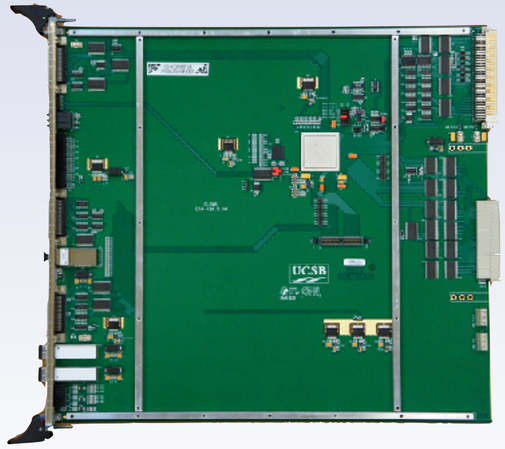
ODMB7 and ODMB5 design and schedule

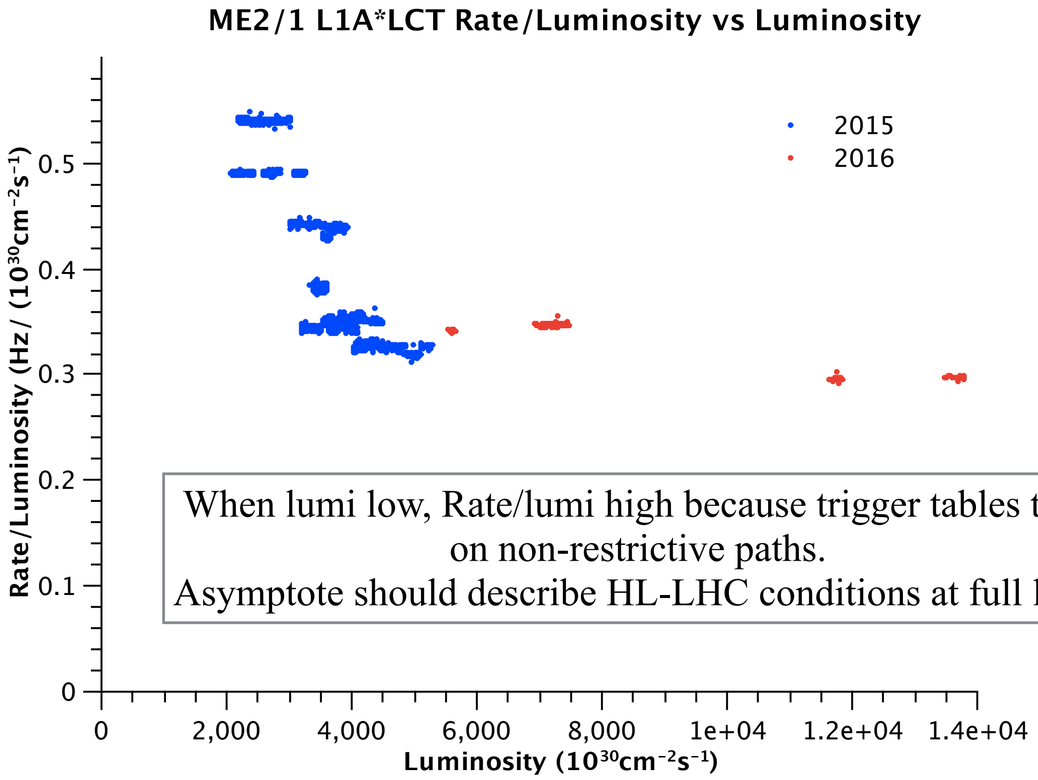


Manuel Franco Sevilla
UC Santa Barbara

10th of April 2018
GEM/CSC upgrade workshop
Texas A&M, College Station

DAQ rates extrapolation to HL-LHC

Rate/lumi seems **constant a high luminosity → quadratic extrapolation**



When lumi low, Rate/lumi high because trigger tables turn on non-restrictive paths.
Asymptote should describe HL-LHC conditions at full lumi

- Baseline is **Stan's quadratic extrapolation**
  - **Linear with L1 rate × linear with luminosity**
- Reality is probably **between linear and quadratic**

$$R_{\mathrm{LCT\times L1A}} \approx R_{\mu_{\mathrm{trig}}} + C_{\mu_{\mathrm{PU}}} \times \mathcal{L} + C_{\mathrm{random}} \times \mathcal{L}$$

