

EMEC Sectors Analysis and Luminosity study using the EMEC HV system

Nacim HADDAD⁽¹⁾

Rajaa Cherkaoui El Moursli⁽¹⁾

Emmanuel Monnier⁽²⁾

(1) Université Mohammed V Rabat - (2) Faculté des Sciences de Luminy

Outline

- ❖ High-voltage channels selection
- ❖ Update in luminosity determination using EMEC HV current
- ❖ Comparison of 3 cross calibration methods
 - ✧ *2-Parameter Fit of EMEC to BCM*
 - ✧ *Impact of EMEC Current Pedestal*
 - ✧ *1-Parameter Fit to EMEC Vs. BCM with direct Measurement of Current before collision*
- ❖ EMEC Sectors Analysis

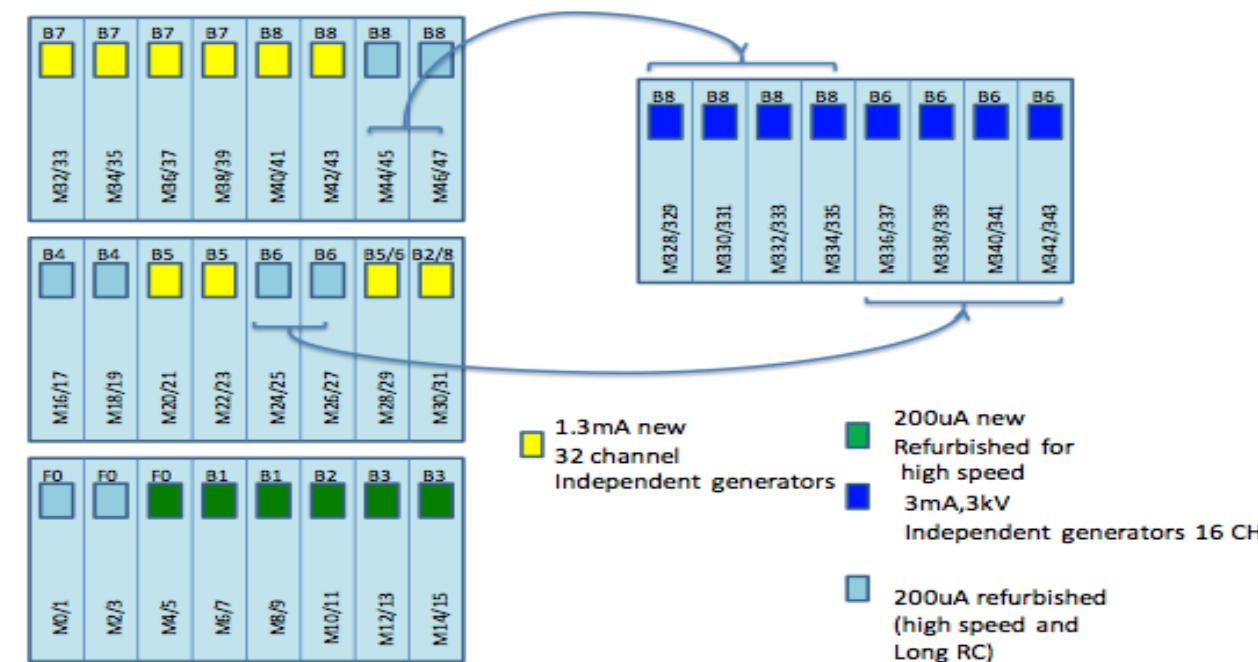
⌘ High-voltage channels Selection/1

- The main feature of the EMEC is its variable gap size: the LAr gap increase when η decrease.
- In order to maintain a uniform response across the EMEC, the HV applied to the different η -sectors varies accordingly.
- The selection procedure was designed to identify issues that would affect the different EMEC sectors performance and ensure that only the best data will be used for luminosity determination .

□ New Modules insertion

- Since 2010, the high-voltage experts decided to implement many features :

- New philosophy ‘auto-recovery mode’ of HV trip management (new firmware : FW 4.34).
- The EMEC sectors have been fed with HV modules with less sensitive to trips (‘long RC’).
- New 32-channel HV modules equipped with independent HV generators are inserted to the sectors from B5 to B8.

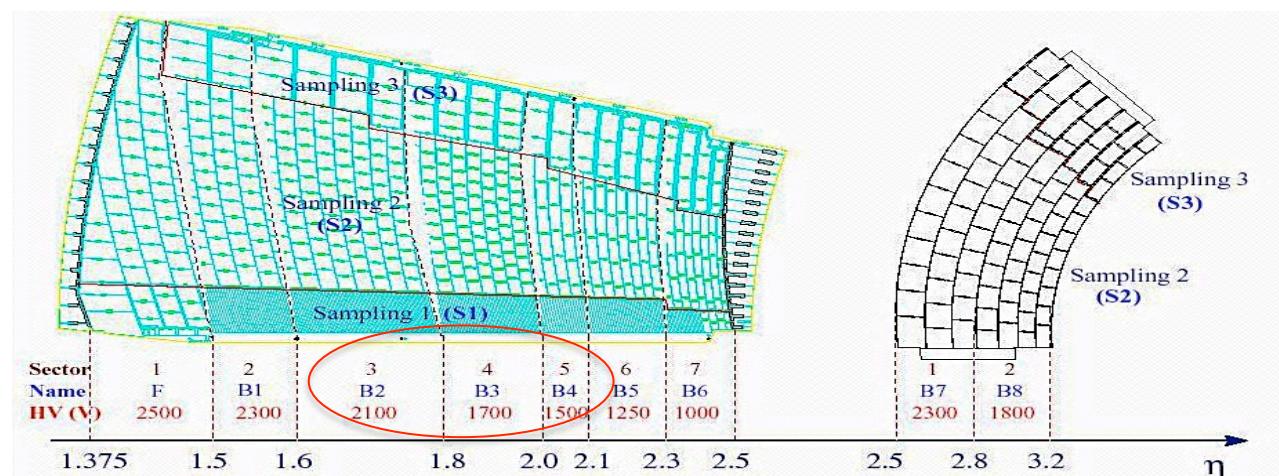


□ Regular Change during 2012

- The modules of sector F0 and B1 have known a regular change during 2012:
 - Many current noise studies in case of sector F0
 - Continuous problems in several channels of sector B1.



As result, we will ignore these sectors to retrain only the HV Lines of sectors B2, B3 and B4.



⌘ High-voltage channels Selection/2

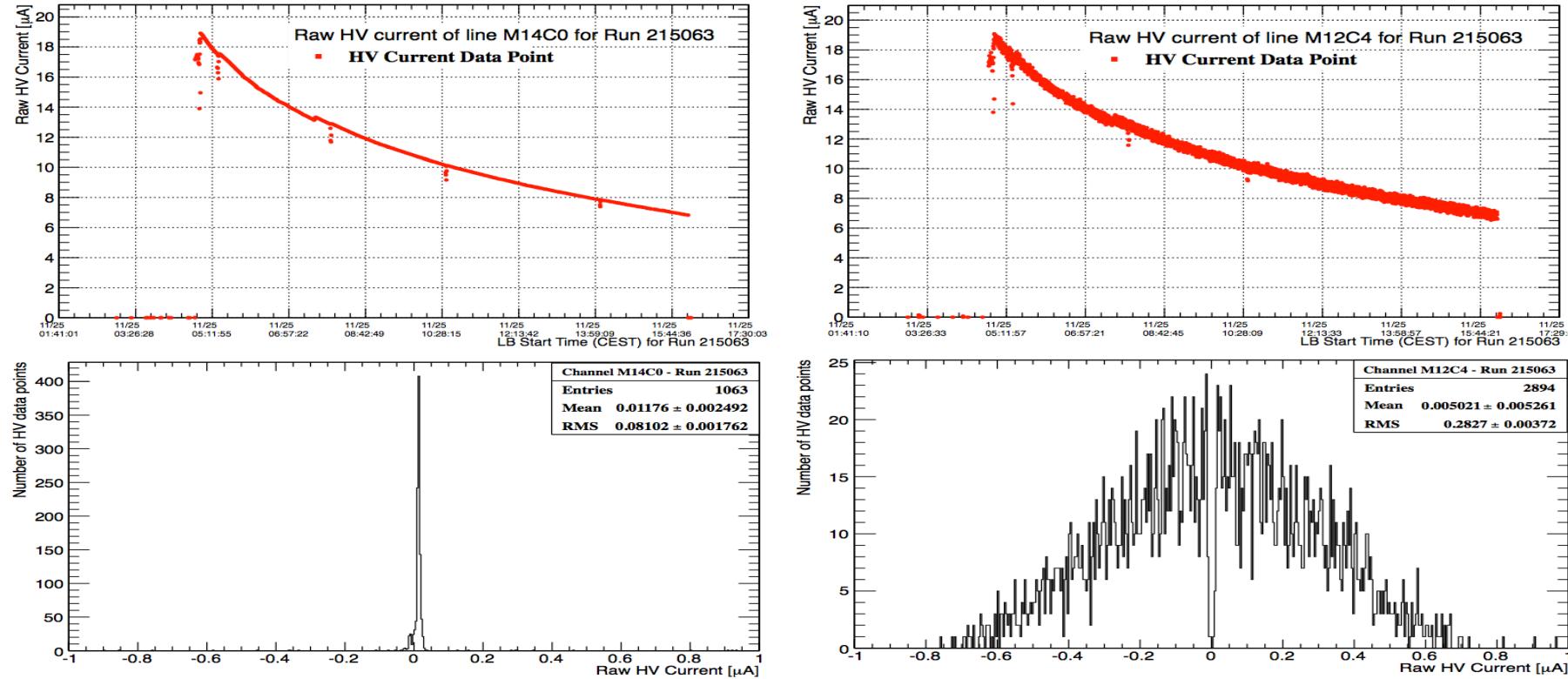
- The High-voltage lines selection has been performed through three different procedures to get a consistent picture of the HV current during each Run.

□ Selection Through number of electrodes

- Retain only channels with 24 electrodes or at least 23 electrodes.
→ 'M111C0' was made by 12 electrodes, which imply a low current and an immediate rejection

□ HV lines with low current noise

- we viewed the root mean square of the distribution of the difference between two successive HV current data points.
→ **RMS > 0.12 μA** represent cases where the current is prone to bursts of noise, resulting in current fluctuations with time.



□ Deadbands for the readout current

- Given this insufficient number of current data point, the selection was performed through de 'Macro Luminosity Blocks (MacroLB ~ 10 minutes)'.
→ Channels with **at least 5 current data points Per Macro Luminosity blocks**.

⌘ High-voltage channels Selection/3

- The combination of these selection criteria bring down the total number of HV lines usable for luminosity determination to 94 out of 576 in EMEC-A and 102 out of 576 in EMEC-C. ➔ **~16% of EMEC-A & ~17% of EMEC-C.**

| EMEC | | | | High-Voltage Line (Channels) | | | | | | | | | | | | | | | |
|-----------|--|-----------|---------|------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Detector | Sides | Sectors | Modules | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 |
| EMEC-A | Electromagnetic End-Cap Calorimeter (EMEC) | Sector B2 | Mod.08 | | | | | | | | | | | | | | | | |
| | | | Mod.09 | | | | | | | | | | | | | | | | |
| | | | Mod.10 | | | | | | | | | | | | | | | | |
| | | | Mod.11 | | | | | | | | | | | | | | | | |
| | | | Mod.12 | | | | | | | | | | | | | | | | |
| | | | Mod.13 | | | | | | | | | | | | | | | | |
| | | | Mod.14 | | | | | | | | | | | | | | | | |
| | | | Mod.15 | | | | | | | | | | | | | | | | |
| | | | Mod.16 | | | | | | | | | | | | | | | | |
| | | | Mod.17 | | | | | | | | | | | | | | | | |
| EMEC-C | Electromagnetic End-Cap Calorimeter (EMEC) | Sector B4 | Mod.18 | | | | | | | | | | | | | | | | |
| | | | Mod.19 | | | | | | | | | | | | | | | | |
| | | | Mod.108 | | | | | | | | | | | | | | | | |
| | | | Mod.109 | | | | | | | | | | | | | | | | |
| | | | Mod.110 | | | | | | | | | | | | | | | | |
| | | | Mod.111 | | | | | | | | | | | | | | | | |
| | | | Mod.112 | | | | | | | | | | | | | | | | |
| | | | Mod.113 | | | | | | | | | | | | | | | | |
| | | | Mod.114 | | | | | | | | | | | | | | | | |
| | | | Mod.115 | | | | | | | | | | | | | | | | |
| Sector B4 | Sector B3 | Sector B2 | Mod.116 | | | | | | | | | | | | | | | | |
| | | | Mod.117 | | | | | | | | | | | | | | | | |
| | | | Mod.118 | | | | | | | | | | | | | | | | |
| | | | Mod.119 | | | | | | | | | | | | | | | | |



: Bad High-Voltage Line



: Good high-voltage line



: Line with Low Number of data points by MacroLB



⌘ Update in luminosity determination

□ We increase the Number of Runs to **278 Run**. We keep {After Selection} : **192 Good Run**

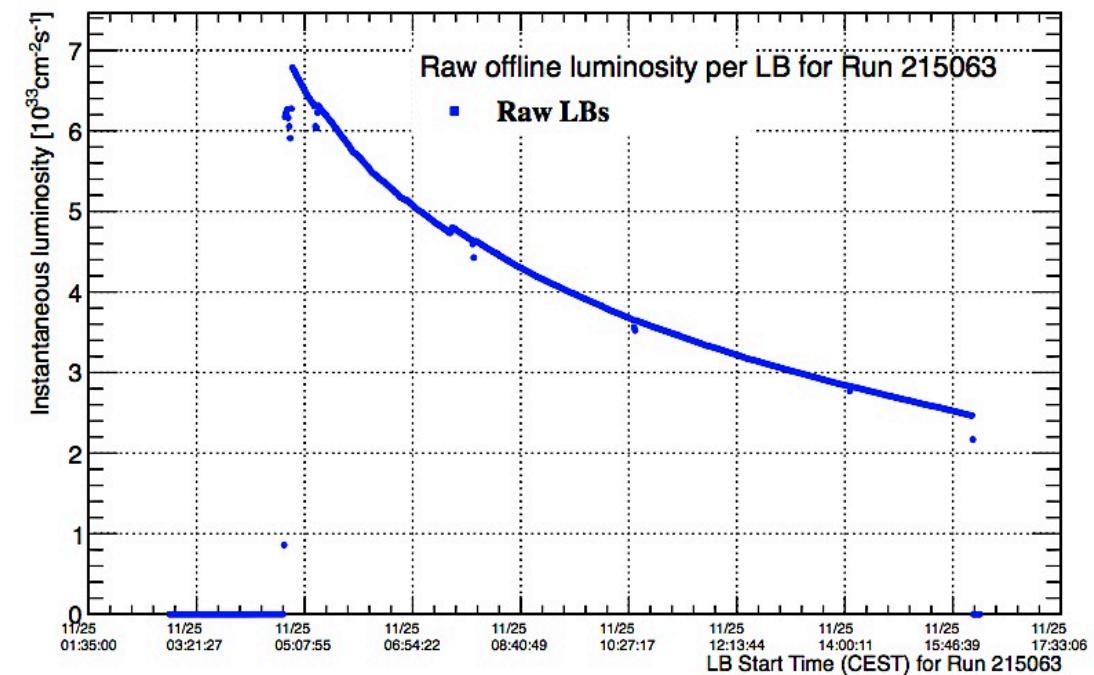
□ Good luminosity Blocks selection

The Selection of Good LumiBlock is Based on 4 criteria, In case of **215063**:

- ✓ **Stable Beams** : Select only the period of stable beams.
- ✓ **Ready for Physics** : Select only the LB ready for physics.

| Run | Links | #LB | Start and endtime (local) | #Events | Ready for physics | LHC FILL | Stable beams |
|-----------------------------------|---|---------------|--|--------------------------|---|--|--|
| 215063 Period: J7,J AllYear | DS, RS, BS, AMI, DQ, ELOG, DCS:SoR/EoR, OKS | 848 (56 s) | Sun Nov 25 2012 02:54:51 – 16:13:40 | 18,807,156 (392.4 Hz) | LB 1 – 124: 0 LB 125 – 833: 1 LB 834 – 848: 0 | LB 1 – 21: 3320 LB 22 – 24: 3321 LB 25 – 848: 3322 | LB 1 – 120: FALSE LB 121 – 842: TRUE LB 843 – 848: FALSE |

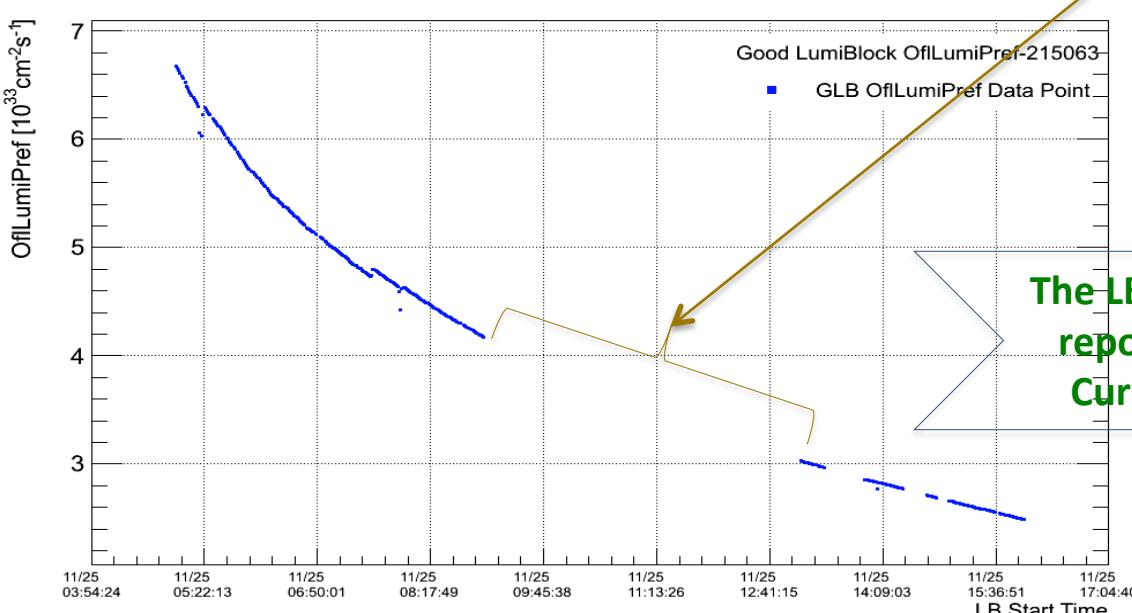
- ✓ **Long LB Duration** : Remove each short LB because that correspond to change of trigger conditions. **LB Duration > 59 s**
- ✓ **Good LB from GRL Report** : Remove each LB selected as bad LB in the Good run List report



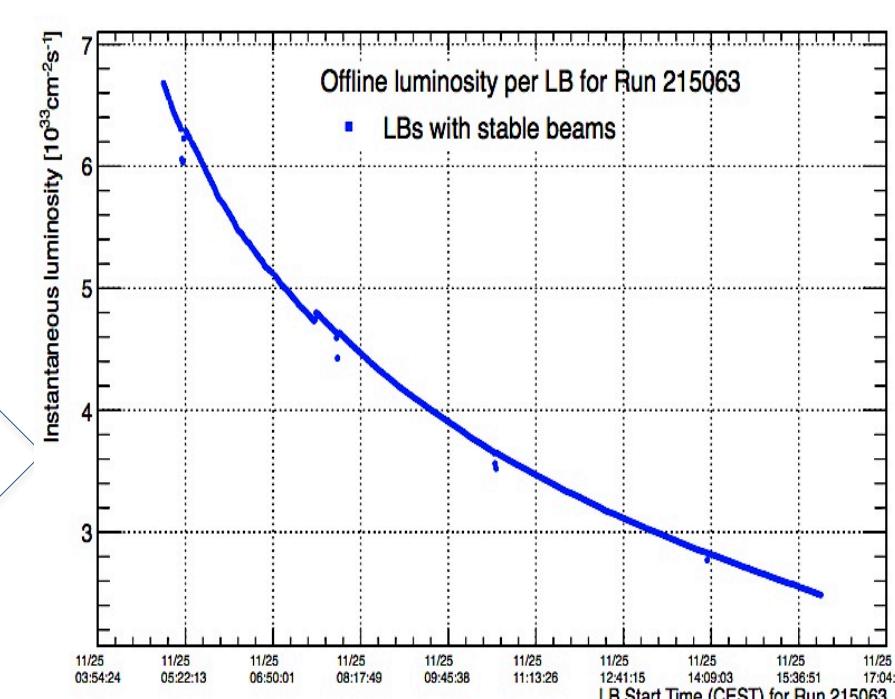
Run: 215063 832 lumi blocks 44.71 % Good

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 |
| 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

□ BCM Luminosity after LB selection



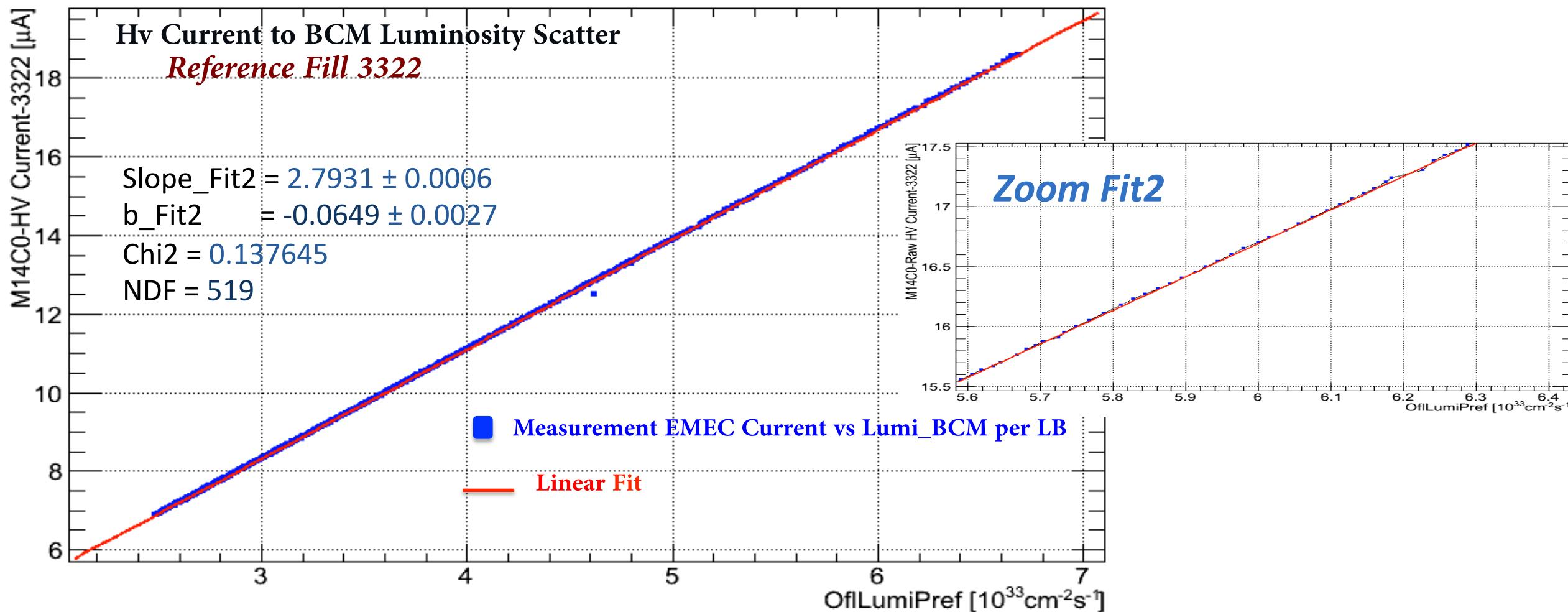
The LB selected as Bad in the GRL report has no effect to The HV Current and BCM Luminosity



