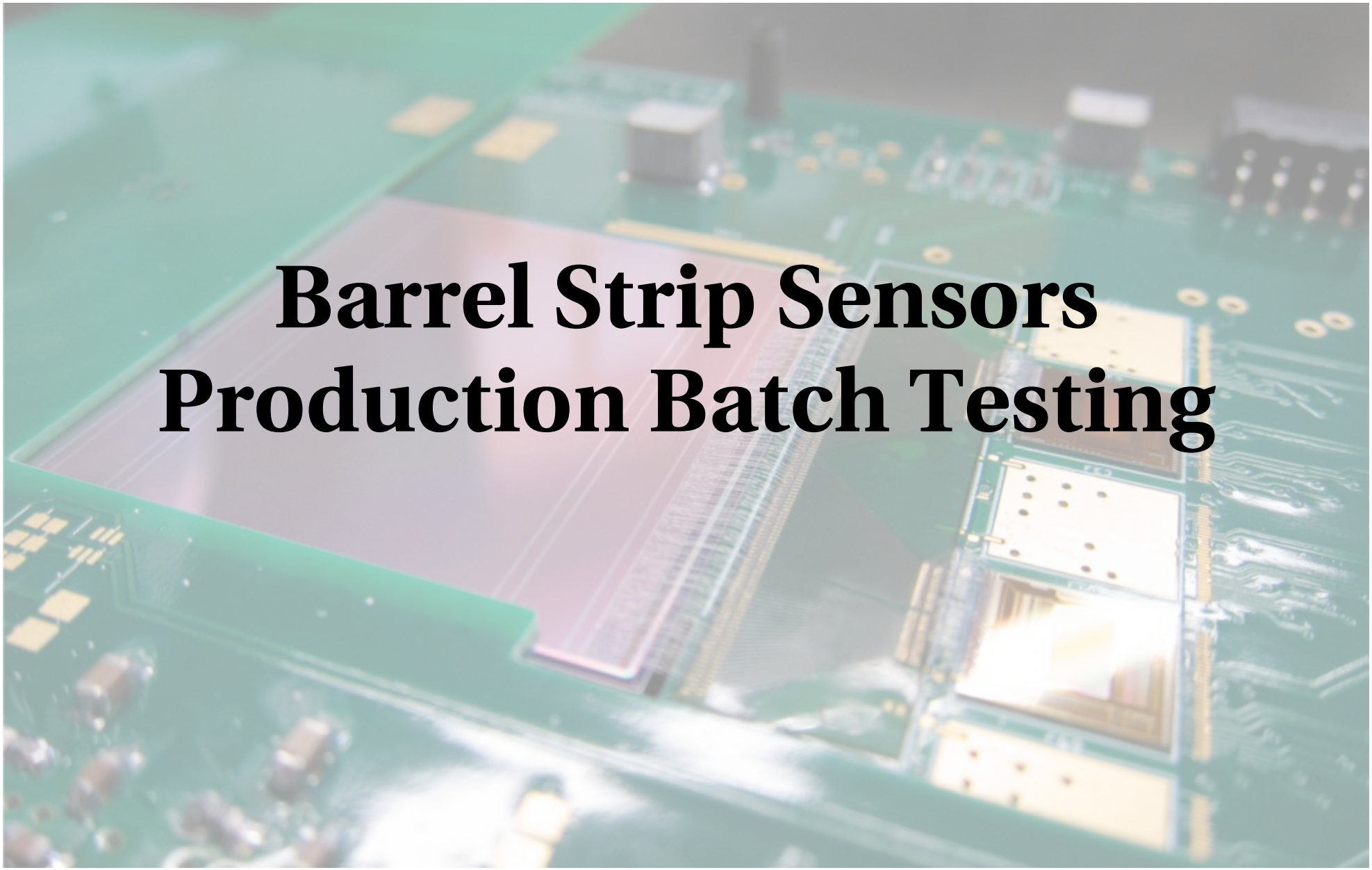
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

