

From whence did ATLAS arise?

(the quarter century: ~1960-85)

Once upon a time, there was an Argonne tandem (started ~1960)

Here is a typical schedule from the 60-s.

TANDEM SCHEDULE		
<u>Group</u>	<u>Participants</u>	<u>Experiment</u>
I	Meyer, Segel, Lee, Hanna, Weinman	gamma rays
II	Huizenga, et al.	fission
III	Lee, Schiffer, Braid, Zeidman	(d, particle)
IV	Schiffer, Lee, Meyer, Allas, Weinman, Mooring	(p, particle)

<u>Date</u>	<u>Group</u>	<u>Area</u>
May 15 - May 18	I	East
May 25 - May 29	III	West
May 31 - June 5	IV	West
June 6 - June 7	I	East
June 8 - June 11	II	East
June 12 - June 13	III	West
June 14 - June 15	I	East
June 16 - June 18	III	West
June 19 - June 21	I	East

We even had an outside user program:

68

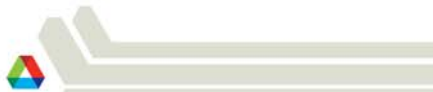
I. C. 9

9. UNIVERSITY USE OF THE 12-MEV ARGONNE TANDEM VAN DE GRAAFF

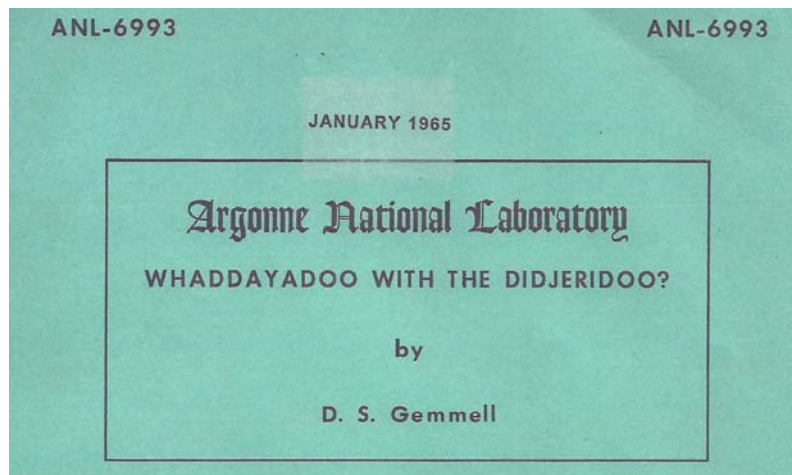
J. P. Schiffer and L. L. Lee, Jr.

Since the fall of 1963, qualified university scientists have been invited to come to the Argonne National Laboratory to use the 12-MeV tandem accelerator and the associated experimental facilities. Ten experiments, accepted by a committee representing the universities and Argonne, have been completed or are currently in progress. These, with their starting dates, are:

1. Multiple Coulomb Excitation and the Reorientation Effect
R. P. Scharenberg (Case Institute of Technology), December 1963.
2. Studies of Energy Levels in Light Nuclei with the Magnetic Spectrograph
C. P. Browne (Notre Dame University), September 1963.
3. Alpha-Gamma Correlation Studies of the Reaction $C^{12}(O^{16}, \alpha)Mg^{24*}$
W. W. Eidson, J. G. Cramer, Jr., and R. D. Bent (Indiana University), August 1964.
4. Magnetic Spectrograph Studies of the Reactions (He^3, α) and (He^3, d)
W. P. Alford, L. M. Blau, D. Cline, and J. J. Schwartz (University of Rochester), May 1964.
5. Study of Reaction Cross Sections with Alpha Particles
L. Haskin (University of Wisconsin), December 1964.
6. Short Nuclear Lifetimes by Doppler-Shift Techniques
R. D. Bent and P. P. Singh (Indiana University), November 1964.
7. Investigation of Ca^{49} Isobaric-Analog States in Sc^{49}
K. W. Jones (Brookhaven National Laboratory), September 1964.
8. (d, p) Reactions on Au and Cd
C. K. Bockelman, P. D. Barnes, and K. J. Wetzel (Yale University), July 1964.



We had one of the first computer-based (*ASI 2100*) data acquisition systems
 (8192 words of memory, 4096 for a data array, 3111 for the program):



IV. MEMORY ALLOCATIONS IN THE 2100 CORE

When the DIDJERIDOO program is loaded in the 2100 core memory, the memory is subdivided in the following way.

Memory locations	No. of words	Purpose
0 - 79	80	Interrupt locations and indices.
80 - 447	368	PHYLIS control program.
448 - 3558	3111	DIDJERIDOO program.
3559 - 3814	256	"BUFF 1". First buffer area for "A" interrupt operation.
3815 - 4070	256	"BUFF 2". Second buffer area for "A" interrupt operation.
4071 - 8166	4096	"4K". The area referred to whenever 4096 words are read into or out of memory.
8167 - 8187	21	Storage of "B" sequence.
8188	1	Run number.
8190 - 8191	2	Storage of identifier for the last program called from the BO5.

