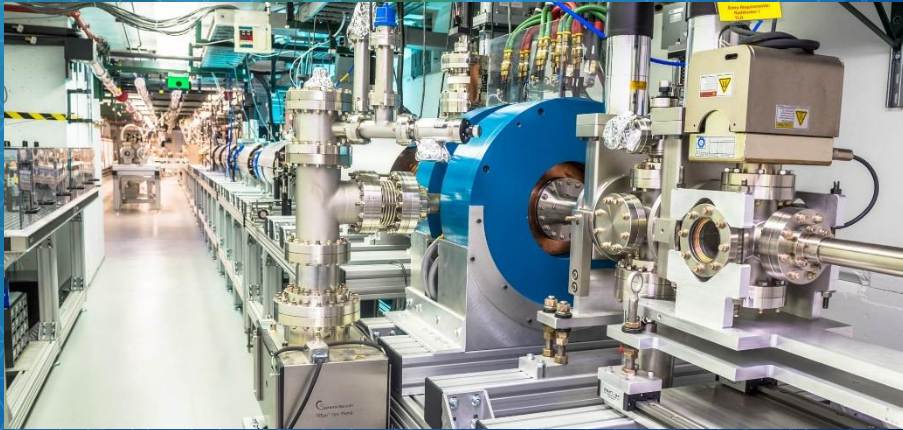
AUGUST 10, 2023

AWA NOW 2023

AWA COLLABORATOR PROGRAM



SCOTT DORAN
AWA Mechanical
Engineering and Design

AWA COLLABORATOR PROGRAM

Outline

- Why choose AWA?
- How do we support our collaborators?
- How does AWA help organize collaborators experiments?

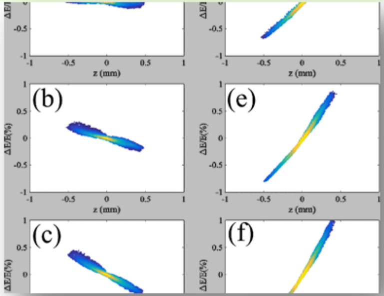
WHY CHOOSE AWA?

AWA COLLABORATOR PROGRAM

Why Choose AWA?

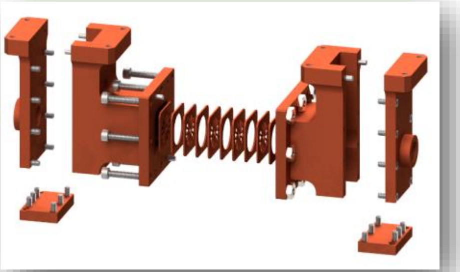
AWA is a Full-Service Research Facility with Many In-house Capabilities

Software



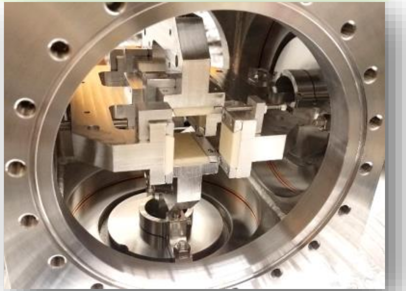
- Epics
- Beam physics
- S2E Simulations

Design



- Electrical engineering and pcb layout
- Mechanical engineering and design
- Beamline layouts
- High resolution renderings for publications

MFG



- High power rf structure design and testing
- Cathode deposition
- Precision UHV Assembly
- Magnet Manufacturing
- Support Structures

Operations

- Beamline Operators
- Control Systems
- Data Acquisitions
- Technical Support

AWA COLLABORATOR PROGRAM

Why Choose AWA?

AWA Leverages Lab Resources to Better Serve Collaborators

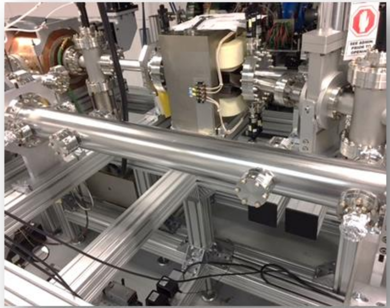
Computing

- Simulations
- Swing at LCRC
- Bebop at LCRC
- Theta at ALCF

APS

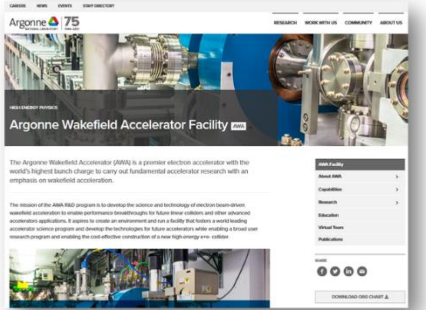
- Surface Studies
- High Power Testing
- RF Systems
- UHV Cleaning
- 3d Printing

Central Shops



- Machining
- Welding
- Brazing
- Inspection
- Consulting

Creative services



- Web publishing
- Photography
- Media art
- Full-service print shop

AWA COLLABORATOR PROGRAM

Why Choose AWA?

AWA Offers a Unique Hands-On Experience Through Traineeship

Building Better Scientists

- At AWA we promote a hands-on approach to learn all facets of an accelerator facility on a small scale. This provides a unique student experience where the students can learn new skill sets and build strong foundations.
- Some of the new skills sets include:
  - Project management
  - Beamline Operator
  - Laser Systems Design/Tuning/Alignment
  - RF Bench-top Measurements Techniques
  - UHV Handling/Assembly/Installation
  - Manufacturing/Fabrication Techniques

- AWA supports a wide range of students:
  - Graduate
    - Integrated: They become and integral part of the AWA team, take on new tasks, participate all aspects of regular employee including a full safety and training profile.
    - Remote: Will generally do most of their work from their university or organization then come to AWA for installation and beamline operations.
    - Hybrid: Generally, is a local student that can make several trips back and forth from their university or organization.
  - AWA participates is the Chicagoland Accelerator Science and Traineeship (CAST). A relatively new program enabled by support from a DOE Traineeship grant.
  - Undergrad (Summer Students) and Internships

HOW DO WE SUPPORT OUR COLLABORATORS?

AWA COLLABORATOR PROGRAM

How Do We Support Our Collaborators?

AWA Has Created a Positive Working Environment for Staff and Collaborators

Flexibility	AWA provides a “flexible” facility with many experimental options.
Assessment	An honest assessment of the scale of your experiment to determine facility impact, schedules, and effort needed.
Application	Applying the proper amount of effort to implement your experiment within your time frame.
Production	Working as a team, we’ll manufacture and produce an experiment that gets results.
Publishing	Web publishing and media reviews for highlight stories in anl.gov.
Continuous Improvement	Using lessons learned to improve ourselves and our facility, so, we can better serve you.

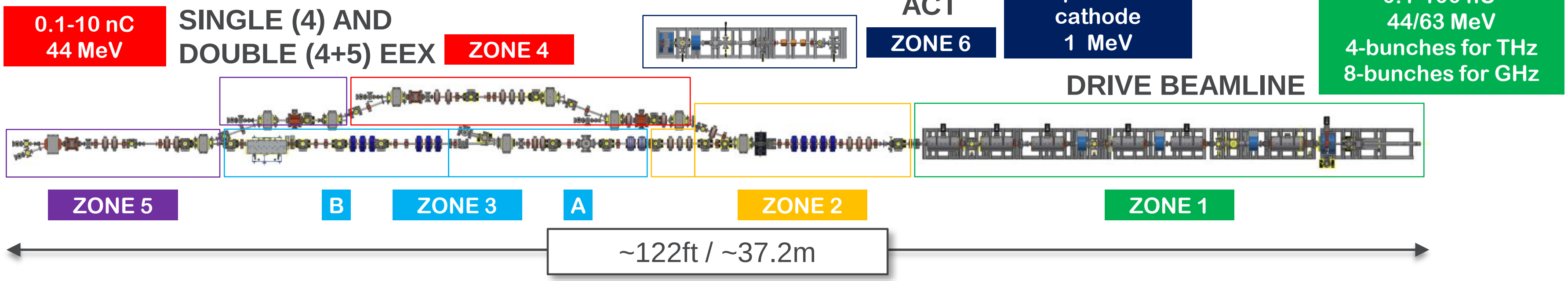
AWA BEAMLINE AVAILABLE BEAM CONDITIONS

Flexibility

AWA provides a flexible facility divided into experimental zones. Each Zone providing unique experimental options.

ZONE 6 (ACT)

- 1 MeV flexible beamline
- Mostly used for cathode tests
- Main diagnostics:
  YAG, ICT, or any other installed diagnostics



ZONE 4 & 5

- ~1 m space is available for experiment.
- Special beams such as longitudinally shaped beam can be provided.
- Main diagnostics:
  YAG, slit/quad scan, ICT, TDC, spectrometer

ZONE 3b

- Beamline with a device test area
- Recently used for ALT-DWA
- Main diagnostics:
  YAG, quad scan, ICT, or any other installed diagnostics

ZONE 3a

- Beamline with a device test area
- Mostly used for SWFA exp
- 11.7 GHz 400 MW PETs available
- Main diagnostics:
  YAG, quad scan, ICT, spectrometer

ZONE 1 & 2

- Fixed beamlines
- Main diagnostics:
  YAG, slit/quad scan, spectrometer, ICT
- Beam shaping (masks, MLC)
- Suitable for small footprint experiment and/or machine learning

AWA COLLABORATOR PROGRAM

Assessment

AWA Supports a Dynamic Range of Experiments and Programs

AWA uses a scaled approach to assess our collaborators experiment/program. The sm/md/lg scale is based on the Scope of Work and how it impacts the AWA Facility

Small

Simulations
Elec/Mech
Assembly
Testing
Yes/No Beam

Medium

Simulations
Elec/Mech Design
UHV Cleaning
UHV Assembly
Vacuum
Diagnostics
Installation
Controls
Beam time
Data Taking

Large

Simulations
Extensive:
Elec/Mech Design
UHV Cleaning
UHV Assembly
Vacuum
Diagnostics
Testing
Ext. Installation
Custom:
- Electronics
- Laser
- Motion Controls

Ext. Beam time
Ext. Data Taking

Experiment/Program Scale

Step 1 → **Assess the Scope of Work and Facility Impact**

AWA COLLABORATOR PROGRAM

Application

AWA Supports a Dynamic Range of Experiments and Programs

Then we plan, organize, and apply our effort to meet the scale of each experiment or program.

ACT

5 Experiments in last 12 Months

Small

Simulations
Elec/Mech
Assembly
Testing
Yes/No Beam

5 Experiments in last 12 Months

Medium

Simulations
Elec/Mech Design
UHV Cleaning
UHV Assembly
Vacuum
Diagnostics
Installation
Controls
Beam time
Data Taking

3 Experiments in last 12 Months

Large

Simulations
Extensive:
Elec/Mech Design
UHV Cleaning
UHV Assembly
Vacuum
Diagnostics
Testing
Ext. Installation
Custom:
- Electronics
- Laser
- Motion Controls

Ext. Beam time
Ext. Data Taking

Experiment/Program Scale

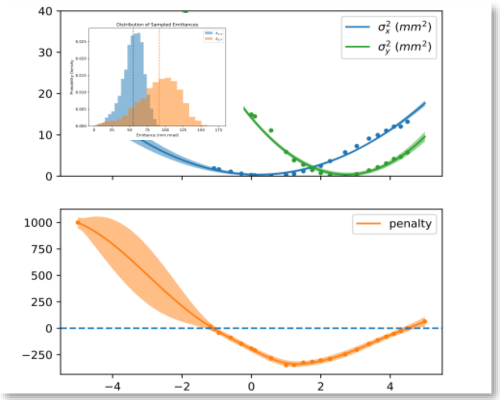
Step 2 → Apply the Level of Effort Needed to Produce Results

AWA COLLABORATOR PROGRAM

Production

Examples of Experiments of Different Scale

Small



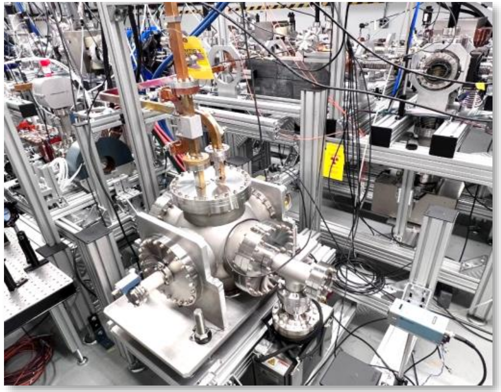
SLAC

Automated Quadrupole Scan Experiment, Ryan Roussel et al
https://arxiv.org/abs/2307.14963

- Software
- Diagnostics
- Zero Installation
- Limited Beam time
- Data Taking

Small scale facility impact
doesn't mean small scientific impact!

Medium

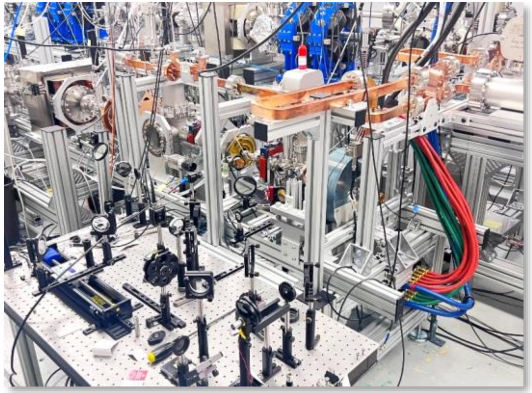


AWA/NIU

X-band Metamaterial Accelerator High-power Test (MTM-AAC), Xueying Lu et al

- Extensive Physics and Simulations
- Extensive Mechanical Design
- Manufacturing at ANL Shops
- Precision UHV Assembly
- Custom Electronics
- Medium Scale Installation (1-2 wk)
- Standard Beam time (1-2 wk)
- Data Taking/Processing

Large



AWA/Euclid/NIU

Travelling-wave Gun (TWG), Chunguang Jing et al

- Extensive Phys/Elec/Mech Design
- Extensive Diagnostics
- Precision UHV Assembly
- Custom Electronics
- Extensive Laser Installation
- Large Scale Installation (3-4 wks)
- Extended Beam Time
- Data Taking with Special Scope

AWA COLLABORATOR PROGRAM

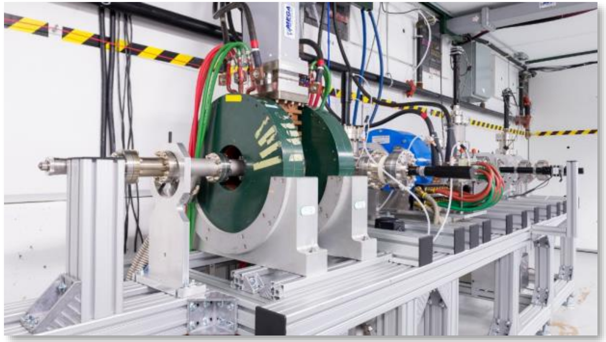
AWA Argonne Cathode Test-stand (ACT)

Success!

More on ACT in Eric's talk.

ACT

- The ACT is an independent beamline not connected to other AWA beamlines.
- It is powered by an RF waveguide switch that transfers the RF power from an accelerating cavity on the drivebeam to the ACT gun.
- This, along with careful scheduling, provides flexibility for collaborators to operate the ACT while the other beamlines may be unavailable due to an installation or other.
- The ACT started out as an RF breakdown studies beamline where we install different cathodes and performed quick-turn experiments. With the addition of laser input, we have been able to expand these capabilities to include low power beam diagnostics.



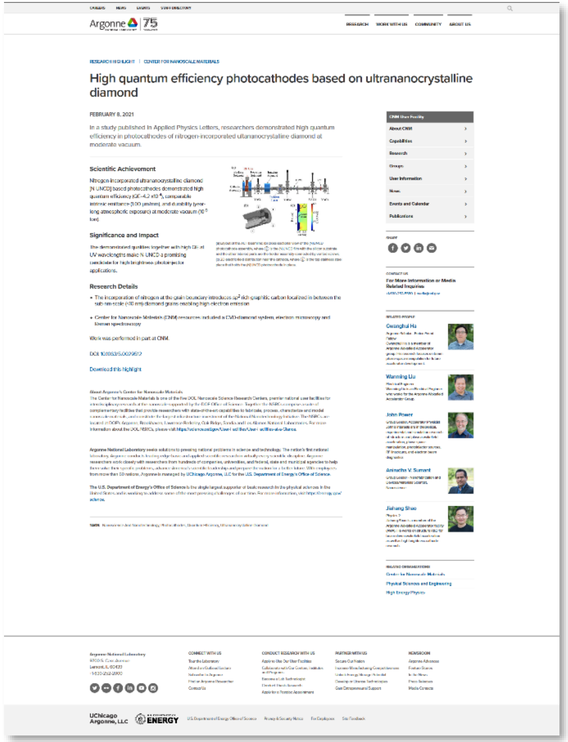
https://www.anl.gov/awa/breakdown-studies

Even though the ACT has had quite a large scientific impact on AWA, we consider the experiments at the ACT to be small because of the relative impact on the facility and the speed at which we can turn experiments around.

Example of an experiment and publication with a nice write-up from the Lab.

Demonstration of nitrogen-incorporated ultrananocrystalline diamond photocathodes in a RF gun environment

Appl. Phys. Lett. **117**, 171903 (2020); https://doi.org/10.1063/5.0029512 Gongxiaohui Chen


RESEARCH HIGHLIGHT | CENTER FOR NANOSCALE MATERIALS

High quantum efficiency photocathodes based on ultrananocrystalline diamond

FEBRUARY 8, 2021

In a study published in Applied Physics Letters, researchers demonstrated high quantum efficiency in photocathodes of nitrogen-incorporated ultananocrystalline diamond at moderate vacuum.

Scientific Achievement

https://www.anl.gov/cnm/article/high-quantum-efficiency-photocathodes-based-on-ultrananocrystalline-diamond

AWA COLLABORATOR PROGRAM

Continuous Improvements

AWA Continuously Improves to Better Serve our Collaborators

When AWA Improves

Whether baby steps or big leaps…

Our Collaborators Benefit

Equipment

Software

Laser

Operations

Communication

Organization

Continuous Improvements

More on C.I. in Wanming's talk.

HOW DOES AWA HELP ORGANIZE COLLABORATORS EXPERIMENTS?

AWA COLLABORATOR PROJECT GUIDEBOOK[1] AND EXPERIMENT LIFECYCLE DOCUMENT (ELD)[2]

For Principal Investigators

AWA COLLABORATOR PROGRAM

How does AWA help organize collaborators experiments?

What Does the AWA Guidebook Contain?

Introduces collaborators to AWA

Describes AWA Capabilities

Provides Experiment Flowcharts

Provides Detailed Information about Experiment Planning and instructions for the AWA ELD

Experiment **L**ifecycle **D**ocument

The ELD is a separate and scalable document that acts as the main form of communication during planning as well as a repository for all the information from your experiment:

Physics, Schedule, Simulations, Schematics, Engineering, Controls, Design, Installation, Run Plan, Operations, Data, Publication, and Lessons Learned

The ELD, along with all other experimental information, is stored and organized in BOX where it is accessible to everyone involved.

FROM PROPOSAL TO EXPERIMENT

AWA Experimental Flow Chart

P.I. Guidebook Reference Slide GO with the Flow!

*Work = design, fabrication, procurement, manufacturing, installation.

Initial Conversation (or LOI)

Written Proposal

One proposal per program

AWA Internal Review

E L D

Experiment Lifecycle Document

Physics Work

Elec. Mech. Eng. Work

Vacuum Work

Controls Work

Laser Work

Finalizing prep. (S2E, parts in-hand)

Experiment Readiness Review

Each run has its own Readiness Review (RR) (see next slide for details)

Finalizing Expected Schedule

Installation (vacuum, laser, camera, etc.)

Experiment & Summary Report

Analysis & Publications

Achievement Notice to AWA

P.I. follows up with AWA with publication (or other) information.

AWA PHYSICS REQUIREMENTS

Laser, e- Beam, RF, Diagnostics, Equipment

ELD Reference Slide
What you need

Round-to-flat and flat-to-round beam transformation (back-to-back transformation) - Philippe Piot, et al

Typical Parameters	Details
Laser	3 mm radius, uniform transverse distribution, 3 ps FWHM (4 BBO crystals except for thickest one)
e- Beam (energy, charge, bunches)	4 linacs (~40 MeV), 1 nC, single bunch. All cavity phases should be adjustable
RF	N/A (not for high-charge experiments)

Special Diagnostics	Details
Scanning Slits	Zone 2 (50 um / 50 um), Zone 3B before second skew triplet (multiple slit), Zone 5 (?? // ??)
TCD in Zone 5	Needed for Longitudinal Phase Space measurement
Breakdown Detection	N/A

Special Equipment	Reason	Status
Bolometer	N/A	
Interferometer	N/A	
Streak Camera	N/A	
Fast scope	N/A	

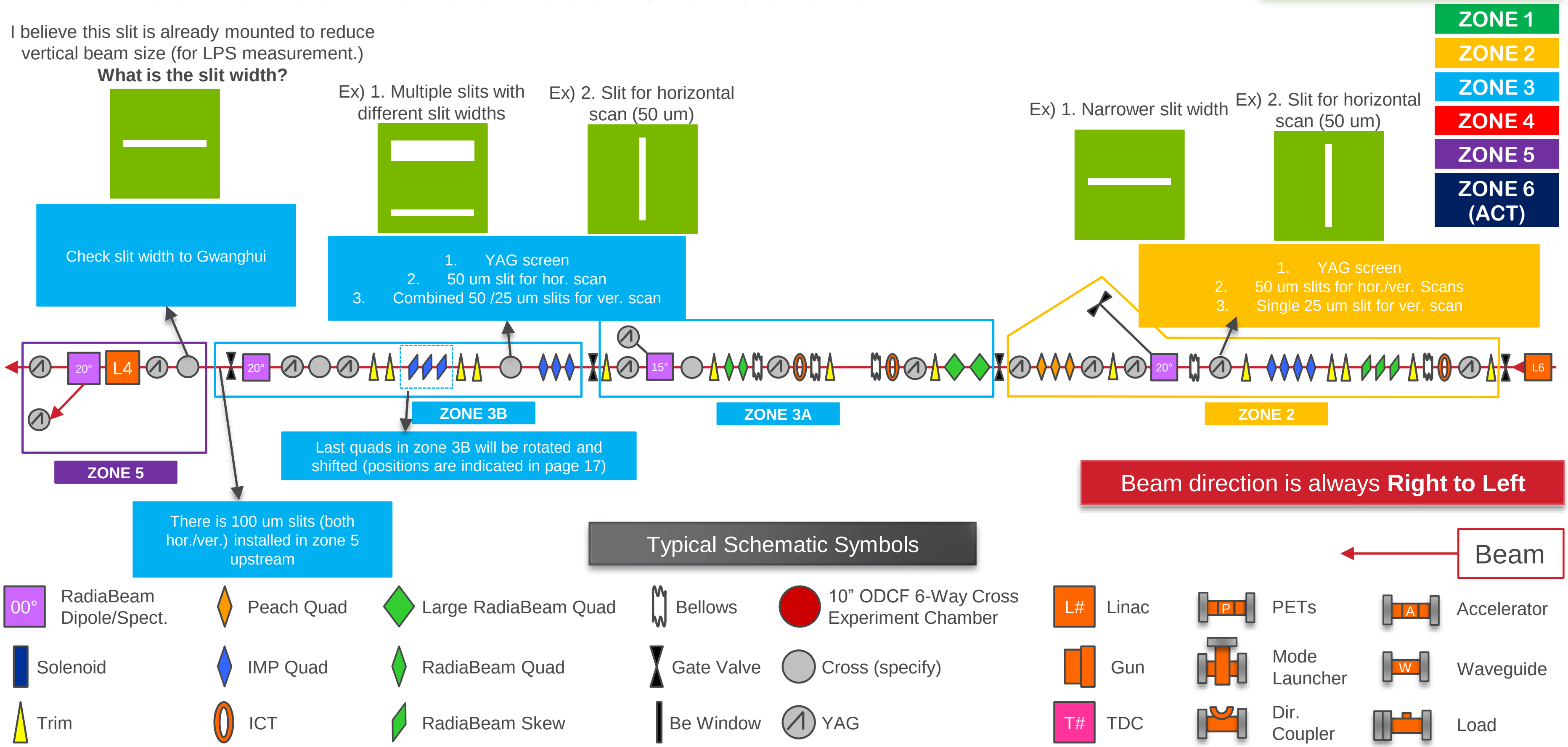
AWA BEAMLINE SCHEMATIC SYMBOLS

AWA Back-to-Back Transformation Slit Installation

ELD Reference Slide
Where you need it

I believe this slit is already mounted to reduce vertical beam size (for LPS measurement.)

