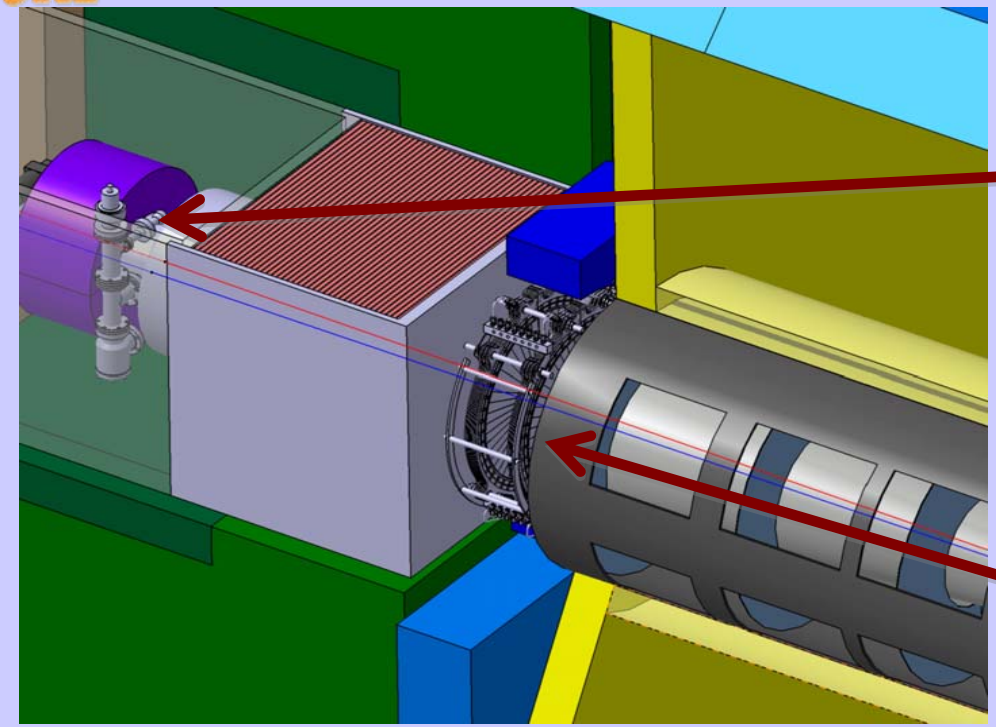
Introduction to the Cracow 2010 FCAL Meeting

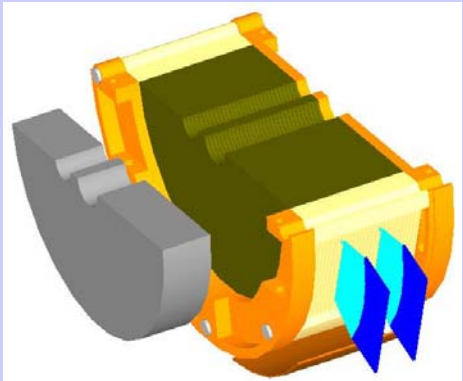
- ILCollider Planning
- Simulation studies, also CLIC planning
- Sensors
- FE ASICs
- System Tests
- short- and midterm plans

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.)

