ParticleZoo Data Integrity Report

v1.0.0

Tests Performed: Sat Oct 18 21:46:01 EDT 2025

Report Created: Sat Oct 18 22:55:10 2025

Executive Summary

This report provides a analysis of 156 processed files from the ParticleZoo image comparison tests.

Overall Performance: 156 files (100.00%) were successfully processed, with 0 failures.

Difference Analysis: The average mean difference across all files is 0.000%, with an average maximum difference of 0.000%. The worst-performing files showed a mean difference of 0.000% and a maximum difference of 0.000%.

This report contains breakdowns by phase space, visualizations of key metrics, and analysis of the comparison results.

Test methodology

Validation is performed by converting 156 diverse phase space files (originally sourced from the IAEA phase space database: https://www-nds.iaea.org/phsp/) across all supported binary formats with PHSPConvert. For each file, a baseline particle fluence TIFF image is then created with PHSPImage at the plane of the phase space file. Three dimensional phase space files are projected to a flat XY plane before image generation. The projection plane is chosen at the lowest Z value found in the file. Consistent image settings are derived from known spatial bounds and particle counts of each phase space file. Afterward, the original phase space file is converted across formats with PHSPConvert. Following each conversion, a new TIFF is generated with PHSPImage using the same bounds and resolution to keep pixels directly comparable.

The absolute percentage differences of each pixel in each image compared to their baseline are calculated with ImageJ/Fiji. The differences are calculated relative to the maximum pixel value in the image. The mean percentage differences and the max percentage differences for each phase space file across all iterations of the file conversion process are reported in this report. All of the original files are in the IAEA format, and in the last step of the conversion process they are converted back into IAEA format for the final consistency check. This approach acts as a simultaneous stress test of the ParticleZoo library, PHSPConvert, and PHSPImage. By cycling directly from one converted format to the next, errors are allowed to accumulate at each stage, enhancing sensitivity to issues.

ASCII formats were omitted from this test due to the expected loss of precision during the conversion process.

Testing workflow:

- Baseline imaging: a normalized 32 bit TIFF is generated with PHSPImage of the original phase space file using spatial bounds and image resolutions appropriate for the particle density and distribution in that file.
- Conversion: the phase space file is converted across supported formats with PHSPConvert
- Step imaging: after each conversion, a TIFF is generated with PHSPImage using the same window and resolution as the reference image.
- Comparison: each new image is compared to the baseline with ImageJ/Fiji to compute percentage differences and statistics.
- The order of format conversion goes as follows: IAEA -> TOPAS (Binary) -> TOPAS (Limited) -> EGS -> ROOT -> IAEA

Disclaimer

Global Statistics and Overview

Key Metrics

Metric	Value
Average Mean Difference	0.000%
Average Max Difference	0.000%
Worst Mean Difference	0.000%
Worst Max Difference	0.000%
Overall Status	Good

