15/8/63

Notes on Initial Allocation of Machine
Time for Experiments on Nimrod

These notes are only intended to provide a basis for discussion.

An estimate has been made of the probable amount of running time that experimental teams can expect up until mid-1964. This is divided into three periods:-

(1) 100 hours up to January, 1964.
(2) 390 hours in the first 13-week period of 1964.
(3) 780 hours in the second 13-week period of 1964.

Only periods 1 and 2 have been considered as it was felt that experience gained in these periods would greatly influence the planning of period 3.

Period 1

This 100 hours may well be made up from much shorter periods, say one 6 or 8 hour shift per day and should be regarded as a period in which teams are setting up their experiments. It is probably unreasonable to expect all setting-up to be completed in this 100 hours.

There are currently eight teams who intend to run experiments on Nimrod. These are:-

(a) U.C.L./Westfield (π2)
(b) A.E.R.E./Birmingham/Bristol (N1)
(c) A.E.R.E./Queen Mary College (P2)
(d) R.H.E.L. (π1)
(e) Imperial College/Manchester (K2)
(f) A.E.R.E./Southampton/U.C.L. (P3)
(g) Oxford University (π1 or π2)
(h) Hydrogen Bubble Chamber (K1)

Teams (a) - (g) will be ready to use Nimrod during this period while the Bubble Chamber will probably arrive at the R.H.E.L. early next year. It would therefore be useful if the K1 beam could be set up during this period too.

There will be enough beam line components available to meet the demands of teams (a) to (g), but for the K1 beam line:

(1) The two separators and associated equipment will not be available for installation until at least the end of 1963.

(2) Some of the quadrupole magnets needed will not be here until February, 1964.

(3) There will be insufficient steel shielding for this beam line until a further delivery is made in February, 1964.

It looks then as though K1 cannot be started before the beginning of 1964 and will probably not run until the second quarter of that year.

A.J. Egginton has estimated that by February, 1964 the power supplies available would be sufficient for $\sim$80% beam lines and that the eight beam lines indicated above could be powered, providing that some reconnection between beam lines could be tolerated. Reconnection is necessary in any case as the magnet current terminal boxes in the magnet room and the experimental area are only sufficient at present for simultaneously running 2 or 3 beams depending on which beams are involved.

If the available time is split between the ~~six~~ teams (a) to (f), (g) being parasitic while π1 are measuring differential cross-sections, it would give each team ~17 hours as main user. As most of these teams would be able to parasite with any main user the actual running time for all teams should be well in excess of this.

During this period -

(1) A.E.R.E./Birmingham/Bristol (N1) would be using the π2 target to set up their apparatus on the N1 beam line.

(2) A.E.R.E./Birmingham/Bristol (N1) and U.C.L./Westfield (π2) would be prepared to take alternate pulses, while A.E.R.E./Q.M.C. (P2) require alternate or one in three pulses.

(3) R.H.E.L. (π1) could work with a foil spill between 3 and 8 GeV with (say) 10% of the total beam.

(4) A.E.R.E./Southampton/U.C.L.(P3) would be using the π2 target with their beam being taken off at a small angle, part of the way along the π2 beam line. P3 will probably be compatible with π2 while both teams are setting up their apparatus, but parallel operation will be difficult later, as both teams need control of the common part of their beam lines.

(5) Oxford University (π1 or π2) propose to set up their experiment behind the π1 beam and will need only one additional quadrupole doublet. During setting up they propose to parasite on π1 but this will not be possible when the polarized target is in use as the beam is deflected downwards by 10° while traversing this target. The polarized target however is unlikely to be used much during period 1.

There are three possible methods of beam sharing:

1. Sharing pulses, i.e. one team would take alternate or one in three pulses.
2. Foil spill of a fraction of the beam during the acceleration cycle.
3. Sharing the flat-top of the pulse.

