

Bump bonding at PSI

- Original Motivation (1995)

- Competence in dealing with bump bonding companies.

- Status (2000)

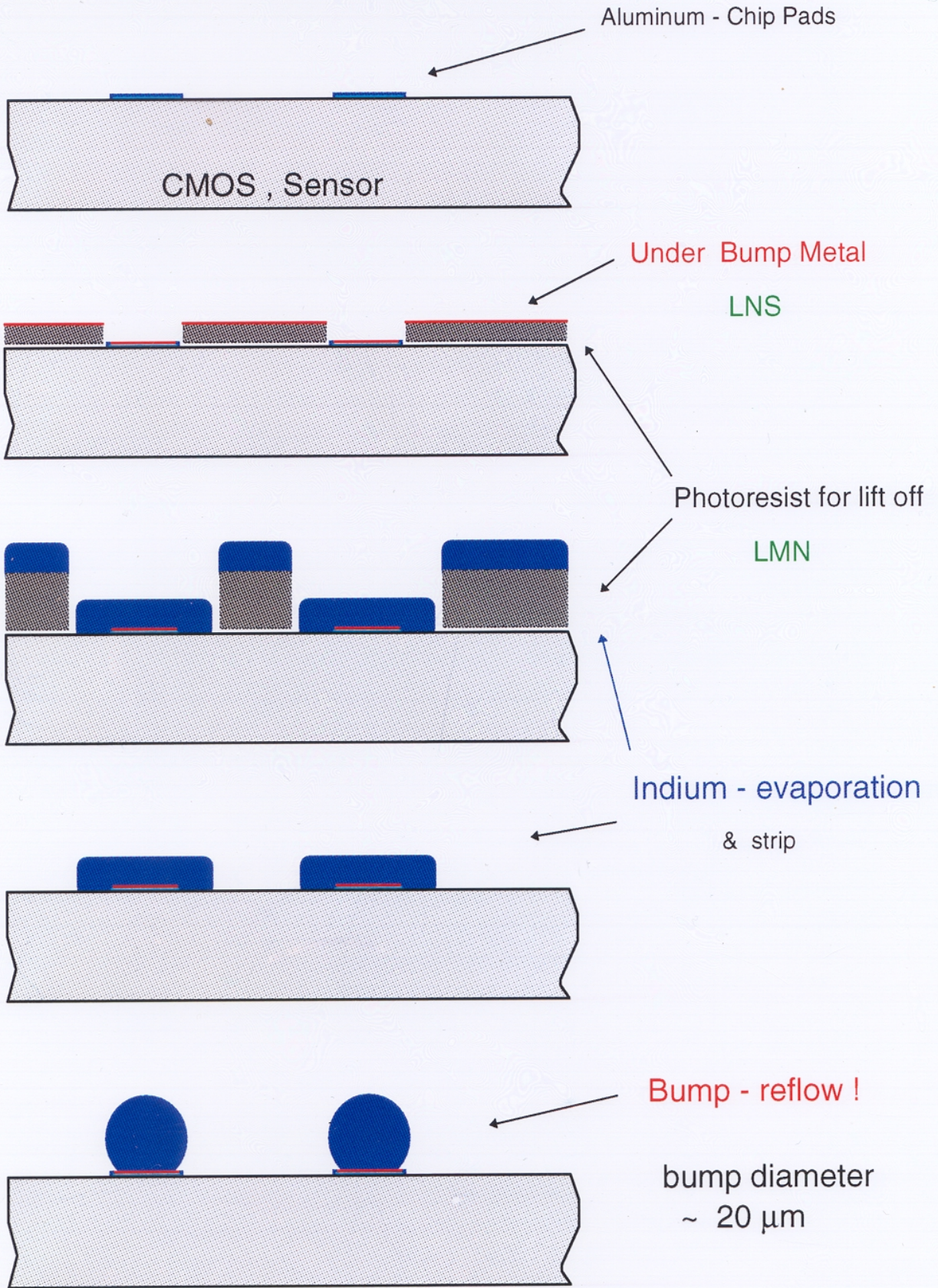
- Bumpbond Prototypes ourselves!

PSI: Labor für Nano & Mikrotechnologie

- Development of process and tests.
- Bump bonding of prototypes
- Mass production.

