



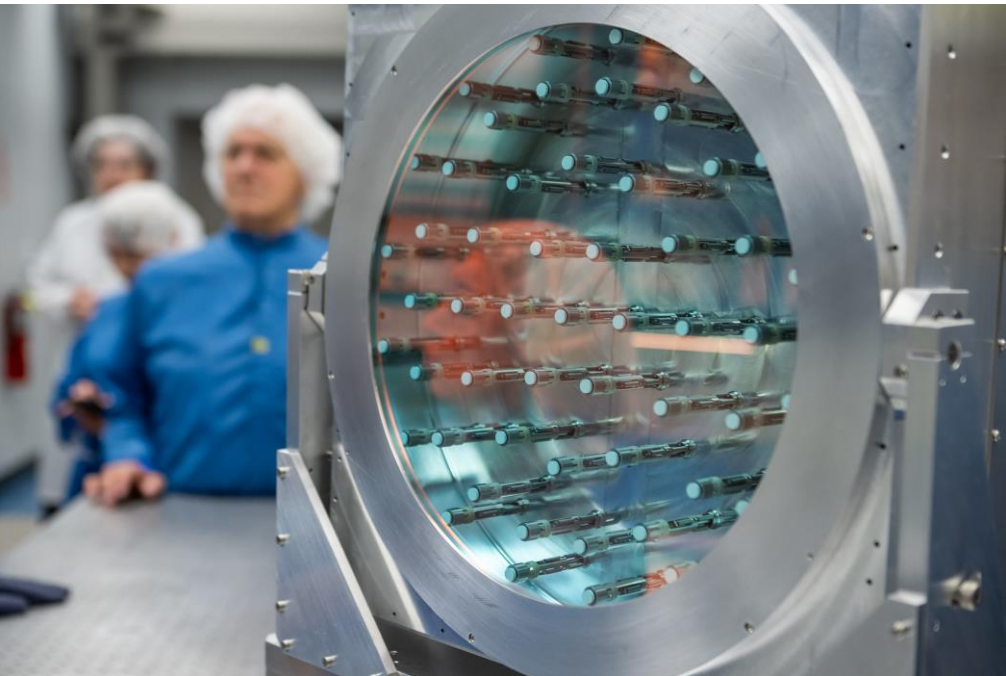
CONSIDERATIONS FOR SUCCESSFUL TRANSITION FROM CONSTRUCTION TO OPERATIONS

NSF Research Infrastructure Workshop

March 26, 2024

Franko Bayer





- **Facility overview, capabilities and operations overview**
- **Performance Measurement Management** (construction with a succinct launch timeline and plan versus operations metrics)
- **Launch planning versus operations management** (standard operating procedures)
- **Risk management and reporting**
- **Impact on how to incorporate EVM**

