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Status of the Accelerator Project at UCA

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—Essentially all spa areas were found to be well within acceptable radiation exposure limits.
—Radon and daughters comprise essentially all of the radioactivity present in the park.
—Dried up springs no longer emit gamma rays. The presence of water is evidently necessary for gamma emissions to exist.

Table 5. PIC Reading Over Hatch Covers - Before and After Opening

		μR h^{-1}	
Spring Number	Before Hatch Removal	After Hatch[a] Replacement	48 hours Later
5.	133	65	136
7.	189	b	190
8.	151	55	161

[a] Spring was opened to ambient atmosphere for one hour before replacing hatch cover.

[b] Hatch not removed.

Table 6. PIC Measurements at Spring Hatch Covers Across Time

	Spring Number		
Date	#5	#7 μR h^{-1}	#8
July 1987	142	185	-
Oct 1987	116	163	-
Nov 1987	119	171	-
Feb 1988	119	-	158
Apr 1988	122	-	164
May 1988	133	189	151
May 1988	136	190	161

- No reading taken

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STATUS OF THE ACCELERATOR PROJECT AT U.C.A.

A 2.5 MV Van de Graaff accelerator is being installed in a new facility at the University of Central Arkansas. The accelerator and some ancillary hardware was donated to the school approximately 10 years ago, while the area in the building became available almost 4 years ago.

The accelerator itself is one of many variants in a series produced by High Voltage Engineering Corporation. Built in the late 1950's, it has passed through several institutional hands in the interim, but has acquired relatively little actual running time. It was originally intended for use with a negative terminal potential to accelerate electrons, as part of an industrial X-ray system. Our use for the machine has required a conversion to positive terminal operation to produce positive ion beams. A more detailed discussion of these modifications and the installation to date appears below.

The laboratory housing the accelerator was designed expressly for that purpose as part of an addition to the science building completed in 1986. It consists of 4 rooms on the main (upper) floor of the building and one large room below them. Figure 1 shows a plan view of the upper floor area and Fig. 2 shows the lower room.

In Fig. 1 we see 2 primary rooms, the control room and the accelerator vault. The control room is outside the curved shield wall of the vault; it houses the control console for the machine as well as providing space for data acquisition equipment. The 2 smaller rooms to the left of the vault will provide office and research area to faculty and students using the machine.

The accelerator vault is 7.9 m in diameter and is enclosed by a high density concrete radiation shield wall; this room and the entire lower room, equally shielded, constitute the high radiation area of the laboratory. This area is protected against entry when radiation may be produced by a system of interlocks on all entrances.

The accelerator is mounted vertically at the vault center so that the beam will immediately exit into the target room below. The machine's baseplate (A) is shown in Fig. 1, and is approximately 1.2 m square. The accelerator pressure tank stands roughly 2.4 m high and is removed and installed with an overhead track crane. A floor slot (B) allows crane access to the target room below. A large conduit (C) carries control cables from the machine baseplate to the console (D). Gas storage and piping equipment for the insulating tank gas will be installed in the vault.

A stairway leads down to the target room, which occupies the area below all of the upper floor rooms plus a short extension to the west. The target room will contain all of the beam handling system as well as the experimental areas. A wide door on the lower floor allows access for large equipment. A corner of the room houses a shielded neutron irradiation source for use in student experiments.

