Supplementary Material – Cascaded Generative and Discriminative Learning for Microcalcification Detection in Breast Mammograms

Fandong Zhang[1,5*]   Ling Luo[2,3*]   Xinwei Sun[2,5]   Zhen Zhou[2,5]   Xiuli Li[2,5]
Yizhou Yu[2]   Yizhou Wang[2,4,5]

[1]Center for Data Science, Peking University   [2]Deepwise AI Lab
[3]School of Cyberspace Security, Beijing University of Posts and Telecommunications
[4]Computer Science Department, School of EECS, Peking University   [5]Peng Cheng Laboratory

{fd.zhang, z.zhou, yizhou.wang}@pku.edu.cn {luoling, sunxinwei, lixiuli, yuyizhou}@deepwise.com

In this document, we provide additional materials to supplement our main submission. In the first section, we provide reconstruction results of different settings of T-test loss. In the second section, we show additional detection results on INbreast dataset and in-house dataset, which demonstrates that our model outperforms our baseline methods on tiny or concealed microcalcifications(μCs). In the third section, we provide the split of train/valid/test sets on INbreast dataset in our experiments.

1. Setting loss type

In Sec. 3.1.2 of our main paper, we have the following equations:

$$r(I) = |f(\Theta; I) - I| = \sum_{\mathcal{P} \in I} |f(\Theta; \mathcal{P}) - \mathcal{P}| \ \left(f(\Theta; \mathcal{P}) \triangleq f(\Theta; I)[\mathcal{P}] \right) \tag{1}$$

$$\mathcal{L} = \max(\beta - \bar{r_p}, 0) + \bar{r_n} + \lambda_p S_{r_p}^2 + \lambda_n S_{r_n}^2 \tag{2}$$

Here we represent and compare the reconstruction results of different settings of reconstruction residual loss.

L1: original T-test Loss proposed in our paper.

L2: replace L1 loss in Eq.1 with L2 loss.

Huber's Loss: λ_p and λ_n in Eq.2 are set to be 0, so the loss function becomes $\mathcal{L} = \max(\beta - \bar{r_p}, 0) + \bar{r_n}$, which can be treated as a variation of Huber Loss according to our derivation in Sec. 3.1.3 of our main paper.

Normal Rec: Only use negative samples (normal tissues) to train the model, of which the loss function is $\mathcal{L} = \bar{r_n}$.

As shown in Fig.1, **L2** leads to similar reconstructions to **L1**. We also find **Huber's Loss** tends to miss several indistinct μCs with more false positives. This indicates that constraints on $S_{r_p}^2$ and $S_{r_n}^2$ are necessary, which can enhance the reconstruction residual of positive pixels while reducing the negative ones. **Normal Rec** reconstructs both μCs and normal tissues well. The model seems to collapse into a simple blurring function.
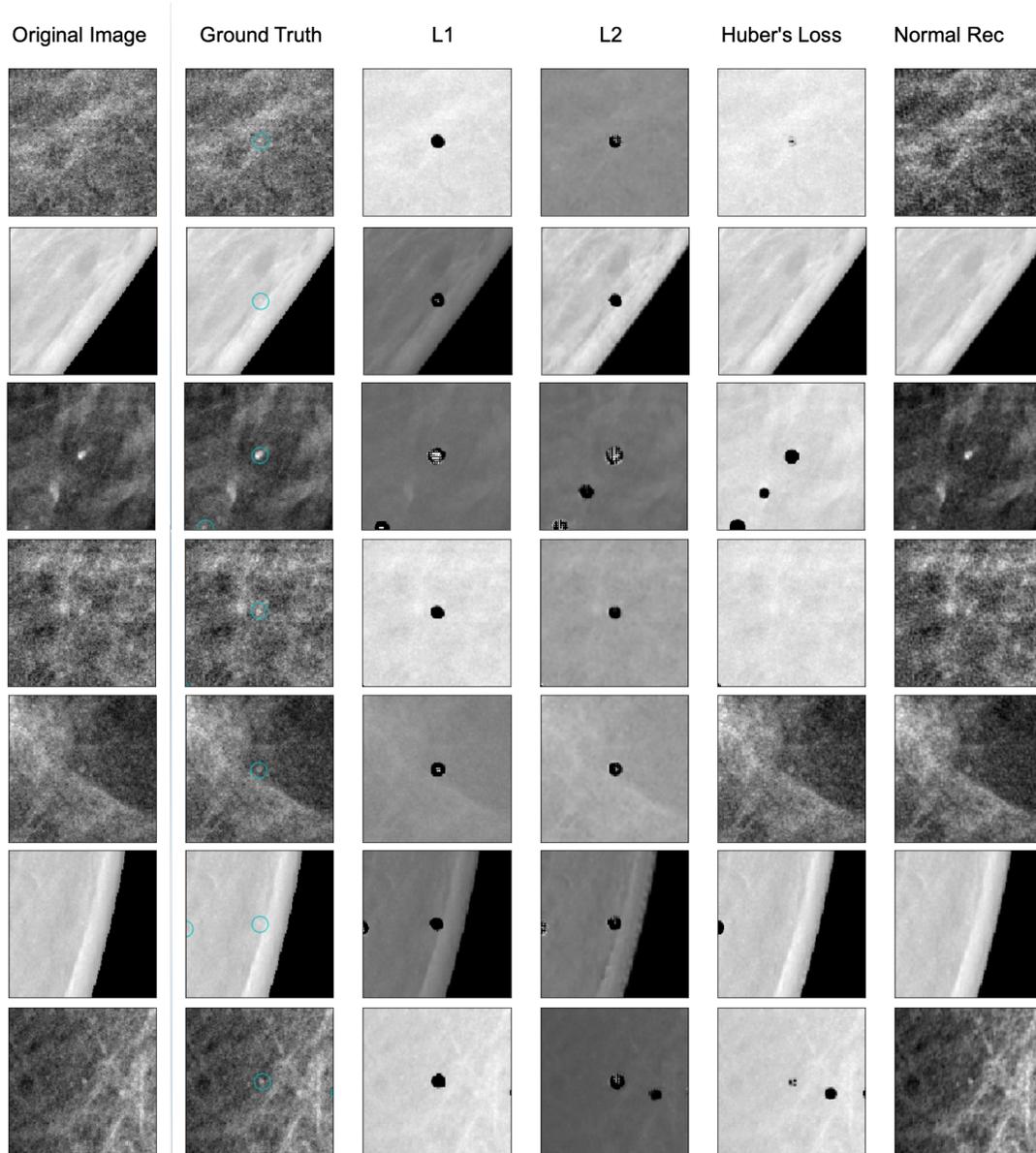
Figure 1. Reconstruction results under different settings of reconstruction residual loss.

