P. Morettini

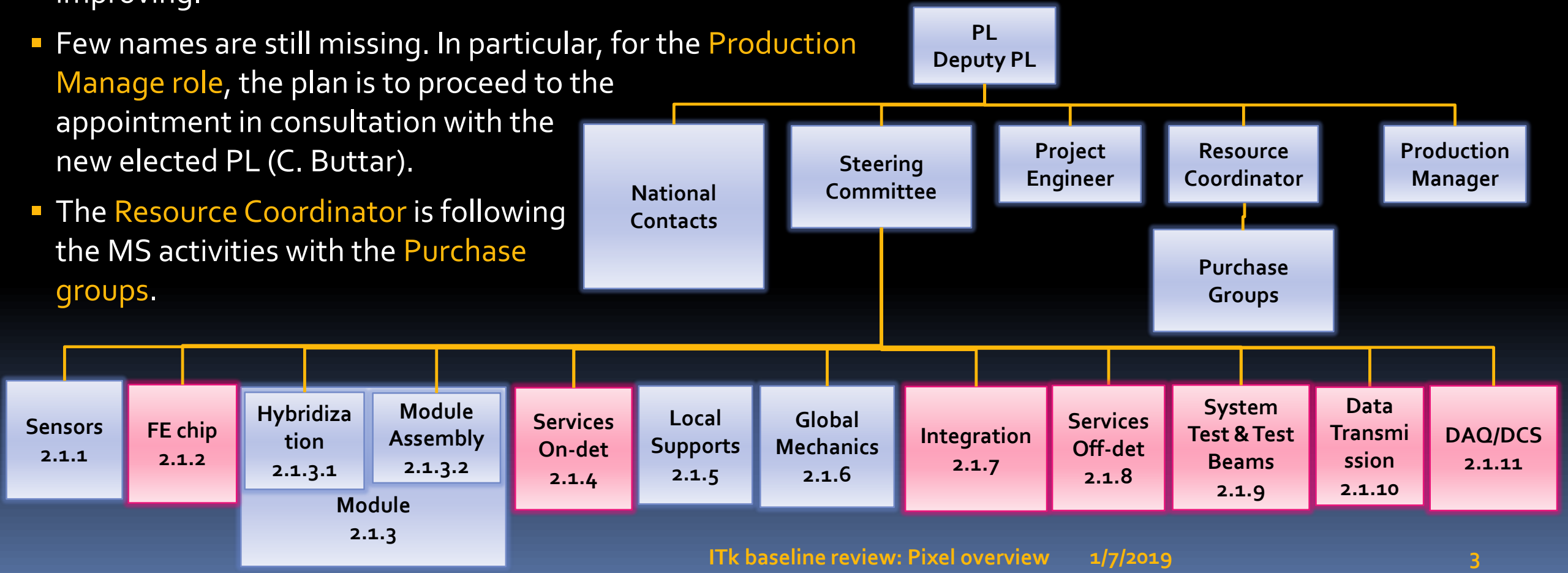
ITk Pixel overview

Contents (my proposal)

- General recommendations: how we addressed them.
  - Repeat slides from May, anything to add?

Addressing the recommendations:
New Pixel Organization

- We setup a new organization, more production oriented.
- We already have two coordinators in most of the boxes, so the resources devoted to coordination tasks are improving.
- Few names are still missing. In particular, for the Production Manage role, the plan is to proceed to the appointment in consultation with the new elected PL (C. Buttar).
- The Resource Coordinator is following the MS activities with the Purchase groups.



Pixel WBS

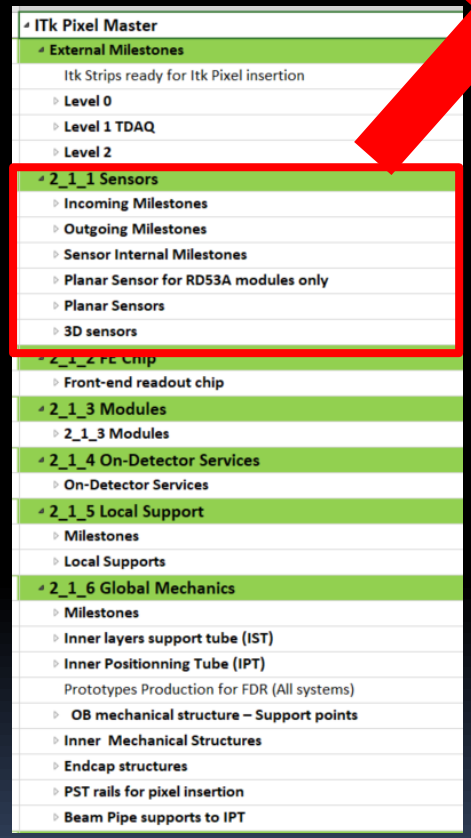
- The new Pixel WBS is divided into 11 lev 3 categories:

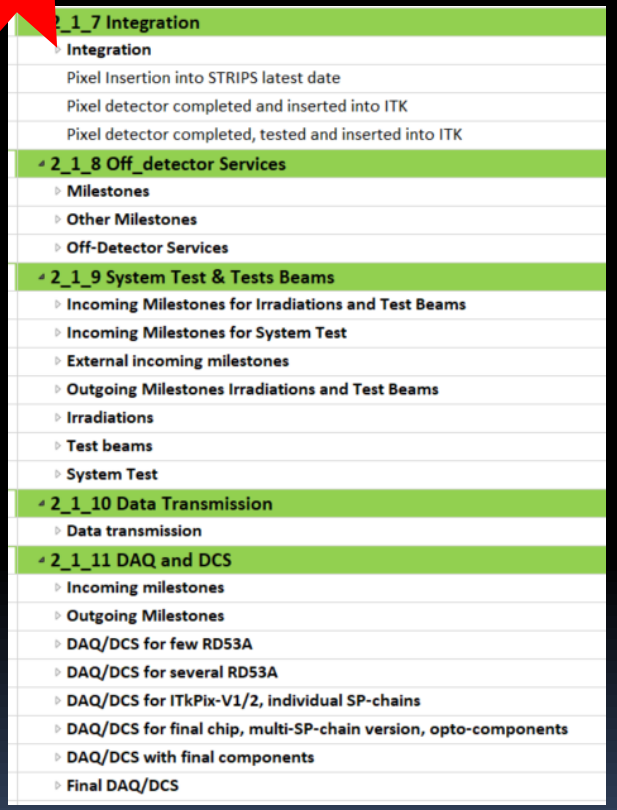
2.1.1	**Sensors**
2.1.1.1	Pixel Planar Sensors
2.1.1.2	Pixel 3D Sensors
2.1.2	**FE Chip**
2.1.2.1	Front-end read-out chip
2.1.3	**Module**
2.1.3.1	Hybridization
2.1.3.2	Module Assembly
2.1.4	**On-Detector Services**
2.1.4.1	On stave/ring services (Type-0)
2.1.4.2	Patch Panel 0 (PP0)
2.1.4.3	Type-1 Services
2.1.4.4	Patch Panel 1 (PP1)
2.1.4.5	PSPP chip and peripherals
2.1.4.6	DCS Controller Chip and peripherals
2.1.5	**Local Support**
2.1.5.1	Local Support cooling line
2.1.5.2	Local support Mechanical Structure
2.1.5.3	Coating of local supports for electrical insulation
2.1.5.4	Module loading on local supports
2.1.6	**Global Mechanics**
2.1.6.1	Inner layers support tube (IST) – Insertion system
2.1.6.2	Inner Positioning Tube (IPT)
2.1.6.3	Outer barrel mechanical structure
2.1.6.4	Inner barrel mechanical structure & insertion tooling
2.1.6.5	Outer Endcap structures
2.1.6.6	PST rails for Pixel insertion
2.1.6.7	Beam Pipe Supports to the IPT

2.1.7	**Integration**
2.1.7.1	Integration of Inner Replaceable Layers
2.1.7.2	Integration of Outer Barrel Layers
2.1.7.3	Integration of Outer Endcaps
2.1.7.4	Integration of Outer System
2.1.7.5	Insertion of Pixel into ITk Strips
2.1.7.6	12.5% or slice test in SR1
2.1.8	**Off-Detector Services**
2.1.8.1	Type 2 Services
2.1.8.2	Patch Panel 2
2.1.8.3	Type 3 cables
2.1.8.4	Patch Panel 3
2.1.8.5	Patch Panel 4
2.1.8.6	Power Supplies
2.1.8.7	Counting Room cables
2.1.9	**System Test, Irradiations & Test Beams**
2.1.9.1	Irradiation Tests
2.1.9.2	Test beams
2.1.9.3	System test
2.1.10	**Data transmission**
2.1.10.1	Data transmission ASICS
2.1.10.2	High speed electrical data cables in Type 1
2.1.10.3	Optical drivers/receivers
2.1.10.4	Optical Patch Panel
2.1.10.5	Optical fibers
2.1.11	**DAQ/DCS**
2.1.11.1	Pixel specific DAQ components
2.1.11.2	Pixel specific DCS components

