R&D of FCAL

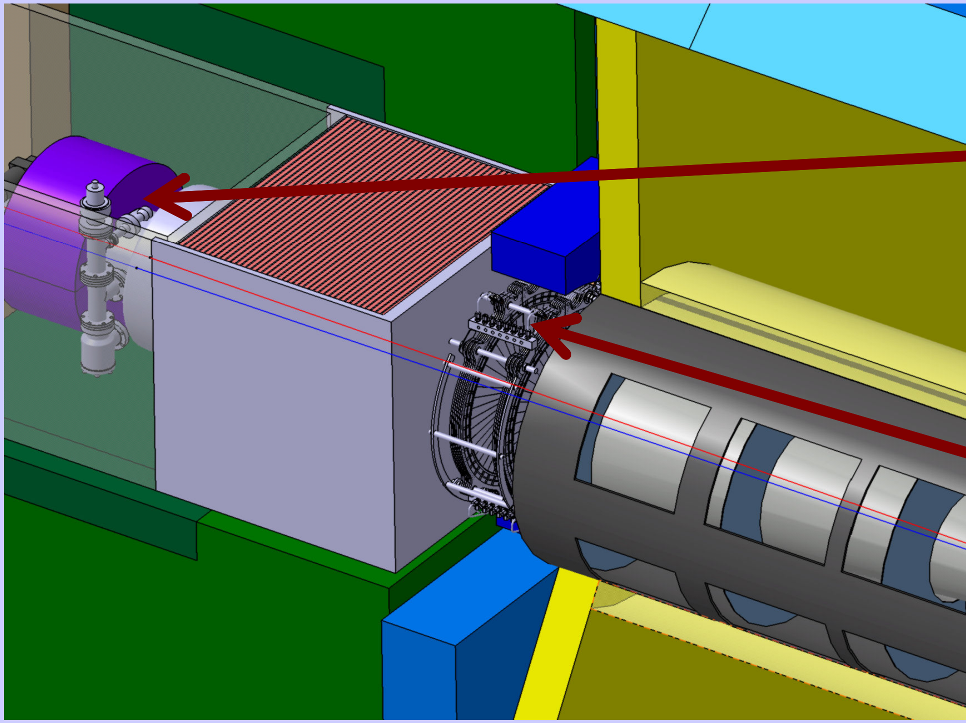
W. Lohmann, DESY

On behalf of FCAL

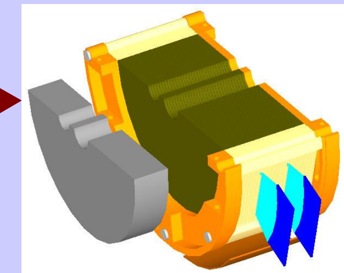
- Simulation studies
- Sensors
- FE ASICs
- System Tests
- short- and midterm plans

Labs involved: Argonne, Vinca Inst, Belgrade, Bukharest, CERN, Univ. of Colorado, Cracow UST, Cracow INP, IKP Dresden, JINR, Royal Holloway, NCPHEP, Santa Cruz, Stanford University, SLAC Tuhoku Univ., Tel Aviv , Univ., DESY (Z.)

