Survey of High-Energy Physics Support at U.S. Universities

A Summary of the Data

P. Oddone and D. Vaughan
Ernest Orlando Lawrence Berkeley National Laboratory
Berkeley, California 94720

October 1997

This work was supported by the Director, Office of High Energy and Nuclear Physics, Office of Energy Research, U.S. Department of Energy, under Contract No. DE-AC03-76SF00098.

Survey of High-Energy Physics Support at U.S. Universities

A Summary of the Data

Table of Contents

Survey of High-Energy Physics Support at U.S. Universities
A Summary of the Data

An essential element of the national high-energy physics program is the engineering and technical infrastructure at U.S. universities, a vital underpinning of the experimental research effort that engages faculty physicists, postdoctoral fellows, and graduate students. Formal HEPAP interest in the continuing health of this infrastructure dates back more than two years. In May 1995, funding data collected from the largest universities indicated declining fiscal support, roughly constant numbers of scientific staff and students, and thus diminishing resources for technical infrastructure.

To pursue this issue in greater depth, HEPAP established the Subcommittee on University Infrastructure in March 1996. Its members were Melissa Franklin, Harvard University (chair); Piermaria Oddone, LBNL; Roberto Peccei, UCLA; and William Willis, Columbia University. Among its efforts, the Subcommittee collected budget data from the DOE's Division of High-Energy Physics and prepared a database for all DOE-funded universities. Budget data alone, however, did not allow a confident characterization of university infrastructure. The Subcommittee reported its conclusions and recommendations in October 1996. Chief among these were the recommendations that HEPAP establish a formal subpanel on university issues and that a survey be undertaken to gather more complete data pertinent to the infrastructure issue.

THE SURVEY

A questionnaire to survey the extent and health of infrastructure support for high-energy physics research at U.S. universities was subsequently developed in February 1997. It was "tested" on several members of HEPAP, revised on the basis of their suggestions, and converted to a Web-based form in the early spring. The Web version and the database associated with it were designed to facilitate annual surveys and updates to the institutional data. In late April, faculty physicists were chosen to represent each of the 120 universities receiving DOE or NSF support for high-energy physics research. Each representative was sent a hard copy of the survey form (attached as Appendix A) and instructions for accessing the Web version. The present summary reflects the responses of 99 university representatives—83% of those contacted.

The questionnaire sought to collect data in four broad areas:

Staffing. Information was requested on the number of staff engaged in or supporting high-energy physics research, as well as the extent of the effort (measured in full-time equivalents, FTEs) and the sources of financial support.

Apportionment of effort. The questionnaire requested estimates of how effort is currently apportioned among the field's major experimental projects and theoretical research programs, as well as estimates of how effort is likely to be allocated in the year 2002.

Engineering and technical capabilities. Each respondent was asked to describe his / her university's major technical capabilities and achievements, and to estimate the cost of providing engineering and technical support for jobs of different sizes.

Demographics. A picture was sought of the current graduate student population, as well as a sense of the universities' future needs for faculty and support personnel.

THE DATA—QUALITY AND LIMITATIONS

Ninety-nine respondents (83%) completed the survey, wholly or in part. Twenty-two respondents used the hard copies provided; the rest entered their responses on the Web page. In qualitative terms, the 21 nonrespondents appear to be roughly representative of all 120 institutions, including large and small universities in about the same proportion. Further, based on census data collected by the Particle Data Group, particle physicists at the 21 unrepresented universities (17% of the 120) represent 12% of the high-energy physicists at the 120 surveyed institutions. We therefore conclude that the universities for which we have data constitute a representative sample, perhaps slightly biased toward the large and medium-sized institutions.

Despite our efforts to provide detailed instructions and several examples, survey responses revealed some confusion (or impatience) in answering several of the questions, especially in providing staffing data. Particularly obvious anomalies included staff numbers reported as fractions and FTEs reported as exceeding the number of staff. In addition, when estimating the apportionment of effort among high-energy physics projects, some respondents apparently included the effort of support personnel (contrary to the instructions), and some showed more effort being devoted to research than could be accounted for in the staffing summaries. Also, respondents using the paper survey sometimes offered answers that could not be adequately captured in the database: hourly support costs of "≤$20," for example, or staffing entries for "other" personnel.

Owing to these and other irregularities—about 40 in all—further inquiries were made to resolve apparent errors. In a few cases, the input data were altered to eliminate obvious entry errors, even in the absence of guidance or confirmation from the respondents. However, a few irregularities remain, where no obvious corrections were available and where we were unable to contact the respondents.

Notwithstanding these irregularities, we believe that the overall quality of the data is good and that a number of conclusions can be safely drawn. Data for number of staff are the most suspect (having apparently been entered by many as FTEs rather than "head counts"), but these data appear only in a single histogram (Figure 3).

THE DATA—DESCRIPTION AND OBSERVATIONS

STAFFING

Details regarding staffing and especially levels of effort, as measured by FTEs, made possible a host of summary presentations, comparisons, and correlations. Table 1 presents the raw totals for the several categories of staff (faculty physicists, postdocs, etc.). Physicists are further classified as experimentalists, theorists, or accelerator physicists. Levels of effort are also broken down by source of support. Some of these data are summarized in the pie charts of Figures 1 (staff breakdown by category) and 2 (FTEs by source of support).

A series of histograms (Figures 3–13) presents detailed data on staffing and research effort at each university. In each figure, the universities are arranged along the horizontal axis in the same order, namely, according to the total number of FTEs engaged in high-energy physics research (including technical and engineering support), "largest" on the left, "smallest" on the right. A brief description of each table and histogram follows.

Table 1: Personnel Summary—This personnel summary presents FTE totals and head counts for relevant categories of staff, broken down both by field of interest and source of support. The FTE totals for experimental physics, theory, and accelerator physics are 1333, 841, and 33, respectively (excluding the effort of support staff and undergraduates). The total staff reported for the 99 responding institutions (excluding support staff and undergraduates) is 2317, compared with 2213 staff identified at the same institutions in the Particle Data Group census.

Figure 1: Total Staff by Category—This pie chart provides an overview of the field's personnel: roughly equal numbers of faculty physicists and graduate students, a substantial cadre of postdoctoral fellows, and a relatively small number (10% of the total) of support personnel.

Figure 2: Total FTEs by Source of Support—The second pie chart illustrates the dominant role of DOE grants and nonfederal sources in supporting high-energy physics. The size of the nonfederal support reflects mainly university support of faculty physicists. (Faculty members were counted as full-time staff, even though a significant portion of their time may be devoted to teaching and other academic responsibilities.)

Figure 3: Total Staff and FTEs—This plot establishes the criterion—namely, total FTEs—by which the universities are ordered on the horizontal axes of all succeeding histograms. An ordered list of institutions follows the figure. The "largest" universities are about four times as large as the median institution, and roughly 25% of the institutions are less than one-tenth the size of the largest. Total staff (head count) follows the same trend, with several notable outliers. A total staff count that significantly exceeds the FTE total can arise, for example, from substantial numbers of participating undergraduates, or graduate students with significant teaching loads. Instances in which staff count equals FTEs may arise if all staff are full-time, but may also result from entry errors—see page 4. The 21 universities for which we received no responses appear at the right of each histogram.

Figure 4: Faculty FTEs by Area of Effort—As expected, the trend of faculty FTEs generally follows that of total FTEs. The median level of faculty effort is 7 FTEs, compared with 27 FTEs at the largest institution (University of Michigan; all others reported 20 or fewer). On average, effort is split between experiment and theory in roughly the same way at large and small institutions, though taken individually, many smaller universities are dominated by one or the other. Overall, the distribution is 53% experiment, 46% theory. Only three of the responding universities (UCLA, Texas A&M, and University of Houston) identified faculty members as involved in accelerator design.

Figure 5: Other Senior Physicist FTEs by Area of Effort—Effort by nonfaculty senior physicists and retired faculty shows a much less predictable distribution than faculty effort. Whereas four of the ten largest universities reported 10 or more FTEs of effort, another four reported 2 or fewer FTEs. On the other hand, only four of the 30 largest universities reported no effort by nonfaculty senior

staff, whereas 45 of the remaining 69 institutions reported no such effort. Effort by nonfaculty physicists is dominated by experimental research.

Figure 6: Postdoctoral FTEs by Area of Effort—Postdoctoral effort generally follows the trend of total effort, but the variability is notable. For example, the five largest universities reported an average of 10.4 postdoctoral FTEs, compared with an average of 17.0 FTEs for the next five. Overall, about 62% of the postdoctoral effort is experimental.

Figure 7: Graduate Student FTEs by Area of Effort—Graduate student effort follows closely the trend of total FTEs and faculty FTEs. The median level of effort is 6 FTEs, compared with 44.6 FTEs at MIT. About 60% of the graduate student effort is devoted to experiment.

Figure 8: Undergraduate Student FTEs—Undergraduate participation in high-energy physics research varies widely among the reporting institutions: Some of the largest universities, for example, reported little or no such participation. The median level of undergraduate effort is about 0.5 FTE.

Figure 9: Professional Support FTEs—The level of support shows great variability, though it very generally follows the trend of total FTEs. None of the 46 smallest universities reported more than 2 FTEs of professional support (many reported none), whereas all but four of the largest 30 reported more than 2 FTEs. Among these 30 largest universities, the median level of support was 4.7 FTEs.

Figure 10: Ratio of Postdoctoral FTEs to Physicist FTEs—"Physicist," as defined here, includes faculty and other senior physicists. The histogram shows considerable variability and no obvious trend. Forty-three universities reported ratios between 0.4 and 1.0. Only Harvard and Caltech reported ratios significantly greater than 1.

Figure 11: Ratio of Student FTEs to Physicist FTEs—Here, "student" encompasses graduates and undergraduates. Again, the dominant impression is variability rather than any trend, though the largest ratios are clustered among the smallest institutions, owing, at least in part, to the small number of faculty and senior physicists at those institutions.

Figure 12: Ratio of Support Staff FTEs to Physicist FTEs—Again, variability dominates a weak correlation with total FTEs. Among the 30 largest

universities, the ratio varies between 0.05 and 0.67; the median is about 0.25. For all institutions, the median is about 0.17.

Figure 13: Ratio of Other Senior Physicist FTEs to Faculty FTEs**—**This histogram reflects the broad features of Figure 5, namely, the relatively large numbers of nonfaculty senior staff at UC Irvine (11.5 FTEs), Tennessee (5), Duke (4), and Fairfield (1), as well as the significant number of small institutions that reported no effort by such staff.

Additional figures are included in Appendix B. The first three (Figures B-1 through B-3) share the qualitative features of Figure 10–12. The remaining eight figures (B-4 through B-11) present ratios that include federally supported faculty FTEs in the denominator. Since most faculty support is nonfederal, the results are ratios that are relatively large and highly variable. These appended figures are listed below:

B-1: Ratio of Postdoctoral FTEs to Faculty FTEs
B-2: Ratio of Student FTEs to Faculty FTEs
B-3: Ratio of Support Staff FTEs to Faculty FTEs
B-4: Ratio of Senior Physicist FTEs to Faculty FTEs, Supported by DOE
B-5: Ratio of Postdoctoral FTEs to Faculty FTEs, Supported by DOE
B-6: Ratio of Student FTEs to Faculty FTEs, Supported by DOE
B-7: Ratio of Support Staff FTEs to Faculty FTEs, Supported by DOE
B-8: Ratio of Senior Physicist FTEs to Faculty FTEs, Supported by NSF
B-9: Ratio of Postdoctoral FTEs to Faculty FTEs Supported by NSF
B-10: Ratio of Student FTEs to Faculty FTEs Supported by NSF
B-11: Ratio of Support Staff FTEs to Faculty FTEs Supported by NSF

APPORTIONMENT OF EFFORT

Table 2 reflects the cumulative responses from all institutions, asked to estimate the apportionment of their scientific effort (not engineering or technical support effort) among the field's major projects. In a similar way, Table 3 shows the responses of the 30 largest universities, as measured by total FTEs. Two disclaimers must be attached to these data: Some respondents noted that projects they expected to be working on in 2002 were not listed. And in other cases, the responses suggested hesitation in estimating how future effort would be apportioned—that is, in many cases, the total number of FTEs projected for 2002 is smaller than the respective total current effort, an apparent consequence of uncertainty rather than pessimism.

Table 2: Apportionment of Effort—
Table 3: Apportionment of Effort at the 30 Largest Universities—
The actual numbers in these tables are less important than their relative values and the trends they reflect: The levels of effort devoted to and projected for the largest projects are summarized below, where they are expressed as percentages of the totals for all projects. Entries under "Chng" reflect projected changes in these percentages.

	All institutions			30 largest institutions		
Project	**Now**	**2002**	**Chng**	**Now**	**2002**	**Chng**
CERN: ATLAS	2.7%	6.7%	+148%	2.6%	6.4%	+146%
CERN: CMS	2.4	6.8	+186	2.3	7.3	+224
CERN: LEP	4.7	1.1	–70	5.6	1.4	–75
Cornell: CESR	6.5	4.2	–35	5.1	3.7	–27
Fermilab: CDF	8.4	8.0	–5	7.8	7.5	–3
Fermilab: D0	7.4	6.9	–7	6.7	6.4	–5
Fermilab: Fixed-target expts	8.0	6.3	–22	7.0	7.3	+4
SLAC: BABAR	4.0	7.3	+83	4.1	6.8	+67
Nonaccelerator expts	10.1	10.7	+6	13.0	12.9	–1
Field theory	9.7	8.6	–11	8.9	7.4	–16
Phenomenology	11.8	12.0	+2	11.7	12.1	+3
String theory	6.8	7.2	+7	6.7	6.7	+1

ENGINEERING AND TECHNICAL CAPABILITIES

Respondents were asked to provide estimates of the hourly costs (to their federal sponsors) of providing engineering and technical support for projects requiring annual expenditures of effort equal to 250, 1000, and 3000 person-hours. Figures 14–17 summarize the results. Each histogram represents a single type of support (electronics engineering, for example), and each bin on the horizontal axis represents a $10 range in hourly costs.

Figure 14: Cost of Mechanical Engineering Support—Thirty-five universities (35% of the respondents) indicated a capability for providing at least 250 person-

hours of mechanical engineering support per year; 20 indicated a capability for 3000 person-hours of such support. At all levels of support, the median cost is between $40 and $50 per hour. Two universities indicated that 1000 person-hours of support were available at less than $20 per hour.

Figure 15: Cost of Electronics Engineering Support—Forty institutions (40% of the respondents) are capable of providing electronics engineering support at the level of at least 250 person-hours per year; 29 indicated a capability for 3000 person-hours of such support. The median cost at all levels of support is between $50 and $60 per hour. As with mechanical engineering, a few universities indicated the availability of inexpensive support, especially at the lower levels of effort.

Figure 16: Cost of Mechanical Technician Support—The distribution of estimated costs for mechanical technician support is much less regular than those for engineering support, with far more institutions indicating the availability of low-cost support—reflecting the presence of university-funded shops. Fifty-nine institutions (60% of the respondents) are able to provide at least 250 person-hours of annual support; 15 of these can provide such support at less than $10 per hour. Forty-two respondents indicated a mechanical technician support capability at the level of 3000 person-hours per year. The median hourly cost of support at the levels of 250 and 1000 person-hours per year is between $20 and $30; for 3000 person-hours of support, it is in the $30 to $40 range.

Figure 17: Cost of Electronics Technician Support—The distribution of electronics technical support costs again reflects the widespread availability of subsidized assistance. Fifty-five schools (56% of the respondents) indicated support capability at the lowest level, 13 of them at a cost below $10 per hour. Thirty-seven institutions are capable of providing 3000 person-hours of such support, three of them at $10 per hour or less. The median hourly costs parallel those for mechanical technician support: $20–30 for 250 or 1000 person-hours of annual support, $30–40 for 3000 person-hours.

DEMOGRAPHICS

Tables 4–7 provide summary information on the graduate student population at the responding universities, as well as summary information for the 30 largest universities, where, as always, size is measured by total FTEs devoted to high-energy physics research. The numbers in Table 4 and 6 (and in Table 9, below) can be extrapolated to the full set of 120 universities by multiplying each by 1.14, a reflection of our estimate that the “missing” institutions represent about 12% of the high-energy physics university community—see page 4.

The respondents’ evaluations of student interest, as compared with five and ten years ago, are summarized in Table 8.

Table 9 and 10 provide summary estimates of projected new hires over the next three years, at all responding universities and at the 30 largest. These estimates project the needs for full-time faculty only. Tables 11 and 12 summarize hypothetical staffing priorities, again for all universities and for the 30 largest institutions. The question posed was, given sufficient additional support, what staff additions would be preferred—2 postdocs, 1 mechanical engineer, 1 electronics engineer, 1 software engineer, 1 postdoc and 1 technician, 2 technicians, or 4 grad students. Some respondents identified only their top two or three choices, in some cases because their university had no support infrastructure to make use of engineers or technicians.

Table 4: Number of Graduate Students by Year of Study—
Table 5: Number of Graduate Students by Year of Study at the 30 Largest Universities—
The distribution of graduate students between experiment and theory and the distribution by year are similar for the 30 largest institutions and the full sample of 99 universities. All told, experimentalists outnumber theory students by a ratio of about 3:2. Among students in their sixth year and above, the preponderance is even greater, about 2:1, perhaps because of the inevitably long time scale of some experiments. Also, in both samples, the number of third-year students is roughly 20% greater than the number of fourth- or fifth-year students.

Table 6: Doctorates Awarded—
Table 7: Doctorates Awarded at the 30 Largest Universities—
The distribution of recent Ph.D. awardees between experiment and theory is again similar for the 30 largest institutions and the full sample, and it parallels the distribution of current students, experimentalists outnumbering theorists by about 3:2. However, the average number of Ph.D.’s awarded in the last two years (a total of 200 per year at all 99 institutions, 128 at the 30 largest) appears to be significantly larger than the number of students currently pursuing doctorates (an average of 186 in the third, fourth, and fifth years of study at all institutions, 111 at the 30 largest).

Table 8: Student Interest—Responses reflect a clear perception of declining student interest in high-energy physics. A rearrangement and clarification of Table 8 follows:

Compared with 5 years ago	**Compared with 10 years ago** ++	+	±	–	– –	**Total**
Much higher (++)	1	0	0	0	0	16 (Much higher + Somewhat higher)
Somewhat higher (+)	2	7	4	2	0	
About the same (±)	1	2	15	13	0	31
Somewhat lower (–)	0	1	0	18	25	47 (Somewhat lower + Much lower)
Much lower (– –)	0	0	1	0	2	
Total	14 (++ and +)		20	60 (– and – –)		

Table 9: Projected New Hires—
Table 10: Projected New Hires at the 30 Largest Universities—
New faculty hires projected for the 30 largest universities and the full sample show similar distributions between experimentalists and theorists, with experimentalists slightly less dominant among the largest schools. The 30 largest institutions account for about 45% of the projected hires. The average number of expected new hires at all 99 universities (46 per year) would account for about one-quarter of the annual production of high-energy physics Ph.D.'s at the same institutions.

