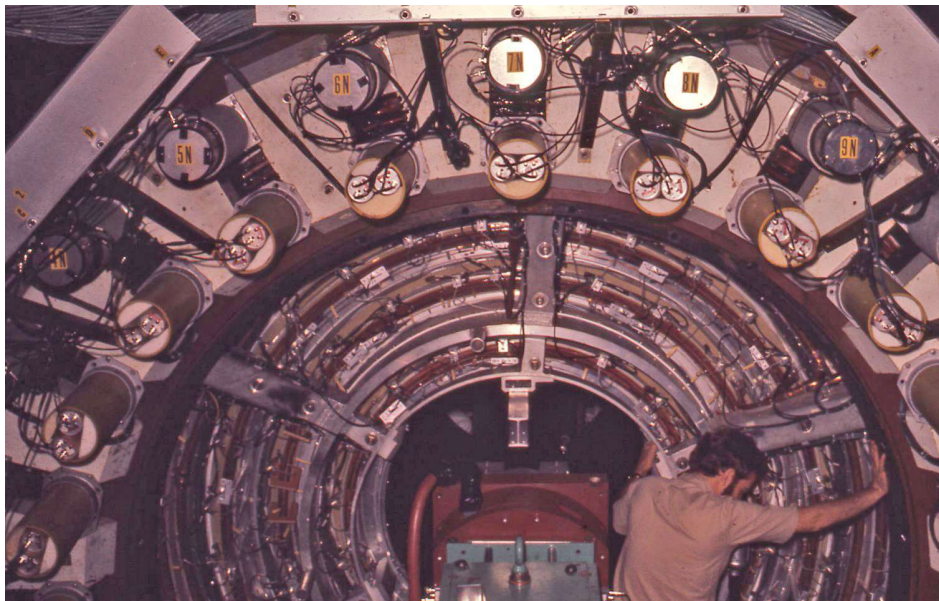
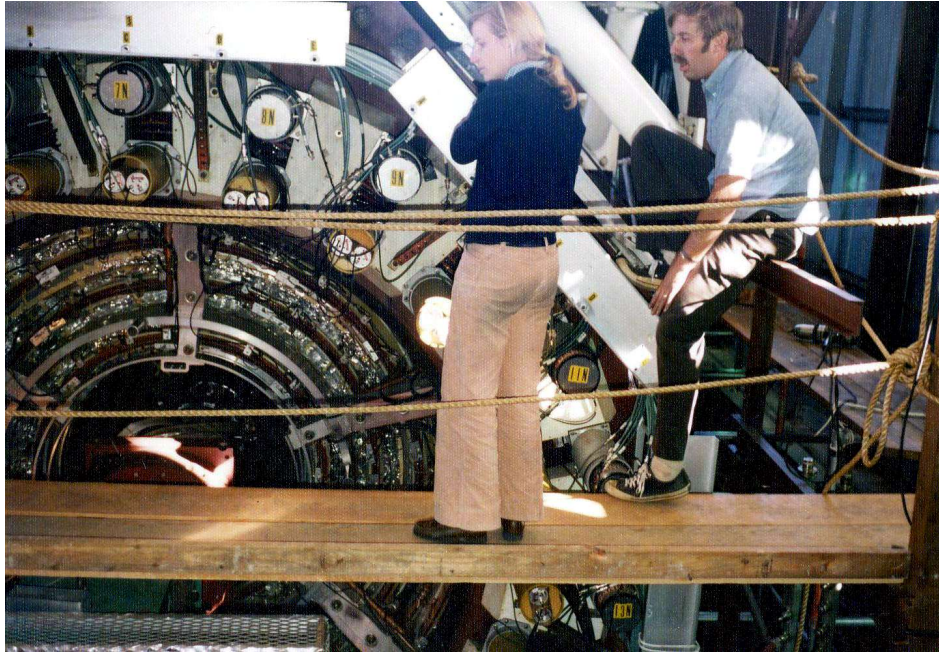


