Report to the IB

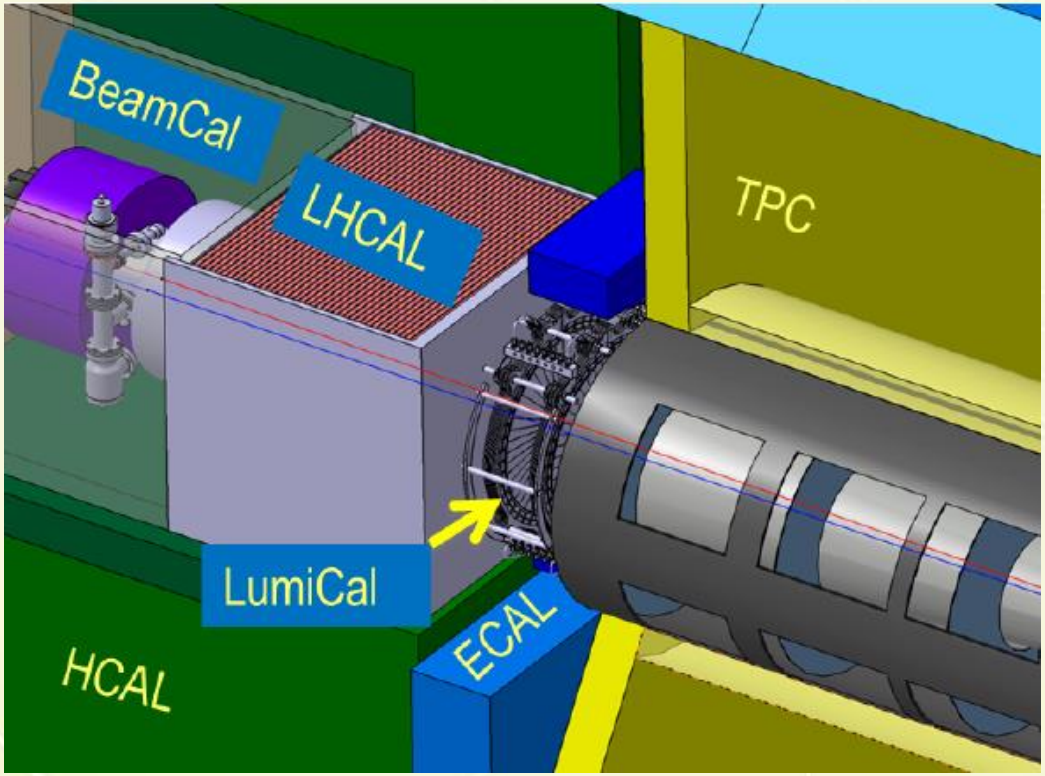
Wolfgang Lohmann, BTU, DESY and RWTH

FCAL workshop DESY Hamburg, Octobre 2018

FCAL Goals

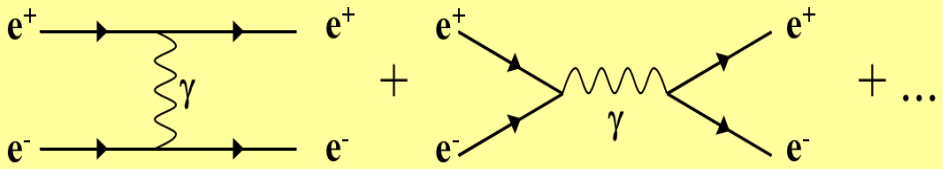
R&D for novel detector technologies to:

- Measure precisely the luminosity in future collider, main focus on e^+e^-
- Instrument the region near the beam-pipe for beam optimization and masking from background, Design and R&D

