

Summary

Fixed Target Experiments Working Group



Dark Forces Workshop
September 26, 2009
Bj Bjorken and John Jaros

Many Plenary Contributions

Introduction to Electron Fixed-Target Experiments
Natalia Toro (*Stanford University*)

New Fixed-Target Experiment for a Heavy Photon Search
Takashi Maruyama (*SLAC*)

Hidden portals through fixed targets
Maxim Pospelov (*Perimeter Institute, University of Victoria*)

Searching for a U-boson with a positron beam and JLab prospects
Bogdan Wojtsekhowski (*Thomas Jefferson National Accelerator Facility*)

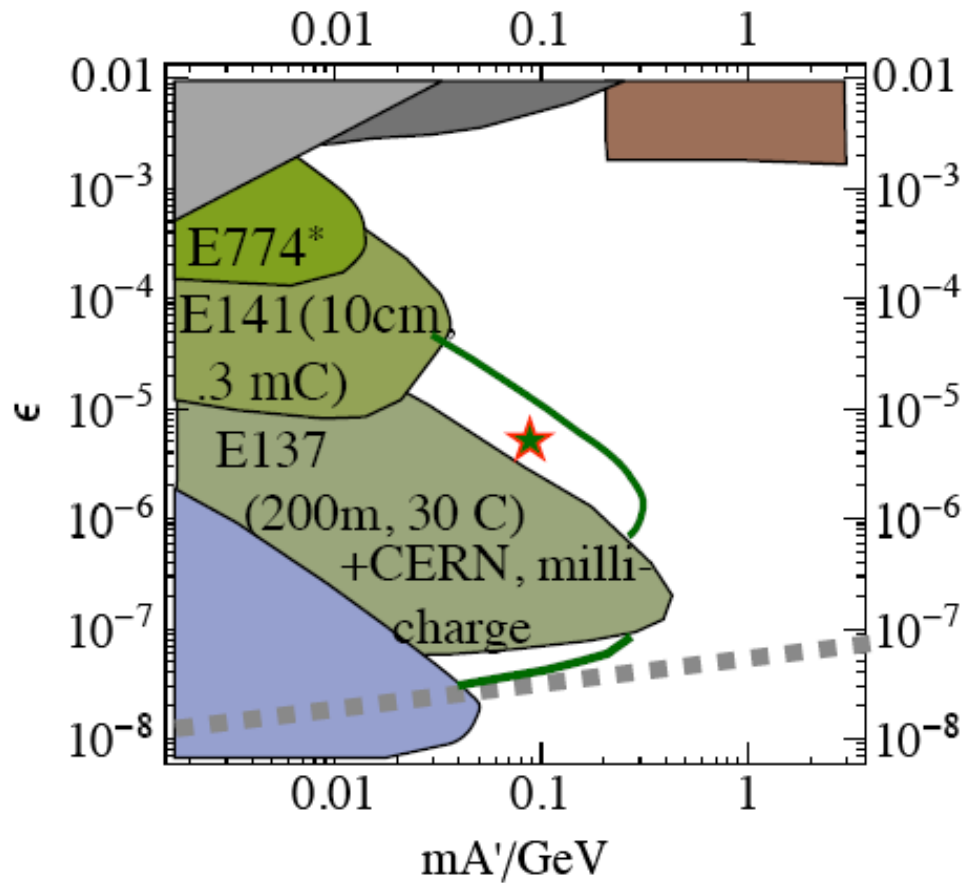
U Boson Search at the JLab Free Electron
Peter Fisher (*Massachusetts Institute of Technology*)

Searches for Axion-like Particles and Paraphotons with JLAB
Andrei Afanasev (*Hampton U/Jefferson Lab*)

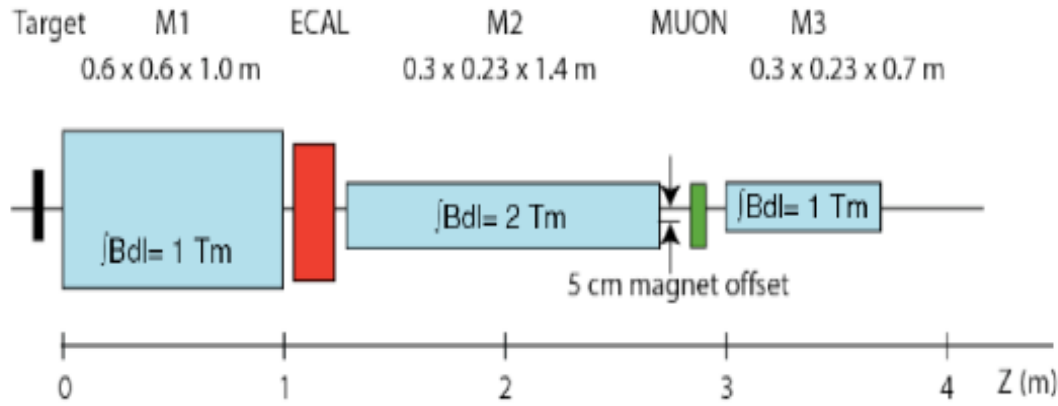
ADMX: Searching for Dark Matter Axions and other Light Hidden Particles
Gray Rybka (*University of Washington*)

Dark matter research at the MESA facility
Kurt Aulenbacher (*Institut für Kernphysik der Universität Mainz*)

