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# Risk Assessment Update: Russian Segment

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Jim Hyde..... [ESCG-KX]  
Michael Bjorkman..... [ESCG-KX]  
Kevin Hoffman..... [ESCG-KX]  
Eric Christiansen... [NASA/JSC-KX]  
Dana Lear..... [NASA/JSC-KX]

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Release	Date	Description
0	July 20, 2012	Review & comment
1	July 23, 2012	Export Control review

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# Introduction

- BUMPER-II version 1.95j source code was provided to RSC-E and Khrunichev at January 2012 MMOD TIM in Moscow
  - MEMCXP and ORDEM 3.0 environments implemented as external data files
  - NASA provided a sample ORDEM 3.0 “.key” & “.daf” environment file set for demonstration and benchmarking BUMPER-II v1.95j installation at the Jan-12 TIM
- ORDEM 3.0 has been completed and is currently in beta testing
  - NASA will provide a preliminary set of ORDEM 3.0 “.key” & “.daf” environment files for the years 2012 through 2028
  - Bumper output files produced using the new ORDEM 3.0 data files are intended for internal use only, not for requirements verification
  - Output files will contain these words `ORDEM FILE DESCRIPTION = PRELIMINARY VERSION: not for production`
  - The projectile density term in many BUMPER-II ballistic limit equations will need to be updated
- Cube demo scripts and output files delivered at the Jan-12 TIM have been updated for the new ORDEM 3.0 data files
- Risk assessment results based on ORDEM 3.0 and MEM will be presented for the Russian Segment (RS) of ISS



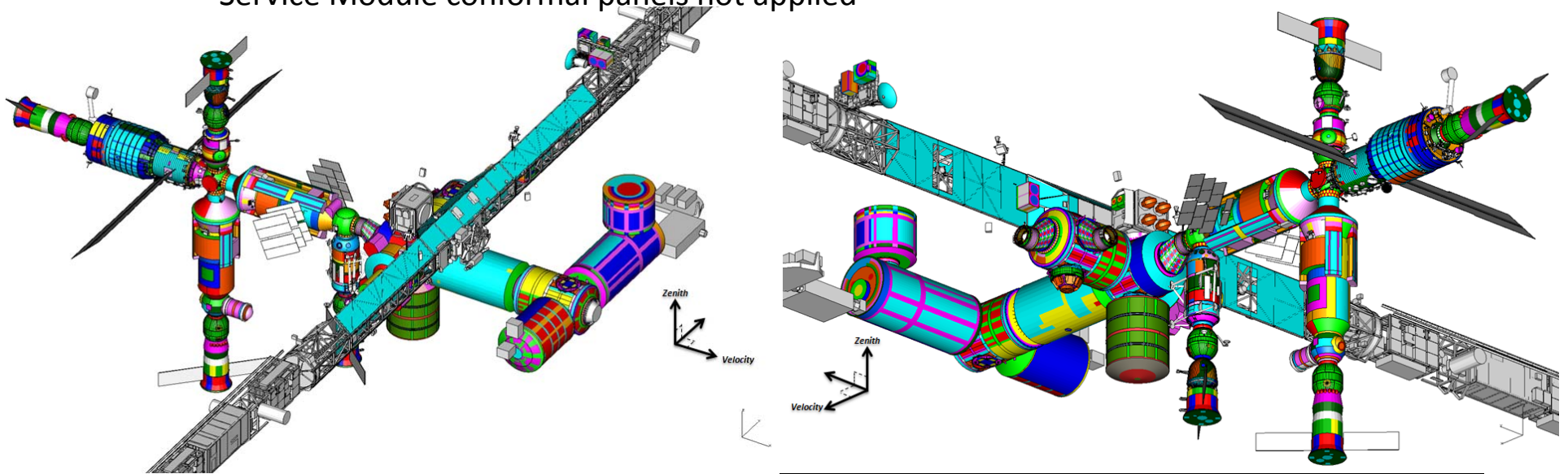
# Projectile Density

- Every Ballistic Limit Equation (BLE) in BUMPER-II is under review and may need to be updated for the high density orbital debris population in ORDEM 3.0
  - the transition velocity from medium to high-velocity will need to shift to the right, since complete melting is expected to occur at higher velocities than aluminum on aluminum impacts
  - results from hypervelocity impacts using steel particles on ISS shields and from hydrocode analyses
- The “MLM” BLE is the only RS equation with no projectile density dependence
  - Equation needs to be revised to include variable projectile density
- See appendix for BLE modification proposal

