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# Possible PXIE-10 MeV Optics and Measurements

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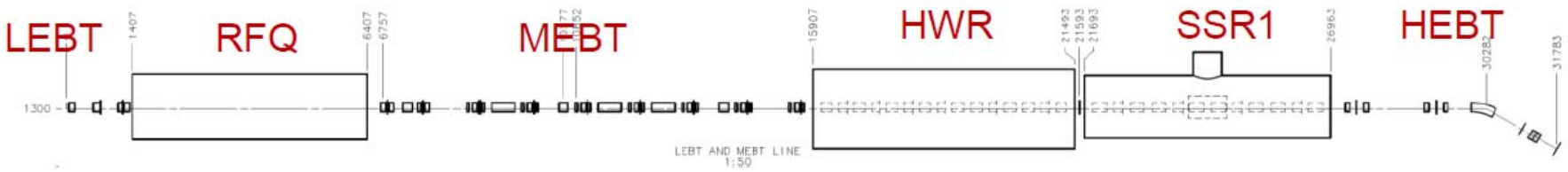
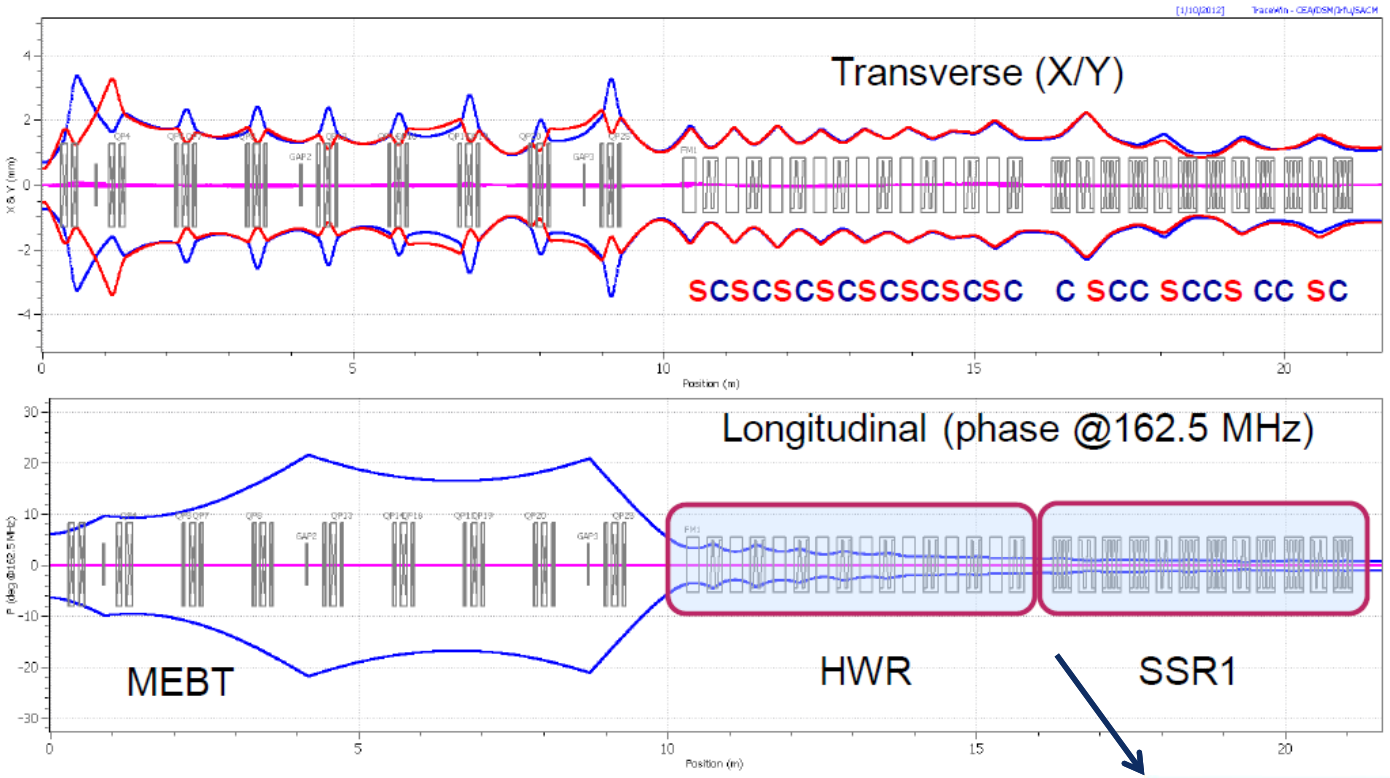
# PXIE Overview : PXIE Handbook