2. Detection results

We next provide additional detection results with a focus on demonstrating the detection of multiple or concealed μCs.

INbreast: We first present additional results on INbreast in Fig.2 and Fig.3. These results demonstrate that our model is ideally suited for detecting μCs with irregular shape or tiny size.

in-house dataset: We show our results on in-house dataset in Fig.4 Fig.5 Fig.6 and Fig.7. Compared with INbreast, in-house dataset has a variety of background and image contrast. While our baselines show disability in discovering μC's with low contrast or hidden in normal tissues, the proposed method is robust on these occasions.
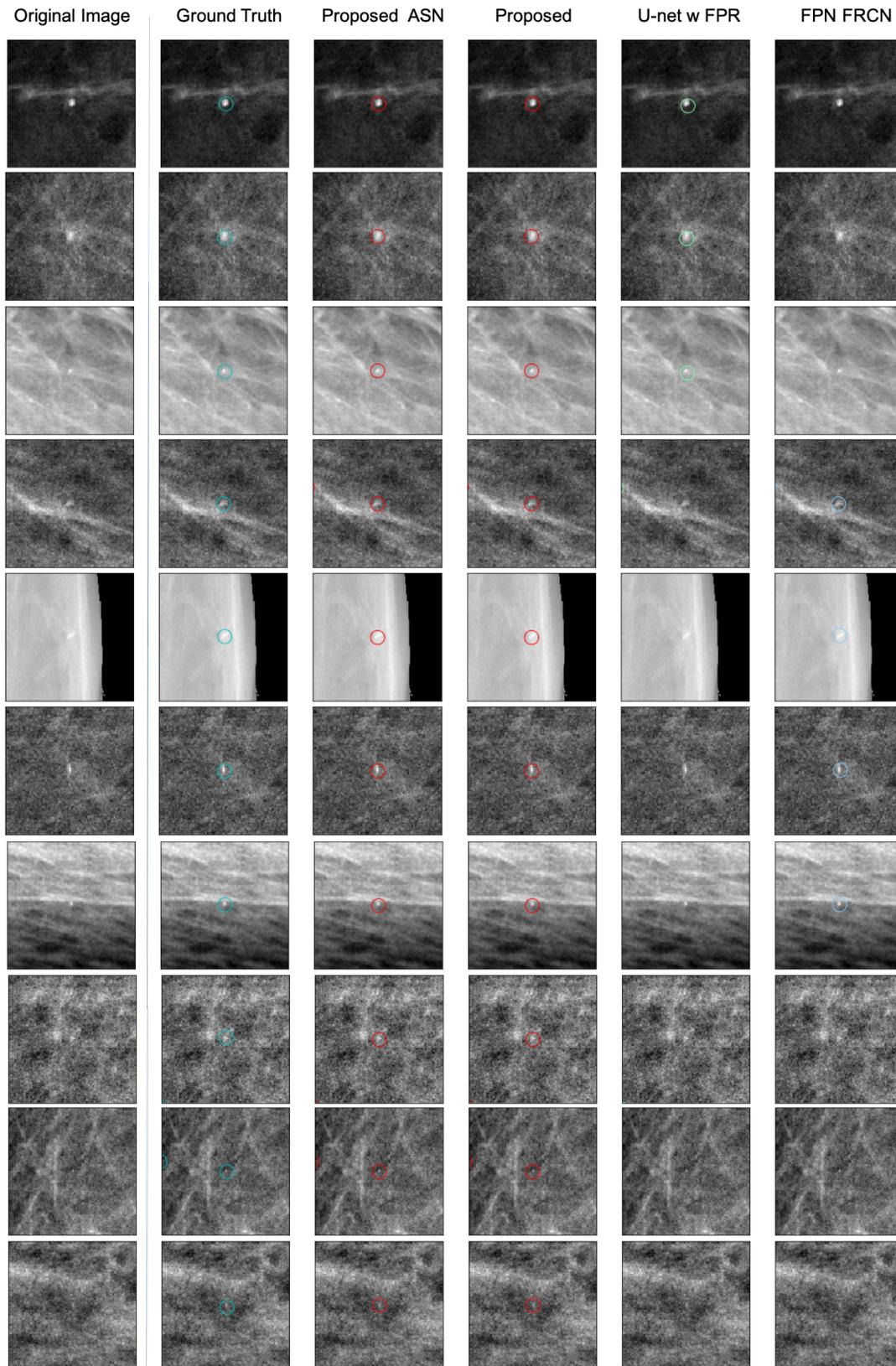
Figure 2. Additional detection results of INbreast.