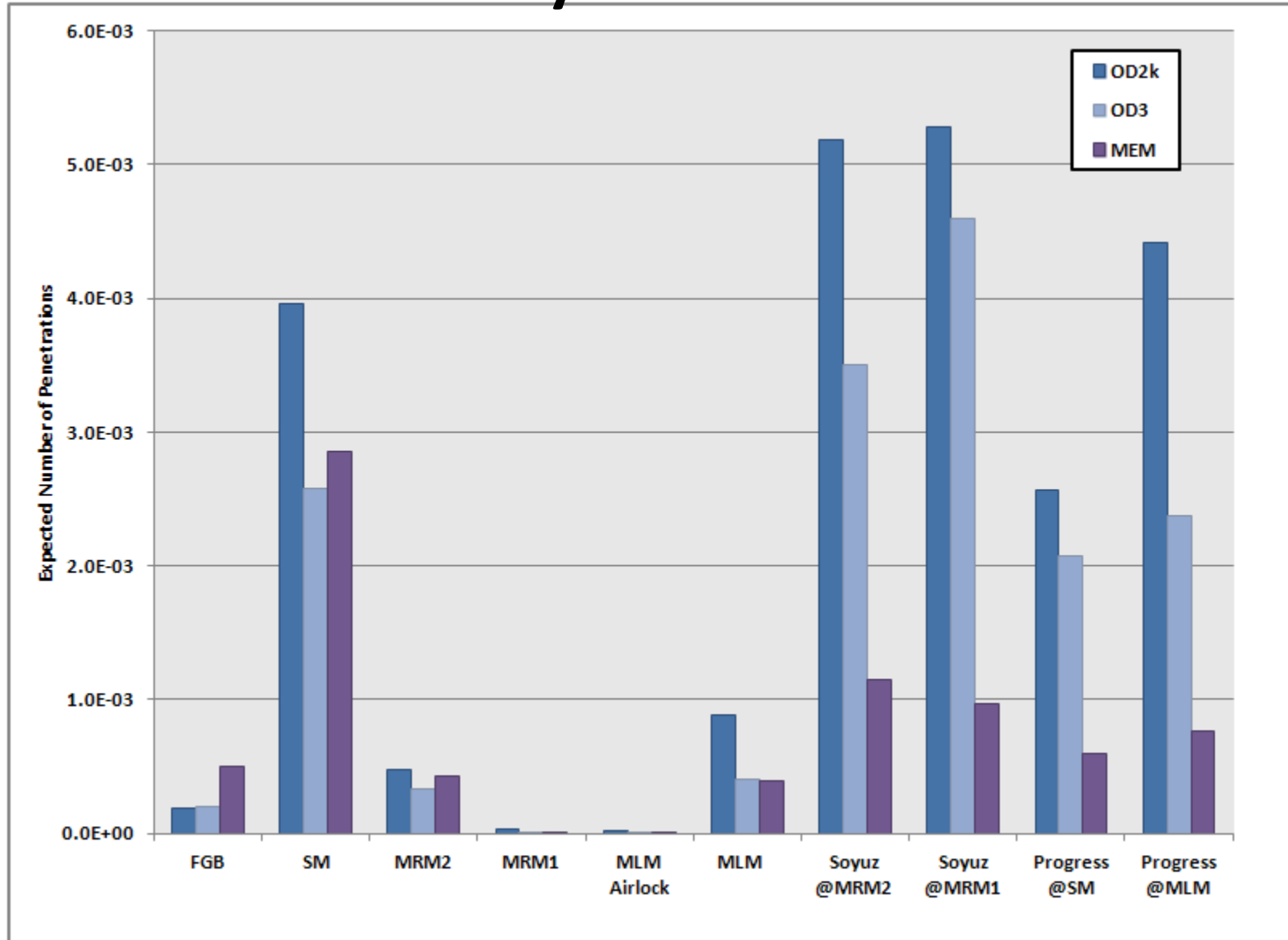


# Preliminary RS Results

- BUMPER-II version: 1.95k
- Environments: OD3, OD2k, MEM
- Analysis Years: 2012 - 2028
- Attitude: ISS YPR attitude =  $-3^{\circ}, -7^{\circ}, +1^{\circ}$  (Bumper RPY =  $+1^{\circ}, +7^{\circ}, +3^{\circ}$ )
- Altitude: 400 km
- Input FEM: ITA12-Stage2014,2-revE-FIN.unv
  - Applied full augmentation to Soyuz Orbital Module & Progress Cargo Module shields
  - Service Module conformal panels not applied

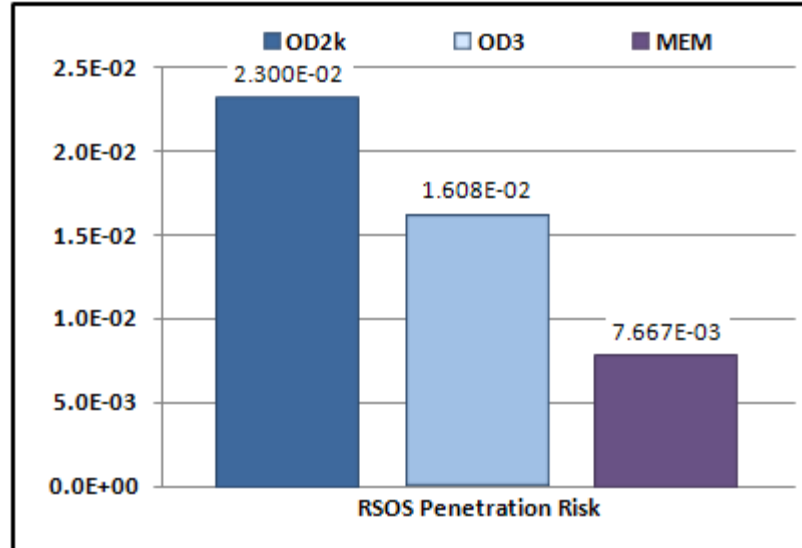


# Preliminary RS Results: 2014

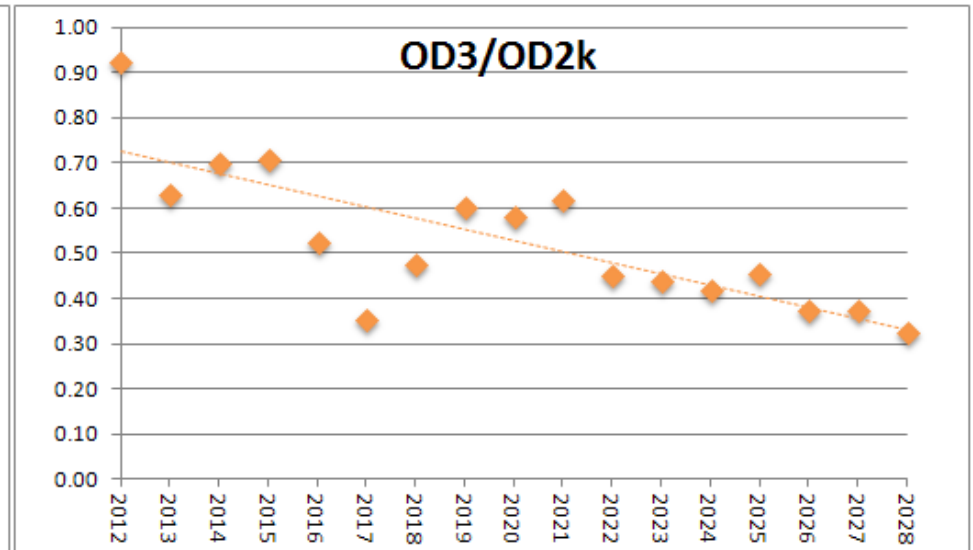
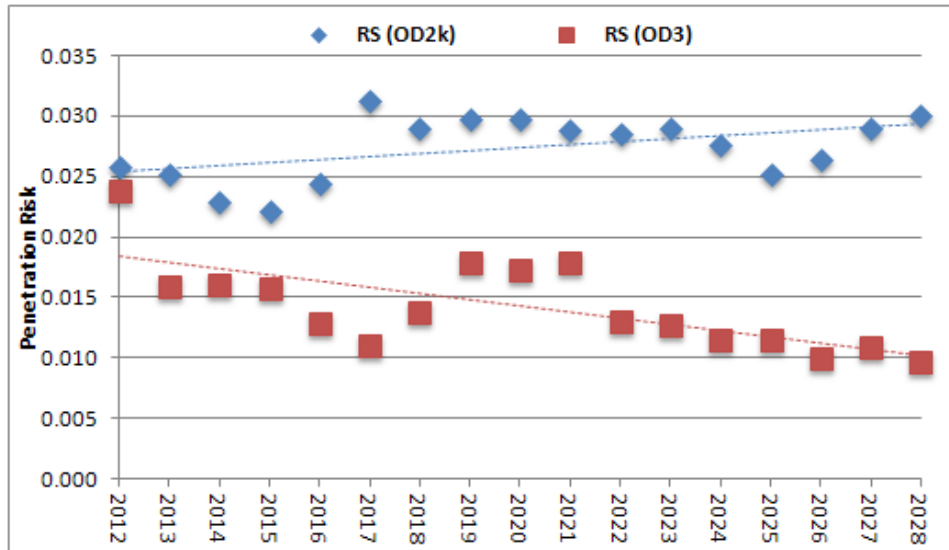