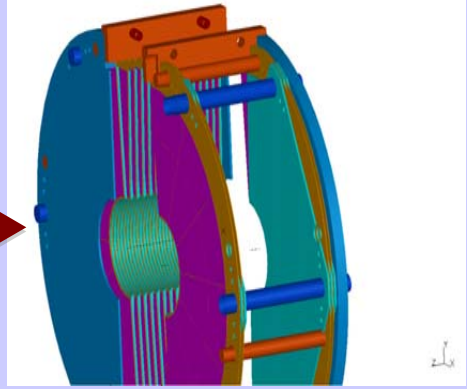
Very forward detectors- challenges



BeamCal + Pair Monitor



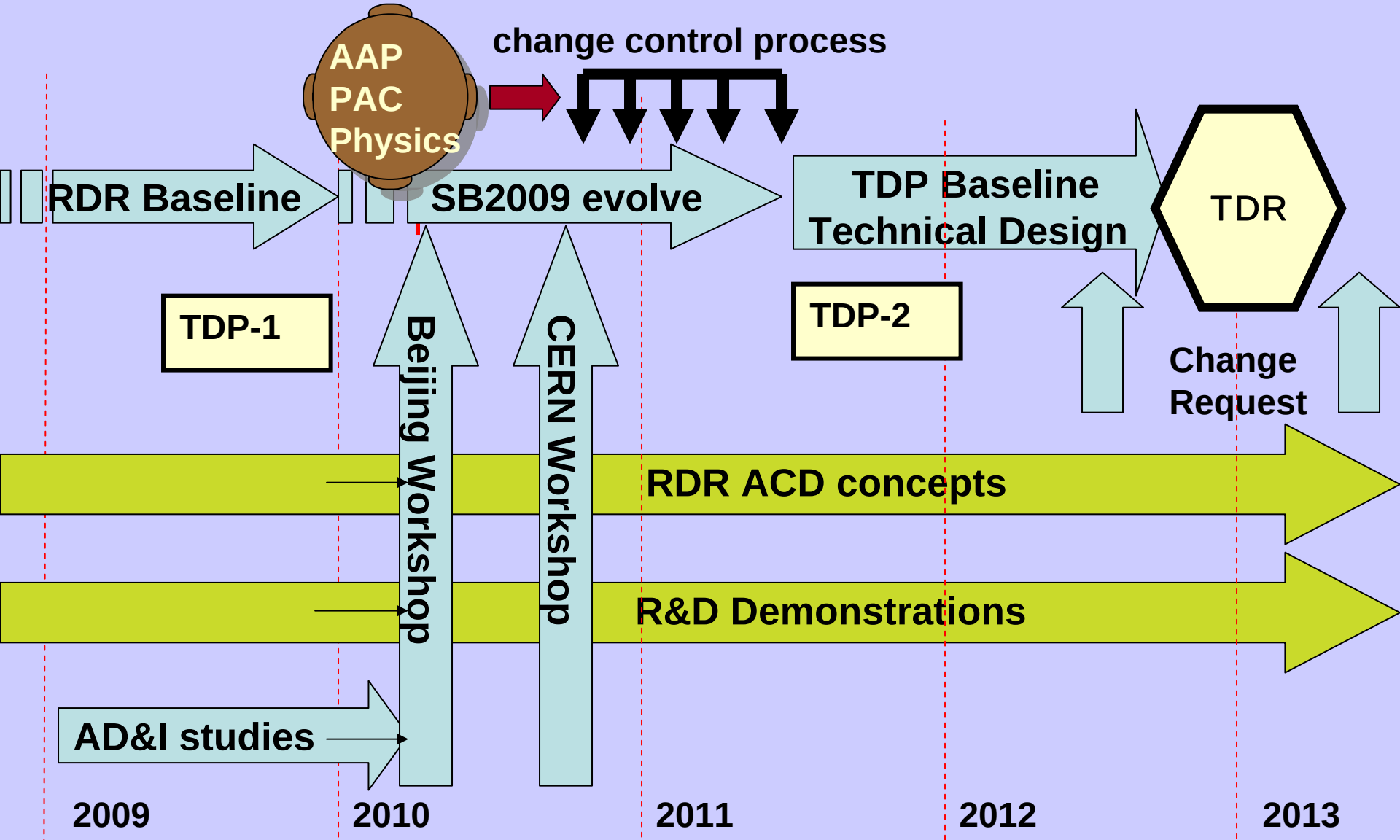
LumiCal



- 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)

Our Goal – Develop Technological Solutions to tackle the Challenges

ILD Planning



Simulation Studies to Refine the Design

BeamCal: Electron Detection Capability
SB2009 beam parameter, no anti DID??

