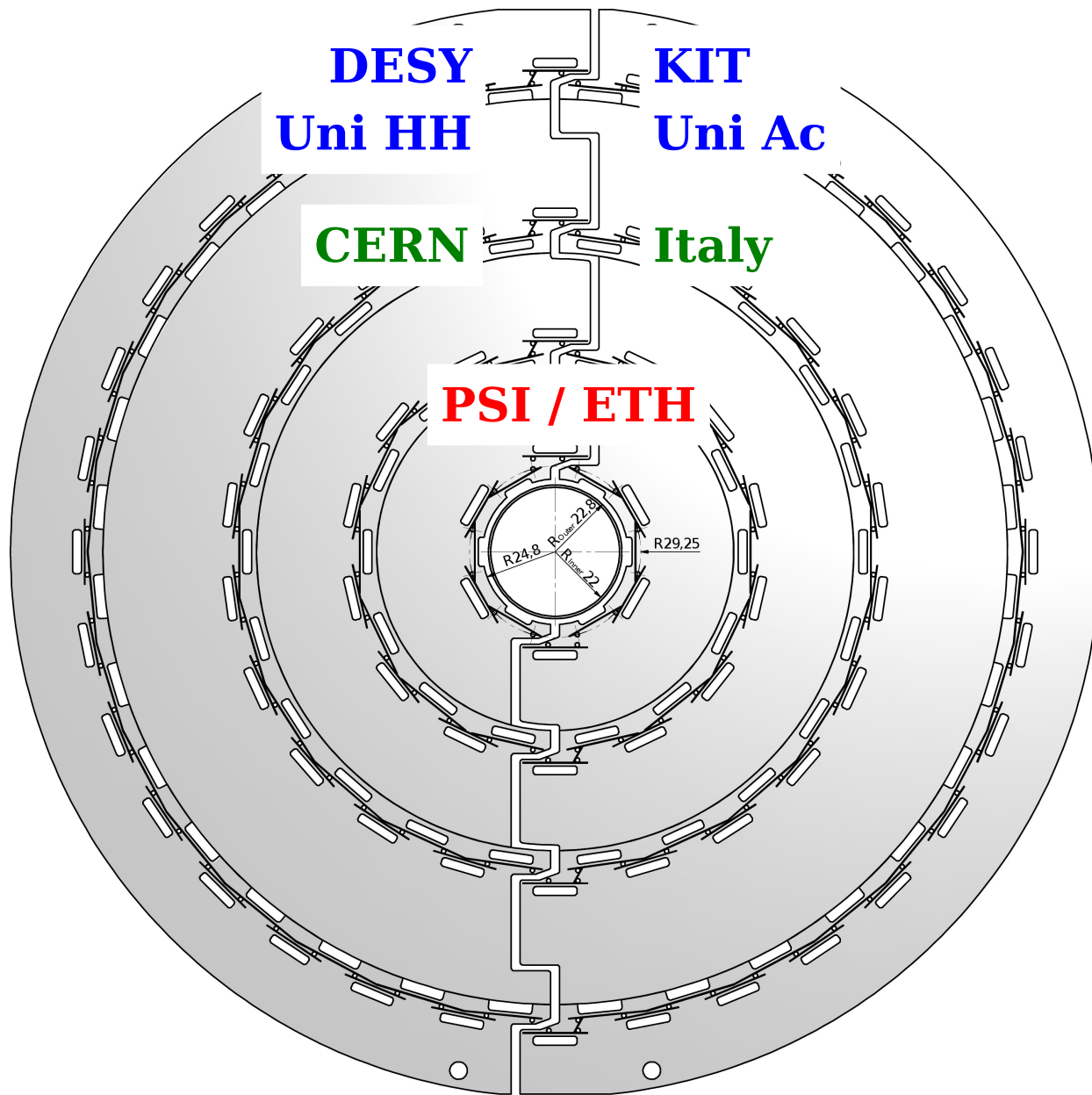


CMS barrel pixel upgrade: numbers



$R_4 = 160$ mm, 512 modules

$R_3 = 109$ mm, 352 modules

$R_2 = 68$ mm, 224 modules

$R_1 = 29$ mm, 96 modules

total:

