

Investigation of one Fan-Out technology

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on behalf of the FCAL collaboration

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1. Motivation

To find a way to make fan-out as thin as possible for BeamCal & LumiCal

Reason: the thicker fan-out, the larger Moliere radius => detection of shower is getting worse, and worse energy & spatial resolution

Situation: there is a well-known technology of ultrasonic aluminum wire wedge bonding for the fan-out contact

- + used in industry for long time, high reliability
- relatively large in height & mechanically vulnerable->needs protection

TAB (*Tape Automated Bonding*), TAU

- + smaller height compare to ultrasonic bonding
- + needs less protection
- more difficult to repair (if connection of one pad is broke, all fan-out must be removed and rebonded again)

Bumped fan-out, DESY
(*details further*)



Outline

1. Motivation
2. Idea
3. Fan-out foil with bumps
4. Contact quality check
5. Test with sensor
6. Summary & further steps



2. IDEA

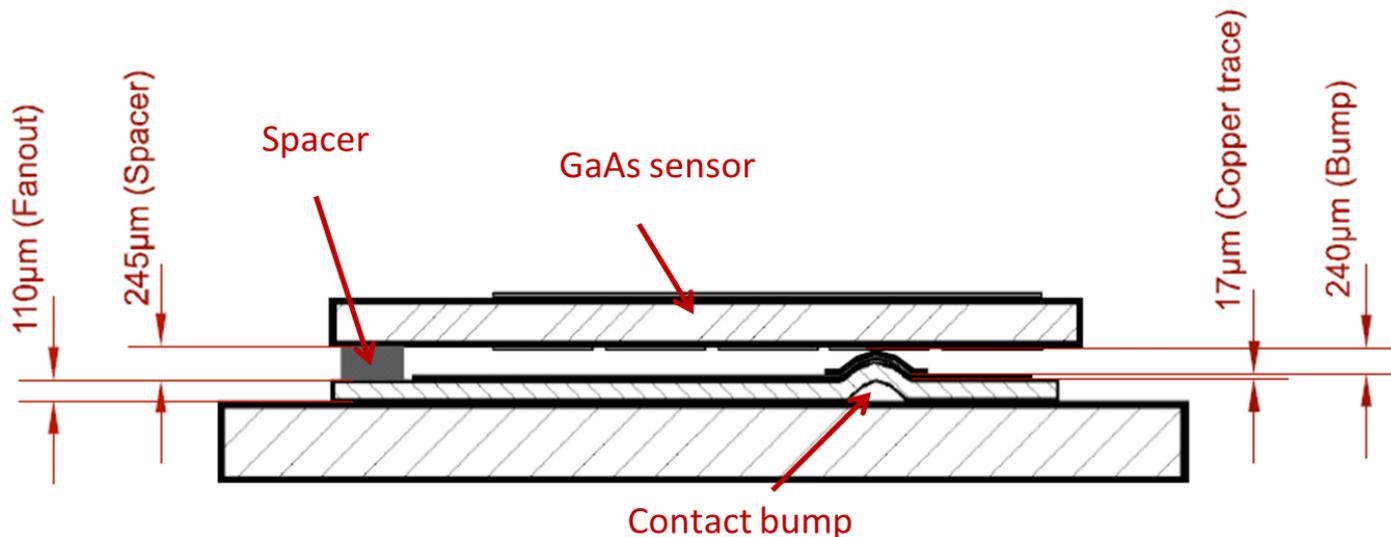
To make fan-out without bonding. Where contact will be provided by pressure.



Can be easily disassembled and reassembled again
After disassembling it doesn't leave remnants: neither glue nor rupture remnants from bond
Assembly can be done much quicker compare to ultrasonic bonding or TAB

