Status Report OLYMPUS Experiment

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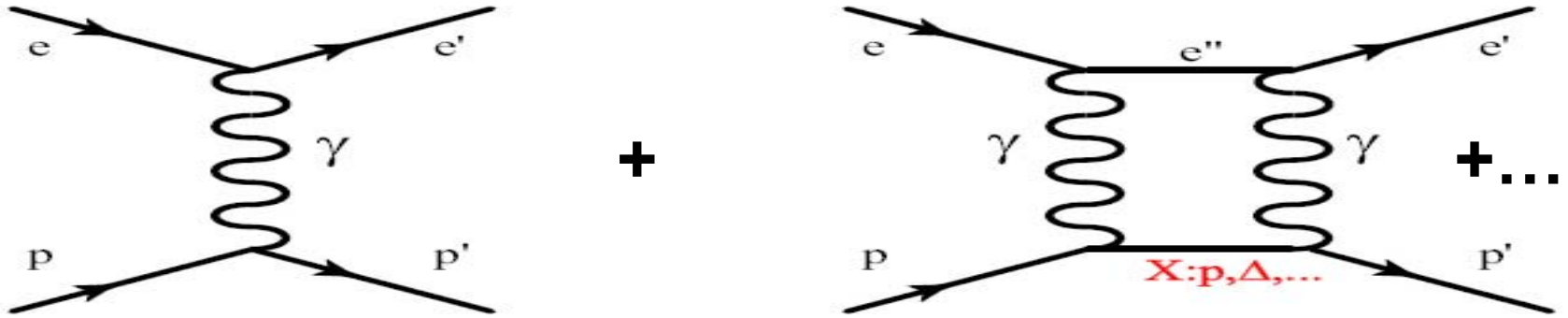
OLYMPUS- collaboration
PRC, May 5-6, 2009, Hamburg

- Motivation
- OLYMPUS experiment
- Status on timeline and funding
- Summary

Elastic Electron Scattering from Proton



Dirac, Pauli FF

$$\langle N(P')|J^{\mu}_{\rm EM}(0)|N(P)\rangle =$$
$$\bar{u}(P')\left[\gamma^{\mu}F_1^N(Q^2)+i\sigma^{\mu\nu}\frac{q_\nu}{2M}F_2^N(Q^2)\right]u(P)$$

Sachs FF

$$G_E = F_1 - \tau F_2; \quad G_M = F_1 + F_2, \quad \tau = \frac{Q^2}{4M^2}$$

Unpolarized Elastic e-N Scattering

$$\frac{d\sigma/d\Omega}{(d\sigma/d\Omega)_{Mott}} = \frac{\sigma}{\sigma_0} = A(Q^2) + B(Q^2)\tan^2\frac{\theta}{2}$$

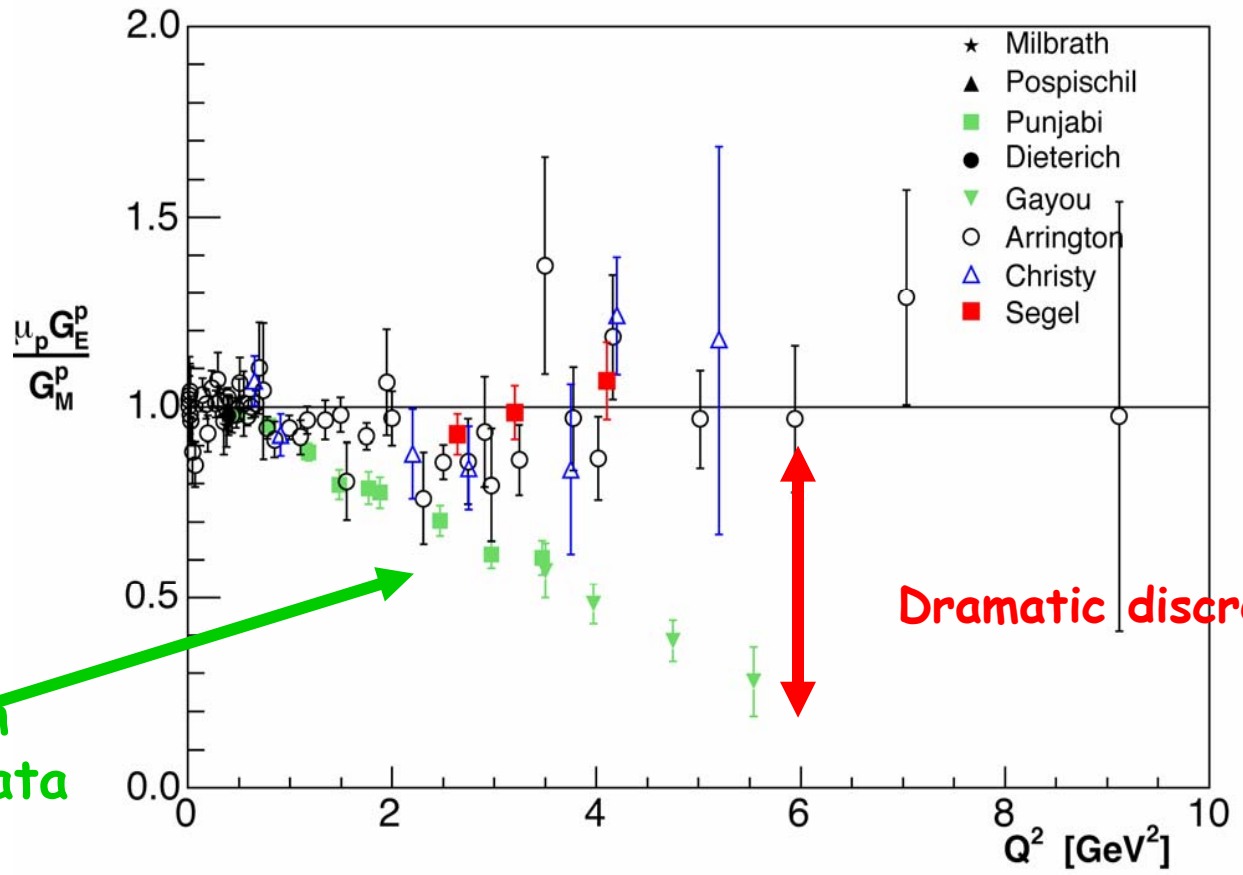
$$= \frac{G_E^2(Q^2) + \tau G_M^2(Q^2)}{1+\tau} + 2\tau G_M^2(Q^2)\tan^2\frac{\theta}{2}$$