Table 11: Hiring Priorities—
Table 12: Hiring Priorities at the 30 Largest Universities—
The hiring preferences expressed by respondents from the largest universities showed no significant differences from those of the broader community. Two postdocs, one postdoc and one technician, and four graduate students were the top three choices in both cases. The four options involving only support personnel lagged significantly among the full group of respondents; among representatives of the largest institutions, one electronics engineer was nearly as attractive as four grad students.

CONCLUSIONS

Extent of Technical Support. As shown in Table 1 and Figure 1, engineers and technicians jointly constitute only 10% of the high-energy physics work force at

U.S. universities—and less than 9% of the effort, as measured by FTEs. On average, roughly four physicists (faculty and nonfaculty) must share the support of each full-time engineer or technician. (The distribution of this ratio is, however, a broad one. Even among the 30 largest universities, the number of physicists per engineer or technician ranges between 1.5 and 20. See Figure 12.) In a broader view of support, postdocs and graduate students, as well as engineers and technicians, might be considered part of the support infrastructure; in this case, each physicist is assisted by 1.7 supporting staff. Seen in a more realistic light, however, postdoctoral fellows and graduate students should probably be seen as part of the physics staff, in need of engineering and technical support.

On average, then, a tenfold preponderance of “physicists” over “support staff” appears to be the most accurate picture. When university representatives were asked to express their priorities for additional staff, however, the clear preference was more postdocs, not additional engineers or technicians (Table 11). An enhanced infrastructure of professional support is therefore not likely to emerge spontaneously from support for increased staff.

Apportionment of Future Resources. In particle physics, the next five years promise to be exciting times: CMS and ATLAS will be under construction at CERN, and BABAR will be commissioned at SLAC’s B Factory. Meanwhile, activity is expected to remain largely undiminished at Fermilab’s major experiments (see page 9). Significant decreases in effort can be expected only at LEP and CESR (and at AGS and SLD, which currently account for only 4.2% of the field’s effort). Table 2 reflects these likely trends, showing erosion (in terms of percentage) in fifteen of the listed research efforts to support increases in only eight. If these decreases in “market share” are not to be translated into fewer workers and diminished productivity at active facilities, additional physics staff will be needed, a demand that can be seen as contrary to a shift in priorities toward infrastructure support—especially in an environment of flat or modestly enhanced funding.

Production of Students and Availability of Jobs. Tables 4 and 6 suggest an annual production of almost 200 high-energy physics Ph.D.’s at the 99 responding universities (notwithstanding a possible slight downward trend in the past few years). An average of 46 openings in high-energy physics is expected at these same institutions over the next three years (Table 9). Also, these 99 universities reported a total of 470 postdoctoral fellows. If the average tenure of a postdoc is taken to be about five years, these figures suggest that about half of all graduate students find suitable postdoctoral positions, and that roughly half of these postdocs eventually find full-time positions in high-energy physics.

Extrapolated to the full set of 120 institutions, the broad picture is much the same. If we assume that the 99 responding universities represent 88% of the high-energy physics population (see page 4), about 52 university jobs are likely to become available nationwide each year, in contrast to an annual production of between 200 and 225 new Ph.D.'s. (Cornell was not included in the survey, as it was considered an "accelerator laboratory"; however, it produces about 10 high-energy physics Ph.D.'s each year. This does not materially change the estimate of 200–225 Ph.D.'s granted per year.)

Unsurveyed laboratories also offer additional opportunities for these students: Based on responses from Argonne, Berkeley, Brookhaven, Cornell, Fermilab, and SLAC, openings for an average of 13 full-time employees can be expected in each of the next three years. Therefore, about 65 full-time positions are likely to become available each year over the next few years, either at universities or national labs.

Table 1 - Personnel Summary

		Data						
Occupation	Speciality	**Total HEP Staff**	**DOE Grants**	**DOE xfers**	**POs**	**NSF grants**	**NSF xfers**	**Nonfederal**
Faculty Physicist	Accel Design	5.5	0.7	0.0	0.0	0.0	0.0	4.8
	Experiment	416.4	52.2	0.1	0.0	19.4	0.2	332.0
	Theory	351.5	34.7	0.0	0.0	17.3	0.0	293.9
Faculty Physicist Total		773.4	87.6	0.1	0.0	36.7	0.2	630.8
Graduate Student	Accel Design	19.0	17.0	0.0	2.0	0.0	0.0	0.0
	Experiment	523.0	325.4	2.3	3.0	93.9	1.0	74.1
	Theory	361.0	104.8	0.0	0.0	41.3	0.0	171.0
Graduate Student Total		903.0	447.2	2.3	5.0	135.2	1.0	245.1
Non Faculty Physicist	Accel Design	3.0	2.1	0.0	0.0	0.0	0.0	0.0
	Experiment	157.0	95.8	1.5	0.1	24.9	0.3	19.3
	Theory	10.0	3.1	0.5	0.0	0.0	0.0	6.4
Non Faculty Physicist Total		170.0	101.0	2.0	0.1	24.9	0.3	25.7
Post Doctoral Fellow	Accel Design	6.0	4.0	0.0	0.0	0.0	0.0	2.0
	Experiment	294.0	215.0	0.5	0.0	60.5	0.0	11.6
	Theory	170.3	89.0	0.0	0.0	33.6	0.0	45.7
Post Doctoral Fellow Total		470.3	308.0	0.5	0.0	94.1	0.0	59.3
Prof support staff	Computer Programmer	39.1	17.3	0.0	0.0	3.1	0.0	9.9
	Engineer - Electronic	67.0	33.2	6.1	4.6	7.4	0.0	6.2
	Engineer - Mechanical	36.0	14.1	1.7	2.0	2.6	2.5	3.0
	Technician - Electronic	53.0	20.1	5.8	0.8	3.5	1.0	8.1
	Technician - Mechanical	93.9	34.3	4.4	1.7	11.3	0.9	14.5
Prof support staff Total		289.0	118.9	18.0	9.1	27.9	4.3	41.6
Undergrad Student		254.5	41.2	4.0	3.6	15.0	1.2	12.7
Undergrad Student Total		254.5	41.2	4.0	3.6	15.0	1.2	12.7
Grand Total		2860.2	1103.9	26.8	17.7	333.9	7.0	1015.3

Figure 1 - Total Number of Staff

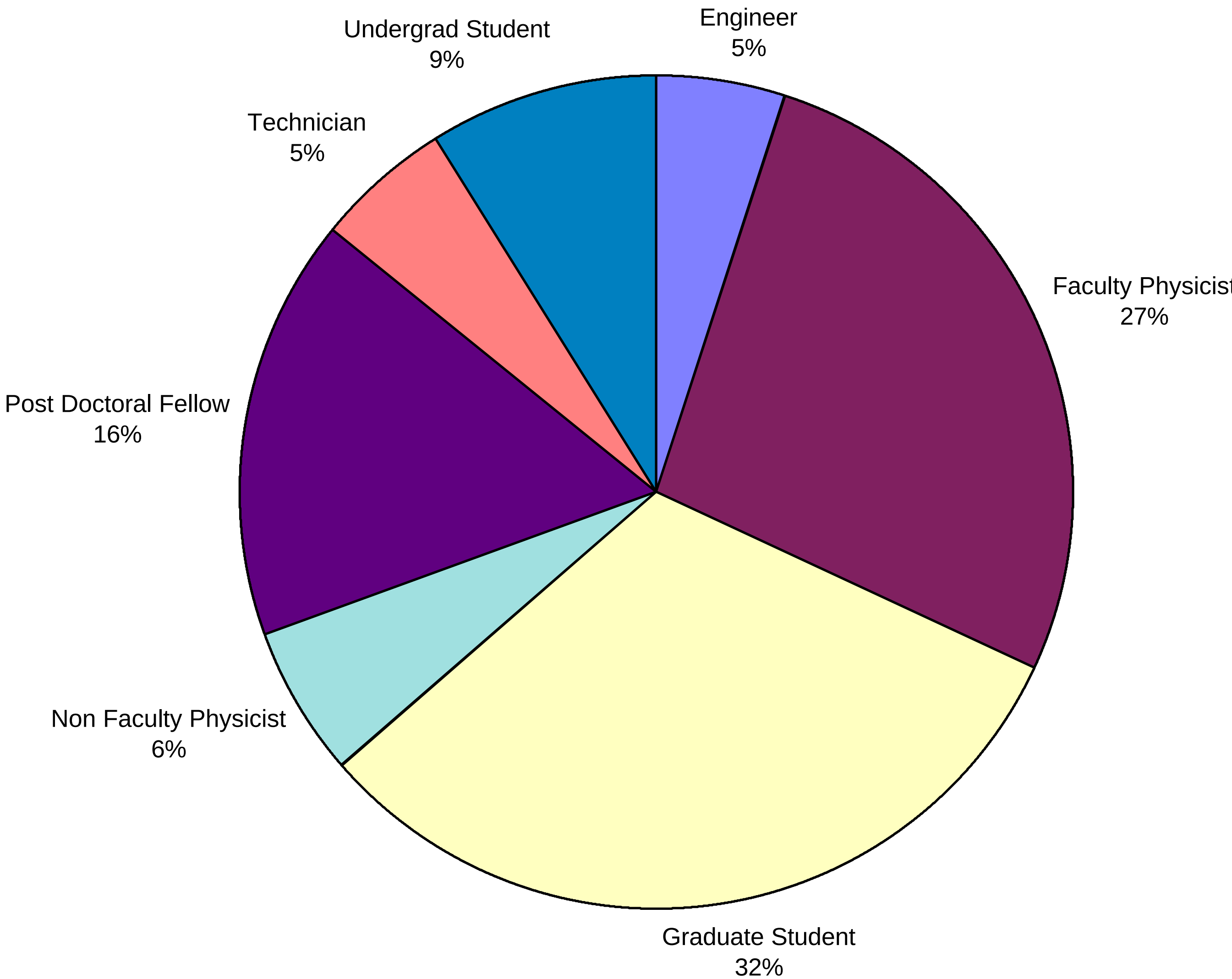
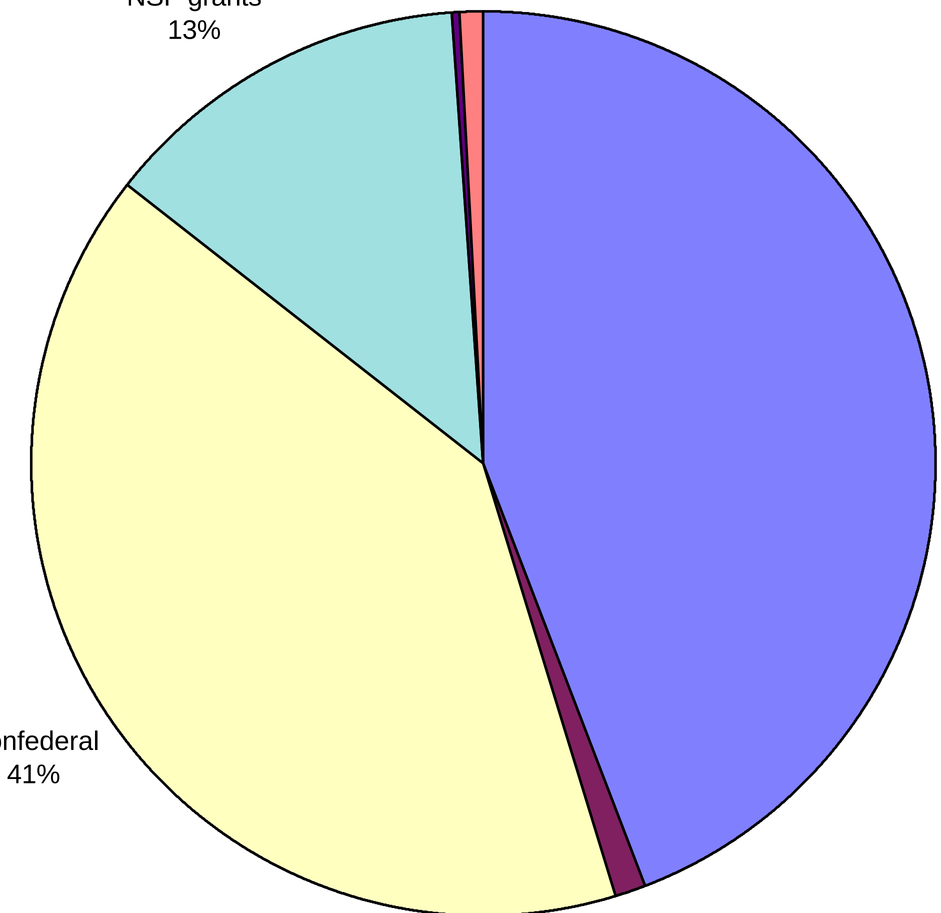


Figure 2 - Total Number of FTEs



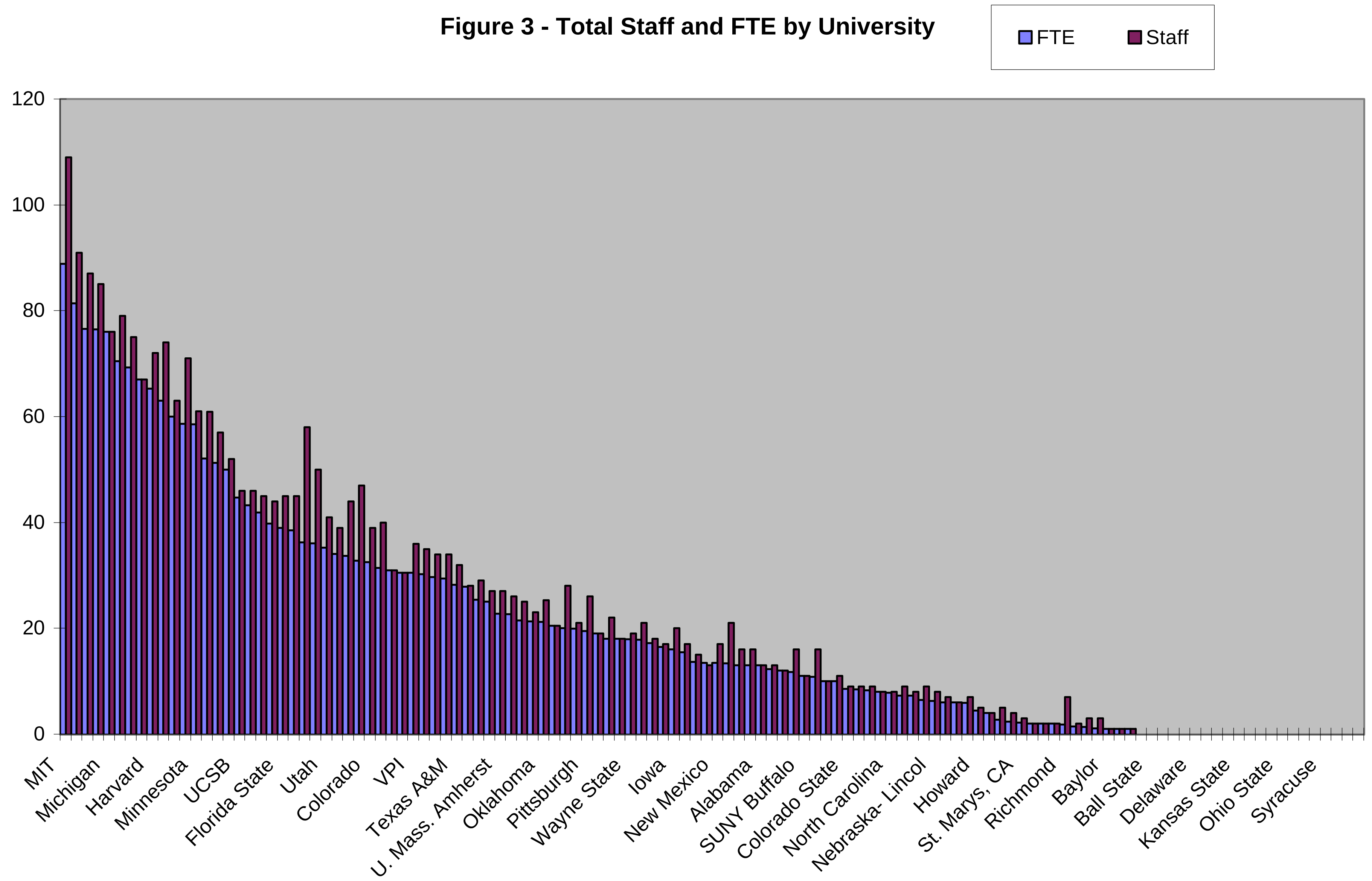


Figure 3 - Total Staff and FTE by University
FTE
Staff
120
100
80
60
40
20
0
MIT
Michigan
Harvard
Minnesota
UCSB
Florida State
Utah
Colorado
VPI
Texas A&M
U. Mass. Amherst
Oklahoma
Pittsburgh
Wayne State
Iowa
New Mexico
Alabama
SUNY Buffalo
Colorado State
North Carolina
Nebraska- Lincol
Howard
St. Marys, CA
Richmond
Baylor
Ball State
Delaware
Kansas State
Ohio State
Syracuse

Total Staff and FTE by University

SurveyId	University	NumberOfFTE	SumOfNumberOfStaff
691	MIT	88.82799998	109
767	Wisconsin	81.42999962	91
753	UCLA	76.60000007	87
721	Princeton	76.49999961	85
697	Michigan	76.00000058	76
659	Chicago	70.45000005	79
664	Columbia	69.27000016	75
656	Cal Tech	67.00000012	67.5
676	Harvard	65.24000013	72
683	Illinois	63.00000009	63
723	Purdue	62.99999985	72.29999995
726	Rochester	58.61000003	71
698	Minnesota	58.50000019	61
732	Stony Brook	57	57
684	Indiana	52	52
752	UC Irvine	51.26000008	57
755	UCSB	44.66999972	46
768	Yale	42.79000005	45.5
696	Michigan State	41.86700024	45
756	UC Santa Cruz	39.74999997	44
673	Florida State	38.95000017	45
718	Pennsylvania	38.5	45
653	Boston	36.24000002	58
745	Texas	36.06999989	50
758	Utah	35.20000032	41
685	Iowa State	34.03000009	39
763	Washington	32.73199974	47
663	Colorado	32.50000012	39
687	Johns Hopkins	31.86000022	34
655	Brown	31.37000005	40
766	William and Mary	31.00000036	31
657	Carnegie-Mellon	30.50000015	30.5
760	VPI	30.50000015	36
677	Hawaii	30.18999976	35
751	UC Davis	29.66999996	34
740	Stanford U.	29.44999996	34
754	UC Riverside	27.82999995	28
710	Northwestern	25.41999999	29
744	Texas A&M	25.25000016	32
709	Northeastern	25.00000003	27
693	U. Mass. Amherst	22.79000008	27
660	Cincinnati	22.66999997	26
761	Virginia	21.5	25
737	Southern Methodi	21.33000003	23
714	Oklahoma	21.22000004	25.29999995
711	Notre Dame	20.5	20.5
743	Tennessee	20.00000007	28