II. Physikalisches Institut



Barrel Strip Sensors Production Batch Testing

LIV. PANDA Meeting, GSI - September 2015

Production Batch

- Ordered 4 Lots with 25 wafer each end of 2014
- Based on 400 wafers ordered with specific resistivity (3 kΩcm)
- 3 Lots delivered so far
  - Post production tests at CiS according to:
    - IV-curve
    - pin-holes
    - breakdown voltage
  - Only sensors that passed the tests are delivered to Giessen
  - So far: low yield

Production Batch

- Yield overview

Lot	b65 (S1)	m65 (S2)
341774	20 %	40 %
341775	4 %	8 %
341776	28 %	36 %
total	**17.3 %**	**28 %**

- Reasons for exclusion/failed test
  - pin-hole excluded - 35 %
  - IV, breakdown excluded - 33 %
- Problem with process at CiS
- Also reported by CBM (J. Heuser)

Production Batch Testing

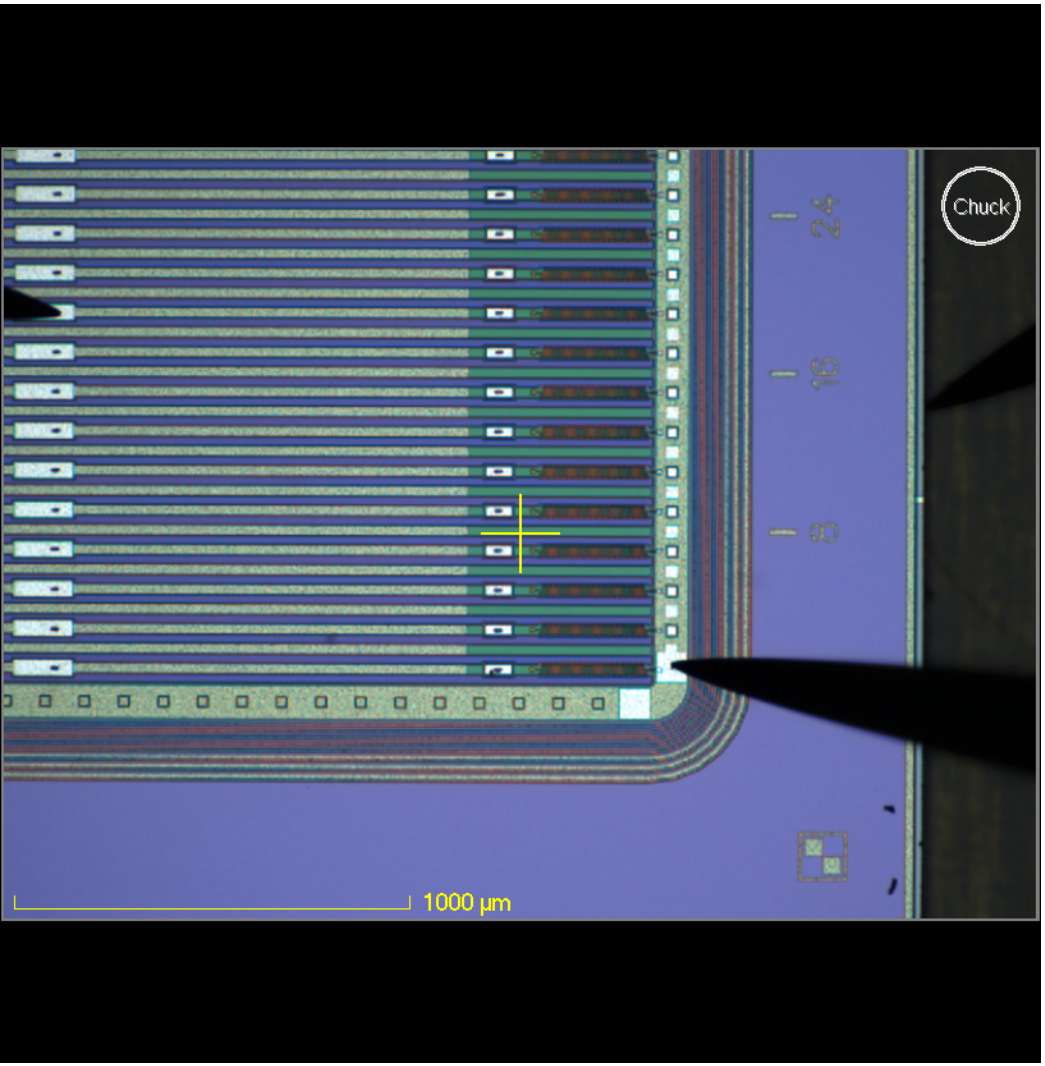
- Tests of delivered sensors in Giessen
- m65 (S2) sensors tested
  - Probe station
    - 2 sensors of lot 341774
    - 1 sensor of lot 341775
    - 2 sensors of lot 341776
  - Probe card
    - one sensor from probe station test for each lot

