Topics for Today

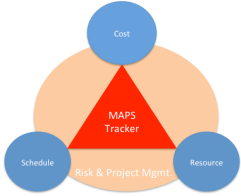
- Discuss current sPHENIX/MAPS plan and find a path forward, need to move FAST!

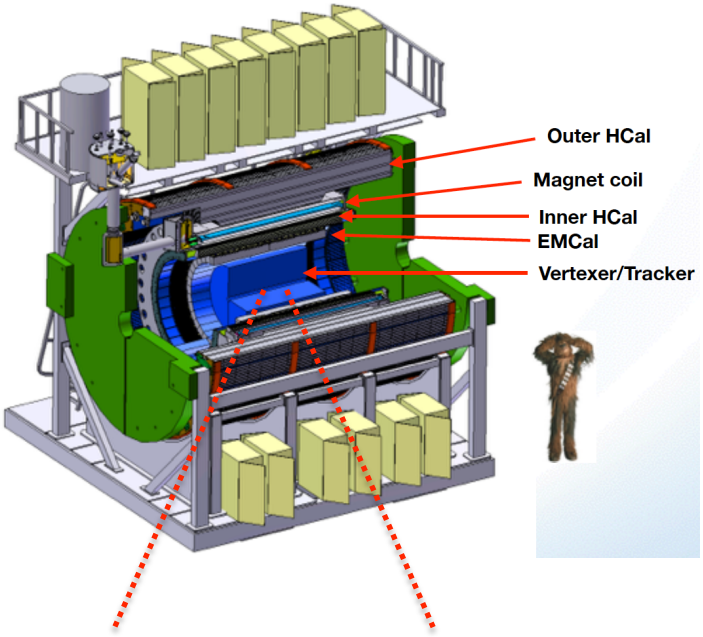
sPHENIX/MAPS: a schedule driven project!

- Identify MIT's interest and responsibility
  - Major tasks to lead
  - Resource and timeline

- A separate MIE?
  - Feasibility, start communication with DOE
  - Develop a plan to identify tasks, resources and timeline
  - Have a pre-proposal soon, by January 2017?

