



# ***TowerJazz CMOS Image Sensors Technology***

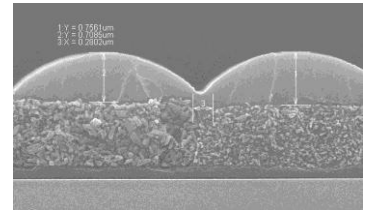
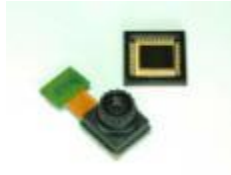
June 2010

Jonathan Gendler  
Director of Marketing, CMOS Image Sensors

**The Global Specialty Foundry Leader**

# Best in Class Technology

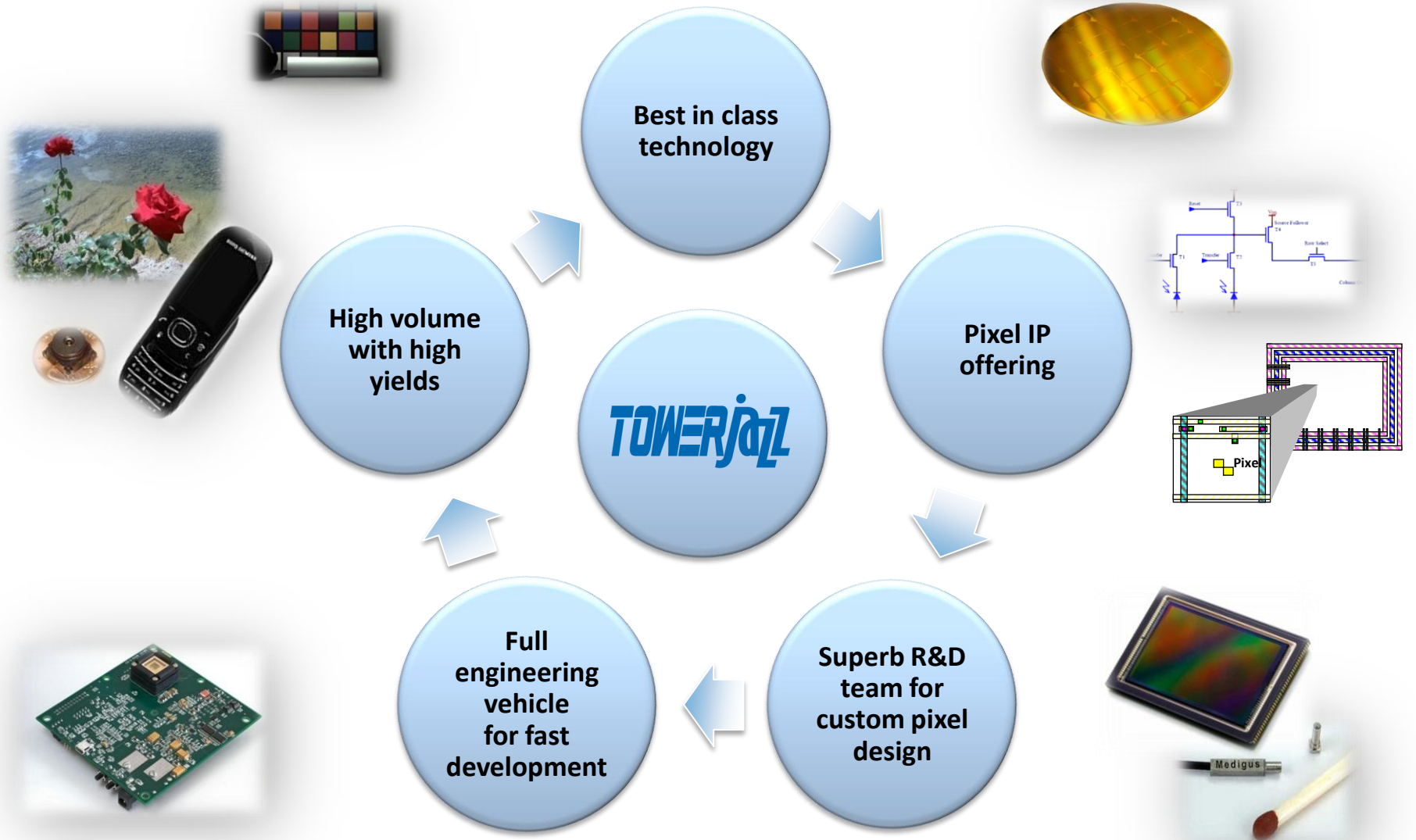
- More than 15 years of experience in CMOS image sensors
- Partnership track record with leading imaging companies
- Wide range of application expertise:
  - Cell phone, Web camera, DSLR, Cinematography, Industrial, Space, Defence, Dental X-Ray, Medical X-Ray, Medical endoscopy and many more.
- Advanced state-of-the-art pixels
  - 3T, 4T and 5T pixels
  - Extremely low dark current
  - In house colour filters and micro lens
- Large sensor patented stitching technology
  - Stitching on full 0.18um technology node in production
  - Up to one die per 8" wafer (5" x 6")
- Network of the best custom design houses
  - Forza Silicon, Cypress (FillFactory), e2v, Anafocus, CMOSIS and more