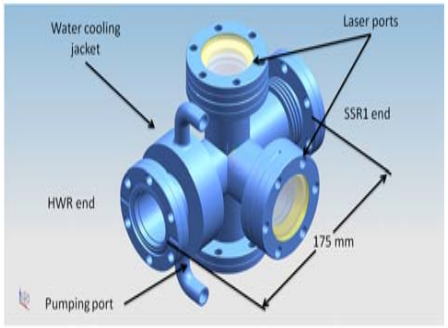
## PXIE Handbook Configuration




- PXIE Scope:
  - CW H- source delivering 5mA at 30 KeV
  - LEBT with beam pre-bunching.
  - RFQ Operation in CW mode and delivering 5mA beam current at 2.1 MeV.
  - MEBT wide band chopping scheme and its absorber
  - HWR and SSR1 CMs and beam acceleration > 15 MeV
  - Beam measurement in HEBT

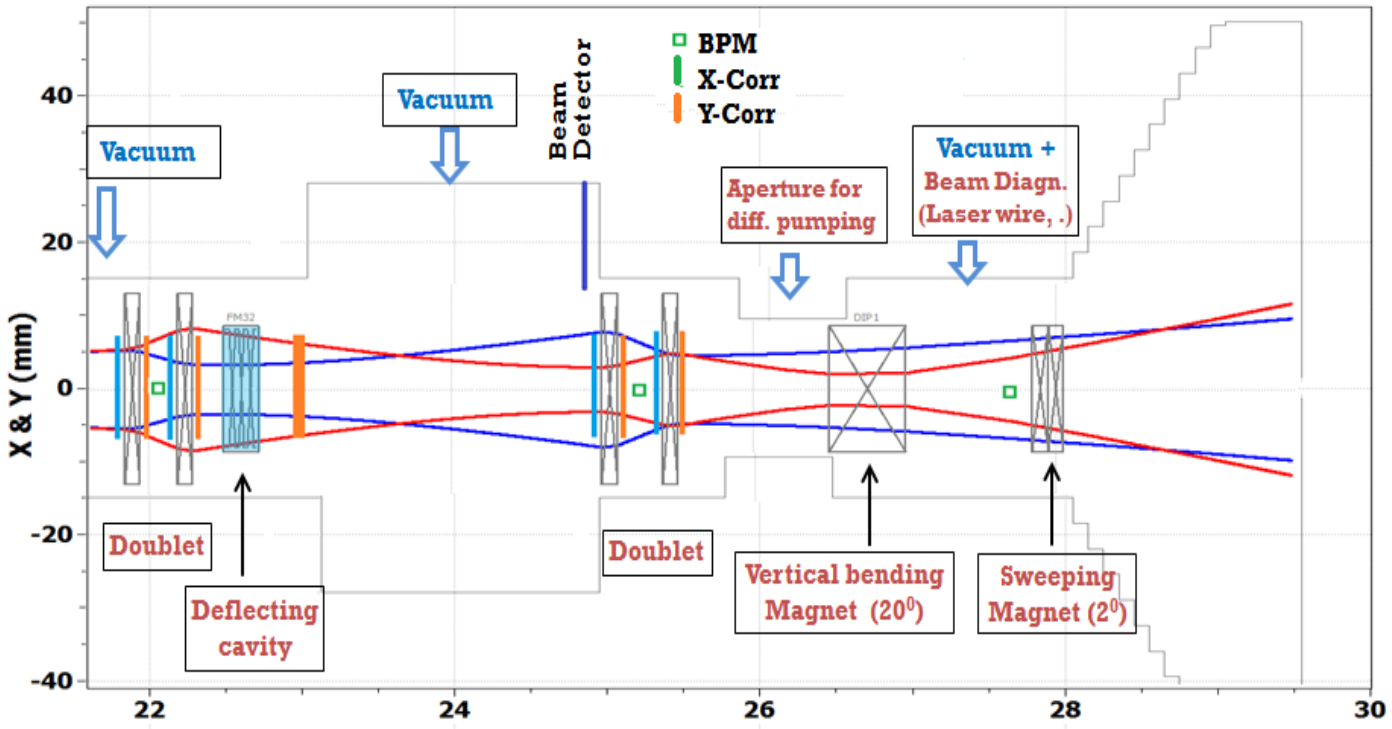
# RMS Beam Envelope through MEBT and SRF Section




- BPMs installed with each solenoids.
- Laser profile monitor and absorber assembly between HWR and SSR1 CMs.