CONSTRUCTION



November 2021

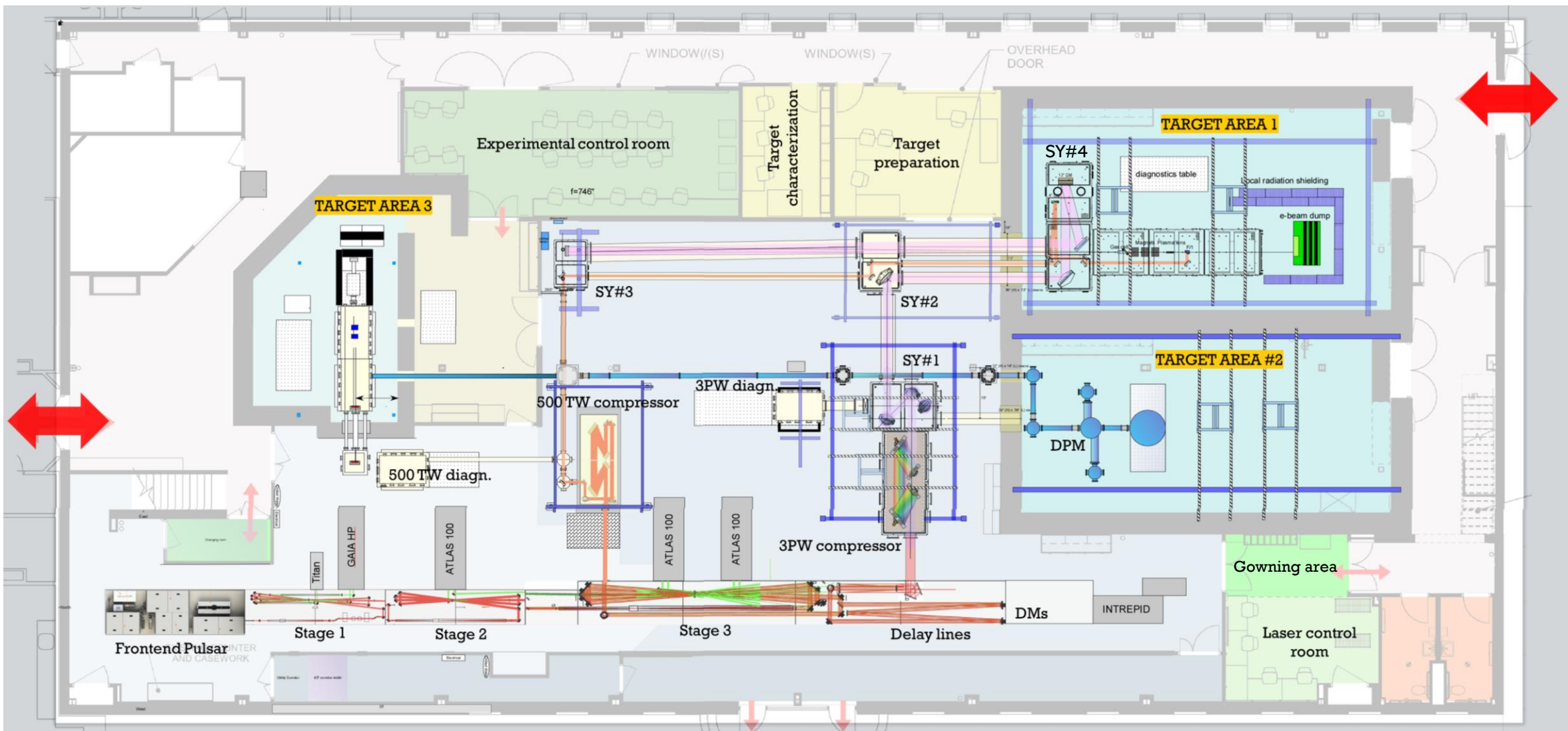
OPERATIONS

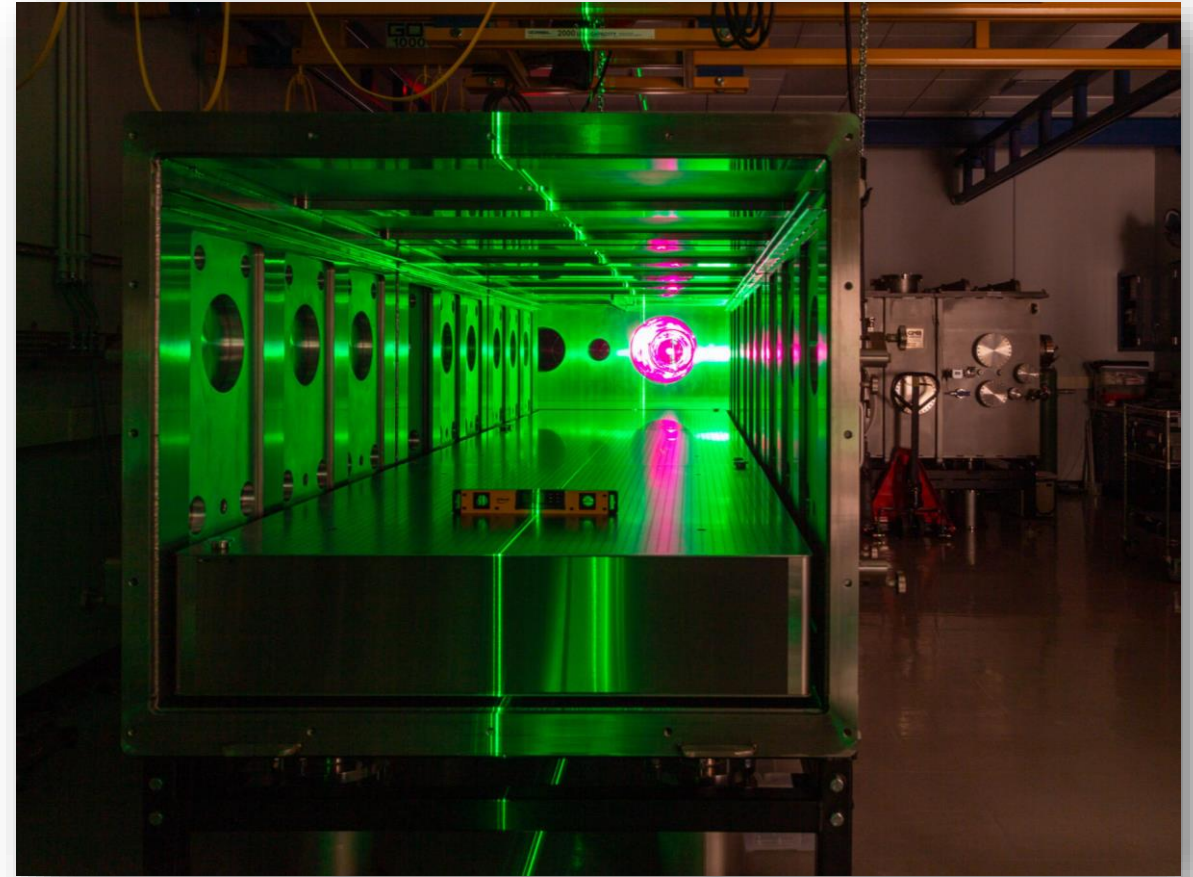


October 2023



ZEUS FACILITY FLOOR PLAN – VACUUM VESSELS AND LASER VACUUM BEAM LINES



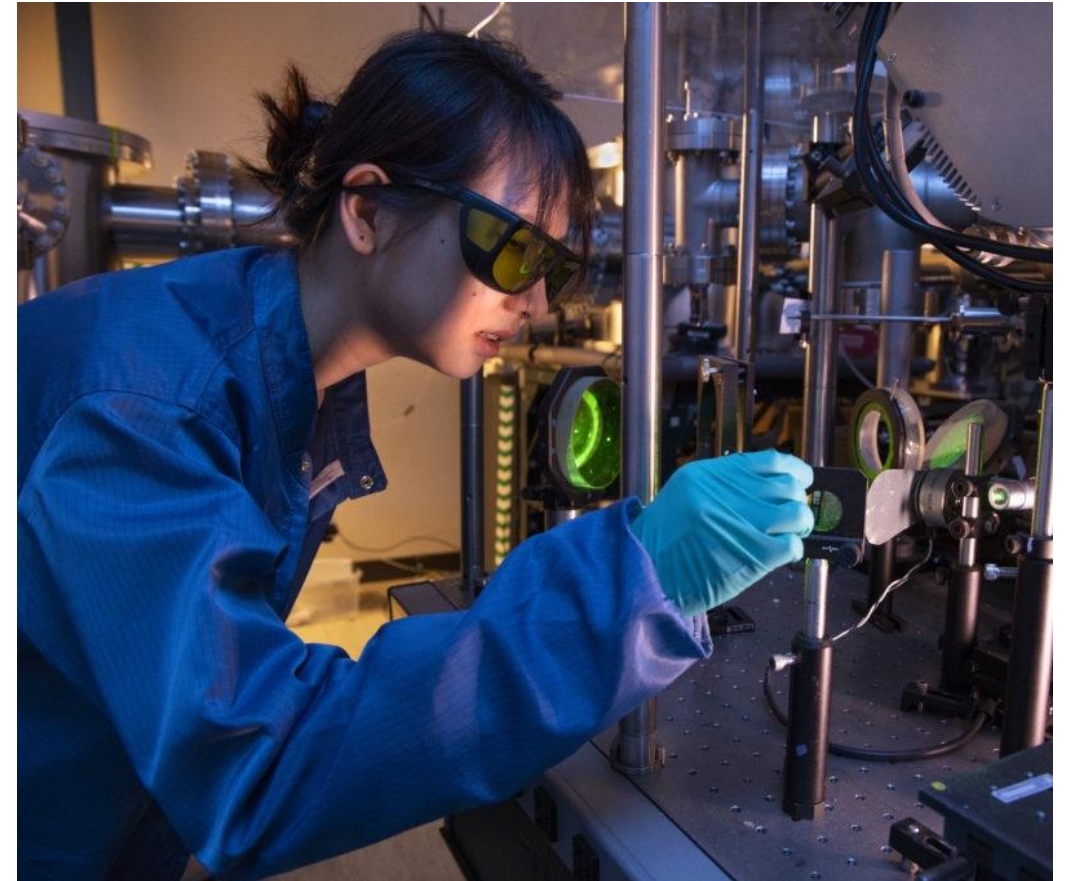


The assembly is completed in June 2023

CAPABILITIES FOR FY25

Parameter	Target area 1 FY24 aim / FY25 aim [targeted FY 26]	Target area 2 FY24 aim / FY25 aim [targeted FY 26]	Target area 3 FY24 aim / FY25 aim [targeted FY 26]
Energy	25 J / 50 J [75 J]	5 J / 12.5 J [75 J]	5 J / 12.5 J [12.5 J]
Pulse duration	25 fs	25 fs	25 fs
Power	1 PW / 2 PW [3 PW]	<200 TW / 500 TW [3 PW]	200 TW / 500 TW [500 TW]
Rep-rate	1 shot per minute	1 shot per minute	200 TW 1 Hz burst mode / 500 TW 1 shot per minute [5Hz burst mode]
Split beam option	No / 1.5 PW & 0.5 PW [2.5 PW & 0.5 PW]	No [No]	No
Plasma Mirror option	No	Yes	No
Focusing	f/64 / f/64 (2 PW) or f/64 (1.5 PW) and f/3 [or (0.5 PW) or f/78 (0.5 PW)]	f/2 [f/2 or f/3]	f/40 / f/40 or f/20
Long pulse option	No / No [Yes]	No / Yes [Yes]	No / No [Yes]

- To provide users with state-of-the-art **high power laser facilities**
- Primary community will be **US academic** users – but will also serve laboratory, **industry and international users**
- Emphasis on **innovative science** and **flexible operation**
- **Emphasis** on graduate student, postdoctoral **training**



- **30 weeks** per year available for **user access**
- Remainder for **maintenance** and **internal access**
- **Flexibility** with **number of weeks** per experiment
 - Some “premade” setups allowing shorter experimental blocks and limited user alignment
 - Longer experimental runs for more complex experiments
 - Contiguous scheduling of experiments with common set-ups
- **Call for proposal** once per year – evaluation by **external proposal review panel**
- No direct funding for users – only **experimental access and support**
- Working on **increasing the number of external users per fiscal year**

Proposal

[Call for Proposal](#)