Allowed Regions



Experimental Apparatus

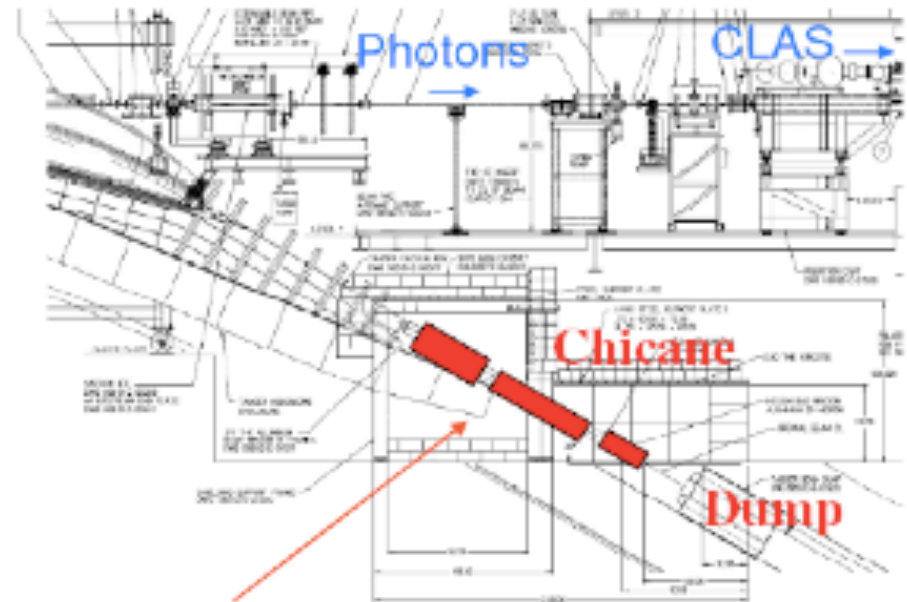
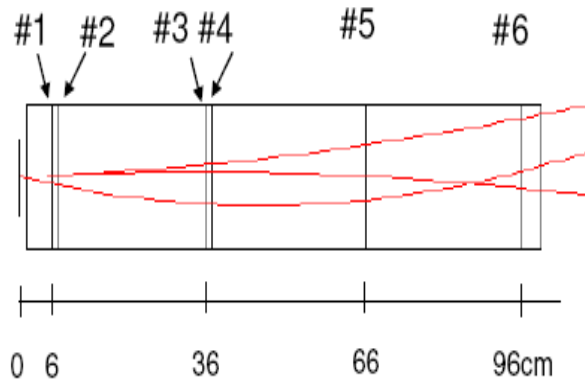


Beam:

- 6 GeV e⁻ 100 nA

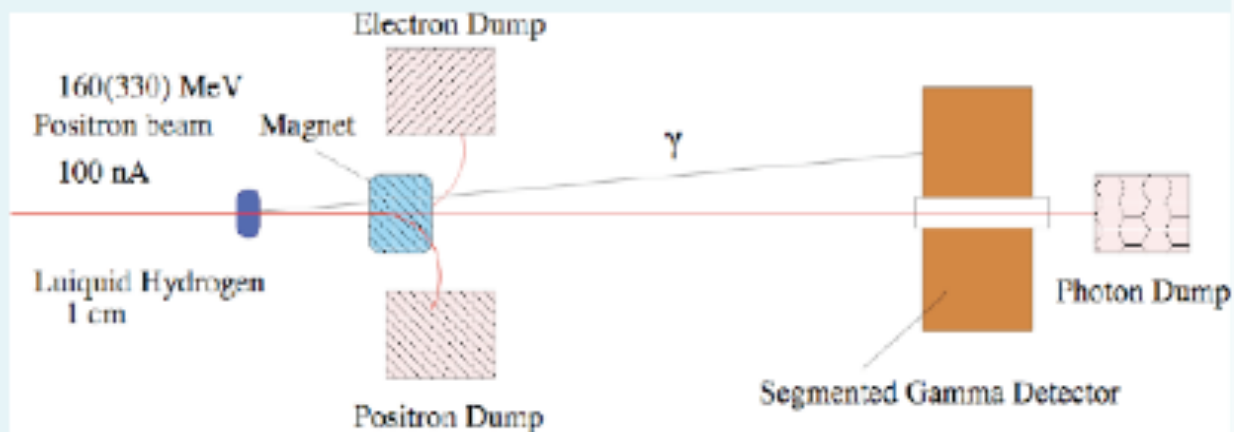
Target:

