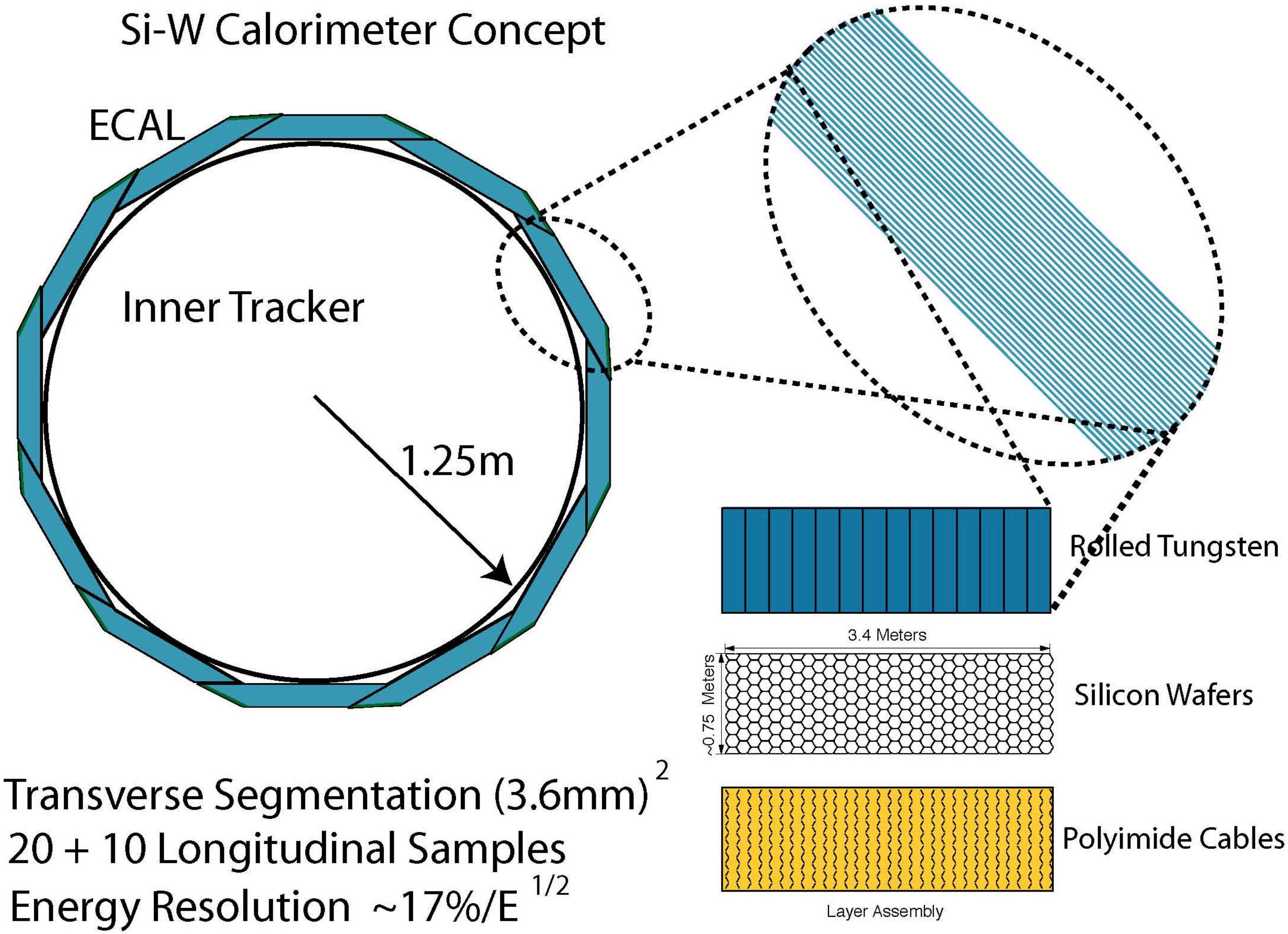
Silicon-Tungsten ECal optimized for SiD



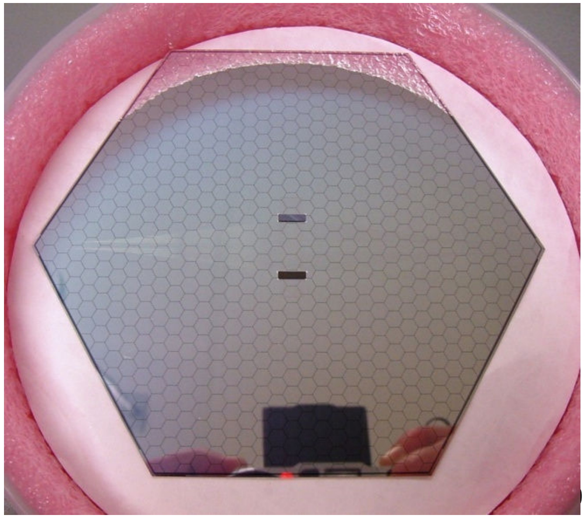
<u>Baseline configuration:</u>

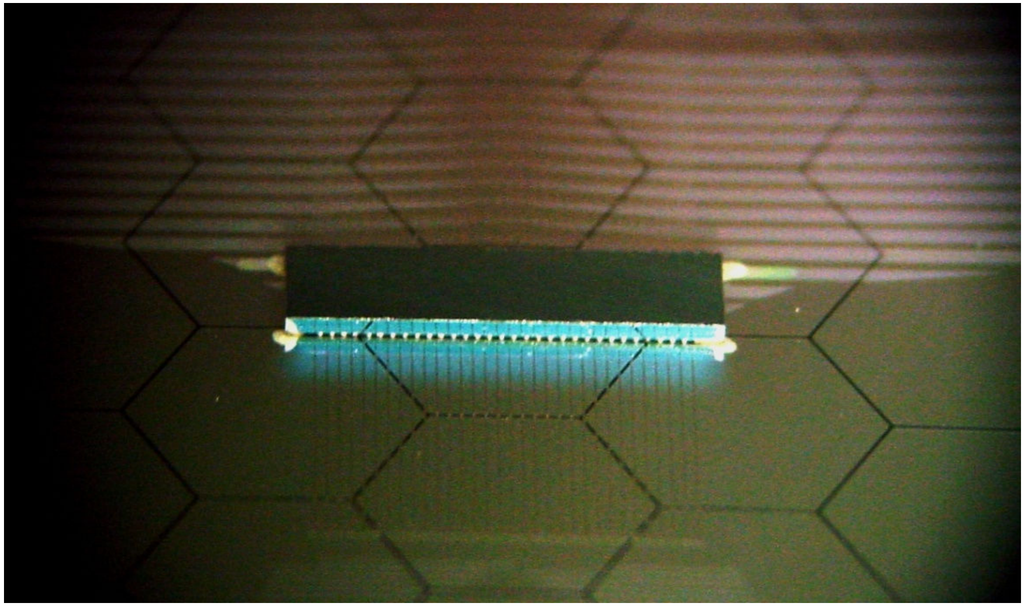
- transverse seg.: 13 mm^2 pixels
- longitudinal: $(20 \times 5/7\ X_0)$ + $(10 \times 10/7\ X_0)$ $\Rightarrow$ 17%/sqrt(E)
