Capital expenditure general goals

- Support broader OSC mission and goals
- Leverage previous capital investments
  - Power/cooling
  - User facing, and infrastructure systems
- Operational improvements
  - Replace older/legacy hardware
  - Increase operational resiliency
  - Decrease operational costs

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Capital budget totals

- Re-appropriated: $1,303,139
- FY17/18: $6,000,000
- What was supposed to be done in FY15/16?
  - Cluster (mostly complete, missing accelerators)
  - Storage (complete except IME deployment)
  - Facilities (complete)
  - Software (anything missing?)
- What was proposed for FY17/18?
  - Complete facilities upgrades ($0.7M)
  - Compute and storage expansions ($4.55M)
  - Next generation "early adopter" system ($0.75M)

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New HPC Systems, or Expansions

- 160 NVIDIA P100 GPUs, ~750 TF peak

- 160 Intel KNL servers, ~425 TF peak

- 320 additional Broadwell based Owens compute nodes, ~300 TF peak

- Double project storage size with 'slow tier' storage

- Next generation "early adopter", details TBD
  - Tighter integration between network, and CPU
  - Non-volatile memory
  - Possibly heterogeneous architectures

- Replace old infrastructure hardware

Spending Breakdown Detail

New Systems	Estimated cost	When (FY)	Difficulty (OSC)	Ease of user adoption
Add OmniPath (OPA) network	$20,000	Q1/17	B	N/A
Pascal based GPUs to Owens	$900,000	Q1/17	A	B
Add KNL systems, OPA integration with storage	$960,000	Q2/17	C/D	C
Tape media	$80,000	Q2/17	A	N/A
SSD for low latency infrastructure I/O	$100,000	Q2/17	B	N/A
Compute node expanstion for Owens	$2,400,000	Q3/17	A	A
Replace LTO4 tape drives, and long term maintenance	$200,000	Q3/17	A	N/A
Replace IBM, and NetApp infrastructure storage	$100,000	Q3/17	B	N/A
UFM servers to replace re-purposed Oakley compute nodes	$10,000	Q3/17	A	N/A
SOCC workroom, phone, and network improvements	$10,000	Q3/17	B	N/A
Project file system expansion	$500,000	Q4/17	B	A
Servers and storage for TSM disk pools	$300,000	Q4/17	B/C	N/A
Fibre-channel switches for tape library	$20,000	Q1/18	A	N/A
Firewall/IDS	$300,000	Q1/18	D	N/A
Next generation "early adopter" system	$700,000	Q3/18	D	D
Total	$6,600,000			
Total capital balance	$7,300,000			
Contingencies include the possible need to expand user home directory storage, IME expansion, various software packages, and consultant fees (HIPAA, USDB/IDM, etc)				
Difficulty is a relative scale, "A" being the easiest.				

