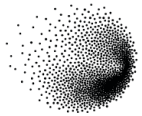


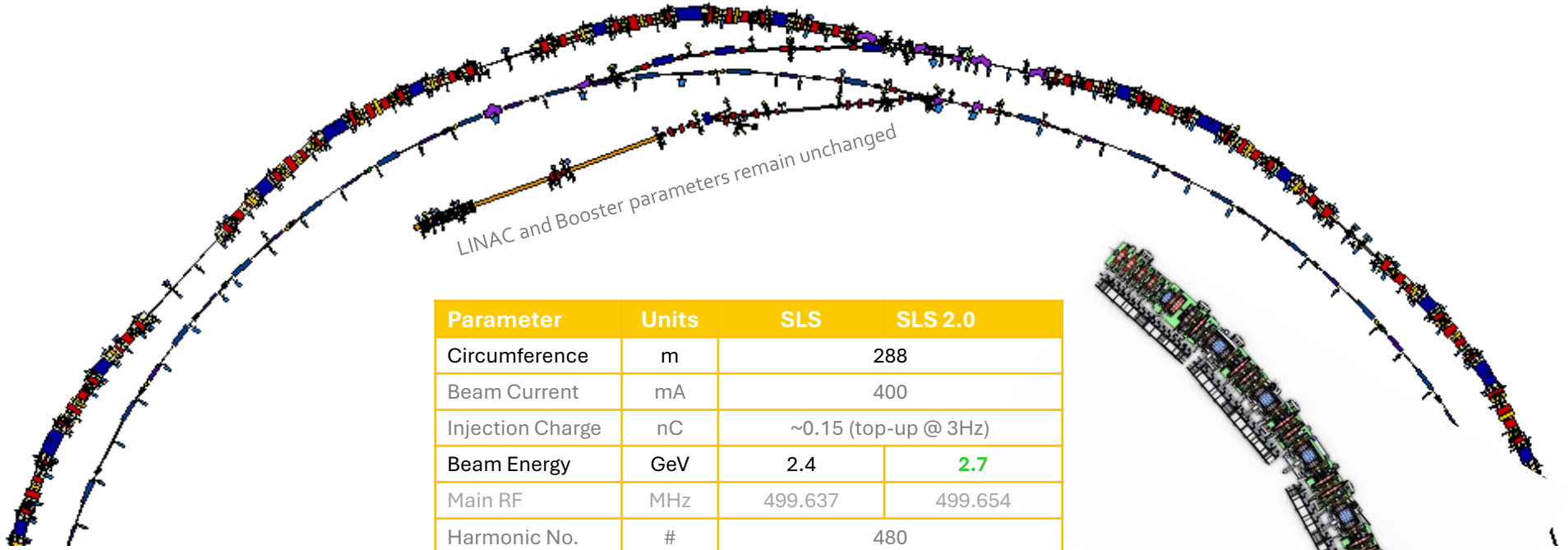
PSI Center for Accelerator Science and Engineering

Diagnostics for SLS2.0

DEELS 2024, Synchrotron SOLEIL

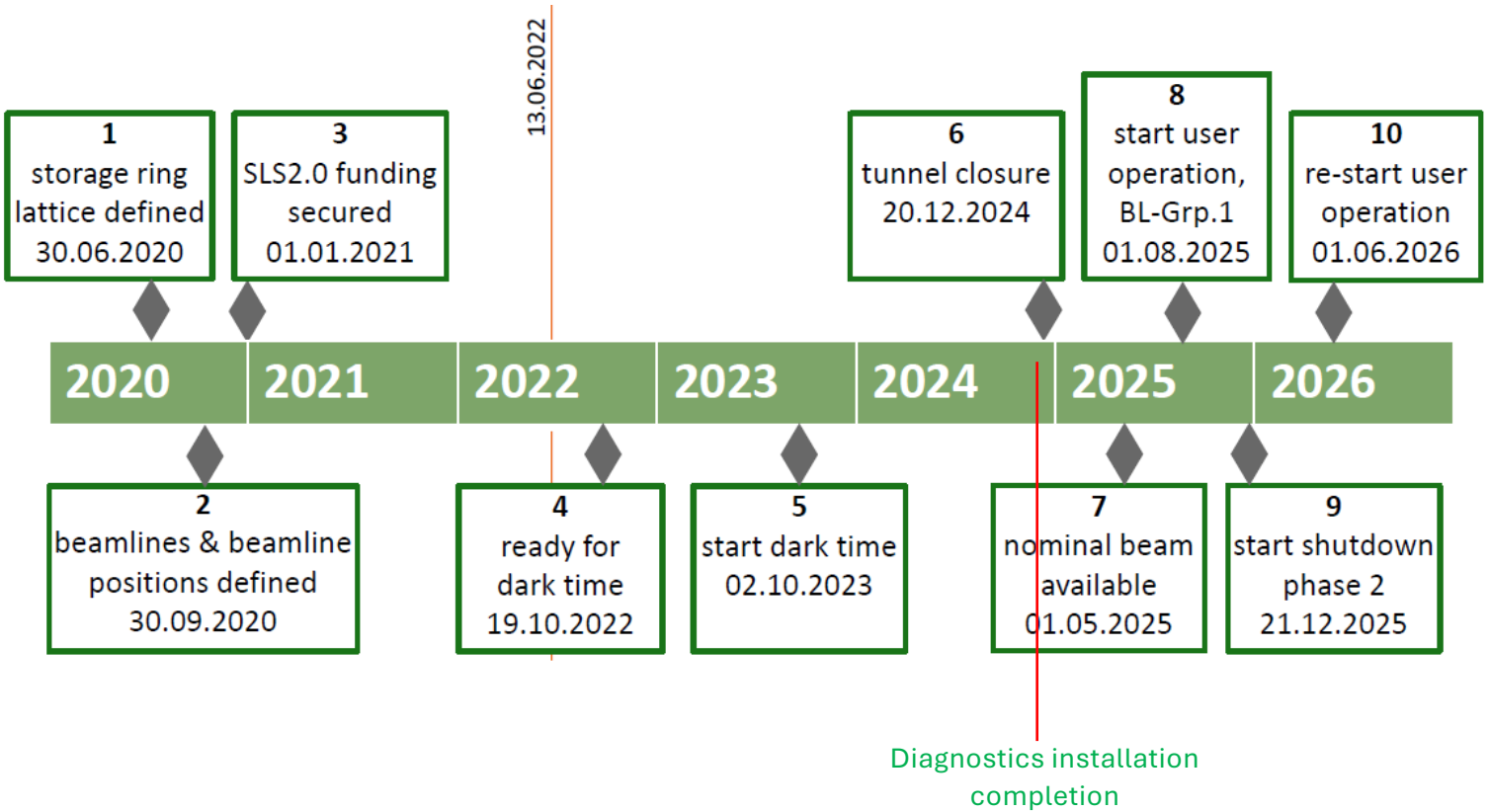
Cigdem Ozkan Loch
Electron Beam Instrumentation group

SLS → SLS 2.0



Parameter	Units	SLS	SLS 2.0
Circumference	m	288	
Beam Current	mA	400	
Injection Charge	nC	~0.15 (top-up @ 3Hz)	
Beam Energy	GeV	2.4	**2.7**
Main RF	MHz	499.637	499.654
Harmonic No.	#	480	
Hor. Emittance	pm-rad	5030	**131-158**
Vert. Emittance	pm-rad	5-10	10
Energy Spread		0.00103	**0.001145**
Ring Beam Pipe		Stainless Steel	**Copper (NEG)**

Timeline



courtesy of Dr. R. Ganter

SLS Dismantling

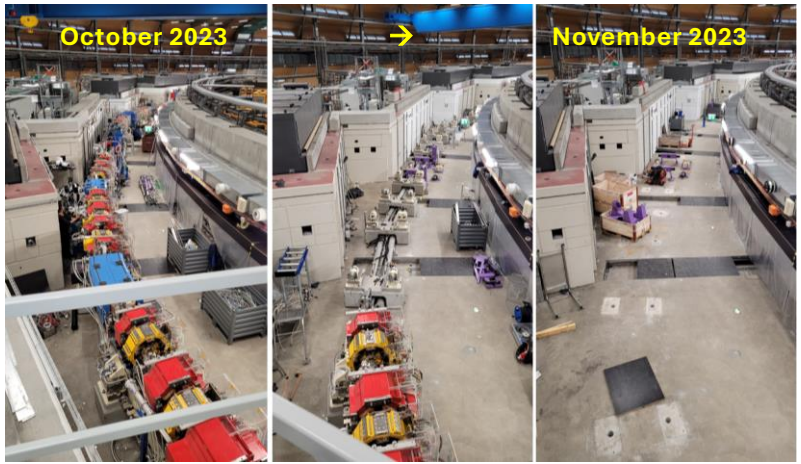
September 30th, 2023: SLS was switched OFF

Dismantling went according to plan

October: Removal of all tunnel roof bars
Removal of all cable trays and cooling distribution along Ring
Removal of all re-used components: 3HC, Kickers, Undulators, …
Removal of RF modulator & Klystron and most of Electrical cabinets
Removal of all front ends