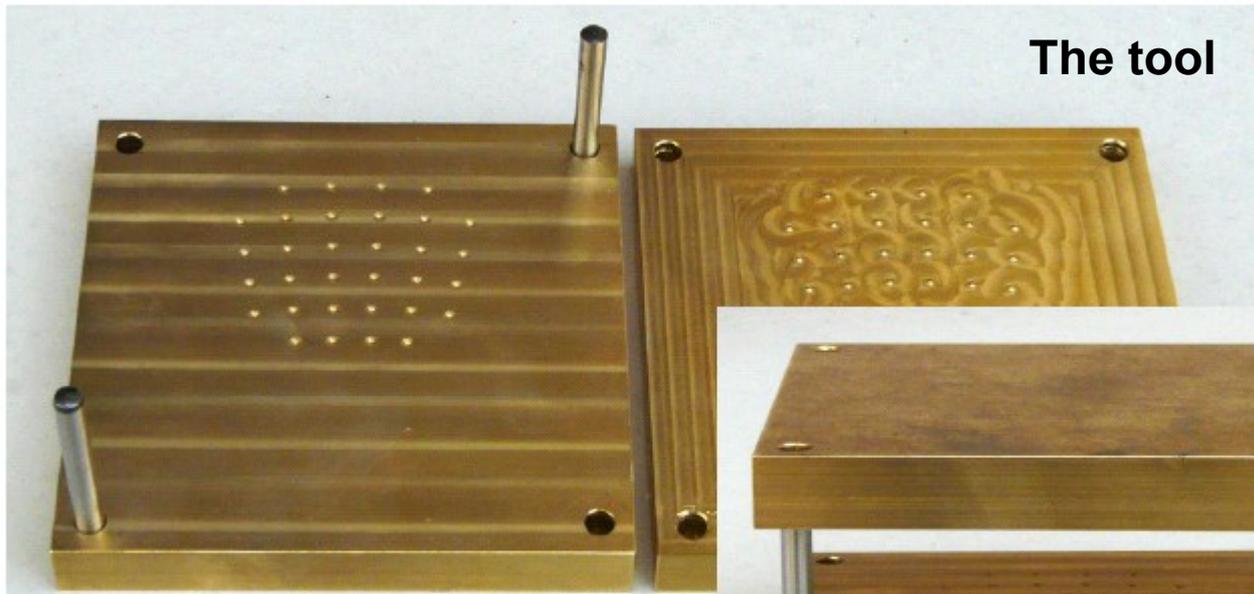


Need to preform uniform pressure
Contacting surfaces of fan-out and sensor must be electrically clean



Due to the spacer the contact bump is compressed by about 10µm.