# Preliminary RS Results: 2014

Module	Expected Number of Penetrations (2014)			OD3 /OD2k	OD3 /MEM	% Total RSOS Risk		
	OD2k	OD3	MEM			OD2k	OD3	MEM
FGB	1.87E-04	2.04E-04	4.95E-04	1.09	0.41	0.8%	1.3%	6.5%
SM	3.96E-03	2.58E-03	2.86E-03	0.65	0.90	17.2%	16.1%	37.3%
MRM2	4.74E-04	3.38E-04	4.25E-04	0.71	0.79	2.1%	2.1%	5.5%
MRM1	2.92E-05	2.79E-06	4.07E-06	0.10	0.69	0.1%	0.0%	0.1%
MLM Airlock	1.72E-05	4.61E-06	8.45E-06	0.27	0.55	0.1%	0.0%	0.1%
MLM	8.80E-04	4.04E-04	3.89E-04	0.46	1.04	3.8%	2.5%	5.1%
Soyuz @MRM2	5.19E-03	3.51E-03	1.15E-03	0.68	3.05	22.6%	21.8%	15.0%
Soyuz @MRM1	5.28E-03	4.60E-03	9.69E-04	0.87	4.74	22.9%	28.6%	12.6%
Progress @SM	2.56E-03	2.07E-03	5.97E-04	0.81	3.47	11.1%	12.9%	7.8%
Progress @MLM	4.42E-03	2.37E-03	7.66E-04	0.54	3.10	19.2%	14.7%	10.0%
<b>RSOS TOTAL</b>	<b>2.300E-02</b>	<b>1.608E-02</b>	<b>7.667E-03</b>	<b>0.70</b>	<b>2.10</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>



# Preliminary RS Results: 2012 - 2028



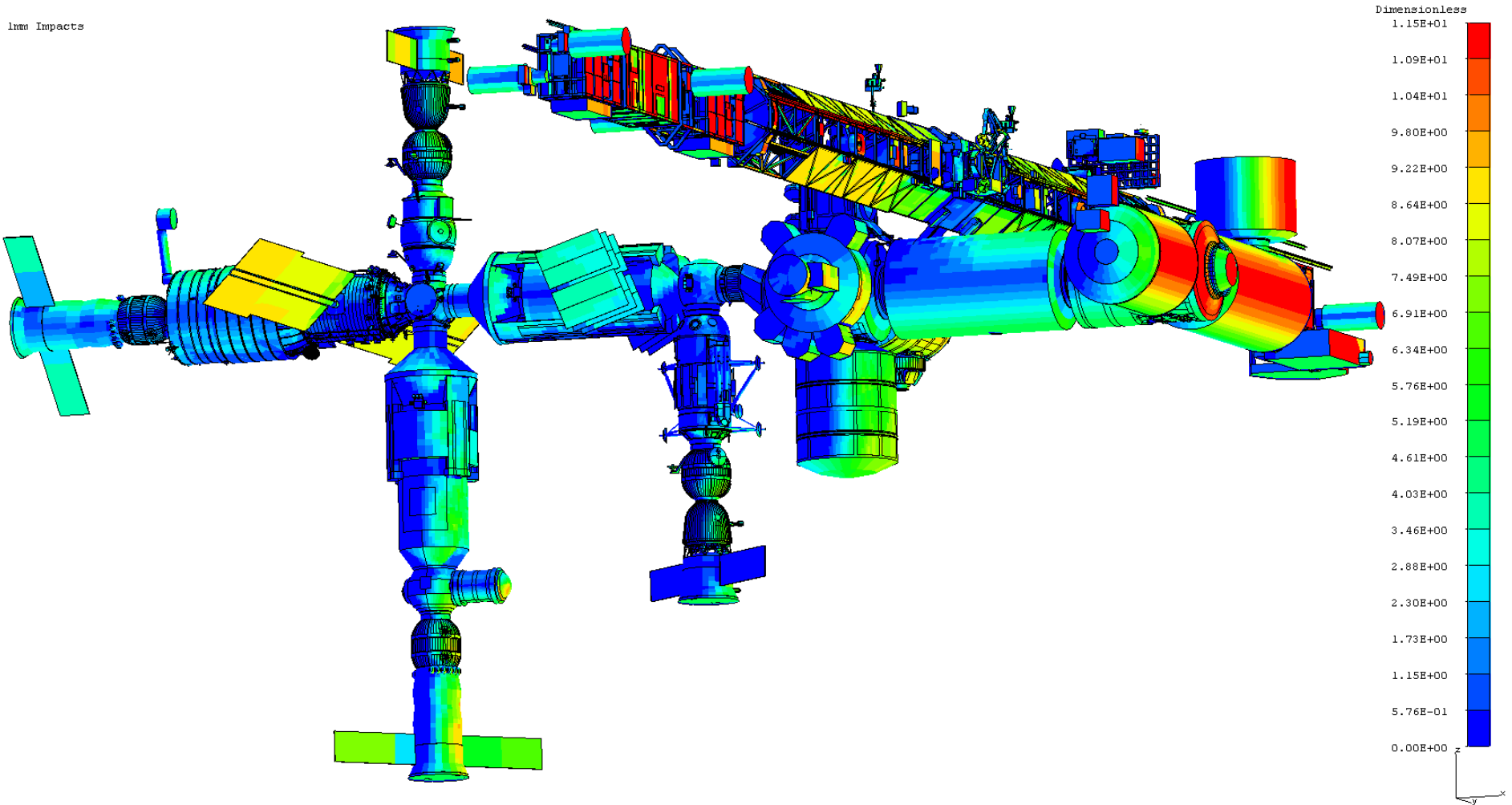
# Preliminary RS Results: 2012 - 2028

Module	2012-2028				
	OD2k	OD3	MEM	OD2k + MEM	OD3 + MEM
FGB	4.007E-03	3.325E-03	8.421E-03	1.243E-02	1.175E-02
SM	8.013E-02	3.634E-02	4.864E-02	1.288E-01	8.498E-02
MRM2	9.781E-03	5.224E-03	7.230E-03	1.701E-02	1.245E-02
MRM1	6.610E-04	4.774E-05	6.913E-05	7.301E-04	1.169E-04
MLM Airlock	3.725E-04	8.132E-05	1.437E-04	5.162E-04	2.250E-04
MLM	1.879E-02	5.949E-03	6.614E-03	2.541E-02	1.256E-02
Soyuz @MRM2	1.040E-01	5.379E-02	1.958E-02	1.236E-01	7.337E-02
Soyuz @MRM1	1.061E-01	7.032E-02	1.647E-02	1.225E-01	8.679E-02
Progress @SM	5.187E-02	2.952E-02	1.016E-02	6.202E-02	3.968E-02
Progress @MLM	8.988E-02	3.767E-02	1.302E-02	1.029E-01	5.069E-02
<b>RS TOTAL (N)</b>	<b>4.655E-01</b>	<b>2.423E-01</b>	<b>1.303E-01</b>	<b>5.959E-01</b>	<b>3.726E-01</b>
<b>RS TOTAL (PNP)</b>	<b>0.6278</b>	<b>0.7848</b>	<b>0.8778</b>	<b>0.5511</b>	<b>0.6889</b>
FGB	0.9%	1.4%	6.5%	2.1%	3.2%
SM	17.2%	15.0%	37.3%	21.6%	22.8%
MRM2	2.1%	2.2%	5.5%	2.9%	3.3%
MRM1	0.1%	0.0%	0.1%	0.1%	0.0%
MLM Airlock	0.1%	0.0%	0.1%	0.1%	0.1%
MLM	4.0%	2.5%	5.1%	4.3%	3.4%
Soyuz @MRM2	22.3%	22.2%	15.0%	20.7%	19.7%
Soyuz @MRM1	22.8%	29.0%	12.6%	20.6%	23.3%
Progress @SM	11.1%	12.2%	7.8%	10.4%	10.6%
Progress @MLM	19.3%	15.5%	10.0%	17.3%	13.6%