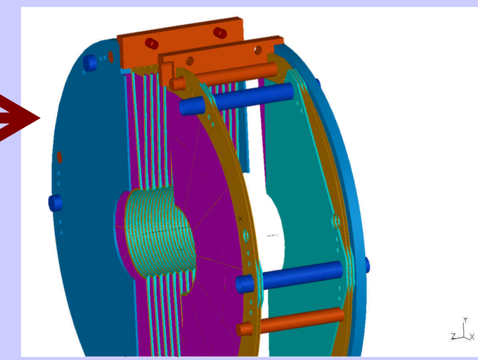
Very forward detectors- challenges



BeamCal
+ Pair
Monitor

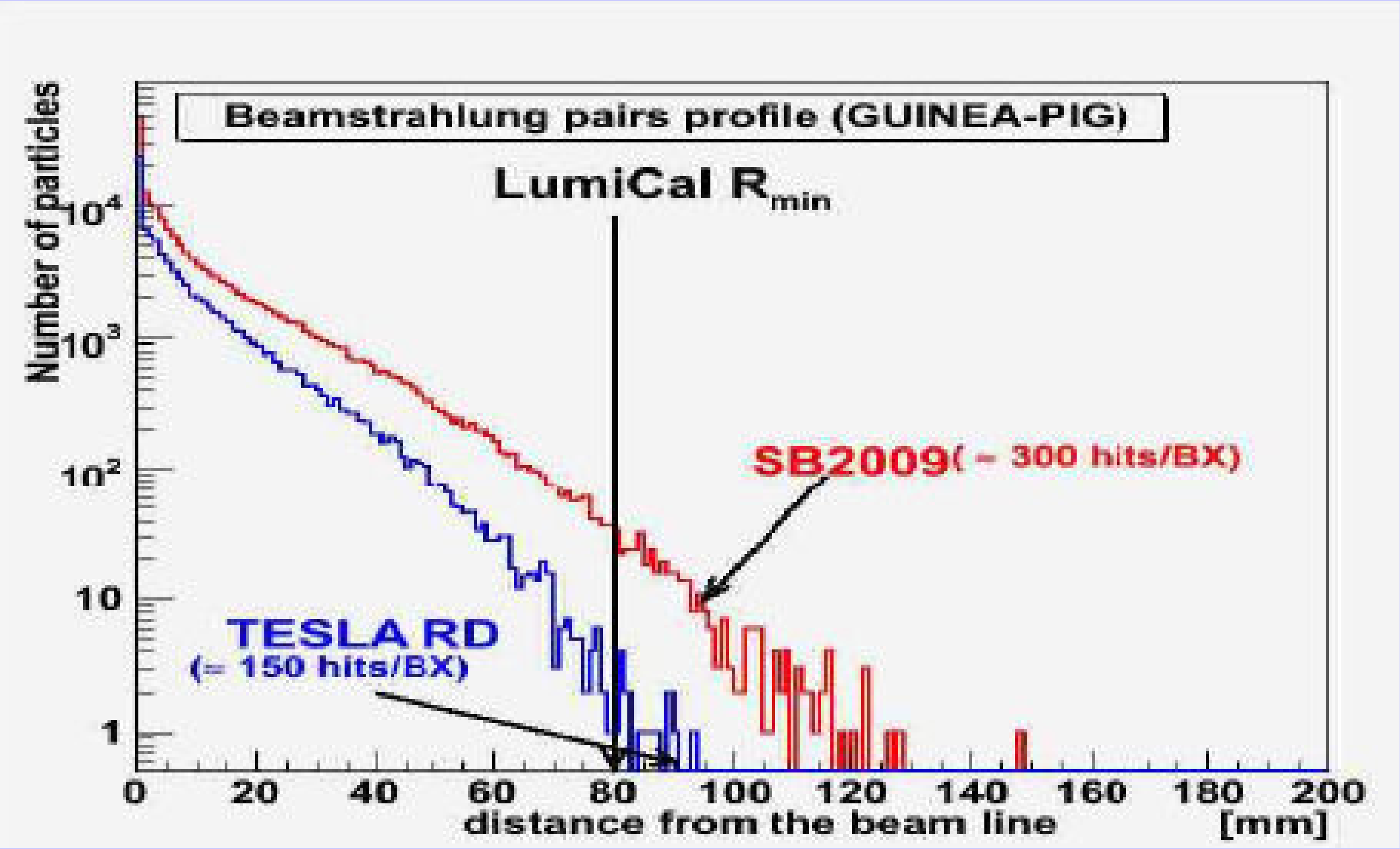


LumiCal



- Ongoing simulations to optimize detector design for
  - precise luminosity measurement,
  - hermeticity (electron detection at low polar angles),
  - assisting beam tuning (fast feedback of BeamCal data to machine)
- Challenges: radiation hardness (BeamCal), high precision (LumiCal) and fast readout (both)

Simulation Studies, impact of SB2009



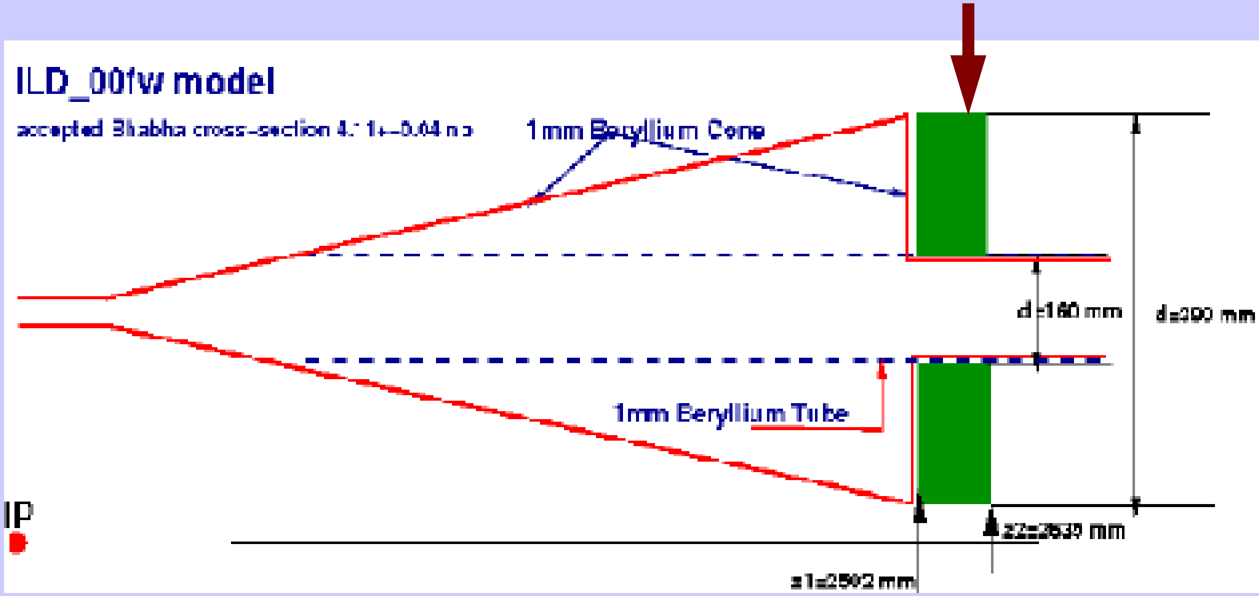
Background in LumiCal is enhanced

- Higher occupation,
- more (useless) data to read out

needs to be studied!

Simulation Studies, beam-pipe shape

LumiCal



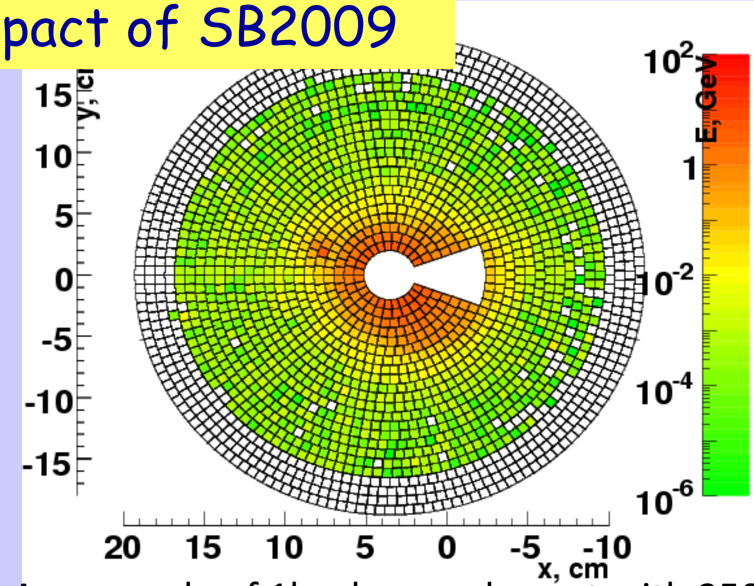
Simulation using 10^6 Bhabha events indicates no impact on the precision of the Lumi measurement

However: keep the konical volume empty

Simulation Studies, impact of SB2009

BeamCal load per BX by a factor of ~2 larger

- single high energetic electrons (photons) detection capability will become worse study: how much?



