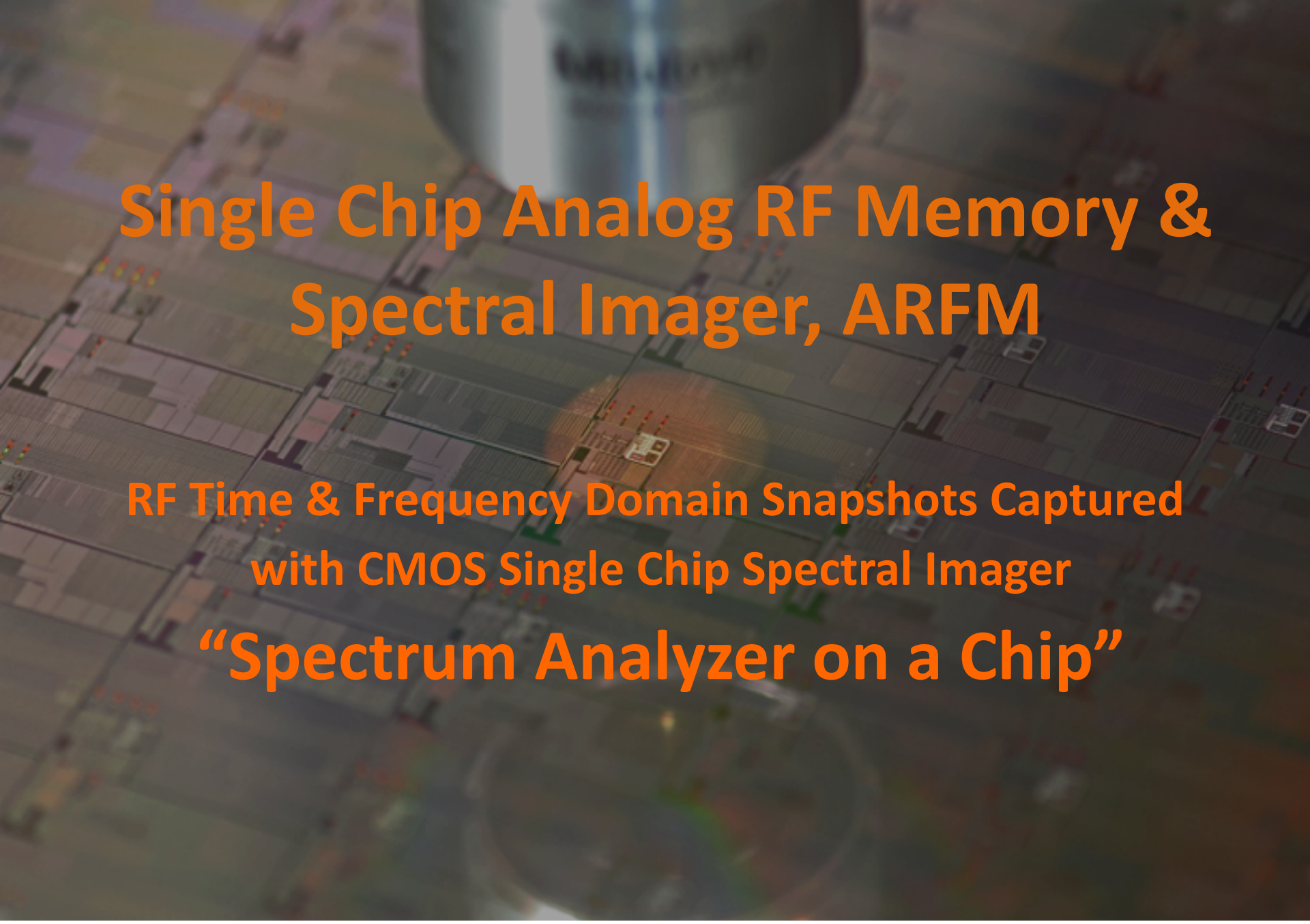


Single Chip Analog RF Memory & Spectral Imager, ARFM

RF Time & Frequency Domain Snapshots Captured with CMOS Single Chip Spectral Imager

"Spectrum Analyzer on a Chip"

