Martin Perl: Berkeley Connections

R. Cahn

for Martin's Berkeley friends and colleagues

Gerry Abrams, Willi Chinowsky, John Kadyk,
George Trilling, Charlie Schwartz

Additional contributions from

Michael Goldhaber, Joel Primack, Herman Winick

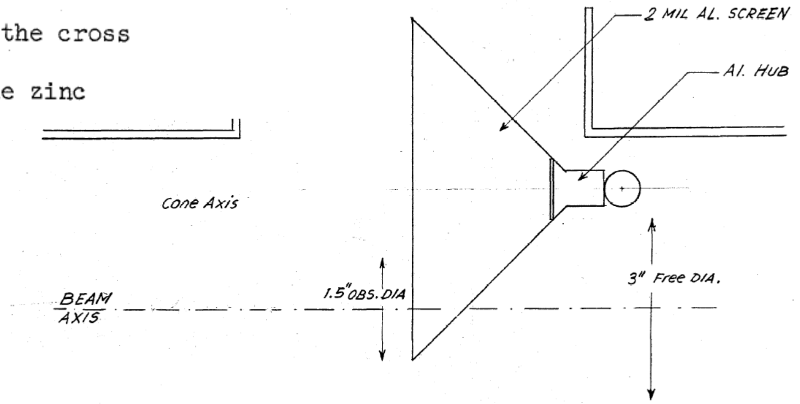
My First Work at SLAC for Dick Taylor - 1965

TN-65-67
R. Cahn
August 1965

BEAM MONITORING IN THE 30 FOOT SECTION

OF END STATION A

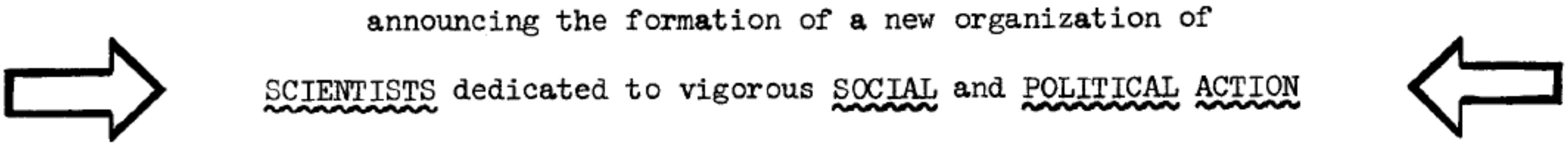
The last 30 feet before the target in End Station A are to be used to determine the intensity, position and cross section of the beam. The intensity is to be monitored by a toroidal device which will not be discussed in this paper. The position is to be determined by microwave devices. Two types of instruments are to be used to observe the cross section: zinc sulfide screens and a Čerenkov cell. Since the zinc



1960s as Seen from Berkeley

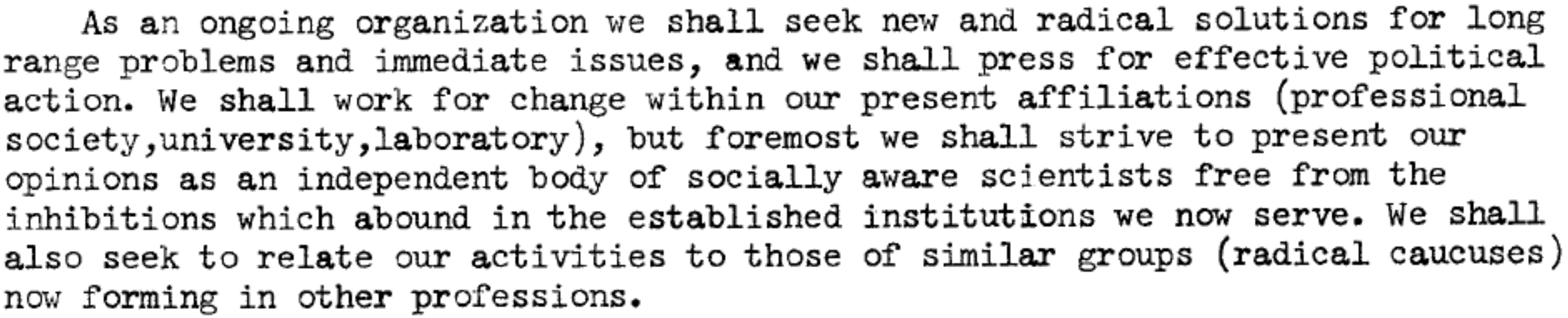
Palo Altan

Founding of SSPA



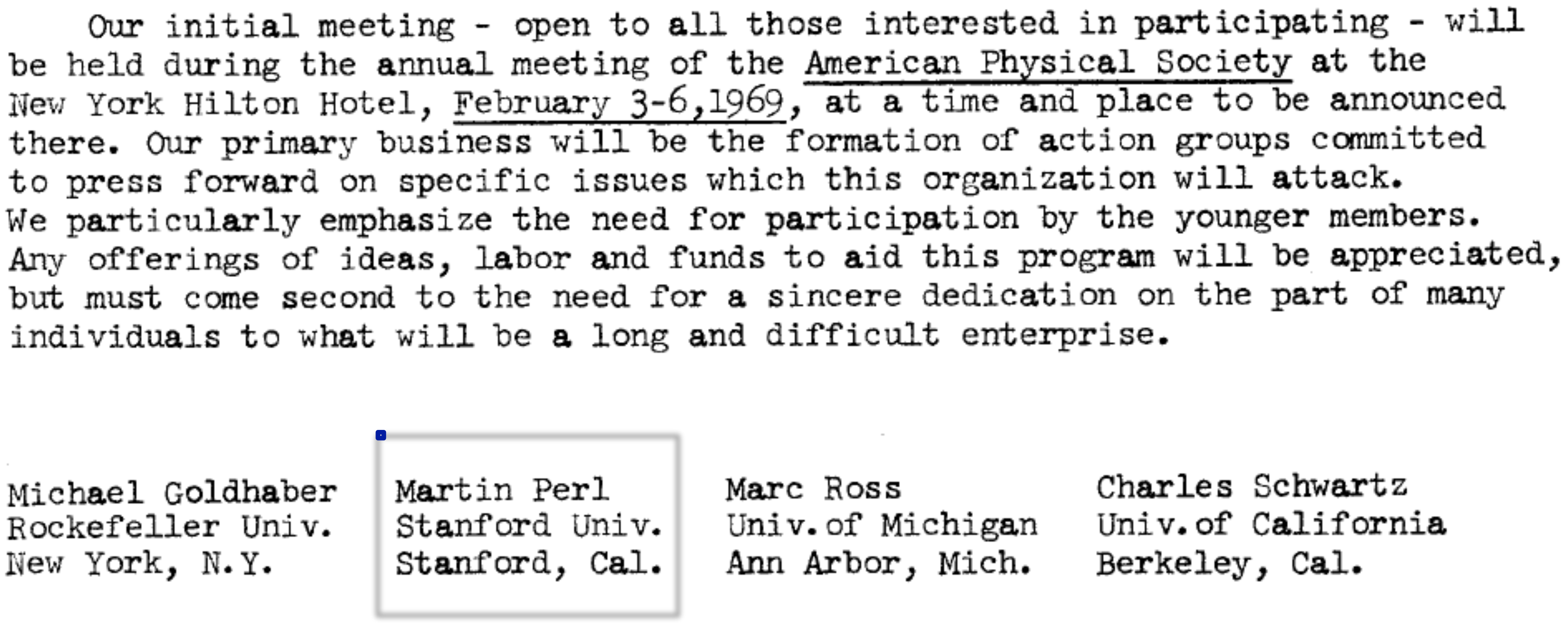
announcing the formation of a new organization of

SCIENTISTS dedicated to vigorous SOCIAL and POLITICAL ACTION



As an ongoing organization we shall seek new and radical solutions for long range problems and immediate issues, and we shall press for effective political action. We shall work for change within our present affiliations (professional society,university,laboratory), but foremost we shall strive to present our opinions as an independent body of socially aware scientists free from the inhibitions which abound in the established institutions we now serve. We shall also seek to relate our activities to those of similar groups (radical caucuses) now forming in other professions.