2-Parameter Fit of EMEC To BCM (b_Fit2, Slope_Fit2)

The Analysis Steps

- For the reference Fill “3322”, Plot the Scatter of HV Current and BCM Luminosity.
- Apply a Linear Fit to this scatter then Get the Fit parameters {Slope_Fit2 ; b_Fit2}

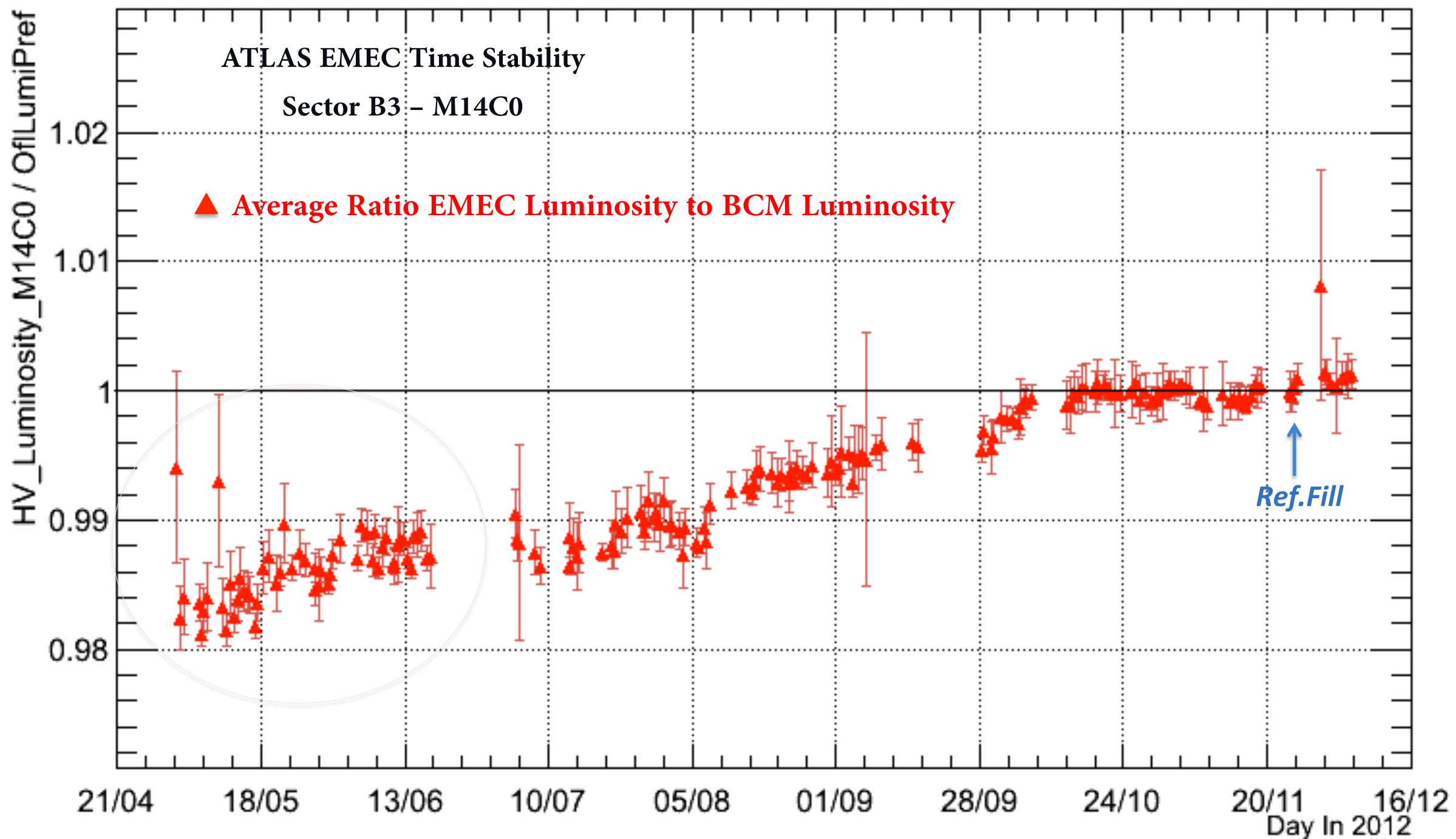


- Use this Fit parameters to Get the EMEC Luminosity

$$\text{EMEC_Luminosity} = [(1 / \text{Slope_Fit2}) * \text{HvCurrent} - (\text{b_Fit2} / \text{Slope_Fit2})]$$

- Plot the Average Ratio of EMEC HV Luminosity To BCM Luminosity [EMEC Time stability]

⌚ 2-Parameter Fit of EMEC To BCM (b_Fit2 , Slope_Fit2)



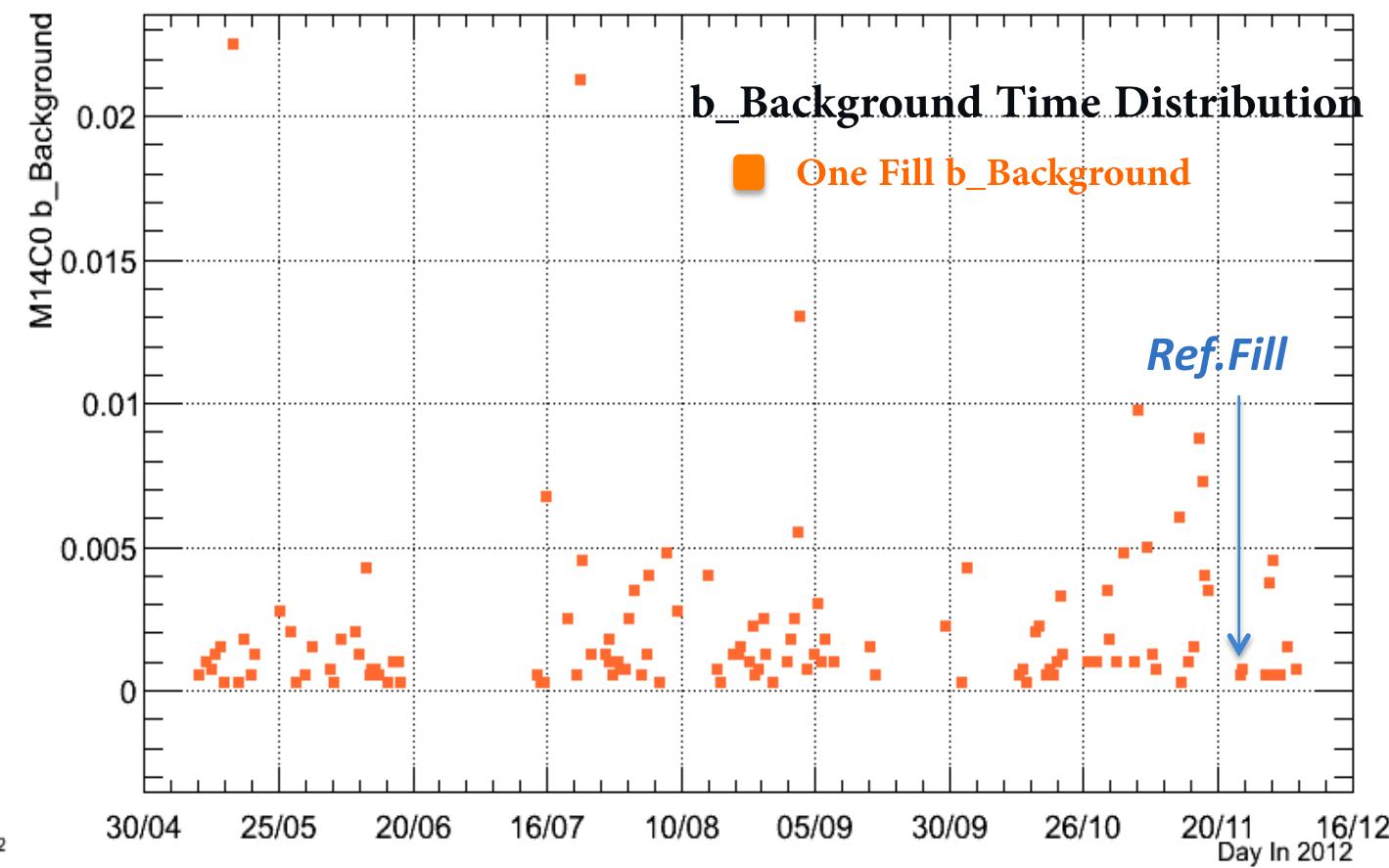
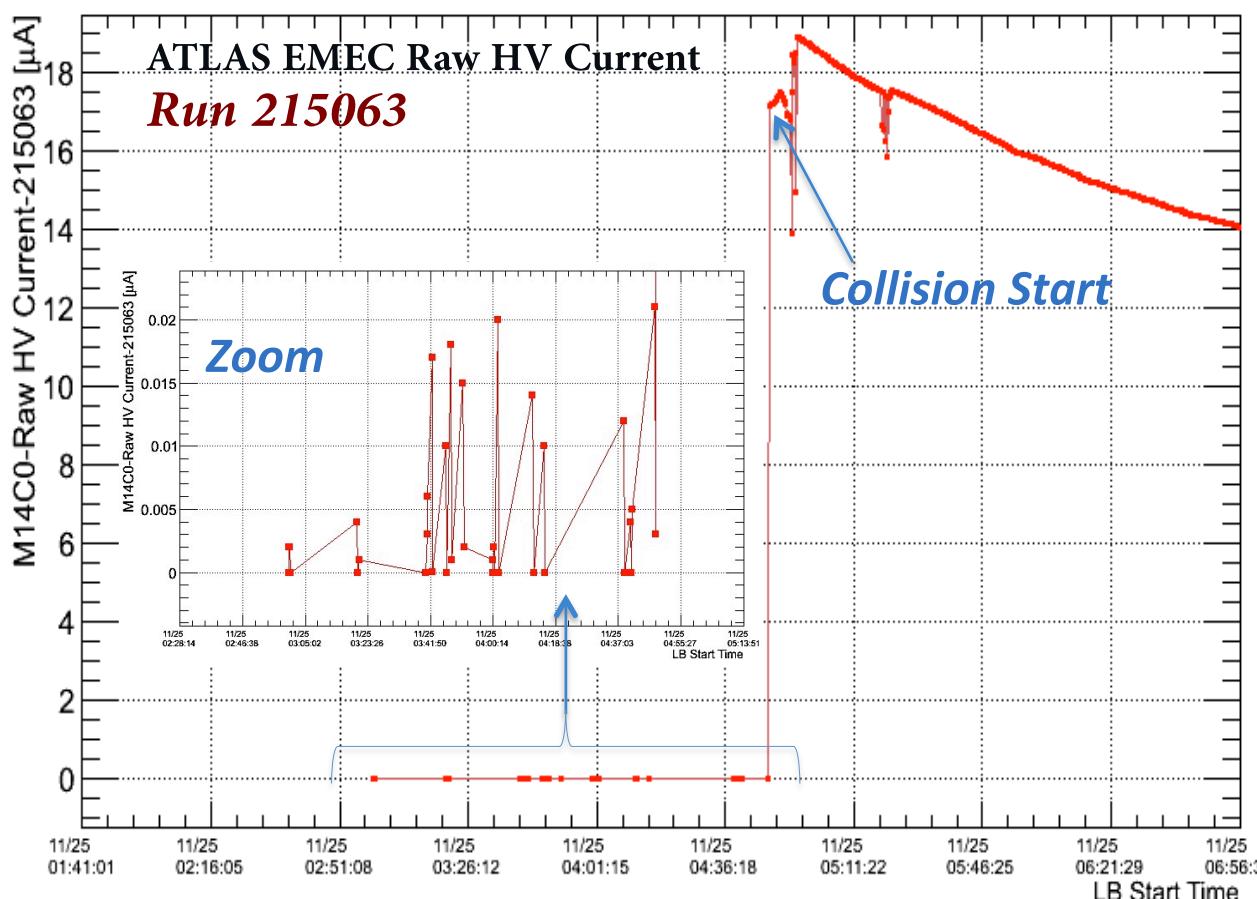
➤ **Slope_Fit2 = 2.79319** (For the Ref. Fill) **b-Fit2 = -0.06493** (For the Ref. Fill)

➔ b-Fit2 correspond to ~0.5% of Average Current

⌚ Impact of the EMEC Current Pedestal (b_Background , Slope_Fit2)

❑ The Analysis Steps

- For the reference Fill “3322”, Plot the **Scatter of HV Current and BCM Luminosity**.
- Apply the same Linear **Fit2** intercept by **b-Background**, then get the **Fit parameters {Slope_Fit2, b_Background}**.
- {**b_Background**} correspond to the Average of the sum of 3 entries before Collision for each Fill.

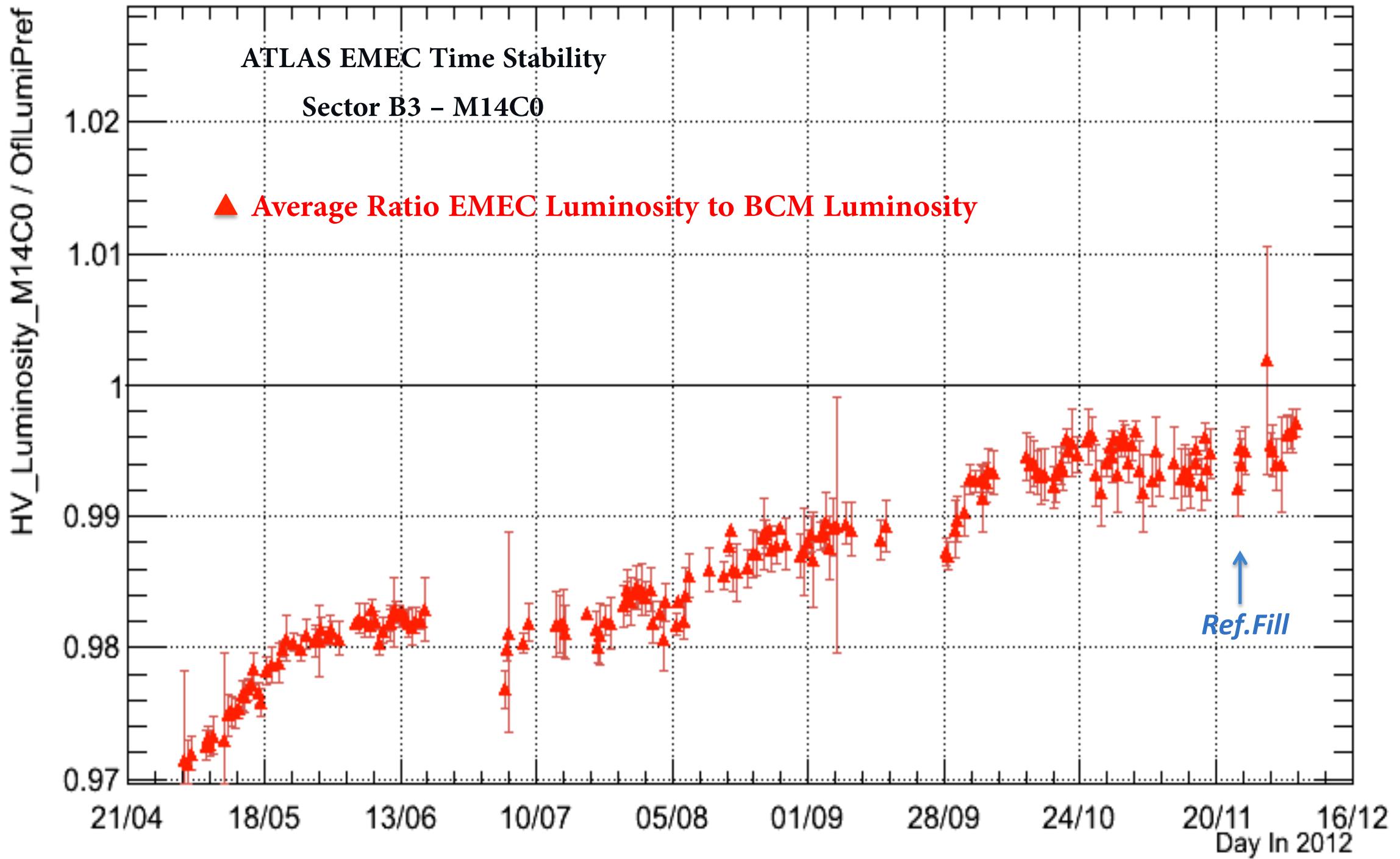


- Use this two parameters {Slope_Fit2 & b_Background} to Get the **EMEC Luminosity**

$$\text{EMEC_Luminosity} = [(1 / \text{Slope_Fit2}) * \text{HvCurrent} - (b_{\text{Background}} / \text{Slope_Fit2})]$$

- Plot the **Average Ratio** of EMEC Hv Luminosity To OfLumiPref [**EMEC Time stability**]

❖ Impact of the EMEC Current Pedestal (b_Background, Slope_Fit2)

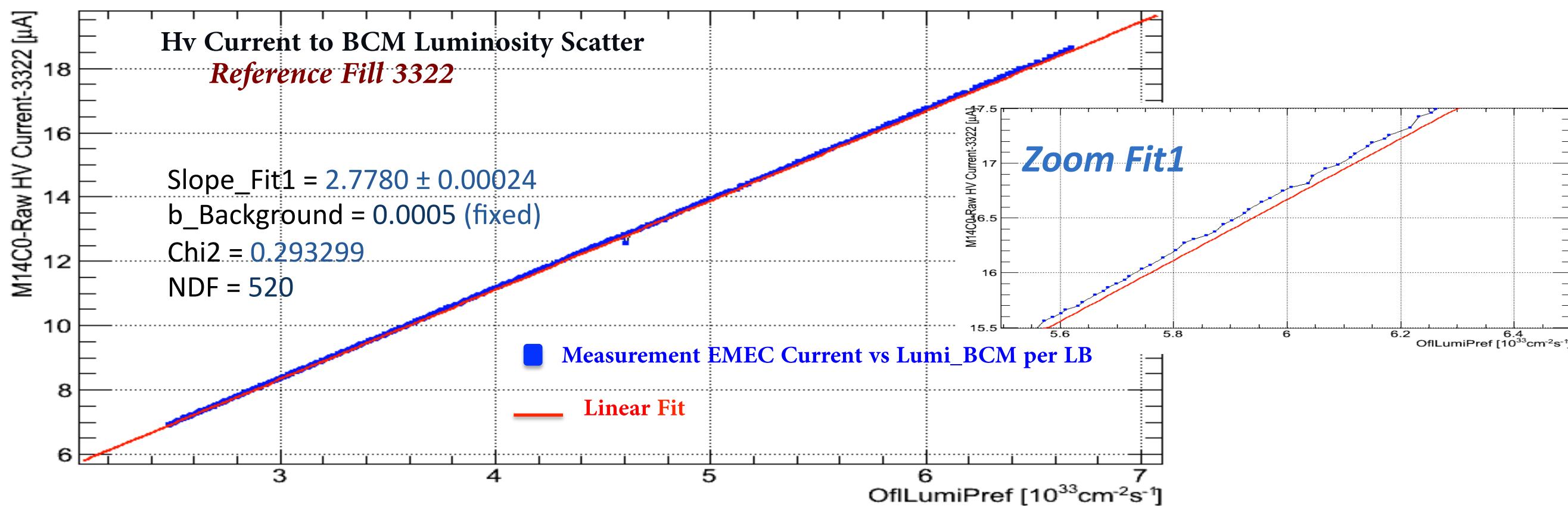


- **Slope_Fit2 = 2.79319** (For the Ref. Fill) **b_Background = 0.0005** (For Ref. Fill, But we get for each Fill a independent b_Background)
- The EMEC Response decrease (by ~0.6%) due to the low b_Background

⌚ 1-Parameter Fit to EMEC vs BCM (b_Background , Slope_Fit1)

The Analysis Steps

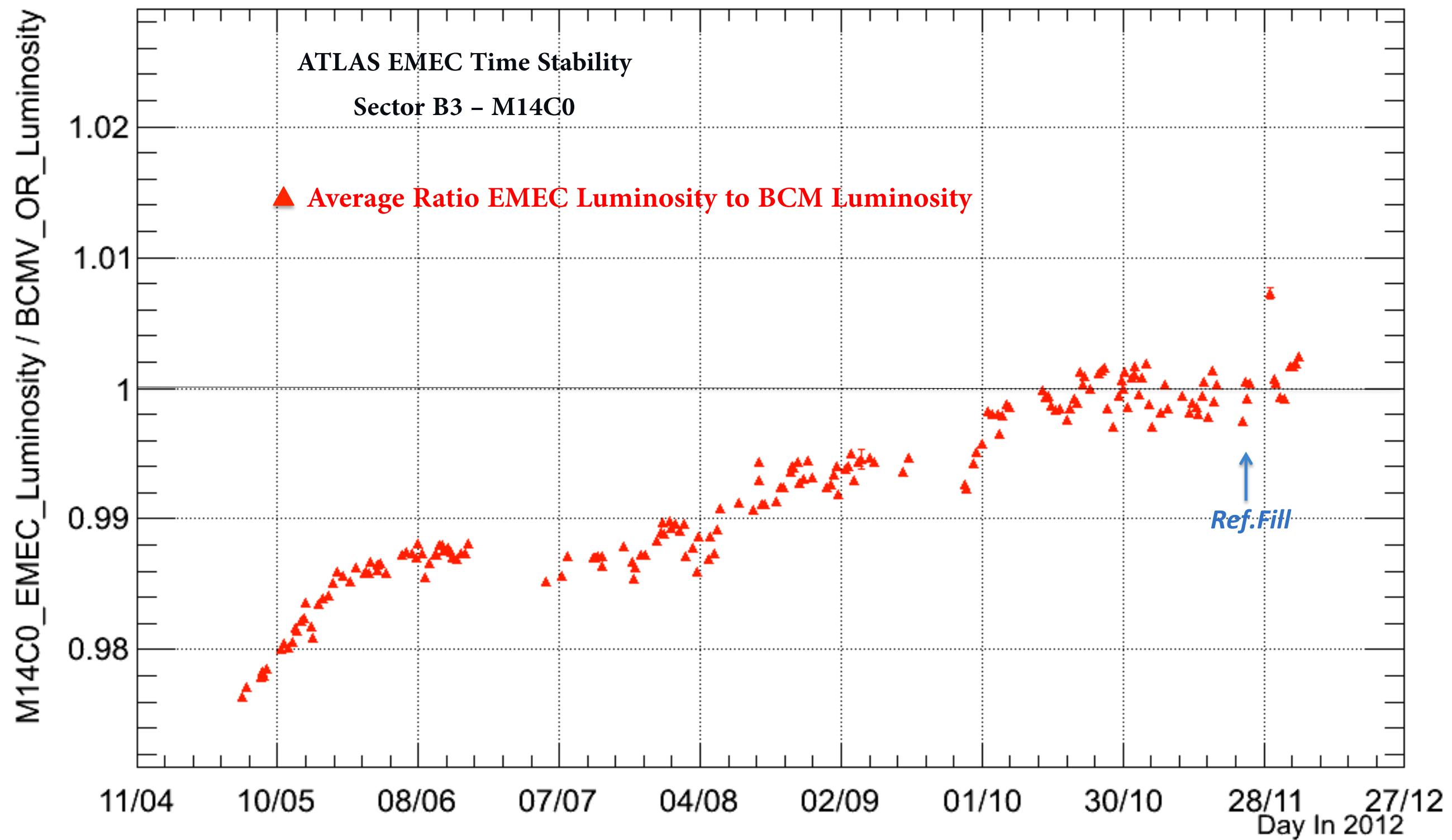
- For the Reference Fill '3322', Plot the **Scatter of HV Current and BCM Luminosity**.
- Apply a Linear **Fit** to this scatter using a new linear Function :
 $\{ [\text{Slope_Fit1}] * x + [\text{b_Background}] \}$ with a fixed b (b_background).