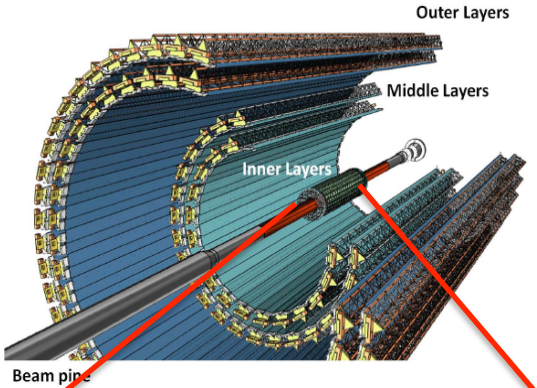
sPHENIX MAPS Inner Tracker

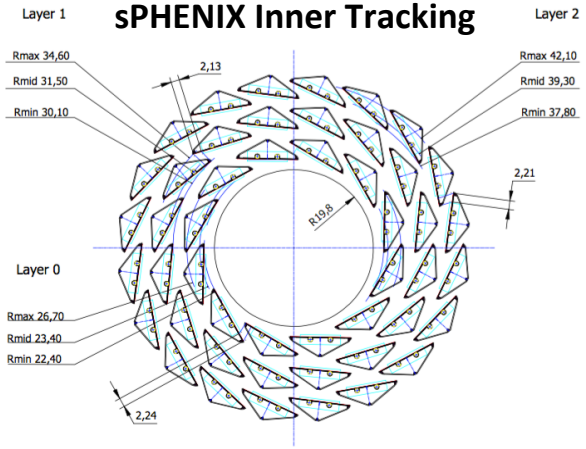


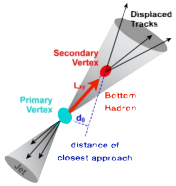


Key issues:
- Readout
- Mechanics

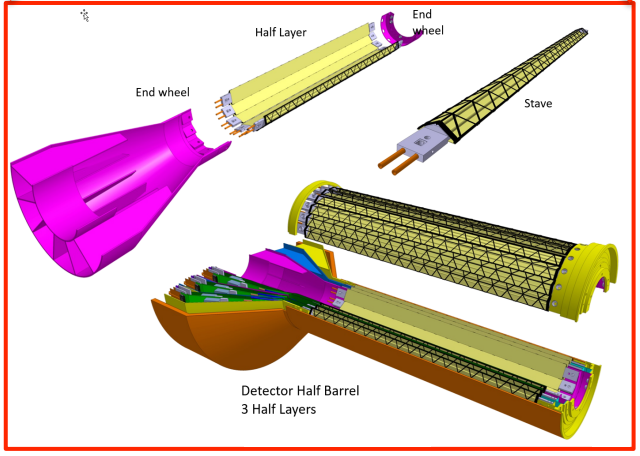
ALICE ITS;
Inner Tracker System



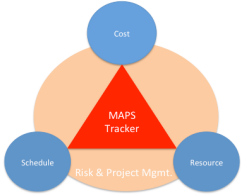


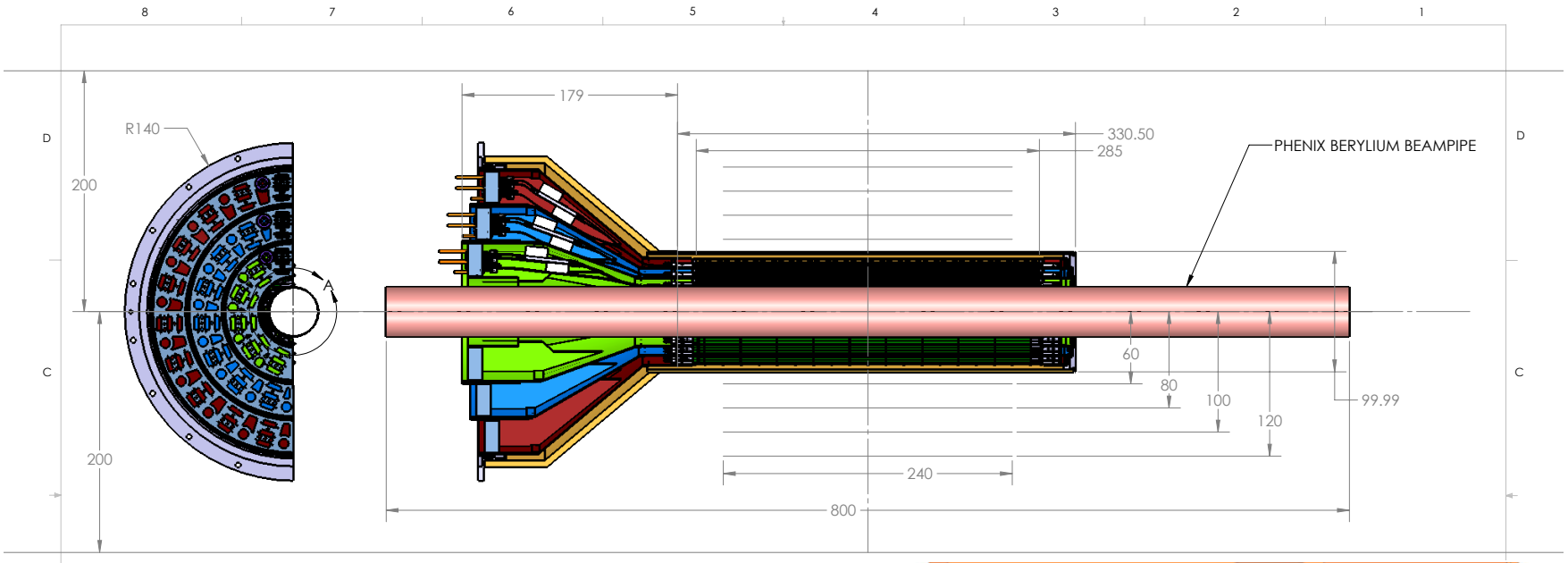


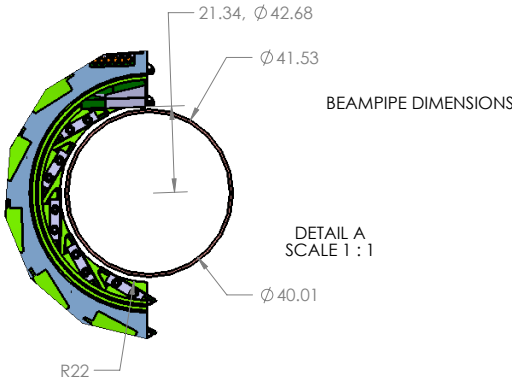
Copy of ITS
Inner Tracker

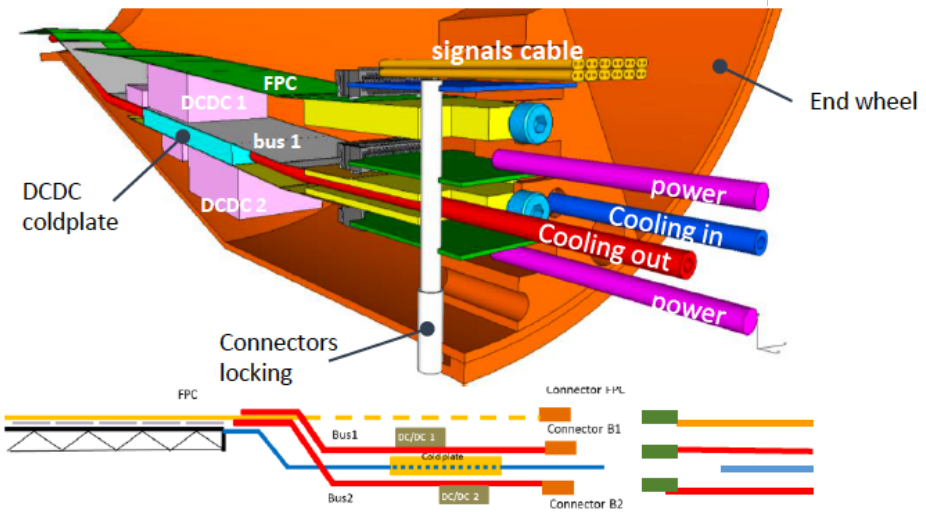


sPHENIX MAPS Inner Tracker





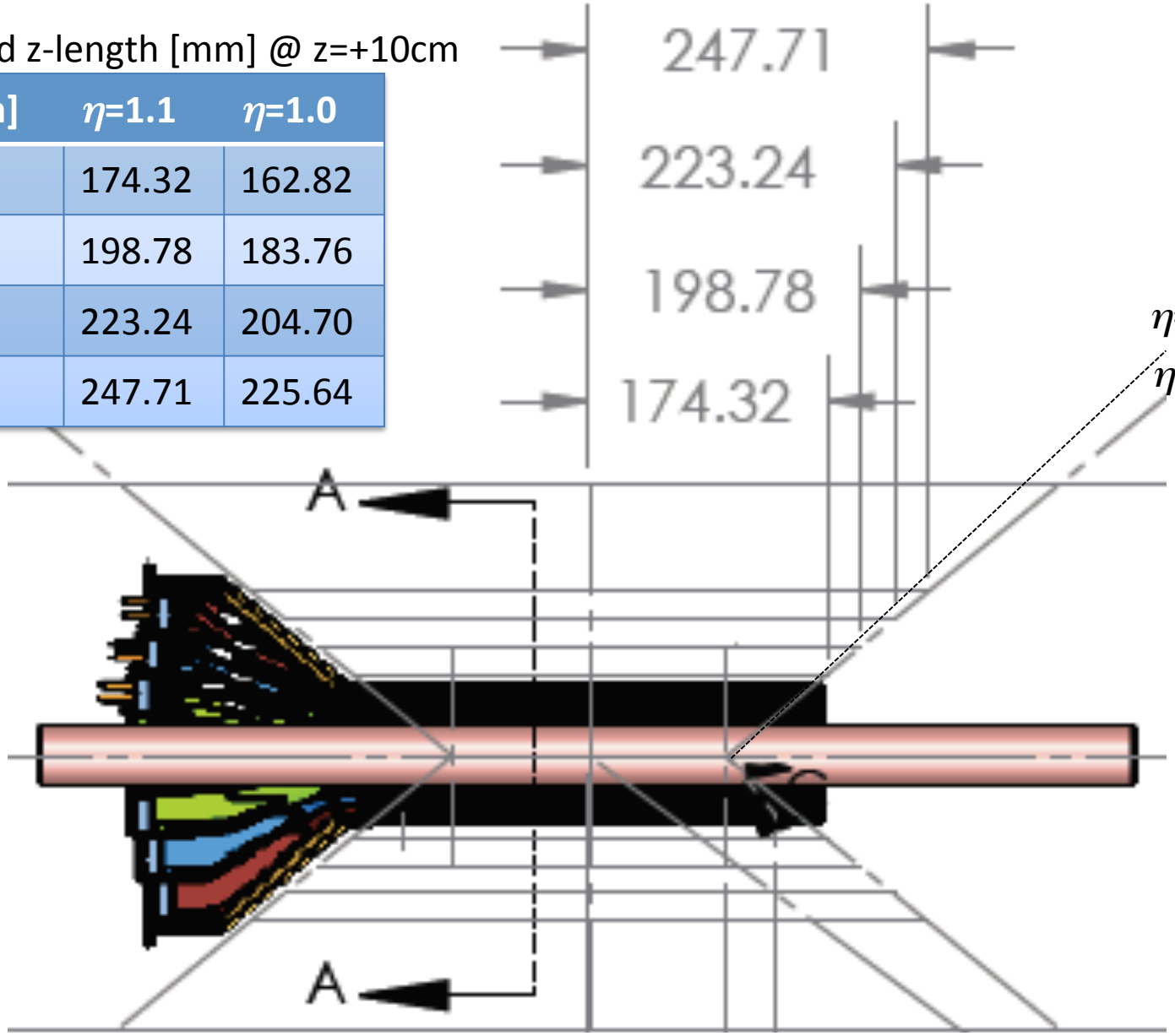




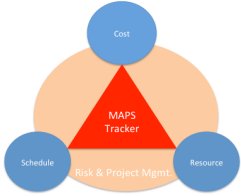
To Include INTT …. Modify End Wheel

Required z-length [mm] @ z=+10cm

r [cm]	η=1.1	η=1.0
6	174.32	162.82
8	198.78	183.76
10	223.24	204.70
12	247.71	225.64



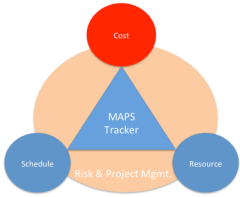
Scope of the Project



- MAPS & Electronics
  - MAPS Detectors
    - MoU to build 68 ITS MAPS staves (40% spares)
    - No modification
  - Readout Electronics
    - Use ALICE/ITS, RDO + CRU
    - Modify/reprogram CRU for sPHENIX
      - Plan-B: build a custom board to convert ALICE/ITS into sPHENIX DAQ format
    - R&D by LANL LDRD
  - Production
    - Extend ALICE/ITS MAPS stave production