What is the slit width?



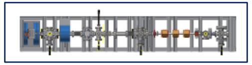
AWA AVAILABLE BEAM CONDITIONS AND EXPERIMENTAL ZONES

ELD Reference Slide
Zones needed

From the “TDC in Zone 5” note in the ELD, we know we need all these zones ready for this experiment

ZONE 6 (ACT)

- 1 MeV flexible beamline
- Mostly used for cathode tests
- Main diagnostics:
  YAG, ICT, or any other installed diagnostics



ACT

ZONE 6

Charge depends on cathode
1 MeV

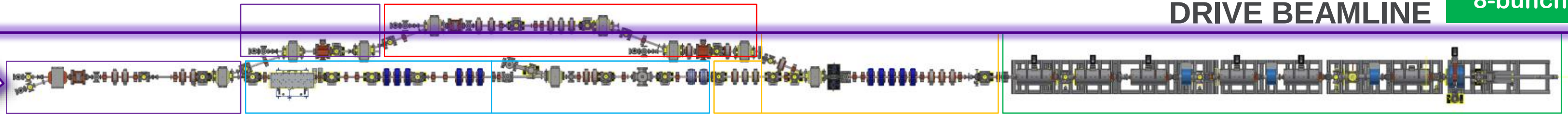
0.1-10 nC
44 MeV

SINGLE (4) AND DOUBLE (4+5) EEX

ZONE 4

0.1-100 nC
44/63 MeV
4-bunches for THz
8-bunches for GHz

DRIVE BEAMLINE



ZONE 5 | B | ZONE 3 | A | ZONE 2 | ZONE 1

~122ft / ~37.2m

ZONE 4 & 5

- ~1 m space is available for experiment.
- Special beams such as longitudinally shaped beam can be provided.
- Main diagnostics:
  YAG, slit/quad scan, ICT, TDC, spectrometer

ZONE 3b

- Beamline with a device test area
- Recently used for ALT-DWA
- Main diagnostics:
  YAG, quad scan, ICT, or any other installed diagnostics

ZONE 3a

- Beamline with a device test area
- Mostly used for SWFA exp
- 11.7 GHz 400 MW PETs available
- Main diagnostics:
  YAG, quad scan, ICT, spectrometer

ZONE 1 & 2

- Fixed beamlines
- Main diagnostics:
  YAG, slit/quad scan, spectrometer, ICT
- Suitable for small footprint experiment and/or machine learning

AWA EXPERIMENT SUMMARY

ELD Reference Slide
You did it!

- Installation Pictures
- Publications
- Proceedings
- Journals
- Lessons Learned
- etc, etc, etc…

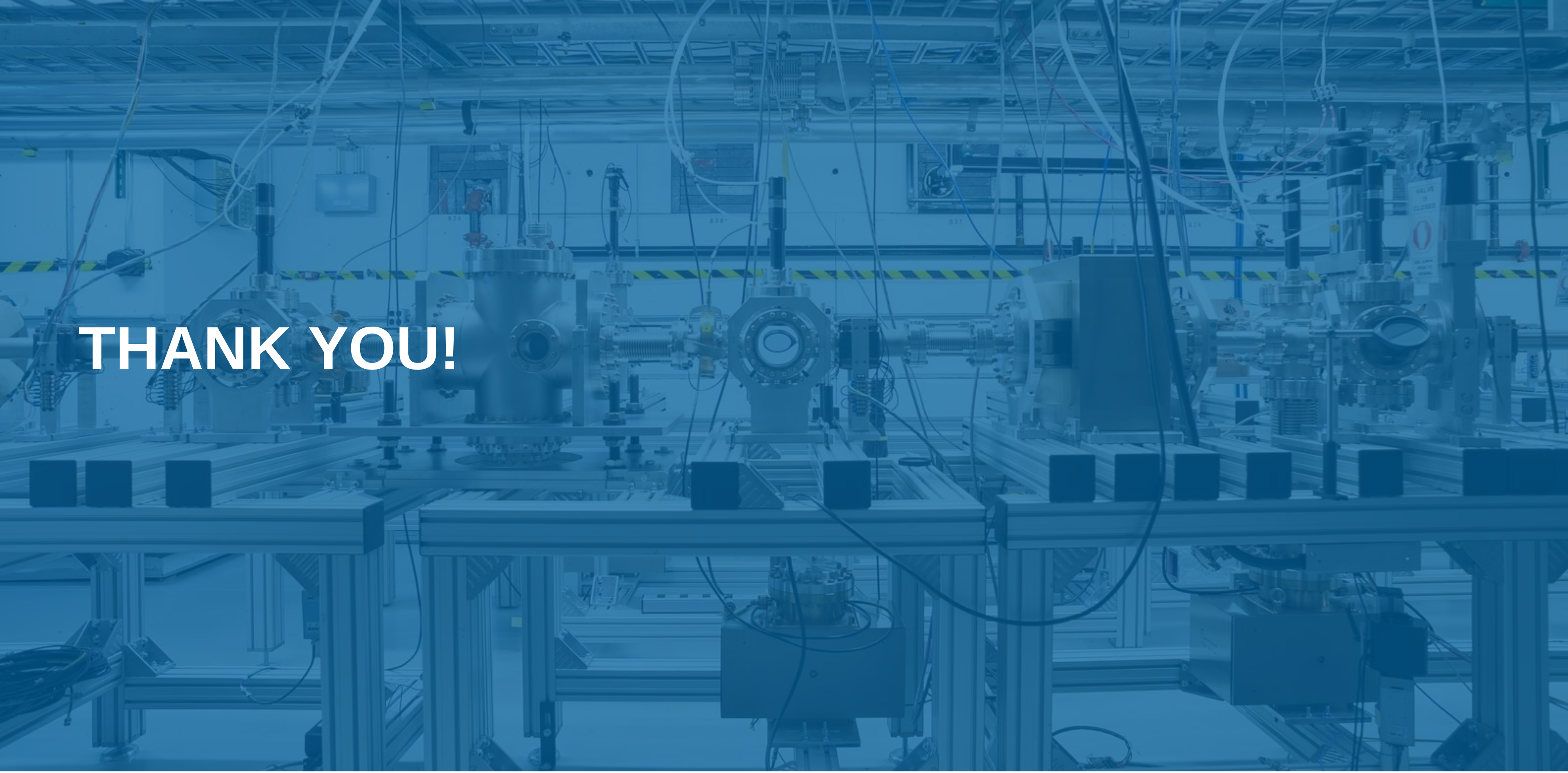
Another Successful Experiment Where Everything Went Swimmingly!

Uploaded to AWA Web Site?		

AWA COLLABORATOR PROGRAM

Summary

- AWA is a full-service research facility that leverages the Labs resources to better serve collaborators.
- AWA uses creative vacuum and RF power strategies for Experimental Zones which creates flexibility for collaborators.
- AWA has developed the ELD to help improve communications, schedules, documentation, and sustainability for collaborators.
- AWA is a happy participant in the CAST program.
- AWA has created a positive and inclusive working environment for staff and collaborators.



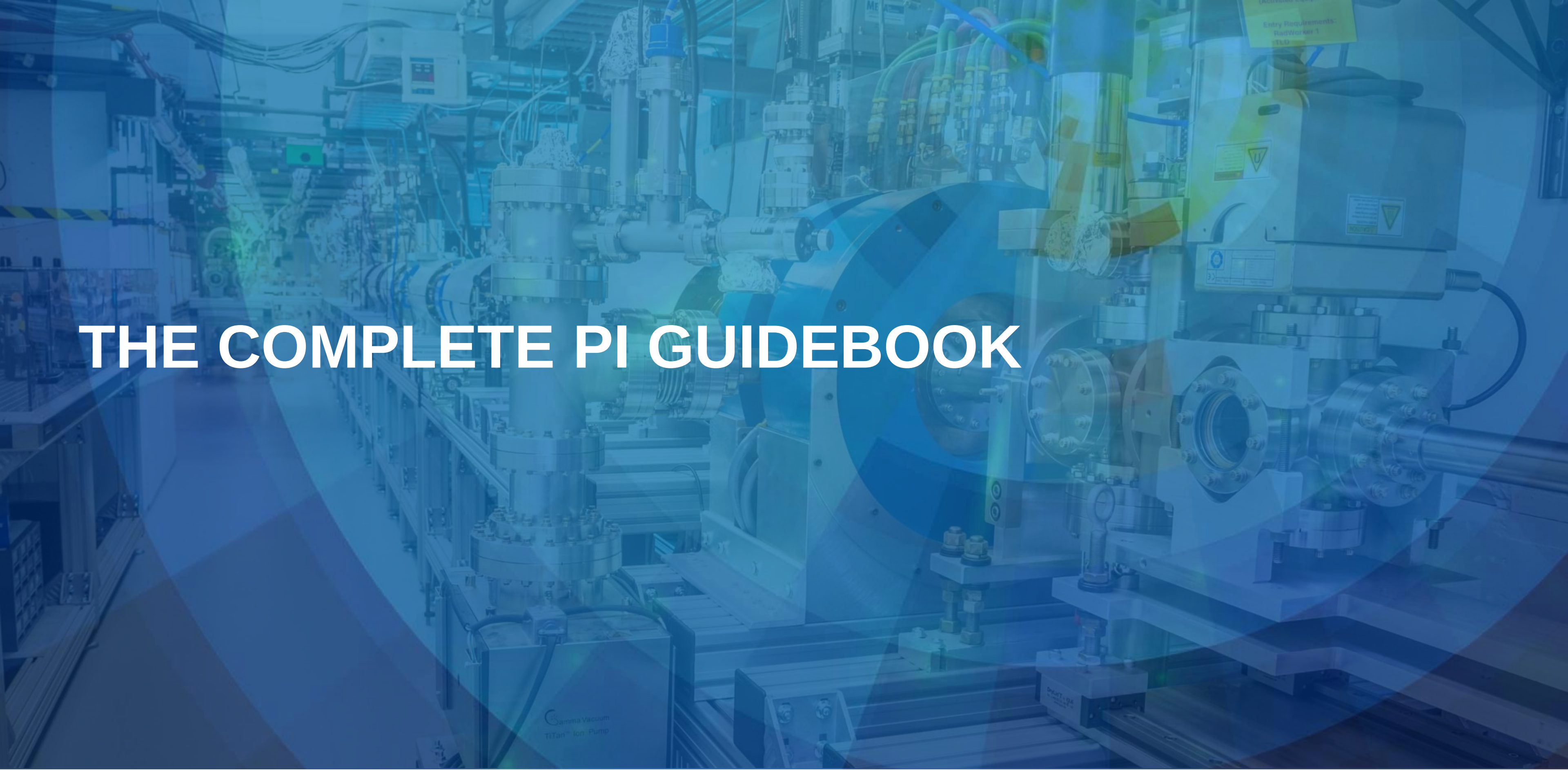
THANK YOU!

Reference slides:

The complete P.I. Guidebook
&
ELD from the Back-to-Back Transformation Experiment

QUESTIONS?

THE COMPLETE PI GUIDEBOOK



U.S. DEPARTMENT OF ENERGY

Argonne National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

Argonne NATIONAL LABORATORY

AWA COLLABORATOR PROJECT GUIDEBOOK AND EXPERIMENT LIFECYCLE DOCUMENT (ELD)

For Principal Investigators

AWA

AWA PERSONAL AND ROLES

www.anl.gov/awa

Rik Yoshida - HEP Division Director
Katrin Heitmann - Deputy Division Director

Norm Rendon
Financial Officer

Greg Landowski
ESH

.
Administration

AWA Group Leader

John Power

Joint Appointment NIU/APS/AWA

Xueying Lu

Joint Appointment NIU/APS/AWA

Philippe Piot

AWA Facility Manager

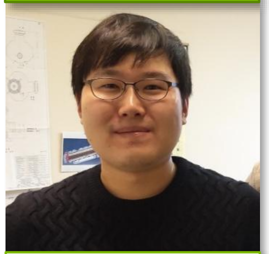
Electron Sources

Eric Wisniewski

Advanced Accelerator Concepts

Gongxiaohui Chen

Beam Physics



Seongyeol Kim

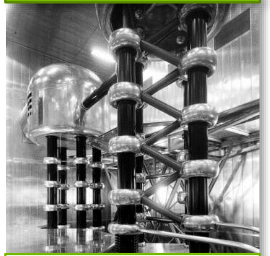
Controls & RF Systems

Wanming Liu

Mech & Civil Engineering

Scott Doran

Master Technician



Charles Whiteford

AWA FACILITY OVERVIEW

Top View - Building 366

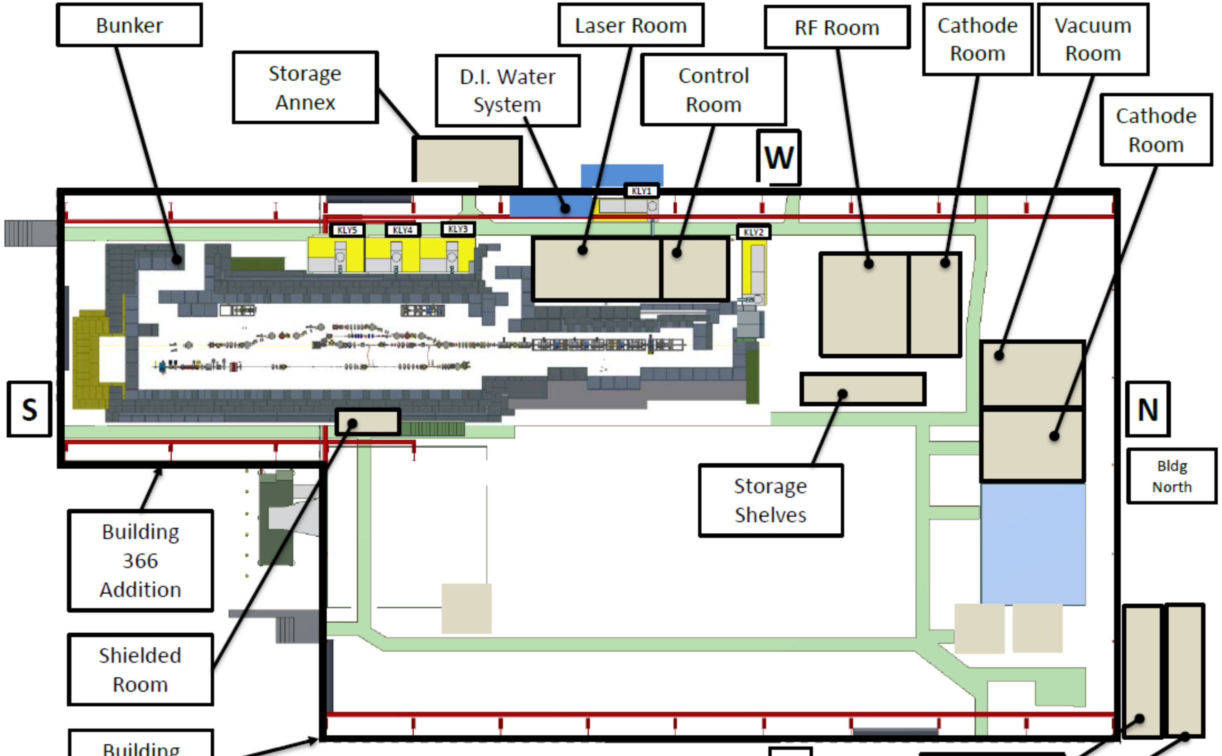
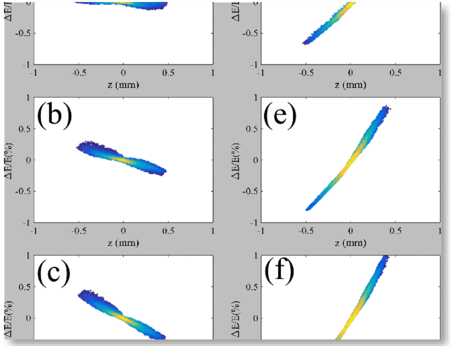


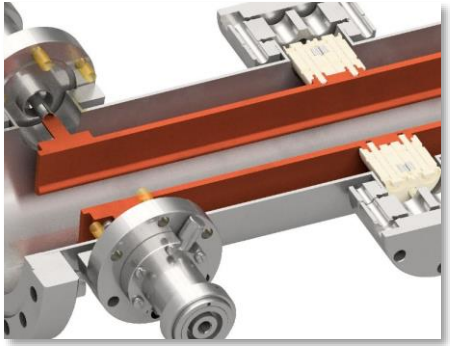
Fig. 1
AWA Areas of Building 366

AWA IS A FULL-SERVICE RESEARCH FACILITY

AWA can provide support for projects of different size and scope. Here are some our in-house capabilities



- Beam physics
- Simulations
- High power rf structure design, cold testing, manufacturing, and in-beam testing
- Electrical engineering and pcb layout



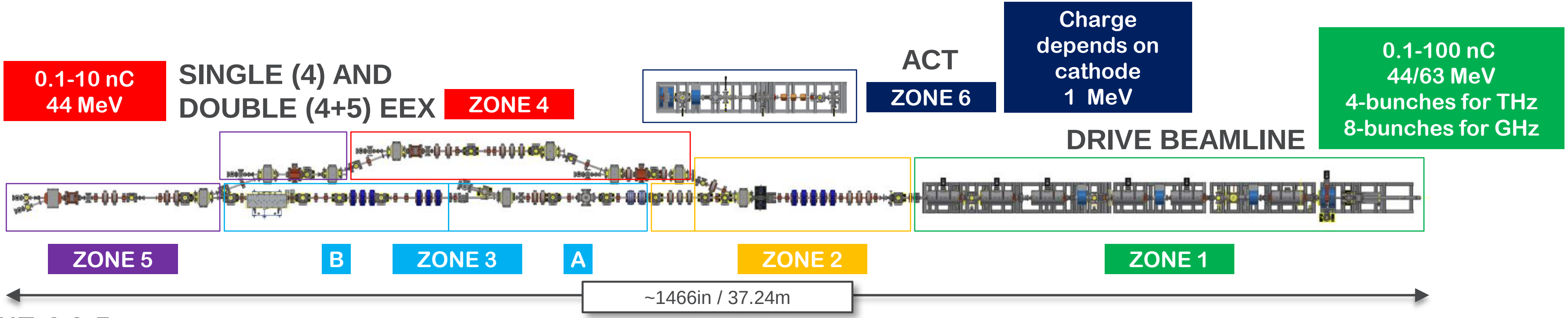
- Cathode deposition
- Mechanical design and manufacturing
- Beamline layouts
- High resolution renderings
- 3d printing

- UHV assembly and installation
- Control systems
- Beamline operators
- Data acquisition
- Professional photography

BEAM PHYSICS → SIMULATIONS → STRUCTURE DESIGN, BUILD, TEST, & INSTALL → ELECTRICAL AND MECHANICAL DESIGN/ENG → BEAMLINE AND CONTROLS LAYOUT → UHV, CONTROLS, & SYSTEMS INSTALL → OPERATE BEAMLINE → ACQUIRE DATA

AWA BEAMLINE AVAILABLE BEAM CONDITIONS

Options, Options, Options…



ZONE 4 & 5

- ~1 m space is available for experiment.
- Special beams such as longitudinally shaped beam can be provided.
- Main diagnostics: YAG, slit/quad scan, ICT, TDC, spectrometer

ZONE 6 (ACT)

- 1 MeV flexible beamline
- Mostly used for cathode tests
- Main diagnostics: YAG, ICT, or any other installed diagnostics

ZONE 3b

- Flexible beamline, dedicated for re-build
- Main diagnostics: YAG, quad scan, ICT, or any other installed diagnostics

ZONE 3a

- Fixed beamline with a device test area
- Mostly used for SWFA exp
- 11.7 GHz 400 MW PETs available
- Main diagnostics: YAG, quad scan, ICT, spectrometer

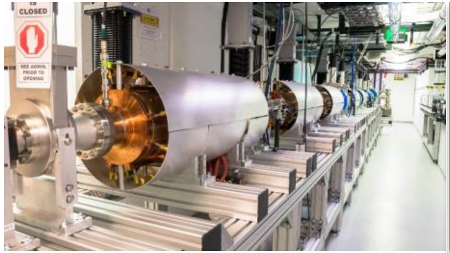
ZONE 1 & 2

- Fixed beamline
- Main diagnostics: YAG, slit/quad scan, spectrometer, ICT
- Suitable for small footprint experiment

Please Talk with Your AWA Partner for More Details or Other Special Conditions

PARAMETER RANGES

AWA Beamlines



DRIVEBEAM

- Nominal beam energy 44 or 63 MeV, 2 Hz rep rate, laser pulse 0.3-6 ps
- Single bunch charge: 0.1-100 nC
- Multi-bunch charge:
  - 1.3 GHz 8-bunch train up to 480 nC
  - THz 4-bunch train up to 20 nC

