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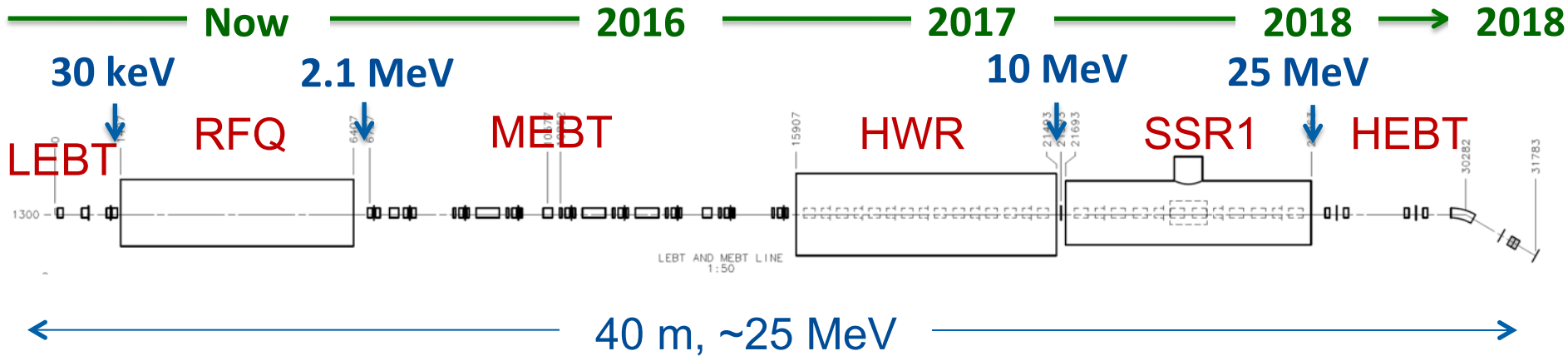
PXIE Plan: 2016, 2017, 2018

Paul Derwent

PIP-II Collaboration Meeting: Working Group 1

9-10 November 2015

PXIE (PIP-II Injector Experiment)



PXIE will address the address/measure the following:

- LEBT pre-chopping : Demonstrated
- Vacuum management in the LEBT/RFQ region : Demonstrated
- Validation of chopper performance
 - Bunch extinction, effective emittance growth
- MEBT beam absorber
 - Reliability and lifetime
- MEBT vacuum management
- CW Operation of HWR
 - Degradation of cavity performance
 - Optimal distance to 10 kW absorber
- Operation of SSR1 with beam
 - CW and pulsed operation
 - resonance control and LFD compensation in pulsed operations
- Emittance preservation and beam halo formation through the front end

Collaborators

ANL: HWR

LBL: LEBT, RFQ

SNS: LEBT

IIFC: MEBT, RF, SSR1

Beam requirements at the end of PXIE:FRS

Parameter	Value	Unit
Beam kinetic energy, Min/Max	15/30	MeV
Average beam power	≤ 30	kW
Nominal ion source and RFQ current	5	mA
Average beam current (averaged over $> 1\mu\text{s}$)	1	mA
Maximum bunch intensity	1.9×10^8	
Minimum bunch spacing	6.2	ns
Relative residual charge of removed bunches	$< 10^{-4}$	
Beam loss of pass-through bunches	$< 5\%$	
Nominal transverse emittance*	< 0.25	μm
Nominal longitudinal emittance*	< 1	eV- μs

* RMS, normalized

- PIP-II requirements are not the same!
 - CW vs pulsed: 20 Hz, 55 msec
 - MEBT end: $0.23 \mu\text{m}$
 - 2 mA

PXIE plan

- FY16: well defined
 - Commission RFQ (RF and beam)
 - Install most of the MEBT magnets
 - Install and test kicker prototypes
 - Initial Machine Protection System
- FY17:
 - Receive HWR
 - Cryogenic Distribution
 - Install final MEBT& HWR
- FY18
 - RF commissioning of HWR
 - 10 MeV beam ? Temporary HEBT?
 - Installation of SSR1
- FY19
 - Final beam parameters