Original Image	Ground Truth	Proposed ASN	Proposed	U-net w FPR	FPN FRCN
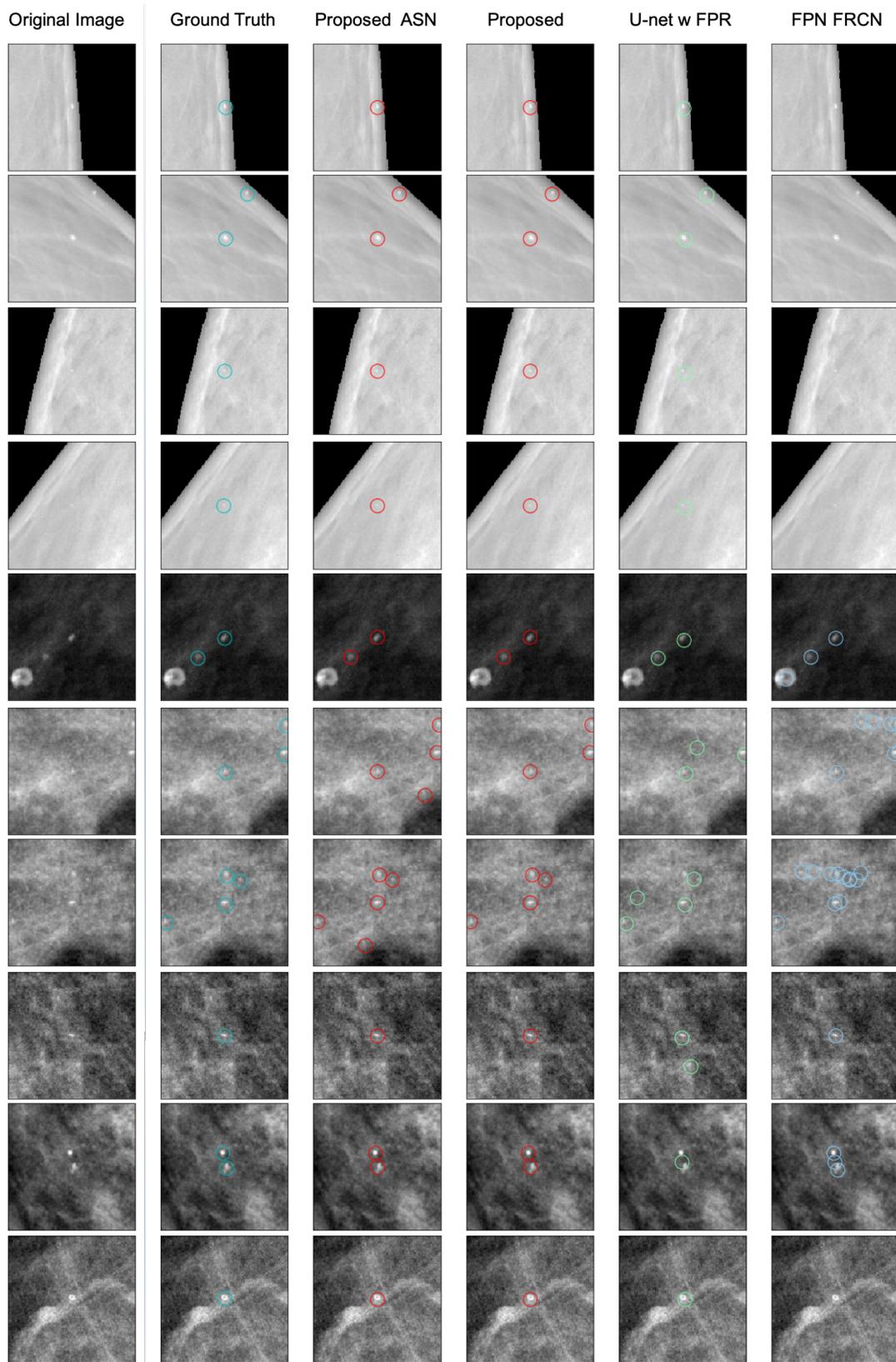
Figure 3. Additional detection results of INbreast.