    - Train sPHENIX personnel for assembly and testing staves at CERN
    - Reproduce additional ALICE RDO+CRU for sPHENIX
  - Ancillary systems
    - LV, cables, crates, racks etc.
    - Slow control, safety and monitoring
- Mechanics & Cooling
  - No/(some) changes to ALICE/ITS inner tracker mechanical structures
    - End Wheels
    - Cylindrical structure shells
    - Detector half barrels
    - Service half barrels
    - Detector and Service half barrels
    - Half support structures
  - Mechanics Integration
    - Conceptual design by LANL LDRD
    - Prototype by sPHENIX R&D
    - Design integration frames
    - Cage etc.
    - Installation tooling etc.
  - Copy ALICE cooling plant design
    - Minor modification to fit sPHENIX
    - Smaller heat load than ALICE ITS
  - Metrology and Survey

MIT leads?

Project Task and Timeline



FY2016 FY2017 FY2018 FY2019 FY2020 FY2021

CD-0 11/1

CD-1 11/1

CD-2/3 8/1

Ready for Beam 6/1

Key R&D

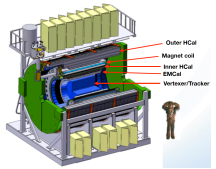
Readout R&D
Mech. design
@LANL/ALICE

Mech. Integr.
& Prototype
@MIT/BNL

A schedule driven project!

Production

MAPS Prod. & QA @ALICE → Stave Prod.&Test @CERN; FEM Prod. @US → Det. Assembly & Test @BNL → Det. Install. @BNL

