



HRP Integrated Research Plan (IRP) - Revision D
 Human Health Countermeasures (HHC) - Bone
 Risk Of Early Onset Osteoporosis Due To Spaceflight
 Legend



G: Ground Study



F: Flight Study



L: Lunar



NSBRI



DA&M: Data Analysis & Modeling



FP: Flight Prep



AO: Add on to another study



Planned/unfunded



Early Start



Task To Be Determined After Decision Point



Major Milestone/Event/Accomplishment



1) Risk Characterization



2) Task↓↑Task



3) Standards - New



4) Standards - Update



5) Tools



6) Technology

7) Countermeasure

8) Information To/From other Elements

9) Information to HSRB

10) Requirements

11) Study

Major Decision Point

Stop





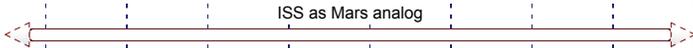
Task Name

ISS and other vehicles

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4



▲a: 6 Crew Capability; ▲b: Shuttle Retired; ▲c: EFT1; ▲d: MPCV CDR; ▲e: EM1; ▲f: EM2; ▲g: End of US Commitment to ISS



Bone Portfolio

Risk Of Early Onset Osteoporosis Due To Spaceflight

Osteo 1: A new acceptable bone health standard using an improved surrogate for bone strength needs to be defined for the flight environment.

[DS] Sibonga: FE Strength Cutoff (Completed)

[DS] Sibonga: FE Strength Cutoff II

[DS] Sibonga: Hip QCT (see Osteo 3 for updates)

Osteo 2 (B1a & B29): What is the incidence & prevalence of early onset osteoporosis or fragility fractures due to exposure to spaceflight.

[NRA] Amin: Bone Epidemiologic Analysis (see Osteo 4 for updates)

[NRA] Amin: Bone Epidemiologic Analysis II (see Osteo 4 for updates)

[DS] Sibonga: Hip QCT (see Osteo 3 for updates)

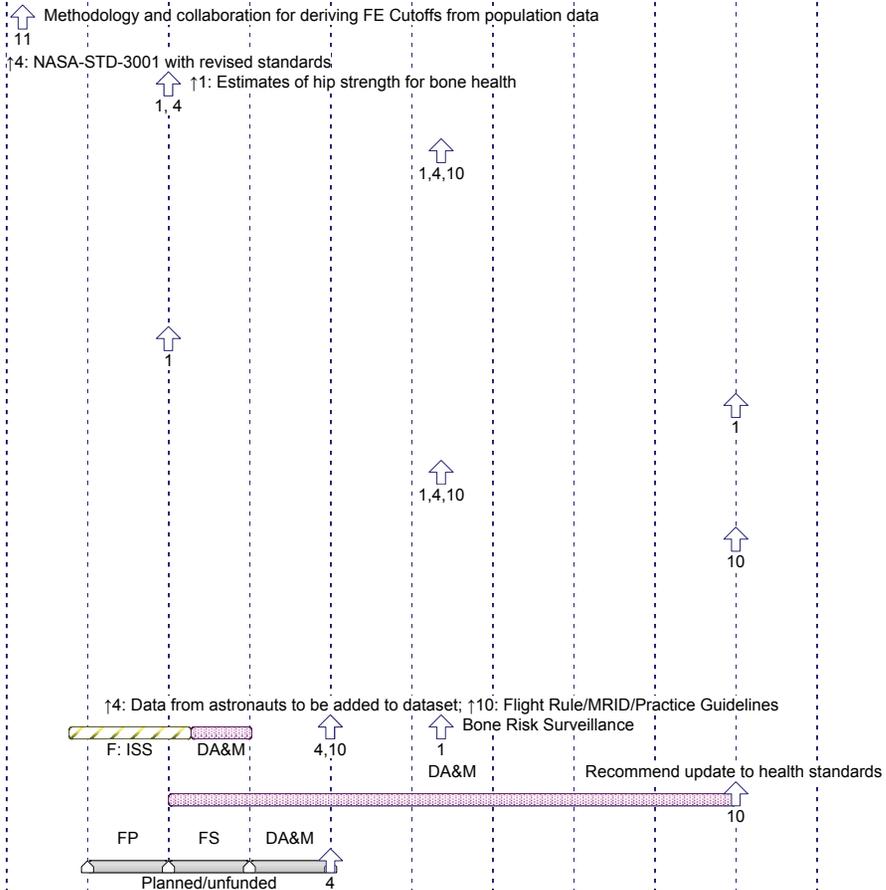
[DS] Sibonga: VCF-MRID (see Osteo 3 for updates)