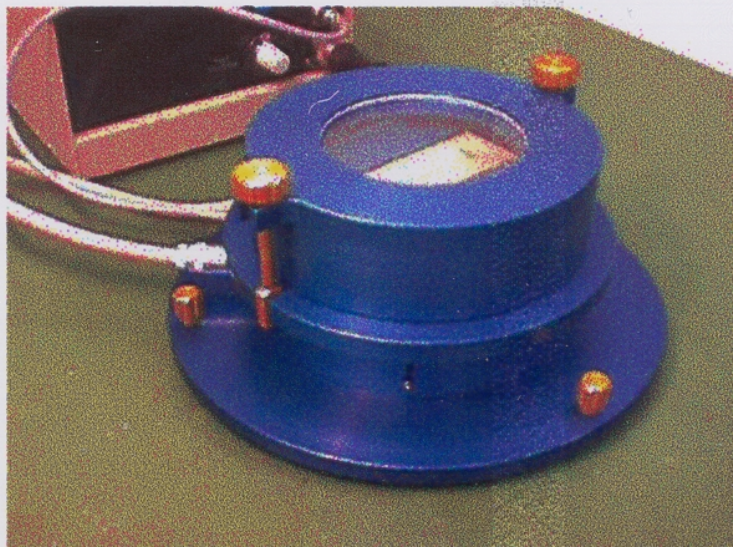
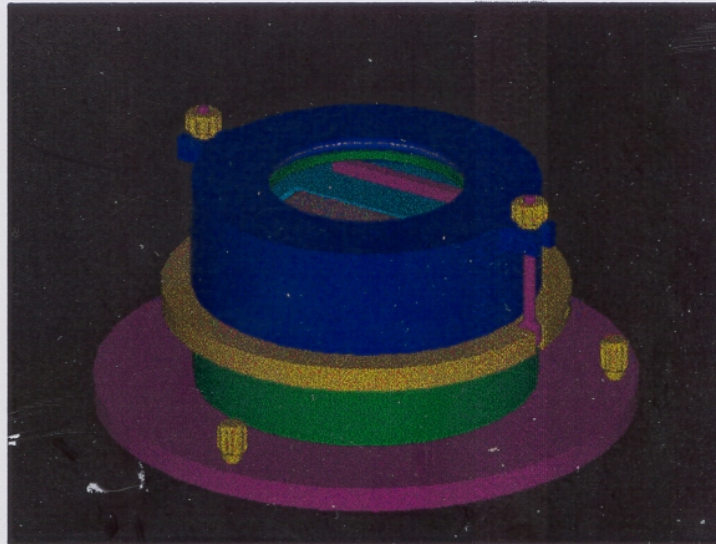
BUMP GROWING

(2 PSI)



Bump bonding reflow oven

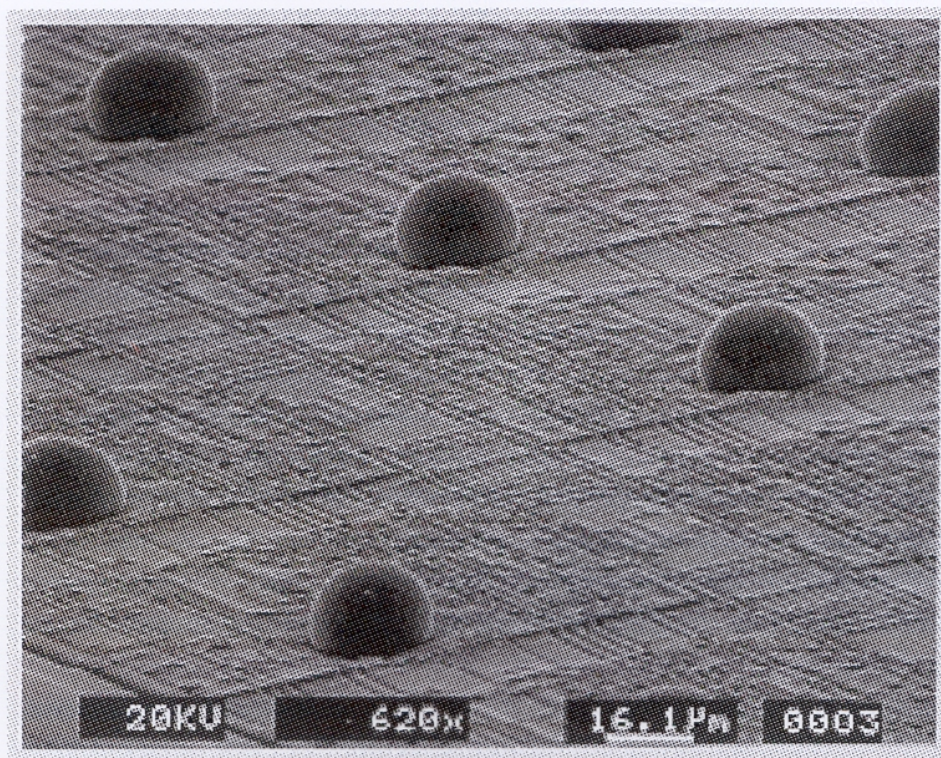
- Reflow oven for complete barrel pixel modules
- Fast $\Delta T/\Delta t$ and controlled gas atmosphere
- Final production oven.