Founders



Our initial meeting - open to all those interested in participating - will be held during the annual meeting of the American Physical Society at the New York Hilton Hotel, February 3-6,1969, at a time and place to be announced there. Our primary business will be the formation of action groups committed to press forward on specific issues which this organization will attack. We particularly emphasize the need for participation by the younger members. Any offerings of ideas, labor and funds to aid this program will be appreciated, but must come second to the need for a sincere dedication on the part of many individuals to what will be a long and difficult enterprise.

Michael Goldhaber
Rockefeller Univ.
New York, N.Y.

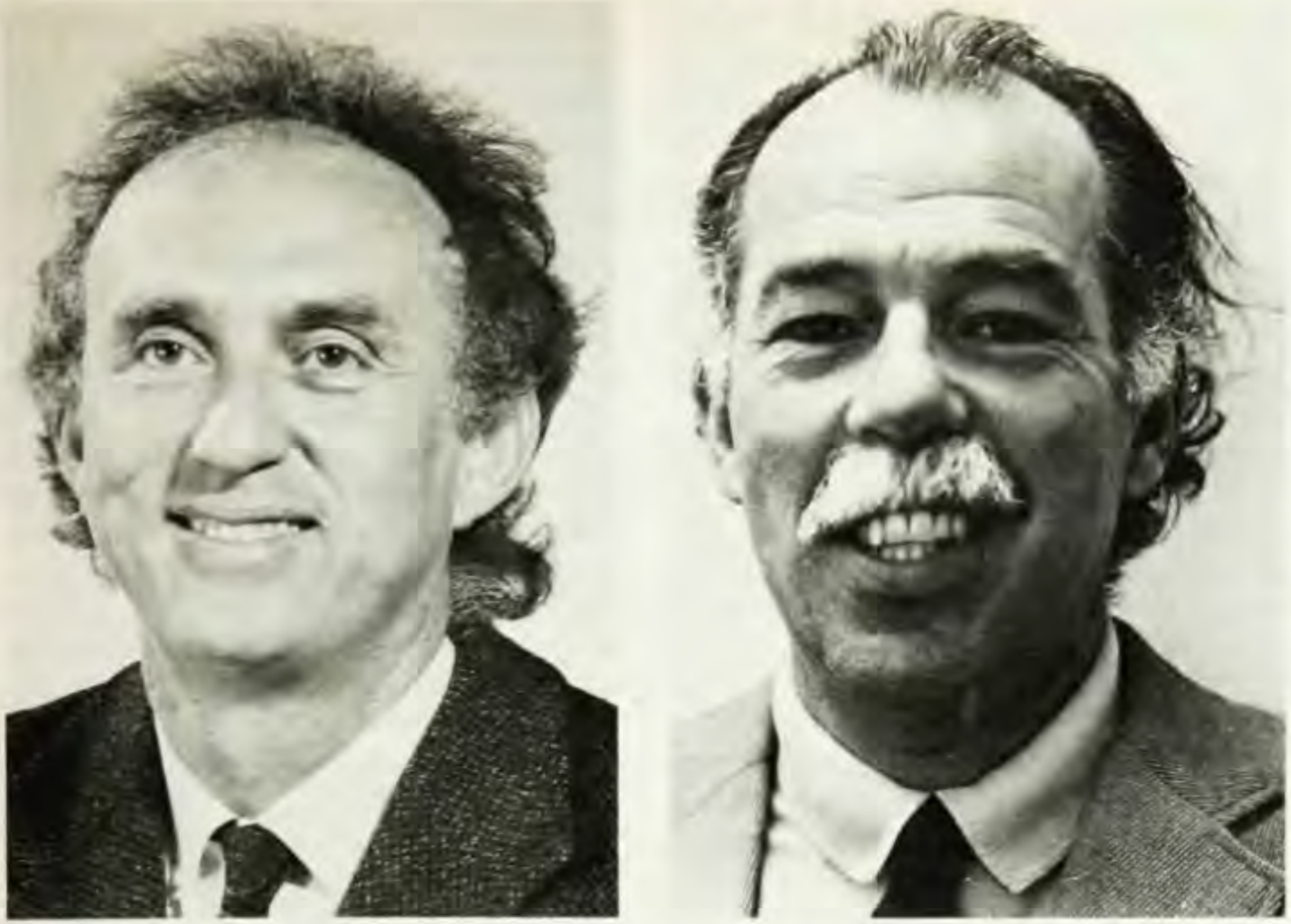
Martin Perl
Stanford Univ.
Stanford, Cal.

Marc Ross
Univ.of Michigan
Ann Arbor, Mich.

Charles Schwartz
Univ.of California
Berkeley, Cal.

Parting of the Ways

Forum on Physics and Society



The first two chairmen of the Forum were Martin Perl (left), who served during 1973, and Earl Callen, elected chairman of the Forum when it was first founded in 1972.

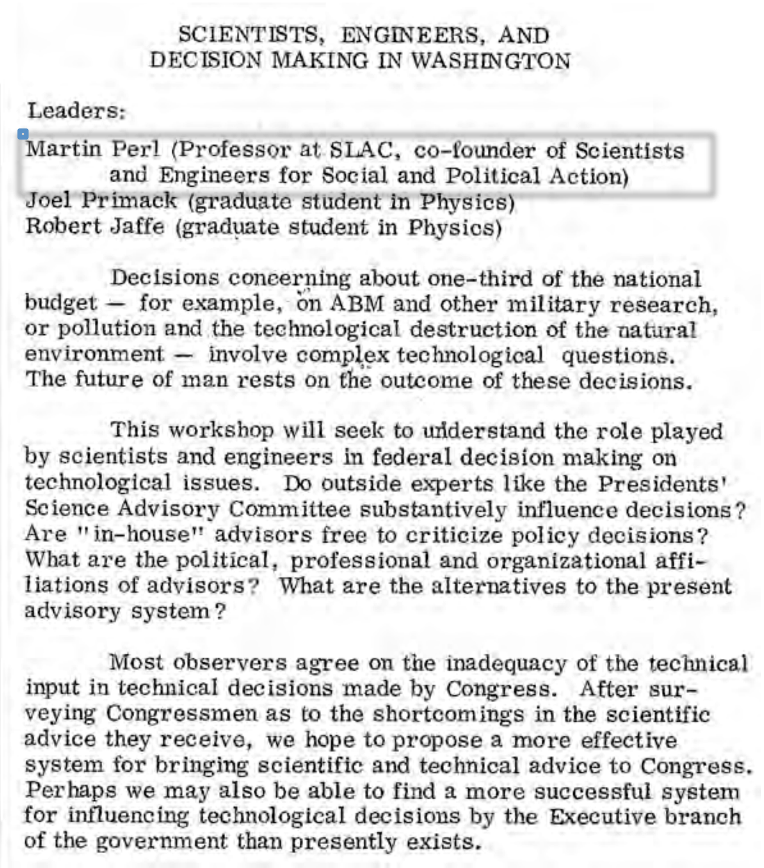
From “History of the APS Forum on Physics and Society (1972–2015)”

“Martin Perl can only be described as a phenomenon. While acting as the second chair of the Forum in 1973-74, he discovered the tau meson, establishing the third family of leptons. (For this discovery he was awarded the 1995 Nobel Prize in physics, shared with Frederick Reines, who was honored for the discovery of the electron's anti-neutrino). And in his spare time Perl established and edited the forum's newsletter, *Physics and Society*, from 1972-79 and mobilized two Penn State Conferences on graduate physics education (1974, 1977). “

David Hafmeister

Martin Perl and SWOPSI

In fall 1969, Bob Jaffe & Joel Primack, who were then Stanford grad students working on high energy physics, started Stanford Workshops on Political and Social Issues (SWOPSI) with student body president Joyce Kobayashi. SWOPSI continued for about 20 years. In fall 1969, Jaffe and Primack co-led one of the first SWOPSI workshops with Martin Perl and Frank von Hippel, on the topic of Scientists, Engineers, and Decision-Making in Washington.