RFQ

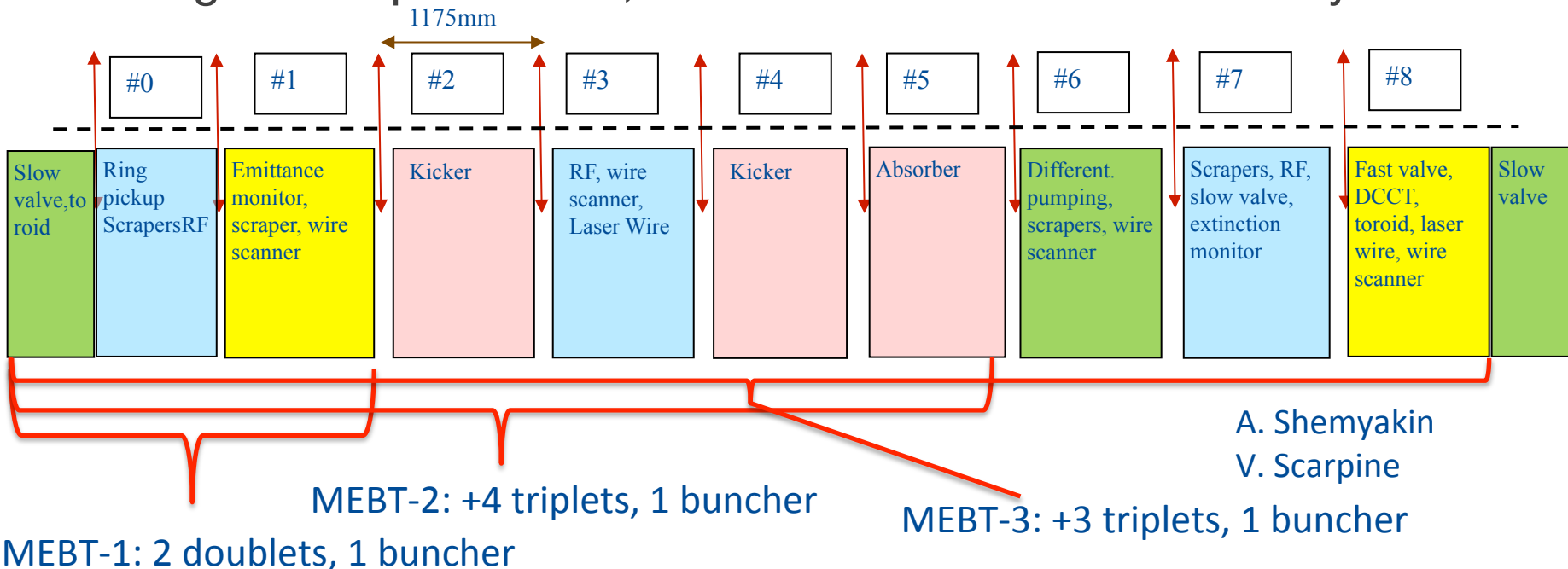
- Designed and fabricated by LBNL
 - Delivered beginning of September
 - Installation in progress
- Two 75 kW 162.5 MHz solid-state amplifiers
- Water and Resonance Control systems
- LLRF



J. Steimel to discuss

MEBT stages

- The MEBT is proposed to be installed in several steps, determined mainly by arrival of magnets from BARC
 - MEBT -x, x=1, 2, 3 in this report corresponds to intermediate configurations with different number of magnets
 - Each configuration may have several variations of different diagnostics placement, which are referred as MEBT x-y

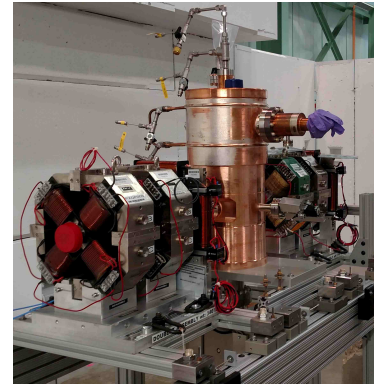


PXIE in FY16

- RFQ beam in pulse mode in Jan 2016
 - RFQ is RF- commissioned
 - MEBT 1-1 is ready to roll in
- Shutdown July 2016 for installation of MEBT-2
- Need:
 - 4 triplets from BARC
 - (delivery June 2016)
 - one re-measured in TD
 - 2nd bunching cavity
 - Kickers and additional diagnostics are ready
- Assembly of MEBT-2 high priority:
 - hold to shutdown in summer 2016
 - define the minimal measurements needed

