AncASIC and EIC-LAS: Power Estimates
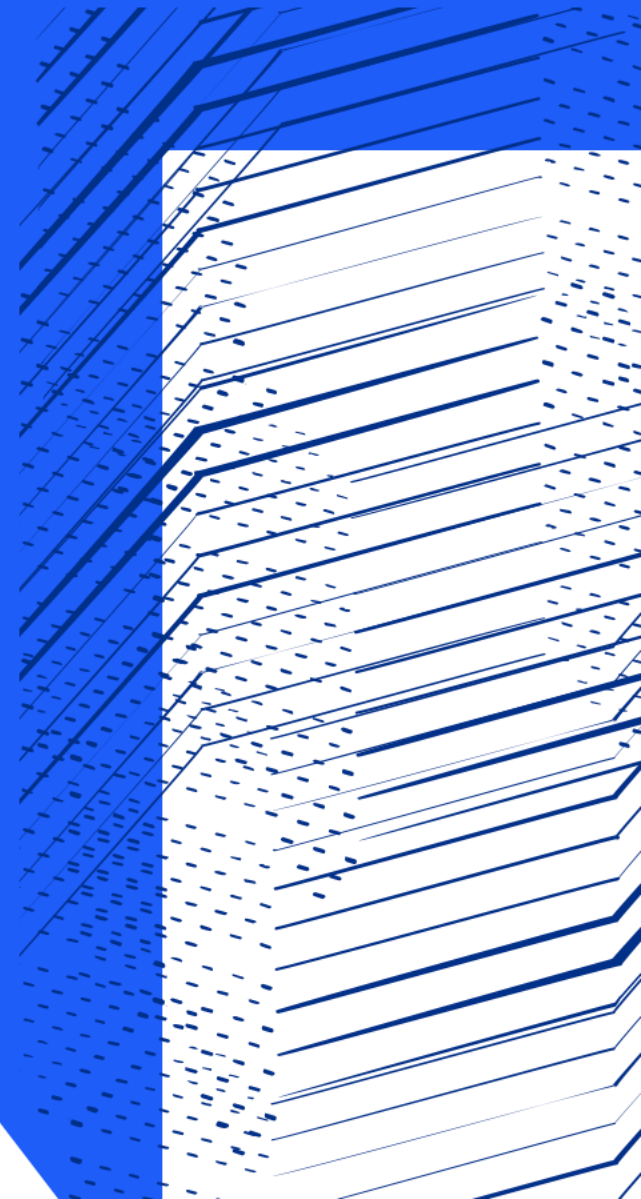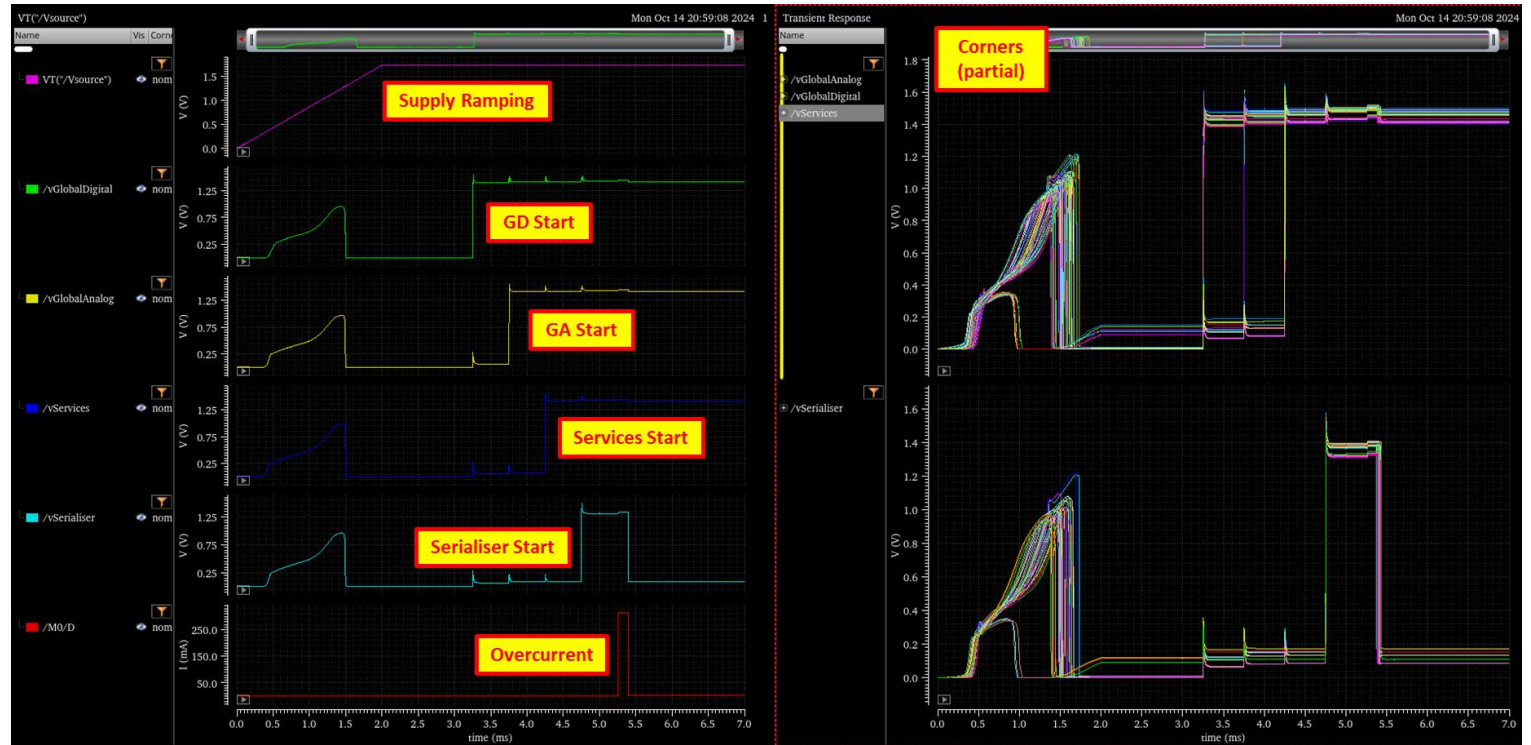
Introduction