- Get the Average of the sum of 3 entries before Collision **{b_Background}** for each Fill.
- Use this two parameters {Slope_Fit1 & b_Background} to Get the **EMEC Luminosity**

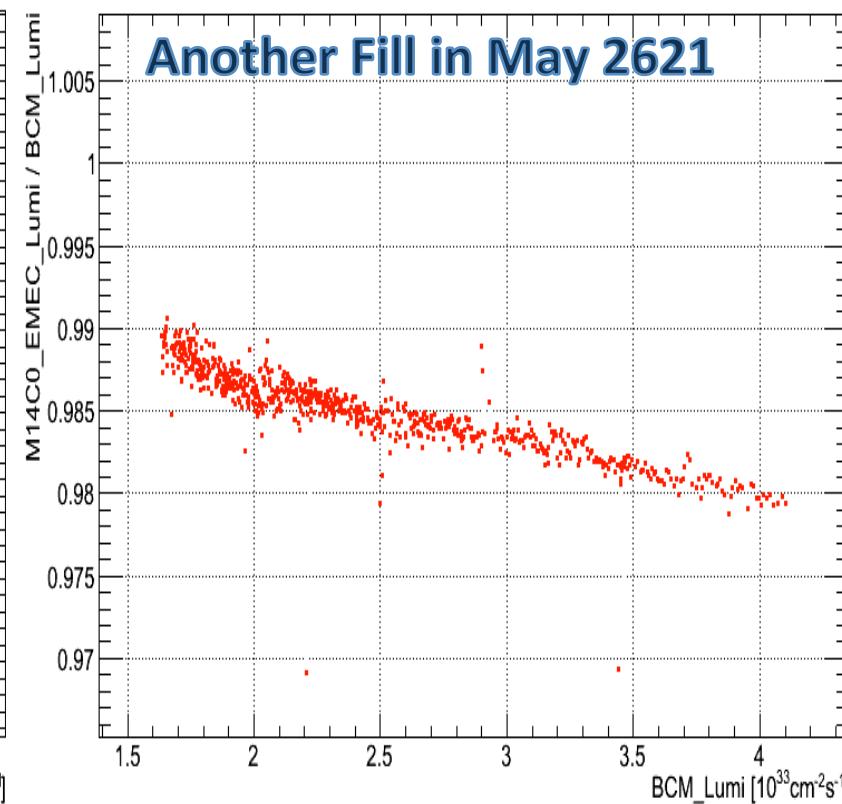
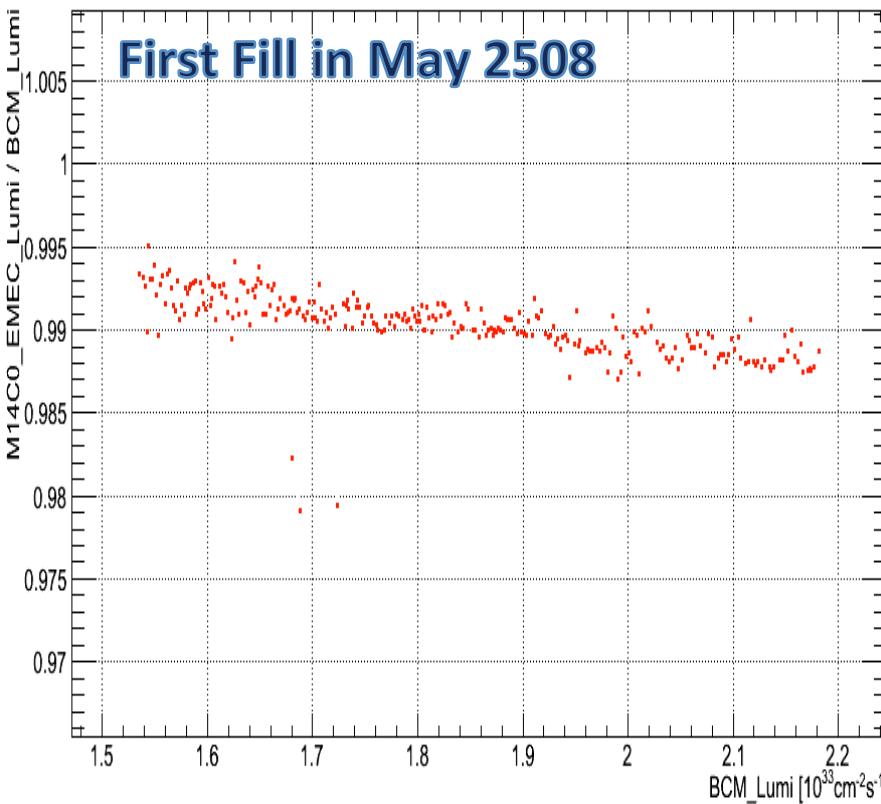
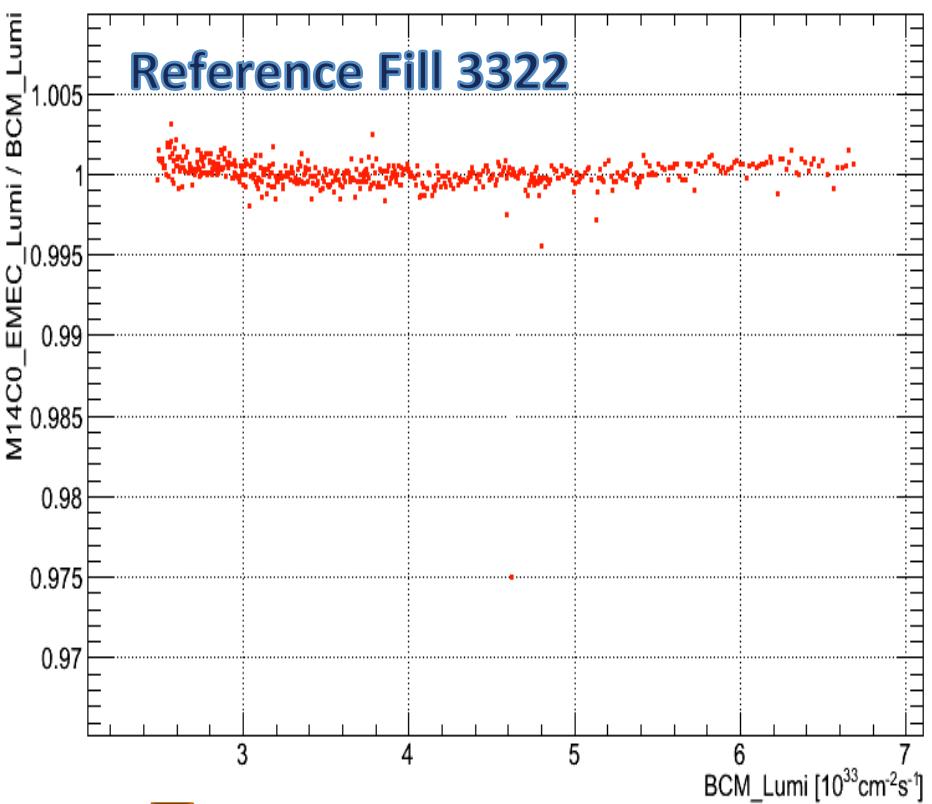
$$\text{EMEC_Luminosity} = [(1 / \text{slope_Fit}) * \text{HvCurrent} - (\text{b_Background} / \text{Slope_Fit1})]$$
- Plot the **Average Ratio** of EMEC HV Luminosity To OfLumiPref [**EMEC Time stability**]

❖ 1-Parameter Fit to EMEC vs BCM (b_Background , Slope_Fit1)

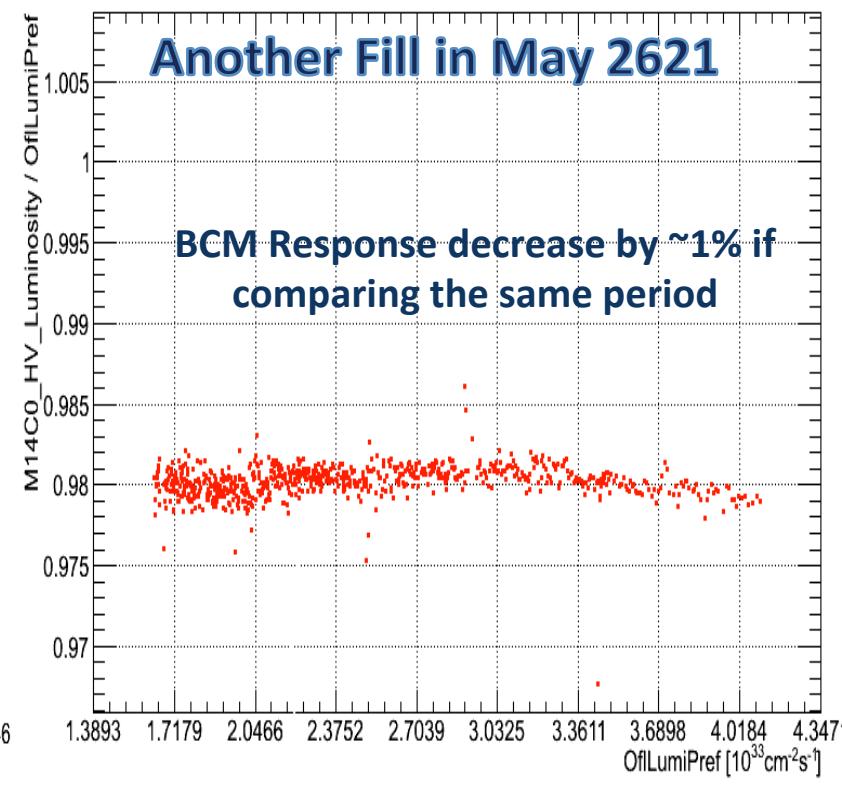
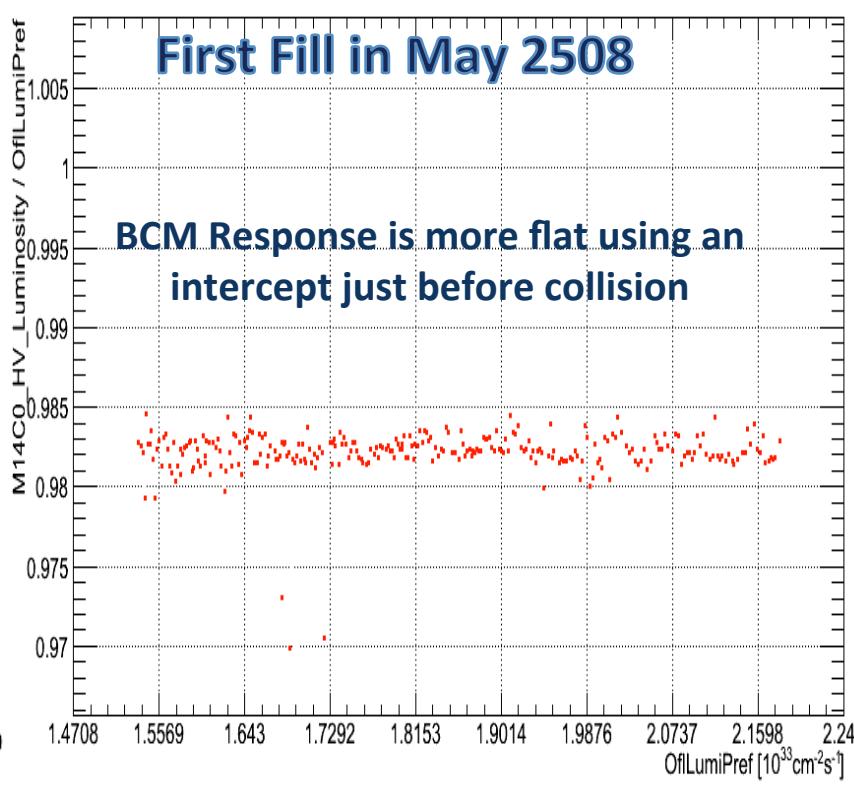
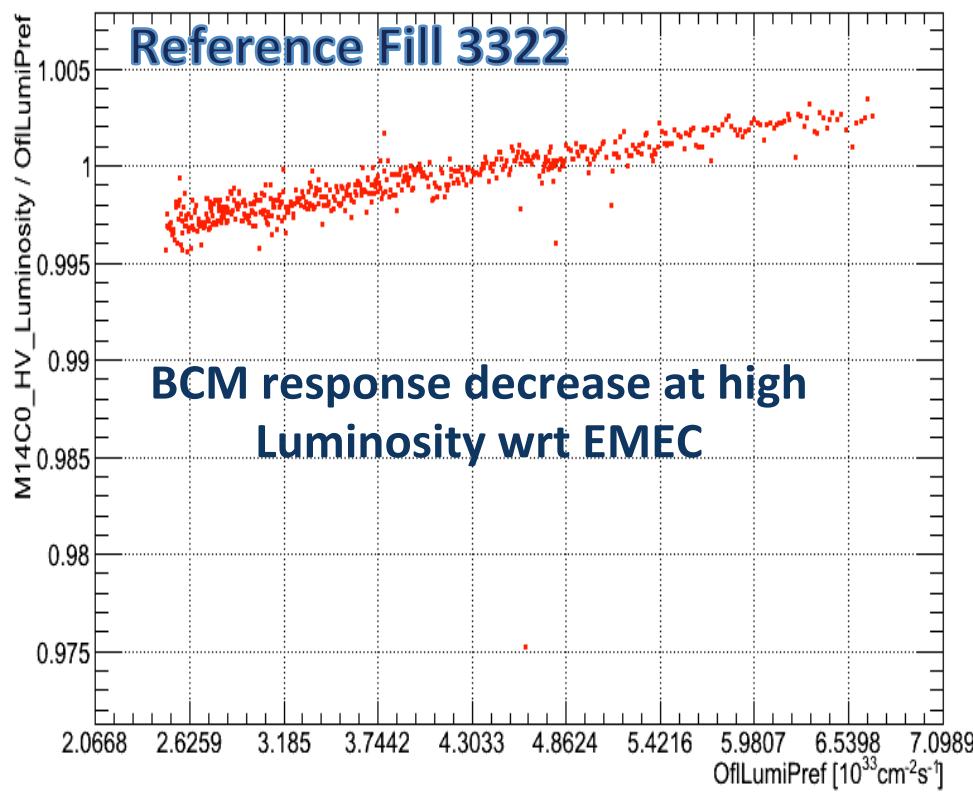


EMEC Ratio Luminosity To BCM Luminosity

2-Parameter Slope Fit2 & b Fit2 :



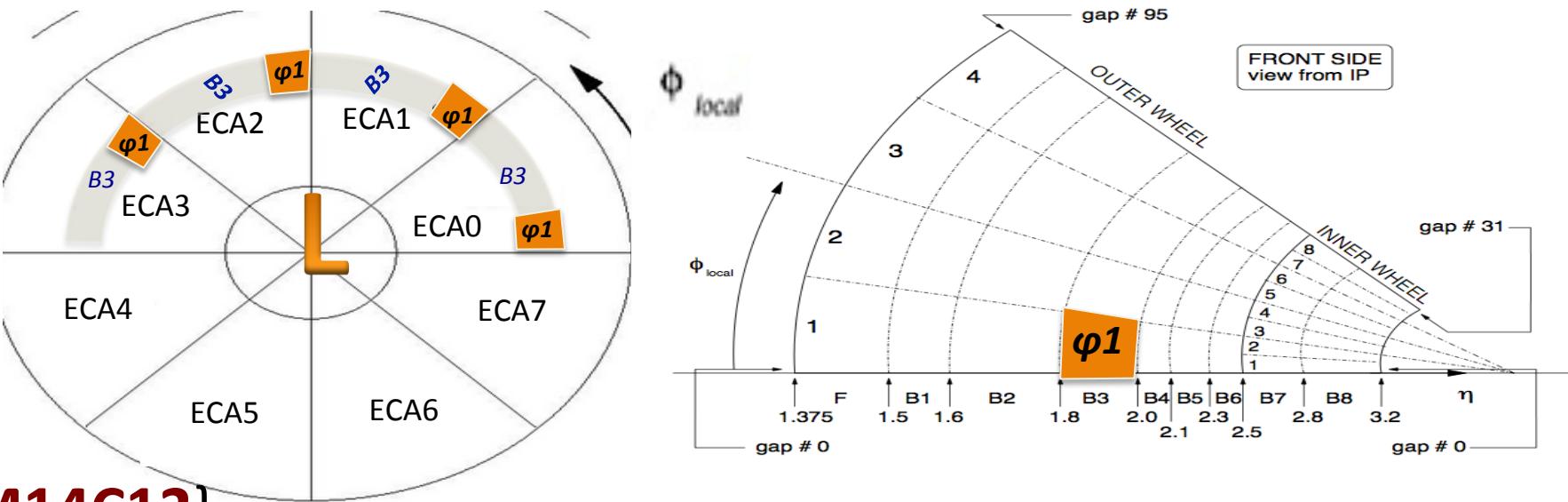
1-parameter : Only slope & Intercept measured before Collision :



| Detector | Detector Side | Detector Wheel | Eta Sector { η } | gap Voltage (H/L) | HV Module | Phi EMEC Sector { ϕ } | Phi HV Sector (Sub ϕ) | | | |
|----------|-------------------------------------|----------------|-----------------------|-------------------|-----------|----------------------------|-----------------------------|-------------|-------------|-------------|
| | | | | | | | $\varphi 1$ | $\varphi 2$ | $\varphi 3$ | $\varphi 4$ |
| {EMEC} | EMEC-A | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.12 | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | B3 (+1700 V) | Lower (L) | Mod.13 | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | EMEC-C | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.14 | ECA7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | B3 (+1700 V) | Lower (L) | Mod.15 | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | Electromagnetic End-Cap Calorimeter | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.112 | ECC0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECC1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECC2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECC3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | B3 (+1700 V) | Lower (L) | Mod.113 | ECC4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECC5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECC6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | EMEC-C | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.114 | ECC7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECC0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECC1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECC2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | B3 (+1700 V) | Lower (L) | Mod.115 | ECC3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECC4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECC5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECC6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECC7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |

Channels Combination 1 - HV Channels Average

- We will focus to Lowest gap of the EMEC-A Sector B3. We will select the HV Channels which provide the current to the Hv Sub Sector Phi1 in the 3 EMEC modules (ECA0-1-2-3)