- 0.01 X₀ Tungsten

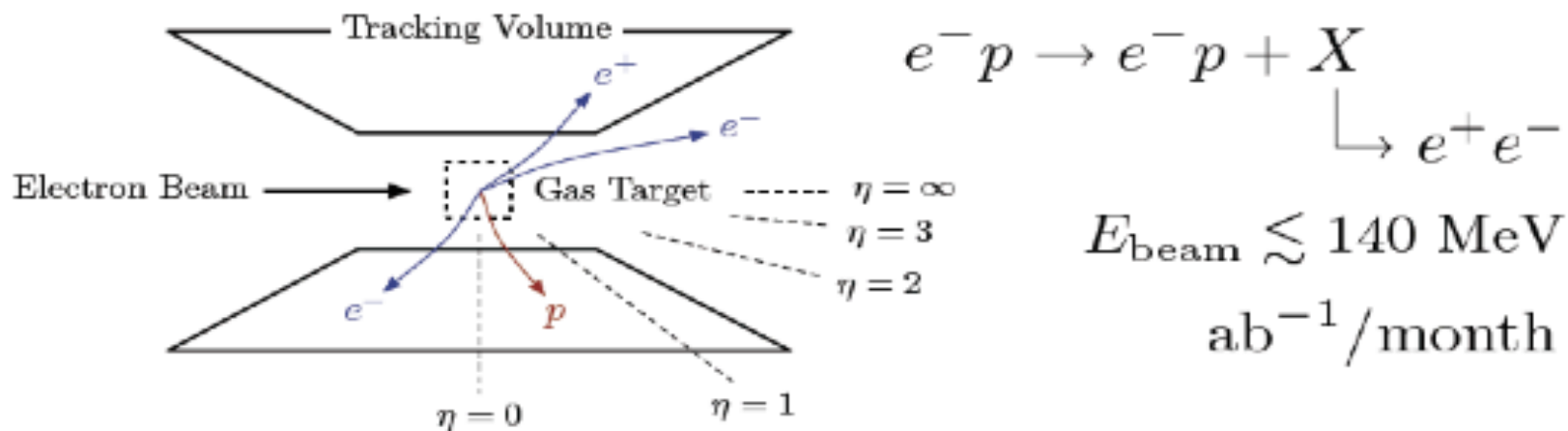


Searching for U Boxon with Positron Beam B. Wojtsekhowski

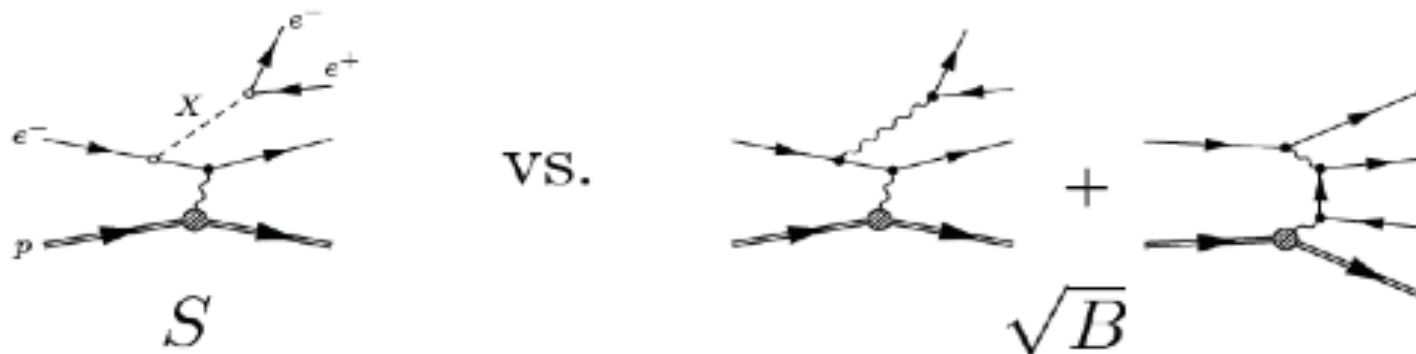
- ⊙ Positron beam with 1–2 MeV spread
- ⊙ Thin – 1 cm liquid hydrogen target
- ⊙ Direct the rest of the beam to the dumps



Electron-Proton Collisions



Narrow Resonance on Huge QED Background



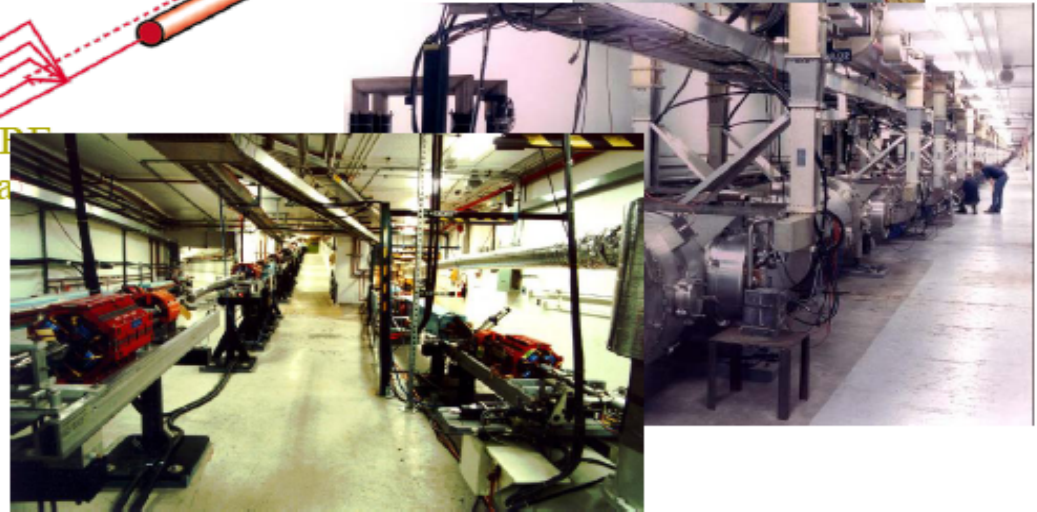
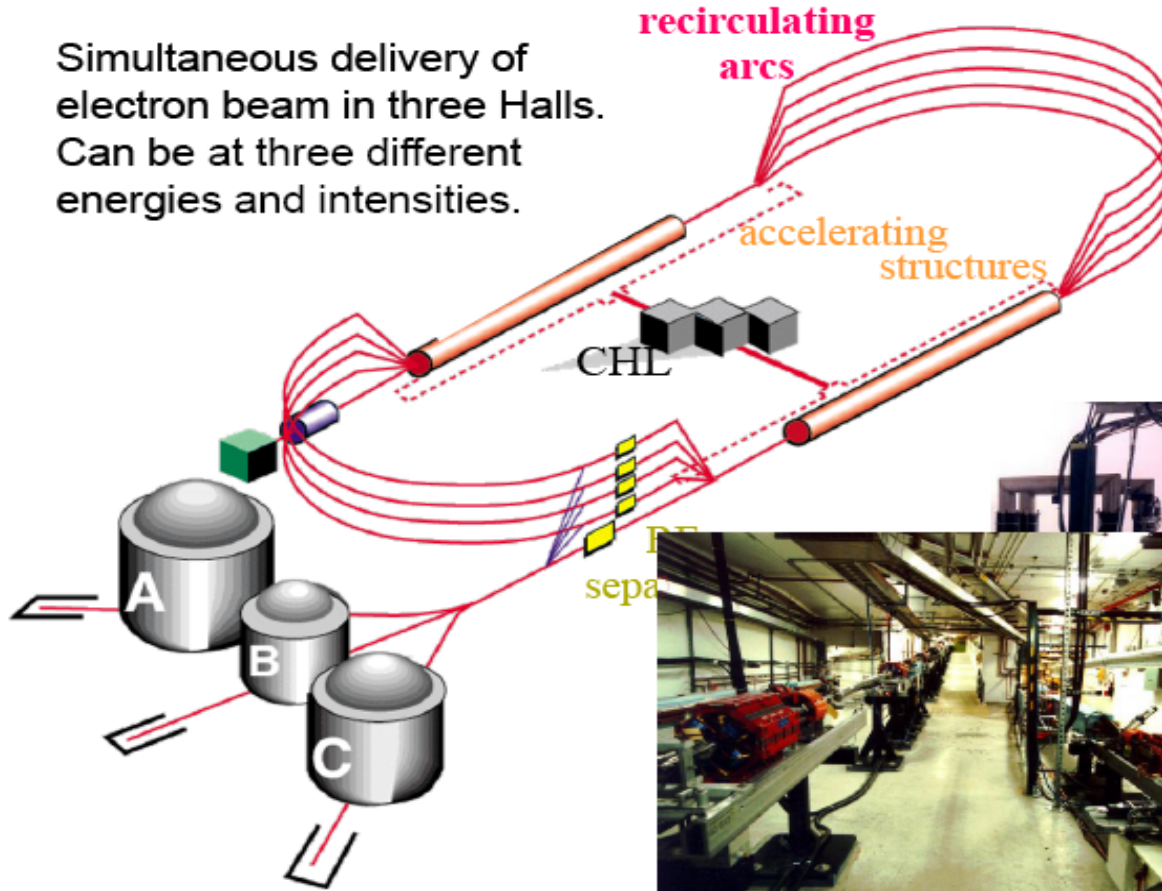
Parallel Highlights

- P. Bosted J Lab Facilities and Possibilities
- K. Aulenbacher Facilities at Mainz

