Marion M. White - ASD

mwhite@aps.anl.gov

- I've tried to address the "talking points" that were provided.
  - Some more than others…

- "You may describe your multi-national laboratory collaborations."

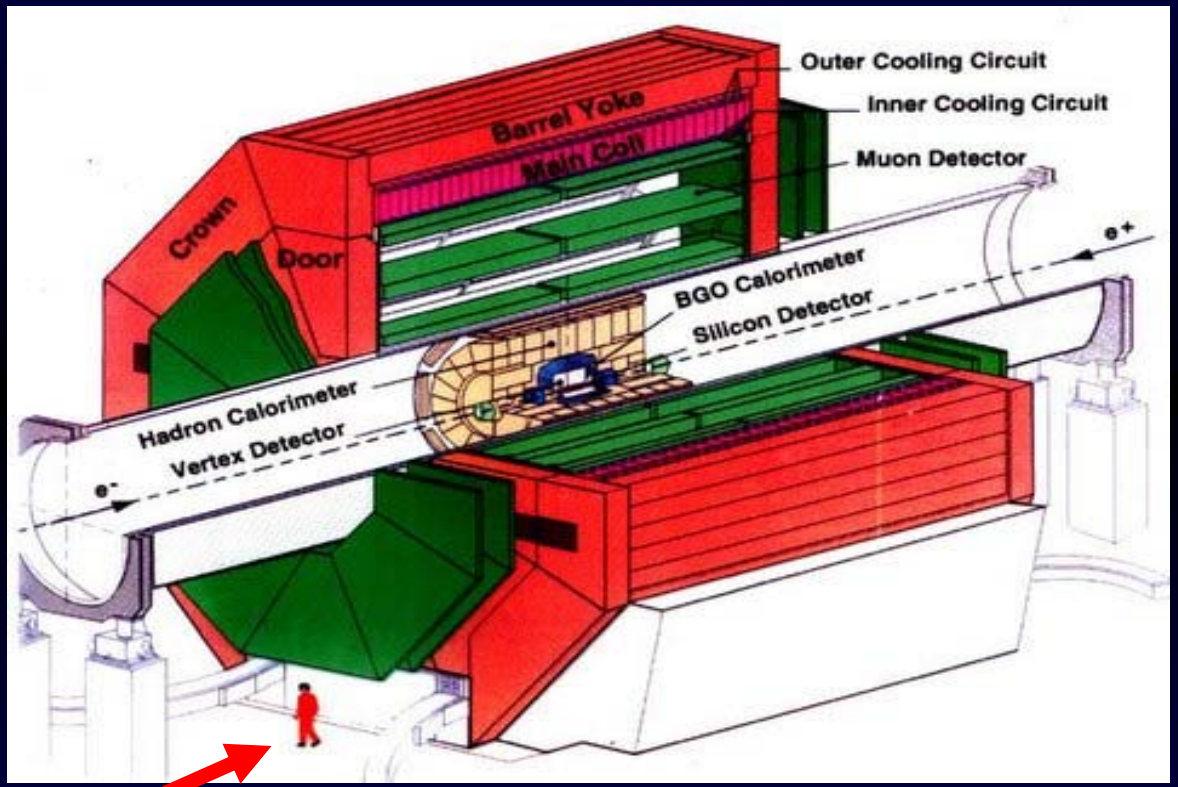
mwhite@aps.anl.gov

Experience in Collaborative Projects

- **TUMM Collaboration** – proton Compton scattering experiment at Cornell; 4 collaborating institutions.
- **Mark-J** at DESY in Germany – high-energy electron-positron collisions, muon detection, electroweak interactions; multinational collaboration, thesis experiment.
- **L3** at CERN near Geneva – higher-energy electron-positron collisions, muon detection, electroweak interactions; lots more nations and institutions in a multinational collaboration.
- **APS** linac: 650-MeV electron-positron. Just ANL.
- **SNS** front end, linear accelerator, and cryogenic systems: six-DOE-Laboratory effort with worldwide R&D help.
- **LCLS** at Stanford - 3-DOE-Laboratory effort. ANL has responsibility for the undulator system.