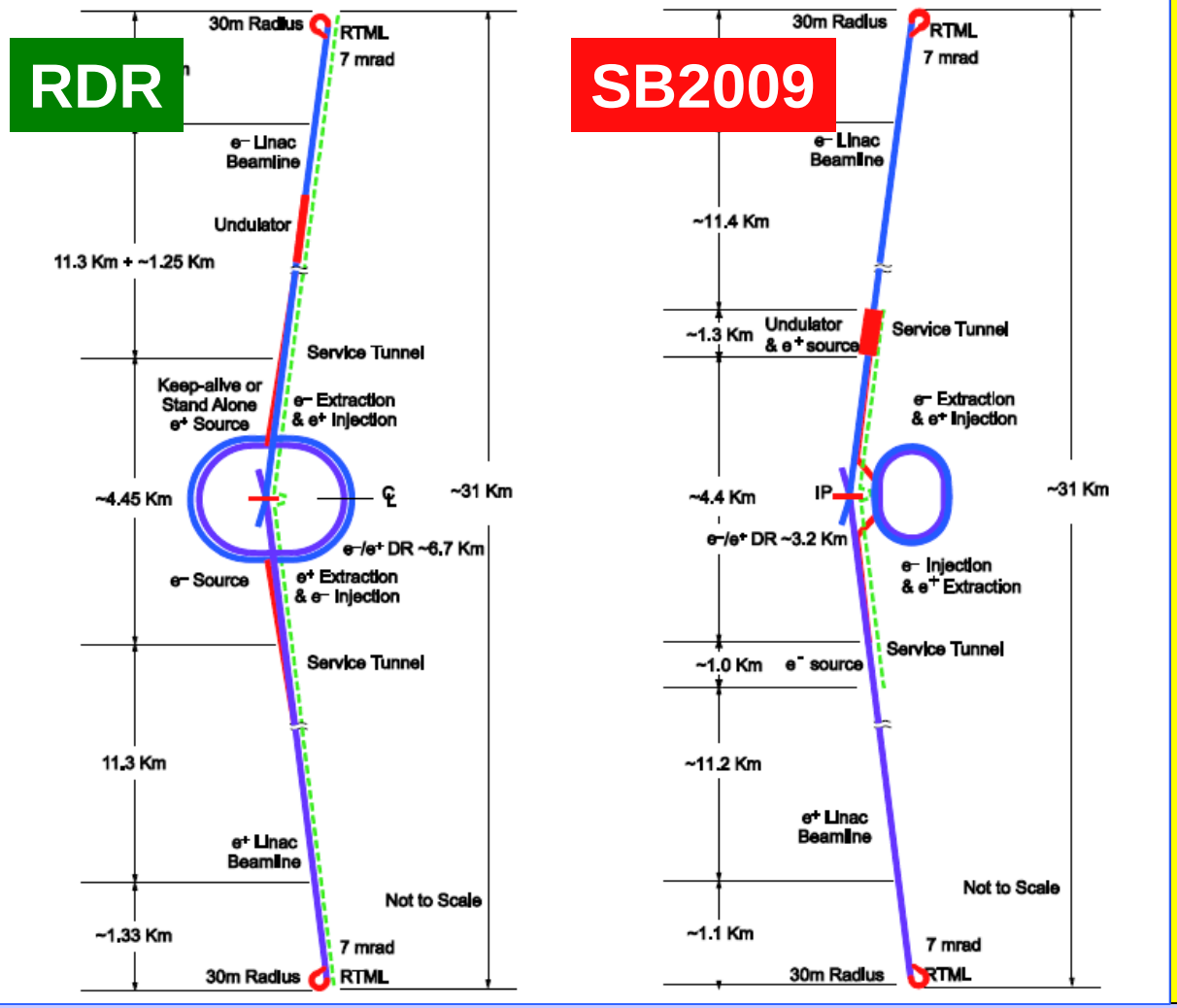
LumiCal: Larger Background for SB2009, possibly no anti-DID, larger inner radius

Both: - exercise of a calibration concept, using muons and Bhabhas

- Conceptual design at 1 TeV, CLIC Design at 3 TeV

CLIC CDR in 2011 !!