J Lab Prospects—Data Mining/New Proposals and B. Wojtsekhowski

CEBAF - Continuous Electron Beam Accelerator Facility

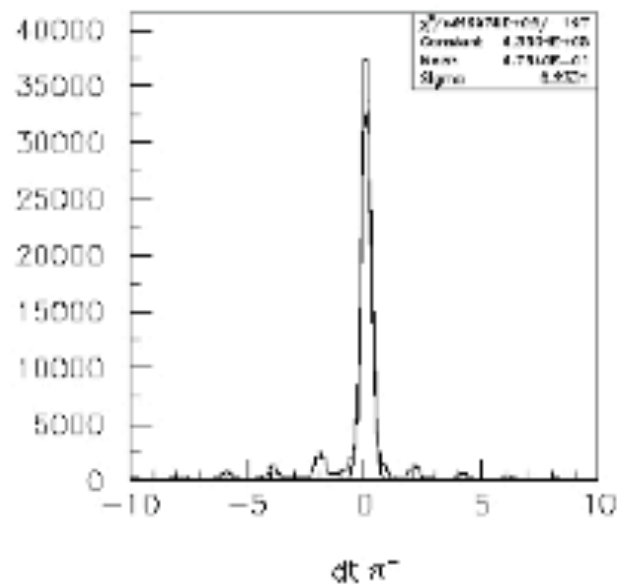
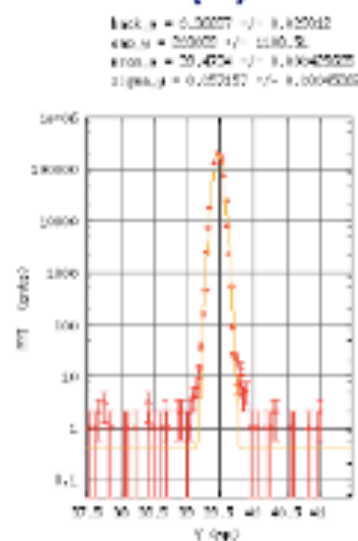
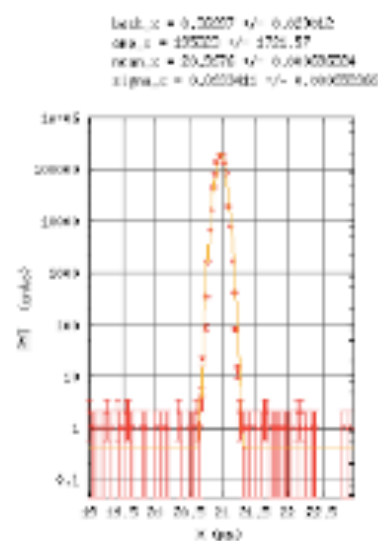
Simultaneous delivery of
electron beam in three Halls.
Can be at three different
energies and intensities.



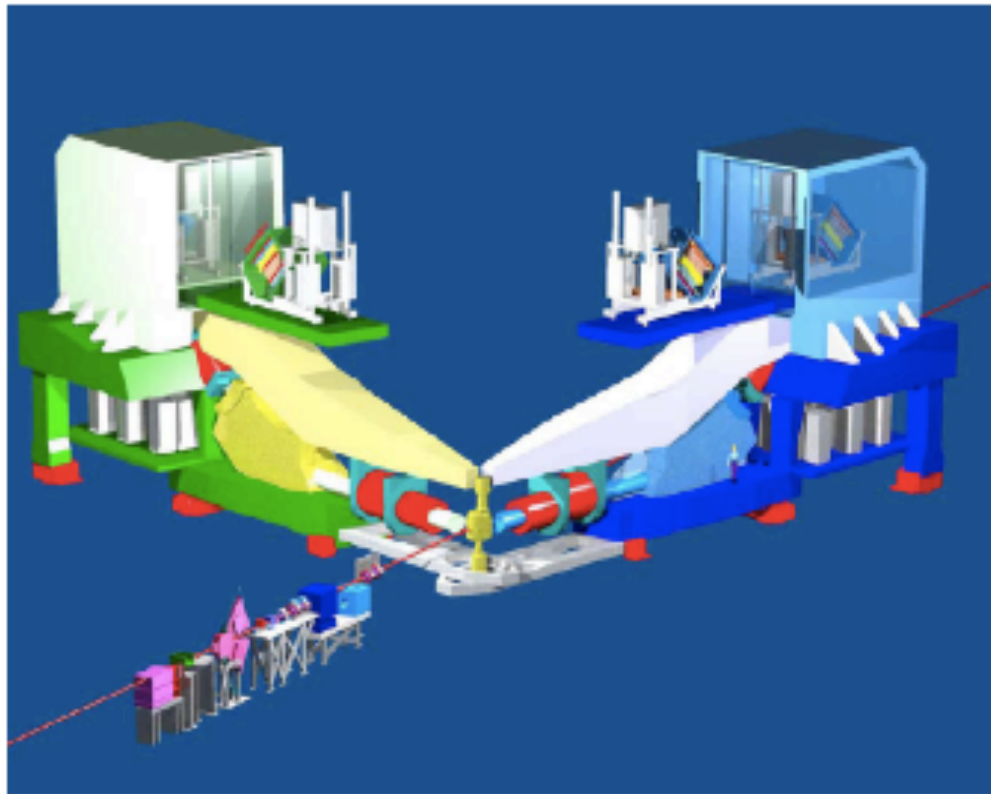
CEBAF Beam Characteristics

Energy < 6 GeV
Beam size <100 μm
Bunch length 300 fs, 90 μm
Energy spread 2.5×10^{-5}
Beam current < 100 μA (A&C)
< 300 nA (B)

Beam polarization ~85%
Fundamental mode frequency 1497 MHz
Bunch repetition 499 MHz/Hall
Bunch separation 2.004 ns

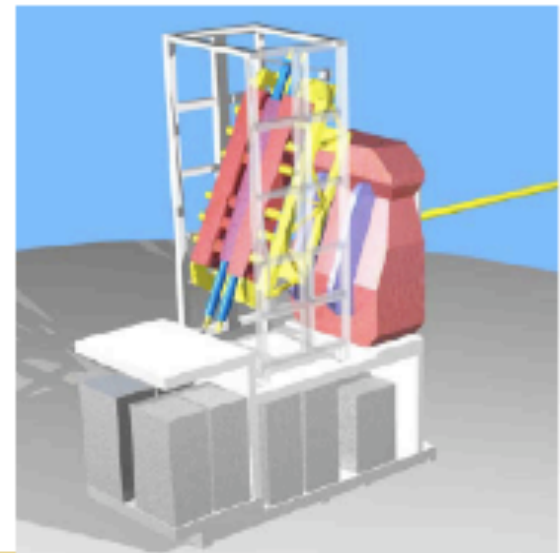


Experimental Hall-A



Big-bite spectrometer

- Base equipment –
 - two high resolution (10^{-4}) spectrometers ($P < 4\text{GeV}$, $\Delta\Omega \sim 6\text{msr}$)
- Additional detectors –
 - Compton polarimeter
 - DVCS calorimeter and
 - proton/neutron detectors