EIC-LAS Power Consumption

- MOSAIX Power Consumption
- LAS Power Consumption

AncASIC Power Consumption

- Towards Increased Realism
- AncASIC Performance
- Caveats

Latest MOSAIX Estimates

- Towards Increased Realism
- AncASIC Performance
- Caveats

N.B. This is a stripped down version of a presentation shown several times before. Here for example.

MOSAIX Power Consumption

- Current consumption numbers for MOSAIX were updated in the engineering review.

- What does this mean for EIC-LAS and the Ancillary ASIC

Current consumption estimates

Full chip consumption estimates [mA]:

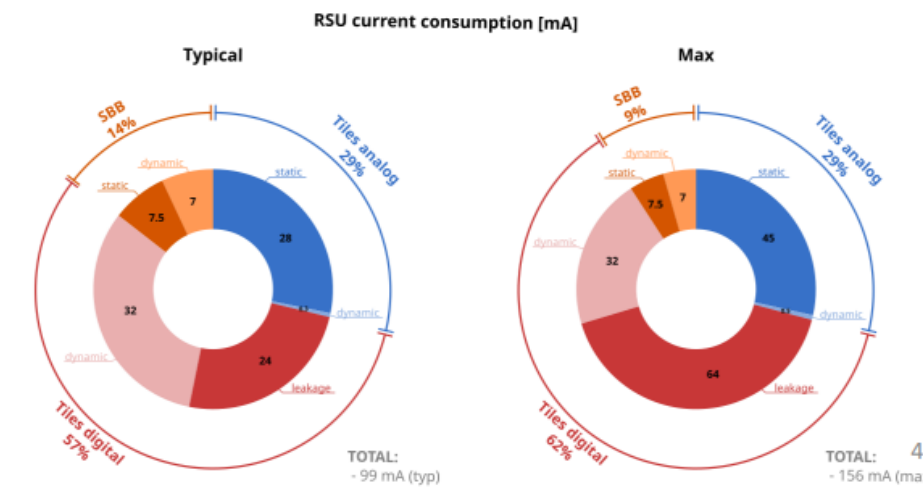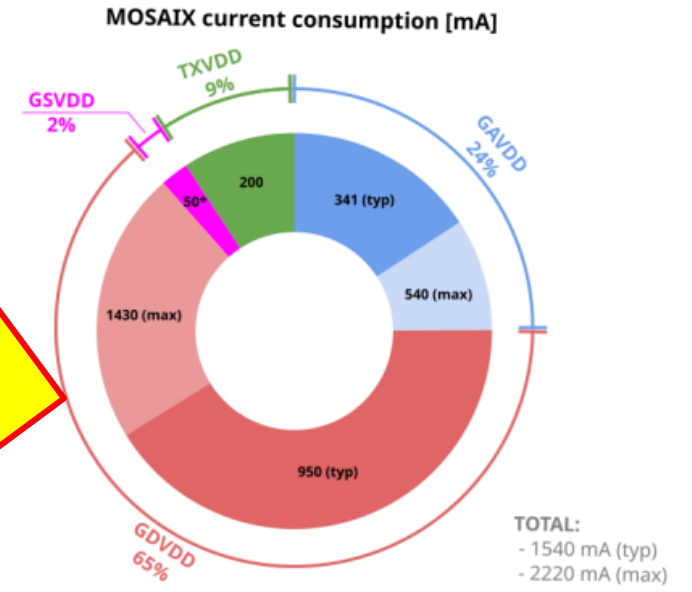| Supply	Typical	Max supported
GSVDD	50*	
GDVDD	950	1430
GAVDD	340	540
TXVDD	200	