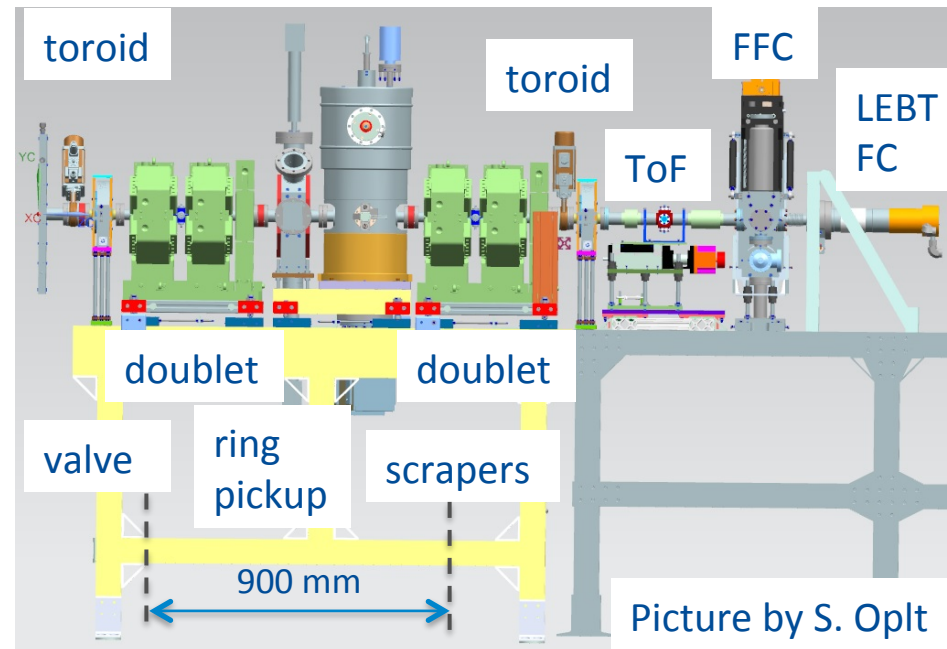
MEBT 1 FY16

- Goals (beam – related)
 - Measure RFQ transmission and H- energy
 - Measure of transverse and longitudinal properties of a pulsed beam
 - Commission MPS
 - Characterize bunching cavity



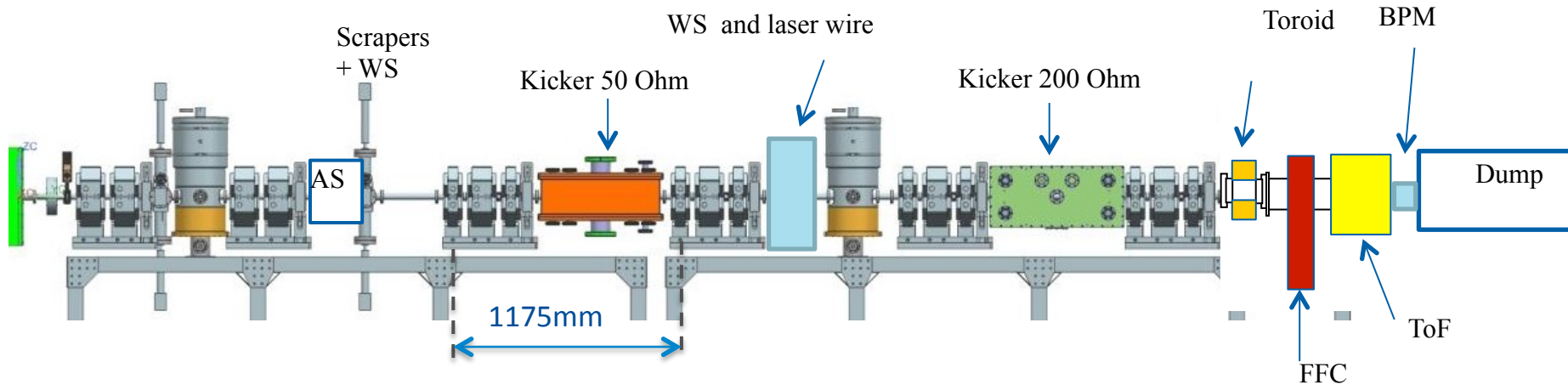
- In parallel, a lot of instrumentation, LLRF and other efforts
- All beam line elements are fabricated