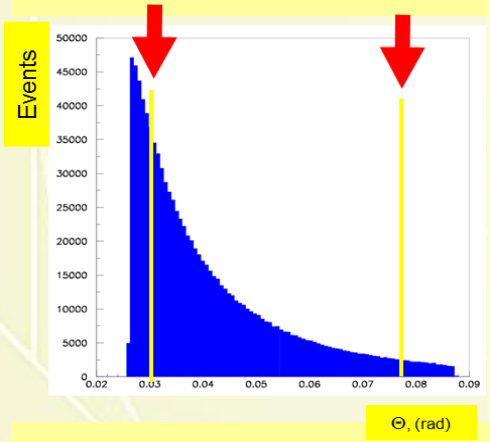


Precise and Fast Luminosity Measurement

Development of algorithms to measure Bhabha scattering



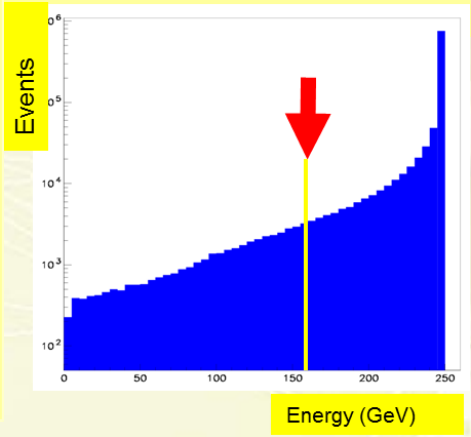
- Understand the luminosity spectrum
- Estimate background processes
- Input from theory