Hobbis and Egginton feel that methods 1 and 2 are most likely to be successful in the early stages of operation although experience might show that method 3 is no more difficult. Flat tops of 20 milliseconds should be available initially and would probably be worked up to 150 msecs during this period. Gray has pointed out that at present only four targets can be controlled to work simultaneously.

The number of teams which could run simultaneously depends on the performance of Nimrod. It is felt that 2 - 3 teams are about the optimum number with at least one other team in a state of readiness as a reserve team. The hydrogen targets are likely to provide one limit on the number of simultaneous experiments unless teams are prepared to use substitute targets, such as polyethylene. This is because present plans are to have two targets in operation in the experimental areas, with one target held in reserve. (The limitation is only the quantity of liquid H_2 we are at present planning to order. This could be changed). A further point to note in this context is that there is unlikely to be any permanent hydrogen exhaust system in the parasitic area until February, 1964. Temporary arrangements will have to be made before hydrogen targets can be used there. P2, P3, π1, π2 and N1 have indicated that they are unlikely to require much liquid hydrogen before January, 1964.

If a maximum of three teams running simultaneously was adopted and users (g) and the team they intend parasiting on are counted as one team it is possible to write down pairs of programmes to include all teams; for example:-

Programme 1a

(a)	U.C.L./Westfield (π2)	Every pulse π2 target
(b)	A.E.R.E./Birmingham/Bristol (N1)	
(f)	A.E.R.E./Southampton/U.C.L. (P3)	

with the other teams in

Programme 1b

(d)	R.H.E.L. (π1)	10% total beam every pulse, 3-8GeV.
(g)	Oxford University (π1)	Foil spill. (π1 target)
(e)	Imperial College/Manchester (K2)	1 pulse in 2 (K2 target)
(c)	A.E.R.E./Q.M.C. (P2)	1 pulse in 2 (P2 target).

Or if (a) and (f) need to run separately:-

Programme 2a

(a)	U.C.L./Westfield (π2)	1 pulse in 2 (π2 target)
(b)	A.E.R.E./Birmingham/Bristol (N1)	1 pulse in 2 (π2 target)
(c)	A.E.R.E./Q.M.C. (P2)	1 pulse in 2 (P2 target)

Programme 2b

(d)	R.H.E.L. (π1)	10% total beam every pulse, 3-8GeV.
(g)	Oxford University (π1)	Foil spill. (π1 target).
(e)	Imperial College/Manchester (K2)	1 pulse in 2 (K2 target)
(f)	A.E.R.E./Southampton/U.C.L. (P3)	1 pulse in 2 (π2 target)

At the dummy scheduling meeting held on 22 /7/63 general opinion seemed to favour programmes 2a and 2b. It was pointed out that it is economical in machine time to use foil spill in each programme. This would provide one way of allowing R.H.E.L. (user (d) above) and Oxford University (user (g)) to work independently.

Wicks expressed doubts at the same meeting as to whether the arrangement of d.c. power supplies in the magnet room and experimental area was capable of running any of the above programmes. Further investigation has shown that the present arrangement will not run any of the combinations of beams shown in the programmes. The best solution to this problem seems to be to remove the eight spare 50 K.W. rectifier sets from the converter house and instal them in the parasitic area. This would enable all the combinations of beams shown above to be powered, providing the d.c. supply system was fully commissioned and capable of running the full 5 M.W. load. Dawson however estimates that the system will not be fully commissioned before the end of 1963 and that by 30/9/63 it should be running at half-power.

If programmes similar to 2a and 2b were adopted and all teams participated equally in the first period each team could expect about 100/6 ~17 hours as main user, with an additional 33 hours of parasitic running. General feeling seems to be that each programme should be on the machine for a few weeks rather than alternate shifts. This is obviously sensible in view of the d.c. supplies problem.

Finally, it would be unrealistic to expect intensities of the order of 10^{12} protons per pulse in this period.

Period 2

The experience gained by the teams in Period 1 would be used extensively in planning this period.