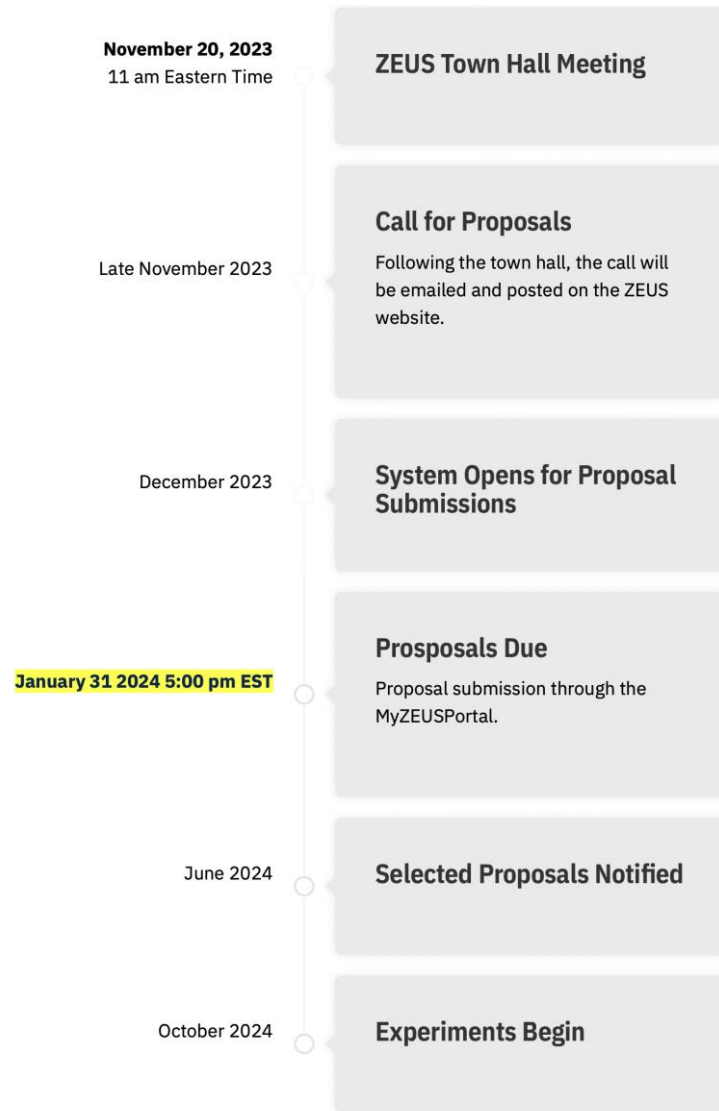
[New Proposal](#)

[User Board](#)

[Editor Board 🔒](#)

[Timeline 🔒](#)

Completed Town Hall: November 20, 2023 at 11:00 AM



(1) Pre-review / Conflict of Interest

PRP members review basic proposal info. COI identified and addressed by chair

(2) Initial Review Stage

Chair assigns 3 reviewers with primaries and secondaries. All PRP reviewers read abstracts

(3) Final Review Stage

Initial ranking by Chair. Primary reviewers leads discussion. Rank ordering. Science mix assessed.

(4) Facility Feasibility Review

Facility COI identified and addressed by Chair. Top ranked proposals sent to ZEUS Director

(5) Final Decision

PRP Review and Feasibility. List of awards submitted to NSF for approval. Decision letters emailed to PIs.

Review process for proposal evaluation:

- Scientific and technical merit
- Proposing team
- Quality of proposed work
- Uniqueness to the facility
- Technical feasibility at the ZEUS facility
- Risk vs. potential impact
- Broadening participation in the high-field science community



MyZEUSPortal is the web-based user interface with the facility.

Here users can **submit a proposal, coordinate their experiment**, find ZEUS info and resources, and view their experimental data.

The **facility staff** also can **communicate and access user requests, check safety courses complete**, etc.

The **external proposal review panel** will access and review proposals through MyZEUSPortal.

User Experiment Schedule Summary FY 2024:

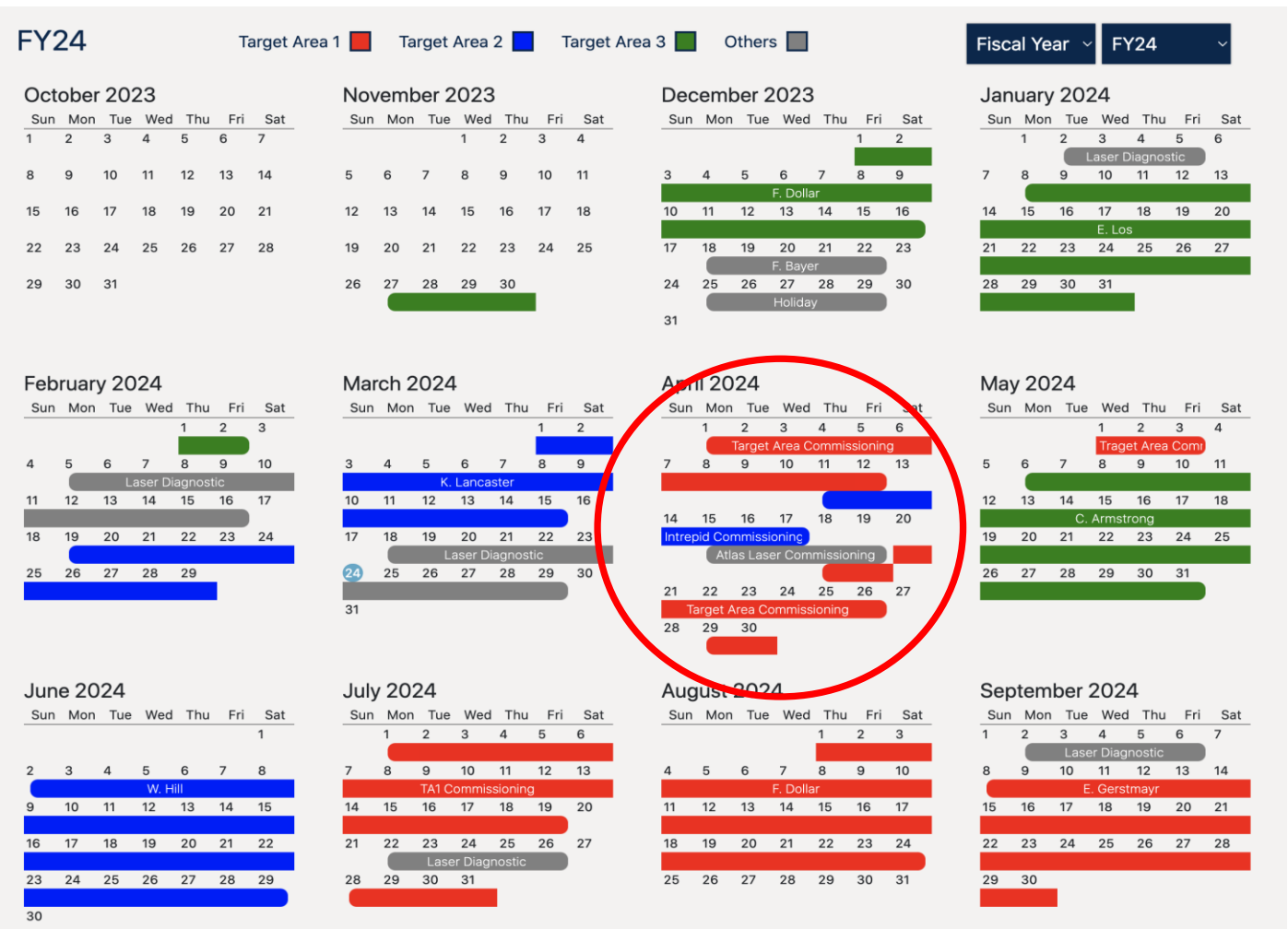
- ❖ **E001: TA3 UC Irvine** PI F. Dollar, Nov 27 – Dec 15
- ❖ **E002: TA3 Imperial College, UK**, PI: E. Los
Jan 08 – Feb 02, 2024
- ❖ **E003: TA2 University of York, UK**, PI: K. Lancaster,
Feb 18 – Mar 15, 2024
- ❖ **E004: TA3 STFC UKRI**, UK, PI: C. Armstrong,
May 6 – May 31, 2024
- ❖ **E005: TA2 University of Maryland**, PI: W. Hill,
- ❖ **E006: TA1 UC Irvine**, PI: F. Dollar, Jul 29 – Aug 31, 2024
- ❖ **E007: TA1 Queens University, Belfast**, PI: E. Gerstmayr,
Sep 09 – Oct 4, 2024

Other:

- ❖ **D60 Crystal Testing: UM and suppliers (Amplitude, Crystal Systems)**, Dec 18 – Dec 22, 2023
- ❖ **Laser Diagnostic: 6 weeks in 2024**
- ❖ **Commissioning: 7 weeks in 2024**

Summary for FY 2024:

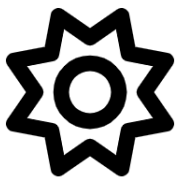
- ❖ 8 external users experiments with collaborators from 13 institutions



[Home](#) [Logout](#)