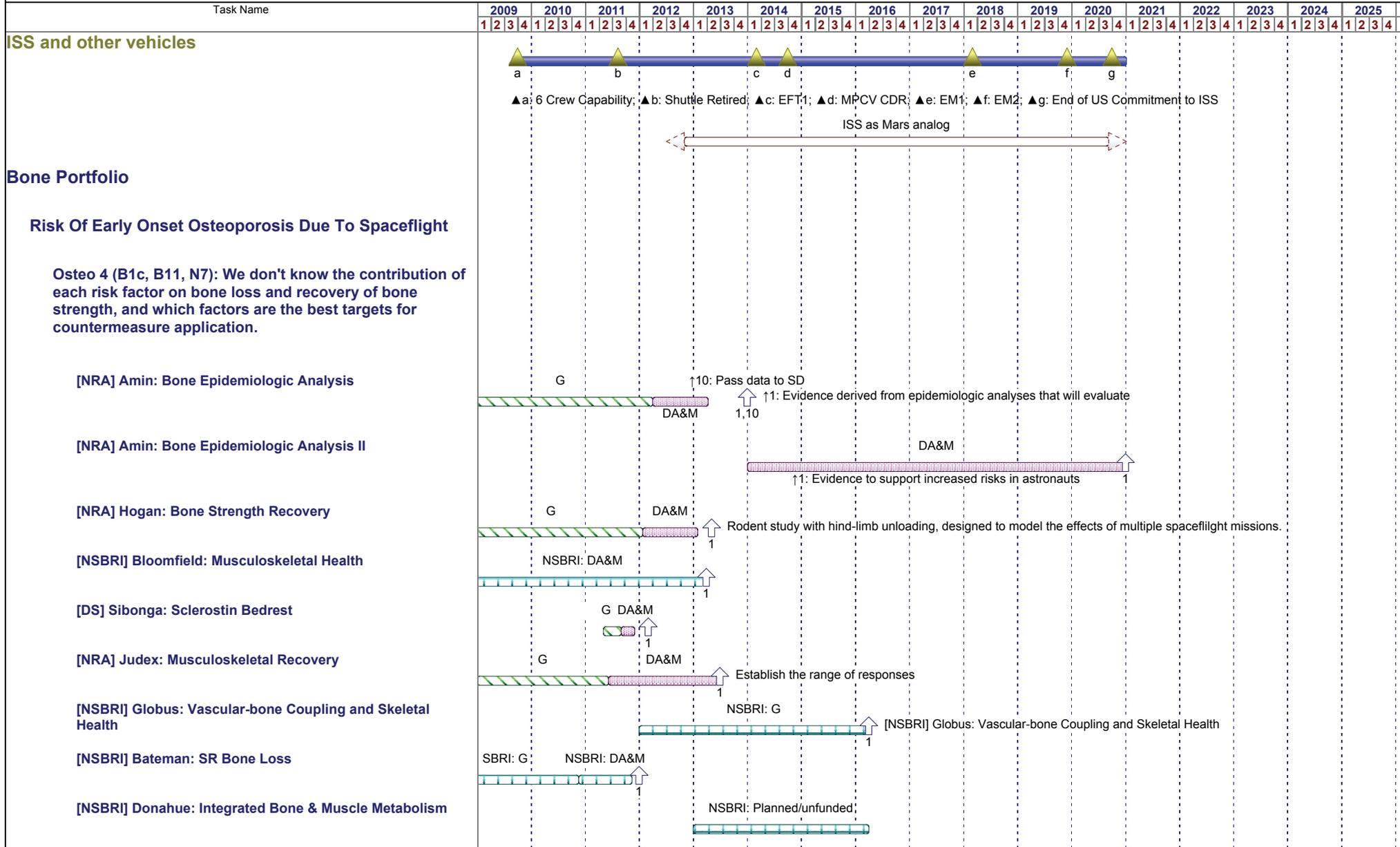
Osteo 3 (B1b & B29): We need a validated clinically relevant method for assessing the effect of spaceflight on osteoporosis or fracture risk in long-duration astronauts.