Some of the initial seven teams would expect to begin data collection during this period.

This means:-

(1) A.E.R.E./Birmingham/Bristol (N1) would no longer be compatible with users (a) and (f) above as they would now be using the N1 target, with the occasional use of the π2 target for checking.

(2) Users (a) (π2) and (f) (P3) would now not be compatible as they each require control of the common part of their beam lines.

(3) Users (d) and (g) each require control of the common part of their beam lines.

There would also be two possible additional contenders for machine time -

1. User (h) above, the Hydrogen Bubble Chamber (K1). Provision should be made for this team to have at least as much time as each of the counter teams. Once the K1 beam line was set up, however, the Bubble Chamber would in general require a short spill time which facilitates beam sharing with other experiments.

2. If Nimrod has been handed over by this time there would need to be an allocation of machine time for a machine development programme.

Some reserve periods should also be included now to allow for contingencies.

Available running time then might have to be shared between

(a) U.C.L./Westfield (π2) π2 target
(b) A.E.R.E./Birmingham/Bristol (N1) N1 target
(c) A.E.R.E./Q.M.C. (P2) P2 target
(d) R.H.E.L. (π1) π1 target
(e) Imperial College/Manchester (K2) K2 target
(f) A.E.R.E./Southampton/U.C.L. (P3) π2 target
(g) Oxford University (π1 or π2) π1 or π2 target
(h) Hydrogen Bubble Chamber (K1) K1 target
(i) Machine development
(j) Reserve periods.

There are therefore ten separate requirements and assuming an equal division of time each team could expect 390/10 39 hours running time as main user. Allowing for two or three teams running simultaneously except when (i) or (j) are users each team could expect

$$\sim \frac{390 - 2 \times 39}{3} - 39 \quad \text{hours, i.e.}$$

$\sim$ 65 hours of parasitic running as well.

These figures will probably need modifying as machine development will probably need more than an equal share of running time in this period. On the other hand, Oxford University (users (g)) have asked for only 10 - 20 hours as main user.

<u>Summary</u> (Assuming equal division of time)

<u>Period 1</u> 100 hours up to January, 1964.

		Main User for
(a) U.C.L./Westfield (π2)		17 hours
(b) A.E.R.E./Birmingham/Bristol (N1)		17 hours
(c) A.E.R.E./Q.M.C. (P2)		17 hours
(d) R.H.E.L. (π1)		17 hours
(e) Imperial College/Manchester (K2)		17 hours
(f) A.E.R.E./Southampton/U.C.L. (P3)		17 hours
(g) Oxford University (π1 or π2)	Parasitic with (d) in this period	0 hours
		102 hours

Each team could also expect ~ 33 hours of parasitic running.

Period 2 390 hours in the first 13-week period of 1964.

		Main User for
(a)	U.C.L./Westfield ($\pi 2$)	39 hours
(b)	A.E.R.E./Birmingham/Bristol (N1)	39 hours
(c)	A.E.R.E./Q.M.C. (P2)	39 hours
(d)	R.H.E.L. ($\pi 1$)	39 hours
(e)	Imperial College/Manchester (K2)	39 hours
(f)	A.E.R.E./Southampton/U.C.L. (P3)	39 hours
(g)	Oxford University ($\pi 1$ or $\pi 2$) Parasitic with (d)	39 hours
(h)	Hydrogen Bubble Chamber (K1)	39 hours
(i)	Machine Development	39 hours
(j)	Reserve Periods	39 hours
		390 hours

Each team could also expect ~ 65 hours of parasitic running.