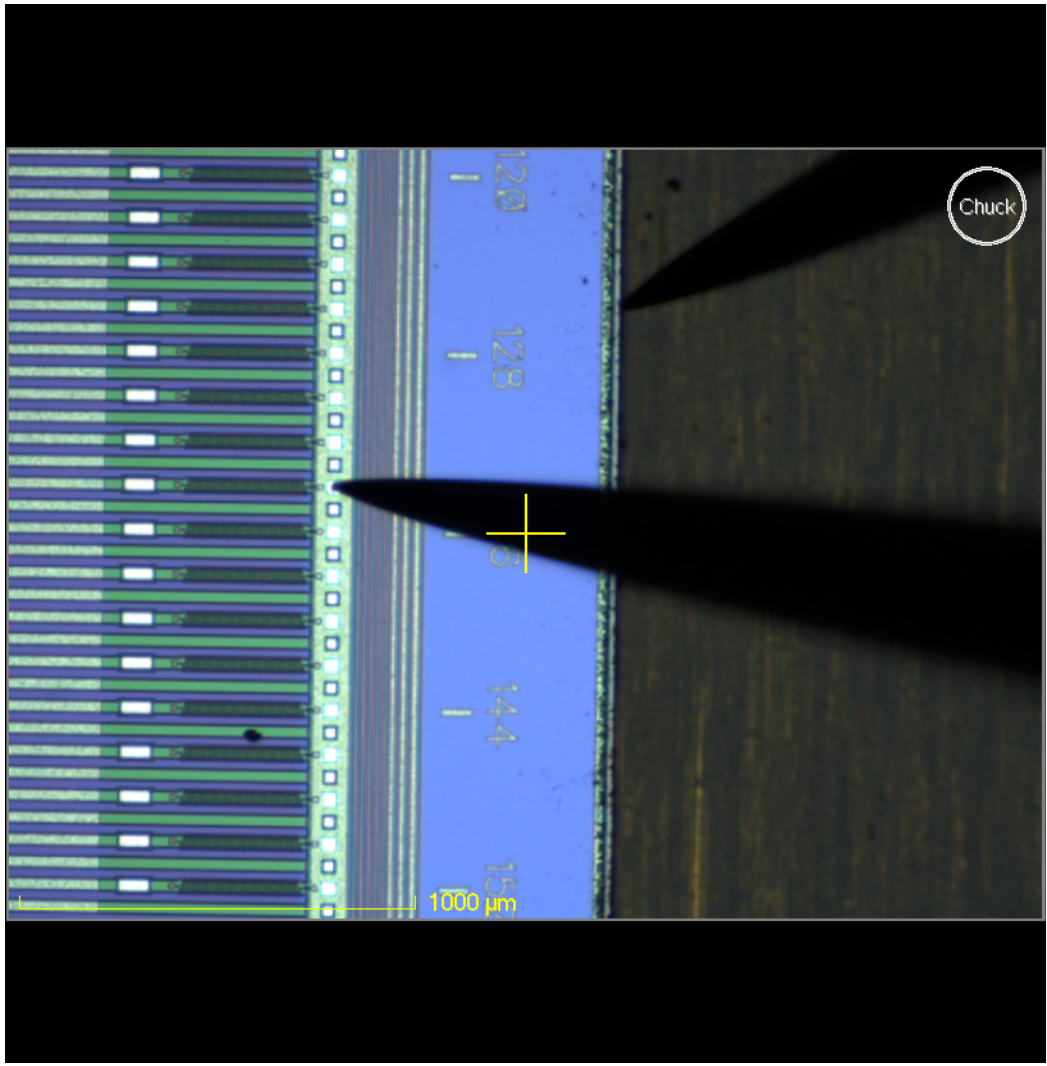
Probe Station Tests

- Limited testing capability (only one sensor side)