- LEC contributiuon:
  - TXVDD: 200mA
  - GSVDD: ~30mA
  - GDVDD: ~100mA

- All the rest uniformly distributed over RSU`s

RSU consumption:

- **GDVDD:**
  - About 70% of the RSU consumption
  - Significant uncertainty due to unknown leakage component
    - temperature
    - process corner
    - irradiation

- **GAVDD:**
  - About 30% of the RSU consumption
  - Varriers with the FE settings
    - typical: 30nA/pixel
    - max: 50nA/pixel

- **GSVDD:**
  - Present, but negligible

MOSAIX

RSU

> MOSAIX currently updating power numbers...

MOSAIX current consumption [mA]

GSVDD 2%
TXVDD 9%
GAVDD 24%
GDVDD 65%

50*
200
341 (typ)
540 (max)
1430 (max)
950 (typ)

TOTAL:
- 1540 mA (typ)
- 2220 mA (max)

RSU current consumption [mA]

Typical

SBB 14%
Tiles analog 29%
Tiles digital 57%

dynamic
static
static
dynamic
dynamic
leakage

7.5
7
28
32
24

TOTAL:
- 99 mA (typ)

Max

SBB 9%
Tiles analog 29%
Tiles digital 62%

dynamic
static
static
dynamic
dynamic
leakage

7.5
7
45
32
64

TOTAL:
- 156 mA (max)

4

LAS Current and Power Consumption

Converting to EIC-LAS

- Assume 6 RSU LAS
- Numbers in red do not have "Max" estimates in the previous slide, so assumed +50% on typ number (since this is true for supplies that do have it)
- EIC-LAS is one LEC and 6 RSU
- To calculate power for a LAS with Length L RSUs, use the formula below for each of the 4 supplies and add the results
    - $P_{LAS} = V(I_{RSU} * L + I_{LEC})$
- To include the AncASIC power, use the power fractions (f_{POWER}) on this slide
    - $P_{ANCASIC} = f_{POWER} * P_{LAS}$

	Voltage(V)	Typ Current Consumption (mA)			Max Current Consumption (mA)		
		RSU	LEC	EIC-LAS	RSU	LEC	EIC-LAS
GAVDD	1.32	28		168	45		270
GDVDD	1.32	71	100	526	111	150	816
GSVDD	1.32	1.6	30	40	2.4	45	59.4
TXVDD	1.2		200	200		300	300
Total				934			1445

AncASIC Power Consumption
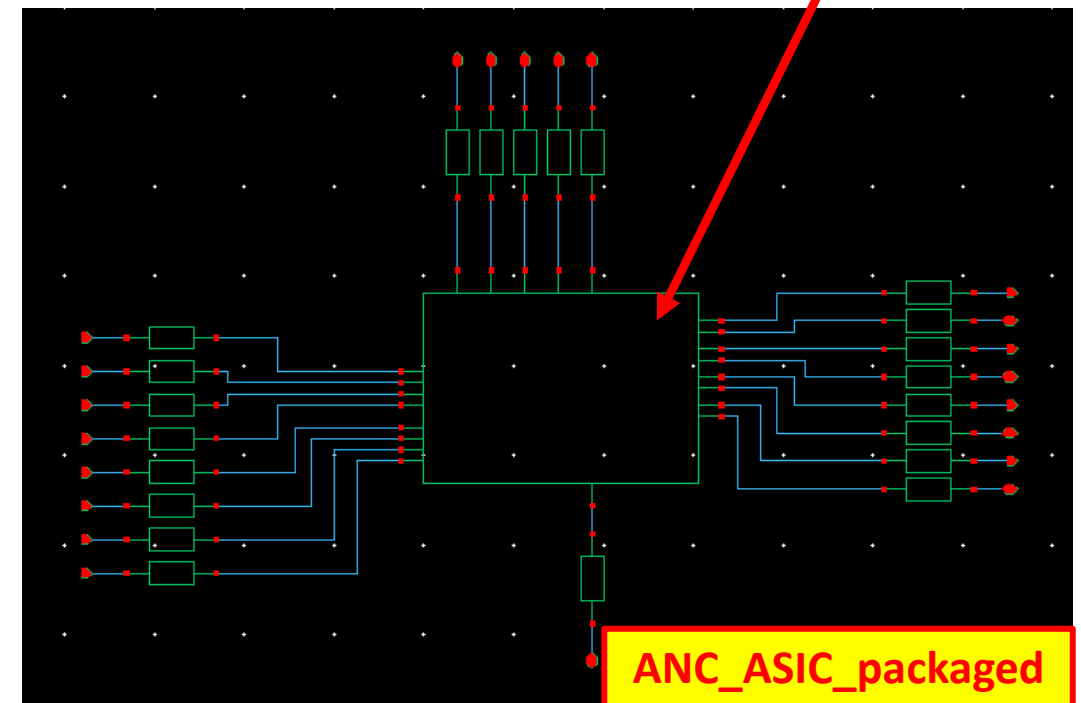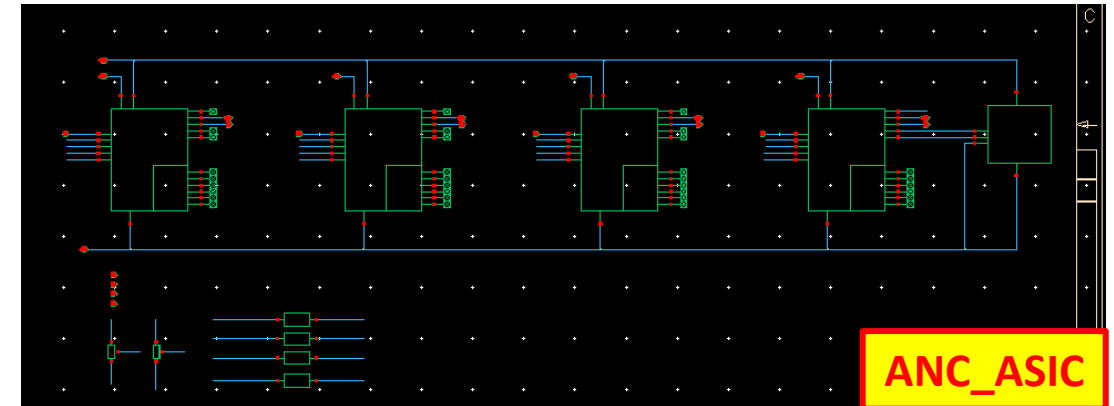
Towards Increased Realism