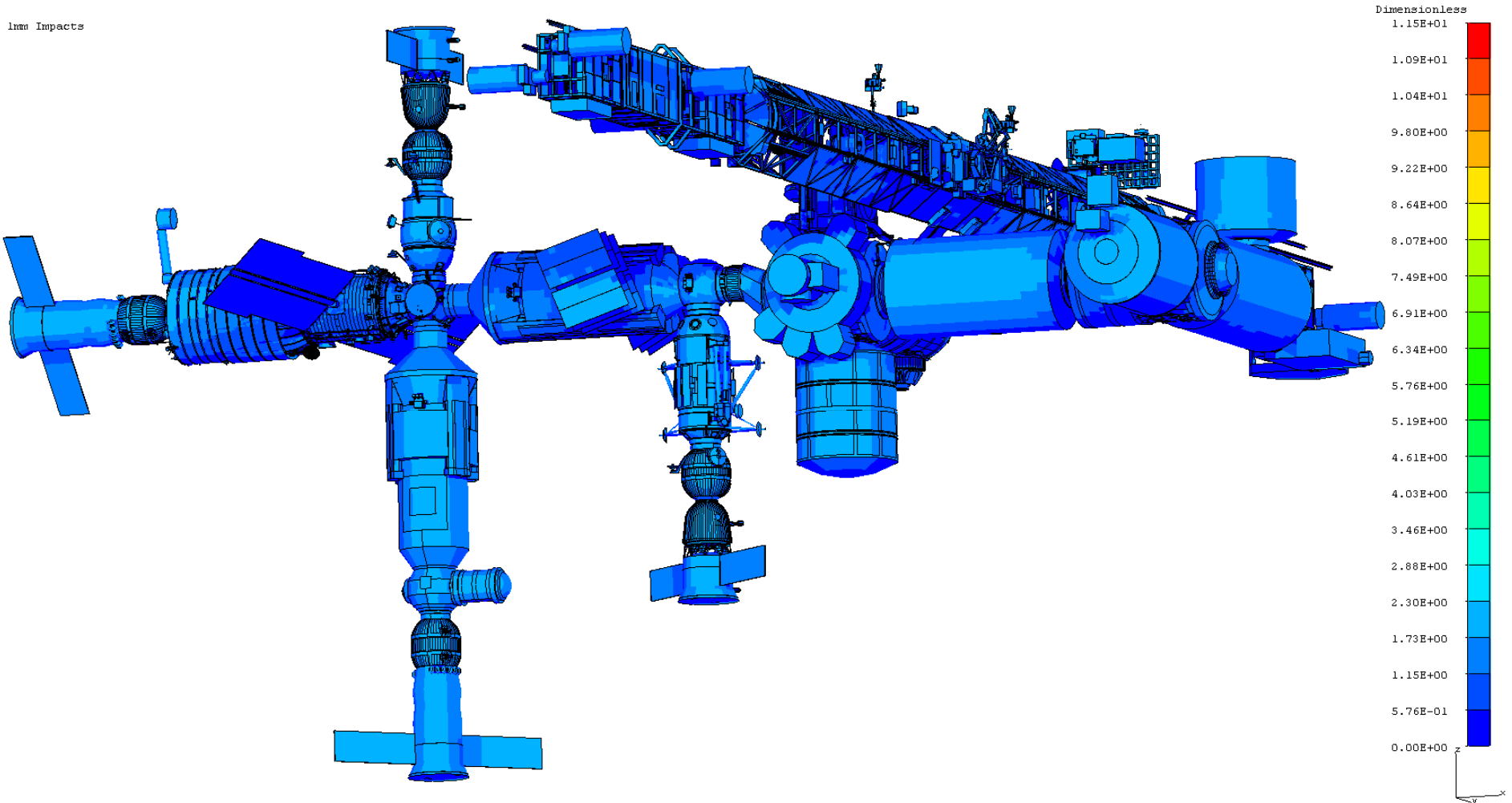




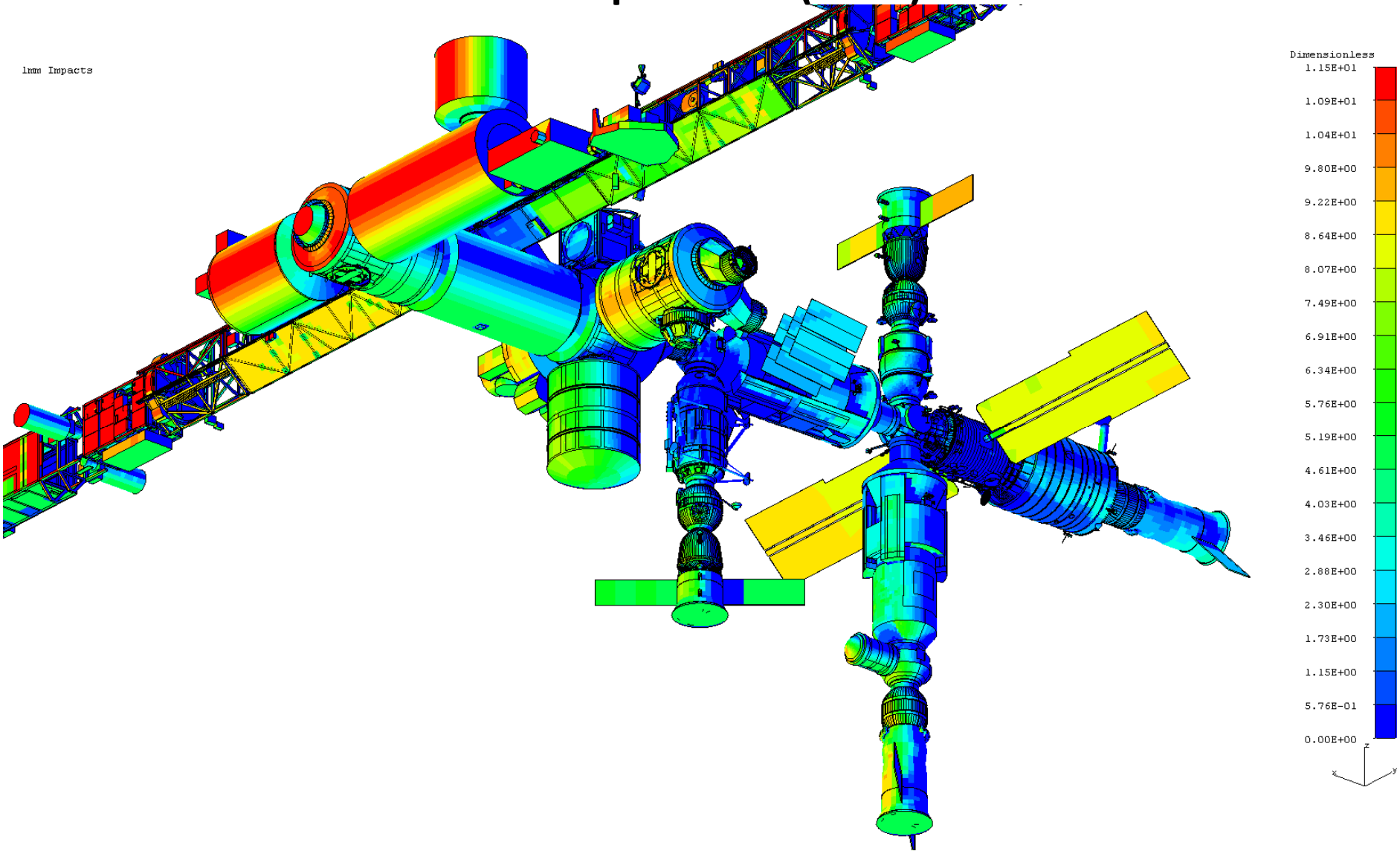
# ISS 1mm Impact Risk (2014) – OD3



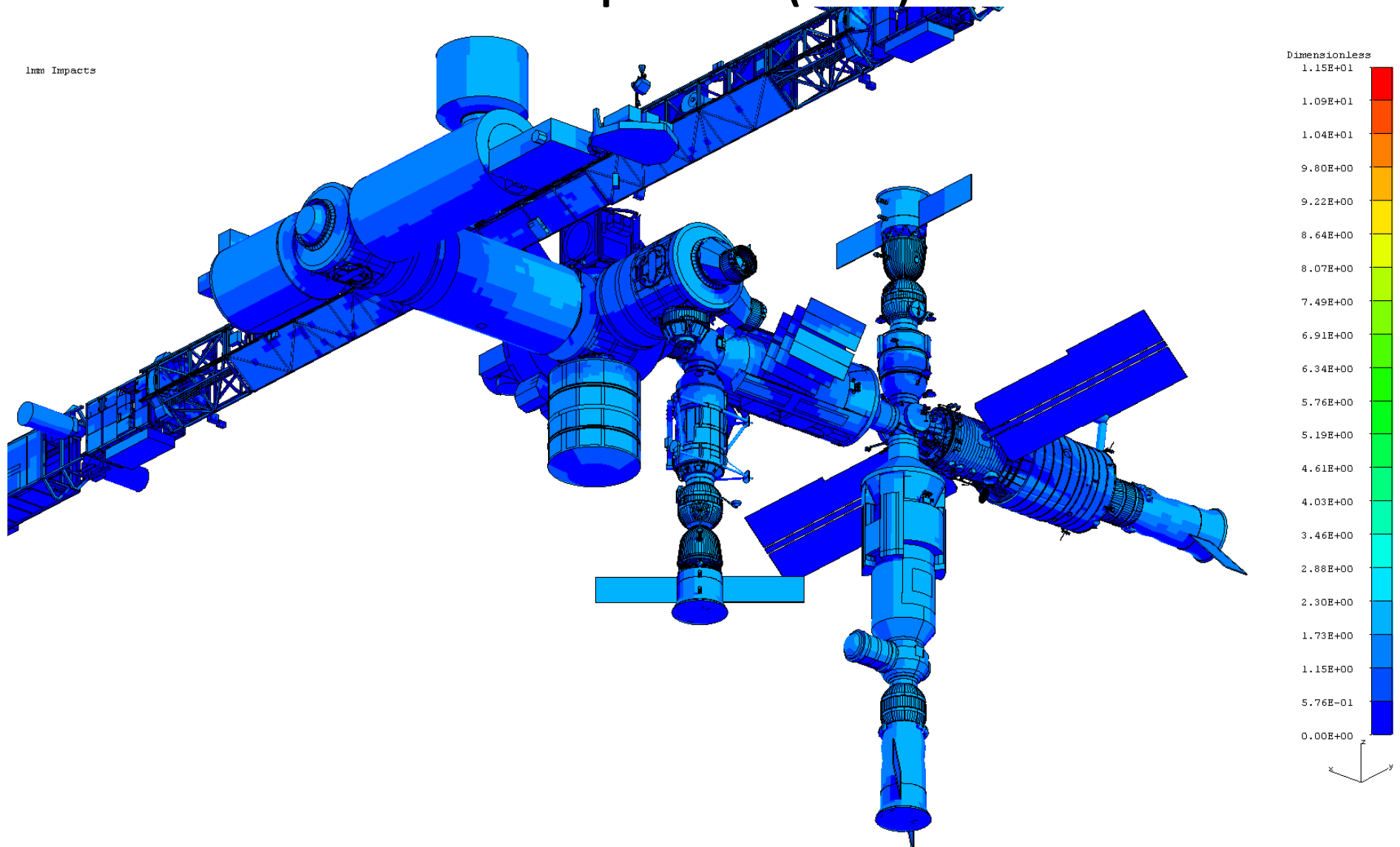
# ISS 1mm Impact Risk (2014) – OD2k



# ISS 1mm Impact Risk (2014) – OD3



# ISS 1mm Impact Risk (2014) – OD2k



# Appendix 1: BLE Modification Plan





# Plan for the First Phase of ISS BLE Changes for Steel Projectiles

Michael D. Bjorkman  
July 12, 2012



# Approach



- Projectile densities come in 4 values
  - 1 g/cc for NaK
  - 1.4 g/cc for low density
  - 2.8 g/cc for medium density and intacts
  - 8 g/cc for high density
- The Whipple shield high speed transition, VH, occurs at different values for different projectile/shield material pairs.
- So build specific Whipple shield BLEs for each projectile/shield pair.
  - Aluminum striking aluminum
  - Steel striking aluminum
  - More?