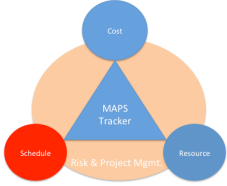


+2% +50%

"MoU" w/ ALICE: ~12/2016
To produce staves, frames and FEMs

From Sep. 2016 Tracker Review

Overview of Schedules

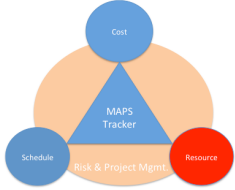


Thu 9/1/16

ID	WBS	Task Name	Duration	Start	Finish
1	1	**MAPS Inner Barrel**	**1217 days**	**Mon 10/3/16**	**Tue 6/1/21**
2	1.1	MAPS Inner Barrel Starts	0 days	Sat 10/1/16	Sat 10/1/16
3	1.2	MAPS Inner Barrel Ends	0 days	Tue 6/1/21	Tue 6/1/21
4	1.3	**Milestones & Key Tasks**	**0 days**	**Mon 10/3/16**	**Mon 10/3/16**
5	1.3.1	**ALICE ITS Key Tasks**	**0 days**	**Mon 1/2/17**	**Mon 1/2/17**
6	1.3.1.1	ALICE MAPS Production (7/17)	240 days?	Mon 8/1/16	Fri 6/30/17
7	1.3.1.2	ALICE ITS IB FPC Production (9/17)	90 days	Mon 5/1/17	Fri 9/1/17
8	1.3.1.3	ALICE ITS IB Stave Production (1/18)	1 day?	Tue 1/2/18	Tue 1/2/18
9	1.3.1.4	ALICE ITS IB Stave Assembly (3/18)	262 days	Mon 1/2/17	Tue 1/2/18
10	1.3.1.5	ALICE ITS Electronics Pre-Production (7/17)	100 days	Wed 2/22/17	Tue 7/11/17
11	1.3.1.6	ALICE ITS Electronics Production (6/18)	240 days	Thu 7/13/17	Wed 6/13/18
12	1.3.2	**sPHENIX Milestones**	**1195 days**	**Tue 11/1/16**	**Tue 6/1/21**
13	1.3.2.1	sPHENIX Technical Design CD-0	0 days	Tue 11/1/16	Tue 11/1/16
14	1.3.2.2	sPHENIX Technical Design (CD-1/CD-3a)	0 days	Wed 11/1/17	Wed 11/1/17
15	1.3.2.3	sPHENIX Technical Dewsgin (CD-2)	0 days	Mon 7/2/18	Mon 7/2/18
16	1.3.2.4	sPHENIX Start Construction (CD-3b)	0 days	Wed 8/1/18	Wed 8/1/18
17	1.3.2.5	sPHENIX Installed and Ready for Beam	0 days	Tue 6/1/21	Tue 6/1/21
18	1.3.3	**LDRD Milestones & Critical Tasks**	**781 days**	**Mon 10/3/16**	**Mon 9/30/19**
19	1.3.3.1	LDRD Start and End	781 days	Mon 10/3/16	Mon 9/30/19
20	1.3.3.8	Complete MoU LANL-ALICE	0 days	Fri 12/9/16	Fri 12/9/16
21	1.3.3.3	Setup ALICE Readout Test Stands	0 days	Fri 2/17/17	Fri 2/17/17
22	1.3.3.4	Complete final sPHENIX Readout Design Review	0 days	Wed 7/26/17	Wed 7/26/17
23	1.3.3.5	Complete Final MAPS Detector Design (CD-1)	0 days	Thu 11/16/17	Thu 11/16/17
24	1.3.3.6	sPHENIX Test Beam	21 days	Fri 2/1/19	Fri 3/1/19
25	1.3.3.7	MAPS Final Design (CD-2/CD-3)?	0 days	Mon 10/3/16	Mon 10/3/16
26	1.5	**sPHENIX Project**	**1217 days?**	**Mon 10/3/16**	**Tue 6/1/21**
27	1.5.1	**sPHENIX Project Management**	**1217 days**	**Mon 10/3/16**	**Tue 6/1/21**
28	1.5.1.1	Level 3 Project Manager	1217 days	Mon 10/3/16	Tue 6/1/21
29	1.5.1.2	Mechanical Liason Engineer	1217 days	Mon 10/3/16	Tue 6/1/21
30	1.5.1.3	Electronics Liason Engineer	1217 days	Mon 10/3/16	Tue 6/1/21
31	1.5.2	**sPHENIX Mechanics Integration**	**289 days**	**Thu 11/2/17**	**Tue 12/11/18**
32	1.5.2.1	**Stave Support Frame & Global Interface to sPHENIX**	**115 days**	**Thu 11/2/17**	**Wed 4/11/18**
37	1.5.2.2	**Cooling System**	**25 days**	**Wed 8/1/18**	**Tue 9/4/18**
41	1.5.2.3	**Safety Systems**	**70 days**	**Wed 9/5/18**	**Tue 12/11/18**
45	1.5.2.4	**Stave Assembly Tooling**	**45 days**	**Thu 4/12/18**	**Wed 6/13/18**
49	1.5.3	Mechanics Final Design Review	12 days	Thu 6/14/18	Fri 6/29/18
53	1.5.4	**MAPS Inner Barrel Review (CD-2/3)**	**12 days**	**Mon 7/2/18**	**Tue 7/17/18**
57	1.5.5	**Productions**	**534 days?**	**Thu 6/14/18**	**Tue 6/30/20**
58	1.5.5.1	Full Pre-Production-Mechnical System Mock Up Test	90 days	Thu 6/14/18	Wed 10/17/18
59	1.5.5.2	**Procurements**	**180 days?**	**Wed 8/1/18**	**Tue 4/9/19**
60	1.5.5.2.1	**CERN Procurements**	**180 days?**	**Wed 8/1/18**	**Tue 4/9/19**
65	1.5.5.2.2	**Non-CERN Procurements**	**107 days**	**Wed 8/1/18**	**Thu 12/27/18**
80	1.5.5.3	**Assembly and Testing at BNL**	**400 days**	**Wed 12/19/18**	**Tue 6/30/20**
89	1.5.6	**Installation**	**131 days**	**Wed 7/1/20**	**Wed 12/30/20**
94	1.5.7	Ready for beam	0 days	Wed 12/30/20	Wed 12/30/20

About 6 months of schedule float

Participating and Interested Institutions



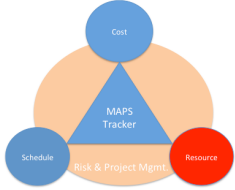
- LANL - Readout & FEMs, Mechanics
- **MIT - Assembly and testing, cooling…**
- LBNL – Mechanical carbon structures, readout
- BNL – Integration and services, safety and monitoring
- UT-Austin – MAPS readout electronics and testing
- Univ. of Colorado – sPHENIX DAQ/DCM-II integration
- Univ. of New Mexico – LV, cabling & connectors
- New Mexico State University – Tracking algorithm and simulations
- Univ. of IL of Chicago – Stave assembly and testing, offline analysis
- Iowa State University – Assembly and testing, simulations
- Georgia State University - Slow control and monitoring
- Florida State University - Offline and simulations
- Univ. of California, Los Angeles – Assembly and testing, simulations
- Univ. of California, Riverside – Assembly and testing, simulations
- RIKEN/RBRC, Japan – Assembly and testing, integration
- Yonsei, Korea – MAPS QA and readout, simulations

From Sep. 2016 Tracker Review

- Czech Republic - Miroslav/Mike Finger, Caclav Vrba et al , tasks TBD
- Peking Univ. – many good students (already on CMS)

Potential collaborators

Organization Chart



BNL Program Manager

sPHENIX Project Office
Manager: Ed O'Brien

sPHENIX MAPS Project Office
Project Manager: *Ming Liu (LANL)*
Deputy Project Manager: *Mike McCumber (LANL)*
Electrical Engineer:TBD
Mechanical Engineer: Walt Sondheim? /MIT?

sPHENIX Management
Spokespersons
Gunther Roland
David Morrison

From Sep. 2016 Tracker Review

Readout *UT/LANL*	*MAPS Sensor* *ALICE*	*Stave* *ALICE*	*Cabling* *UNM*	*Mechanics* *MIT/LBNL*	*Integration* *MIT*	*Electrical* *BNL*	*Software* *UIC/FSU*
FEM *M. Prokop LANL*	*Sensor Design* *ALICE*	*Stave Design* *ALICE*	*High density cables* *UNM*	*Structure Design* *LANL/MIT*	*Cooling* *MIT*	*Low Voltage* *UNM/NMSU*	*Simulation* *ISU/GSU/*
Slow Control & Monitoring *BNL*	*Sensor Production* *TowerJAZZ*	*Stave Assembly* *MIT/UIC/LANL*	*LV* *UNM/NMSU*	*Assembly* *BNL/MIT*	*Alignment* *BNL/UIC*		*Offline* *NMSU/FSU*
DCM Integration *Colorado*	*Sensor QA* *Yonsei(Korea)*	*Stave QA* *MIT/ISU*	*Fibers* *UNM*	*Installation* *BNL/MIT*	*Mechanical Stability* *BNL*		*B-jet tagging* *LANL,NMSU*
					Safety System *BNL*		

A Separate MIE Proposal for the sPHENIX MAPS Inner Tracker?

