The ALICE Silicon Pixel Detector

P. Riedler/CERN
For the ALICE SPD Team
The ALICE Silicon Pixel Detector (SPD)

2 barrel layers
\( \Delta z = 28.3 \text{ cm} \)
\( r = 3.9 \text{ cm} \) & \( 7.6 \text{ cm} \)

9.83 mio. pixels
The two barrels will be built of 10 sectors, each equipped with 6 staves:

**Material budget (each layer)**  
\[ \approx 0.9\% X_0 \text{ (Si } \approx 0.37, \text{ cooling } \approx 0.3, \text{ bus } 0.17, \text{ support } \approx 0.1) \]

**Sector - Carbon Fibre Support**

*INFN Padova*
Carbon Fiber Support - Stave Mounting

Carbon Fibre Sector
Each Stave is built of two **HALF-STAVES**, read out on the two sides of the barrel, respectively.

- **Bus**
- **ALICE1LHCb chip**
- **Silicon sensor**
- **Grounding foil**
- **Cooling tube**
- **MCM**
- **Ladder: 5 chips+1 sensor**
- **193 mm long**
- **Carbon-fibre sector**

Assembly: see talk by R. Santoro
Bump Bonding

In Bump Bonds

See talks by M. Campbell, J. Salmi

Bump Bonding

Bonding Pad on ALICE Chip

SEM Pictures
(CERN, VTT)

Pb-Sn Bump Bond

In Bump Bonds
1 p-in-n silicon sensor
- 72.72 mm x 13.92 mm
- 200µm thick

5 readout chips
- 0.25µm CMOS
- 13.68 mm x 15.58 mm
- 750µm native thickness
  thinned to 150µm thickness

40960 bump bonds
- 25µm diameter
Stand-off: ~12µm (In), ~20µm (Pb-Sn)
ALICE Ladder - 200µm+150µm

Idet @50V=180nA

Sr-Measurements:

<table>
<thead>
<tr>
<th>Chip</th>
<th>Working pixels</th>
<th>Missing pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chip 43</td>
<td>99.7%</td>
<td>28</td>
</tr>
<tr>
<td>Chip 46</td>
<td>99.95%</td>
<td>4</td>
</tr>
<tr>
<td>Chip 42</td>
<td>99.98%</td>
<td>2</td>
</tr>
<tr>
<td>Chip 32</td>
<td>99.98%</td>
<td>2</td>
</tr>
<tr>
<td>Chip 30</td>
<td>100%</td>
<td>0</td>
</tr>
</tbody>
</table>
ALICE Pixel Bus

- 5 layer Al-Kapton flex
- wire bonds to the ALICE1LHCb chip
- provides data-, control- and power-lines between MCM and chips

M. Morel

Bond Workshop 11/6/2003 P. Riedler/CERN
ALICE Ladder Mounted on a Prototype Bus

Pixel Ladder mounted on Prototype Bus
1 Sensor + 5 ALICE Pixel Chips
40960 Bump Bonds
Wire bonding to the Bus

Wire bonding from ALICE pixel chips to a prototype bus

- ~1100 Wire bonds/half-stave
- 25µm diameter wire
- Bonding to 4 different levels
- Bonding pads on the bus: 80 x 300µm²
- Step height: 40-60µm
Multi Chip Module (MCM)

• Analog Pilot (AP)
• Digital Pilot (DP)
• GOL (Giga-bit optical link)

Analog Pilot:
• Reference bias
• ADC (T, V and I monitor)

Digital Pilot:
• Timing, Control and Readout

ALICE1LHCb chip

Laser and pin diode
In Si-case
1.2 x 17 x 5.5 mm³

Data out
Clock
JTAG
Multi Chip Module (MCM)

Prototype

Final version: ceramic hybrid (100 x 11 mm²)
Connection between Bus and MCM

Space reserved for connections between Pixel bus & MCM
(DATA, CONTROL, REF, JTAG)

PIXEL_BUS POWER SUPPLY EXTENDER

SDM comp

PIXEL BUS

DETECTOR

PIXEL CHIP

MCM

COOLING TUBE

M. Morel
Summary

- The ALICE SPD will start production at the end of 2003.

- The SPD will contain
  - 240 bump bonded ladders
  - 1200 r.o. chips
  - 60 staves
  - ~ 9.81 mio bump bonds
  - ~ 150,000 wire bonds

- Al-Kapton bus will be produced at CERN, prototypes have been received.

- Due to material budget constraints the r.o. chips are thinned to 150µm and sensors of 200µm thickness are used.

- The complex assembly procedure is in preparation.
  (see talk by R. Santoro).