M | **ZEUS** ZETTAWATT-EQUIVALENT ULTRASHORT PULSE LASER SYSTEM UNIVERSITY OF MICHIGAN

Welcome to My ZEUS Portal, **Franko Bayer!**



Laser Status



My Data



ZEUS Open Data



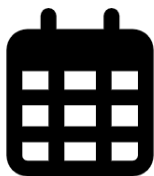
Proposal



Experiment



Lab Resources



Calendar




Self Service



ZEUS Contact

Experiment Summary list by Fiscal Year

Home Logout



**ZETTAWATT-EQUIVALENT
ULTRASHORT PULSE LASER SYSTEM**
UNIVERSITY OF MICHIGAN

Experiment Board

New experiment

Start date	Proposal Title	PI	Affiliation	TA	Status
2023-11-27	Betatron spectral and divergence measurements in the XUV	Franklin Dollar	University of California, Irvine	3	submitted
2023-12-18	Ti:Saphire D60 Crystal Testing - Impact of fumes within substrate regarding beam quality and fluorescence lifetime	Franko Bayer	University of Michigan	N/A	submitted
2024-01-08	Non-linear Compton scattering in the classical-quantum transition regime with Bayesian optimisation	Eva Los	Imperial College London	3	submitted
2024-02-19	Towards the first generation of QED-plasmas in the laboratory	Kate Lancaster	University of York	2	submitted
2024-05-06	X-ray ptychography from a laser-driven betatron source	Chris Armstrong	Science and Technology Facilities Council	3	submitted
2024-06-02	Quantitative measurement of ejected electrons from a focused relativistic pulse: a tool for direct assessment of tightly-focused petawatt lasers	Wendell Hill	University of Maryland	2	pending input
2024-07-28	Soft X-ray Generation in Laser Wakefield Acceleration	Franklin Dollar	University of California, Irvine	1	pending input
2024-09-08	Parametric study of strong radiation reaction using a laser wakefield accelerator and a plasma mirror	Elias Gerstmayr	Queen's University Belfast	1	pending input

Functionality Summary:

- ❖ Link to proposal description and experiment detail
- ❖ List of Collaborators including safety training status tracking
- ❖ Safety courses – tracking completion
- ❖ List of Collaborators including safety training status tracking

Home Logout **M ZEUS** ZETTAWATT-EQUIVALENT ULTRASHORT PULSE LASER SYSTEM UNIVERSITY OF MICHIGAN

Experiment details: E-5 **Proposal**

Status: submitted

General

Experiment ID* E-5 Proposal Title* Non-linear Compton scattering in the classical-quantum transition regime with Bayesian optimisation

Target Area* TA3 Experiment Start* 01/08/2024 Experiment End* 02/02/2024

Experimenters **Import from proposal**

ID	On-site	First Name	Last Name	Email	Affiliation	Title	Profile	course1	course2	course3	course4	course5
<input type="checkbox"/> 25	<input checked="" type="checkbox"/>	Kate	Lancaster	kate.lancaster@york.ac.uk	University of York	Senior Lecturer	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	02/12/25	02/18/25
<input type="checkbox"/> 77	<input checked="" type="checkbox"/>	Alex	Morris	alexander.morris@liverpool.ac.uk	University of Liverpool	PhD student	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	02/01/25	03/11/25
<input type="checkbox"/> 82	<input checked="" type="checkbox"/>	Radhika	Nayli	radhika.nayli@strath.ac.uk	University of Strathclyde	PhD student	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	02/18/25	02/18/25
<input type="checkbox"/> 59	<input checked="" type="checkbox"/>	Christina	Ingleby	christina.ingleby@york.ac.uk	University of York	PhD Student	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	02/18/25	02/18/25
<input type="checkbox"/> 60	<input checked="" type="checkbox"/>	Nathan	Smith	nathan.smith@york.ac.uk	University of York	Postgrad Researcher	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	02/18/25	03/04/25
<input type="checkbox"/> 32	<input type="checkbox"/>	Matthew	Alderton	matthew.alderton@strath.ac.uk	University of Strathclyde	PhD Student	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	mm/dd/yy	mm/dd/yy

- 3 months

Meeting participants: Target area link scientist, PI and User team, Engineers, laser representative.

Register all users through the MyZEUSPortal.

-1 month

First planning stage: Identify elements of experimental **design** that **require development**.
Order targets.

Coordinate with User office to initiate travel plans and take required safety training before arrival.

-2 weeks

Second planning stage: **Finalize** experimental **design**, **diagnostic requirements**, **set up** and identify issues or concerns. Plan logistics for external equipment.

Third planning stage: Final readiness review before experiment start.

Set up weeks

External users arrive to prepare their experiment set up. UM team will attempt to complete set up prior to arrival



Functionality Summary:

- ❖ Experiment scheduling based on standard process steps
- ❖ Meeting schedule and document repository (PDF upload)
- ❖ List of Collaborators including safety training status tracking
- ❖ Publication tracking
- ❖ Close out report (*under development*)

Experiment

Experiment details

Operation

User Management

Survey Summary

Milestones

Kick-off meeting	completed	09/22/2023		Choose File
Registration	completed	12/14/2023		Choose File
Schedule confirmation	completed	12/14/2023		Choose File
Design confirmation	completed	10/26/2023		Choose File
Diagnostic equipment	completed	10/26/2023		Choose File
Target	completed	12/01/2023		Choose File
One-month prior meeting	completed	12/01/2023		Choose File
Two-weeks prior meeting	completed	02/14/2024		Choose File
Safety training	completed	02/19/2024		Choose File
Preliminary results	pending			Choose File
Final close out	pending			Choose File
Post experiment evaluation	pending			Choose File
Publications	pending			Choose File

E002 Imperial College –E. Los:

Link Scientist: Yong Ma

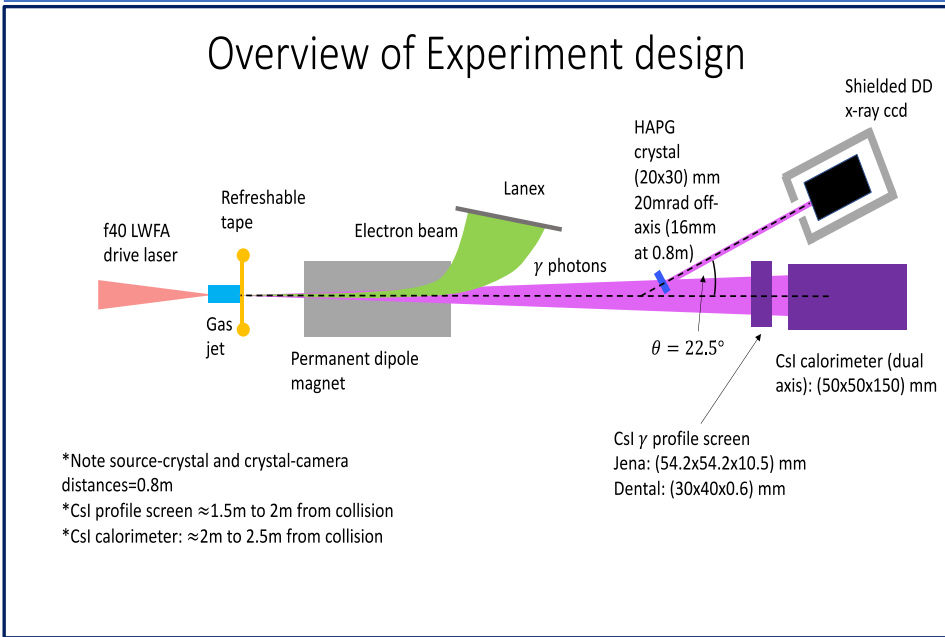
Experiment Time:

Non-linear Compton scattering in the classical-quantum transition regime with Bayesian optimization

January 8, 2024 – February 2, 2024

Design:

Status Summary:



- Waiting for UMich email addresses for users to complete safety training, targeted for first week in December
- Users will bring tape drive, currently at an experiment at ELI
- Working on **pre-customs clearance for equipment shipment** from RAL (crystal, mounts, actuators, spectrometer, lenses)
- **Next follow up meeting: second week in December**

Key Next Steps:

- Confirm set up for f/40 focusing geometry
- Check DX420 CCD availability, cooling, power supply and signal output
- Processed procurement of two motorised vacuum compatible goniometers with encoders
- Complete registration and safety training