November: Removal of all girders with magnets

December: Tunnel floor painted



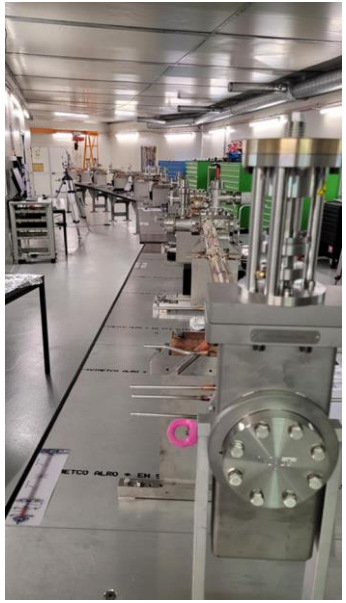
courtesy of Dr. R. Ganter

Give away

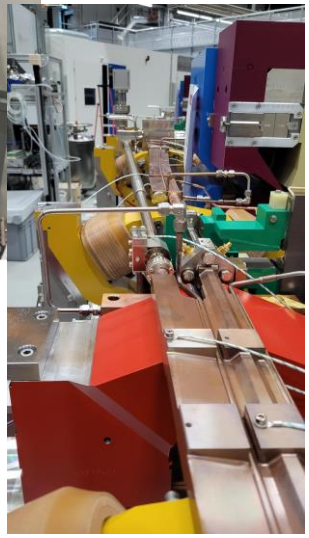
- 14 sets of Bergoz BPM electronics (2 per set) available for free…!!!
- They were installed around the IDs, integrated to a position interlock signal to the MIS once the beam would extend a pre-defined position offset.

Arc vacuum chamber

18m arc assembly



Arc transport & storage frame

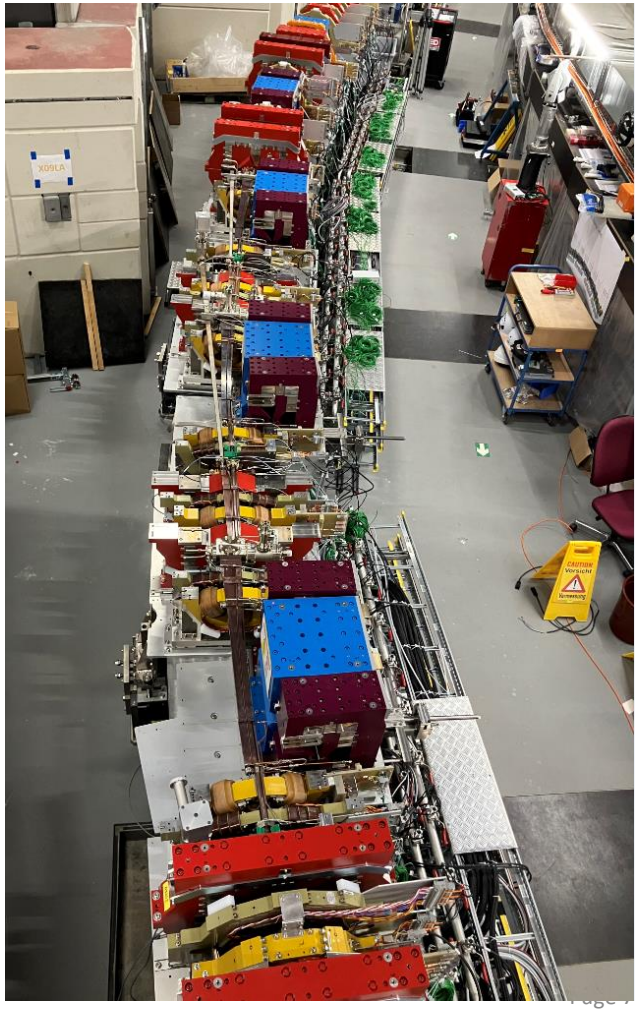


- Vacuum arc fits in the magnets apertures
- Installation procedure validated
- … minor corrections of cooling pipes.

courtesy of Dr. R. Ganter

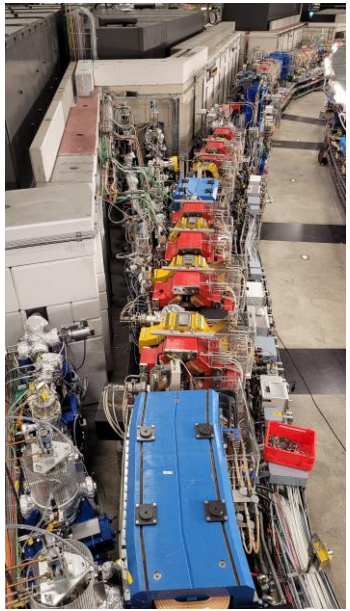
Installation

- Arc assembly and alignment at off-site assembly/storage location
- Girder pre-aligned and installed on ground plates
- Permanent magnet dipoles are on slides and pushed into place after the vacuum chamber is completed
- One arc installed every two weeks
- Most cables prepared in factory and installed in bundles (length + plug)
- Radial position of consecutive magnets within +/- 60µm
- Longitudinal position of magnets are within +/- 500µm

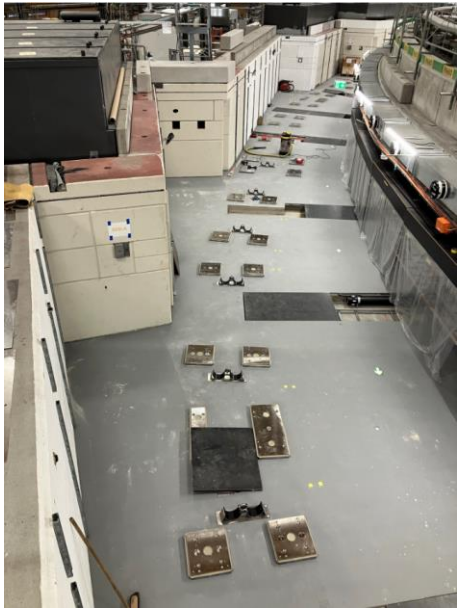


courtesy of Dr. R. Ganter

Then and now…



October 2023



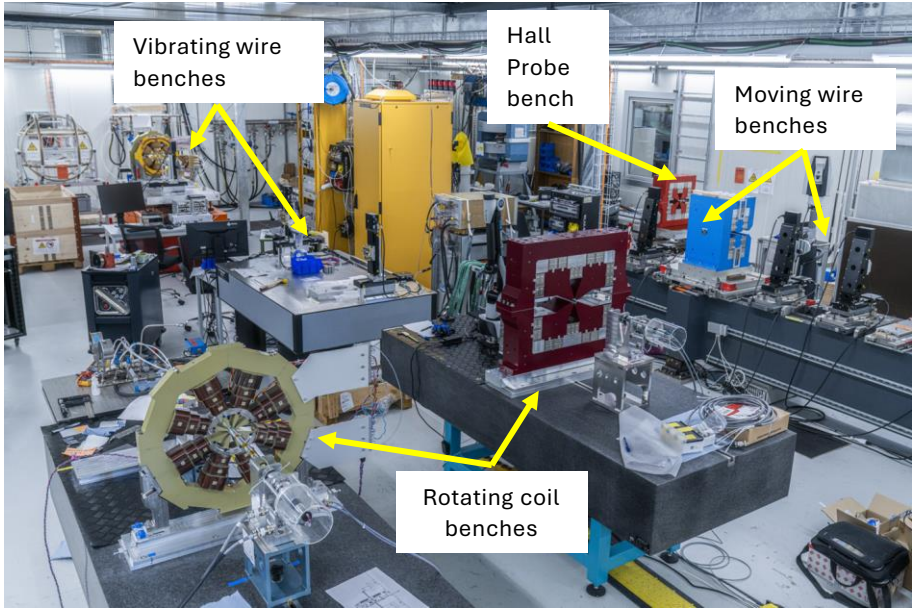
January 2024

February 2024

April 2024

4 arcs installed
5th almost complete

Other systems



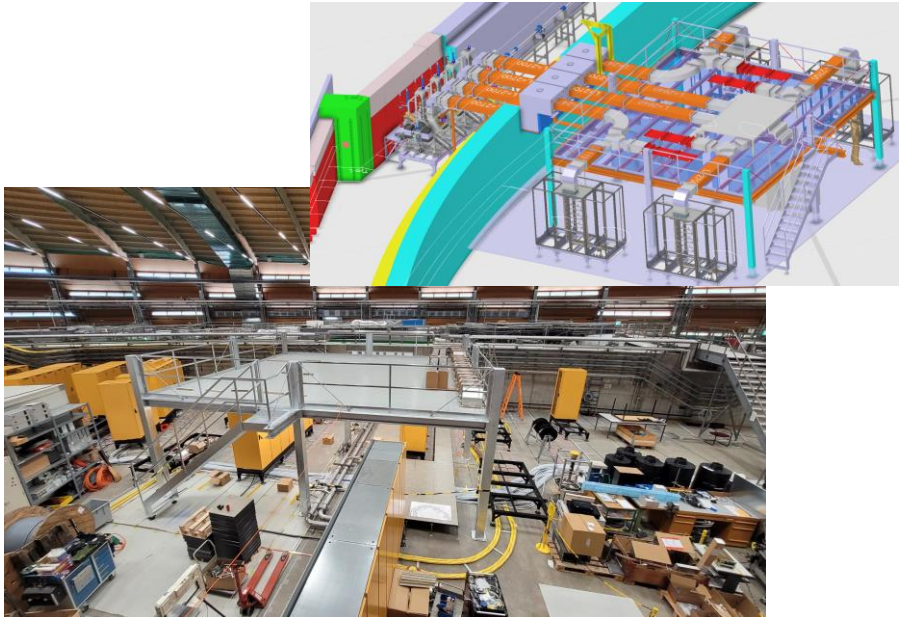
- Magnet assembly and tests proceeding in a timely fashion
  - Quadrupole Series: 112 /112 ready
  - Steerers: 117 / 117 ready
  - Sextupoles: 194 / 270 ready
  - Octupoles: 194 / 268 ready
  - Triplet Bending magnet: 26 / 60 ready
  - Reverse Bends: 104 / 150 ready (2 per day)
- Cross talk measurements on going to check against simulation results

