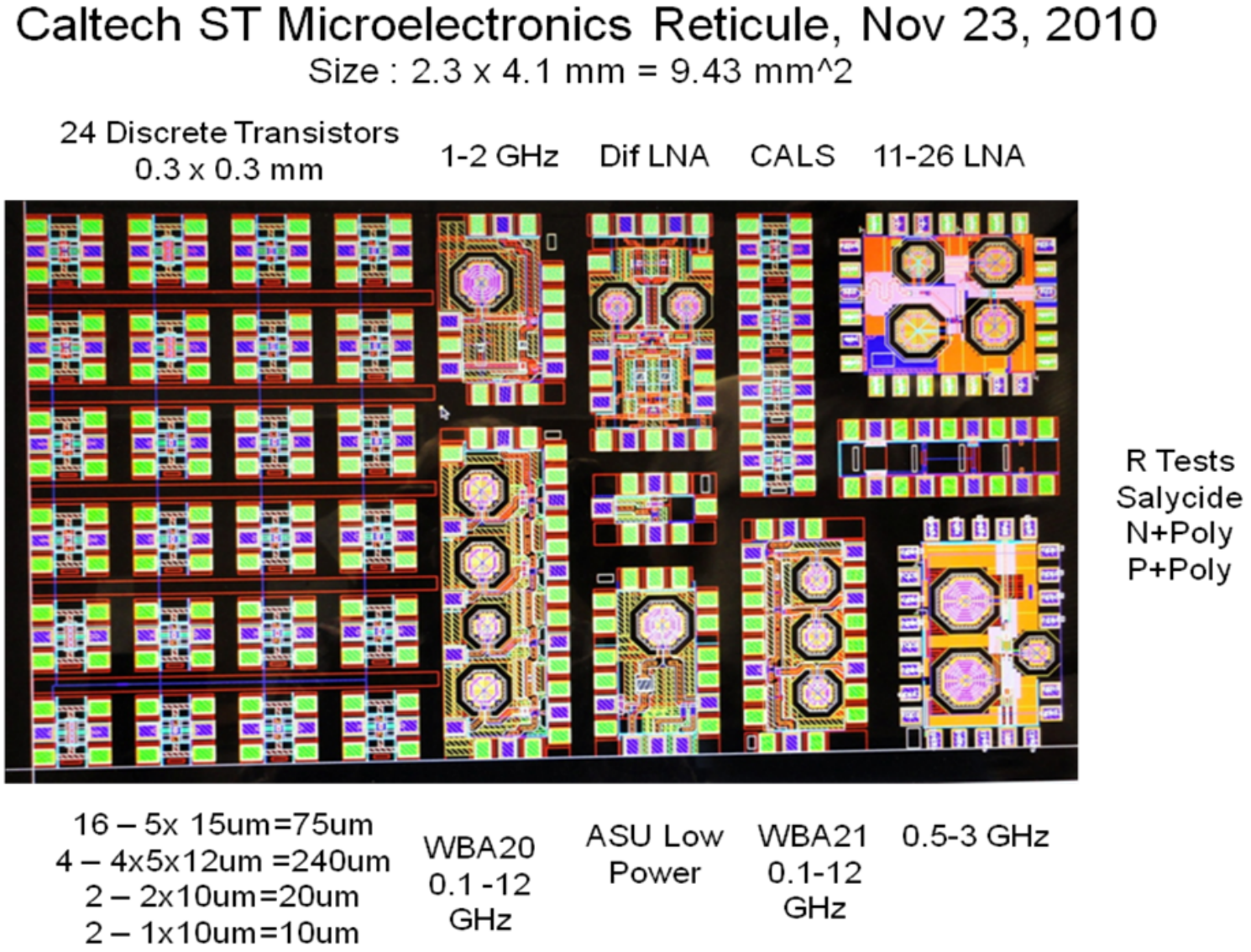
Technical Capabilities Needed for New Discoveries in Radio Astronomy

1. Transformational technology – give examples
2. We should “spin on” to the wireless technology explosion
3. Chip designers – show example
4. Cross technical discipline designers – show example
5. Show career path for research engineers in radio astronomy
6. Revise export and immigration regulations

This 2 x 4 mm piece of silicon cost $55,000 and is made in France!



Transformational Technology Example
Reduce Correlator Power Consumption by 300

- A major impediment to construction of very-large-*N* arrays is the power consumption of digital signal processing. A correlator for $N = 2000$ and bandwidth $B = 1$ GHz built using the same technology and architecture as ALMA's would consume 7.9 MW.
- A correlator's computation rate is $N(2N+1)B$ complex multiply-accumulates per second, regardless of architecture. But practical correlators must also do I/O and store data temporarily in memories. The rates of these operations depend strongly on architecture and they can easily consume the vast majority of the power.
- A recent study[1] shows that low power requires an architecture that minimizes memory operations. This implies a matrix (not pipeline) structure and avoiding RAM accumulator banks.
- Large correlators using programmable devices (FPGAs, GPUs, CPUs) are impractical in present technology and will always use >100x more power than ASIC-based implementations.
- Using 90nm CMOS (already behind the current SoA) and the optimum architecture, we predict that the $N = 2000$, $B = 1$ GHz correlator will consume less than 35 kW. A demonstration ASIC is being designed.

[1] L. D'Addario, "Low-Power Correlator Architecture For the Mid-Frequency SKA." Submitted to SKA Memo Series.

Packaging Technology of Modern Electronics

- Electronic functions are orders of magnitude smaller and less expensive
- How can we use this technology for radio astronomy.