The research program was very productive for about a decade, focusing on the systematic exploration of nuclear structure and reactions with light ions:

Dipole giant resonance studies, its dissolution into "intermediate structure" and quadrupole admixtures.

Beginnings of gamma spectroscopy and lifetime measurements.

Proton strength functions.

Systematic exploration of direct reactions and optical models - collaboration with the Oak Ridge group (Satchler et al) to establish reliability of DWBA.

Studies of single-particle states.

Residual NN interaction, from transfer data near doubly magic nuclei.

J-dependence in direct reactions

Studies of fission systematics

Single-particle and pairing excitations in actinides



Meanwhile various upgrades were going on:

The tandem was exchanged for a larger (FN) model and converted to SF_6 gas system.

Ray Herb started his company (NEC); we converted to his technology (oil-free vacuum system, charging chains, etc.)

But we also tried to get funding for a higher-energy tandem and with a post-accelerator for heavy-ions, the latter driven partly by the interest in the Chemistry Division in heavy element research. There were several versions of proposals in the later 1960s.

We wanted higher energies, and a large TU tandem looked very promising.

Argonne National Laboratory

INTRA-LABORATORY
CORRESPONDENCE

DATE April 8, 1969
TO Staff members involved with the TU-cyclotron proposal
FROM J. P. Schiffer
SUBJECT TU-injected cyclotron

A recent memo from Lowell Bollinger has asked for your help in preparing the scientific justification for the proposed TU-injected cyclotron. Enclosed is a list of topics that have been accumulated together with names of staff members who (mostly) have agreed to work on these topics. AUA Universities which may be called on for assistance are also given. Each section might start with a statement of present accomplishments, emphasizing AUA and ANL accomplishments where appropriate. Figures and tables should be used if they seem called for. This would then be followed by discussion of what type of research one would do with the proposed facility, the TU tandem by itself as well as the cyclotron. Emphasis should be put on categories for which this facility would be unique. Whereas we are not proposing to incorporate some major experimental items such as a magnetic spectrograph, an on-line computer, a polarized source or a time-of-flight system in the initial proposal, experiments requiring such facilities should not be excluded. Generally, proposed experiments should be put into theoretical perspective, pointing out how the experiments would contribute to our understanding.

We persuaded Ray Herb to bid on a large tandem (equivalent to TU, but vertical) and negotiated for a while

National Electrostatics Corp., Graber Road, Box 117
Middleton, Wisconsin 53562, Telephone 608/836-6091, Cable: NATELCO

March 18, 1971

Dr. Paul Mooring
Argonne National Laboratory
9700 Cass Avenue
Argonne, Illinois 60439

Dear Dr. Mooring:

We have carefully reviewed our proposal of September 16, 1970 for a Pelletron Model 20UD Column and we find that the prices quoted can remain unchanged. If inflationary trends continue a compensating price rise may be necessary within about six months.

Rolf Siemssen, then a staff member in the Physics Division, had come back from a trip to Germany in 1969 with news about a new type of linac based on a helical resonator (Klein at Frankfurt) that seemed ideal for heavy-ion acceleration.

Warren Ramler was the engineer in charge of the cyclotron in the Chemistry Division, and decided to pursue it as a superconducting structure.

A test cavity was designed and built by Ralph Benaroya and tested in 1971, and its performance was surprisingly good.

Lowell Bollinger stepped down as Division Director in 1972 to systematically address the task of developing the technology into a viable accelerator.

Some people were apprehensive about too much emphasis on heavy ions:

May 9, 1972

TO: L. M. Bollinger

FROM: J. P. Schiffer

I would like to make two points to you in writing regarding the accelerator proposal. Both of them express my latent fears about pressing the LINAC concept too hard.

A.) Our principal scientific interest in Physics is in the tandem. We have not done an adequate job on any of the administration, Duffield and Nevitt as well as McDaniel and Kolstad, in persuading them that this is the most important part of the research. To my mind this is a bad mistake, because inevitably we get the reaction that we should wait and see what comes out of the Berkeley SUPERHILAC. I would guess that this will be two or three years, and if there are no indications for superheavies there will be no money for a new machine. If there are some tentative, inconclusive indications the AEC will want to wait and see. It seems to me that we are in a very vulnerable position by having it fixed in the minds of all the decision-makers that our principal aim is an accelerator which can get superheavies, a "me too" justification which is very easily punctured administratively as well as scientifically.