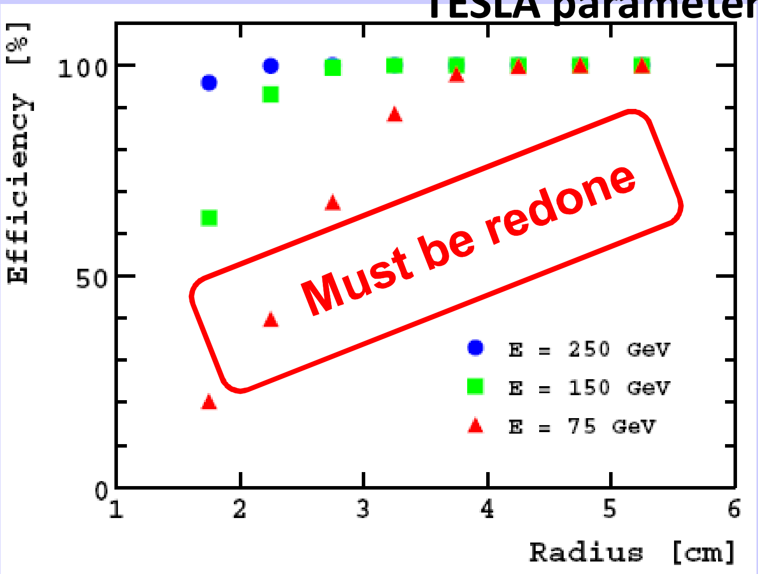
An example of 1background event with 250GeV single high energetic electron

Simulation tools:

- Guinea Pig
- BeCaS (a stand alone Geant4 BeamCal simulation programm)
- Mokka

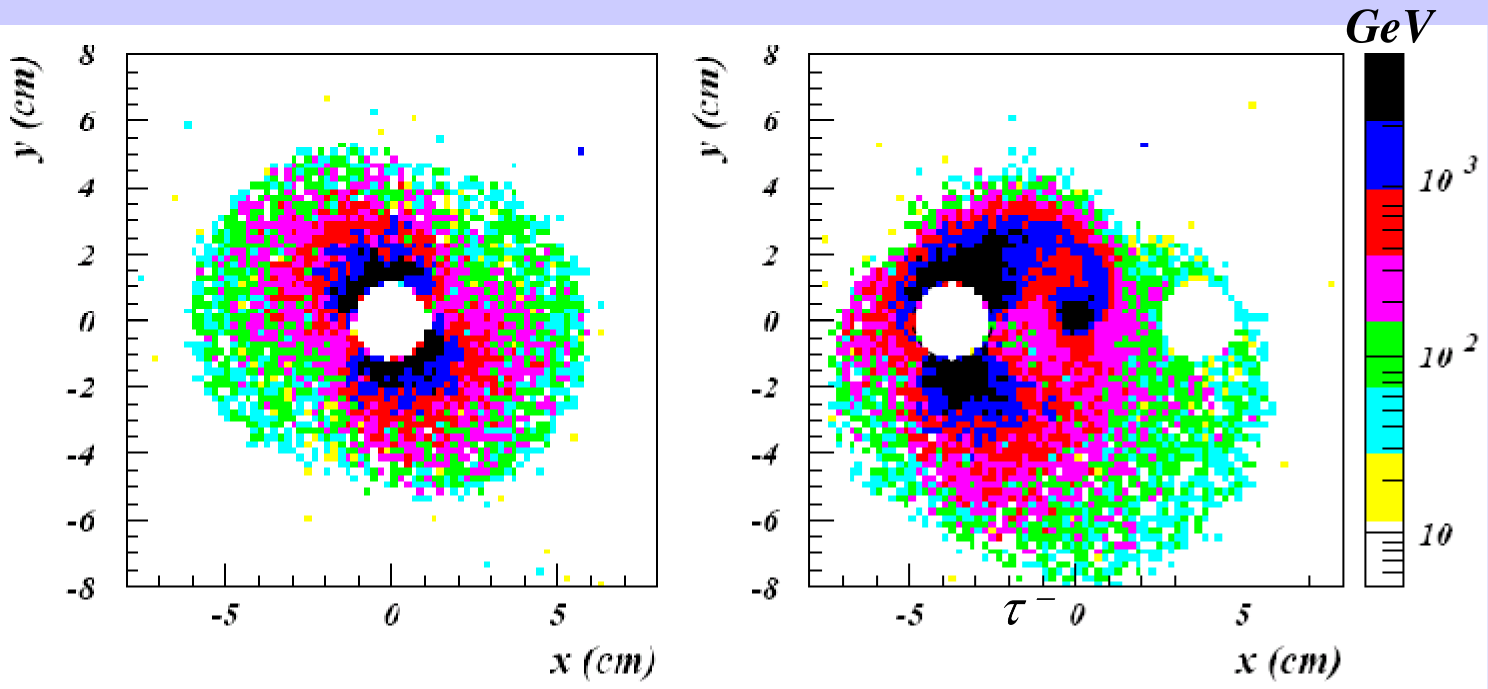
See talk by Bogdan Pawlik on the Software pre-meeting

TESLA parameters



Forward (BeamCal) Veto

- Identify energetic spectator e+ and/or e- from $\gamma\gamma$ events
- Complication from beamstrahlung