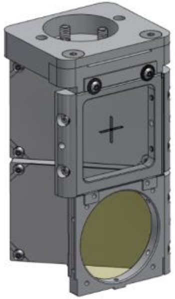
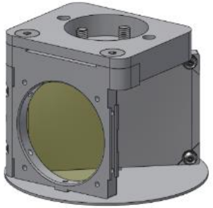
EEX

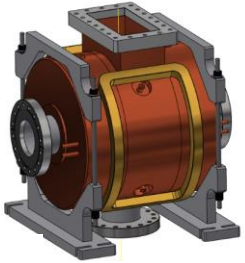
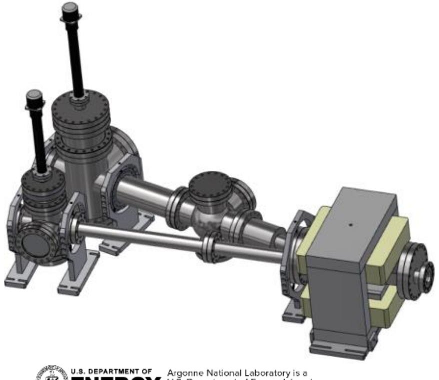
- Nominal beam energy 44 MeV, 2 Hz rep rate
- Single bunch Charge 0.1-10 nC
- Beam shaping with masks available

ACT

- Nominal beam energy 1 MeV, RF pulse length 10 us, 2 Hz rep rate
- Charge with copper cathode, 200 pC
- 65-100 MV/m cathode surface field

AWA STANDARD DIAGNOSTICS AVAILABLE

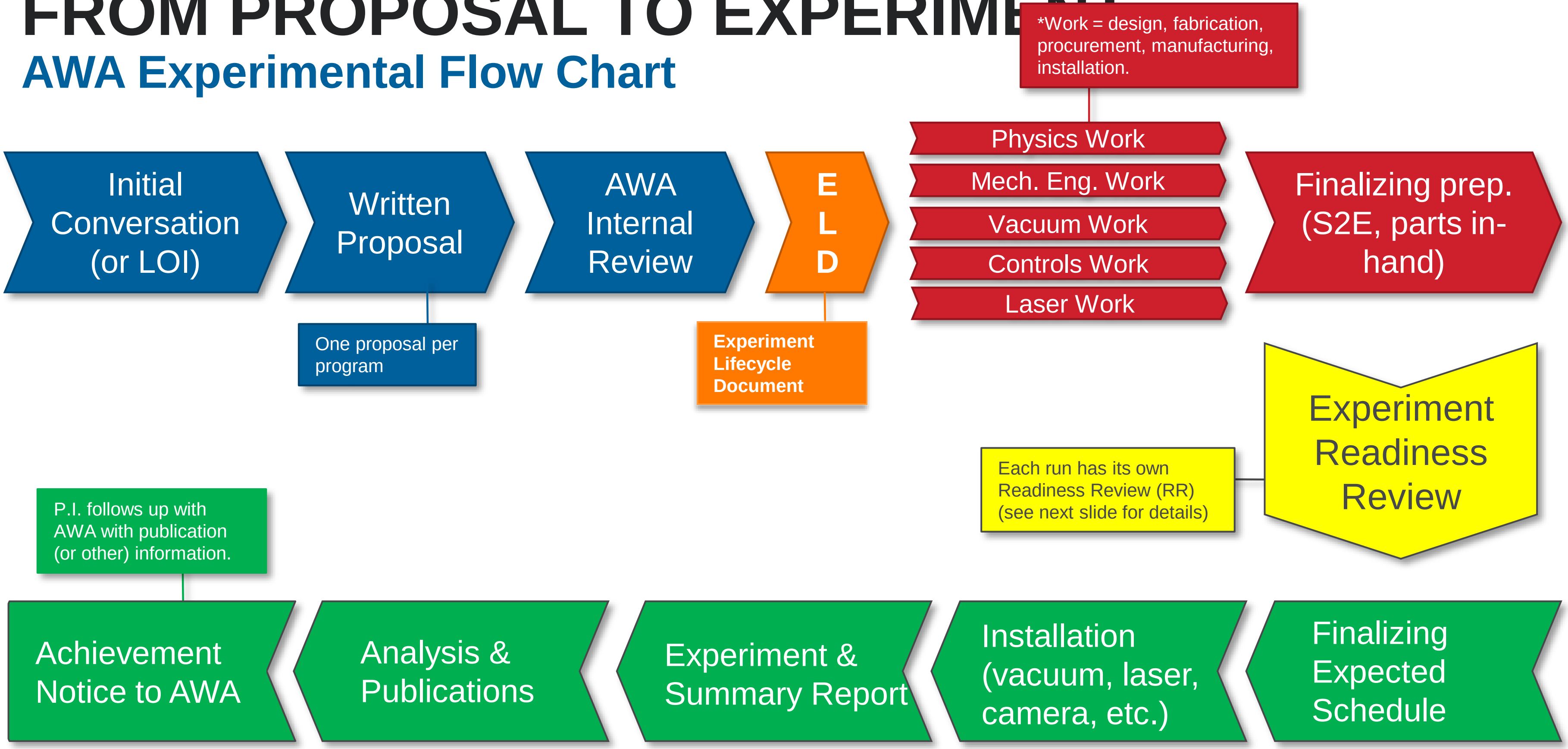




- YAGs: 50 mm dia. screen, image beam transverse profile/intensity distribution
- ICTs: charge measurement, 70 pC – 500 nC
- Transverse Deflecting cavities (L-band) for longitudinal phase space measurement --- located in Zone 4 and Zone 5
- BPMs for position-jitter monitoring
- Trigger control and synchronization
- Scanning slits for emittance measurements (50 micron) Zones 2,4,5
- Solenoid or quad scans
- Spectrometers: beam energy measurement in Zones 2,3,5

PROPOSALS, EXPERIMENTS, & ELD'S

FROM PROPOSAL TO EXPERIMENT

AWA Experimental Flow Chart

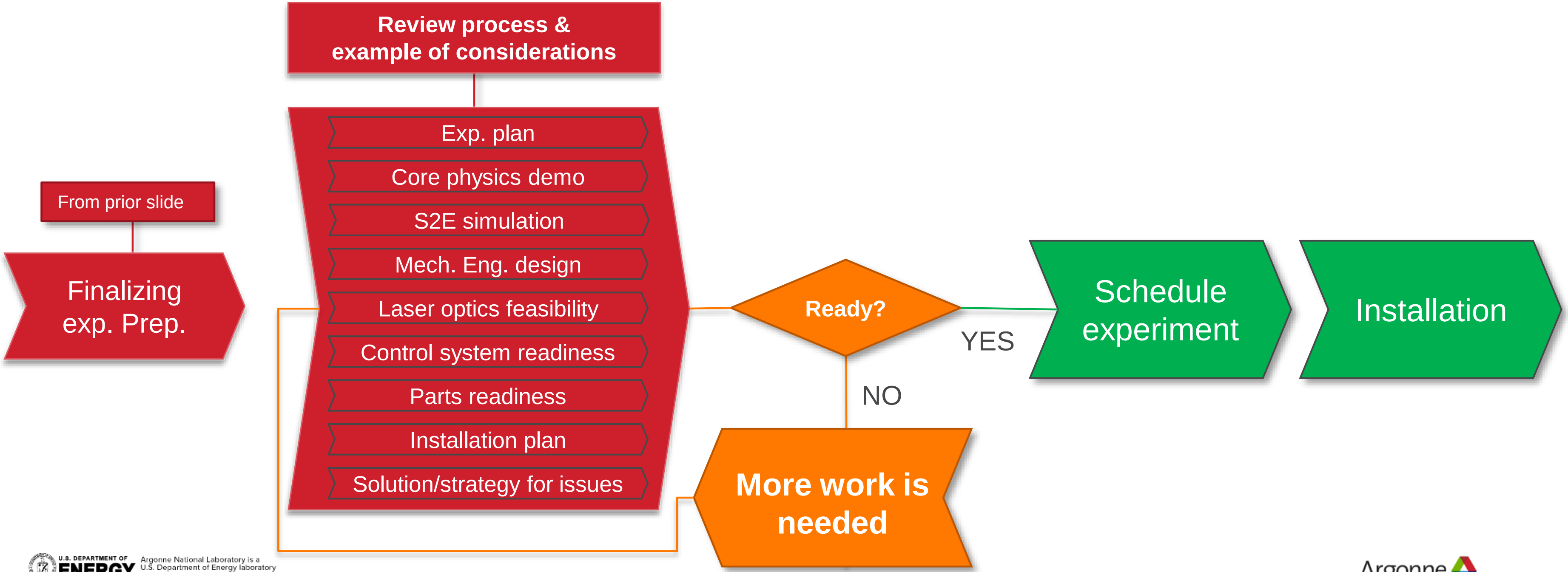


AWA EXPERIMENT READINESS REVIEW

Subtitle, delete if not needed

It is our goal to make all experiments start and finish on time with great results

To make this happen, the experiment has to be well-prepared and nicely planned out. All participants should discuss possible show stopping issues and come up with solution/strategy to handle those issues.



FROM PROPOSAL TO EXPERIMENT - DETAILS

Subtitle, delete if not needed

Initial conversation (or LOI)

- Collaboration work at AWA usually starts with in-person conversation, phone-call, or email exchange. Also, it is possible to send LOI to AWA group to initiate the collaboration.
- During this informal phase, we can discuss the feasibility and beamtime availability of the proposed experiment at AWA

Written Proposal

- If the initial discussion is positive, the next step is a proposal template for collaborators to fill out and submit relevant information to AWA.
- AWA group uses this information to conduct an internal review to confirm experimental feasibility, facility schedule, alignment between the project and AWA's vision/role, etc.

Internal review

- AWA will have internal review when the written proposal is received.
- The outcome of the review will determine whether or not the collaboration is a good fit and to decide AWA's commitment to the project.

Physics effort

- The physics effort includes various design and optimization work, and detailed work will depend on the experiment type.
- e.g. EM / beam simulation for core physics, RF structure design, beamline / diagnostics design, injector optimization, tolerance study, etc.

Mechanical engineering & vacuum work

- Once the physics design is finished, engineering design for the beamline starts. This includes design of beamline, confirmation of vacuum parts, design and fabrication of vacuum and external components.
- All mechanical & vacuum work for the experiment should be discussed with Scott and Eric.

Controls work

- Experiments require remote controls of various electronic devices (e.g. actuator, rotation/translation stages, magnets, camera, etc). Device connection and control should be confirmed prior to experiments.
- All controls work (especially collaborator provided devices) should be discussed with Wanming.

Laser work

- All experiments need specific laser setup (e.g. spot size, pulse length, etc). Also, depending on what experiment requires, laser may have custom requirements
- The laser requirements should be designed and confirmed prior to experiments; the details should be discussed with John.

FROM PROPOSAL TO EXPERIMENT - DETAILS

Subtitle, delete if not needed

Finalizing preparation

- Prior to the readiness review, core physics has to be demonstrated in the simulation, and any possible physics issues should be explored by simulation (e.g., S2E simulation incl. diagnostics).
- Prior to the review, engineering/vacuum/controls/laser work should be completed. All necessary parts should be ordered, manufactured, and cleaned properly.

Experiment readiness review & scheduling

- To avoid unexpected show stopping situations, we want to review the readiness of the experiment.
- Once the experiment is ready, then it will be scheduled. But, experiment can be deferred depending on the review result.
- Please find more details in the later slides.

Installation

- Experiments require installation and hardware preparation work.
- Vacuum installation, diagnostics setup (e.g. camera), laser setup and alignment, system connection to control system, etc. Most of these will be done by AWA crew.
- Some special setups may be required for some experiments. For example, fast scope for RF signal detection, breakdown detection, radiation measurement, etc. Some of this work will require collaborator guidance or participation.

Experiment & Summary report

- Normal operation hours are 8 am – 6 pm, from Monday to Friday.
- All experiments should be planned for normal operation hours.
- Once the experiment is finished, PI should submit a concise summary report to AWA group, please include the central result and any lessons learned.
- These summaries are an important avenue for AWA group to continuously improve the facility and experiment experience.

Analysis & publication

- AWA group will participate in the data analysis and discussion.
- Regular meetings are recommended until the result is published and the case is closed.
- It is important for all authors to participate in the publication preparation.
- It is recommended to confirm the content with AWA staff.

Achievement notice to AWA

- It is important for AWA to keep tracking all achievements to prove the facility’s vitality.
- Therefore, we ask all collaborators to please promptly notify us about notable achievements.

AWA EXPERIMENT LIFECYCLE DOCUMENT (ELD) DETAILS AND INSTRUCTIONS

The ELD (separate file):

- The ELD is a simple set of slides that will help organize your experiment by helping P.I's organize and communicate the necessary details of the experiment with AWA.
- The ELD is especially important tool to use early in the project so the team can determine long lead time (and other) issues. It is also critical to use when the project has new and/or updated information, such as a schematic change or simulation updates that will affect schedule, controls, or engineering.
- The ELD is to be updated and presented to AWA staff during collaborator and/or experiment meetings.

Sections within the ELD:

The ELD is broken down to five major sections:

1. Your Experiment
2. Physics
3. Engineering / Controls
4. Safety and Hazard Analysis
5. Summary and Follow-up

Experiment Organization and the ELD:

Once your experiment has been accepted, AWA will populate a space in our secure BOX area with several folders to help organize your experiment. Each experiment will have its own ELD. It will look similar to this:

BOX > AWA_Experiments > Collaborator_Name > Experiment_Name

(each experiment will have predetermined sub-folders)

Meetings, Proposal, Physics, Engineering, Controls, Fabrications, Run, Post-experiment, etc.

Here is the basic process:

1. The Project Guidebook and the ELD Template will be placed at the "Collaborator" level. This is to assist AWA with version control.
2. The P.I. will copy and paste the ELD from the "Collaborator" level into the "Meetings" sub-folder and change the name of the ELD to add the experiment acronym. This is the ELD the P.I. will update for meetings for each specific experiment.
3. For each meeting, the ELD will be copied, and renamed with a new date. Simply copy and paste the ELD in place (in the BOX meetings folder) and change the date in the file name. This allows us to easily see changes and updates to the ELD as well as preserving prior information.
4. For each new experiment, the process will be repeated.

YOUR EXPERIMENT

TIMELINE AND SCHEDULING

Subtitle, delete if not needed

All projects require organization and schedule management, and it is especially important for experiments. Depending on the size and complexity of the project, the PI can choose to make either a simple timeline or a more complex version such as a Pert chart.

Simple: e.g. MS Word Table with Tasks

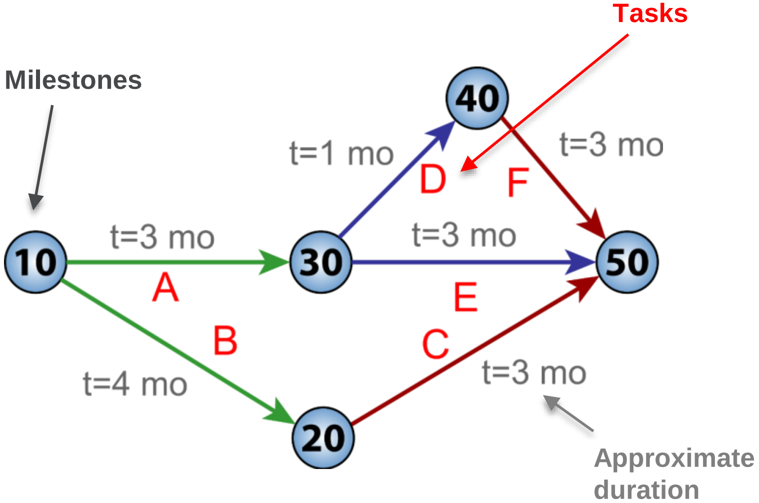
Example

PHASE 1 PERFORMANCE SCHEDULE

We present an approximate schedule for these tasks in the Table below:

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
Task 1									
Task 2									
Task 3									
Task 4									
Task 5									

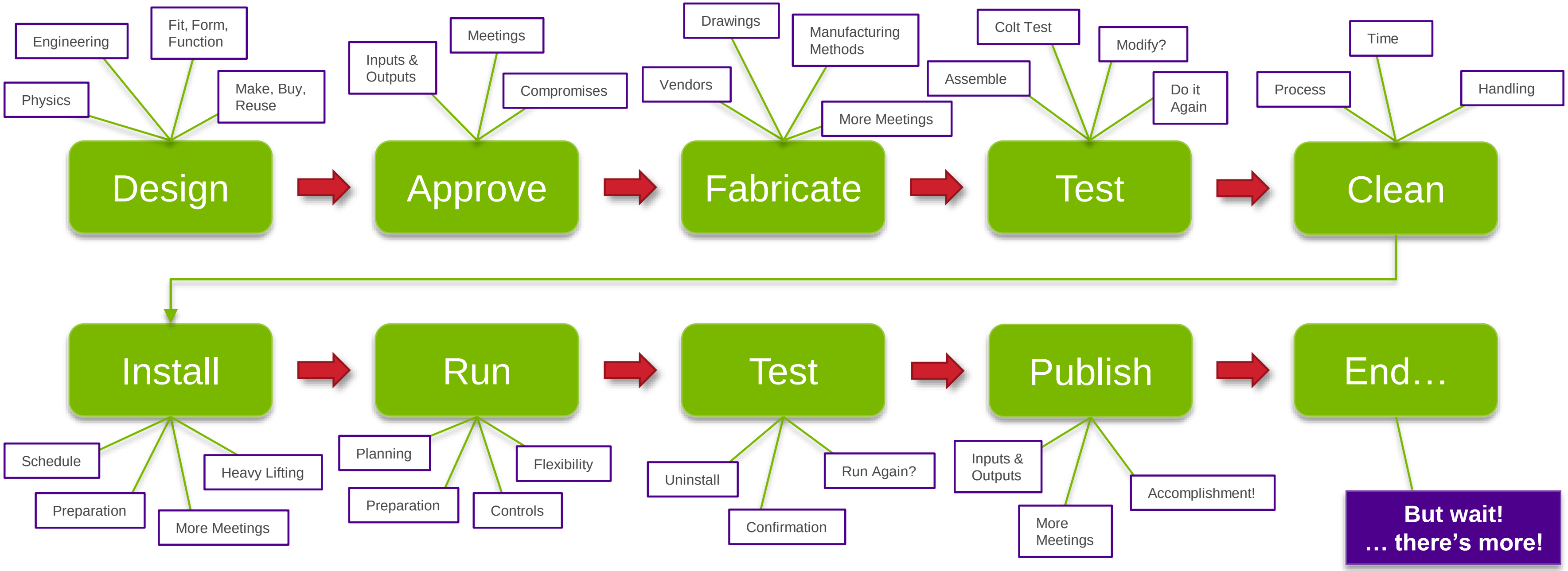
Complex: e.g. PERT CHART



References:
https://en.wikipedia.org/wiki/Program_evaluation_and_review_technique
https://en.wikipedia.org/wiki/Critical_path_method

EXPERIMENT LIFECYCLE
… and Project Management

There are many moving parts in each experiment and each experiment can differ greatly. Each of the major steps below involves different disciplines and different levels of expertise. The ability to communicate across disciplines is a skill that takes time to develop. Ask lots of questions, especially early in the process. Below are some of the ways different aspects of an experiment are connected and they tasks they require.



AWA Is here to help with all of this. It's what we do.

AWA EXPERIMENT TEAM

List PI's, Team Members Roles and Responsibilities

- Collaborator / Organization
  - Personnel
- AWA
  - Personnel

AWA EXPERIMENT TASKS AND COMPONENTS

Assign, Track, and Update Major Tasks

Track Purchased Component Status and Location

Space will be provided for each of these.

Use as the project needs.

EXAMPLE OF AWA EXPERIMENT RUN PLAN

Planning and Preparation are the Keys

The experiment plan must be written and shared to all participants prior to the experiment

a. To get feedback to find any missing steps or measurements
b. To inform the goals and what will happen
c. To confirm if the schedule is either too tight or too loose.