B.) Should we be successful in demonstrating that the superconducting LINAC can be built (as we probably will be) and funding becomes probable, there is an excellent chance, to my mind, that we would be forced into building an all LINAC machine. This would make more sense because

Our field is not immune to fashions, just as other human activities,

Heavy ions were in --- light-ion physics was considered passè.

We announced the proposal to our user community

April 10, 1972

NEWSLETTER

ON THE ARGONNE PROPOSAL FOR A HEAVY-ION ACCELERATOR

In 1969 Argonne National Laboratory proposed the construction of a major user-controlled accelerator facility for use in both heavy-ion research and intermediate-energy physics. Since then there have been a series of developments that have changed both the scientific and technological perspectives. The purpose of this note is to acquaint the community of interested nuclear physicists and chemists with the current thinking at Argonne on this subject.

There is a widespread and growing conviction that heavy-ion projectiles have great potential for investigations in several fields. The experimental evidence that qualitatively new features of nuclear structure are likely to emerge from such studies has been steadily accumulating. The impact on fields such as atomic and solid-state physics is also likely to be substantial.

In the meantime a small group at Argonne was studying the possibility of using a superconducting linac instead of a cyclotron. A helical cavity seemed attractive for heavy ions, especially in the superconducting mode. However, the prospects for a successful superconducting linac seemed quite bleak until late 1971, when a way was found to stabilize the surfaces of superconducting cavities.

This development (described below) leads us now to propose that the next large heavy-ion facility should consist of a 20-MV Pelletron tandem coupled to a superconducting helical linac.



We came up with a very attractive tandem-linac proposal

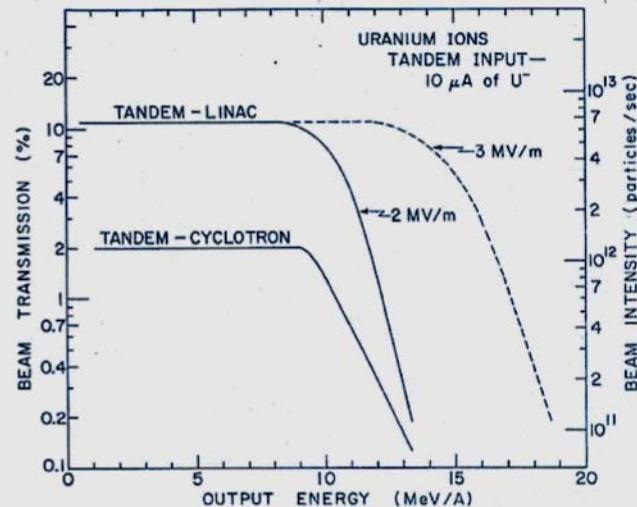
August 8, 1973

BEAM CHARACTERISTICS TANDEM-SUPERCONDUCTING LINAC SYSTEM

A schematic representation of the accelerator system is given in Fig. 1, where the main beam-forming components are identified. The attached tables give beam characteristics for several representative projectiles and conditions of operation.

BEAM CURRENT

We assume that the limit on the achievable beam current is set by the beam-carrying capacity of the low-energy accelerator tube. This limit is assumed to be $10 \text{ particle } \mu\text{A}$, which is believed to be realistic, although much greater than has been achieved yet for heavy ions. For the same quantity, the ORNL group have been using the higher value $25 \text{ } \mu\text{A}$. If this higher value is used, then all of our beam currents should be multiplied by 2.5.



In these pre-NSAC days, a committee was appointed through the NRC (Bromley was in charge) and Feshbach was the chair.

Feshbach's committee was very skeptical about a superconducting linac (partly because of the experience at Stanford and 'experts' who were negative) and Argonne lost out.

Lowell Bollinger wrote me about the aftermath.



U of C-AUA-USAEC

ARGONNE NATIONAL LABORATORY

July 20, 1973

Dr. J. P. Schiffer
Physik Department E12
Technische Universitat Munchen
8046 Garching
W. Germany

Dear John:

You asked for reports about anything that I might learn about the deliberations of the Panel. When I returned home Tuesday night, I became increasingly disturbed about the possible influence of Tombrello's statement about the new spiral accelerating structure. As a result, we have made some inquiries, calculations, and model tests. It turns out that Tombrello's statement was very misleading, as might have been expected. The work at Cal Tech is being carried out by Shephard and Dick (the same two men who first demonstrated the usefulness of the variable reactance for vibration control), and Tombrello apparently is not involved in the work at all. Indeed, this is the work that he was condemning so vigorously some 18 months ago.

DOE did agree to continue technical developments and we did manage to get some money to develop the sc linac technology.

Lowell decided that the split ring at Caltech (Shepard et al.) looked more promising, Shepard came to Argonne and we switched to resonators of his design.

Bit by bit we received additional moneys in small installments (not a 'project'. We built more and more resonators and cryostats - this became the booster.