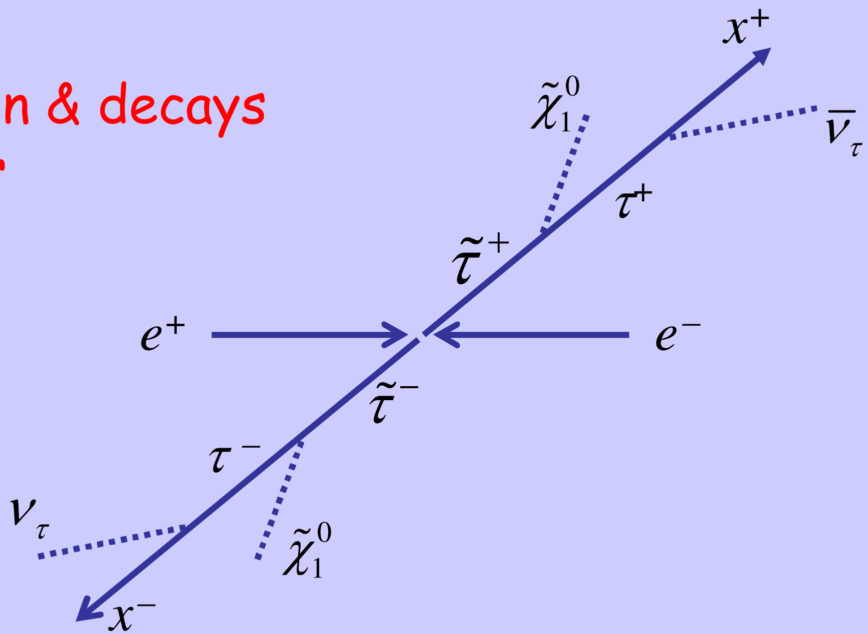


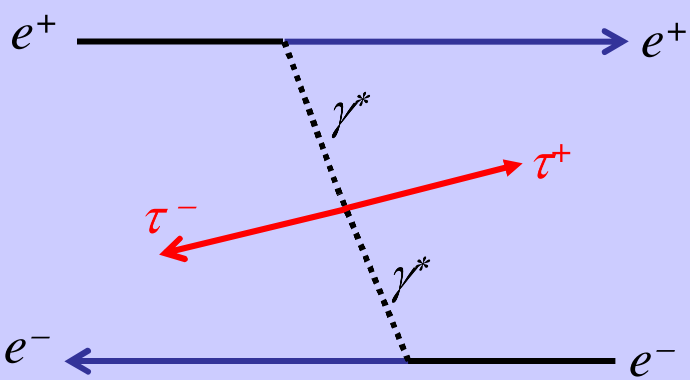
➔ Very challenging to have a radiation hard yet a very efficient BeamCal for e/γ ID

Zhiqing Zhang, LAL

Expected Signature at an ILC Detector

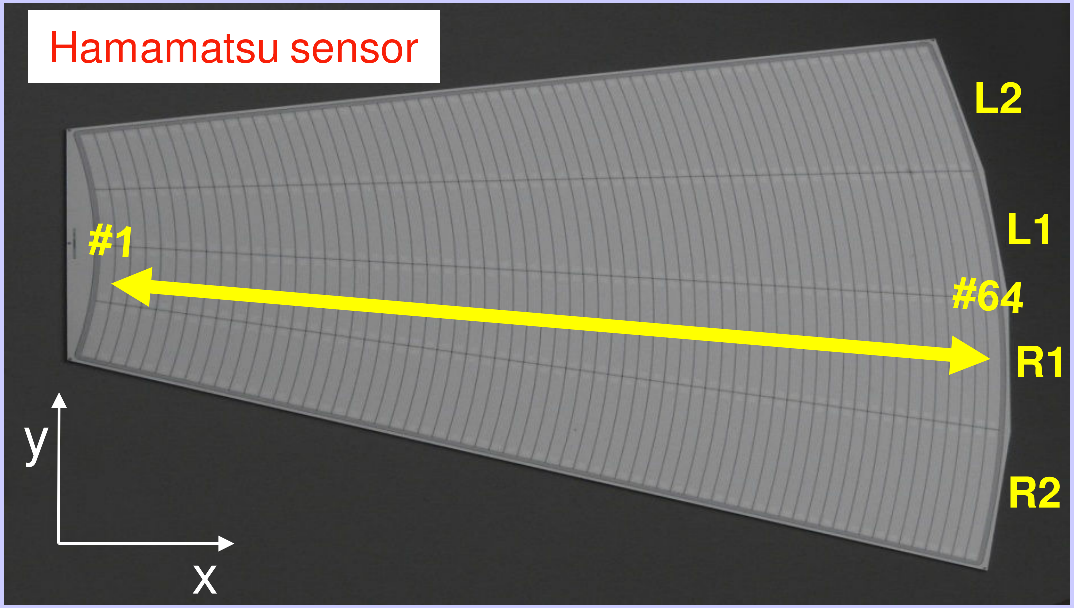
Stau production & decays
@ e+e- collider

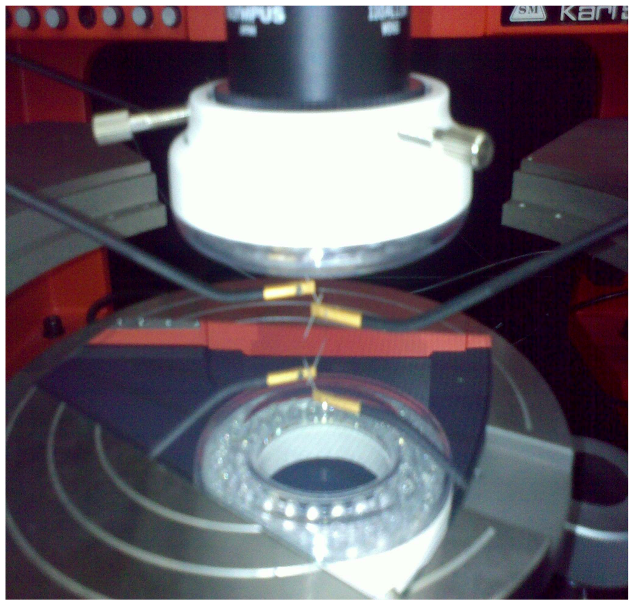




- Difficulty n° one:
  Missing energy from both LSP $\tilde{\chi}_1^0$
  and neutrino(s) in tau decay final state
- Difficulty n° two:
  Large SM background contributions

LumiCal sensors





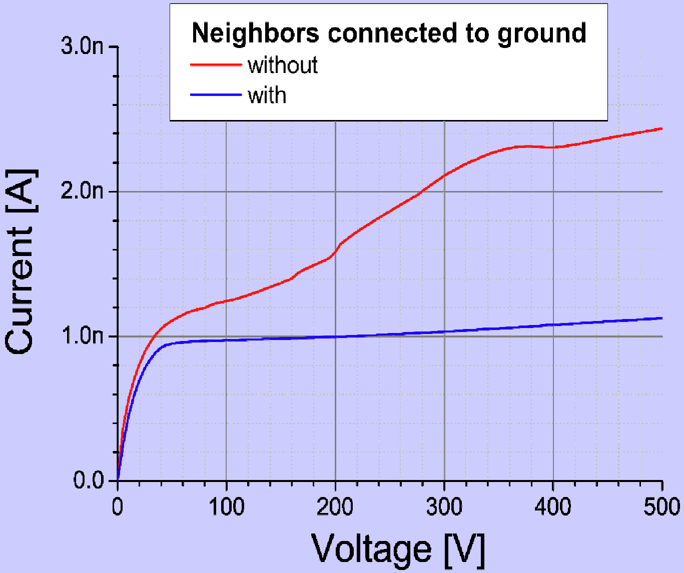
LumiCal: low irradiation load → silicon-tungsten sampling calorimeter