There is no specific form. However, it would be good if your plan includes:

- Project goal/measurement targets
- Daily goals
- Daily detailed actions
- Concern or possible issues (major ones only)

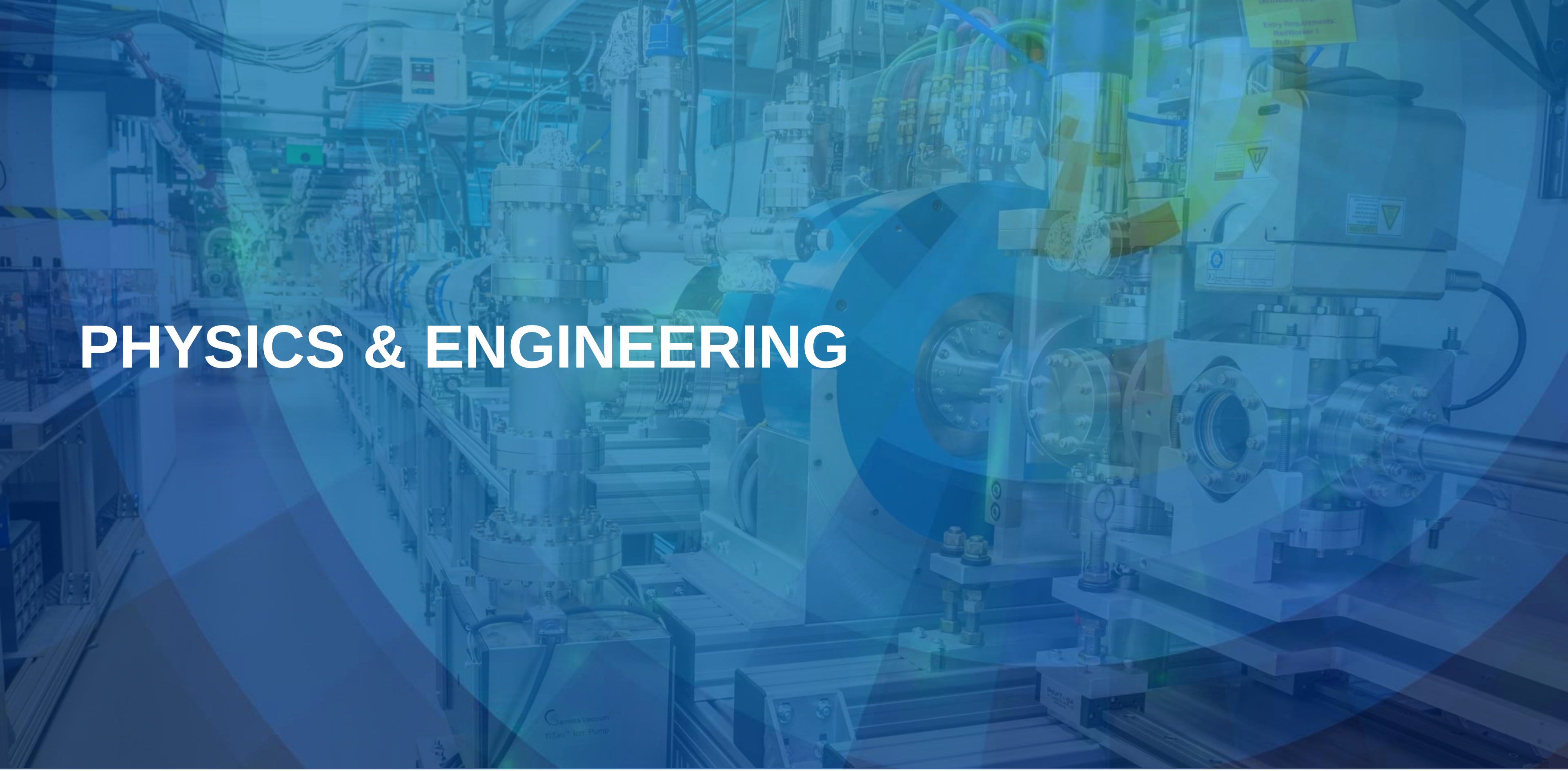
Example

Day 1

Goal:
- All operation system and equipment response check
- Confirm THz drive bunch train generation

Morning:
Send single drive bunch to the end of the beamline and check all system.
- YAG actuator, camera iris setup
- Quad and trim magnet response and polarity
- Deflecting cavity power/phase control

Afternoon:
Send four laser pulse and generate THz drive bunch train.
- Bunch separation should be checked and set by TDC measurement
  - Timing setup may need laser realignment
- TDC measurement needs calibration
- Test all four-beam focus to structure center YAG
  - Tune the beam based on bunch #2
  - measure bunch train projected emittance, if time permits

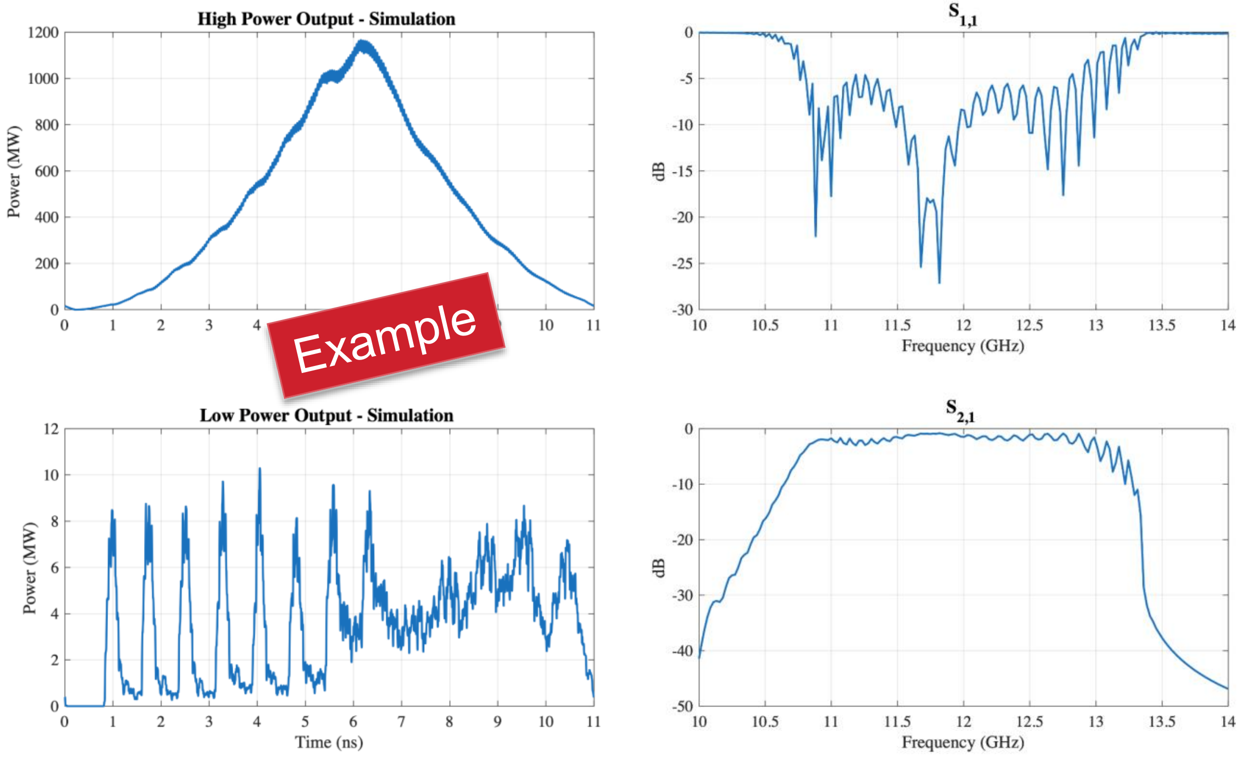


PHYSICS & ENGINEERING

PHYSICS & SIMULATIONS

Simulation Updates

- There will be space in the ELD to place simulations, other related physics information, and updates.

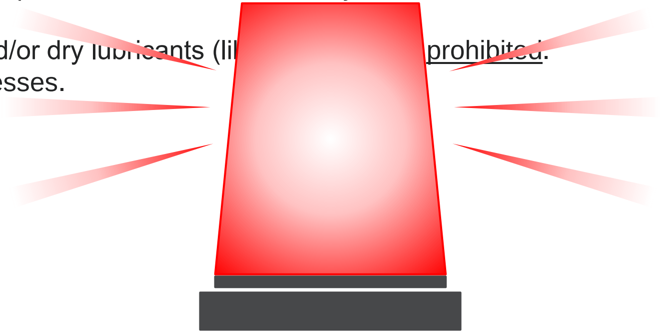


AWA ENGINEERING REQUIREMENTS

AWA Vacuum and Design Requirements

This slide is for general reference. Consult AWA personnel prior to designing anything for inside or outside vacuum.

- All in-vacuum components and processes must be pre-approved by AWA prior to design phase.
- UHV requirements for AWA include several factors. For example:
  - Material selection
    - Some approved material for inside vacuum (a full list can be provided):
      - SST, Aluminum, Copper, Alumina ceramic, Quartz, Gold, Tungsten, and Silver-plated hardware if necessary.
    - Prohibited material for inside vacuum:
      - Use of "UHV" epoxy, adhesives, hydrocarbons, Teflon, and "UHV" grease and/or dry lubricants (li[…] prohibited.
    - To avoid program delays, consult with AWA prior to choosing material and/or processes.
  - Manufacturing methods
    - Brazing (hydrogen braze ok, other must be approved), welding, fastening, etc.
      - Consult with AWA personnel prior to defining manufacturing processes.
    - Machining
      - Use UHV best practices to prevent virtual leaks.
      - Venting for blind holes and mating surfaces.
      - Many cutting fluids and abrasives are prohibited.
      - Consult with AWA prior to manufacturing or defining a manufacturing process.



- Cleaning for UHV
  - APS MOM group cleaning method for UHV is preferred.
  - AWA in-house cleaning uses similar processes as APS and is available for

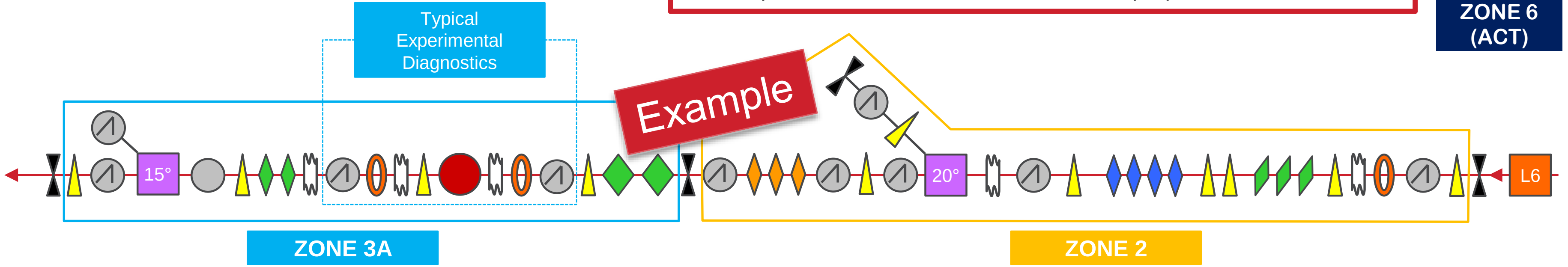
AWA BEAMLINE SCHEMATIC SYMBOLS

AWA Schematic Symbols

AWA Drivebeam Zones 2 & 3a
Show for reference

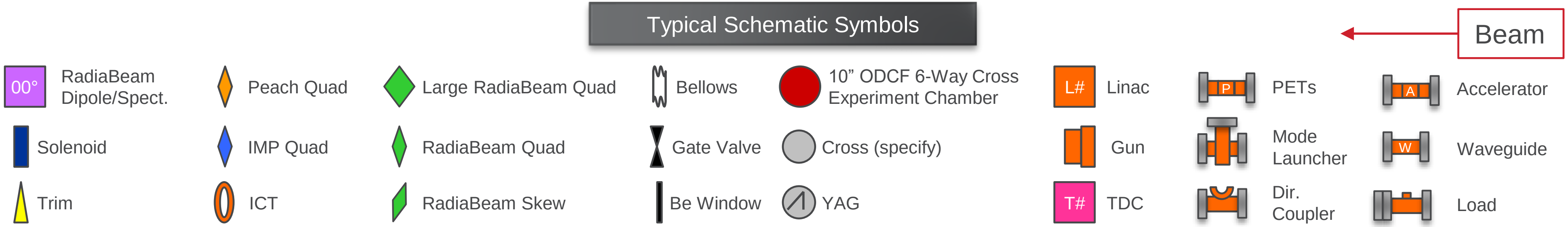
PI's: Use these symbols to build your schematic. Other pictures may be used to provide more experiment specific details (see next page for example). Add critical dimensions and other symbols, as necessary. Use Experimental Zone color codes when labeling Zones. A copy of this page will be in the ELD to build your schematics. The more comprehensive the schematic, the better prepared we all can be.

- ZONE 1
- ZONE 2
- ZONE 3
- ZONE 4
- ZONE 5
- ZONE 6 (ACT)



Beam direction is always **Right to Left**

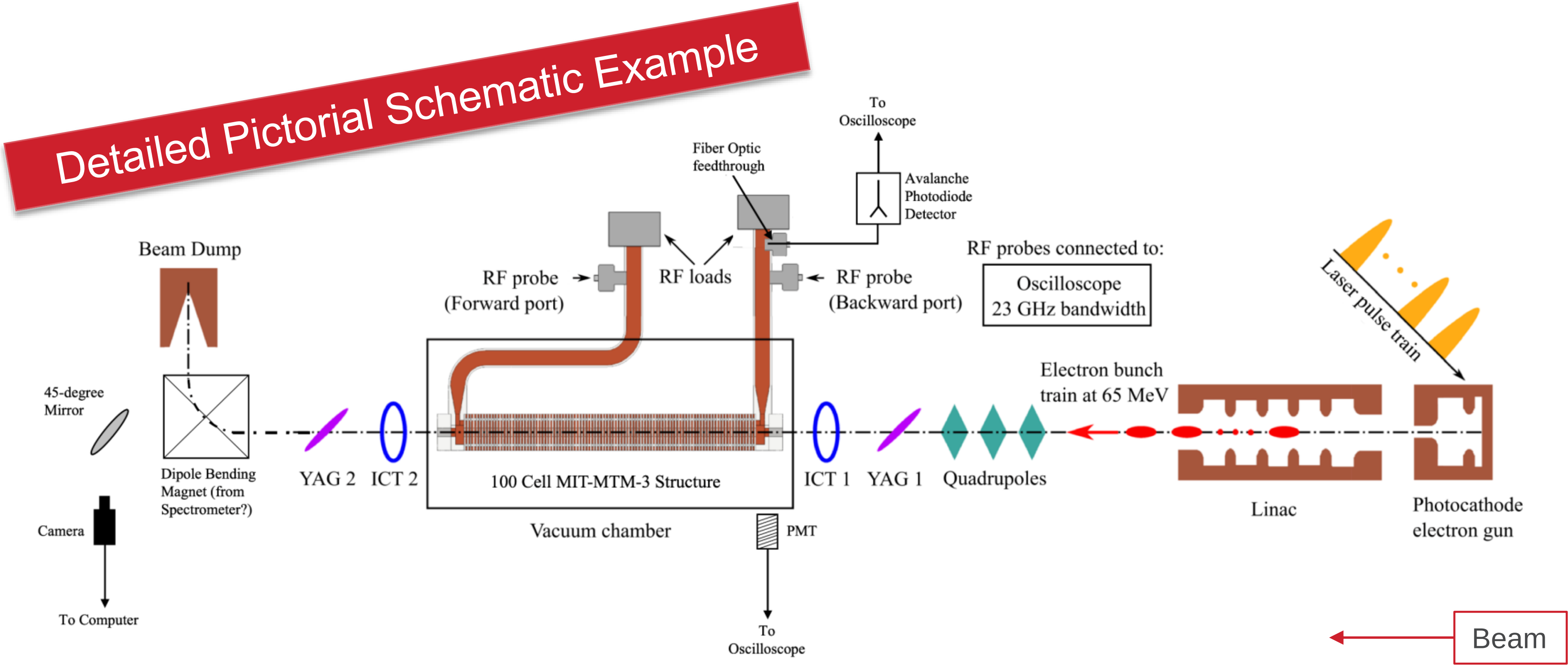
Typical Schematic Symbols



AWA DETAILED EXPERIMENT SCHEMATIC

AWA Detailed Experimental Layout

PI's: Detailed pictorial schematics are encouraged as they help with preparing for installations as well as can be used in publications.

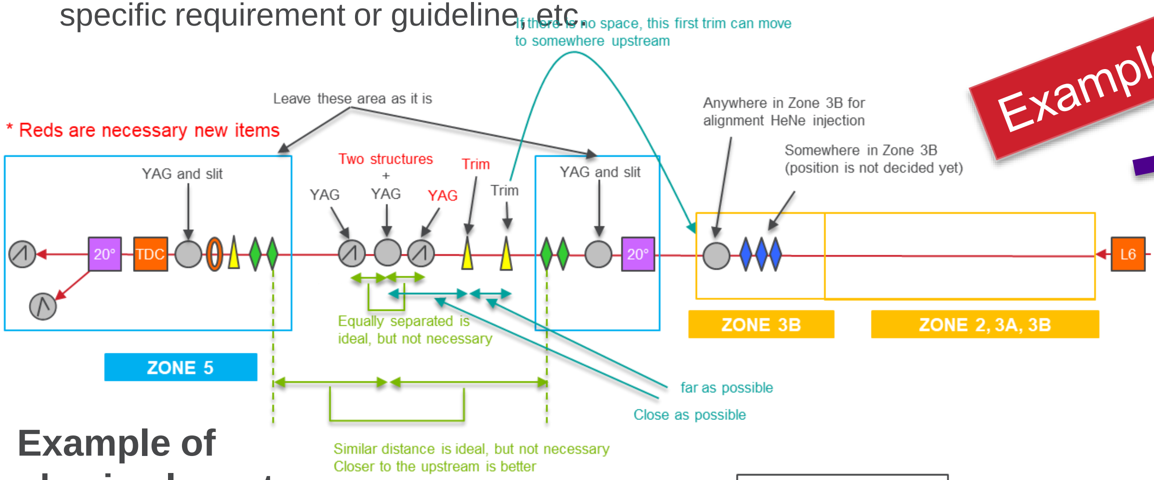


PHYSICS LAYOUT TO ENGINEERING LAYOUT

Schematics Lead the Way

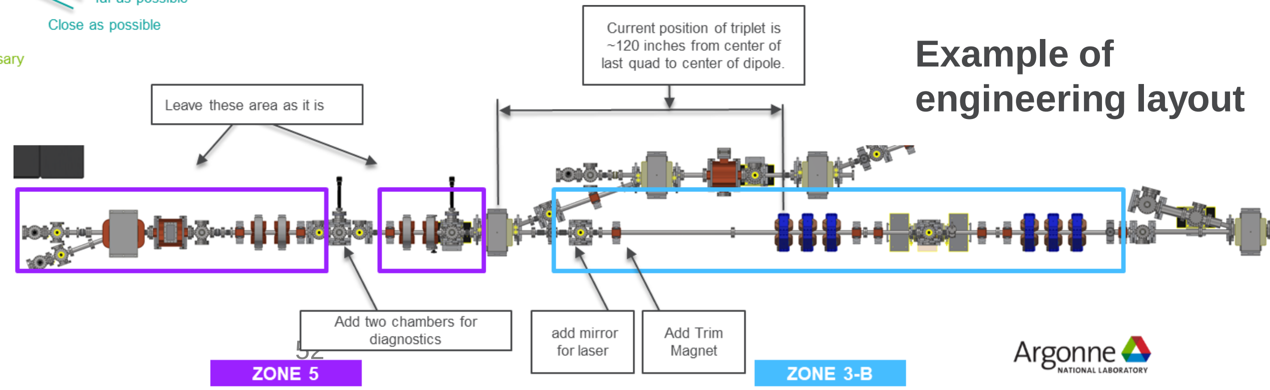
- The physics layout including all necessary information should be provided prior to the start of engineering design of the beamline.
- This information includes element location, element-to-element distances, necessary diagnostics and location, any specific requirement or guideline, etc.

Example



Example of physics layout

Beam

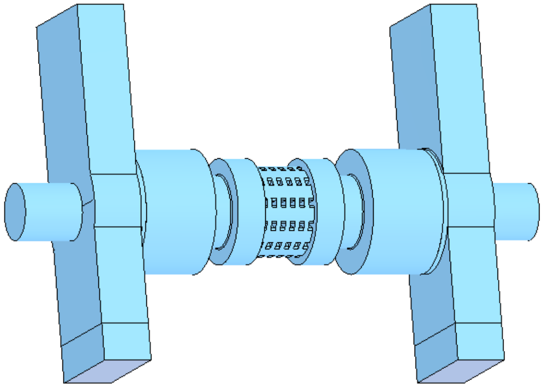


Example of engineering layout

PHYSICS DESIGN TO ENGINEERING DESIGN

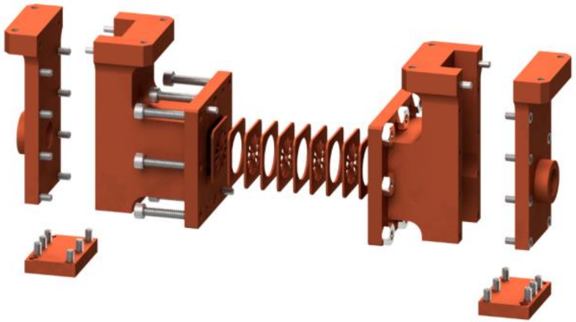
Physics Drive Everything

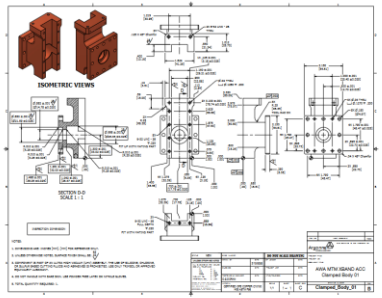
- The physics design including all necessary information should be provided prior to the start of engineering design of the of major components.
- This information includes all element necessary to create the physical parts needed for any given design.

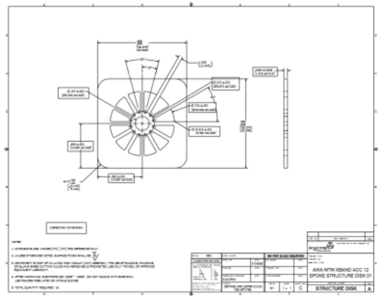


Example of physics design for accelerating structure

Example







Example of completed engineering design based on physics design

AWA ENGINEERING REQUIREMENTS

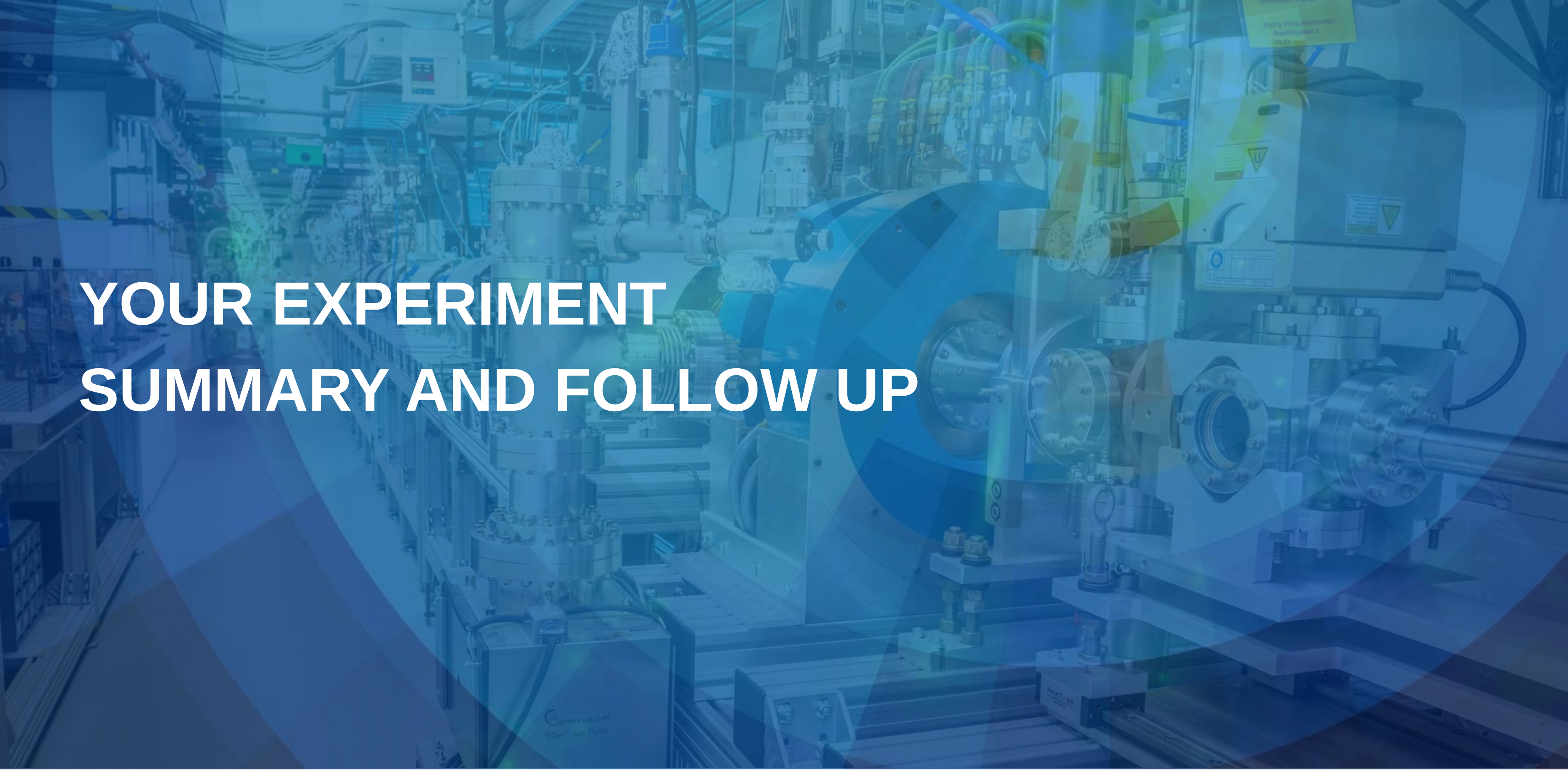
Special Controls, Electrical, RF, Mechanical, Parameters/Requests

Special Controls	Details
?	
?	
?	