By ~1980 we had considerable success, and proposed ATLAS.

With the help of Florida State (Congressman Fuqua) we also acquired more political clout and our proposal went through NSAC successfully.

The scientific plan for ATLAS was described in response to some (sympathetic) Congressional questions.

Response to questions on the Argonne Tandem Linac Accelerator System (ATLAS)
from the House Science and Technology Committee

March 16, 1984

1. What new science is being explored by the ATLAS facility? What scientific opportunities are being exploited?

The science of nuclear physics concerns itself with the properties of atomic nuclei and nuclear matter. The December 1983 DOE/NSF Long Range Plan for Nuclear Science identified the key scientific challenges facing nuclear physics. The present prototype superconducting linac at Argonne, and especially the full ATLAS facility when it is completed in 1985, address important aspects of about half of these key questions posed in the Long Range Plan. By providing precision beams of heavy ions in the energy range comparable to the internal energies in nuclei, ATLAS can contribute in a unique way as is detailed below, where the relevant questions from the Long Range Plan are cited.

HIGH SPIN NUCLEI: How does the nucleus rearrange its shape and structural symmetries under increasingly rapid rotation?

The properties of rapidly rotating nuclei are an important frontier area of experimental investigation and the characteristics of ATLAS are especially well suited to these studies. The study of shape transitions, of possible super-deformed nuclei, and the reordering of the protons and neutrons in nuclei under extremes of rotations can be studied with unequalled ease. The fact that for several years the world's record in the highest measured discrete spin came from the prototype linac that is the first stage of ATLAS, is an early indication of the capabilities of this technology. The insights and simplifications to be gained from the study of high spin nuclei are considerable and the research opportunities with ATLAS are at the forefront of this area.

MACROSCOPIC PHENOMENA: What are the new macroscopic and microscopic phenomena associated with collisions between two nuclei? How and on which time scale is energy absorbed and a new equilibrium established?

ATLAS as well as the present linac represent a powerful facility to study the physics of interaction between colliding nuclei at energies comparable to nuclear binding energies. How do nuclei fuse? What are the systematics for fission? How is mass and energy exchanged by colliding nuclei? These are major areas of study for which the unique energy variability and timing of ATLAS beams make it into a very effective facility. The good energy resolution and easy energy variability also permit exploration of resonance studies -- an important class of physics in this area.

EXOTIC NUCLEI: What happens to nuclei at the limits of stability?

An important dimension in nuclear structure is that represented by changes in the number of neutrons vs. protons. In regions of a great excess of either neutrons or of protons, the question arises whether this imbalance affects the relative importance of the effective internucleon interactions. This would be reflected in changes in the masses of nuclei, in different shell closures, and thus in different shapes. ATLAS is uniquely suited to investigate such questions and to search for new nuclei because of the capability to easily provide the appropriate energy-projectile combination,



And equipment was built to make use of the new capabilities.

ARGONNE NATIONAL LABORATORY

9700 SOUTH CASS AVENUE, ARGONNE, ILLINOIS 60439

Telephone 312/972- 4004

RECEIVED

September 7, 1984

SEP 10 1984

J. P. SCHIFFER
Dr. Enloe T. Ritter, Director
Division of Nuclear Physics, GTN - ER-23
Office of High Energy and Nuclear Physics
U.S. Department of Energy
Washington, DC 20545

Dear Enloe,

This is by way of a progress report on the development of the BGO γ -ray detector facility for use at ATLAS.

The project is coming along on schedule and within budget. Phase I of the facility development (the construction of 6 Compton-suppressed spectrometers together with an inner array of 14 BGO detectors) is expected to be operational with ATLAS by the summer of 1985. All of our extensive testing of the prototype detectors has indicated that the final facility will meet and probably exceed the specifications that we originally proposed. The prototype BGO Compton-suppressor has performed impressively. With the Ge detectors we expect to use in the final configuration we should obtain performance close to or better than the best that has been achieved in Compton-suppression efforts, giving peak/total ratios of ~ 0.65 for an incident photon energy of ~ 1.2 MeV.

We are now ready to proceed with plans to develop Phase II of this project. In this connection, Notre Dame University is currently preparing a proposal for submission to your office for a total of \$400k for Fiscal Years 1986 and 1987 to enable them to continue their portion of the project. At Argonne we are proposing to contribute \$300k from our ATLAS-related equipment funding. The cost to complete the entire facility remains as initially projected, namely, \$1445k. The following table shows a breakdown of the sources of funding for the two phases of the facility:

(Thousands of Dollars)

	Phase I		Phase II		
	FY84	FY85	FY85	FY86	FY87
ANL Equipment Funds	350	0	185	50	50
ANL and U of C					
Discretionary Funds	175	20	15	0	0
Notre Dame	200	0	0	200	200
Totals	725	20	200	250	250