- ✓ Design (optimized geometry for luminosity measurement)
- ✓ Hamamatsu sensor prototypes (6", p in n, DC-coupled)

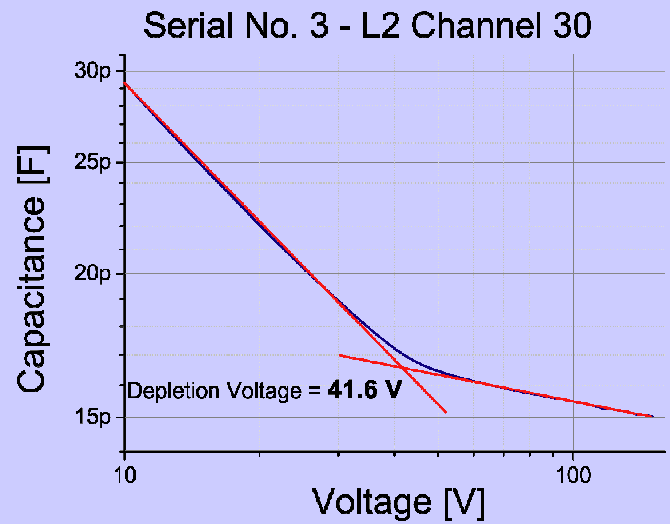
Measurements in Cracow, Zeuthen, Tel Aviv (cross calibration)