Michael Wyatt

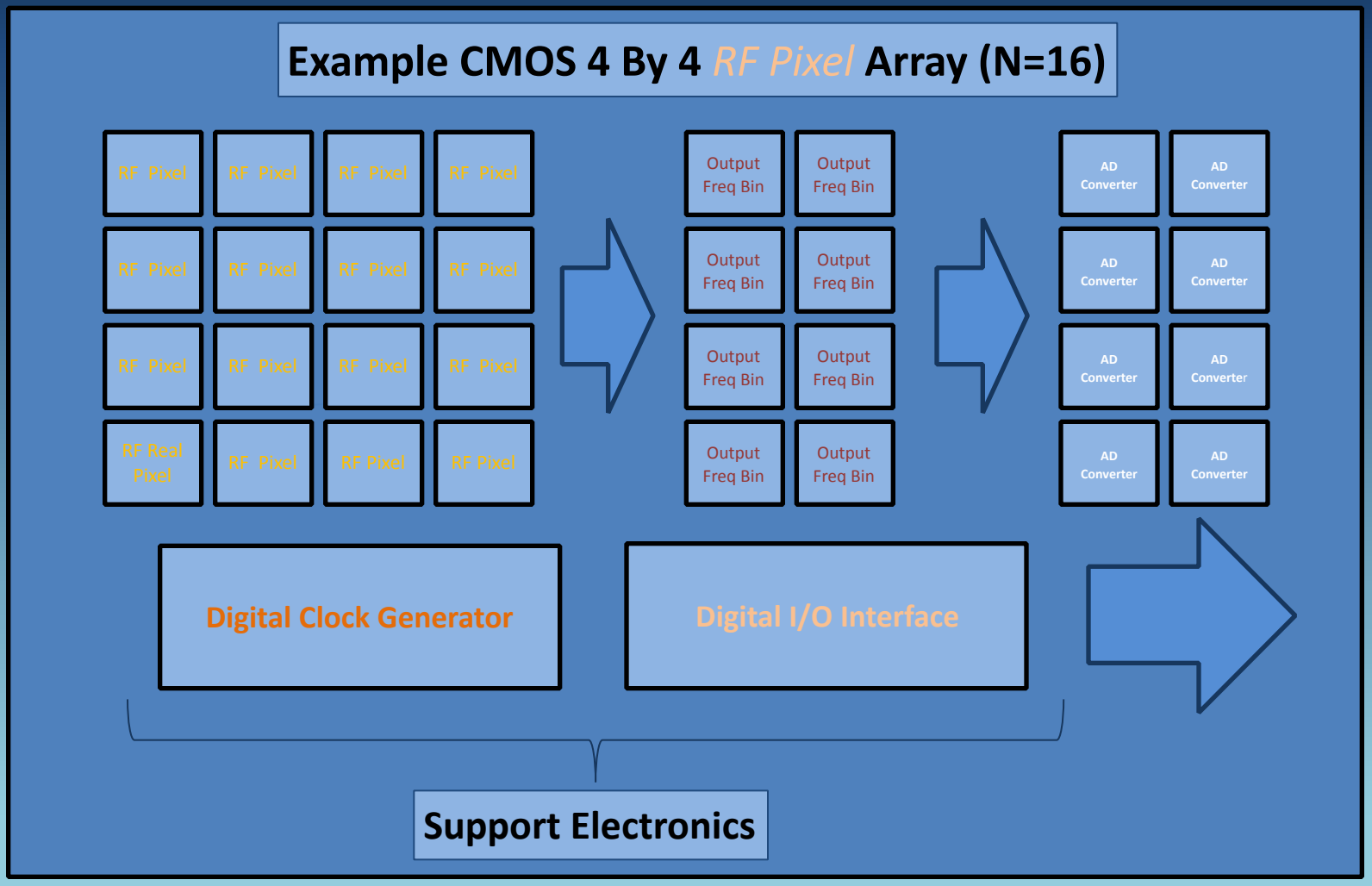
Single Chip ARFM Time & Spectral Domain Imager