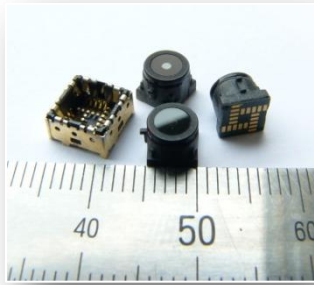
# Specialty CIS Applications



# CMOS Image Sensors – TowerJazz philosophy



# Consumer



# Small pixel offering

Pixel Size ( $\mu\text{m}$ )	Pixel Type	Full Well ( $e^-$ )	Dark Signal ( $\text{mV}/\text{sec}$ @30C)	Responsivity ( $\text{V}/\text{Lux}\cdot\text{sec}$ )
3.6	3T BPD	11,000	9	2
3.2		10,000	<b>10X</b> 15	1.3
3.6	4T APD	14,000	1	1.5
3.2	4T-2S APD	14,000	0.5	1.2
2.8		14,000	<b>10X</b> 0.5	1
2.2	4T-4S APD	14,000	0.1	0.5

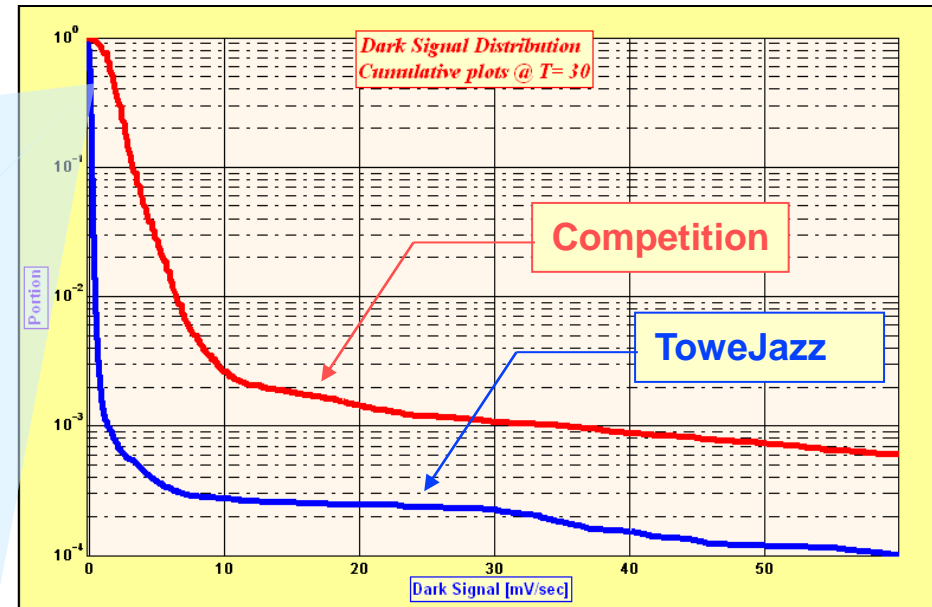
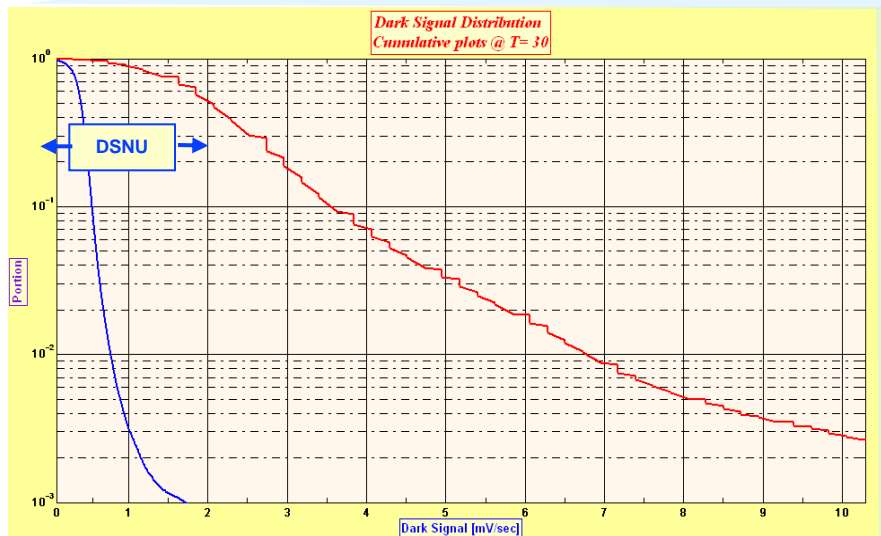
BPD – Buried Photo Diode

APD – Advanced Photo Diode



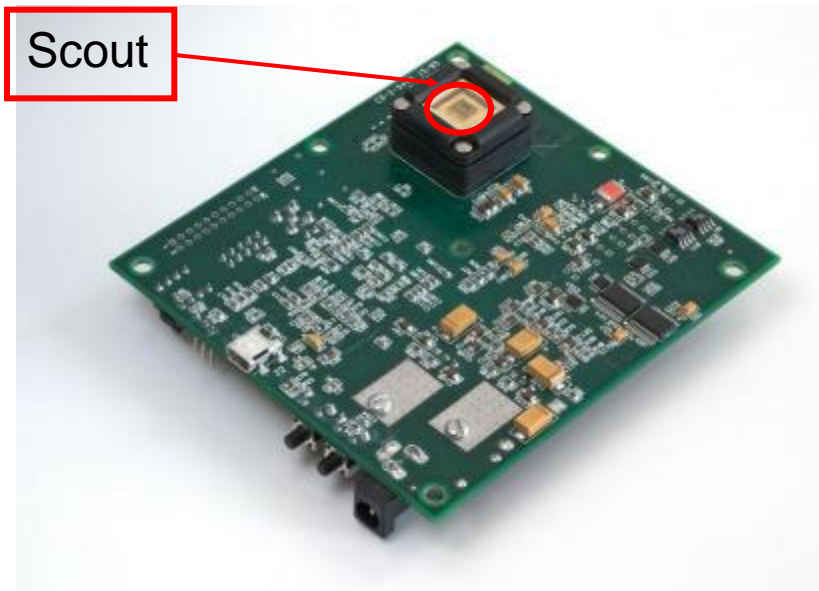
# Very Low Dark Current Pixels

- Measured on TowerJazz 2.2um state-of-the-art pixel at 30 degrees Celsius
- Median Dark Signal is less than 0.5mV/sec
- DSNU value is less than 1mV/sec
- Less than 0.1% of the pixels has dark current higher than 2mV/sec – very low bright pixel count !