1184 modules

18'944 ROCs

78.8 M pixels

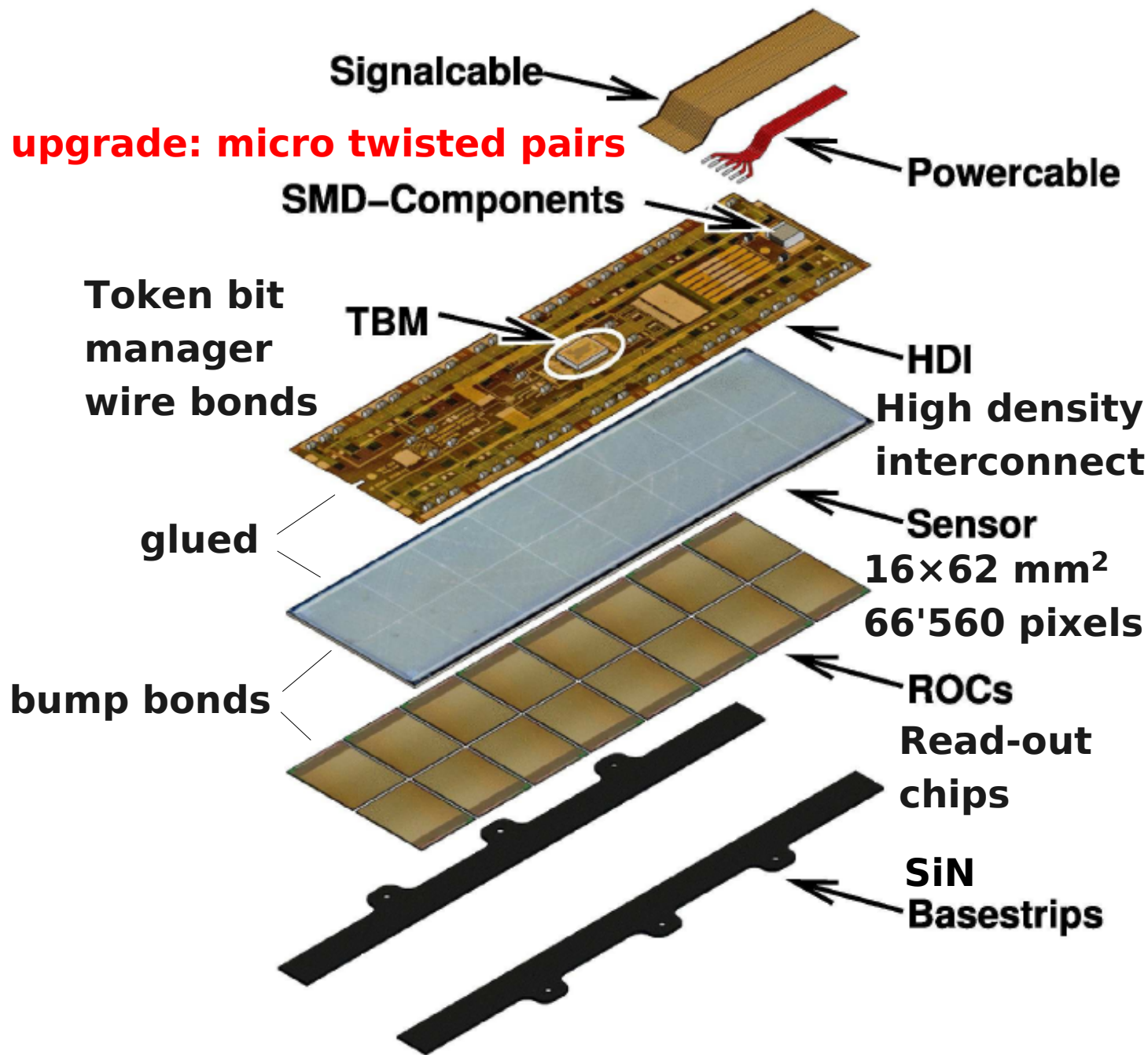
(1.6 × present barrel)