BUMP GROWING

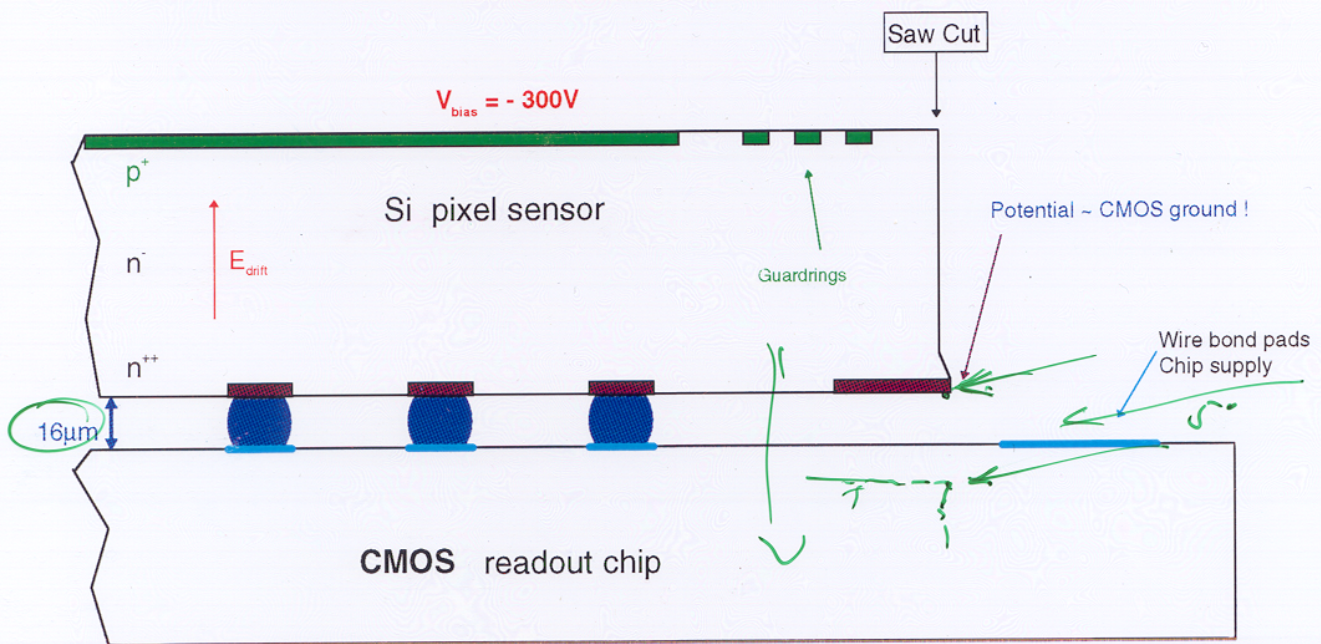
at PSI

- DMILL read out chip 22x30 pixels (125 μ x 125 μ)
- Single chip processing for UBM at LMN & LNS
- Indium deposition bumps
- In house process for prototypes



Bumpbond assembly with n⁺ on n-bulk sensor

- segmented readout electrodes n⁺-pixel --> collect electrons !



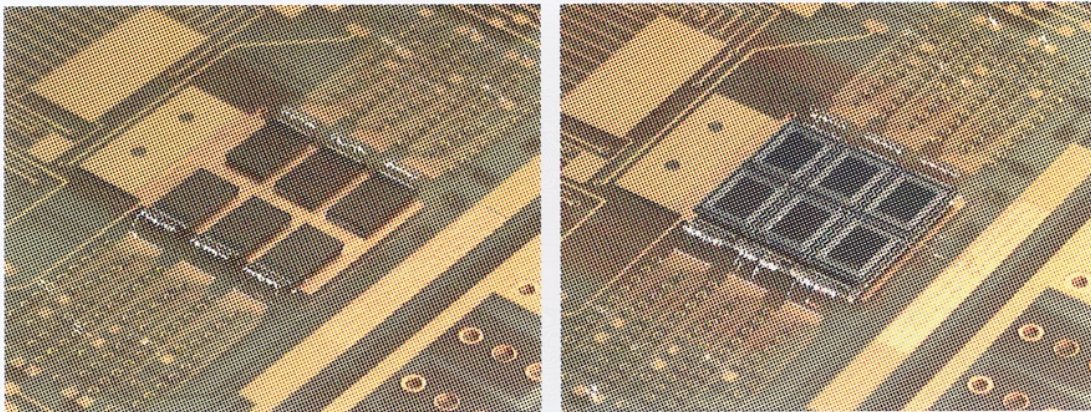
- double sided processing. (n⁺-pixel on n-bulk material, p⁺-isolation)
 - > more masks (10-11), higher costs/cm² !
- Saw cut of silicon sensor & p⁺-side bias voltage
 - > n-side cutting edge at ~CMOS potential !!
- Bias voltage degradation across guard rings
- No voltage break down to CMOS readout surface (~0Volt) even for large detector bias voltages (300-400Volt!)
- Should be Ok. even with detector after type inversion!! ($\sim 10^{13} \pi/cm^2$)