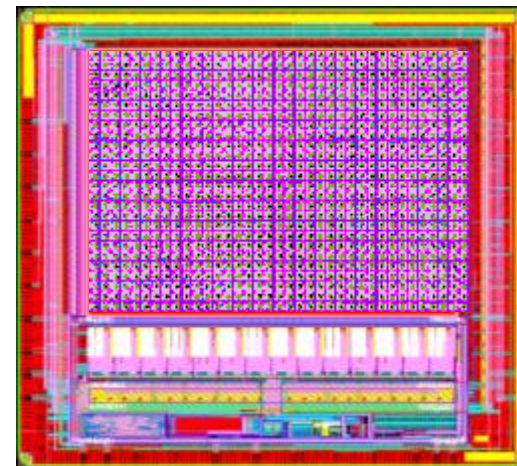


# TowerJazz Engineering Vehicle – “Scout”

- Designed by TowerJazz design team and used for pixel development
- Run on Tower’s 0.18um technology
- Low noise board designed by TowerJazz with less than 150uV noise level
- Offered to customers as a pixel development vehicle service



Scout board



Scout GDS

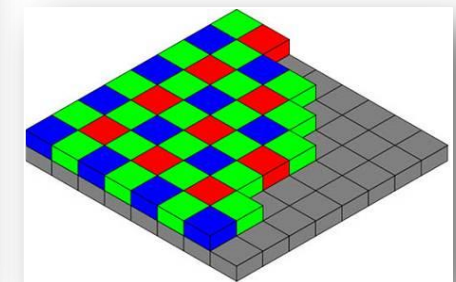
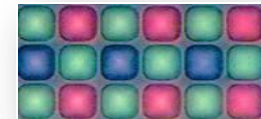
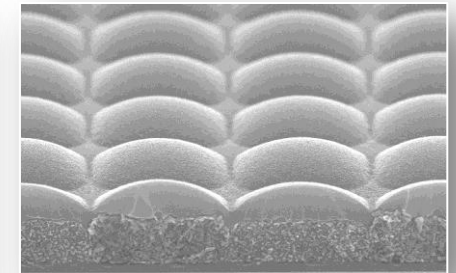
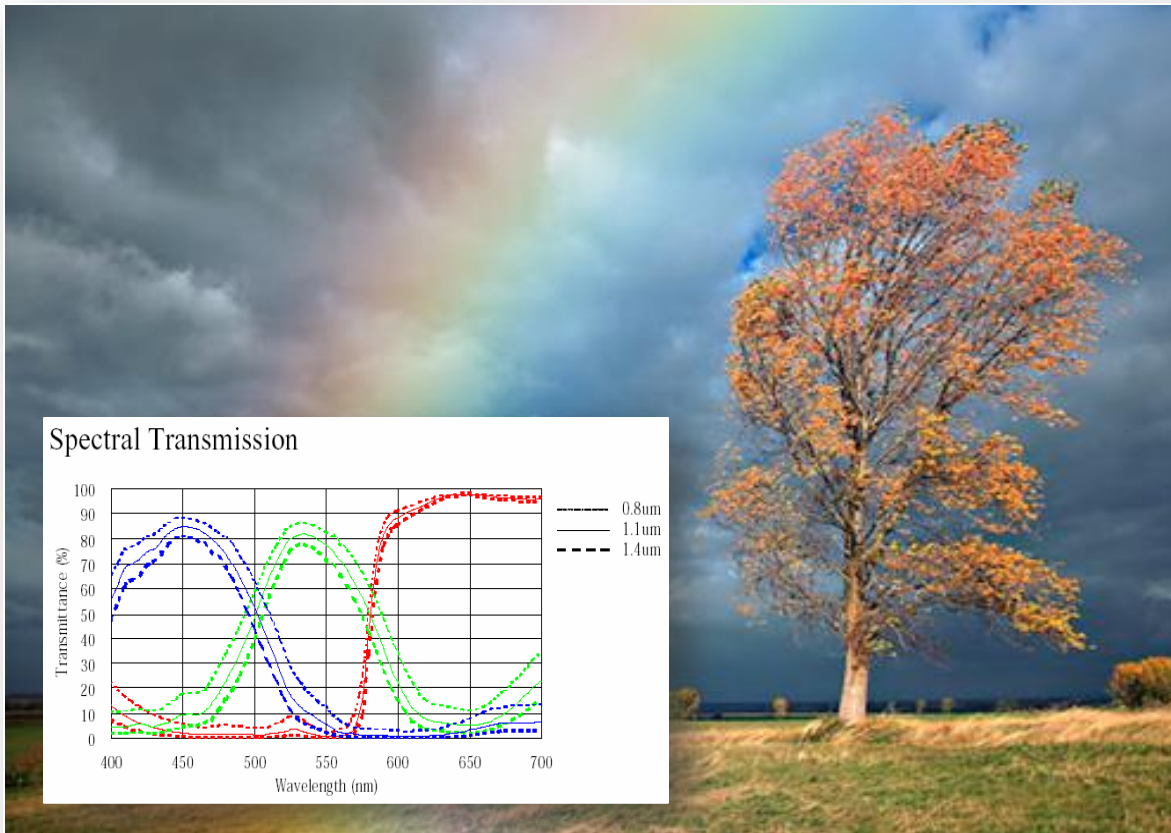
# Photography