mwhite@aps.anl.gov

The L3 Detector at CERN



Human

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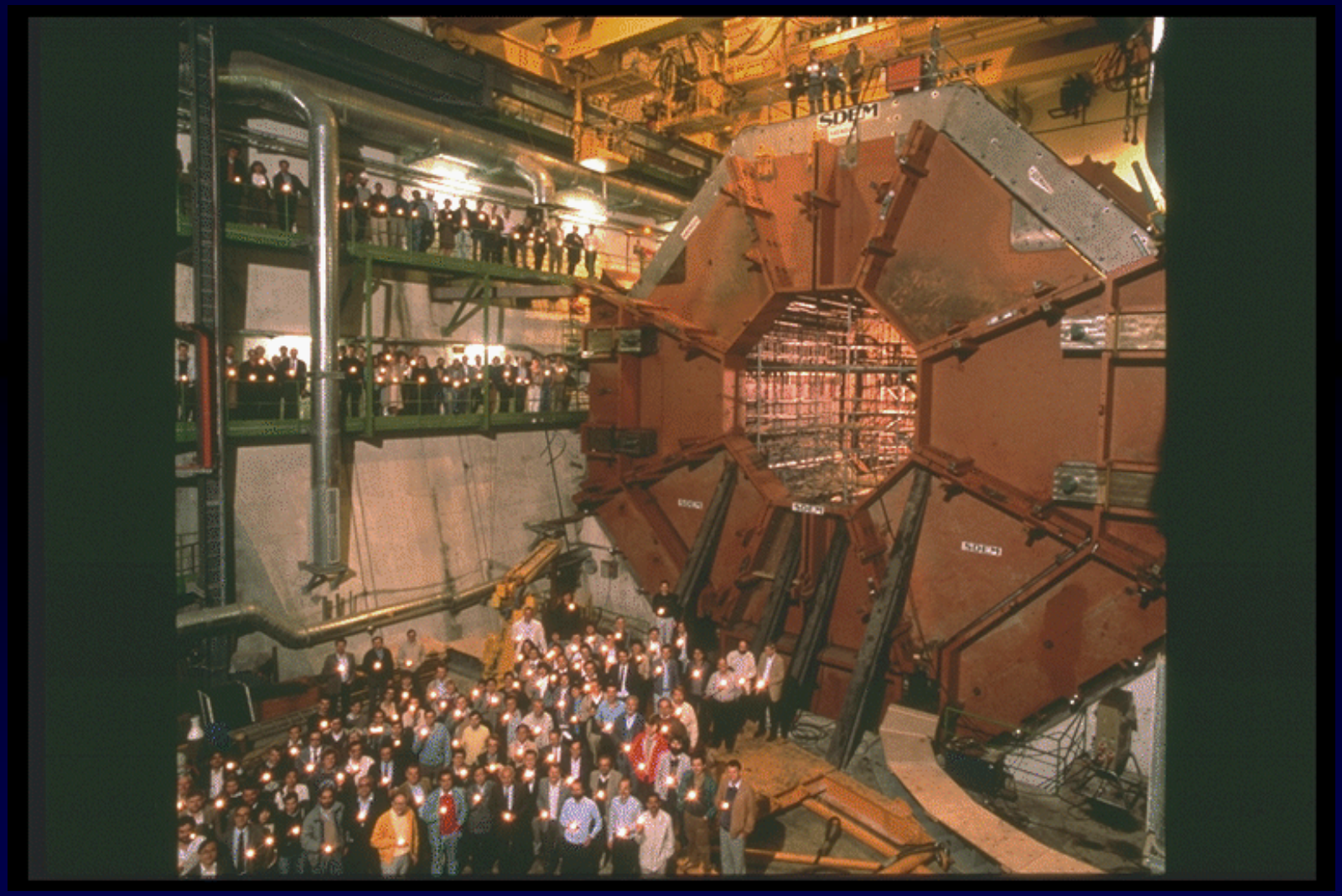
L3 – Under Construction