Build an "AncASIC"

- 4x SLDO plus OVP
- No NVG, slow control, AncASIC SLDO

AncASIC Packaging

- Determine number of pads per supply based on EM limits
- Assume Max condition and 20% shunt overhead
- Iout must equal Iin to cover case where all current is shunted
- **N.B. These are only the supply pads**. Does not includes controls, NVG, Slow Control etc.

Supply	Current (mA)	Pads Required
Iin/Iout	1734	15/15
GAVDD	270	3
GDVDD	816	7
Services	59.4	1
Serialiser	300	3

ANC_ASIC

ANC_ASIC_packaged

Towards Increased Realism

FPC Trace Resistance

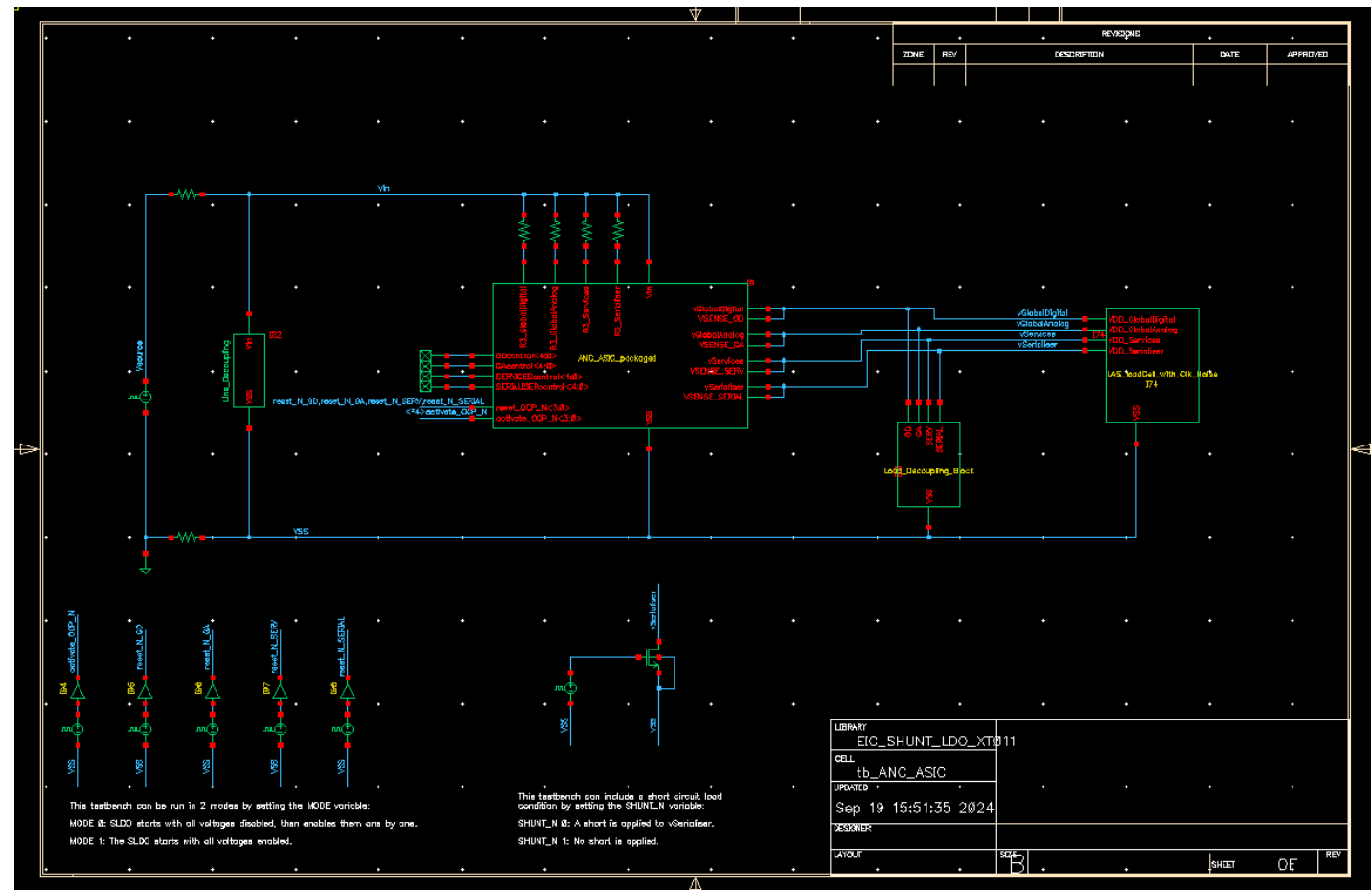- Using input and output trace resistance provided by Marcello – 94.6mOhm