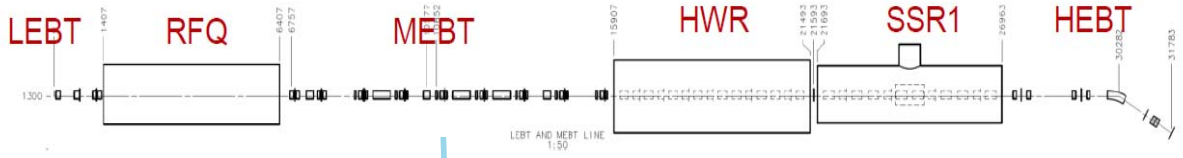
# PXIE: HEBT




- Beam Diagnostics in HEBT:
  - Beam Current measurement
  - Beam Energy
  - Beam 3 D profile measurement and Beam emittances
  - Beam Loss and Halo measurement
  - Beam extinction measurements

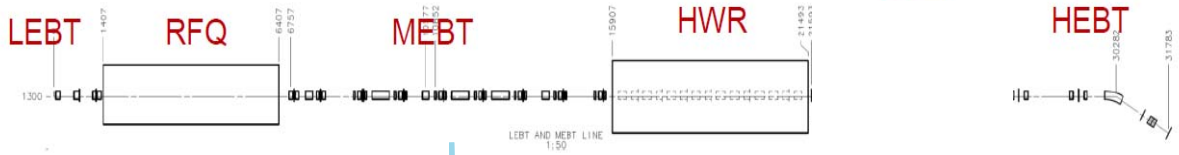
# PXIE-10: A Temporary PXIE Configuration

PXIE




Budgetary constraint

PXIE-10

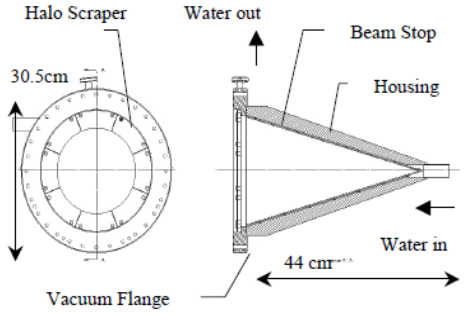



Budgetary constraint

PXIE-10 with Temp. HEBT


- Temp. HEBT uses spare MEBT magnets
  - Integral field ~ 1.5 Tesla.
  - No additional costs
- SNS Dump is used at the end.