Special Electrical/RF	Details
?	
?	
?	

Special Mechanical	Details
?	
?	
?	

Space to define other than ordinary needs or anything else you want.



YOUR EXPERIMENT SUMMARY AND FOLLOW UP

AWA EXPERIMENT SUMMARY

Installation Pictures

- Place pictures of actual installation here.

Space in the summary section of the ELD to detail data results.

Add pics screen grabs, analysis, and other info.

AWA EXPERIMENT SUMMARY

Data

- Provide data summary and images here.

Space in the summary section of the ELD to detail data results.
Add pics screen grabs, analysis, and other info.

AWA EXPERIMENT SUMMARY

Lessons Learned

- What did we do well?
- How can we improve?

Space in the summary section of the ELD to detail data results.
Add pics screen grabs, analysis, and other info.

AWA EXPERIMENT SUMMARY

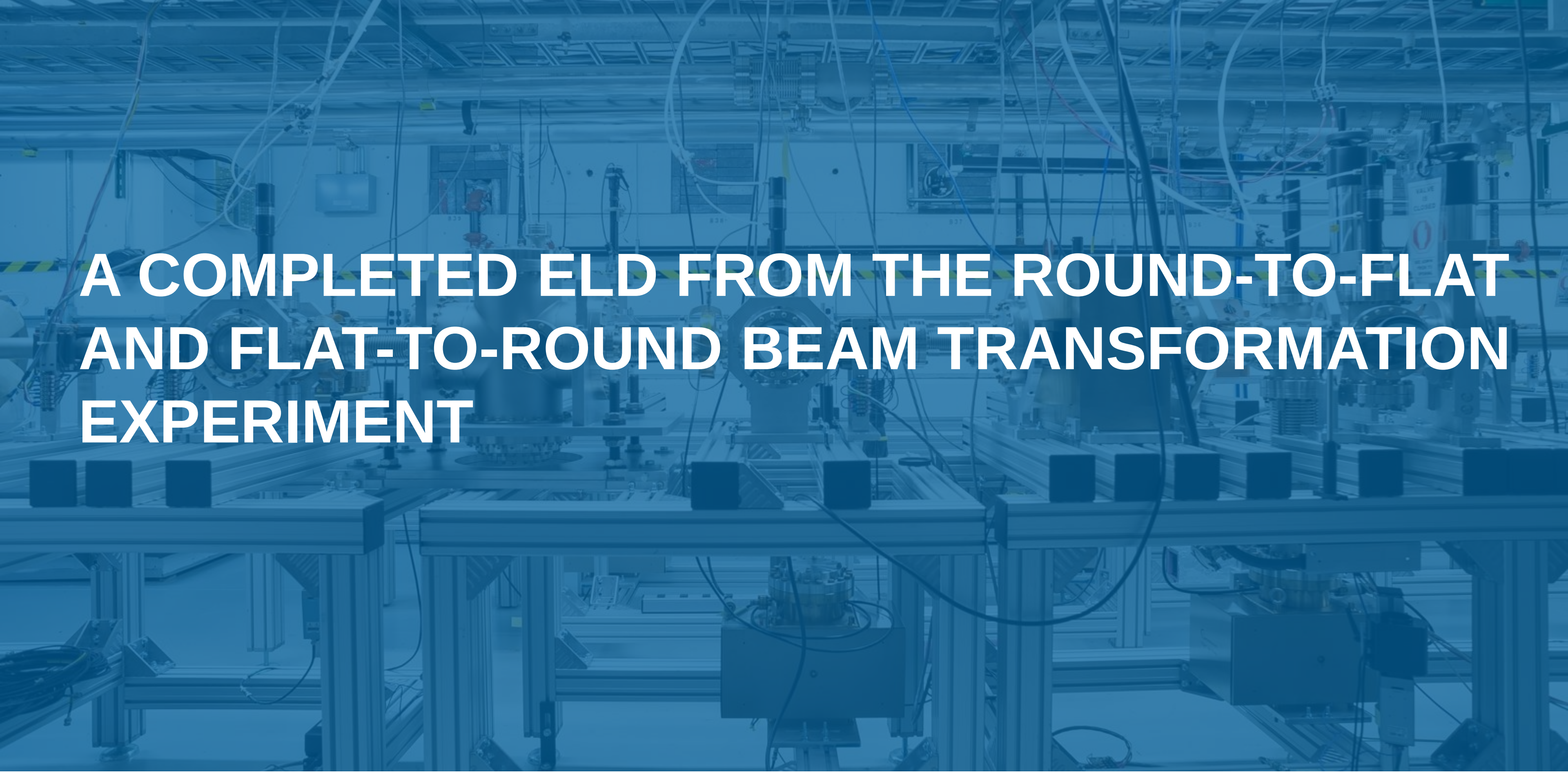
Publications, Proceedings, Journals

- List all publications, proceedings, etc. here and provide links.

Space in the summary section of the ELD to detail data results.
Add pics screen grabs, analysis, and other info.

Uploaded to AWA Web Site?		

THANK YOU!



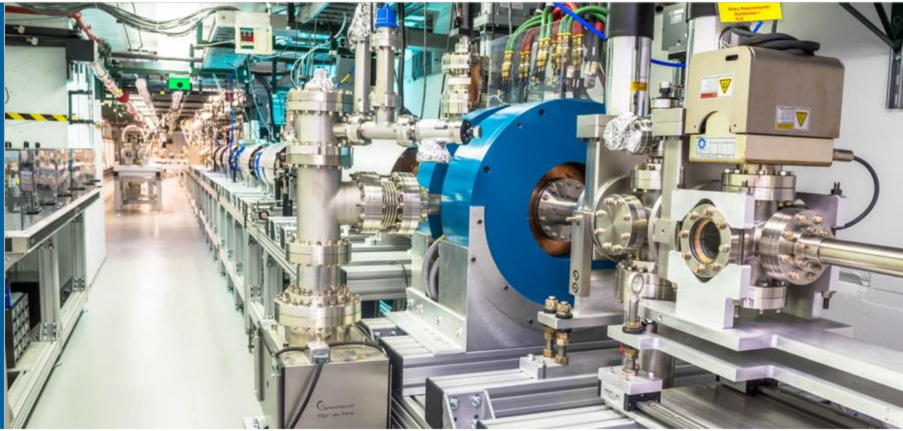
A COMPLETED ELD FROM THE ROUND-TO-FLAT AND FLAT-TO-ROUND BEAM TRANSFORMATION EXPERIMENT

April 7th, 2023

ROUND-TO-FLAT AND FLAT-TO-ROUND BEAM TRANSFORMATION

ROUND-TO-FLAT AND FLAT-TO-ROUND BEAM TRANSFORMATION (BACK-TO-BACK TRANSFORMATION)

EXPERIMENT LIFECYCLE DOCUMENT



COLLABORATOR PI

P.I. Name: Philippe Piot

Title: Professor

Affiliation: Northern Illinois University

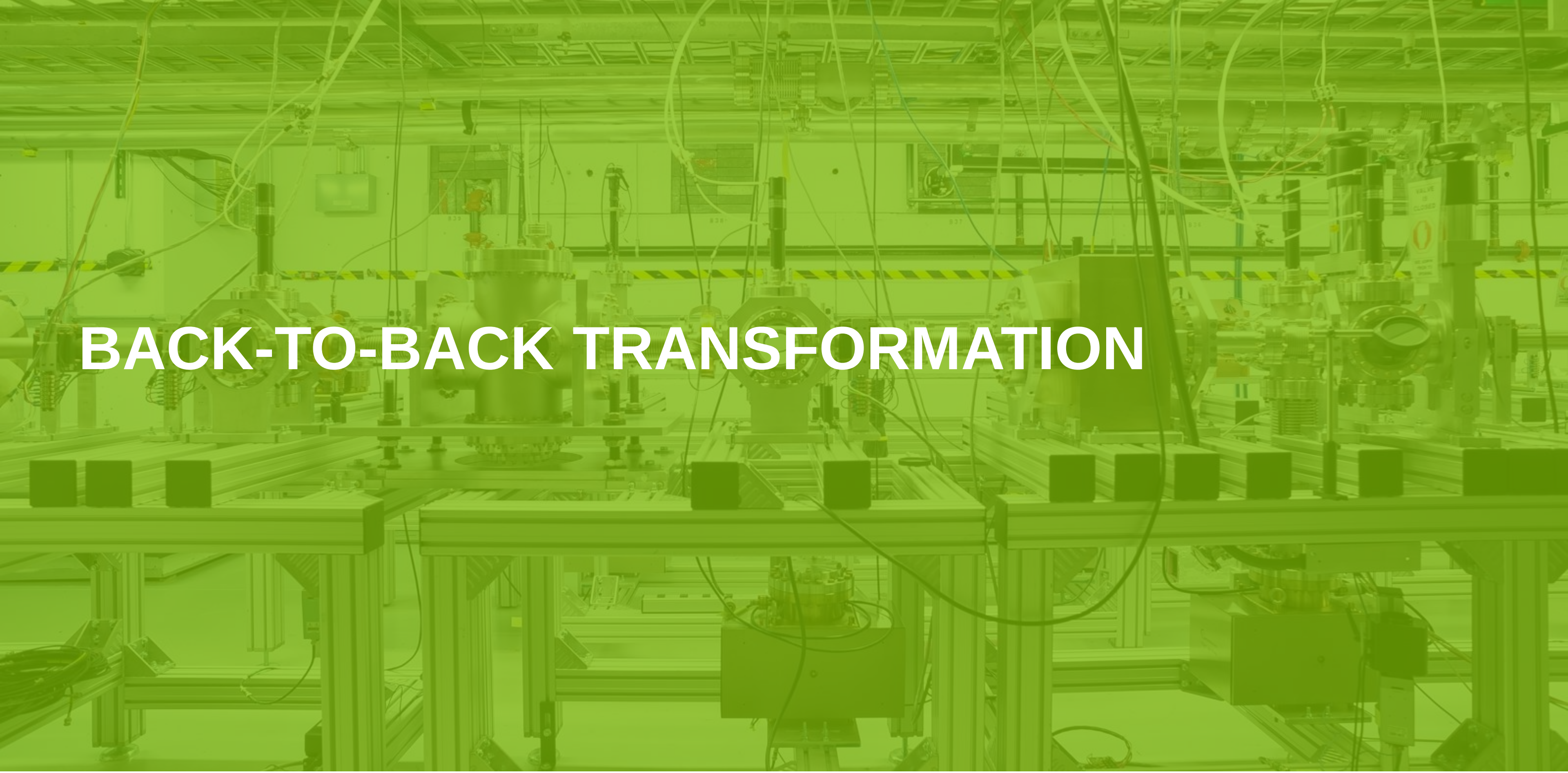
AWA LOCAL FACILITATOR

AWA Facilitator: Seongyeol Kim

Title: Postdoc

Affiliation: Argonne National Laboratory

BACK-TO-BACK TRANSFORMATION



BACK-TO-BACK TRANSFORMATION

General Information

Title of Experiment and Acronym	Round-to-flat and flat-to-round beam transformation (back-to-back transformation)
General Description	Generate magnetized beam and flat-beam, and transform the beam into round beam using skew quadrupole magnets
Scientific outcome and impact	We can explore how to transport the magnetized beam for hadron cooling using electron beam (expecting 1 journal paper + 1 conference paper)
Hard Deadline	Before IPAC'23 (early May)
Proposed Run Date	Initially, it was March 6th to 10th >> April 10th to 21st (can be shifted depending on the installation; prior week is for the installation)
Experimental Zone	Zone 1, 2, 3 (A,B), and 5

TIMELINE AND SCHEDULING

Experimental + project schedule

FY23	January	February	March	April	May	June
Physics work (simulation, optimization)						
Plan for diagnostics						
Development of the beam tuning toolbox						
Installation, perform experiment				Newly added		
Do analysis, get ready for paper submission						

AWA EXPERIMENT TEAM

List PI’s, Team Members Roles and Responsibilities

- Collaborator / Organization
  - Philippe Piot / NIU: PI of this project, manage overall the project, participate in the experiment, work on the paper manuscript

- AWA
  - Seongyeol Kim: lead the project; work on the simulation, optimization, and experiment. Work also on the data analysis and the paper manuscript with PI
  - Scott Doran: mechanical work (parts, installation) of the elements that are required for the experiment such as quad rotation for skew quad, and slits (with chambers) for the diagnostics
  - Eric Wisniewski: mechanical work and operation of the accelerator to generate and tune the beam
  - Wanming Liu: Assist people for adjustment of the RF phase (of the cavities). Also assist people for EPICS system (data taking, on-line tuning if necessary)
  - John Power: supervise the experiment, work on the paper manuscript with PI

AWA EXPERIMENT TASKS

Assign, Track, and Update Major Tasks

Task	Assigned To	Status	Commented date	DONE
Installation	Scott Doran, Eric Wisniewski	In zone 2 and 3B, we need anti-collision box	Apr/3/23	YES

AWA EXPERIMENT TASKS

Assign, Track, and Update Major Tasks

Task	Assigned To	Status	Commented date	DONE
Installation	Scott Doran, Eric Wisniewski	Vent everything in zone 2, 3, 5	Mar/27/23	YES
Installation	Scott Doran	Zone 5: being left of PAL structure and YAG, and replace the YAG	Mar/27/23	YES
Installation	Seongyeol Kim	Zone 5: check the slit width before TDC4 (Inquire Gwanghui)	Mar/27/23	YES
Installation	Scott Doran	Zone 4: replace 50 um slit before TDC3	Mar/27/23	YES
Installation	Scott Doran	Zone 3B: build new cross for slits and YAGs (next to existing cross)	Mar/27/23	YES
Installation	Scott Doran	Zone 3B: skew second triplet (later, we should think about having the schedule to move it back to normal quadrupole magnet)	Mar/27/23	YES
Installation	Charles Whiteford	Cable connection on bucking/focusing solenoid (at the very last step since we might have some more normal runs such as BAM test)	Mar/27/23	NOT YET
Installation	Seongyeol Kim	Zone 2, 3, 5: specify the Blackfly cam positions	Mae/27/23	YES

AWA EXPERIMENT TASKS (CONT'D)

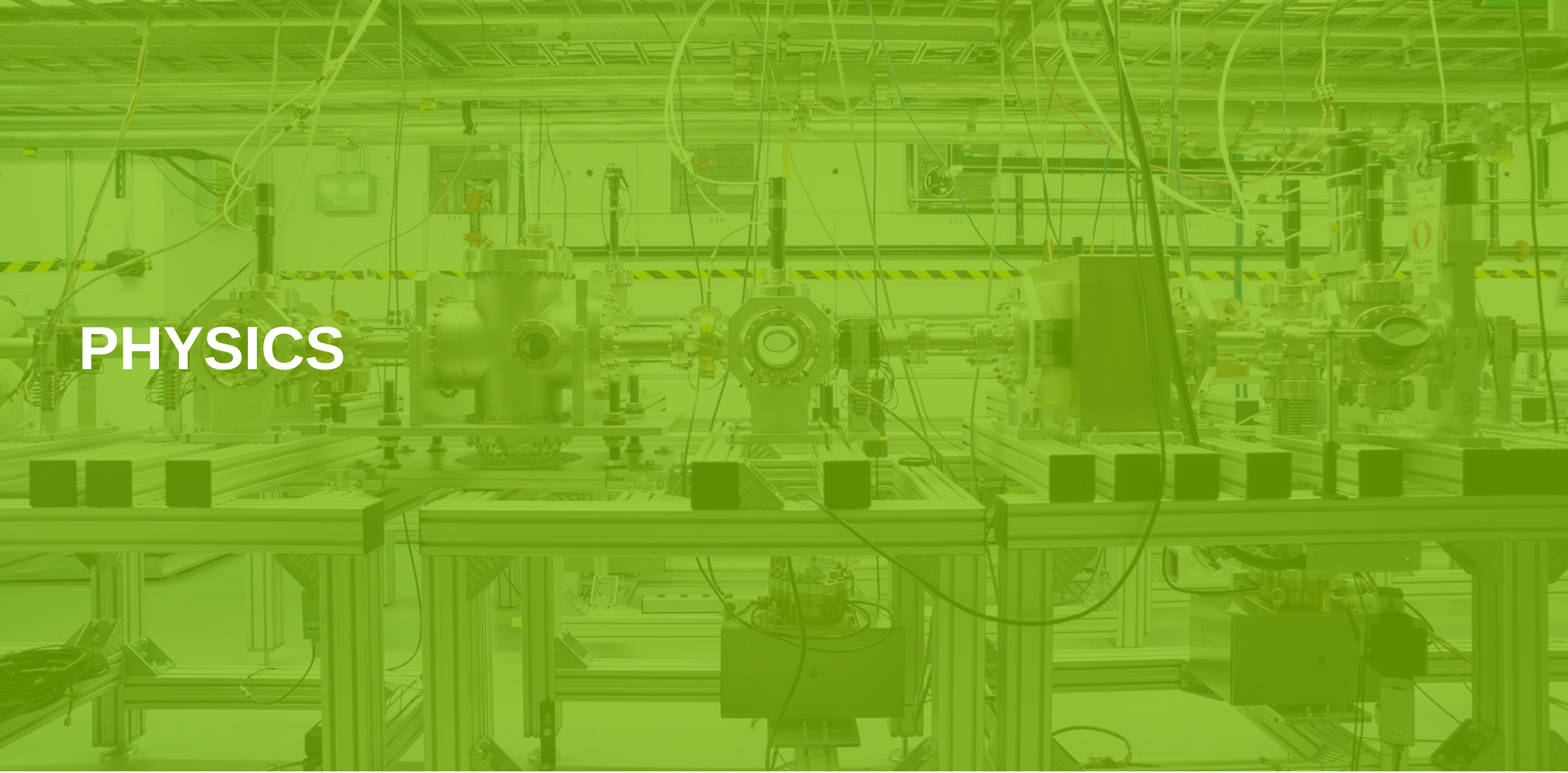
Assign, Track, and Update Major Tasks

Task	Assigned To	Status	Commented date	DONE
Physics simulation	Seongyeol Kim	First start-to-end simulation completed. Some more simulations can be done to have more parameters set for experiment	Jan/16/23	YES
Beam optimization	Seongyeol Kim	Simulation done for beam optimization.	Jan/16/23	YES
Toolbox for optimization	Seongyeol Kim	Working on it (whether to use Xopt or multiple screens to check Twiss parameters)	Jan/16/23	YES
Installation (diagnostic instruments; YAG, camera, slits, etc)	Scott Doran	Having discussion with Seongyeol Kim about the slits (multiple slits using 2' by 2' tungsten piece). Will have more information through the schematic view that Seongyeol Kim will make.	Jan/16/23	YES
Installation (skew quads)	Scott Doran	We understood which quads should be rotated and shifted in terms of the position.	Jan/16/23	YES
Laser works	Eric Wisniewski, Seongyeol Kim, Philippe Piot, John power	We need to have very uniform transverse distribution of the laser at the cathode using MLA. Not demonstrated yet.	Jan/16/23	YES
Installation	Scott Doran	Talk to Frank to modify the parts for new slits in Zone 3B. Also need to modify the motorized actuator to fit the YAG and slits	Jan/18/23	YES

AWA EXPERIMENT COMPONENTS

Track Purchased Component Status and Location

Part	Status	Location
Slits (multiple)	N/A	Zone 2, Zone 3B
Slit	N/A	If already installed, what is the slit (direction) and width in Zone 5?