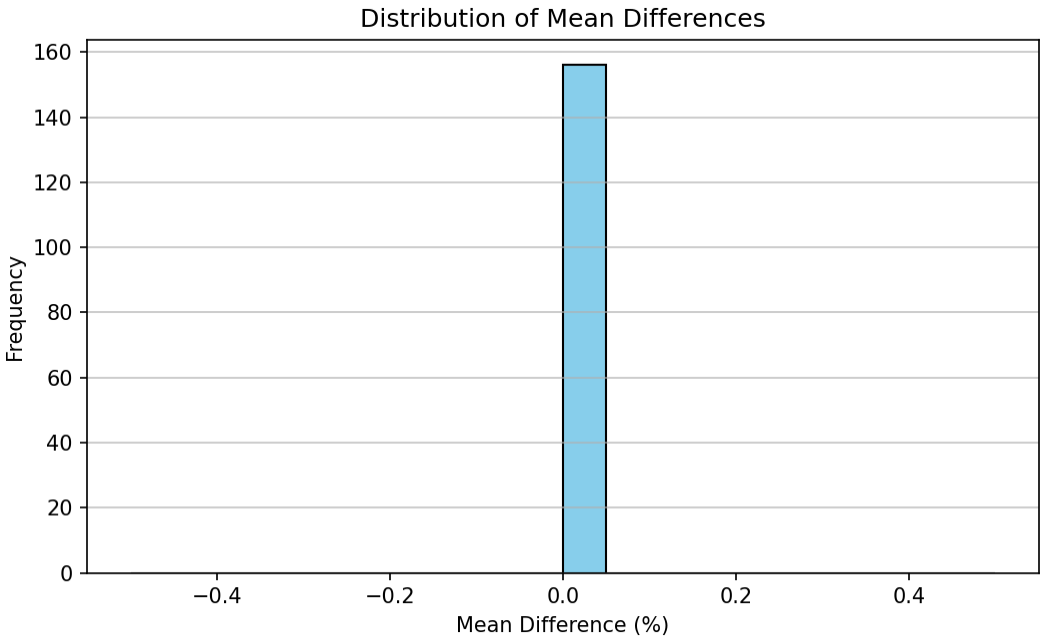
Threshold Bands

Severity Band	Threshold Range
Critical	> 1.0%
Warning	0.2% - 1.0%
Review	0.10% - 0.2%
Good	≤ 0.10%

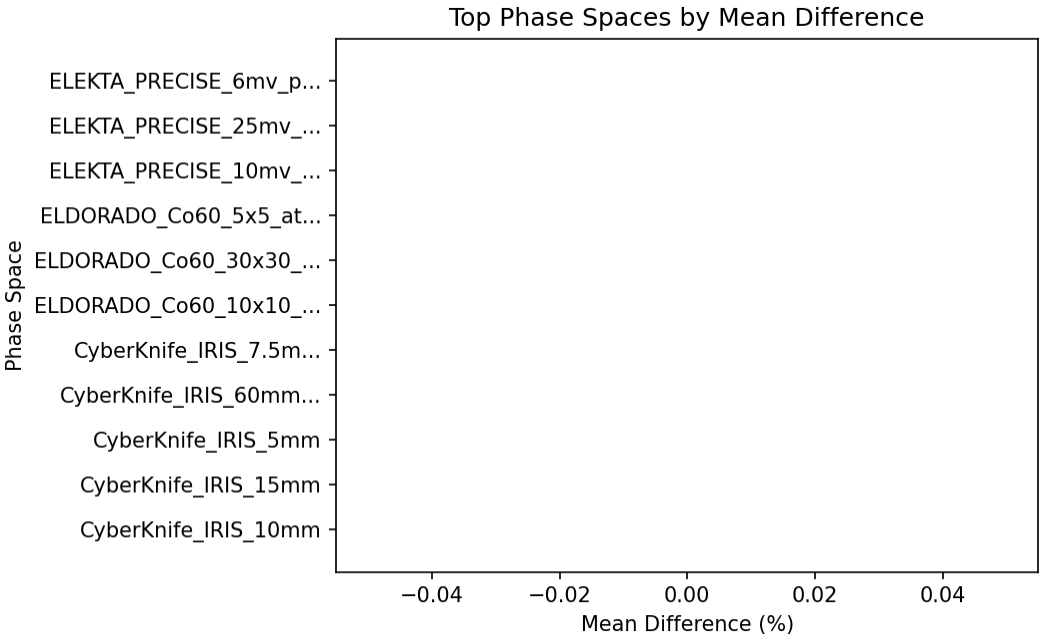
Summary

Phase Space Count by Band: Critical (>5%): 0; Warning (1-5%): 0; Review (0.1-1%): 0; Good (<=0.1%): 156.