MOLDING TOOL

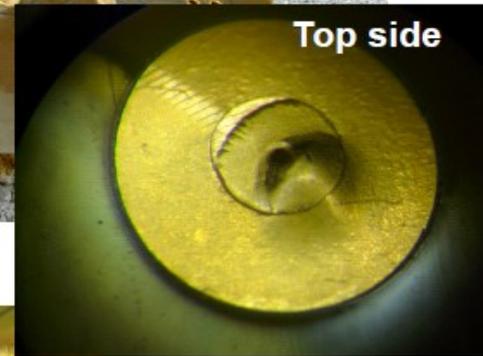


By some mistake not all bumps have right position, some have slight shift

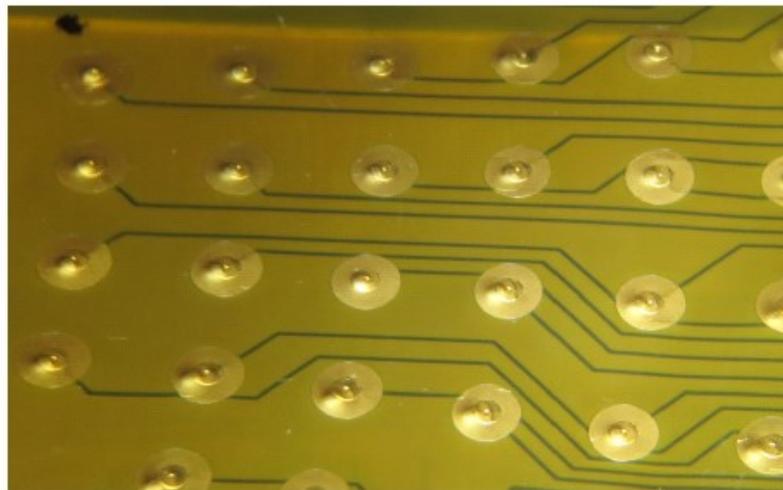
3. MOLDED FOIL



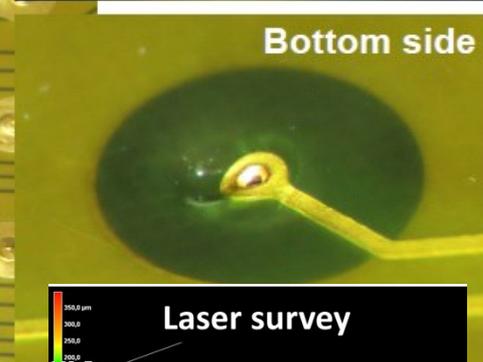
Fanout foil, molded



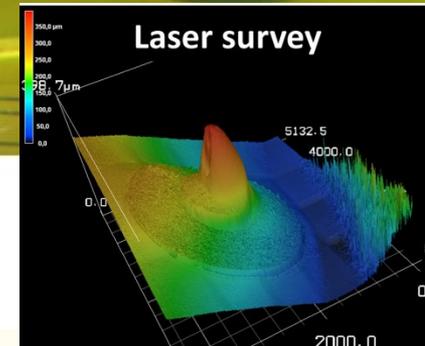
Top side



Close view of molded bumps



Bottom side

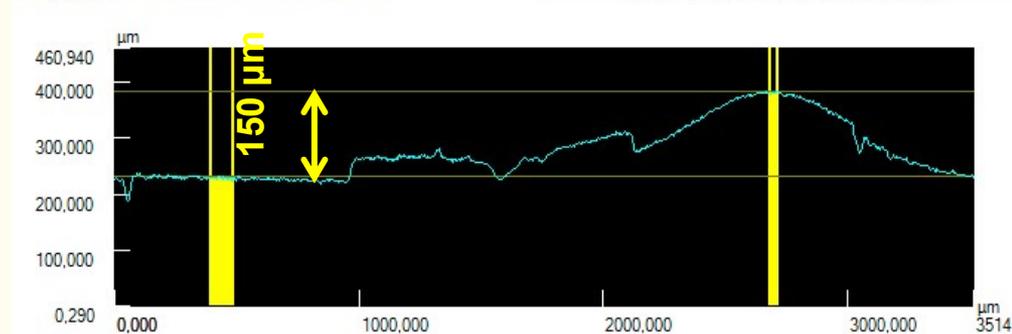
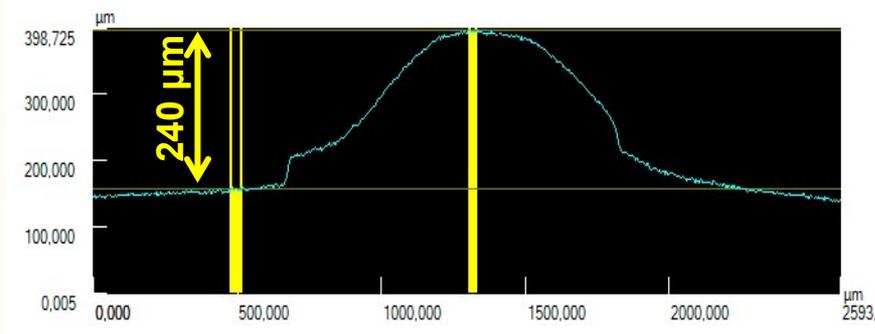
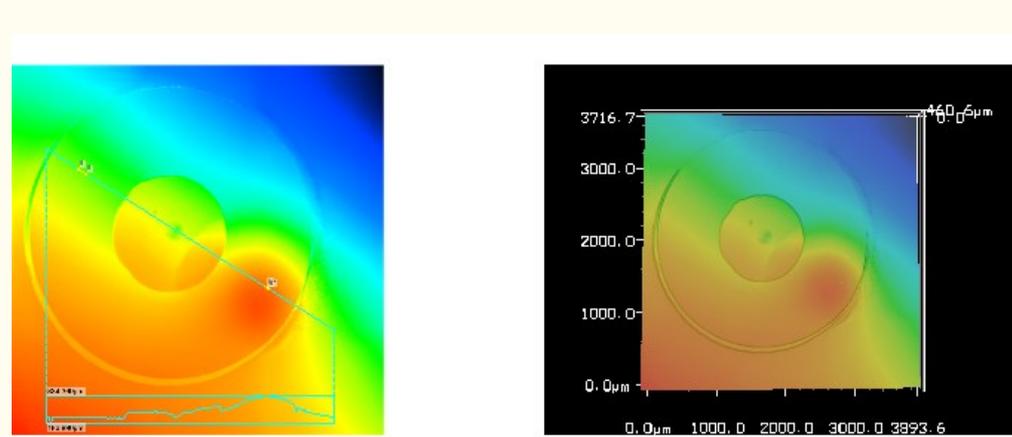
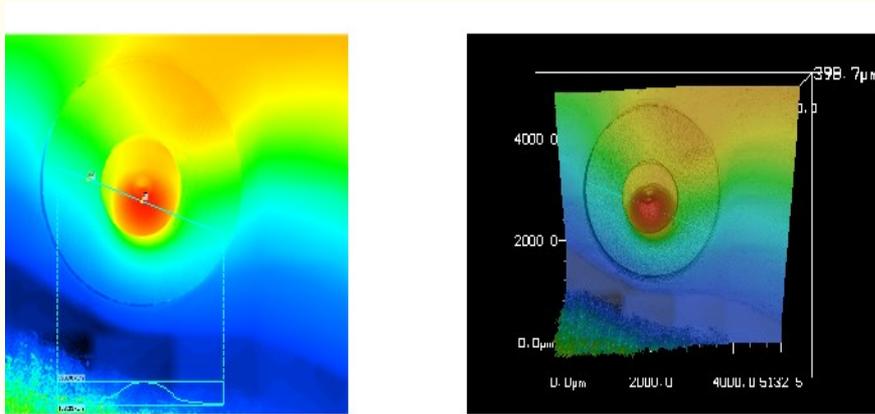


Laser survey

LASER SURVEY

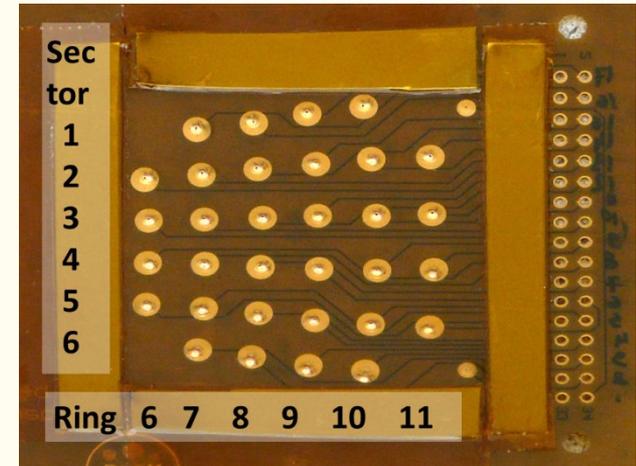
“Good” pad, top

“Bad” pad, top



4. CONTACTS QUALITY CHECK

- First, few tests just after molding
- then after mechanical manipulations (bending etc)
=> foil with gilt contacts is relatively resistant to the mechanical bending
- then with spacer



Contact Resistance

| | Sector 1 | 2 | 3 | 4 | 5 | 6 | | |
|---------|----------|------|------|------|------|------|-----|-------|
| Ring 11 | | 0.38 | 0.38 | 0.34 | 0.33 | | | |
| 10 | 0.38 | 0.38 | 0.37 | 0.38 | 0.38 | 0.40 | Min | 0.333 |
| 9 | 0.40 | 0.38 | 0.38 | 0.38 | 0.37 | 0.40 | | 0.356 |
| 8 | 0.38 | 0.38 | 0.38 | 0.38 | 0.40 | 0.38 | | 0.400 |
| 7 | 0.47 | 0.40 | 0.38 | 0.37 | 0.37 | 0.42 | Max | 0.467 |
| 6 | | 0.38 | 0.42 | 0.40 | 0.42 | | | |