759	Vanderbilt	19.93000007	21
719	Pittsburgh	19.45999995	26
727	Rockefeller	19	19
749	Tufts	18.00000001	18
716	Oregon	17.99999997	18
764	Wayne State	17.98000021	19
689	Kansas	17.83000001	21
757	UC San Diego	17.23000003	18
704	New York U	16.5	17
686	Iowa	15.9875101	20
654	Brandeis	15.4999999	17
669	Duke	13.6499999	15
690	LSU	13.5000001	13
705	New Mexico	13.49999999	17
717	Penn State	13.33999995	21
747	Texas, Arlington	13	16
682	Illinois, Chicag	12.99999999	16
649	Alabama	12.99999997	13
681	Illinois Inst of	12.24999999	13
736	USC	12.00000019	12
708	Northern Illinoi	11.74999994	16
730	SUNY Buffalo	11.00000009	11
724	Rice	10.88000003	16
762	Washington U.	10.00000018	10
733	San Fran. State	9.99999997	11
671	Fairfield	9	9
662	Colorado State	8.580000013	9
679	Houston	8.499999985	9
735	South Carolina	8.25000006	9
703	City College	7.999999911	8
707	North Carolina	7.800000072	8
748	Texas Tech	7.300000012	9
695	Miami	7.24999994	8
702	Nebraska- Lincol	6.25	8
731	SUNY Binghamton	6	6
729	SUNY Albany	5.999999985	6
665	Connecticut	5.879999936	7
680	Howard	4.499999985	5
668	Drexel	3.99999997	4
713	OK State	2.759999961	5
701	Mt. Holyoke	2.329999983	4
739	St. Marys, CA	2.169999987	3
722	Puerto Rico	2.000000045	2
700	Missouri	1.99999997	2
734	South Alabama	1.98999995	2
725	Richmond	1.799999982	7
738	Southern U.	1.500220001	2
741	Swarthmore	1.329999998	3
670	Emory	1.120000012	3
652	Baylor	0.999999985	1
678	Hobart & Wm Smit	0.999999985	1

765	West Virginia	0.999999985	1
650	Arizona	0	0
651	Ball State	0	0
658	Case Western	0	0
661	Clemson	0	0
666	Dartmouth	0	0
667	Delaware	0	0
674	Florida	0	0
672	Florida A&M	0	0
675	Hampton	0	0
688	Kansas State	0	0
692	Maryland	0	0
699	Mississippi	0	0
706	Norfolk State	0	0
712	Ohio State	0	0
715	Old Dominion	0	0
720	Prairie View	0	0
728	Rutgers	0	0
742	Syracuse	0	0
746	Texas, Dallas	0	0
694	U. Mass.	0	0
750	UC Berkeley	0	0

Figure 4 - Faculty FTE by Specialty

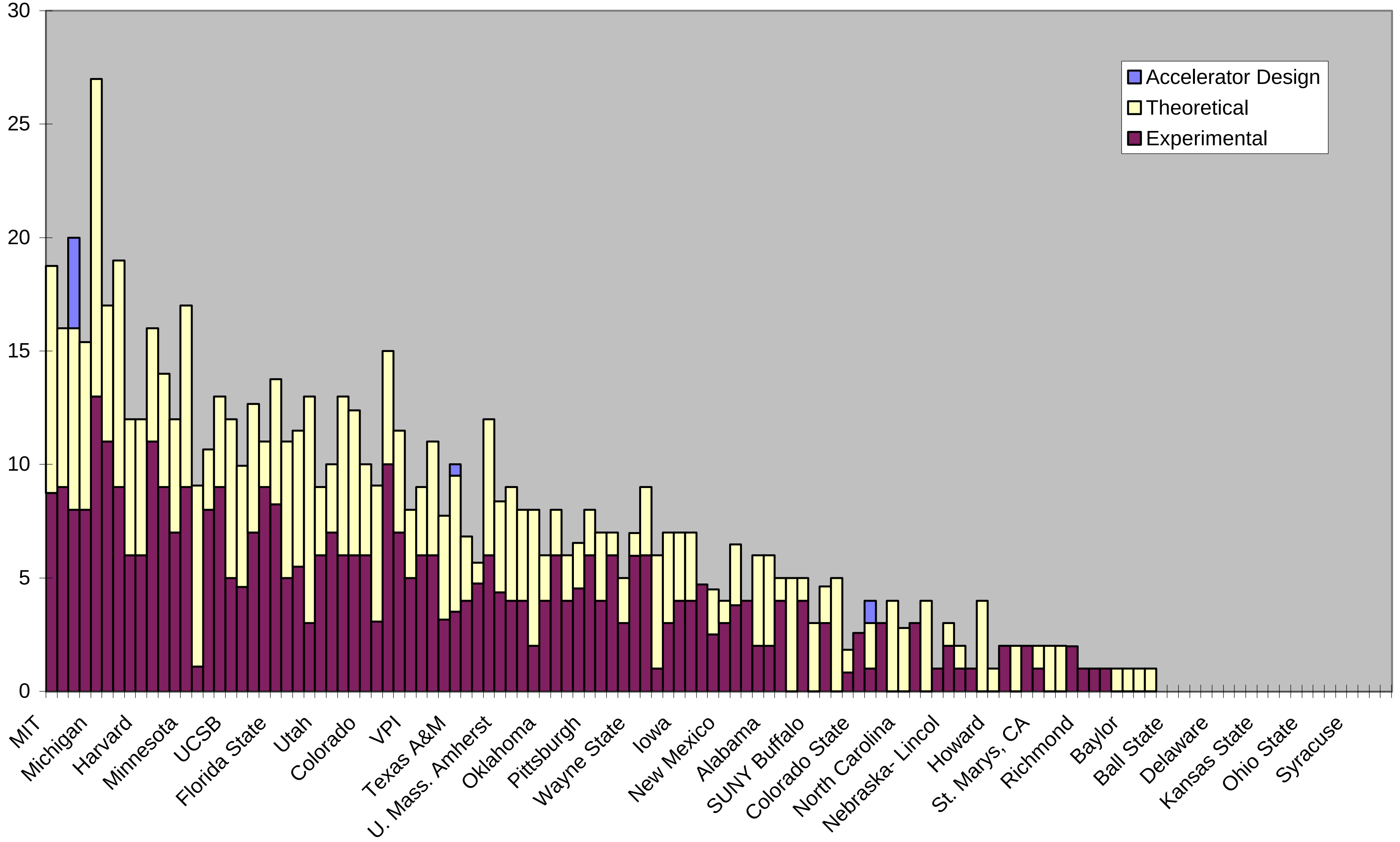


Figure 5 - Senior Physicist FTE by Specialty

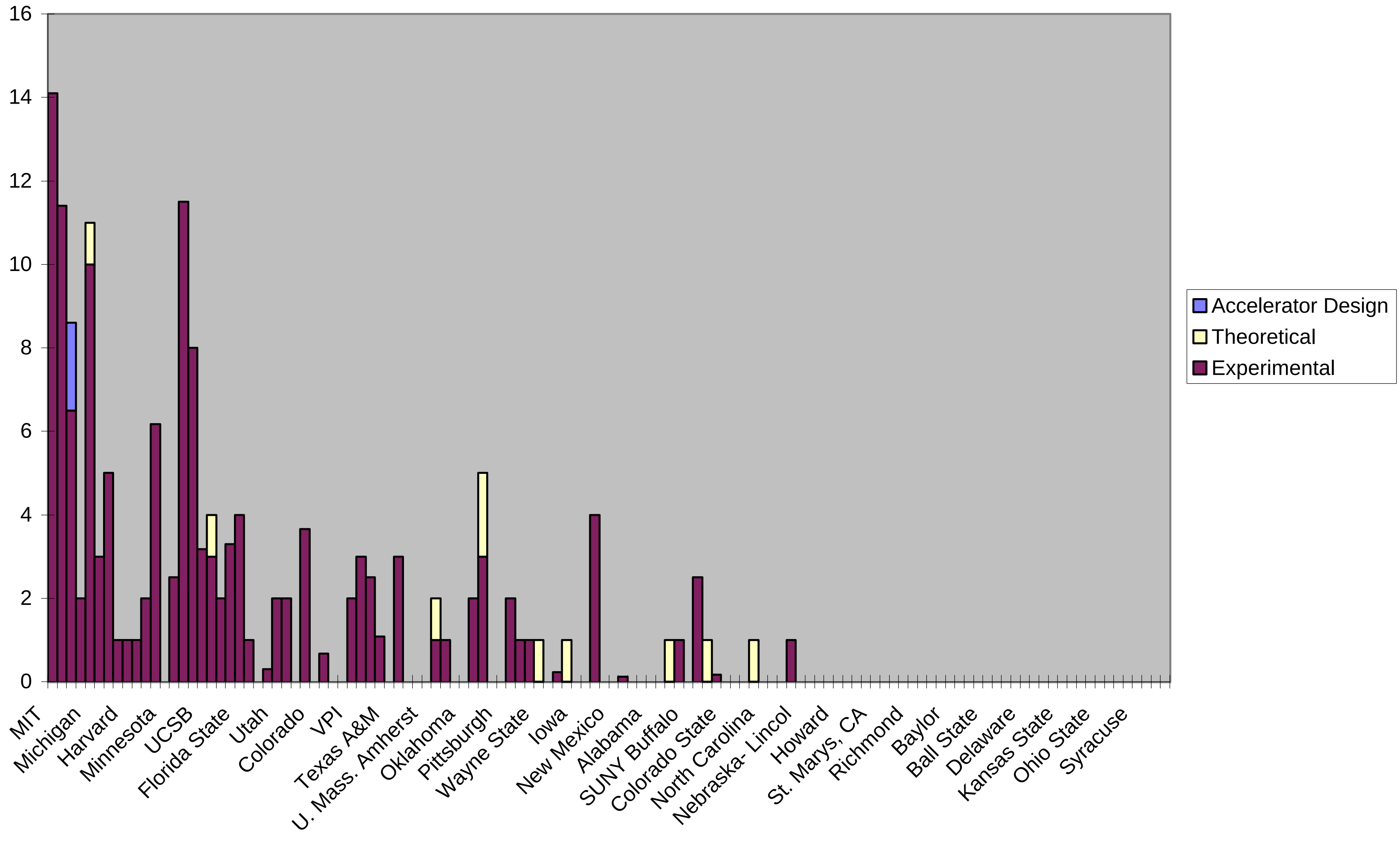
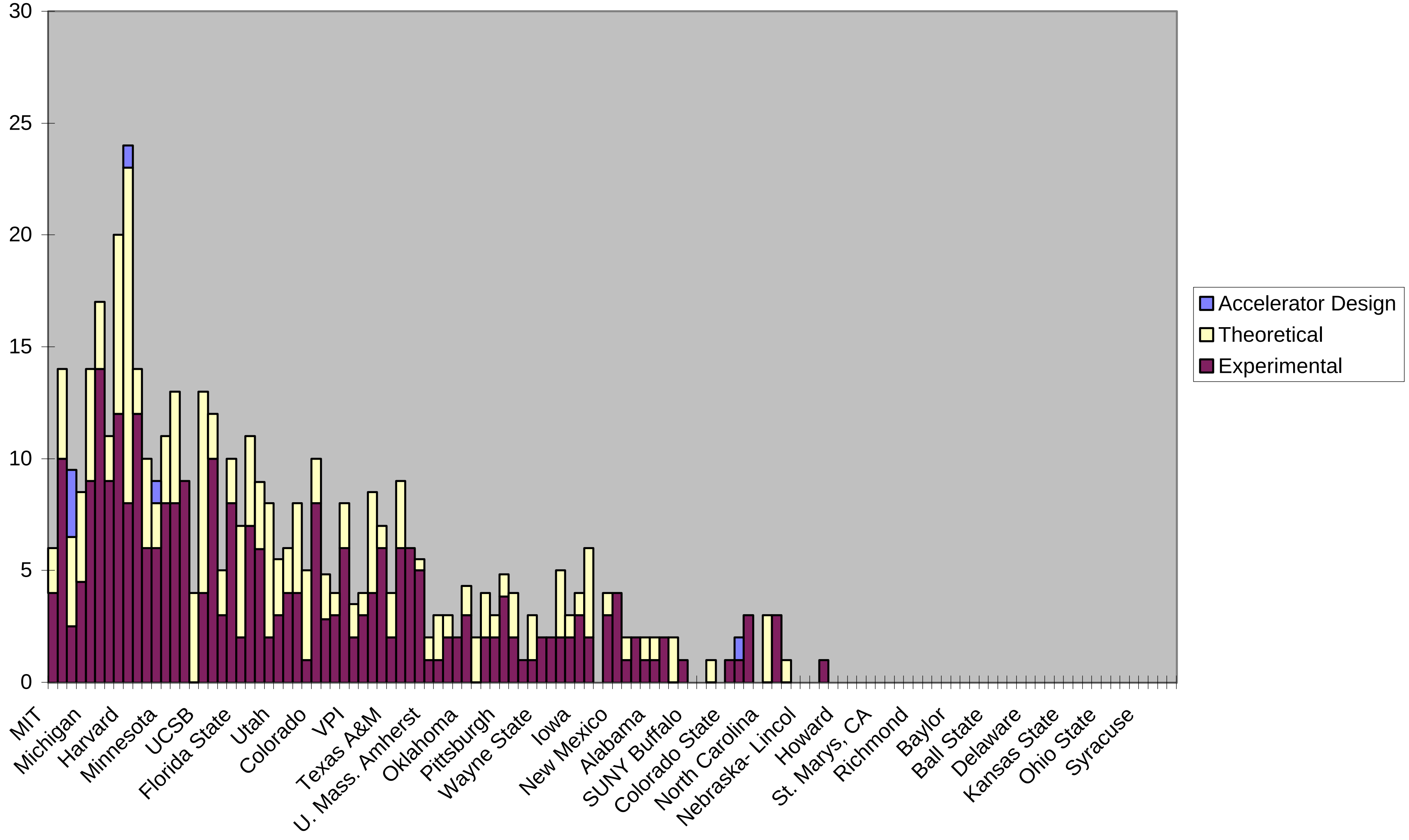


Figure 6 - Post Doctorate FTE by Specialty



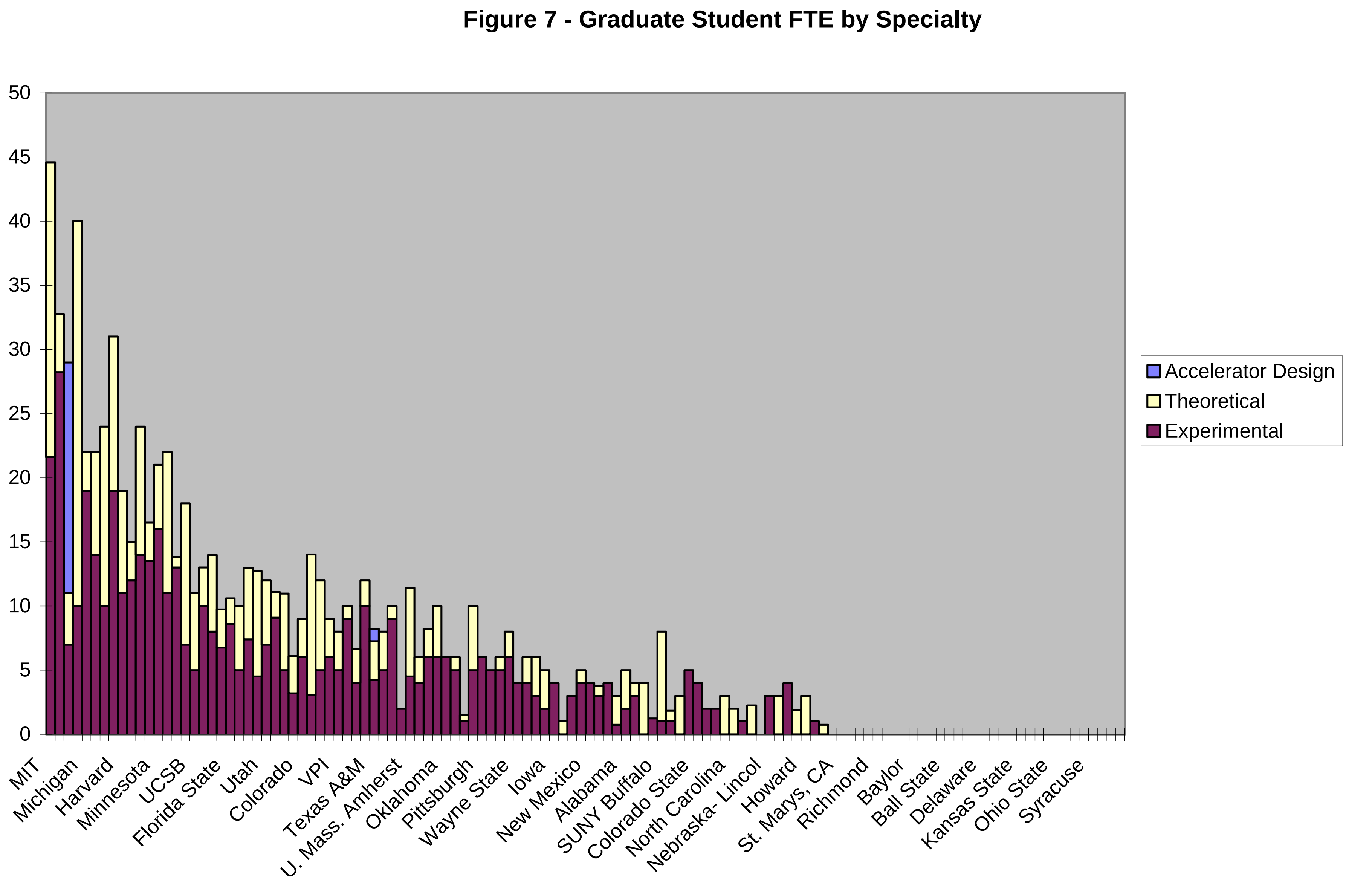


Figure 7 - Graduate Student FTE by Specialty
50
45
40
35
30
25
20
15
10
5
0
MIT
Michigan
Harvard
Minnesota
UCSB
Florida State
Utah
Colorado
VPI
Texas A&M
U. Mass. Amherst
Oklahoma
Pittsburgh
Wayne State
Iowa
New Mexico
Alabama
SUNY Buffalo
Colorado State
North Carolina
Nebraska- Lincol
Howard
St. Marys, CA
Richmond
Baylor
Ball State
Delaware
Kansas State
Ohio State
Syracuse
Accelerator Design
Theoretical
Experimental