# 50<sup>th</sup> Anniversary Psi-Prime discovery (21 Nov 1974)

A Look Back

Chuck Morehouse

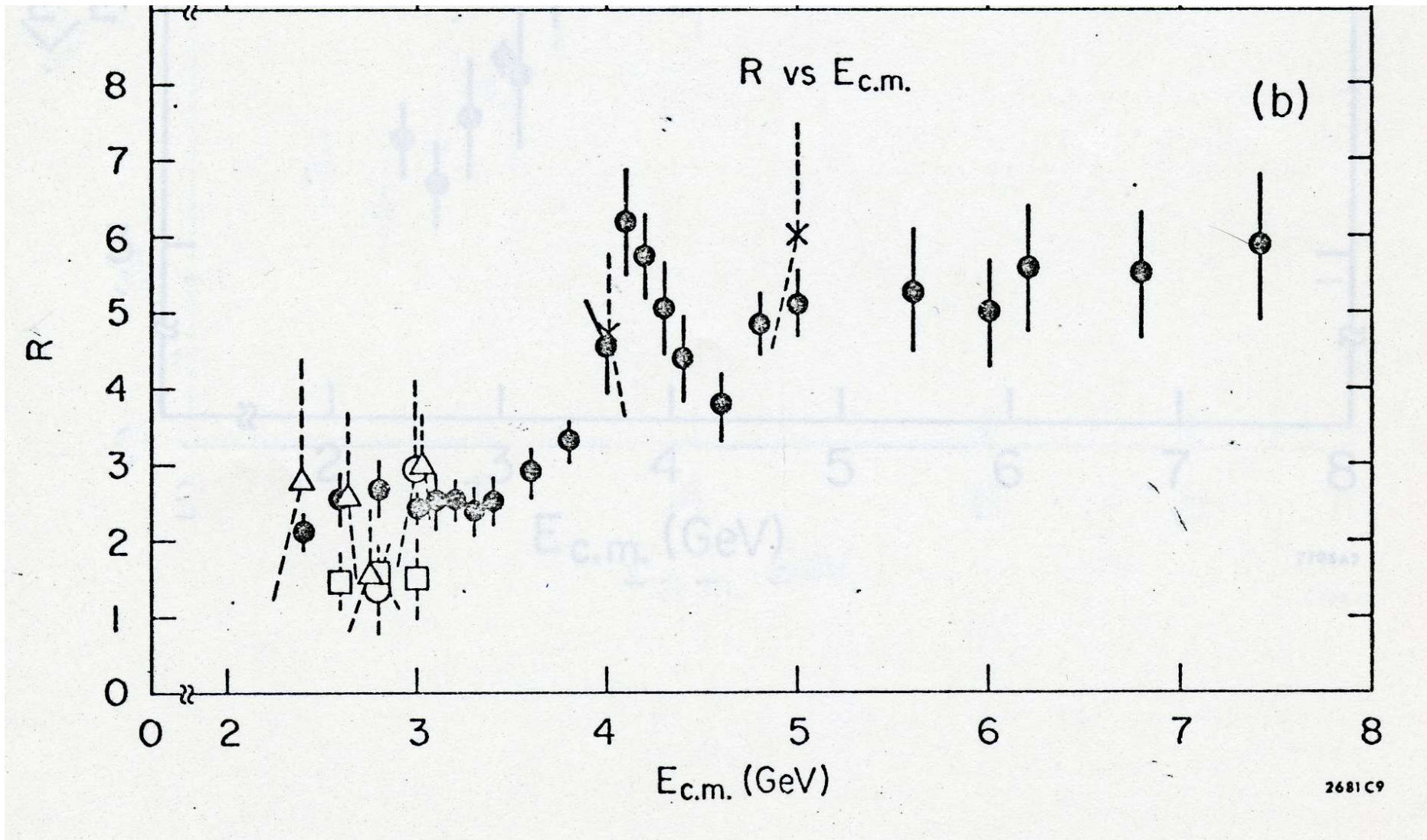
# MARK1 – Building Phase – 1972-1973



50th Anniversary of the November Revolution  
Psi-Prime Discovery

# Measurements of R circa 1974/1975

(mostly MARK1 data)



# MARK1 experimental process – R to Psi-Prime

- Measuring R (up to Nov 1974)
  - Detect features in R at few percent level
  - Hadron “multi-prong” events (about 1 per minute)
  - Runs last many hours to obtain required statistics
  - Event analysis offline on mainframe
  - Runs spaced several hundred MeV apart
  - “Interesting” features over large energy ranges
- Scanning for new resonance – experimental approach
  - Assume “medium” size, narrow width
  - Need to scan energy at 1-2 MeV steps – **big effort at SPEAR** (radiative tail enables contiguous energy steps)
  - Runs now a collection of “mini-runs” with short summary
  - Implement online “mini-run” summary – **big effort of analysis, networking**
  - Each “mini-run” should contain a few events (~2 minutes per “mini-run”)
  - Use “Marty’s” prediction (3.794 GeV) to select starting energy of (3.6 GeV) 1.8 GeV per beam.