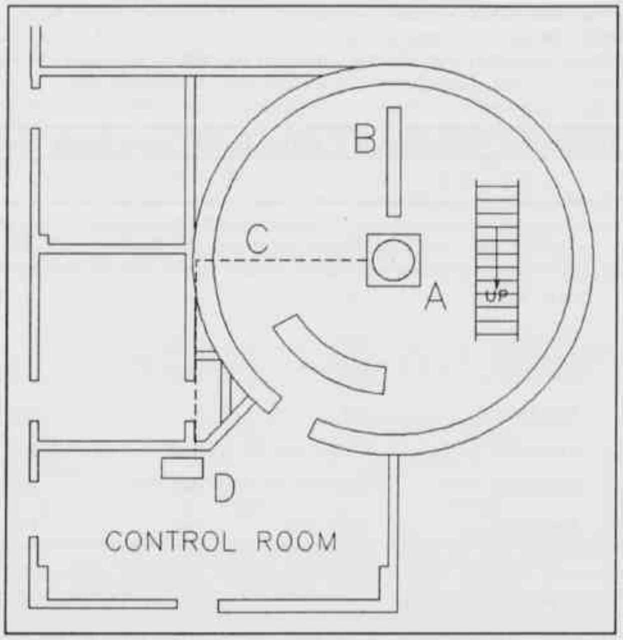

Figure 1. U.C.A. Accelerator Area - upper floor

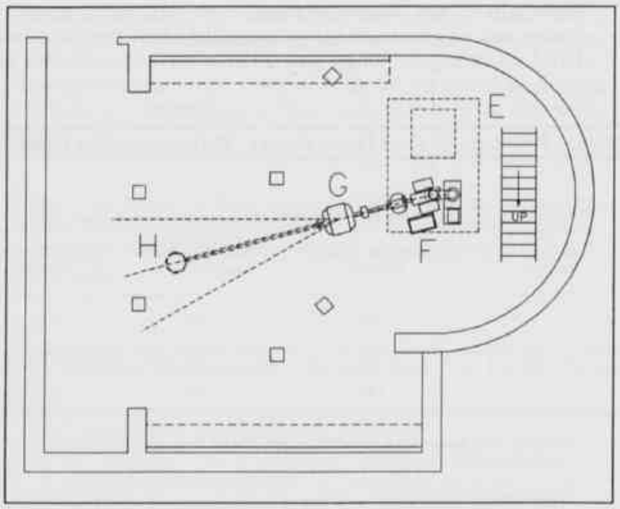

Figure 2. U.C.A. Accelerator Area - lower floor

The dashed outline denoted (E) in Fig. 2 represents an extension of the target room below floor level. This region is designed for future use as a neutron irradiation area; the floor of the target room in this area is heavily shielded. The remainder of the neutron area is approximately 6.1 m below outside ground level and consequently well shielded. This region will allow experiments that produce relatively high radiation exposures to be conducted. This area is also part of the interlocked safety system.

The beam line components and other equipment shown in Fig. 2 will be mentioned at the appropriate points in the discussion of the accelerator installation which follows.

The machine itself was originally a long column 2.5 MV electron accelerator; the reduction of the column in length provided room for the installation of a positive terminal; this was a common modification of the series. The machine arrived at our school with all of the major components, i.e., console, base assembly, column, accelerating tube, and drive and cooling systems, essentially intact and in good condition.

Considering the usual financial and time constraints, the work on installation has progressed well. A substantial amount of time went into basic mechanical installation of the base and column assemblies. The machine was in place and assembled within a year and console wiring was largely in place; belt drive and charging systems were installed and tested. Console functions relating to basic machine operation were wired and checked.

Our use of the accelerator will be entirely with positive ion beams. As the accelerator was originally designed for electron beams, we had to provide a positive potential terminal and an ion source. The construction of these items took place after the main components were in place. The terminal supports and powers various power supplies necessary to operate the ion source, which is a conventional RF bottle source that produces a beam of very low energy ions by electron stripping in a high frequency electric field and concentration by an axial magnetic field. The primary use of this machine will involve the production of proton beams. The ion source gas handling system will allow the changeover of source gas without disruption of tank pressure or source vacuum.

As the terminal and ion source are at high potential relative to the baseplate, ion source parameters such as pressure, extraction voltage, and beam focus voltage are controlled by insulating rods extending up through the column. Stepper motors drive these rods. The controllers for the motors were designed and built in the lab; the console controls for these were installed and the ion source was tested for basic operation.

Subsequent and recent work has been devoted primarily to the beam handling system. The beam system exits the accelerator downward into a 4 inch beam line. This line also contains the first of what will be several vacuum pump stations. The tube and beam line vacuum currently is being maintained by a conventional oil diffusion pump; the system has not been rigorously sealed nor leak-chased at this point as there are beam line modifications to be made in the near future.