Utilize Digital Imaging Sensor/DRAM Technology

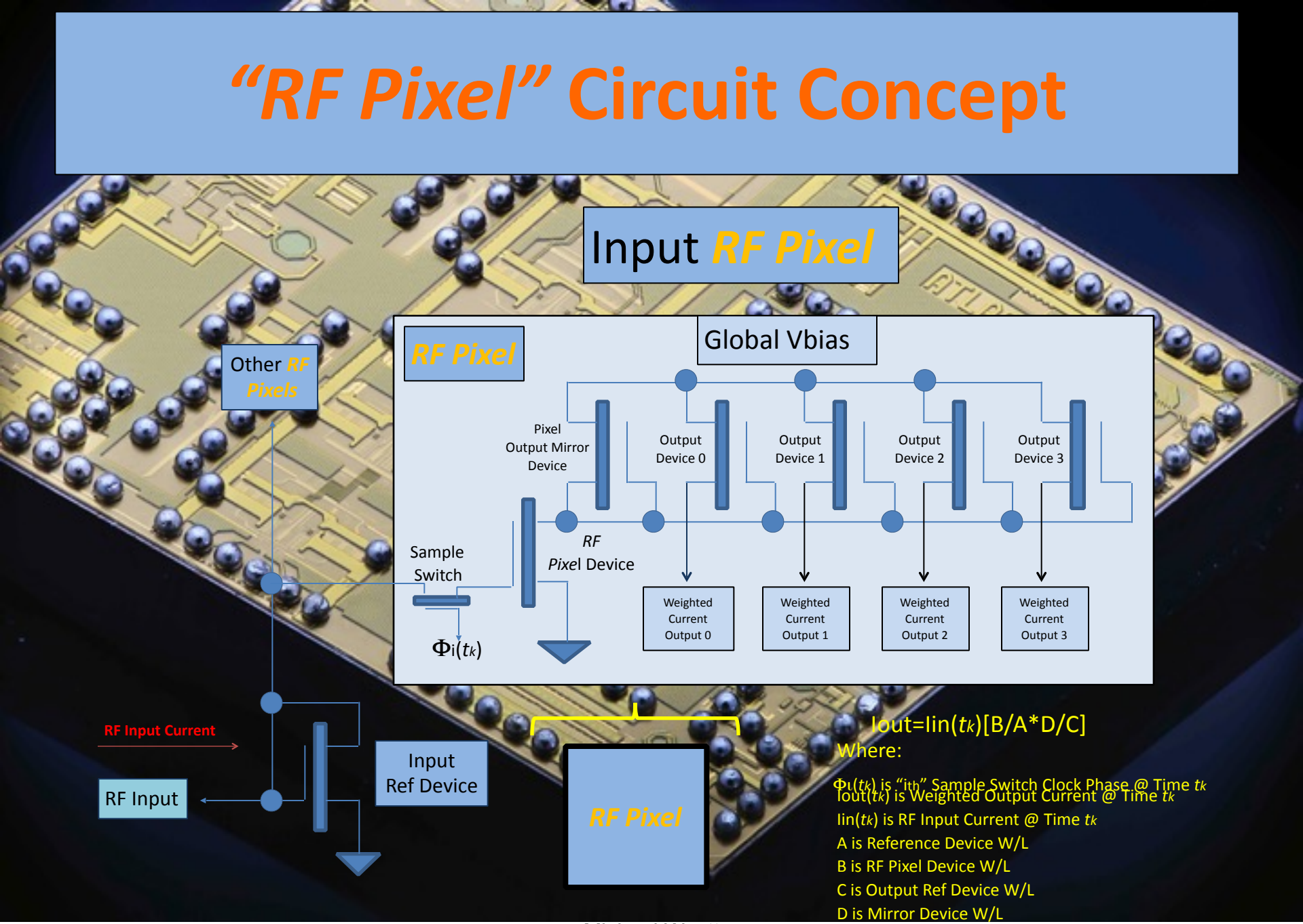
- Employ Large CMOS Sensor Device Arrays
  - Sensor Configured
    - "N_c" Columns
    - "N_{row}" Rows
    - N Array Size = $N_c * N_{row}$
  - Signal Input
    - Applied to each Column via NMOS switch
      - » Column Sequentially Addressed in Time
      - » Stores Signal Input *Current* on *RF Pixel* Column NMOS Device
        - Behaves like N *Current Mode* Sample and Holds
    - Step to next Column when previous Column full
- Captures RF Time Domain
  - Discrete Time Continuous Amplitude
  - N Time Samples
  - N**ts* = Total Capture Time Slot
- Large Number of *RF Pixels*
  - Limited by Chip Size
    - Greater than 100K Pixels
      - » 10u by 10u CMOS (Example)
- High RF Sample Rates
  - Limited by Clock/Switch Speed
    - Improves with Silicon Feature Size Reduction
- Large RF "Image" Capture Time
  - Limited by Chip Size
    - Improves with RF Pixel Number
  - Limited (long end) by NMOS Device Gate Charge Hold Time
    - Dictated by Process Node
    - Limited by Leakage
    - Partial Leakage Compensation Possible