MOSAIX Loads

- Unknown, so using:
  - capSerialiser – 10nF
  - capServices – 100nF
  - capGlobalAnalog – 1uF
  - capGlobalDigital – 10uF

R3 Values

- Ideal (no tolerance or E series)
- Tolerance and non-ideal value will reduce power efficiency

Decoupling

- 10uF Line Decoupling
- 100nf Load Decoupling

AncASIC Performance
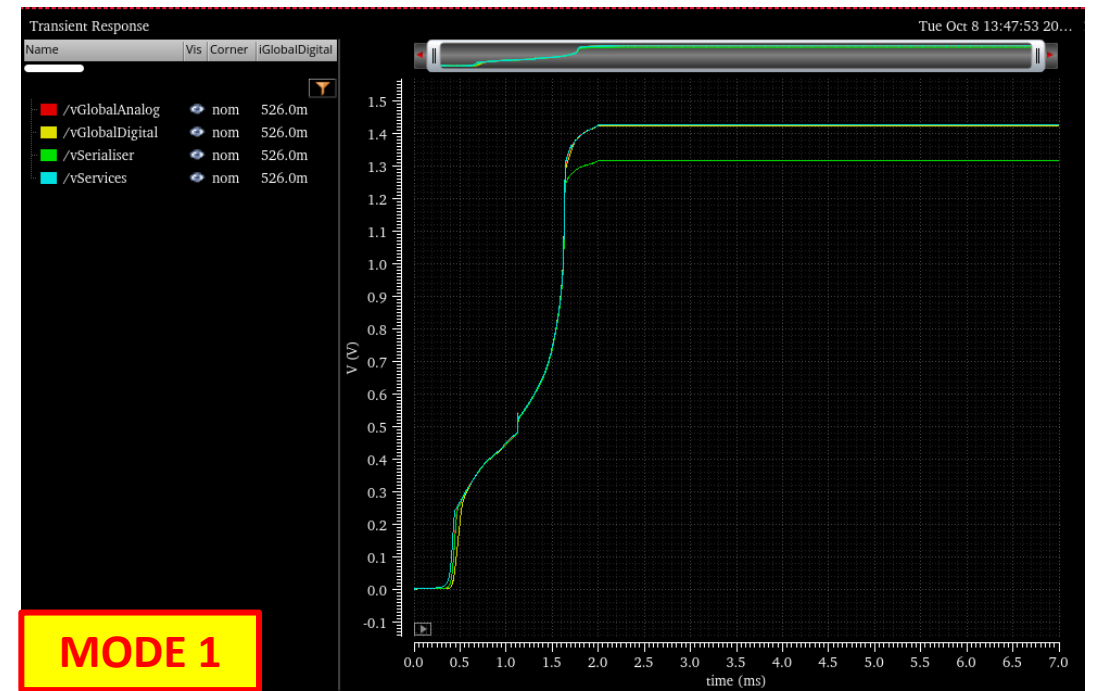
Boundary Conditions

- 3 Conditions
    - 6 RSU LAS – Expected
    - 6 RSU LAS – Max
    - MOSAIX (12 RSU) – Expected

- 2 Modes
    - MODE 0: SLDOs disabled at startup and turned on individually
    - MODE 1: SLDOs enabled at start-up

- +10% shunt overhead based on https://cds.cern.ch/record/2292628/files/CR2017_385.pdf