Key Mile Stones	Date	Status
Kick Off Meeting	09.19.2023	Completed
Registration	TBD	In progress
Safety Training	TBD	In progress
Schedule Confirmation	10.12.2023	Completed
Design Confirmation	10.12.2023	Completed
List of Diagnostic Equip.	10.12.2023	Completed
Target	11.08.2023	Completed
One Month Prior	11.16.2023	Completed
Two Weeks Prior	12.13.2023	Open
Prl. Results Review	Feb 2024	Open
Close Out Meeting	Mar 2024	Open
Post - Experiment Eval.	Mar 2024	Open
Publications/Authorship	TBD	TBD

EXPERIMENT SUMMARY STATUS FY 2024

	TA3 - E001 F. Dollar Nov. 27 – Dec 15	TA3 - E002 E. Los Jan 08 – Feb 02	TA2 - E003 K. Lancaster Feb 18 – Mar 15	TA3 - E004 C. Armstrong May 06 – May 31	TA2 - E005 W. Hill Jun 10 – Jul 5	TA1 - E006 F. Dollar Jul 29 – Aug 23	TA1 - E007 E. Gerstmeier Sep 09 – Oct 01
Kick-Off Meeting	Completed	Completed	Completed	Completed	Completed	May	June
Registration	Completed	Completed	Completed	Completed	In Progress	May	June
Schedule Confirmation	Completed	Completed	Completed	Completed	Completed	Completed	Completed
Diagnostic Equipment List	Completed	Completed	Completed	Completed	In Progress	Open	Open
Target	Completed	Completed	Completed	Completed	In Progress	Open	Open
Design Confirmation	Completed	Completed	Completed	In Progress	In Progress	Open	Open
Preparation Mtg. One month prior	Completed	Completed	Completed	April	May	Open	Open
Preparation Mtg. two weeks prior	Completed	Completed	Completed	April	May	Open	Open
Safety Training	Completed	Completed	Completed	May	June	Open	Open
Result Review	Completed	Completed	May	June	July	Open	Open
Close-Out Meeting	Completed	Completed	May	July	August	Open	Open

7 am – 2 technicians arrive, **warmup laser systems**, start alignment, maintenance

8 am – users arrive, morning meeting with TA Link scientist, technical staff

(daily experiment status review meetings)

10 am – laser availability (first alignment beams, then high power beams)

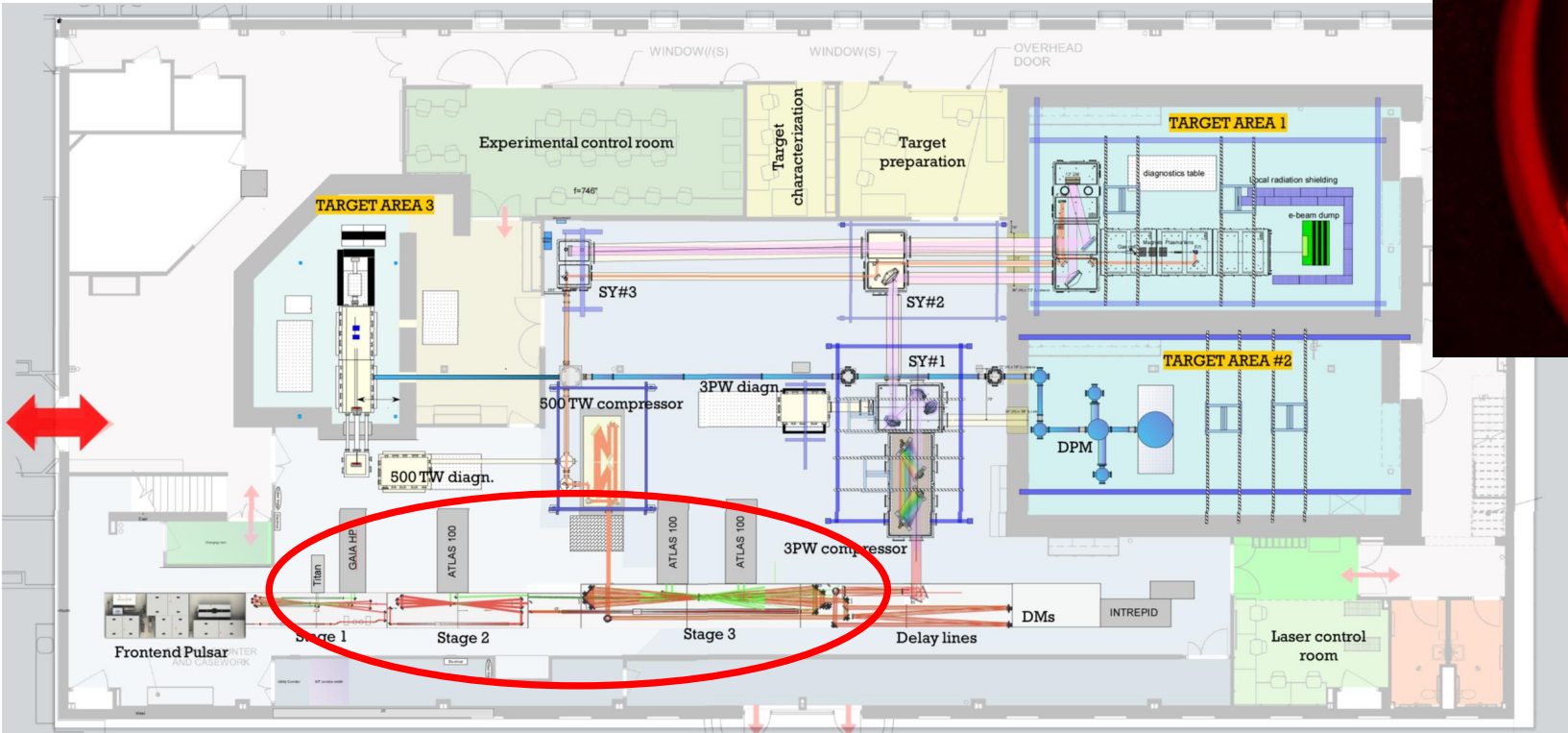
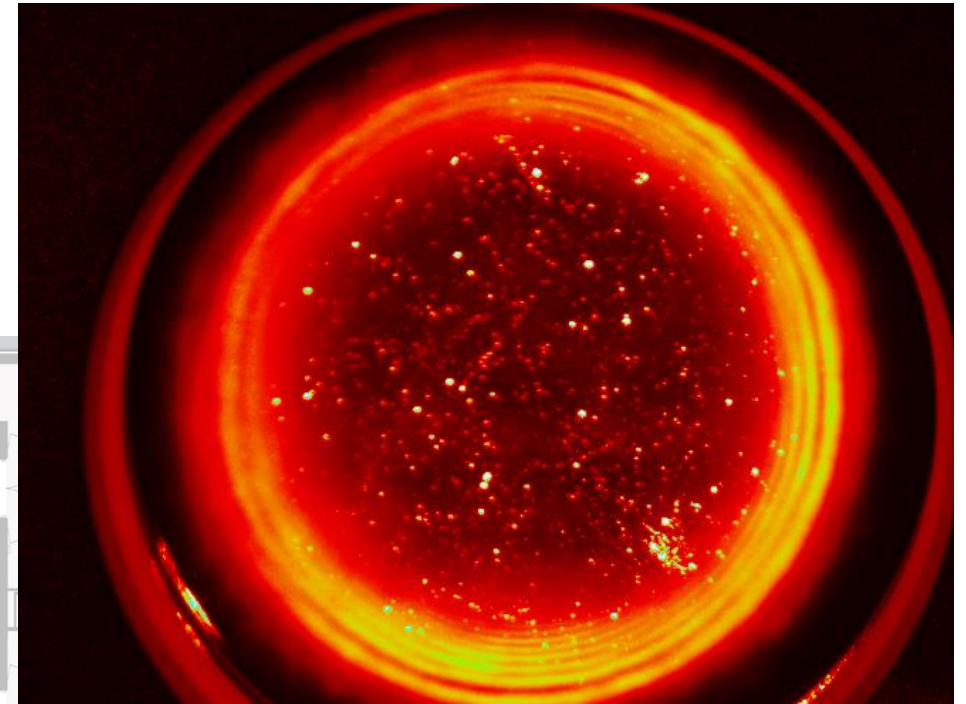
12 pm – 2 laser technicians arrive