- Cinematography – full 5K Camera (12Mp)
- High end 3K video with 180 fps
- 5.4um 4T pixel, 50Ke well capacity and low noise
- 6.0um 5T pixel, 30Ke well capacity and global shutter
- Patented stitching for large sensors



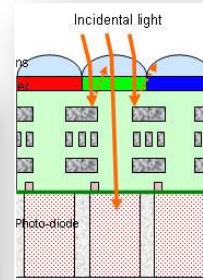
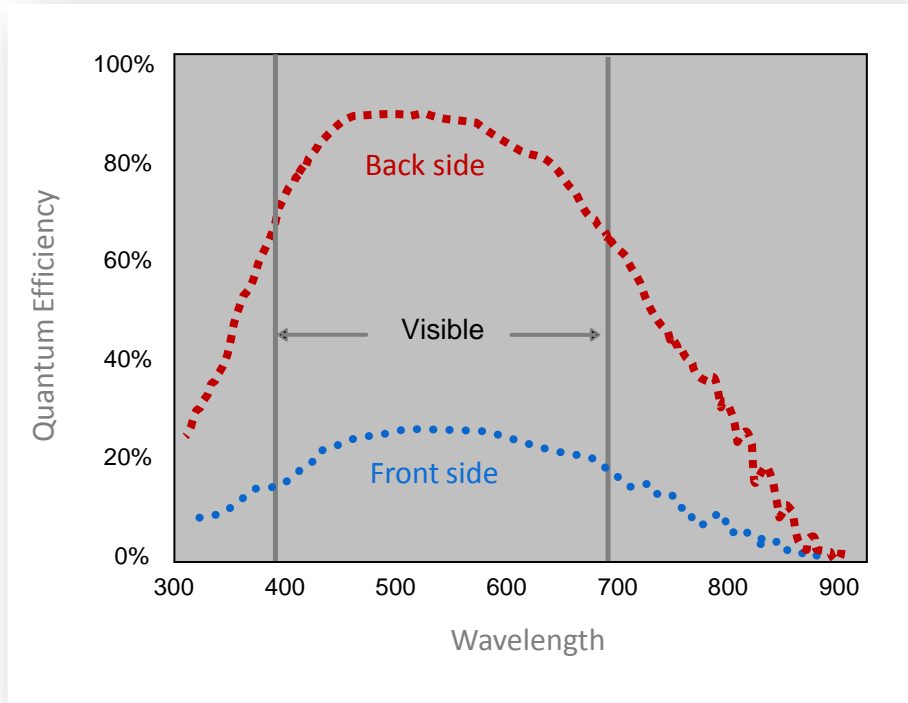
# Color filters and micro Lens

- **One stop shop:** in-house post-processing for professional quality color imagers
- **Optimized process:** State of the art Fuji color filters and near-gapless micro-lenses

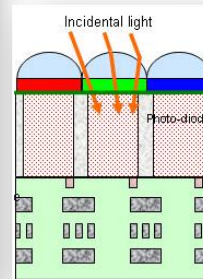
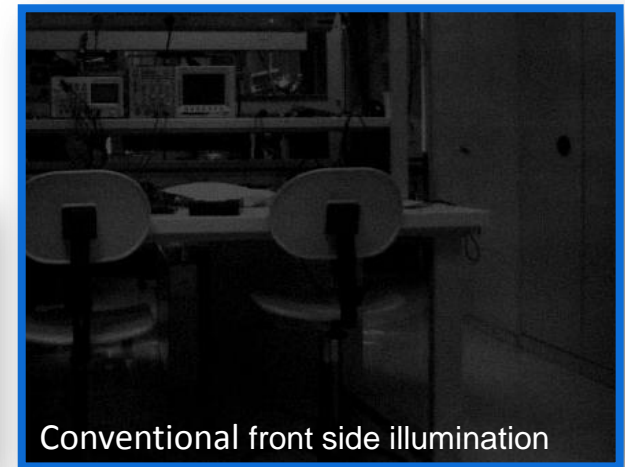


# Backside illumination

- Quantum efficiency and SNR improvement
- Excellent corner response and low cross-talk
- Pixel design flexibility (metal density)