Addressing the recommendations:
Schedule ownership

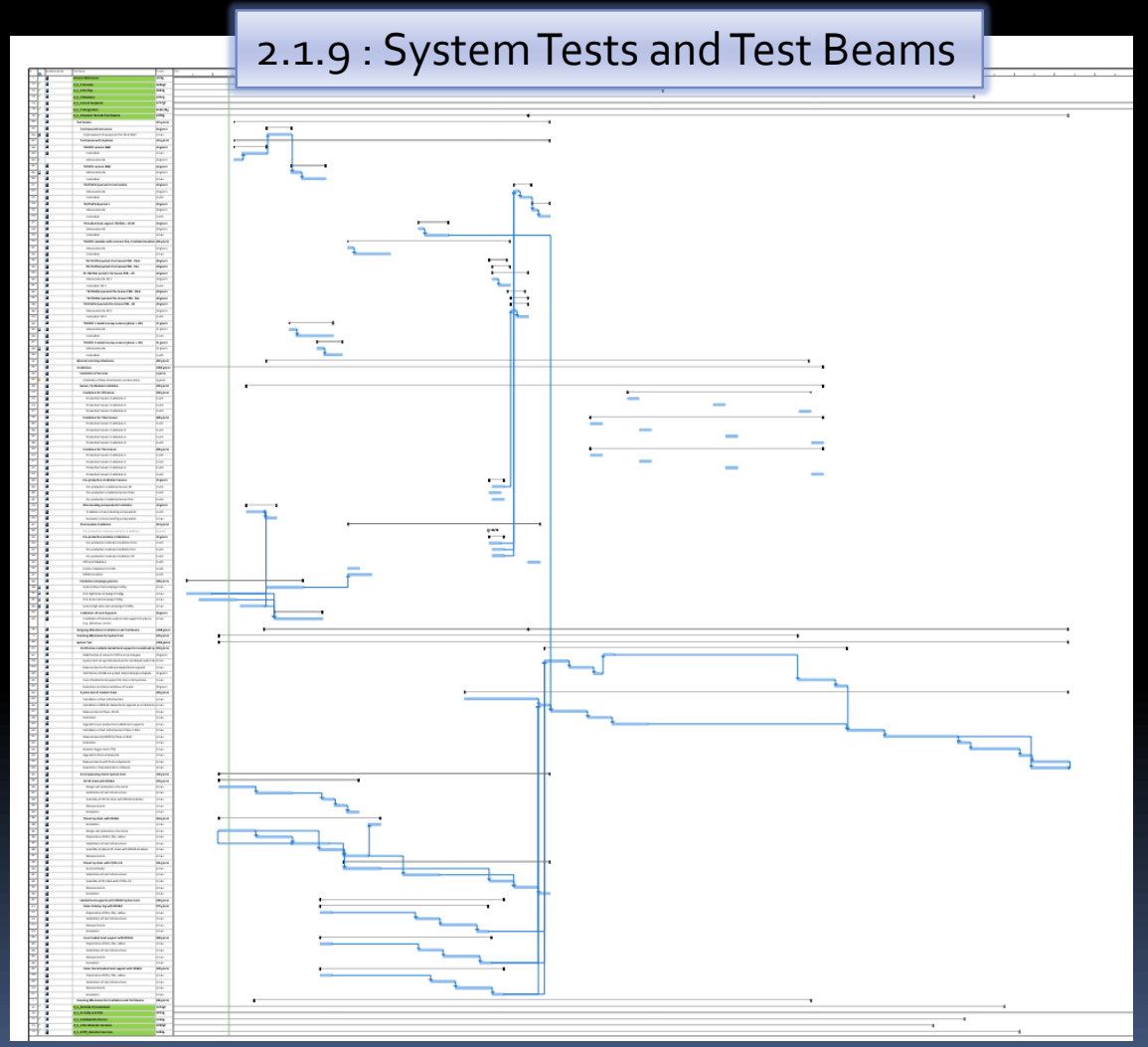
- The pixel schedule is now divided in 12 files: one master, owned by the PE and 11 L3 files owned by the corresponding coordinators.
- The coordinators did an enormous amount of work in reviewing and improving their part (in some case, a complete rewrite was needed).
- The files are linked via a set of milestones copied in all files, to make editing at L3 possible.
- In total, ~7000 lines and ~2500 milestones (with several repetitions…)





Addressing the recommendations:
Test Beams, Irradiations, System Tests

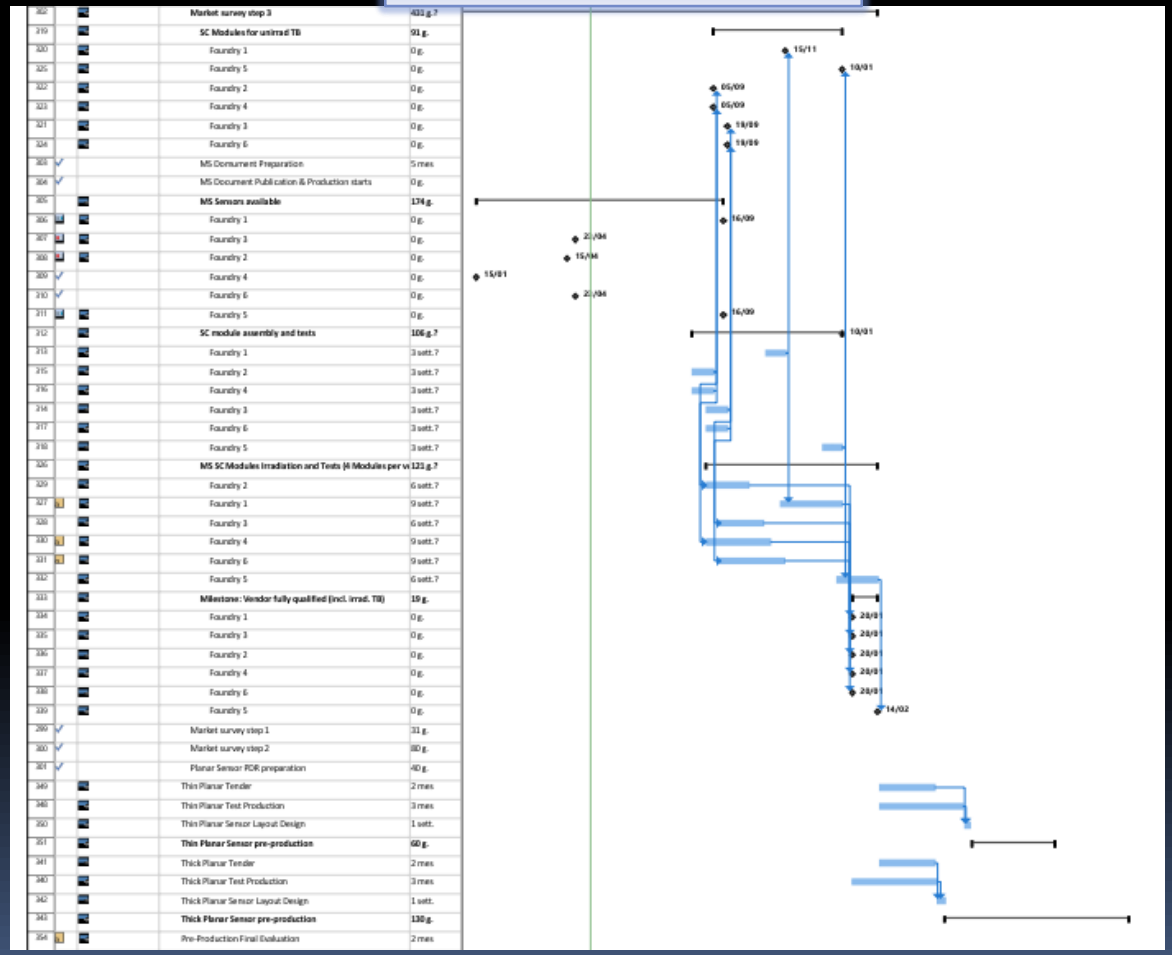
- All the activities related to tests and preparations to the reviews have been expanded and properly linked to production activities.
- The testing activities have dependencies on the availability of the specific equipment (DAQ, DCS, Power Supplies, cooling systems…).