[DS] Sibonga: Hip QCT

[DS] Sibonga: VCF-MRID

[NRA] TBD: Bone Measures Add-On to OP Summit Follow-On Study







Task Name

ISS and other vehicles

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4



▲a: 6 Crew Capability; ▲b: Shuttle Retired; ▲c: EFT1; ▲d: MPCV CDR; ▲e: EM1; ▲f: EM2; ▲g: End of US Commitment to ISS

ISS as Mars analog

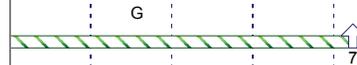


Bone Portfolio

Risk Of Early Onset Osteoporosis Due To Spaceflight

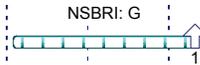
Osteo 4 (B1c, B11, N7): We don't know the contribution of each risk factor on bone loss and recovery of bone strength, and which factors are the best targets for countermeasure application.

[NRA] Lang: Musculoskeletal LDLM



[DS] Pennline: Bone Turnover Model: Initial Implementation

[NSBRI] Mellor: Early Arthritis



[DS] Sibonga: FE Strength Cutoff II (see Osteo 1 for updates)



[DS] SM Smith: BioSurveillance (see HHC-Multisystem Gap N14 for updates)



[DS] LeBlanc: Bisphosphonates SMO [see Osteo 7 for updates]



[NSBRI] Vignaux: Nervous system & bone loss

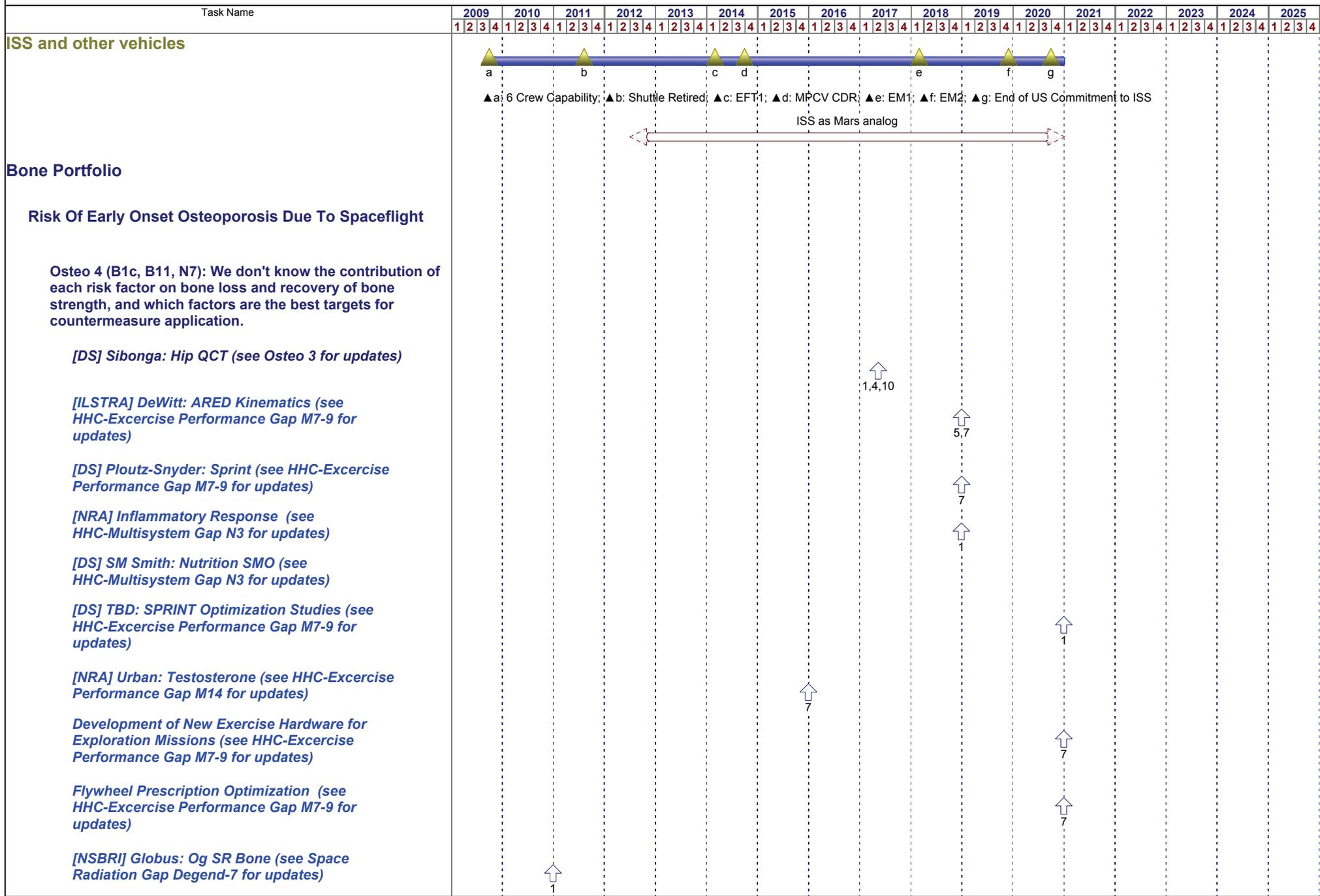
T TBD: Task to be determined after decision point