# My Lucky Day!

Rodrigo de Triana  
Lookout in  
Crowsnest  
on Pinta  
11 Oct 1492



Chuck Morehouse  
(SLAC - Night Shift Leader)  
Alan Litke  
(UCB)  
Bob Stege  
(SPEAR Operator)

21 November 1974

# Run 1521 – start 00:00 Hours, 21 Nov 1974

21 NOV 1974 93

SP-17 BNL RUN 1520 1.54 GEV 3.9 KG CF-XXXXXXXX TL-2 A(2)

SCALERS

1	DS TRUE	54421	10	0
2	DS FLSE	366	11	0
3	LU NU.SD	23905	12	EVENTS 858
4	LU ND.SU	30516	13	PIPE/100 198232
5	LIVETIME	30266	14	0
6		0	15	THYRTRON 858
7		0	16	CLCKTIME 36334
8		0	17	0
9		0	18	0

INTEGRATED LUMINSITY =  $.740E 33$   
PITSBRT

$E = 1.54 - 1.558.$

I	P	PI	MICROPITS
E+ 4.2	$.166E-08$	$.693E-08$	24.
E- 4.0	$.158E-08$	$.624E-08$	22.

LIVETIME = 2977.30 SEC. LIVETIME FRACTION = .835  
INTEGRATED LUM =  $.729E 33$  T/F = 147.27  
EXPECTED MU PAIR PRODUCTION IS 6  
E = 1.570 GEV RUN 1520

1947  
1847  
3694

21 Nov '74  
0000 - Begin Run 1521 at 1.8 GeV.

BEGIN RUN NO. 1521 TIME 0000 DATE 11/21 TAPE NO. 1581

SPEAR CONFIG. L1.8/ SOLENOID  ON  OFF

TRIGGER NADRON LOGIC A  B  C  D  TOPO  MAJ

SPECIAL CONDITIONS \_\_\_\_\_

END RUN TIME \_\_\_\_\_

RUN INDEX	START	END	AVC L X 10 <sup>20</sup>	TRIGGERS	PIPE CNTR	LIVE TIME	COMPUTATIONS
1521	6/6	3/3	4.4	2308	575K	8X61	ESCAN from 1.80
1522	3/3	2/2	.99	968	58K	4290	ESCAN from 1.845
1523	6/6		.42	286	45K	820	
1524			.21	154			
1525			.19	191			
1526			.17	173			
1527			.16	261			
1528			.14	226			

}  $\psi^* (3690)$   
?

# Run 1521 – “We see a possibly significant bump”

94 21 NOV 1974 21 NOV 1974

00:30 HOURS ALL SEEMS STABLE (PRAY FOR US)

MUON CHAMBERS SHOW LOW AND DECREASING EFFICIENCY

Getting 2 sparks 2 close on 13, 14 missing 1<sup>st</sup> & 2<sup>nd</sup> fids on 16.  
 The muon chambers are not essential for the scan but are more important for peaking and dipping. Some one ought to look into this Thurs. day.

The wand signals look OK for muon chambers. All (11, 12, 13, 14, 16) have small 2<sup>nd</sup> fids. Zero X's are seeing the 1<sup>st</sup> fids. Trouble is, to kill all 5 chambers 2 ANNS must go out. Assuming 11, 12, 13, 14, 16 wands are what they need to be (11, 12, 13, 14, 16) at least 11 & 12 show no serious error problems.

02:10  $\mu$  ch.  $\epsilon$  looks to be below 20% now. It is as if the  $\mu$  chambers are never giving any sparks now and  $\epsilon$  is steadily declining as more and more "production" come in.

SOMEBODY PLEASE LOOK INTO THIS ON MY SHIFT.

02:30 WE SEE A POSSIBLY SIGNIFICANT BUMP AT 1.847-1.848 (nominal), LOOKS ~ 6 MW film (steps on 2 MW cm). STOP RUN GO 1.845  $\frac{1}{2}$  10 cm.

WE WILL GO BACK OVER IT IN  $\frac{1}{4}$  Step Size

SP-17 BNL RUN 1522 1.85 GEV 3.9 KG CF-XXXXXXXX TL-2 A(2)				
SCALERS				
1	DS TRUE	45378	10	0
2	DS FLSE	29	11	0
3	LU NU+SD	19229	12	EVENTS 968
4	LU ND+SU	26149	13	PIPE/100 58323
5	LIVETIME	42903	14	0
6	0	0	15	THYRTRON 968
7	0	0	16	CLCKTIME 46554
8	0	0	17	0
9	0	0	18	0
INTEGRATED LUMINOSITY =		.101E 34		
PITS9RT				
	I	P	PI	MICROPITS
E+	2.1	.143E-08	.305E-08	15.
E-	2.3	.139E-08	.319E-08	16.
LIVETIME = 4193.40 SEC. LIVETIME FRACTION = .921				
INTEGRATED LUM = .990E 33 T/F = 1537.03				
EXPECTED MU PAIR PRODUCTION IS 5				
E = 2.000 GEV RUN 1522				
EXPECTED MU PAIR PRODUCTION IS 23				
E = 2.000 GEV RUN 1521				