MODE 1

MODE 0

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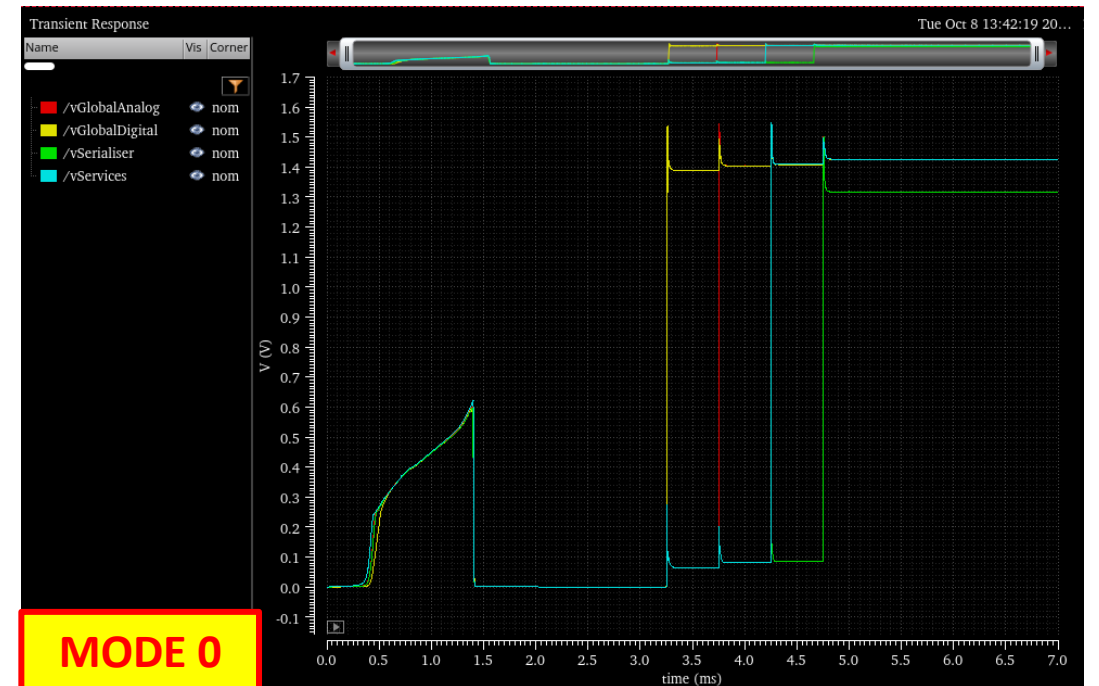
AncASIC Performance

Overall Power Consumption

EIC-LAS, AncASIC and Total Power (mW)	MODE 0										
	Typ				Max				Total		
	EIC-LAS	AncASIC			EIC-LAS	AncASIC			Min	Nom	Max
		Min	Nom	Max		Min	Nom	Max			
Global Digital	701	131	210	238	1088	193	341	394	832	911	1482
Global Analog	224	61	71	83	360	88	111	147	285	295	507
Services	53	28	32	44	80	18	41	66	81	85	146
Serialiser	246	47	115	128	369	37	172	246	293	361	615
Total	1224	267	428	493	1897	336	665	853	1491	1652	2750
AncASIC Power Fraction		21.81%	34.97%	40.28%		17.71%	35.06%	44.97%			