Enables Large Array Single Chip RF Time Domain Signal Capture

Notional 4 By 4 Example: Single Chip RF Imager

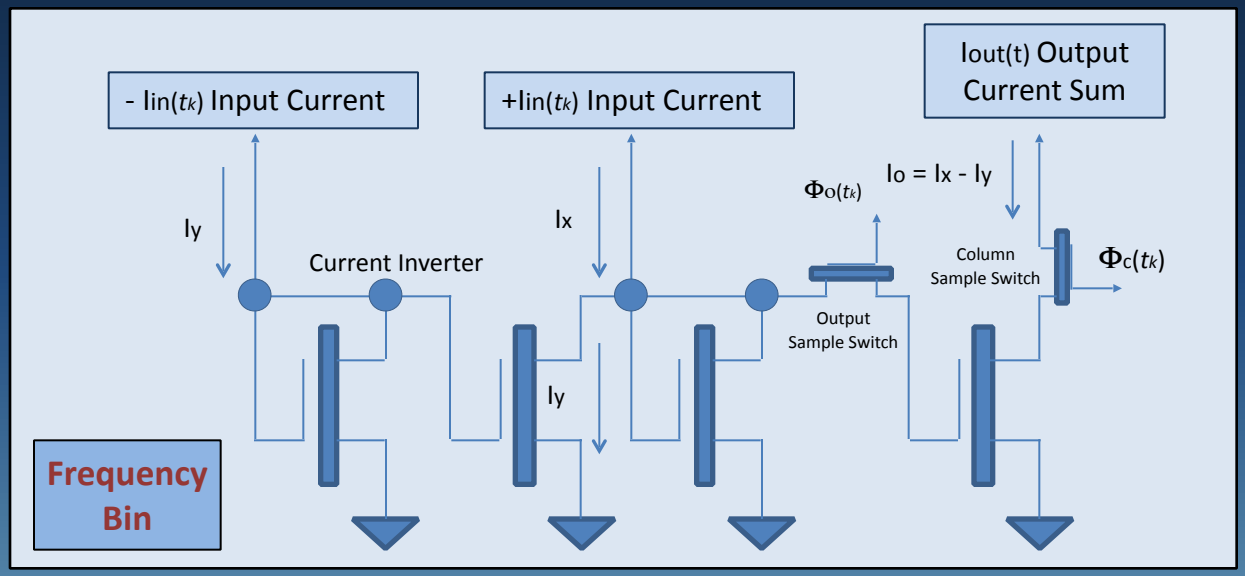


"RF Pixel" Circuit Concept



Spectral Image Analog FFT
"Frequency Bin" Circuit Concept

Output Current **Summation** *Frequency Bin*