SNS Dump



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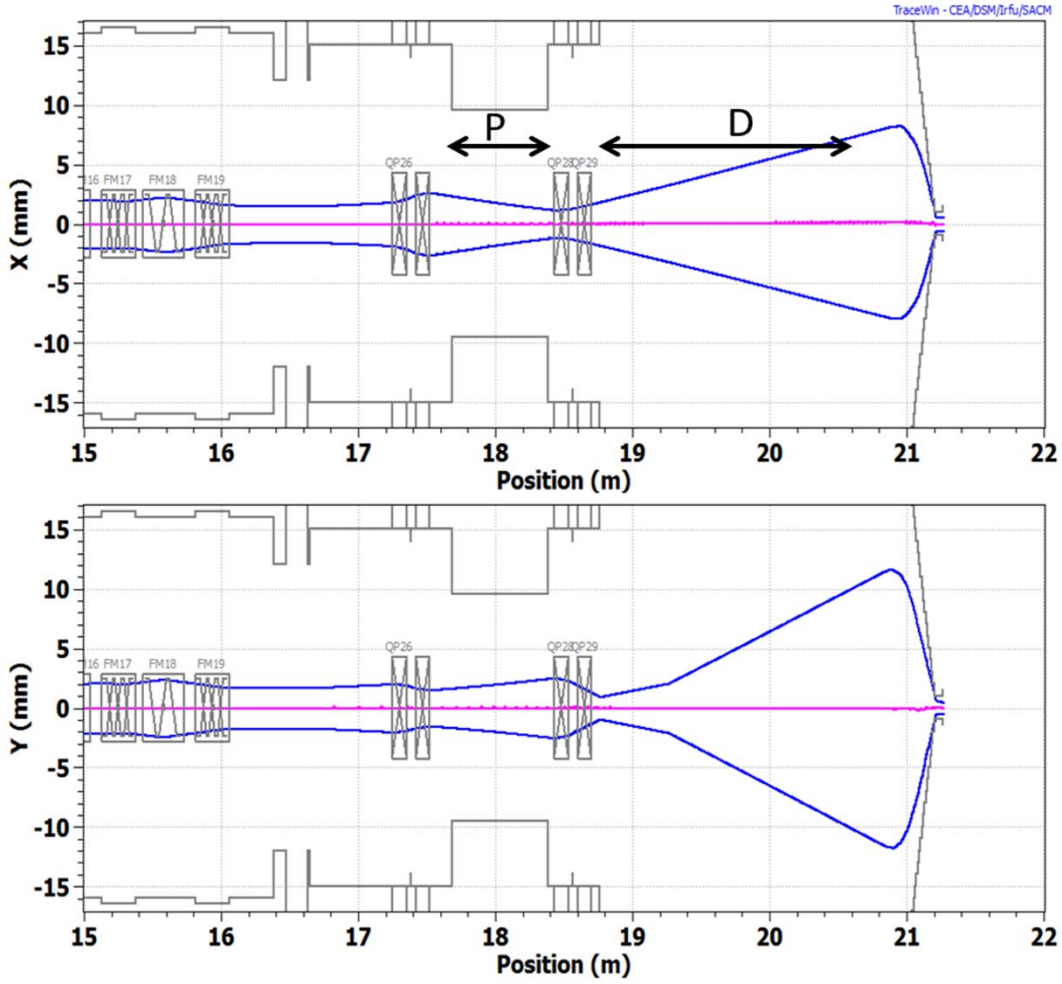
# PXIE-10 : Preliminary Temp. HEBT Optics