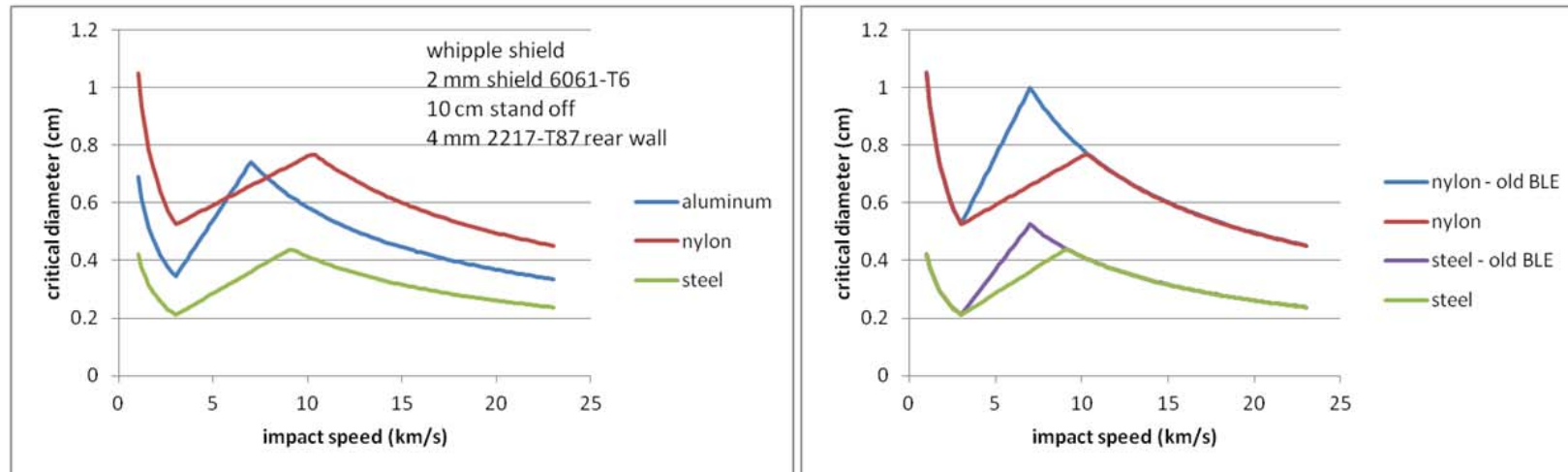


# Proposed NEW\_NONOPTIMUM Change



1. Steel projectiles release into melt when striking aluminum bumpers at 9.1 km/s.
2. Nylon projectiles shock aluminum bumpers into states that release into melt when they strike at 10.3 km/s

## NEW\_NONOPTIMUM BLE



Calculated using the SESAME 2150 table for iron, the 3400 table for aluminum and the ANEOS eos for nylon







```
Function NEW_NONOPTIMUM_STEEL(velm, angr, shield_thick, SHDENM, standoff, wall_thick, VWDENM, FY)
    Pi = 3.14159265
    VH = 9.1
    proiden = 7.8724

    VNORM = velm * Cos(angr)

    diam_lo = ((wall_thick * Sqr(FY / 40000#) + shield_thick) / (0.6 _
        * Cos(angr) ^ (5# / 3#) * Sqr(proiden) * (3 * Cos(angr)) ^ (2# / 3#))) ^ (18# / 19#)
    mass_hi = (wall_thick / 0.16) ^ 2# * (6# / Pi * SHDENM) ^ (-1# / 3#) * _
        standoff / (VH * Cos(angr)) ^ 2 * FY / 70000#
    diam_hi = (6# * mass_hi / (Pi * proiden)) ^ (1# / 3#)

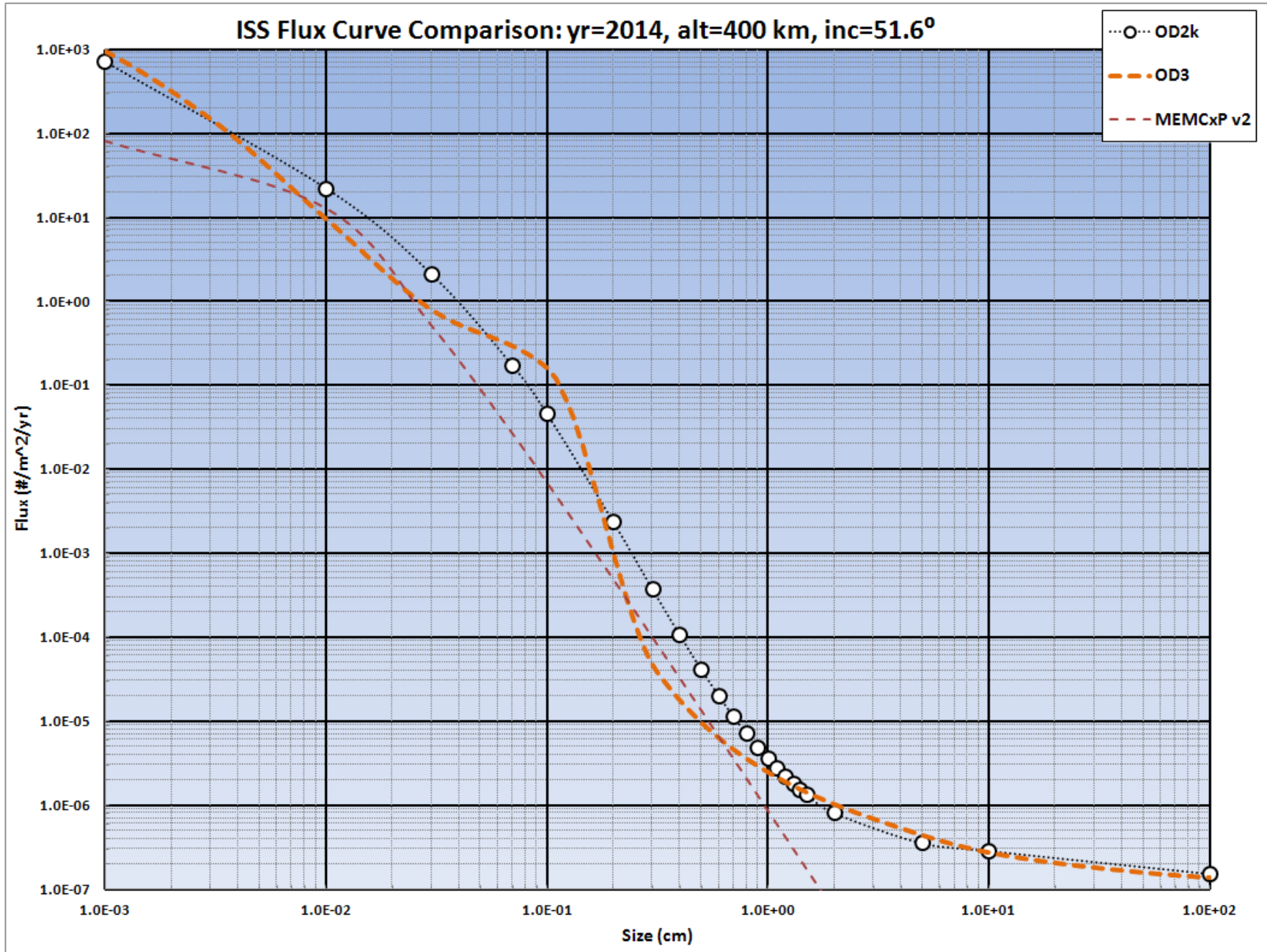
    If VNORM > VH Then
        mass = (wall_thick / 0.16) ^ 2# * (6# / Pi * SHDENM) ^ (-1# / 3#) * _
            standoff / VNORM ^ 2 * FY / 70000#
        diam = (6# * mass / (Pi * proiden)) ^ (1# / 3#)
    ElseIf VNORM > 3 Then
        diam = diam_lo + (diam_hi - diam_lo) / ((VH - 3) * Cos(angr)) * (VNORM - 3)
    Else
        diam = ((wall_thick * Sqr(FY / 40000#) + shield_thick) / (0.6 _
            * Cos(angr) ^ (5# / 3#) * Sqr(proiden) * velm ^ (2# / 3#))) ^ (18# / 19#)
    End If

    NEW_NONOPTIMUM_STEEL = diam
End Function
```