Figure 8 - Undergraduate FTE

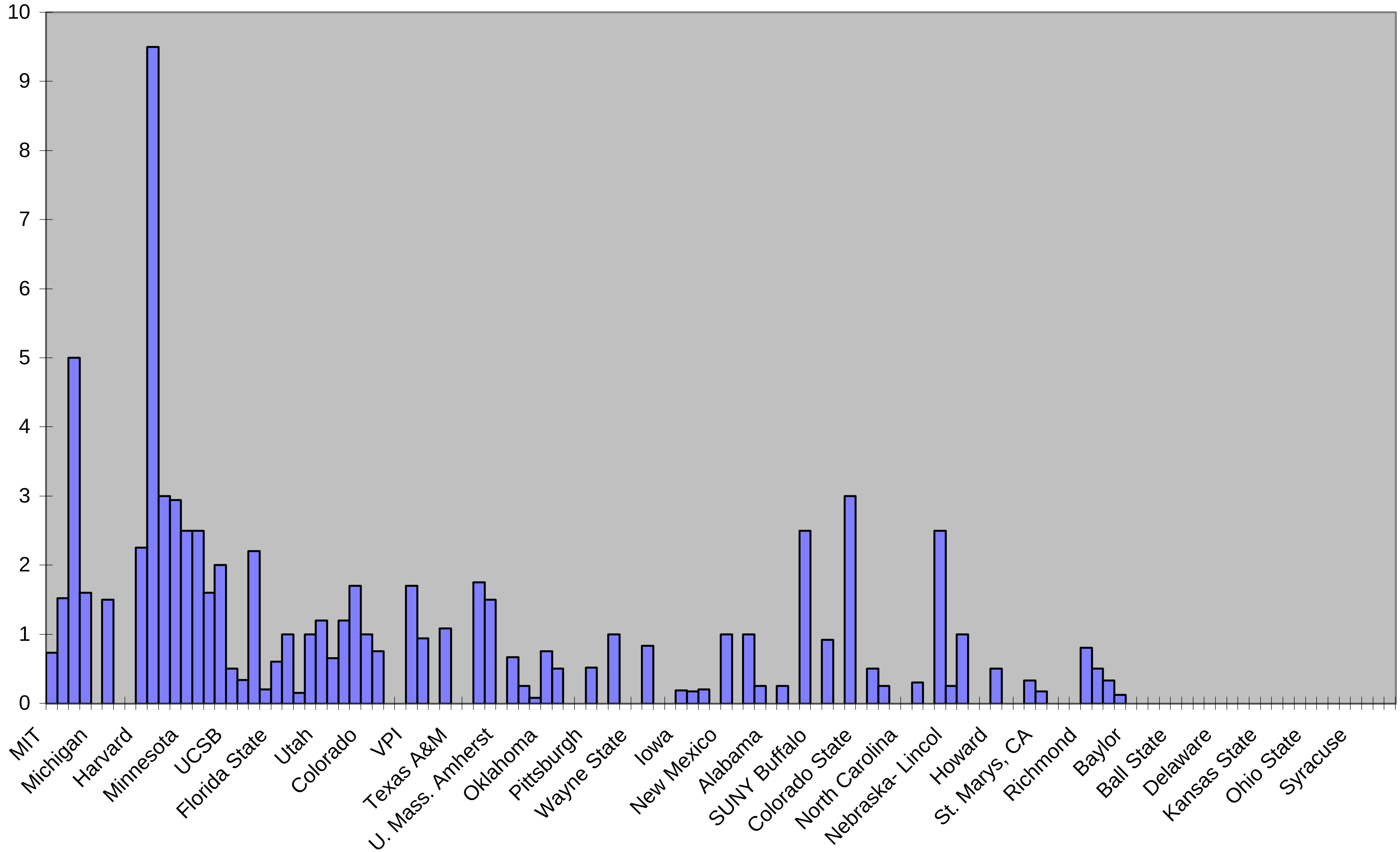


Figure 9 - Professional Support FTE

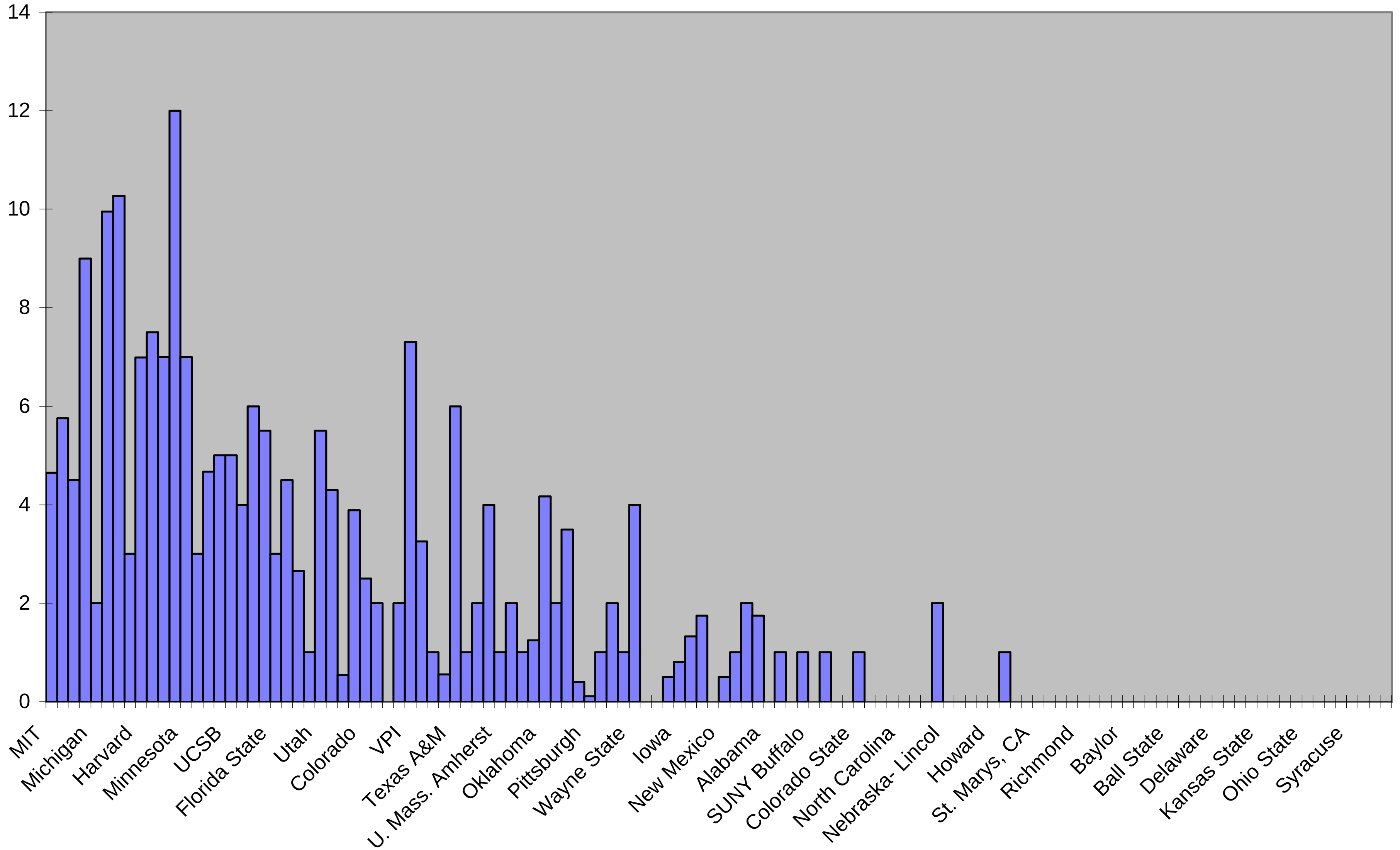


Figure 10 - Ratio of Postdoctoral FTEs to Physicist FTEs

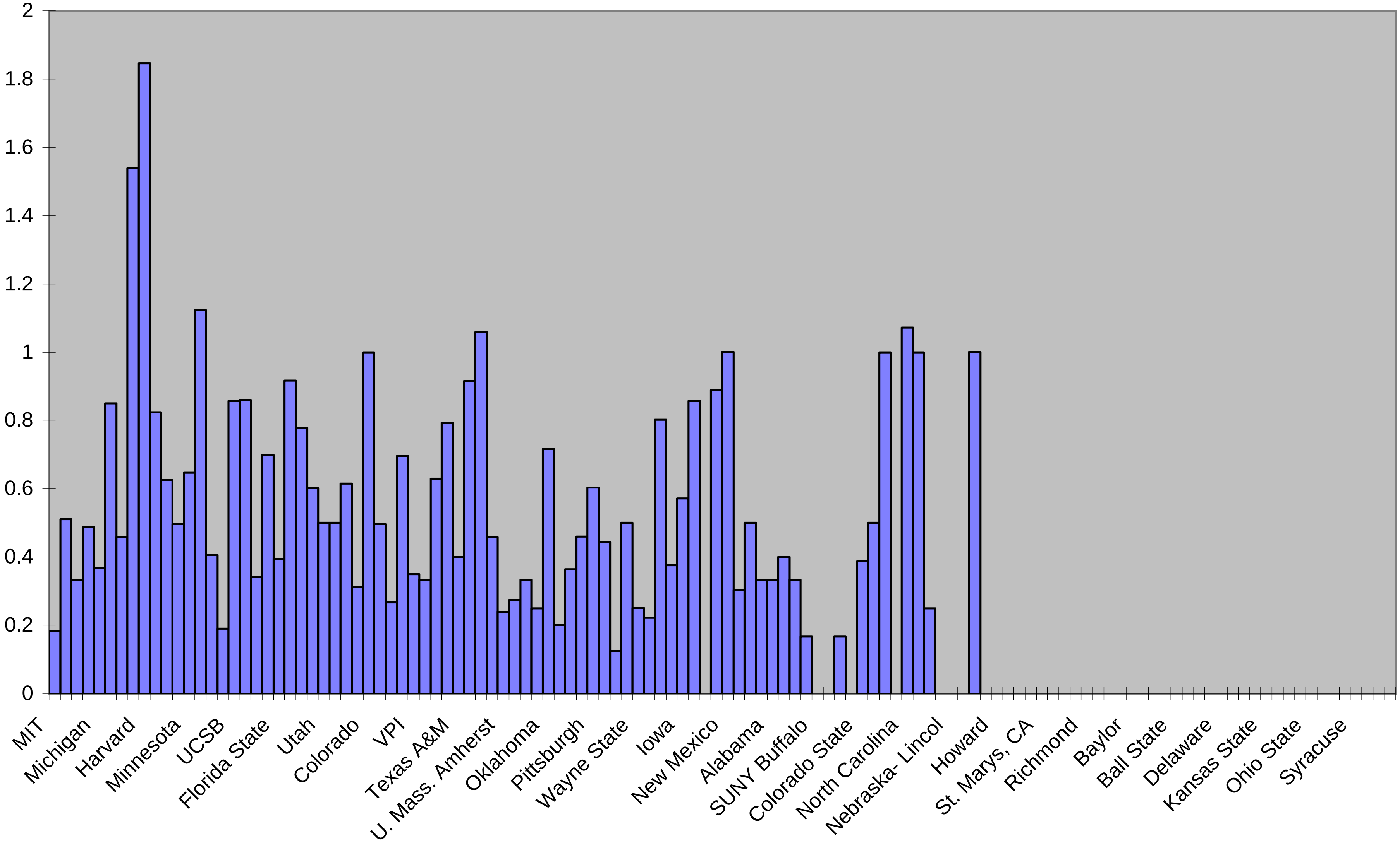


Figure 11 - Ratio of Student FTEs to Physicist FTEs

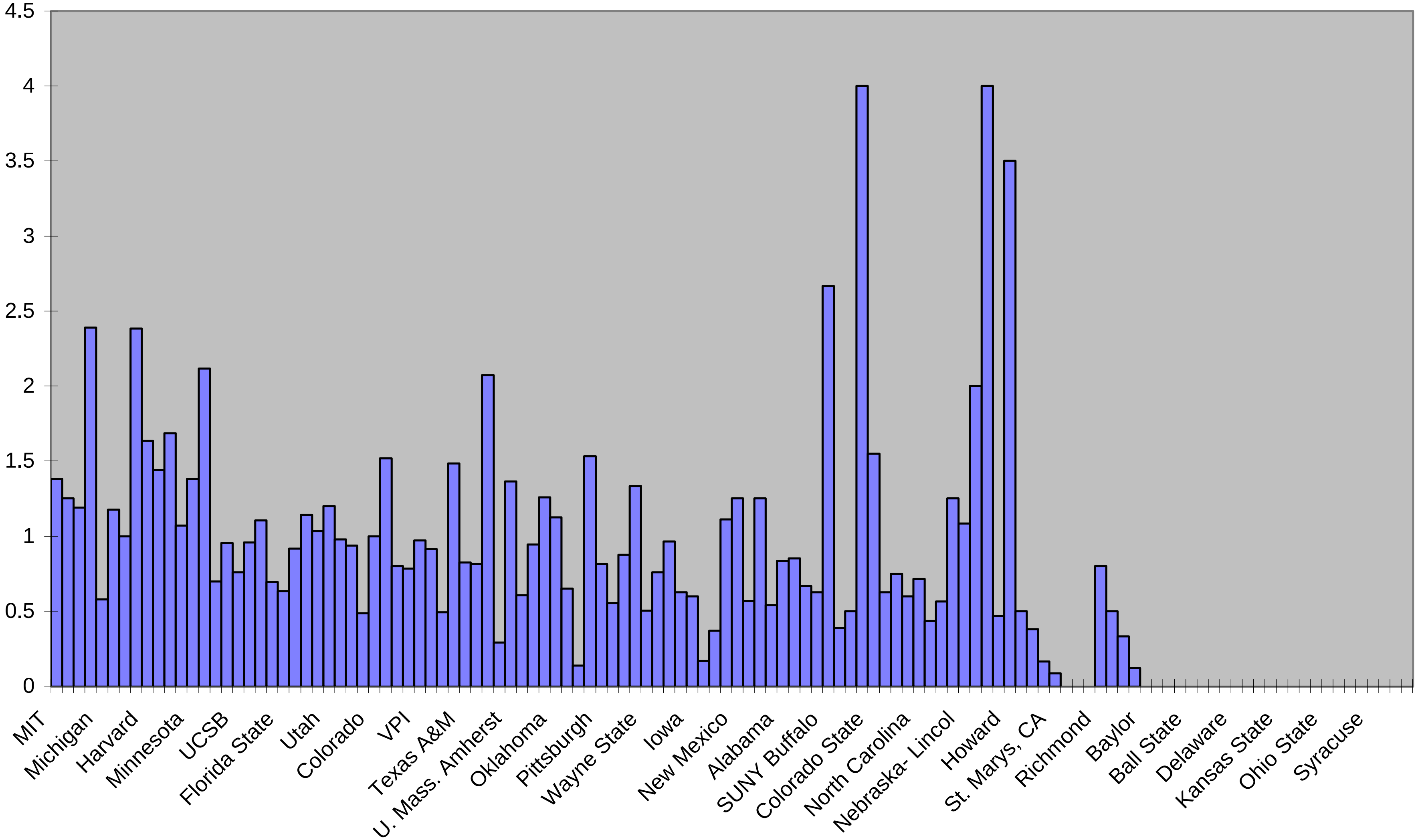


Figure 12 - Ratio of Support Staff FTEs to Physicist FTEs

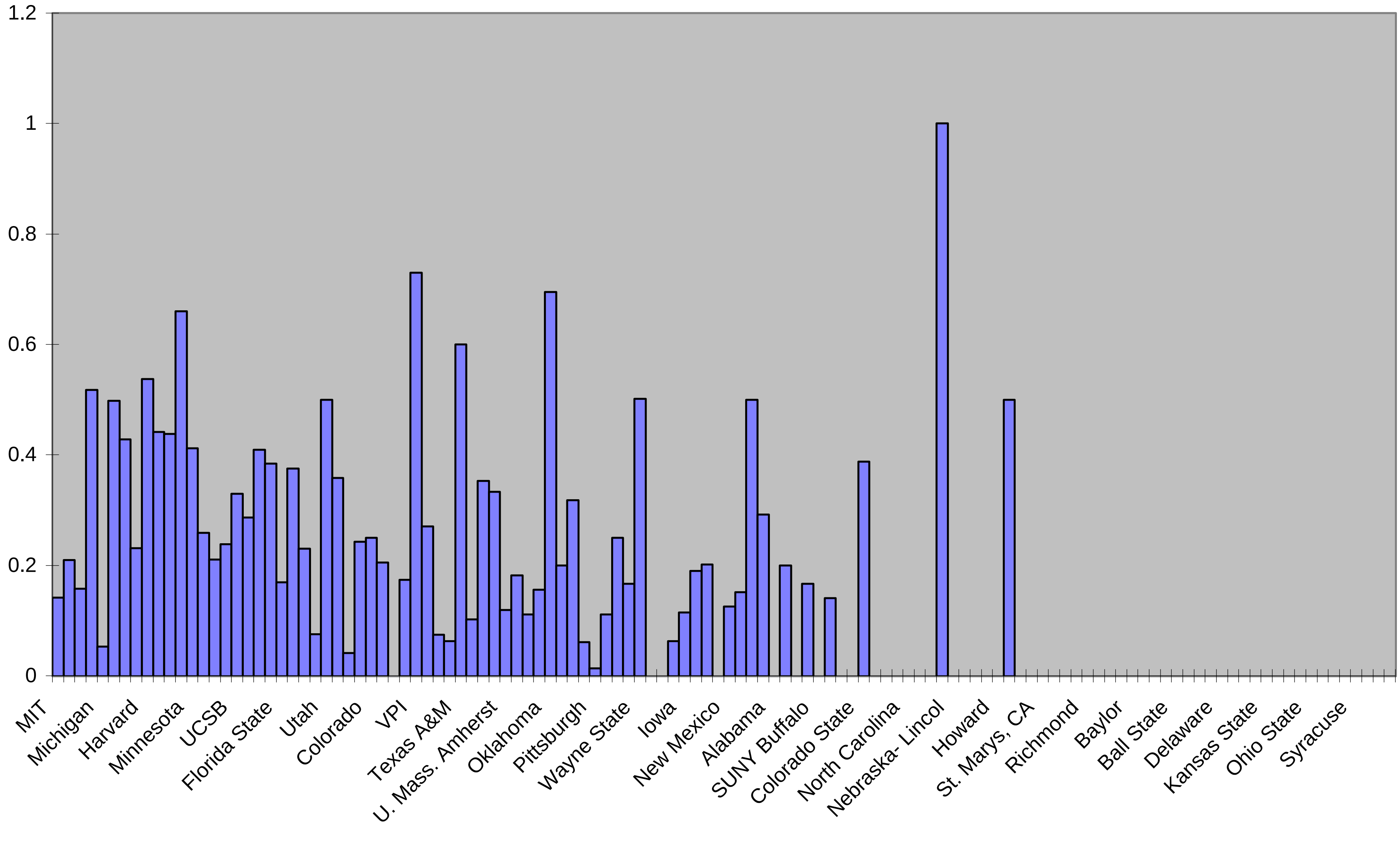


Figure 13 - Ratio of Senior Physicist FTEs to Faculty FTEs

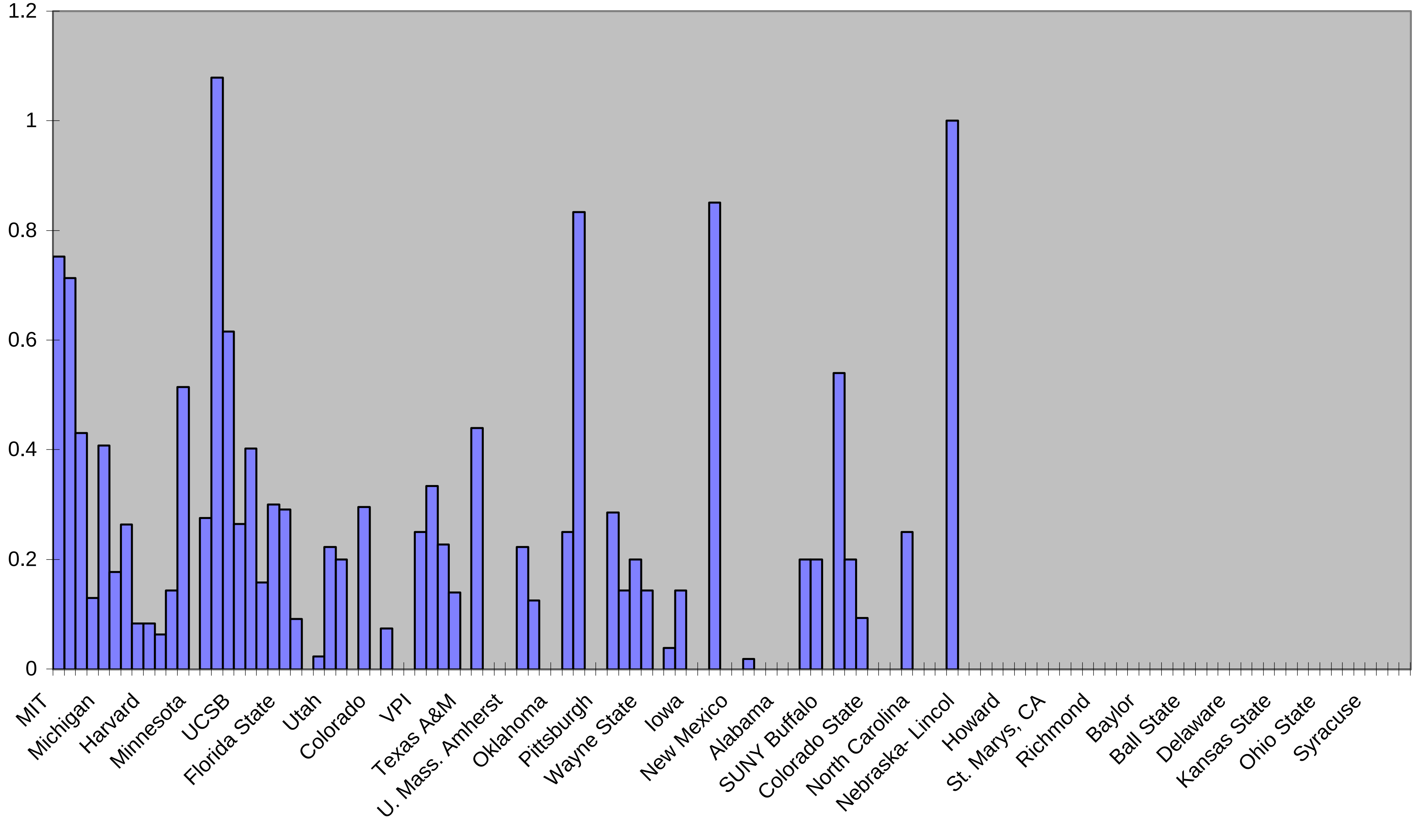


Table 2 - Apportionment of Current Effort

	Data	
ProjectName	**Current FTE**	**Projected FTE**
Accelerator R D/design	36.50	33.50
Brookhaven: AGS	46.65	23.77
CERN: ATLAS	54.84	133.44
CERN: CMS	48.40	135.85
CERN: LEP	95.86	22.47
CERN: Other	20.00	16.00
Cornell: CESR	131.22	84.00
DESY	54.30	38.40
Fermilab: CDF	170.22	158.64
Fermilab: D0	149.59	137.14
Fermilab: Fixed target exps	162.63	125.25
Field theory research	196.50	171.46
IHEP: BES	6.30	2.50
KEK: BELLE	15.30	28.60
Nonaccelerator experiments	204.04	213.37
Nonspecific expt research	13.60	13.00
Other non - US accelerators	14.50	6.50
Other theoretical research	41.76	37.63
Other US accelerators	11.60	23.90
Particle astrophysics theory	47.81	52.29
Phenomenology research	238.07	238.28
SLAC: BaBar	80.77	145.03
SLAC: Other	9.50	4.50
SLAC: SLD	38.18	0.00