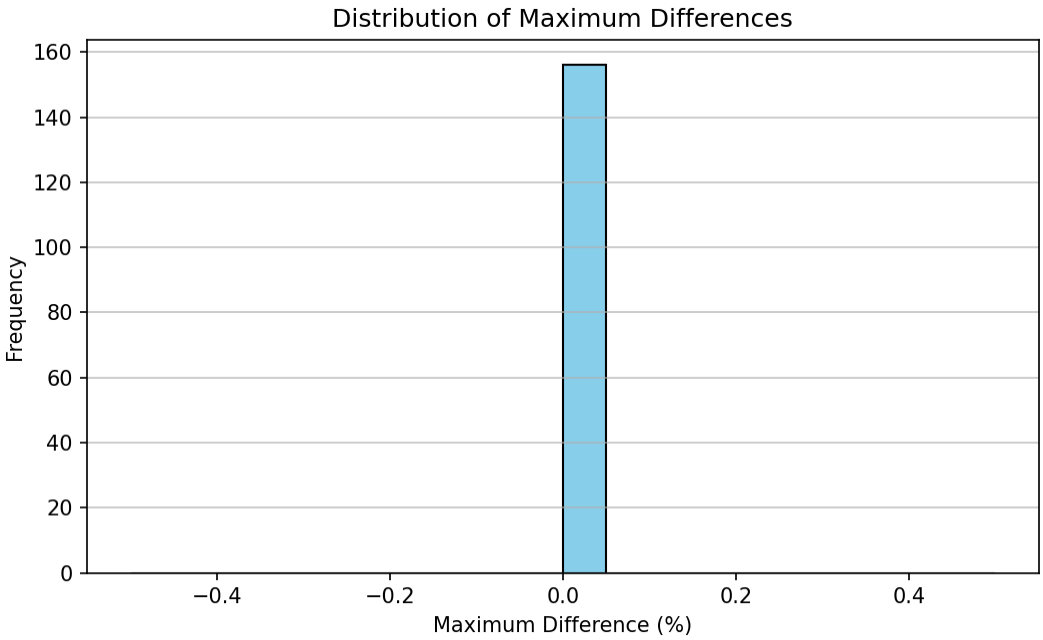
Distribution of Mean Differences



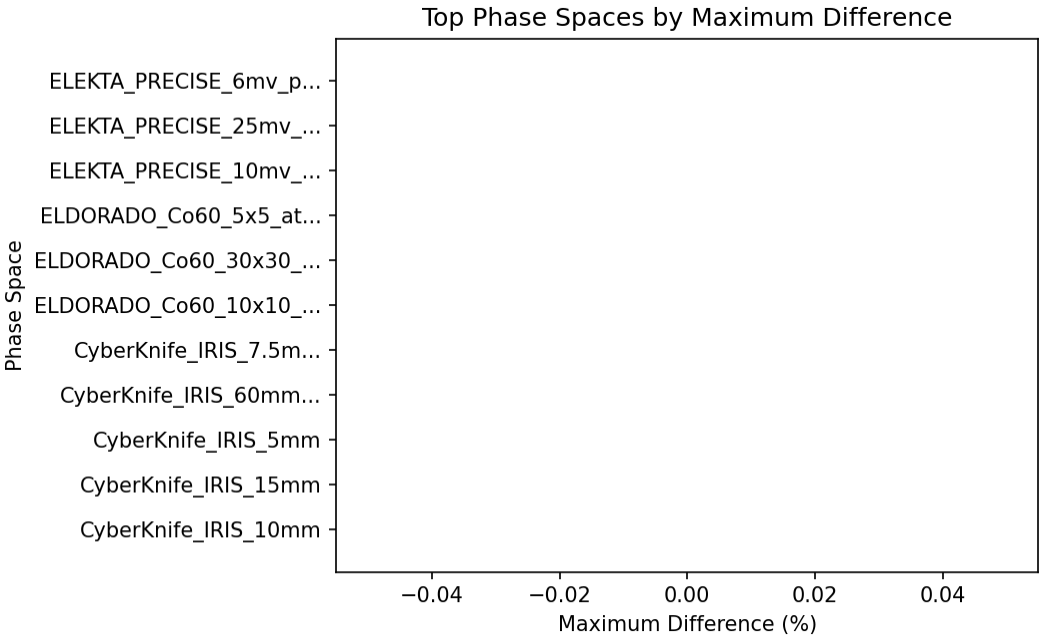
Top Phase Spaces by Mean Difference



Distribution of Maximum Differences



Top Phase Spaces by Maximum Difference



Analysis by Phase Space (Mean Differences)

This section provides a breakdown of mean differences by phase space, categorized by threshold bands.

Phase Spaces for Review

No phase spaces fall into the Review range (0.1-1%).