SCIENTISTS, ENGINEERS, AND
DECISION MAKING IN WASHINGTON

Leaders:

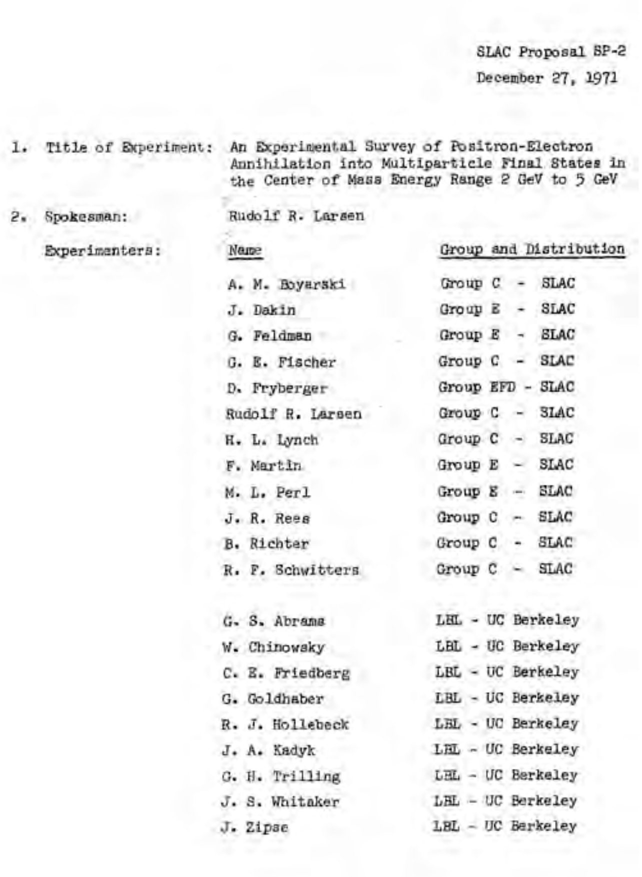
Martin Perl (Professor at SLAC, co-founder of Scientists and Engineers for Social and Political Action)
Joel Primack (graduate student in Physics)
Robert Jaffe (graduate student in Physics)

Decisions concerning about one-third of the national budget — for example, on ABM and other military research, or pollution and the technological destruction of the natural environment — involve complex technological questions. The future of man rests on the outcome of these decisions.

This workshop will seek to understand the role played by scientists and engineers in federal decision making on technological issues. Do outside experts like the Presidents' Science Advisory Committee substantively influence decisions? Are "in-house" advisors free to criticize policy decisions? What are the political, professional and organizational affiliations of advisors? What are the alternatives to the present advisory system?

Most observers agree on the inadequacy of the technical input in technical decisions made by Congress. After surveying Congressmen as to the shortcomings in the scientific advice they receive, we hope to propose a more effective system for bringing scientific and technical advice to Congress. Perhaps we may also be able to find a more successful system for influencing technological decisions by the Executive branch of the government than presently exists.

SLAC-LBL Detector at SPEAR



SLAC Proposal SP-2
December 27, 1971

1. Title of Experiment: An Experimental Survey of Positron-Electron Annihilation into Multiparticle Final States in the Center of Mass Energy Range 2 GeV to 5 GeV

2. Spokesman: Rudolf R. Larsen

Experimenters:

Name	Group and Distribution
A. M. Boyarski	Group C - SLAC
J. Dakin	Group E - SLAC
G. Feldman	Group E - SLAC
G. E. Fischer	Group C - SLAC
D. Fryberger	Group EFD - SLAC
Rudolf R. Larsen	Group C - SLAC
H. L. Lynch	Group C - SLAC
F. Martin	Group E - SLAC
M. L. Perl	Group E - SLAC
J. R. Rees	Group C - SLAC
B. Richter	Group C - SLAC
R. F. Schwitters	Group C - SLAC
G. S. Abrams	LBL - UC Berkeley
W. Chinowsky	LBL - UC Berkeley
C. E. Friedberg	LBL - UC Berkeley
G. Goldhaber	LBL - UC Berkeley
R. J. Hollebeck	LBL - UC Berkeley
J. A. Kadyk	LBL - UC Berkeley
G. H. Trilling	LBL - UC Berkeley
J. S. Whitaker	LBL - UC Berkeley
J. Zipse	LBL - UC Berkeley

SLAC Proposal SP-2
December 27, 1971

Using the SPEAR magnetic detector we can begin to answer in detail such basic questions as: Does the cross section for e+e- to hadrons support the parton model? What are the q^2 dependencies of the hadronic elastic form factors? Symmetry schemes lead us to expect as many K's as π's at high energy – will this prevail? Will we observe "bumps" in form factors reflecting the existence of high-mass vector mesons?

Berkeley names: G. S. Abrams, W. Chinowsky, C. E. Friedberg, G. Goldhaber, R. J. Hollebeek, J. A. Kadyk, G. H. Trilling, J. S. Whitaker, J. Zipse

Gerry Abrams Recounts LBL Role

- The overall design was basically a cylindrical detector with a solenoidal magnet, built to maximize the instrumented solid angle . As a group familiar with the analysis benefits of full event reconstruction, from a long bubble chamber and analysis history, the LBL Group naturally gravitated toward this (then) novel approach toward an "electronic bubble chamber".

- The first contribution made by LBL to the detector was the tracking software developed by Willi and students. You can ask Willi, but as I recall, Emilio said sure, Willi could work on the project, but with the restriction that it couldn't cost any money (i.e., no construction funding).
- Bob Budnitz and I took a night in a SLAC beam-line early on, and took data with an electron beam to establish that the preferred technique to construct an electromagnetic shower detector at SPEAR was to build a Pb-scintillator sandwich, alternating layers of Pb with panels of scintillating plastic, with photomultipliers reading out the scintillator signals.

- George and Gerson were able to convince Physics Division management that LBL needed to have an important construction role in the detector (i.e. money had to be put forward by us).

- A beam test at the Bevatron, led by John Kadyk, established the detailed design for the dimensions of the Pb sheets and the scintillator panels. The design was optimized to measure the energy of multi-GeV electrons, sure to be abundant once data-taking began. The consequences for the electrons from tau decay, to be discovered later by Martin, was an unfortunate impairment in our ability to distinguish lower energy electrons from pions. (But Martin was talented, and stubborn, enough to overcome this disadvantage.)

SLAC-LBL Detector

Scott Whittaker, a student, mostly alone, assembled the shower detectors in a Bevatron bay. He also did the software, and the calibration (I think).

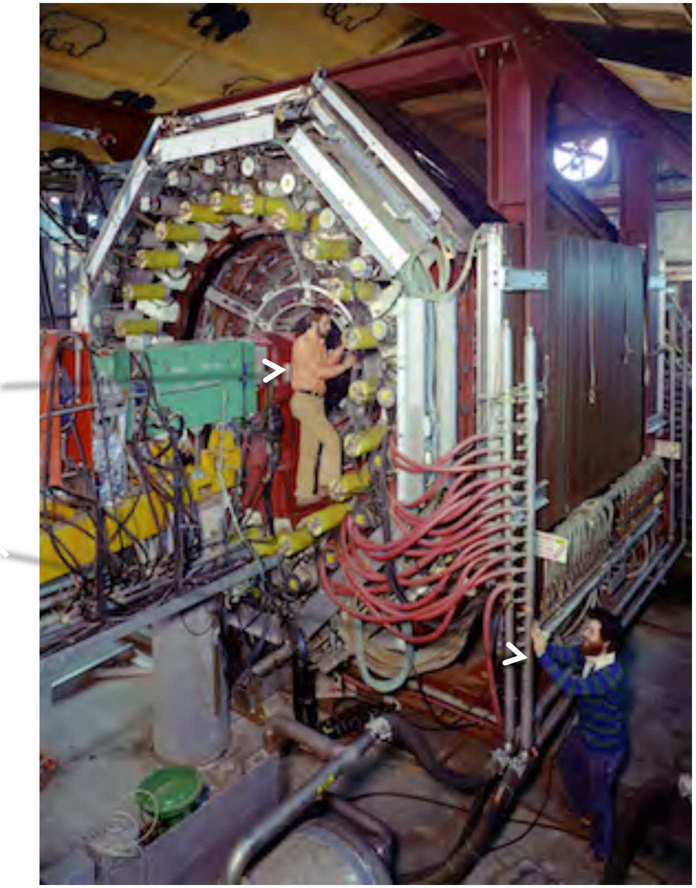
John Kadyk's Version!

- LBL was asked to build an efficient "shower detector", and it worked quite well as this, but Burt also tried to use it as a "shower calorimeter", a performance for which it was never intended, or requested, having only six layers of Pb radiator per detector. So it was called the calorimeter produced by LBL, which measured energy only poorly. … it did well at shower detection, which is all that Burt ever asked us to provide.

