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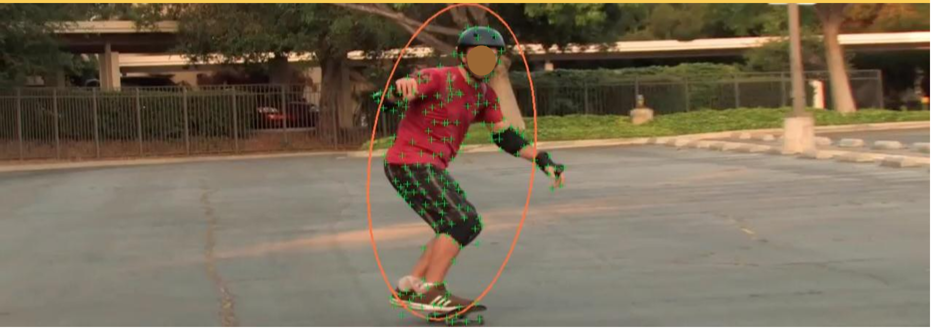


SESAME

(Video SEarch with Speed and Accuracy for Multimedia Events)
Multimedia Event Detection (MED) System

November 26, 2012

SRI International

UNIVERSITY OF AMSTERDAM

UNIVERSITY OF SOUTHERN CALIFORNIA 1880

Overview

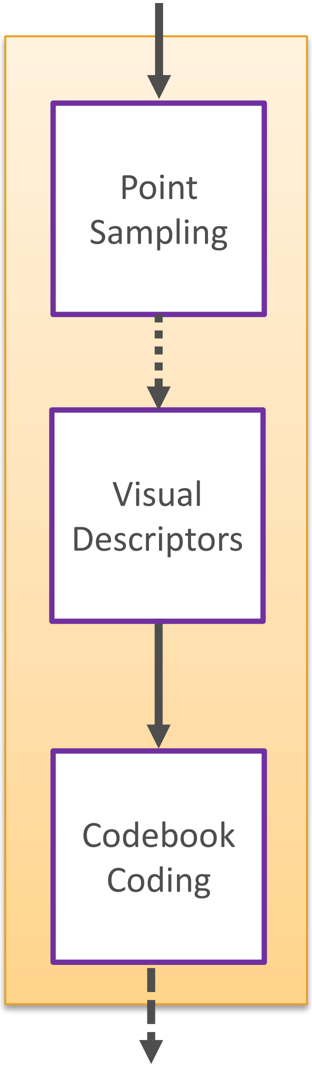
- Event classifiers
- Fusion and threshold selection
- Waypoint experiments on development set
- MED12 evaluation results

14 Low-level and High-level Event Classifiers

- **Low-level features**
  - visual features (2)
  - motion features (5)
  - audio features (1)

- **Concept-level features:**
  - visual concepts (2)
  - ASR (2)
  - video OCR (2)

Visual Features: Bag-of-Words and Difference Coding



Bag of words for

event agents *and*

visual scenes, objects, persons, actions

State-of-the-art

ColorSIFT [Van de Sande et al. TPAMI 2010]

Soft-Assignment [Van Gemert et al. TPAMI 2010]

Real-time Bag-of-Words [CIVR09 best paper]

TSIFT [under review]

Two event classifiers based on visual features

1 frame sampled in every 2 seconds of video

	Sampling	Descriptors	Codebook	Aggregation	Kernel
1.Color average coding	Dense Harris	PCA reduced: SIFT, CSIFT, TSIFT	4096, hard 1x1,1x3	Average	Fast HIK
2. Color difference soft coding	Dense	PCA reduced: SIFT, CSIFT, TSIFT	1024, soft 1x1,1x3	Average	Linear

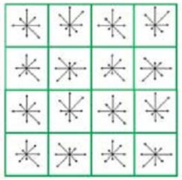
Waypoint experiments showed:

- average coding outperformed difference coding
- difference coding complemented average coding in late fusion experiments