- Setup
  - biasing: 2 needles via p-side bias ring and sensor edge (bulk)
  - LCR: 1 kelvin probe on AC-pad to chuck
  - kapton tape between sensor and chuck
- Measurements
  - IV
  - CV
  - 6 strips per sensor (only p-side)
- Advantage
  - fast screening possible
  - precise values (calibration)
- Disadvantage
  - no realistic measurement case (strip to chuck)

Probe Station Setup

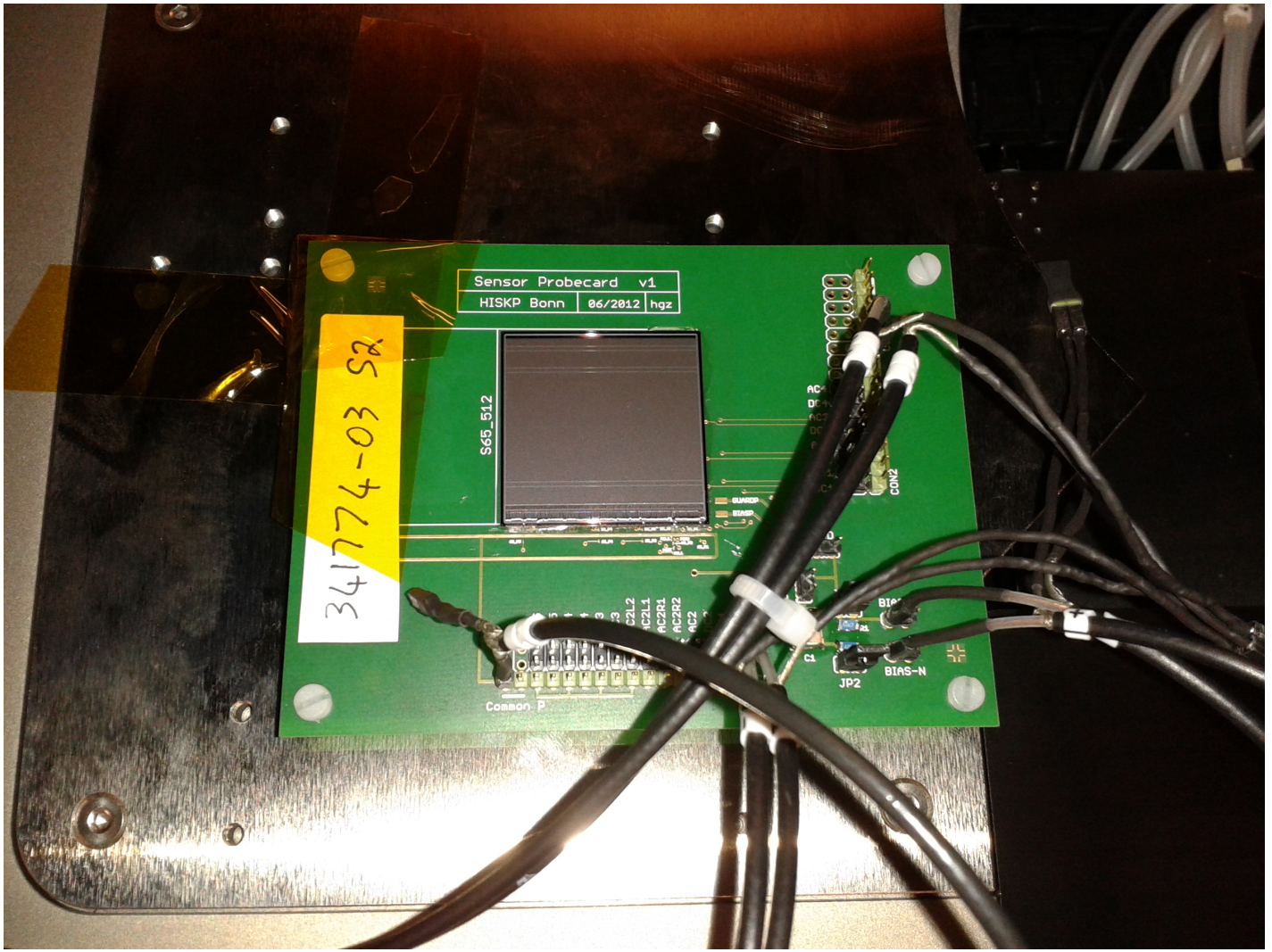




Probe Card Tests

- High testing capability (both sensor sides)
  - Strips bonded to probe card
    - p- and n-side
    - common line and some individual strips
    - AC-pads and DC-pads
  - Every second strips bonded
    - floating strip like in final detector
  - Possibility to "cancel out" structures
  - Advantage
    - realistic measurement case
  - Disadvantage
    - unknown offset (PCB trace from pin-header to bond pad)

Probe Card Setup



Probe Station Results

- Primary to compare with CiS measurements

- Depletion voltage
  - 3 kΩcm ± 10% relates to 82…107 V
  - agreement with CiS within ±10%
- Leakage current
  - consider different temperatures of measurements
  - within ±10%
- Breakdown voltage
  - to occur systemically earlier (e.g. 320V instead of 460V)
- Single strip to chuck capacity
  - value comparable to probe card measurement for c_b

Probe Card Results

- Extract values that are not accessible via probe station
  - Like
    - entire p-side to entire n-side → Cb
    - single strip one side to entire opposite side
    - entire side to biasring → stray capacity
    - n-side