PHYSICS

AWA PHYSICS REQUIREMENTS

Laser, e- Beam, RF, Diagnostics, Equipment

Typical Parameters	Details
Laser	3 mm radius, uniform transverse distribution, 3 ps FWHM (4 BBO crystals except for thickest one)
e- Beam (energy, charge, bunches)	4 linacs (~40 MeV), 1 nC, single bunch. All cavity phases should be adjustable
RF	N/A (not for high-charge experiments)

Special Diagnostics	Details
Scanning Slits	Zone 2 (50 um / 50 um), Zone 3B before second skew triplet (multiple slit), Zone 5 (?? // ??)
TCD in Zone 5	Needed for LPS measurement
Breakdown Detection	N/A

Special Equipment	Reason	Status
Bolometer	N/A	
Interferometer	N/A	
Streak Camera	N/A	
Fast scope	N/A	

PHYSICS & SIMULATIONS

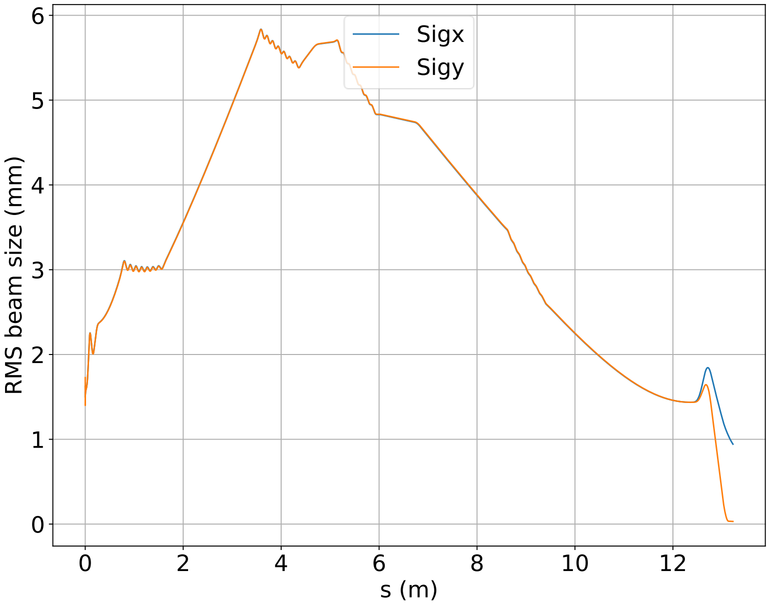
Simulation Updates

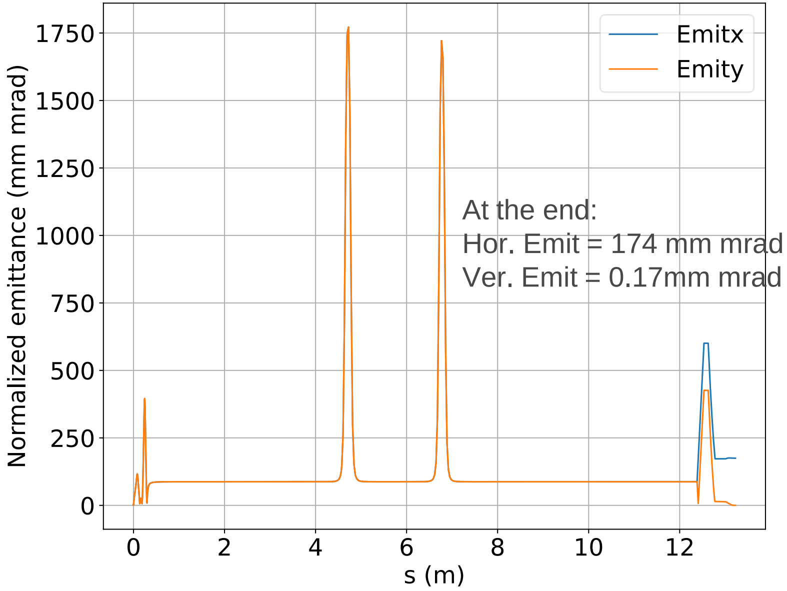
- Grid = 32x32x32, #particles = 32x32x32x8 = 262144, EBIN = 5

Parameters	Value (Blue = from MOGA)
Initial UV radius	3.0 mm
UV pulse	3.0 ps FWHM (Initially, it was 0.3 ps FWHM)
Charge	1.0 nC
Gun phase Linac phase	-30 degrees from optimal (maximum energy gain) -18 / -32 / -13 / -19 degrees from on-crest (L1, 2, 3, 5)
Beam energy	39.3 MeV
B/F solenoid magnet	550 A
Matching solenoid magnet	210 A
Drive linac solenoid currents (#2, #3)	129 / 110 A [(I/330)*0.500875 (T)]
Skew quadrupole strength (#1, #2, #3)	-2.64 / +3.48 / -3.27 T/m

PHYSICS & SIMULATIONS
Simulation Updates

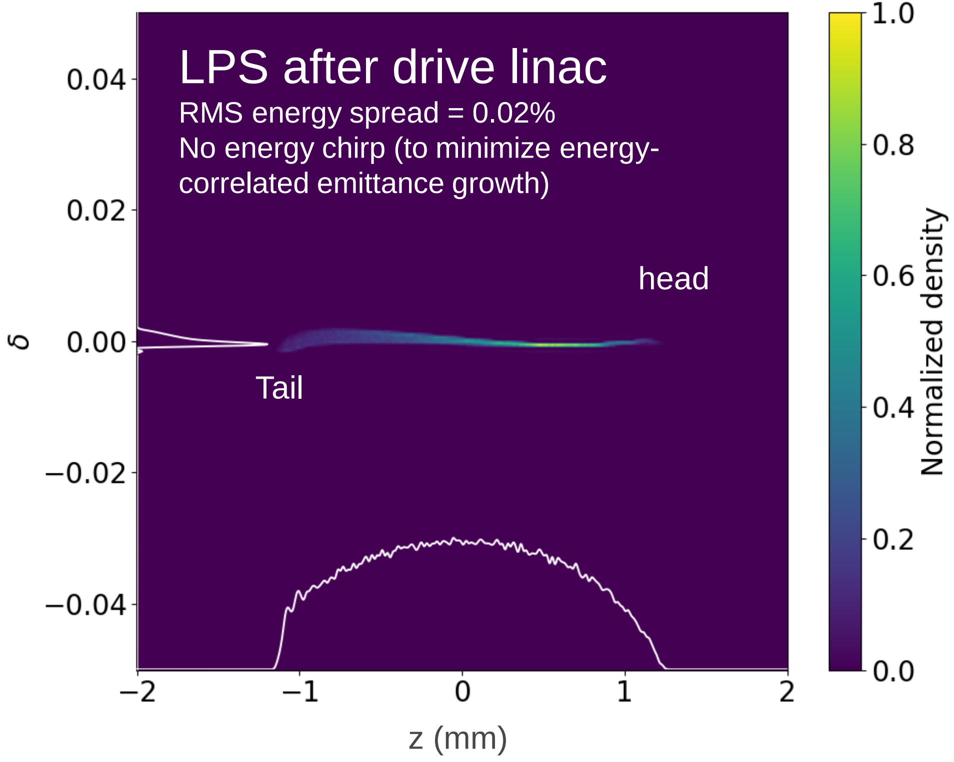
Beam envelope and emittance





PHYSICS & SIMULATIONS

Simulation Updates

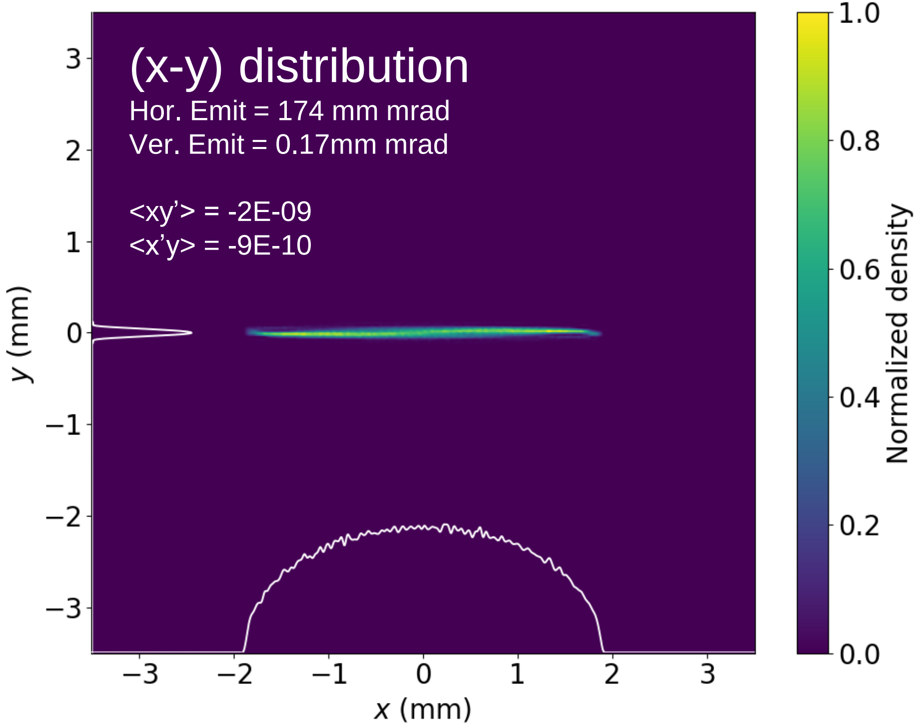


PHYSICS & SIMULATIONS

Simulation Updates

Phase space right after the skew triplet

- Hard-edge quadrupole field used in OPAL sim

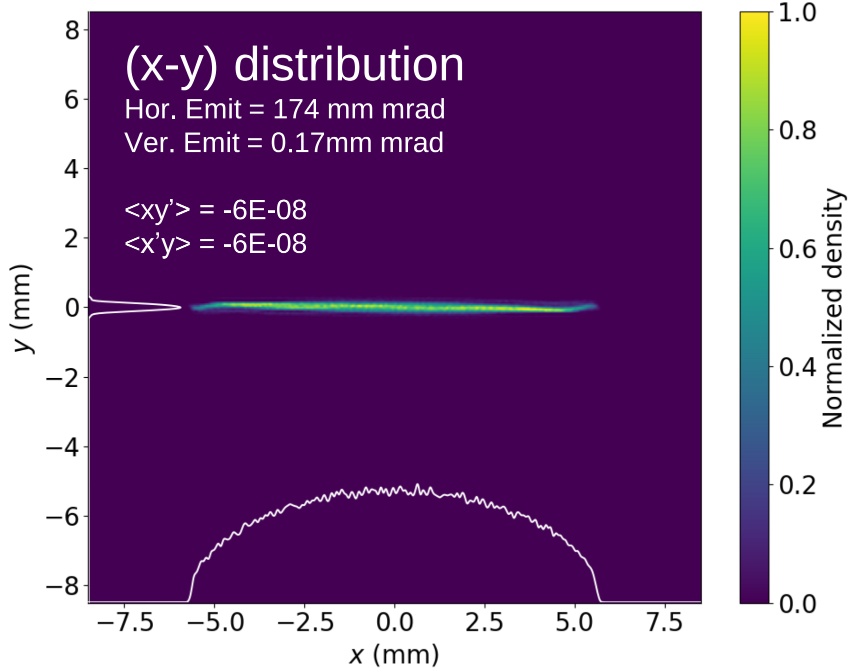


PHYSICS & SIMULATIONS

Simulation Updates

Phase space right after 1.0 m from skew triplet

- Hard-edge quadrupole field used in OPAL sim

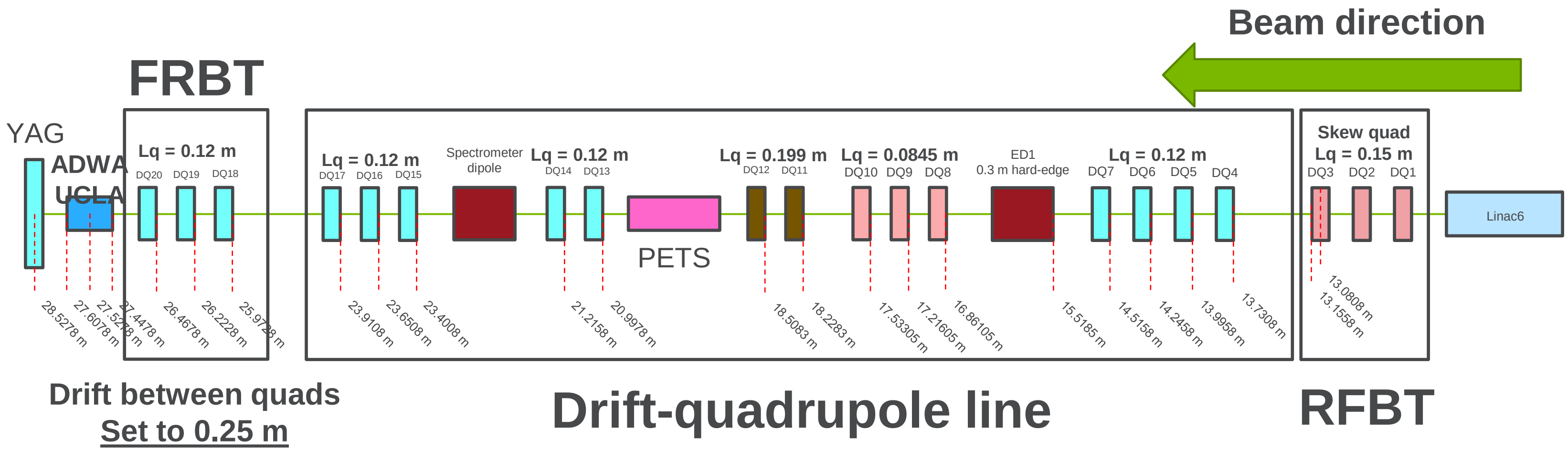


PHYSICS & SIMULATIONS

Simulation Updates

AWA lattice: From Zone 2 to 3 and 5

- First target: use the existing quadrupole setting in the AWA bunker

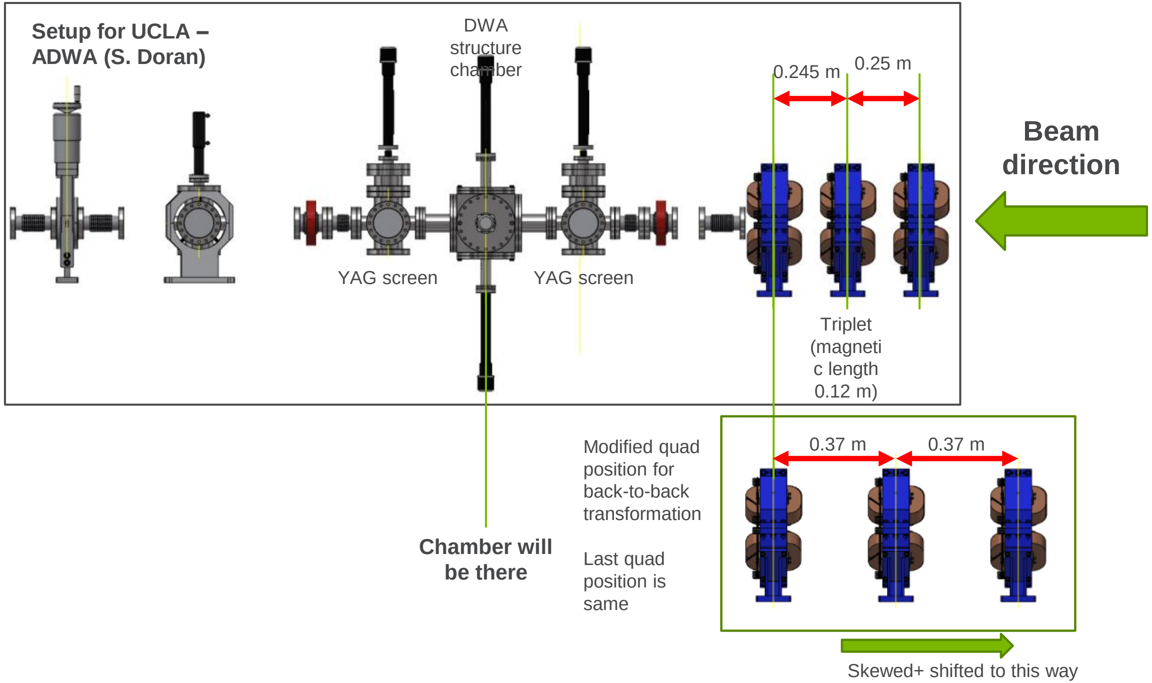


- We can only change the position of last triplet (3 quads) in zone 3B

PHYSICS & SIMULATIONS

Simulation Updates

Quadrupole magnet setup

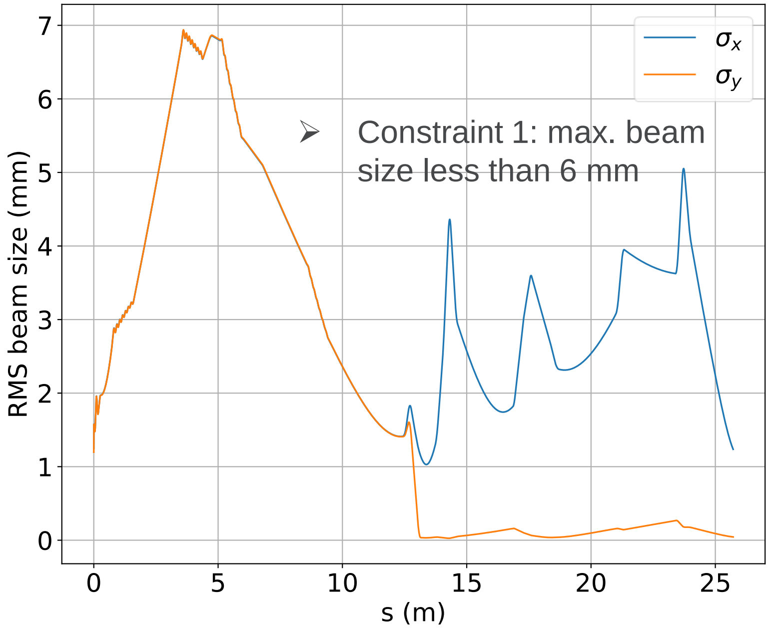


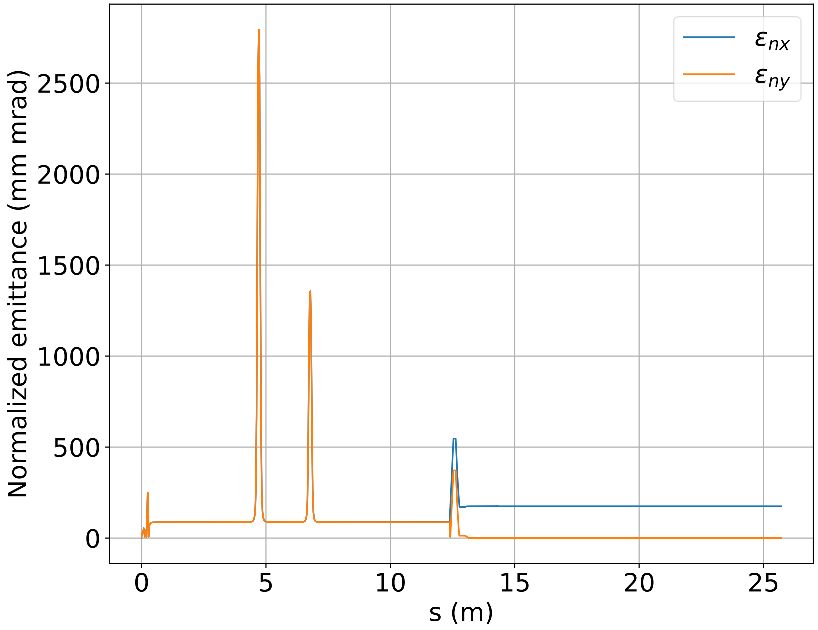
PHYSICS & SIMULATIONS

Simulation Updates

Flat beam transport along drift-quadrupole line

- Twiss parameters: set to similar as those right after the first skew triplet
- **Space charge force is included (Start-to-end)**



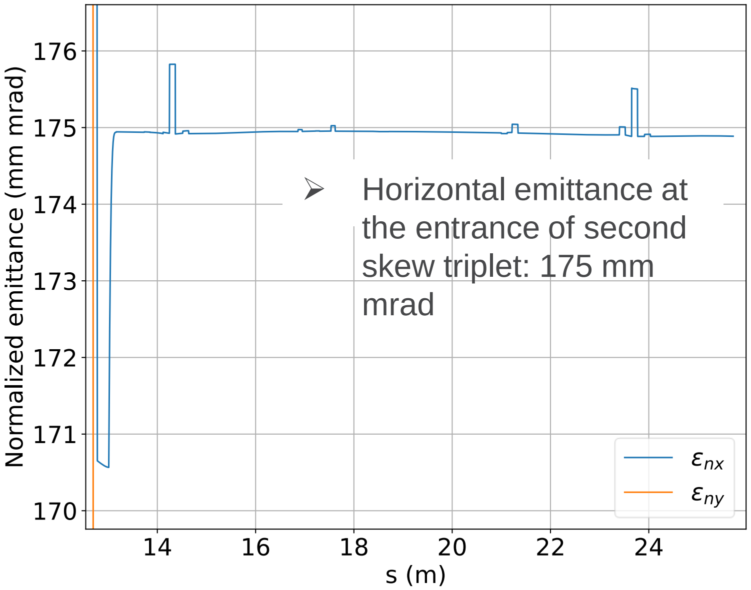


PHYSICS & SIMULATIONS

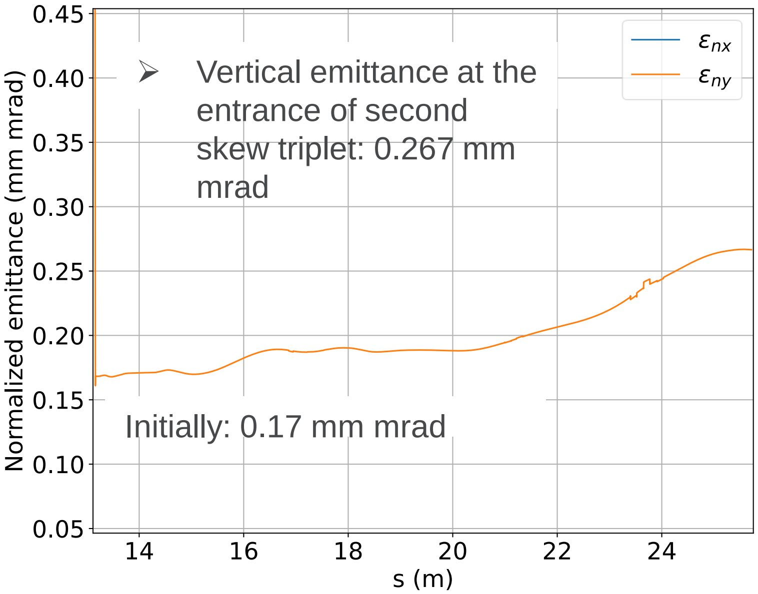
Simulation Updates

Flat beam transport along drift-quadrupole line

- Twiss parameters: set to similar as those right after the first skew triplet
- Space charge force is included (Start-to-end)
- MOGA was used to minimize emittance growth against SC + aberration