For ~ 50 years unpolarized cross section measurements have determined the elastic FF G^p_E and G^p_M using the Rosenbluth separation

$\sigma_{red} = d\sigma/d\Omega\ [\varepsilon(1+\tau)/\sigma_{Mott}] = \tau G_M^2 + \varepsilon G_E^2$

$\tau = Q^2/4M^2$ $\qquad$ $\varepsilon = [\ 1 + 2(1+\tau)\tan^2\theta/2\ ]^{-1}$

Rosenbluth and Recoil Polarization

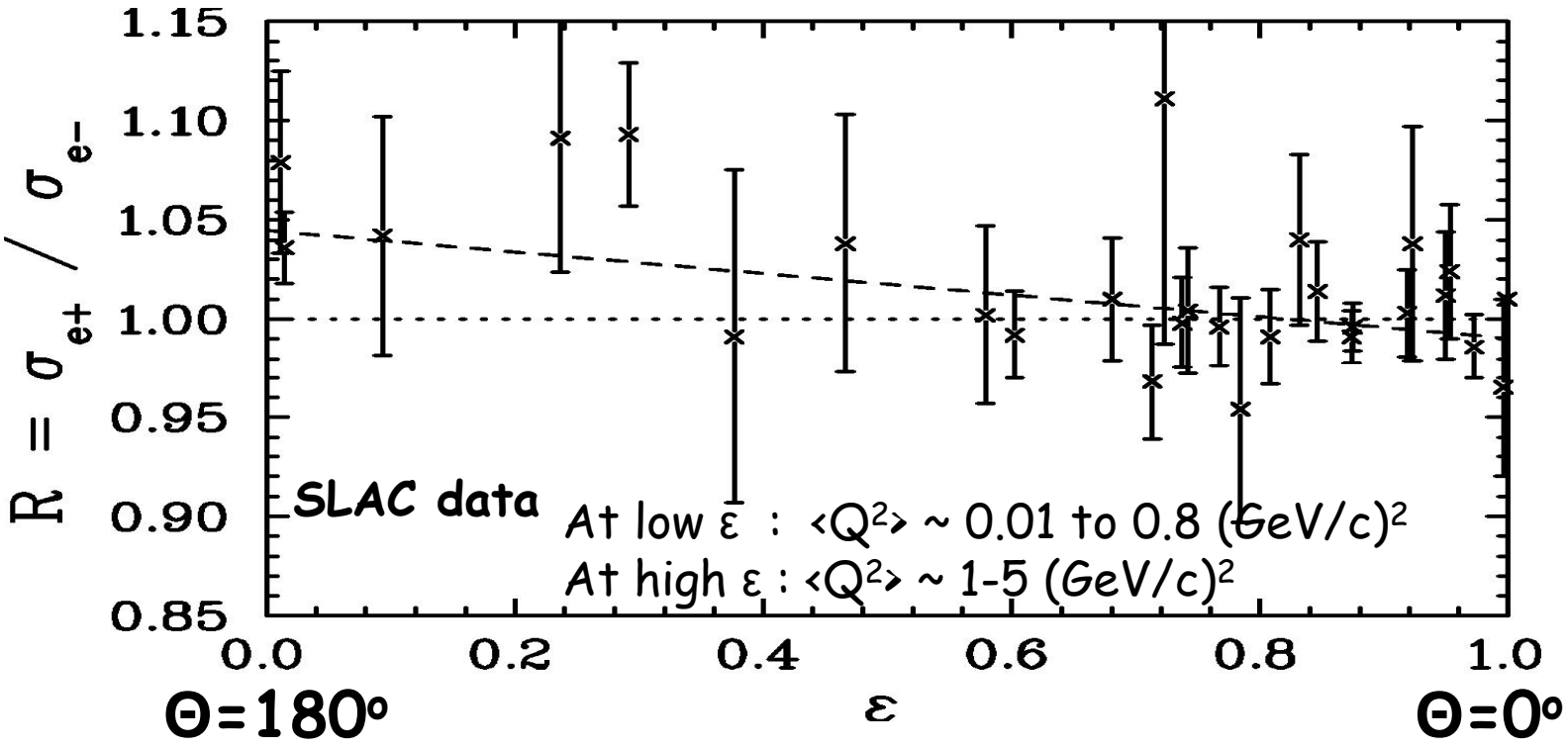


- All Rosenbluth data from SLAC and Jlab in agreement.
- Dramatic discrepancy between Rosenbluth and recoil polarization technique
- Discrepancy explained as effect of two photon exchange (TPE)