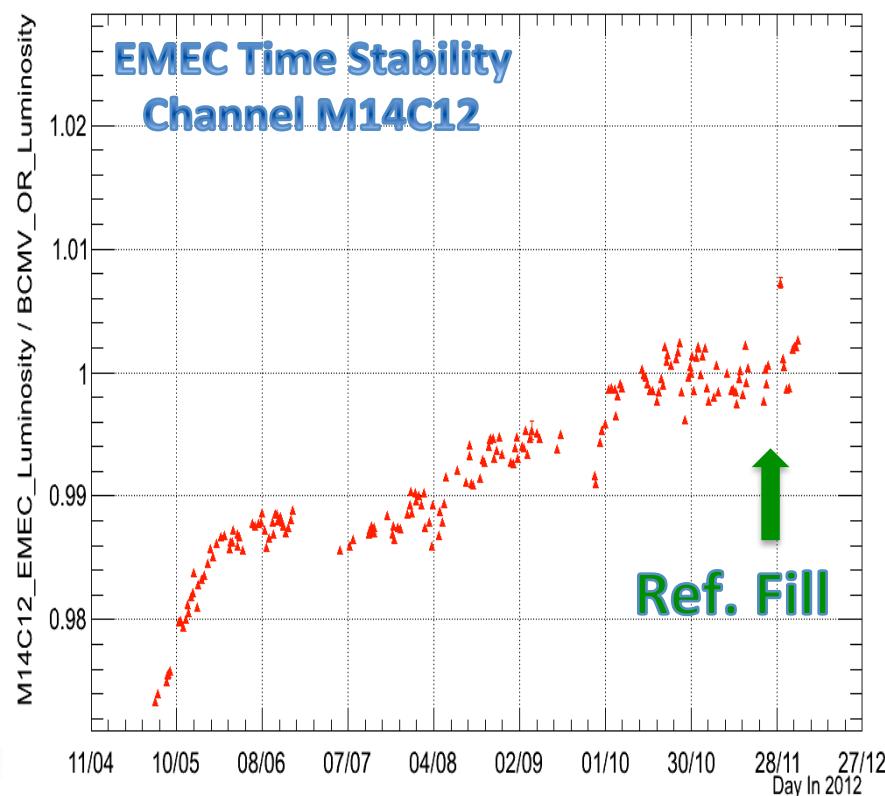
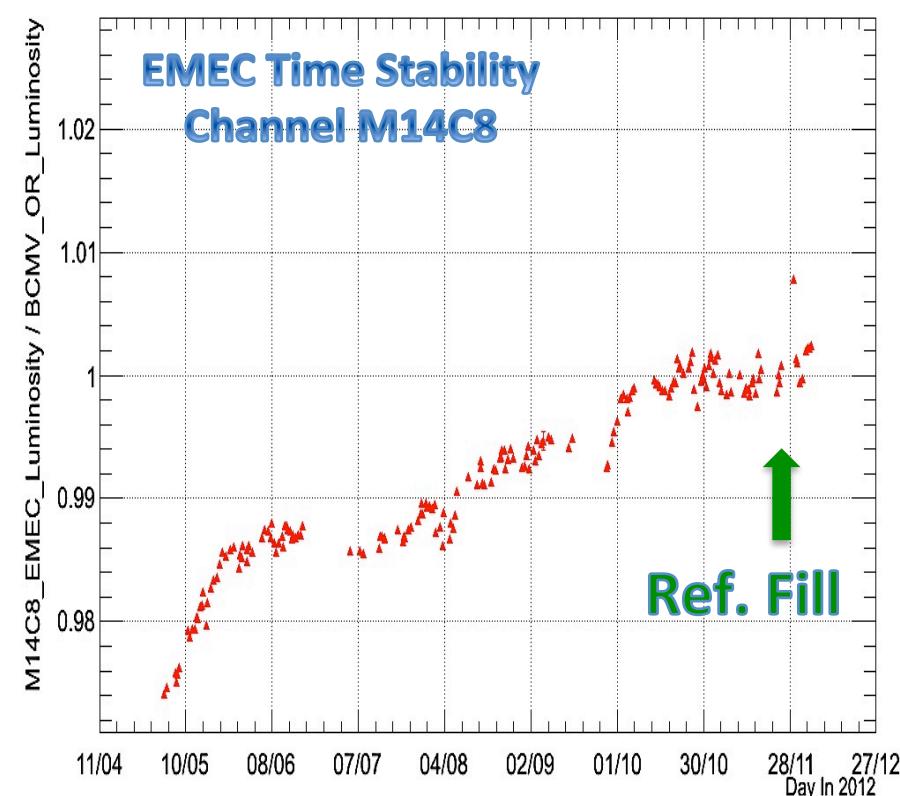
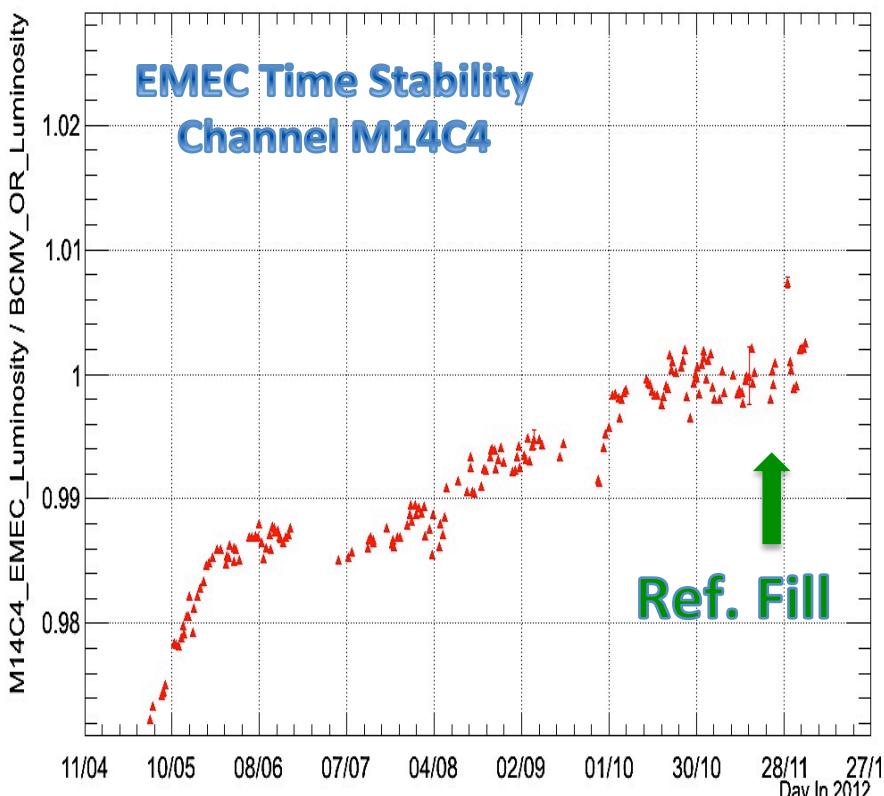
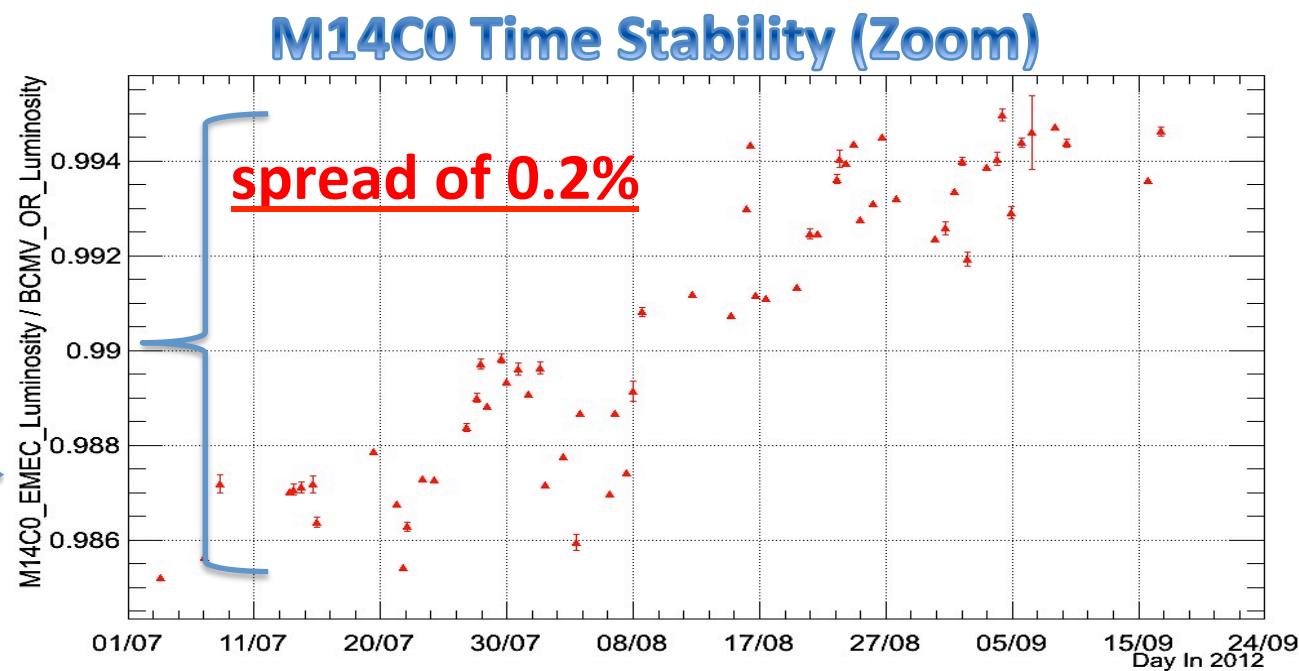
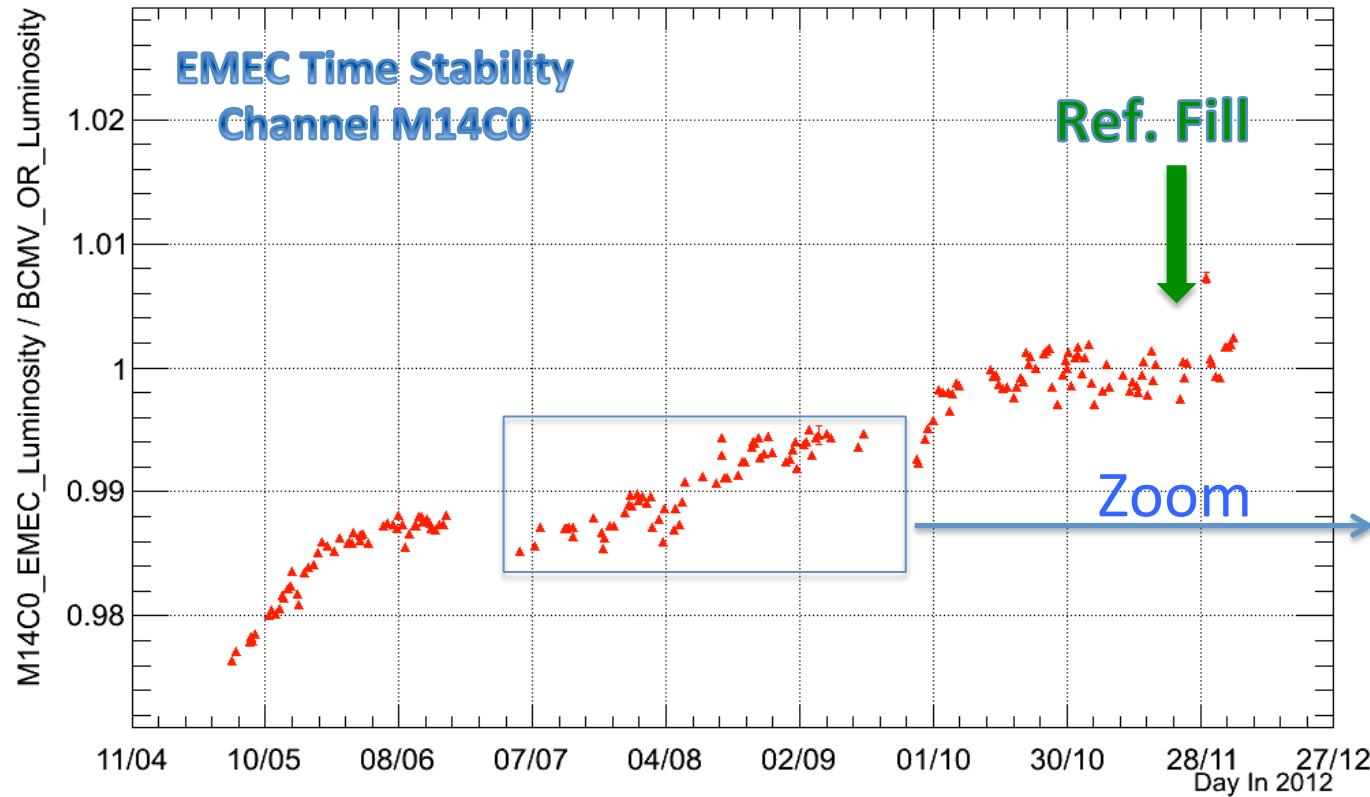


→ {M14C0-M14C4-M14C8-M14C12}

| Detector | Detector Side | Detector Wheel | Eta Sector {η} | gap Voltage (H/L) | HV Module | Phi EMEC Sector {φ} | Phi HV Sector (Sub φ) | | | |
|----------|---------------|----------------|-----------------|-------------------|-----------|---------------------|-----------------------|------------|------------|------------|
| | | | | | | | φ1 | φ2 | φ3 | φ4 |
| {EMEC} | EMEC-A | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.12 | | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA0 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA1 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | Mod.13 | ECA2 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA3 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA4 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | B3 (+1700 V) | Lower (L) | Mod.14 | ECA5 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA6 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA7 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | Mod.15 | ECA0 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA1 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA2 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA3 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA4 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA5 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA6 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | | Channel 12 | Channel 13 | Channel 14 | Channel 15 |

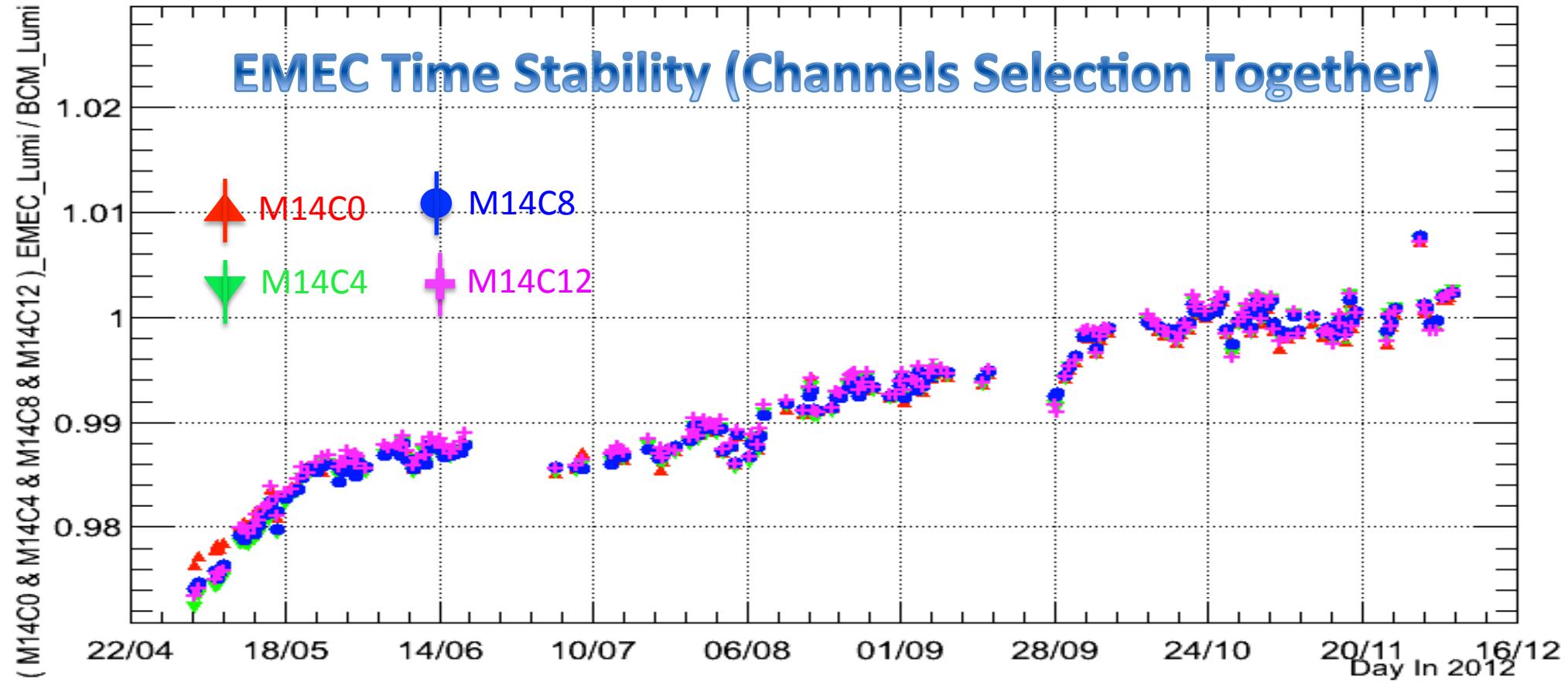
EMEC Time Stability {M14C0 – M14C4 – M14C8 – M14C12}

- We Plot the Average ratio EMEC Luminosity to BCM Luminosity for the 4 Channels selected

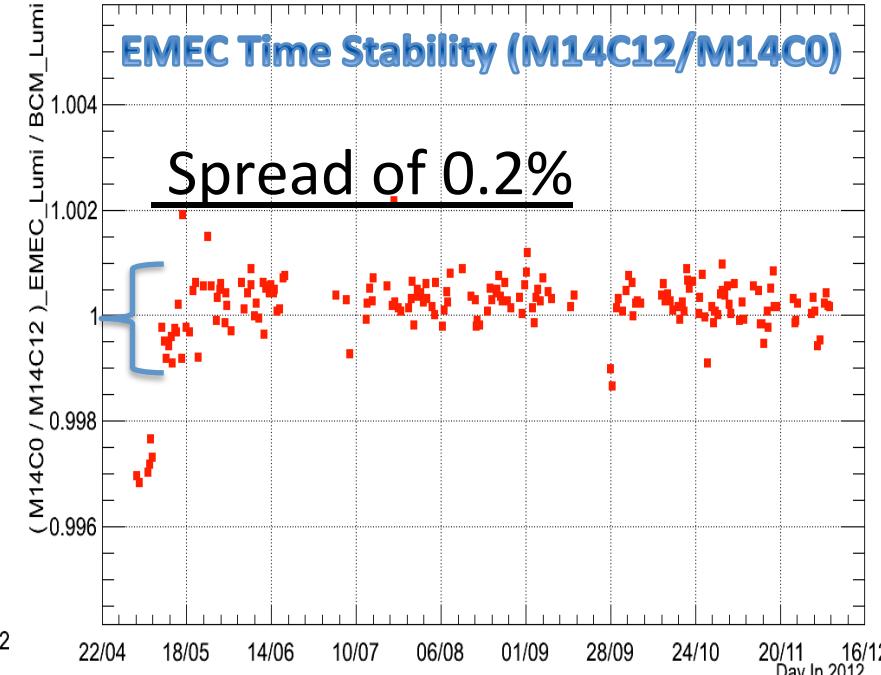
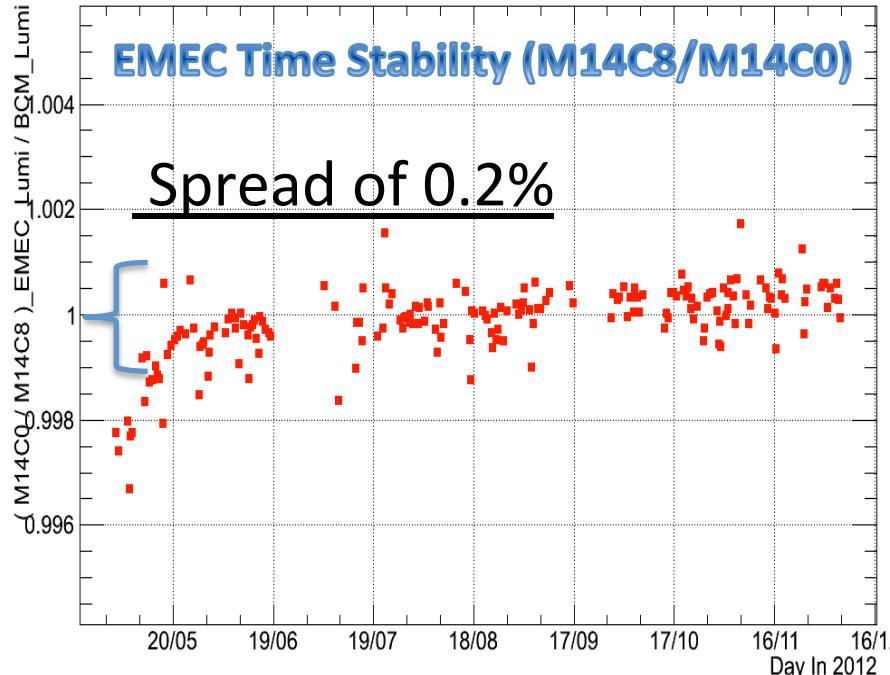
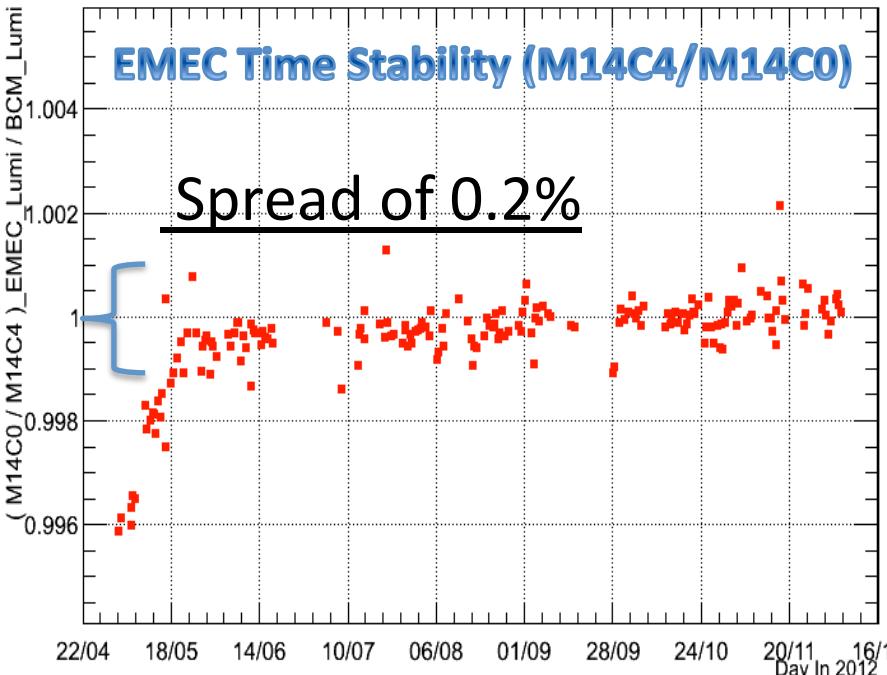


EMEC Time Stability {M14C0 – M14C4 – M14C8 – M14C12}

- The Average ratio EMEC Luminosity to BCM Luminosity for the 4 Selected Channels {Time Stability}

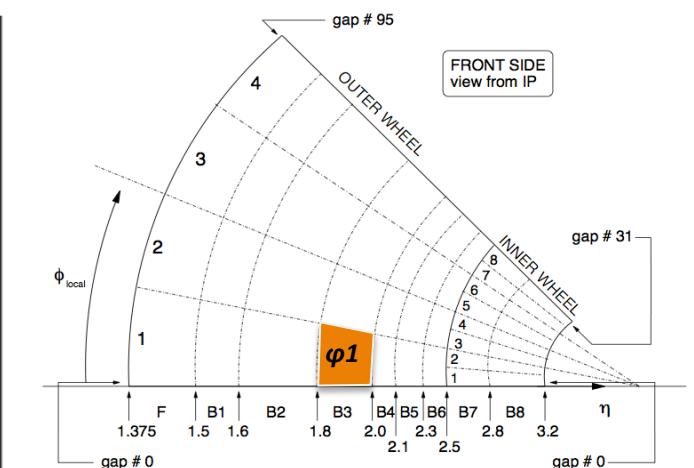
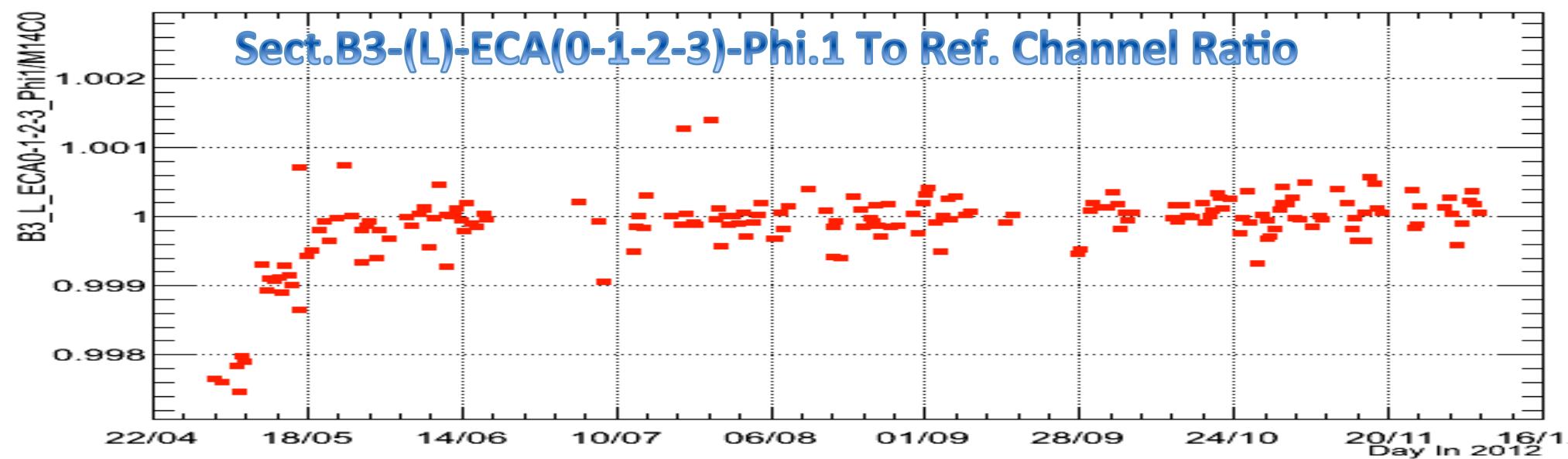
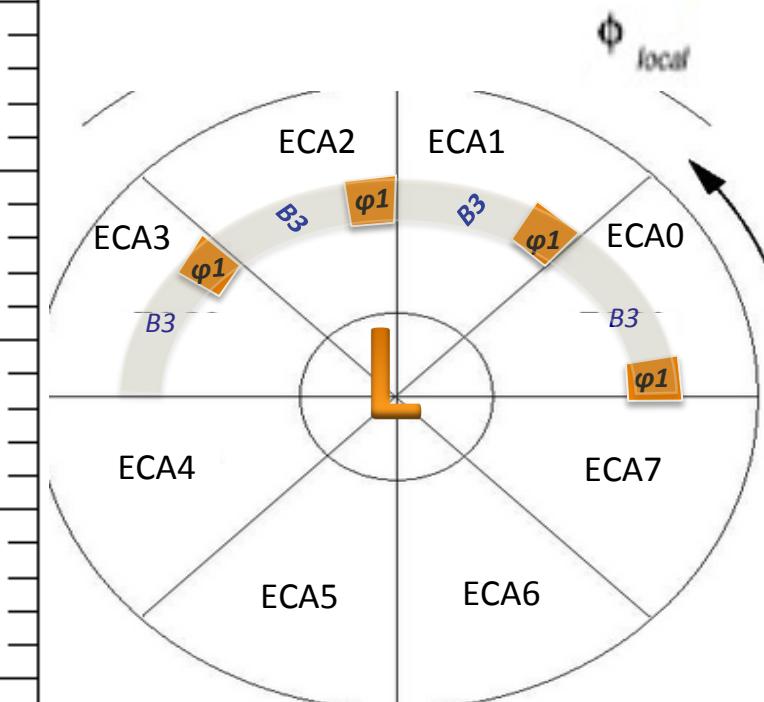
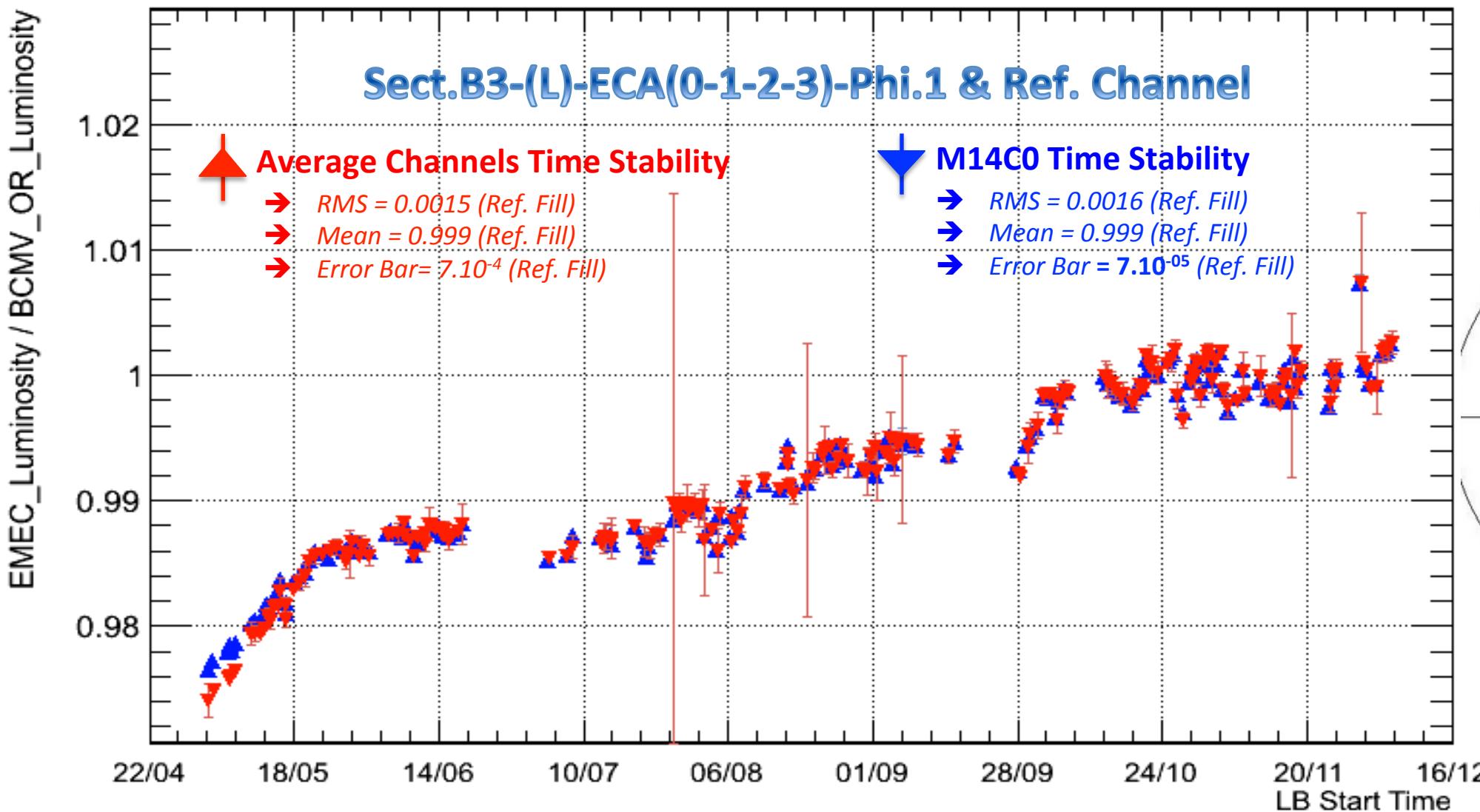