Low-level motion features

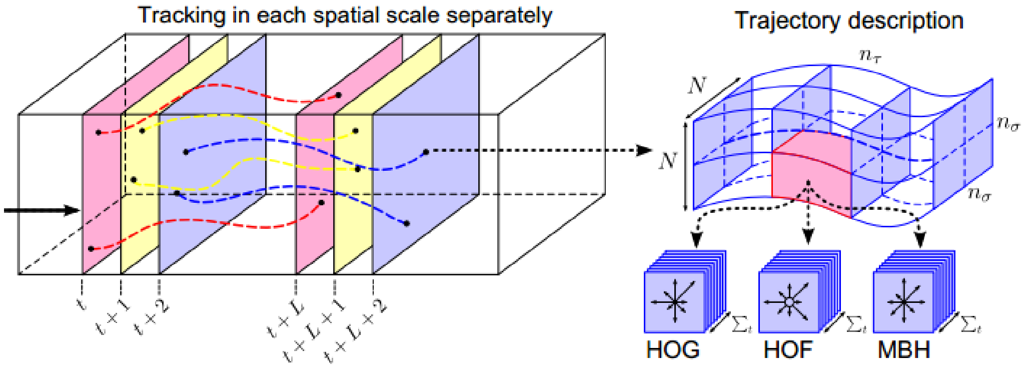
- **STIP:**
  - Corner like detectors in 3D
  - 72-dim HOG + 90-dim HOF

- **MoSIFT**
  - SIFT like detectors in 2D, filtered by motion
  - Extracted, quantized and pooled by CMU



Alexander Kläser et al,
BMVC 2008

- **Dense Trajectories (DT):**
  - Generate tracklets for densely sampled points
  - Describe each tracklet by shape, HoG, HoF and MBH of the volume around it



Wang et al.,
CVPR 2011

Event classifiers using low-level motion features

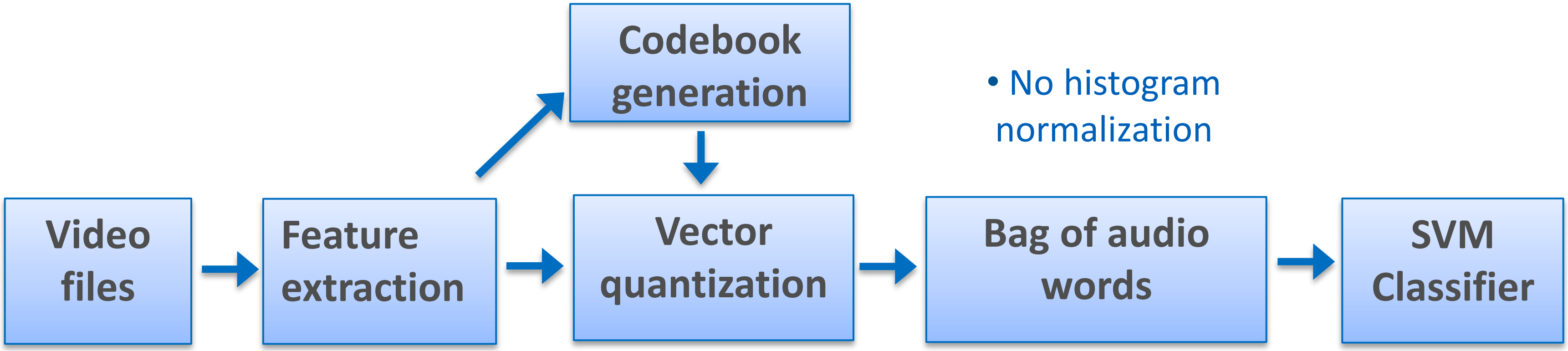
- **5 event classifiers:**

Event Classifier	Feature	Descriptor	Aggregation	Kernel
1	STIP	1st-order Fisher	Average	Gaussian
2	STIP	2nd-order Fisher	Average	Gaussian
3	DT	1st-order Fisher	Average	Gaussian
4	DT	2nd-order Fisher	Average	Gaussian
5	MoSIFT	MoSift	Average	χ2

