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88" USER ASSOCIATION NEWSLETTER

We inaugurate the designation of the 88" cyclotron as a national facility with a new tradition, a newsletter to be circulated periodically among the users and potential users of the cyclotron, to keep you informed of the capabilities of the accelerator, the available beam lines and instrumentation. We hope it will prompt you to consider carrying on an experiment or program here, and assist you in its planning.

Although the 88" cyclotron is not a new machine -- having operated reliably for over two decades -- many signs point to its continuing vitality. High on this list is its versatility in servicing a wide range of interests: nuclear physics (heavy ions and both polarized and unpolarized light ions), biological and medical physics, atomic physics, and applied research. Additionally there has been a continued effort in PIG source development to provide useable beams over a wide range of mass and charge, and an ongoing history of accelerator improvement projects. Notable among these have been the development of axial field injection and the installation of a new ionizer for the polarized ion source, the development of high field capability (the upgrade from K = 140 to K = 160 having been completed more than a year ago), and most importantly, the present work in building an electron cyclotron resonance (ECR) source. This source will produce high charge states of very heavy ions with high intensity, and is projected to be operational in October, 1984.

Similarly, another sign of vitality is the continual turnover and reallocation of beam lines for intermediate-term programs. Cave 5, for example, has seen radioisotope dating, a hybrid streamer chamber and integrated chip bombardment in line 5A over the past few years; 5B has seen isotope production for medical research, and more recently a parity non-conservation experiment in polarized p-p scattering. Cave 4A was expanded and heightened for the new 60" scattering chamber. Nevertheless the old 36" chamber which it replaced is now being reactivated and is being reinstalled in Cave 4C upstream of the QSD spectrometer where it will serve as a second general purpose scattering chamber, and will also be used for detector development. In another issue will be featured the LLNL beam swinger project in 4C that aims at $(\vec{p},n)$ and $(\vec{n},n)$ studies with a 30-50 m neutron time-of-flight arm. All these signs, taken together with the consistent high experimental on-time fraction per year, explain in large part the repeated findings of the Department of Energy's accelerator review that the 88" cyclotron is one of the highest ranked accelerators in scientific productivity.

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In line with its designation as a national facility, both an Executive Committee of the 88" Cyclotron Users Association and a Program Advisory Committee have been formed. Initially appointed by the Nuclear Science Division of LBL, the Executive Committee consists of Karl Van Bibber, Chairman (Stanford University, (415)-497-0196), Frank Dietrich (LLNL, (415)-422-4521), and Marie-Agnes Deleplanque (LBL, (415)-486-5384); they will advise Bob Stokstad ((415)-486-5088) who is Scientific Director. The purpose of the Executive committee is to represent tne interests of the users to the management of the 88" cyclotron, the Nuclear Science Division, and LBL. They will serve staggered three year terms; subsequent members will be elected by the users organization after nomination by the Executive Committee. The members of the PAC are C. Konrad Gelbke, Chairman (MSU), Charles Goodman (IUCF) and Jorgen Randrup (LBL). They are appointed by the NSD for three-year terms and make recommendations to the Scientific Director.

The accelerator operates 5 days a week for 10 1/2 months a year. A recent beam list is attached to indicate the types of beams, energies, and intensities available. New beams are often developed at the request of the experimenters. A plan view of the cyclotron laboratory is also attached and shows the physical layout of the cyclotron and experimental caves.

We anticipate that each issue of this newsletter will highlight some new and important development regarding the accelerator or instrumentation of beam lines. The next issue will be a description and update of progress on the ECR source. For this issue only a general survey of the laboratory is given, listing below the most frequent in-house users of each cave, their interests, and telephone numbers ((415)-486-xxxx) where they may be contacted for specific details.

<u>Cave 0</u>. Cave 0 has been designed for bombardments producing high levels of radiation. A. Ghiorso (x6471) is studying the fission mechanism of transuranic elements by tape transport techniques (spontaneous fission in ms range), and gas jet spectometer techniques (10-100 ms range). G. Seaborg (x5661) and K. Moody (x7395) study massive transfer on actinide elements by off-line radiochemical separation (>20 min) with subsequent α,γ,f counting. Remote controlled extraction of irradiated targets may be possible in the near future. Y. Yano (x5435, x6187) now produces isotopes for medical research in this area. This cave is also frequently used by K. Hulet (LLNL).

Cave 1. The group of L. Moretto (x5510) and G. Wozniak (x5071) carry out experiments on deep inelastic scattering (particle-particle, particle-gamma) in 1B, in a cylindrical chamber 15.2 cm high, 66 cm diameter, with an additional wedge extending from $120^{o} \rightarrow -20^{o}$ and of radius 1m. The group of R. Diamond (x5720), F. Stephens (x5724) and M. A. Deleplanque (x5384) study nuclear structure at high spins in 1A with a large sum spectrometer (two 33 cm x 20 cm NaI crystals), 8 12.7 cm x 15.2 cm NaI detectors, and 4 Ge detectors (eff. $\gtrsim$ 15%). This group is building a system of 21 Ge detectors with BGO anti-Compton shields.