- The Ratio Time Stability of each Selected Channel to the reference Channel (M14C0)



Sector B3- (L) - ECA(0-1-2-3) - Sub-Sector (Φ_1)

Ref. Channel M14C0 to Average Channels Combination 1



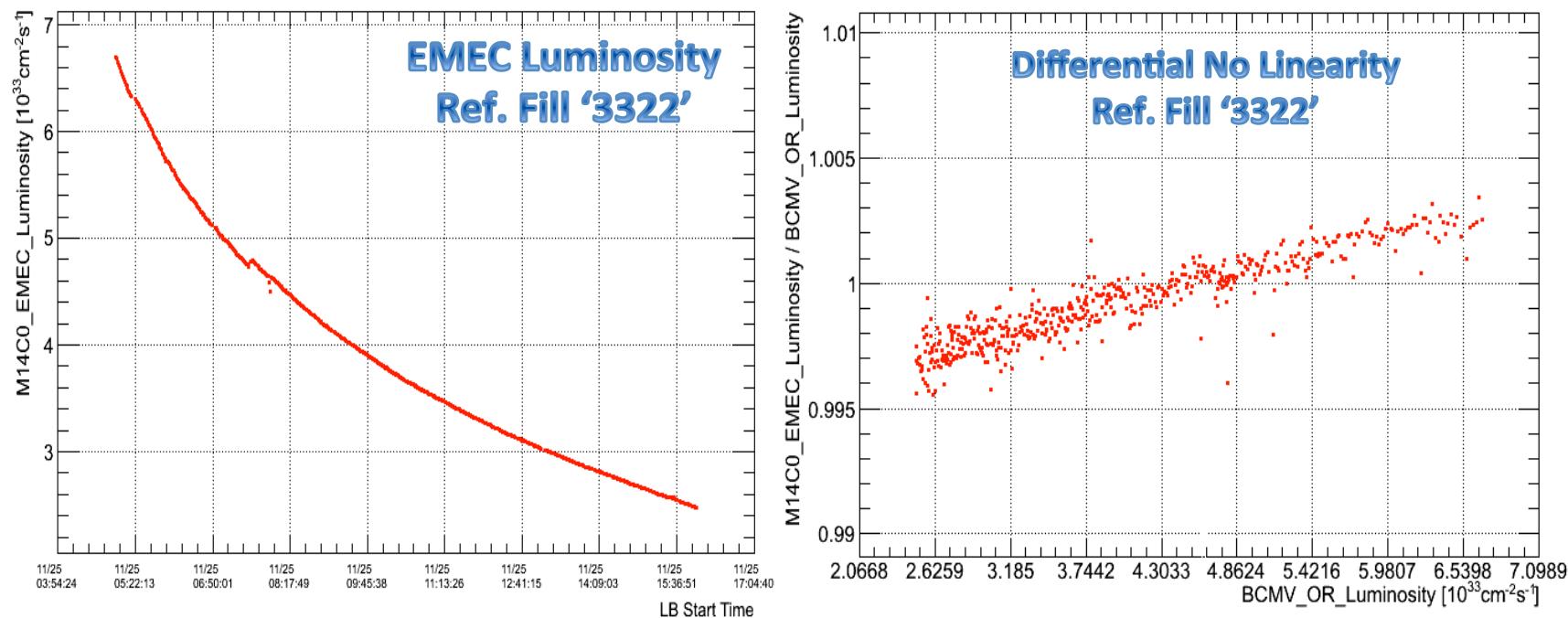
Summary

- The ratio of single channel to the reference one gives a small spread of 0.2%, very close to the spread of every single channels, we deduce a negligible effect of BCM.
- Combining Channels in Highest gap gives an different EMEC effect than in Lowest gap. (**Run 2**) Comparing the both gap with combining a corresponding (Highest/Lowest) gap channels to verify if in lowest region we obtain an accurate results.
- Need more Good channels in each EMEC geometry to build an accurate idea about the efficiency of the channels combination (**Run2**).
- (**In Backup**) the same analysis using the average of Raw Hv Current for a different EMEC Geometry and then Determinate the EMEC Luminosity.
- **This analysis will be published in two (2) notes with the LAr group (writing by myself under submission) & the Luminosity Task force group.**

Backup

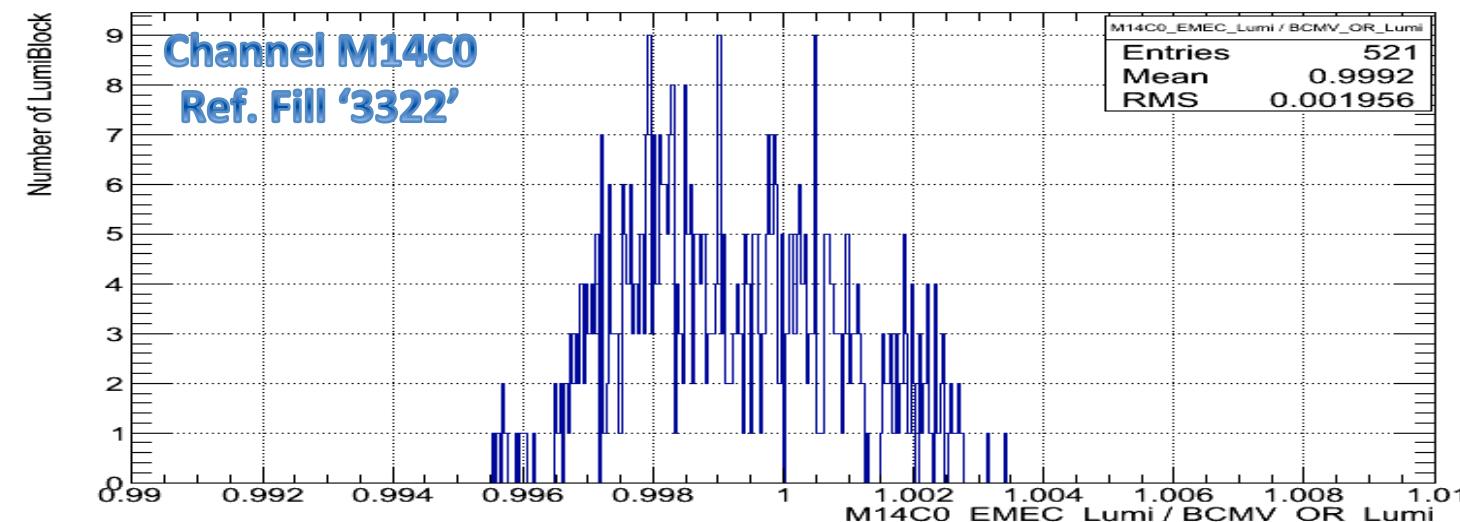
EMEC Luminosity Studies

- We calculate the EMEC Luminosity from a calibrated BCMV_OR Luminosity to HV Current with a direct measurement of Current before collision.
- The BCM Response decrease at High Luminosity wrt to EMEC.



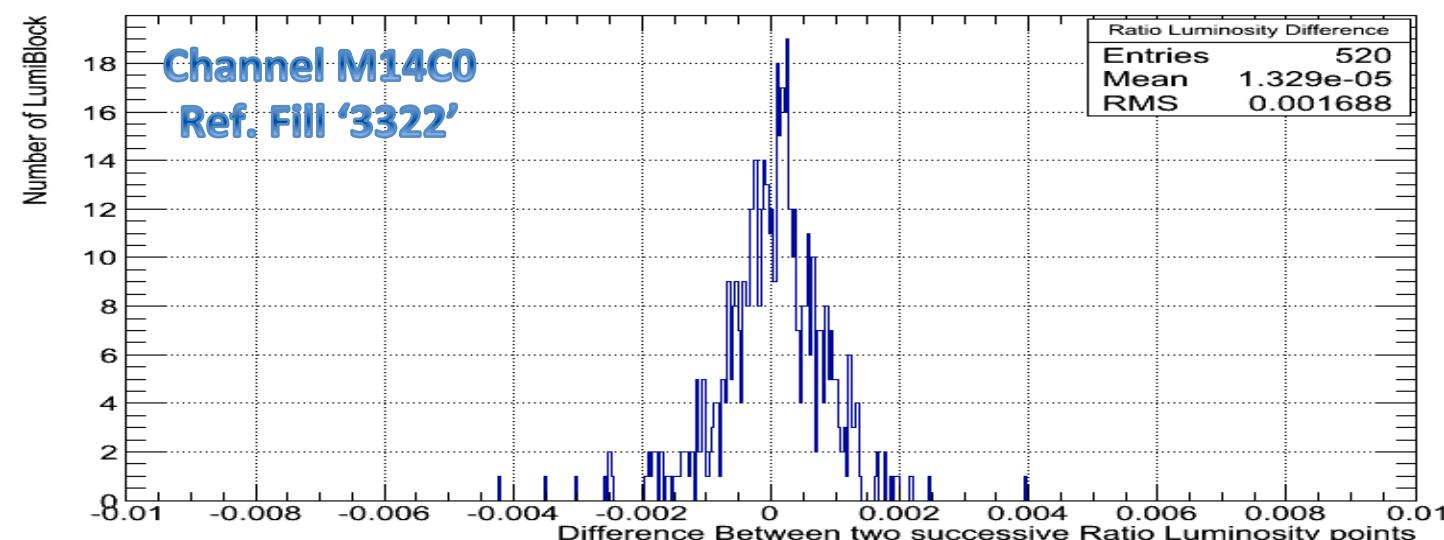
□ Error bars (Original approach):

- We plot the ratio EMEC Luminosity to BCM Luminosity distribution with μ -dependence effect.
 - RMS = 0.0019
 - Mean = 0.999 (*For Time Stability*)
 - Error = RMS/ $\sqrt{(\text{Nbr.LB})}$ = $9 \cdot 10^{-5}$



□ Error bars (Refined Approach):

- We plot the distribution of the difference between two successive points from the ratio EMEC luminosity to BCM Luminosity.
- BCM Errors negligible → interne calculation
 - RMS = 0.0016
 - Error = RMS/ $\sqrt{(\text{Nbr.LB})}$ = $7 \cdot 10^{-5}$

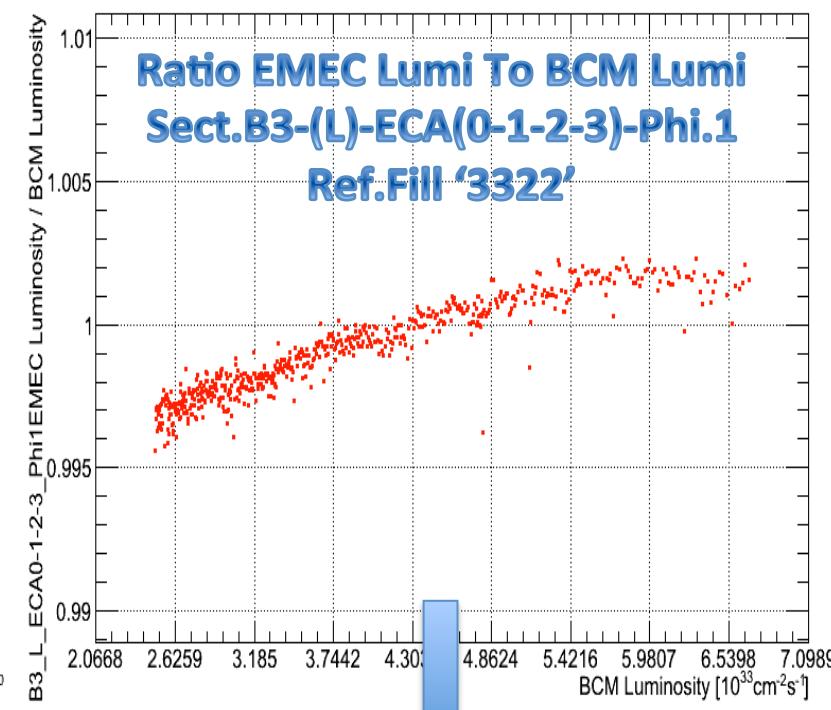
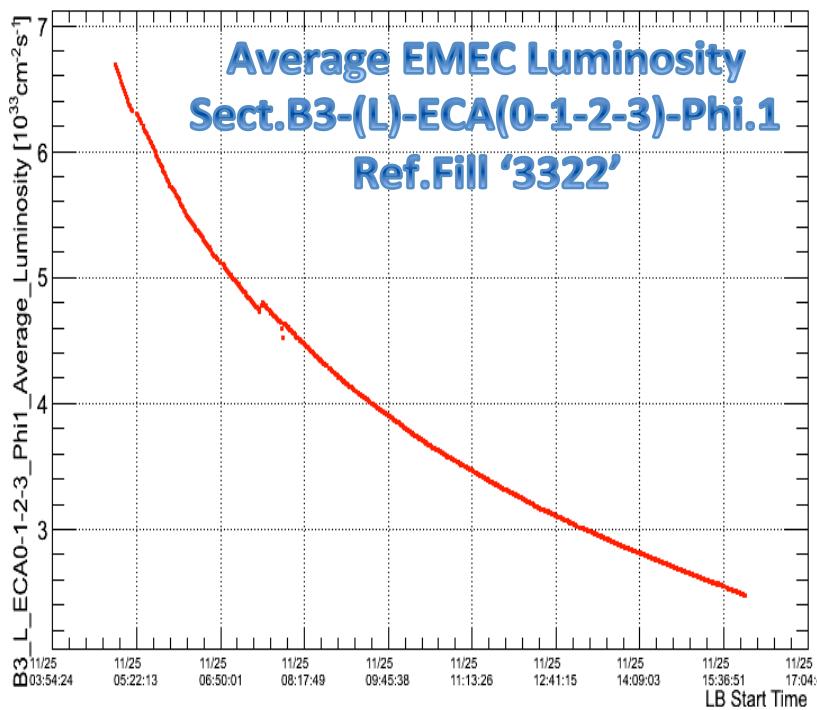


Sector B3- (L) - ECA(0-1-2-3) - Sub-Sector (*Phi1*)

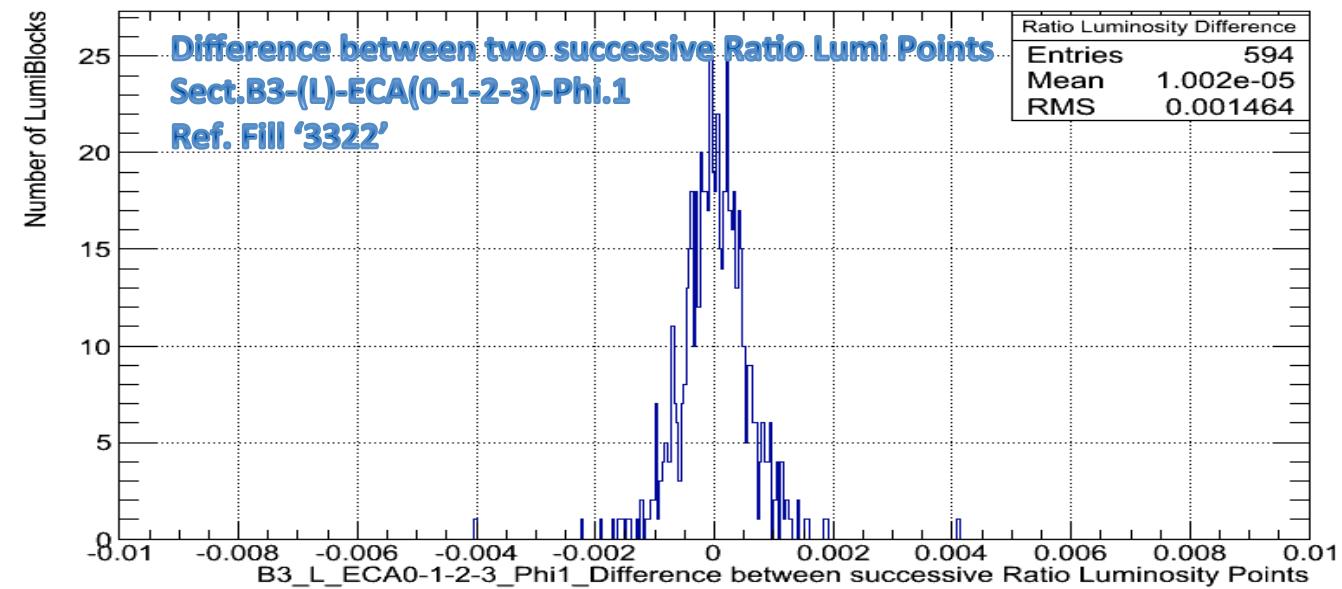
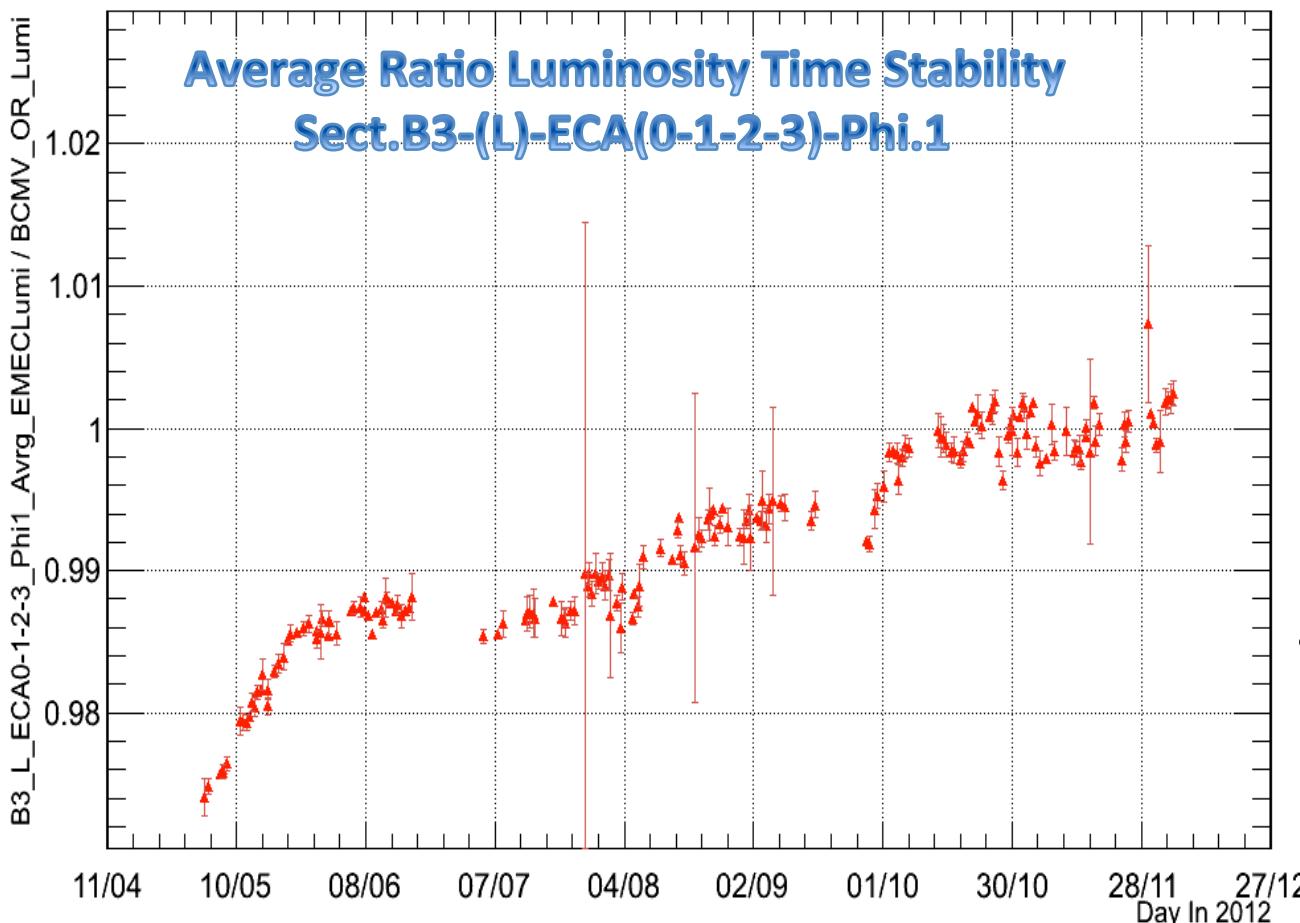
Average Channels Time Stability {M14C0 – M14C4 – M14C8 – M14C12}

The Average EMEC Luminosity

- We calculate the Average EMEC Luminosity from the average of each LB for the 4 channels selected.
- The Average Luminosity is calculating by LB following the number of Channels.
- BCM response decrease at High Luminosity wrt EMEC.