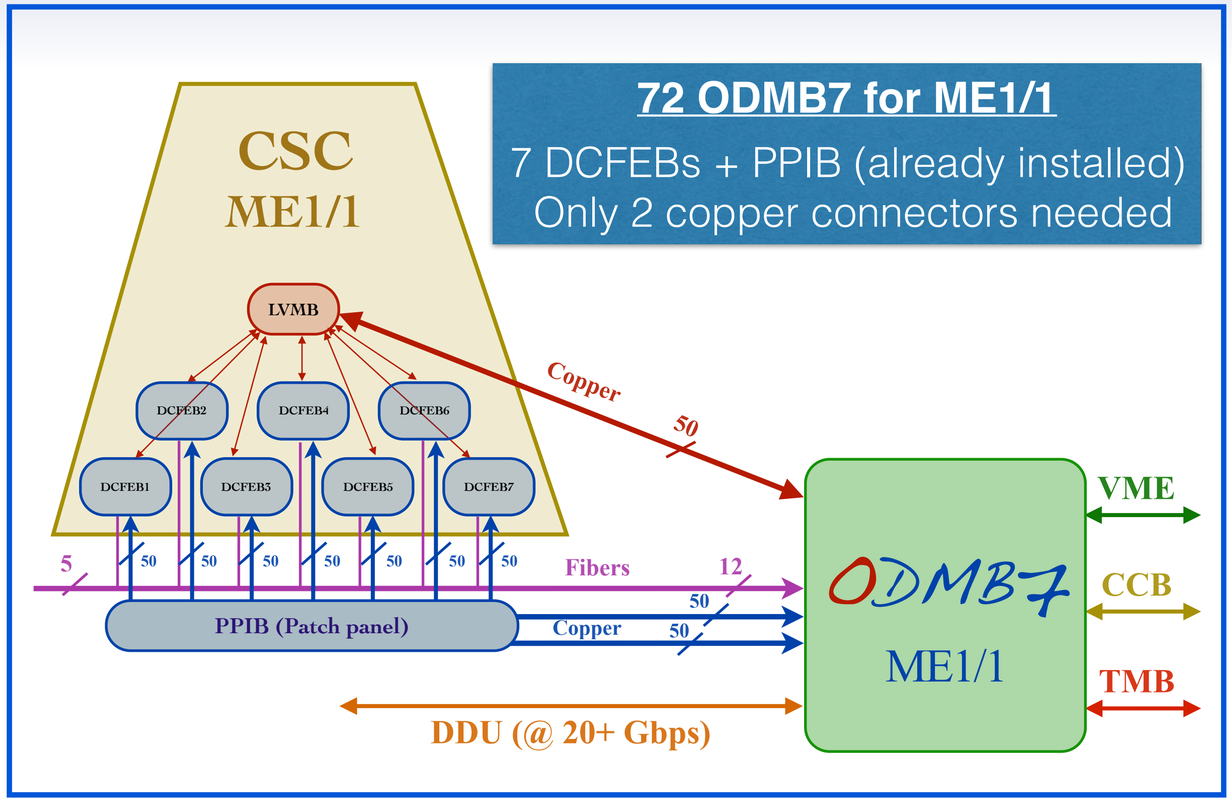
  - $R_{\mu trig}$: rate of triggered muons
  - $C_{\mu PU}$: additional muons coming from PU
  - C_{random}: random hits
- $R_{\mu trig}$ would be constant with luminosity if the fraction of the L1 rate dedicated to muons was constant
- $C_{\mu PU}$ is linear with lumi, but probably small
- **Key is size of $R_{\mu trig}$ vs $C_{random} \times L$**
  - If the former is large, you'd expect rate/lumi to keep decreasing → **current data rates would be overestimated**