2 pm – afternoon meeting with TA Link scientist, technical staff

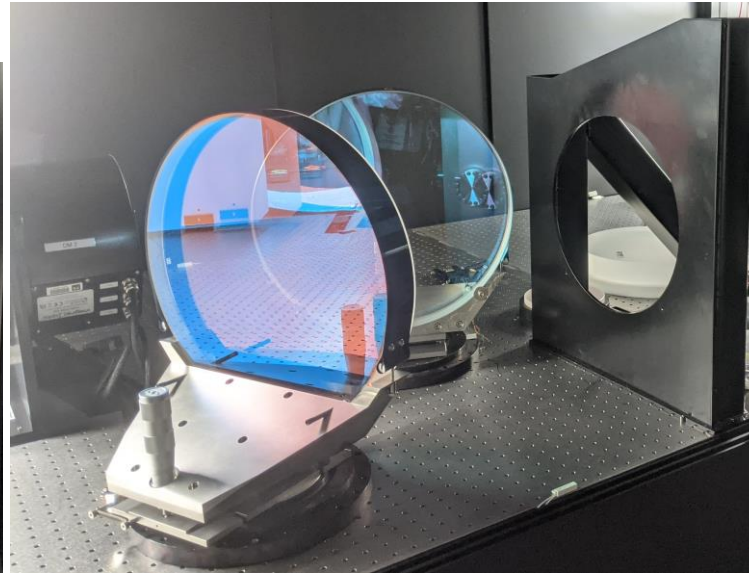
8 pm – end of laser operations, data available on user web-site,

P.I. sends daily experiment status summaries, including achievements and outlook for the next day

- D60 Ti-Sapphire Crystal within first amplification stage pumped with 20J (high rep rate pump lasers)
- Example of surface contamination which poses the risk subsequent optics damage

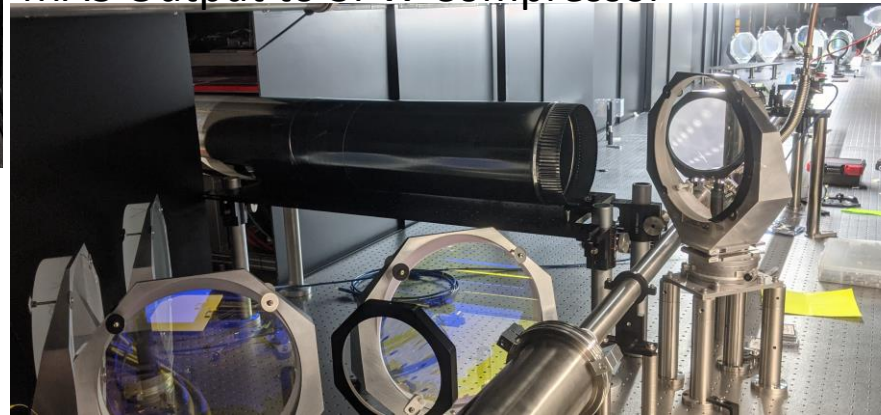


MA3 Spatial filter and achromat lenses



16" Mirror Mount: In Air

MA3 Output to 3PW Compressor



G on target and within budget **Y** critical but on time and within budget **R** not on target and/or over budget

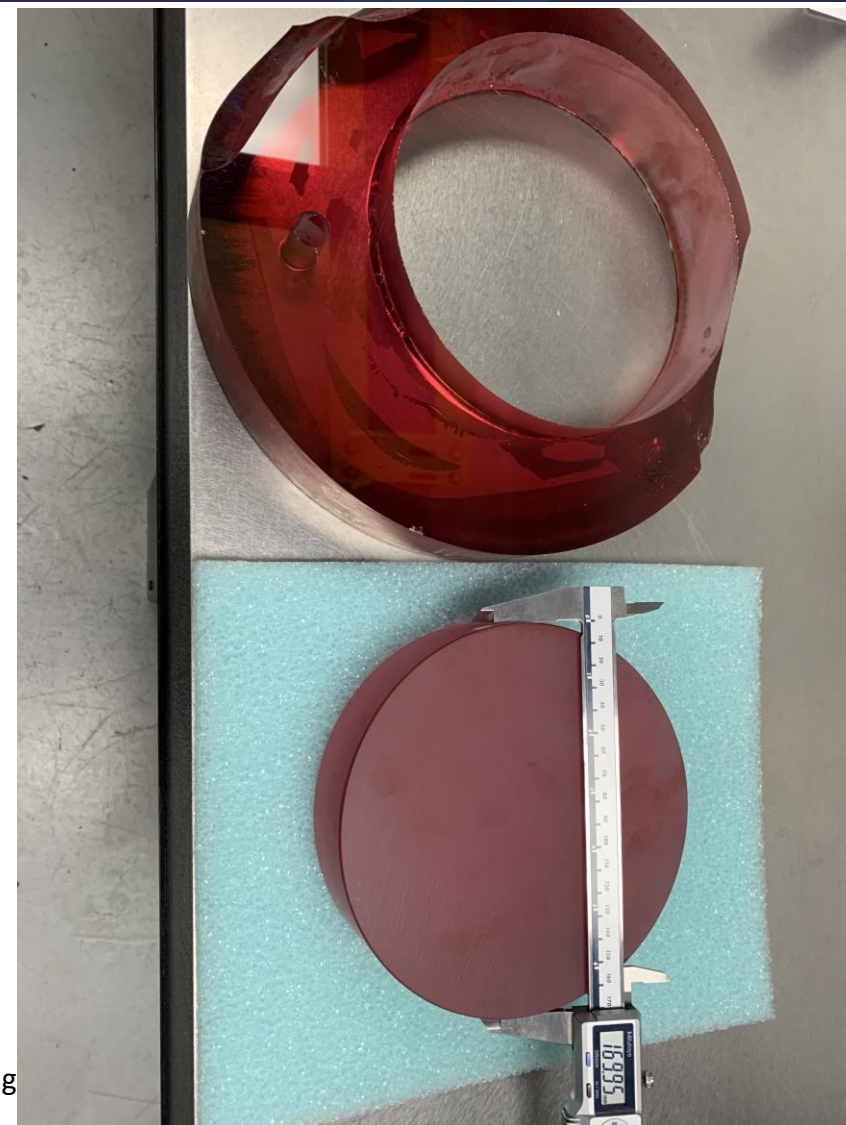


Y D170 spare substrate:

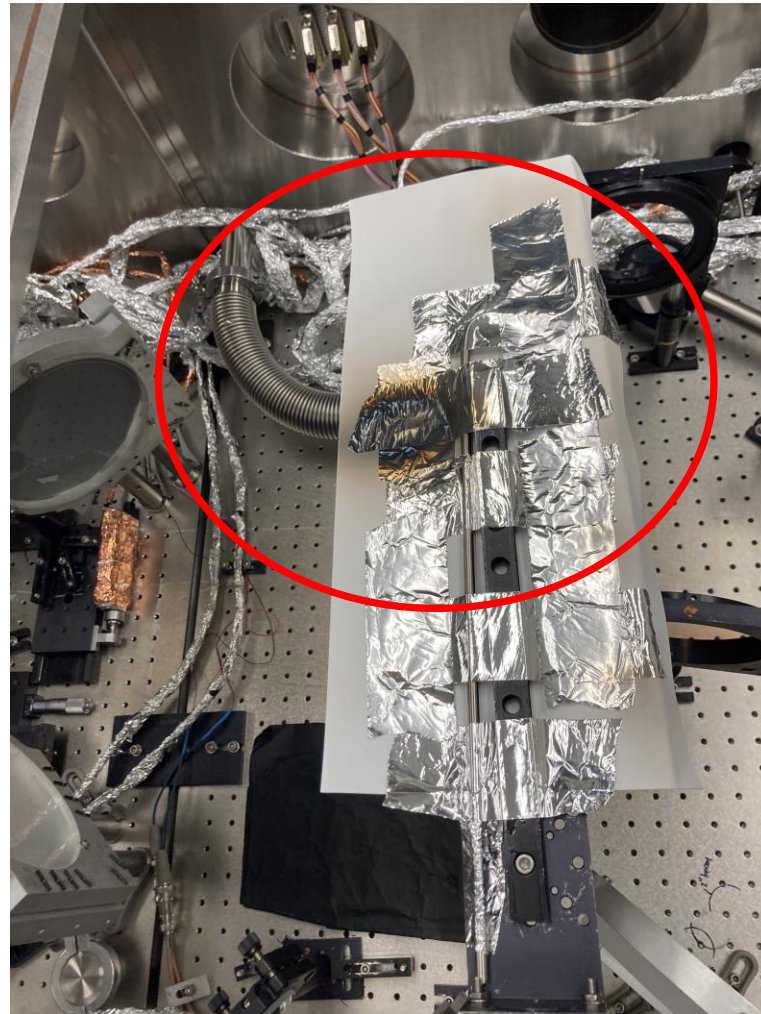
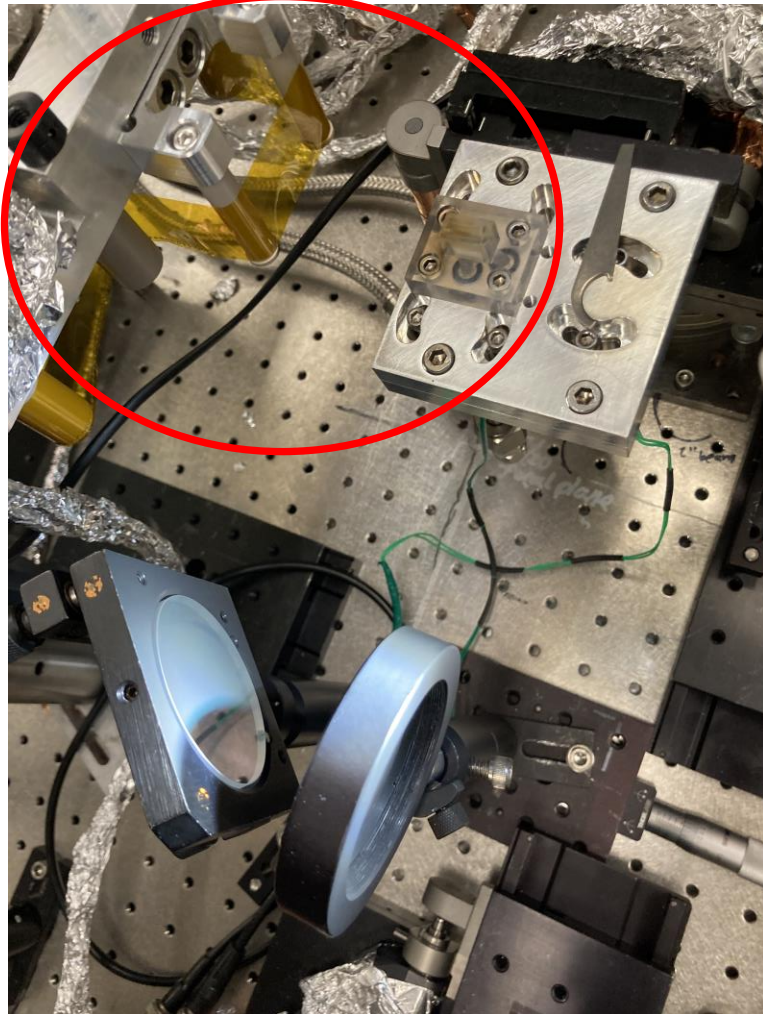
➤ **Key Milestones:**

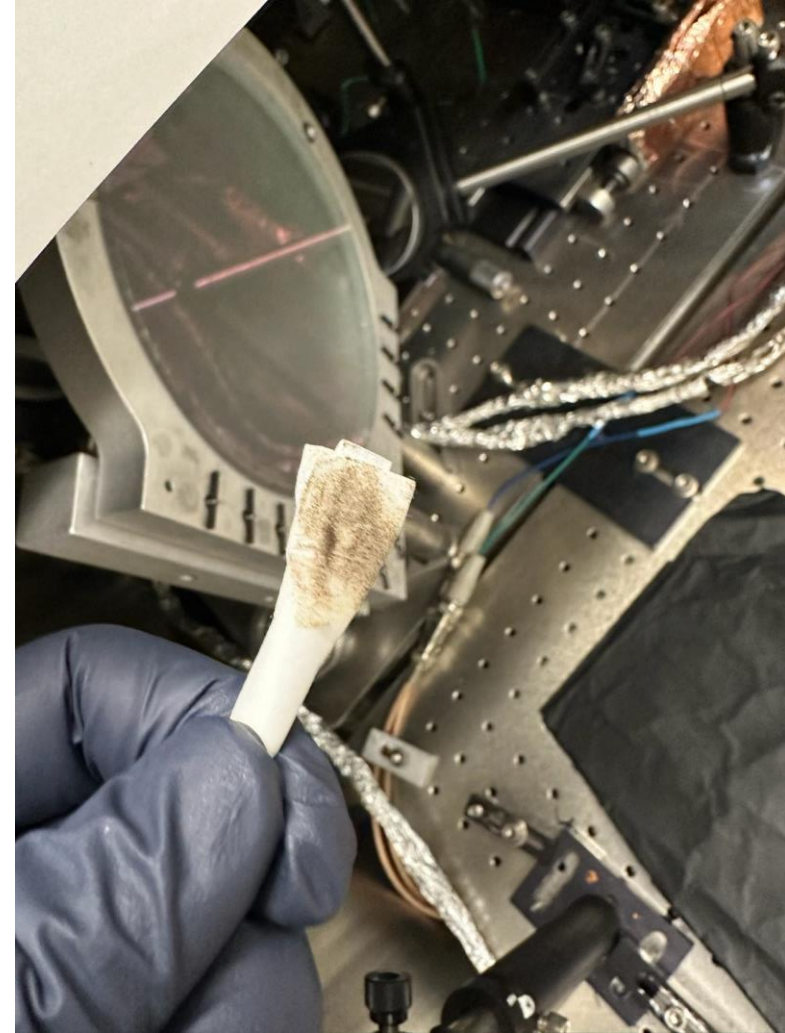
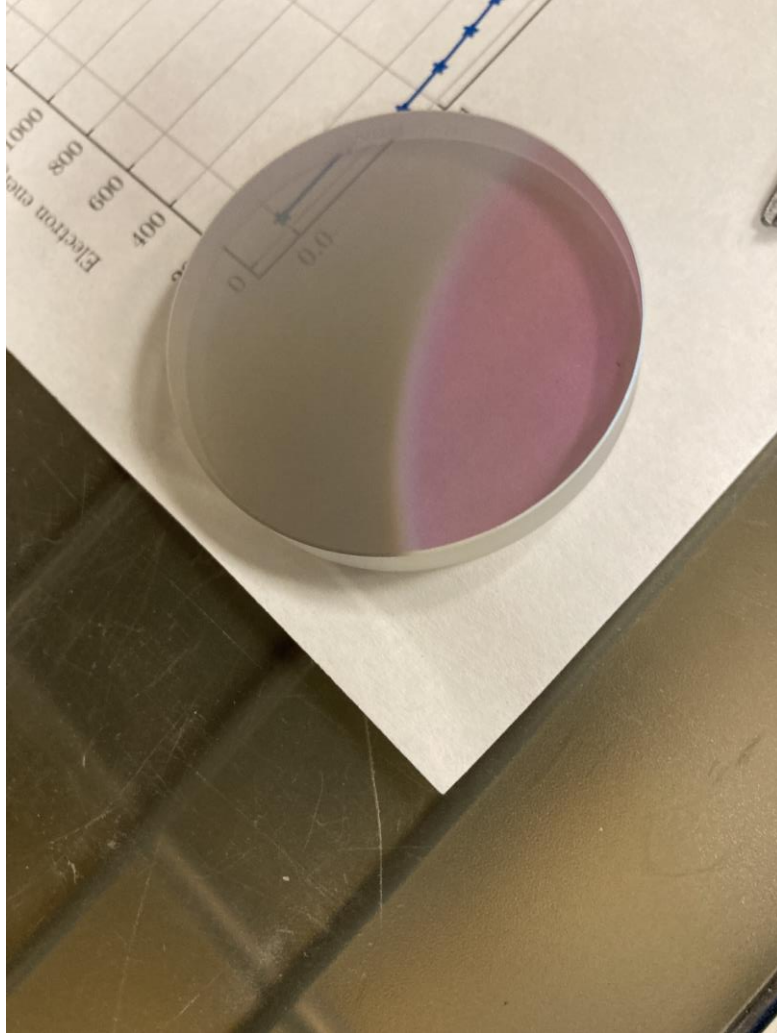
	Status/ Target Date
➤ Order placement:	Completed
➤ Confirm aperture placement:	Completed
➤ Cut crystal:	Completed
➤ Confirm Wedge position:	Completed
➤ Sent to super polishing:	Completed
➤ Receive back from polishing:	April 30
➤ Interferometry report (after polishing):	May 06
➤ Dimensions Confirmation (mount fabrication)	May 10
➤ Complete coating:	May 24
➤ Final interferometry report:	May 31
➤ Delivery:	June 14 – 28