Standard Deviation

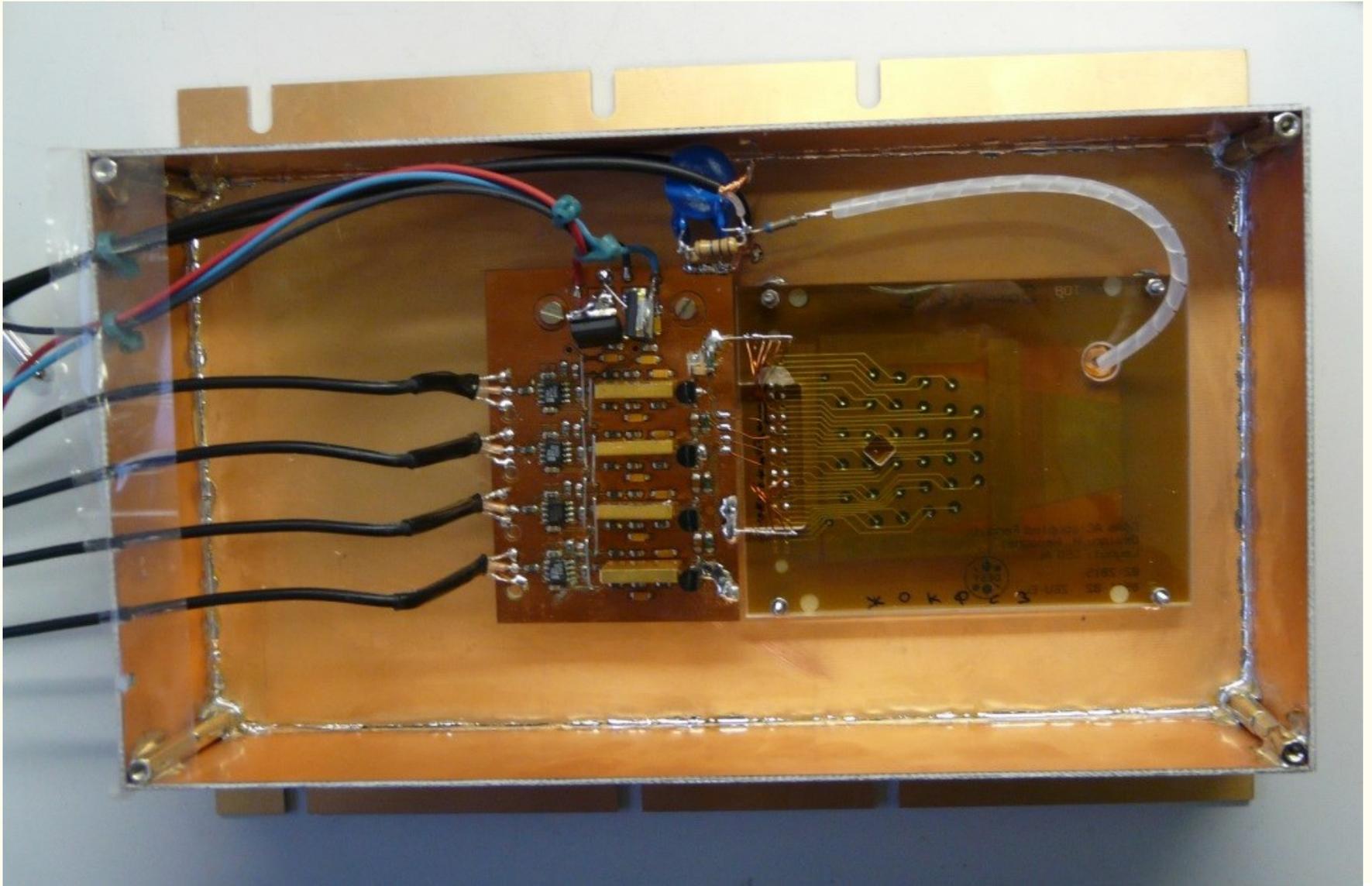
| | Sector 1 | 2 | 3 | 4 | 5 | 6 | | |
|---------|----------|-------|-------|-------|-------|-------|-----|-------|
| Ring 11 | | 0.041 | 0.041 | 0.055 | 0.052 | | | |
| 10 | 0.045 | 0.041 | 0.052 | 0.041 | 0.041 | 0.000 | Min | 0.000 |
| 9 | 0.000 | 0.041 | 0.041 | 0.045 | 0.052 | 0.000 | | 0.009 |
| 8 | 0.041 | 0.041 | 0.041 | 0.041 | 0.000 | 0.041 | | 0.027 |
| 7 | 0.052 | 0.000 | 0.041 | 0.052 | 0.052 | 0.041 | Max | 0.055 |
| 6 | | 0.045 | 0.041 | 0.000 | 0.045 | | | |