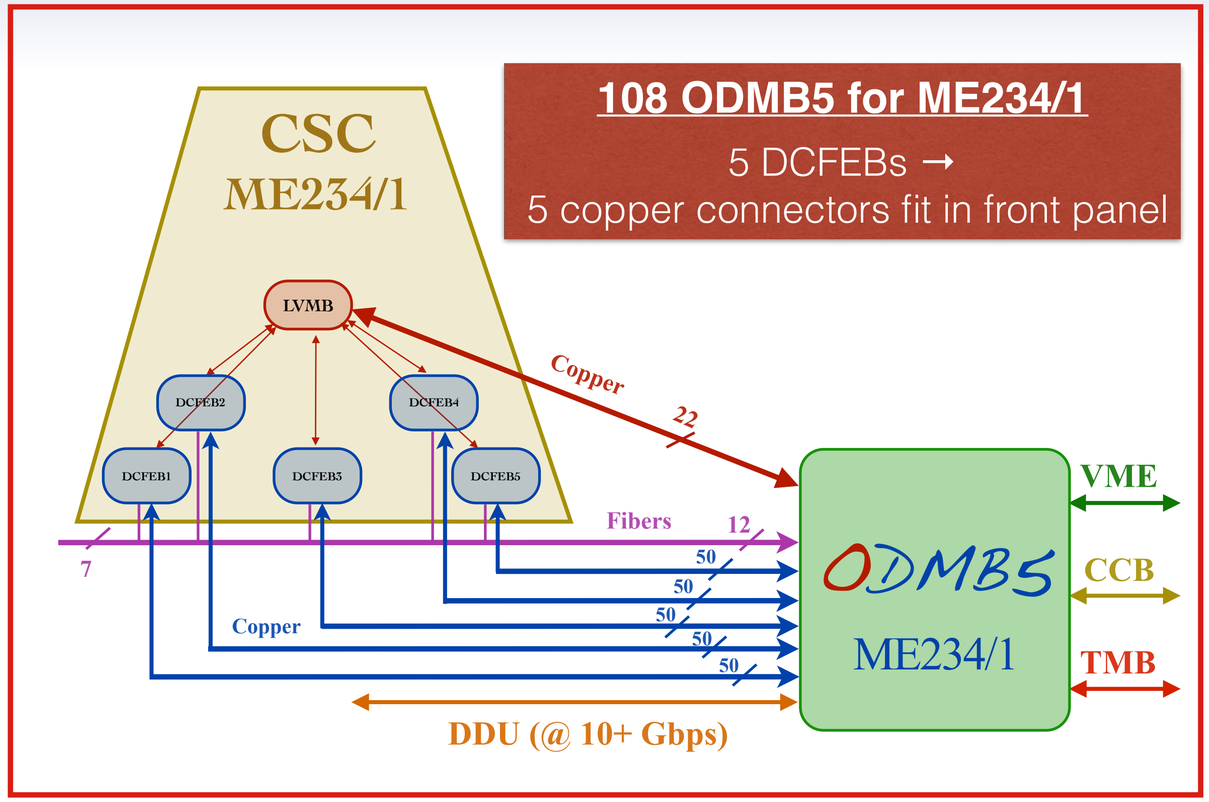
Data rates at the HL-LHC

- **ODMBs/DMBs in ME1234/1 not able to cope** with data rates expected at the HL-LHC

	Linear extrapolation						Quadratic extrapolation					
	$\mathcal{L} = 5 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$			$\mathcal{L} = 7.5 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$			$\mathcal{L} = 5 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$			$\mathcal{L} = 7.5 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$		
Chamber	Rate [Gb/s]	Link [Gb/s]	Util. [%]	Rate [Gb/s]	Link [Gb/s]	Util. [%]	Rate [Gb/s]	Link [Gb/s]	Util. [%]	Rate [Gb/s]	Link [Gb/s]	Util. [%]
ME1/1	0.9	1×1.6	67	1.3	1×1.6	100	4.3	1×1.6	333	9.6	1×1.6	749
ME2/1	0.6	1×1.6	44	0.9	1×1.6	66	2.8	1×1.6	221	6.4	1×1.6	498
ME3/1	0.3	1×1.6	25	0.5	1×1.6	37	1.6	1×1.6	125	3.6	1×1.6	281
ME4/1	0.3	1×1.6	25	0.5	1×1.6	37	1.6	1×1.6	123	3.5	1×1.6	276
ME1/2	0.1	1×1.6	4	0.1	1×1.6	6	0.3	1×1.6	20	0.6	1×1.6	45
ME2/2	0.0	1×1.6	3	0.0	1×1.6	4	0.2	1×1.6	13	0.4	1×1.6	28
ME3/2	0.0	1×1.6	3	0.1	1×1.6	5	0.2	1×1.6	15	0.4	1×1.6	35
ME4/2	0.1	1×1.6	6	0.1	1×1.6	9	0.4	1×1.6	31	0.9	1×1.6	70
ME1/3	0.0	1×1.6	0	0.0	1×1.6	1	0.0	1×1.6	2	0.1	1×1.6	5
	Aggressive, probable underestimation						**Conservative, in TDR**					