Good Phase Space Performance (All Items)

Listing all 156 phase spaces with minimal differences (<0.1%).

Good Performance (Set 1)

Phase Space	Mean Difference (%)
CyberKnife_IRIS_10mm	+0.000%
CyberKnife_IRIS_15mm	+0.000%
CyberKnife_IRIS_5mm	+0.000%
CyberKnife_IRIS_60mm_part1	+0.000%
CyberKnife_IRIS_60mm_part2	+0.000%
CyberKnife_IRIS_60mm_part3	+0.000%
CyberKnife_IRIS_60mm_part4	+0.000%
CyberKnife_IRIS_7.5mm	+0.000%
ELDORADO_Co60_10x10_at80p5	+0.000%
ELDORADO_Co60_30x30_at80p5	+0.000%
ELDORADO_Co60_5x5_at80p5	+0.000%
ELEKTA_PRECISE_10mv_part1	+0.000%
ELEKTA_PRECISE_10mv_part2	+0.000%
ELEKTA_PRECISE_10mv_part3	+0.000%
ELEKTA_PRECISE_10mv_part4	+0.000%
ELEKTA_PRECISE_25mv_part1	+0.000%
ELEKTA_PRECISE_25mv_part2	+0.000%
ELEKTA_PRECISE_25mv_part3	+0.000%
ELEKTA_PRECISE_25mv_part4	+0.000%
ELEKTA_PRECISE_6mv_part1	+0.000%
ELEKTA_PRECISE_6mv_part2	+0.000%
ELEKTA_PRECISE_6mv_part3	+0.000%
ELEKTA_PRECISE_6mv_part4	+0.000%
SIEMENS_PRIMUS_6mv_0.5x0.5	+0.000%
SIEMENS_PRIMUS_6mv_0.8x0.8	+0.000%
SIEMENS_PRIMUS_6mv_1.2x1.2	+0.000%

SIEMENS_PRIMUS_6mv_1.5x1.5	+0.000%
SIEMENS_PRIMUS_6mv_1.8x1.8	+0.000%
SIEMENS_PRIMUS_6mv_10x10	+0.000%
SIEMENS_PRIMUS_6mv_15x15	+0.000%
SIEMENS_PRIMUS_6mv_1x1	+0.000%
SIEMENS_PRIMUS_6mv_2.5x2.5	+0.000%
SIEMENS_PRIMUS_6mv_20x20	+0.000%
SIEMENS_PRIMUS_6mv_2x2	+0.000%
SIEMENS_PRIMUS_6mv_3x3	+0.000%
SIEMENS_PRIMUS_6mv_5x5	+0.000%
VarianClinaciX_6MV_05x05	+0.000%
VarianClinaciX_6MV_10x10_w1	+0.000%
VarianClinaciX_6MV_10x10_w2	+0.000%
VarianClinaciX_6MV_10x10_w3	+0.000%
VarianClinaciX_6MV_1x1	+0.000%
VarianClinaciX_6MV_20x20_aboveMLC_w1	+0.000%
VarianClinaciX_6MV_20x20_aboveMLC_w2	+0.000%
VarianClinaciX_6MV_20x20_w1	+0.000%
VarianClinaciX_6MV_20x20_w2	+0.000%
VarianClinaciX_6MV_20x20_w3	+0.000%
VarianClinaciX_6MV_2x2	+0.000%
VarianClinaciX_6MV_4x4	+0.000%
Varian_Clinac_2100CD_6MeV_10x10	+0.000%
Varian_Clinac_2100CD_6MeV_15x15	+0.000%

Good Performance (Set 2)