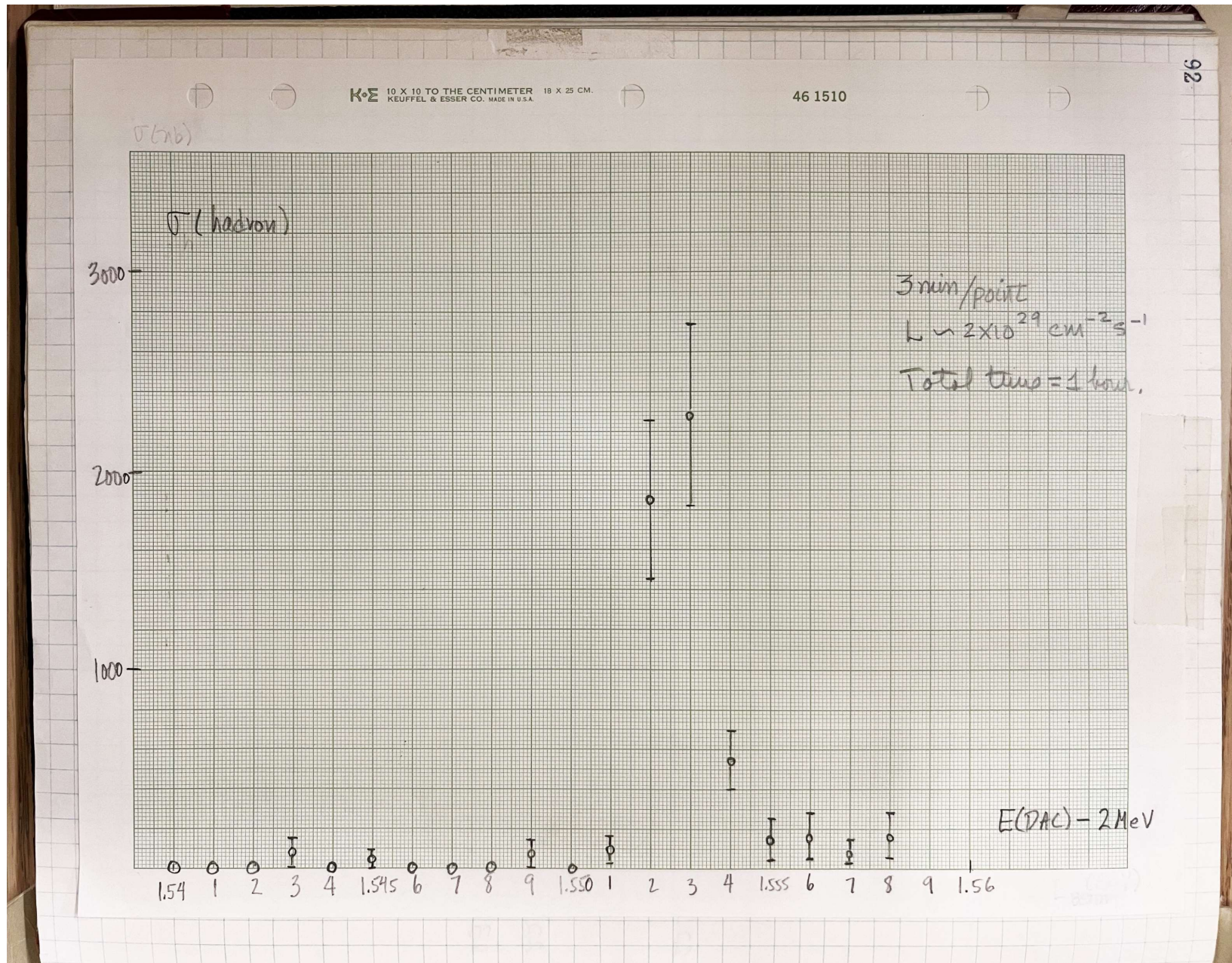


# Run 1521 – Teletype Printout 02:30 Hours - “We See A Possibly Significant Bump”

```
FROM OPR (OPERATOR): (MIBEC028) 9 E=1.550 SIG= 0.0 +- 0.0
? ###
FROM OPR (OPERATOR): (MIBEC028) 10 E=1.551 SIG= 8.00E 01+- 8.01E 01
? ###
FROM OPR (OPERATOR): (MIBEC028) 11 E=1.552 SIG= 0.0 +- 0.0
? ###
FROM OPR (OPERATOR): (MIBEC028) 12 E=1.553 SIG= 1.07E 02+- 6.18E 01
? ###
FROM OPR (OPERATOR): (MIBEC028) 13 E=1.554 SIG= 1.85E 03+- 3.97E 02 2 **
? ###
FROM OPR (OPERATOR): (MIBEC028) 14 E=1.555 SIG= 2.29E 03+- 4.82E 02 2 **