spares: produce 50% more

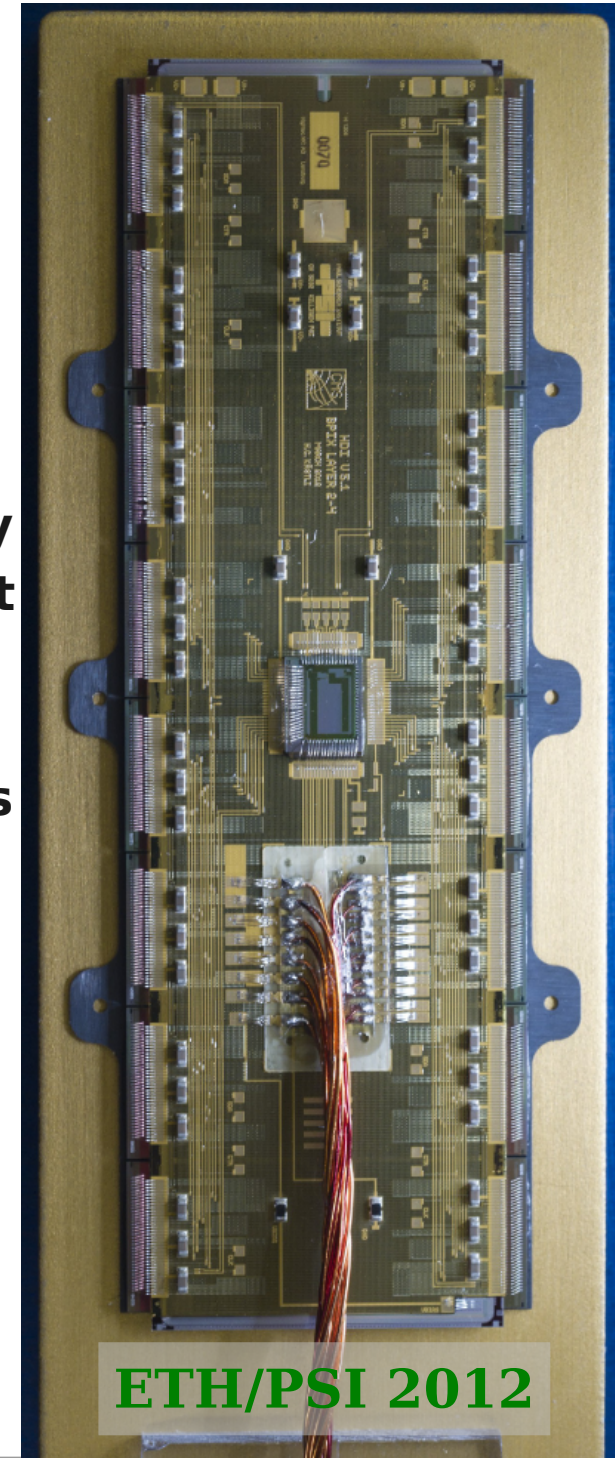
Project time line in HH

- Produce assembly tools since 2010
- Develop testing and calibration procedures 2011
- Bump bonding tests end 2010-2012
- Establish sensor testing procedures 2012
- Decide on bump bonding technique mid 2012
- Contribute to digital ROC pre-series testing 2012
- Assembly and test procedures established 2013
- Receive all components for series production 2013-2014
- Module assembly and calibration 2014-2015
- 4th layer assembly and test end 2015
- Full system test at CERN 2016
- Ready for installation in CMS end 2016

CMS barrel pixel module



368 modules to be produced in HH



ETH/PSI 2012

Pixel upgrade achievements in 2012

Bump bonding:

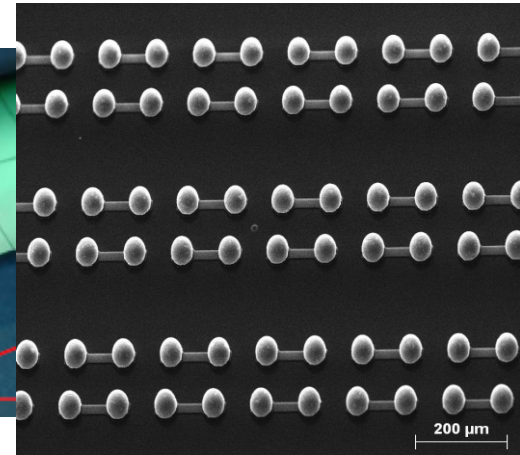
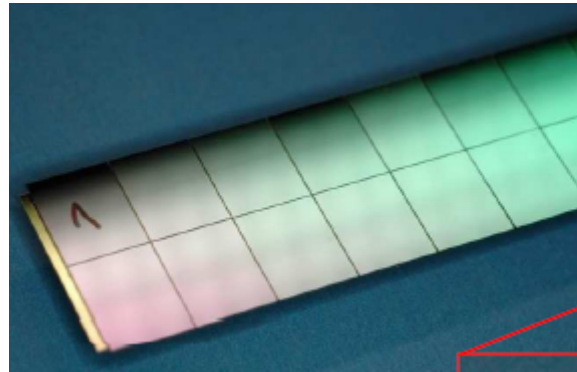
Solder jet and flip chip bonding
process established with industry:

5 Hz, 99.87% yield.

First machine delivered at FEC
(320 kEUR)

66'560 solder balls

40 μm SnAg spheres



New readout Chip:

extended data buffers

on-chip ADC

160 MHz digital readout

faster comparator

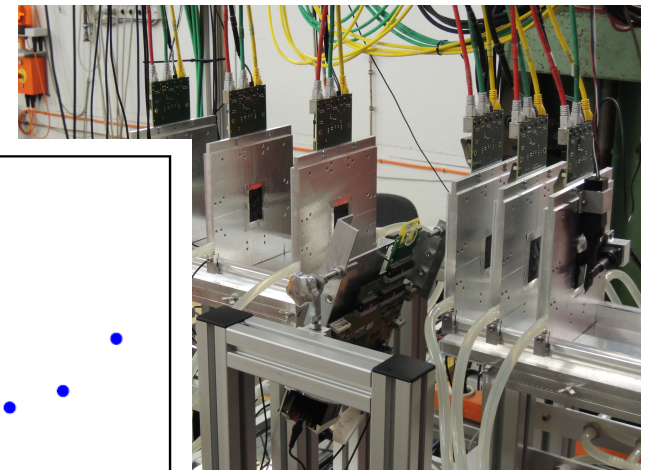
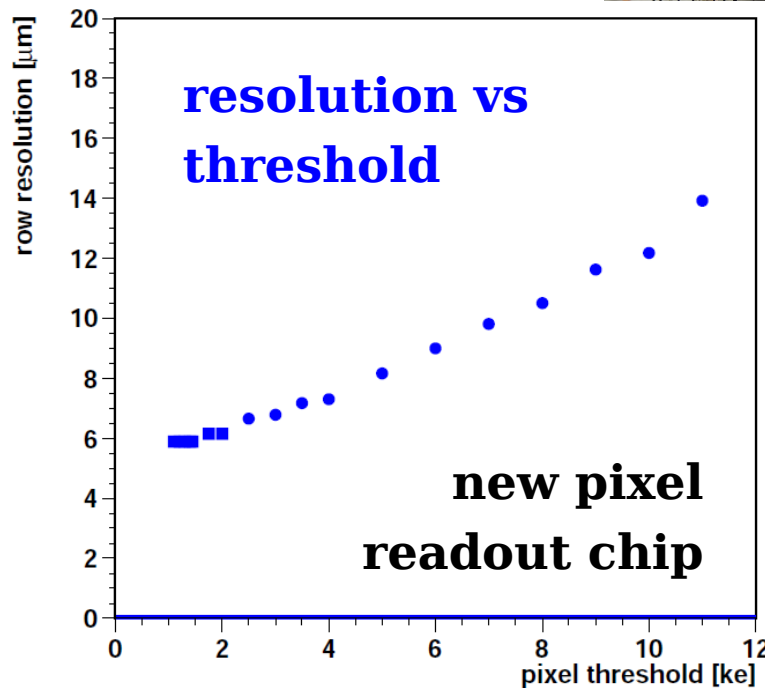
less cross talk

lower thresholds

radiation hardness

all confirmed.