- All power supplies have been made, tested and are being installed into the racks
- BPMs (mechanics and electronics) are on the right track

courtesy of Dr. R. Ganter

Other systems

Four cavities at PSI:
- 1 cavity already conditioned to 600 kV
- 1 cavity under conditioning in a test stand



Location of Solid state amplifiers (SSA)
500 MHz / 150 kW, 4 units
Delivery schedule is tight

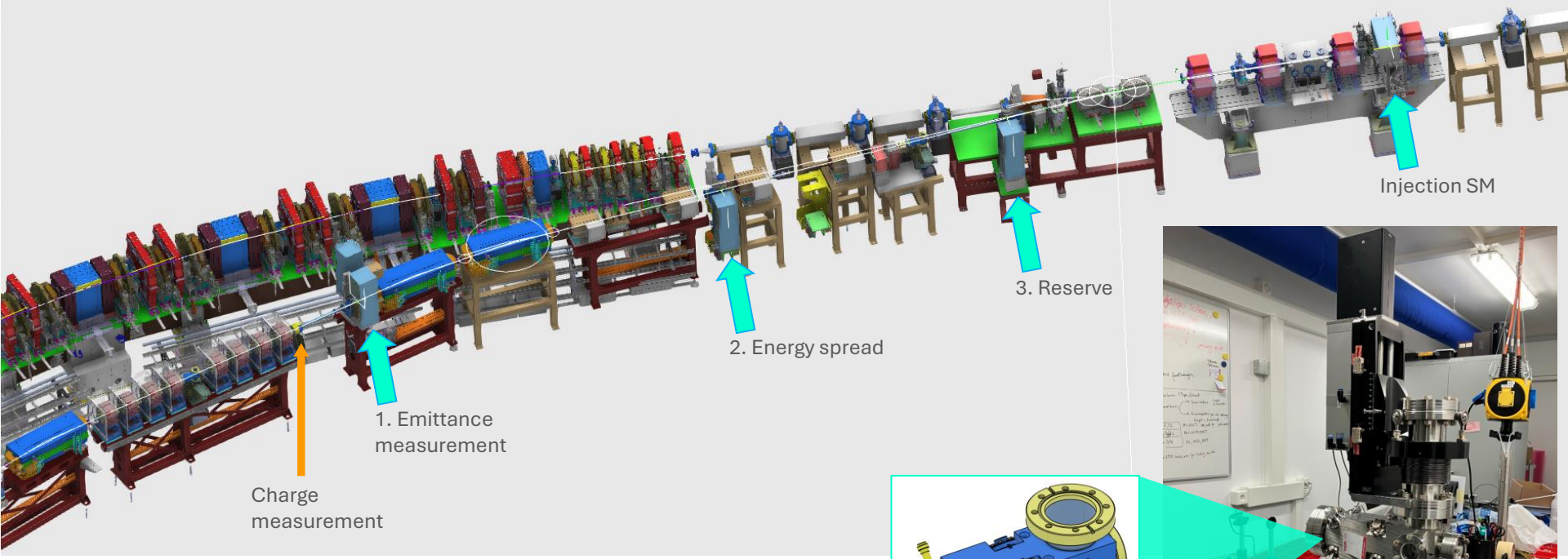
courtesy of Dr. R. Ganter

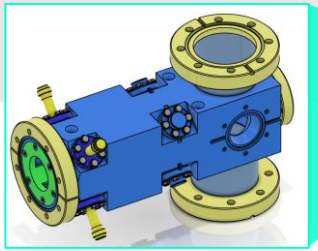
Baseline systems

Inherited Devices	Purpose	Requirements	for SLS 2.0
Current Monitor (Bergoz PCT)	Storage Ring Current, Transmission Efficiency and Lifetime	0-400mA to 0.1mA	Adapt mechanically New DAQ system
Charge Monitors (Bergoz ICT)	Transfer efficiency	0-400pC to 1%	New DAQ system
Fill Pattern Monitor	Synchronization of the injection chain to refill any electron bucket, to keep desired storage ring filling pattern	Sufficient bandwidth & gain to resolve single electron buckets	Relocate New DAQ system
Streak Camera	Bunch length measurement	2ps resolution every 100ms	Relocate to new BL

New Devices	Purpose	Requirements	for SLS 2.0
Screen Monitors in BRTL	Emittance and Twiss parameter measurement from booster	< 10µm/pixel, higher sensitivity (< 10pC), 20mmx20mm FOV	New design New controls
Loss Monitors	Protecting and positioning beam within IDs Scraper optimization Sensitive for lifetime Low charge on-axis injection	Locating losses in BRTL and SR Turn-by-turn	New
Beam Size Monitors	Coupling and emittance measurements, stability diagnostics, energy spread	Sensitive to low currents, high dynamic range and rep rate	2 new front ends