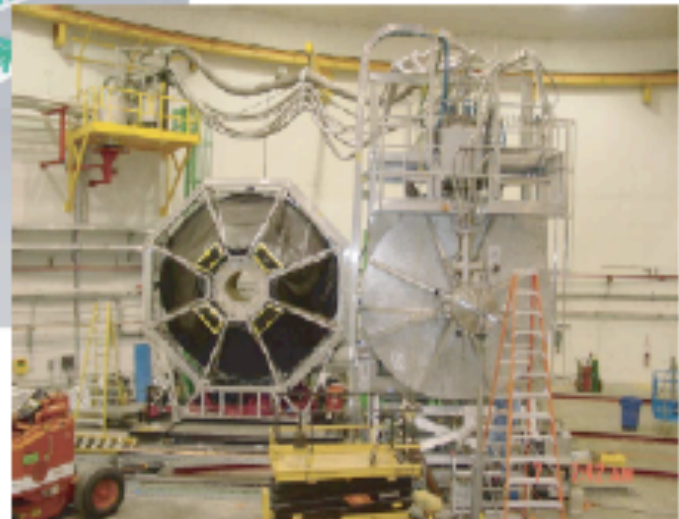
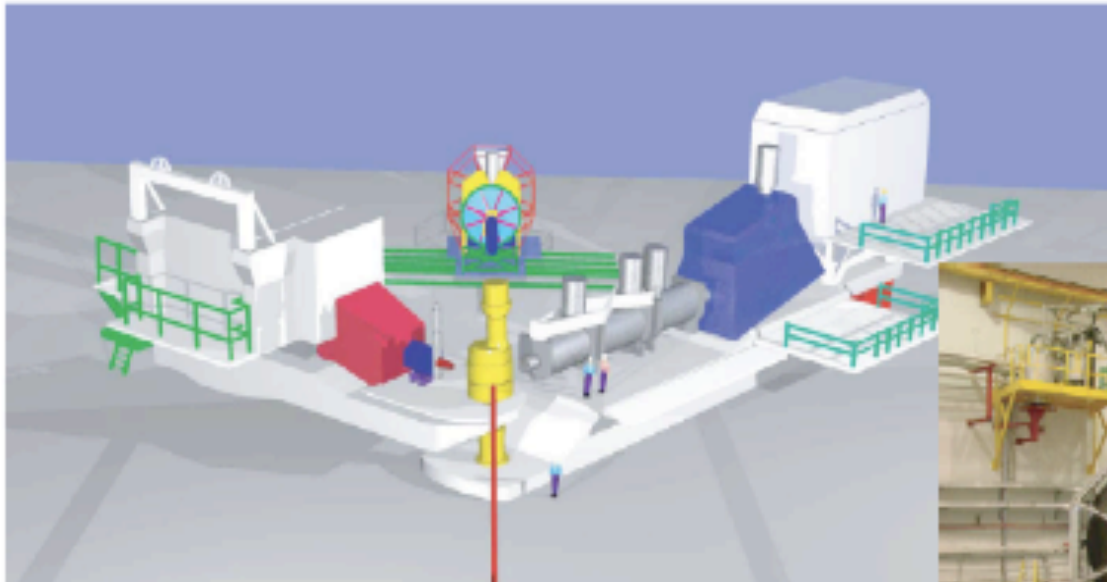


Experimental Hall-C

Base equipment –

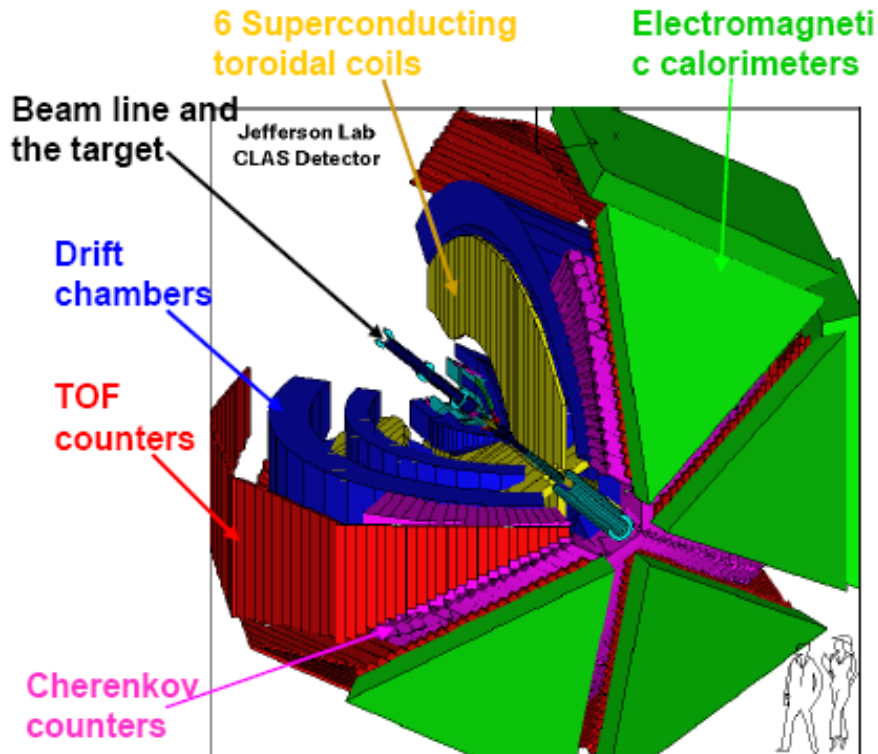
high momentum spectrometers, $P < 7.5 \text{ GeV}$, $\Delta P/P < 10^{-3}$, $\Delta\Omega \sim 6 \text{ msr}$

short orbit spectrometer, $P < 2 \text{ GeV}$, $\Delta P/P \sim 10^{-3}$, $\Delta\Omega \sim 9 \text{ msr}$