Addressing the recommendations:
Market surveys

- The planning for the on going Market Surveys (Sensors and Hybridization) is included in the schedule. This planning is strictly correlated to the one for RD53A modules production.
- The impact of other anticipated market surveys is as well included in the schedule for the corresponding item.

Sensor Market Survey



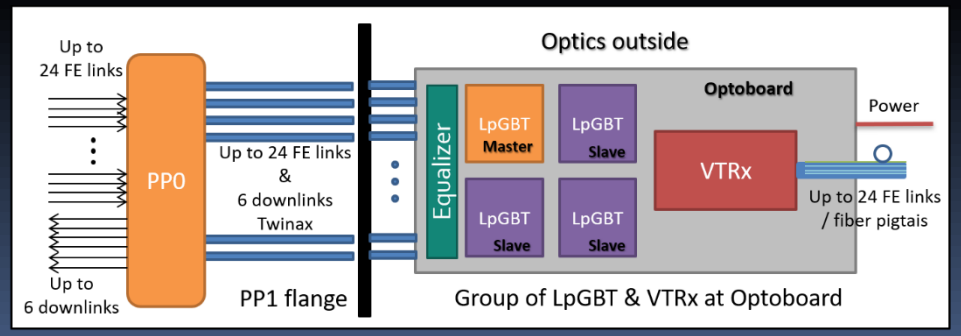
Addressing the recommendations:
Services

- We created two task forces, on data transmission and serial power, to address the criticalities identified in the services design and find solutions more compatible with the schedule constraints.
- The mandate was to provide a recommendation for a baseline design, so that we can proceed to a schedule review in spring.
- The recommendations from the two task forces have been analysed and discussed in a workshop on March 4-5.

Data transmission

The selected baseline for data transmission is "Direct".

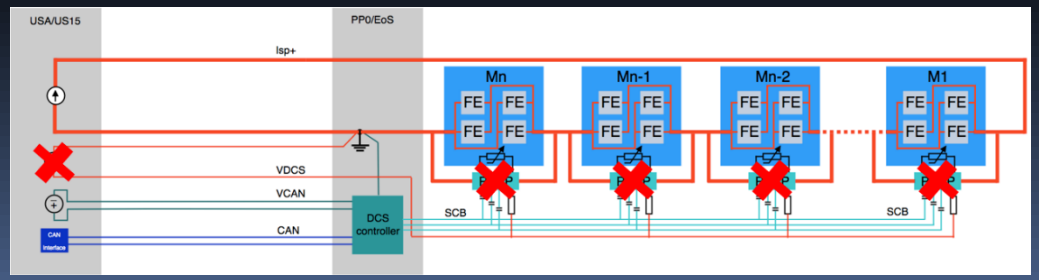
- Twinax cables @ 1.28 Gbps up to ID endplate
- Active equalizer at the receiving side
- Link aggregation using lpGBT and optical conversion with VTRx outside.
- We rely on RD53B compression schema to reduce the number of cables. Up link aggregation is used in layer 1 only. Down link sharing not used in the baseline.



Serial power

The decision is not to use the PSPP chip, because the SLDO in the RD53B chip should provide all the safety factors needed.

- The proposal is to keep the DCS chip at PP0 to perform temperature and voltage drop measurement at each module in the serial power chain.
- At the same time, monitoring based on FE chip measurements will be finalized. The DCS chip monitoring is seen as a redundant tool to improve safety in serial power operation.
- The schedule of the DCS chip is tight, and will be reviewed in the following months.