Cave 2. Cave 2 has one beam line; this cave is used by the Cerny group (J. Cerny x5670, M. Cable x5088) for the study of exotic nuclei. Recoil products are transported by a helium jet into either an area neighboring the chamber, or on top of the cave roof where the RAMA (Recoil Atomic Mass Analyzer) system resides. The RAMA system consists of an ion source, sextupole magnet, Wien filter, dipole magnet and the focal plane, which may be instrumented for β, γ or light ion counting.

Cave 3. This cave is largely used by outside physicists. Experiments utilizing low beam currents permit the experimenters to work from a console adjacent to the beam line. K. Hulet of Livermore carries out a program of transuranic research in Cave 3.

Cave 4A. This cave houses a large general purpose 60" scattering chamber (R. Stokstad, x5088). In addition to the removable lid, the sidewalls of the scattering chamber may be disconnected from the beam line and removed for ease of setup. This chamber is frequently used by outside groups; recently groups from Krakow and a LASL-ORNL collaboration have performed experiments here. A LBL-Stanford collaboration likewise uses the 60" chamber for experiments involving the "Plastic Box", a 4π detector consisting of solid state telescopes and thin double-walled plastic scintillator. This device is also available for general use.

Cave 4B. H. E. Conzett (x5088) studies spin-polarizaton phenomena in nuclear reactions and scattering of $\vec{p}$ and $\vec{d}$. The scattering chamber in this line is cylindrical, 91 cm in diameter, and 38 cm high. Frequent callaborations have been formed with groups from Manitoba, Birmingham, Ohio State, Livermore, Laval and U.C. Davis.

Cave 4C. A Quadrupole-Sextupole-Dipole (QSD) magnetic spectrometer resides in 4C; its focal plane is instrumented with an array of proportional wires position sensitive in the horizontal direction an ionization counter and a stopping scintillator (B. Harvey, x5088). Also on its scattering chamber is a 2 meter time of flight arm, with carbon foil - microchannel plate start and stop detectors. The total energy detector has been either solid state detectors or a deep gas counter (Y. D. Chan, x5088). A second general purpose scattering chamber (36" diameter) is being installed upstream of the QSD scattering chamber.

Cave 5. The main users of 5A are industrial research corporations that expose integrated circuit chips to low intensity beams to simulate and study the effects of cosmic rays. Cave 5 is also the proposed location for the new system of anticompton germanium detectors.

Data Acquisition/Analysis. Two MODCOMP "Classics" are now operational allowing simultaneous data acquisition and multi-user data analysis. Data collection of up to 32 parameters may be performed either through the 5μsec Multiplexer ADC, or through CAMAC.

Bob Stokstad, Ruth-Mary Larimer and Claude Lyneis (x5088) are at the diposal of the users and can be contacted at any time for general or specific questions.

Concerning the operation of the PAC and the submission of proposals, it was felt that the flexibility and informality of our previous mode of operation should continue insofar as possible. Thus proposals for nuclear physics experiments can be submitted at any time; they will be transmitted to the PAC and a recommendation will be returned to the Scientific Director within two weeks. While there is no specific form of proposals for experiments, they should be kept less than two pages. In the case of ongoing programs rather than a single experiment, a description comparable to the DOE 189 form may be submitted; in this case the text should not exceed three pages. When the recommendation is returned to the Scientific Director, he will then allot and schedule time on a week-by-week basis as traditionally done at the 88" cyclotron. Advanced scheduling and arrangements for users who have to make travel arrangements will of course be made.

Persons interested in requesting beam time for applications or for purposes other than nuclear research should first contact Bob Stokstad.

We wish to be responsive to your needs as users or potential users, and we are eager to receive your questions, comments, suggestions, and criticisms concerning your experience here in the past.