Team	Beam Line	Experiment	Machine Energy Required (GeV) *(For these experiments maximum primary energy is required)	Secondary Particle	Spill Time (msecs.)	Secondary Momentum (GeV/C)	Required Primary Intensity (Protons/Pulse)	Secondary Intensity (particles/pulse)	Machine Time (Hours)	Setting-up Time (Hours)	Target	Radial Position	Requirements
ASRd/Queen Mary College	P2	p-p scattering	8 (6, 4 also but not included in estimates of running time - see P1 on Table II)	Elastically scattered proton ($3\frac{3}{4}^o$ to forward direction)	>50 with >100 preferred	8.8	10^{11} preferred 10^{10} min.	10^6 10^5 preferred (10^4 min.)	160 really 150	160 (+ 100 contingency)	1 cm x 1 cm x 15 cm Beryllium with lip (Inside radius)	r_o	~5 seconds needed between pulses for print out when data taking
ASRd/Southampton/ U.C.L.	P3	Study of resonances near threshold $p + p \rightarrow d + \rho^+$ $p + p \rightarrow d + \zeta$	8	Inelastically scattered protons (20° to forward direction)	>100 msec.	1.5 - 4.5	10^{11} or more	$\sim 10^5$	200 hrs. for ρ + ζ	100 hrs. 25% parasitic on π2	π2	Positives No radial adjustment	Can use maximum machine repetition rate. Requires complete control of part of π2 beam for data collection.
RHEL	π1	π^--p polarization at 900 MeV	3	Negative pions ($26\frac{1}{2}^o$ to forward direction)	500 preferred but >50 msec. acceptable	0.9 - 1.15	10^{11}	$\sim 10^5$	100 for differential cross sections. 500 for polarization	170 (with 10^9 protons per pulse and spill 50 msec)	1 cm x 1 cm x 10 cm Heavymet (Inside radius)	r_o	(1) Diff. X-section (2) Poln. run with polarised target. Can use max. machine repetition rate.
UCL/Westfield	π2	$\pi^{\pm}$ + p elastic scattering cross-sections near 2 GeV/c	8	Positive and negative pions (20° to forward direction)	100 min. >200 desirable	1.6 - 3.0	10^{11}	2×10^3	200 5 momenta π^+ 5 momenta π^- (using every pulse)	100 ($50\pi^+$ $20\pi^-$ + 30 contingency) 50% parasitic on P3	1 x 1 x 12 Heavymet with lip (Inside radius)	r_o - 6" → r_o adjustment required	Can use max. repetition rate. Requires complete control over π2 beam for data collection.
ASRd/Birmingham/ Bristol	N1	np charge exchange scattering	7 5 3	Neutrons (0° to forward direction)	>50 with >100 preferred	7.8	2.10^{11}	2.6×10^5	100/Energy	100 (Parasiting off π2 target)	Lithium deuteride (2 x 2 x 15) cm^3 if feasible. Otherwise Be same size. Inside radius.	r_o	For data collection primary beam energy must be constant from pulse to pulse and within 1 pulse to better than 1/2%. ~5 secs. rep. rate as P2.
Imperial College/ Manchester	K2	Accurate determination of the width of the ω^o resonance	8*	Negative kaons (0° to forward direction)	100 min. >200 desirable	1.25 - 1.5	10^{11}	~100	200 (at 1 picture per pulse)		¼" x 1¼ cm x 15 cm of stainless steel	Radial adjustment required for op. over 1.25 GeV/c - 1.5 GeV/c range	Can use maximum machine repetition rate.
Oxford University	π1	$d\sigma/d\Omega$ in reaction $\pi^- + p \rightarrow n + \pi^o$ and other possibilities	As π1	As π1	As π1	As π1	10^{11} 10% spill	$\sim 10^4$ for setting up $> 10^5$ for neutron work	10 - 20 hours		As π1	As π1	Need control of π1 for data collection. Cannot parasite when polarized target in use. Can use max. machine repetition rate.