N.B. FPC traces add another 200mW

Prev values: 1702   2581

AncASIC Performance

AncASIC Power Variation in Corners
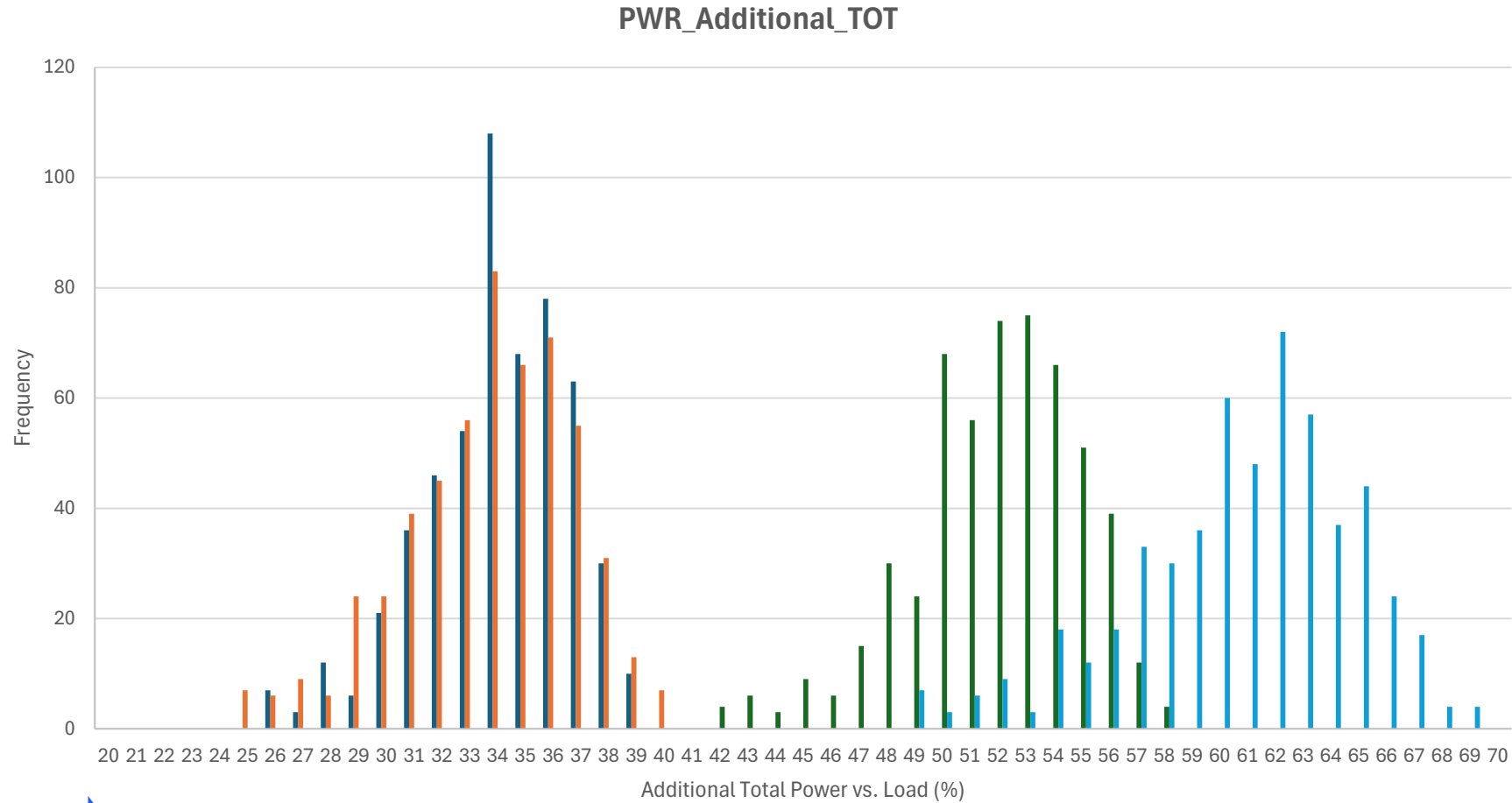
AncASIC Power Fraction

PWR_Additional_SHUNT
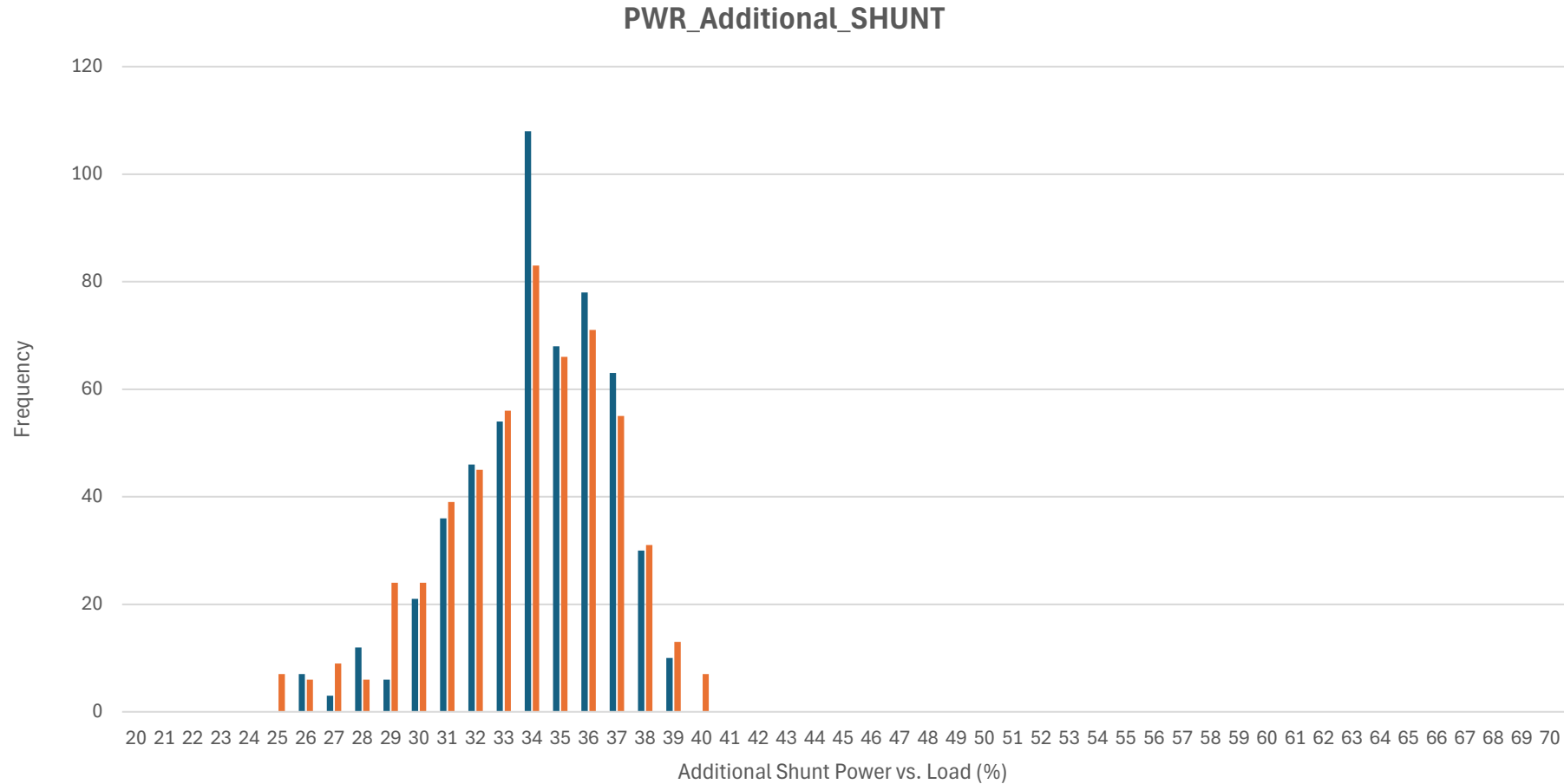
- Graph shows power consumed by the AncASIC as a fraction of LAS power over the corners