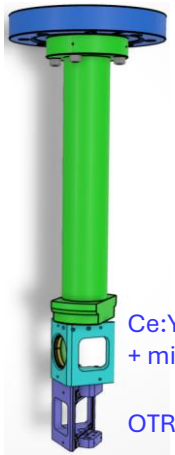
Booster-to-Ring Transfer Line

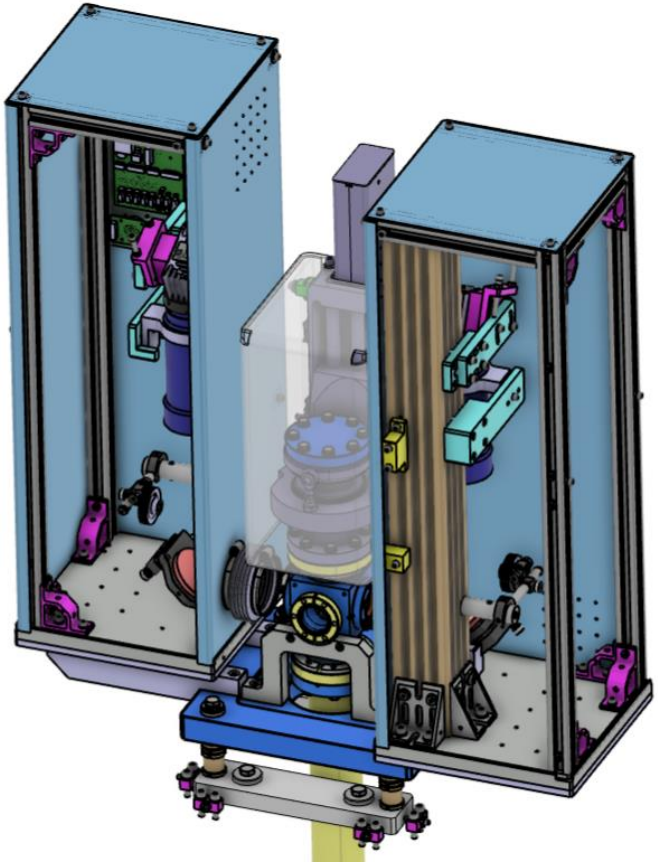




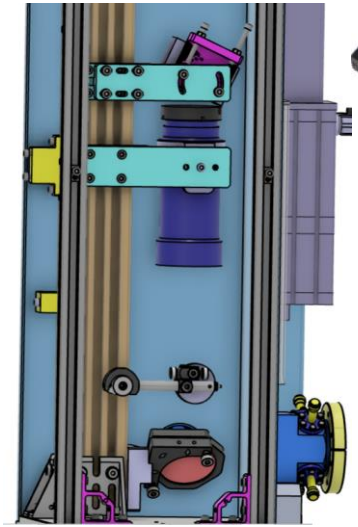
SITF 500MHz stripline + SM chamber

Screen Monitor



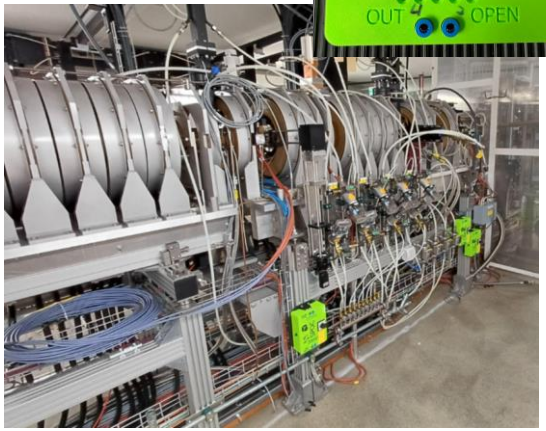


Basler acA4505

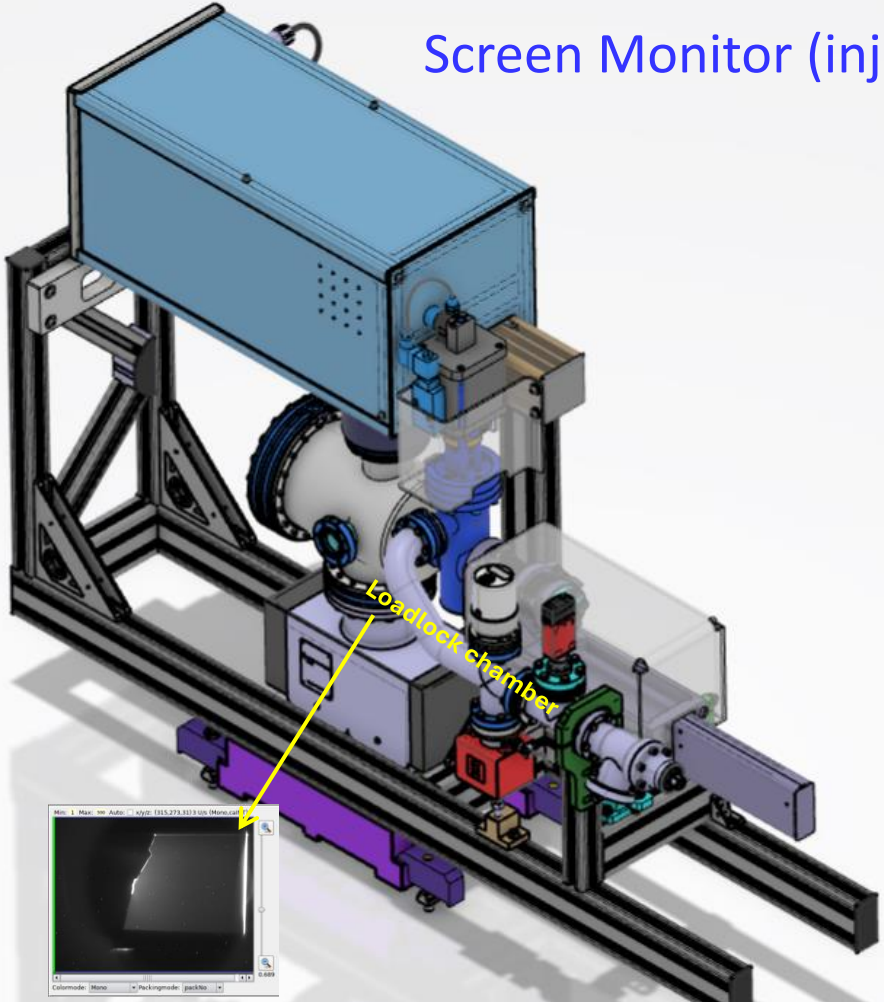


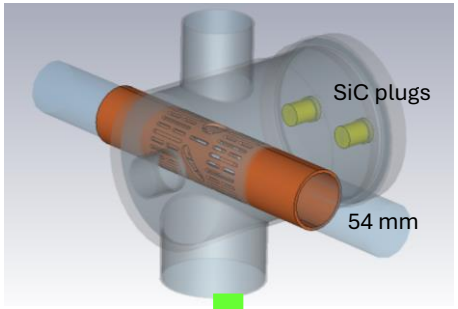
Scheimpflug geo.

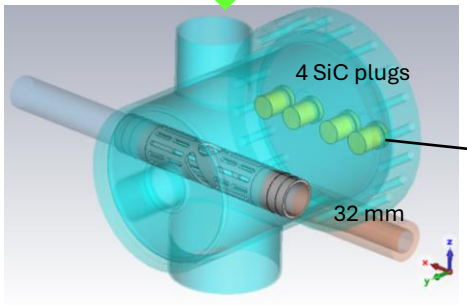
Canon focus ring

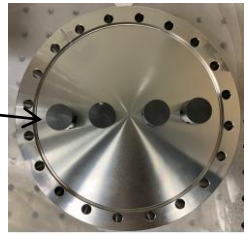


Screen Monitor (injection straight)





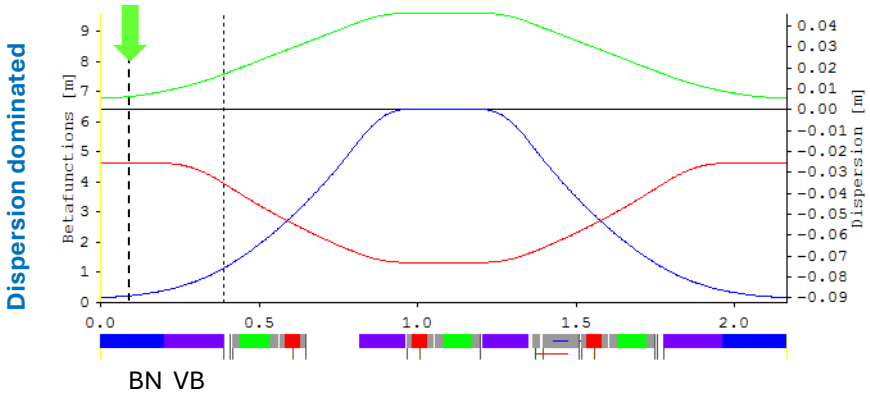




- ✓ stable regarding CBI from long./transv. HOMs
- ✓ max. dissipated power: 11.1W/SiC + 1.4W on beam pipe

Impedance calculations done by Dr. A. Citterio

Storage Ring Beam Size Monitor

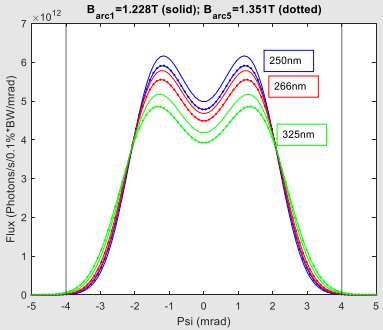


Horizontal emittance	Open IDs, low current	150 pm
	Closed IDs, 400mA	136 pm
	Nominal	157 pm
Vertical emittance	1-2% coupling	2-3 pm
	Nominal	10 pm
	Range of operation	8-12 pm

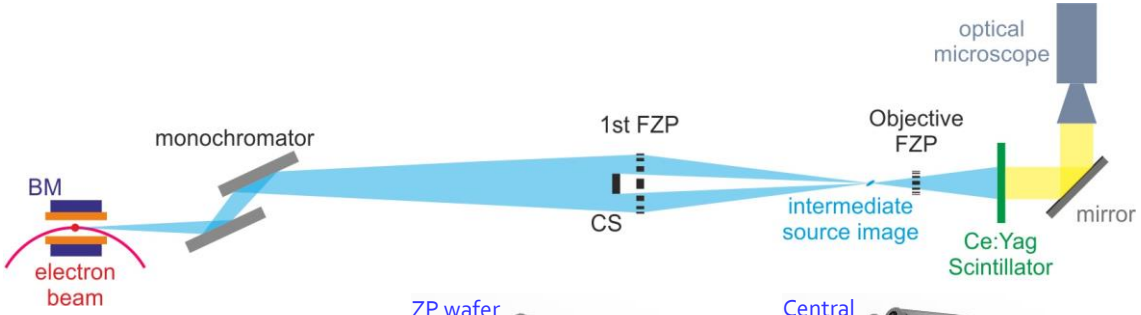
Vertical emittance change of 1pm → σ_y=400 nm
Horizontal emittance of 7pm → σ_x=250nm

Diagnostics front end

Opening angle: 8mrad x 8mrad

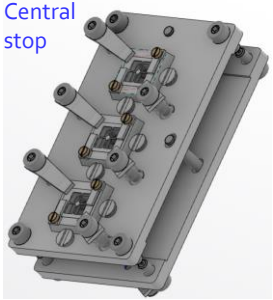


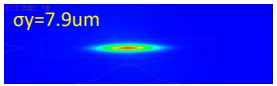
Fresnel Zone Plates

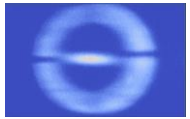


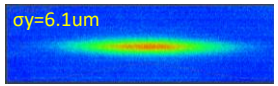
ZP wafer

Central stop









- ✓ Simultaneous 2D info
- ✓ Tilt
- ✓ Very small beams
- ✓ Excellent resolution
- ✓ Fits inside tunnel walls
- ✓ In-house production