New Collider Layout



- Single Tunnel for main linac
- Move positron source to end of linac ***
- Reduce number of bunches factor of two (lower power) **
- Reduce size of damping rings (3.2km)

- Integrate central region
- Single stage bunch compressor

New Beam Parameters

	RDR			SB2009 w/o TF				SB2009 w TF			
CM Energy (GeV)	250	350	500	250.a	250.b	350	500	250.a	250.b	350	500
Ne- ($*10^{10}$)	2.05	2.05	2.05	2	2	2	2.05	2	2	2	2.05
Ne+ ($*10^{10}$)	2.05	2.05	2.05	1	2	2	2.05	1	2	2	2.05
nb	2625	2625	2625	1312	1312	1312	1312	1312	1312	1312	1312
Tsep (nsecs)	370	370	370	740	740	740	740	740	740	740	740
F (Hz)	5	5	5	5	2.5	5	5	5	2.5	5	5
γex ($*10^{-6}$)	10	10	10	10	10	10	10	10	10	10	10
γey ($*10^{-6}$)	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
βx	22	22	20	21	21	15	11	21	21	15	11
βy	0.5	0.5	0.4	0.48	0.48	0.48	0.48	0.2	0.2	0.2	0.2
σz (mm)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
σx eff ($*10^{-9}$ m)	948	802	639	927	927	662	474	927	927	662	474
σy eff ($*10^{-9}$ m)	10	8.1	5.7	9.5	9.5	7.4	5.8	6.4	6.4	5.0	3.8
L (10^{34} $cm^{-2}s^{-1}$)	0.75	1.2	2.0	0.2	0.22	0.7	1.5	0.25	0.27	1.0	2.0

- **(Tentative!) At 250 GeV CM the mitigations may give:**
  - x 2 L due to double rep rate
  - x ~ 1.4 L due to FD optimized for low E

Simulation Studies to Refine the Design

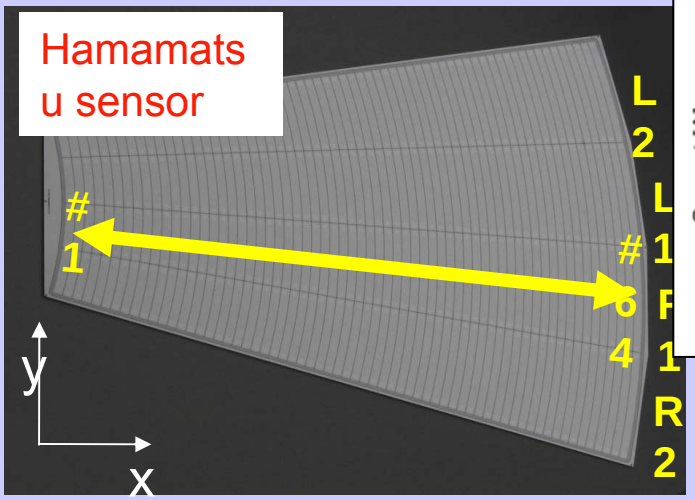
Where are we to prepare the DBD (Detector TDR) in 2012/13 ??