Phase Space	Mean Difference (%)
Varian_Clinac_2100CD_9MeV_10x10	+0.000%
Varian_Clinac_2100CD_9MeV_15x15	+0.000%
Varian_Clinac_600C_6MV_10x10	+0.000%
Varian_Clinac_600C_6MV_1x1	+0.000%
Varian_TrueBeam6MV_01	+0.000%
Varian_TrueBeam6MV_02	+0.000%
Varian_TrueBeam6MV_03	+0.000%
Varian_TrueBeam6MV_04	+0.000%
Varian_TrueBeam6MV_05	+0.000%
Varian_TrueBeam6MV_06	+0.000%
pxe06h12.1	+0.000%
pxe06h12.2	+0.000%

pxe06h12.3	+0.000%
pxe06h12.4	+0.000%
pxe06h12.5	+0.000%
pxe06h12.6	+0.000%
pxe06h12.7	+0.000%
pxe06h12.8	+0.000%
pxe06h12b.1	+0.000%
pxe06h12b.2	+0.000%
pxe06h12b.3	+0.000%
pxe06h12b.4	+0.000%
pxe06h12b.5	+0.000%
pxe06h12b.6	+0.000%
pxe06h12b.7	+0.000%
pxe06h12b.8	+0.000%
pxe09h12.1	+0.000%
pxe09h12.2	+0.000%
pxe09h12.3	+0.000%
pxe09h12.4	+0.000%
pxe09h12.5	+0.000%
pxe09h12.6	+0.000%
pxe09h12.7	+0.000%
pxe09h12.8	+0.000%
pxe09h12b.1	+0.000%
pxe09h12b.2	+0.000%
pxe09h12b.3	+0.000%
pxe09h12b.4	+0.000%
pxe09h12b.5	+0.000%
pxe09h12b.6	+0.000%
pxe09h12b.7	+0.000%
pxe09h12b.8	+0.000%
pxe12h12.1	+0.000%
pxe12h12.2	+0.000%
pxe12h12.3	+0.000%
pxe12h12.4	+0.000%
pxe12h12.5	+0.000%
pxe12h12.6	+0.000%
pxe12h12.7	+0.000%
pxe12h12.8	+0.000%

Good Performance (Set 3)

Phase Space	Mean Difference (%)
pxe12h12b.1	+0.000%
pxe12h12b.2	+0.000%
pxe12h12b.3	+0.000%
pxe12h12b.4	+0.000%
pxe12h12b.5	+0.000%
pxe12h12b.6	+0.000%
pxe12h12b.7	+0.000%
pxe12h12b.8	+0.000%
pxe15h12.1	+0.000%
pxe15h12.2	+0.000%
pxe15h12.3	+0.000%
pxe15h12.4	+0.000%
pxe15h12.5	+0.000%
pxe15h12.6	+0.000%
pxe15h12.7	+0.000%
pxe15h12.8	+0.000%
pxe15h12b.1	+0.000%
pxe15h12b.2	+0.000%
pxe15h12b.3	+0.000%
pxe15h12b.4	+0.000%
pxe15h12b.5	+0.000%
pxe15h12b.6	+0.000%
pxe15h12b.7	+0.000%
pxe15h12b.8	+0.000%
pxe18h12.1	+0.000%
pxe18h12.2	+0.000%
pxe18h12.3	+0.000%
pxe18h12.4	+0.000%
pxe18h12.5	+0.000%
pxe18h12.6	+0.000%
pxe18h12.7	+0.000%
pxe18h12.8	+0.000%
pxe18h12b.1	+0.000%
pxe18h12b.2	+0.000%
pxe18h12b.3	+0.000%
pxe18h12b.4	+0.000%
pxe18h12b.5	+0.000%

pxe18h12b.6	+0.000%
pxe18h12b.7	+0.000%
pxe18h12b.8	+0.000%
pxe21h12.1	+0.000%
pxe21h12.2	+0.000%
pxe21h12.3	+0.000%
pxe21h12.4	+0.000%
pxe21h12.5	+0.000%
pxe21h12.6	+0.000%
pxe21h12.7	+0.000%
pxe21h12.8	+0.000%
pxe21h12b.1	+0.000%
pxe21h12b.2	+0.000%

Good Performance (Set 4)

Phase Space	Mean Difference (%)
pxe21h12b.3	+0.000%
pxe21h12b.4	+0.000%
pxe21h12b.5	+0.000%
pxe21h12b.6	+0.000%
pxe21h12b.7	+0.000%
pxe21h12b.8	+0.000%

Analysis by Phase Space (Maximum Differences)

This section provides a breakdown of maximum differences by phase space, categorized by threshold bands.