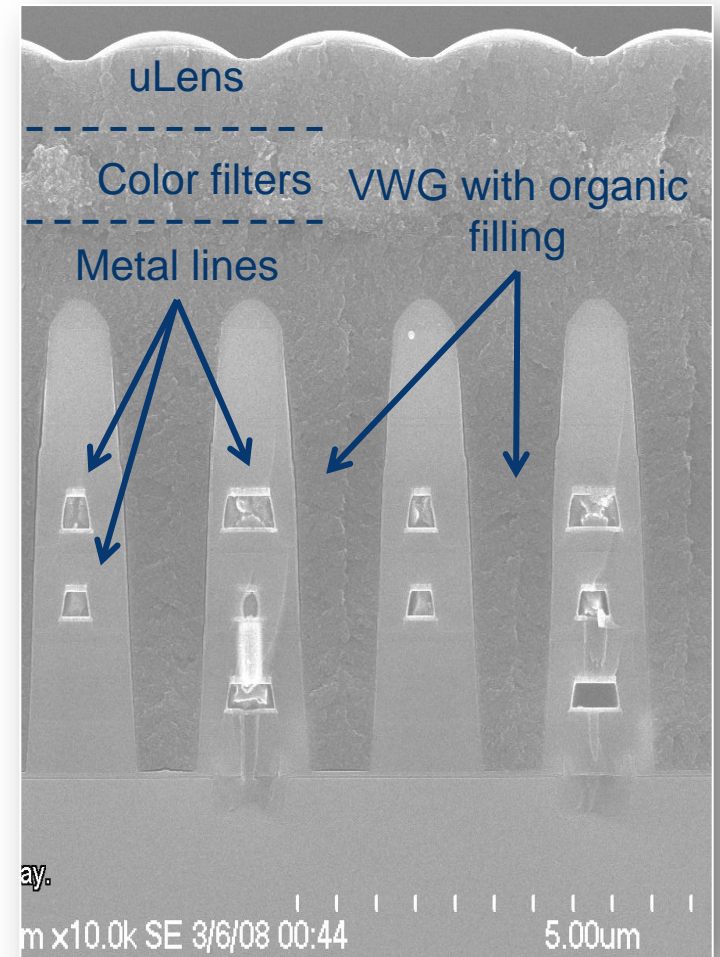
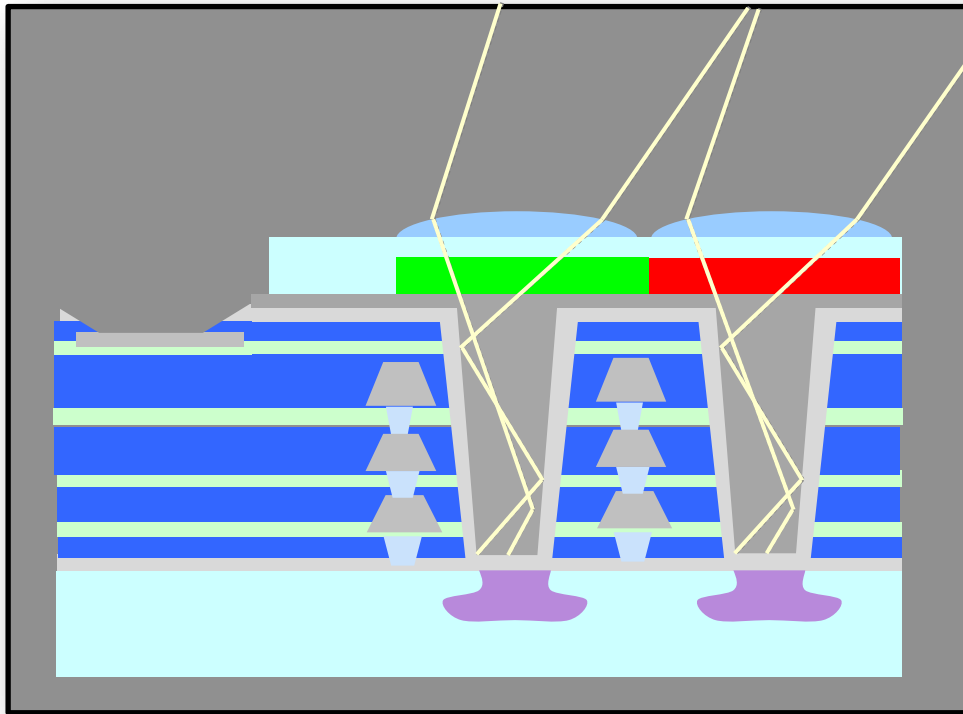
Customer 3MPix product



\* 2.7 $\mu$ m pixel, no  $\mu$ lens

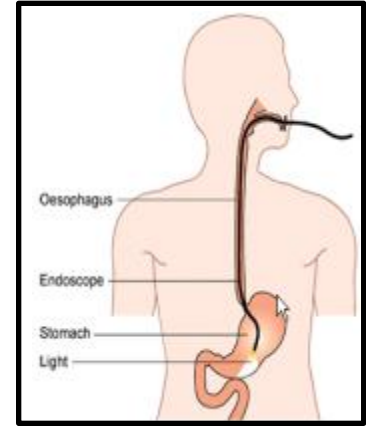
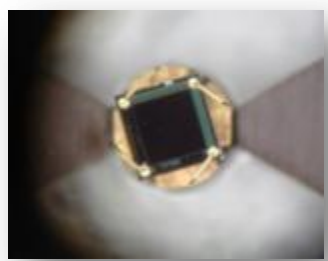
# Front-side via wave guides (VWG)

- Increased sensitivity & Reduced cross talk
- Maintaining large aspect ratio
- Excellent extension coefficient for global shutter  
→ Floating diffusion shielded from light



# Endoscopy and Gastrointestinal

- The smallest camera in the world 700um x 700um for disposable applications
- Cooperation with market leaders