? ###
FROM OPR (OPERATOR): (MIBEC028) 15 E=1.556 SIG= 5.28E 02+- 1.47E 02 1 **
? ###
FROM OPR (OPERATOR): (MIBEC028) 16 E=1.557 SIG= 1.53E 02+- 1.08E 02
? ###
FROM OPR (OPERATOR): (MIBEC028) 17 E=1.558 SIG= 1.69E 02+- 1.19E 02
? ###
FROM OPR (OPERATOR): (MIBEC028) 18 E=1.559 SIG= 7.89E 01+- 5.58E 01
? ###
FROM OPR (OPERATOR): (MIBEC028) 19 E=1.560 SIG= 1.74E 02+- 1.23E 02
```



# Run 1521 – Plot by Alan Litke

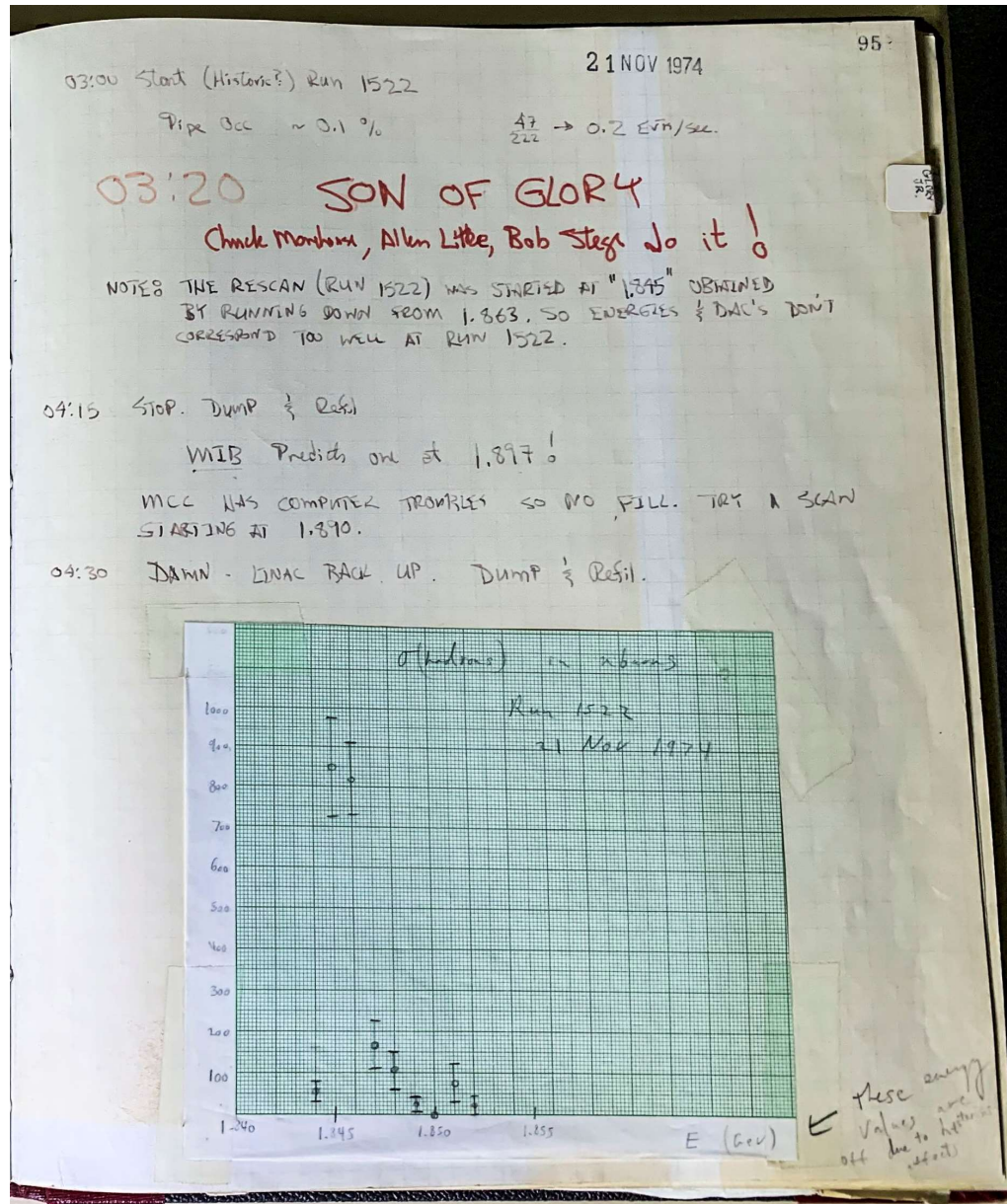


Gerson Goldhaber in the SLAC Beamline  
quoting Robert Walgate in the New Scientist  
quoting CCM

