Recommendations from the March 2015 P2MAC
iTrack Review ID # 43306

#	Committee Recommendation	Assigned	Status
R1	Perform a comprehensive beam dynamics analysis to identify performance-limiting mechanisms and parameters including effects of space charge, wall impedances, and electron-cloud in the Booster, RR, and MI.	Lebedev	Action plan includes 3 major items: (1) Effect of beam space charge at injection to Booster, (2) Transition crossing in the Booster, and (3) electron cloud instability in Recycler. 1) Item 1 looks as the mostly understood. First, twice higher injection energy to Booster greatly mitigates the space charge effects. Additionally, performed simulations point out that sensitivity to the space charge will be greatly reduced if Booster lattice will be periodic. To achieve this we need two things: first, optics correction based on optics measurements; second removal of optics perturbation which broke lattice periodicity. The latter can be resolved by zeroing current of extraction dogleg at injection. 2) Transition crossing in Booster is a high priority item. The major complication comes from large longitudinal impedance due to laminated dipoles. Significant progress has been achieved (See: (1) Project X Document 1354, (2) PIP-II Document 25 and (3) Rings Program by Valeri Lebedev in https://indico.fnal.gov/conferenceOtherViews.py?view=standard&confid=10586). However additional time is required to have a final resolution. 3) E-p instability is a serious problem which can limit PIP-II performance. Active studies of the instability have

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			been carried in Recycler in the support of high power beam delivery to NOvA. We also have a PhD student (s. Antipov) working in it.
R2	Assess Booster transition-crossing performance with benchmarked simulation codes.	Lebedev	Action plan includes the following major steps: (1) Benchmark a C-code specially written for simulations of beam acceleration in Booster, (2) write a new code for simulation of beam longitudinal dynamics with integrated GUI capable to address majority of problems we encounter in Fermilab. Benchmarking already resulted in good calibration of Booster longitudinal impedance. However simulations are still quite different from measurements in a number of details. The resolution will go in two directions: improving understanding of measured data and improving simulation details. Writing a new longitudinal code will take at least a year.
R3	Demonstrate with realistic simulations that slip stacking in RR at high intensity can be achieved with an acceptable loss budget. Identify the resulting requirements for equipment and for the beam from the Booster.	Lebedev	Simulations presented in PIP-II RDR are sufficiently detailed and assure us that the slip-stacking in Recycler will have acceptable beam loss if the Booster beam longitudinal emittance will stay at the same level with increased intensity. Booster transition crossing is the major limitation on the Booster longitudinal emittance. Therefore success of detailed simulations of beam acceleration in Booster, which proves that the required value of beam emittance can be achieved, will assure us that the slip staking in Recycler can be performed with acceptable beam loss.
R4	Identify and exploit a code of higher quality than ESME. Else trigger the development of a better code jointly with other concerned laboratories	Lebedev	Creation of the new code was initiated. It includes the following steps: (1) identify major algorithms required for computations and document them, (2) determine

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	(CERN, SNS, J-PARC, GSI, BNL…)		input file standard (input language) which will be sufficiently flexible for description of problems we encounter in Fermilab, (3) write the code, and (4) benchmark the code. Presently we are about half done with item 1. A number of tests were carried out, mostly with acceleration in Booster, which assure us that we have adequate understanding of the problems. It is already clear that this effort will require considerable time. First tests of actual software are expected in about year. We intend to discuss details of the code internally in Fermilab and externally with other institutions at the beginning of step 2 (input file description).
R5	Use PXIE to debug the combined operation of systems. This will save time during the actual PIP-II commissioning.	Derwent	We plan on using PXIE in this manner. Operations at PXIE will mimic the PIP-II scenario as closely as possible.
R6	Develop strategies to reduce the risk related to large in-kind contributions.	Holmes, Mishra	The risk mitigation strategy concerning in-kind contributions will be based on developing sufficient expertise and infrastructure at Fermilab, or in other U.S. national laboratories, to allow for component fabrication in the U.S. if necessary. The strategy will be further developed and described in the Risk Management Plan prepared for CD-1.
R7	As a test case, analyze and follow the risk (technical & schedule) for the Horizontal Test Stand set-up.	Mitchell	A Risk Assessment of the HTS-2 was performed and resides in Teamcenter as Item # ED0002501. The findings of the Risk Assessment suggested that the procurement in India would pose the greatest challenges. Indeed, the procurement process at RRCAT in India is a very long process that Fermilab is watching very closely. However, the procurement of this cryostat