- This idea of a separate MIE has been brought up and discussed at several meetings recently

- sPHENIX collaboration proposed "cost reduced" baseline configurations, (I) & (II).
  - In both scenarios, we need MAPS!
  - Still waiting for final decisions/inputs from ALD

- MAPS is considered by BNL ALD to have the best chance to get additional fund for sPHENIX
  - With strong consortium of outside institutions (LANL+MIT+LBNL? + UT..), thus there is a strong push/desire from ALD/sPHENIX project office to get a separate MIE for MAPS

A Proposal

- A MAPS detector subgroup to identify and work on
  - Tasks, Resources and Responsibilities for each institution
  - Agreement on each institution's interest and available resource
  - Start joint R&D on critical tasks
    - LDRD, associate members and other R&D fund etc

- Pre-proposal writing?
  - Identify required resources ($$ and manpower) and timeline
  - Intended contributions from all institutions
  - Electronics and readout – LANL
  - Mechanic system and integration – MIT
  - Ancillary and other systems – other collaborators
  - A draft by January 2017? Discussions with DOE during Feb budget meeting

- More communications with DOE
  - Based on updated resource loaded Cost and Schedule from pre-proposal
  - Then decide on next step
    - either go forward or not, work out a plan with DOE
  - Get more support from ALD & DOE on CERN-SPHENIX agreement etc.

Back up

A Small Group Meeting 10/21/2016

Ed, Dave M, Gunther and Ming

Summary:

1. High level sPHENIX-ALICE "Agreement":

> "The document that we intend to have both
> CERN and DOE sign agreeing to cooperate on MAPS
> development for sPHENIX, will not be a Memorandum of Understanding
> but rather an agreement to collaborate, an agreement to provide
> resources, or something similar. " from Ed.

2. ALD plans to work on sPHENIX-ALICE Agreement with DOE and sPHENIX management, willing to go to CERN for negotiation etc.

3. Use US/ALICE state-I management document as an example for MAPS planning/proposal writing

4. >$2M MIE as an individual federal budget item, there could be some flexibilities, we try to work out MAPS plan/pre-proposal first then deal with this later

5. Develop a pre-proposal (by the end 2016?), identify the timeline of M&S fund and manpower needs to match ALCIE/ITS and sPHENIX schedules, starting from Cost & Schedule documents we already have

6. To get all interested parties involved in the pre-proposal writing

My Understanding of sPHENIX Project

- sPHENIX MIE is a DOE project costing $30-35M through savings from RHIC operation, NO additional fund will be given to BNL for sPHENIX
- Given the limited M&S from RHIC operation saving, one seemingly attractive option is to submit a separate MIE for the MAPS
- Money and Schedule Challenges if a new MAPS MIE
  - It is not very clear DOE will be ready financially for such proposal, and also the timeline if approved.
  - From what ALD described, DOE (Jehanne and Tim) thought this was a good idea but it is too early to say more than that.
- The separate MAPS/MIE timeline needs to be tied to the ALICE/ITS production and also the sPHENIX schedules
  - ALICE/ITS production ends early summer 2018
- Potential high impacts on the sPHENIX-ALICE MoU/Agreement
  - Resources, lab space and man power
  - Schedules

DOE MIE Process and Challenges

- Contact for new scientific proposals
  - Associate Director for NP (Tim), who will then identify point of contact for the project
    - Jehanne Gillo
- For a project with Total Estimated Cost(TEC) < $10M
  - no CD process needed: good news
  - The 3-layer MAPS inner tracker fit this scope

- For a project with TPC > $2M
  - "includes all engineering and fabrication costs, needs to be identified individually in the federal budget as Major Item of Equipment(MIE)" - concern over timeline
  - If submitted and reviewed and DOE "mission need" approved in FY17
    - the earliest date to receive fund is FY20, Oct. 2019.
  - Federal budget prepared 2-year in advance
  - DOE budget request to Congress ~Feb 2018
  - It is hard to have a complete proposal submitted, reviewed and approved for "DOE mission need" and have this MIE included in the Feb. 2017 DOE budget request (~3 months from now)
    - while we are still waiting for (CD0 and) CD1 approval from DOE
  - http://science.energy.gov/np/facilities/project-development/

- Challenges to match ALICE/ITS production schedules
  - Early fund (~$1M) needed summer 2018 to continue ALICE/ITS production line for sPHENIX MAPS staves

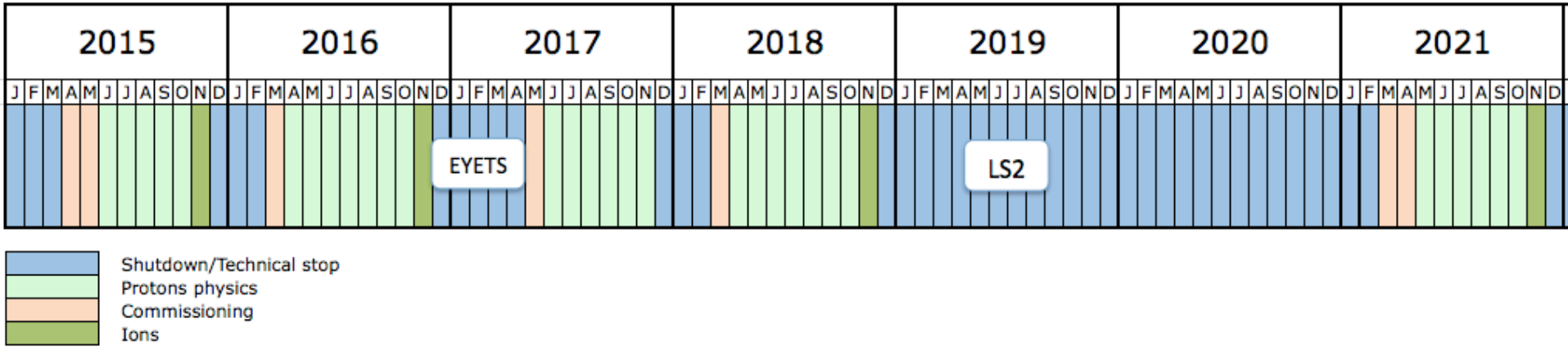
My Conclusion

- The normal MIE process may not match current ALICE/ITS and sPHENIX installation and run schedules, need to work closely with DOE how to proceed
- Some minimum fund (~$1M) must be secured for the MAPS stave production at CERN following the completion of ALICE/ITS project, such as $$ from RHIC operation savings or foreign contributions etc.