Regular reviews (**every two weeks**) to monitor progress and discuss updates



G on target and within budget **Y** critical but on time and within budget **R** not on target and/or over budg





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Lab Resources

Clean Room

- 1. Standard Operating Procedures
 - [ZEUS Front End User Manual and SOP v1-1.pdf](#)
 - [ZEUS ATLAS SOP Notes v1-4.pdf](#)
 - [ZEUS MA1 Signal Alignment SOP Notes v1-0.pdf](#)
- 2. Manuals
 - [Quantum Technology Pockels Cells User Manual v1-0.pdf](#)

Software

- [How to connect to ZEUS VPN.pdf](#)
- [Connect to Turbo storage.pdf](#)
- [Datauploader.zip](#)

Target Area 2



Facility

- [ZEUS Laser Safety Warning Sign Rules v1-2.pdf](#)
- [User instruction on My ZEUS portal.pdf](#)
- [ZEUS-SafetyLock-OutProcedure.pdf](#)



Target Area 1



Target Area 3

- [SOP-TA3Shooting.pdf](#)
- [TA3SOP-ZEUS500TWCcompressorpumpingandventinging.pdf](#)
- Target Chamber layout
 - [TA3 Chamber layout.pdf](#)



- MyZEUSPortal has user documents as well as standard operations procedures for laser operators
- Working on developing swim-lane work flow for entire experiment life cycle (call for proposal to experiment close out)
- Key elements will be based on and include inputs, outputs and process step controls
- Will be combined with RACI chart and reporting responsibilities

➤ Swim lane Process Flow:

- For the entire experiment cycle (call for proposal to close out reviews)
- Will be based on inputs, outputs and include RACI charts as well as reports

EVM STATUS SUMMARY – 4TH QTR. AUGUST FY 2023

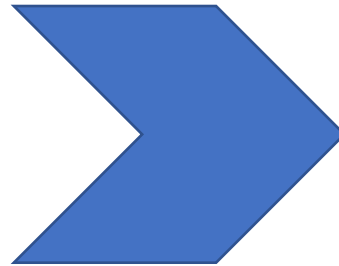


WBS	PV		AC		EV		CV	SV	CPI	SPI
EVM Metrics Summary by Quarter FY 2023							CV=EV-AC	SV=EV-PV	CPI=EV/AC	SPI=EV/PV
1st Qtr	\$	14,898,637	\$	14,939,769	\$	14,921,221	\$ (18,550)	\$ 22,586	0.999	1.002
2nd Qtr	\$	15,262,742	\$	15,293,230	\$	15,274,503	\$ (18,729)	\$ 11,760	0.999	1.001
3rd Qtr	\$	15,409,346	\$	15,438,645	\$	15,418,577	\$ (20,070)	\$ 9,230	0.999	1.001
4th Qtr	\$	16,365,891	\$	16,369,483	\$	16,366,598	\$ (2,885)	\$ 706	1.000	1.000
EVM Metrics Detail - April										
1.1 Lab Design	\$	154,211	\$	150,306	\$	154,211	\$ 3,905	\$ -	1.026	1.000
1.2 Lab Construction		58,564		64,147		58,564	(5,583)	-	0.913	1.000
2.1 Laser Concept Design		1,244,979		1,257,139		1,244,980	(12,159)	-	0.990	1.000
2.2 Laser Procurement		7,271,874		7,242,013		7,271,874	29,861	-	1.004	1.000
2.3 Laser System Control		760,697		767,957		760,697	(7,260)	-	0.991	1.000
2.4 Laser Assembly		1,736,987		1,729,456		1,723,548	(5,908)	(13,439)	0.997	0.992
3.1 Target Area Concept Design		358,468		396,499		358,468	(38,031)	-	0.904	1.000
3.2 Target Area Procurement		2,896,315		2,900,456		2,896,315	(4,141)	-	0.999	1.000
3.3 Target Area Assembly		814,456		817,845		814,983	(2,862)	527	0.997	1.001
4.1 Laser Commissioning		398,959		404,118		419,239	15,121	20,280	1.037	1.051
4.2 Target Area Commissioning		415,987		402,561		409,325	6,764	(6,662)	1.017	0.984
4.3 Radiation Shielding		254,395		236,987		254,395	17,408	-	1.073	1.000
Cum Project Total	\$	<u>16,365,891</u>	\$	<u>16,369,483</u>	\$	<u>16,366,598</u>	\$ <u>(2,885)</u>	\$ <u>706</u>	<u>1.000</u>	<u>1.000</u>



WBS:

1. **User Interactions**
2. **Laser Operations**
 - 2.1 Laser Controls
 - 2.2 Laser Maintenance/Repair
 - 2.3 Laser System Upgrades
3. **Target Area Operations**
 - 3.1 Preparation for user experiments
 - 3.2 Target area repair/maintenance
 - 3.3 Diagnostic repair/maintenance
 - 3.4 New diagnostic development
4. **Engineering Operations**
 - 4.1 Target fabrication
 - 4.2 Vacuum Systems
 - 4.3 Control Systems
 - 4.4 Data storage/transfer
 - 4.5 Procurement



Metrics:

- **Continuation of EVM metrics with a focus on experiment operations**
- Focus on **quantitative measurements per experiment:**
 - Experiment phases will include
 - **Preparation and set up**
 - **Experiment duration**
 - **Post experiment** evaluation and analysis
 - Laser parameters (e.g. Pulse energy, pulse duration, power)
 - Laser availability for shots on target
 - Number of shots per experiment
 - Successful user experiments
 - Number of students and postdocs trained at facility
 - User evaluations
 - Publications
- Financials associated to WBS numbers
- **Categories:**
 - Science and Technology
 - Operations Management
 - Finance

➤ **Swim lane Process Flow:**

- For the entire experiment cycle (call for proposal to close out reviews)
- Will be based on inputs, outputs and include RACI charts as well as reports

The ZEUS team



Karl Krushelnick (PI)
 Director



Louise Willingale
 Associate Director



Alec Thomas
 Co-PI



Igor Jovanovic
 Co-PI



Carolyn Kuranz
 Co-PI



Anatoly Maksimchuk
 Experimental Manager



John Nees
 Laser Manager



Franko Bayer
 ZEUS Project Manager



Bixue Hou
 Engineering Manager



Yong Ma
 Link Scientist



Paul Campbell
 Link Scientist



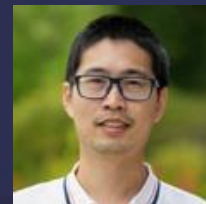
Milos Burger
 Laser Scientist



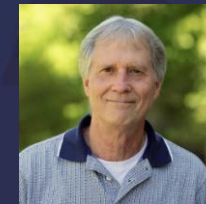
Galina Kalinchenko
 Laser Engineer



Grant Young
 Sen. Laboratory Engineer



Qing Zhang
 Data Scientist



Richard Van Camp
 Laboratory Engineer



Gregg Sucha
 Laser Engineer



Elizabeth Oxford
 Outreach Coordinator



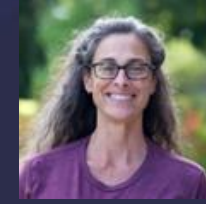
<https://zeus.engin.umich.edu/>



Lauren Weinberg
 Laser Engineer



Richard Anthony
 Laboratory Engineer



Sallee Klein
 Target Fabrication



Gaylene Opal-Deitering
 Admin. Assistant Sr.
 Amy Brooks
 Res. Admin. Mgr.

Mid-scale Research – Award # 2126181

Questions & Answers