Two board designs: ODMB7 - ODMB5





- **Two** very similar **designs with main difference in front panel**

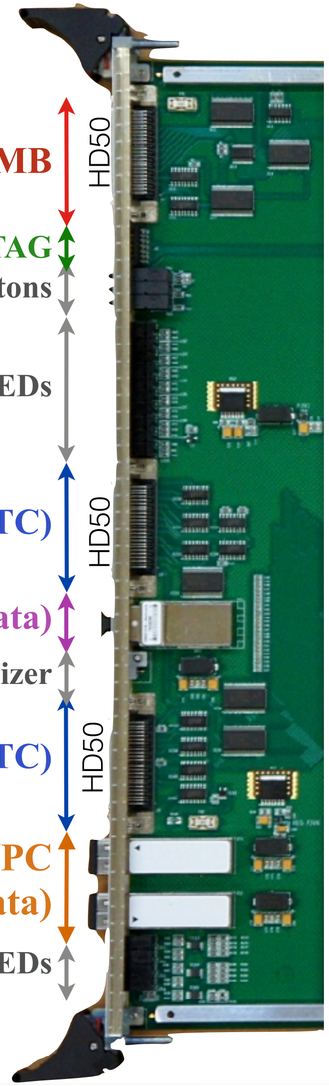
Notation

	ME1/1	ME234/1	Outer rings
Pre-LS1	DMB	DMB	DMB
LS1-LS3	ODMB	DMB	DMB
Post-LS3	ODMB7	ODMB5	DMB

ODMB

Key design changes

ODMB7



- **New ODMB7/5 largely based on LS1 ODMB**
  - ➡ Similar PCB, with very different front panels
- **New FPGA** with higher speed links (next slide)
  - ➡ Or just to reduce cost if using lpGBT
- **10 Gbps transmitter** to FED (4 TX, 1 RX)
  - ➡ VL+ (new VTTx) if compatible with schedule
- **12 RX Firefly** to replace Reflex photonics Snap-12

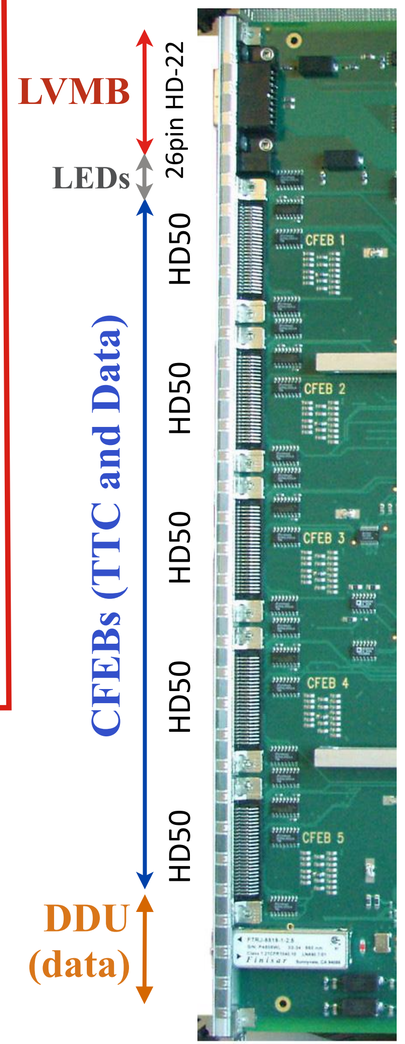
ODMB7 in ME1/1

- Front panel similar to the ODMB's
- Ability to relay FW to ALCT/DCFEB for remote programming

ODMB5 in ME234/1

- Front panel similar to the DMB's

ODMB5



FPGA choice

- Budgeted same cost as ODMB from LS1 (with a $822 FPGA)
  - Other components might increase price (faster transceiver, repeater for remote programming)
  - **Need an FPGA under $700**
- Two options
  - **Artix-7 limits links to 6.4 Gb/s**
  - **PolarFire requires learning new system**

	Used in current ODMB	Virtex-6 XC6VLX130T 1FFG1156C	Artix-7 XC7A200T 2FFG1156C	PolarFire MPF300TS FCG1152
Logic elements	52k	128k	215k	300k
Total RAM	3 Mb	9.5 Mb	13 Mb	20.6 Mb
Clock managers	2	10	10	8
I/O pins	300	600	500	512
Opt. transceivers	8	20 @ 5 Gb/s	16 @ 6.6 Gb/s	16 @ 12.5 Gb/s
Price		$1054	$294	$391