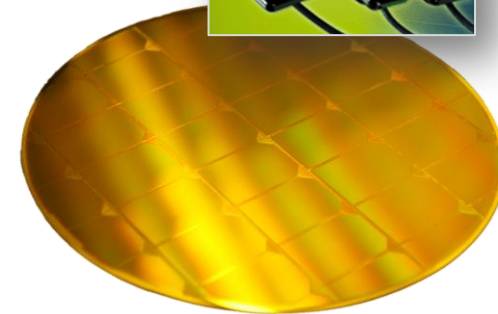
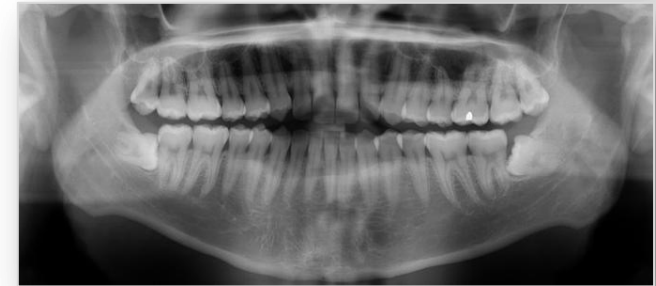
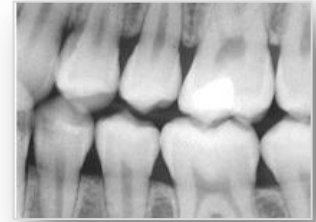
# Medical X-Ray CMOS Sensors

- Large flat panel detectors
- Replacing older technologies of a:Si and Image Intensifiers
- 0.18um process technology on 8" wafers
- Mass production with excellent yields



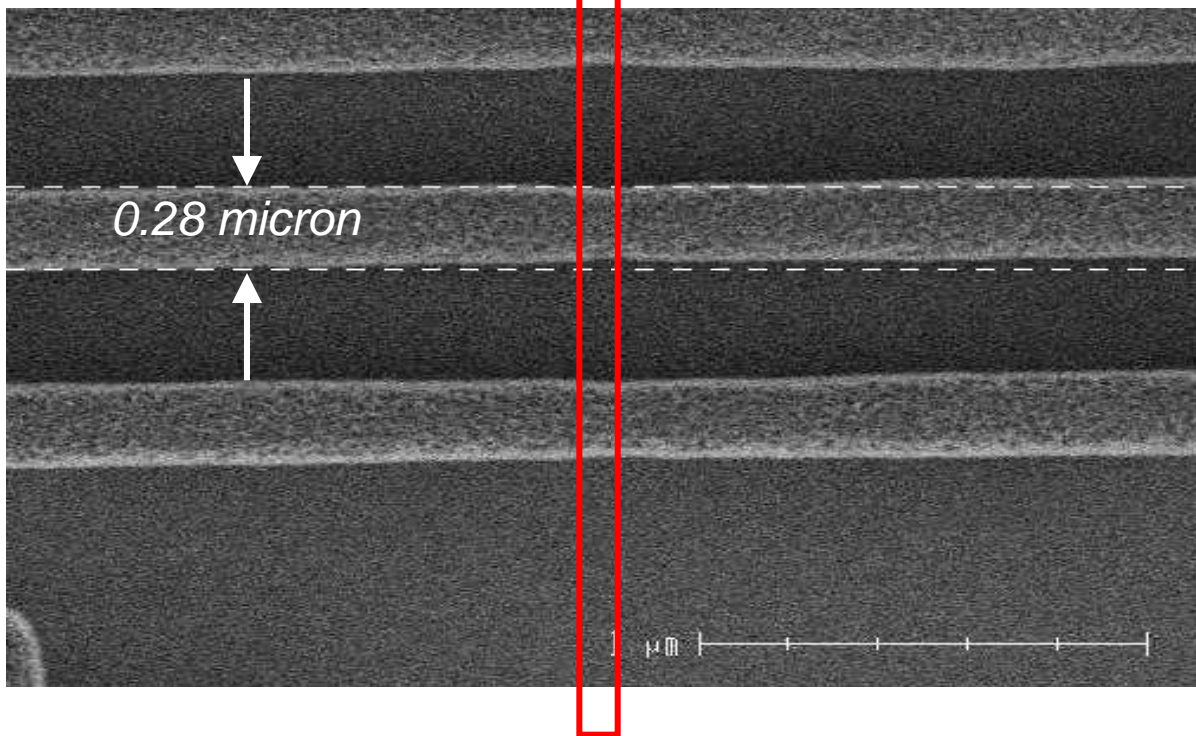
# Dental X-Ray CMOS Sensors

- Market Leader for Intra Oral dental x-ray CMOS sensors
- Supplying all Tier-1 vendors
- Around 75% of dental CMOS market share
- Global Customer base: US, Europe and Asia

