Deliverables for BNL Internships:
Project Report

Office of Educational Programs

Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

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Collaborating & Submitting

- If you are part of a collaborative team, you only need to complete ONE abstract for a general audience, ONE report, and ONE poster.
- List all collaborative authors and simply swap the order for each deliverable when you submit your individual copy of a deliverable.
- Create a subfolder named FINAL DELIVERABLES in your SharePoint folder.
- Drop all deliverables in the FINAL DELIVERABLES SharePoint folder.

General types: Abstract for a General Audience, Project Report, Poster

Standard outlines:

- I – M – R – A – D

  Introduction, Methods, Results, And Discussion

- Narrative, Process, et al.

Project Report Paper

- The main text of the paper is to be between 1500 and 3000 words. The word count does not include footnotes, appendices, the bibliography and similar items. All appendices together must be three pages or less.
- The form of the paper should follow the guidelines of the appropriate portions of the *Style Manual from the American Institute of Physics.*
- The final paper that you submit should be in "publication" form.
- Everyone submits to their SharePoint folder; DOE interns (SULI, CCI, VFP) must also submit required deliverables using the online WDTS web site, as an Adobe Acrobat (.pdf) files, prior to the end of your appointment.

Project Report Paper: Publication form

I. General instructions

- Submit manuscripts in English only (American spelling).
- Use subheadings for each section
- Double space (1 inch margins), minimum 12 point font
- Indent paragraphs so that the start of a new paragraph is clearly distinguished, especially where there is a continuation of an existing paragraph after a displayed equation.
- Number all pages in sequence, beginning with the title and abstract pages.

Project Report Paper

II. Title

- Place the title about a third of the way down from the top of the first page.
- Begin the first word with a capital letter; thereafter capitalize only proper names and acronyms.
- Author(s): You as the first author, your mentor as concluding author. Identify affiliated institutions.

Project Report Paper

Authors' names and affiliations

- Type the authors' names above their affiliations
- Omit titles such as Professor, Doctor, etc.
- In the affiliation, use no abbreviations except for state in address. Give an adequate postal address including the ZIP.
- See page 6 and 7 of *AIP Style Manual* for examples of how to format authors' names.

Title/Author format example

Drag on an axially symmetric body in the Stokes flow of micropolar fluids

John J. Doe and James G. Smith

Department of Physics, Massachusetts Institute of Technology, Cambridge, Masssachusetts 02139

You, Your School's Department, Your College, City, State ZIP

Your mentor, BNL Department, Brookhaven National Laboratory, Upton, NY 11973

Project Report Paper

III. Abstract

- Begin the abstract on a new page.
- Use wider side margins for the abstract than for the rest of the manuscript, so that it will be clear where the abstract ends and the main text begins.
- Type or print the abstract double spaced, preferably as one paragraph of continuous text. Avoid displayed mathematical expressions, figures, and tables.
- If a reference to the literature is needed, write it out within square brackets in the text of the abstract rather than referring to the list at the end of the paper. For example: The measurement of hydrogen permeation into iron reported by W. R. Wampler [J. Appl. Phys. 65, 4040 (1989)], who used a new method based on ion beam analysis,...
- Define all nonstandard symbols, abbreviations, and acronyms.

More on the report abstract

- State the subject of the paper immediately, indicating its **scope and objectives**. Do this in terms understandable to a nonspecialist. Describe the treatment given the subject by one or more such terms such as "brief," "comprehensive," "preliminary," "experimental," or "theoretical."
- Indicate the **methods** used to obtain experimental results. If they are novel, state the basic principles involved, the operational ranges covered, and the degree of accuracy attained.
- Summarize or discuss the experimental or theoretical **results, the conclusions, and other significant items in the paper.** Do not hesitate to give numerical results or state your conclusions in the abstract.
- Do not cite the literature references by the numbers in the list at the end of the paper, and do not refer by number to a selection, equation, table, or figure within the paper. Nonstandard symbols and abbreviations used in the abstract must be defined there as well as in the main text.
- Use running text only. Never use displayed mathematical expressions or numbered equations. Omit tables, figures, and footnotes.
- Keep the length of the abstract to a small percentage of that of the paper. Write concise, straightforward English; make every word count. Try to substitute words for phrases and phrases for clauses. Be terse, but not telegraphic; do not omit a's, an's, or the's. Regardless of the length of the final draft of your abstract, study it again with a view to shortening it further to a minimum length.