String theory research	136.53	143.05
Grand Total	2024.65	1988.56

Table 3 - Apportionment of Current Effort at Top 30 Universities

	Data	
ProjectName	**Current FTE**	**Projected FTE**
Accelerator R D/design	33.00	31.00
Brookhaven: AGS	34.12	18.17
CERN: ATLAS	34.65	83.30
CERN: CMS	29.55	93.85
CERN: LEP	74.02	17.85
CERN: Other	16.00	6.00
Cornell: CESR	66.65	47.50
DESY	32.00	26.40
Fermilab: CDF	102.72	97.14
Fermilab: D0	87.85	82.10
Fermilab: Fixed target exps	92.25	93.50
Field theory research	116.52	96.08
IHEP: BES	5.00	2.00
KEK: BELLE	11.00	20.00
Nonaccelerator experiments	171.53	166.03
Nonspecific expt research	5.50	6.00
Other non - US accelerators	8.50	2.00
Other theoretical research	29.66	25.53
Other US accelerators	4.60	9.40
Particle astrophysics theory	32.68	34.71
Phenomenology research	154.48	156.10
SLAC: BaBar	53.70	87.70
SLAC: Other	8.00	1.00
SLAC: SLD	26.39	0.00
String theory research	87.84	86.75
Grand Total	1318.20	1290.11

Figure 14 - Mechanical Engineer Histogram

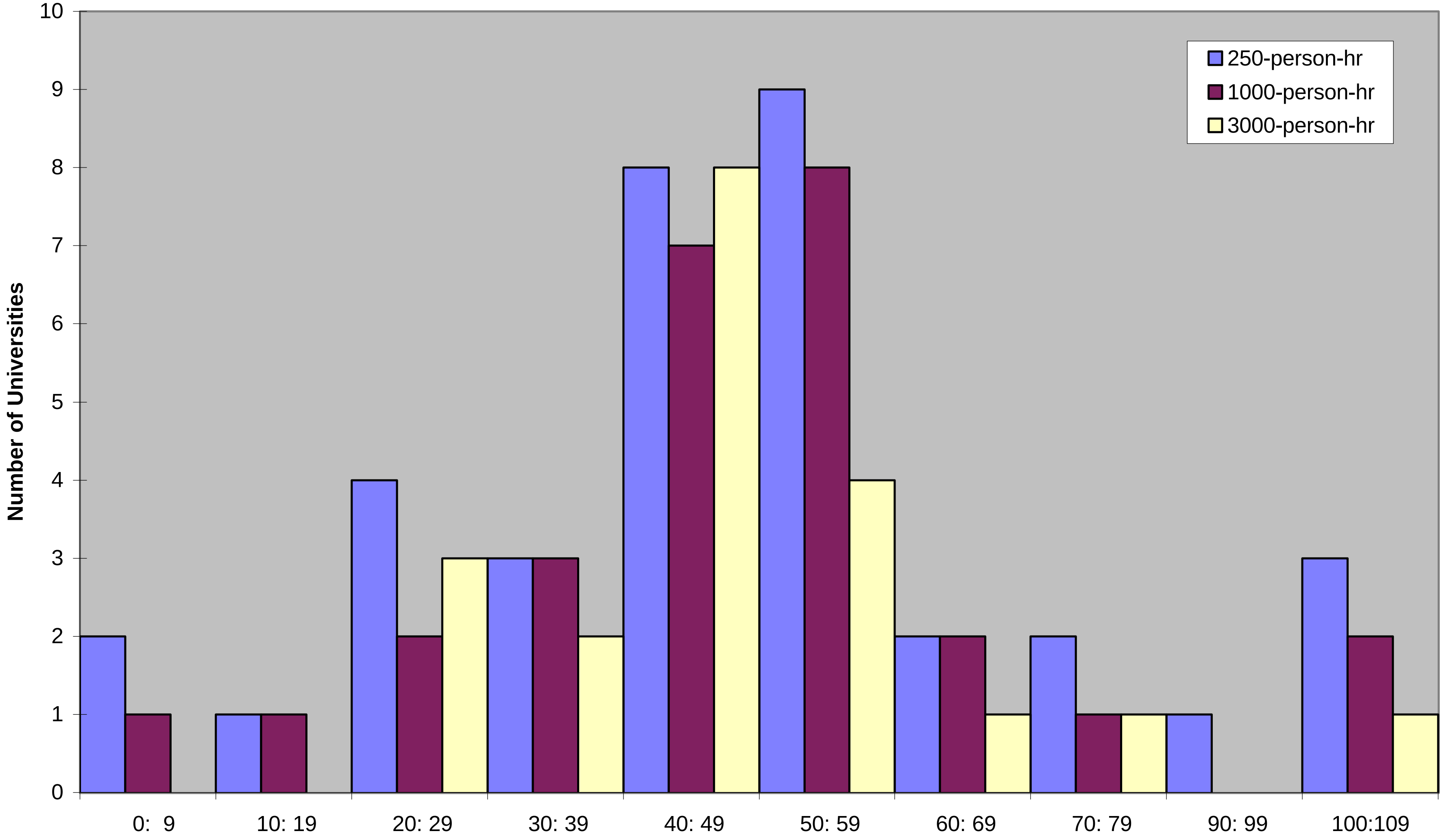
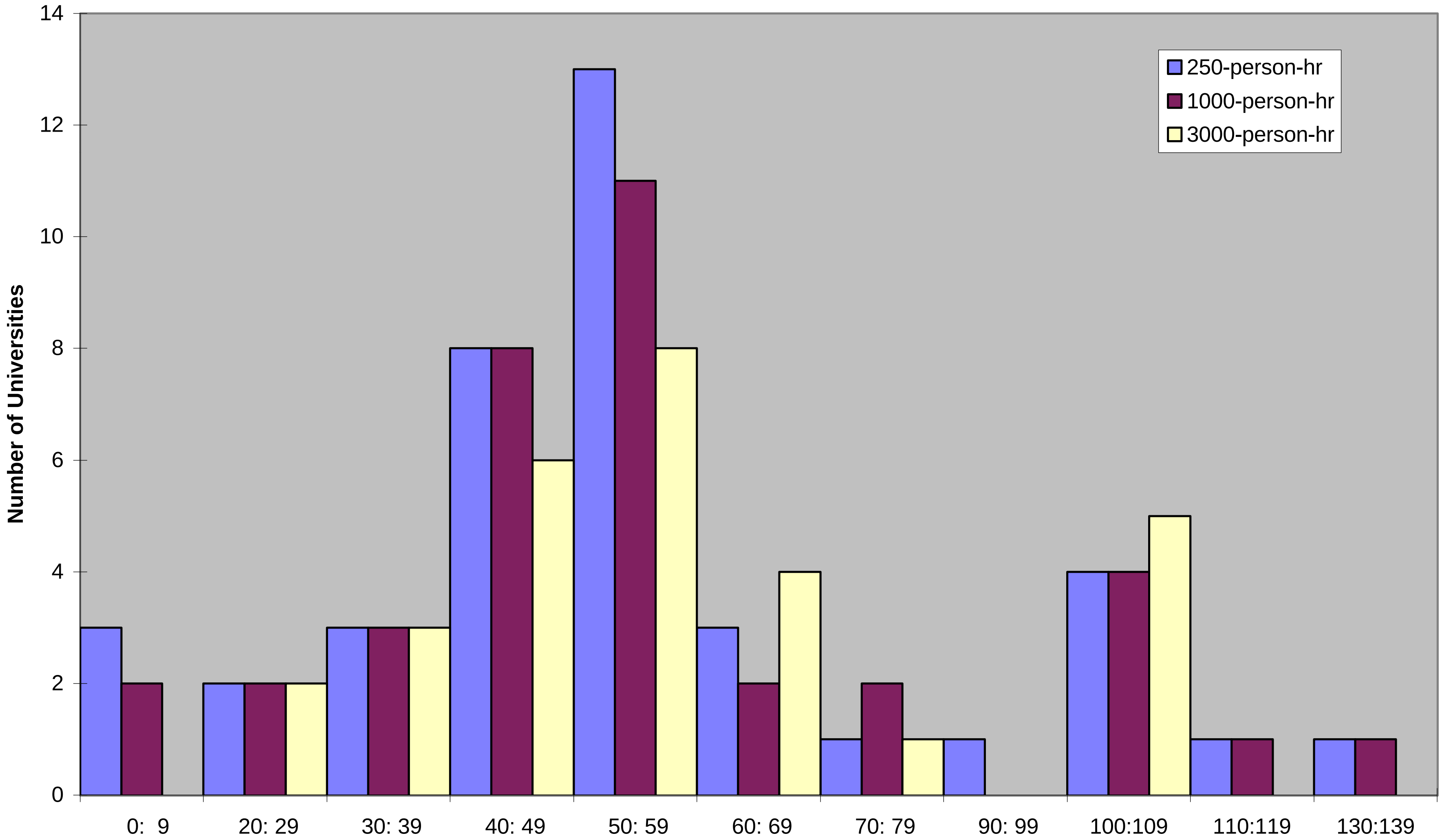


Figure 15 - Electrical Engineer Histogram



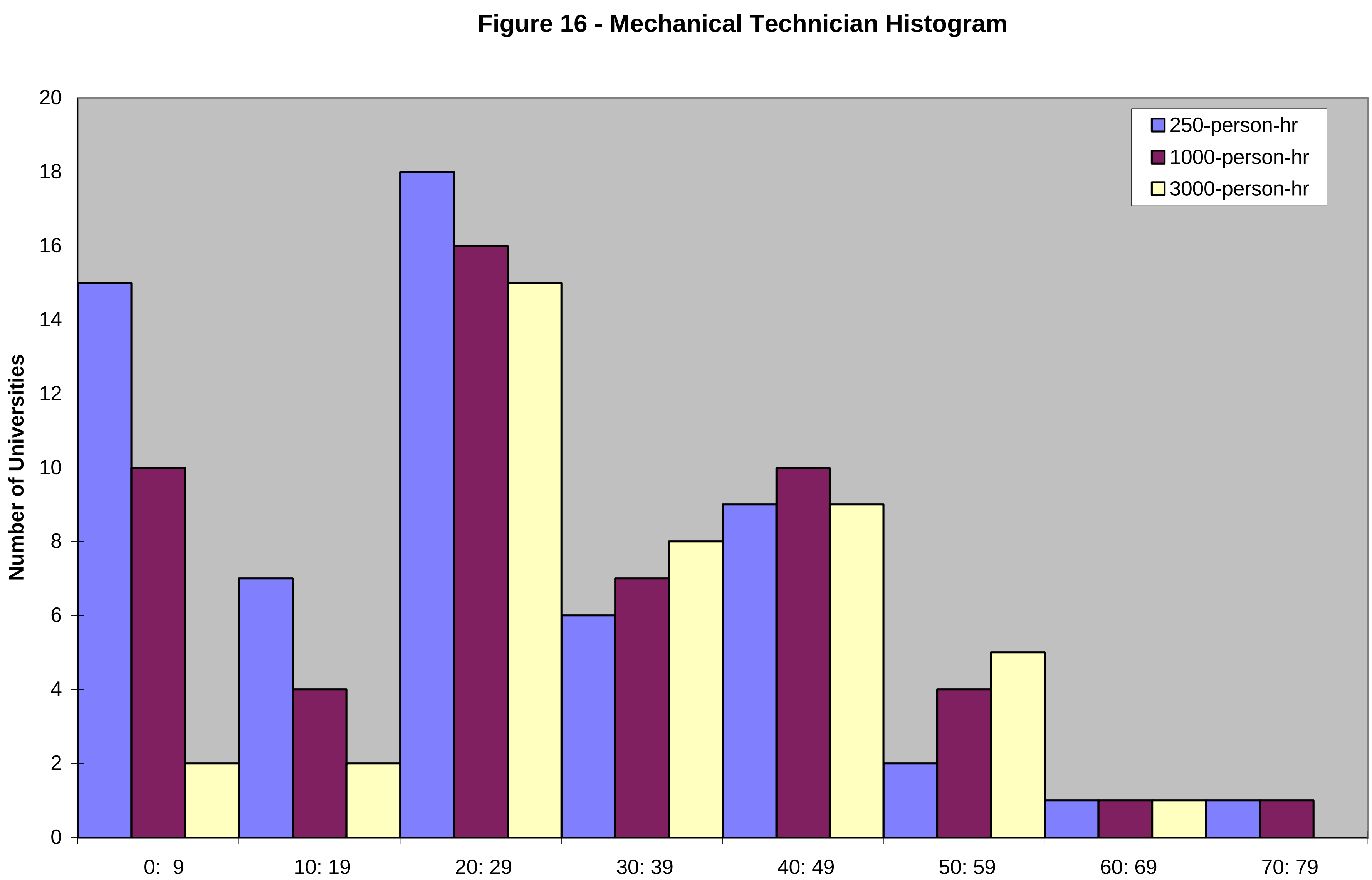


Figure 16 - Mechanical Technician Histogram
Number of Universities
20
18
16
14
12
10
8
6
4
2
0
0: 9
10: 19
20: 29
30: 39
40: 49
50: 59
60: 69
70: 79
250-person-hr
1000-person-hr
3000-person-hr