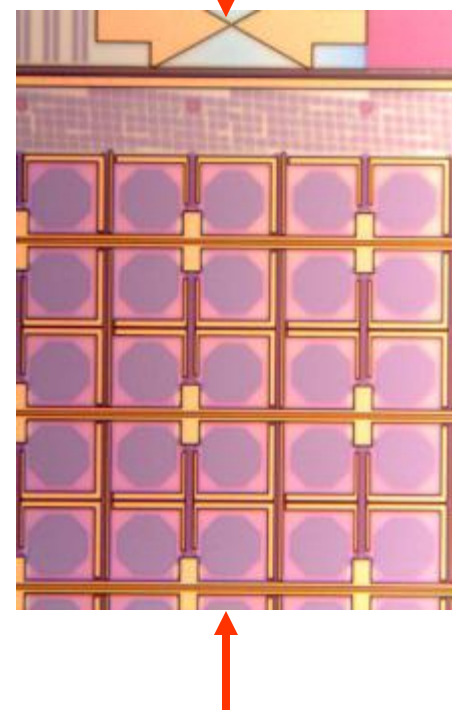


# TowerJazz Stitching Performance – 0.18um

Seamless stitch boundary



Stitch Line



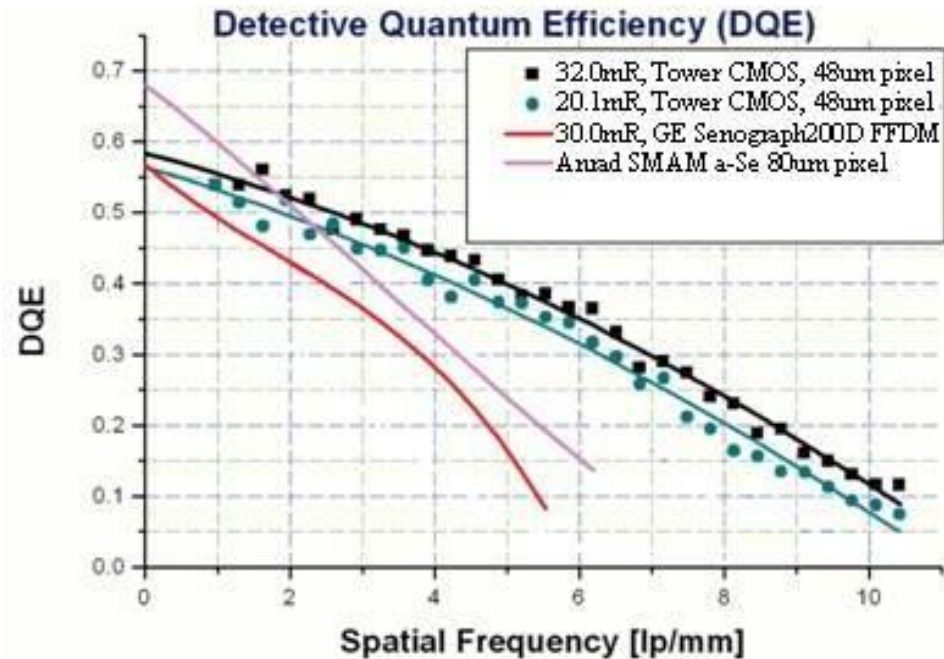
# TowerJazz Leadership in CIS X-Ray

- Stitching technology in production in Fab 2:
  - 8 inch wafers
  - State of the art 0.18um process technology
  - 4x better stitching accuracy compared to 0.5um technology
- Large scanner field size (32x25mm)
  - Intra-Oral Smaller (infant size) sensor does not require stitching at all
  - Intra-Oral Large (adult) sensor with only one dimension stitching boundary
- Inherent low defect density due to the fully SMIF (class <1) and advanced 0.18um equipment
- Easy to integrate analog and digital SOC functionality
- High performance pixel technology with very low dark current
- Rich library and IP offering and design tool support

# X-Ray Pixel Offering

Pixel Size (um)	Pixel Type	Full Well (e-)	Dark Signal (mV/sec @30C)	Responsivity (V/Lux*sec)
20	N+	600,000	3	1.5
20	N-well	650,000	3.4	1.7
20	BPD	600,000	0.4	1.5

- Pixel customization of size and well capacity are available as a service
- BPD: Buried Photo Diode

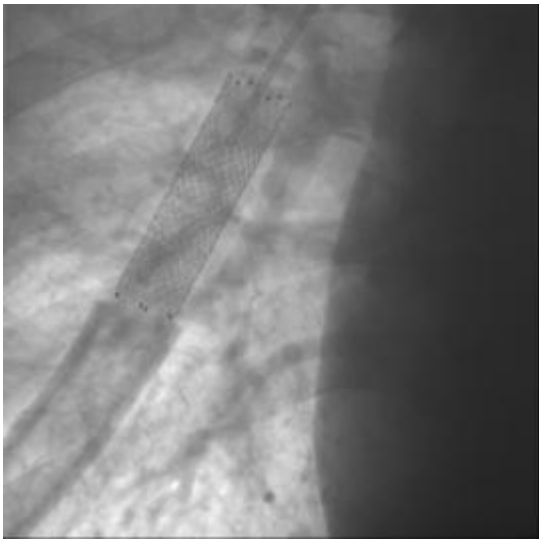


# Fluoroscopy and Radiography

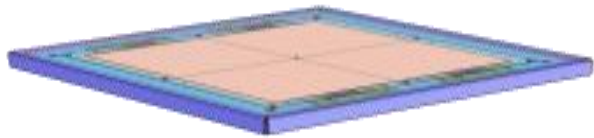
**C&T Medical Solutions** – TowerJazz & CMT Medical Technologies  
(from Thales Group) JV for designing, manufacturing and sell of CMOS based X-Ray flat panels for medical applications