Additional detectors –
Qweak, BigCal

Hall B CLAS detector



Charged particles:

- $\Theta = 10$ to 130 degree
- $dP/P = 0.5\%$ to 2%
- $\Delta\phi \sim 80\%$ of 2π

Neutrals:

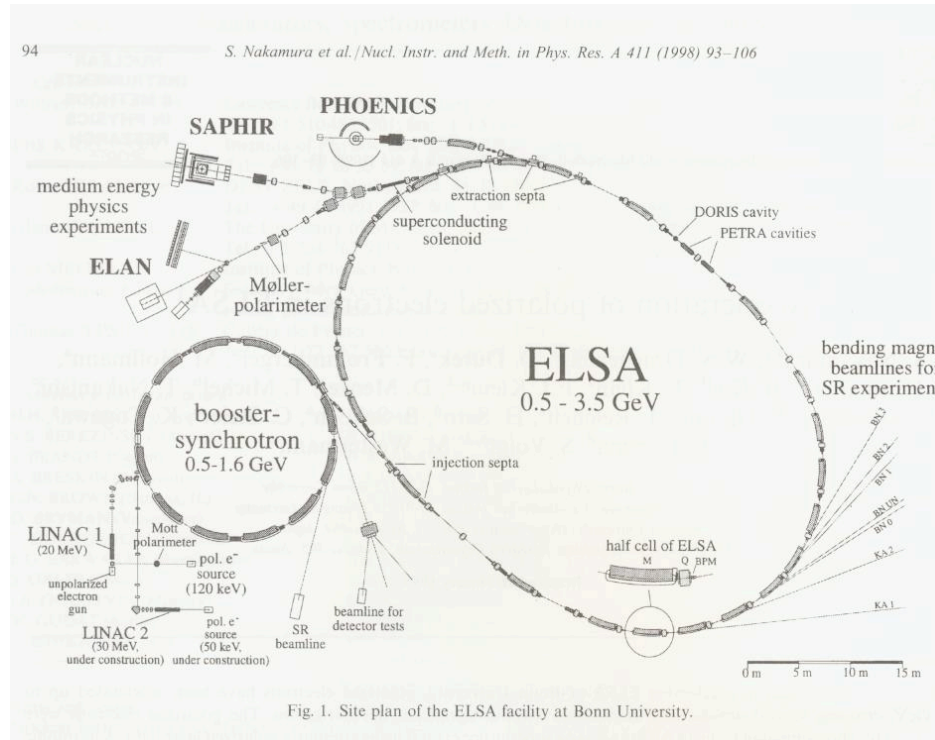
- $\theta = 2$ to 45 degree
- $\Delta\phi \sim 50\%$ of 2π

Electrons:

- $\theta = 15$ to 50 degree
- $\Delta\phi \sim 50\%$ of 2π

Best suited for multi-particle final states

ELSA: slow extracting stretcher ring at BONN University



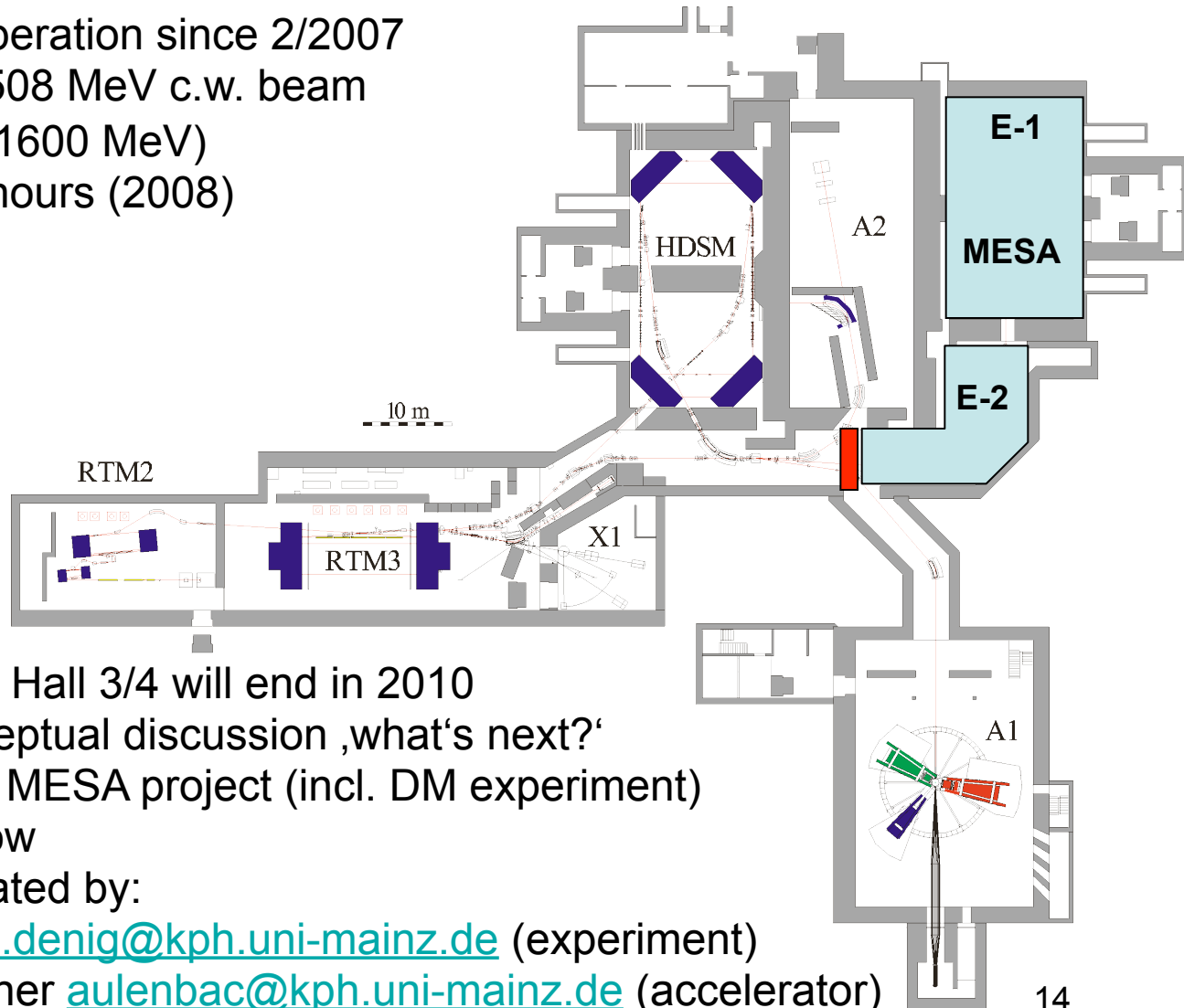
Energy 0.5--3.5 GeV

external beam current a few nA (--100na?)