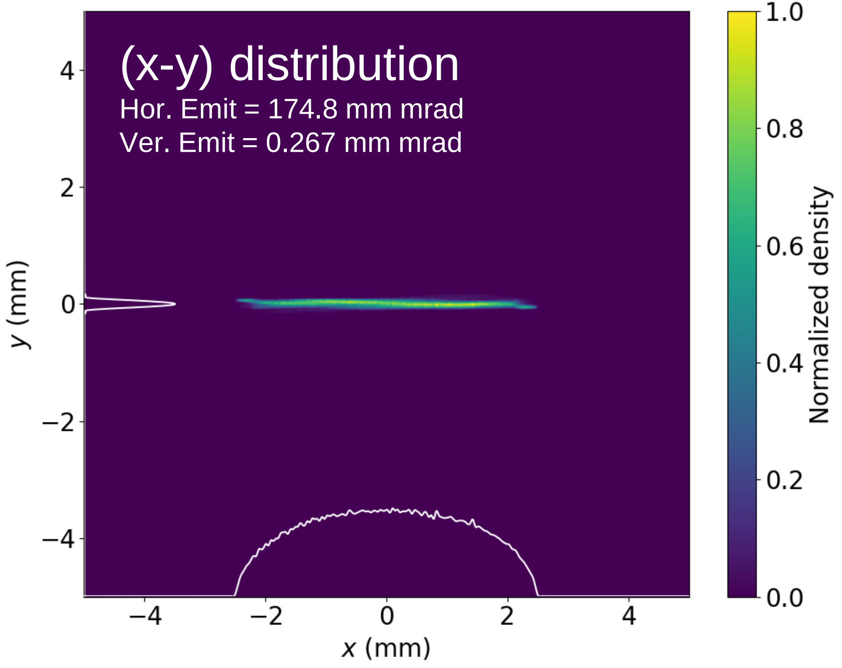


Zoom-in plot



Phase space right at the end of transport line

- Space charge included in the simulation

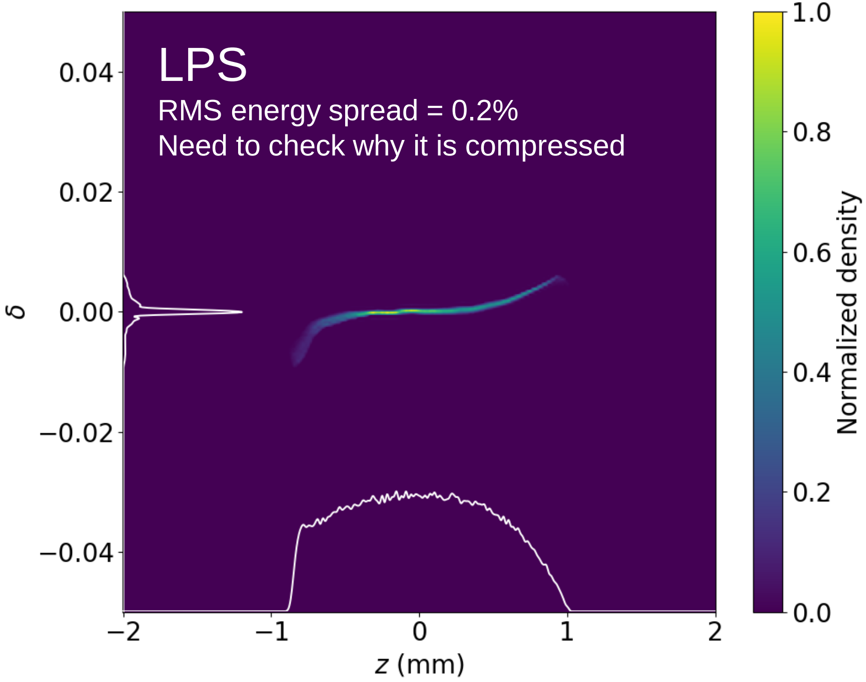


PHYSICS & SIMULATIONS

Simulation Updates

Phase space right at the end of transport line

- Space charge included in the simulation



PHYSICS & SIMULATIONS

Simulation Updates

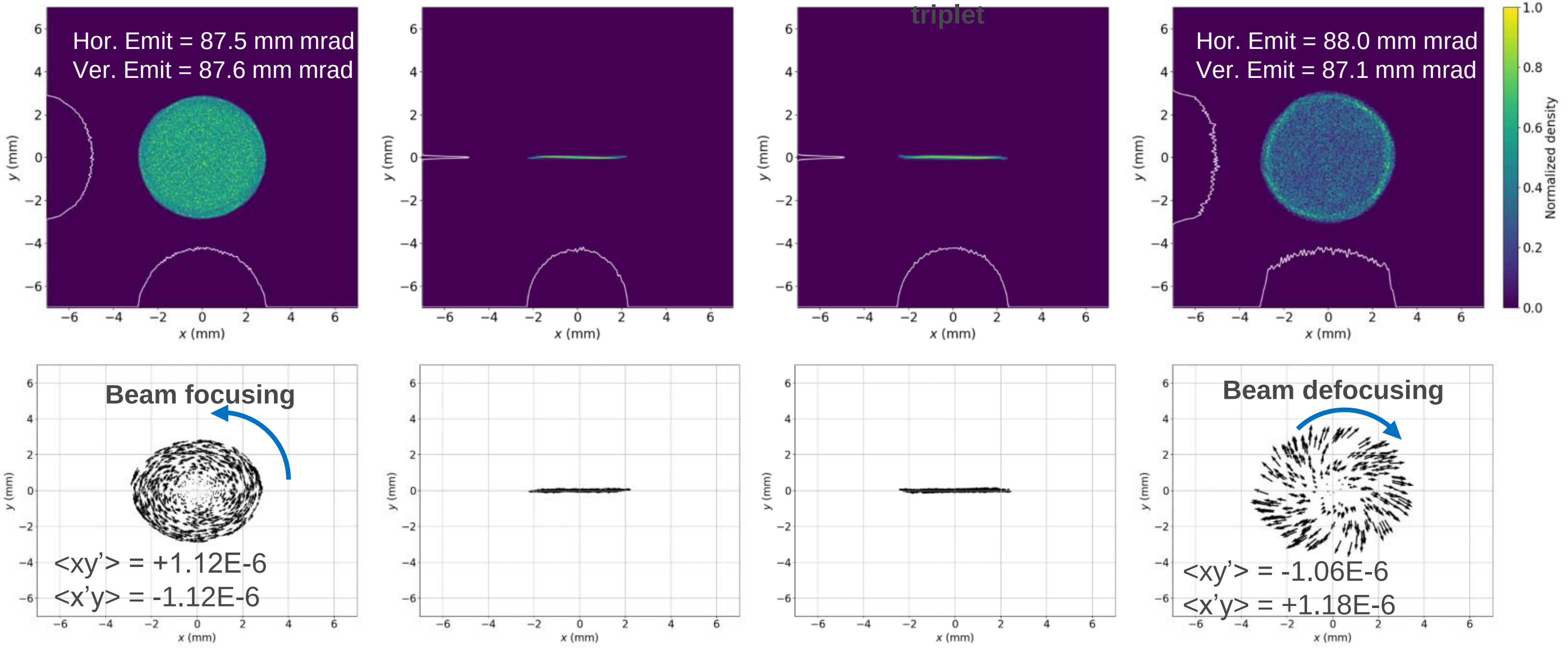
Phase space: Round >> Flat >> Round

Before 1st skew triplet
-2.64 / +3.48 / -3.27 T/m

After 1st skew triplet

Before 2nd skew triplet

After 2nd skew triplet
-2.37 / +1.46 / -1.04 T/m

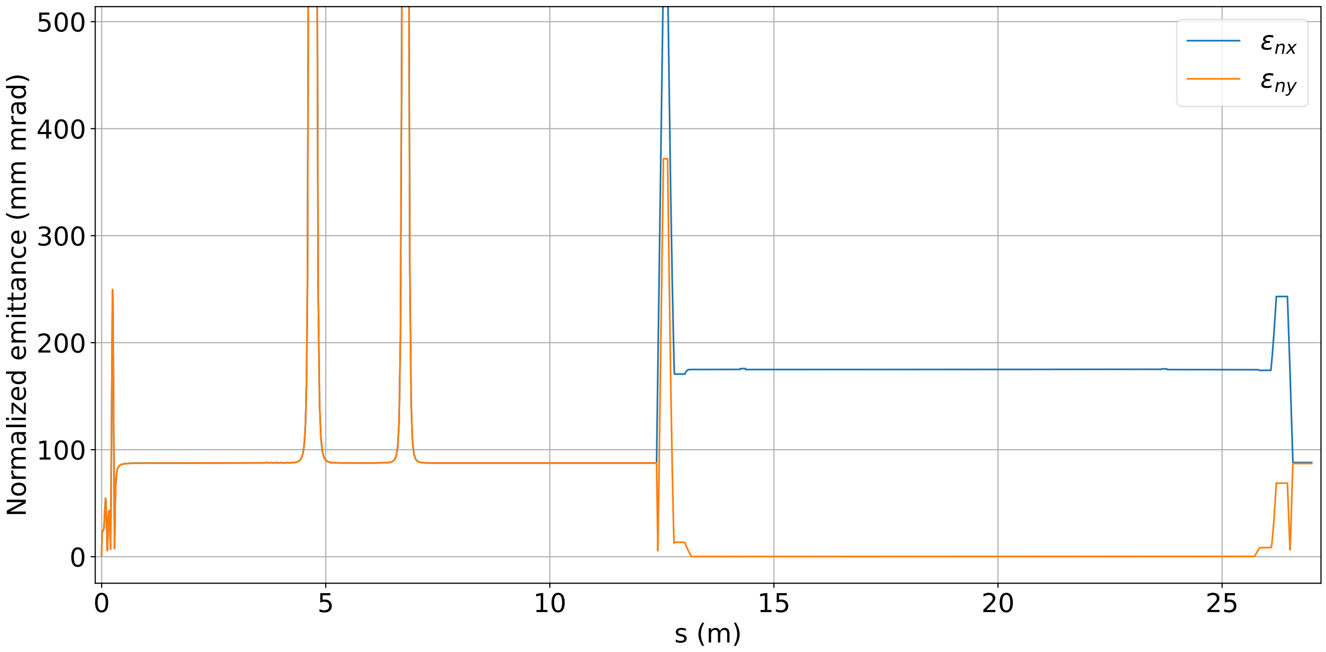


PHYSICS & SIMULATIONS

Simulation Updates

Start-to-end simulation for back-to-back transformation

- Entire drive linac + back-to-back beamline

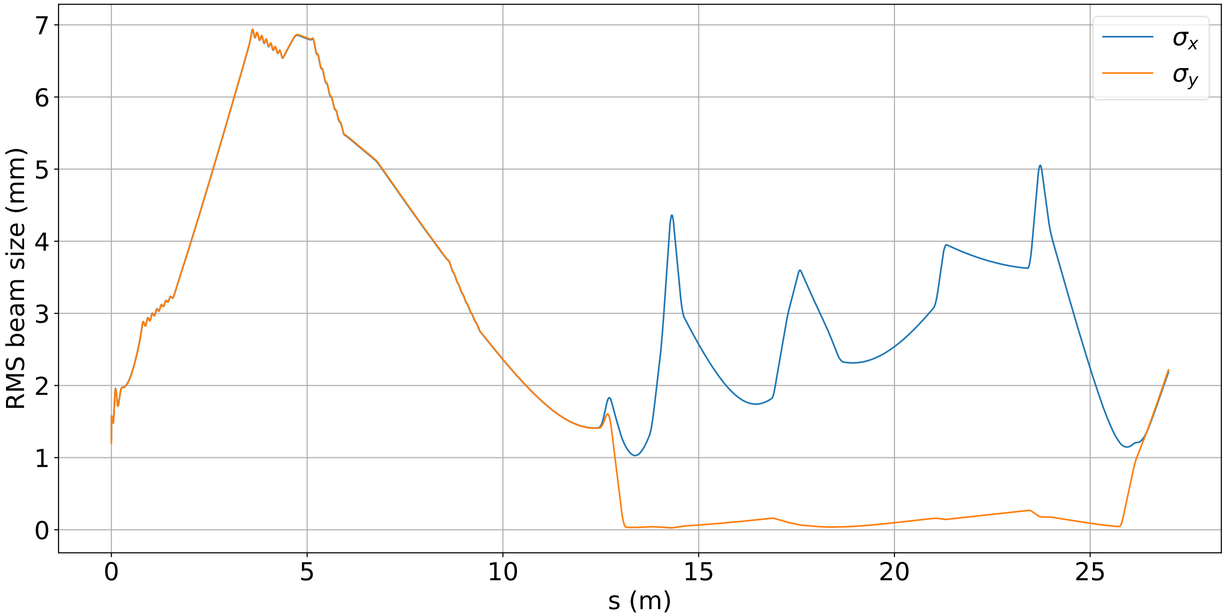


PHYSICS & SIMULATIONS

Simulation Updates

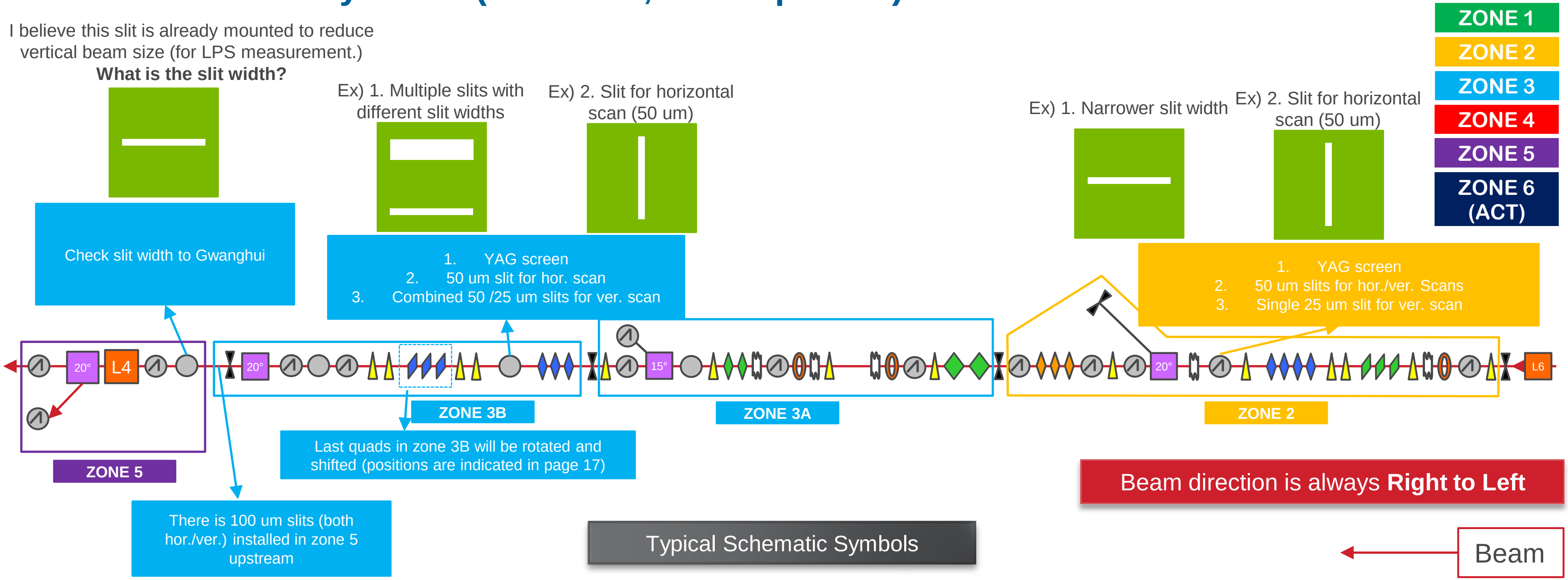
Start-to-end simulation for back-to-back transformation

- Entire drive linac + back-to-back beamline

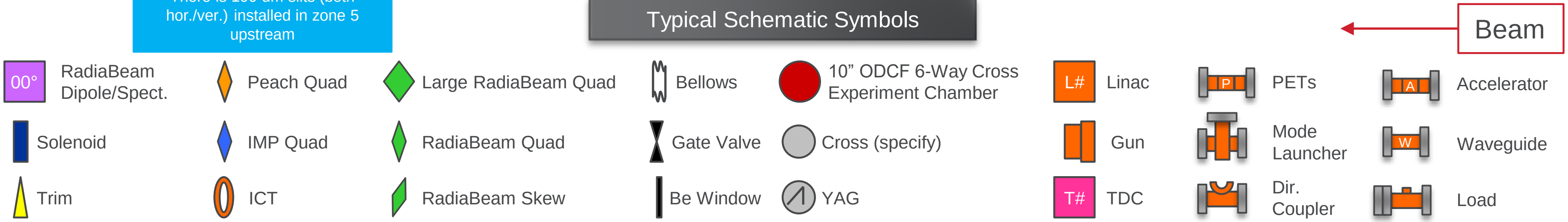


AWA BEAMLINE SCHEMATIC SYMBOLS

AWA Schematic Symbols (March 27, 2023 updated)

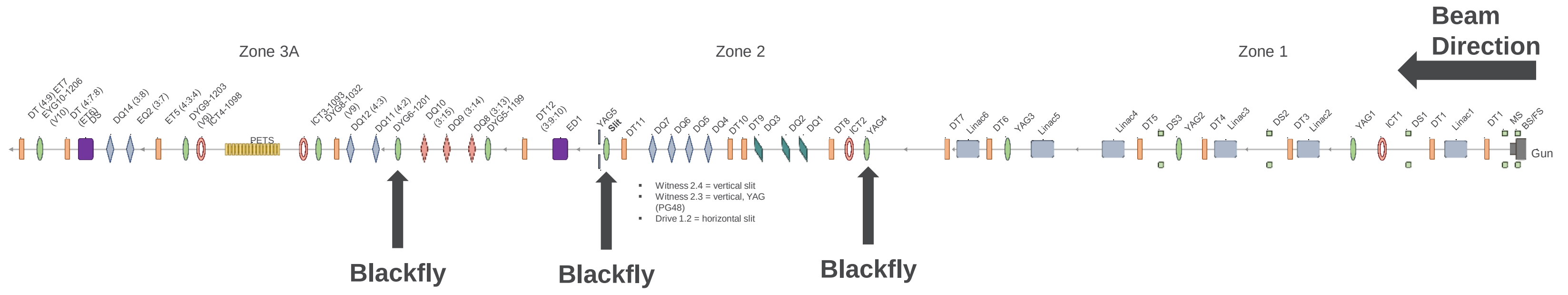


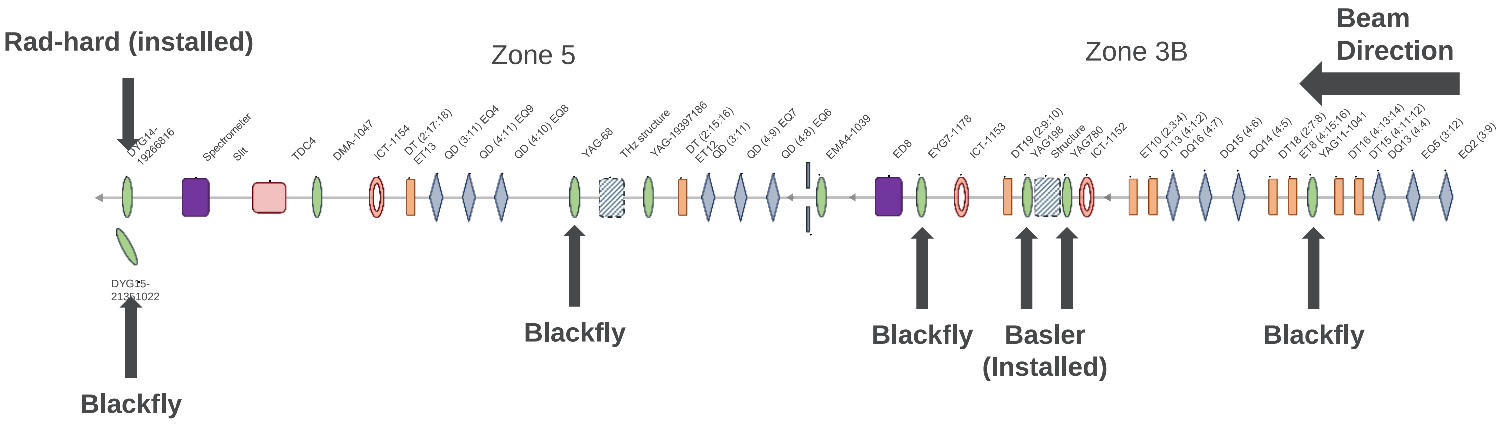
Typical Schematic Symbols



AWA BEAMLINE: CAMERA POSITIONS

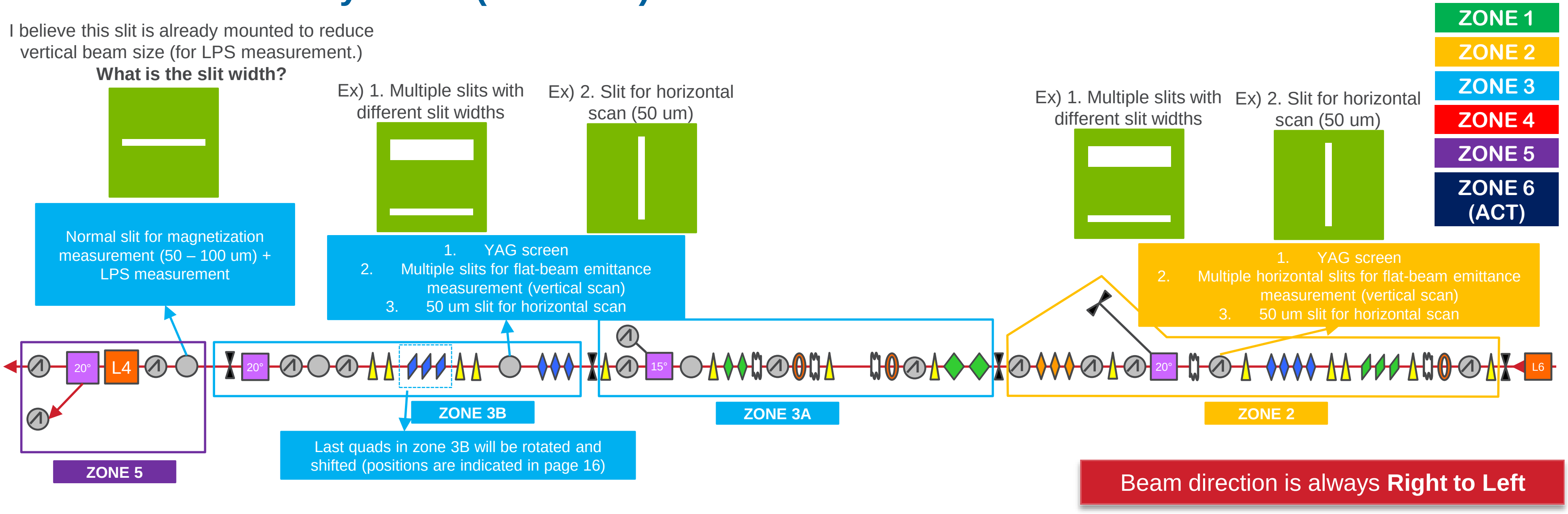
Beamline configuration (Mar 27, 2023). Beamline direction: **from right to left**