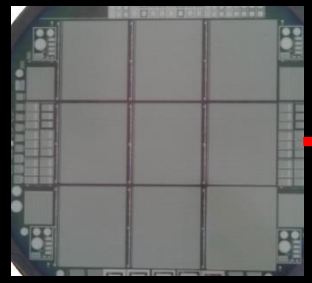


Contents (my proposal)

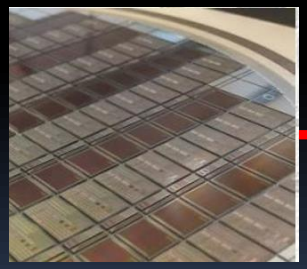
- General recommendations: how we addressed them.
  - Repeat slides from May, anything to add?
- Production model
  - Nomenclature, definition of the different steps

Production steps

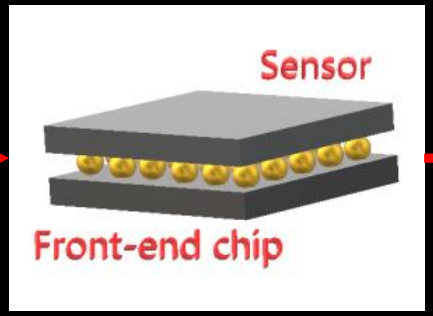
Shown in November, to be expanded with local supports and services prod