SLAC-LBL Detector

Roy Schwitters

Carl Friedberg



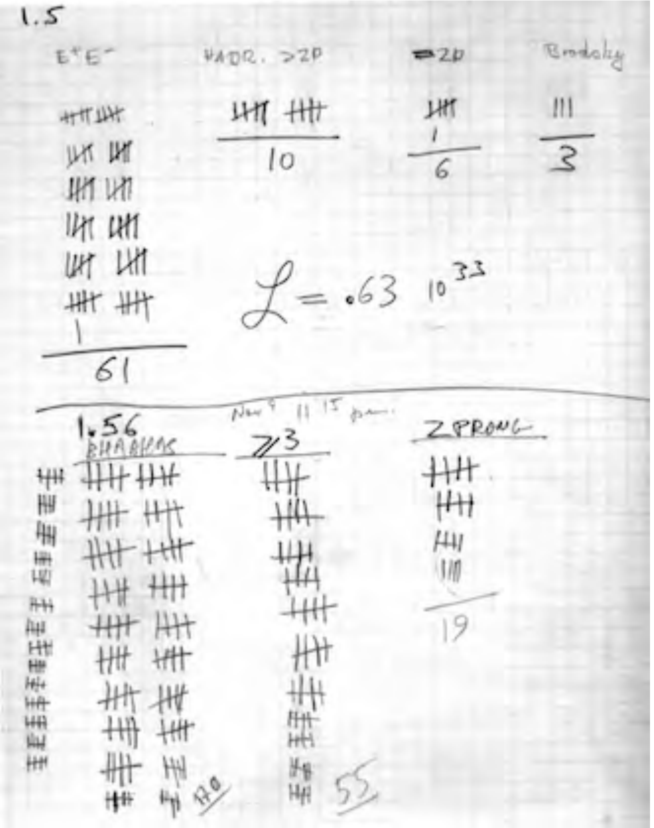
When anything went wrong with the shower detectors, they were called the "LBL Shower Detectors". When they functioned normally and well, they became the "SLAC-LBL Shower Detectors"; thankfully, this was the standard mode.

LBL Team

Willi Chinowsky, Don Briggs, Gerry Abrams, Bob Hollebeek, John Kadyk, George Trilling, Scott Whittaker, Gerson Goldhaber
(Bernard Sadoulet not present)

Willi, Martin, Francois, Gerson

November Revolution: Ψ



Gerson's event tally

Kadyk sees 20% anomaly
in σ measurement at 3.2 GeV

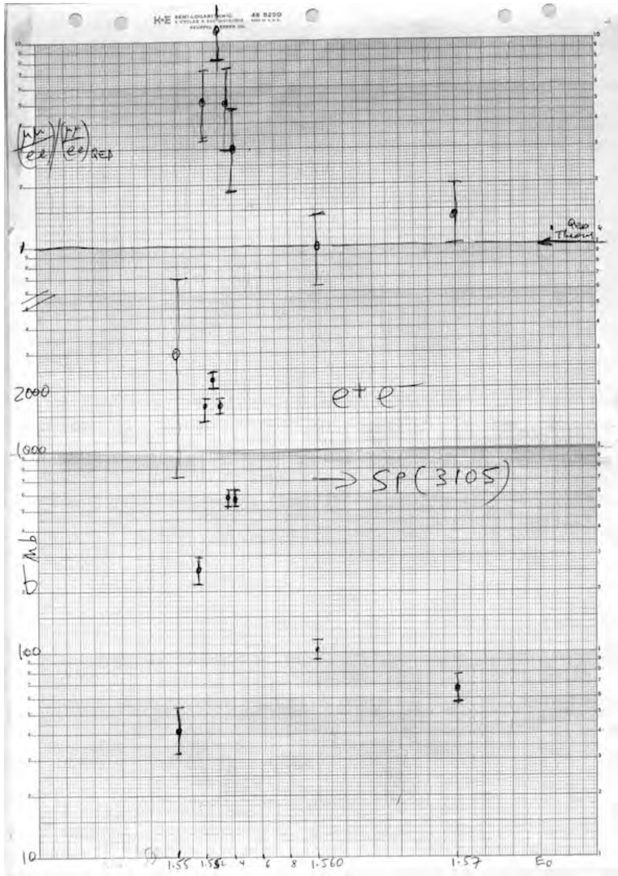
Marty Breidenbach said "go back"

Roy doing measurement

Inconsistent results at 3.1 GeV

Abrams transfers electronic data
to film à la bubble chamber

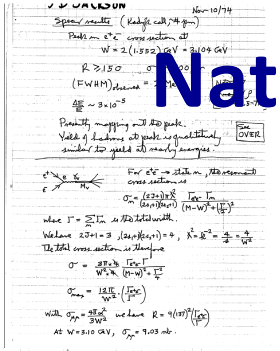
Dedicated scan around 3.1 GeV
with careful energy measurement



Gerson's cross section plot

Gerson Goldhaber, Marty Breidenbach, Ewan Patterson,
Herman Winick, Francois Vanucci

Nature Assigns Jackson a Homework Problem



J D JACKSON Nov 10/74

Spear results (Kadyk call, ~4 pm)

Peak in e^+e^- cross section at

$W = 2(1.552)$ GeV $= 3.104$ GeV

$R \gtrsim 150$ σ

$(\text{FWHM})_{\text{observed}} =$

$\frac{\Delta E}{E} \sim 3\times10^{-5}$

Presently mapping out the peak.
Yield of hadrons at peak is qualitatively similar to yield at nearby energies.

See OVER

For $e^+e^- \rightarrow$ state n, the resonant cross section is

$$\sigma_n = \frac{(2J+1)\pi\lambda\!\!\!^{-2}}{(2s_1+1)(2s_2+1)} \frac{\Gamma_{e^+e^-}\Gamma_n}{(M-W)^2+\left(\frac{\Gamma}{2}\right)^2}$$

where $\Gamma = \sum_n \Gamma_n$ is the total width.

We have $2J+1 = 3$, $(2s_1+1)(2s_2+1) = 4$, $\lambda\!\!\!^{-2} = k^{-2} = \frac{4}{s} = \frac{4}{W^2}$

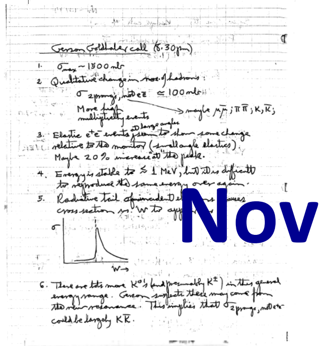
The total cross section is therefore

$$\sigma = \frac{3\pi\times4}{W^2\times4} \frac{\Gamma_{e^+e^-}\Gamma}{(M-W)^2+\frac{\Gamma^2}{4}}$$

$$\sigma_{max} = \frac{12\pi}{W^2}\cdot\left(\frac{\Gamma_{e^+e^-}}{\Gamma}\right)$$

With $\sigma_{\mu\mu} = \frac{4\pi\alpha^2}{3W^2}$ we have $R = 9(137)^2\left(\frac{\Gamma_{e^+e^-}}{\Gamma}\right)$

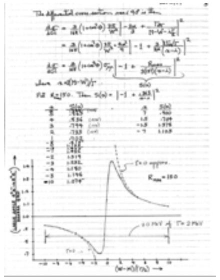
At $W = 3.10$ GeV, $\sigma_{\mu\mu} = 9.03$ nb.