- **Evaldas idea**
  - If lpGBT compatible with schedule, **use cheaper Artix-7 + lpGBT for 10 Gb/s links**

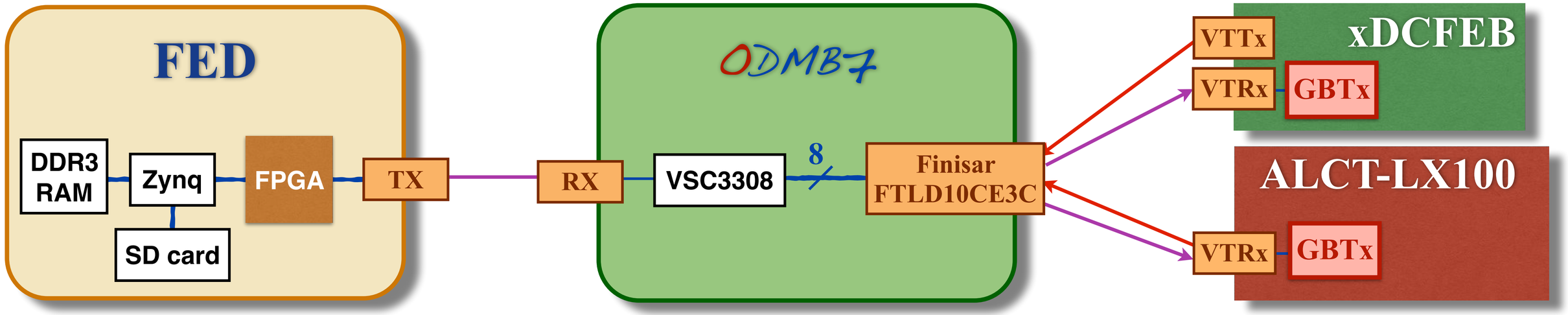
Bandwidth utilization

- TDR written for design 5e34 (PU140), but **need to design for ultimate 7.5e34 (PU200)**
  - Utilizations up to 50% if 6.4 Gb/s links and 900 fibers
  - **Optimal solution is 10 Gb/s links and 900 fibers**

	6.4 Gb/s links 900 fibers			**10 Gb/s links** 720 fibers			**10 Gb/s links** 900 fibers		
Chamber	Rate [Gb/s]	Link [Gb/s]	Util. [%]	Rate [Gb/s]	Link [Gb/s]	Util. [%]	Rate [Gb/s]	Link [Gb/s]	Util. [%]
ME1/1	9.6	4×6.4	47	9.6	3×10	40	9.6	4×10	30
ME2/1	6.4	3×6.4	42	6.4	2×10	40	6.4	3×10	27
ME3/1	3.6	2×6.4	35	3.6	1×10	45	3.6	2×10	22
ME4/1	3.5	2×6.4	35	3.5	1×10	44	3.5	2×10	22
ME1/2	0.6	1×1.6	45	0.6	1×1.6	45	0.6	1×1.6	45
ME2/2	0.4	1×1.6	28	0.4	1×1.6	28	0.4	1×1.6	28
ME3/2	0.4	1×1.6	35	0.4	1×1.6	35	0.4	1×1.6	35
ME4/2	0.9	1×1.6	70	0.9	1×1.6	70	0.9	1×1.6	70
ME1/3	0.1	1×1.6	5	0.1	1×1.6	5	0.1	1×1.6	5