The downgoing beam line terminates at the entrance port of a 90° bending magnet (F in Fig. 2). This magnet holds a pair of large water cooled coils on either side of a beam line segment, producing a horizontal magnetic field. This has the effect of turning the beam into the horizontal direction where it exits the magnet about 0.9 m above the floor level. This is the extent of the existing beam line. The construction of concrete support pillars and positioning equipment for the substantial burden of the magnet has been completed during the past few months.

Immediate plans include the installation of the bending magnet power supply and its associated plumbing and wiring. The remaining steps necessary to test the accelerator for beam production will be completed during the remainder of the spring and summer of this year. The short range aim is to have basic beam production and transport from the accelerator at nearly the design energy of 2.5 MeV by the end of summer 1990.

Figure 2 also shows the major items remaining to be designed, built, and installed. Some of these items are commercially produced, but the majority of the beam line and vacuum system will be constructed in the lab.

The beam will continue from the exit port of the first magnet through a beam line section which will also contain another vacuum pump station. From this section it will enter another magnet (G), the switching magnet, which will steer the beam into one of 3 beam lines leading to 3 experimental stations. This will allow several experimental setups to use the accelerator without conflict. The layout of these lines was dictated by both the fixed exit angles of the switch magnet and the support posts for the shield wall above. Each of these beam lines will terminate in a scattering chamber (H) in which beam particles interact with the target and in which detectors are mounted to detect the products of the resulting reactions. A third vacuum pump station is planned for the scattering chamber area.

Extensive work remains to be done in a number of areas in the lab. Foremost among these after the basic accelerator functions are established are design and construction of equipment to measure and regulate the beam energy with precision. Other necessary projects include improvements to the vacuum system and its gauging capabilities, beam focussing and diagnostic equipment and electronics, and target chamber design.

In summary, a positive ion accelerator is being installed at the University of Central Arkansas. The major hurdles involved in the machine installation and checkout have been passed, and basic beam production is expected in the relatively near future. This laboratory will enable the physics department to offer its students valuable experience with experimental techniques and procedures in a research environment not commonly found in our type of institution.

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A SYNOPSIS OF THE BELOSTOMATIDAE OF ARKANSAS

There have been no studies treating specifically of the Belostomatidae of Arkansas. Pertinent information is either in taxonomic studies which include Arkansas material (Menke, 1958; 1963) or lists of aquatic macroinvertebrates from particular sites within the state (Harp and Harp, 1980; Farris and Harp, 1982; Huggins and Harp, 1983). The purposes of this paper are to present the first statewide species list, to delineate geographic distributions, and to define preferred habitats for belostomatid species, insofar as present knowledge will allow. Arkansas species may be identified by using Gonsoulin's (1973) key to Louisiana species.

Most information presented has been compiled from specimens in the ASU Aquatic Macroinvertebrate Museum; however holdings of the ASU Entomological Museum, and UA-Fayetteville Museum, and UA-Little Rock Entomological Museum were examined, and literature records are included. Finally, 2 collecting trips were made to south and central Arkansas counties to diminish distributional gaps in the data.

Belostoma lutarium (Stal) was first reported from Arkansas by Menke (1958). It is our most common species of *Belostoma*, being represented from 278 collections in 51 counties (Fig. 1). Froeschner (1962) listed only one Missouri specimen but suggested it should occur widely in the state. Gonsoulin (1973) reported this as the most common species of the genus in Louisiana, being found in all aquatic habitats in the state. Wilson (1958) stated that this species was very common in Mississippi, being collected in shallow brackish pools and stock ponds filled with submerged and emergent vegetation. This species occurs in all aquatic habitats in Arkansas, in all physiographic provinces; however, it was most often collected in lowland ponds, streams, and lakes, and in ditches and bayous within the Mississippi Embayment, the Gulf Coastal Plain and Crowley's Ridge. The Louisiana collections include specimens captured during all months except February, May, September and December; the Missouri specimen was collected in July; the Mississippi bugs were collected March-November (Wilson, 1958; Froeschner, 1962; Gonsoulin, 1973). In Arkansas this species has been taken in all months of the year.