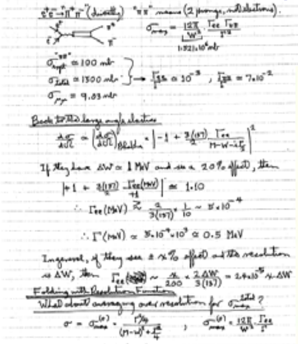


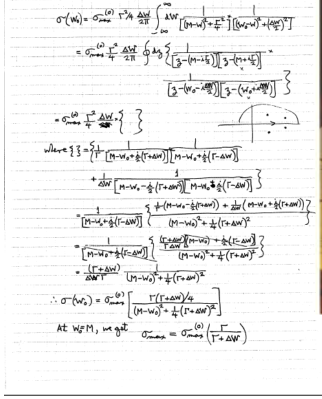
Gerson Goldhaber call (8.30 pm)

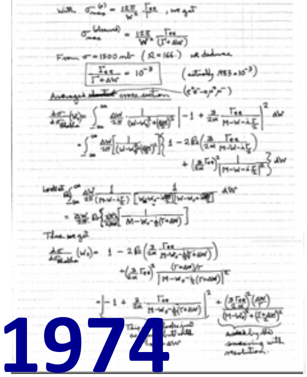
1. $\sigma_{max} \sim 1500$ nb
2. Qualitative change in nos. of hadrons:
   $\sigma_{\text{2 prongs, not } e\bar{e}} \simeq 100$ nb $\rightarrow$ maybe $\mu\bar{\mu}$; $\pi\bar{\pi}$; $K,\bar{K}$;
   More high multiplicity events
3. Elastic e^+e^- events at large angles seem to show some change relative to the monitor (small angle elastics). Maybe 20% increase "at" the peak.
4. Energy is stable to $\lesssim 1$ MeV, but it is difficult to reproduce the same energy over again.
5. Radiative tail of incident e… causes cross section vs. W to app…

6. There are lots more K^0's (and presumably $K^\pm$) in this general energy range. Gerson suspects these may come from the new resonance. This implies that $\sigma_{\text{2 prongs, not } e^+e^-}$ could be largely $K\bar{K}$.

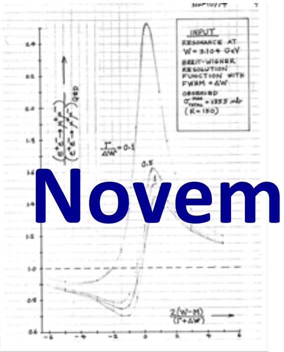


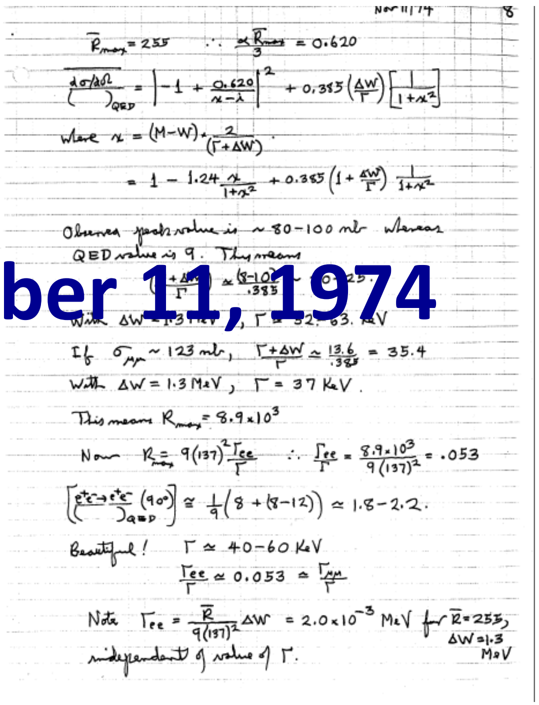






November 10, 1974





Nov 11/74 8

$\bar{R}_{max} = 255$ ∴ $\frac{\alpha\bar{R}_{max}}{3} = 0.620$

$$\frac{\overline{d\sigma/d\Omega}}{(\quad)_{QED}} = \left|-1 + \frac{0.620}{x-i}\right|^2 + 0.385\left(\frac{\Delta W}{\Gamma}\right)\left[\frac{1}{1+x^2}\right]$$

where $x = (M-W)\cdot\frac{2}{(\Gamma+\Delta W)}$.

$$= 1 - 1.24\frac{x}{1+x^2} + 0.385\left(1+\frac{\Delta W}{\Gamma}\right)\frac{1}{1+x^2}$$

Observed peak value is ~80–100 nb whereas QED value is 9. This means

$\left(1+\frac{\Delta W}{\Gamma}\right) \approx \frac{(8-10)}{.385} \sim 20-25.$

With $\Delta W = 1.3$ MeV, $\Gamma \approx 52-63.$ KeV

If $\sigma_{\mu\mu} \sim 123$ nb, $\frac{\Gamma+\Delta W}{\Gamma} \simeq \frac{13.6}{.385} = 35.4$

With $\Delta W = 1.3$ MeV, $\Gamma = 37$ KeV.

This means $R_{max} = 8.9\times10^3$

Now $R_{max} = 9(137)^2\frac{\Gamma_{ee}}{\Gamma}$ ∴ $\frac{\Gamma_{ee}}{\Gamma} = \frac{8.9\times10^3}{9(137)^2} = .053$

$\left[\frac{e^+e^-\rightarrow e^+e^-}{(\quad)_{QED}}(90°)\right] \cong \frac{1}{9}\left(8+(8-12)\right) \simeq 1.8-2.2.$

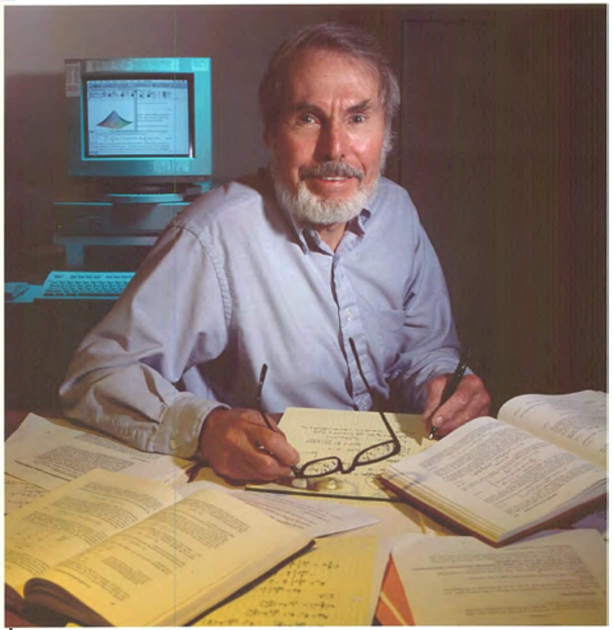
Beautiful! $\Gamma \simeq 40-60$ KeV

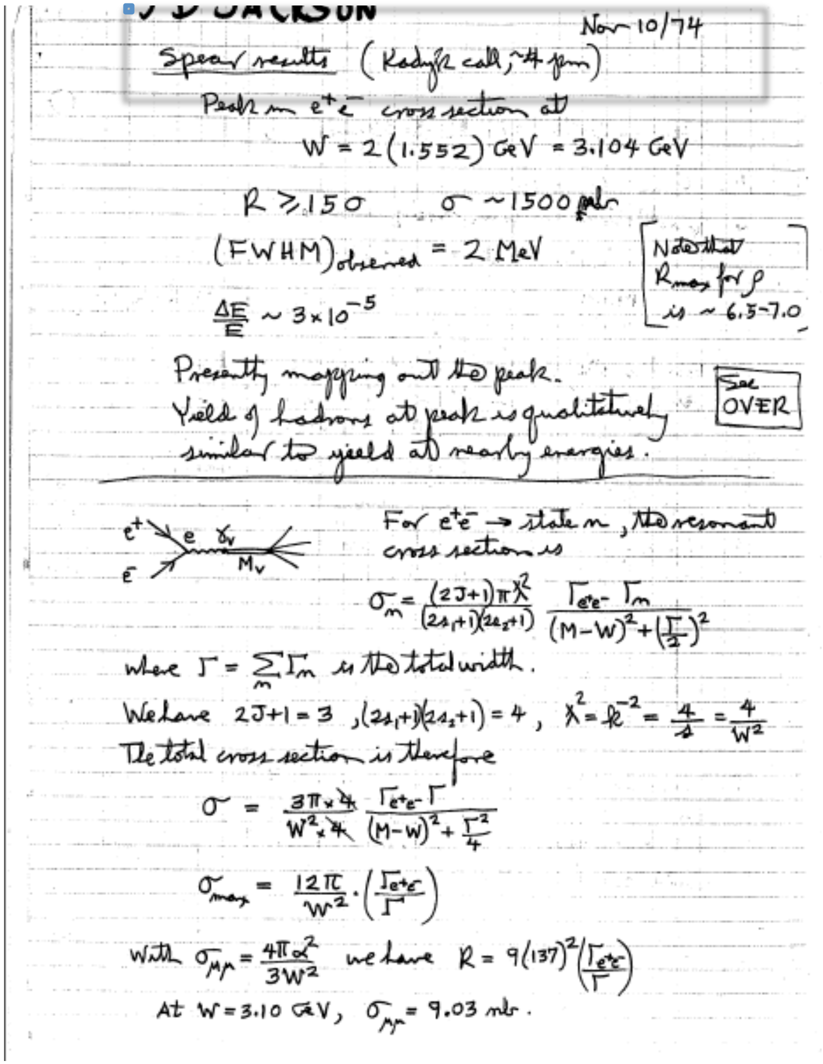
$\frac{\Gamma_{ee}}{\Gamma} \simeq 0.053 \doteq \frac{\Gamma_{\mu\mu}}{\Gamma}$

Note $\Gamma_{ee} = \frac{\bar{R}}{9(137)^2}\Delta W = 2.0\times10^{-3}$ MeV for $\bar{R} = 255$, $\Delta W = 1.3$ MeV

independent of value of Γ.

