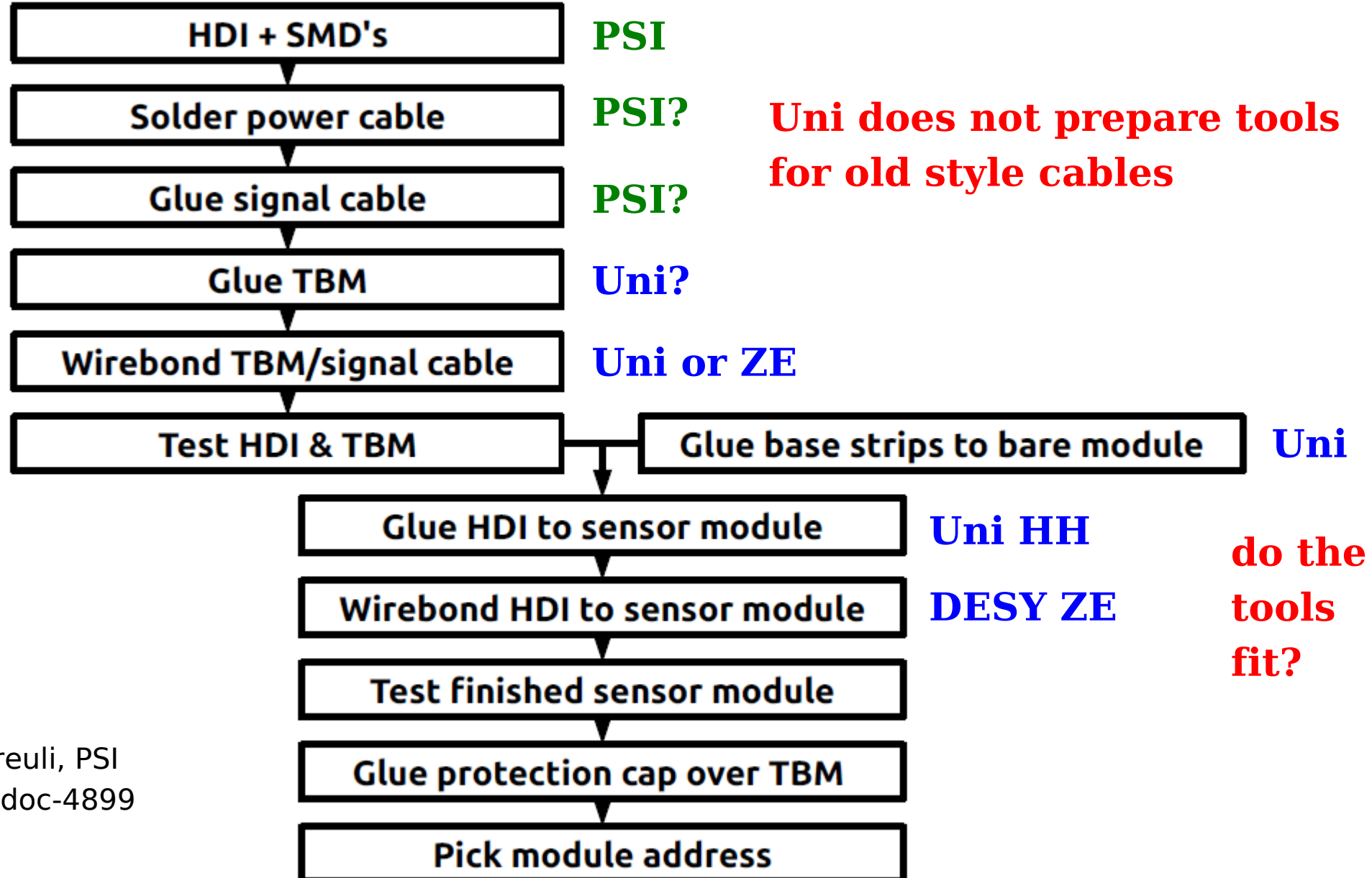
full-module $\hat{=}$ 16 ROCs



What is required for old-style modules?
ROC size is 0.8 mm smaller.
Base strips?
HDI: from S. Costa
TBM: from PSI
cables?