- **Waypoint experiment showed:**
  - Dense Trajectory gives the best performance
  - 2nd order Fisher vector is better than 1st order
  - All 3 motion features are complementary in late fusion experiments

Event Classifier using Low-level Audio Features

- Codebook size = 1000



Video files

Feature extraction

Codebook generation

Vector quantization

Bag of audio words

SVM Classifier

- No histogram normalization

- 16 kHz sampling rate
- MFCCs every 10 ms
- 12 coeff.+ log-energy + Δ+ Δ-Δ of each = 39 dim total
- No MFCC normalization

- Soft quantization

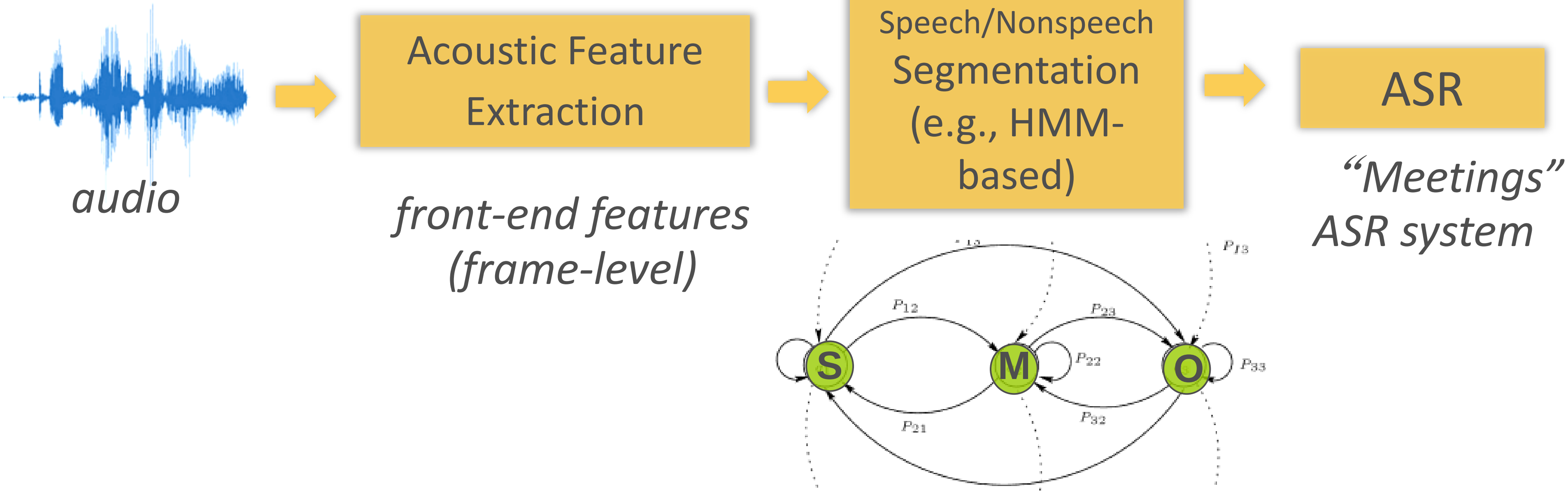
  → add distance from nearest codeword instead of +1 to the histogram for each quantized vector

- Histogram intersection kernel

Event Classifiers using Visual Concept Detectors

- **1346 concept detectors**
  - 346 concepts from the TRECVID 2012 SIN task
  - 1,000 concepts from ImageNet
  - All trained using color difference coding with linear SVM
- **Two event classifiers**
  - One used random forests
  - One used a non-linear SVM

Automatic Speech Recognition (ASR)



audio

Acoustic Feature Extraction

front-end features (frame-level)