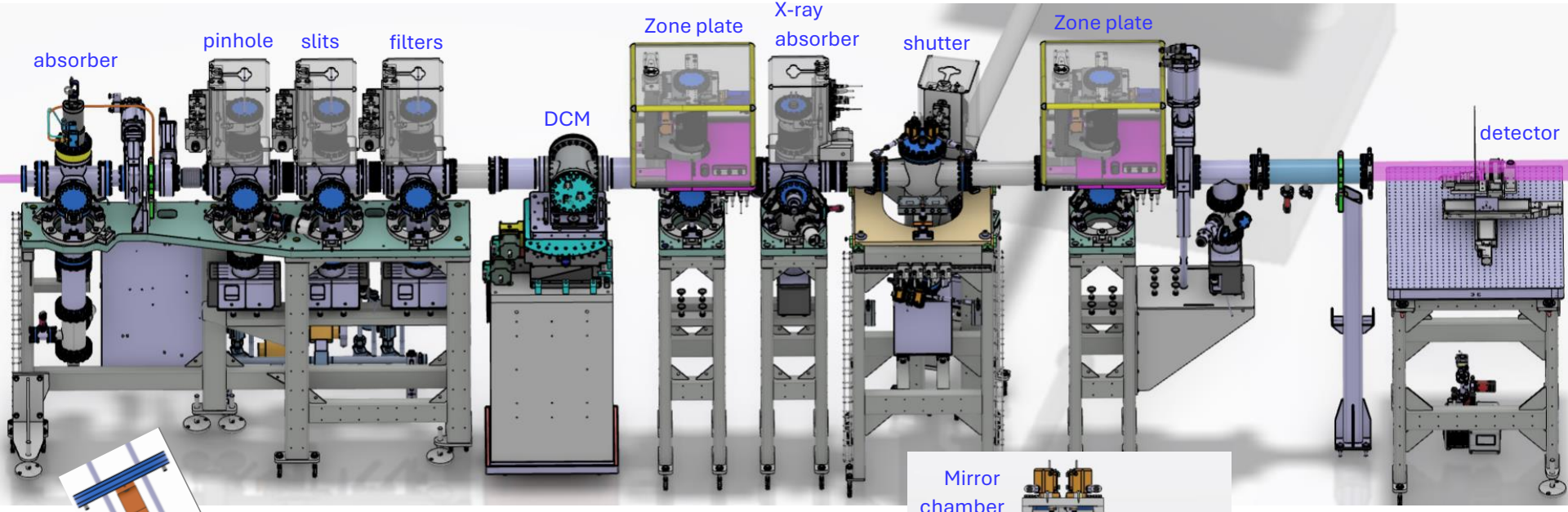
- Nominal beam size at the BM: 8.6 x 6.8μm^2
- Vertical beam size variation: 2-28μm
  Horizontal beam size variation: 5-12μm
- Outermost zone width is 120nm
  - due to 1st ZP demagnification →~650nm at source plane
  - spatial resolution of 2nd ZP is ~146nm
  - with detector sampling of 2.5x → sampling at electron beam size plane ~260nm

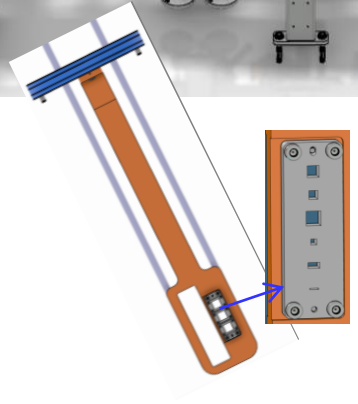
- Source point - CZP: 7500mm
- CZP - MZP: 1748.6mm
- MZP - detector: 1589.8mm
- FOV at source: 35μm x 35μm
- Effective Magnification: 5
- Central Stop Size: 0.79mm