Figure 17 - Electronics Technicians Histogram

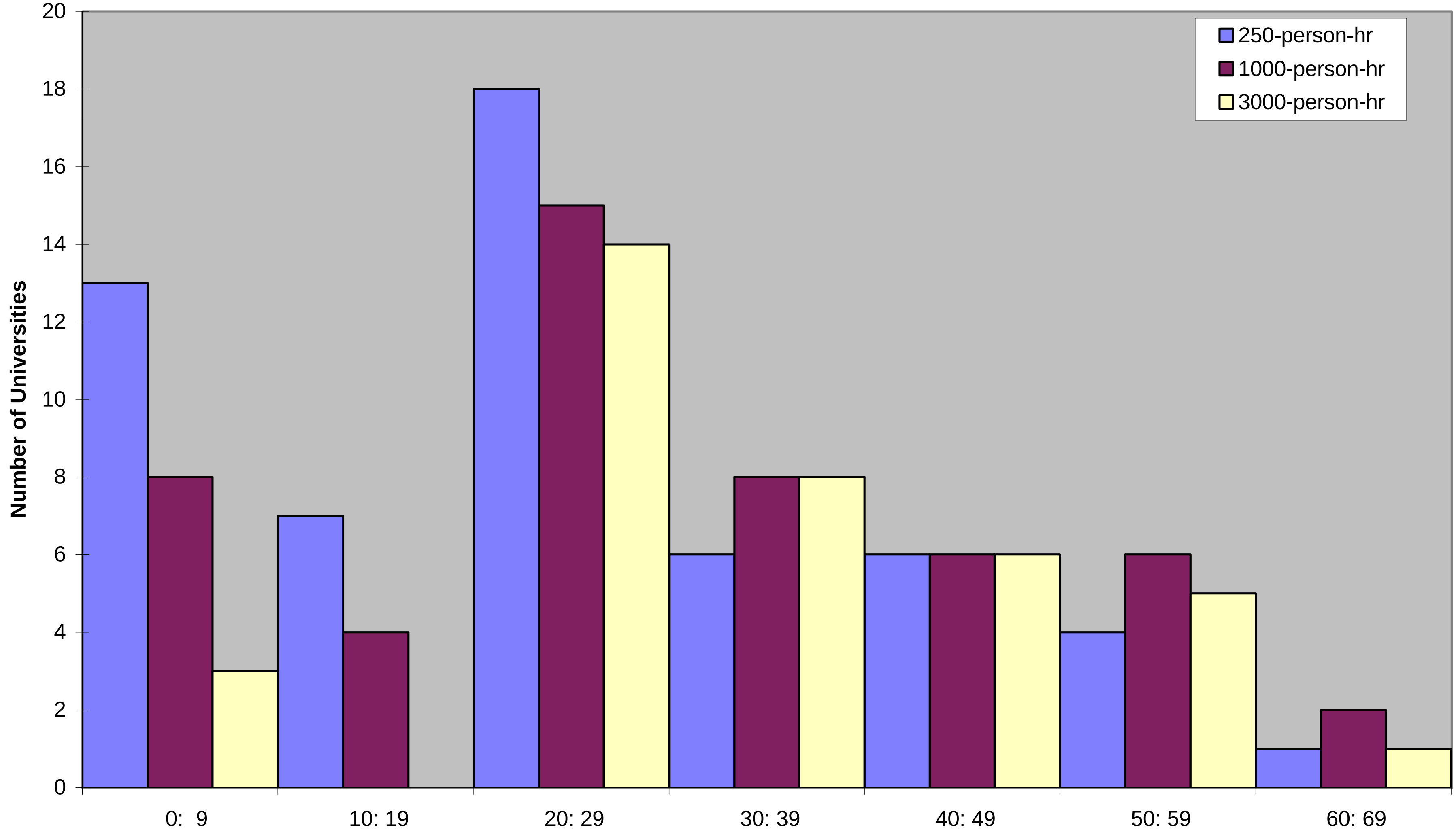


Table 4 - Number of High Energy Physics Graduate Students

	Data	
Year	**Experimental**	**Theoretical**
3rd year	125	90
4th year	92	73
5th year	107	72
6th year and above	102	48
Grand Total	426	283

Table 5 - Number of High Energy Physics Graduate Students
Top 30 Universities

	Data	
Year	**Experimental**	**Theoretical**
3rd year	79	42
4th year	62	44
5th year	58	49
6th year and above	71	35
Grand Total	270	170

Table 6 - Ph.D.'s in High-Energy Physics

	Data	
Year	**Experimental**	**Theoretical**
Phds awarded last year	124	68
Phds awarded this year (est)	121	88
Grand Total	245	156

Table 7 - Ph.D.'s in High-Energy Physics
Top 30 Universities

	Data	
Year	**Experimental**	**Theoretical**
Phds awarded last year	74	46
Phds awarded this year (est)	77	59
Grand Total	151	105

Table 8 - Student Interest in High-Energy Physics

	Data				
Level	Much Higher	Somewhat Higher	About the Same	Somewhat Lower	Much Lower
About the same	1	2	15	13	0
Much higher	1	0	0	0	0
Much lower	0	0	1	0	2
Somewhat higher	2	7	4	2	0
Somewhat lower	0	1	0	18	25
Grand Total	4	10	20	33	27

Table 9 - Projected New Hires

Projected Hires	
Speciality	Total
Accel Design	2
Experiment	86
Theory	51
Grand Total	139

Table 10 - Projected New Hires
Top 30 Universities

Projected Hires	
Speciality	Total
Accel Design	1
Experiment	36
Theory	25
Grand Total	62

Table 11 - Hiring Priority

HiringSlot	Data 0	1	2	3	4	5	6	7	Average
Four Graduate Students	0	14	21	24	15	4	3	7	3.13
One Elec Eng	0	8	9	9	11	16	15	8	4.25
One Mech Eng	0	2	6	6	3	10	25	22	5.38
One Post Doc & One Tech	0	23	20	21	11	3	1	0	2.42
One Software Eng	0	2	7	6	22	11	13	15	4.74
Two Post Docs	0	42	23	12	4	6	1	1	2.06
Two Techs	0	0	4	2	9	23	15	20	5.41
Grand Total	0	91	90	80	75	73	73	73	27.38

Table 12 - Hiring Priority
Top 30 Universities

	Data							
HiringSlot	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Average**
Four Graduate Students	3	5	7	6	2	3	2	3.57
One Elec Eng	4	4	4	6	5	3	2	3.75
One Mech Eng	0	4	3	1	4	7	9	5.21
One Post Doc & One Tech	7	5	10	3	2	1	0	2.68
One Software Eng	0	4	1	5	4	8	6	5.04
Two Post Docs	14	5	3	3	2	0	1	2.21
Two Techs	0	1	0	4	9	6	8	5.54
Grand Total	28	28	28	28	28	28	28	28.00

APPENDIX A

Survey of High-Energy Physics Support at U.S. Universities —The Questionnaire

SURVEY OF HIGH-ENERGY PHYSICS SUPPORT AT U.S. UNIVERSITIES

The High Energy Physics Advisory Panel advises both the Department of Energy and the National Science Foundation on the conduct of high-energy physics research. The following survey is an effort by HEPAP to assess trends in the funding and staffing of high-energy physics projects at U.S. universities, and in particular, the supporting technical and engineering infrastructure. We are asking you, as the correspondent for your institution, to provide information not only for projects in which you are involved, but also for other high-energy physics projects at your institution.

Please answer the questions as completely as you can, summarizing all high-energy physics efforts at your institution. Please write neatly. Again, you are the *only* person at your institution receiving this questionnaire.

For further information or clarification, please call Douglas Vaughan at Lawrence Berkeley National Laboratory, phone 510/486-5698, e-mail *gdvaughan@lbl.gov*.

Your name ______________________________

Institution ______________________________

Phone number ______________________________

E-mail address ______________________________

GENERAL INSTRUCTIONS: QUESTIONS 1 AND 2

The first two questions request information on the distribution of high-energy physics effort at your institution. Most of the answers are to be given in terms of *full-time equivalents*, or FTEs, where 1 FTE is equal to one calendar year's effort by a full-time staff member. Some examples follow.

Example 1

The following staff configuration is represented in the table entries below:

- 1 faculty theoretical physicist, supported for two months during the summer by an NSF grant (note that each full-time faculty should be counted as 1 FTE, regardless of the time spent teaching—in this example, time is therefore apportioned 2/12 NSF, 10/12 nonfederal)
- 2 faculty experimental physicists, both supported for two months during the summer by an NSF grant
- 1 retired faculty experimental physicist, supported one-quarter time by an NSF grant (note that retired faculty are shown as "other senior physicists")
- 1 nonfaculty accelerator physicist, supported one-half time by DOE base funding

		No. of high energy physics FTEs supported by					
	No. of HEP staff	**DOE grants**	**DOE xfers**	**POs**	**NSF grants**	**NSF xfers**	**Non-federal**
Faculty physicists							
Theoretical	1				0.17		0.83
Experimental	2				0.33		1.67
Accelerator design							
Other senior physicists							
Theoretical							
Experimental	1				0.25		
Accelerator design	1	0.50					

Example 2

A second example:

- 3 grad students (2 theoretical, 1 experimental), supported full-time by NSF grants
- 1 grad student (experimental), supported by the institution for four months as a teaching assistant, the rest of the time by a DOE grant (note that, for grad students, the time spent teaching does not appear in the survey)
- 2 undergraduate students, each supported one-quarter time for nine months by a DOE grant (note that each therefore counts as 0.25×0.75 FTE)

		No. of high energy physics FTEs supported by					
	No. of HEP staff	**DOE grants**	**DOE xfers**	**POs**	**NSF grants**	**NSF xfers**	**Non-federal**
Graduate students							
Theoretical	2				2.00		
Experimental	2	0.67			1.00		
Accelerator design							
Undergrad students	2	0.38					

Example 3

- 1 mechanical engineer, supported for three months by a DOE grant
- 2 electronics engineers, each supported full-time by a purchase order from Fermilab for work on CDF
- 2 electronics engineers, each supported for six months by the transfer of DOE funds from SLAC for BABAR support
- 4 electronics technicians, supported for a total of six person-months of effort by a DOE grant

Prof support staff							
Mech engineers	1	0.25					
Elec engineers	4		1.00	2.00			
Computer pgmmers							
Mech techs / machnsts							
Elec technicians	4	0.50					
Other (pls specify) ________							

Questions 1 and 2 follow

1. ***Personnel Engaged in High-Energy Physics Research***

- Please provide for your institution a breakdown of the **staff engaged in all facets of high-energy physics research** during fiscal 1997 (Oct 1996–Sep 1997). Indicate the total number of staff, as well as the number of full-time equivalents supported by
  i. DOE High Energy Physics grants (base funding)
  ii. The transfer of DOE funds from other institutions (usually DOE national labs), typically earmarked for detector work
  iii. Purchase orders from national labs to build equipment
  iv. NSF grants (exclude the amount of any funds transferred to another institution)
  v. The transfer of NSF funds from other universities
  vi. Nonfederal sources of support, including state and university funds

  One FTE reflects one calendar year's effort by a full-time staff member; compute each full-time faculty member as 1 FTE, regardless of nonresearch teaching responsibilities.

		No. of high-energy physics FTEs supported by					
	No. of HEP staff	**DOE grants**	**DOE xfers**	**POs**	**NSF grants**	**NSF xfers**	**Non-federal**
Faculty physicists							
Theoretical							
Experimental							
Accelerator design							
Other senior physicists							
Theoretical							
Experimental							
Accelerator design							
Postdoctoral fellows							
Theoretical							
Experimental							
Accelerator design							
Graduate students							
Theoretical							
Experimental							
Accelerator design							
Undergrad students							
Prof support staff							
Mech engineers							
Elec engineers							
Computer pgmmers							
Mech techs / machnsts							
Elec technicians							
Other (pls specify) ____________							

2. Apportionment of Current Effort

- In the current fiscal year, **how is the total effort of high-energy physicists (faculty and other senior physicists, postdocs, and grad students) at your institution apportioned** among the field's major projects? How do you foresee effort being apportioned in the year 2002, assuming a constant level of effort over the next five years? Please indicate levels of effort in full-time equivalents.

	No. of FTEs (physicists only)	
	Current	**Projected 2002**
Specific experiments		
Brookhaven—AGS		
Cornell—CESR		
Fermilab—CDF		
—D0		
—Fixed-target expts		
SLAC—BABAR		
—SLD		
—Other		
Other U.S. accelerators		
CERN—LEP		
—ATLAS		
—CMS		
—Other		
DESY		
KEK—BELLE		
IHEP—BES		
Other non-U.S. accelerators		
Nonaccelerator expts		
Nonspecific experimental research		
Accelerator R&D / design		
Theoretical research		
String theory		
Field theory		
Phenomenology		
Particle astrophysics theory		
Other theory		
Other		
______________________		
______________________		
______________________		

GENERAL INSTRUCTIONS: QUESTION 3

Question 3 seeks to identify some of the important resources at your institution, together with the costs of using those resources. In answering the first part of the question, provide reasonable detail about current capabilities and facilities (including, for example, design expertise, unique experience in detector fabrication, state-of-the-art shop facilities, etc.).

In the final part of the question, provide the fully burdened cost to federal agencies for projects (of the three indicated sizes) done by engineers and technicians.

Example

The following situation is reflected in the table entries below:

- First $50,000 of effort by mechanical engineers (500 hours) or mechanical technicians (667 hours) fully subsidized by the university (no cost to DOE or NSF)
- 1 electronics engineer fully supported (1840 hours) by a DOE grant (base funding)
- Additional engineering effort charged to specific projects at $100/hr; additional technical support charged at $75/hr

	Hourly cost for a project requiring an annual expenditure of effort equal to		
	250 person-hrs	**1000 person-hrs**	**3000 person-hrs**
Mechanical engineers	$0	$50	$83
Electronics engineers	100	100	100
Mechanical technicians	0	25	58
Electronics technicians	75	75	75

Note that the cost of electronics engineering is $100/hr, regardless of whether support comes from base funding or a specific project. For mechanical engineers and mechanical technicians, the hours costs vary with the size of the project, owing to the university subsidy. For example, the hourly cost for a 3000-hour effort by mechanical engineers is

$$(3000 - 500) \times \$100 \ / \ 3000 = \$83$$

Questions 3 and 4 follow

3. Current Engineering and Technical Capabilities and Costs

- Briefly summarize the **most important technical capabilities** and facilities at your institution.

  ____

  ____

  ____

  ____

- Briefly describe the high-energy physics **equipment now being constructed or assembled** at your institution. How is the engineering and technical effort being paid for?

  ____

- What are the **most significant high-energy physics construction or assembly projects** your institution has completed in the past five years? Do you still have the capabilities to undertake such tasks?

  ____

  ____

- What are the **<u>approximate</u> fully burdened hourly costs** to DOE or NSF for high-energy physics jobs undertaken by engineers or technicians at your institution? For each box, assume a single job, to be completed within one year by the indicated engineers or technicians. If such a job is too large for your institution, so indicate with an "×" in the corresponding box.

	Hourly cost for a project requiring an annual expenditure of effort equal to		
	250 person-hrs	**1000 person-hrs**	**3000 person-hrs**
Mechanical engineers			
Electronics engineers			
Mechanical technicians			
Electronics technicians			

4. Demographics

- Please indicate the **number of high-energy physics graduate students** currently enrolled at your institution (regardless of source of support), by current year of study.

	No. of grad students	
	Experiment	**Theory**
3rd year		
4th year		
5th year		
6th year and above		

- How many students received **Ph.D.'s in high-energy physics** last year? How many to you expect to receive them this year?

	No. of Ph.D.'s awarded	
	Experiment	**Theory**
Last year		
This year (est)		

- Indicate your general impression of **student interest in high-energy physics**, as compared with five and ten years ago.

Compared with five years ago:

❍ Much higher
❍ Somewhat higher
❍ About the same
❍ Somewhat lower
❍ Much lower

Compared with ten years ago:

❍ Much higher
❍ Somewhat higher
❍ About the same
❍ Somewhat lower
❍ Much lower

- How many **new, full-time, tenured and tenure-track high-energy physics faculty** do you expect (or guess) your institution will hire over the next three years? Include new hires to replace retiring faculty or faculty not granted tenure, and assume a constant level of DOE / NSF support (in FY97 dollars).

	No. of projected new hires
Theoretical physicists	
Experimental physicists	
Accelerator physicists	

- Indicate the **additional high-energy physics staff needs** at your institution by assigning a priority order (1 highest, 7 lowest) to the following choices. Assume that additional funding would be available to support your staff choices.

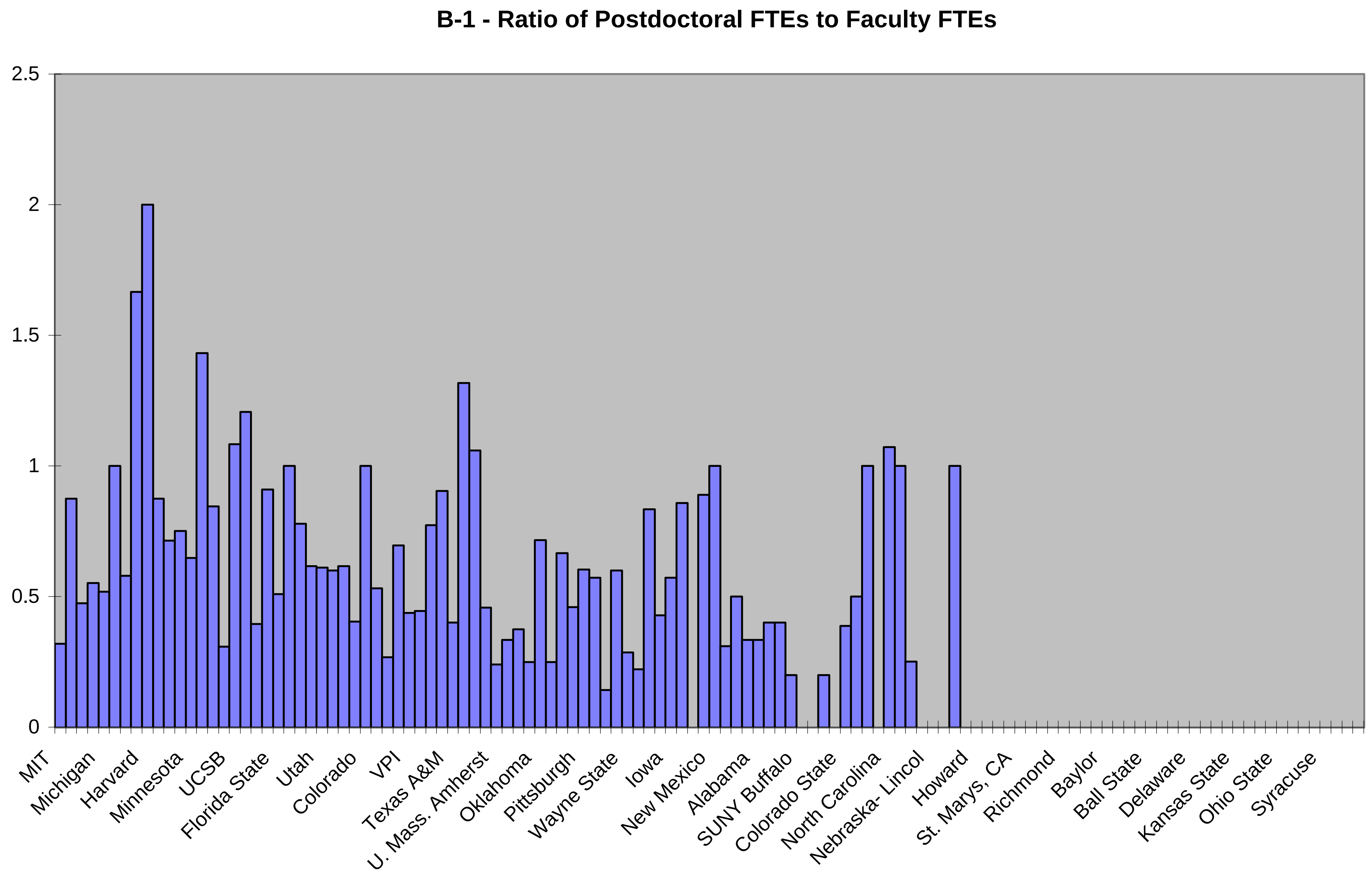
	Priority
Two postdoctoral fellows	
One mechanical engineer	
One electronics engineer	
One software systems engineer	
One postdoc and one technician	
Two technicians	
Four graduate students	