- Typ and Max cases for LAS shown

- No major variation since presented as a percentage

AncASIC Performance

Total Power Variation in Corners

PWR_Additional_TOT

Legend:
- Typ - Mode 0 Shunt
- Max - Mode 0 Shunt
- Typ - Mode 0 Tot
- Max - Mode 0 Tot

X-axis: Additional Total Power vs. Load (%)
Y-axis: Frequency

FPC Consumption

- FPC traces consume considerable power

- Increase from ~35% to 50-60% of LAS

- Due to >1A through 200mohm

- Varies with Typ and Max corner due to current increase

- Cooling problem or not? To be included in model?

Power Caveats…

Caveats to the numbers

- Best estimate from MOSAIX. Not a warranty.
- Possibility that LEC value will rise (additional functions)
- For GAVDD, it is likely that EIC-LAS will be in the Max case, since we want the fastest frontend speed
- We may be able to reduce TXVDD consumption if we don't need all the transmitters (or can run slower)
- Need to add consumption of non-SLDO AncASIC
- Mis-match in GAVDD, GDVDD consumption may require different input voltages (waste of power in serial powering chain)
- Irradiation

Future Updates

- May be future releases from MOSAIX
  Yes! See following slides
- ~~AncASIC will need to be updated once porting to XT011 is completed~~
- Test results from ER2

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Latest MOSAIX Estimates

Evolving Design

- As the design evolves and simulations become more precise, numbers change.
- Long story short, this means a rise in GDVDD

Current [mA] / RSU							
	DC		Dynamic	Leakage		Total	
	Nominal	Max		Expected	Max	Expected	Max
Analogue pixels	25	42				25	42
Digital pixels			0.2	10 **7**	27 **21**	10 **7**	27 **21**
Digital columns			2.3	13 **3**	35 **10**	15 **6**	37 **12**
Biasing and monitoring	3.6	3.6				3.6	3.6
Readout peripheries			30 **72**	1.1	2.8	31 **73**	33 **74**
Data backbone	9 **1**	9 **1**	4 **11**			13 **12**	13 **12**
RSU Total	38	54	37	24	64	98	154
- GDVDD	0	0	37	24	65	56 **98**	96 **120**
- GAVDD	28.6	45.6				28.6	45.6

Latest MOSAIX Estimates

Integration in AncASIC Sims and LAS Estimates

- No time to do this before Frascati
- Simple estimates added below based on previous slides

	Voltage(V)	Typ Current Consumption (mA)			Max Current Consumption (mA)		
		RSU	LEC	EIC-LAS	RSU	LEC	EIC-LAS
GAVDD	1.32	28		168	45		270
GDVDD	1.32	~~71~~ 98	100	~~526~~ 688	~~111~~ 120	150	~~816~~ 870
GSVDD	1.32	1.6	30	40	2.4	45	59.4
TXVDD	1.2		200	200		300	300
Total				~~934~~ 1096			~~1445~~ 1499

1422 mW (+16%)

AncASIC (+35%): 1919 mW (+16%)

1943 mW (+2%)

AncASIC (+45%): 2817 mW (+2%)

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Very Preliminary!!!

Questions?

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