Critical Max Differences

No phase spaces exceed 5% max difference.

Warning Max Differences

No phase spaces between 1-5% max difference.

Phase Spaces for Review (Maximum Differences)

No phase spaces fall into the Review max difference range (0.1-1%).

Good Max Differences

156 phase spaces with <0.1% max difference.

Good Max Differences (Set 1)

Phase Space	Max Difference (%)
CyberKnife_IRIS_10mm	+0.000%
CyberKnife_IRIS_15mm	+0.000%
CyberKnife_IRIS_5mm	+0.000%
CyberKnife_IRIS_60mm_part1	+0.000%
CyberKnife_IRIS_60mm_part2	+0.000%
CyberKnife_IRIS_60mm_part3	+0.000%
CyberKnife_IRIS_60mm_part4	+0.000%
CyberKnife_IRIS_7.5mm	+0.000%
ELDORADO_Co60_10x10_at80p5	+0.000%
ELDORADO_Co60_30x30_at80p5	+0.000%
ELDORADO_Co60_5x5_at80p5	+0.000%
ELEKTA_PRECISE_10mv_part1	+0.000%
ELEKTA_PRECISE_10mv_part2	+0.000%
ELEKTA_PRECISE_10mv_part3	+0.000%
ELEKTA_PRECISE_10mv_part4	+0.000%
ELEKTA_PRECISE_25mv_part1	+0.000%
ELEKTA_PRECISE_25mv_part2	+0.000%
ELEKTA_PRECISE_25mv_part3	+0.000%

ELEKTA_PRECISE_25mv_part4	+0.000%
ELEKTA_PRECISE_6mv_part1	+0.000%
ELEKTA_PRECISE_6mv_part2	+0.000%
ELEKTA_PRECISE_6mv_part3	+0.000%
ELEKTA_PRECISE_6mv_part4	+0.000%
SIEMENS_PRIMUS_6mv_0.5x0.5	+0.000%
SIEMENS_PRIMUS_6mv_0.8x0.8	+0.000%
SIEMENS_PRIMUS_6mv_1.2x1.2	+0.000%
SIEMENS_PRIMUS_6mv_1.5x1.5	+0.000%
SIEMENS_PRIMUS_6mv_1.8x1.8	+0.000%
SIEMENS_PRIMUS_6mv_10x10	+0.000%
SIEMENS_PRIMUS_6mv_15x15	+0.000%
SIEMENS_PRIMUS_6mv_1x1	+0.000%
SIEMENS_PRIMUS_6mv_2.5x2.5	+0.000%
SIEMENS_PRIMUS_6mv_20x20	+0.000%
SIEMENS_PRIMUS_6mv_2x2	+0.000%
SIEMENS_PRIMUS_6mv_3x3	+0.000%
SIEMENS_PRIMUS_6mv_5x5	+0.000%
VarianClinaciX_6MV_05x05	+0.000%
VarianClinaciX_6MV_10x10_w1	+0.000%
VarianClinaciX_6MV_10x10_w2	+0.000%
VarianClinaciX_6MV_10x10_w3	+0.000%
VarianClinaciX_6MV_1x1	+0.000%
VarianClinaciX_6MV_20x20_aboveMLC_w1	+0.000%
VarianClinaciX_6MV_20x20_aboveMLC_w2	+0.000%
VarianClinaciX_6MV_20x20_w1	+0.000%
VarianClinaciX_6MV_20x20_w2	+0.000%
VarianClinaciX_6MV_20x20_w3	+0.000%
VarianClinaciX_6MV_2x2	+0.000%
VarianClinaciX_6MV_4x4	+0.000%
Varian_Clinac_2100CD_6MeV_10x10	+0.000%
Varian_Clinac_2100CD_6MeV_15x15	+0.000%
Varian_Clinac_2100CD_9MeV_10x10	+0.000%
Varian_Clinac_2100CD_9MeV_15x15	+0.000%
Varian_Clinac_600C_6MV_10x10	+0.000%
Varian_Clinac_600C_6MV_1x1	+0.000%
Varian_TrueBeam6MV_01	+0.000%
Varian_TrueBeam6MV_02	+0.000%
Varian_TrueBeam6MV_03	+0.000%