"We were running along--one event in an interval, then zero, then one. Then 20 events all of a sudden. I said 'That's a fluctuation.' The guy with me on shift said 'That's not a fluctuation.' The next interval had 18 events. He said 'Do you believe me that it's not a fluctuation?' The next one was 15, then back to zero again. I believed him."

--Chuck Morehouse, quoted by Robert Walgate in *New Scientist*, 11 March 1976

# Run 1522 - Re-run over the "possibly significant bump"



Acknowledge: SLAC Archives – Dorothy Leung, Jean Deken & Jacqueline Orrell for obtaining logbook images

# “Start Spreading the News”

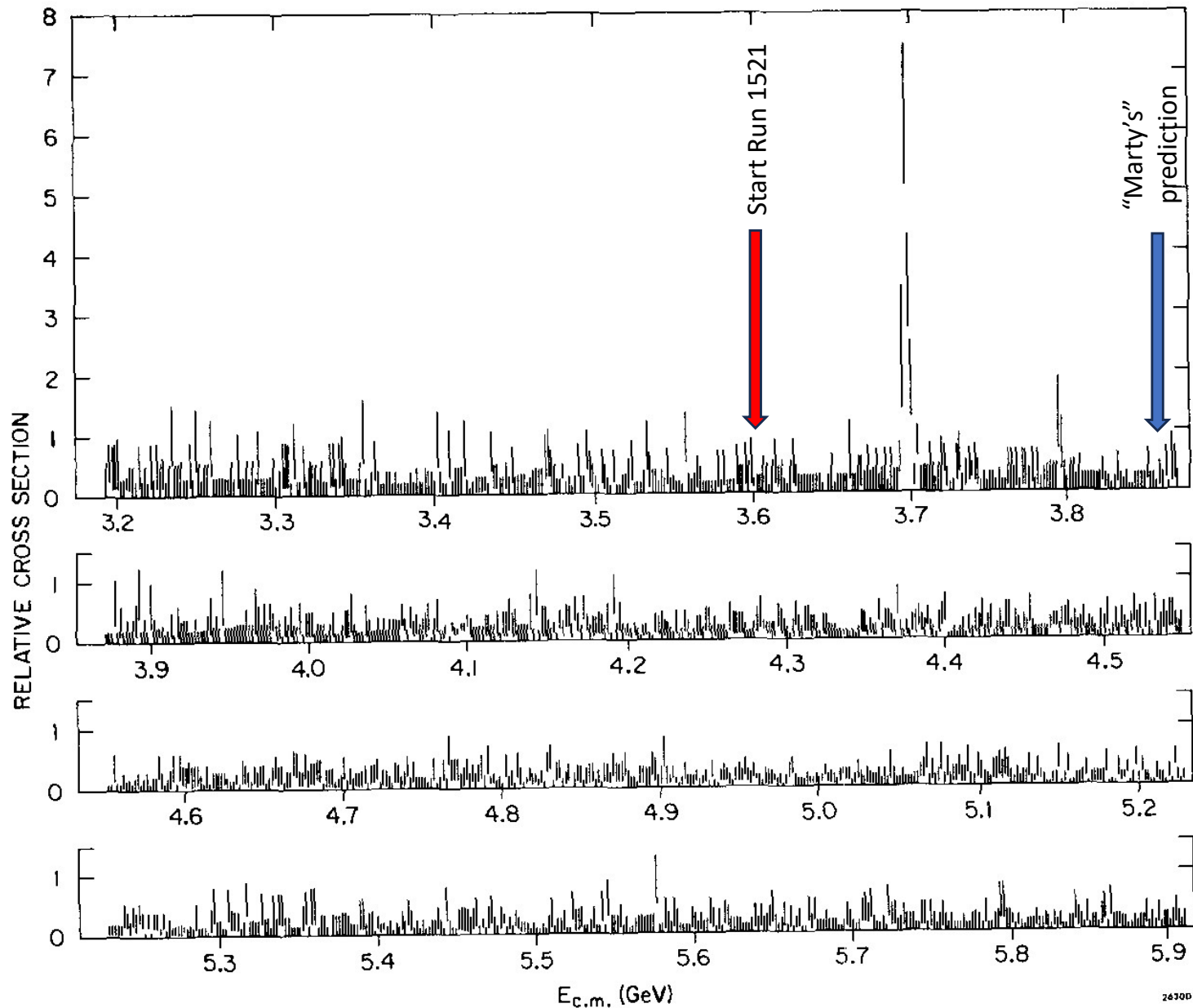
*CCM conversation later with Dick Taylor –*