7.2 kPa - any of the contacts show contact

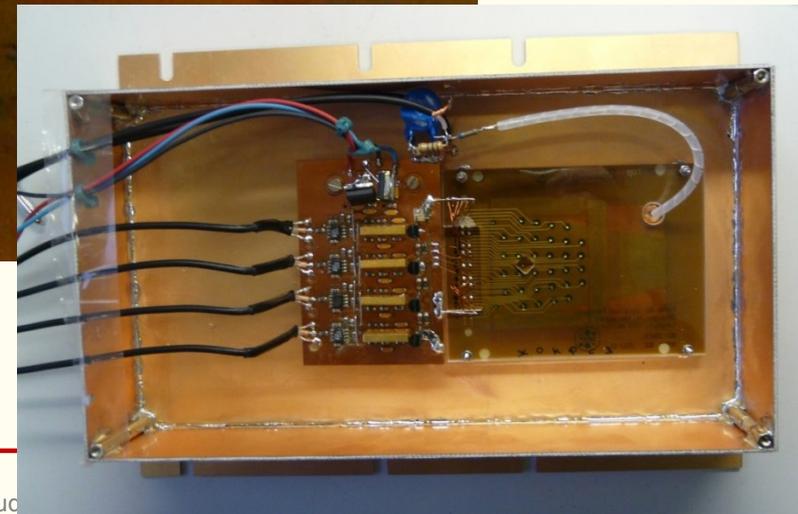
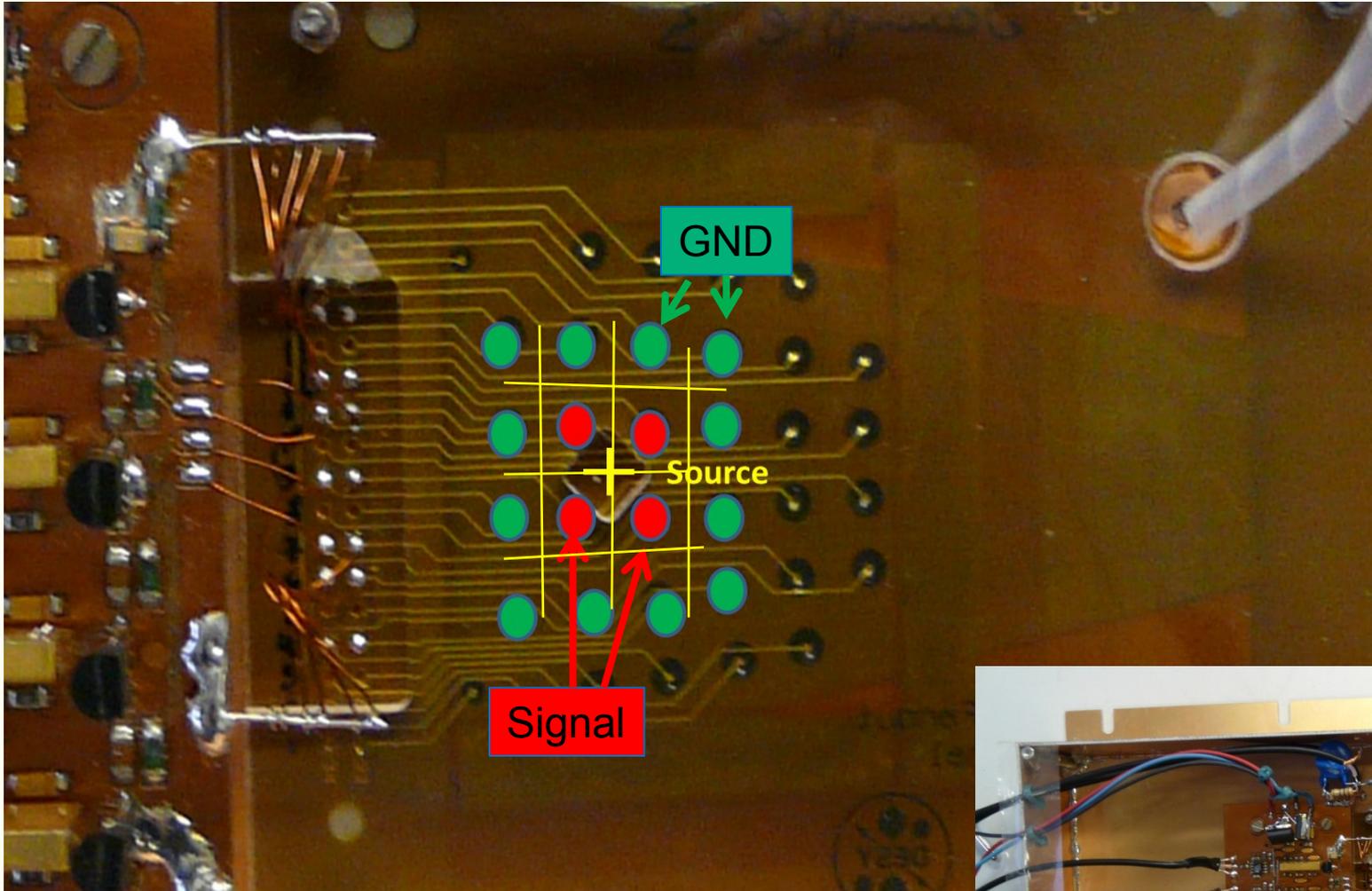
1.7 kPa - at least half of the pads shows contact