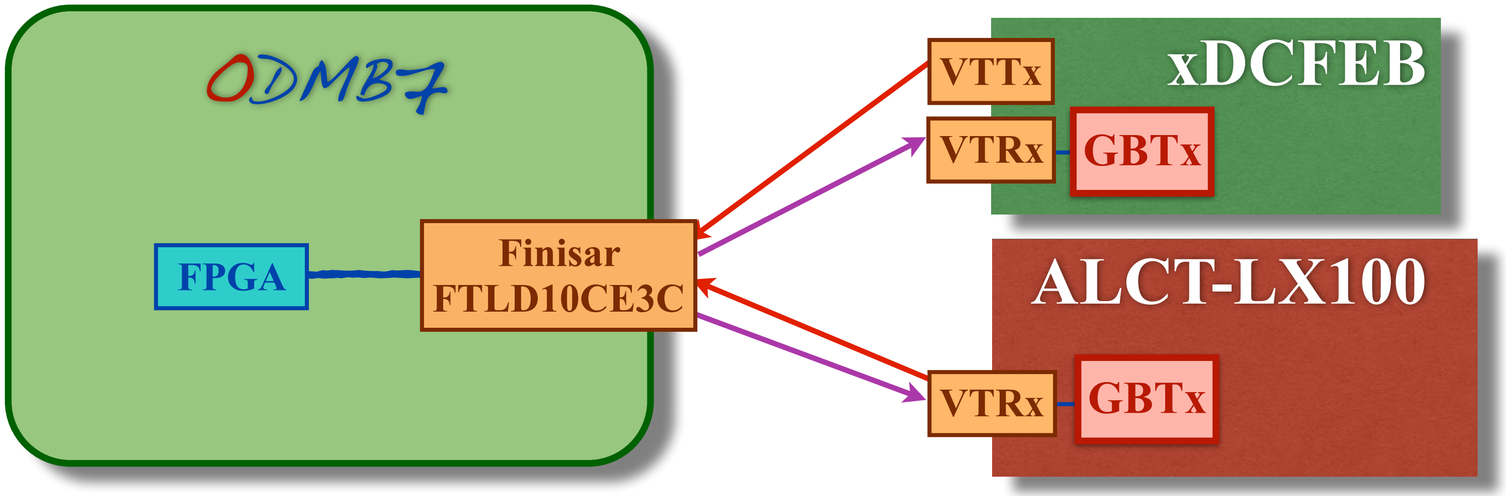
For ME4/2, we need shielding and data reduction

Remote programming of ALCT/DCFEB



- Additional requirement for ODMB7 is remote programming of ALCT/DCFEBs
- FED would send FW to the ODMB7, which would fan it out to the ALCT/DCFEBs
  - ➡ Needs to avoid FPGA in ODMB → use VSC3308 repeater or similar