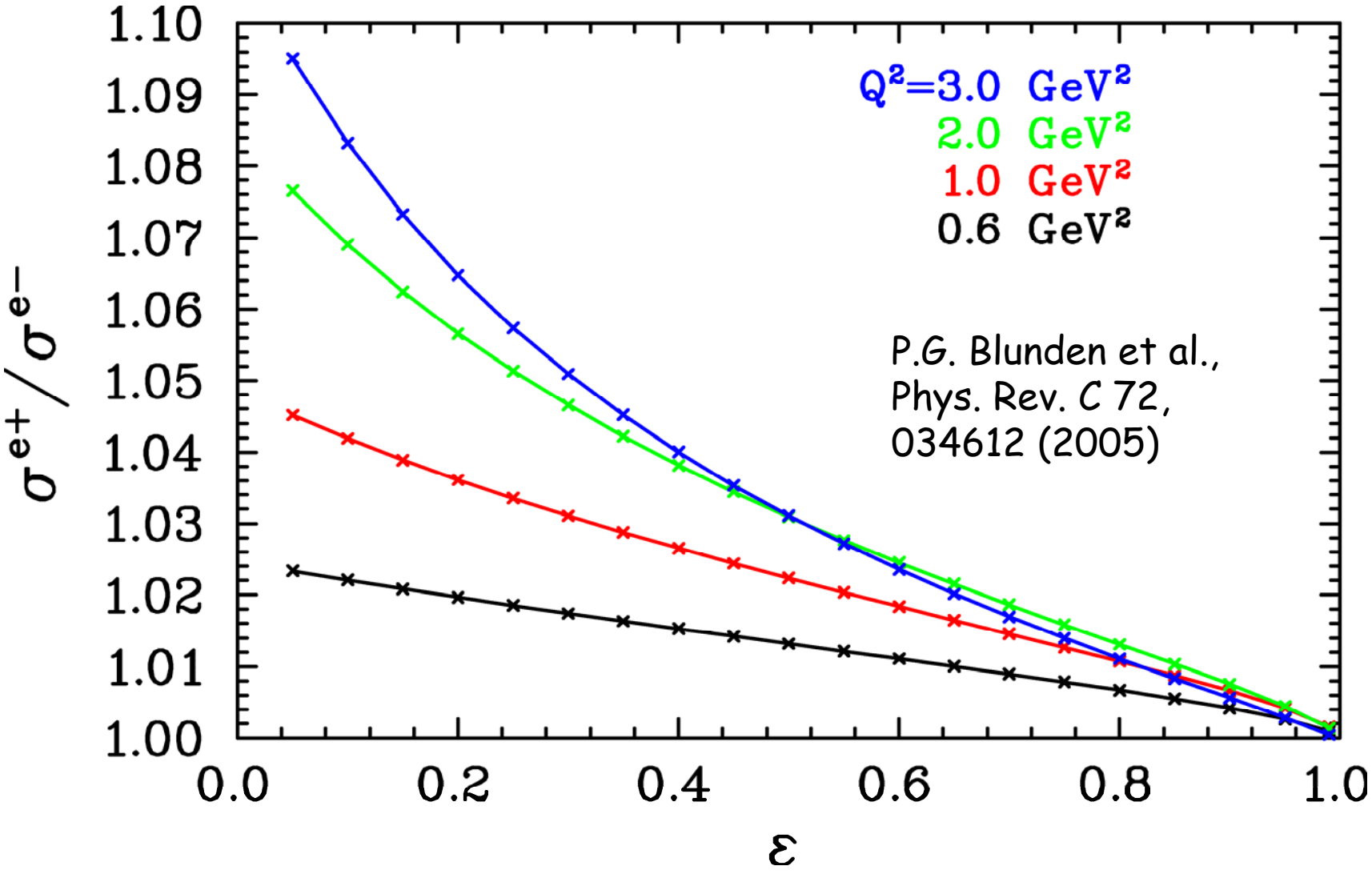
Two Photon Exchange

Precision comparison of positron-proton and electron-proton elastic scattering over a sizable ε range at $Q^2 \sim$ 2-3 $(GeV/c)^2$