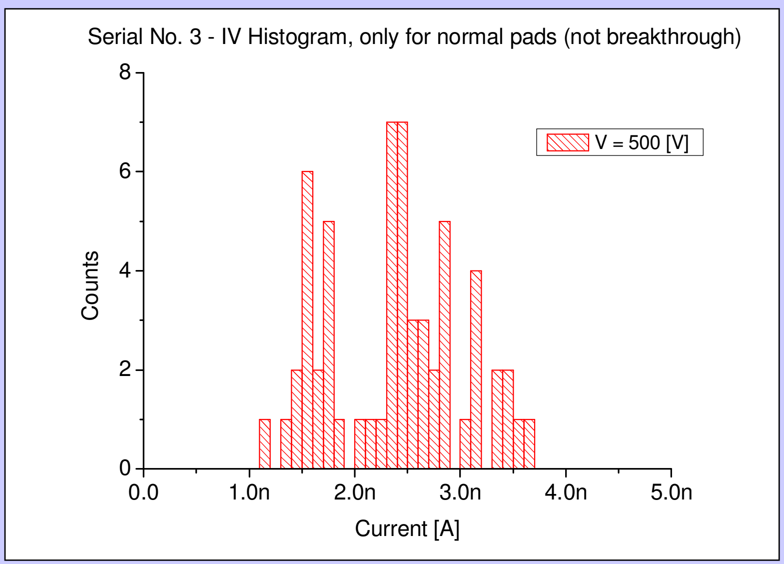
LumiCal sensors

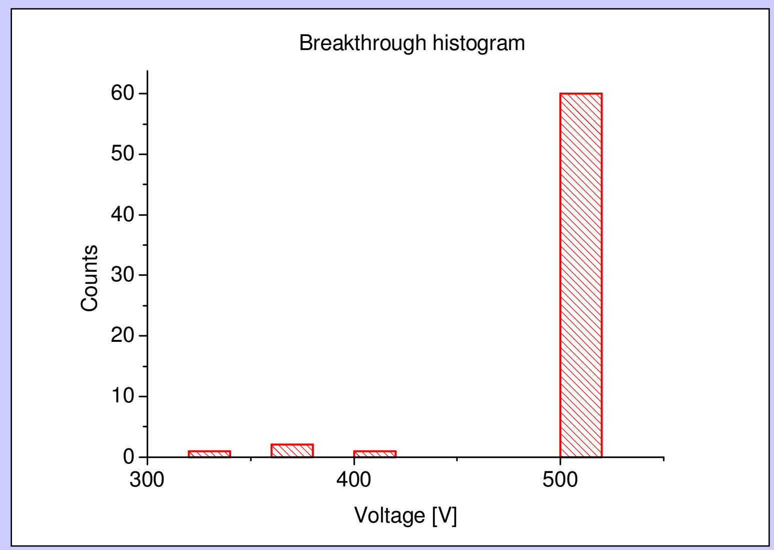
I/V Measurement



C/V Measurement







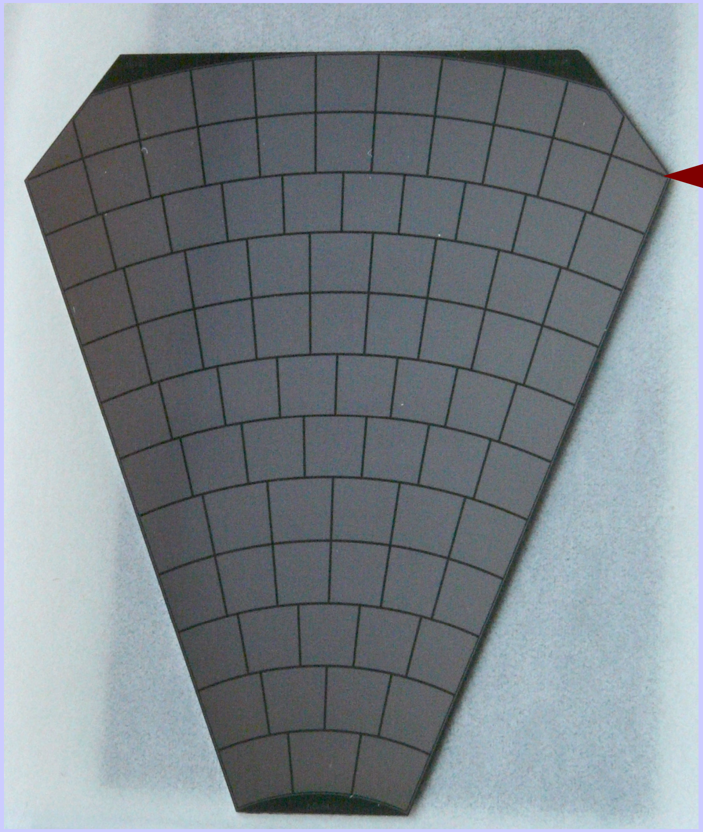
BeamCal sensors

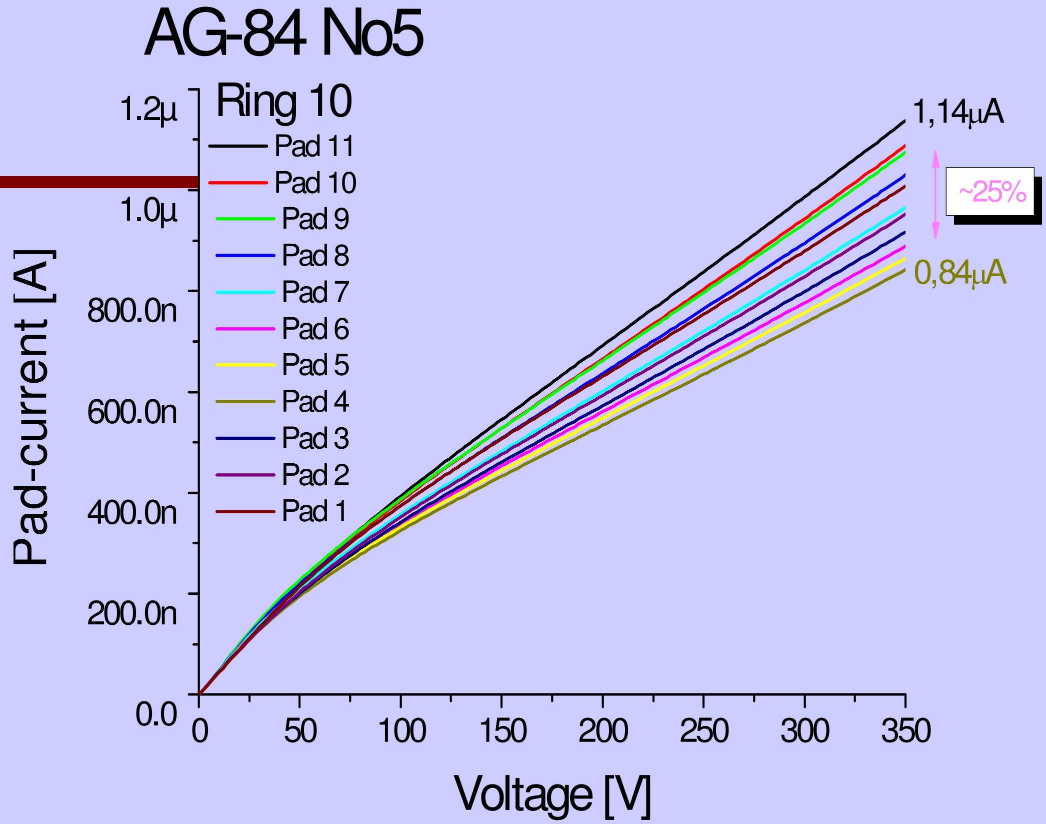
GaAs sensors, delivered by JINR

(produced in Tomsk, Sibirian Academy of Science)

500 μm thickness, 3 inch wafer, Au metallisation

Probe station measurements

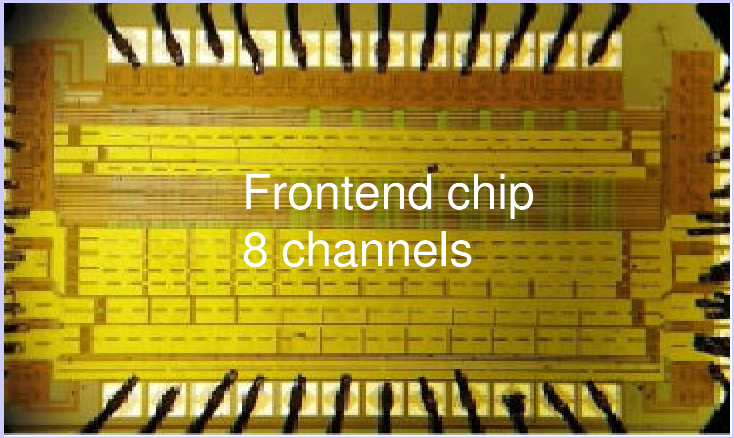


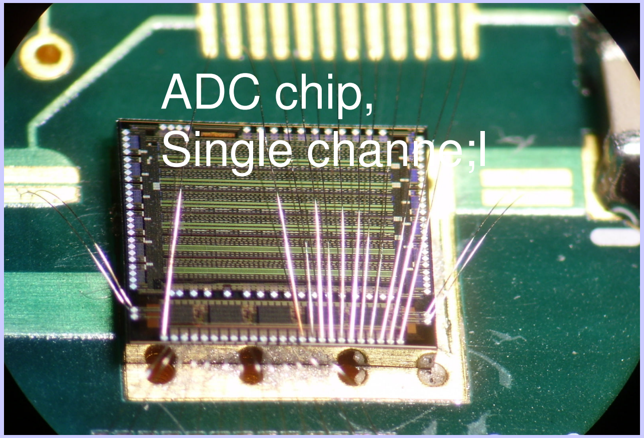


FE ASICs

- Frontend readout prototype chip developed at UST Cracow, manufactured in a MPW run (0.35 μm AMS)
- Measured (preliminary results) in Cracow and Zeuthen:
  - Noise ≈ 300 e^- (+ 28 e^-/pF), gain ≈ 35 mV/fC
- ADC prototype chip developed at UST Cracow, manufactured in a MPW run
- Measurements done in Cracow- matches the requirements
  - Resolution 10 bit,