*“Isn’t it amazing to be the only one who knows about something that within a few hours will be known around the world”*

- CCM calls Marty
- Marty comes in and starts to call others, control room fills up
- Burt comes through the door of the Control Room and sees the crowd – most wonderful look comes over his face (surprise and joy)
- Computer Center requested to postpone scheduled maintenance .  
Message sent out to groups hooked up to the SLAC mainframe:  
“DUE TO NEW PATICLE DISCOVERY..SYSTEM WAS NOT TAKEN DOWN THIS MORNING”
- CCM goes home to sleep. Calls Dad in San Francisco – *“We just discovered something important. You will read about it this afternoon in the newspaper.”*
- Phys. Rev. Lett. **33**, 1453 (1974) - 9 Dec 1974

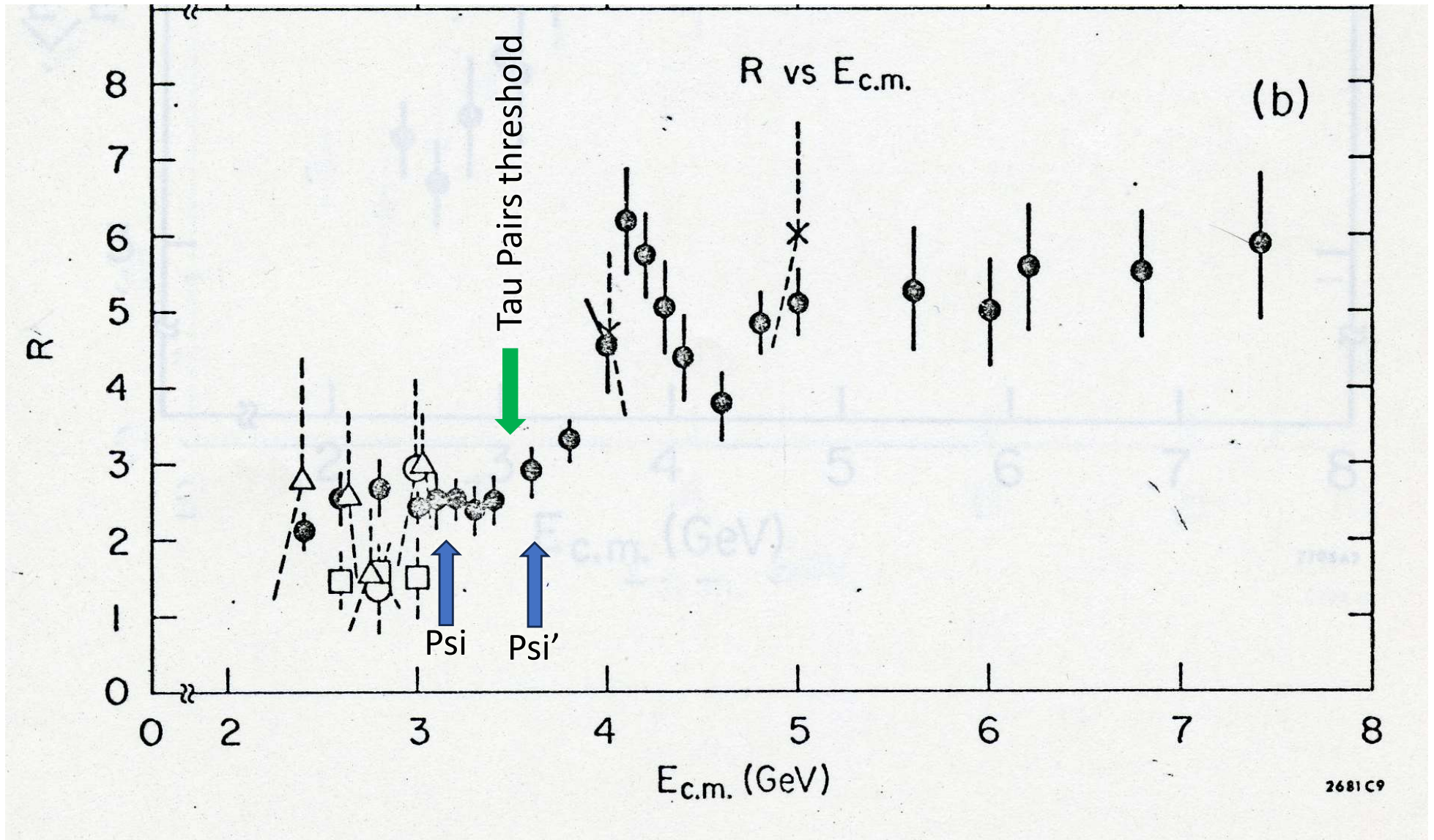
# Detailed scan over entire SPEAR energy range