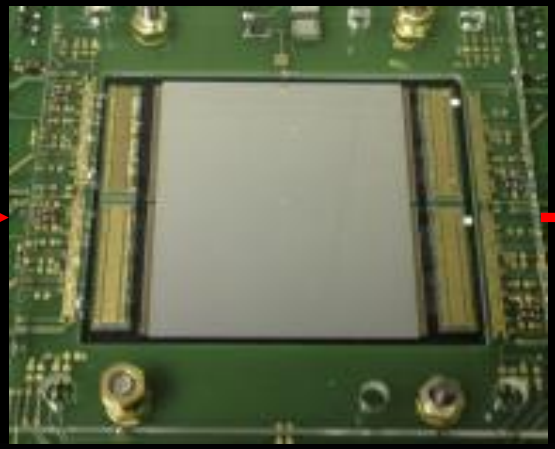
Sensor



FE chip



Bare Module



Assembled Module

Module Loaded on Local Support

Hybridization

Module Assembly

Module Loading

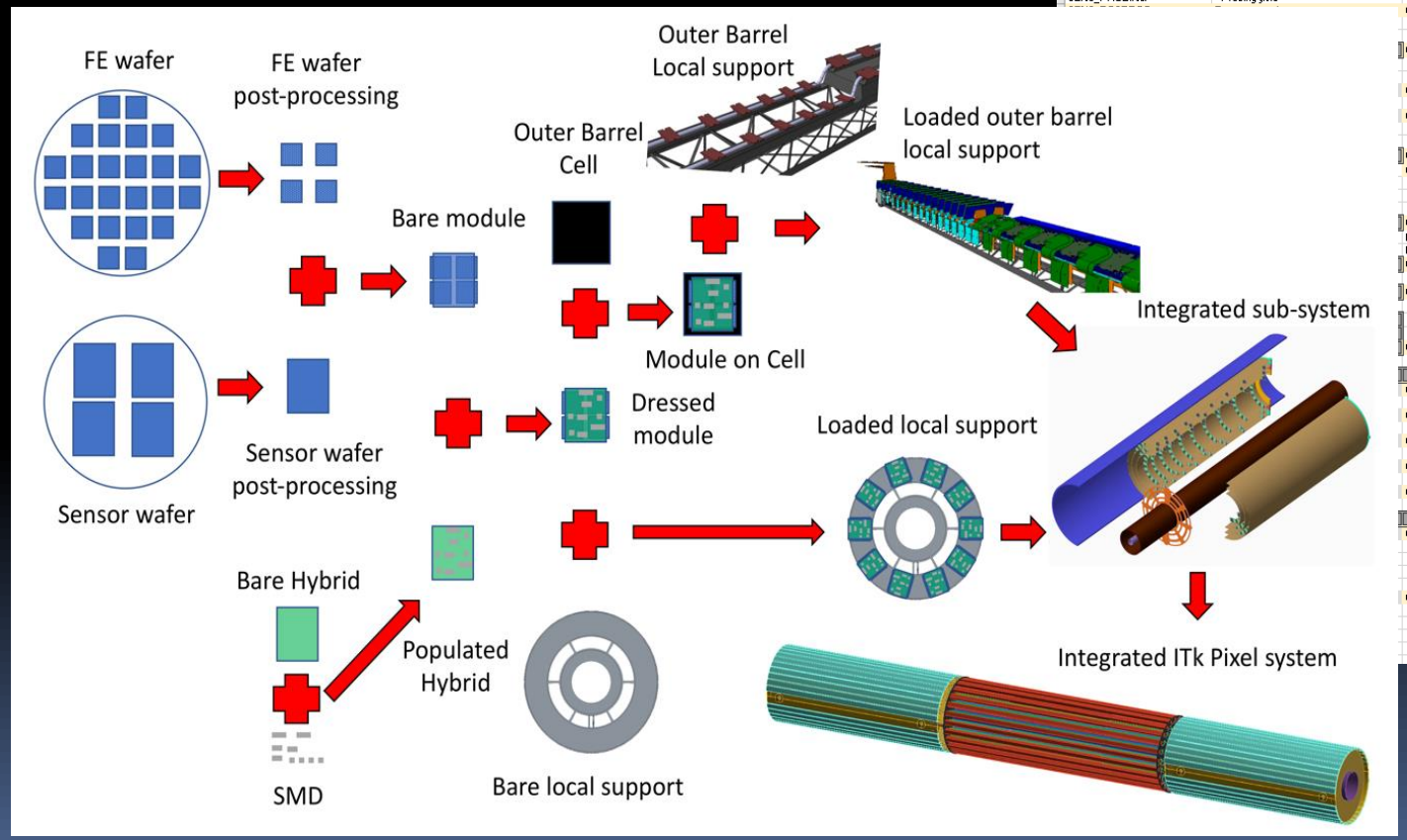
Production model: intro

Shown in November, to be expanded with local supports and services prod

- The production of the Pixel Detector is divided in three main blocks:
  - Module production: the fabrication of the bare module (hybridization) is performed in industry. The assembly of the module and the testing is performed in 10 module production clusters.
  - Module loading: in this phase, the modules are mounted on the local supports and connected to the services distribution. Modules are tested after loading to verify connections and cooling.
  - Detector integration: the loaded local supports (staves or rings) are mounted on the global support structures that are then assembled to form the complete detector. Modules are tested at each stage, and a full test is performed in octant at the end of the integration.

Yield model

- A complete yield model has been developed to take into account losses during the full production cycle.



		PL-100-QUAD	PL-150-DUAL	PL-150-QUAD	PL-150-EC	3D-SINGLE	3D-DUAL	3D-QUAD	GENERIC	
		Planar 100 Qu	lanar 150 Du	lanar 150 Qu	Planar 150 EC	3D Single	3D Dual	3D Quad	Generic	
C-SENS	Sensros	Cumulative sensor yield	0,485	0,542	0,488	0,507	0,301	0,301	0,301	0,493	Sensros
SENS_WAFER	Yield on wafer		0,800	0,800	0,800	0,800	0,500	0,500	0,500		Yield on wafer
C-SENS_USE	Probing	Cumulative sensor use yield	0,607	0,677	0,610	0,634	0,603	0,603	0,603	0,634	Probing
SENS_PROBING	Probing yield		0,999	0,999	0,999	0,999	0,999	0,999	0,999		Probing yield
		Cumulative sensor post'proces	0,931	0,931	0,931	0,931	0,931	0,931	0,931		Post-processing
			0,980	0,980	0,980	0,980	0,980	0,980	0,980		UBM
			0,950	0,950	0,950	0,950	0,950	0,950	0,950		Dicing and thinning
		Cumulative FE yield	0,359	0,401	0,361	0,375	0,356	0,356	0,356	0,375	FE
			0,610	0,610	0,610	0,610	0,610	0,610	0,610		Wafer yield
			0,436	0,436	0,436	0,436	0,436	0,436	0,436		Total pre-prod yield
		Cumulative FE use yield	0,588	0,657	0,592	0,614	0,584	0,584	0,584	0,615	Probing
			0,999	0,999	0,999	0,999	0,999	0,999	0,999		Probing yield
		Cumulative FE post-processing	0,903	0,903	0,903	0,903	0,903	0,903	0,903	0,903	Post-processing
			0,950	0,950	0,950	0,950	0,950	0,950	0,950		Bump deposition
			0,950	0,950	0,950	0,950	0,950	0,950	0,950		Dicing and thinning
		Cumulative flex yield	0,687	0,767	0,691	0,718	0,683	0,683	0,683	0,718	Flex
		Cumulative flex production yield	0,951	0,951	0,951	0,951	0,951	0,951	0,951	0,951	Flex Yield
			0,980	0,980	0,980	0,980	0,980	0,980	0,980		Inspection
			0,980	0,980	0,980	0,980	0,980	0,980	0,980		Loading
			0,990	0,990	0,990	0,990	0,990	0,990	0,990		Testing
		Cumulative local suppot yield	0,863	0,863	0,863	0,863	0,863	0,863	0,863	0,863	Local supports
		Local support use	0,970	0,970	0,970	0,970	0,970	0,970	0,970		Local support use
		Local support fabrication yield	0,890	0,890	0,890	0,890	0,890	0,890	0,890		Local support fabrication yield
		Cumulative PSPP chip yield								0,801	PSPP
										0,850	Wafer yield
		Cumulative DCS chip yield								0,801	DCS chip
										0,850	Wafer yield
										0,950	lpGBT yiel
										0,950	VTRx+ yield
		Cumulative CMOS chip yield								0,565	CMOS chip yield
										0,700	CMOS chip yield
											Module assembly
		Cumulative bare module yield	0,652	0,728	0,656	0,681	0,648	0,648	0,648	0,682	Bare module assembly
			0,950	0,950	0,950	0,950	0,950	0,950	0,950		Flip-chip yield
		Cumulative module assembly	0,687	0,767	0,691	0,717	0,682	0,682	0,682	0,718	Module assembly
			0,950	0,950	0,950	0,950	0,950	0,950	0,950		IV of planar sensor yield
		Cumulative module yield	0,723	0,807	0,727	0,755	0,718	0,718	0,718	0,755	Module Build
			0,995	0,995	0,995	0,995	0,995	0,995	0,995		Flex attach to bare module
		Cumulative module QC yield	0,727	0,811	0,731	0,759	0,722	0,722	0,722	0,759	Module Build
			0,820	0,910	0,820	0,820	0,820	0,820	0,820		Module QC
		Cumulative mod post-prod yield	0,886	0,891	0,891	0,925	0,880	0,880	0,880	0,897	Module distribution
			0,990	0,990	0,990	0,990	0,990	0,990	0,990		Shipping yield
											Module loading/integratio
		Cumulative loading yield	0,895	0,900	0,900	0,935	0,889	0,889	0,889		Loading
			1,000	0,980	0,980	1,000	1,000	1,000	1,000		Loading to cell
			1,000	0,995	0,995	1,000	1,000	1,000	1,000		Cell shipment
			1,000	0,990	0,990	1,000	1,000	1,000	1,000		Flex bending
			0,990	0,990	0,990	0,990	0,990	0,990	0,990		Loding on local support
		Cumulative stavefring yield	0,904	0,942	0,942	0,944	0,898	0,898	0,898		Integration yield
			1,000	0,990	0,990	1,000	1,000	1,000	1,000		Stave thermal QC yield
			1,000	0,990	0,990	1,000	1,000	1,000	1,000		Stave electrical QC yield
			1,000	0,995	0,995	1,000	1,000	1,000	1,000		Shipping yield
			0,904	0,966	0,966	0,944	0,898	0,898	0,898		Integration yield