Original Image	Ground Truth	Proposed ASN	Proposed	U-net w FPR	FPN FRCN
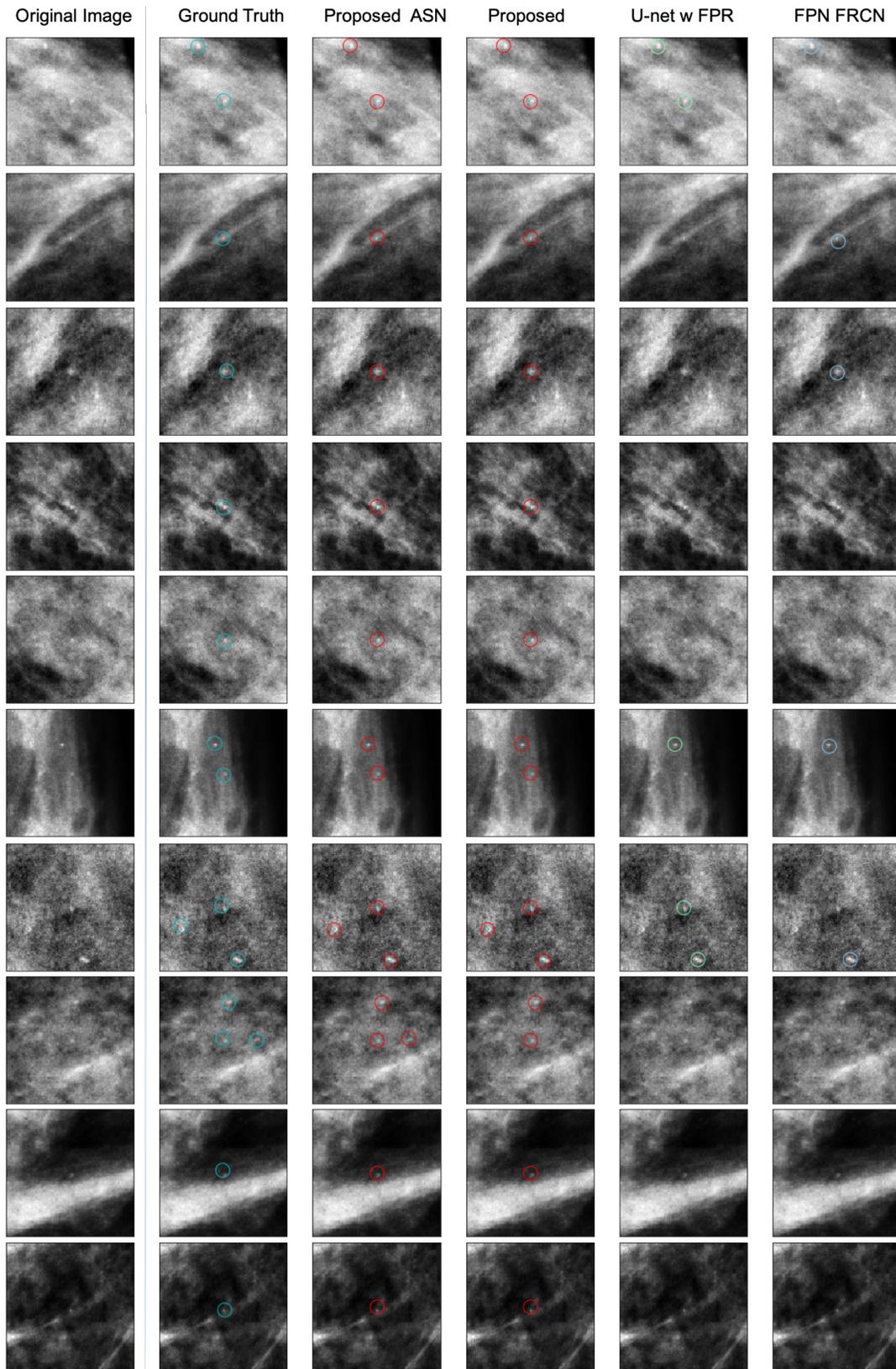
Figure 4. Additional detection results of in-house dataset.

Original Image	Ground Truth	Proposed ASN	Proposed	U-net w FPR	FPN FRCN
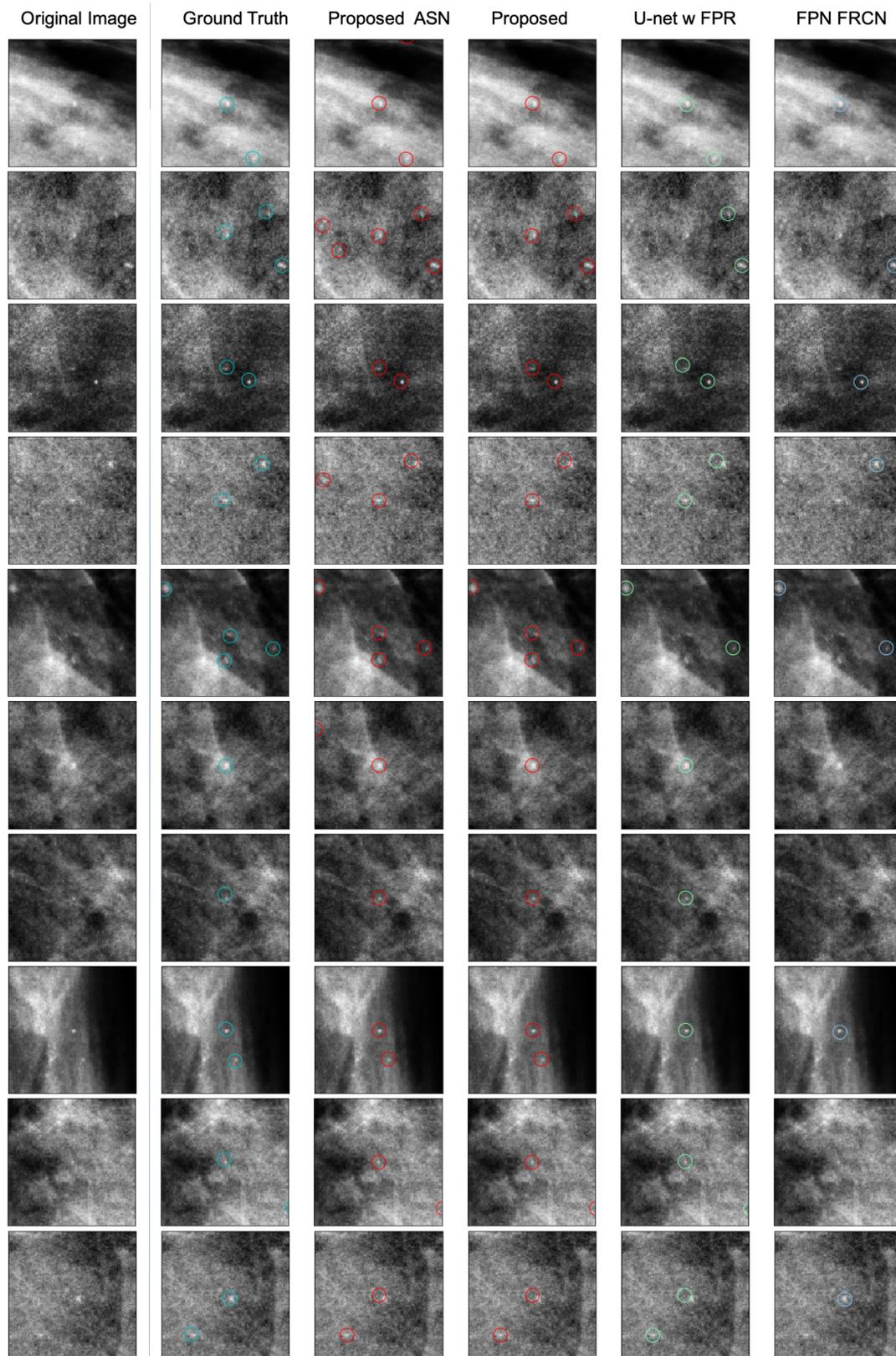
Figure 5. Additional detection results of in-house dataset.