Peak Performance by Quarter
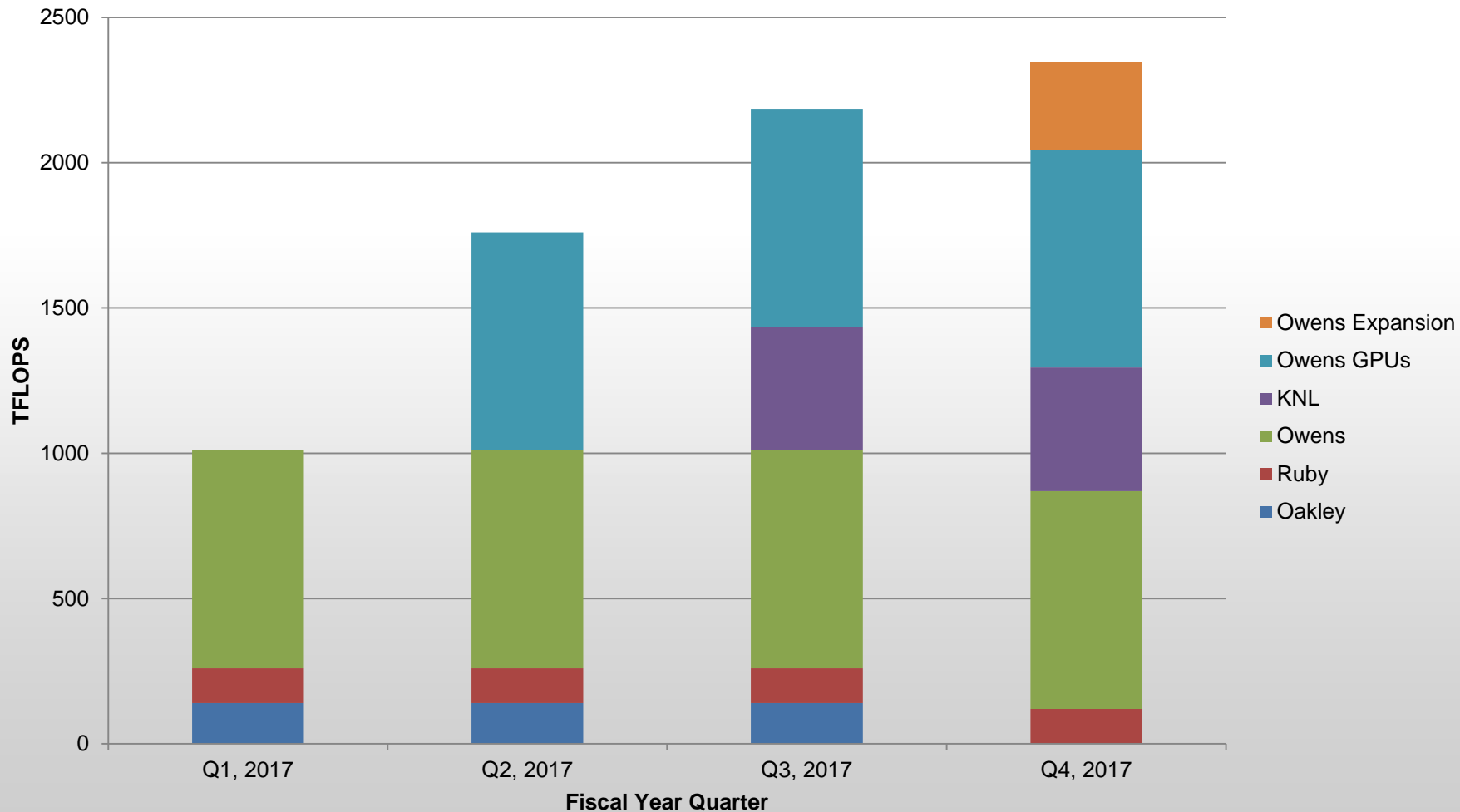
Average Power by Quarter
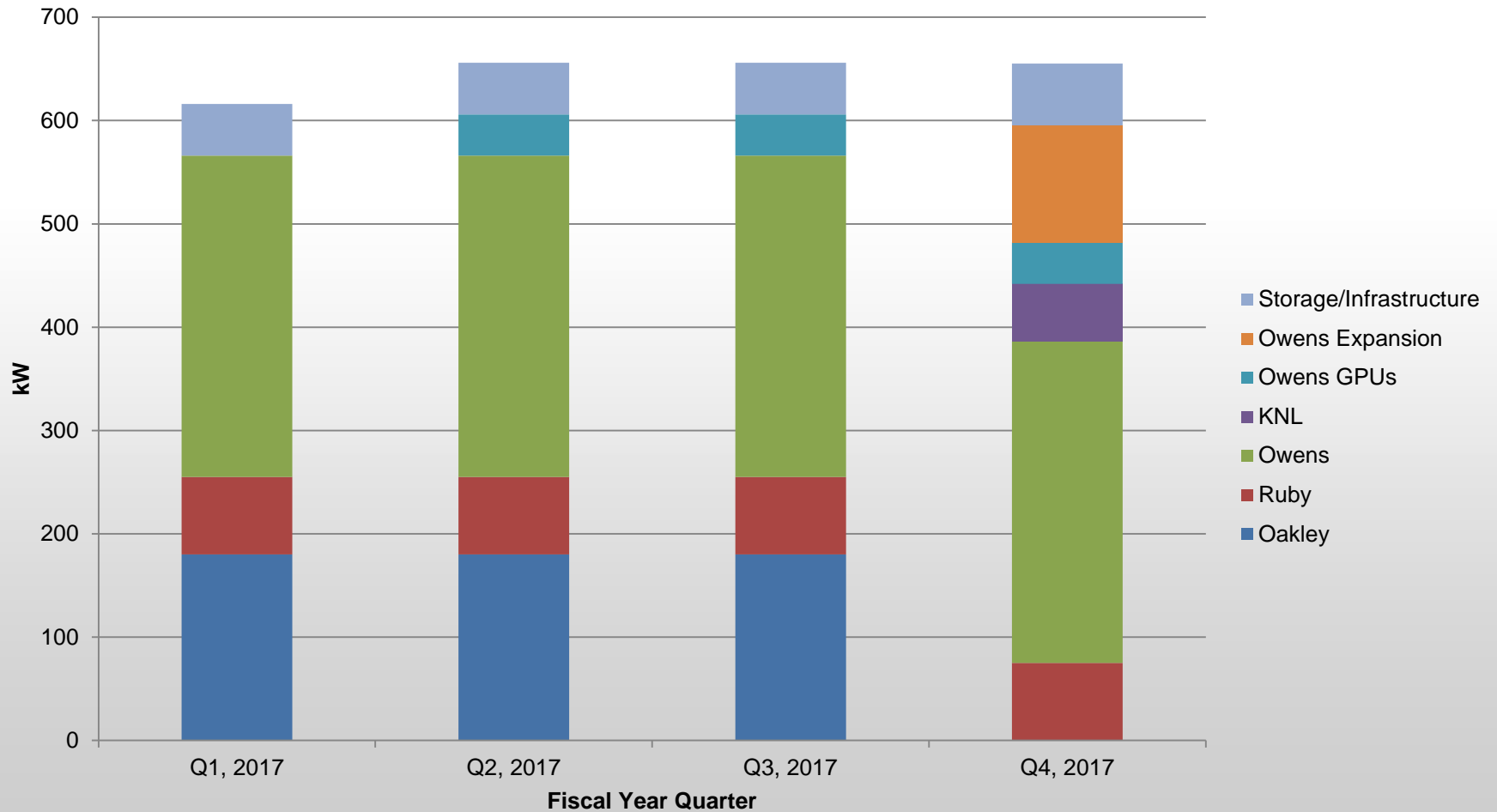
Power, Cooling, and Floor Footprint