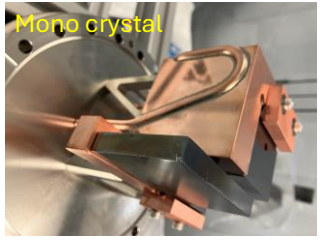
} 11.8keV

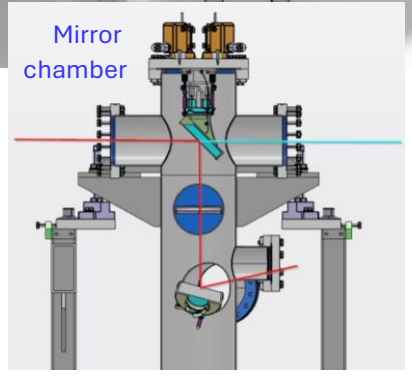
Produced at PSI by Dr. J. Vila Comamala

Arc01/1st dipole: emittance measurement

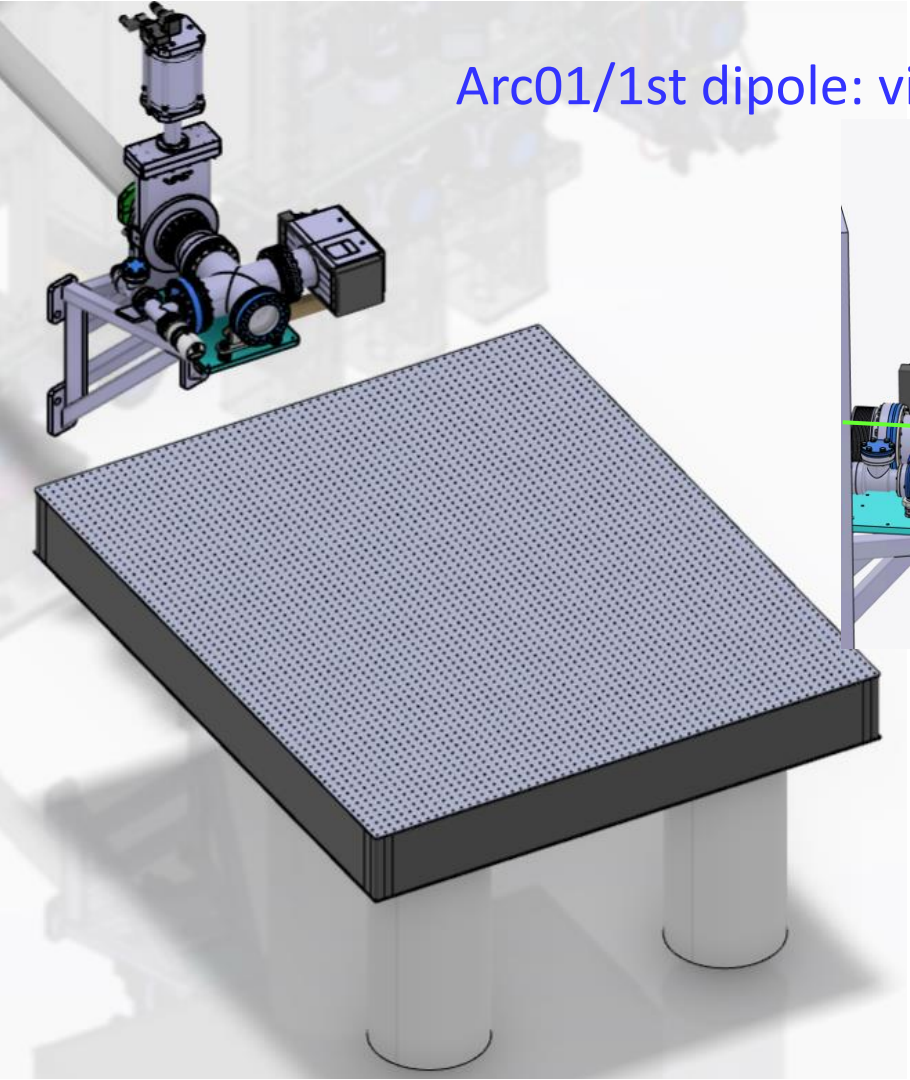


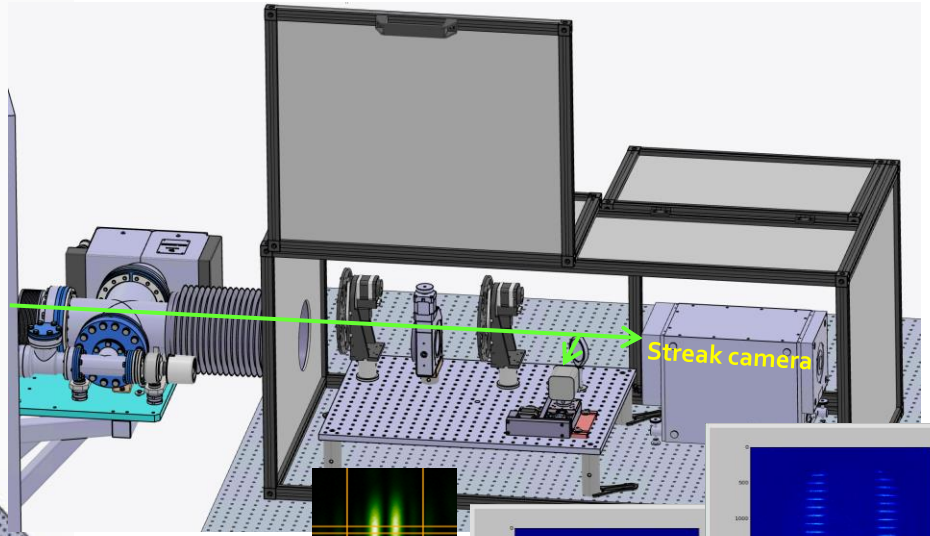


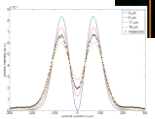




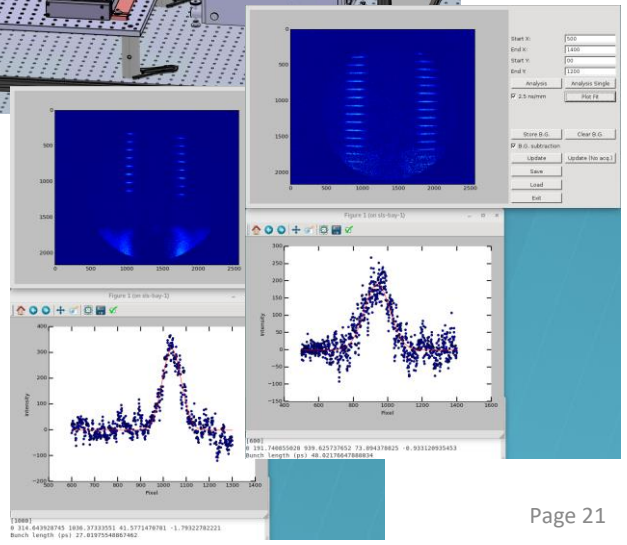
Arc01/1st dipole: visible line





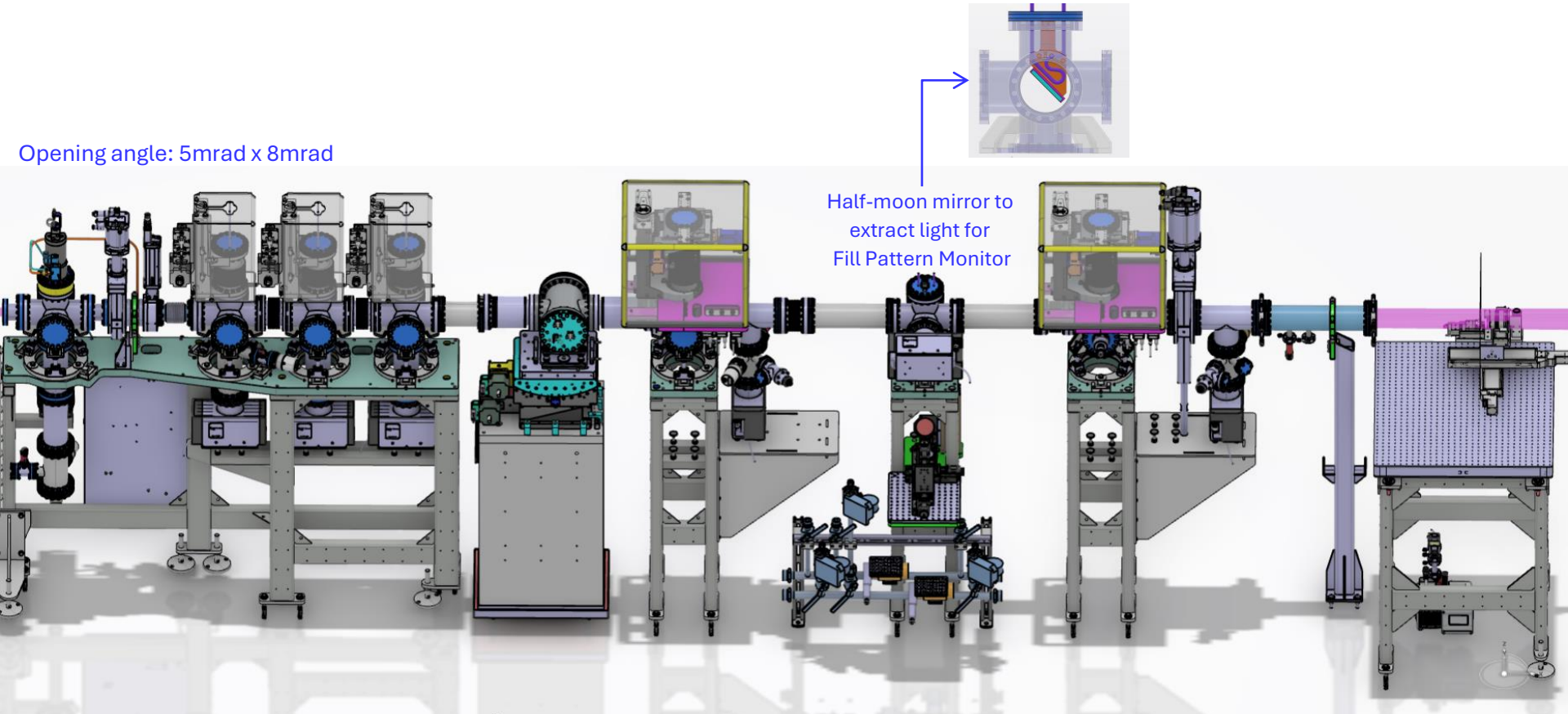


pi-polarization

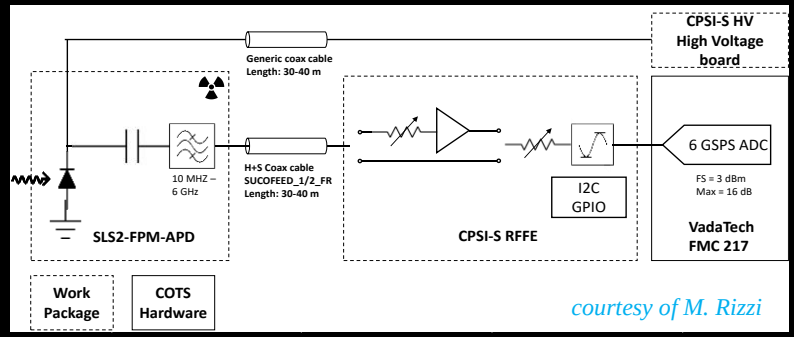


Arc08/standard dipole : dispersion dominant

Opening angle: 5mrad x 8mrad



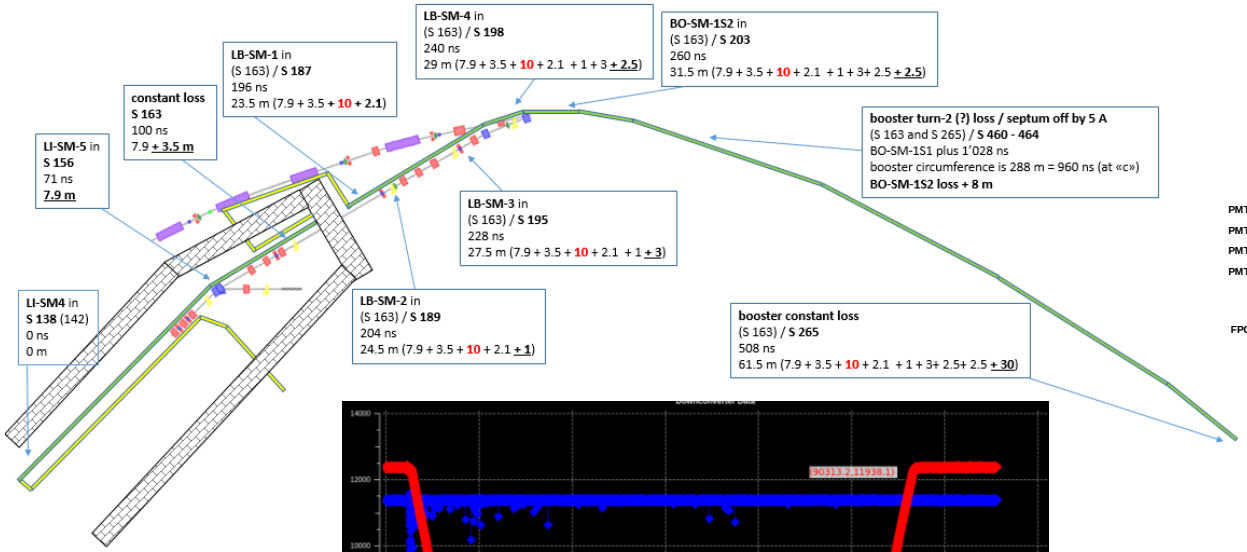
Fill Pattern Monitor

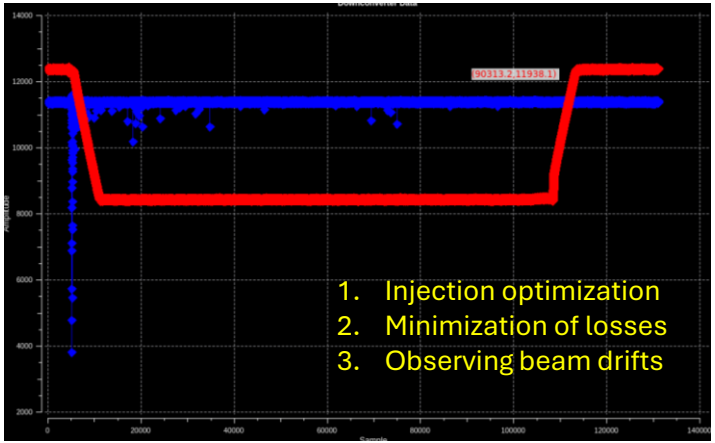


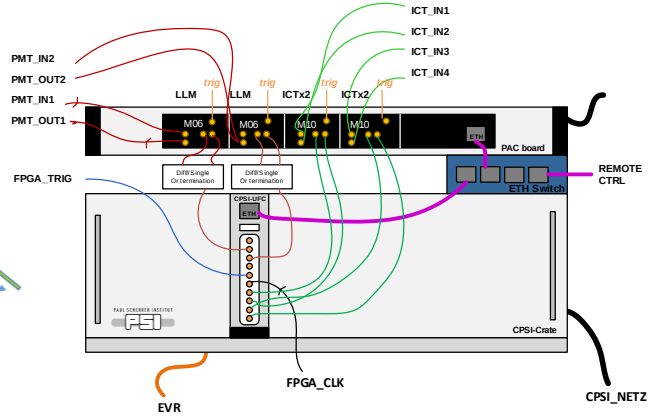
courtesy of M. Rizzi

- Two options for an interleaved sampling scheme is under evaluation
  - 4GSps interleaved on 12 turns (i.e. 96S/b)
  - 6GSps interleaved on 16 turns (i.e. 192S/b)
- *FPFB is under the domain of the BPM & FB group*