- 1 mm readout gaps $\Rightarrow$ 13 mm effective Moliere radius

Goals of the R&D

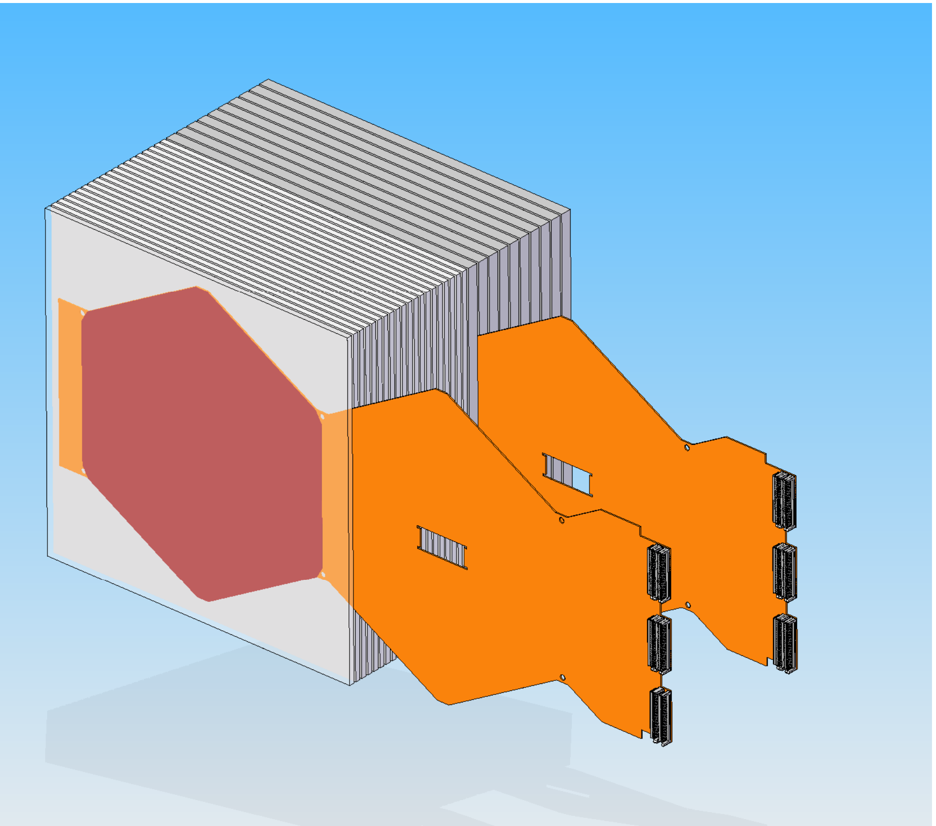
Design a practical ECal which (1) meets (or exceeds) the LC physics requirements (2) with a technology that would actually work at a LC.