  - Capacity values from measurements on the following slides

Sensor Capacities

$$c_{tot} = c_b + c_{is} + c_s$$

c_b body capacity

c_{is} interstrip capacity

$c_s = c_{s,p} + c_{s,n}$ stray capacity

Sensor Capacities - c_b

	100kHz	1MHz
C_b	291.7±7.9	358.1±10.2
c_b	1.14±0.03	1.40±0.04
c_b P1	1.37±0.10	2.61±0.24
c_b P2	1.18±0.12	2.26±0.22
c_b P3	1.25±0.12	2.31±0.26
c_b P4	1.28±0.09	2.27±0.24
c_b P5	1.13±0.10	2.32±0.26
c_b N1	1.40±0.05	0.63±0.13

Sensor Capacities - c_{is}

	100kHz	1MHz
c_{is} P1	4.62±0.33	5.09±0.47
c_{is} P2	5.66±0.34	6.29±0.49
c_{is} P3	5.24±0.29	6.47±0.47
c_{is} P4	4.93±0.26	6.09±0.44
c_{is} P5	4.27±0.26	5.41±0.43
c_{is} N1	7.70±1.65	12.2±1.6

Sensor Capacities - c_s

	100kHz	1MHz
ComP to p-bias	9.5±10.5	122.79±11.7
per p-strip	0.04±0.04	0.48±0.05
ComP to n-bias	24.3±3.5	9.33±2.16
per p-strip	0.10±0.01	0.04±0.01
ComN to p-bias	9.5±10.5	125.8±8.8
per n-strip	0.04±0.04	0.49±0.03
ComN to n-bias	451.5±9.2	122.1±10.5
per n-strip	1.76±0.04	0.48±0.04

Sensor Capacities - c_{tot}

	100kHz	1MHz	
ComP per strip	6.15±0.38	7.79±0.56	
c_{tot} P1	6.33±1.83	8.76±1.12	
c_{tot} P2	6.98±0.51	9.07±0.77	(c_s from ComP)
c_{tot} P3	6.63±0.46	9.30±0.79	(c_s from ComP)
c_{tot} P4	6.59±1.13	9.49±1.84	
c_{tot} P5	5.88±1.04	8.75±1.34	
ComN per strip	10.64±1.76	14.57±1.71	
c_{tot} N1	11.99±2.25	14.33±3.06	

Sensor Capacities - c_{tot}

		100kHz	1MHz
m65 (S2)	p-side	**6.15±0.38**	**7.79±0.56**
(3.5x3.5 cm²)	n-side	**10.64±1.76**	**14.57±1.71**
b65 (S1)	p-side	**6.15±0.38**	**7.79±0.56**
(3.5x6.0 cm²)	n-side	**18.60±3.10**	**25.50±3.00**

Thank you for your Attention

end