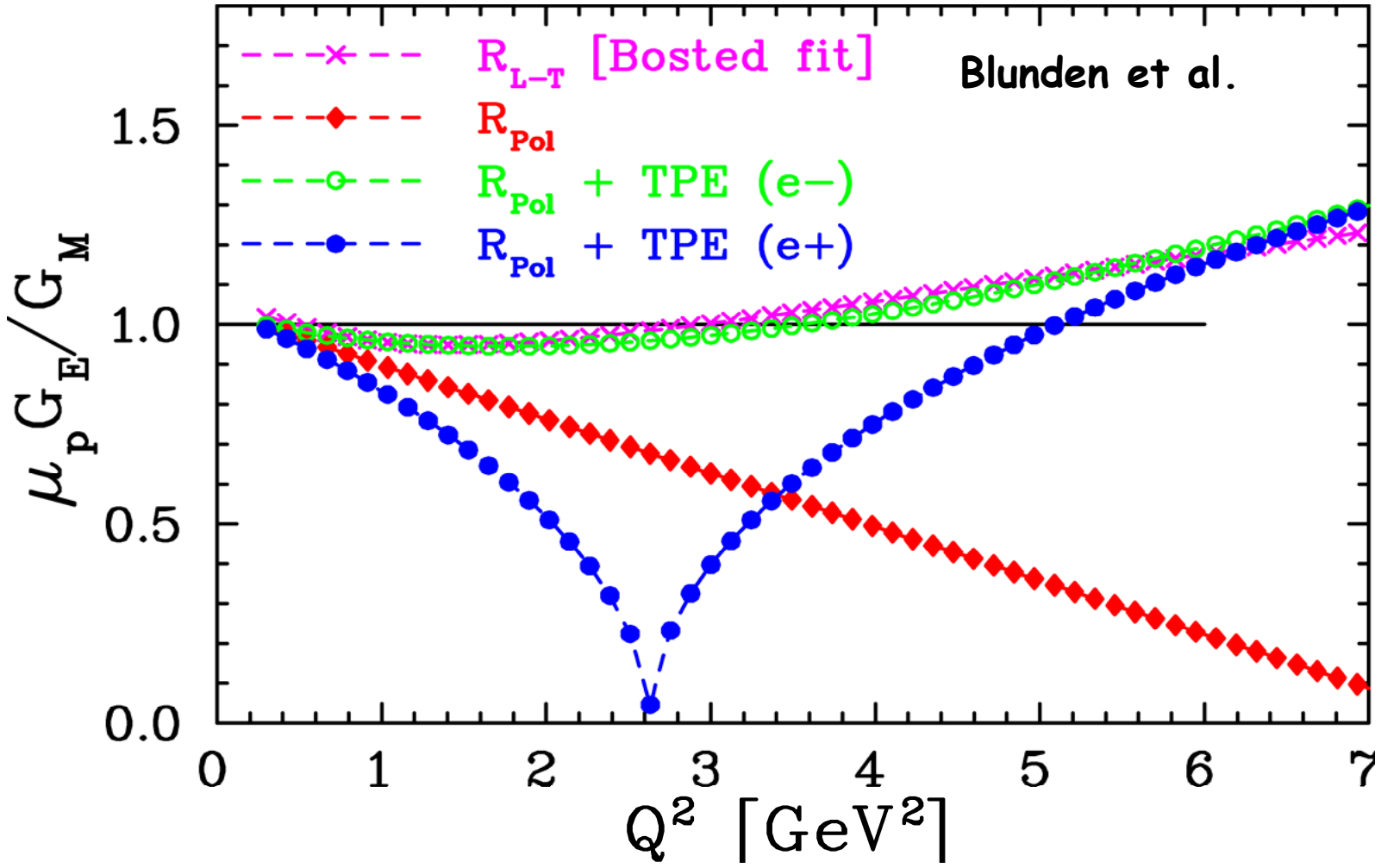
J. Arrington PRC 69, 032201(R) (2004)



e^+p/e^-p Cross Section Ratio



Proton form factor ratio

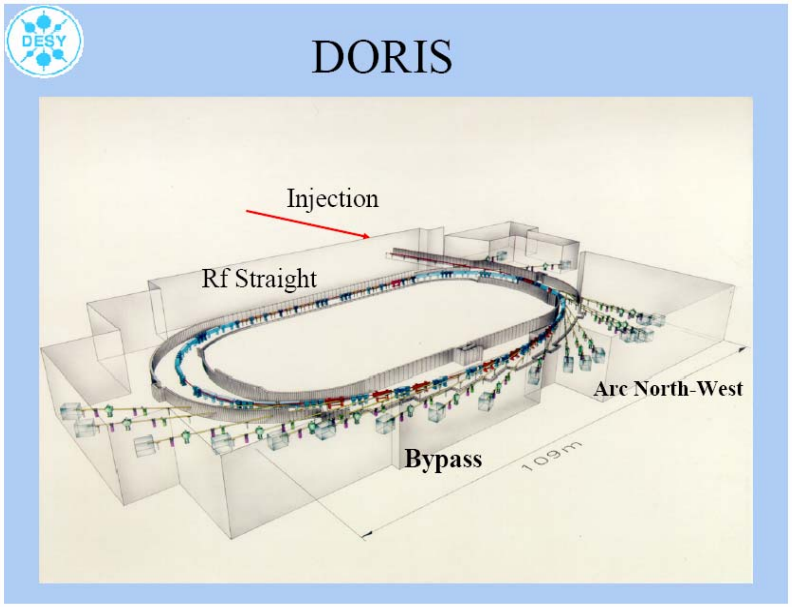


Experimental Requirements

- Both electron and positron beams available
- Incident on unpolarized hydrogen target at luminosity of

  ~ 5 x 10^{32} cm^{-2} s^{-1}
- Beam energies of 2.3 to 4.5 GeV
- Detector to measure elastic scattering in ε range from 0.4 to 1 at Q^2 ~ 2-3 $(GeV/c)^2$ i.e. scattering angles from ~ 20^o to ~ 70^o
- Experiment requires frequently switching from e^+ beam to e^- beam
- Measure ratio of positron-proton to electron-proton unpolarized elastic scattering to 1% stat.+sys.
- Control of systematic uncertainties essential.