$$\mathcal{L} = N / \sigma$$

Count Bhabha events

From theory

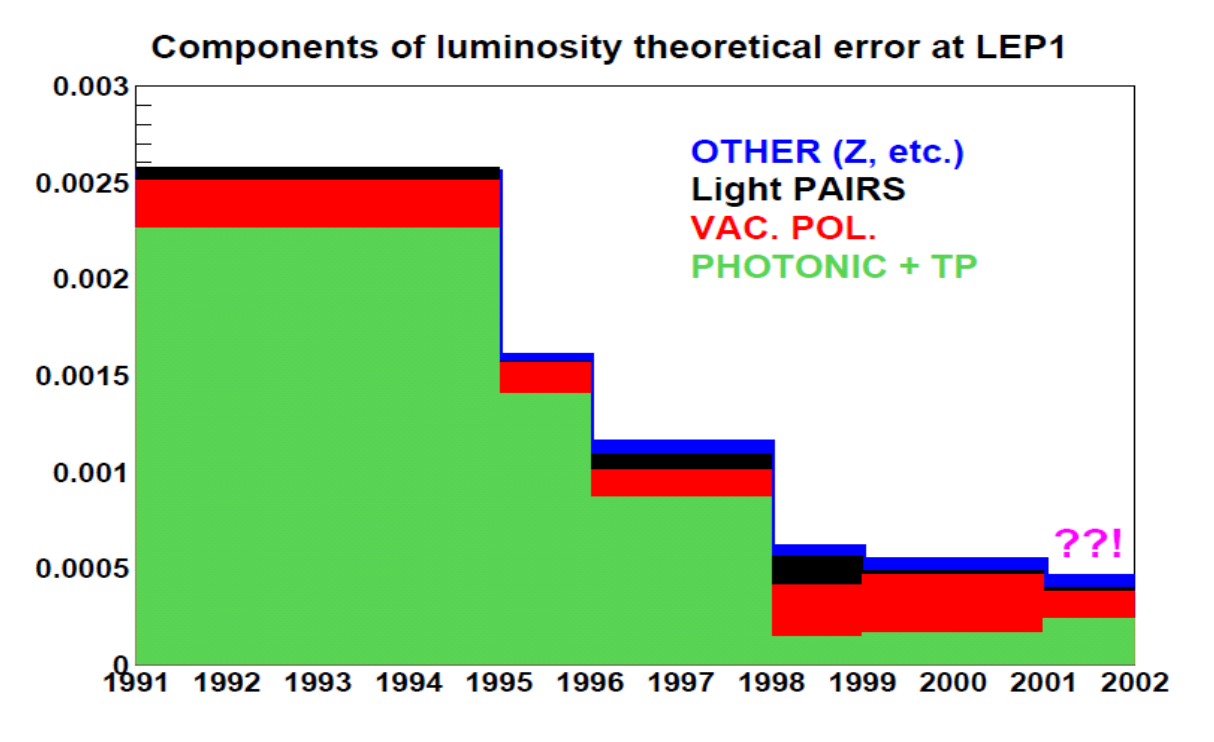


Exploit beamstrahlung depositions for beam-tuning

Contribute to the physics program

Bhabha Scattering, Theory Status

Theory uncertainties in the Bhabha cross section at LEP1 (S. JADACH, FCAL workshop Cracow 2006):



There is a lack of MC generators optimized for higher energies. Activities e.g. in JINR and University of Minsk may be interesting for us for application

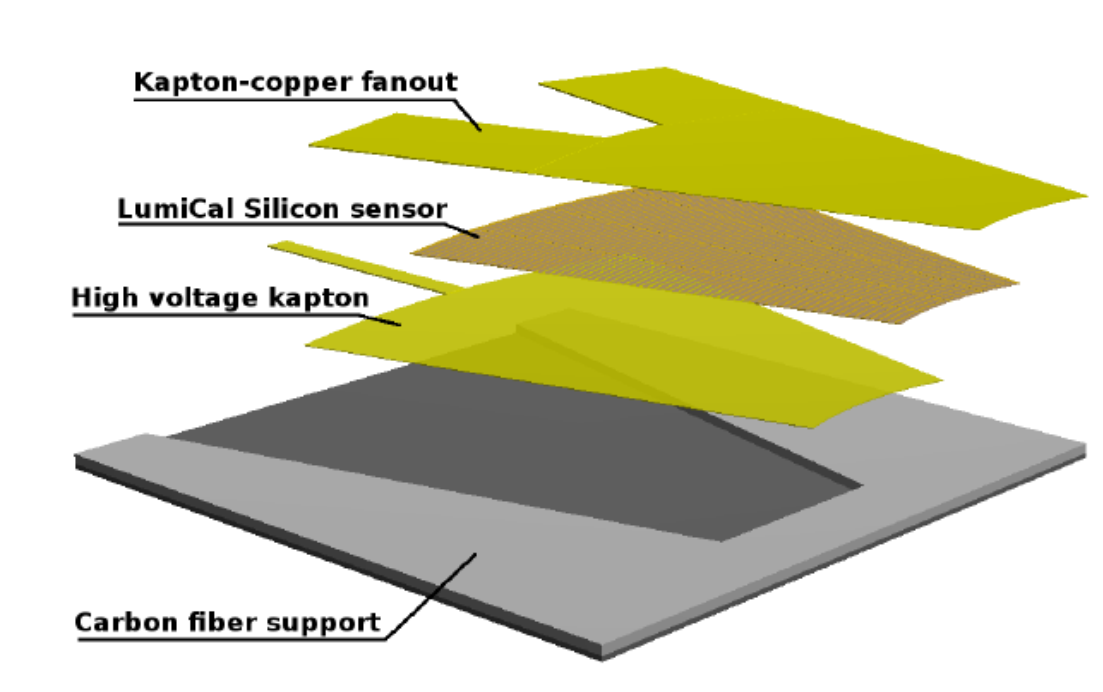
R&D Challenges

highly compact calorimeter

- Moliere radius down to the ‘’technological limit” by using very thin detector planes, based on new connectivity technology (e.g. bump bonding, thin fan-out PCB) → examples exist