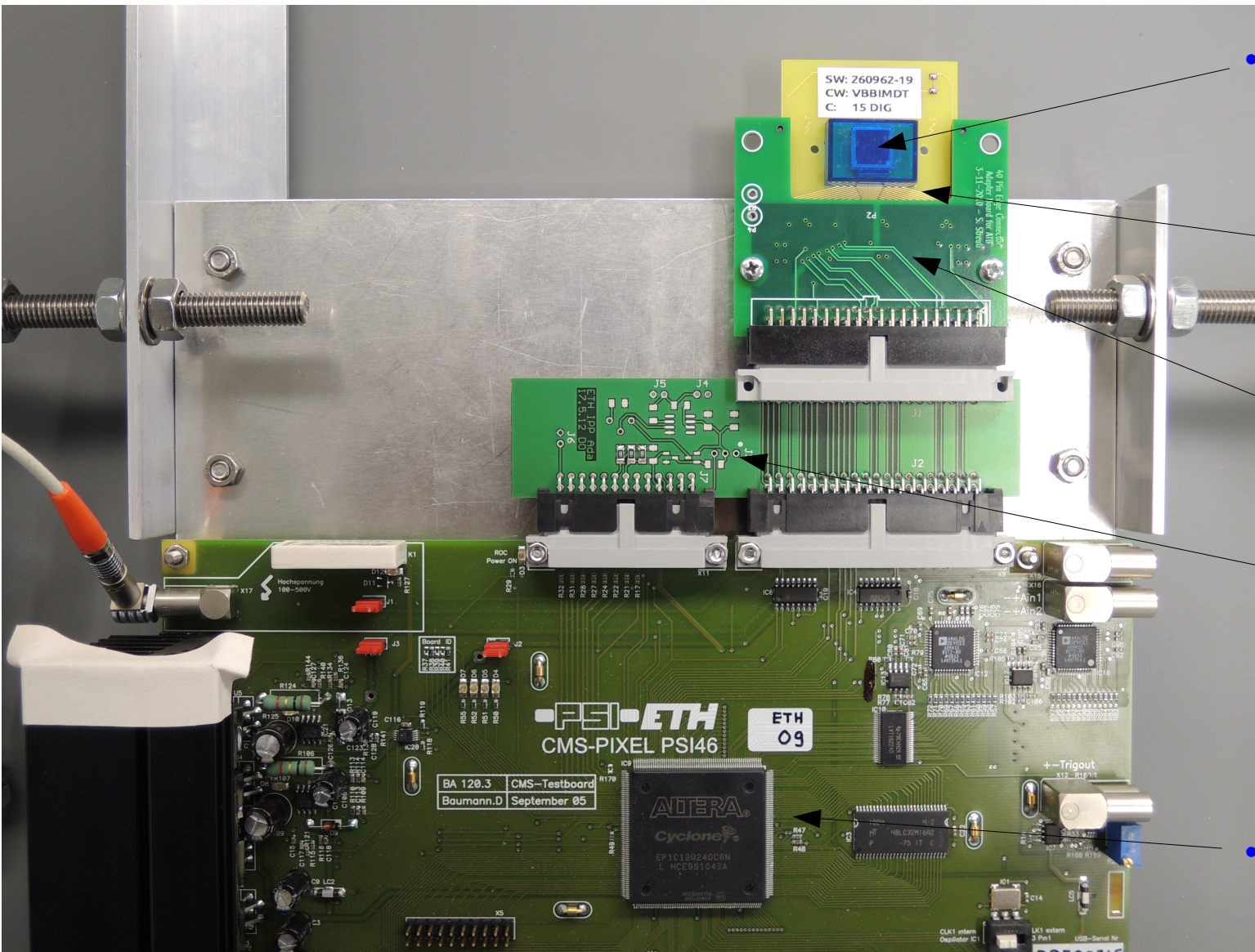
Old style module production?