- **Need RFQ and bunching cavity phase-locked**



MEBT 2 FY16

- 2016- installation of MEBT 2-1 and LEBT bend
 - First two MEBT sections stay unchanged
 - Keep emittance scanner in the same position to understand possible changes due to the LEBT bend



- Add:
 - 4 triplets with BPMs, 1 bunching cavity, 2 kicker prototypes, +BPM
 - Assembly with Wire scanner and Laser wire with electron collection
- Design just started

PXIE in FY17

- MEBT measurements continue until shutdown for HWR
 - Continuing with MEBT2, chopper system
- Goal: HWR Delivery in Q3FY17, installation
 - priority for PIP-II management
- Need to be ready
 - Cryo distribution
 - 162.5 MHz RF power sources
 - 12-14 month lead time?

P. Ostroumov
C. Baffes
M. White

What if scenario for the HEBT

- HWR ready, SSR1 not ready HWR: Q3 FY17
- 10 MeV HEBT? SSR1: Q3 FY18
 - do we install a short HEBT? Decision point ~ May 2016
 - Pros:
 - Understanding of beam from HWR crucial: first SRF CM
 - Quantify beam through 1 CM vs 2 CM
 - Beam and RF commissioning experience then directly applicable to SSR1
 - Cons:
 - Resource allocation for design/installation of short HEBT
 - Slows down readiness for 25 MeV HEBT
- Full 50 kW CW HEBT
 - Big question here is 50 kW beam absorber
 - design, fabrication, installation, ALARA
 - PIP-II does not run CW beam through HWR or SSR1
 - 20 Hz, 55 msec pulse, 2 mA peak

FY18 Goals

- Getting fuzzier: many dependencies
- HWR RF commissioning
 - dependent on 162.5 MHz RF amp, LLRF, Interlocks
 - 10 MeV HEBT?
- SSR1 & HEBT installation
 - 25 MeV HEBT
 - size of dump?
 - goals for beam operation?
 - CW vs pulsed

Working group 1: PXIE

- We would like to focus on the plan for the next three years:
 - What are the goals and deliverables of the R&D phase of PXIE during this time frame?
 - What are the identified responsibilities among collaborators and where are opportunities for additional collaboration?

12:30 - 17:15 Working Group Meetings: Working Group 1

Location: Floating Point

12:30 **PXIE Plan: 2016, 2017, 2018** 30'

Speaker: Paul Derwent (Fermilab)

13:00 **RFQ Commissioning Plan** 30'

Speaker: Mr. James Steimel (Fermilab)

13:30 **MEBT Components: Buncher cavities, kicker/absorber, vacuum system** 30'

Speaker: Alexander Shemyakin (Fermilab)

14:00 **Instrumentation Development** 30'

Speaker: Vic Scarpine (Fermilab)

14:30 **HWR** 30'

Speaker: Dr. Peter Ostroumov (Argonne National Laboratory)

15:00 **Break** 30' (IARC Auditorium)

15:30 **LLRF and Resonance Control for PXIE: RFQ, HWR, SSR1** 30' (IARC Auditorium)

Speaker: Mr. Brian Chase (FNAL)

16:00 **PXIE Cryo Distribution** 20'

Speaker: Michael White (Fermilab)

16:20 **Integration of HWR, SSR1, and Cryo Distribution into PXIE enclosure** 20'

Speaker: Mr. Curtis Baffes (Fermilab)

16:40 **Discussion / Preparation for WG1 Report** 20'

Joint with WG2

Summary

- FY16 plan understood
- FY17 plan pictured, lots of dependencies to make it happen
 - have some decision points in FY16
- FY18 fuzzier
- Goals and Deliverables:
 - are we on track?
 - do they need adjustment?
 - HEBT requirements
 - operational order
 - beam through 1 or 2 CMs?

MEBT-2 goals (FY17): Before installation of HWR

- Characterize transverse and longitudinal optics of the longer beam line, start experiments with laser wire and WCM
- Main goal: test and characterize kickers
 - First, separately, looking at the trajectory with BPMs
 - 50 Ohm powered by two 81.25 MHz CW amplifiers
 - 200 Ohm: two prototype 500V switches
 - Then, synch them and try to remove every other bunch