*Remember: not all contacts have right bumping

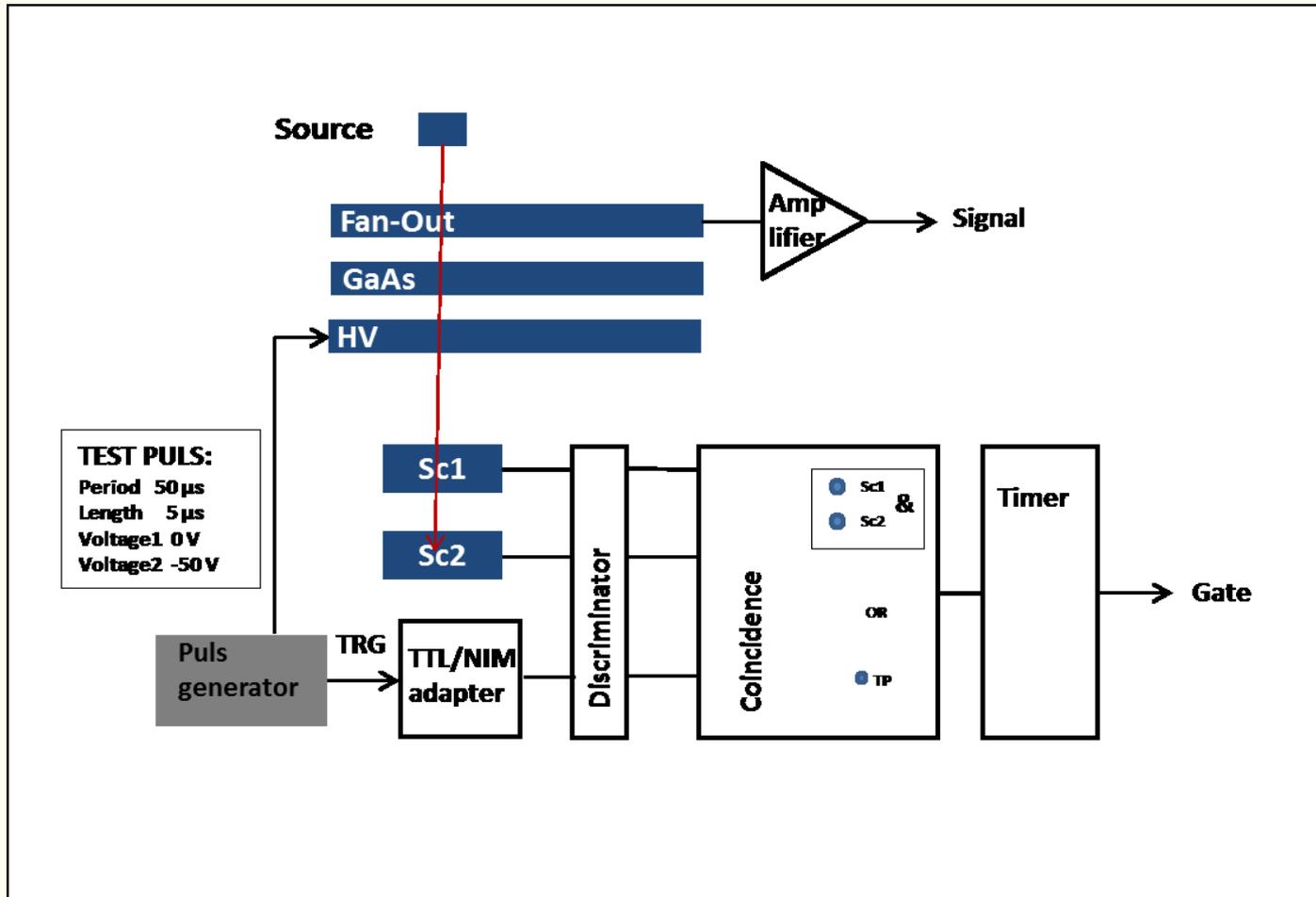
BOX



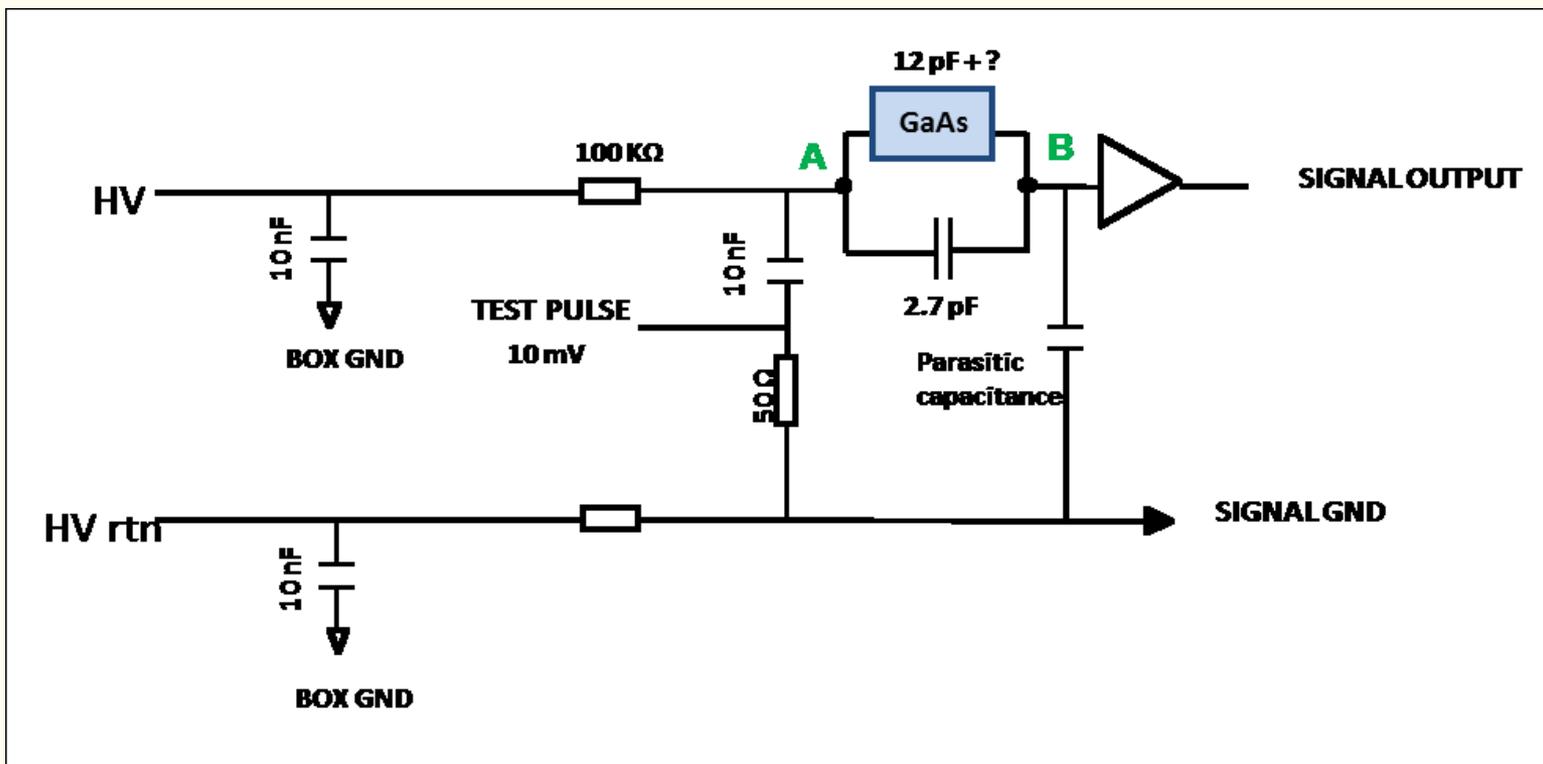
BOX



5. TEST WITH SENSOR



TEST WITH TEST PULSE



| | | | | | |
|----------|---------------------|--------------|-----------------|-------|------------------|
| I CASE | (known C): | 2.7 pF | | 36 mV | } $\Sigma=74$ mV |
| II CASE | (sensor): | 12 pF | (expect 160 mV) | 38 mV | |