Team	Beam Line	Experiment	Machine Energy Required (GeV) *(For these experiments maximum primary energy is required)	Secondary Particle
ASRG/Queen Mary College	P2	p-p scattering	8 (6, 4 also but not included in estimates of running time - see P1 on Table II)	Elastically scattered proton ($3\frac{3}{4}^{o}$ to forward direction)
ASRG/Southampton/ U.C.L.	P3	Study of resonances near threshold $p + p \rightarrow d + \rho^{+}$ $p + p \rightarrow d + \zeta$	8	Inelastically scattered protons (20^{o} to forward direction)
RHEL	$\pi 1$	π^{-}-p polarization at 900 MeV	3	Negative pions ($26\frac{1}{2}^{o}$ to forward direction)
UCL/Westfield	$\pi 2$	$\pi^{\pm} + p$ elastic scattering cross-sections near 2 GeV/c	8	Positive and negative pions (20^{o} to forward direction)
ASRG/Birmingham/ Bristol	N1	np charge exchange scattering	7 5 3	Neutrons (0^{o} to forward direction)
Imperial College/ Manchester	K2	Accurate determination of the width of the ω^{o} resonance	8*	Negative kaons (0^{o} to forward direction)
Oxford University	$\pi 1$	$d\sigma/d\Omega$ in reaction $\pi^{-} + p \rightarrow n + \pi^{0}$ and other possibilities	As $\pi 1$	As $\pi 1$

Spill Time (msecs.)	Secondary Momentum (GeV/C)	Required Primary Intensity (Protons/Pulse)	Secondary Intensity (particles/pulse)	Machine Time (Hours)
>50 with >100 preferred	8.8	10^{11} preferred 10^{10} min.	10^6 10^5 preferred (10^4 min.)	160 really 150
>100 msec.	1.5 - 4.5	10^{11} or more	$\sim 10^5$	200 hrs. for ρ + ξ
500 preferred but >50 msec. acceptable	0.9 - 1.15	10^{11}	$\sim 10^5$	100 for differential cross sections. 500 for polarisation
100 min. >200 desirable	1.6 - 3.0	10^{11}	2×10^3	200 5 momenta π^+ 5 momenta π^- (using every pulse)
>50 with >100 preferred	7.8	2.10^{11}	2.6×10^5	100/Energy
100 min. >200 desirable	1.25 - 1.5	10^{11}	~ 100	200 (at 1 picture per pulse)
As $\pi 1$	As $\pi 1$	10^{11} 10% spill	$\sim 10^4$ for setting up $\geq 10^5$ for neutron work	10 - 20 hours

Setting-up Time (Hours)	Target	Radial Position	Requirements
160 (+ 100 contingency)	1 cm x 1 cm x 15 cm Beryllium with lip (Inside radius)	r_o	~5 seconds needed between pulses for print out when data taking
100 hrs. 25% parasitic on π2	π2	Positives No radial adjustment	Can use maximum machine repetition rate. Requires complete control of part of π2 beam for data collection.
170 (with 10^9 protons per pulse and spill 50 msec)	1 cm x 1 cm x 10 cm Heavymet (Inside radius)	r_o	(1) Diff. X-section (2) Poln. run with polarized target. Can use max. machine repetition rate.
100 ($50\pi^+$ + $20\pi^-$ + 30 contingency) 50% parasitic on P3	1 x 1 x 12 Heavymet with lip (Inside radius)	r_o - 6" → r_o adjustment required	Can use max. repetition rate. Requires complete control over π2 beam for data collection.
100 (Parasiting off π2 target)	Lithium deuteride (2 x 2 x 15) cm^3 if feasible. Otherwise Be same size. Inside radius.	r_o	For data collection primary beam energy must be constant from pulse to pulse and within 1 pulse to better than 1/2%. ~5 secs. rep. rate as P2.
	¼" x 1¼ cm x 15 cm of stainless steel	Radial adjustment required for op. over 1.25 GeV/c - 1.5 GeV/c range	Can use maximum machine repetition rate.
	As π1	As π1	Need control of π1 for data collection. Cannot parasite when polarized target in use. Can use max. machine repetition rate.