Karl Van Bibber

Frank Dietrich

Marie-Agnes Deleplanque

88-Inch Cyclotron Beam List

Ion		Energy[a)] (MeV)	Ext. Beam Intensity (eμA[b)])
p		0.2 - 55	100 - 20
p (polarized)		6 - 55	1.0
d		0.5 - 65	100 - 20
		65 - 70	∿0.5
d (polarized)		10 - 70	1.0
$^{3}He^{1+}$	(d)	2 - 47	>20
$^{3}He^{2+}$	(d)	4 - 140	100 - 10
$^{4}He^{2+}$		3 - 130	100 - 10
		130 - 140	∿0.5
$^{6}Li^{1+}$	(d)	2 - 23	10
$^{6}Li^{2+}$	(d)	23 - 93	5
$^{6}Li^{3+}$	(d)	93 - 195	0.5
$^{7}Li^{2+}$		20 - 80	5
$^{7}Li^{3+}$		80 - 180	0.5
$^{9}Be^{2+}$		15 - 62	5
$^{9}Be^{3+}$		62 - 140	2
$^{9}Be^{4+}$		140 - 249	.05
$^{10}B^{2+}$	(d)	14 - 56	10
$^{10}B^{3+}$	(d)	56 - 126	50
$^{10}B^{4+}$	(d)	126 - 224	0.3
$^{10}B^{5+}$	(d)	224 - 320	0.001
$^{11}B^{2+}$		12 - 51	10
$^{11}B^{3+}$		51 - 115	50
$^{11}B^{4+}$		115 - 204	0.3
$^{12}C^{2+}$		12 - 47	>20
$^{12}C^{3+}$		47 - 105	30
$^{12}C^{4+}$		105 - 212	5 - .5
$^{12}C^{5+}$		187 - 306	0.05 - .001
$^{12}C^{6+}$		292 - 384	10^{5} p/sec
$^{13}C^{3+}$	(d)	43 - 97	>20
$^{14}N^{2+}$		10 - 40	20
$^{14}N^{3+}$		40 - 90	15
$^{14}N^{4+}$		90 - 160	15
$^{14}N^{5+}$		160 - 250	2
$^{14}N^{6+}$		250 - 360	10^{6} p/sec
$^{14}N^{7+}$		360 - 448	100 p/sec
$^{15}N^{4+}$	(d)	84 - 150	15
$^{16}O^{1+}$		9	1
$^{16}O^{2+}$		9 - 35	>5
$^{16}O^{3+}$		35 - 79	20
$^{16}O^{4+}$		79 - 155	30 - .2
$^{16}O^{5+}$		140 - 219	5
$^{16}O^{6+}$		219 - 315	0.3
$^{16}O^{7+}$		315 - 429	10^{7} p/sec
$^{16}O^{8+}$		429 - 512	0.2 p/sec
$^{18}O^{3+}$	(d)	31 - 70	20
$^{18}O^{4+}$	(d)	70 - 124	>10
$^{18}O^{5+}$	(d)	124 - 194	5