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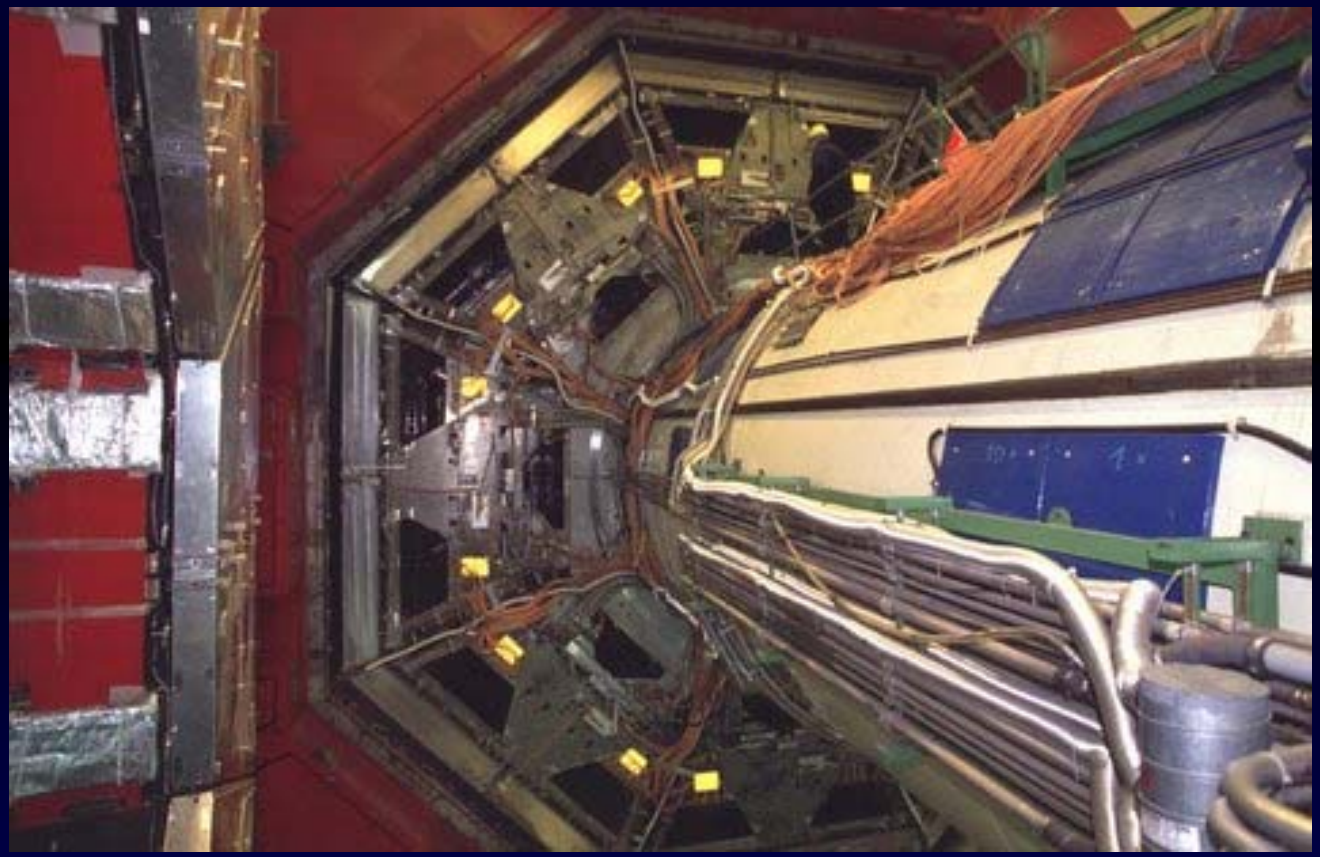
The L3 Muon Detector