CMS Pixel Upgrade TDR
completed and approved



DESY
test beam
telescope

Pixel plans for 2013

- Sensors:
 - receive pre-series with up to 150 sensors Feb 2013
- Readout chip:
 - receive pre-series with 600 chips April 2013
- Continue beam tests:
 - Irradiated samples, final readout chip Spring 2013
 - NIM publication Summer 2013
- Establish in-house bump bonding at FEC:
 - first bare module Summer 2013
- Preparations towards series production:
 - first full module Summer 2013
 - take cold calibration box into operation Autumn 2013
 - establish all test and calibration procedures Autumn 2013

Pixel module production: human resources

Production of 384 barrel pixel modules at DESY and Uni HH 2013 - 2015

task	quantity	group	needed		available	
			Tech	Phys	Tech	Phys
sensors I-V	384	Uni HH	0.5	0.5	0.5	0.5
bump bonding	384	DESY-FEC	1	2	1	2
bare module test	384	DESY-CMS	1	1	1	1
bond TBM to HDI	384	DESY-ZE	0.5		0.5	
glue HDI to sensor	384	Uni HH	1		1	
bond ROCs to HDI	5600	DESY-ZE	2		2	
module testing	384	DESY-CMS	1	1	1	1
cold calibration	384	DESY-CMS	1	2	1	1
X-ray calibration	384	Uni HH	1	2	1	2
layer assembly	1	DESY-CMS	1	1	1	1
layer system test	1	DESY-CMS	0.5	2	0.5	1
sum			10.5	11.5	10.5	9.5

need one more student and postdoc generation until 2015/16

PhD and postdoc topics

- Postdocs A. Petrukhin, S. Habib, J. Olzem left
- Students A. Burgmeier, L. Calligaris focus on analysis
- Chip and sensor tests in lab and beam, before and after irradiation:
2013, H. Perrey, S. Spannagel, J. Kieseler
- Develop procedures to monitor the bump bonding quality:
2013-14, G. Dolinska, I. Korol
- Prepare cold calibration of modules:
2013, C. Diez Pardos, S. Spannagel
- Production quality monitoring, data base: 2014, open
- Module calibration: 2014, open
- Prepare layer system test: 2014/15, open

Backup slides

Work packages in D-CMS

4th layer: 512 modules + 256 spares = 768

task	quantity	DESY	HH	Ka	Ac
sensors I-V	768		384	384	
bare modules	768	384		384	
bond TBM to HDI	768	384		384	
glue HDI to sensor	768		350	384	
bond ROCs to HDI	400k	200k		200k	
module testing	768	384		384	
cold calibration	768	384			384
X-ray calibration	768		350		384
layer assembly	1	1			
layer system test	1	1			
DC-DC converters	2200				all

module production task sharing in HH

- sensor inspection, I-V, C-V Uni HH
- UBM, wafer thinning, dicing Pactech
- bump bonding DESY FEC
- bare module testing, re-work DESY CMS & FEC
- HDI test, TBM gluing Uni HH
- TBM wire bonding DESY ZE or Uni HH
- Module gluing: HDI, cable, base strips Uni HH
- ROC to HDI wire bonding DESY ZE
- Module testing, cold calibration DESY CMS
- X-ray calibration Uni HH
- layer assembly and ladder test DESY CMS

Femto flip chip bonder from FineTech

**Precision automated
flip chip bonder
Femto from Finetech**

**Reflow soldering
by chuck and bond
head heating
in formic acid
atmosphere**

Known good die test

**Detailed parameter
logging**

Being installed at FEC