Please return this questionnaire to

Douglas Vaughan
Lawrence Berkeley National Laboratory
Building 50A-4119
1 Cyclotron Road
Berkeley, California 94720

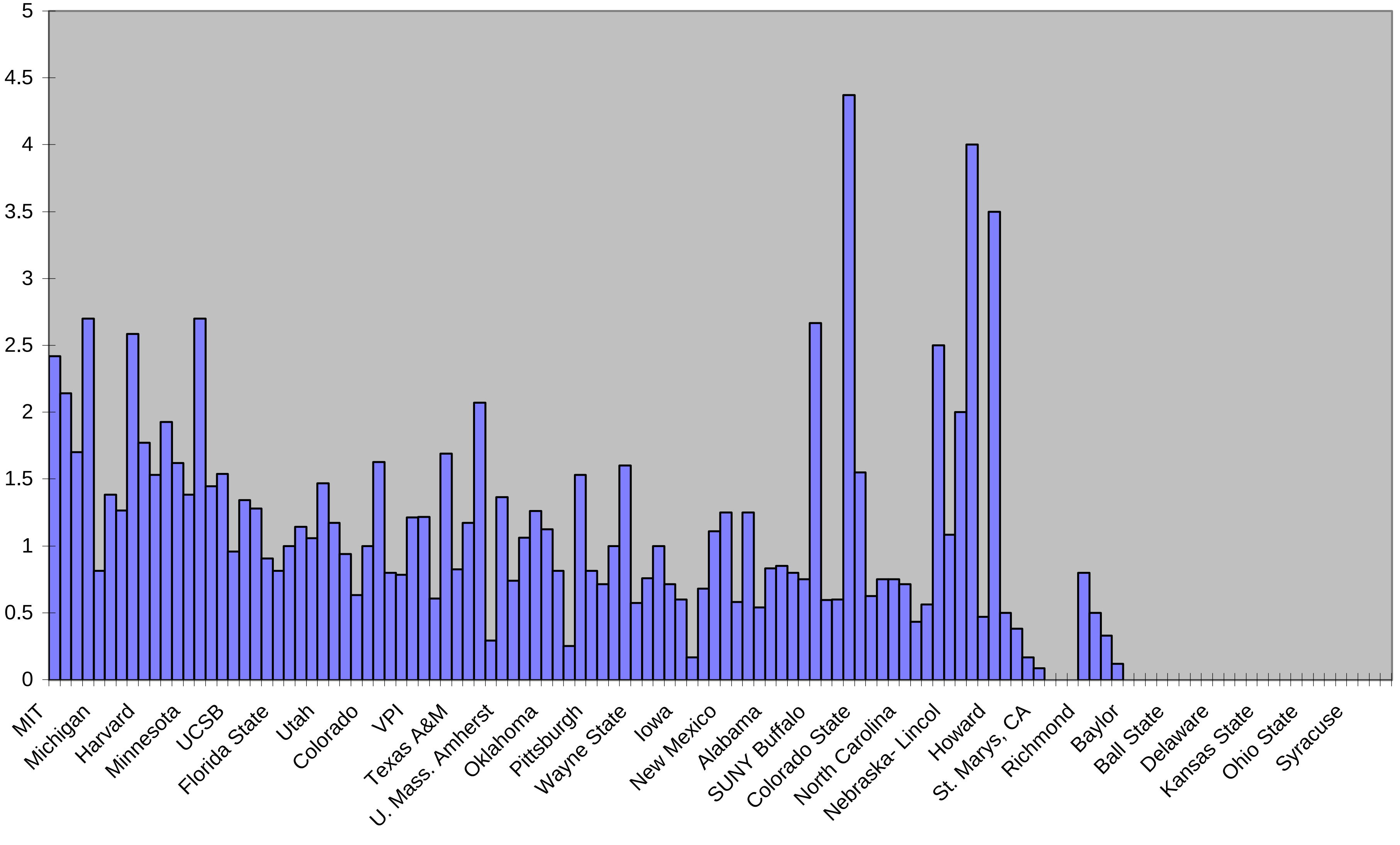
APPENDIX B

Additional Figures

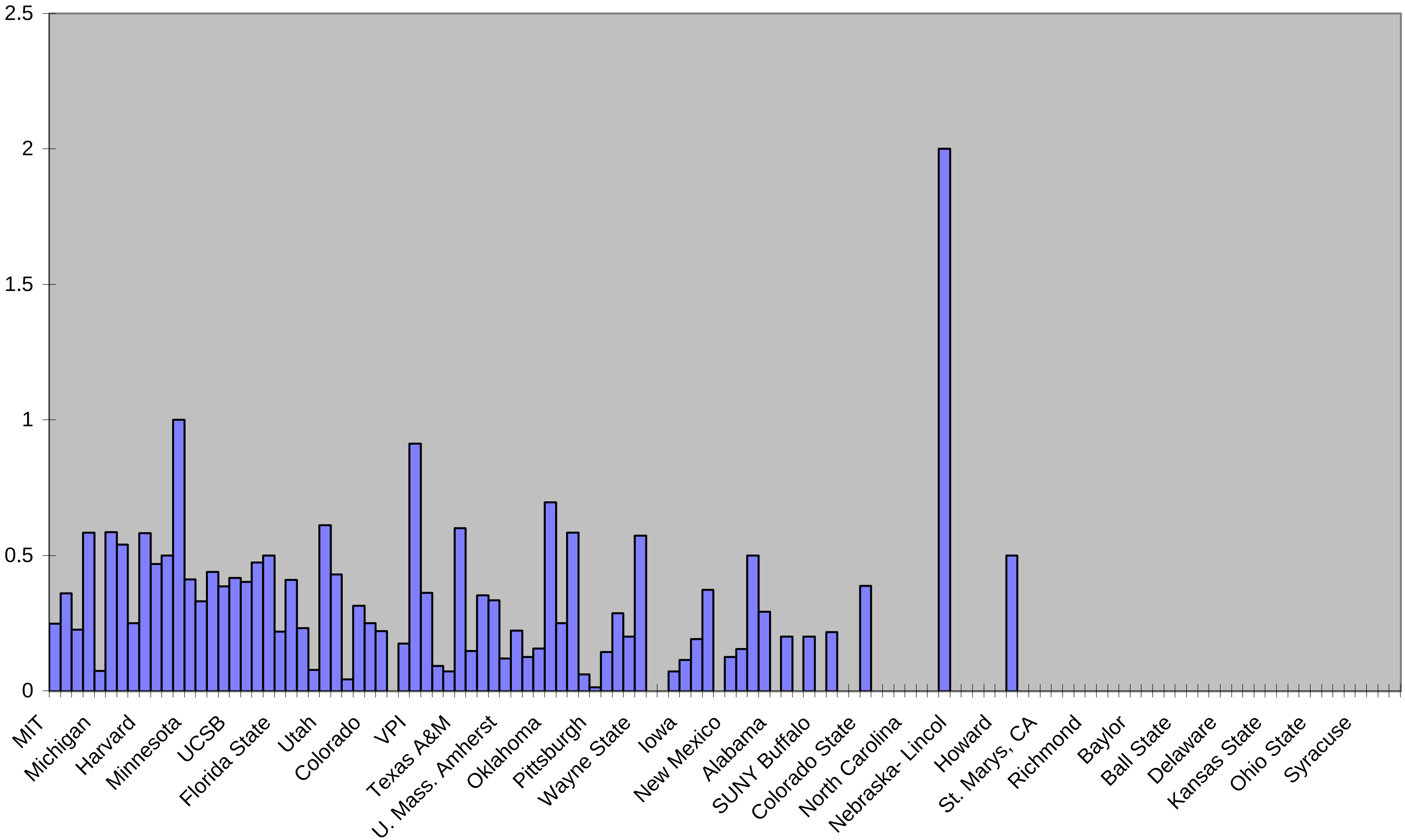


B-1 - Ratio of Postdoctoral FTEs to Faculty FTEs
2.5
2
1.5
1
0.5
0
MIT
Michigan
Harvard
Minnesota
UCSB
Florida State
Utah
Colorado
VPI
Texas A&M
U. Mass. Amherst
Oklahoma
Pittsburgh
Wayne State
Iowa
New Mexico
Alabama
SUNY Buffalo
Colorado State
North Carolina
Nebraska- Lincol
Howard
St. Marys, CA
Richmond
Baylor
Ball State
Delaware
Kansas State
Ohio State
Syracuse

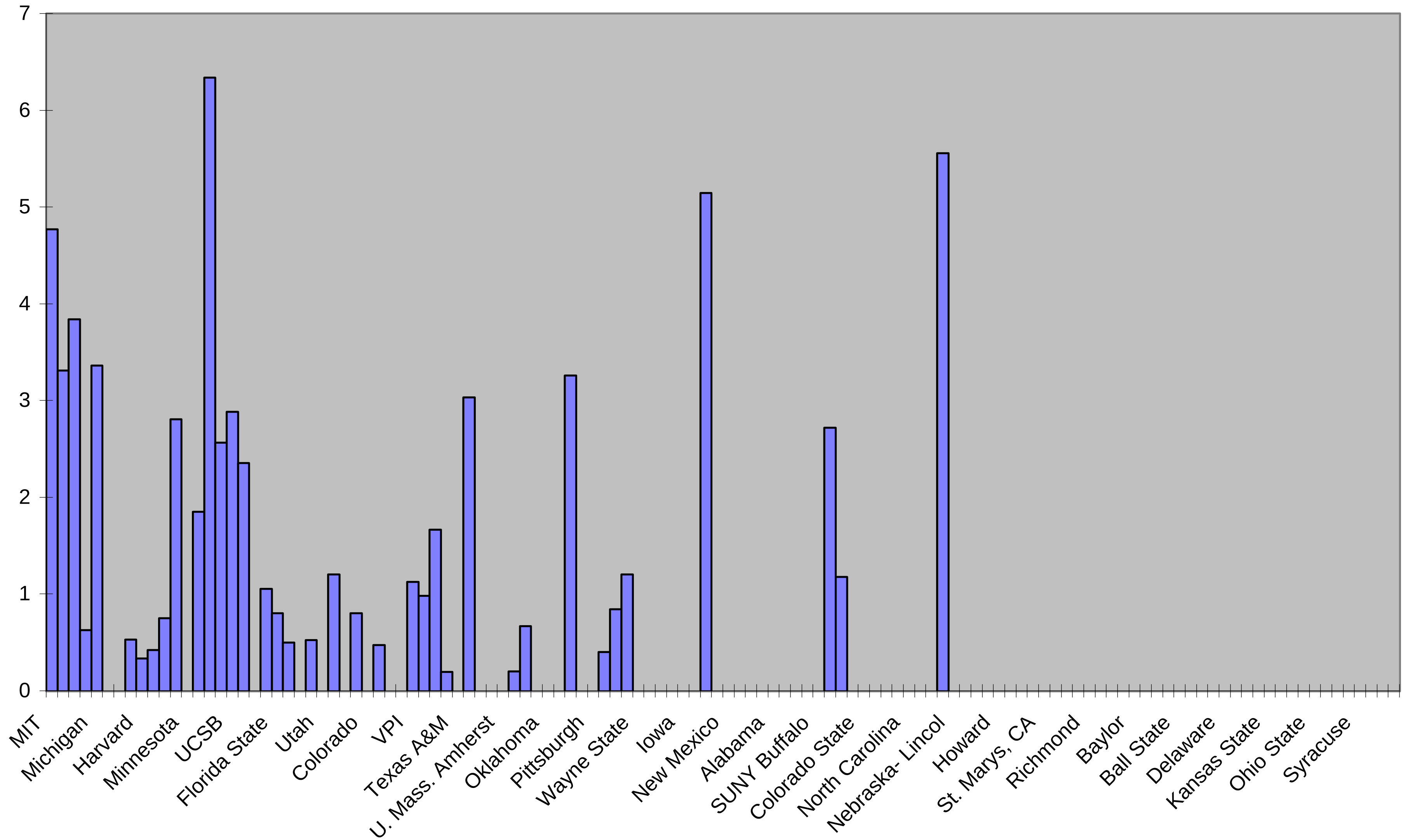
B-2 - Ratio of Student FTEs to Faculty FTEs



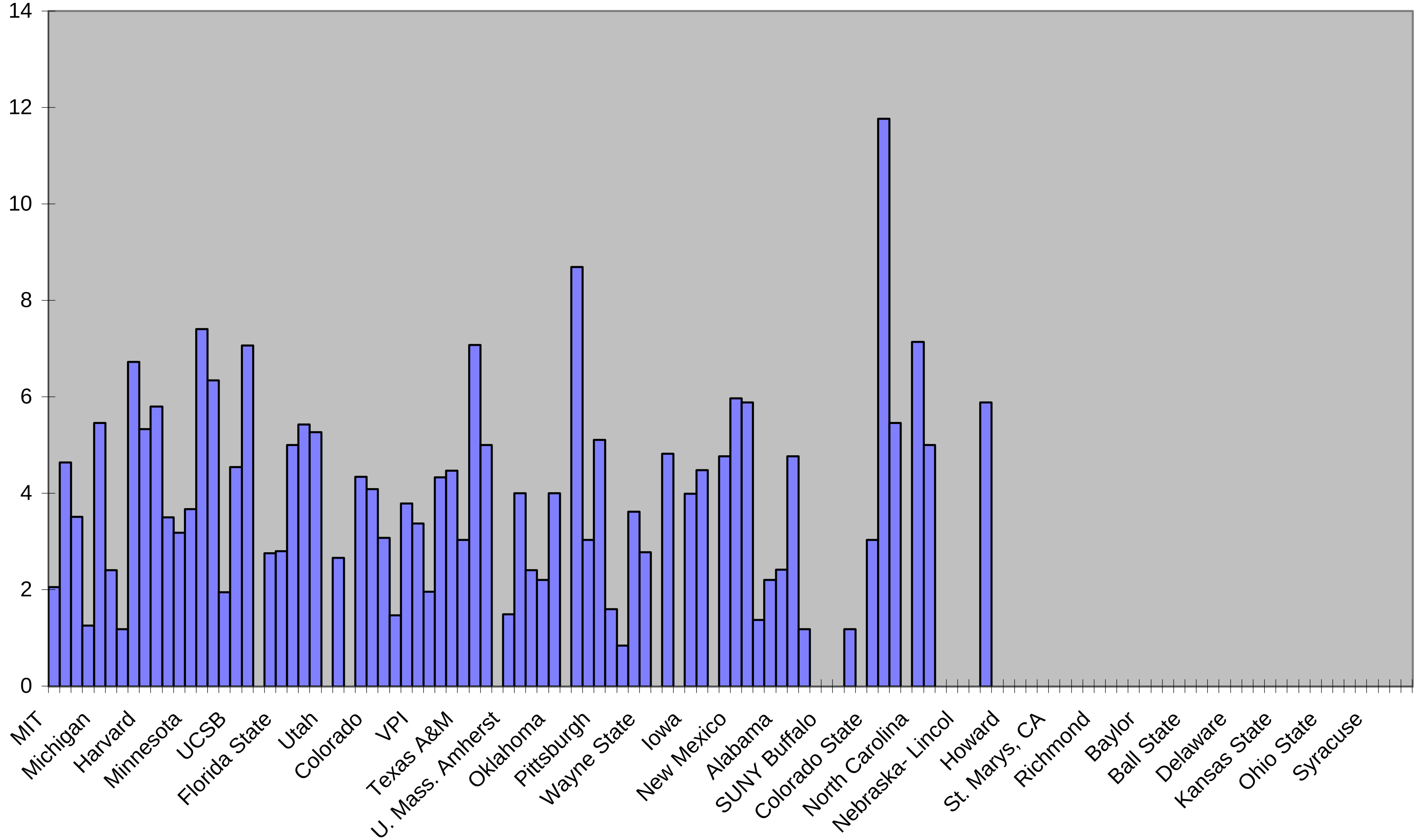
B-3 - Ratio of Support Staff FTEs to Faculty FTEs