Other considerations:

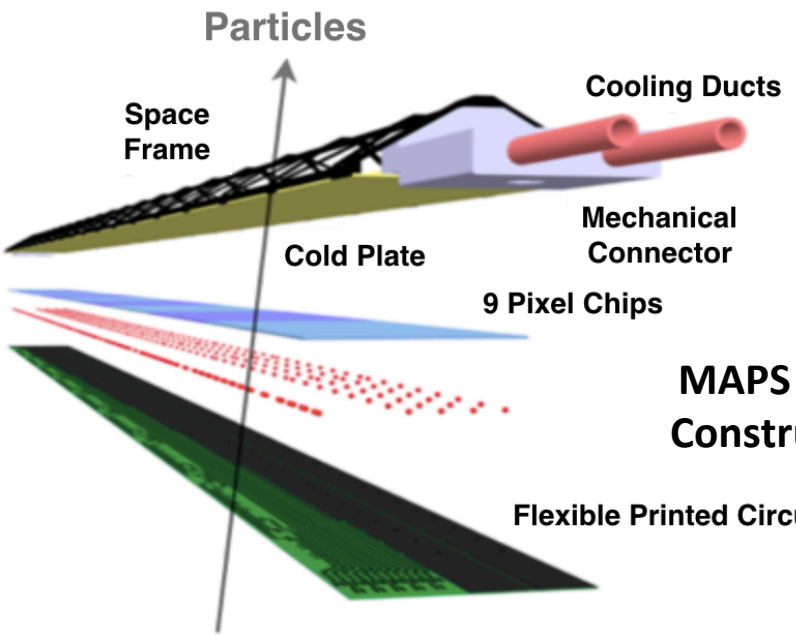
- Can we defend the "BNL base line TPC only" tracking system for the sPHENIX physics program, with separate MAPS MIE?
- If MAPS delayed, with TPC only, it won't be able to do tracking

Long Term LHC Schedule



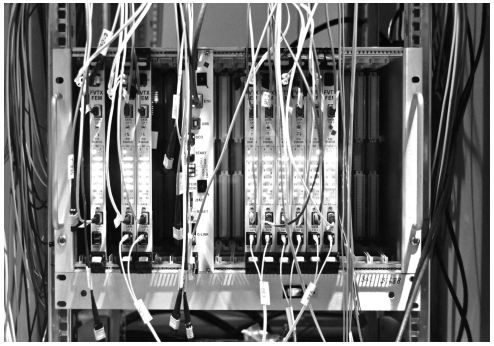
Experimental R&D Deliverables: Tracker

LDRD Experimental Goal: LANL built 4-stave prototype tracker at test beam with custom sPHENIX readout



MAPS Stave Construction

1st MAPS prototype sensor being studied at TA-53

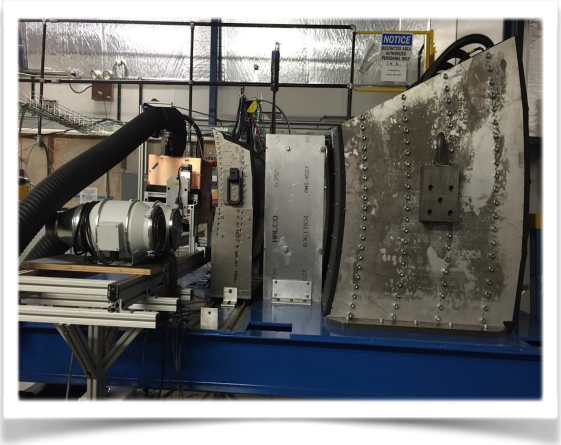


Annual FermiLab Test Beam

Test prototype tracker

Validate tracking and reconstruction

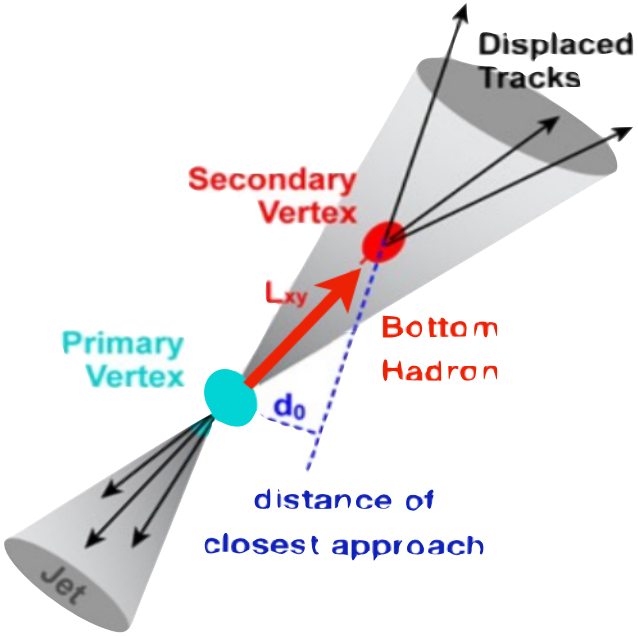
Custom Front-End, intergrate into sPHENIX Readout (FVTX expertise)



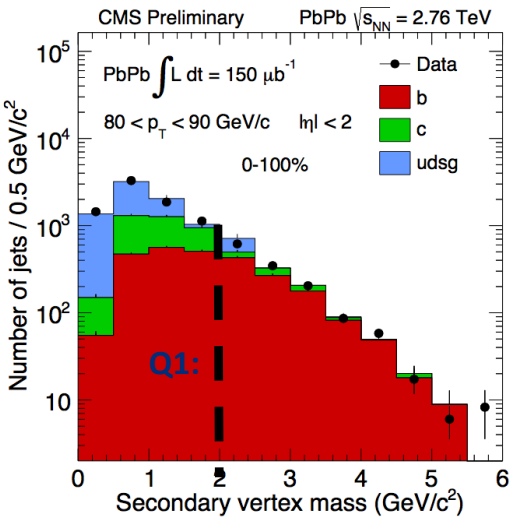
sPHENIX EMCAL & HCAL Prototypes taken April 19, 2016