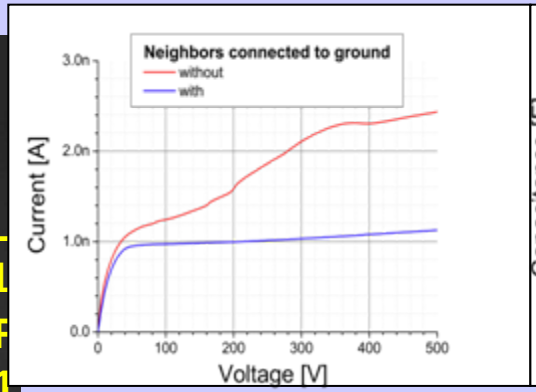
LumiCal sensors

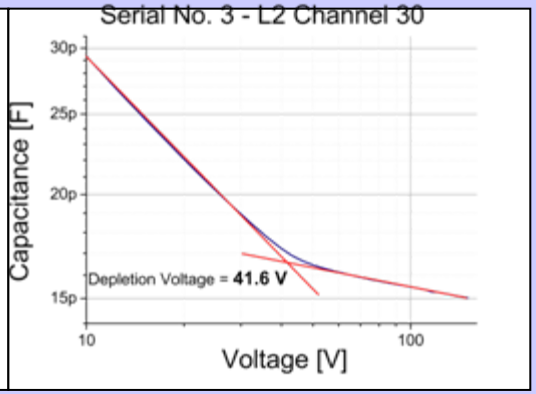
LumiCal: low irradiation load → silicon-tungsten sampling calorimeter

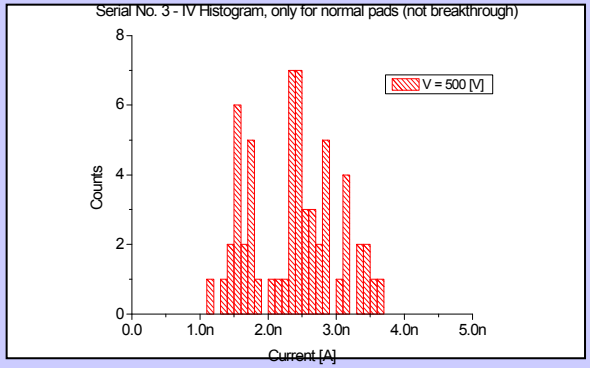
- ✓ Design (optimized geometry for luminosity measurement)
- ✓ Hamamatsu sensor prototypes (6", p in n, DC-coupled)

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









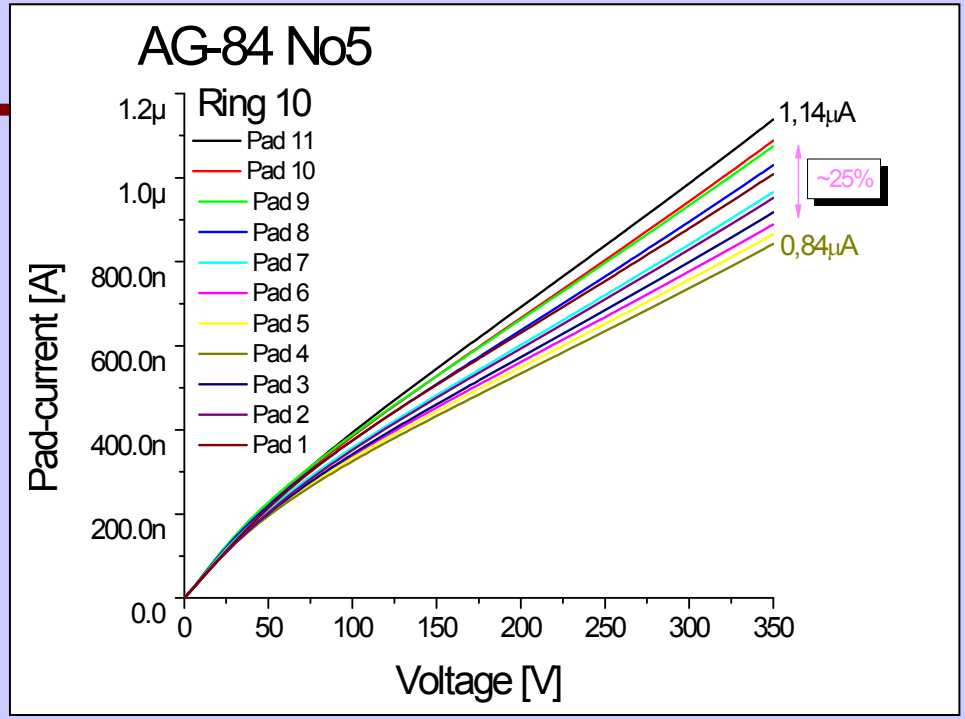
BeamCal sensors

GaAs sensors, delivered by JINR

(produced in Tomsk, Sibirian Academy of Science)