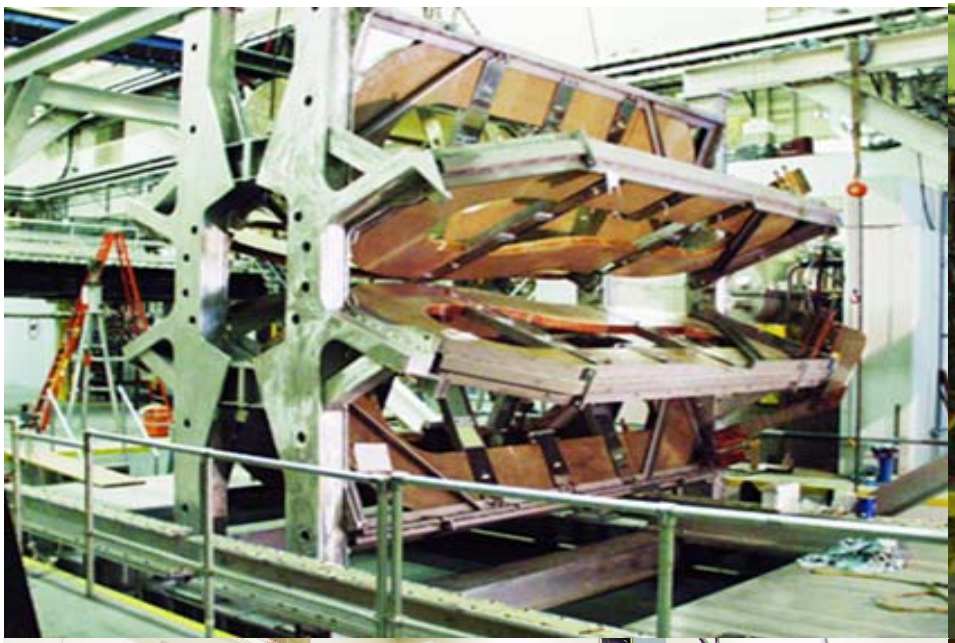
OLYMPUS experiment at DORIS

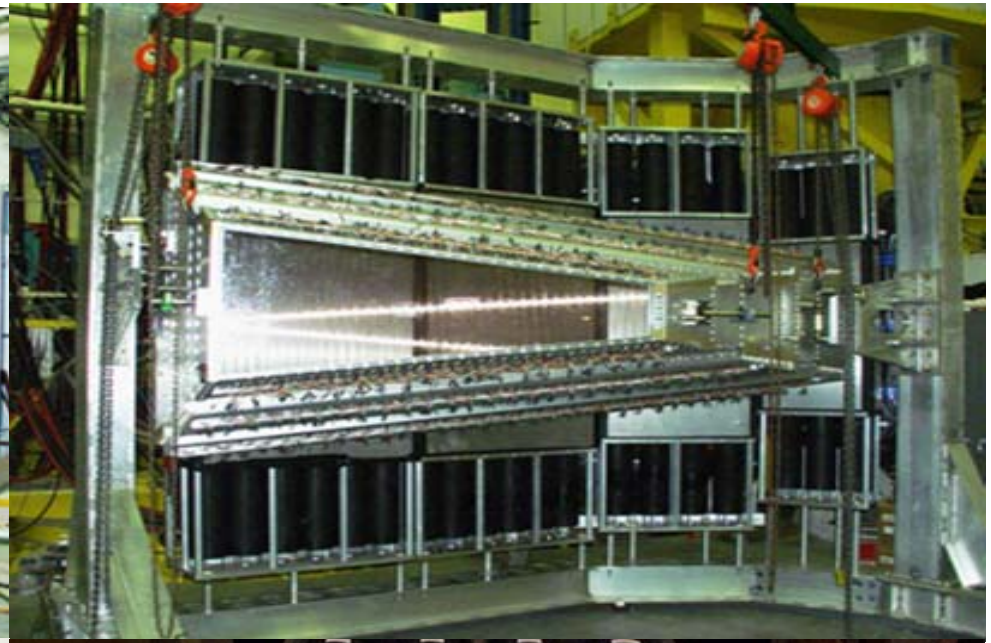


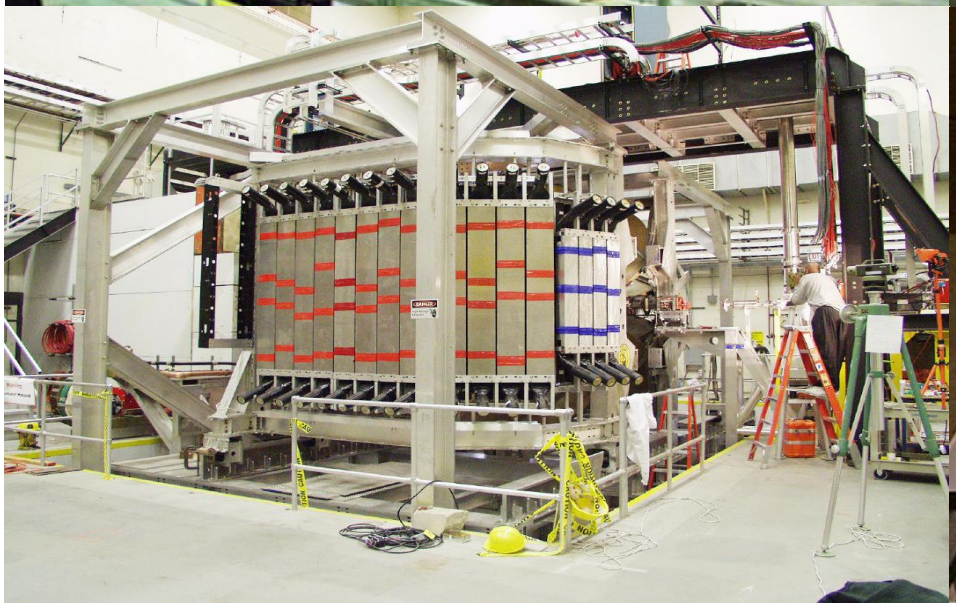
OLYMPUS-Proposal PRC October 2008
conditional approved