Experimental R&D Deliverables: Physics

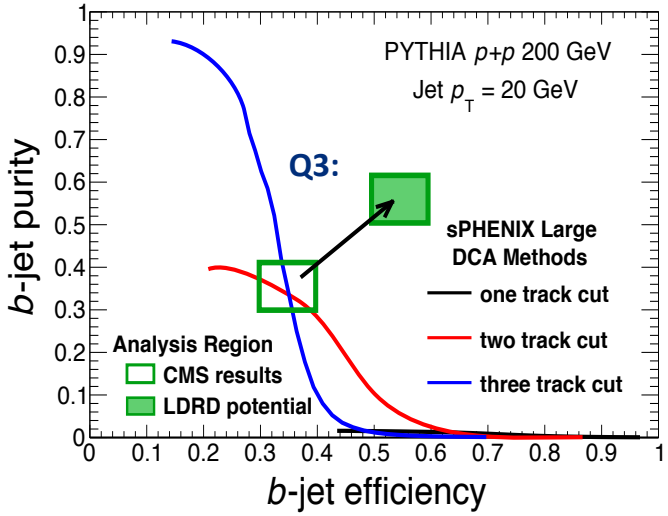
LDRD Experimental Goal: Improved B-jet Identification in Heavy Ion Collisions



Secondary Vertexing



Track-Counting

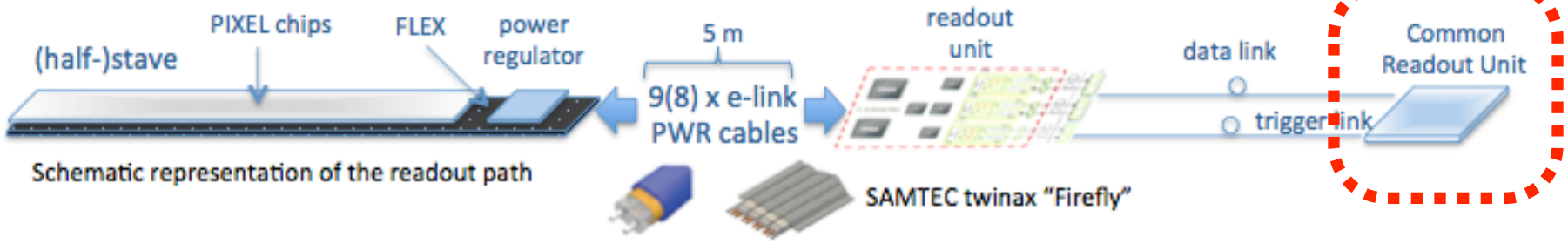


- LANL proposed tracker, a new b-jet identification with **high efficiency** and **high purity** is possible
- Figure of merit is ***efficiency x purity.*** Greatly enhancing the b-jet physics program, x4 improvement in FOM

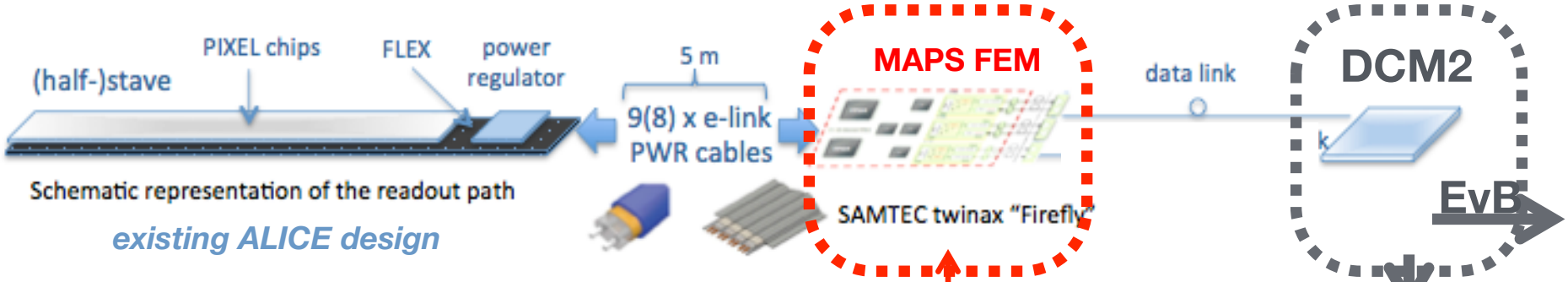
MAPS Electronics

ALICE readout path

Plan A: reprogram



Plan B: sPHENIX readout path (held as contingency)



Summary of a Meeting with ALICE/ITS Manager Dr. Luciano Musa, 09/12/2016

- A Skype Meeting ~1.5hr, Luciano and Ming
  - Very productive, discussed many technical details of MoU
  - Concluded with a to-do list and possible timeline

- Updated current status
  - LANL LDRD scope and plan
  - sPHENIX MAPS proposal and recommendations from recent tracking review
  - ALICE/ITS MAPS project progress status

- MoU discussions
  - LANL LDRD MoU
  - sPHENIX production “MoU”

- CERN and ALICE managements are fully aware of our intention to use MAPS for sPHENIX inner tracking
  - ALICE spokespersons + ITS project management
  - CERN Exp. Dept. Director of Research
  - Work out a MoU between CERN and BNL for sPHENIX project

LANL R&D MoU

- Join ALICE/ITS project as associate members
  - Work on ALICE/ITS project at CERN/ALICE and build up experience on MAPS technologies
    - Assembly, operate and test MAPS/staves at CERN
    - At a level of ~1FTE for 6 months, 1/2017 – 7/2017
  - R&D for sPHENIX MAPS prototype detector
    - Obtain ALICE/ITS prototype staves and readout system and test bench for R&D
    - CERN facilities and expertise
    - Readout and mechanics
    - Software

- Access/obtain needed technical design files for MAPS R&D
  - Intellectual property agreement on MAPS, TBD, likely not an issue (Luciano will follow up)
  - Allow us to reproduce readout electronics boards (RDO, CRU etc) in US if needed
  - Modify mechanical structure as needed