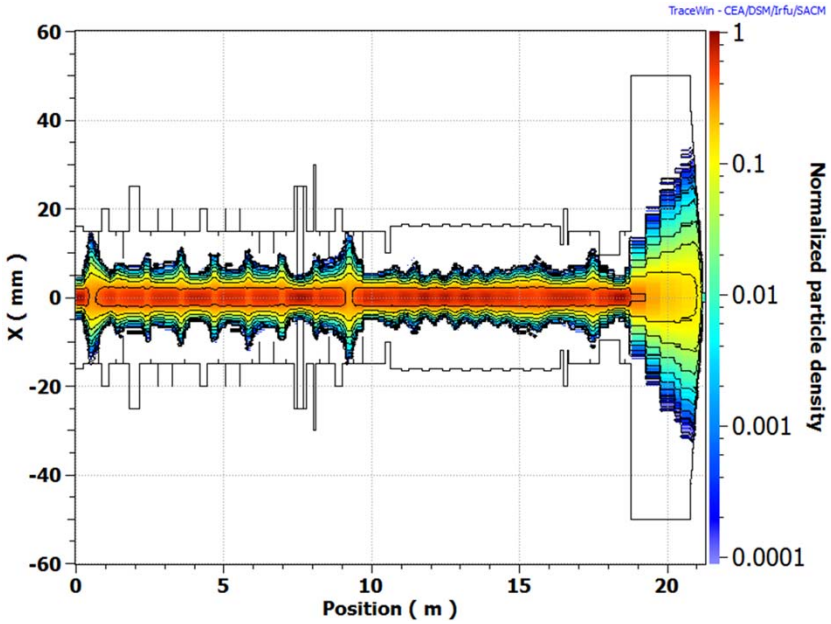
## Transverse RMS Envelope



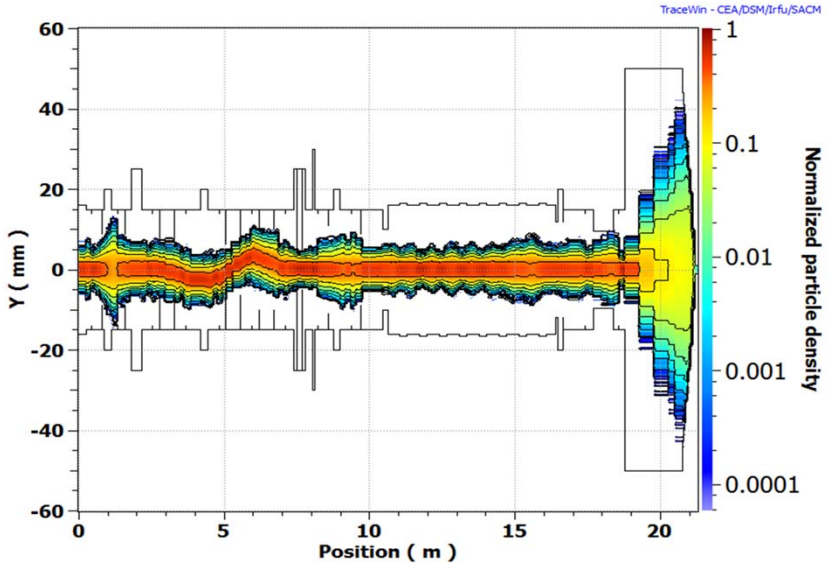

- First doublet is placed about the same location as first solenoid in SSR1 section.
- P : Differential pumping section.
  - Aperture of beam pipe in this section is 19 mm.
  - Length of Pumping section is 700 mm.
- D : Diagnostic section.
  - Aperture 100 mm
  - Length 2 m

# PXIE 10: Beam density

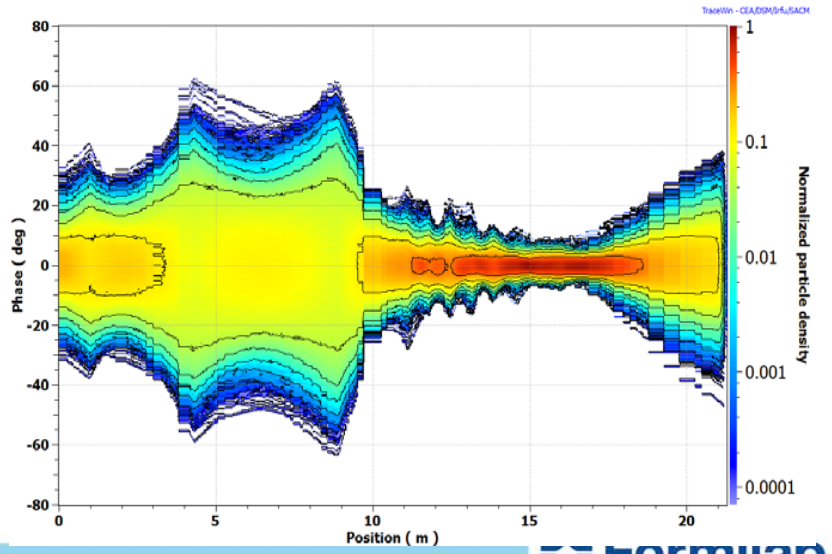
## Horizontal Beam density




## Vertical Beam density




## Longitudinal Beam density



# Is Worth to have PXIE-10 ?

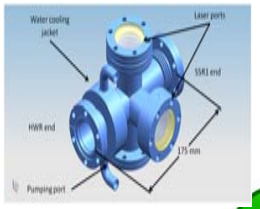
- HWR is first SRF section in PIP-II linac and most crucial one. Anything happens here would propagate all the way to linac. Thus, A better understanding of this section allows to produce a high quality beam along the linac.
- Beam diagnostics just after CM allows better characterization of HWR cryomodule.
- Experience/Lessons learned with HWR during installation, commissioning and operation such as warm to cold transition, understanding of vacuum level, assembly procedure etc. would be directly applicable to SSR1 section. It would expedite SSR1 commissioning.

## PXIE-10: Objectives

- Operational
- Beam Optics

# PXIE-10: Operation Objectives

- Achieving 10 MeV Energy at the end of HWR.
  - Transition between HWR and SSR1 section occurs at 10 MeV.
- Validating cavities and solenoids achieve their design parameters.
- Alignment tolerances of beamline elements after cool-down.
- Characterization of HWR cavities:
  - RF Processing of HWR Cavities
  - Understanding of microphonics
  - Static Lorentz force detuning
  - Fluctuation in resonant frequency in helium pressure variation (df/dP)
- CM cool-down procedure
  - Understanding how CM cooling procedure affects overall cavity performance
- Validating the concept/design of Diagnostic box.