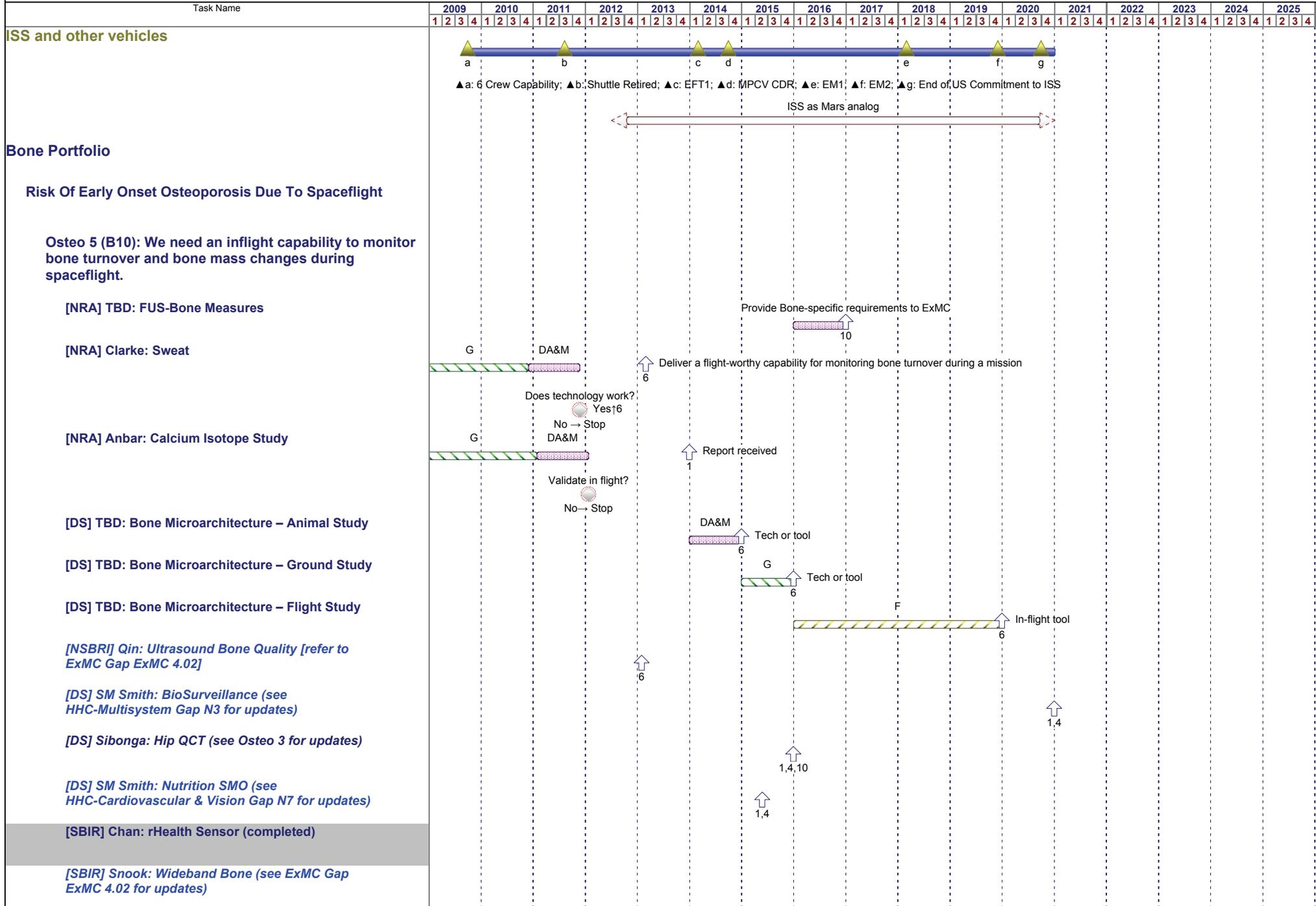
[NRA] SM Smith: Pro-K (see HHC-Multisystem Gap N14 for updates)