Contact: Wolfgang Hillert w.hillert@ikp.uni-bonn.de (accelerator)

MAMI-C @ Mainz University

- MAMI-C: In Operation since 2/2007
- 100 μ A, 180-1508 MeV c.w. beam
(increased to 1600 MeV)
- op-time: 7000 hours (2008)



- Experiments in Hall 3/4 will end in 2010
- Currently conceptual discussion ,what's next?'
- One possibility MESA project (incl. DM experiment)
→ talk tomorrow
- efforts coordinated by:

Achim Denig a.denig@kph.uni-mainz.de (experiment)

Kurt Aulenbacher aulenbac@kph.uni-mainz.de (accelerator)

What are we looking for?

- Heavy Photon ($U, X, \gamma^*, A', \dots$)
- Beam Dump Products (H_D, W_D, \dots)
- What else?

Where? Available Facilities

J Lab	CEBAF	e-	1-6 GeV	10nA-100 μ a	CW (500 MHz)	NOW
	FEL	e-	100 MeV	5–10 mA	CW	NOW (internal)
	CEBAF upgrade	e-	12 GeV	10nA-50 μ a	CW (500 MHz)	2013
	FEL upgrade	e-	200 MeV	5–10 mA	CW	2010 (internal)
SLAC	FACET	e-	20 GeV	30Hz	10^{11} /pulse	2011
	ESTB	e-	14 GeV	5Hz	few x 10^9 /pulse	2011??
	Damping Ring		1.2 GeV	Resonant Extraction?		???
BONN	ELSA	e-	.5-3.5 GeV	\geq few nA?	CW (500 MHz)	NOW
MAINZ	MAMI	e-	.18-1.5 GeV	fA–100 μ A	CW (2.5 GHz)	NOW
	MESA	e-	100 MeV	10 mA	CW	2014 (internal)
	MESA	e-	137 MeV	0.15 mA	CW	2014 (external)
DESY	XFEL	e-	17.5 GeV	10Hz	10^{10} / bunch 3000/pulse	2015
	DORIS	e+	storage 5 GeV	???		NOW (internal)
CESR		e-	5 GeV	storage ring	resonant extraction?	

Other: protons (SNS, LSND... –see M. Pospelov talk), muons (COMPASS, MINOS, ...) , neutrinos (FNAL...) – not discussed.

Different machines, different production mechanisms

M. Pospelov

- $m_{V,h'} < 100$ MeV - LSND, SNS
- $m_{V,h'} < 1$ GeV - MiniBooNE
- $m_{V,h'} \gtrsim 1$ GeV - MINOS, (T2K, NOvA, Project X, ...)

$$m_{V,h'} \lesssim m_\pi$$

$$m_{V,h'} \lesssim 400 \text{ MeV}$$

$$m_{V,h'} \lesssim m_\rho$$

$$m_{V,h'} \gtrsim 1 \text{ GeV}$$

$$\pi^0 \rightarrow \gamma V, \gamma V h'$$

$$\eta \rightarrow \gamma V, \gamma V h'$$

$$\Delta \rightarrow NV$$

$$\rho^0, \omega, \phi \rightarrow V h', V \pi^0(\eta)$$

$$q + \bar{q} \rightarrow V, V h', \dots$$

$$q + g \rightarrow V h', qV, \dots$$

How? Possible Experiments

Data Mining:

- J Lab Existing Data $eA \rightarrow A' \rightarrow e+e-X$ (6GeV) $.2 < m < 2$ GeV $\epsilon > 10^{-3}$
- BLAST?
- Proton experiments? Miniboone, Microboone analyzing...
- Muons (COMPASS, MINOS)

J Lab Future Proposals with Existing Apparatus

- 50 MeV up, $\epsilon > 10^{-4}$? Ticking clock (2 mo. to propose)
- Hall C: muon wall behind Qweak?

New J Lab Experiments

- FEL – MIT/Berkeley (LOI this fall, also Mainz) $10 < m < 80$ MeV, $\epsilon > 10^{-3.5}$
- Hall B – JLab/SLAC $100 < m < 600$ MeV, $\epsilon > 2 \cdot 10^{-5}$ (gap $\sim 10^{-4}$)
- New beam dump experiments: $m < 100$ MeV, $\epsilon \sim 10^{-5}$ op $10^{-8} - 10^{-7}$