Belostoma flumineum Say has not been reported previously from the state. It has been taken in 48 collections in 15 counties in Arkansas (Fig. 2). This is the most common species of the genus in the United States (Gonsoulin, 1973). It has been found year round in Missouri (Froeschner, 1962) and is expected to occur throughout the state. It ranks far behind *B. lutarium* in distribution in Louisiana with collections in March and July from sluggish streams or marsh areas with abundant aquatic vegetation (Gonsoulin, 1973). Wilson (1958) reported this species from stagnant waters in Mississippi. The Arkansas specimens were collected every month except December and in 3 physiographic provinces, the Ozarks, Mississippi Embayment and Crowley's Ridge. Approximately one-half were collected from Ozark streams and one-third from lowland ponds. They also occurred in Ozark ponds and lakes and lowland streams.

Belostoma testaceum (Leidy), not previously reported from Arkansas, was taken in 13 collections in 10 counties (Fig. 3). This species has a fairly wide distribution in Louisiana and was found in June, August, October and November (Gonsoulin, 1973). One specimen was taken in Mississippi from a shallow, shaded pool in a dense swamp (Wilson, 1958). Though not reported from Missouri, it is expected to occur there (Froeschner, 1962). Habitat was not recorded in previous studies (Foreschner, 1962; Gonsoulin, 1973). In Arkansas this species (collected March, April, June, September, October, November, December) was most often found in lowland ponds and rivers, roadside ditches and swamps in the Mississippi Embayment and Crowley's Ridge.

Huggins and Harp (1983) first reported *Belostoma fuscivente* (Dufour) from Arkansas. It is the least common belostomatid in the state, occurring in only 2 collections from 2 counties (Fig. 4). Gonsoulin (1973) recorded a large range extension for this species, which had previously been documented from southern Texas and southeastern Arizona; however, it is not found on the Missouri list (Froeschner, 1962). Habitats from which this species was taken are a lowland creek in the Ouachitas (Arkansas River Valley) and a lowland pond in the Gulf Coastal Plain, both of which appeared to have good quality water. In Louisiana this species was taken in July, August and October; in Arkansas, it was collected in July and November.

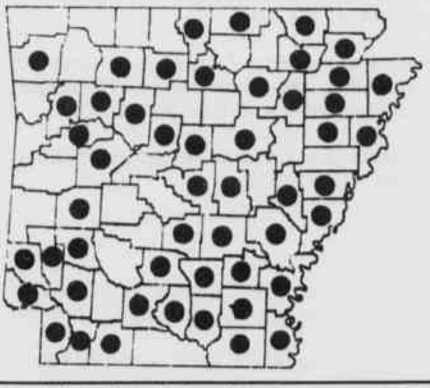

Figure 1. *B. lutarium*

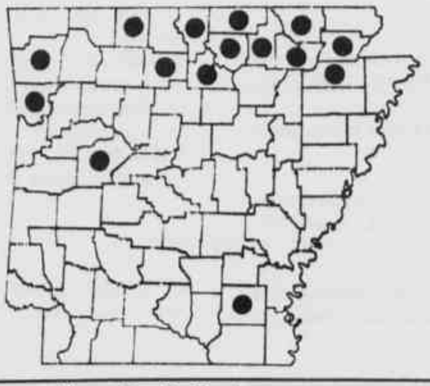

Figure 2. *B. flumineum*

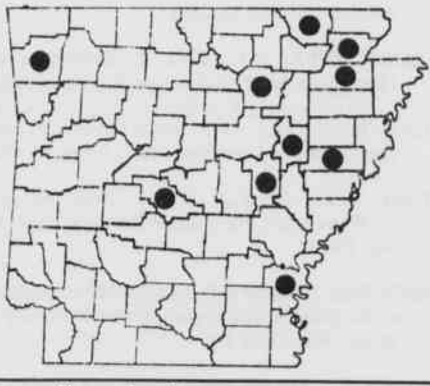

Figure 3. *B. testaceum*