| III CASE | (both in parallel): | 2.7 12 pF | (expect 47 mV) | 68 mV | |

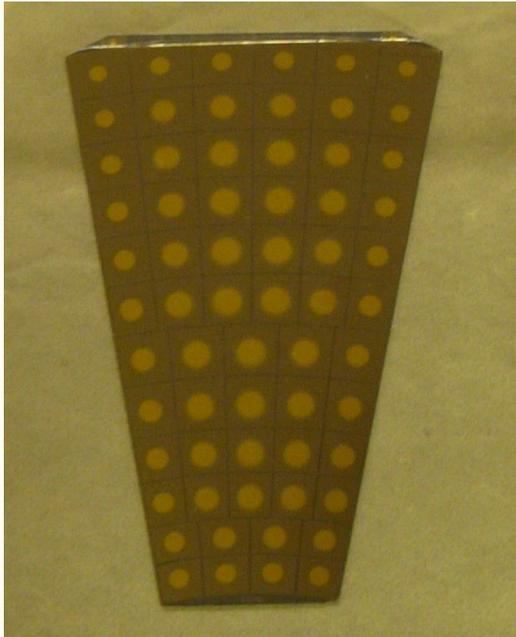
SUMMARY & FURTHER

The studies of fan-out with bumps is going on at DESY Zeuthen

Fan-out shows good contact

The test with sensor shows that probably contact with oxidized sensor is not very good

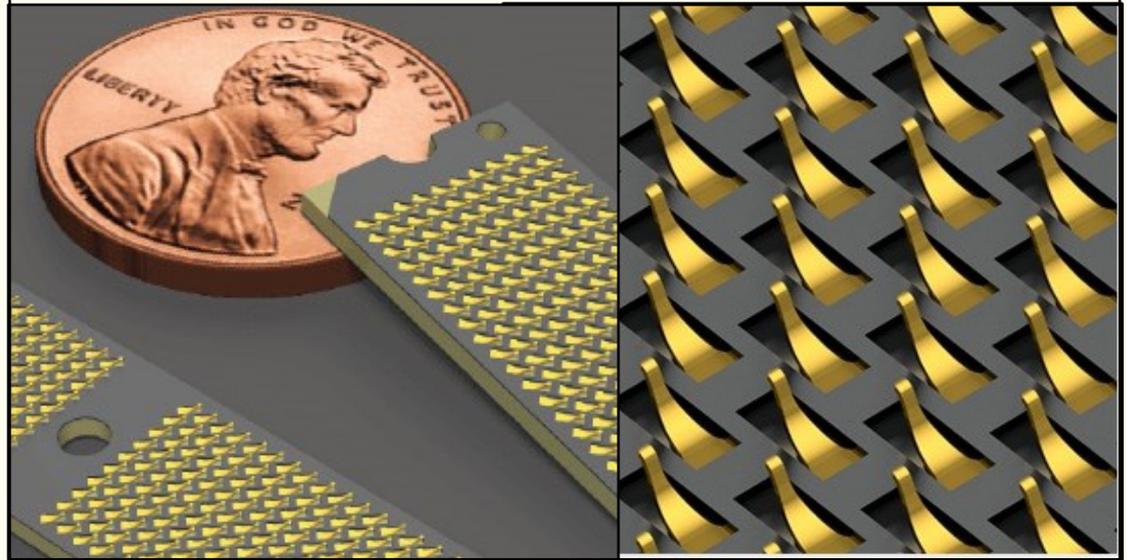
Gold covered GaAs from GSI,
First Sample