- ✓ energy 2.3 to 4.5 GeV
- ✓ e+ and e^- beams
- ✓ regular switching between e+ and e^-
- ✓ lumi ~ 6 x 10^{32} cm^{-2} s^{-1} with internal H_2 gas target
- ✓ space for detector
- ✓ installation and commissioning in parallel with synch. rad. operation
- ✓ data taking in dedicated beam time ~ 1 month in 2011
  2 month in 2012

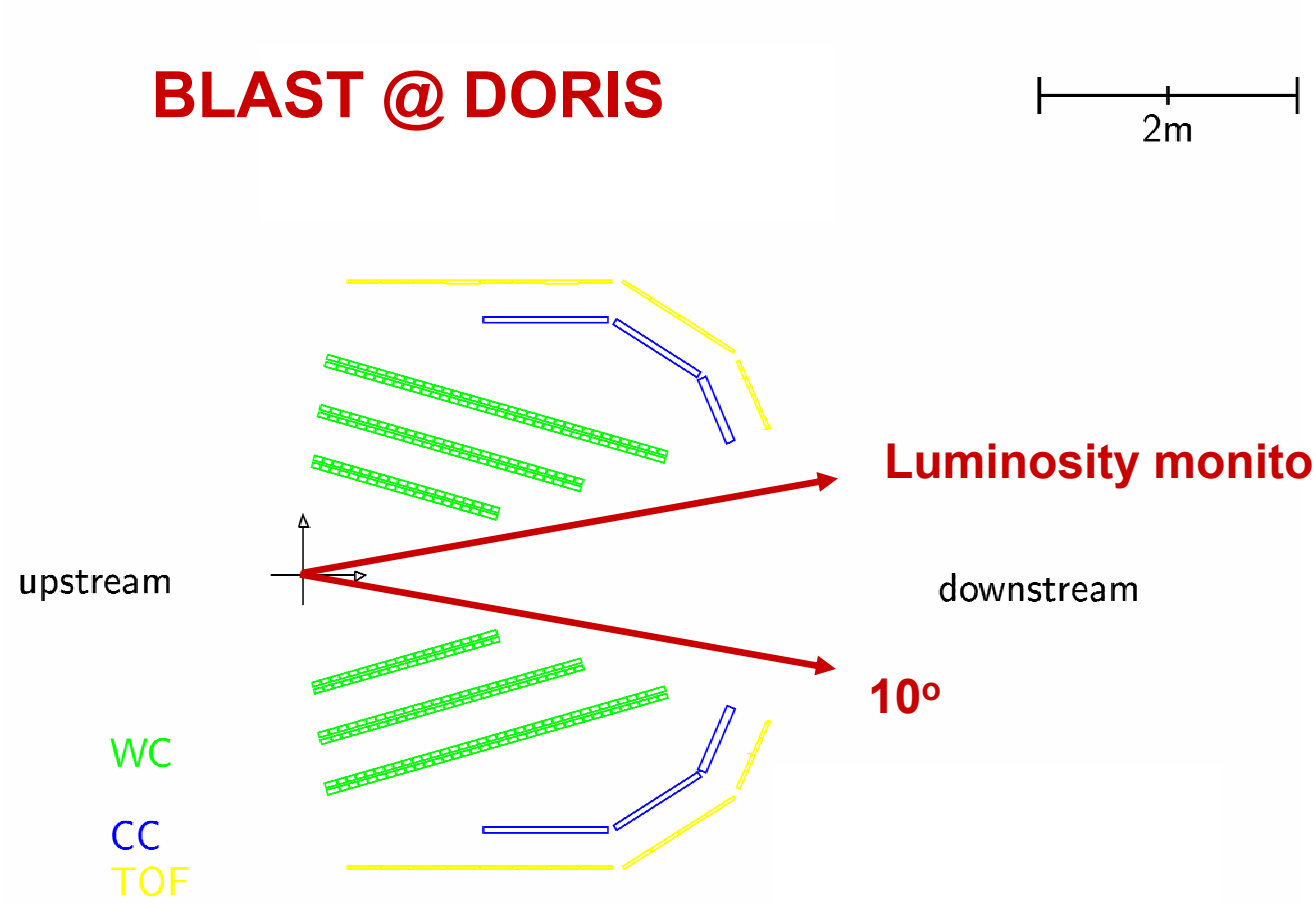
The Detector and Target exist





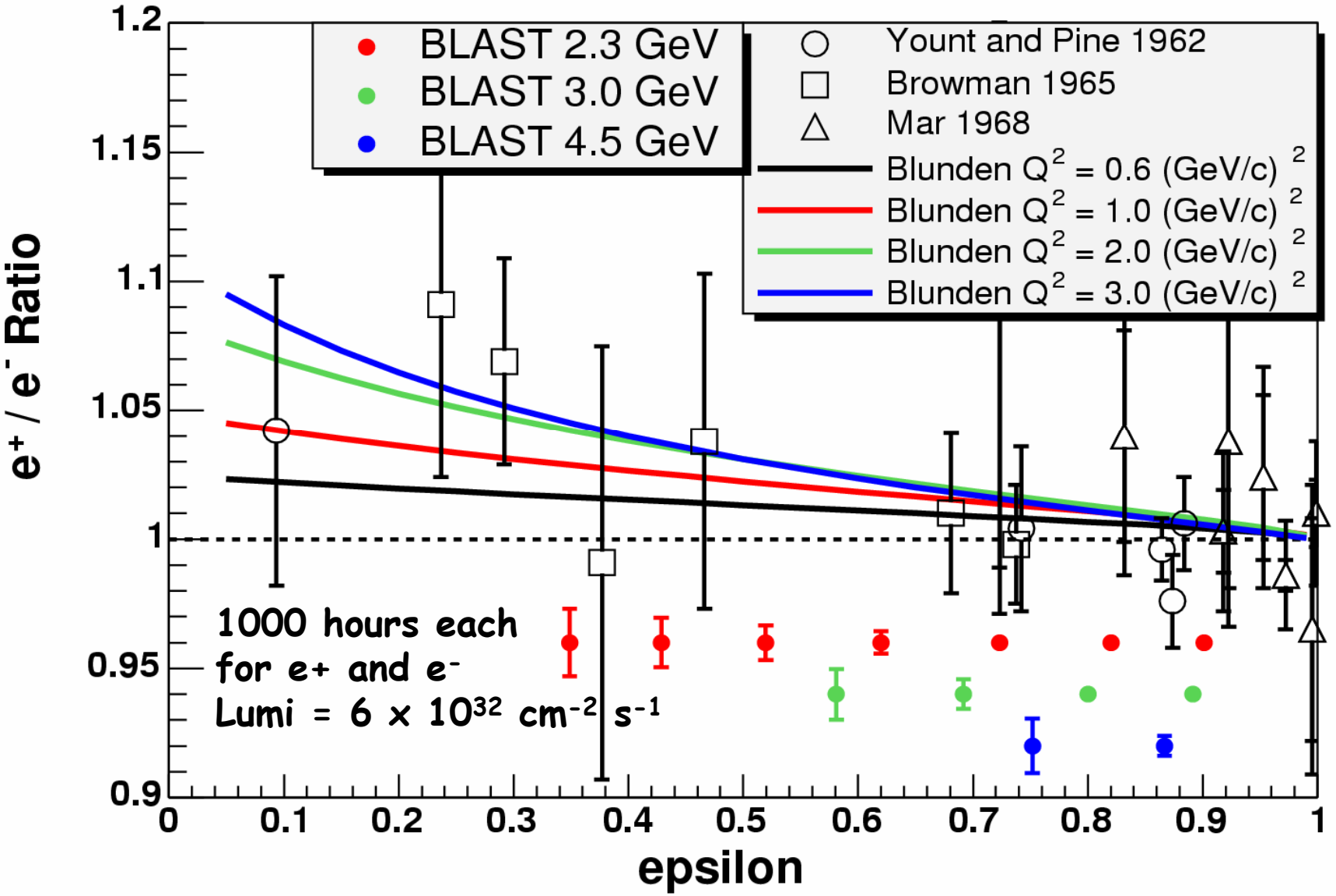


OLYMPUS Setup



- Change BLAST polarity once a day
- Change between electrons and positrons once a day
- Left-right symmet

OLYMPUS Projected Results



Status of OLYMPUS -Project

- OLYMPUS-Proposal conditionally approved by PRC October 2008:

  1.) details of the OLYMPUS installation and running have to be worked out

  2.) necessary funding becomes available

Status on 1.)

Detail plan for OLYMPUS installation and running has been worked out, presented and approved at the OLYMPUS- collaboration meeting April, 2009

Responsibilities:

BLAST-detector:	MIT, University of Colorado, Arizona State University
Target:	MIT, INFN Ferrara, Universität Erlangen-Nürnberg
New Intersection point:	DESY, MIT, St. Petersburg NPI
New Luminosity Monitor:	Hampton University, INFN Bari, INFN Rome
Trigger, DAQ:	Universität Bonn, Universität Mainz
Electronics:	Universität Bonn, MIT, Universität Mainz
Tracking detectors:	MIT, INFN Rome, Universität Mainz
Particle Identification:	University of Glasgow, Arizona State University