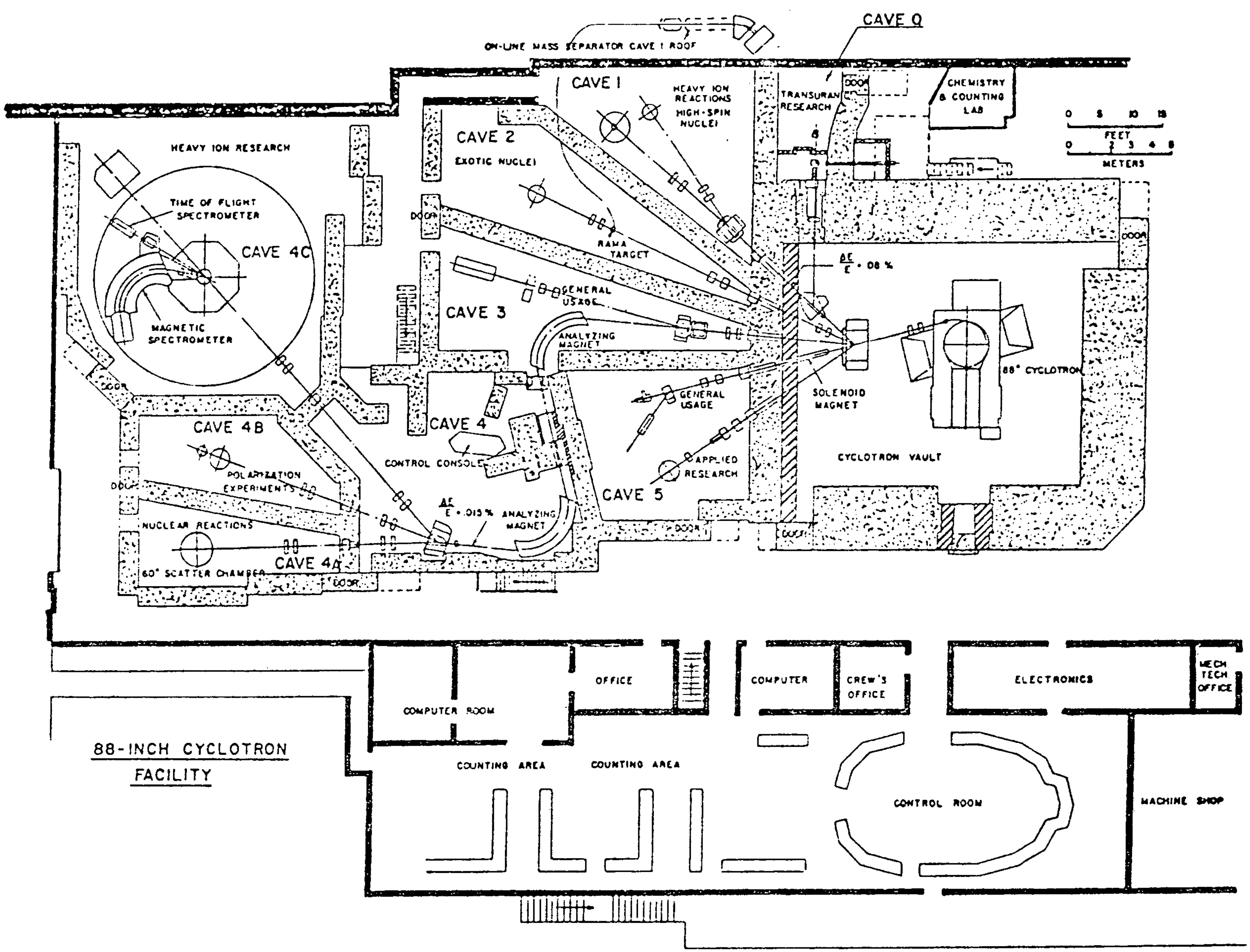
Ion		Energy[a)] (MeV)	Ext. Beam Intensity (eμA[b)])
$^{19}F^{3+}$		30 - 66	5
$^{19}F^{4+}$		66 - 118	10
$^{19}F^{5+}$		118 - 184	2
$^{20}Ne^{3+}$		28 - 63	>10
$^{20}Ne^{4+}$		63 - 112	10
$^{20}Ne^{5+}$		112 - 175	5
$^{20}Ne^{6+}$		175 - 252	1
$^{20}Ne^{7+}$		252 - 343	0.01
$^{20}Ne^{8+}$		343 - 448	∿50 epA
$^{22}Ne^{5+}$	(d)	102 - 159	∿5
$^{22}Ne^{6+}$	(d)	159 - 229	1
$^{24}Mg^{4+}$		50 - 93	2
$^{24}Mg^{5+}$		93 - 146	0.2
$^{25}Mg^{4+}$	(d)	50 - 90	2
$^{26}Mg^{4+}$	(d)	48 - 86	2
$^{26}Mg^{5+}$		86 - 145	.08
$^{28}Si^{5+}$		80 - 125	1
$^{28}Si^{6+}$		125 - 180	0.2
$^{28}Si^{7+}$		180 - 245	0.05
$^{32}S^{6+}$		100 - 158	2
$^{32}S^{7+}$		158 - 238	0.2 - .03
$^{35}Cl^{7+}$		144 - 196	0.5
$^{35}Cl^{8+}$		196 - 256	0.05
$^{37}Cl^{6+}$		95 - 136	0.3
$^{37}Cl^{7+}$		136 - 185	0.08
$^{40}Ar^{2+}$		3.5 - 14	0.4
$^{40}Ar^{6+}$		87 - 126	4
$^{40}Ar^{7+}$		126 - 172	2
$^{40}Ar^{8+}$		172 - 224	0.5
$^{40}Ar^{9+}$		224 - 280	10^{5} p/s
$^{40}Ar^{10+}$		280 - 350	10^{3} p/s
$^{40}Ca^{6+}$		87 - 126	1
$^{40}Ca^{7+}$		126 - 172	0.2
$^{56}Fe^{10+}$		180 - 250	1 p/s
$^{63}Cu^{9+}$		142 - 180	5 enA
$^{63}Cu^{10+}$		180 - 222	0.1 enA
$^{63}Cu^{11+}$		222 - 269	5 x 10^{3} p/sec
$^{84}Kr^{2+}$		1.6 - 6.6 (c)	.001
$^{84}Kr^{8+}$		82 - 107	.250
$^{84}Kr^{9+}$		107 - 135	.120
$^{84}Kr^{10+}$		135 - 167	.030
$^{84}Kr^{11+}$		167 - 202	.003
$^{197}Au^{13+}$		102 - 120	2 p/sec
$^{197}Au^{14+}$		120 - 140	0.1 p/sec

a) Heavy ion energy range shows nominal maximum energy for a particular charge state down to energy which can be reached by the next lowest charge state. The maximum energy for several heavy-ion beams has been increased to $E = 160\ Q^2/A$ MeV. Beams can also be run at energies below 1 Mev/nucleon.

b) Electrical microamperes except as noted. ΔE/E ∿0.3%. Intensity on target will be less, depending on mode of beam transport.

c) 15th harmonic.

d) Isotopically enriched source feed.



88-Inch Cyclotron experimental and control areas.

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