“SAMTEC” interposer

Standard height 1 mm

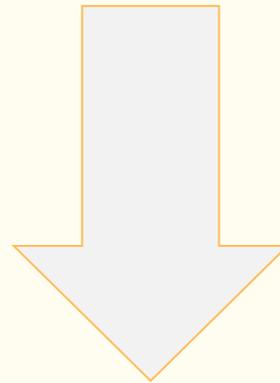
Custom - up to 0.5 mm



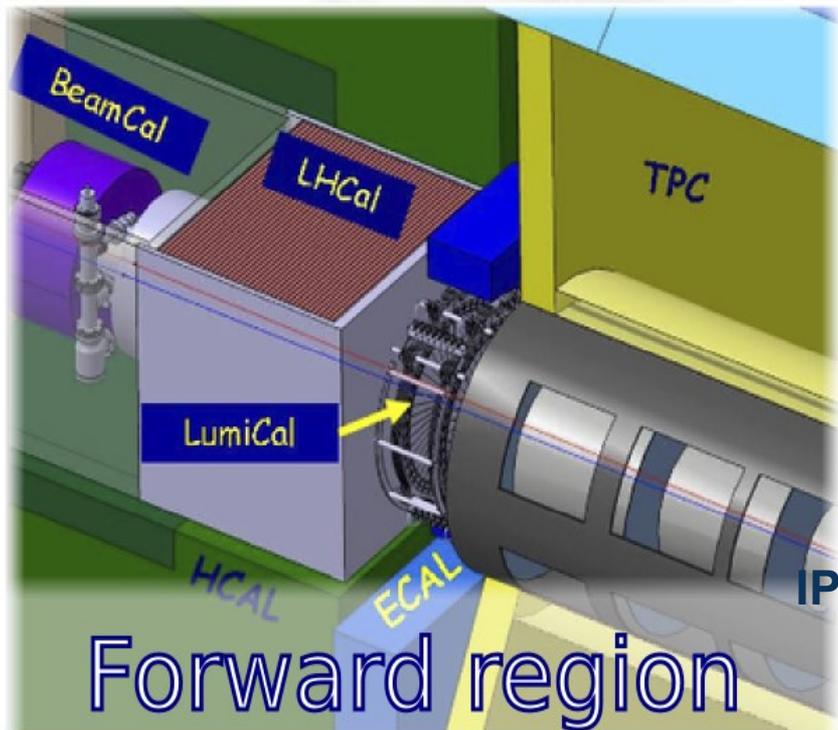
Thank you for your attention!



Backup slides



Beam Calorimeter at ILC

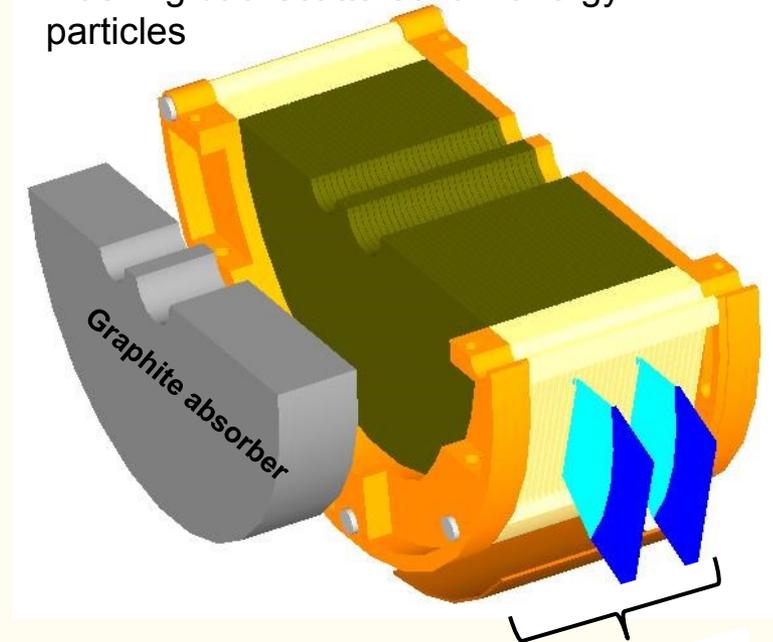


Beam parameters from the ILC Technical Design Report (November 2012)

- Nominal parameter set
- Center-of-mass energy 1 TeV

Purposes of BeamCal:

- Detect showers (SH) from single high energy electrons on the top of the background (BG)
- Determine Beam Parameters
- Masking backscattered low energy particles



| | | |
|-------------------|----------|-----------|
| Tungsten absorber | ~ 3.5 mm | } 1 X_0 |
| Sensor | ~ 0.3 mm | |
| Readout plane | ~ 0.2 mm | |

30 layers