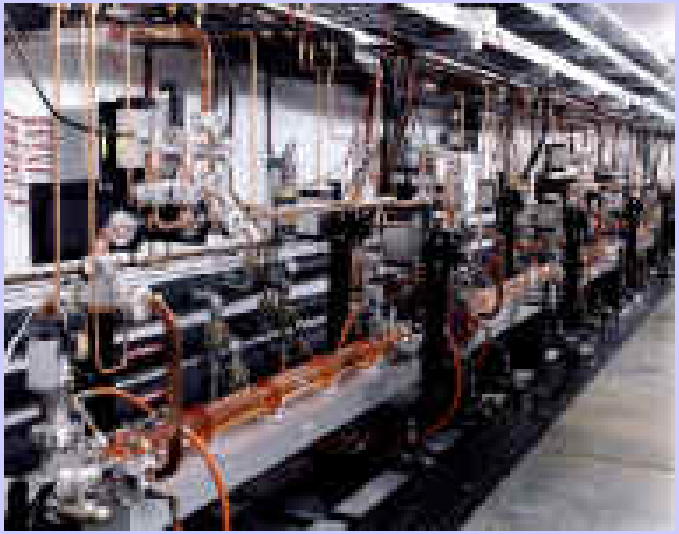
500 μm thickness, 3 inch wafer, Au metallisation

Probe station measurements



BeamCal sensors

Rad. Hard Silicon sensor tests at the NLCTA beam (150-200 MeV electrons)



SLAC and
UC Santa Cruz

SENSOR
DUMMY

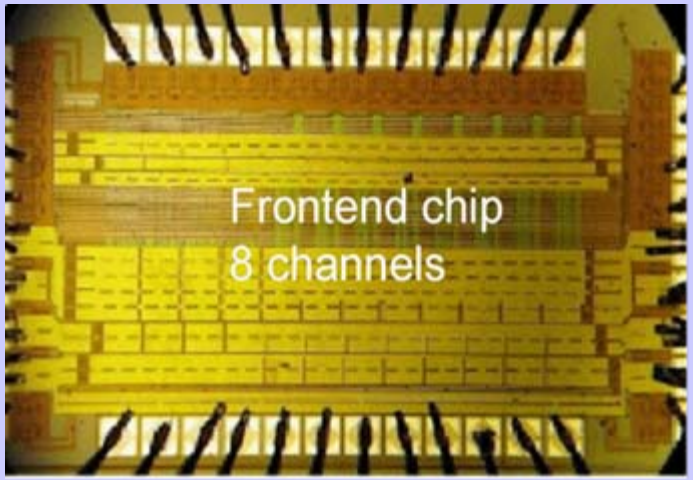
n- and p-type float-zone and magnetic Czochralski sensors