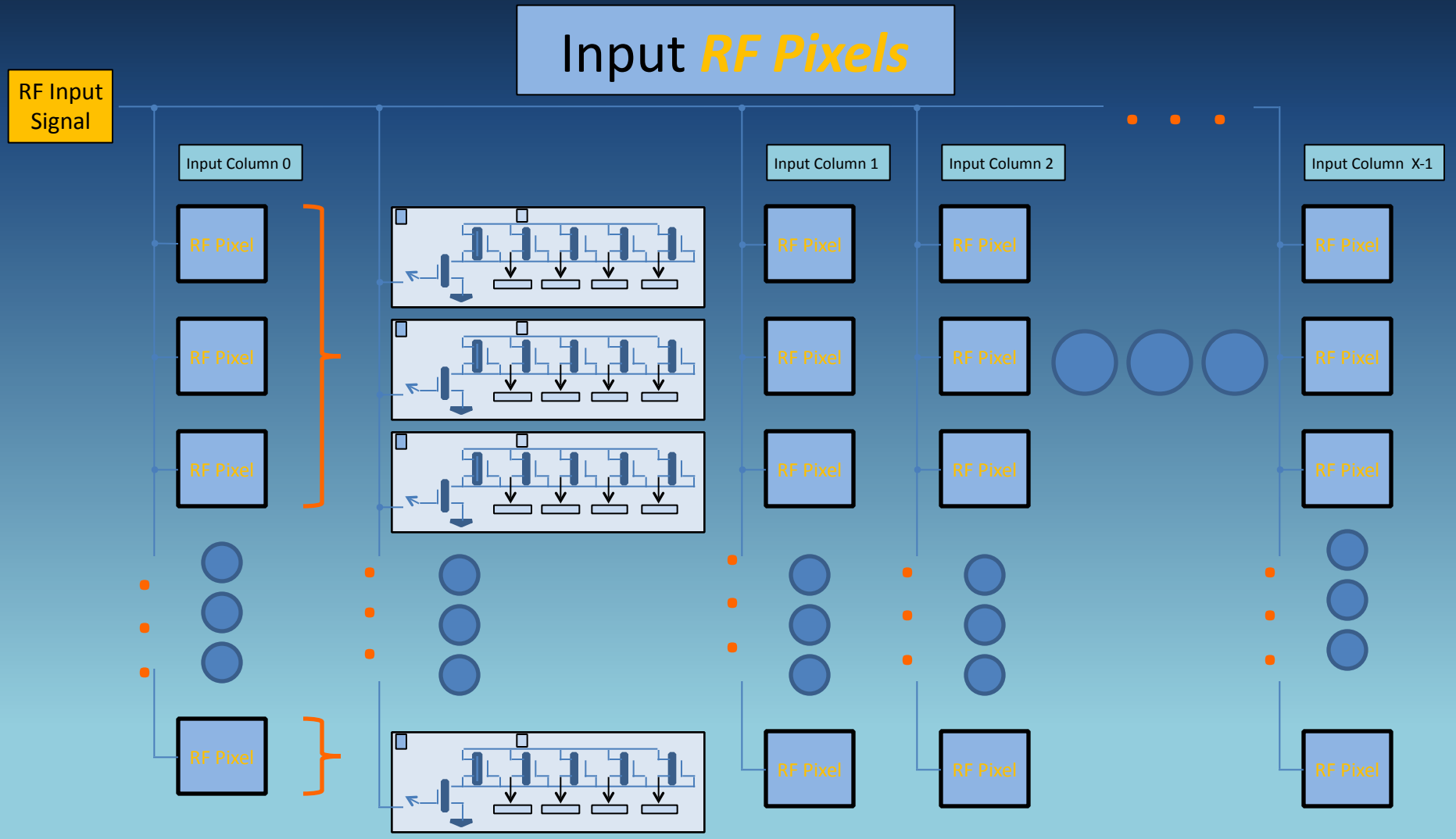


Output Frequency Bin

$$Iout(t) = \Sigma +Iin(t_k) - \Sigma -Iin(t_k)$$

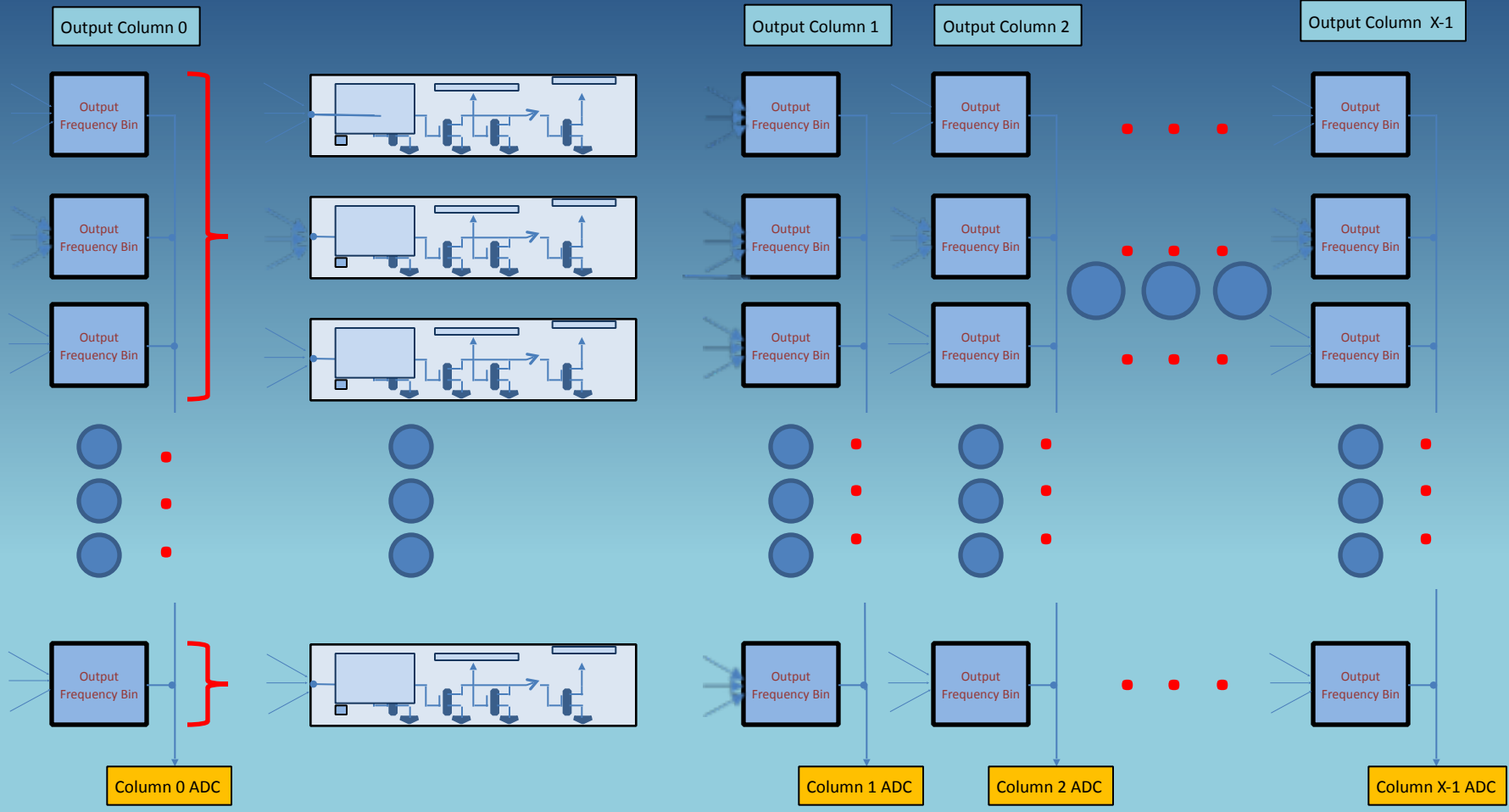
Where:
$Iout(t_k)$ is Weighted Sum Output Current
$+Iin(t_k)$ is Added Input Current
$-Iin(t_k)$ is Subtracted Input Current