Project Report Paper

IV. Introduction

- Make the precise subject of the paper clear early in the introduction. As soon as possible, inform the reader what the paper is about. Depending on what you expect your typical reader already knows on the subject, you may or may not find it necessary to include **historical background**, for example. Include such information only to the extent necessary for the reader to understand your statement of the subject of the paper. As part of the background, you may also wish to include a **review of the relevant literature**.

Project Report Paper

Introduction, continued

- Indicate the **scope of coverage of the subject**. Somewhere in the introduction state the limits within which you treat the subject. This definition of scope may include such things as the ranges of parameters dealt with, any restrictions made upon the general subject covered by the paper, and whether the work is theoretical or experimental.

Project Report Paper

Introduction, continued

- State **the purpose of the paper**. Every legitimate scientific paper has a purpose that distinguishes it from other papers on the same general subject. Make clear in the introduction just what this purpose is. The reader should know what the point of view and emphasis of the paper will be, and what you intend to accomplish with it.

Project Report Paper

V. Main body of the paper

- The discussion of your project and its outcomes. Include **scope and objectives, methods, results**, and other significant items in this section

VI. Conclusion

- Typical functions of the conclusion of a scientific paper include (1) summing up, (2) a statement of conclusions, (3) a statement of recommendations, and (4) a graceful termination. Any one of these, or any combination, may be appropriate for a particular paper.

Project Report Paper

VII. Footnotes and references

- Place all footnotes (including references) in order of citation as a separate, double-spaced list at the end of the manuscript, before the tables and figures.
- Type or print each footnote as a separate indented paragraph beginning with the appropriate superscript indicator.
- For references cited in the text use superscript numerals running consecutively through the text: 1, 2, 3, etc. Place citation indicators *after* commas, periods, quotation marks, colons, and semicolons

Project Report Paper

Acknowledgements

- As a part of the acknowledgements for both your report and poster, you must include the following statement, depending on your program(s):
  - **Science Undergraduate Laboratory Internships (SULI)**
    "This project was supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Science Undergraduate Laboratory Internships Program (SULI)."
  - **Community College Internships (CCI)**
    "This project was supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Community College Internships Program (CCI)."
  - **Visiting Faculty Program (VFP)**
    "This project was supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Visiting Faculty Program (VFP)."
  - **Collegiate Science and Technology Entry Program (CSTEP)**

    "This project was supported in part by the New York State Collegiate Science and Technology Entry Program (CSTEP) at (Name of school), under the CSTEP-Supplemental Undergraduate Research Program (SURP) at Brookhaven National Laboratory."
  - **Louis Stokes Alliance(s) for Minority Participation (LSAMP)**

    "This project was supported in part by the National Science Foundation, Louis Stokes Alliance(s) for Minority Participation (LSAMP) at (Name of school), under the LSAMP Internship Program at Brookhaven National Laboratory."
  - **Brookhaven National Laboratory Supplemental Undergraduate Research Program (SURP)**

    "This project was supported in part by the Brookhaven National Laboratory (BNL), (Name of Department) , under the BNL Supplemental Undergraduate Research Program (SURP) ."
  - **Brookhaven National Laboratory-Virginia Pond Scholarship Program (VPSP)**

    "This project was supported in part by the Brookhaven National Laboratory-Virginia Pond Scholarship Program, under the VPSP-Supplemental Undergraduate Research Program (SURP)."

NOTE: Wherever you see the parenthetic comment either Name of School or Name of Department in the above statements, please replace the parentheses with the formal name of your school or BNL department.

Appendixes

- As needed. All graphics, tables, etc. should EACH have a caption identifying the information displayed.

NOTE: CCI Appendix requirement

Appendix. Please provide the additional information requested below. The Appendix is in addition to the report body above, and this content is not counted towards the report page limit.

- **Participants-** In a **table**, list the names, institutions, and roles of each person who participated in the project, including host lab personnel, CCI, VFP, or SULI students, or other students, as appropriate. Include a brief statement of each participant's project team role.
- **Scientific Facilities** - Briefly state if any scientific user facilities were part of your project activities, including identification of the facility.
- **Notable Outcomes** - Publications, Reports, Manuals, Drawings/Schematics, Patents, or Presentations. List any articles, patent disclosures, laboratory technical reports, invited/contributed conference/workshop presentations, technical documents, and/or internal presentations resulting from activities performed under this appointment. Please include full bibliographical citations, co-authors, affiliations, titles, and/or venues, as appropriate.