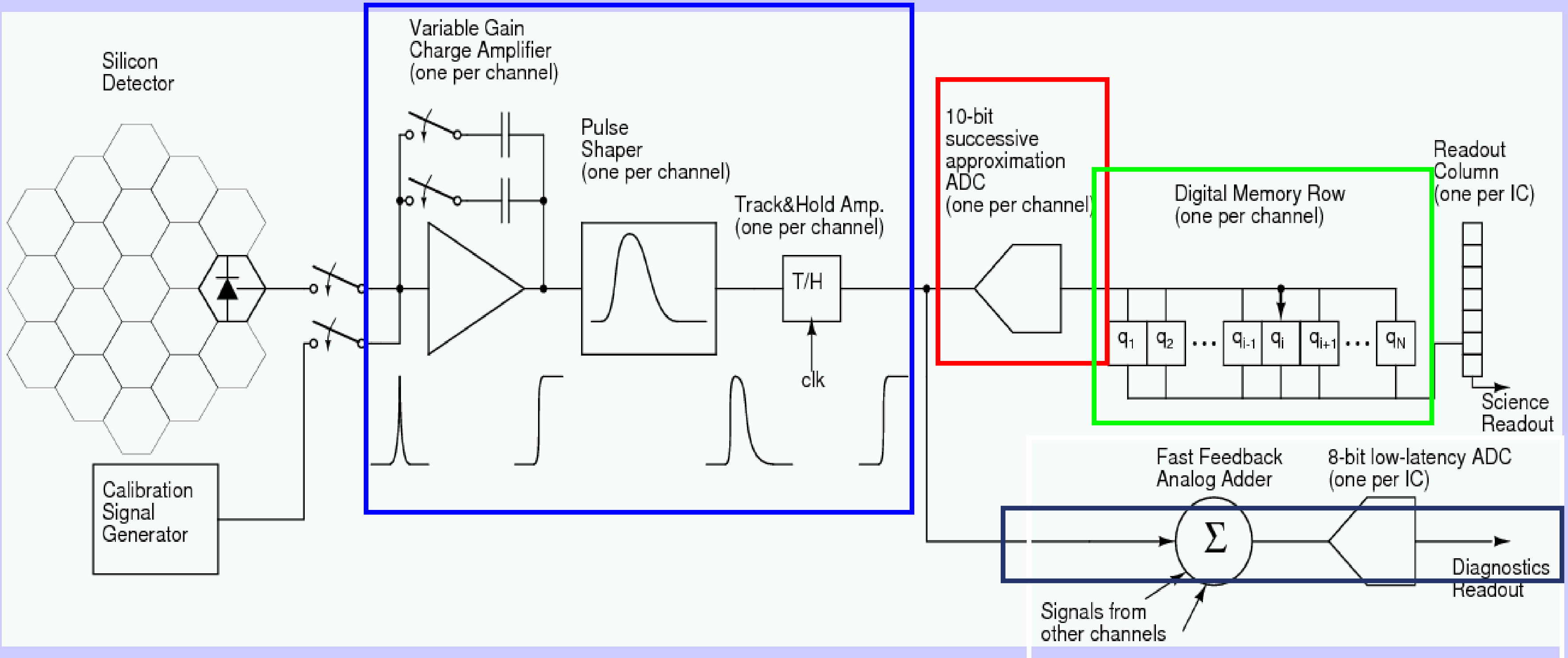
    S/N ≥ 58 dB up to 25 MHz ➛proof of principle (pipelined ADC)





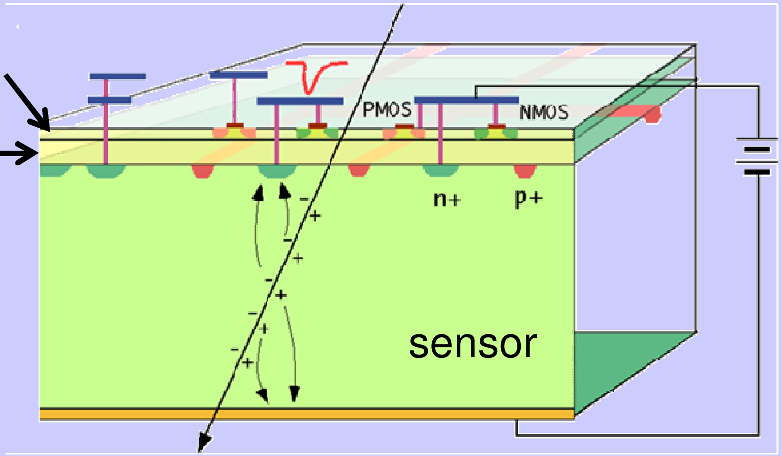
- 8 channel ADC: submission beginning of February

FE ASICs

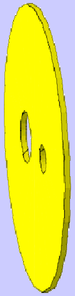


- Design at Stanford University (KPIX technology, 0.18 μm TSMC)
- readout between bunch trains ('science readout')
- prepared for fast feedback (diagnostics readout to machine)
- prototypes expected in 2010

Pair Monitor

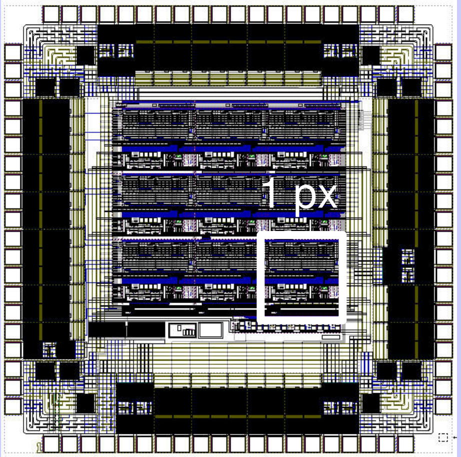


- Pixel size: 400 x 400 μm^2
- Radius: 10 cm
- Total number of pixels: ~**200,000**



→ Monolithic construction allows the elimination of the bump-bonding process.
- First step: design of a readout prototype ASIC for 3x3 pixels:
- digital readout (preamp, discriminator, counter)

- manufactured chip (CMOS 0.2 μm, SOI technology)
- performance measurements:
  - gain: ~ 17 mV/fC
  - noise: ~ 260 e^- (+ 130 e^-/pF) @ signals ~ 20000 e^-



Next steps in FCAL research

shortterm:

Full assembly of a Prototype Sector

- Sensors and ASICs connection (Cracow and DESY)
- DAQ (+Tel Aviv)
- Plan for a Beamtest in Summer at DESY

midterm:

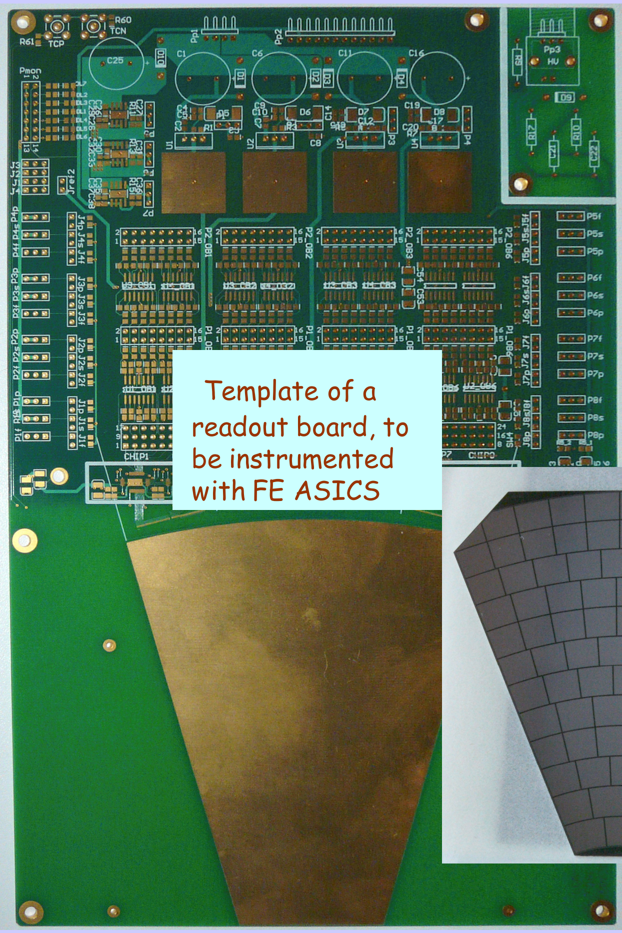
FP7 application (AIDA)

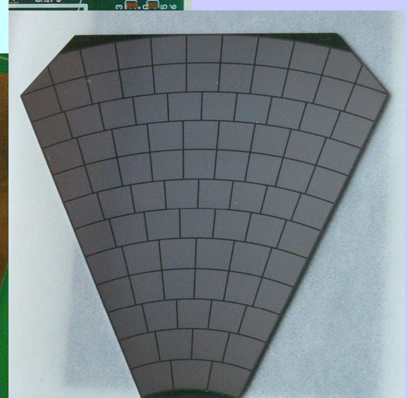
- Infrastructure to allow 'Physics studies" after 2012
- Cracow (2x), DESY, Tel Aviv (from EUDET)

  + VINCA and IFIN-HH (associats)

Readout/Fanout of sensors

System Test in a beam



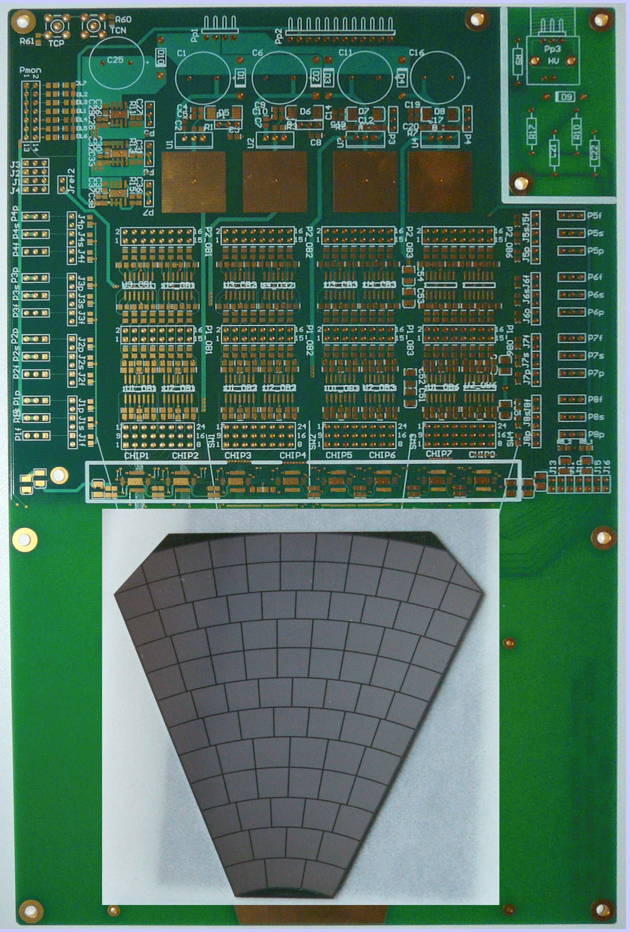


- fine pitch PCB, (100…200μm for current few channel FE chips)
- flexible PCB to be designed. matters of crosstalk & capacitive load
- wire bonding to pads (wire bonding needs ~ 3mm gap between absorber tiles)
- alternative connection techniques are investigated
- wire bonding to FE chip
- Silicon and GaAs sensor samples

FCAL Collaboration
High precision design

Shortterm Future

System Test in a beam



Readout/Fanout of sensors

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Midterm Future

FP7 Partners:

AGH-UST Cracow	**(Marek Idzik)**
CERN Geneva	**(Lucie Linsen)**
DESY Zeuthen	**(W. Lohmann)**
IFJPAN Cracow	**(L. Zawiejski)**
TAU Tel Aviv	**(H. Abramowicz)**

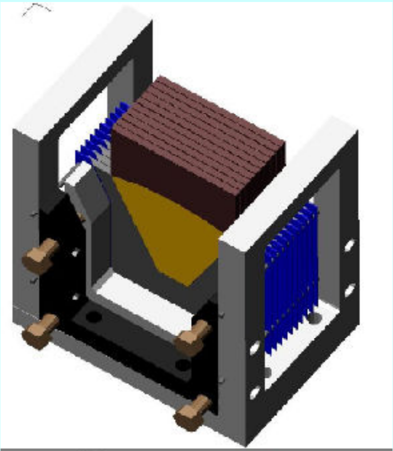
Infrastructure to tackle the scientific goal:

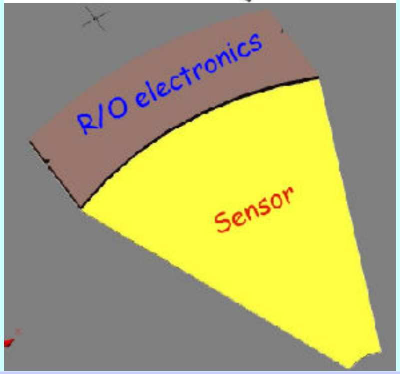
FCAL Specific infrastructure:

- Flexible, high precision tungsten structure
- Fast FE Readout
- Module construction and test devices (jigs, mechanics and electronics test facilities)
- Position control devices

Infrastructure common with others:

- Power pulsing
- Data acquisition
- Tracking in front of the calorimeter





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