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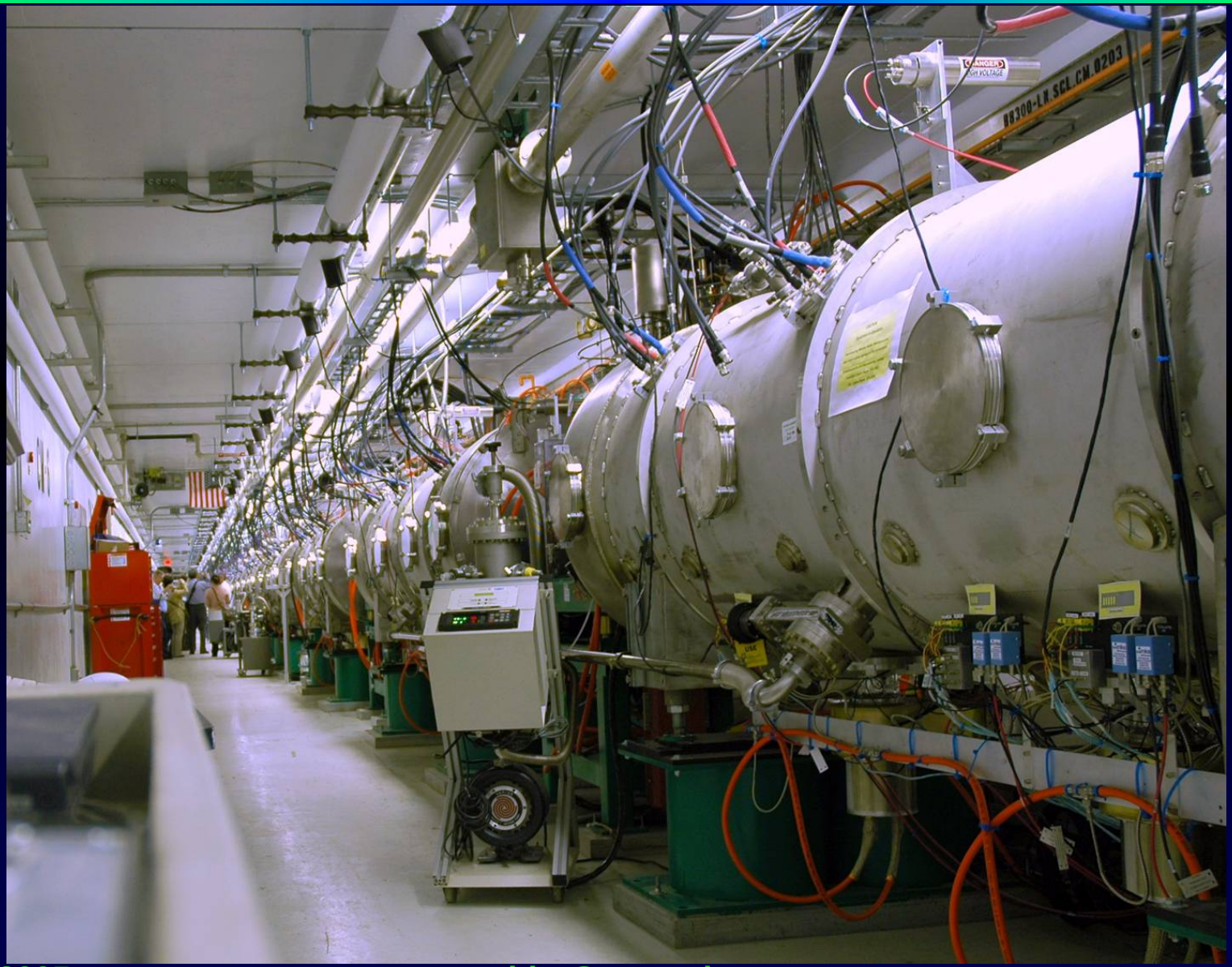
The SNS Superconducting Linac



mwhite@aps.anl.gov

SNS Linac - Klystron Gallery

mwhite@aps.anl.gov

SNS Linac - Central Helium Liquefier

mwhite@aps.anl.gov

Related Tasks

- Detector design or accelerator simulation, design, construction, installation, commissioning, operation, maintenance, collecting and analyzing data. Presenting or using results.