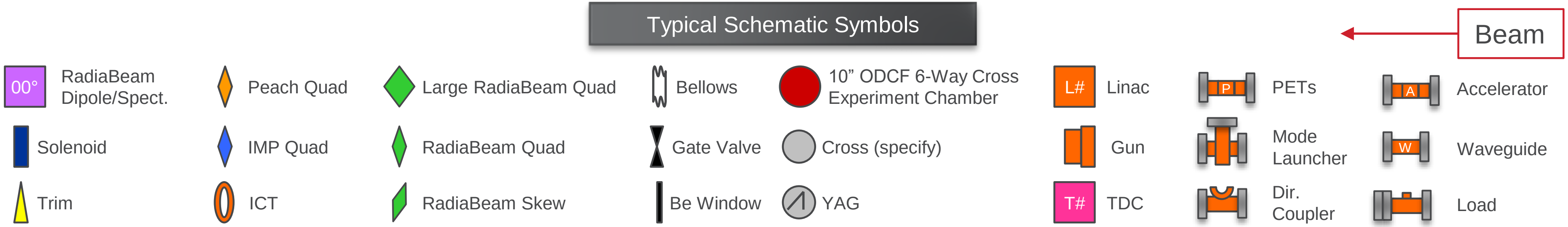




AWA BEAMLINE SCHEMATIC SYMBOLS

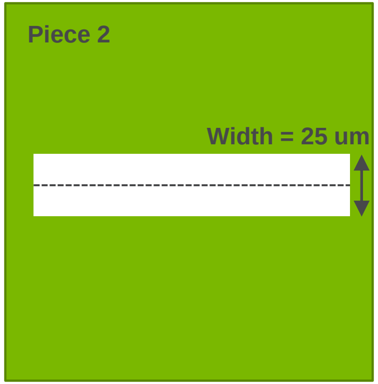
AWA Schematic Symbols (Jan 2023)



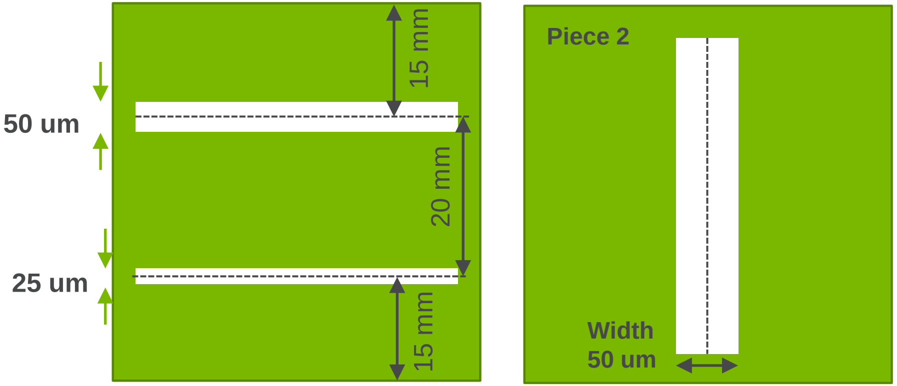


SLIT FOR DIAGNOSTICS: JAN/18/2023

New parts: confirmed with manufacturer and Scott

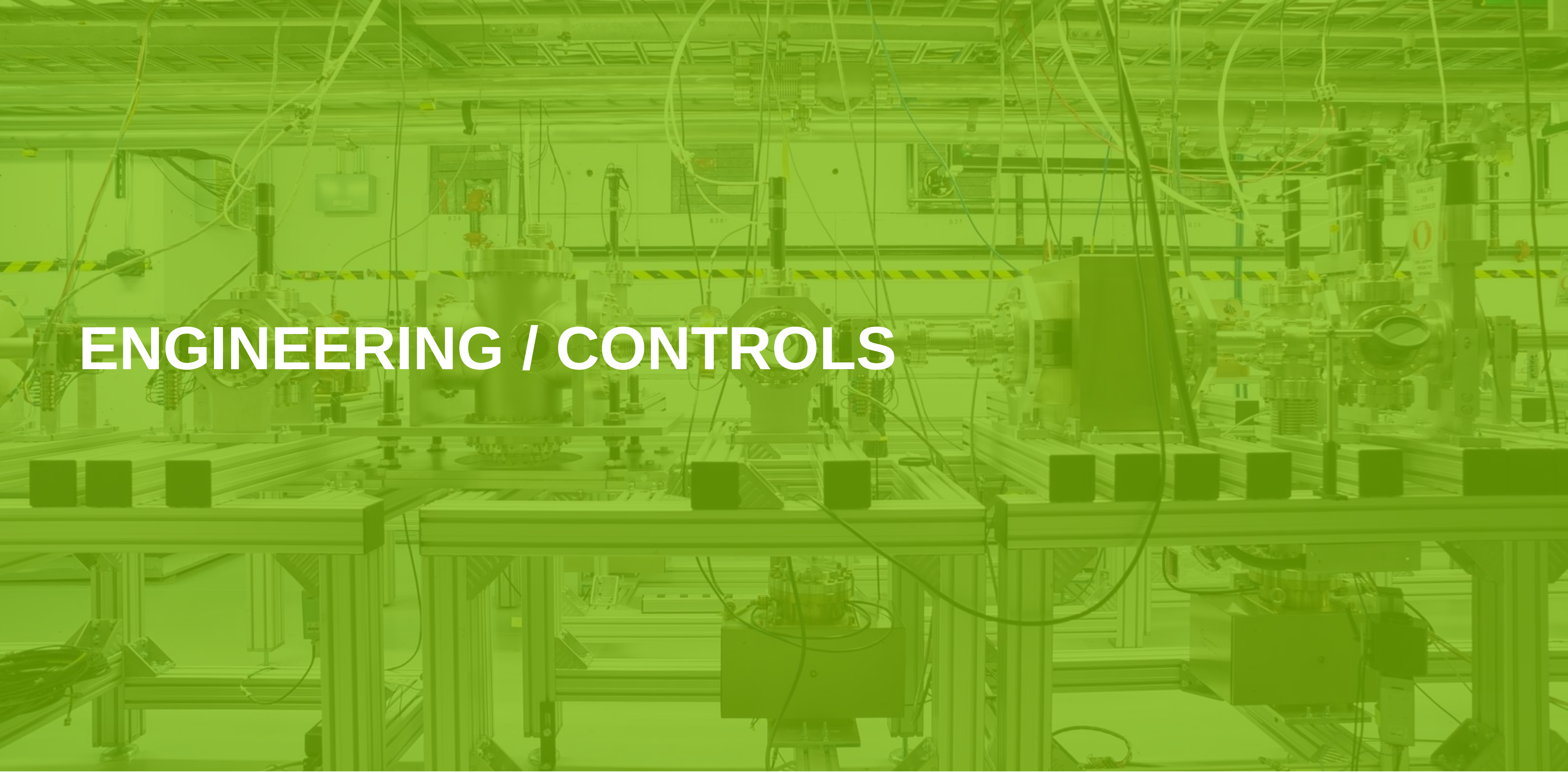


This piece will be installed in zone 2 (for vertical scan, we then have 25 um and 50 um slit, where the 50-um slit is already mounted)



These two pieces will be fabricated and placed in zone 3B (According to the actuator we have in the AWA bunker, we will make two slits in a single piece for vertical scan)

ENGINEERING / CONTROLS



SPECIAL ENGINEERING REQUIREMENTS

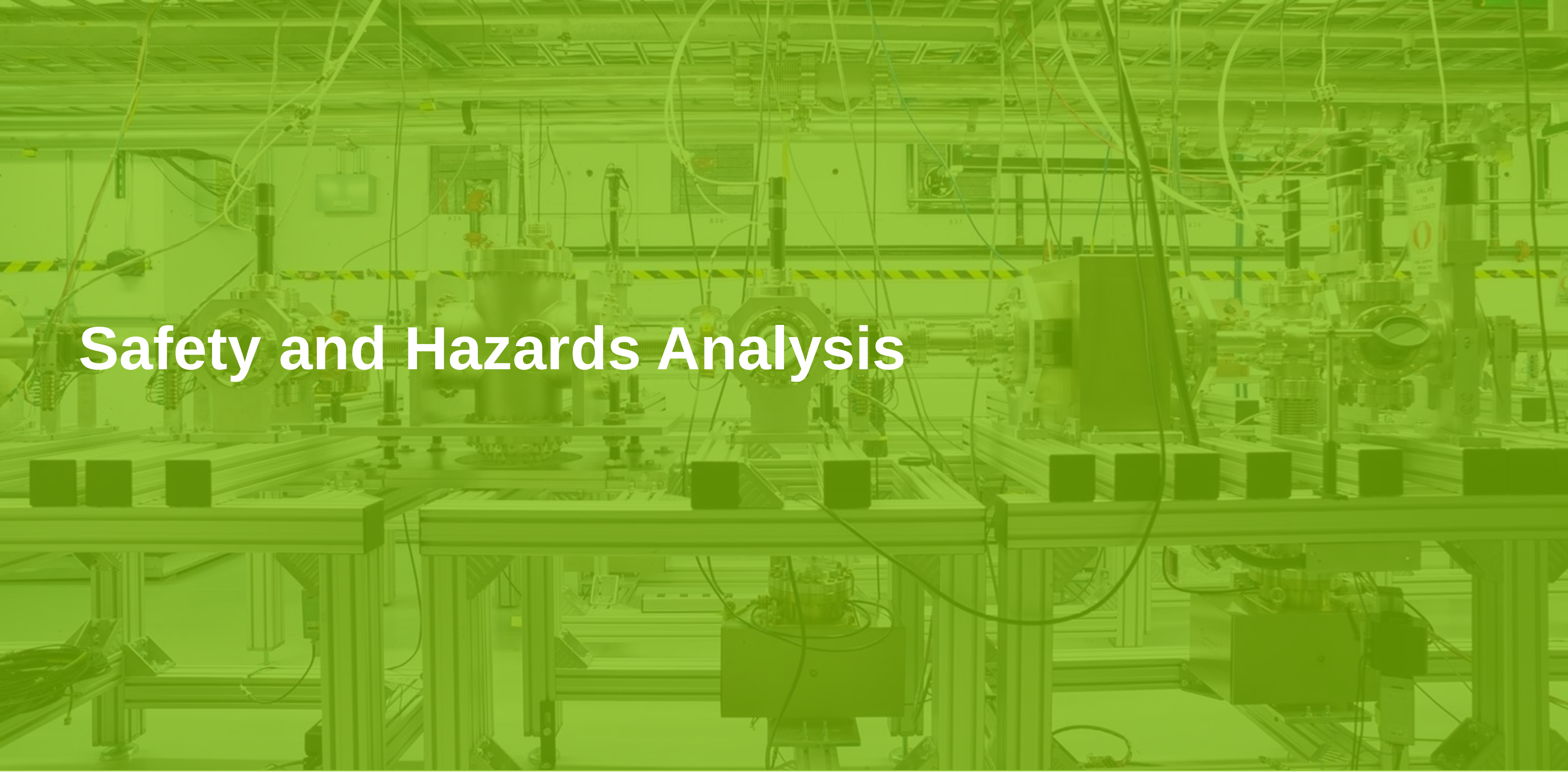
Special Controls, Electrical, RF, Mechanical, Parameters/Requests

Special Controls	Details
?	
?	
?	

Special Electrical/RF	Details
?	
?	
?	

Special Mechanical	Details
?	
?	
?	

Safety and Hazards Analysis

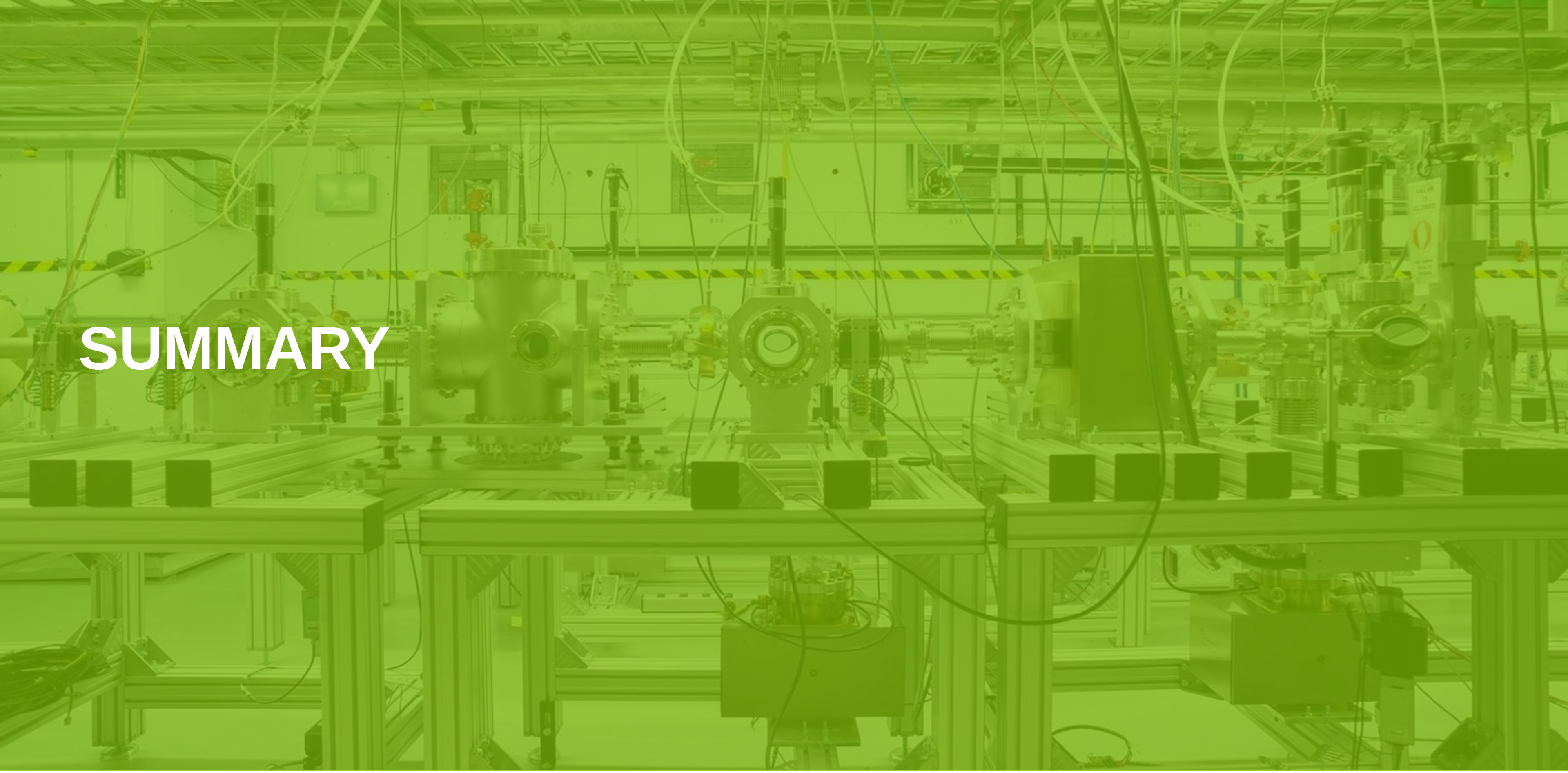


HAZARDS ANALYSIS SUMMARY

Do the project hazards fall under the existing AWA WCD and SAD? (this will need to be determined with the help of AWA staff and if necessary, the ESH coordinator)

- YES.

- If YES then no further action required.
- If No then a project-specific WCD may be required. If the project/task is simple, then WCD-EZ (Form ANL-1223) may be appropriate. Place a link to the WCD here.



SUMMARY

AWA EXPERIMENT SUMMARY

Installation Pictures

- Place pictures of actual installation here.

AWA EXPERIMENT SUMMARY

Data

- Provide data summary and images here.

AWA EXPERIMENT SUMMARY

Lessons Learned

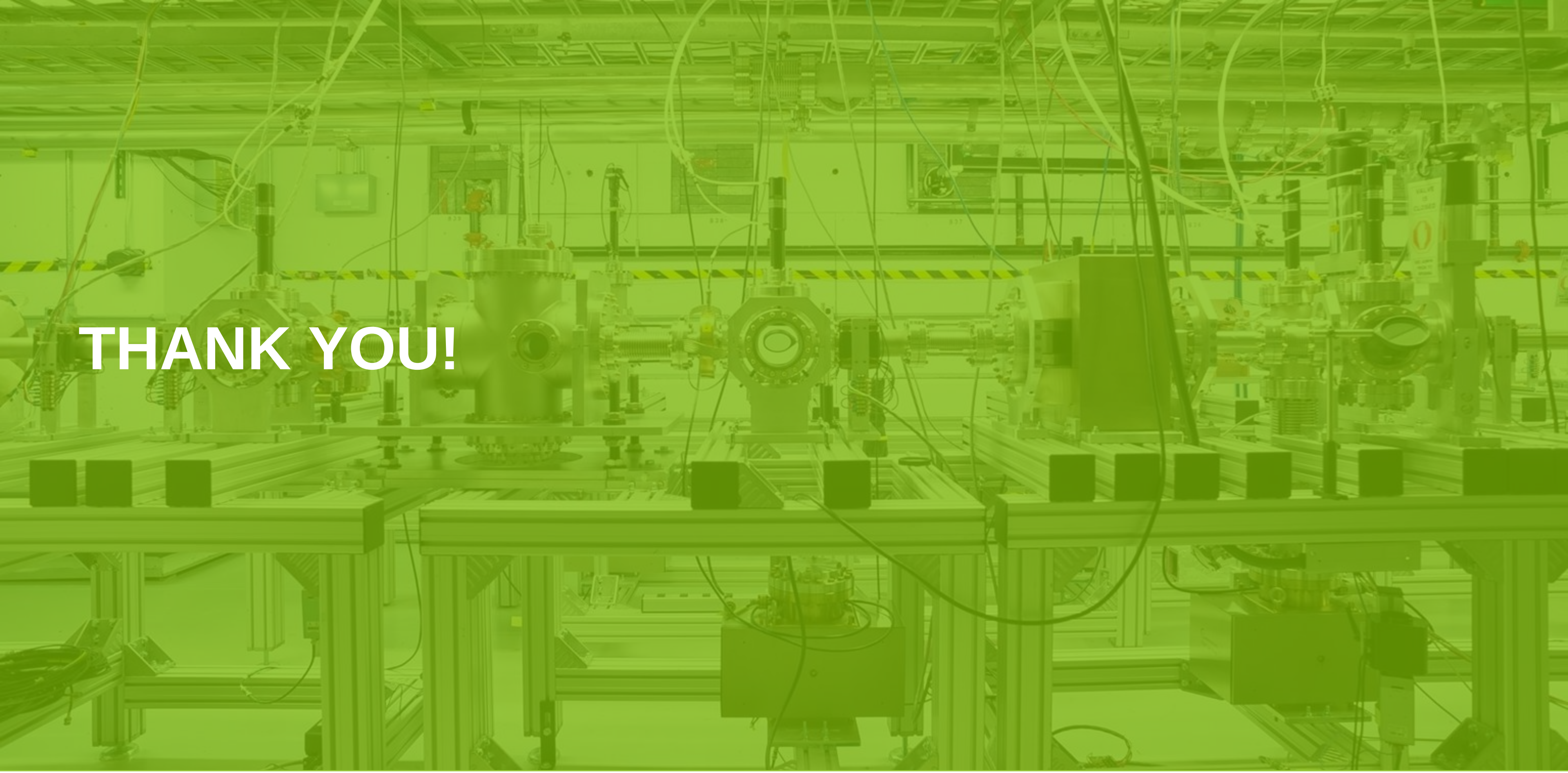
- What did we do well?
- How can we improve?

AWA EXPERIMENT SUMMARY

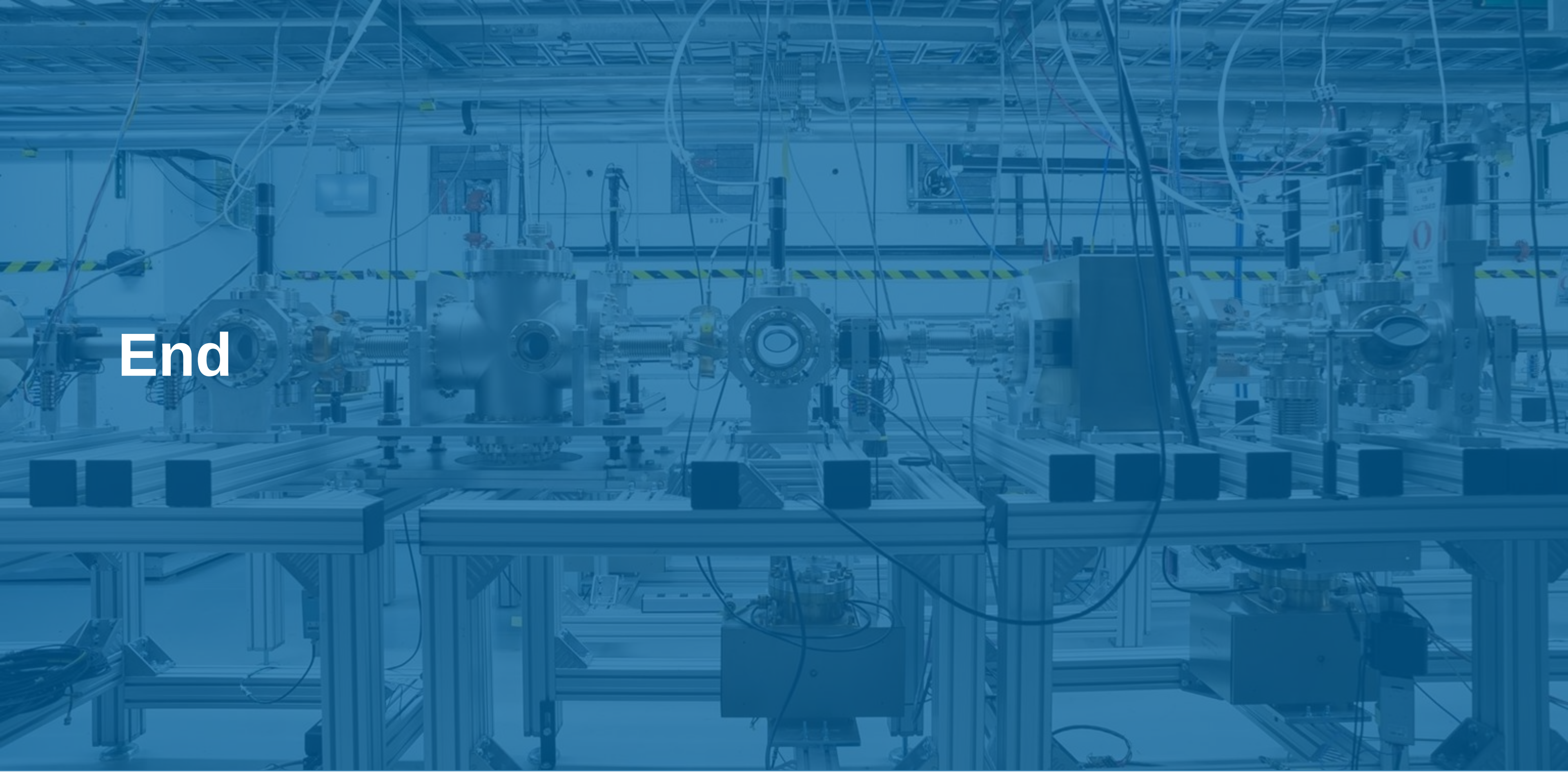
Publications, Proceedings, Journals

- List all publications, proceedings, etc. here and provide links.

Uploaded to AWA Web Site?		



THANK YOU!



End