Sample report pages (Title page)

Saving energy in the Brookhaven National Laboratory Computing Center: Cold aisle containment implementation and computational fluid dynamics modeling

Student Intern
Earth and Environmental Engineering, Columbia University, New York, NY 10027

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Sample report pages (Abstract page)

Abstract

This research project in the Energy Utilities Department is a study of energy efficiency improvement in the Data Center building at Brookhaven National Laboratory. The Data Center houses rows of large computer servers. These servers, like all computers, give off a substantial amount of heat and must always be kept cool to run efficiently. The total electricity usage of data centers, primarily computer power and A/C units, accounted for 1.6% of all US electricity usage in 2006, and is projected to increase by 12% annually. Due to the growing importance of data centers in an increasingly computer-dependent world and the large amount of cooling necessary to keep them running, the DOE has recently committed to a new energy efficiency standard for data centers that requires a 30% reduction in energy usage from their expected energy requirements, based on size. This study focuses on the modeling and implementation of curtains and baffles to save cooling energy by containing the cold air entering the server rooms. These curtains ensure that none of the cold air is cycled back into the A/C units without first passing through and cooling the servers. A 3D model was made of the airflow and temperature distribution in the data center using Ansys CFX, a Computational Flow Dynamics software. A temporary trial of the containment was performed using plastic sheets to verify the computer model and identify major benefits and problems with containment. The trial showed that containing two of three aisles with incoming cold air led to an 8.9°F decrease in the hottest inlet temperature to the computers. The model supported this excellent result and can now be used to model other curtain placements and configurations to find the most efficient and inexpensive solution.

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Brookhaven National Laboratory

Sample report pages (Introduction, etc.)

I. Background

A. Data Centers and Energy Usage

Data centers are extremely important, large users of energy. In 2006, they accounted for about 1.6% of all US electricity usage,[1,2] and this figure is projected to grow by 12% annually.[1] Data centers use this energy not only to run the extremely powerful computers housed there, but also to power air conditioning units throughout the facility to prevent the computers from overheating. Of the 23.8 million kilowatt-hours of energy that the Brookhaven Data Center consumes each year, about 60% powers the computer servers and 40% goes to cooling.[4] While it is nearly impossible to reduce the amount of energy used by the computers without reducing the Center's computing capabilities, there are a number of techniques that can be employed to cool the servers more efficiently. Lowering the amount of energy required to cool a data center would yield large energy savings.

B. Air Flow in a Data Center and Cold Aisle Containment

In many data centers, including the Data Center at Brookhaven National Laboratory, the air conditioning units pump cold air into an area below the floor called the plenum, as shown in Figure 1. This cold air comes up through porous floor tiles into an aisle with computer racks facing inward, called the cold aisle. This air in the cold aisle goes through the small fans in the computers and into the neighboring outflow aisle, called the hot aisle, where all the server racks are back-to-back. The air then rises up from the hot aisle and eventually reenters the air conditioners.

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Sample report pages (Pages w/ figures)

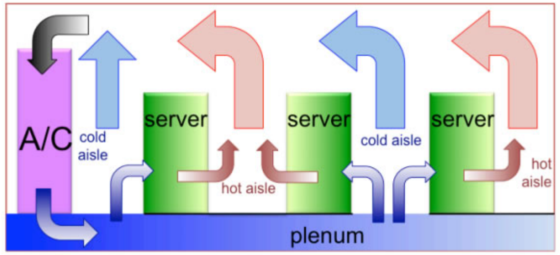

Figure 1. Diagram of typical airflow inside a data center

There are two main inefficiencies that result from this. The first and most significant source of inefficiency is the fact that the recirculated cold air wastes fan energy because this air does nothing to cool the actual servers, but it leaves the cold aisle and enters to the air conditioner unit simply to be blown back to the cold aisle it came from. The second source of inefficiency is the fact that the entire room is being cooled. Any cooling leakage that the room experiences, for example from an open door to an adjacent room or the sun's radiation on a hot day, will require that the air conditioners work harder to counteract those effects and chill the entire volume of the room.