- Action items:
  - Ming/LANL will work with Luciano to write "Express of Interest" to join ALICE/ITS project as associate members (Luciano will send design drawings and sample letter etc.), ~2 weeks (done!)
  - Luciano will present the request to the ALICE collaboration at next Alice Collaboration Meeting, early November 2016 (planned)
  - Ming+LANL folks will visit CERN Labs and attend ALICE Week/Collaboration Meeting during the week of 11/10-15, 2016, discuss collaboration plan etc.
  - Luciano/ALICE will provide technical documents and design files for LANL R&D
  - Luciano/ALICE will help to procure prototype detector+test bench etc. for LANL R&D

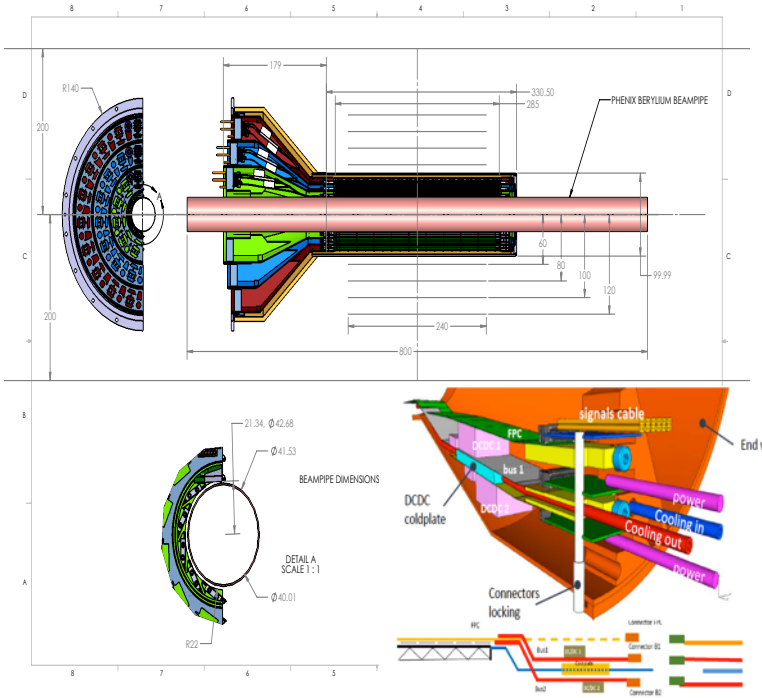
CERN-BNL "MoU" for sPHENIX Production

- Defined the minimal scope of the project in the MoU
  - A 3-layer MAPS detector identical to ITS/IB
    - 48 staves + 40% spares = 68
  - MAPS chips
    - 68 fully tested staves, 68x9=612 chips
    - 20% fully tested spare MAPS chips, 612x20% = 122 chips
    - Total 734 MAPS chips
  - Flexible PC boards (FPC) with connectors and cables
    - One per stave, 68 of them
    - Cables and connectors customized to meet CERN safety rules
      - Luciano/CERN will send documents to confirm they also meet BNL safety standards
  - Fully assembled and tested Staves
    - Preparation and cleaning of MAPS, FPCs and frames etc.
    - Alignment and gluing
    - Wire bonding
    - Assembly work mostly done by CERN techs
    - Final testing mostly by sPHENIX students/postdocs/techs
  - Mount staves on the ITS/IB space frame, ship fully tested space frame to BNL
    - Space frames to mount staves
    - Cold plates
    - Electrical connectors etc.
    - Mechanical tubes/connectors
    - Metrology done at CERN
  - Setup a construction DB for sPHENIX production
    - Traveler documents

- All produced at CERN by ALICE ITS production lines
  - CERN technicians and facilities
  - With help frpm sPHENIX students/postdoc + some Techs

CERN-BNL "MoU" for sPHENIX Production (cont.)

- sPHENIX Beam pipe and ITS/IB End Wheels
  - Default plan is to use the same End Wheels for sPHENIX MAPS tracker
    - CERN will produce them for sPHENIX
  - If needed, CERN engineer can also adjust the current MAPS/IB design to increase the inner radius a bit to fit the sPHENIX beam pipe, while keeping the full azimuthal coverage.
    - But this also requires redesign of the End Wheels.
- Service End Wheels
  - sPHENIX likely needs to modify/redesign it, not in the MoU CERN procurement
- 5m long SAMTEC cables
  - Modified by SAMTEC to meet ALICE/CERN safety requirements; CERN provides document to help sPHENIX's procurement
    - 5m length is close to the limit for 1.2Gb/s signal; ALPIDE-4 can drive longer distance at lower speed ~600Mb/s.
    - 600Mb/s already sufficient for ALICE (by x2)



CERN-BNL MoU for sPHENIX Production (cont.)

- Readout Electronics
  - RDO boards
    - One per stave, 48 + 20% spare = 58 total
    - CERN produce and test them all
      - some special parts produced at CERN only
  - CRU
    - NOT in the MoU, could be added later if needed.
    - One for every 2 staves, 48/2 + 20% = 29
    - Reproduce with design files in US possible

- Action items
  - Luciano/ALICE will produce preliminary cost estimate and production schedule, in progress
  - Early R&D on readout integration, the need of CRU or not, LANL in progress.
  - Early sPHENIX R&D to determine the maximum length of SAMTec cable needed for sPEHINX
  - Early sPHENIX mechanical integration design to determine the scope of mechanical system work
  - Try to have a draft by Oct. 15, 2016, later

- Scope of MoU
  - Scientific collaboration
  - Preliminary cost and schedule estimate

Near Term Plan

- A draft MoU by mid of October
- LANL R&D starts Oct. 3, 2016
  - Setup test bench etc.
- Prepare for next sPHENIX C&S review
  - Implement recent review recommendations
  - Funding approach, CD-1/3a, MoU etc
- Update resource plan and C&S
  - Identify resources for major tasks
    - MIT, LBNL?, UT-Austin and other institutions
  - Project FTE profile, students and postdocs contributions etc
- Establish collaboration for early R&D work
  - Visit MIT Bate lab in late October
    - mechanical system
  - Visit CERN ALICE/ITS Labs in Nov.,
    - Join ITS project, train new people
    - MAPS readout and test
  - Visit LBNL, UT-Austin and other institutions?
    - Joint R&D for LANL LDRD and sPHENIX
  - Meet people, visit facilities, match resources to tasks
- Hold regular meetings (bi-weekly?)
  - discuss progress, issues and needs etc.