Varian_TrueBeam6MV_04	+0.000%
Varian_TrueBeam6MV_05	+0.000%
Varian_TrueBeam6MV_06	+0.000%

Good Max Differences (Set 2)

Phase Space	Max Difference (%)
pxe06h12.1	+0.000%
pxe06h12.2	+0.000%
pxe06h12.3	+0.000%
pxe06h12.4	+0.000%
pxe06h12.5	+0.000%
pxe06h12.6	+0.000%
pxe06h12.7	+0.000%
pxe06h12.8	+0.000%
pxe06h12b.1	+0.000%
pxe06h12b.2	+0.000%
pxe06h12b.3	+0.000%
pxe06h12b.4	+0.000%
pxe06h12b.5	+0.000%
pxe06h12b.6	+0.000%
pxe06h12b.7	+0.000%
pxe06h12b.8	+0.000%
pxe09h12.1	+0.000%
pxe09h12.2	+0.000%
pxe09h12.3	+0.000%
pxe09h12.4	+0.000%
pxe09h12.5	+0.000%
pxe09h12.6	+0.000%
pxe09h12.7	+0.000%
pxe09h12.8	+0.000%
pxe09h12b.1	+0.000%
pxe09h12b.2	+0.000%
pxe09h12b.3	+0.000%
pxe09h12b.4	+0.000%
pxe09h12b.5	+0.000%
pxe09h12b.6	+0.000%
pxe09h12b.7	+0.000%
pxe09h12b.8	+0.000%
pxe12h12.1	+0.000%

pxe12h12.2	+0.000%
pxe12h12.3	+0.000%
pxe12h12.4	+0.000%
pxe12h12.5	+0.000%
pxe12h12.6	+0.000%
pxe12h12.7	+0.000%
pxe12h12.8	+0.000%
pxe12h12b.1	+0.000%
pxe12h12b.2	+0.000%
pxe12h12b.3	+0.000%
pxe12h12b.4	+0.000%
pxe12h12b.5	+0.000%
pxe12h12b.6	+0.000%
pxe12h12b.7	+0.000%
pxe12h12b.8	+0.000%
pxe15h12.1	+0.000%
pxe15h12.2	+0.000%
pxe15h12.3	+0.000%
pxe15h12.4	+0.000%
pxe15h12.5	+0.000%
pxe15h12.6	+0.000%
pxe15h12.7	+0.000%
pxe15h12.8	+0.000%
pxe15h12b.1	+0.000%
pxe15h12b.2	+0.000%
pxe15h12b.3	+0.000%
pxe15h12b.4	+0.000%

Good Max Differences (Set 3)

Phase Space	Max Difference (%)
pxe15h12b.5	+0.000%
pxe15h12b.6	+0.000%
pxe15h12b.7	+0.000%
pxe15h12b.8	+0.000%
pxe18h12.1	+0.000%
pxe18h12.2	+0.000%
pxe18h12.3	+0.000%
pxe18h12.4	+0.000%
pxe18h12.5	+0.000%

pxe18h12.6	+0.000%
pxe18h12.7	+0.000%
pxe18h12.8	+0.000%
pxe18h12b.1	+0.000%
pxe18h12b.2	+0.000%
pxe18h12b.3	+0.000%
pxe18h12b.4	+0.000%
pxe18h12b.5	+0.000%
pxe18h12b.6	+0.000%
pxe18h12b.7	+0.000%
pxe18h12b.8	+0.000%
pxe21h12.1	+0.000%
pxe21h12.2	+0.000%
pxe21h12.3	+0.000%
pxe21h12.4	+0.000%
pxe21h12.5	+0.000%
pxe21h12.6	+0.000%
pxe21h12.7	+0.000%
pxe21h12.8	+0.000%
pxe21h12b.1	+0.000%
pxe21h12b.2	+0.000%
pxe21h12b.3	+0.000%
pxe21h12b.4	+0.000%
pxe21h12b.5	+0.000%
pxe21h12b.6	+0.000%
pxe21h12b.7	+0.000%
pxe21h12b.8	+0.000%