Longitudinal Loss Monitor

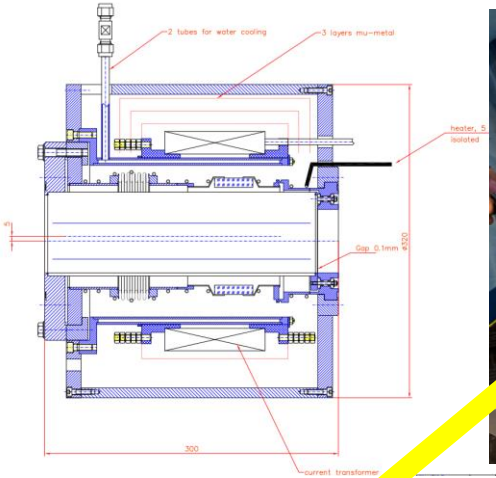


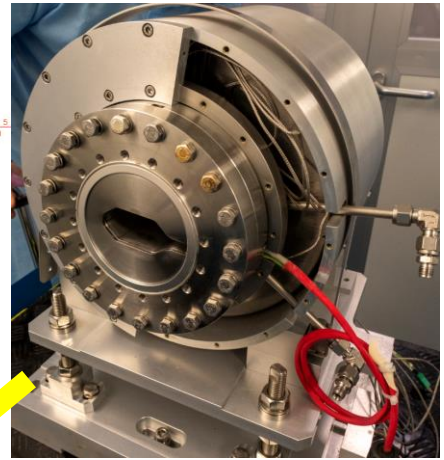




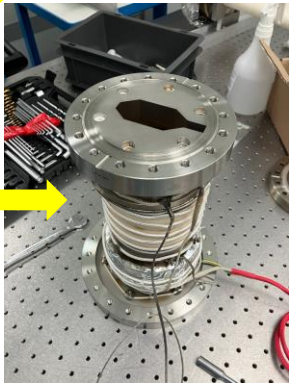
- ADC: 250MHz / 16 bit / 8 inputs
- Input voltage ±1V /a DC 50Ohm
- Level-shifter circuitry module and Photomultiplier module on PAC board

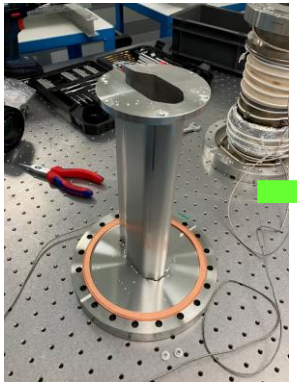
Current monitor: archeological findings

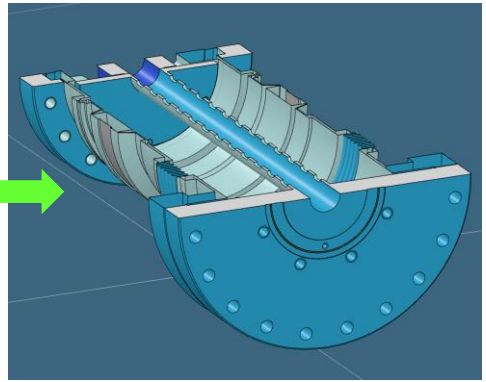




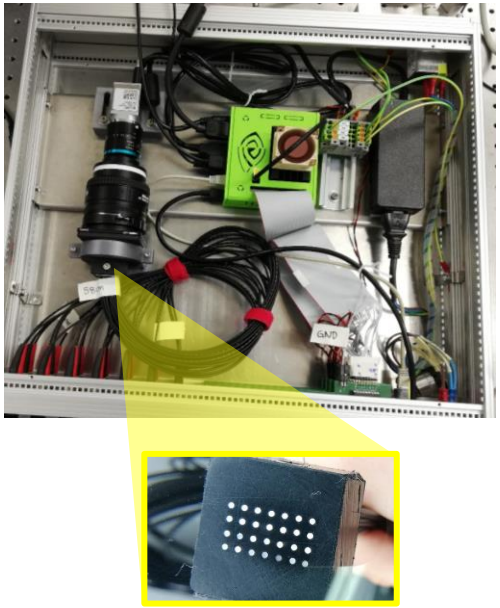
Same DAQ solution as ICTs

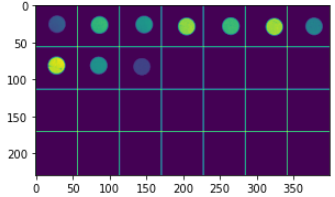




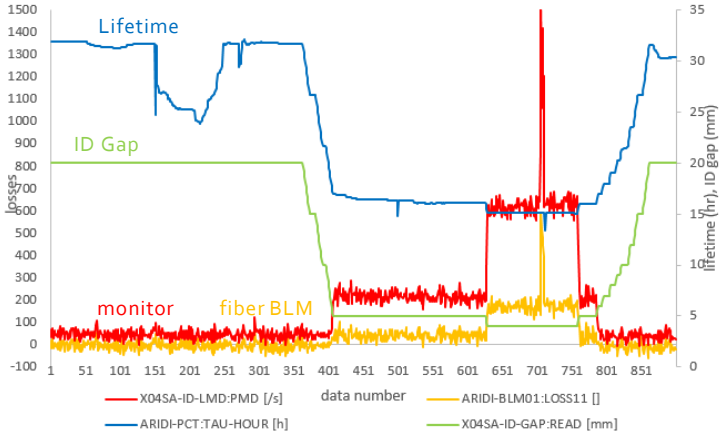


Loss Monitors for Surveillance

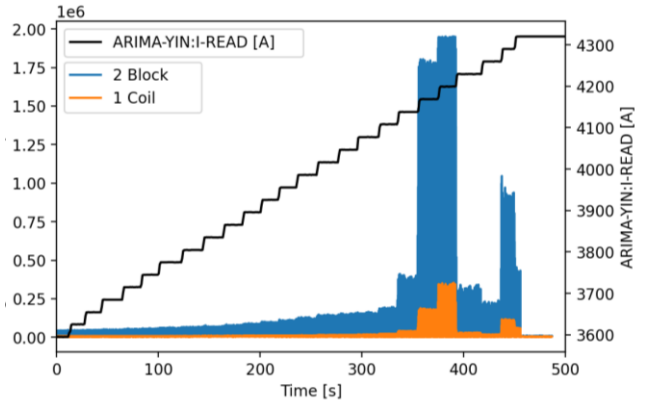


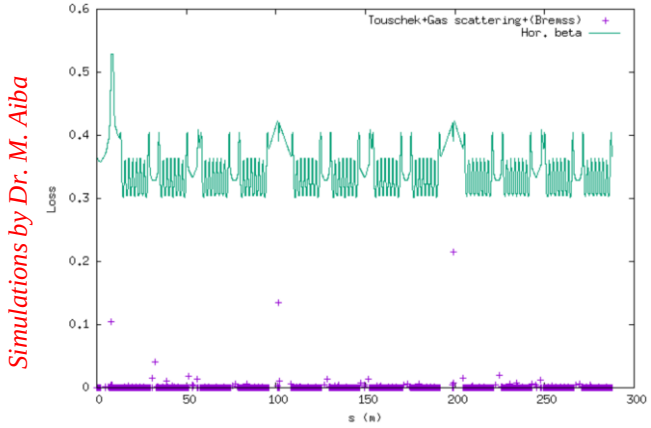


Scintillator geometry



EJ-204 + BCF-92

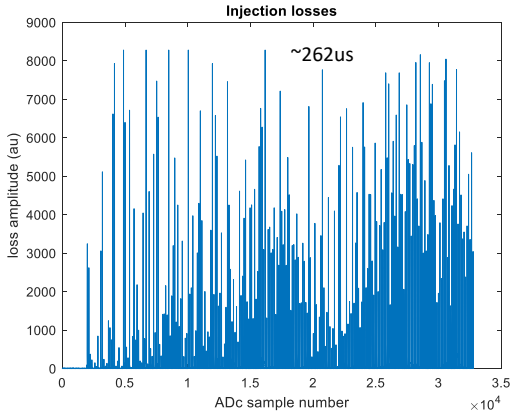


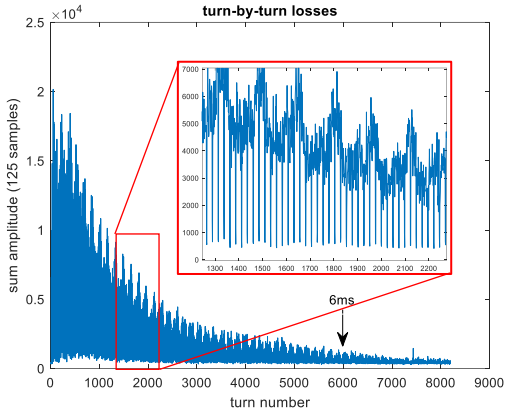


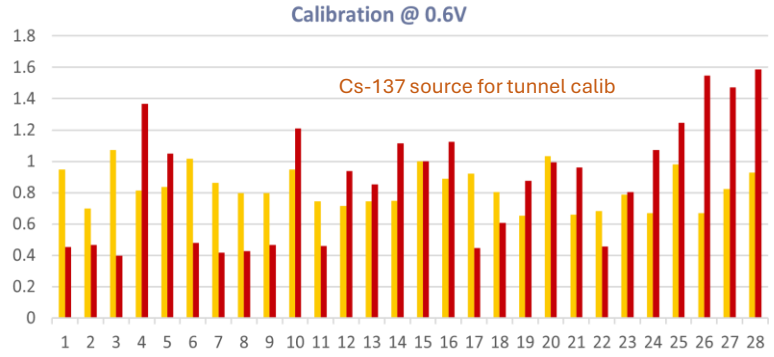
Simulations by Dr. M. Aiba

- 7 per arc
- Downstream of every undulator
- 5 in the Booster-to-Ring transfer line
- PETG housing & brass screws to avoid disturbing magnetic axis