S. Streuli, PSI
CMS-doc-4899
2011

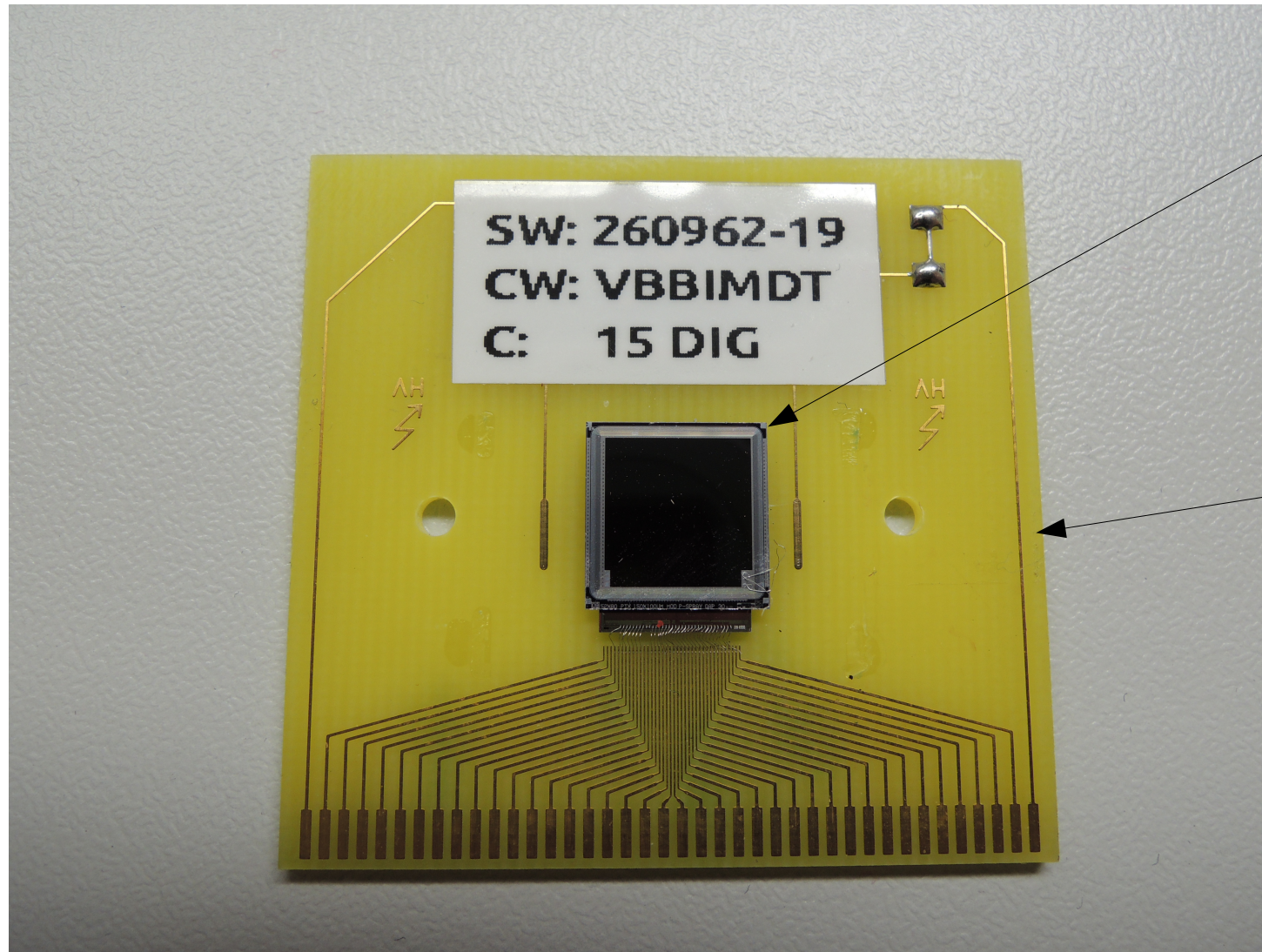
Back up

Test setup at DESY



- Single chip module:
 - ▶ Indium bump bonded at PSI
 - ▶ Glued and wire bonded to carrier printed circuit board
 - ▶ Interface card to psi46 TB with edge connector
 - ▶ ETH adapter card for digital 160 MHz differential signal directly into FPGA (LCDS into LVDS)
- FPGA firmware update to select digital path as 'TBM channel 1'

CMS pixel single chip module



- **Single chip module:**

- **Si: $10 \times 10 \text{ mm}^2$**
- **Indium bump bonded at PSI**
- **Glued and wire bonded to carrier printed circuit board**
- **PCB: $40 \times 40 \text{ mm}^2$**

CERN PS irradiation Oct 2012

- CERN PS IRRAD 1: 24 GeV protons
- **psi46dig chip 202 with sensor = sample 1785**
 - 29.10.2012, 9:26 – 16:00, **$F = 0.91 \cdot 10^{14}/\text{cm}^2$** ($\pm 7.4\%$)
- **psi46dig chip 203 with sensor = sample 1786**
 - 28./29.10.2012, 17:05 – 8:45, $F = 2.27 \cdot 10^{14}/\text{cm}^2$
 - 29.10.2012, 9:26 – 16:00, $F = 0.91 \cdot 10^{14}/\text{cm}^2$
 - 30.10.2012, 9:27 – 12:52, $F = 0.60 \cdot 10^{14}/\text{cm}^2$
 - total **$F = 3.77 \cdot 10^{14}/\text{cm}^2$** ($\pm 7.6\%$)
- Fluence values are as requested