Timing Scintillators:	University of New Hampshire

Timeline

- OLYMPUS proposal conditionally approved by PRC in October 2008
- Requests submitted to funding agencies:
  December 2008 (Germany) and January 2009 (US)
- Remove ARGUS experiment in Summer 2009
- Ship BLAST/OLYMPUS detector and OLYMPUS target in summer/fall 2010
- Modify DORIS beamline and install OLYMPUS target in DORIS in winter 2010/11 shutdown.
- Install complete OLYMPUS experiment in summer 2011
- Commission in fall 2011
- Take data in 2012

Status of OLYMPUS -Project

Status on 2.) Necessary Funding

German groups submitted grant request to the BMBF, December 2008

American groups submitted grant request to NSF and DOE January 2009

Funding Requests:

Transportation BLAST-detector:	500,-k$	only American Groups
Target:	450,- k$	only American Groups
Luminosity Monitor:	120,- k$	only American Groups
Trigger, DAQ:	235,- kEuro	Bonn, Erlangen, Mainz
New Intersection Region:	280,- kEuro	only European groups
DORIS Modifications:	487,- kEuro	all groups
OLYMPUS Operation Costs:	585,- kEuro	all groups
DORIS Operation Costs:	450,- kEuro	direct request to BMBF or DESY

Summary

- The OLYMPUS experiment has been approved by DESY conditional on the funds being available.

- A schedule for the installation, commissioning and data taking has been established.

- Detailed discussion of the technical issues are getting underway.

- The critical path issue now is to secure the necessary funding required to carry out OLYMPUS.