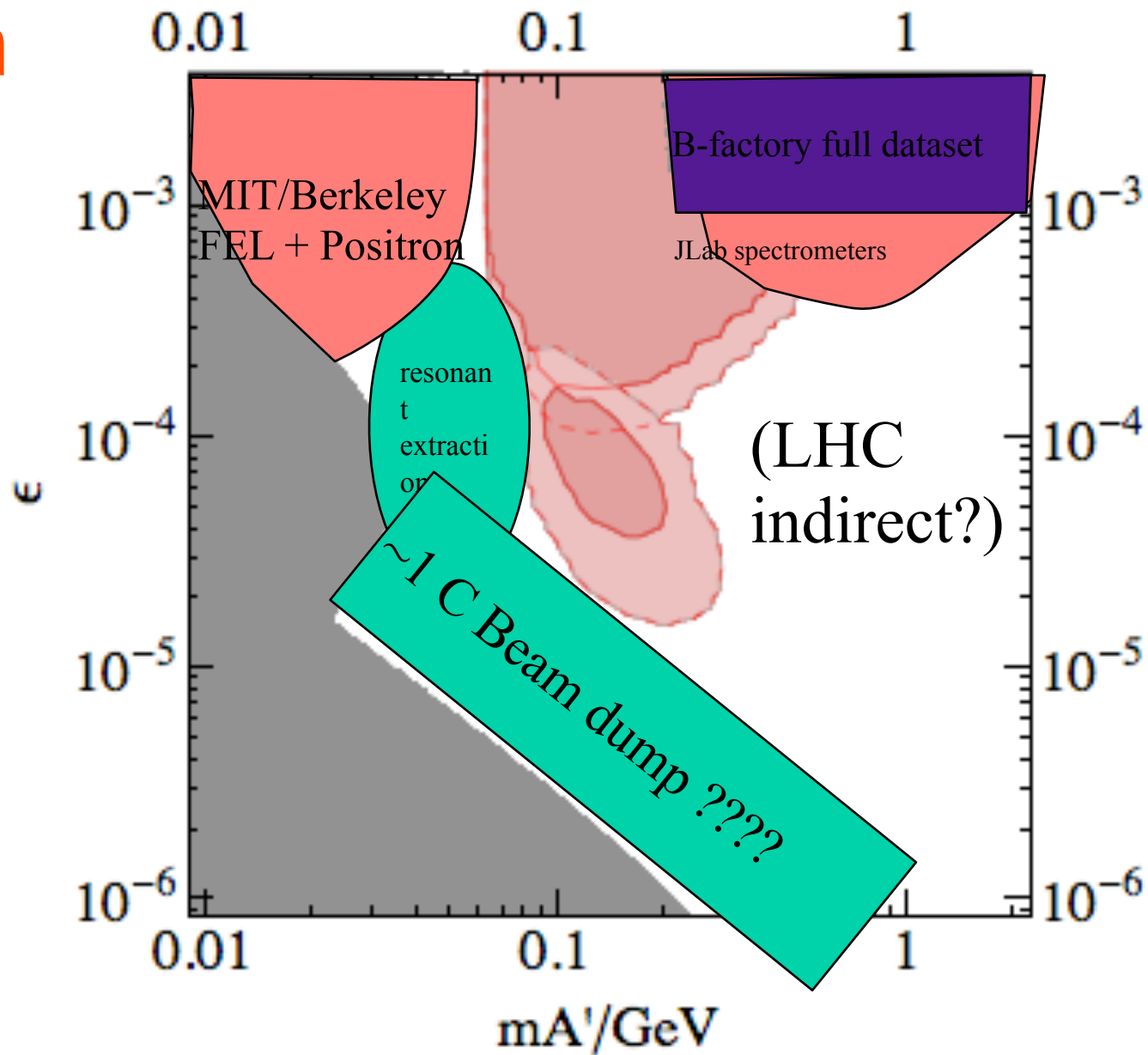
Positron Experiments

- e^+ on H: $5 < m < 30$ MeV, $\epsilon > 10^{-4}$ (indep. of decay mode)
- OLYMPUS internal target ep elastic (data taking 2012)

Resonant Extraction from Damping ring experiments:

- Possible opportunities at SLAC, CESR, Bonn, MAMI (cw)

Reach



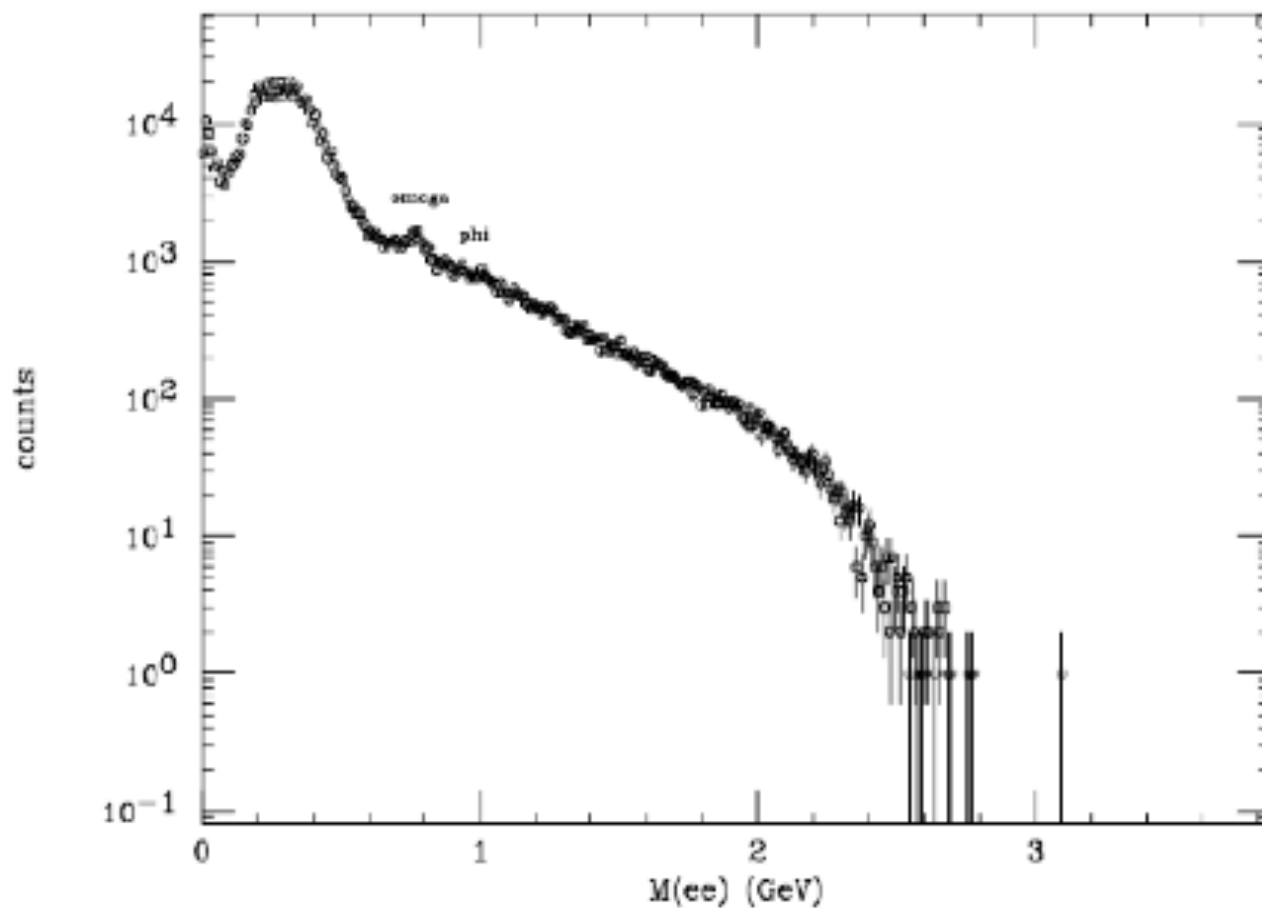
When?

- Data being mined NOW
- J Lab before shutdown (2012)
Proposals for existing apparatus SOON
- Longer Range Plans
Mainz, DESY FEL,...

“Data mining” from Hall B

Bosted

CLAS online 5 days NH₃ target E=6 GeV



Who?

Conclusions

Heavy Photon Searches

Two Thumbs Up