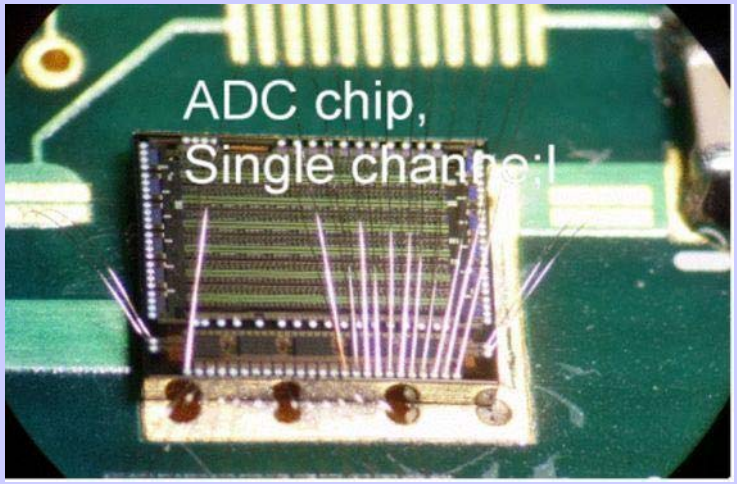
Create neutron flux by absorber

See also the talk by Bruce Schumm in the MDI session

FE ASICs, LumiCal

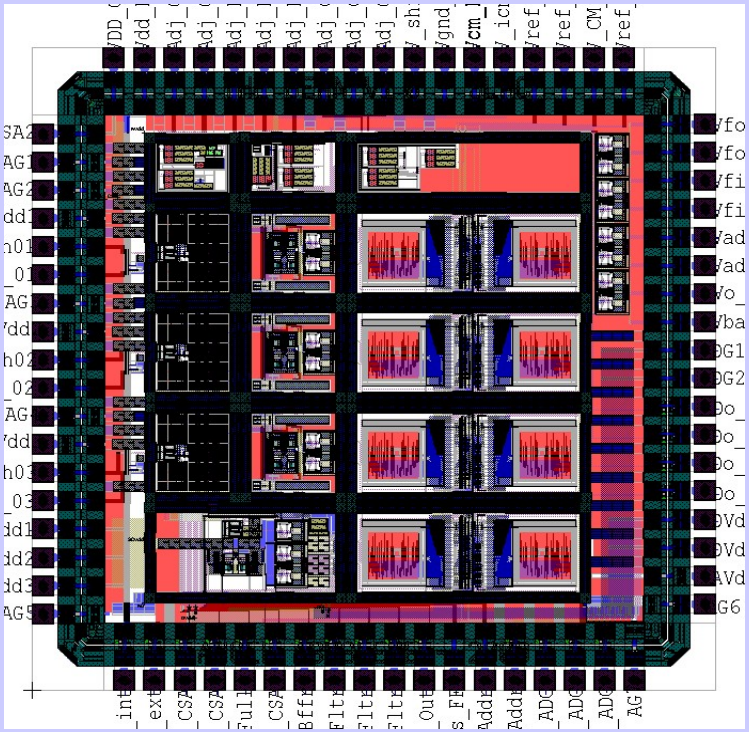
- Frontend readout prototype chip developed at UST Cracow, manufactured in a MPW run (0.35 μm AMS)
- Measured (preliminary results) in Cracow and Zeuthen:
  - Noise ≈ 300 e^- (+ 28 e^-/pF), gain ≈ 35 mV/fC
- ADC prototype chip developed at UST Cracow, manufactured in a MPW run
- Measurements done in Cracow- matches the requirements
  - Resolution 10 bit,
    S/N ≥ 58 dB up to 25 MHz ➡ proof of principle (pipelined ADC)