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			is the responsibility of RRCAT as part of the IIFC agreement. Fermilab will continue to follow this procurement very closely.
R8	The Committee is convinced of the importance of System Engineering and Integration and strongly encourages a proper implementation. Early agreement on this practice with partner laboratories will be essential for the in-kind contributions from international partners.	Mitchell, Mishra	In Teamcenter, Item # ED0001224 has been created which organizes the entire PIP-II project's engineering documentation. It also provides access to all of our budget and schedule information and IIFC deliverables. This tool provides ALL of the PIP-II collaborators with direct access to all engineering documents. It is the basis for the PIP-II WBS. Engineers are being trained on how to use this system and progress is being made with its implementation.
R9	Develop a project wide strategy to identify a passive measure supporting a successful resonance control.	Yakovlev	To withstand Lorentz forces, helium pressure fluctuation and microphonic a general strategy is applied to the SC cavity and cryostat designs. The passive measures of resonance control strategy include adding RF power to compensate for the expected peak frequency detuning, minimizing Helium bath pressure peak to peak variations, reducing the sensitivity of the cavity resonant frequency to the helium bath pressure and LFD (Lorentz Force Detuning), and minimizing effect of external sources by reducing sensitivity to their perturbations as well as their amplitudes. Specific realizations of these measures depends on particular cavity design and are included in the Functional Requirement Specifications and will be pursued in the course of design work. Requirements on vibration characteristics of the surrounding enclosures and support systems are addressed in recommendation L4.

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L1	Specify “particle free” conditions for the last part of the MEBT.	Shemyakin	Specification of "particle free" conditions for the last part of the MEBT is described as a part of a more general document "Low Particulate Vacuum requirement", TC# ED0004444 prepared by Alex Chen. Presently it is in a draft form, awaiting a broader discussion and eventual approval, but it is currently providing requirements that are to be followed in practice.
L2	Evaluate the risk related to the single window RF power coupler design of SSR1.	Yakovlev	The single window coupler is much simpler mechanically and less expensive than a two window coupler, especially if the coupler is powerful and the antenna must be cooled, as in our case. To reduce the risk of window failure each coupler will be tested at a power level significantly higher than the operational power level. For example, the operational power level of SSR1 is about 6 kW (in case of CW) and the couplers are tested at ~ 30 kW, CW, full reflection. With this routine the risk of window failure is considered low. A design a double-window version is studied as a possible alternative.
L3	Consider measures to reduce the filling/decay times in the cavities for pulsed operations.	Yakovlev	Long filling and decay times increase cryogenic loads. The most straightforward way to decrease filling/decay time is to use excessive RF power. During filling time, higher RF power allows one to reach designed gradient in shorter time. During decay time RF power with appropriate phase will reduce the decay time. There is an optimal balance between decreasing cryogenic loads and required extra RF power. A balance is described in the RDR. This balance will be revisited as part of the final optimization of the technical parameters of both RF and

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			cryogenic systems.
L4	Translate the needs for mechanical stability of cavities and cryomodules into functional specifications for the civil engineering design (if needed).	Mitchell, Dixon	By the end of January, 2016, a Functional Requirement Specification will be written so that facility engineers in FESS will understand the vibration issues that impact the function of the PIP-II cavities and cryomodules. From this requirement, FESS will be able to properly design the enclosure and machinery layout and mountings to minimize the impact of vibration on the LINAC SRF components.