The EMEC Time Stability



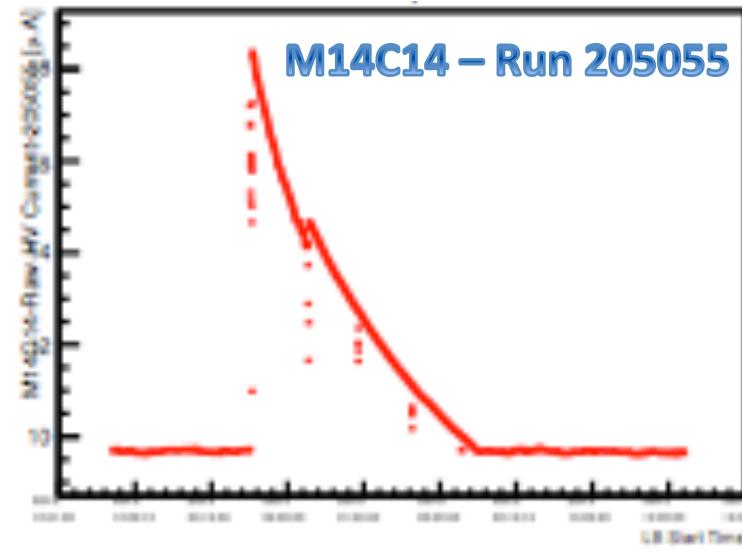
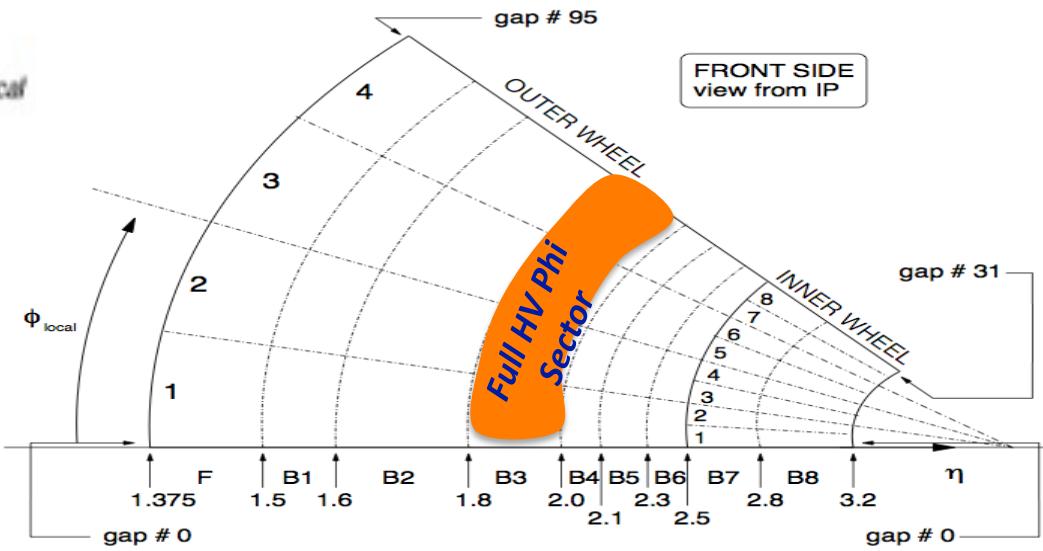
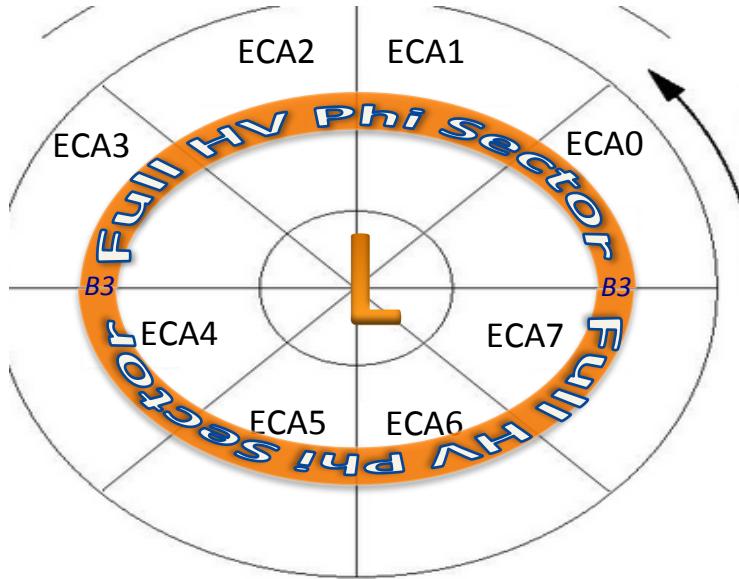
- The distribution of the difference between two successive points from the ratio EMEC lumi to BCM

→ RMS = 0.0015

→ Error = RMS/ \sqrt{N} (Nbr.Channels) = 7.10⁻⁴

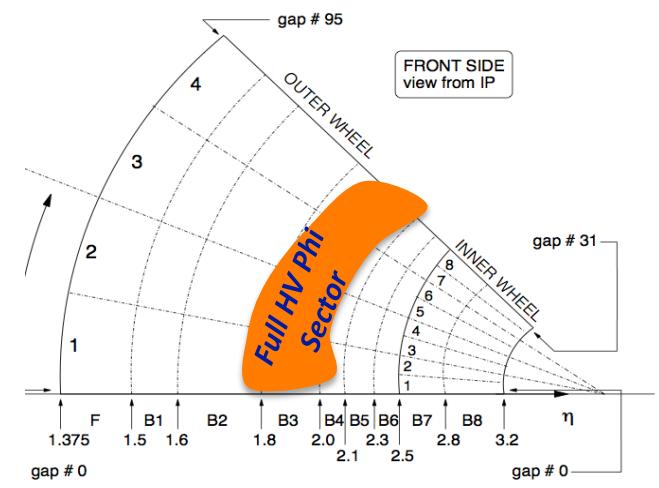
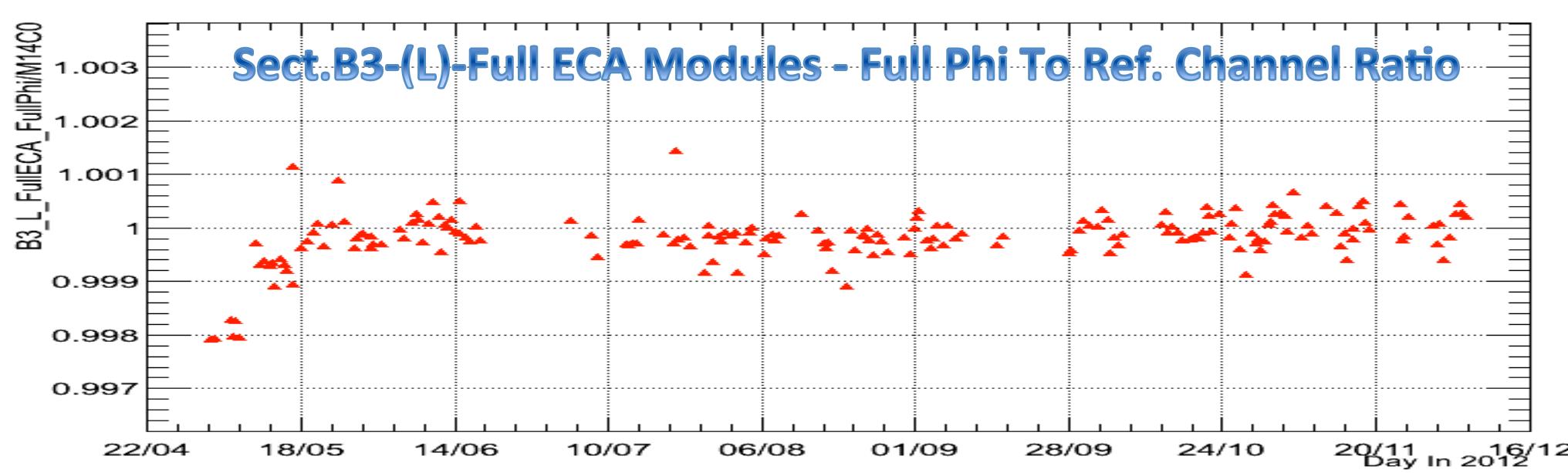
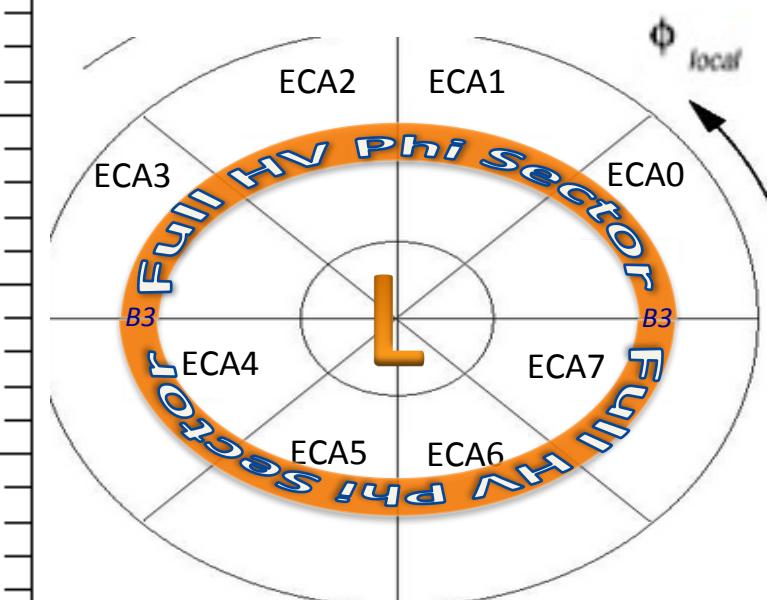
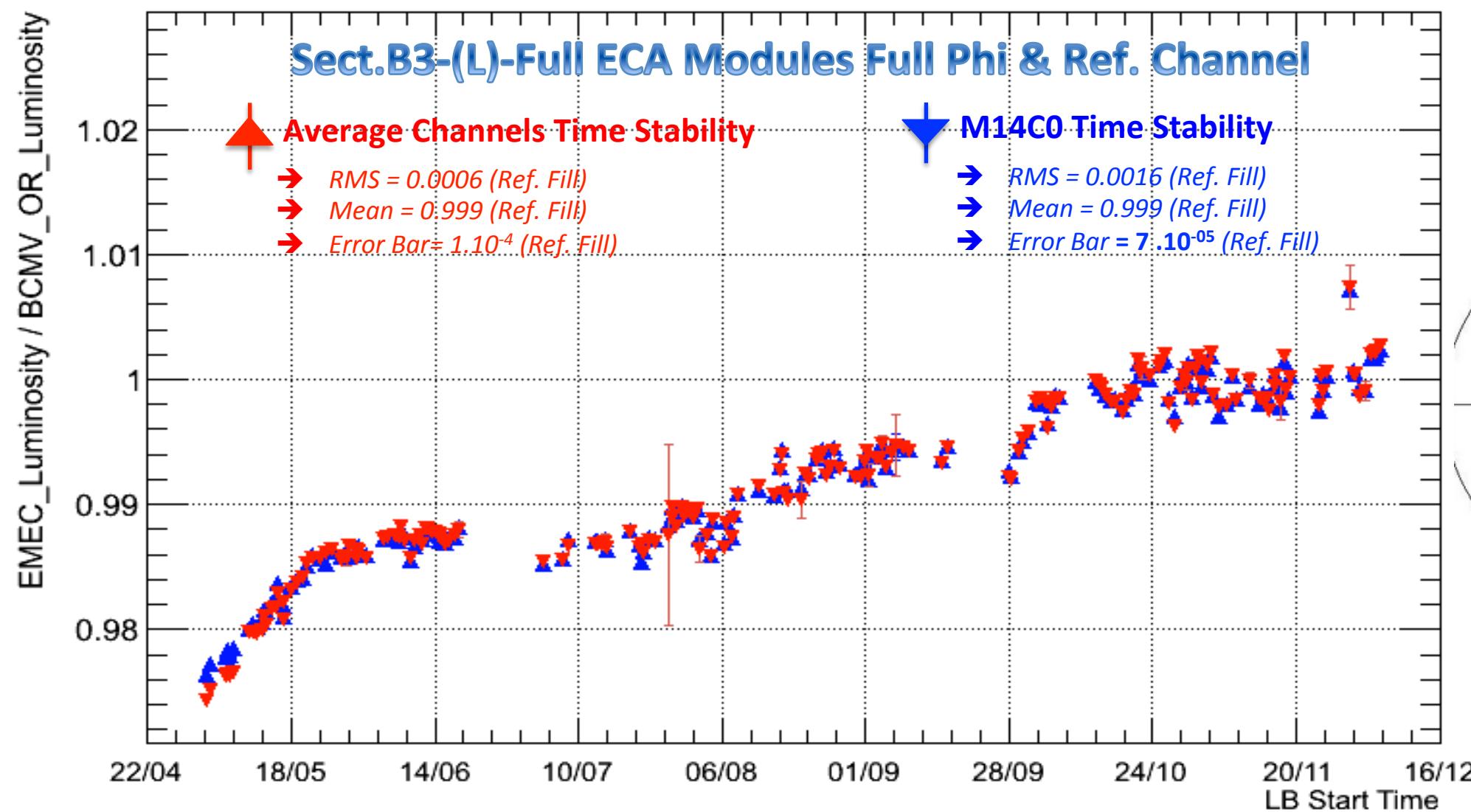
Channels Combination 2 - HV Channels Average

- We will focus to Lowest gap of EMEC-A Sector B3. We will select the HV Channels which provide current to the Full ECA Modules following the Full HV Sub sector → {Full Module 14 & Module 15}



| Detector | Detector Side | Detector Wheel | Eta Sector {η} | gap Voltage (H/L) | HV Module | Phi EMEC Sector {φ} | Phi HV Sector (Sub φ) | | | |
|----------|---------------|----------------|-----------------|-------------------|-----------|---------------------|-----------------------|------------|------------|------------|
| | | | | | | | φ1 | φ2 | φ3 | φ4 |
| {EMEC} | EMEC-A | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.12 | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | Mod.13 | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | B3 (+1700 V) | Lower (L) | Mod.14 | ECA7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | Mod.15 | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |

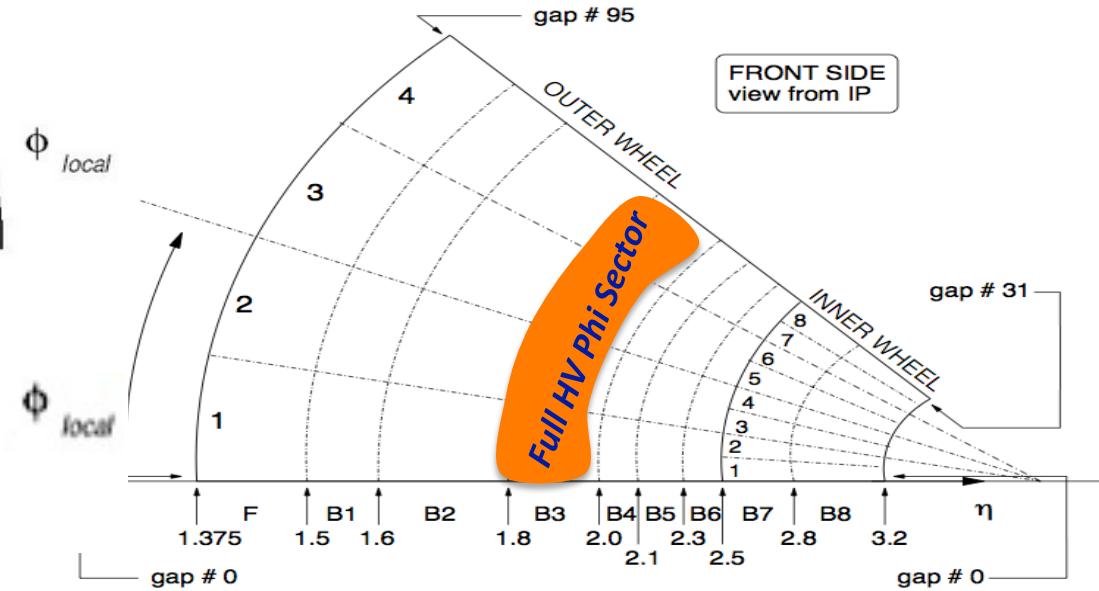
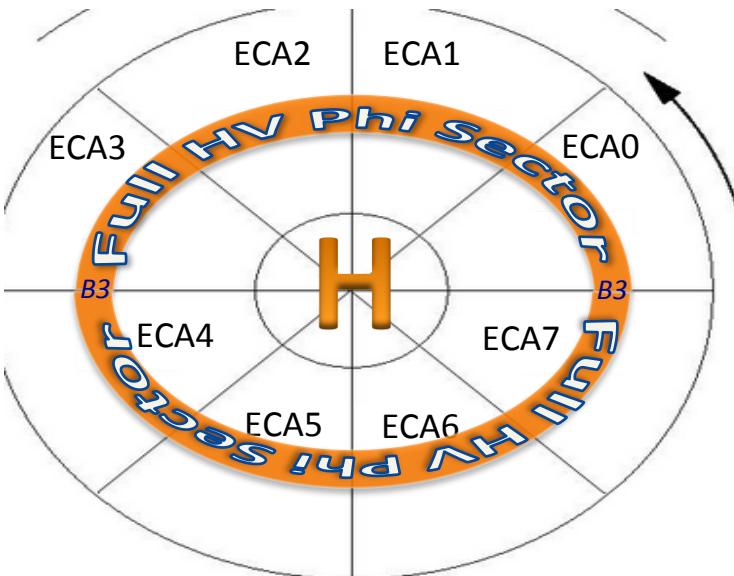
Sector B3- (L) – Full ECA Modules – Full Sub-Sectors Phi Ref. Channel M14C0 to Average Channels Combination 2



Channels Combination 3 - HV Channels Average

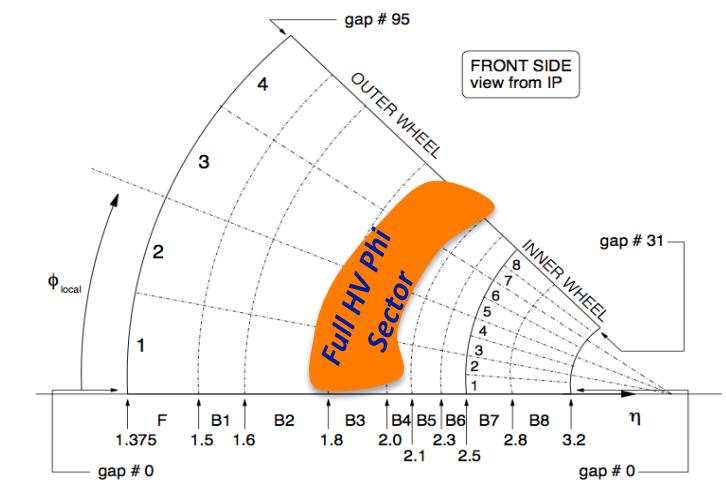
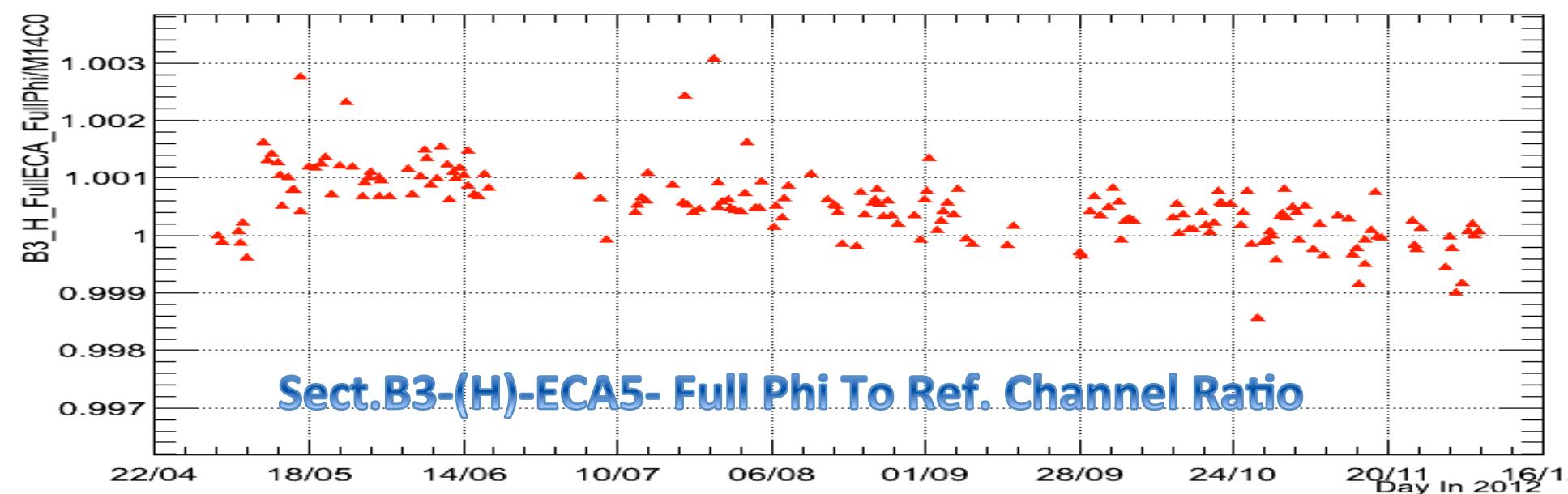
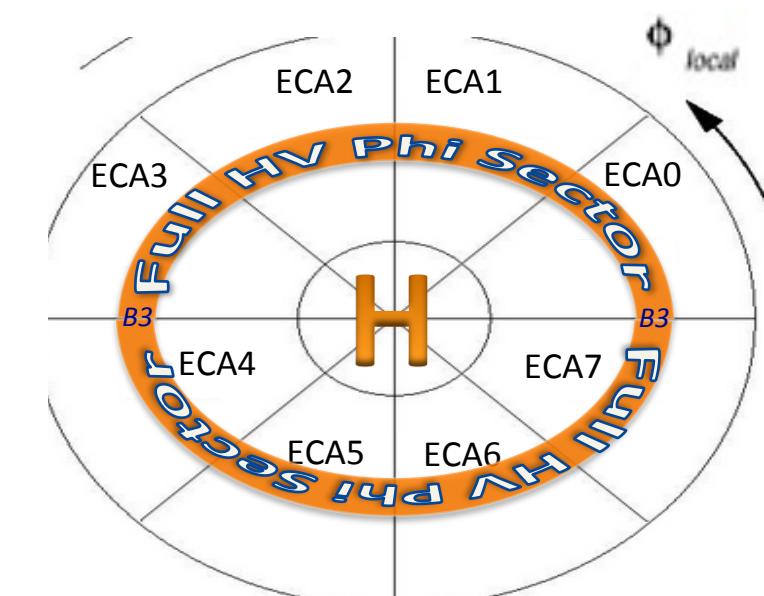
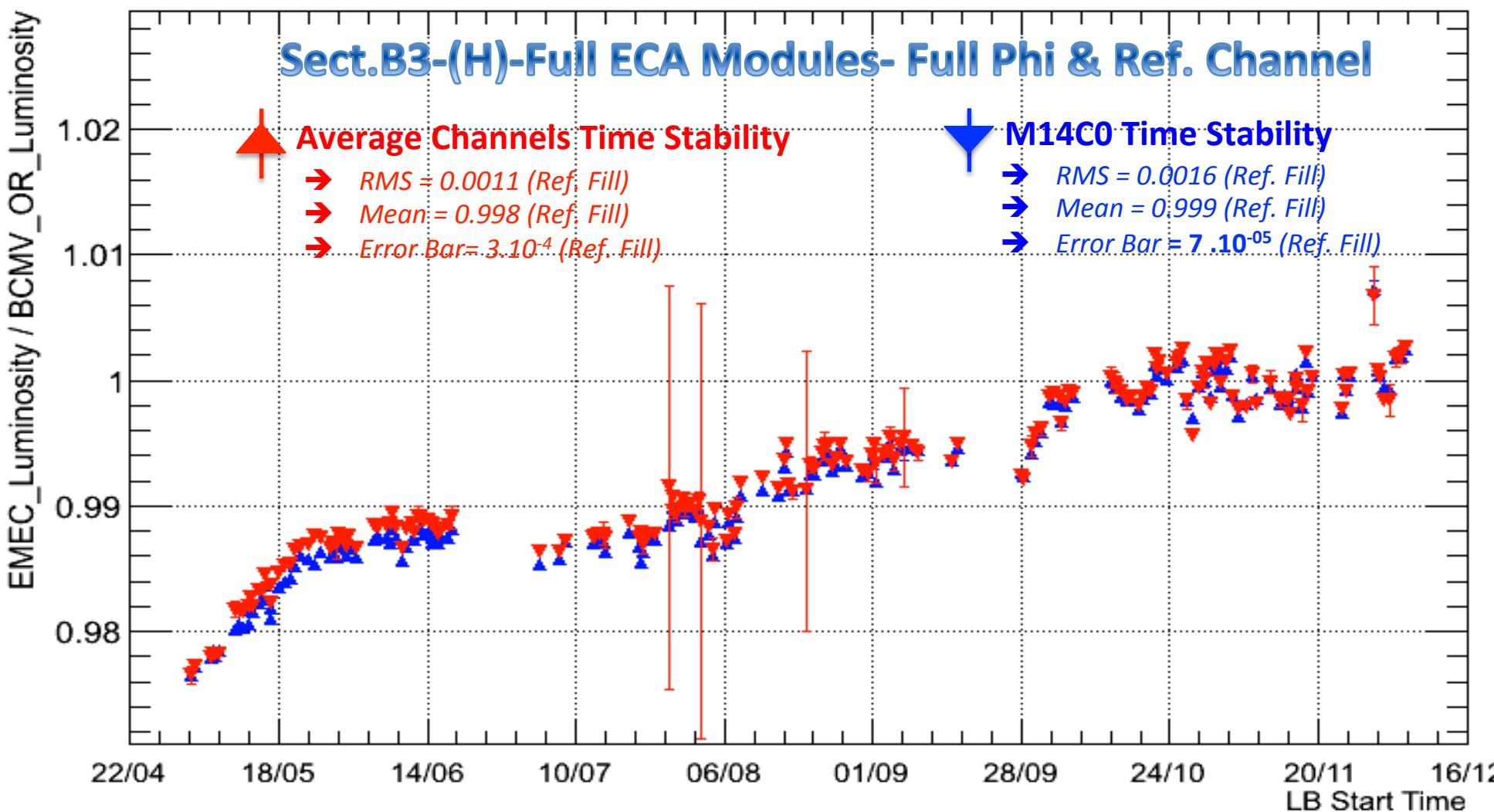
- We will focus to Highest gap of EMEC-A Sector B3. We will select the HV Channels which provide the current to the EMEC modules in Full ECA Modules following the Full HV Sub sector.