November 11, 1974





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$R \gtrsim 150$ $\sigma \sim 1500$ nb

$(\text{FWHM})_{\text{observed}} = 2$ MeV

$\frac{\Delta E}{E} \sim 3\times10^{-5}$

Note that R_{max} for ρ is ~ 6.5–7.0

Presently mapping out the peak.
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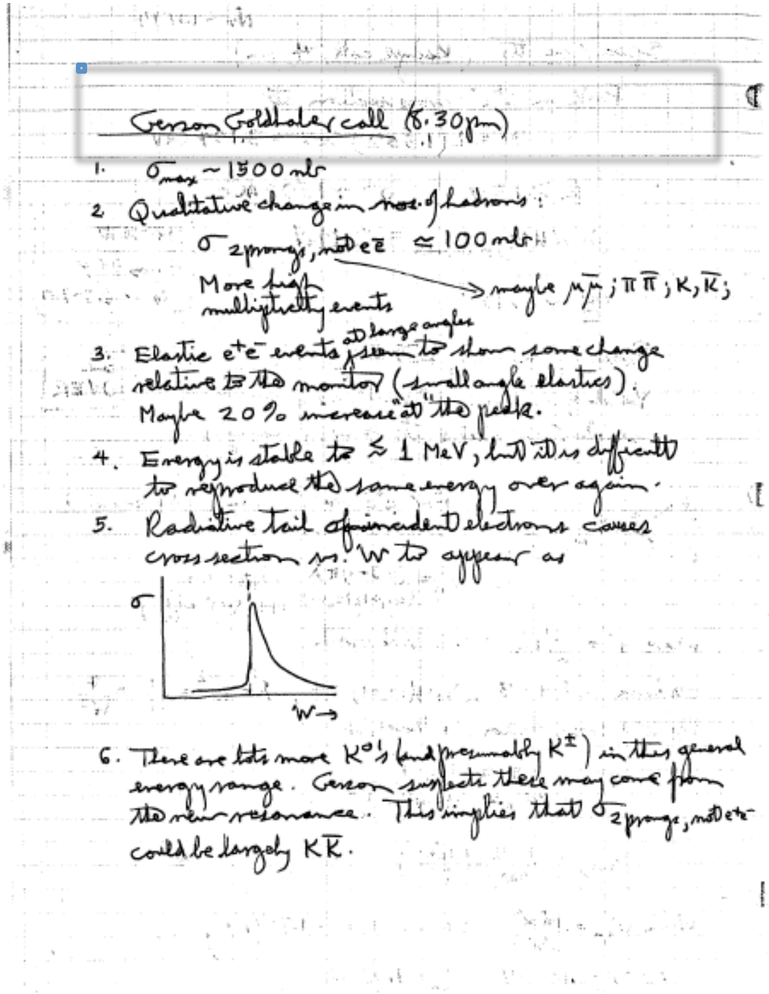

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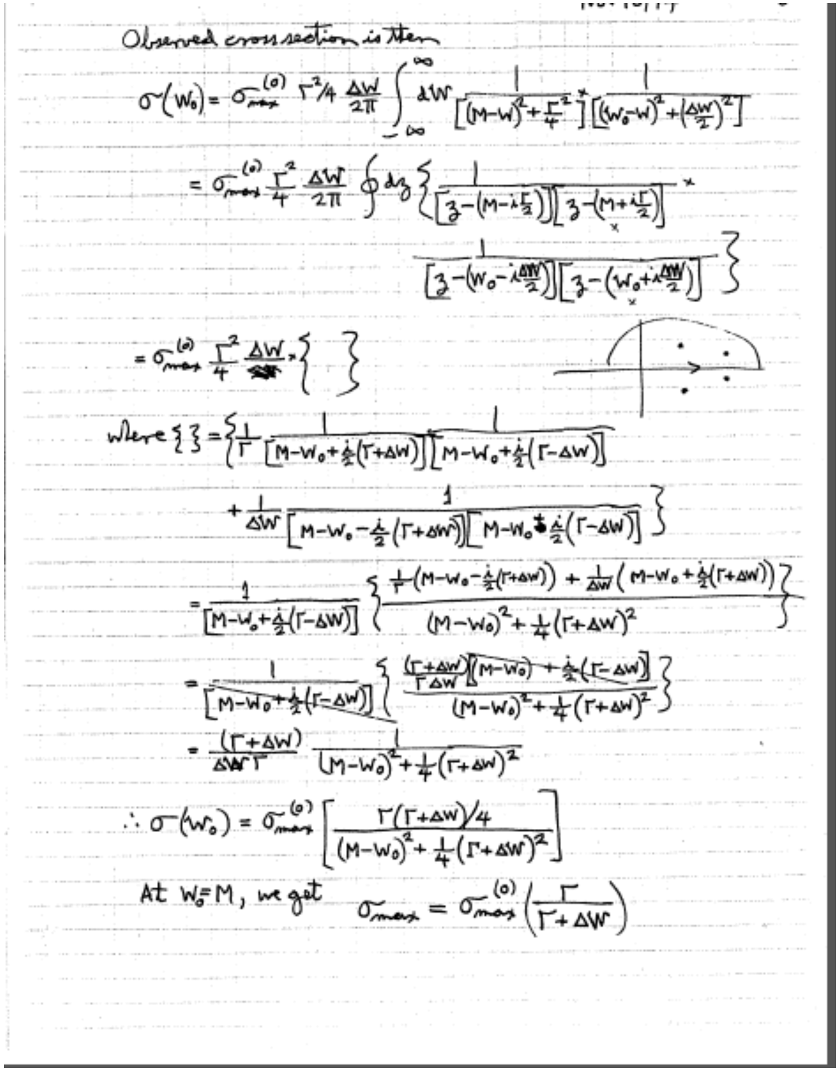


Observed cross section is then

$$\sigma(W_0) = \sigma_{max}^{(0)}\,\Gamma^2/4\,\frac{\Delta W}{2\pi}\int_{-\infty}^{\infty} dW\,\frac{1}{\left[(M-W)^2+\frac{\Gamma^2}{4}\right]}\times\frac{1}{\left[(W_0-W)^2+\left(\frac{\Delta W}{2}\right)^2\right]}$$

$$=\sigma_{max}^{(0)}\frac{\Gamma^2}{4}\frac{\Delta W}{2\pi}\oint dz\left\{\frac{1}{\left[z-(M-i\frac{\Gamma}{2})\right]\left[z-(\underset{\times}{M+i\frac{\Gamma}{2}})\right]}\times\frac{1}{\left[z-(W_0-i\frac{\Delta W}{2})\right]\left[z-(\underset{\times}{W_0+i\frac{\Delta W}{2}})\right]}\right\}$$

$$=\sigma_{max}^{(0)}\frac{\Gamma^2}{4}\Delta W\times\{\quad\}$$

$$\text{where }\{\,\}=\left\{\frac{1}{\Gamma}\frac{1}{\left[M-W_0+\frac{i}{2}(\Gamma+\Delta W)\right]\left[M-W_0+\frac{i}{2}(\Gamma-\Delta W)\right]}+\frac{1}{\Delta W}\frac{1}{\left[M-W_0-\frac{i}{2}(\Gamma+\Delta W)\right]\left[M-W_0+\frac{i}{2}(\Gamma-\Delta W)\right]}\right\}$$