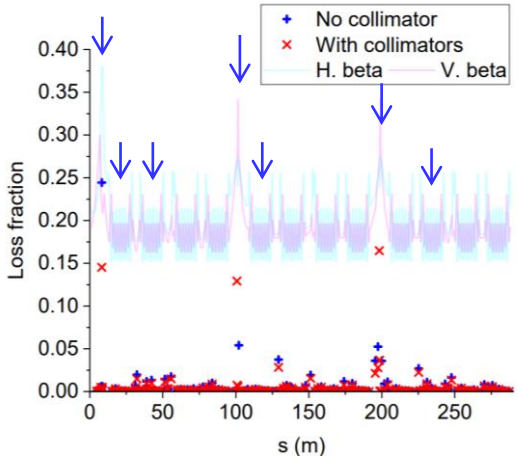
BLMs for TbT loss detection

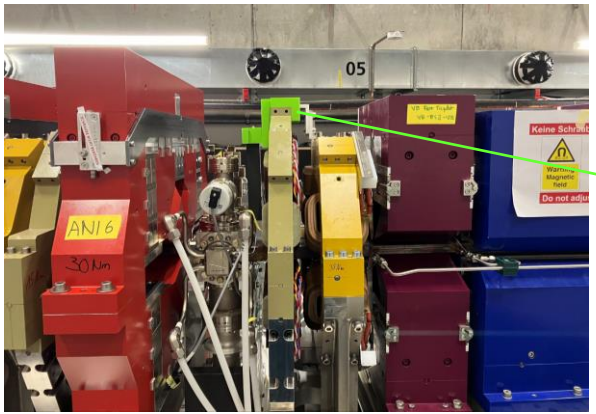


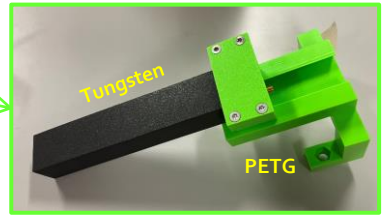




Simulations by Dr. M. Aiba

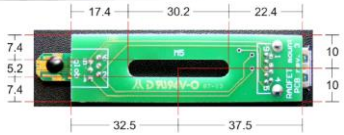


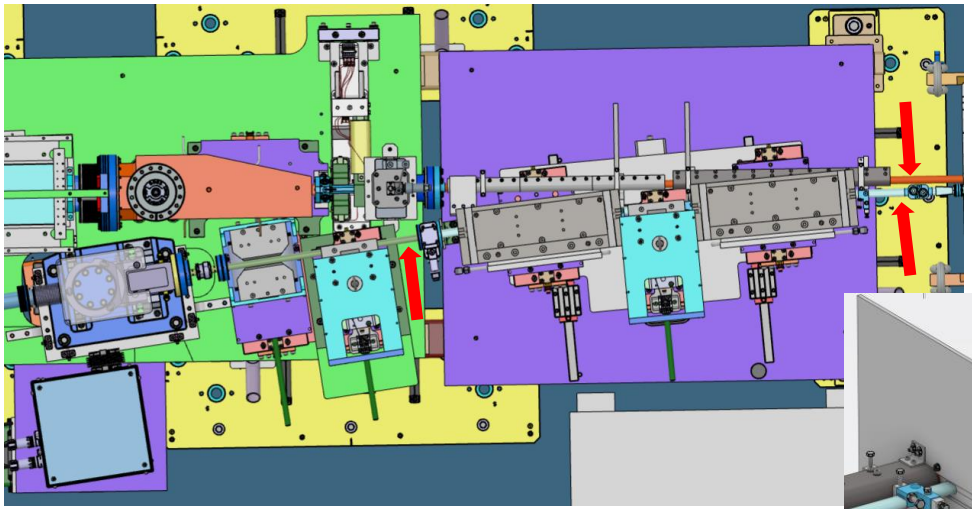




Dose rate monitoring

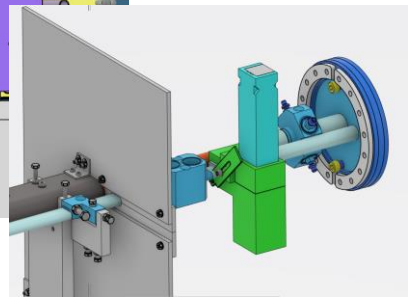
- Track accumulated dose and dose rate changes at strategic locations
- Operation in 25V bias mode
- Minimum integration time 20 seconds
- No feedbacks planned
- Change the connectors to RJ45 (thanks to S. Grulja) → temperature reading lost





Additional locations:

- downstream of collimators and in line of sight in downstream arcs
- one at reference position (last triplet of last arc)

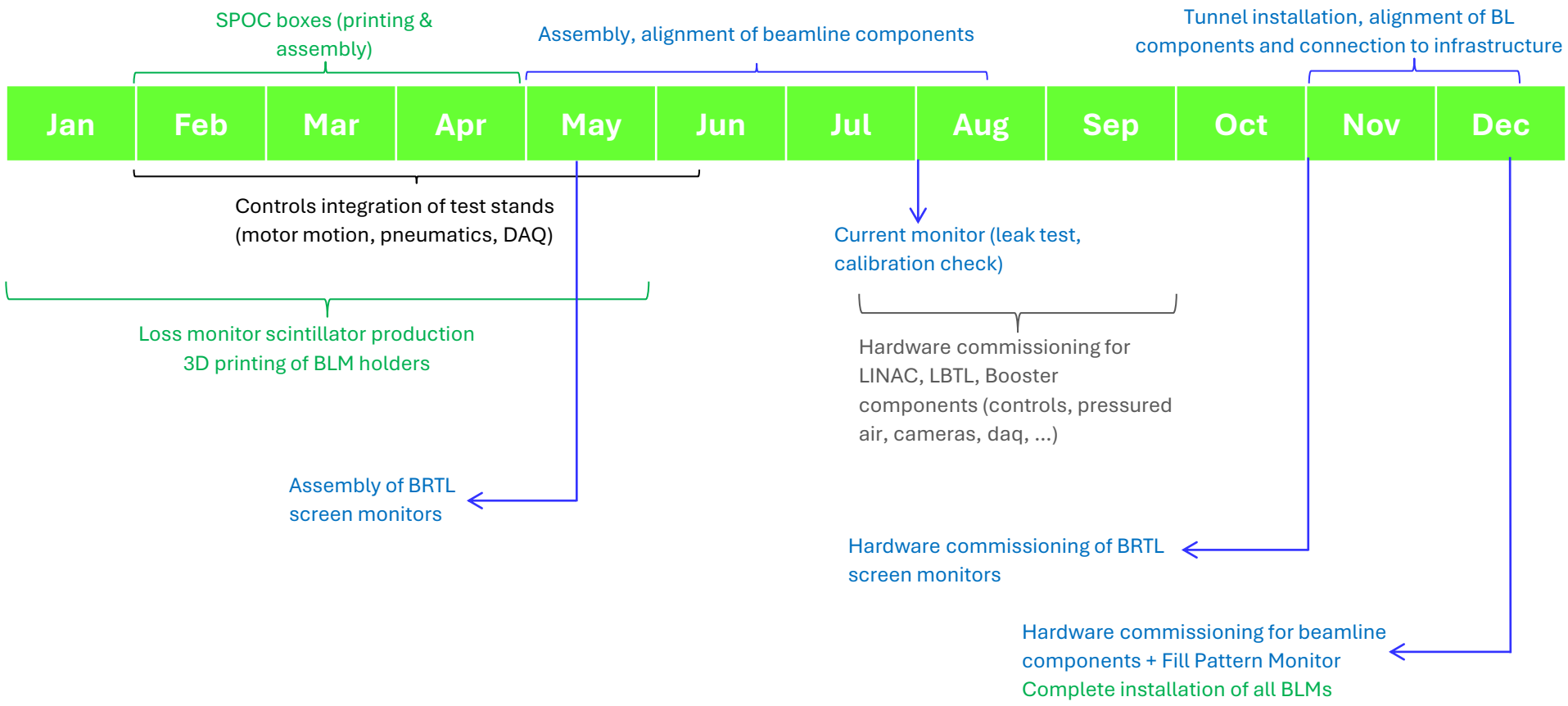


https://accelconf.web.cern.ch/ibic2013/papers/tupc45.pdf

So far

- ✓ Motion control hardware
- ✓ Pneumatics control hardware
- ✓ DAQ system (ICT, PCT, Booster PCT)
- ✓ Screen monitors (chambers and components)
- ✓ BLMs, BLDs
- ✓ 3D printing
- ✓ Most beamline components

Forecast 2024



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