→ {Full Module 12 & Module 13}

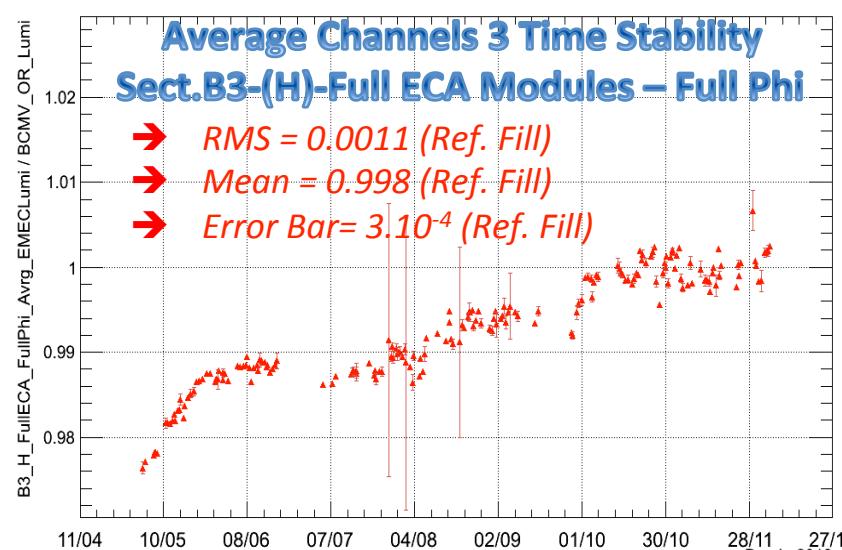
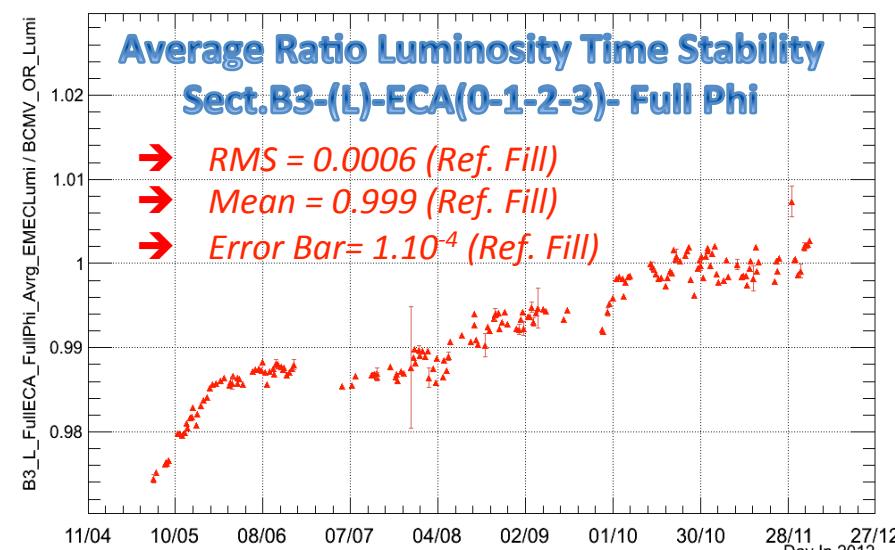
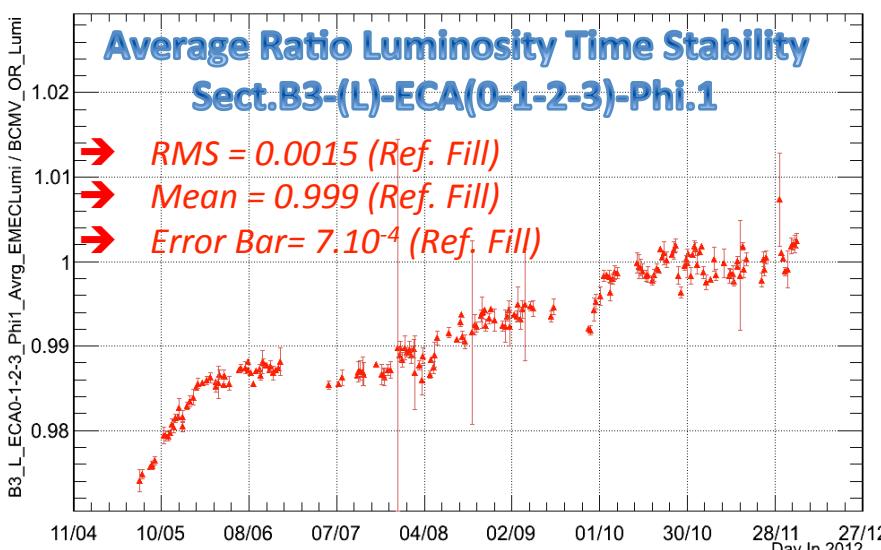
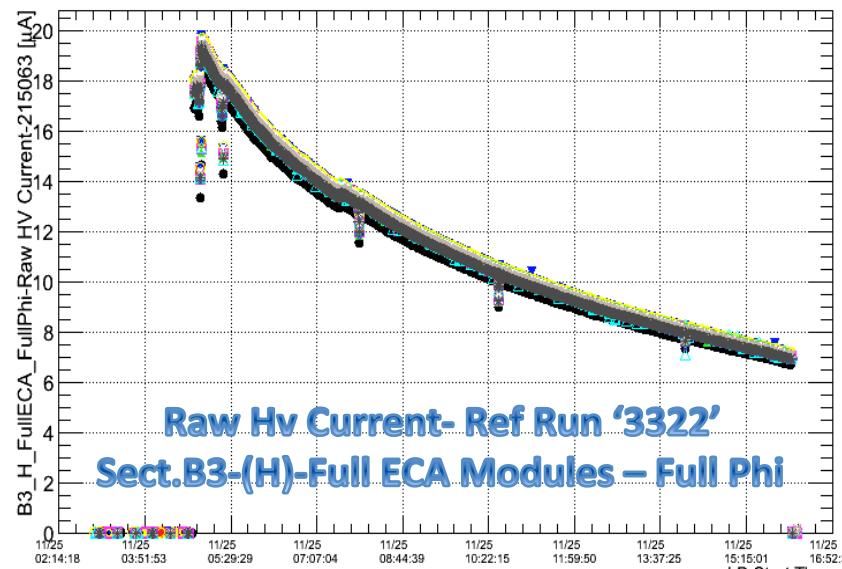
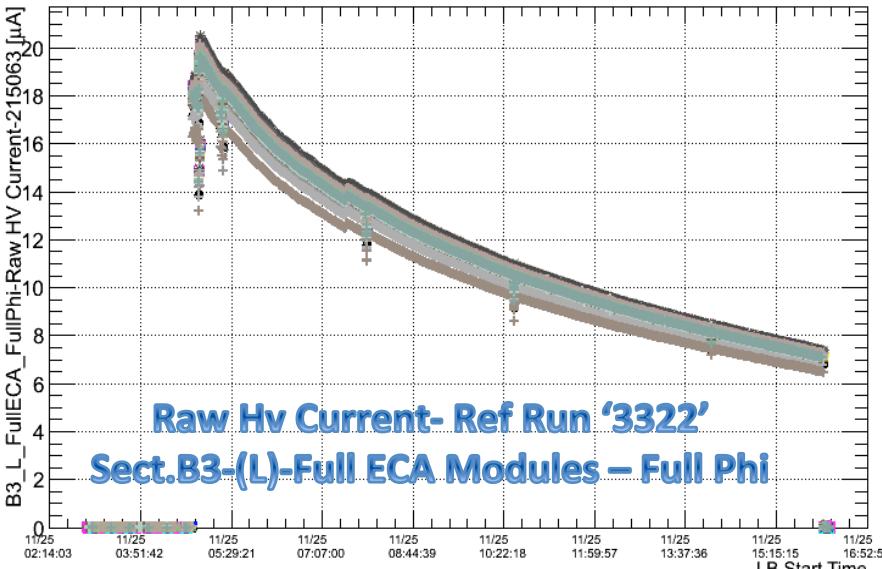
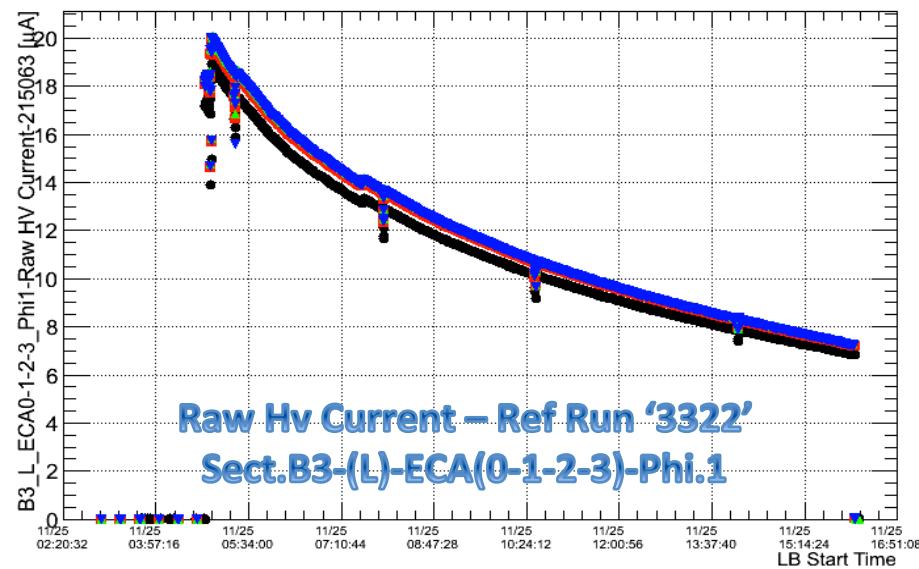
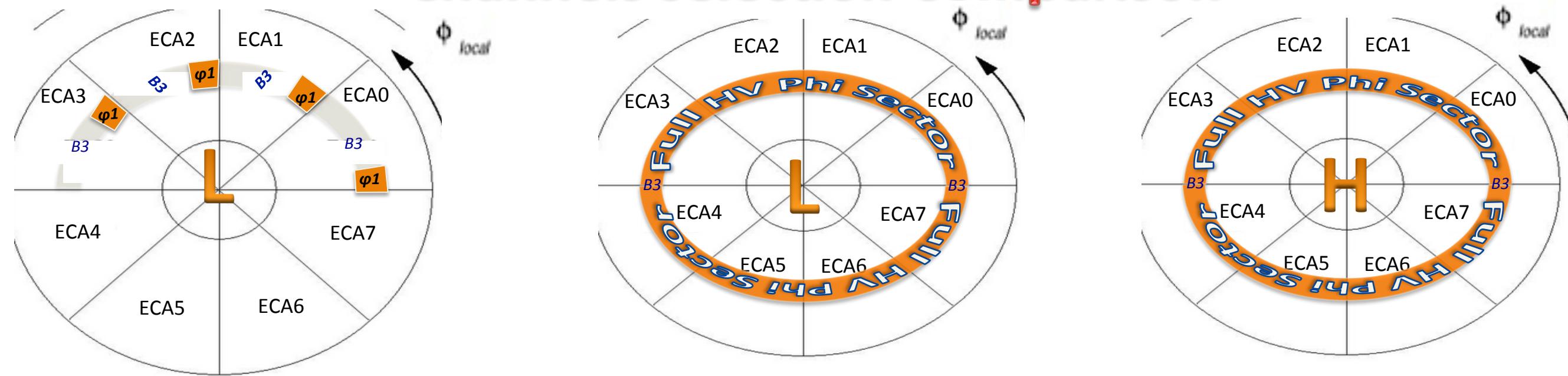


| Detector | Detector Side | Detector Wheel | Eta Sector $\{\eta\}$ | Line Voltage (H/L) | HV Module | Phi EMEC Sector $\{\phi\}$ | Phi HV Sector (Sub ϕ) | | | |
|----------|---------------|----------------|-----------------------|--------------------|-----------|----------------------------|-----------------------------|-------------|-------------|-------------|
| | | | | | | | $\varphi 1$ | $\varphi 2$ | $\varphi 3$ | $\varphi 4$ |
| {EMEC} | EMEC-A | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.12 | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | Mod.13 | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | B3 (+1700 V) | Lower (L) | Mod.14 | ECA7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | Mod.15 | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |

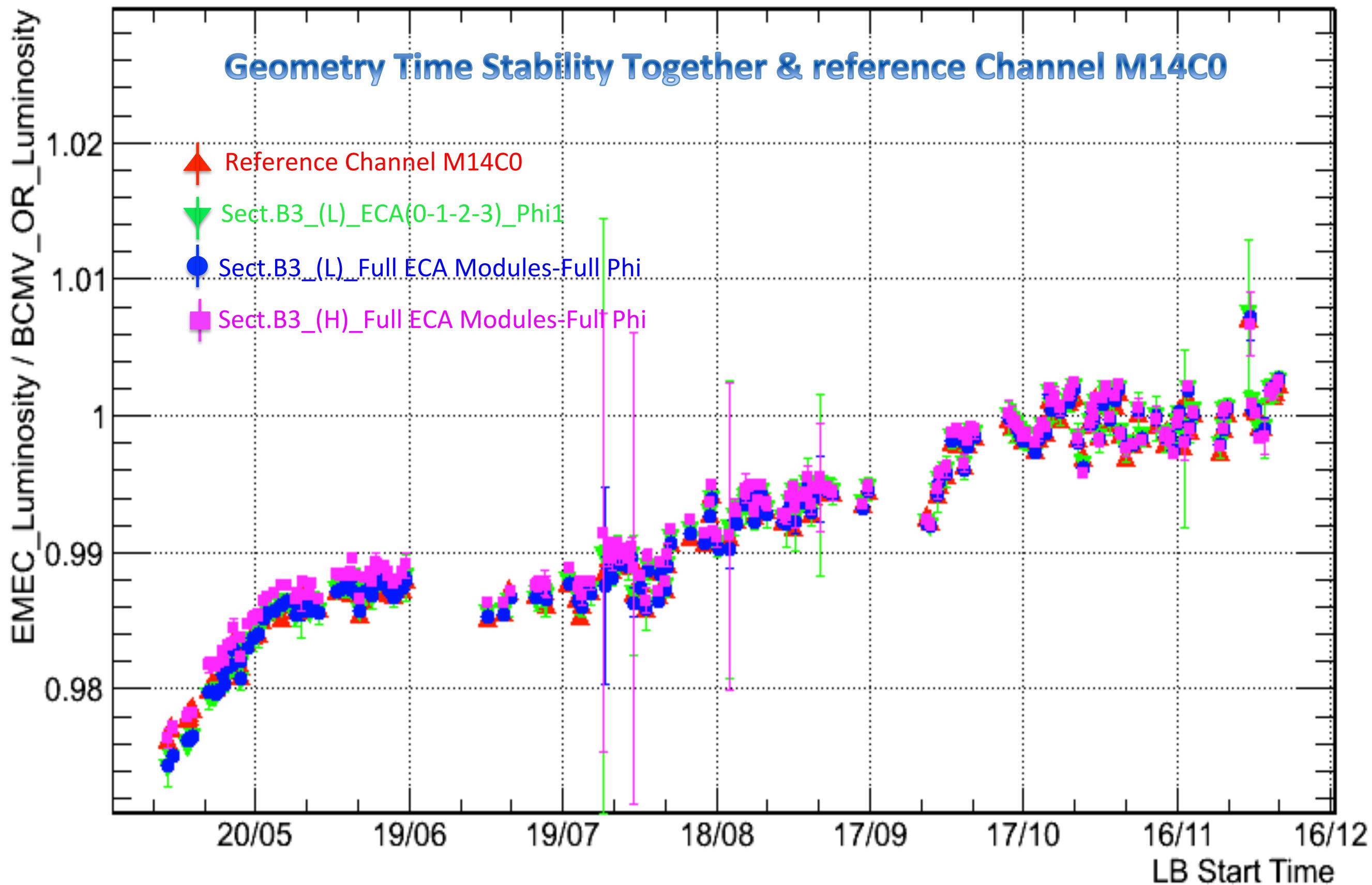
Sector B3- (H) – Full ECA Modules – Full Sub-Sectors Phi Ref. Channel M14C0 to Average Channels Combination 3



Channels selection Comparison

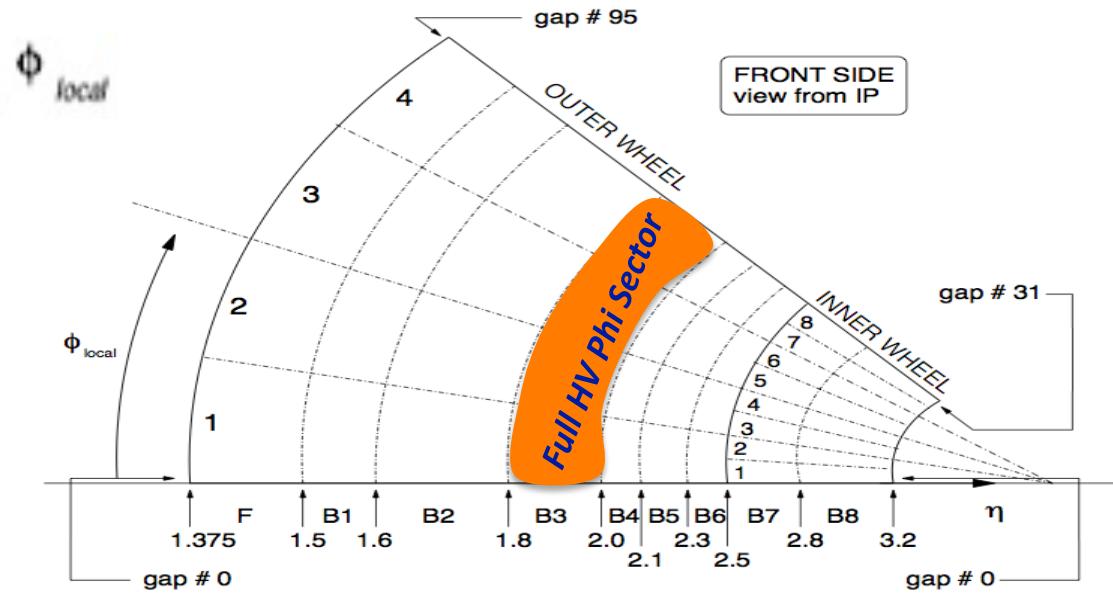
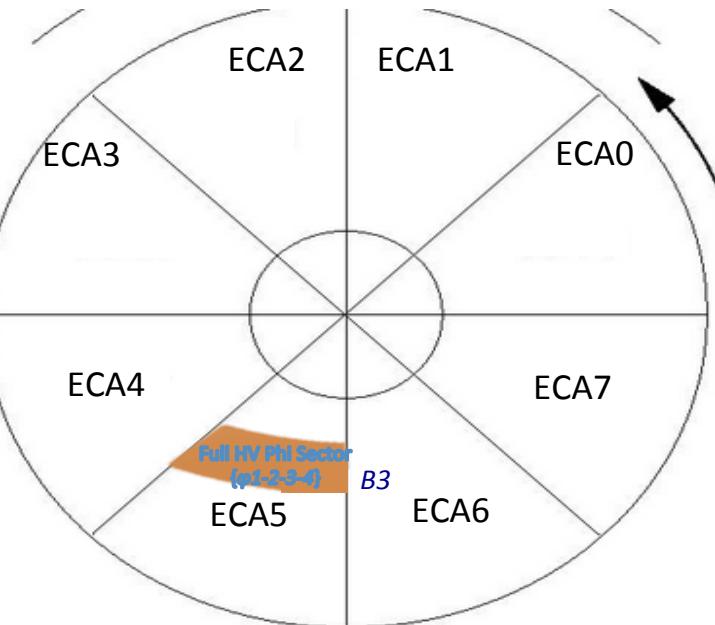