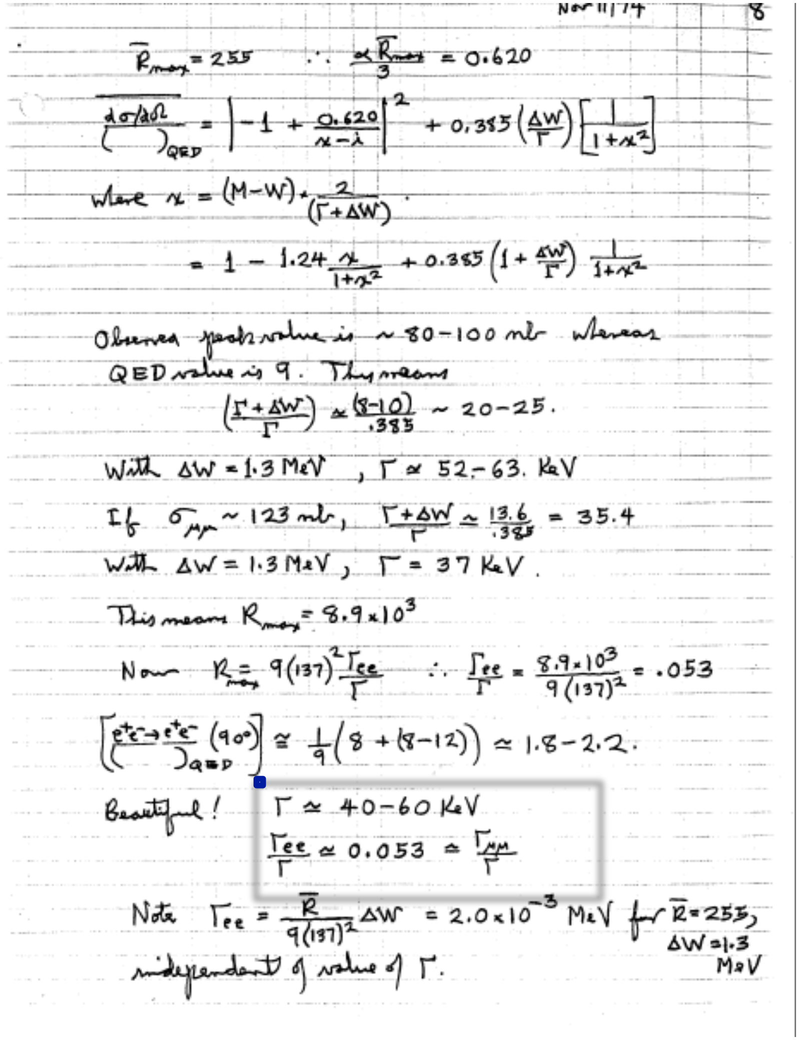
$$=\frac{1}{\left[M-W_0+\frac{i}{2}(\Gamma-\Delta W)\right]}\left\{\frac{\frac{1}{\Gamma}\left(M-W_0-\frac{i}{2}(\Gamma+\Delta W)\right)+\frac{1}{\Delta W}\left(M-W_0+\frac{i}{2}(\Gamma+\Delta W)\right)}{(M-W_0)^2+\frac{1}{4}(\Gamma+\Delta W)^2}\right\}$$

$$=\cancel{\frac{1}{\left[M-W_0+\frac{i}{2}(\Gamma-\Delta W)\right]}}\left\{\frac{\frac{(\Gamma+\Delta W)}{\Gamma\Delta W}\cancel{\left[(M-W_0)+\frac{i}{2}(\Gamma-\Delta W)\right]}}{(M-W_0)^2+\frac{1}{4}(\Gamma+\Delta W)^2}\right\}$$

$$=\frac{(\Gamma+\Delta W)}{\Delta W\,\Gamma}\,\frac{1}{(M-W_0)^2+\frac{1}{4}(\Gamma+\Delta W)^2}$$

$$\therefore\ \sigma(W_0)=\sigma_{max}^{(0)}\left[\frac{\Gamma(\Gamma+\Delta W)/4}{(M-W_0)^2+\frac{1}{4}(\Gamma+\Delta W)^2}\right]$$

At $W_0=M$, we get $\sigma_{max}=\sigma_{max}^{(0)}\left(\frac{\Gamma}{\Gamma+\Delta W}\right)$



Nov 11/74 8

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$$\left[\frac{e^+e^-\to e^+e^-}{(\quad)_{QED}}(90^\circ)\right]\cong\frac{1}{9}\left(8+(8-12)\right)\simeq 1.8-2.2.$$

Beautiful!

$$\boxed{\begin{aligned}&\Gamma\simeq 40-60\text{ KeV}\\&\frac{\Gamma_{ee}}{\Gamma}\simeq 0.053\doteq\frac{\Gamma_{\mu\mu}}{\Gamma}\end{aligned}}$$

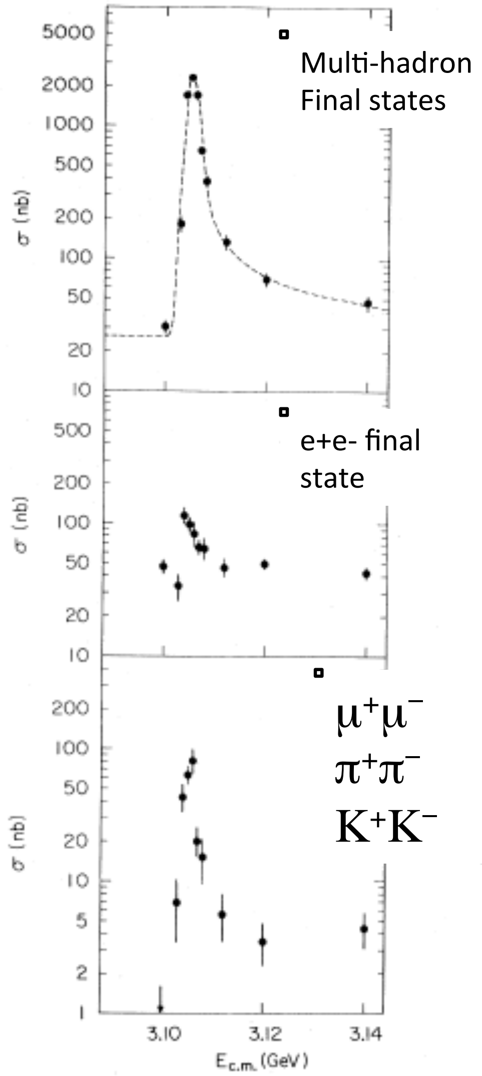
Note $\Gamma_{ee}=\frac{\bar{R}}{9(137)^2}\Delta W=2.0\times10^{-3}$ MeV for $\bar{R}=255$, $\Delta W=1.3$ MeV

independent of value of Γ.