Supervised Speech/Nonspeech Segmentation (e.g., HMM-based)

ASR

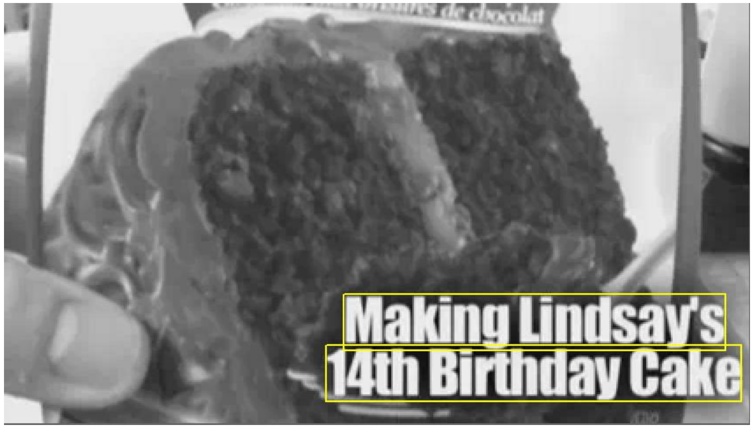
"Meetings" ASR system

- **Un-adapted ASR system trained on far-field microphone meetings data**
- **3-state ergodic HMM for audio segmentation (speech, music, other)**
- **ASR configured to recognize spoken English**

Video OCR

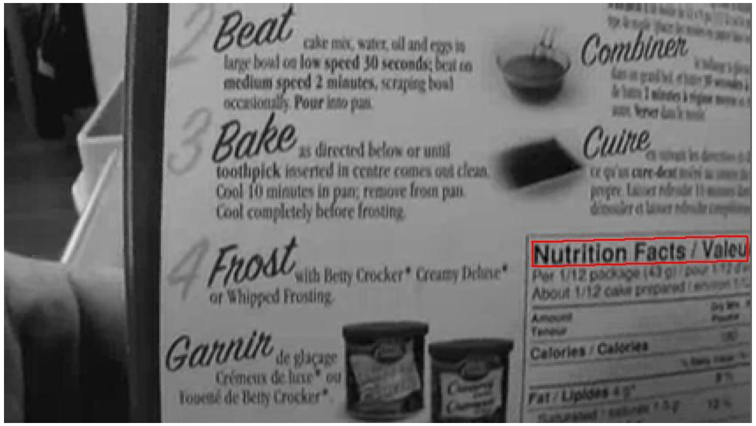
- **SRI’s video optical character recognition (video OCR) for detection, tracking, and recognition of text**
  - **recognizes both overlay text and in-scene text**
  - **configured to recognize English language text**

Text captions



“Making Lindsay s 14th Birthday Cake”

In-scene text


Beat
cake mix, water, oil and eggs in large bowl on low speed 30 seconds; beat on medium speed 2 minutes, scraping bowl occasionally. Pour into pan.
Bake
as directed below or until toothpick inserted in centre comes out clean. Cool 10 minutes in pan; remove from pan. Cool completely before frosting.
Frost
with Betty Crocker® Creamy Deluxe® or Whipped Frosting.
Garnir
Combiner
Cuire
Nutrition Facts / Valeu
Calories / Calories
Fat / Lipides

“Nutrition Facts – Valeu”