<https://irradiation.web.cern.ch/irradiation/Dosimeter/Sets-2012.htm>

Box for module cold calibration

► Challenges

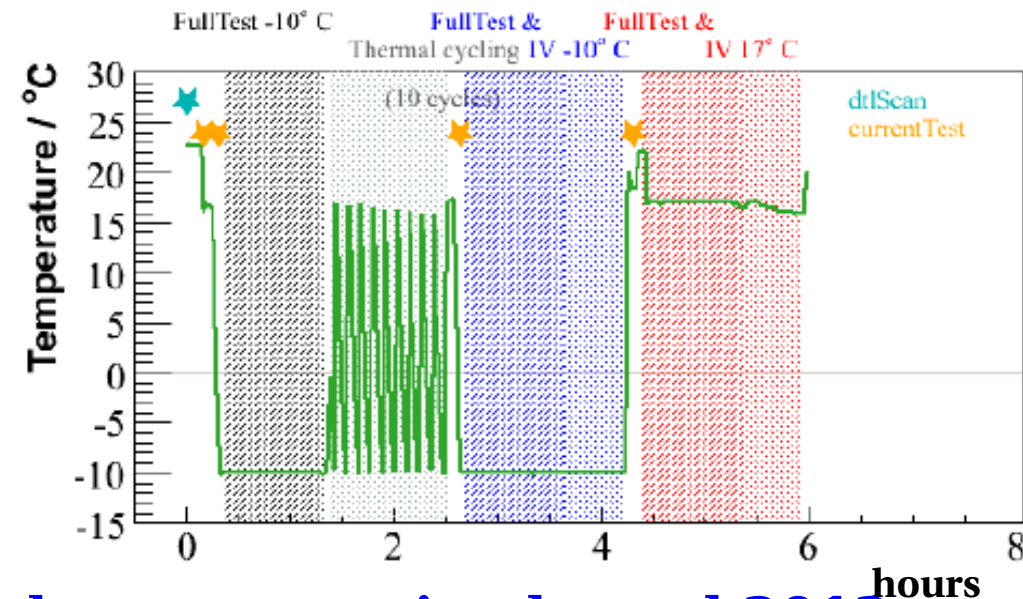
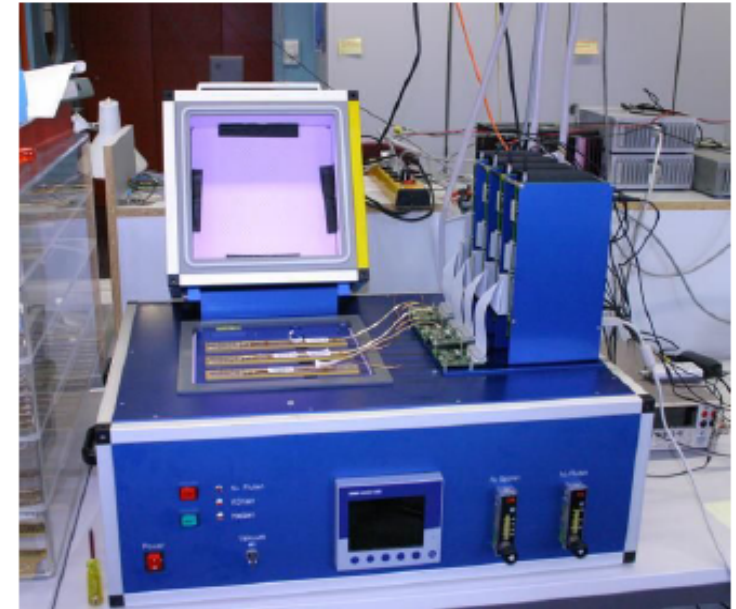
- Huge number of channels: $5 \div 6 \times 10^7$
- Multy-dimensional parameter space: 29 DACs/ROC
- Temperature dependence: tests done at -10°C and $+17^\circ\text{C}$ **upgrade: -20°C**

► Test set up

- Programmable cooling box
- 4 modules at a time
- Custom built test-boards with FPGA

► Procedure

- Start-up adjustments
- Full Test at -10°C
- 10 thermal cycles
- Full Tests and IV at -10°C and $+17^\circ\text{C}$



DESY box designed by C. Muhl, under construction by end 2012