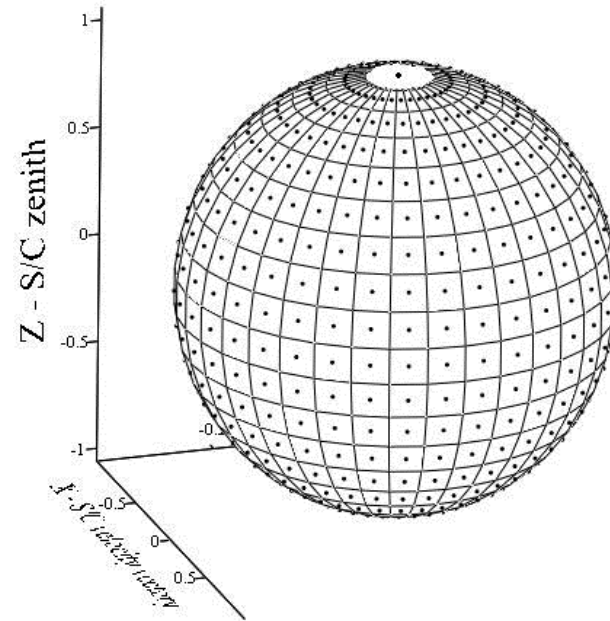
# Appendix 2: Backup Charts





# ORDEM 3.0: Background

- Model Populations
  - RORSAT NaK coolant droplets
  - Low-density fragments
  - Medium-density fragments and degradation/ejecta
  - Intact objects
  - High-density fragments and degradation/ejecta
- Density Bins
  - NaK = 1.0 g/cm<sup>3</sup>
  - Low = 1.4 g/cm<sup>3</sup>
  - Medium = 2.8 g/cm<sup>3</sup>
  - High = 8.0 g/cm<sup>3</sup>
- Altitude range: 100 to 40,000 km
- Time Range: 1995 to 2035
- Threats originate from 612, 10° x 10°, patches on the sky sphere plus a north and south pole patch, for a total of 614 patches.
- The discrete closing speed distribution has 23 speed bins, from 0 to 1 km/s, 1 to 2 km/s, ... 22 to 23 km/s
- Total number of fluence integration steps for each element of analysis FEM: 614 threats x 23 speed bins = 14,122 steps.



# ORDEM 3.0: Data Files (1/2)

- ORDEM 3 application produces three intermediate files
  - IGLOOFLUX\_SC.OUT
    - igloo patch fluxes
    - 14,122 rows: 614 threats x 23 speeds
    - 55 columns: 11 sizes x 5 populations
  - IGLOOFLUX\_SIGMAPOP\_SC.OUT
    - Correlated population uncertainty estimates (for future use)
  - IGLOOFLUX\_SIGMARAN\_SC.OUT
    - Random uncertainty estimates (for future use)

**Debris type codes**  
 NK - sodium-potassium (NaK) reactor coolant  
 LD - general low-density debris  
 MD - general medium-density debris  
 HD - general high-density debris  
 IN - intact/launched objects

**Debris size bin codes, in powers of 10  $\mu$ m**  
 10 =  $10^{1.0} \mu\text{m} = 1.00\text{e-}5 \text{ m} = 10 \mu\text{m}$   
 15 =  $10^{1.5} \mu\text{m} = 3.16\text{e-}5 \text{ m} = 31.6 \mu\text{m}$   
 20 =  $10^{2.0} \mu\text{m} = 1.00\text{e-}4 \text{ m} = 100 \mu\text{m}$   
 25 =  $10^{2.5} \mu\text{m} = 3.16\text{e-}4 \text{ m} = 316 \mu\text{m}$   
 30 =  $10^{3.0} \mu\text{m} = 1.00\text{e-}3 \text{ m} = 1 \text{ mm}$   
 35 =  $10^{3.5} \mu\text{m} = 3.16\text{e-}3 \text{ m} = 3.16 \text{ mm}$   
 40 =  $10^{4.0} \mu\text{m} = 1.00\text{e-}2 \text{ m} = 1 \text{ cm}$   
 45 =  $10^{4.5} \mu\text{m} = 3.16\text{e-}2 \text{ m} = 3.16 \text{ cm}$   
 50 =  $10^{5.0} \mu\text{m} = 1.00\text{e-}1 \text{ m} = 10 \text{ cm}$   
 55 =  $10^{5.5} \mu\text{m} = 3.16\text{e-}1 \text{ m} = 31.6 \text{ cm}$   
 60 =  $10^{6.0} \mu\text{m} = 1.00\text{e+}1 \text{ m} = 1 \text{ m}$

```
ORDEM Debris flux through spacecraft 'igloo'.
Igloo Debris Populations Flux in Bin (no./km^2/yr)
Year: 2012 Elements: 14122 Populations: 55 a = 6778.136 e = 0.000000 inc = 51.60
```

Element	az_low	az_high	el_low	el_high	vel_low	vel_high	Flux NK10	Flux NK15	Flux NK20	Flux NK25	Flux NK30	Flux NK35	Flux NK40	Flux NK45	Flux NK50	Flux NK60
1	-180.000	180.000	-90.000	-85.000	0.000	1.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
2	-180.000	180.000	-90.000	-85.000	1.000	2.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
3	-180.000	180.000	-90.000	-85.000	2.000	3.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
4	-180.000	180.000	-90.000	-85.000	3.000	4.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
5	-180.000	180.000	-90.000	-85.000	4.000	5.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
6	-180.000	180.000	-90.000	-85.000	5.000	6.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
7	-180.000	180.000	-90.000	-85.000	6.000	7.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
8	-180.000	180.000	-90.000	-85.000	7.000	8.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
9	-180.000	180.000	-90.000	-85.000	8.000	9.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
10	-180.000	180.000	-90.000	-85.000	9.000	10.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
11	-180.000	180.000	-90.000	-85.000	10.000	11.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
12	-180.000	180.000	-90.000	-85.000	11.000	12.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
13	-180.000	180.000	-90.000	-85.000	12.000	13.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
14	-180.000	180.000	-90.000	-85.000	13.000	14.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
15	-180.000	180.000	-90.000	-85.000	14.000	15.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
16	-180.000	180.000	-90.000	-85.000	15.000	16.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
17	-180.000	180.000	-90.000	-85.000	16.000	17.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
18	-180.000	180.000	-90.000	-85.000	17.000	18.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
19	-180.000	180.000	-90.000	-85.000	18.000	19.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
20	-180.000	180.000	-90.000	-85.000	19.000	20.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
21	-180.000	180.000	-90.000	-85.000	20.000	21.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
22	-180.000	180.000	-90.000	-85.000	21.000	22.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
23	-180.000	180.000	-90.000	-85.000	22.000	23.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
24	-180.000	180.000	85.000	90.000	0.000	1.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
25	-180.000	180.000	85.000	90.000	1.000	2.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
26	-180.000	180.000	85.000	90.000	2.000	3.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
27	-180.000	180.000	85.000	90.000	3.000	4.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
28	-180.000	180.000	85.000	90.000	4.000	5.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
29	-180.000	180.000	85.000	90.000	5.000	6.000	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00