Cost Estimate-Operation

Operation Costs (in k€)						power cost			
DORIS operation	costs/month (2	2009	2010	2011	2012	increase 15%/year	flat	flat - 2011 2012 + 10%	remarks
numberof months		0	0	0.0	3.0				
electrical power (2.0 Ge	150	0	0	0	787	787	450	495	1
man power (40 FTEs)	216	0	0	0	729	729			3
investment,maintenanc	100	0	0	0	338	338			3
sum	466	0	0	0	787	787	450	495	
OLYMPUS operation									
electrical power (2.2 M	160	0	0	0	837	837	479	526	
water cooling (30 kW)	2	0	0	0	11	11	7	7	
gases (130000l/month)	10	0	0	0	34	34	34	34	
computing	20	0	0	0	68	68	68	68	
sum		0	0	0	950	950	586	635	
sum operation						1737	1036	1130	

Cost Estimate-Investment

Investments (in k€)

Infrastructure OLYMPUS	cost (k€) cost (k€)	cost (k€) hired labo	remarks	design/planning man powe (m m)	design/planning group	design/planning schedule	construction man powe (m m)	construction group	construction schedule
Cooling (pump stand, control cabinet, piping, cabling) extern	200	50		3	(MKK2)/ex	6/09 - 11/0	6	(MKK2)/ex	11/09 - 10/10
prepare transformer	10								6/09 - 7/09
Cabling magnet (incl. external work)				1	(MKK1)/ext		2	(MKK1)/ex	6/09 - 8/09
10kV to transformer									
AC transformer-PS									
DC PS-Magnet	150								
sum OLYMPUS	360	50		4			8		

Cost Estimate-Investment

DORIS									
remotely controlled polarity switches	90	10		1	MKK1		2	(MKK1)/ext	6/09 - 8/10
power and signal cabling	47	5			MKK1		1	ext./MDI	
additional pair of quads	24			0.5	MEA			ext.	
" modify/connect PS, cabling	14	1		0.2	MKK1		0.2	ext./MKK	
modify/rebuild 3 kicker pulser (1 Desy/2 Doris	86		2	0	MIN		12	MIN	6/09 - 11/09
modify 2 septa					MIN		2	MIN	
modification of vacuum system						6/09 - 11/09			11/09 - 8/10
2 valves, Doris profile	55			0.2	MVS		0	ext.	
synchrotron light absorbers (try to reuse)	50			4	F1		12	ZM	
connecting beam pipes	10			3	F1		4	ZM	
quadrupole chamber	3			1	MVS		4	MVS	
tests and installation vacuum parts							4	MVS	
move 2 cavities	10			0.5	MHFe		2	MHFe	12/10 - 1/11
remove water pipes from IP					MKK2		0.5	MKK2	
relocate cables from IP	20	15			MDI		1.5	MDI/+ext.	
personal interlock,"Not Aus"	10			1	MPS		1	MPS	2/11 - 2/11
construction work	60			0.5	ZBAU			ext.	8/10 - 9/10
modify IP region									12/10 - 2/11
rebuild MHFsl Lab									08/10 - 09/10
remove Argus	5	28		4	MEA		12	MEA/ext.	07/09 - 09/09
rebuilding IP region and shielding		28		4	MEA		12	MEA/ext.	12/10 - 2/11
install Olympus				4	MIT/MEA		12	MIT/MEA	05/10 - 07/11
alignement	3						1	MEA	7/11
software							4	MST	
sum DORIS	487	87		24			87		
							111	MM	
sum investment	847	137 (hired labor)							
sum investment (incl. hired labor)	984								
sum investment + 10%contingency	1083								
sum operation	1130								
total sum	2213						123	MM	
							ca. 10	FTE	

Cost Estimate

Remarks

1 Electrical power for 2.0GeV incl. cooling, 30% preaccel.
2 In addition, 58k€ for 2 spares if required
3 not included in sum

Power cost 3 options	inflation
power cost increase/year	
1.15	1.03
constant until 2012	
constant until 2011 + 10% in 2012	

A 10% overhead and 7% VAT has to be added to all DESY invoices to other institutes.

- No funds in DESY budget for operation and investments, except usual contribution to common fund of collaboration
- DESY will provide man power as much as possible, but will need some hired labor.
- Some machine groups, MKK (power supplies and cooling) and MVS (vacuum systems), are overloaded with new DESY projects.
  - MKK cooling and MVS no man power for DORIS/OLYMPUS, except some general contact and advice.
  - Need man power for OLYMPUS cooling and modification of vacuum system
    - Outside institutes or outside engineering firm (expensive)
    - Vacuum system design probably engineer from research division
- Funds for operation and investments have to be provided by collaborating institutes

- Possible in-kind contributions of institutes
  - Cooling system (design, ordering, setup,…)
  - Polarity switches (buy switches or assembly in workshop)
  - Modification of vacuum system (beam pipe, collimators)
  - Send technicians (ARGUS removal, modification of IR,…)

Other Experiments

- **JLab**

  No positron beams. Approved experiment to compare e^+p to e^-p elastic scattering using secondary beams and the CEBAF Large Acceptance Spectrometer. Challenging systematics.

- **Novosibirsk**

  Similar experiment to DESY experiment has been considered. Positron currents are about an order of magnitude lower. No momentum measurement.

- **Parity violating electron scattering**

  Experiments at JLab and Mainz which measure transverse spin asymmetries are sensitive to two photon effects but not directly to the contribution which enters in G_E^p/G_M^p.