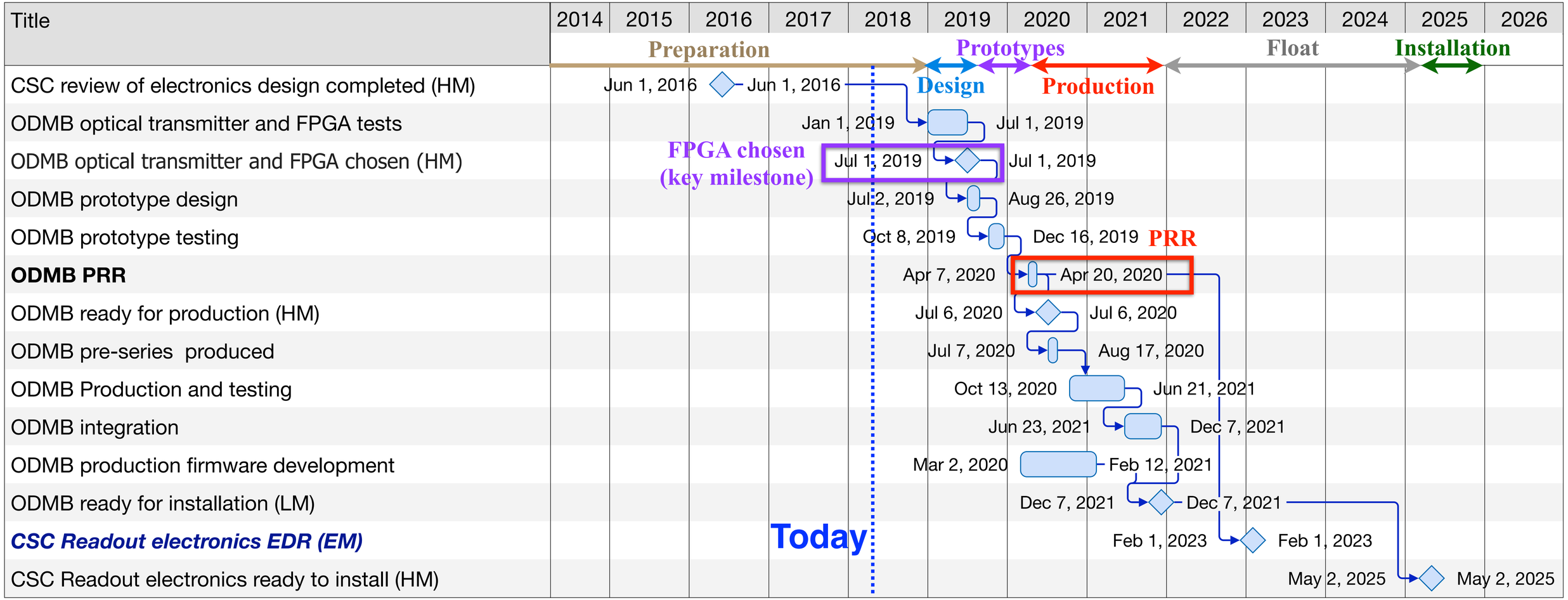
Option: FW from ODMB7



- Pros
  - Allows to upload different firmware to individual chambers
  - A bit cheaper
- Cons
  - Longer boot-up time (perhaps still in the shadow of other boards)

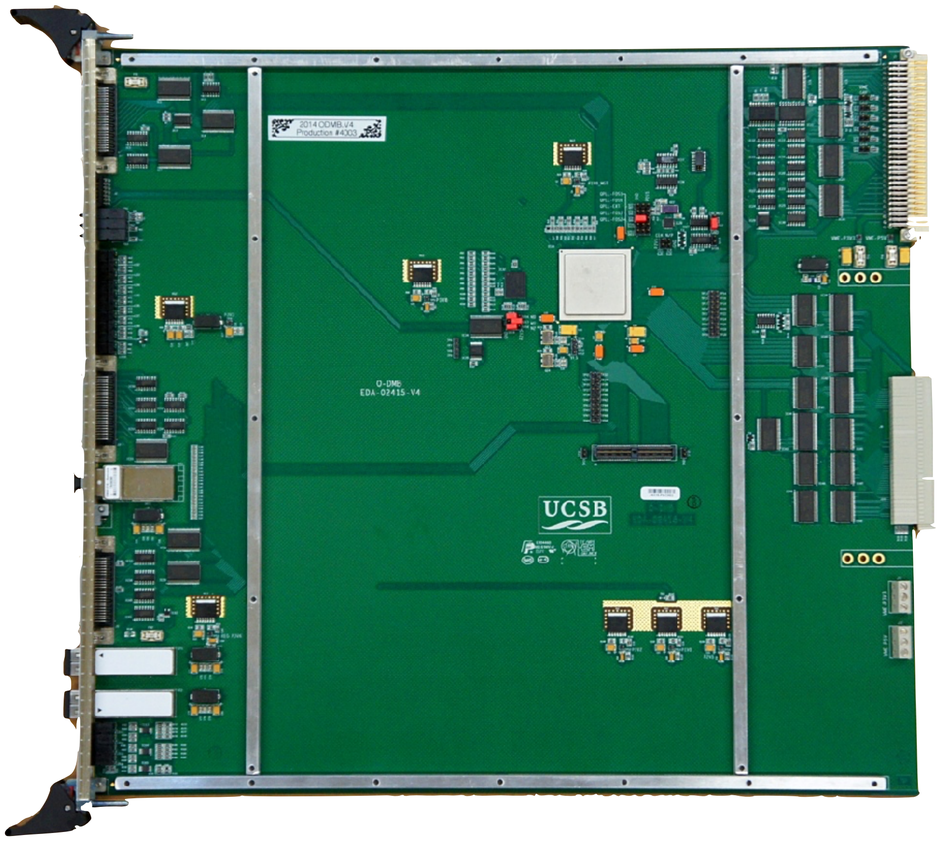
Schedule

- Early schedule driven by engineering resource optimization



Summary

- New ODMB7 and ODMB5 **similar to** ODMB **from LS1 upgrade**
- Key design changes
  - **New FPGA** with higher speed links
    - Or just to reduce cost if using lpGBT
  - **10 Gbps transmitter** to FED (4 TX, 1 RX)
    - VL+ (new VTTx) if compatible with schedule
  - **12 RX Firefly** to replace Reflex photonics Snap-12
- Key question is **FPGA choice**
  - Also, should ALCT/DCFEBs be **programmed from ODMB?**
- **Early schedule**
  - Need to choose FPGA by July 2019
  - Prototypes validated by July 2020 for PRR
  - Production in 2020-21
  - Installation in 2025



Backup