Example IGLOOFLUX\_SC.OUT file



# ORDEM 3.0: Data Files (2/2)

- IGLOOFLUX\_SC.out is processed by an external utility
  - >95% of the 776,710 entries are zeros
  - Generate an index to the non-zero values (\*.key file)
  - Compress the file by removing the zeros (\*.daf file)
  - ASCII (plain text) format
  - Reduces the amount of RAM required
- The final version of ORDEM 3.0 is expected to be released in mid 2012.
- NASA will provide a sample ORDEM 3.0 “.key” & “.daf” environment file for demonstration and benchmarking BUMPER-II v1.95j installation.
- After the final release, NASA will provide 27 ORDEM 3.0 output file sets at 400 km altitude & 51.6° inclination.
  - Individual years 2012 through 2035 (24 .key & .daf file sets)
  - Combined 2012 thru 2022 (current + 10yr)
  - Combined 2012 thru 2027 (current + 15yr)
  - Combined 2012 thru 2032 (current + 20yr)



# ORDEM 3.0: BUMPER-II Execution

- GEOMETRY
  - Altitude and inclination prompts for ORDEM 3.0 option removed
  - Execution time for ISS model with 708,392 elements  $\approx$  6 hours
  - File size  $\approx$  1.8 GB
- SHIELD
  - Prompts removed for the altitude, inclination, start date or duration. The altitude and inclination are implicit in the ORDEM3 “.daf” file and the start date and duration are read from the header in the “.key” file
  - Prompt added for the root file name of the “.daf” and the “.key” files
  - Execution time for ISS model with 708,392 elements  $\approx$  10 minutes
  - Output includes subtotals for each population:

RANGE	STARTING	ENDING	PENETRATIONS	NaK	LOW DENSITY	MEDIUM DENSITY	HIGH DENSITY	INTACTS	AREA (M <sup>2</sup> )
1	20001	24858	0.396887E-04	0.107567E-06	0.719892E-06	0.249733E-04	0.127364E-04	0.115151E-05	180.6006077
2	20001	20500	0.195207E-05	0.510211E-38	0.268951E-07	0.141834E-05	0.385058E-06	0.121776E-06	11.6261567





# MEMCxP v2: Background

- Calculates directionality of 1 microgram meteoroids
- Uses Grun flux to calculate other sizes
- Model Populations
  - Asteroids
  - Jupiter family comets
  - Short period comets
  - Long period comets
- Density = constant  $1.0 \text{ g/cm}^3$
- Threats originate from **equal area** patches (like the blocks of ice in an igloo) on the sky sphere similar to the SSP 30425 micrometeoroid threats.
  - 21 speed bins: 0 to 5 km/s, 5 to 15 km/s, 15 to 25 km/s, ... 95 to 105 km/s
  - 1,652 threat directions
  - Note: ORDEM 3.0 uses **equal angular** patches, like lines of latitude and longitude on a globe.





# MEMCXP v2: Data File

- MEMCXP application produces one output file for BUMPER-II
  - Based on random draws from an input file of state vectors describing spacecraft trajectory
  - Default filename: AvgMEMIgllooDist.out (Iglloo patch fluxes in 21 speed bins)
  - 1,652 rows (igloo patches) x 30 columns (speed bins & threat direction info)
- NASA will provide a 400 km MEMCXP v2 environment file for BUMPER-II

Flux distributed by speed bins, speed bin labels are midpoints of speed range

ID	I	J	PHI1B(I)	PHI2B(I)	THETA1B(IJ)	THETA2B(IJ)	PHIavg	THETAavg	0	5	10	15	20	25	30	35	40	45
1	1	1	-90.00	-85.00	0.00	120.00	-87.50	60.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
2	1	2	-90.00	-85.00	120.00	240.00	-87.50	180.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
3	1	3	-90.00	-85.00	240.00	360.00	-87.50	300.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
4	2	1	-85.00	-80.00	0.00	40.00	-82.50	20.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
5	2	2	-85.00	-80.00	40.00	80.00	-82.50	60.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
6	2	3	-85.00	-80.00	80.00	120.00	-82.50	100.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
7	2	4	-85.00	-80.00	120.00	160.00	-82.50	140.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
8	2	5	-85.00	-80.00	160.00	200.00	-82.50	180.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
9	2	6	-85.00	-80.00	200.00	240.00	-82.50	220.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
10	2	7	-85.00	-80.00	240.00	280.00	-82.50	260.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
11	2	8	-85.00	-80.00	280.00	320.00	-82.50	300.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
12	2	9	-85.00	-80.00	320.00	360.00	-82.50	340.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
13	3	1	-80.00	-75.00	0.00	22.50	-77.50	11.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
14	3	2	-80.00	-75.00	22.50	45.00	-77.50	33.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
15	3	3	-80.00	-75.00	45.00	67.50	-77.50	56.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
16	3	4	-80.00	-75.00	67.50	90.00	-77.50	78.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
17	3	5	-80.00	-75.00	90.00	112.50	-77.50	101.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
18	3	6	-80.00	-75.00	112.50	135.00	-77.50	123.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
19	3	7	-80.00	-75.00	135.00	157.50	-77.50	146.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
20	3	8	-80.00	-75.00	157.50	180.00	-77.50	168.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
21	3	9	-80.00	-75.00	180.00	202.50	-77.50	191.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
22	3	10	-80.00	-75.00	202.50	225.00	-77.50	213.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
23	3	11	-80.00	-75.00	225.00	247.50	-77.50	236.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
24	3	12	-80.00	-75.00	247.50	270.00	-77.50	258.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
25	3	13	-80.00	-75.00	270.00	292.50	-77.50	281.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
26	3	14	-80.00	-75.00	292.50	315.00	-77.50	303.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
27	3	15	-80.00	-75.00	315.00	337.50	-77.50	326.25	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
28	3	16	-80.00	-75.00	337.50	360.00	-77.50	348.75	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
29	4	1	-75.00	-70.00	0.00	16.36	-72.50	8.18	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
30	4	2	-75.00	-70.00	16.36	32.73	-72.50	24.55	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
31	4	3	-75.00	-70.00	32.73	49.09	-72.50	40.91	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
32	4	4	-75.00	-70.00	49.09	65.45	-72.50	57.27	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
33	4	5	-75.00	-70.00	65.45	81.82	-72.50	73.64	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
34	4	6	-75.00	-70.00	81.82	98.18	-72.50	90.00	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
35	4	7	-75.00	-70.00	98.18	114.55	-72.50	106.36	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
36	4	8	-75.00	-70.00	114.55	130.91	-72.50	122.73	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
37	4	9	-75.00	-70.00	130.91	147.27	-72.50	139.09	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000
38	4	10	-75.00	-70.00	147.27	163.64	-72.50	155.45	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000	0.000000E+000



# ITA-12 Stage 2014-2

905 Property IDs  
708,392 Elements