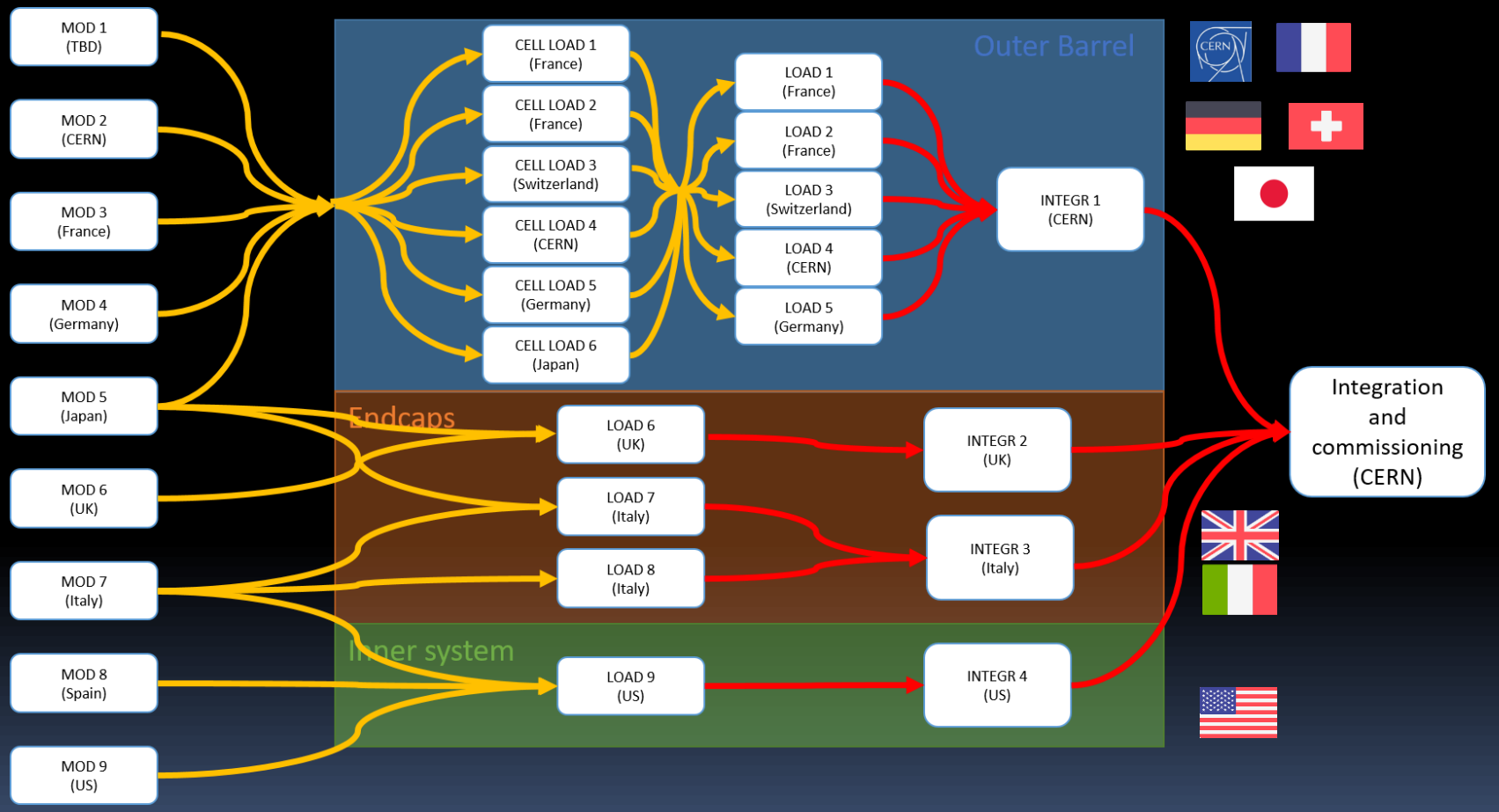
Average cumulative good FE/Sensor yield

60-63%

Production flow

Shown in November, to be updated

- 9 module production and test clusters
  - The inner system requires specialized modules (3D and thin planar).
  - For the rest, the aim is to have as much as possible compatible designs and tools.
- 5 loading centers for the outer barrel (for a total of 8 lines), 3 for the endcaps and 1 for the inner system.
- The inner system is integrated quadrants in US and shipped to CERN.
- The two endcaps will be assembled in UK and Italy, the outer barrel at CERN.