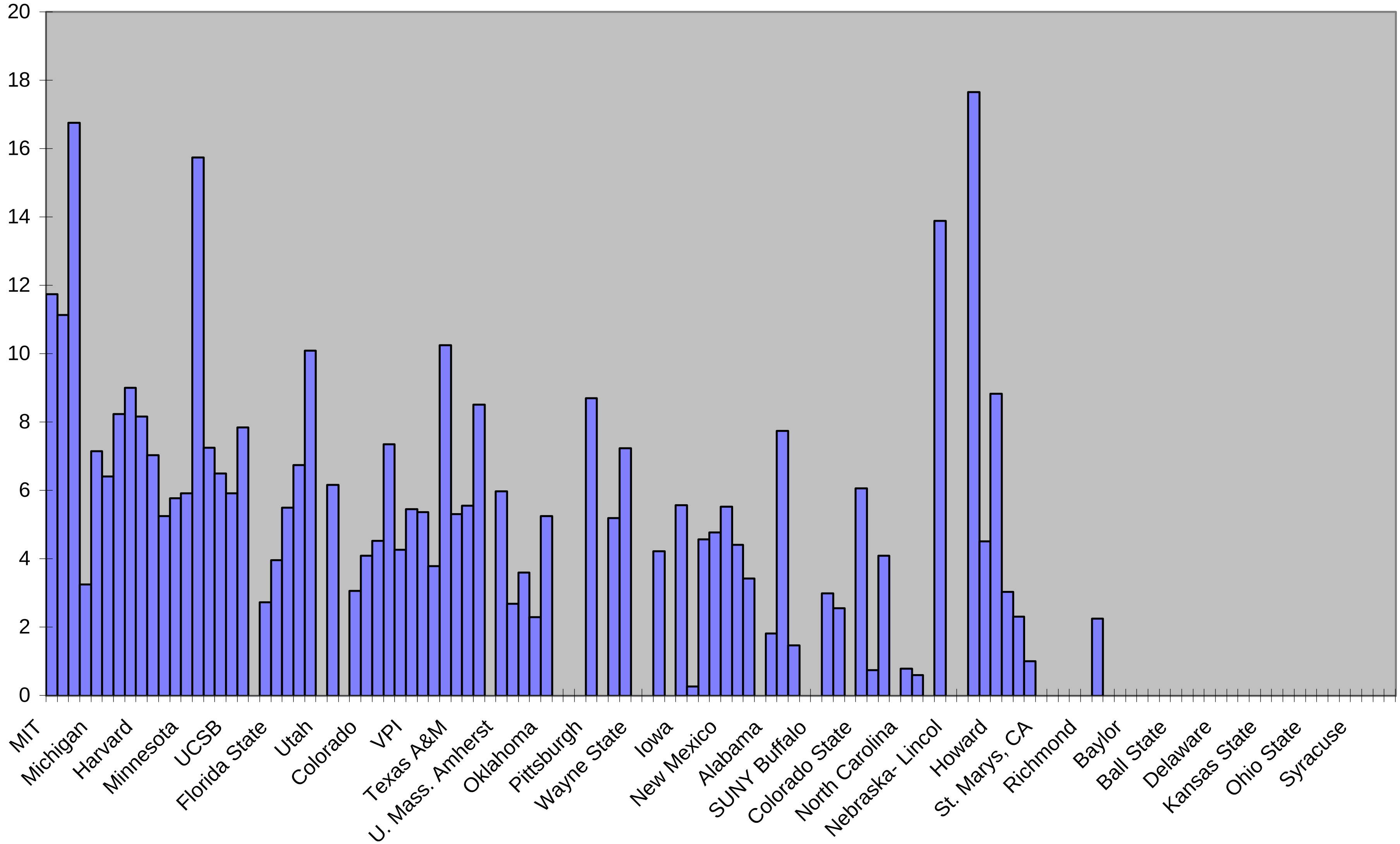
B-4 - Ratio of Senior Physicist FTEs to Faculty FTEs Supported by DOE grants, transfers or POs

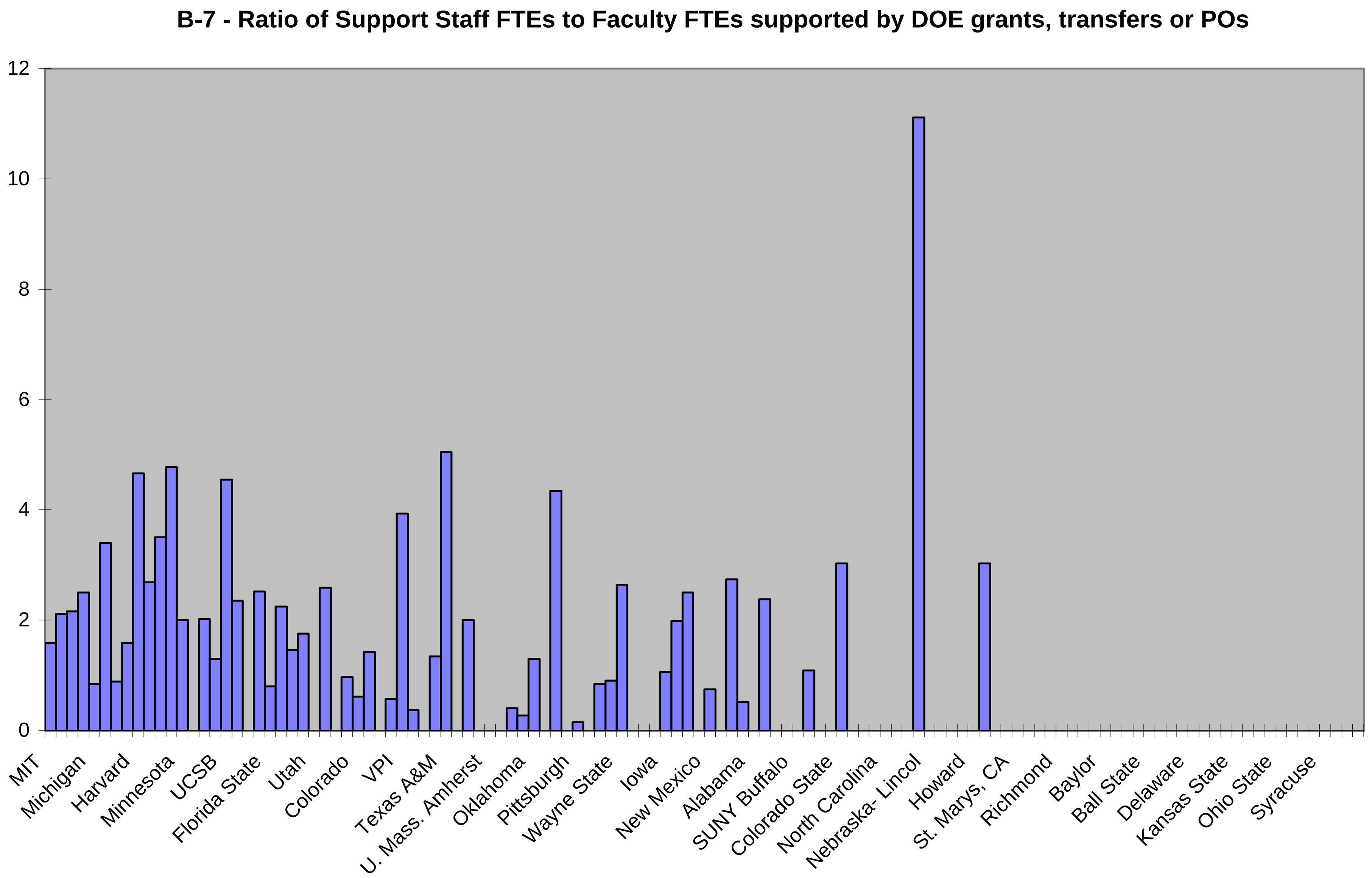


B-5 - Ratio of Postdoctoral FTEs to Faculty FTEs supported by DOE grants, transfers, or POs



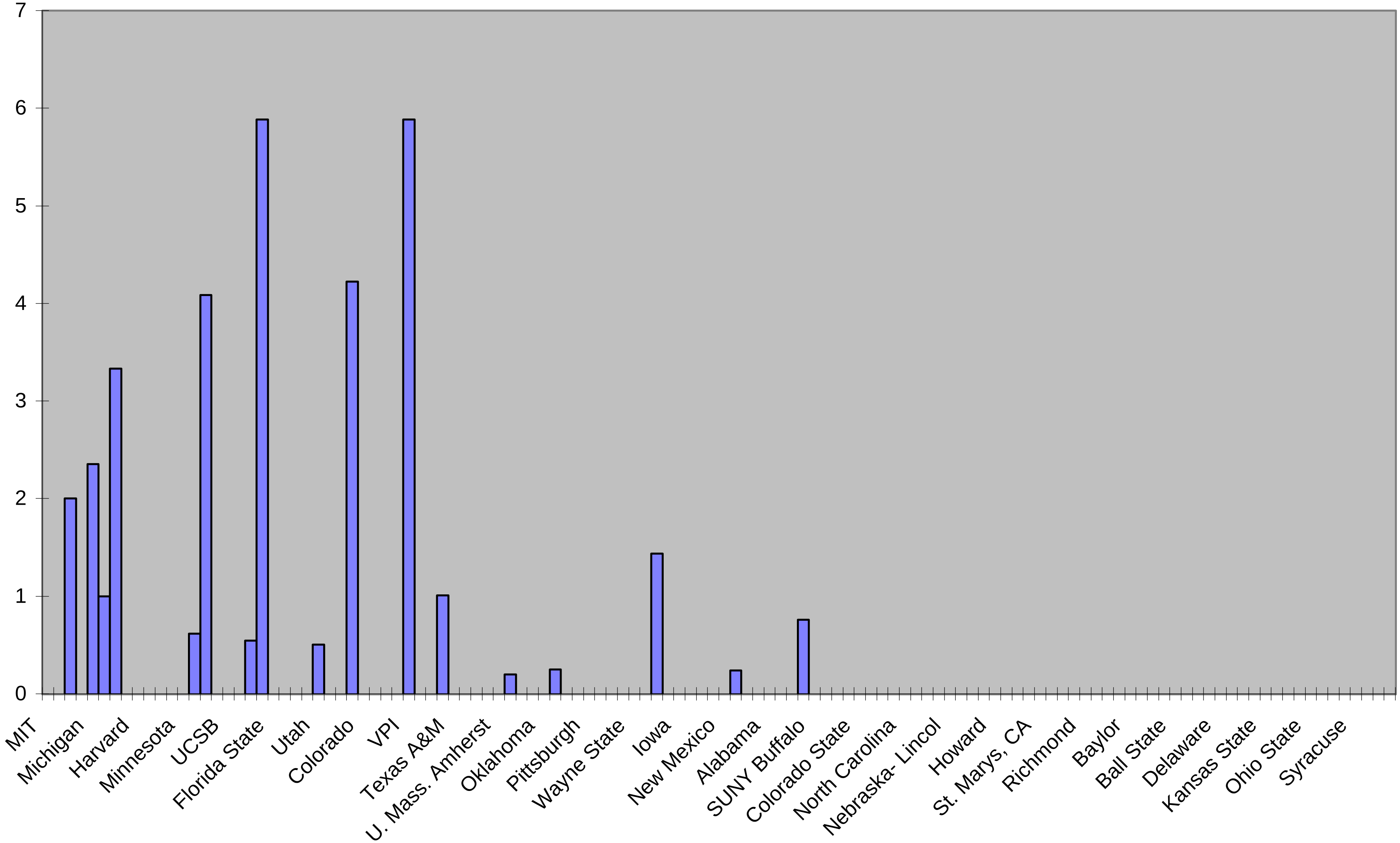
B-6 - Ratio of Student FTEs to Faculty FTEs supported by DOE grants, transfers or POs



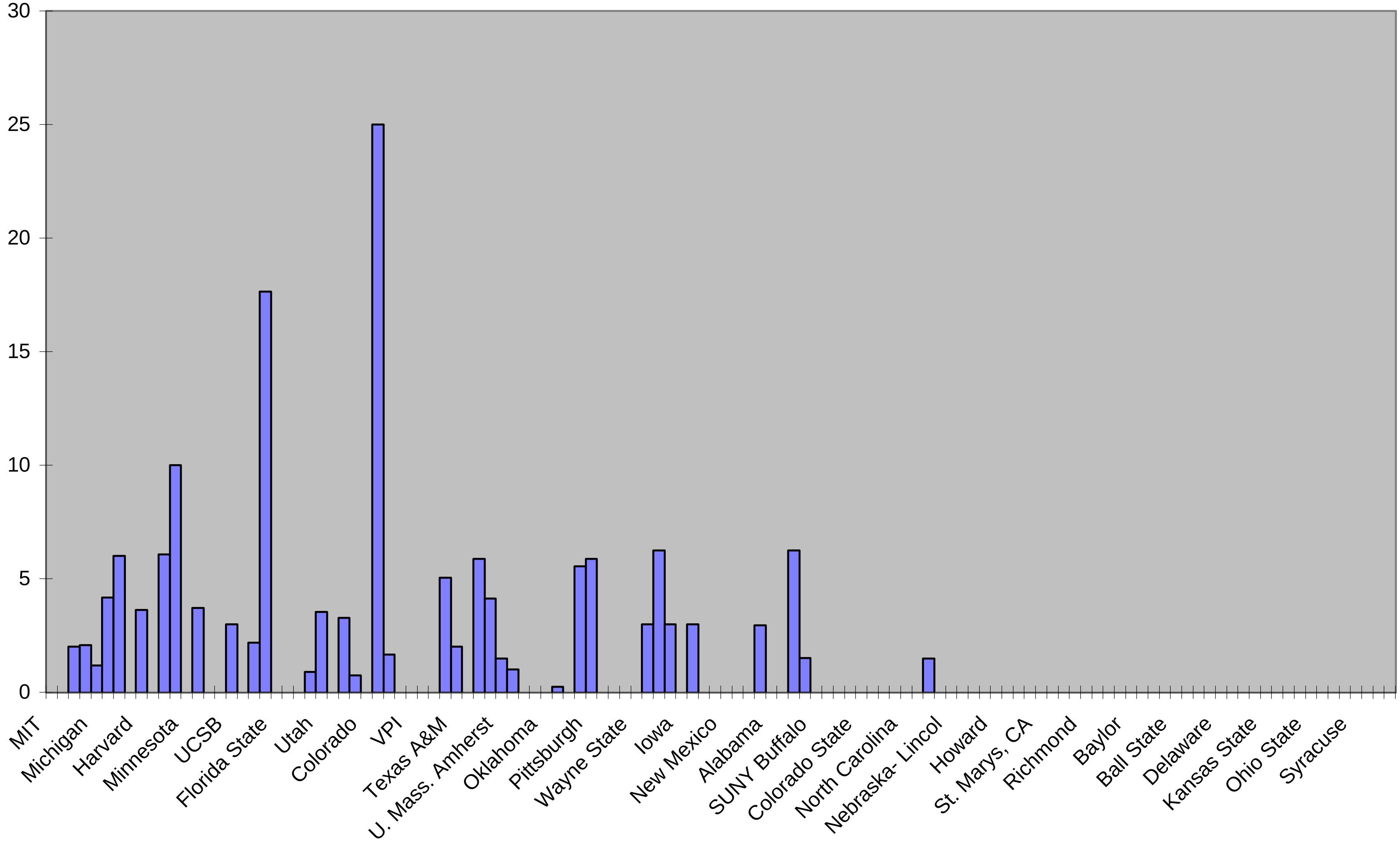


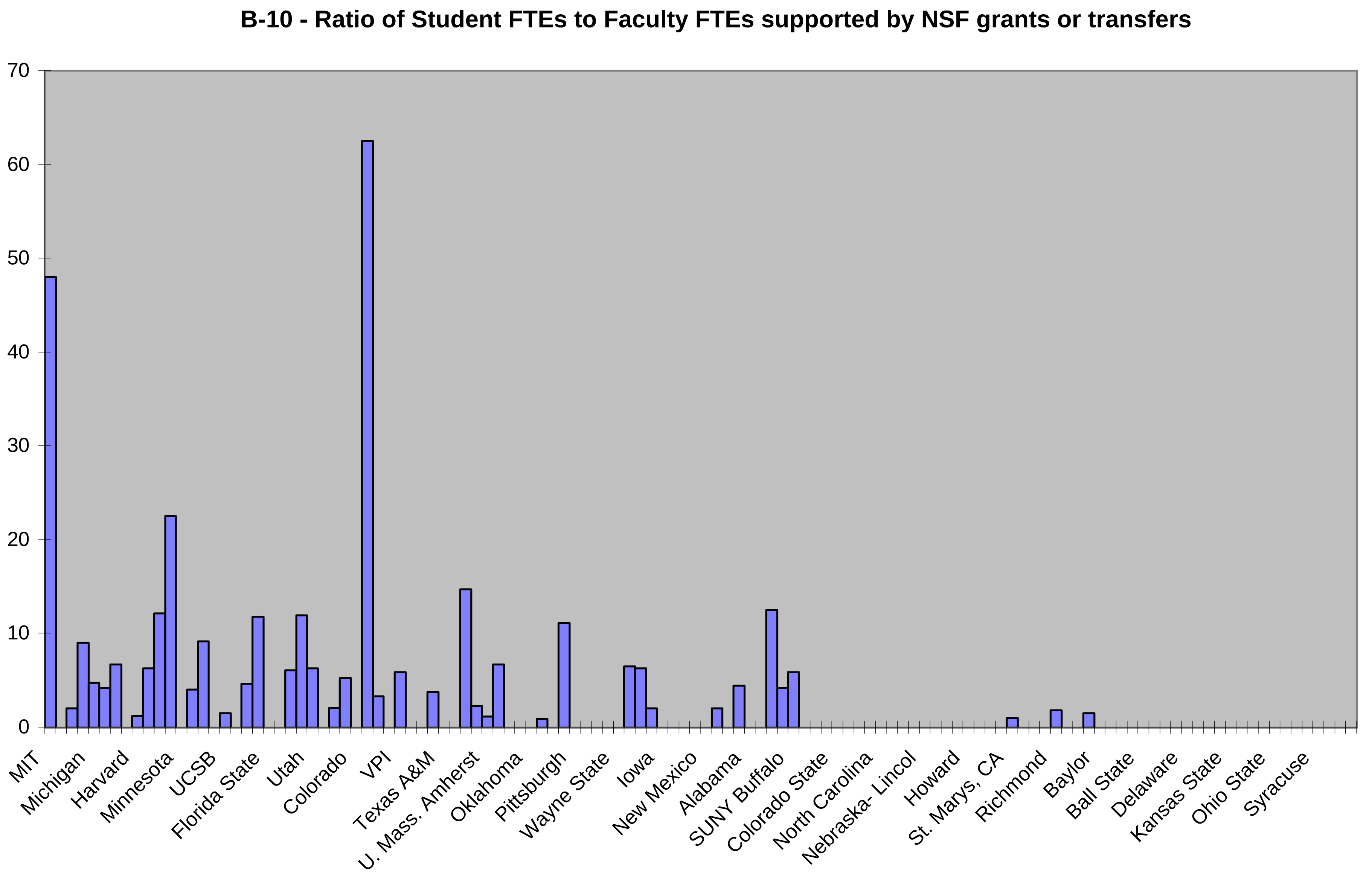
B-7 - Ratio of Support Staff FTEs to Faculty FTEs supported by DOE grants, transfers or POs
12
10
8
6
4
2
0
MIT
Michigan
Harvard
Minnesota
UCSB
Florida State
Utah
Colorado
VPI
Texas A&M
U. Mass. Amherst
Oklahoma
Pittsburgh
Wayne State
Iowa
New Mexico
Alabama
SUNY Buffalo
Colorado State
North Carolina
Nebraska- Lincol
Howard
St. Marys, CA
Richmond
Baylor
Ball State
Delaware
Kansas State
Ohio State
Syracuse

B-8 - Ratio of Senior Physicist FTEs to Faculty FTEs supported by NSF grants or transfers



B-9 - Ratio of Postdoctoral FTEs to Faculty FTEs supported by NSF grants or transfers




B-10 - Ratio of Student FTEs to Faculty FTEs supported by NSF grants or transfers
70
60
50
40
30
20
10
0
MIT
Michigan
Harvard
Minnesota
UCSB
Florida State
Utah
Colorado
VPI
Texas A&M
U. Mass. Amherst
Oklahoma
Pittsburgh
Wayne State
Iowa
New Mexico
Alabama
SUNY Buffalo
Colorado State
North Carolina
Nebraska- Lincol
Howard
St. Marys, CA
Richmond
Baylor
Ball State
Delaware
Kansas State
Ohio State
Syracuse

B-11 - Ratio of Support Staff FTEs to Faculty FTEs supported by NSF grants or transfers