Are those objectives feasible at PXIE-10 ? Yes

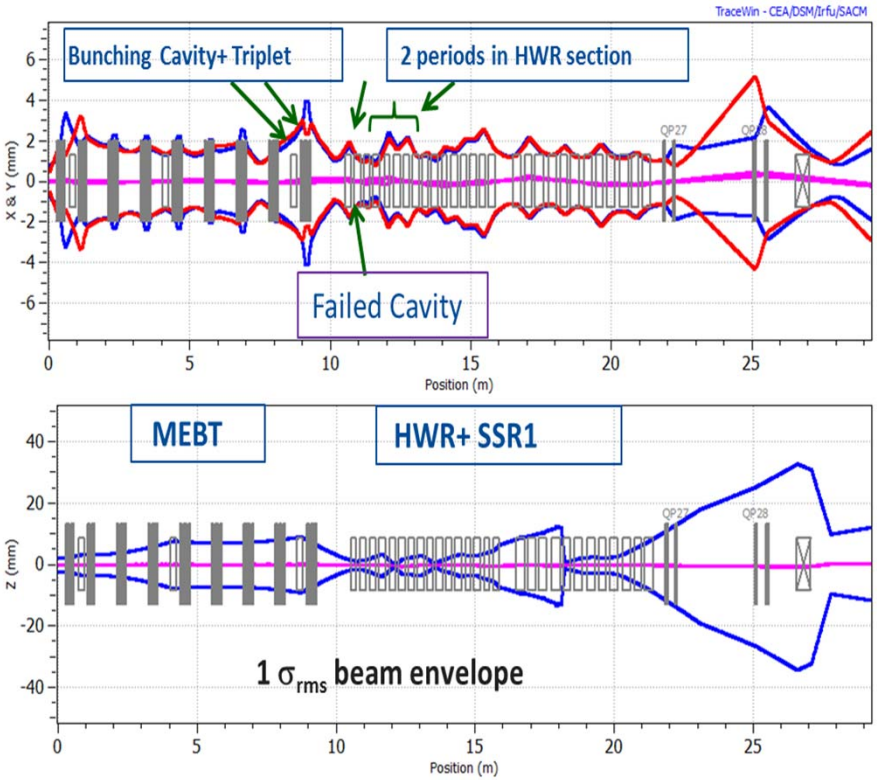
# PXIE-10: Beam Optics Objectives

- Passing the beam through HWR cryomodule.
  - Aimed for no beam losses in SRF section.
    - Beam loss can be measured using Toroids, ring pickup, DCCT
- Beam characterization:
  - Energy Measurements using time of flight method.
  - Beam transverse profile measurement
    - Using scrapers, wire scanners
    - Laser wire
  - Longitudinal Profile
    - FFC
    - Laser wire
  - Transverse phase portrait
    - Double slit monitor
  - Emittance measurement using
    - Quadrupole scanning or Solenoid scanning.

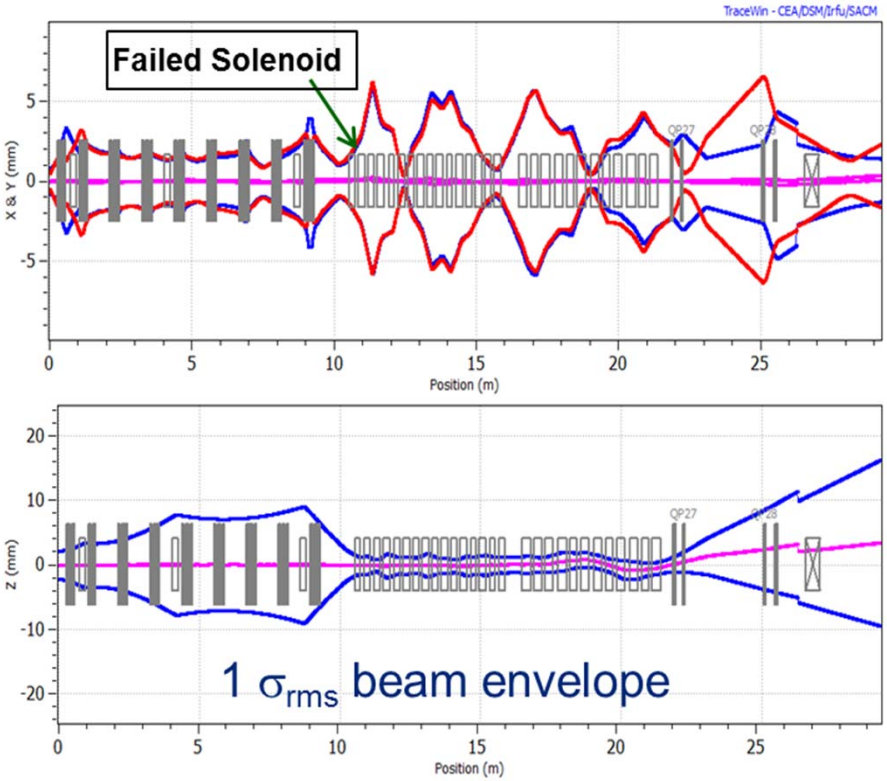
# Beam Optics Objectives: Study of Fault Scenario

- Failures of first cavity and solenoid are very critical.