Both of these sources of inefficiency can be corrected with containment. In the containment model, shown in Figure 2, the top of the cold aisle is blocked off. In a three-dimensional view of the aisles, the two sides of the cold aisles would also be shown as blocked off. This containment does not allow any cold air to escape the cold aisle without first passing through the servers. This solves the first problem because it makes the system such that the air must first pass through and cool a server to return to the air conditioner and be pumped into the plenum. The second issue is significantly improved, as well, because the volume of space that is

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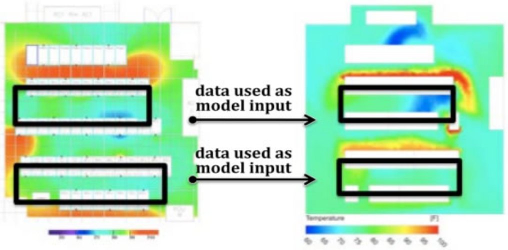
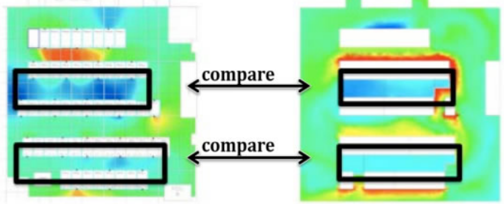
the actual experimental data taken in the containment scenario, shown in Figure 15. These temperature gradients also match very well and support the model's accuracy.



Figures 14 and 16. Uncontained scenario of experimental data and computer model, respectively



Figures 15 and 17. Contained scenario of experimental data and computer model, respectively

The second focus of comparison was the temperature of the air returning to each of the two air conditioner units. Table 1 shows the uncontained and contained temperatures of return air to the air conditioners in both the experimental data and the model predictions. The model's return air predictions are consistently colder than the experimentally measured temperatures. This could likely be fixed by adjusting boundary conditions of the model slightly. Despite overall colder temperatures predicted by the model, the changes in temperature from uncontained

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Sample report pages (Page w/ references)

V. References

[1]ENERGY STAR Program, US Environmental Protection Agency. "Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431." Aug 2007.

[2]US Energy Information Administration. <http://www.eia.gov/totalenergy/data/annual/showtext.cfm?t=ptb0801>

[3]ASHRAE. "Recommendations for Meeting Energy Efficiency Requirements for New Federal Data Centers." Aug 2011.

[4]Lizardos, Brookhaven National Lab. "Computer Facilities Energy Efficiency Study: Building Nos. 459 and 515." Dec 2011.

[5]Federal Energy Management Program, US Dept of Energy. "Retro-Commissioning Increases Data Center Efficiency at Low- Cost: Success at Savannah River Site (SRS) at Low-Cost."Dec 2010.

[6]Federal Energy Management Program, US Dept of Energy. "Data Center Airflow Management Retrofit: Technology Case Study Bulletin." Sept 2010.

“I,” “we,” and impersonal constructions

“I,” “we,” and impersonal constructions (1) --*AIP Style Manual*, pp. 14-15

The old taboo against using the first person in formal prose has long been deplored by the best authorities and ignored by some of the best writers. "We" may be used naturally by two or more authors in referring to themselves; "we" may also be used to refer to a single author and the author's associates. A single author should also use "we" in the common construction that politely includes the reader: "We have already seen .... "But never use "we" as a mere substitute for "I," as in, for example, "In our opinion ... ," which attempts modesty and achieves the reverse; either write "my" or resort to a genuinely impersonal construction.

"I," "we," and impersonal constructions (2)

The passive is often the most natural way to give prominence to the essential facts:

Air was admitted to the chamber.

(Who cares who turned the valve?) But avoid the passive if it makes the syntax inelegant or obscure. A long sentence with the structure

The values of ... have been calculated.

is clumsy and anticlimactic; begin instead with I [We] have calculated ...

“I,” “we,” and impersonal constructions (3)

The author(s)" may be used as a substitute for "I [we]," but use another construction if you have mentioned any other authors very recently, or write "the present author(s)."

“I,” “we,” and impersonal constructions (4)

Special standards for usage apply in two sections of a paper: (i) Since the abstract may appear in abstract journals in the company of abstracts by many different authors, avoid the use of "I" or "we" in the abstract; use "the author(s)" or passives instead, if that can be done without sacrificing clarity and brevity. (ii) Even those who prefer impersonal language in the main text may well switch to "I" or "we" in the acknowledgments, which are, by nature, personal.