Construction and tests of Minimodule

6 pixel chips (22x30 pixel) bumpbonded with pixel sensor for minimodule (3960 pixels)

Test bumpbonding of several pixel chips to one sensor unit → Module bumping

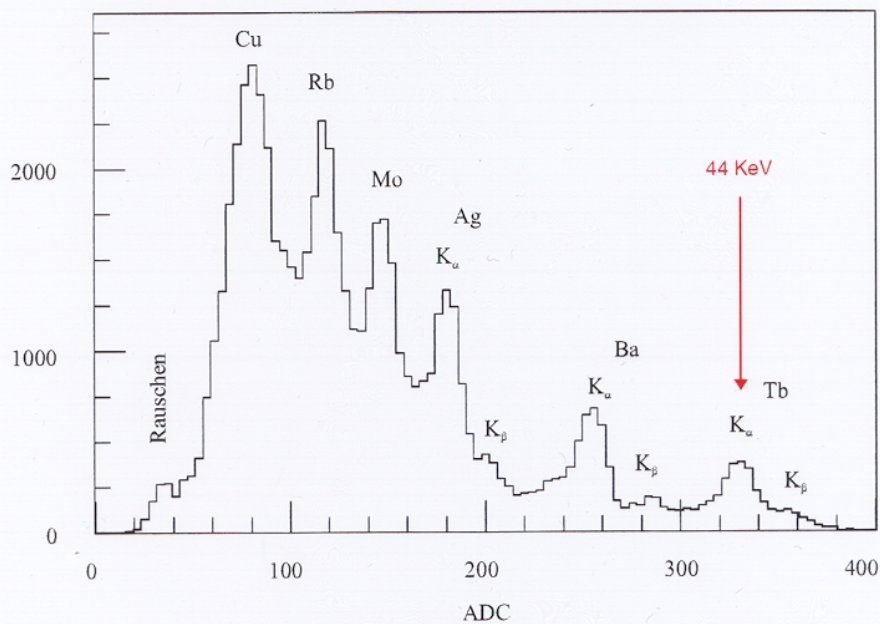
Bad pixels: $5/3960 = 0.13\%$

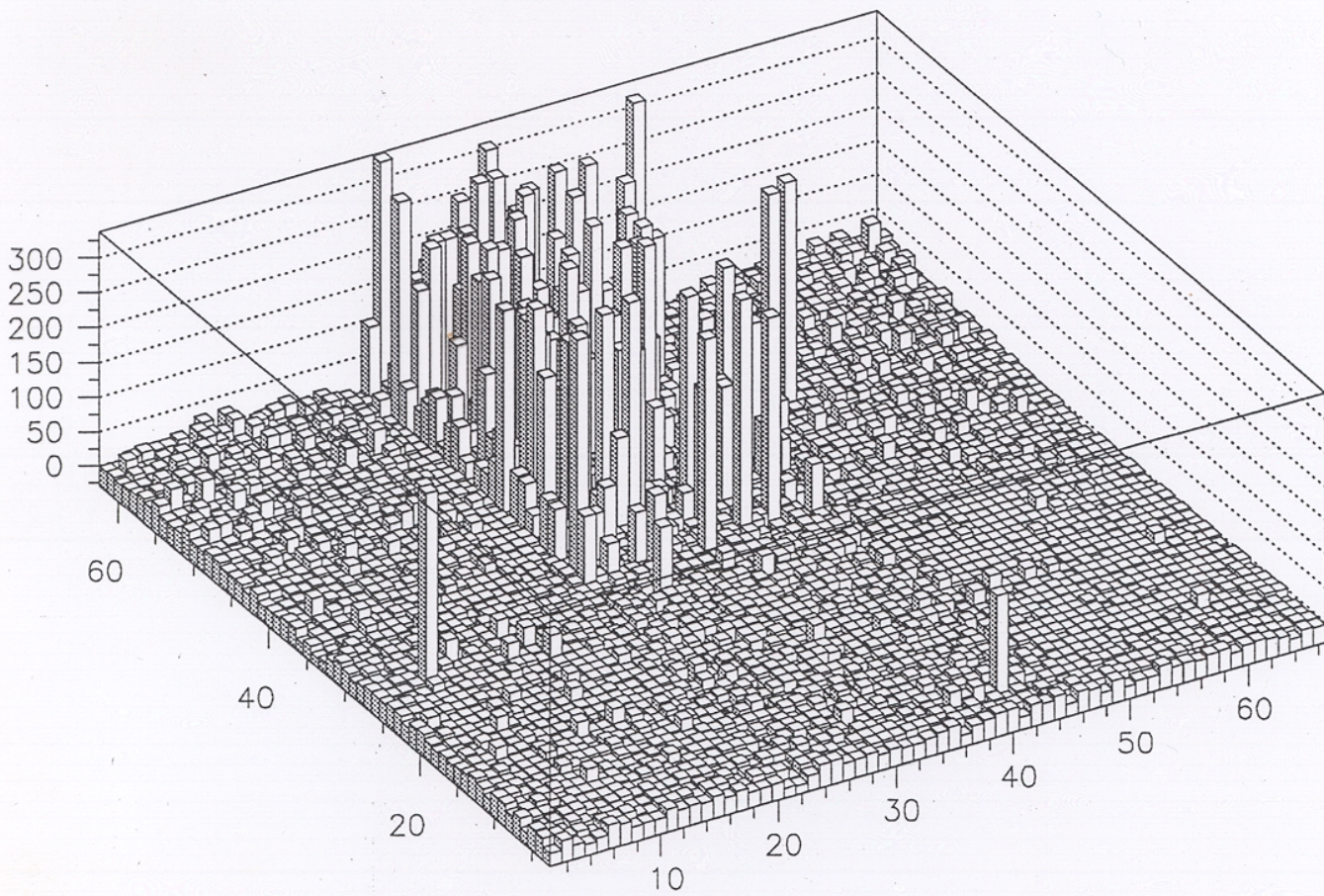


Gain experience of operating 6 chips same hybrid → System aspects