Original Image	Ground Truth	Proposed ASN	Proposed	U-net w FPR	FPN FRCN
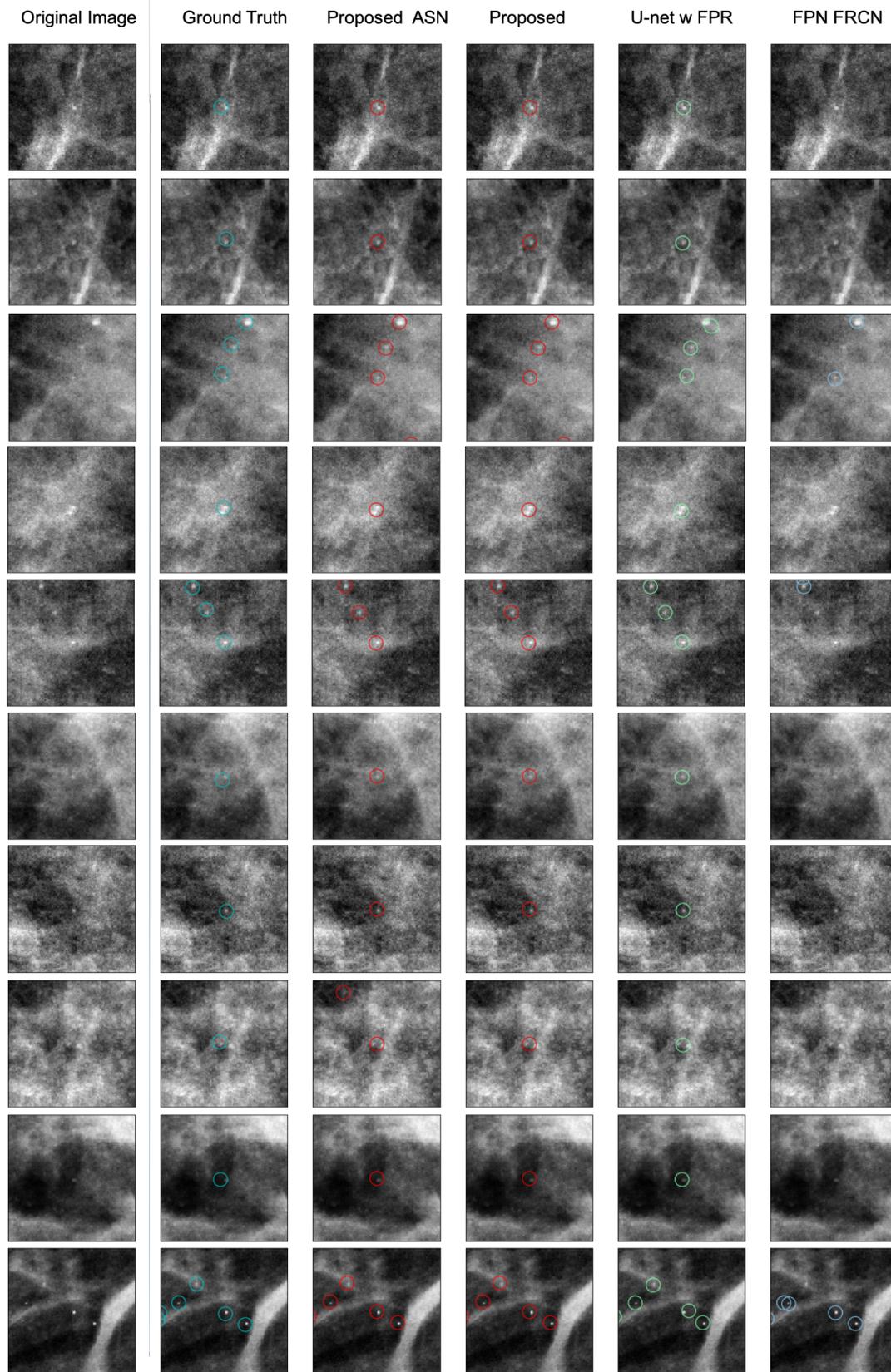
Figure 6. Additional detection results of in-house dataset.