Contents (my proposal)

- General recommendations: how we addressed them.
  - Repeat slides from May, anything to add?
- Production model
  - Nomenclature, definition of the different steps
- Production schedule
  - One slide per item, indicating the duration, the time span, the most important assumptions (like number of vendors or number of assembly lines).
- Short analysis of the critical path.

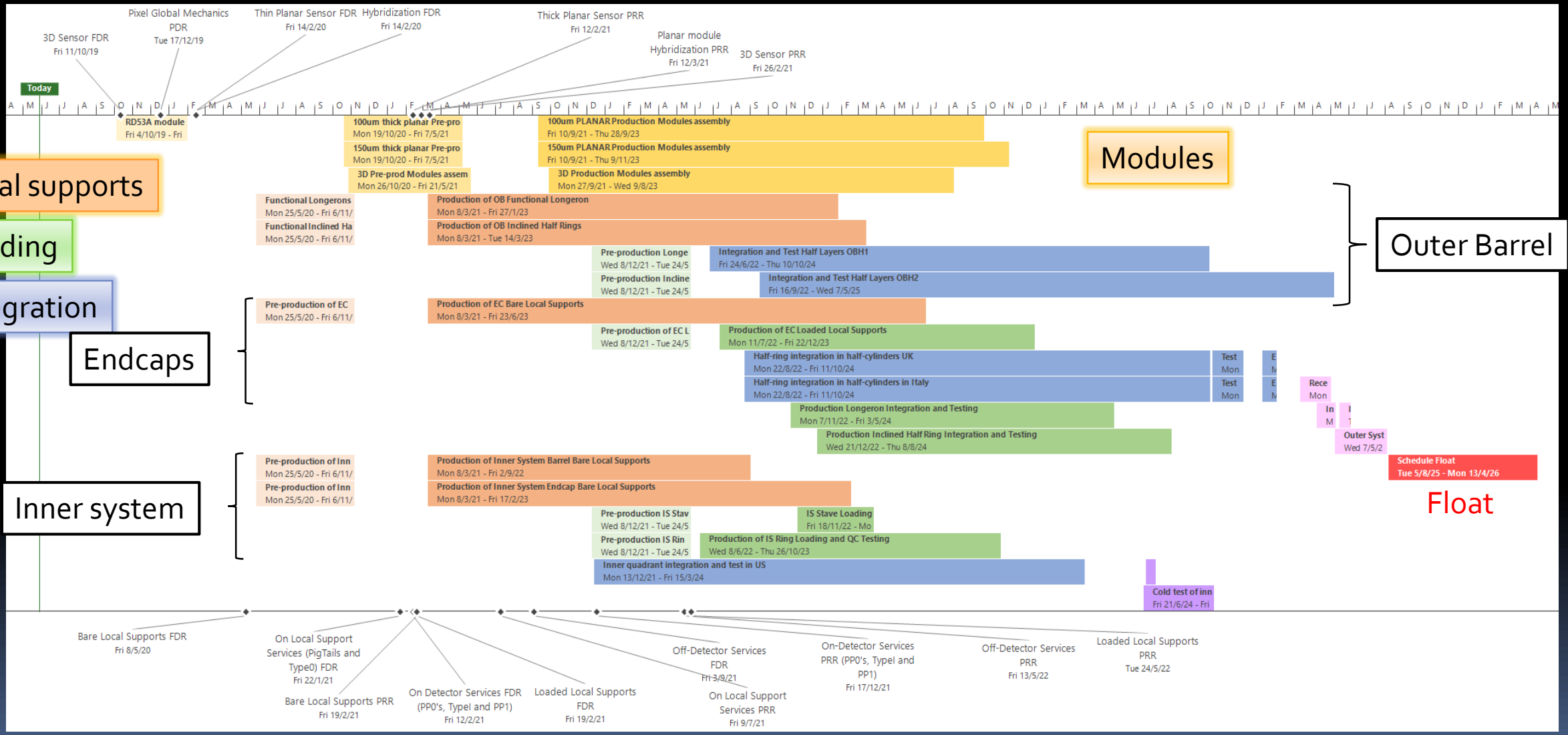
Contents (my proposal) (2)

- Global timeline, delivery date (Pixel ready for insertion -> Aug 25
- Table with important milestones
- Open points still to define and dates (milestones) for the decision
  - 3D sensors design, 25x100 vs 50x50
  - Layer 0 radius

In total I think this could be ~25 slides, too much for 15'. The first part can be reduced and also the production model, especially if we assume that the reviewers are the same as in the previous session.

Pixel timeline

Final, need to remove float?



Most important review dates (updated)

Review	Date	Comments
Modules PDR	Sep 2019	Based on RD53A modules
3D sensors FDR	Oct 2019	At the end of the 3D sensors MS
Services PDR	Oct 2019	Serial power and data transmission with RD53-A chips
Global Mechanics PDR	Dec 2019	
Planar sensors FDR	Feb 2020	When at least 4 vendors are qualified in the Planar sensor MS
Hybridization FDR	Feb 2020	At the end of the Hybridization MS
Modules FDR	Apr 2020	Based on ITkPix-V1 modules
Bare Local supports FDR	May 2020	Review of the mechanical structure.
On-det Services FDR	Feb 2021	
Loaded Local Supports FDR	Feb 2021	Functional LS review. Mechanical structures loaded with functional modules required.
Global Mechanics FDR	Feb 2021	
Sensor PRR	Feb 2021	
Off-det services FDR	Sep 2021	