radiation hard sensors for BeamCal

→ studies ongoing, new concept for BeamCal

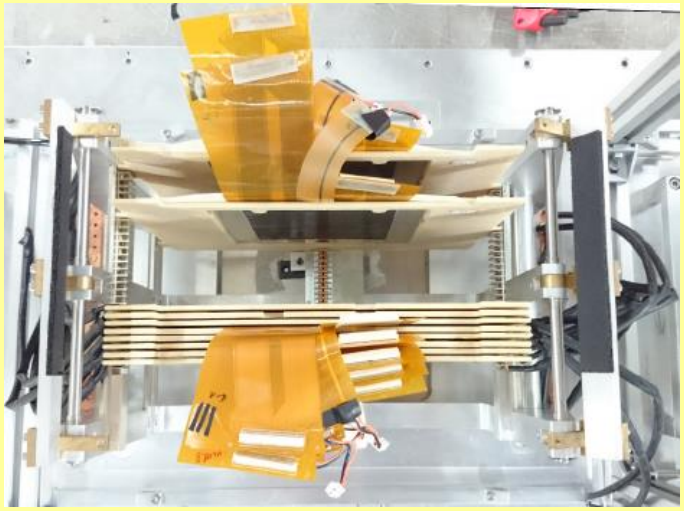


R&D Challenges

construction of a demonstrator calorimeter

- completion of the mechanical structure (+laser alignment)
- production of sufficient ASICs in 130 nm technology
- demonstration of power pulsing
- readout board with data concentrator and data transfer

→ much work to be done



beam tests

- Energy resolution (luminosity spectrum)
- spatial resolution (angular spectrum)
- bias in the angular measurements (systematic shift to be quantified)

Status of the Demonstrator

Major Topic: demonstrator for beam tests (2019/20)

- Sensors (available, but to be qualified)
- Absorber planes (available, but need mechanical integration)
- Detector plane (technology available, production to be done)
- ASICs (to be produced), APV25 with charge devider as second option
- DAQ with FPGA in preparation
- Laser alignment?

Test-beam: since CERN is not providing test-beam in 2019/20, should try get beam-time at DESY, .

Publications

- Presence on conferences was very good, e.g. ICHEP
- publication in „The European Physical Journal C“ to be finalised

Molière radius measurement using a compact prototype of LumiCal in a test set-up

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Molière radius measurement using a compact prototype of LumiCal in a test set-up

H. Abramowicz[1], A. Abusleme[2], K. Afanaciev[3], Y. Benhammou[1], L. Bortko[a,4], O. Borysov[1], M. Borysova[b,1], I. Bozovic-Jelisavcic[5], G. Chelkov[6], W. Daniluk[7], D. Dannheim[8], K. Elsener[8], M. Firlej[9], E. Firu[10], T. Fiutowski[9], V. Ghenescu[10], M. Gostkin[6], M. Hempel[a,4], H. Henschel[4], M. Idzik[9], A. Ignatenko[c,3], A. Ishikawa[11], A. Joffe[1], S. Kananov[1], O. Karacheban[a,4], W. Klempt[8], S. Kotov[6], J. Kotula[8], D. Kozhevnikov[6], V. Kruchonok[6], B. Krupa[7], Sz. Kulis[8], W. Lange[4], J. Leonard[4], T. Lesiak[7], A. Levy[1], I. Levy[1], W. Lohmann[a,4], S. Lukic[5], J. Moron[9], A. Moszczynski[7], A.T. Neagu[10], F.-X. Nuiry[8], M. Pandurovic[5], B. Pawlik[7], T. Preda[10], O. Rosenblat[1], A. Sailer[8], B. Schumm[12], S. Schuwalow[d,4], I. Smiljanic[5], P. Smolyanskiy[6], K. Swientek[9], P. Terlecki[9], T. Wojton[7], H. Yamamoto[11], L. Zawiejski[7], I.S. Zgura[10], A. Zhemchugov[6]

- More papers on irradiation studies ?