[NRA] TBD: n-3 Fatty Acids (see HHC-Multisystem Gap N14 for updates)





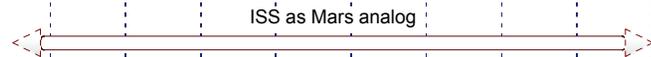
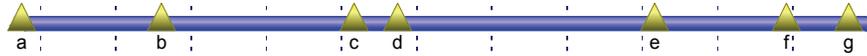




Task Name

ISS and other vehicles

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4



Bone Portfolio

Risk Of Early Onset Osteoporosis Due To Spaceflight

Osteo 6: How do skeletal changes due to spaceflight modify the terrestrial risk of osteoporotic fractures?

[DS] LeBlanc: Bisphosphonates SMO (see Osteo 7 for updates)

[DS] Sibonga: VCF-MRID (see Osteo 3 for updates)

[DS] Sibonga: FE Strength Cutoff II (see Osteo 1 for updates)

[NRA] Amin: Bone Epidemiologic Analysis (see Osteo 4 for updates)

[NRA] Amin: Bone Epidemiologic Analysis II (see Osteo 4 for updates)

[NSBRI] Qin: Ultrasound Bone Quality [refer to ExMC Gap ExMC 4.02]

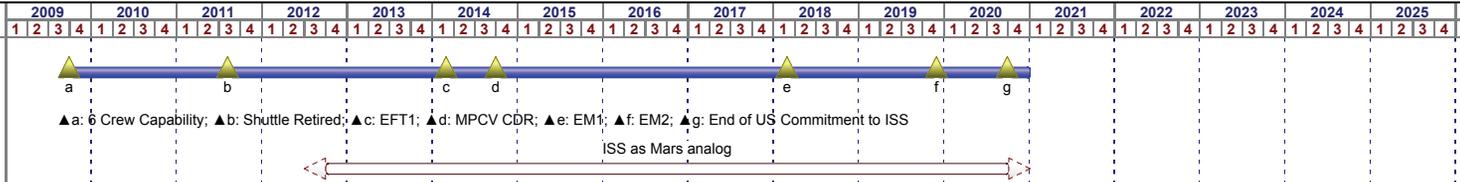
[DS] Sibonga: Hip QCT (see Osteo 3 for updates)





Task Name

ISS and other vehicles



Bone Portfolio

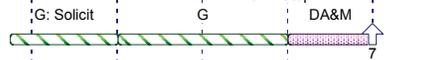
Risk Of Early Onset Osteoporosis Due To Spaceflight

Osteo 7: (B3, MO5, B15) We need to identify options for mitigating early onset osteoporosis before, during and after spaceflight.

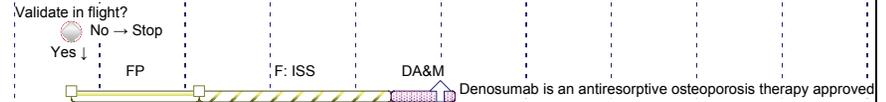
[DS] LeBlanc: Bisphosphonates SMO



[NRA] TBD: Dmab Analogue



[NRA] TBD: Dmab Flight



[NRA] TBD: Emerging Drug (TBD) Analogue Validation



[NRA] TBD: Emerging Drug (TBD) Flight Validation



[NRA] TBD: Flight Validation of an Integrated Nutritional, Pharmaceutical and Exercise CM



[NSBRI] Bajaj: ImmobilizeBone



[NRA] Amin: Bone Epidemiologic Analysis (see Osteo 4 for updates)



[NRA] Amin: Bone Epidemiologic Analysis II (see Osteo 4 for updates)



[NRA] TBD: n-3 Fatty Acids (see HHC-Multisystem Gap N14 for updates)



[DS] Sibonga: Hip QCT (see Osteo 3 for updates)



[NSBRI] Ploutz-Snyder: Exercise Training on Compact Equipment (see HHC-Exercise Performance Gap M7-9 for updates)



[DS] Ploutz-Snyder: Sprint Study (see HHC-Exercise Performance Gap M7-9 for updates)



[DS] SM Smith: Nutrition SMO (see HHC-CV Gap N7 for updates)