Augustin et al. Γ<1.3 MeV

JDJ: 40 keV < Γ <60 keV

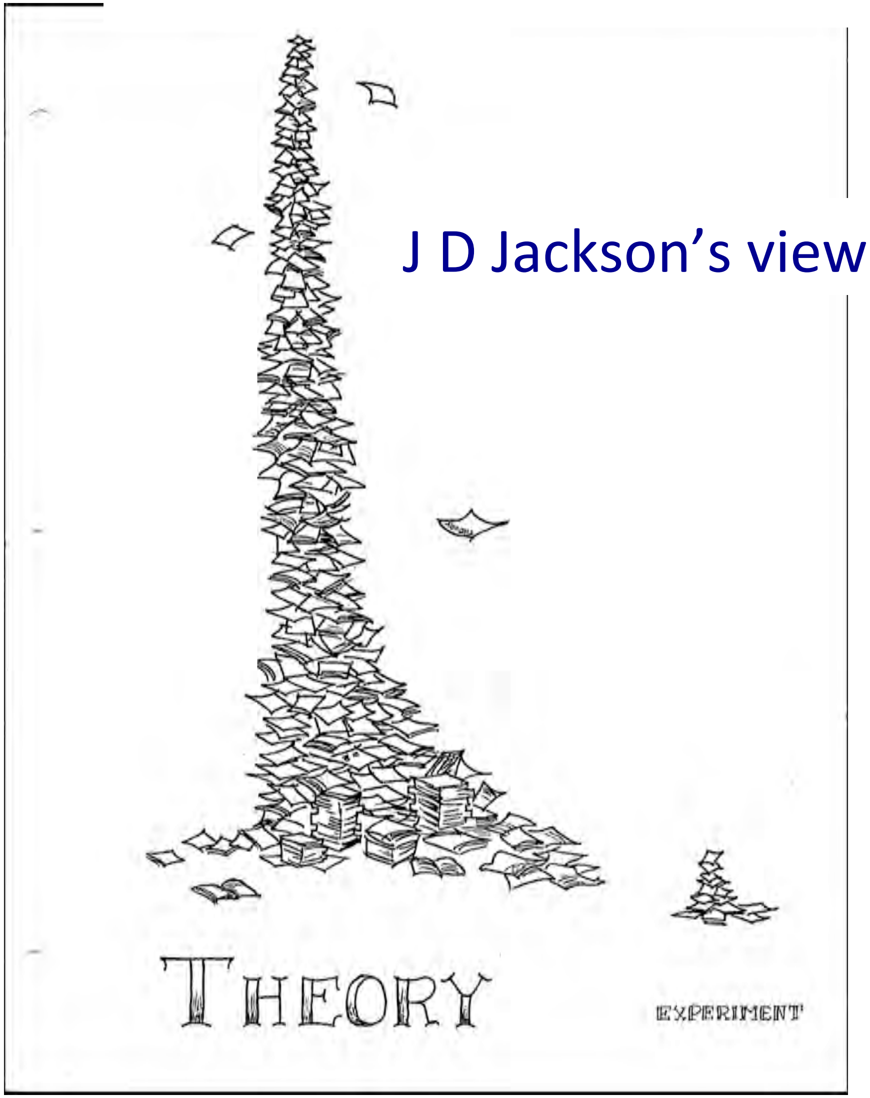
Ψ



Multi-hadron
Final states

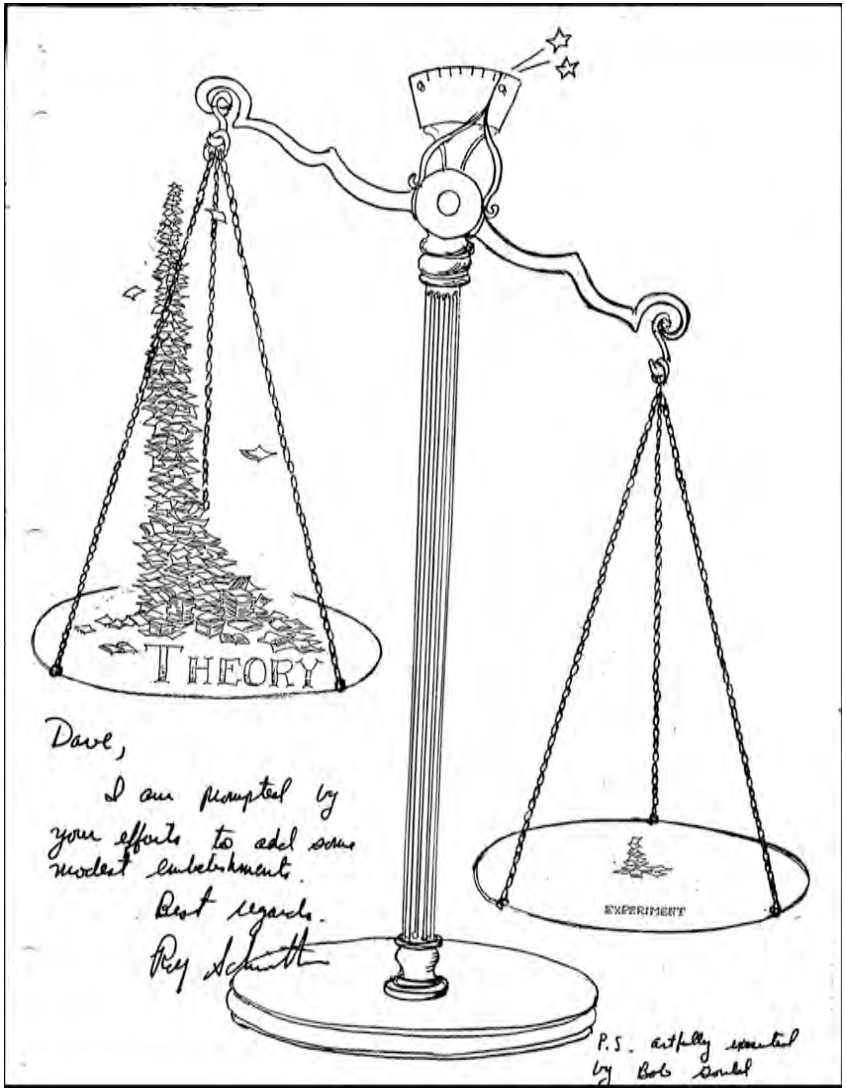
e+e- final
state

$\mu^+\mu^-$
$\pi^+\pi^-$
K^+K^-



J D Jackson's view

Roy Schwitters' view



Dave,

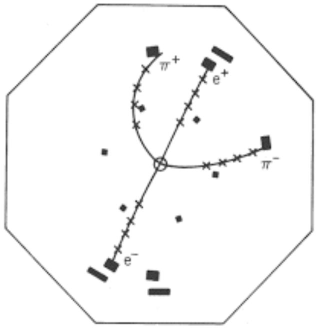
I am prompted by your efforts to add some modest embellishment.

Best regards.

Roy Schwitters

P.S. artfully executed by Bob Gould

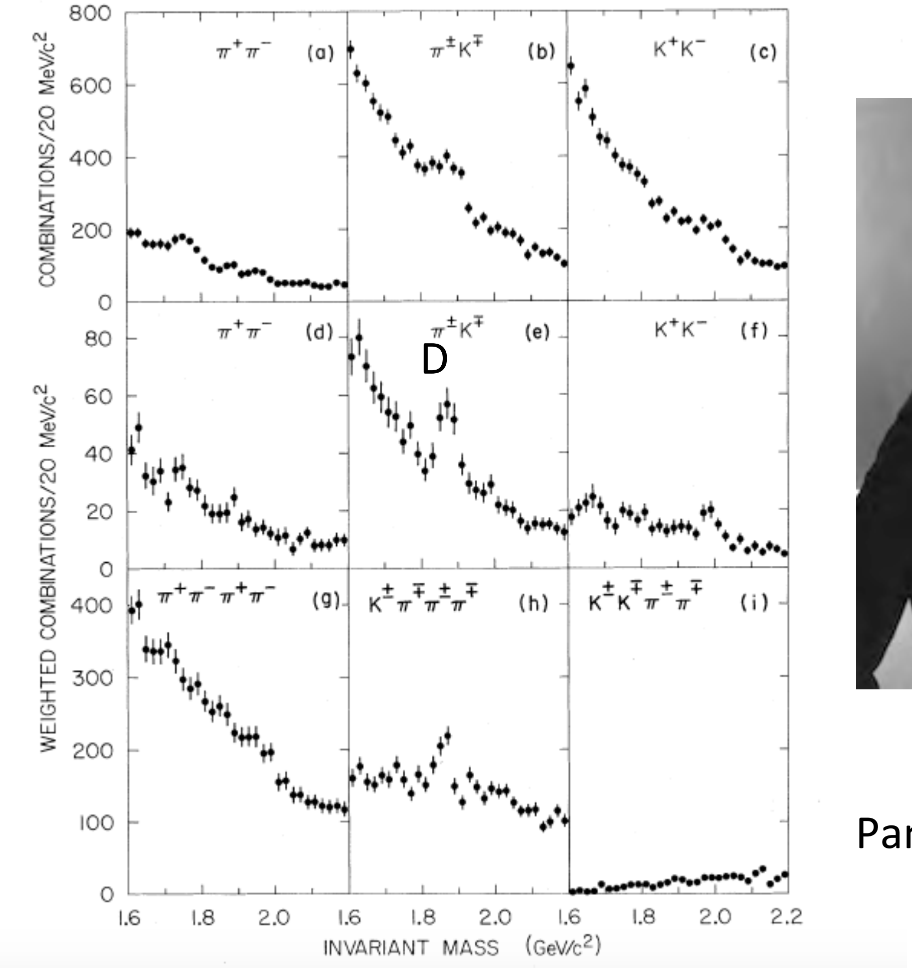
Ψ’



$\Psi' \rightarrow \psi\, \pi\pi$

Charm

ππ πK KK



George Trilling and
Gerson Goldhaber

Panofsky Prize to Gerson and François Pierre

Gerson's View of This Time