- Current average power: 450kWh
- After full Owens deployment: 650kWh (est.)
- Owens footprint room for growth: 9 additional racks
  - Using this space keeps the maximum open for future systems

Total power	1,725 kW
Total usable power	1,200 kW
Total cooling, air plus Rear Door Heat Exchangers (RDHx)	322 Tons/1,225 kW
Free RDHx capacity	24 Tons/80kW (8, 10kW doors)

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Older slides

New Systems	
Add OmniPath network, integration with storage (2:1, up to 192 nodes, late 2016)	$80,000
Add KNL systems (early 2017)	$900,000
Next generation "early adopter" system (2018)	$700,000
Compute expansion	
Pascal based GPUs to Owens (early 2017)	$900,000
Compute nodes additions to Owens (mid 2017)	$2,400,000
User storage expansion	
Project expansion (mid 2017)	$500,000
Servers and storage for TSM disk pools (mid 2017)	$300,000
Tape media (as needed)	$80,000
Tape drives (Q4 FY17, include long term maintenance)	$200,000
Legacy infrastructure hardware replacement	
SSD for low latency infrastructure I/O (late 2016, early 2017)	$100,000
Replace IBM, and NetApp infrastructure storage (early 2017)	$100,000
Fibre-channel switches for tape library (mid 2017)	$20,000
UFM servers to replace re-purposed Oakley compute nodes (mid 2017)	$10,000
SOCC workroom phone, and network improvements	$10,000
Security hardware	
Firewall/IDS (2017)	$300,000
Total	$6,600,000

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Power required by new systems beyond 650 kW average

System	Maximum	75% load (typical average)
GPUs for Owens	50 kW	38 kW
KNL cluster	56 kW	42 kW
Owens compute expansion	140 kW	120 kW
Next generation system	100 kW	67 kW
Misc.	30 kW	30 kW
Oakley	-240 kW	-180 kW
Rough net additional load	+160 kW	+120 kW