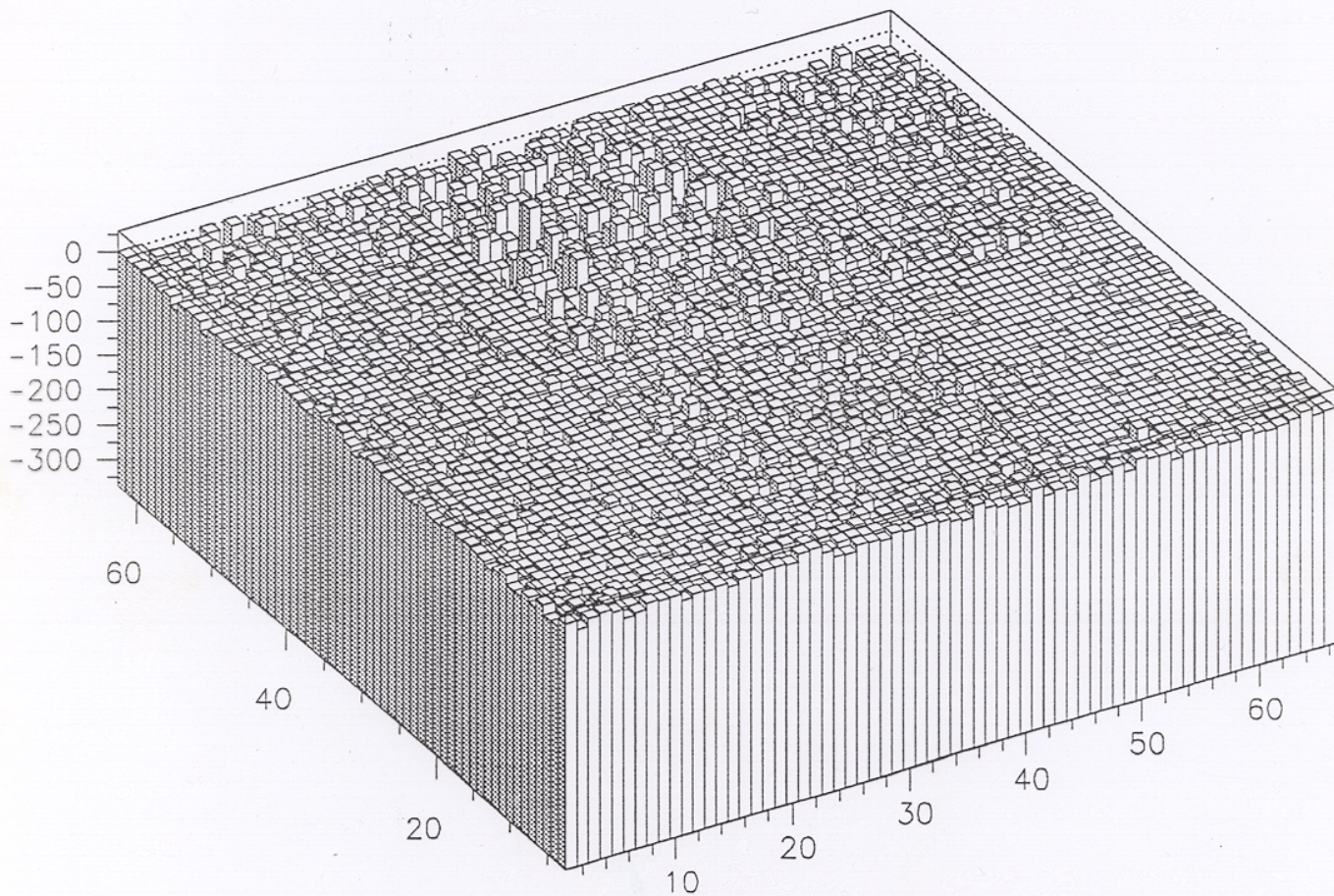
Measured spectrum from x-ray sources

D. Meer, Diploma ETH Zürich, Feb.2000

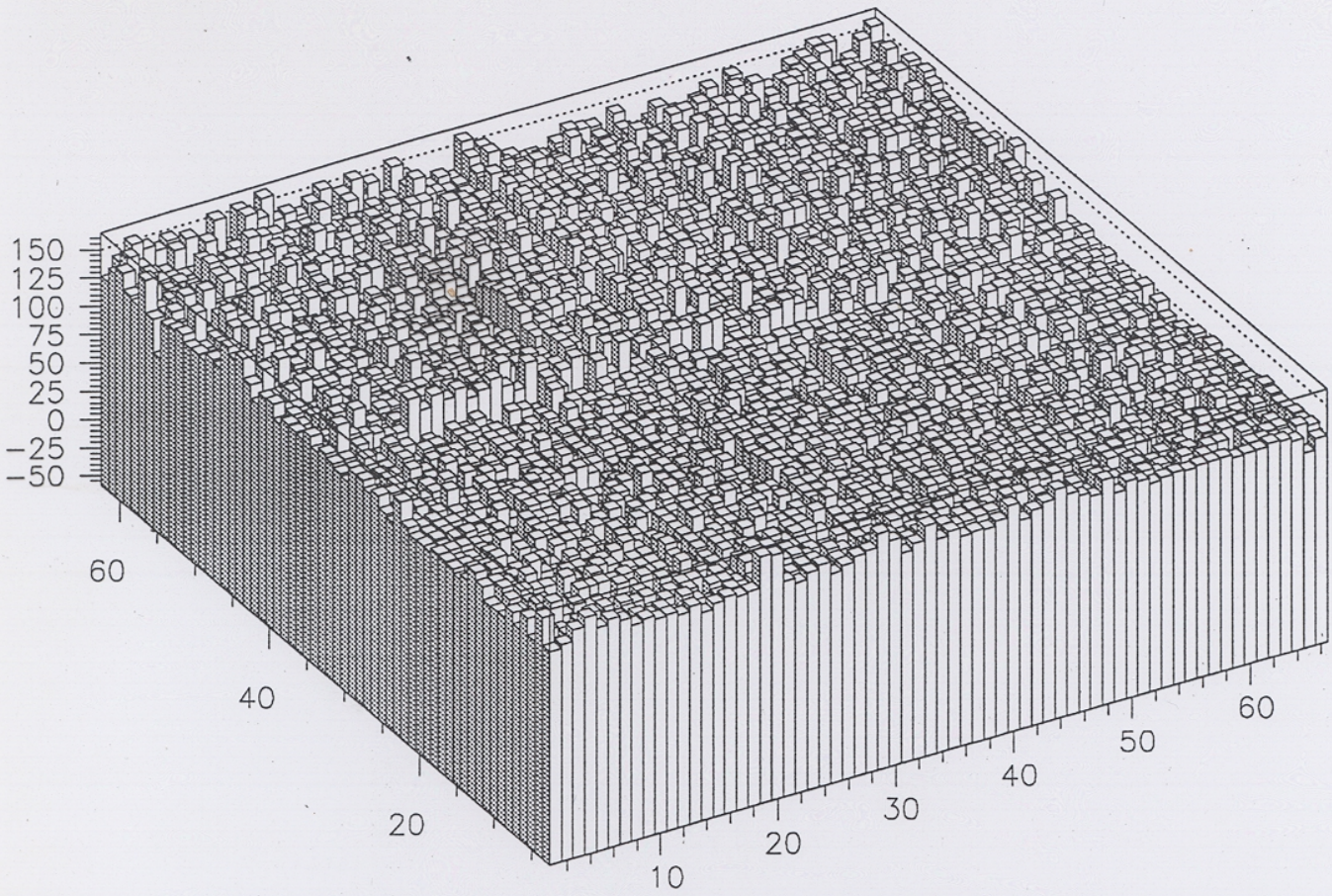




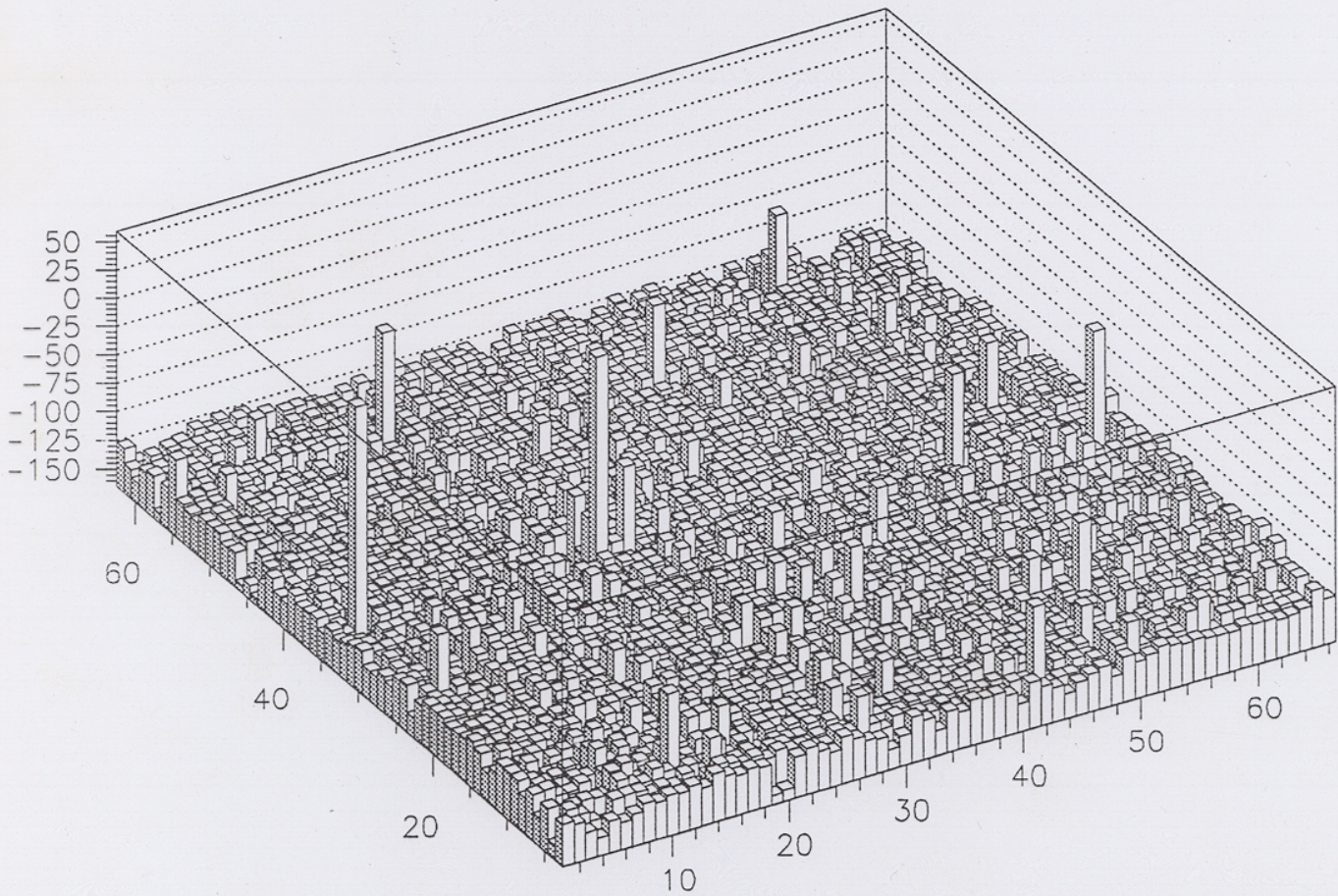
Backplane-Pulse, Modul 1



Backplane-Pulse, Modul 1 inverse



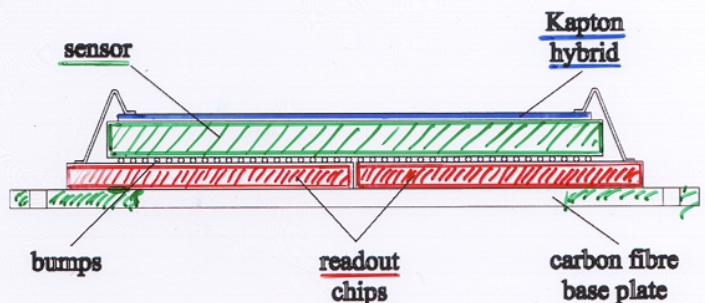
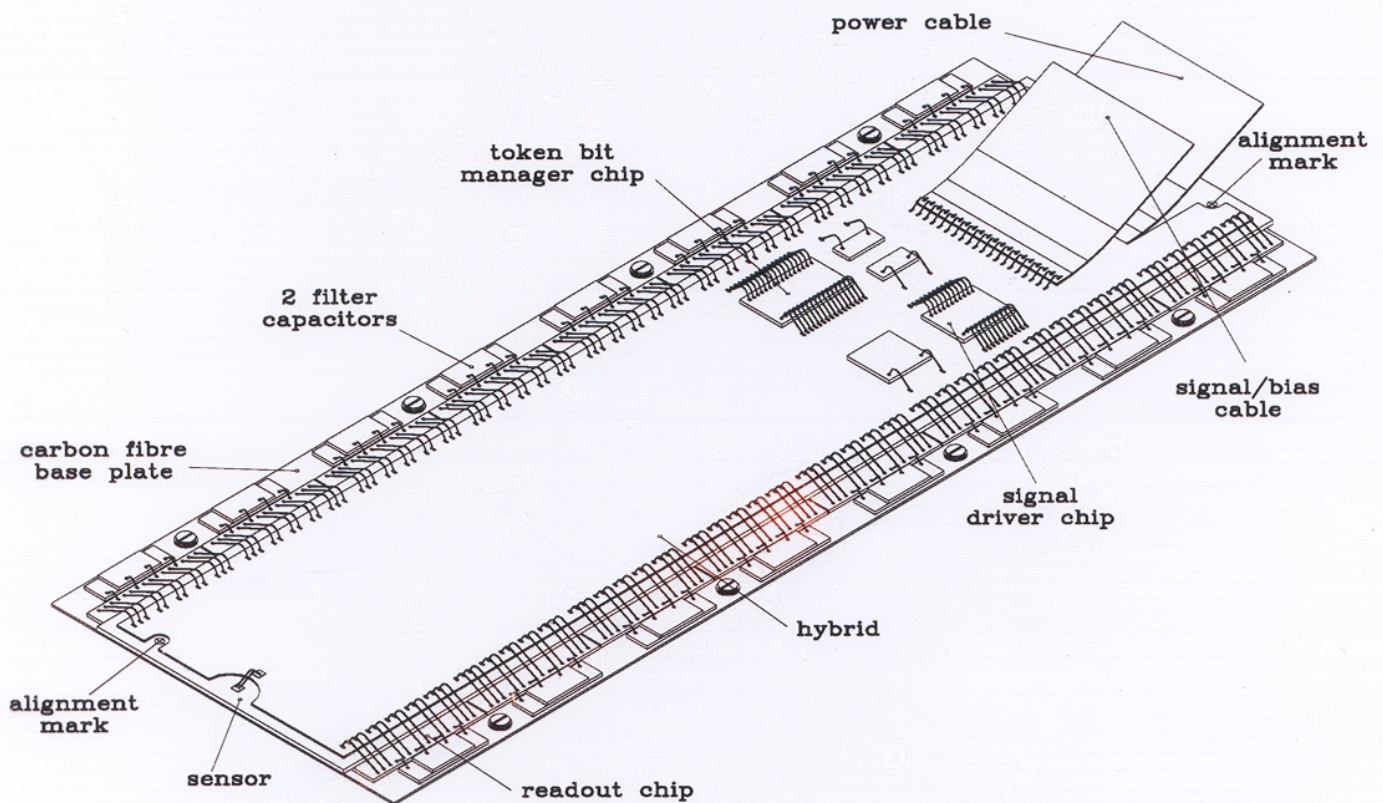
Backplane-Pulse, Modul 2



Backplane-Pulse, Modul 2 inverse