mwhite@aps.anl.gov

A few of the issues we need to deal with:

Safety of self, safety of others – particularly students, work planning, budget, scheduling, rf power systems, accelerating cavity design, calibration, superconducting rf, cryogenic systems, readout electronics, nonflammable cable, crane operation, water chemistry and biology, DC and pulsed power supplies, power systems, ground counterpoise, lightning protection, concrete shrinkage, electromagnets, permanent magnets, accelerator beam diagnostics, vacuum systems, positron production, cluster formation, avalanche and gas amplification, explosive gas mixtures, simulations, survey and alignment, stability, beam transport, electromagnetic shielding, radiation shielding, radiation monitoring, controls systems, radiation damage, materials science, material behavior at high and very low temperatures, thin films, readout, monitoring, database, debugging, repair, training operators, taking data, doing analysis, etc., etc., etc….

mwhite@aps.anl.gov

“Why collaborate?”

- **Because no single person can be an expert at all of that….**
- And because a talented group can do far more than any single person in a given time.

mwhite@aps.anl.gov

“Why multi-disciplinary research?”

- Almost every problem today has a multi-disciplinary solution, or, the arrived-at solution would very likely have been better if the problem had been viewed as if it were multi-disciplinary.
  - Look at highway design and traffic flow; somewhere, someone should have gotten some good technical advice.
  - Science projects are different than making shopping centers. Usually, there’s R&D involved because nobody knows how to do it.

mwhite@aps.anl.gov

A “simple” problem

- **Searching luggage at the airport:**
  - Physics, safe x-ray production, electronics, signatures of materials, choice of inspection technique, optimization of time spent per object scanned, x-ray penetration depth, event reconstruction, differentiation of various materials, how to make it 3-D, automation, economics, making, installing, and using the system, statistics, how to decide what to look for, robustness and reliability, biohazards, training people, dealing with people, ethics, how to decide what to do when there’s a problem, law enforcement, making the whole process simple enough for an average person to use….

mwhite@aps.anl.gov

“Won’t it take more time, effort, and hassle to go outside of a known discipline?”

- Whether it does or not, it will be worth it.
- You can’t do everything.
- No matter how bright you are, you can’t know everything there is to know about all possible aspects of anything.
- There’s a limited amount of time to gain experience.
- Use it on what matters most…

mwhite@aps.anl.gov

Nobody gets a prize for reinventing the wheel

- No matter how great it is, it's just a wheel (unless you are a wheel designer). The wheel and the car are part of the means by which you get where you need to go.
- Don't forget what you're out there for. It's too easy to get distracted and waste time on stuff that's interesting but not really useful.
- Many people think they need to invent every detail in-house - don't bother.
- Save time and money by using what someone else already knows how to do [with appropriate thanks and credit to them, else nobody will work with you again.]
- Ask your vendor for suggestions on how to design something that can be made more cheaply but does what you want.

mwhite@aps.anl.gov

Life without an overview

- My PhD thesis advisor called it the "frog in a hole."
- You only see a tiny bit, but believe it's the whole world and live your life accordingly.
- Almost everyone else has a different perspective than yours; a good collaboration will help you and ideally will be of benefit to everyone involved.

mwhite@aps.anl.gov

“What can someone else tell me about my field?”

Maybe a lot, maybe a little.