## Failure of First Cavity



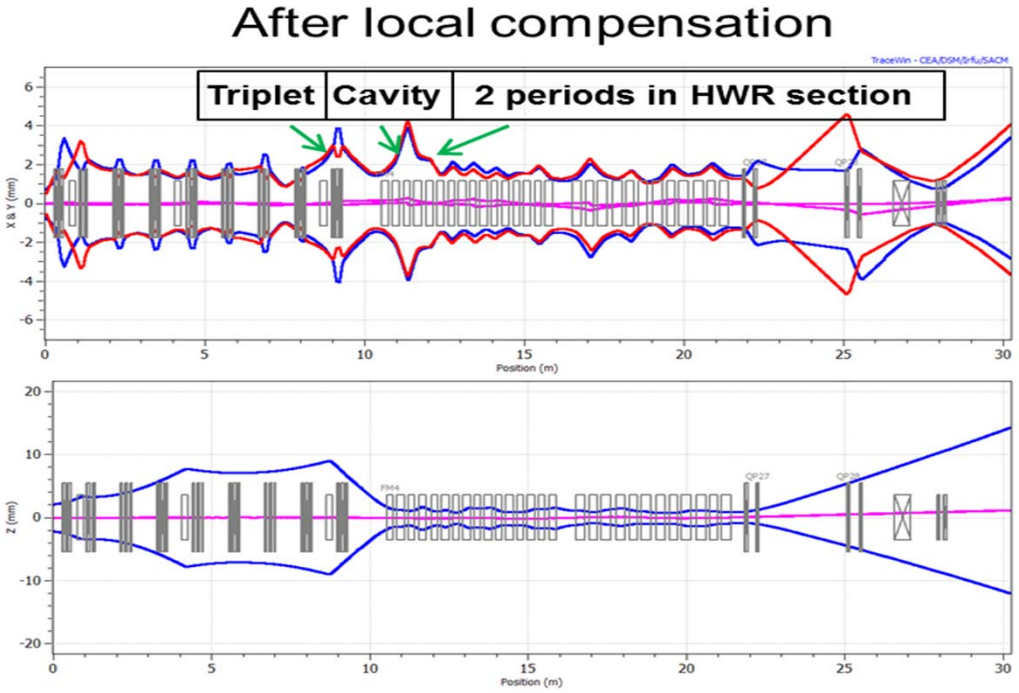

## Failure of First Solenoid




- 40% of the beam is lost (incl.15% between CM's)

# Beam Optics Objectives: Understanding of Local compensation

- Tuning of neighboring elements in vicinity of failed elements.
  - Realizing local compensation method.
  - How fast we could perform in real world.




- PXIE-10 is ideal platform
  - Diagnostic is  downstream.
  - Avoid any possibility of SSR1 damage due to beam.
  - In case of any damage of component or diagnostic, we could replace it during SSR1 commissioning down time.

Can we do it at PXIE-10 ?  Absolutely

# Conclusion

- PXIE-10 is a step towards PXIE. It is not an alternative of PXIE.
- We could achieve several objectives synchronize with original PXIE scope.
- Of-course an effective use of time between HWR1 and SSR1 commissioning.

# Back-ups

# Beam Optics Objective: Initial Mismatch Analysis

- Optics of HWR section is designed for matched beam coming out from MEBT. In order to understand sensitivity of linac to initial mismatch, we need to perform mismatch analysis.

- A better understanding of beam mismatch can help to reduce beam losses along the linac.
- Allows to estimate beam acceptance of HWR section
  - Measurement of beam losses w.r.t initial mismatch.
    - Difference in beam current at entrance and exit of HWR cryomodule characterizes beam losses in HWR section.
    - Beam current can be measured using current transformers.

Modified it…

# Beam Optics Objectives:

- Excitation of beam orbit using correctors in-built in solenoids