| Original Image	Ground Truth	Proposed ASN	Proposed	U-net w FPR	FPN FRCN
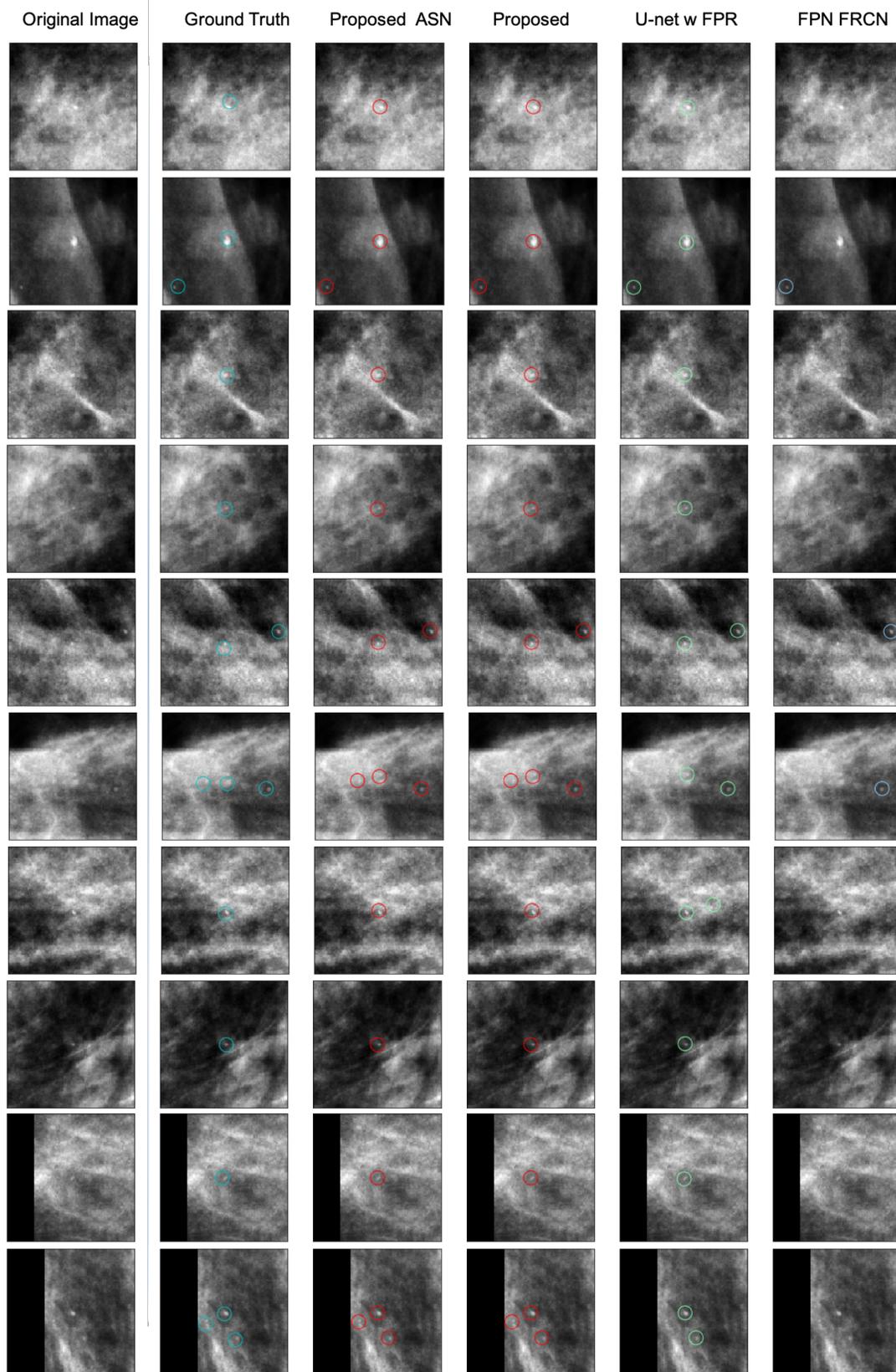
Figure 7. Additional detection results of in-house dataset.