Single Chip ARFM Time Capture



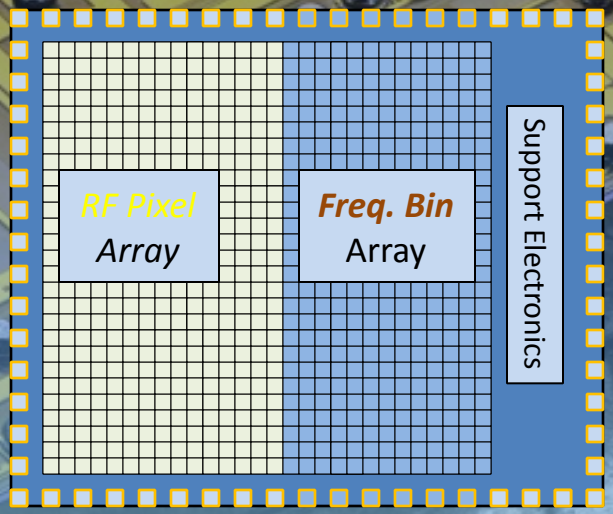
Single Chip ARFM Spectral Image

Output Current Summation *Frequency Bins*



Example Single Chip 10K RF Pixel ARFM Time & Spectral Domain Imager

- **Example Chip: 10K *RF Pixel*, DC-5GHz, @ 1MHz Res. with 1us RF Spectral Image Capture**
  - **4mm by 3mm CMOS Chip Size**
    - **100 by 100 X & Y Array**
      - **10u by 10u *RF Pixel* Size**
        - **NMOS Sample Device**
    - **10GSPS Sample Rate**
      - **1us Total RF Time Image Capture**
        - **10ns per Column**
      - **DC-5GHz Nyquist Frequency Span**
        - **1MHz Frequency Resolution**
    - **10 Bit Analog to Digital Conversion**
      - **One AD Converter per Column**
        - **100 Total**
  - **Input Clocking**
    - **Single Input Clock Reference**
    - ***RF Pixel* Sample Clock Derived**
      - **Each Column Delay/Phase Locked**
    - **Column ADC**
      - **Delay/Phase Locked**
    - **Output Clock**
      - **Delay/Phase locked**
  - **Single 2.7 Volt Supply**
    - **On Chip Low Drop Out Regulators**
    - **Higher Efficiency with separate 1.2v Digital Supply**
  - **Digital Interface**
    - **100 10 Bit AD Converter**
    - **10K 10 Bit Words**
    - **High Speed Digital Data Outputs**
      - **Advanced FPGA Compatible**
      - **Advanced DSP Compatible**



Example 10K CMOS Chip

Similar Size Chip on a Dime