Other Publications

Contributions to the

- LCC Detector R&D Liaison Report
- CLIC detector paper

FCAL: Development of highly compact and precise luminometers

1 Motivation for Forward Calorimetry at Linear Collider Detectors

Forward calorimters at linear collider detectors are indispensable to measure precisely a key quantity needed to convert count rates in cross sections, the luminosity. The gauge process is low angle Bhabha scattering, which can be calculated with high precision in Quantum Electrodynamics. Since Bhabha scattering has a very steep dependence on the polar angle, an excellent angular resolution is required for its measurement, making the mechanical precision of the device and the granularity to a challenge. Very forward calorimeters are also foreseen for beam tuning in a fast feedback system to maximise the luminosity during data taking. Last but not least, forward calorimeters increase the angular coverage of the detector, improving such the missing energy measurement, important e.g. for Beyond Standard Model (BSM) phenomena resulting in low momentum particles in their decay chain.

Never finished topics

- Calibration and alignment with muons (MC to be done)
- CLIC timing, FE, readout, background → impact on performance
- BeamCal/LumiCal performce in the new ILD software

FCAL Funding

Europe

- National funding Agencies
- AIDA 2020 (2020)
- current JINR-BMBF program ends 2017, new application written, pending

Chile

- Angel got a grant

US ???

Japan

- application not successful

Particularly difficult in some eastern Europe institutions,

What we do after AIDA 2020 ????

A clear political statement about „the future of particle physics“ is indeed timely

FCAL Costing

BeamCal			
Mechanics			
	number	price	total
tungsten plates	140	3000	420000
support frames	3	20000	60000
temparature stabilisation	2	15000	30000
GaAs sensors	900	1000	900000
sensor support structures	140	1000	140000
Front-end ASICs			
prototyping	50	1000	50000
chips	3500	30	105000
probecard for tests	1	20000	20000
front-end electronics			
PCB and assemply	350	70	24500
bonding			40000
components			30000
Data acqusition			
Receiver cards	350	300	105000
crates	50	1000	50000
crate computer	50	1000	50000
racks	1	2000	2000
PCs	5	2000	10000
Power supplies			
HV	5	4000	20000
LV	5	4000	20000
cables			40000
sum			2116500

LumiCal			
Mechanics			
	number	price	total
tungsten plates	140	3000	420000
support frames	3	15000	45000
temperature stabilisation	2	15000	30000
sensor support structures	140	1000	140000
Connectivity			
fan out Kapton HV			45000
fan out Kapton, signal			45000
Silicon sensors	800	2000	1600000
Laser positioning system			
laser	2	10000	20000
sensors	20	1000	20000
mirrors and frames	20	1500	30000
Front-end ASICs			
prototyping	50	1000	50000
chips	3500	60	210000
probecard for tests	1	20000	20000
front-end electronics			
PCB and assemply	750	70	52500
bonding			50000
components			50000
Power supplies			
HV			50000
LV			50000
cables and connectors, patch panels			70000
Data acquisition			
Receiver cards	750	300	225000
crates	50	1000	50000
crate computer	50	1000	50000
racks	1	2000	2000
PCs	5	2000	10000
sum			3334500

LHCal			
Mechanics			
	number	price	total
tungsten plates, 5.6 t	60	15000	900000
support frames	3	20000	60000
temparature stabilisation	2	15000	30000
Connectivity			
fan out Kapton HV			70000
fan out Kapton signal			70000
Si sensors	60	20000	1200000
Front-end ASICs			
Kpix chips	150	1300	195000
probecard for tests	1	20000	20000
front-end electronics			
PCB and assemply	350	70	24500
bonding			20000
components			10000
Data acqusition			
Receiver cards	350	300	105000
crates	50	1000	50000
crate computer	50	1000	50000
racks	1	2000	2000
PCs	5	2000	10000
Power supplies			
HV	5	4000	20000
LV	5	4000	20000
cables			40000
sum			2896500

FCAL Costing

Total costs: 8350 k

This is without personpower for assmbly and montage

Personnel Changes

DESY	students?
CERN	
Cracow UST	
Cracow INP	
ISS	
JINR	1 Ph.D.
Kiev	
Tau	searching for a Postdoc
UC_Santa Cruz	
Vinca	