Channels selection Comparison



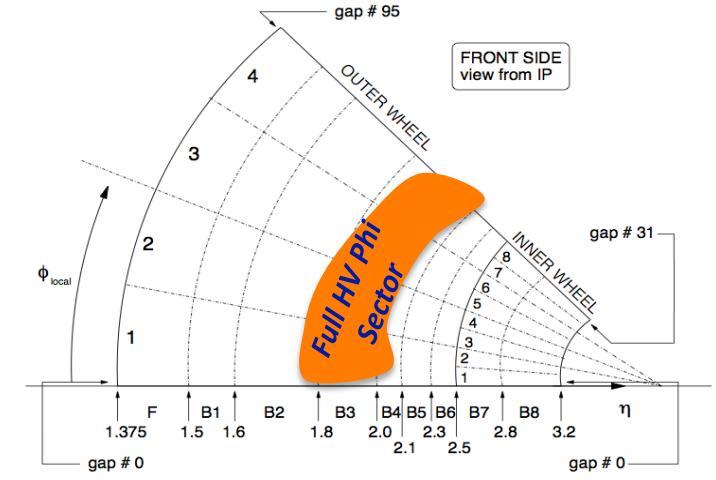
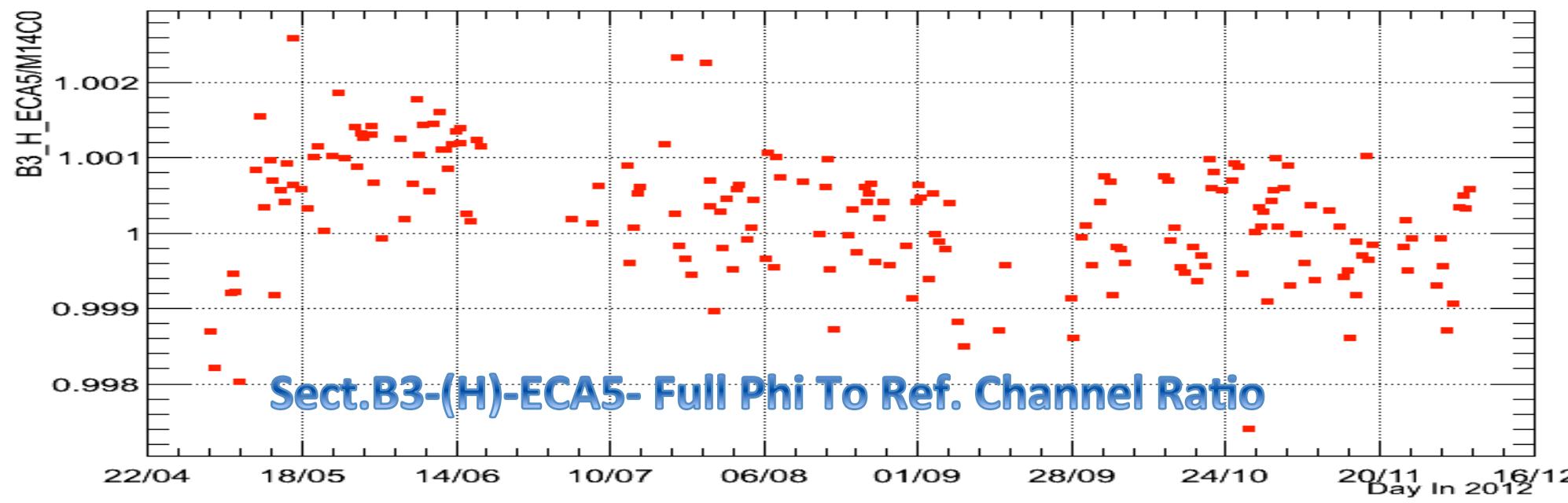
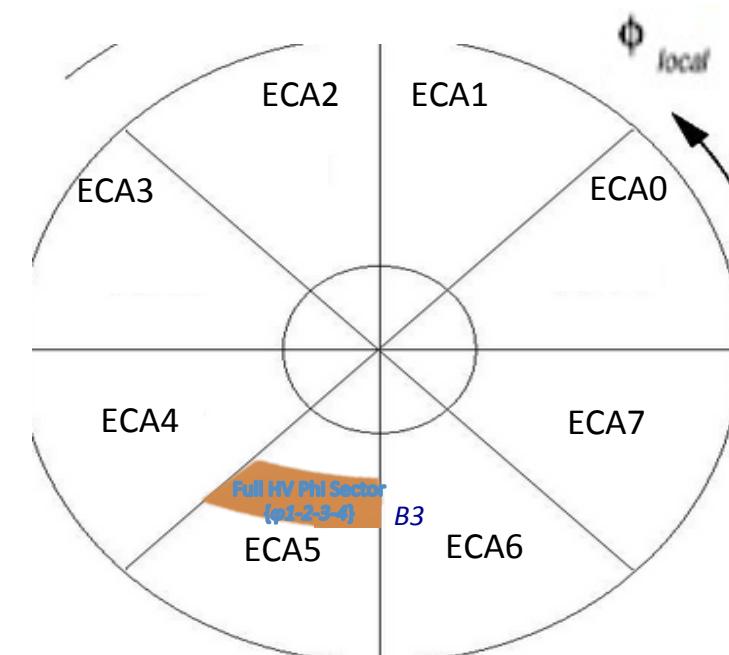
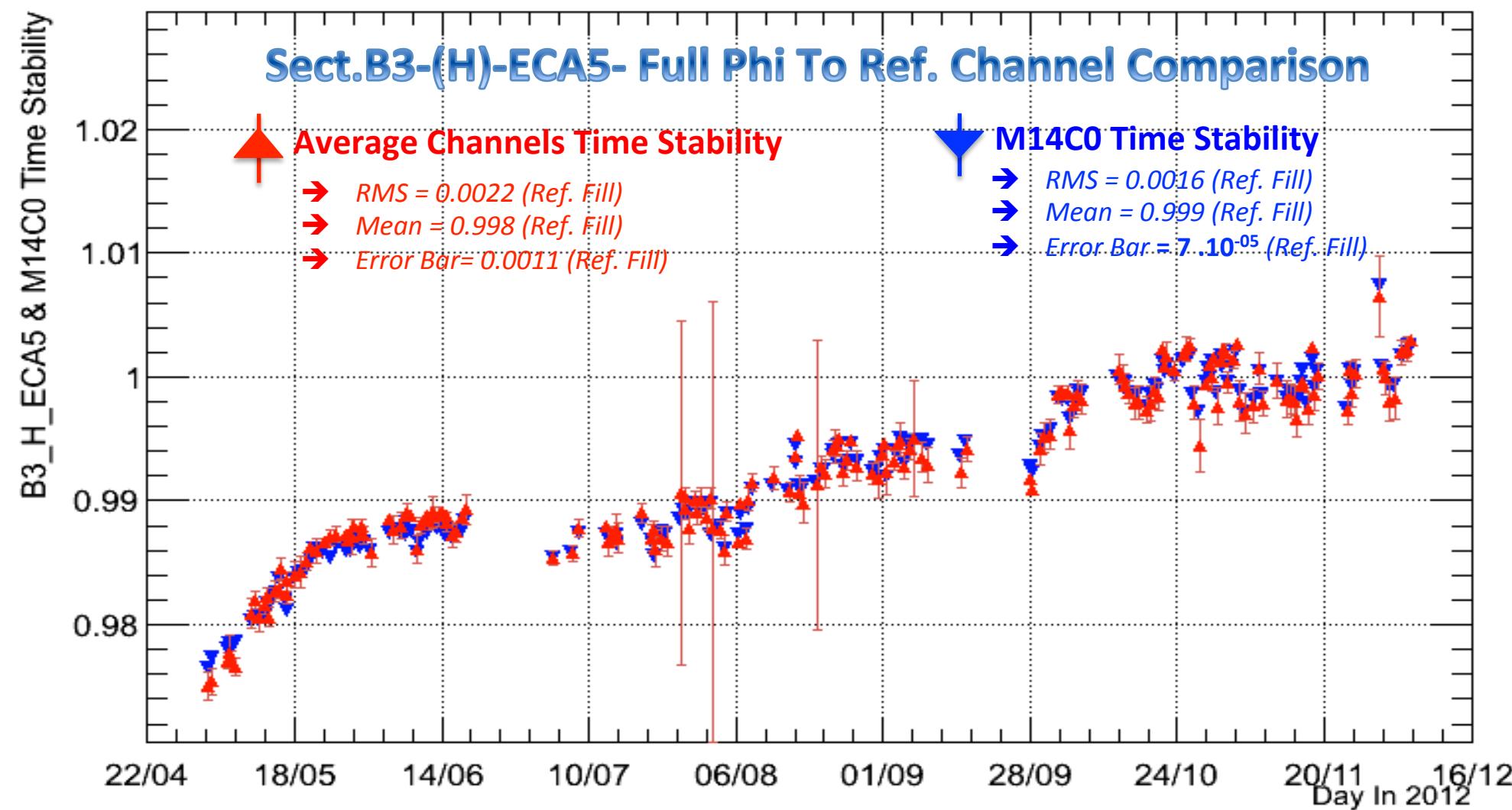
Channels Combination 4 - HV Channels Average

- We will focus to Highest gap of Sector B3 of the EMEC-A Side.
 - We will select the HV Channels which provide the current to the EMEC module ECA5 following the Full HV Sub sector.
- {M13C4-M13C5-M13C6-M13C7}

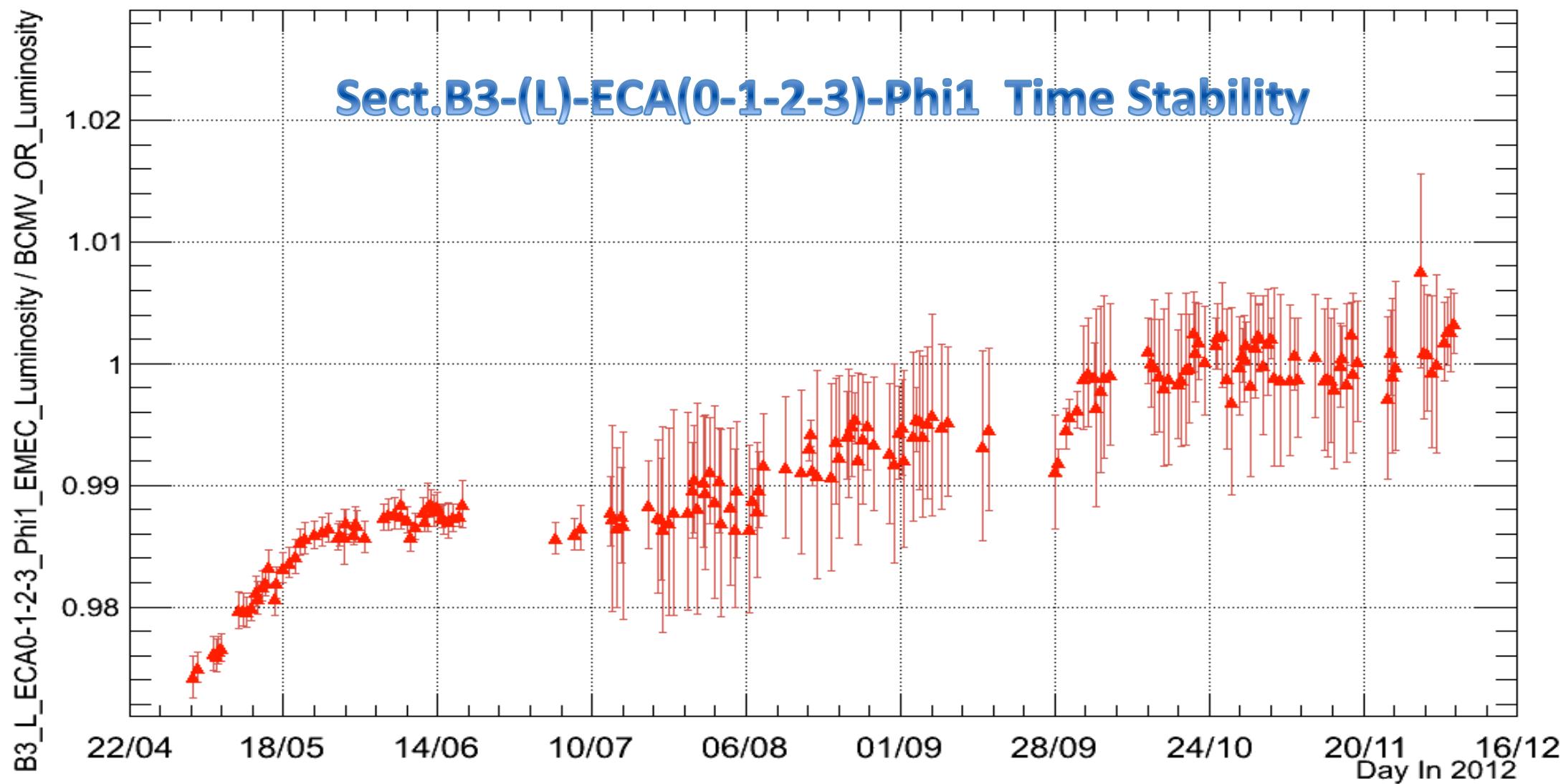
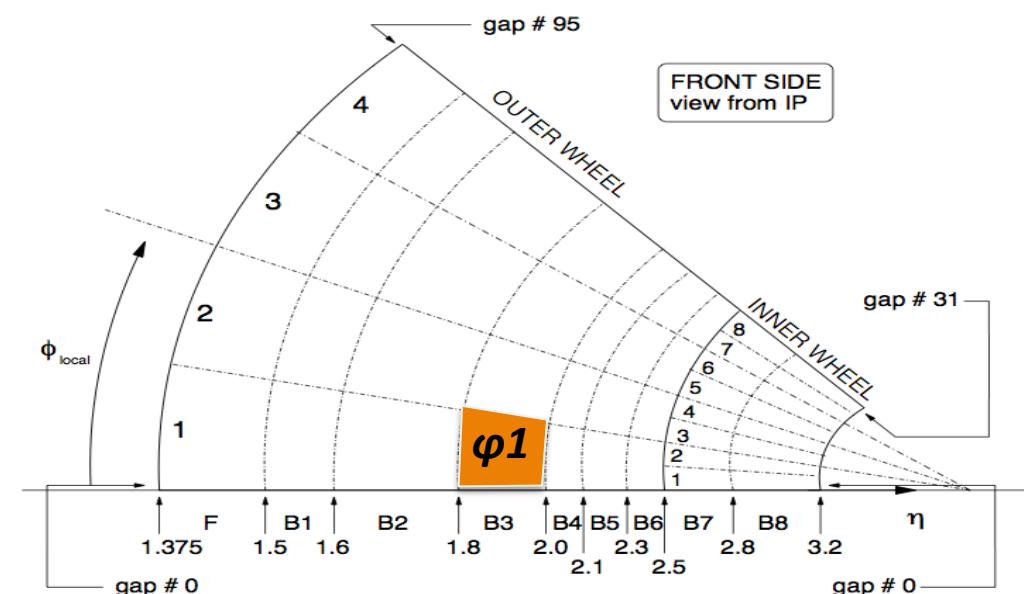
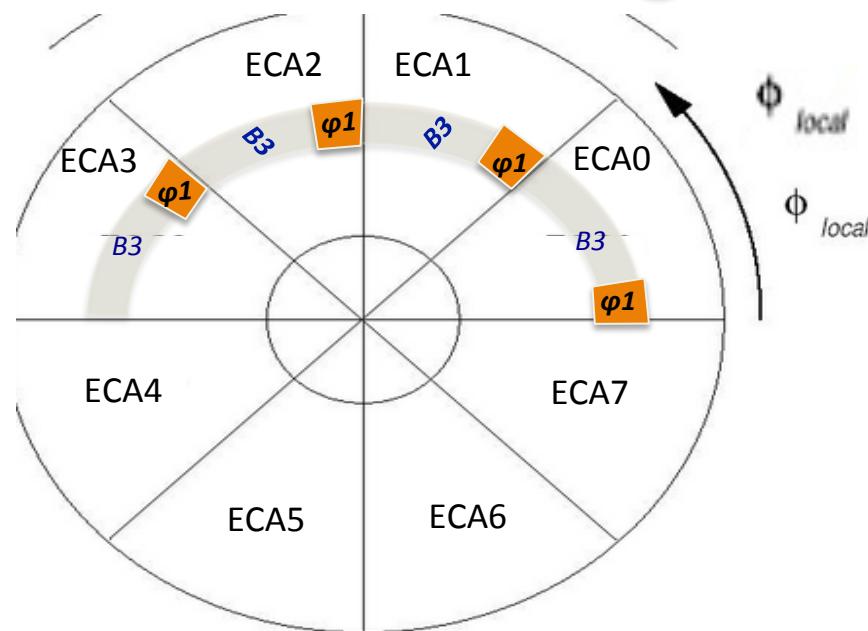


| Detector | Detector Side | Detector Wheel | Eta Sector $\{\eta\}$ | Line Voltage (H/L) | HV Module | Phi EMEC Sector $\{\phi\}$ | Phi HV Sector (Sub ϕ) | | | |
|----------|---------------|----------------|-----------------------|--------------------|-----------|----------------------------|-----------------------------|-------------|-------------|-------------|
| | | | | | | | $\varphi 1$ | $\varphi 2$ | $\varphi 3$ | $\varphi 4$ |
| {EMEC} | EMEC-A | Outer Wheel | B3 (+1700 V) | Higher (H) | Mod.12 | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | Mod.13 | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | B3 (+1700 V) | Lower (L) | Mod.14 | ECA7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA0 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA1 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA2 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | Mod.15 | ECA3 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |
| | | | | | | ECA4 | Channel 0 | Channel 1 | Channel 2 | Channel 3 |
| | | | | | | ECA5 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| | | | | | | ECA6 | Channel 8 | Channel 9 | Channel 10 | Channel 11 |
| | | | | | | ECA7 | Channel 12 | Channel 13 | Channel 14 | Channel 15 |

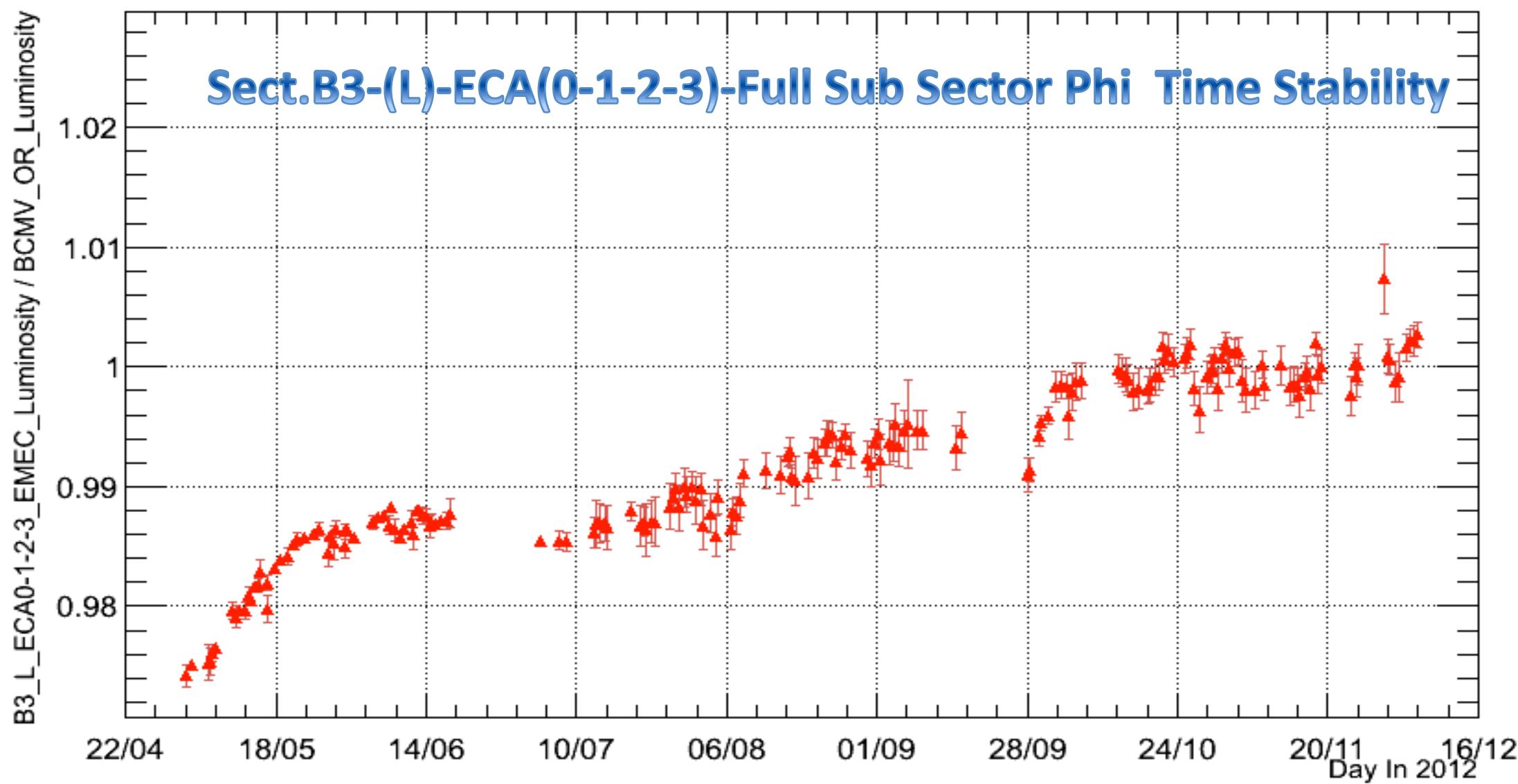
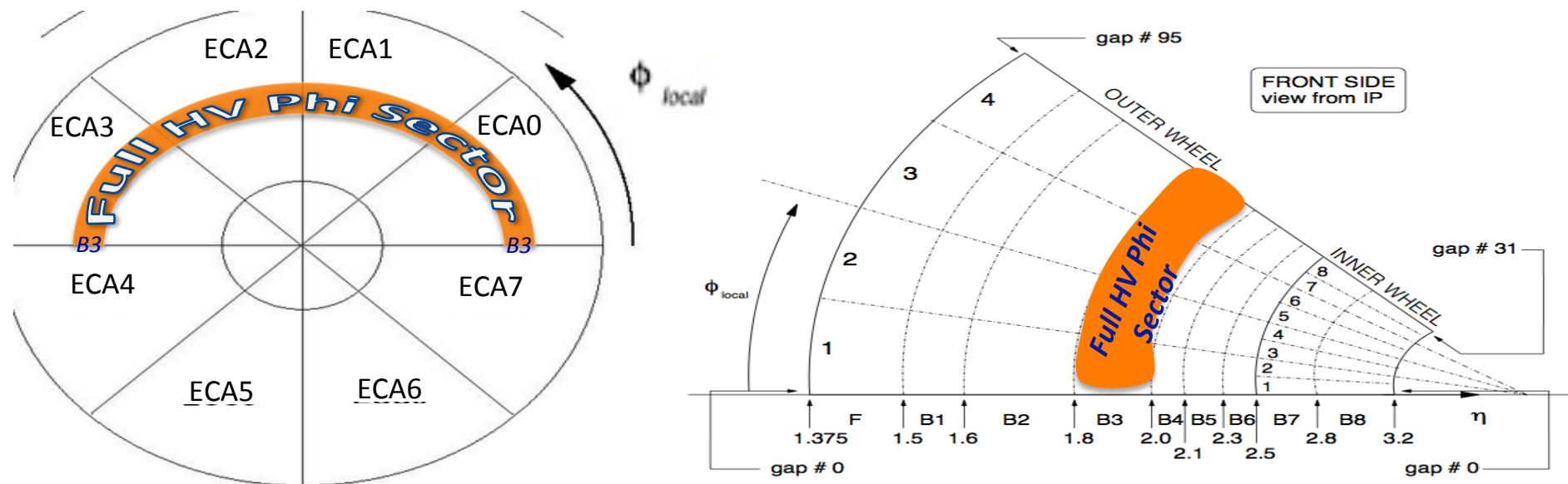
Sector B3- (H) - Sector (ECA5) – Full Sub-Sectors Phi Ref. Channel M14C0 to Average Channels 3 Comparison



HV Current Average Analysis : Channels Combination 1



HV Current Average Analysis : Channels Combination 2



HV Current Average Analysis : Channels Combination 3