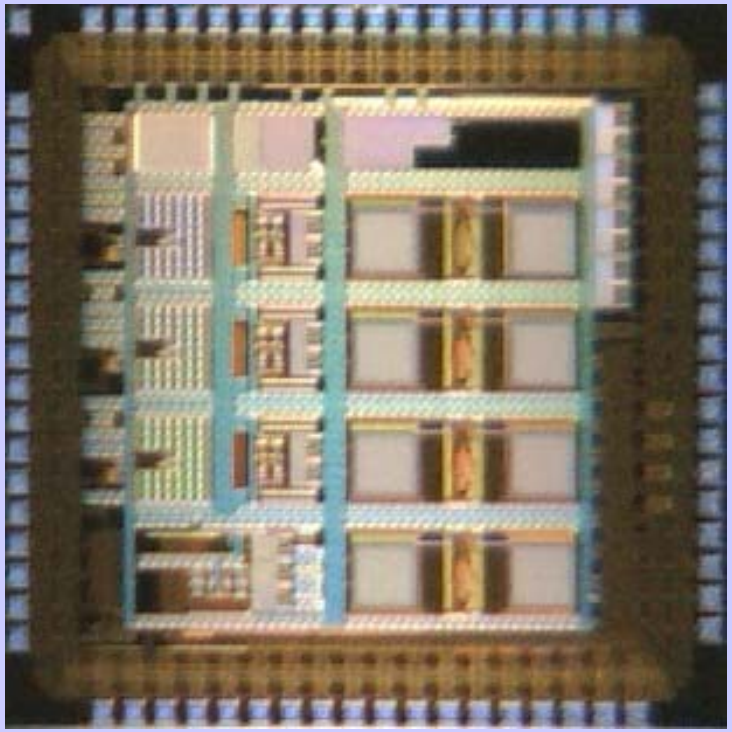




- 8 channel ADC: submission done beginning of February

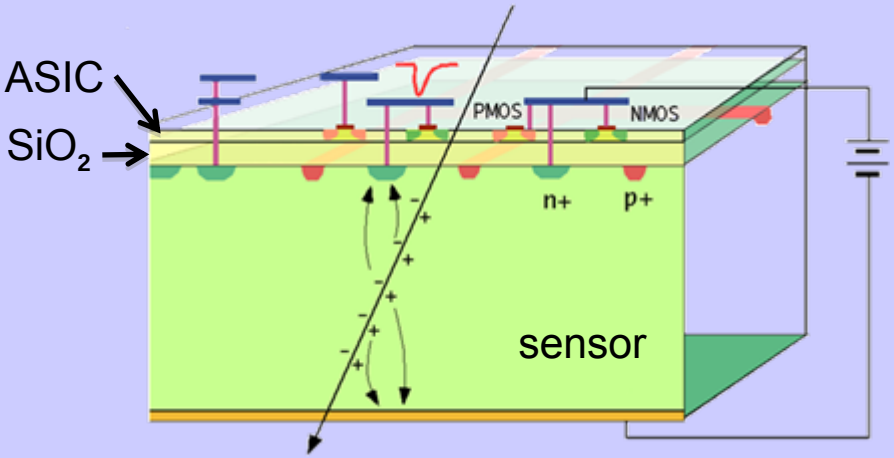
FE ASICs, BeamCal





- TSMC 0.18um, 1.8V
- 72 pads, 2.4mm x 2.4mm (incl. pads)
- 7306 nodes, 35789 circuit elements
- 3 charge amplifiers, 4 x 10-bit, fully diff. SAR ADCs, 1 SC adder, 3 SC filters

Pair Monitor

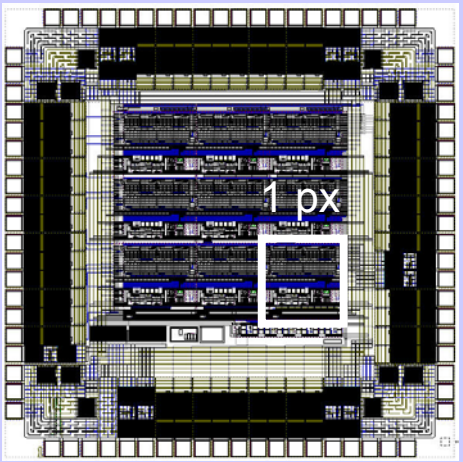


- Pixel size: 400 x 400 μ m^2
- Radius: 10 cm
- Total number of pixels: **~200,000**

→ 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 μ m, SOI technology)
- performance measurements:
  - gain: ~ 17 mV/fC
  - noise: ~ 260 e$^-$ (+ 130 e$^-$/pF) @ signals ~ 20000 e$^-$



Next steps in FCAL R&D

shortterm:

Full assembly of a Prototype Sector

- Sensors and ASICs connection (Cracow, DESY, help from other labs)
- DAQ (+Tel Aviv, CERN)
- Goal: 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)
- Test of KPiX (Stanford, Santa Cruz)

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