3. Set division of INbreast

In the end, we provide the image name list of our train/valid/test division on public dataset INbreast.
Train set:

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22579730_bbd6a3a35438c11b_MG_R_ML_ANON
22579754_bbd6a3a35438c11b_MG_L_ML_ANON
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50999175_cb65e8dac169f596_MG_R_CC_ANON
50999246_cb65e8dac169f596_MG_L_ML_ANON
50999273_cb65e8dac169f596_MG_R_ML_ANON
50999300_cb65e8dac169f596_MG_L_CC_ANON
50999327_cb65e8dac169f596_MG_R_CC_ANON
53580804_51bec6477a7898b9_MG_L_ML_ANON
53580831_51bec6477a7898b9_MG_R_ML_ANON
53580858_51bec6477a7898b9_MG_L_CC_ANON
53580885_51bec6477a7898b9_MG_R_CC_ANON
53580979_4c341dad22471922_MG_L_ML_ANON
53581006_4c341dad22471922_MG_R_ML_ANON

53581033_4c341dad22471922_MG_L_CC_ANON
53581060_4c341dad22471922_MG_R_CC_ANON

Valid set:

20586908_6c613a14b80a8591_MG_R_CC_ANON
20586934_6c613a14b80a8591_MG_L_CC_ANON
20586960_6c613a14b80a8591_MG_R_ML_ANON
20586986_6c613a14b80a8591_MG_L_ML_ANON
22427682_d713ef5849f98b6c_MG_R_CC_ANON
22427705_d713ef5849f98b6c_MG_L_CC_ANON
22427728_d713ef5849f98b6c_MG_R_ML_ANON
22427751_d713ef5849f98b6c_MG_L_ML_ANON
22579847_301f1776aebbf5d2_MG_R_CC_ANON
22579870_301f1776aebbf5d2_MG_L_CC_ANON
22579893_301f1776aebbf5d2_MG_R_ML_ANON
22579916_301f1776aebbf5d2_MG_L_ML_ANON
22613770_45c7f44839fd9e68_MG_R_CC_ANON
22613796_45c7f44839fd9e68_MG_L_CC_ANON
22613822_45c7f44839fd9e68_MG_R_ML_ANON
22613848_45c7f44839fd9e68_MG_L_ML_ANON
22614074_6bd24a0a42c19ce1_MG_R_CC_ANON
22614097_6bd24a0a42c19ce1_MG_L_CC_ANON
22614127_6bd24a0a42c19ce1_MG_R_ML_ANON
22614150_6bd24a0a42c19ce1_MG_L_ML_ANON
22670442_7e677f3d530e41ed_MG_R_CC_ANON
22670465_7e677f3d530e41ed_MG_L_CC_ANON
22670488_7e677f3d530e41ed_MG_R_ML_ANON
22670511_7e677f3d530e41ed_MG_L_ML_ANON
22670620_e15a16f87b4f9782_MG_R_CC_ANON
22670643_e15a16f87b4f9782_MG_L_CC_ANON
22670673_e15a16f87b4f9782_MG_R_ML_ANON
22670703_e15a16f87b4f9782_MG_L_ML_ANON
24055149_606e9b184978a350_MG_L_ML_ANON
24055176_606e9b184978a350_MG_R_ML_ANON
24055203_606e9b184978a350_MG_L_CC_ANON
24065251_c4b995eddb3c510c_MG_L_ML_ANON
24065270_c4b995eddb3c510c_MG_R_ML_ANON
24065289_c4b995eddb3c510c_MG_L_CC_ANON
24065308_c4b995eddb3c510c_MG_R_CC_ANON
24065530_d8205a09c8173f44_MG_L_ML_ANON
24065557_d8205a09c8173f44_MG_R_ML_ANON
24065584_d8205a09c8173f44_MG_L_CC_ANON
24065611_d8205a09c8173f44_MG_R_CC_ANON
27829134_fbb55bf7fff48540_MG_R_CC_ANON
27829161_fbb55bf7fff48540_MG_L_CC_ANON
27829188_fbb55bf7fff48540_MG_R_ML_ANON
27829215_fbb55bf7fff48540_MG_L_ML_ANON
50994535_de4c34099d6ef8de_MG_R_ML_ANON
50994562_de4c34099d6ef8de_MG_R_CC_ANON
50994589_de4c34099d6ef8de_MG_R_ML_ANON
50994616_de4c34099d6ef8de_MG_R_CC_ANON
50995963_d742ec2f9b90aa62_MG_L_ML_ANON
50995990_d742ec2f9b90aa62_MG_L_CC_ANON

50996800_fdf4a1516f88b280_MG_L_ML_ANON
50996827_fdf4a1516f88b280_MG_R_ML_ANON
50996854_fdf4a1516f88b280_MG_L_CC_ANON
50996881_fdf4a1516f88b280_MG_R_CC_ANON
51048738_3f22cdda8da215e3_MG_R_ML_ANON
51048765_3f22cdda8da215e3_MG_R_CC_ANON
51049249_832ebce700241036_MG_L_CC_ANON
51049276_832ebce700241036_MG_L_ML_ANON
53581237_80123a24997098dc_MG_R_ML_ANON
53581264_80123a24997098dc_MG_R_CC_ANON
53582304_8913a7e0cf3bd74e_MG_R_ML_ANON
53582331_8913a7e0cf3bd74e_MG_R_CC_ANON
53582395_3f0db31711fc9795_MG_L_ML_ANON
53582422_3f0db31711fc9795_MG_R_ML_ANON
53582449_3f0db31711fc9795_MG_L_CC_ANON
53582476_3f0db31711fc9795_MG_R_CC_ANON
53586361_dda3c6969a34ff8e_MG_L_ML_ANON
53586388_dda3c6969a34ff8e_MG_R_ML_ANON
53586415_dda3c6969a34ff8e_MG_L_CC_ANON
53586442_dda3c6969a34ff8e_MG_R_CC_ANON
53587572_11e6732579acf692_MG_L_ML_ANON
53587599_11e6732579acf692_MG_L_CC_ANON

Test set:

20588138_8d0b9620c53c0268_MG_R_ML_ANON
20588164_8d0b9620c53c0268_MG_R_CC_ANON
20588190_8d0b9620c53c0268_MG_L_CC_ANON
20588216_8d0b9620c53c0268_MG_L_ML_ANON
22614236_1e5c3af078f74b05_MG_L_CC_ANON
22614266_1e5c3af078f74b05_MG_L_ML_ANON
22614353_d065adcb9905b973_MG_R_CC_ANON
22614379_d065adcb9905b973_MG_L_CC_ANON
22614405_d065adcb9905b973_MG_R_ML_ANON
22614431_d065adcb9905b973_MG_L_ML_ANON
24055274_1e10aef17c9fe149_MG_L_ML_ANON
24055328_1e10aef17c9fe149_MG_R_ML_ANON
24055355_1e10aef17c9fe149_MG_L_CC_ANON
24055382_1e10aef17c9fe149_MG_R_CC_ANON
24055445_ac3185e18ffdc7b6_MG_L_ML_ANON
24055464_ac3185e18ffdc7b6_MG_R_ML_ANON
24055483_ac3185e18ffdc7b6_MG_L_CC_ANON
24055502_ac3185e18ffdc7b6_MG_R_CC_ANON
24065380_83db89f57aea498a_MG_L_ML_ANON
24065407_83db89f57aea498a_MG_R_ML_ANON
24065434_83db89f57aea498a_MG_L_CC_ANON
24065461_83db89f57aea498a_MG_R_CC_ANON
24065680_5291e1aee2bbf5df_MG_L_ML_ANON
24065707_5291e1aee2bbf5df_MG_R_ML_ANON
24065734_5291e1aee2bbf5df_MG_L_CC_ANON
24065761_5291e1aee2bbf5df_MG_R_CC_ANON
30011484_349323117bf0fd93_MG_R_CC_ANON
30011507_349323117bf0fd93_MG_L_CC_ANON
30011530_349323117bf0fd93_MG_R_ML_ANON

30011553_349323117bf0fd93_MG_L_ML_ANON
30011798_4f20c1285d8f0b1f_MG_R_CC_ANON
30011824_4f20c1285d8f0b1f_MG_L_CC_ANON
30011850_4f20c1285d8f0b1f_MG_R_ML_ANON
30318067_4f20c1285d8f0b1f_MG_L_ML_ANON
50993399_5d85ecc9cf26b254_MG_L_ML_ANON
50993426_5d85ecc9cf26b254_MG_L_CC_ANON
50993616_b03f1dd34eb3c55f_MG_L_ML_ANON
50993643_b03f1dd34eb3c55f_MG_L_CC_ANON
50993670_b03f1dd34eb3c55f_MG_L_ML_ANON
50993697_b03f1dd34eb3c55f_MG_L_CC_ANON
50995872_c94d8a1ebd452afe_MG_L_ML_ANON
50995899_c94d8a1ebd452afe_MG_L_CC_ANON
50996945_ce5e5e18a261cd29_MG_L_ML_ANON
50996972_ce5e5e18a261cd29_MG_R_ML_ANON
50996999_ce5e5e18a261cd29_MG_L_CC_ANON
50997026_ce5e5e18a261cd29_MG_R_CC_ANON
50997053_ce5e5e18a261cd29_MG_L_CC_ANON
50997080_ce5e5e18a261cd29_MG_L_ML_ANON
50997107_ce5e5e18a261cd29_MG_R_ML_ANON
50997134_ce5e5e18a261cd29_MG_R_CC_ANON
50997597_67cc8c9939d74a9a_MG_L_ML_ANON
50997624_67cc8c9939d74a9a_MG_R_ML_ANON
50997651_67cc8c9939d74a9a_MG_L_CC_ANON
50997678_67cc8c9939d74a9a_MG_R_CC_ANON
50998177_f34ee0ab6591b792_MG_L_ML_ANON
50998204_f34ee0ab6591b792_MG_R_ML_ANON
50998231_f34ee0ab6591b792_MG_L_CC_ANON
50998258_f34ee0ab6591b792_MG_R_CC_ANON
50999432_f62fbf38fb208316_MG_L_ML_ANON
50999459_f62fbf38fb208316_MG_L_CC_ANON
51048891_f3e93e889a7746f0_MG_L_ML_ANON
51048918_f3e93e889a7746f0_MG_R_ML_ANON
51048945_f3e93e889a7746f0_MG_L_CC_ANON
51048972_f3e93e889a7746f0_MG_R_CC_ANON
51049053_8c105bb715bf1c3c_MG_L_ML_ANON
51049080_8c105bb715bf1c3c_MG_R_ML_ANON
51049107_8c105bb715bf1c3c_MG_L_CC_ANON
51049134_8c105bb715bf1c3c_MG_R_CC_ANON
53581860_21e6cc12630e5e9f_MG_L_ML_ANON
53581887_21e6cc12630e5e9f_MG_R_ML_ANON
53581914_21e6cc12630e5e9f_MG_L_CC_ANON
53581941_21e6cc12630e5e9f_MG_R_CC_ANON
53582540_3e73f1c0670cfb0a_MG_R_ML_ANON
53582567_3e73f1c0670cfb0a_MG_R_CC_ANON
53586869_6ac23356b912ee9b_MG_L_ML_ANON
53586896_6ac23356b912ee9b_MG_L_CC_ANON