Phys Rev Lett - April 1975



# MARK1 additions to R

(Ironically not in the “interesting” area!)



# My view from afar (in time and distance)

Our discoveries of the PSI and PSI-Prime in November 1974 were unique in the history of particle physics.

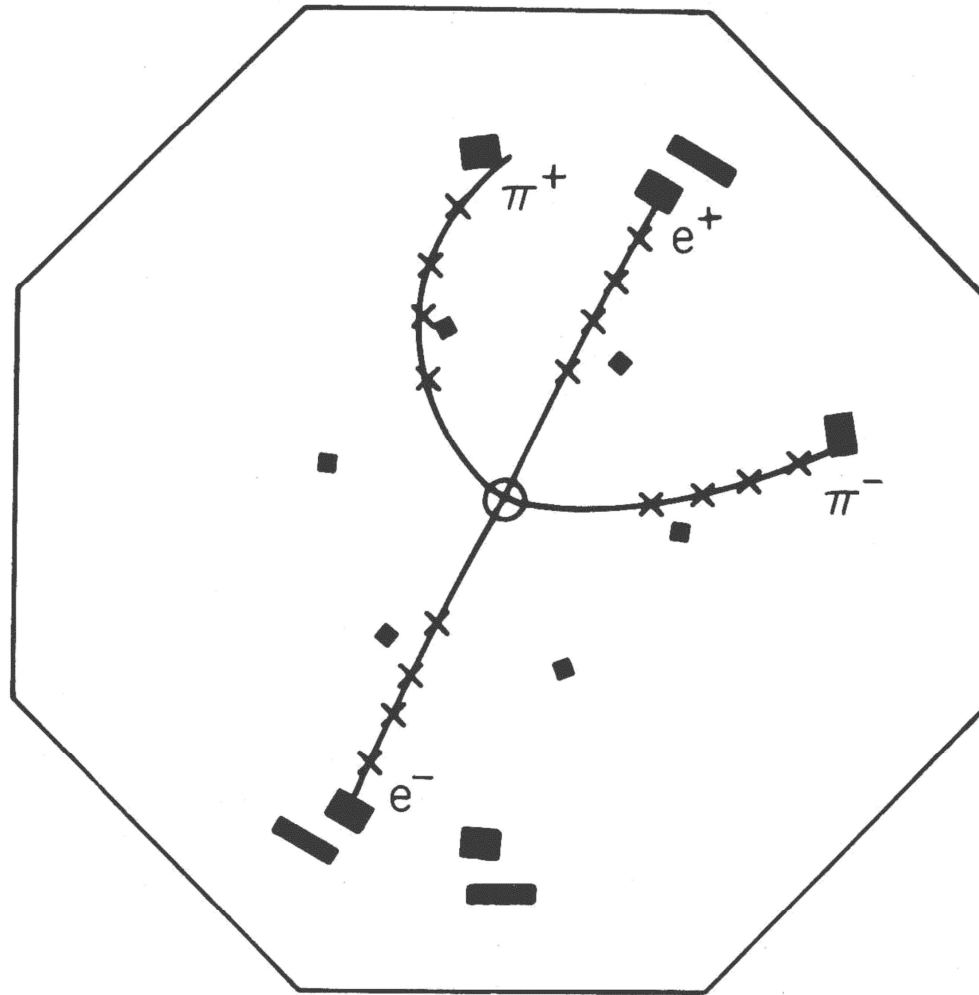
They were made in real time – in front of our eyes as we watched. We understood what we were seeing as it happened.

Other possible exception/examples of real-time discoveries (that I can find):

- Discovery of the nuclear atom by Rutherford (actually Ernest Marsden) (1911)
- Anti-proton events at the Bevatron (1955)

**LUCKY US!**

# And Finally – the Psi Prime Self-Portrait (Double Self Portrait?)



My sincere thanks to all my colleagues who enabled my participation  
In the discovery and this remembrance of the Psi and Psi-Prime.