- I know what I need, but have no clue how to do it.
- There are lots of aspects to any problem and there’s always a limited budget.
- Someone else’s expertise can make the difference between whether your project succeeds or fails.
- **You may not know that unless you make the effort to talk to other people.**

mwhite@aps.anl.gov

“How to get started?”

- **How to build relationships, how to learn about research where I can make a contribution?**
  - You may be the world expert in some area and the person to whom others come for help.
  - Someone else may need your help, but as things usually go, neither of you knows about the other without help.
  - Use the web, construct and use your own networks. If you have a good idea for an LDRD look around for collaborators; together, you may have a stronger proposal.
  - Look at Lab initiatives, government initiatives, and spend some time looking at what is funded.
  - **Ask people.**

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- **Will the Lab provide vehicles and support to carry these out? What additional resources and rewards are available?**
  - The lab is a big place and every Division is different. **Ask.**
  - **If you think you found a way to bring outside money in to support your work, talk to your supervisor to understand the ground rules.**

mwhite@aps.anl.gov

“Biggest obstacles in making a cross-discipline research team successful?”

- **Lack of communication or poor communication. There are innumerable ways for us to not all speak the same language.**
- Poor organization
- Poor documentation or none at all.
- When decisions are not made at the right time, the whole thing can grind to a halt. A standing army is expensive; stand for too long and you get distracted.
- Lack of a well-defined common goal and requirements can waste a lot of time and money.

mwhite@aps.anl.gov

“What can make collaborations easier”

- Be clear about what you expect of others, document it, and make the documentation and resources easily available to them.
- Manage by inclusion – really motivates people.
- Make sure what is expected of you is equally clear and documented.
- Hire competent people.
- Configuration control. It helps make sure you know if something changes.
- Be patient if impatience does not gain you anything.

mwhite@aps.anl.gov

- "Will these projects help me get more dollars and advance my career track - or will it take me off track?"
  - **Like the 8-ball says – "*That Depends*"**

mwhite@aps.anl.gov

- "If I work across Laboratories do I have to worry about protecting intellectual property?"
  - You have to worry about it no matter what.
  - There are also business-sensitive issues. If your vendor develops a better way to do something, you shouldn't broadcast it to their competition.
  - And if the wrong people get to see your cost estimates at the wrong time, that's how much it will cost.

mwhite@aps.anl.gov

- "What skills, abilities beyond technical competence, does it take to make these collaborations work?"
  - Ability to communicate, patience, involving and praising your colleagues, keeping things in perspective, thick skin and ability to go with the flow = sometimes the flow doesn't make much sense but someone somewhere supposedly has the overview.

mwhite@aps.anl.gov

- "What have you learned from your experience that you would do differently next time around?"
  - Large projects should get several years funding as soon as they are approved. You cannot imagine how much time is wasted replanning when the money doesn't arrive.
  - But, that is our system.
  - Each project is different, so not all lessons learned are transferable.
  - Allocate time and $ for the R&D.
  - It can really be a lot of fun.

mwhite@aps.anl.gov

- “What are the biggest factors to a successful collaboration?”
  - Whatever you are doing should be something you will be proud of when it is successfully completed.
  - A competent, dedicated team can accomplish amazing things.
  - Optimism – a little success goes a long way.
  - Collaborations are made of people. When things go well, the people will get along. When things go astray, the pressure builds and many humans do not get along so well anymore.

mwhite@aps.anl.gov

- Upper management can disagree and feud a lot, but if the engineers and scientists are at odds and won’t communicate, you are doomed.
- Try to maintain an even keel, realizing with some empathy that your partners are as enthusiastic to be successful as you.
- Talk to your colleagues. A lot.

mwhite@aps.anl.gov

- This is dedicated to all of the efforts, both large and small, that failed because someone wanted to do it all alone, without getting outside collaborators who may have had the expertise to mitigate the meltdown.

mwhite@aps.anl.gov

Thank you

mwhite@aps.anl.gov