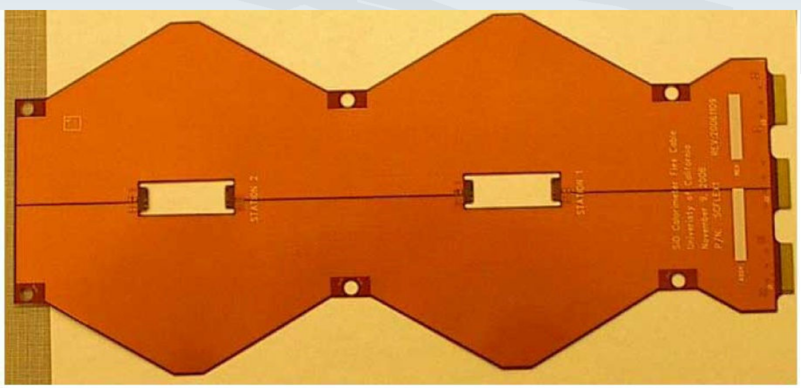
- Physics: A highly-segmented imaging Si-W ECal: Very collimated EM showers and MIP tracking; only modest EM energy resolution OK
- The key to making this practical is a highly integrated electronic readout
  - ~1000 pixels per readout chip (KPiX) with power pulsing
- Readily segmented silicon: 13 mm^2 is current default
- Interconnects give small readout gap (1 mm): $\Rightarrow$13 mm eff. Moliere radius
  - Bump-bond KPiX directly to Si sensor
  - Flex cables to outside





R&D test beam module





R&D project goal: Produce full-depth (30 layer) module which uses the technologies for the LC detector:

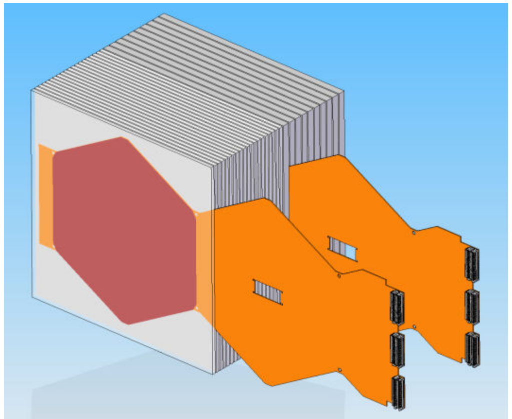
- 1024-channel KPiX chips (30)
- 1024 pixel silicon sensors (30)
- KPiX bump-bonded to Si sensors
- Tungsten

First test-beam module one sensor wide (15 cm x 15 cm)

- Final flex cables, but shorter

Characterize in a test beam (mainly electrons and/or photons)

Current R&D status



- KPiX
  - Current is 256 channel chips (KPiX-8)
    - Performance sufficient for ECal
  - Order 512-channel chip Nov 2009
  - Order 1024-channel chip (KPiX) March 2010
- Silicon sensors
  - 40 sensors in hand and ready (30 needed)
- Tungsten
  - In hand (20 x 2.5 mm + 10 x 5.0 mm; 92% W alloy)
- Interconnects
  - Flex cables – 2nd iteration in progress; not expected to be a problem
  - Bump bonds – using gold stud bumps for prototyping; recent trials look good

test beam requirements and plans

- Initial test beam studies: An electron beam like that possibly available at SLAC would be ideal:
  - 5-10 GeV or more
  - Well localized and controllable beam
  - LC-like time structure (for KPiX electronics)
  - Small number of (simultaneous) electrons per bunch:
    - zero,1,2,… electrons per bunch

- Need to begin data taking in beam in 2011 – will run at SLAC if a beam exists by then
- Current expectation is for SLAC test beam available ~winter 2011
  - See Carsten Hast talk
  - Will evaluate alternatives if necessary: FNAL, DESY, …

- Would assume prototype to be incorporated in a beam with hadrons and an HCal prototype at a later stage

SiD Si/W ECal R&D Collaboration

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- KPiX readout chip
- downstream readout
- mechanical design and integration

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- detector development
- readout electronics

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- readout electronics

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LAPP Annecy

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