Hand Radiography X-Ray



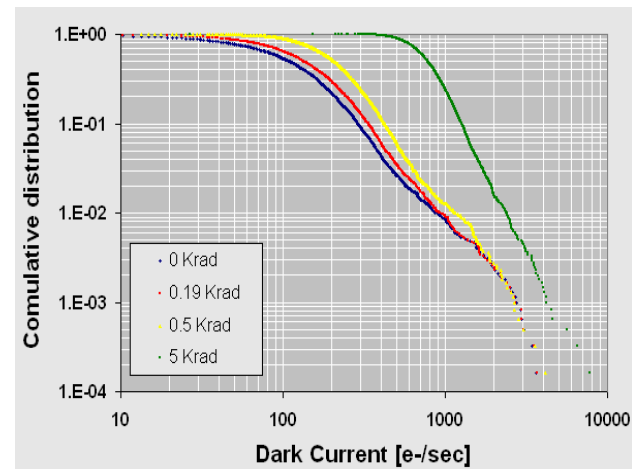
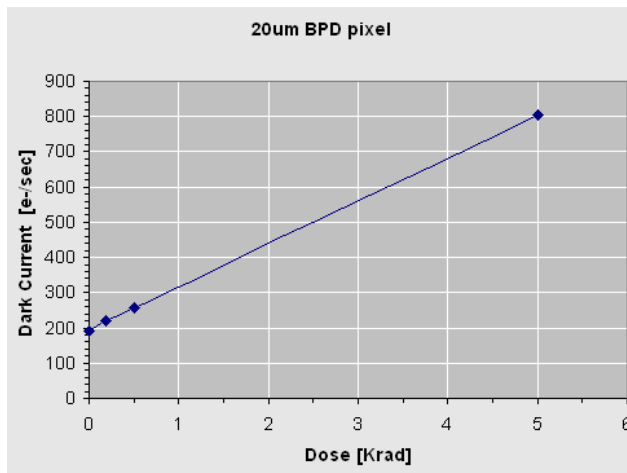
Chest and Stent in Fluoro



# Reliability (radiation hardness)

CMOS X-ray degradation tested up to 5KRad at 50KeV, w/o scintillator.

- Minimal degradation effects where observed.
  - Factor 4 mean dark current increase, factor 2 on DSNU
- Assuming 10% penetrating the scintillator, this brings up to 5x better than spec requirement of lifetime = 100Gy



# Space applications

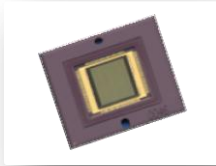
- Several Space sensors made through 3<sup>rd</sup> party custom design companies
- Large stitched sensor capability
  - Up to 0.5 Giga pixel with 5.4um pixel
  - Up to 1.3 Giga pixel with 3.3um pixel
- Super low dark current ~10 e/s per pixel at room temp
  - 2X lower for each 5°C reduction
- Super low noise ~3 electrons
- Experience with rad-hard applications
- IR sensitivity targets:
  - 50% QE @ 850nm
  - 30% QE @ 900nm
- Soft X-Ray (10~50nm):
  - Large sensor backside illumination in 2011
  - Novel backside passivation technology



# Summary of application range



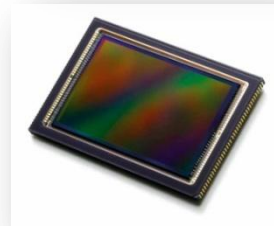
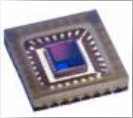
**Medical (X-ray)**



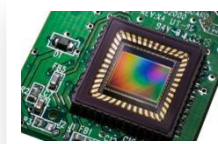
**Industrial,  
Machine Vision,  
Bar-Code**



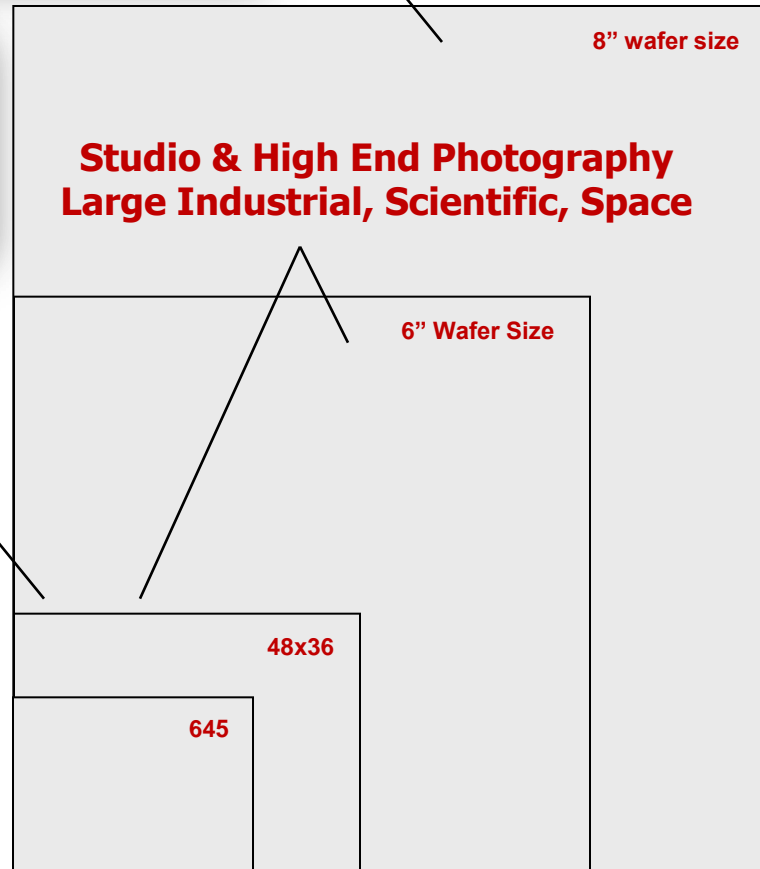
**Consumer**



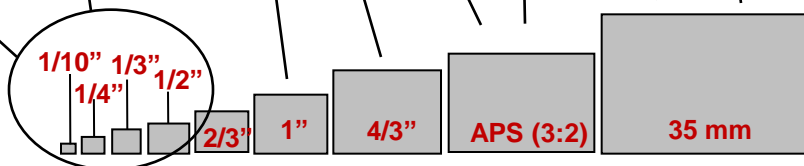
**Professional  
Photography**



**Prosumer  
Photography**



**Small Medical**



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