BARREL PIXEL MODULE

- Silicon sensor $16 \times 64\text{mm}^2$, $250 \mu\text{m}$ thick, $150\mu\text{m}$ square pixels
- 16 Readout chips (52×53 pixel) ---> ~44k pixel ---> 2.4 Watt
- ~ 1 % X_0



butting chips !

Indium alloys for bump growing

Improve mechanical strength without loss of reliable bump connection that was obtained so far with pure Indium technique.

<u>Alloy</u>	<u>Solidus</u> [Celsius]	<u>Strength</u> [PSI]	<u>Strength</u> [gr/mm ²]	<u>Strength</u> [mgr/bump]	<u>Strength</u> [gr/chip]
In (100)	157	273	190	76	210
In Ag (97/3)	143	800	560	224	620
In Sn (52/48)	118	1720	1200	480	1320

- In Sn probably needs modification of evaporation equipment
- Ag or Sn activation ?

Mass production

- 2003 - 2004 bump bond ~ 400 modules
($r = 4 \text{ \& } 7 \text{ cm}$) (barrel)
- 2006 - 2007 another ~ 400 Modules
($r = 11 \text{ cm}$ layer)

Detector (Sensor)

- Sensor manufacturer does UBM
- Photo litho & Iridium → Company Reinhardt Microtech
→ PSI

Chips

- UBM → Honeywell would do, TEMIC not!
→ Company Reinhardt Microtech
- Photo litho & Iridium →

Chip placement & Reflow at PSI

→ feedback & quality monitoring

→ keep documentation logistic low!!