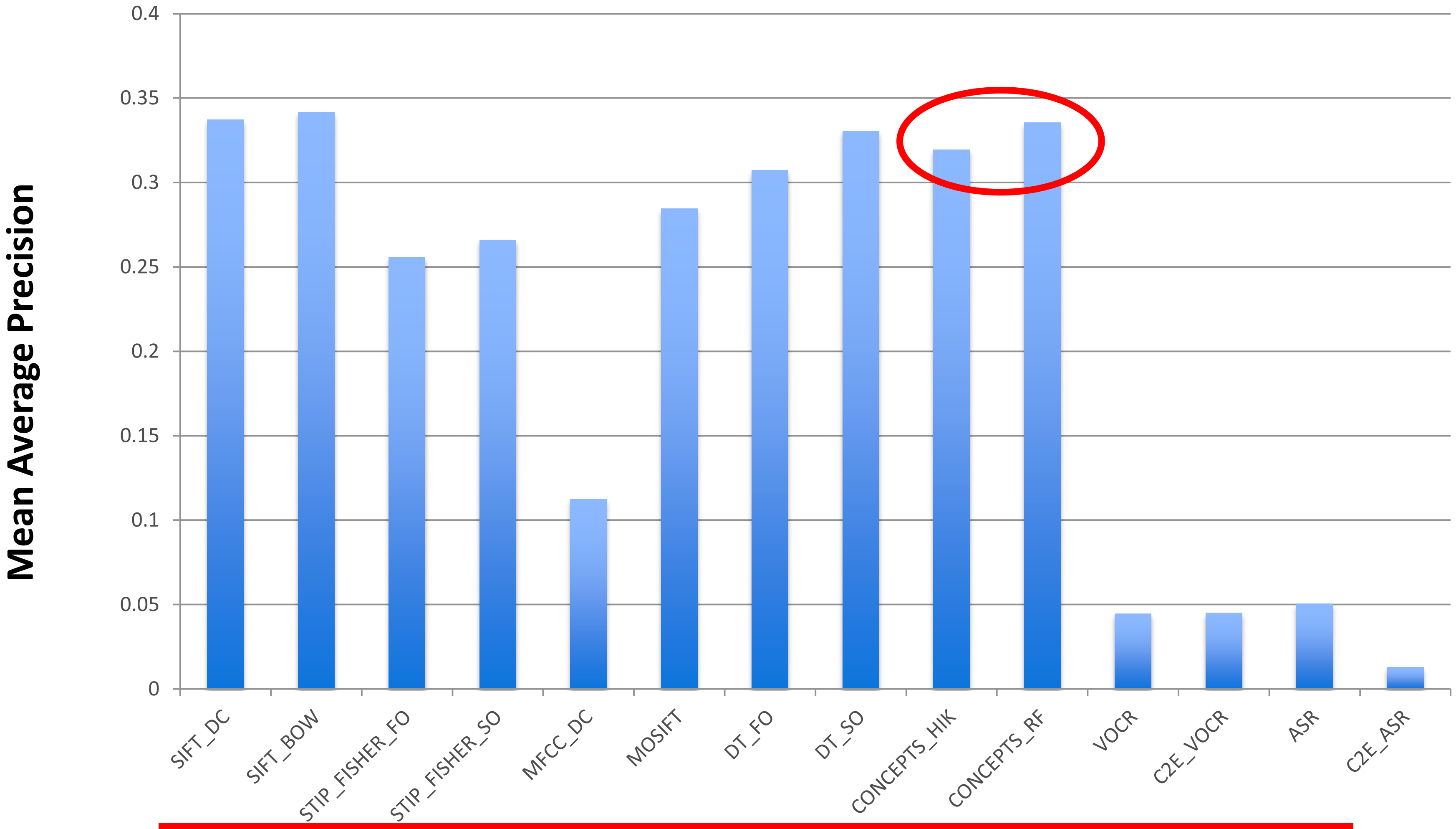
4 Event Classifiers for ASR and OCR Text

- **Each classifier measures the overlap of text in the test video with text in the event model using logistic regression**

- **Two event classifiers (one for ASR and one for OCR) based on text found in training set clips**
  - Unigram bag-of-words event models

- **Two event classifiers (one for ASR and one for OCR) based on text found in the event explications**
  - Identified the top-most relevant terms from the event explication using inverse document frequency (IDF) on a large English language text corpus
  - Augmented the terms with associated concepts found in WordNet

Performance of Individual Event Classifiers: EKFull

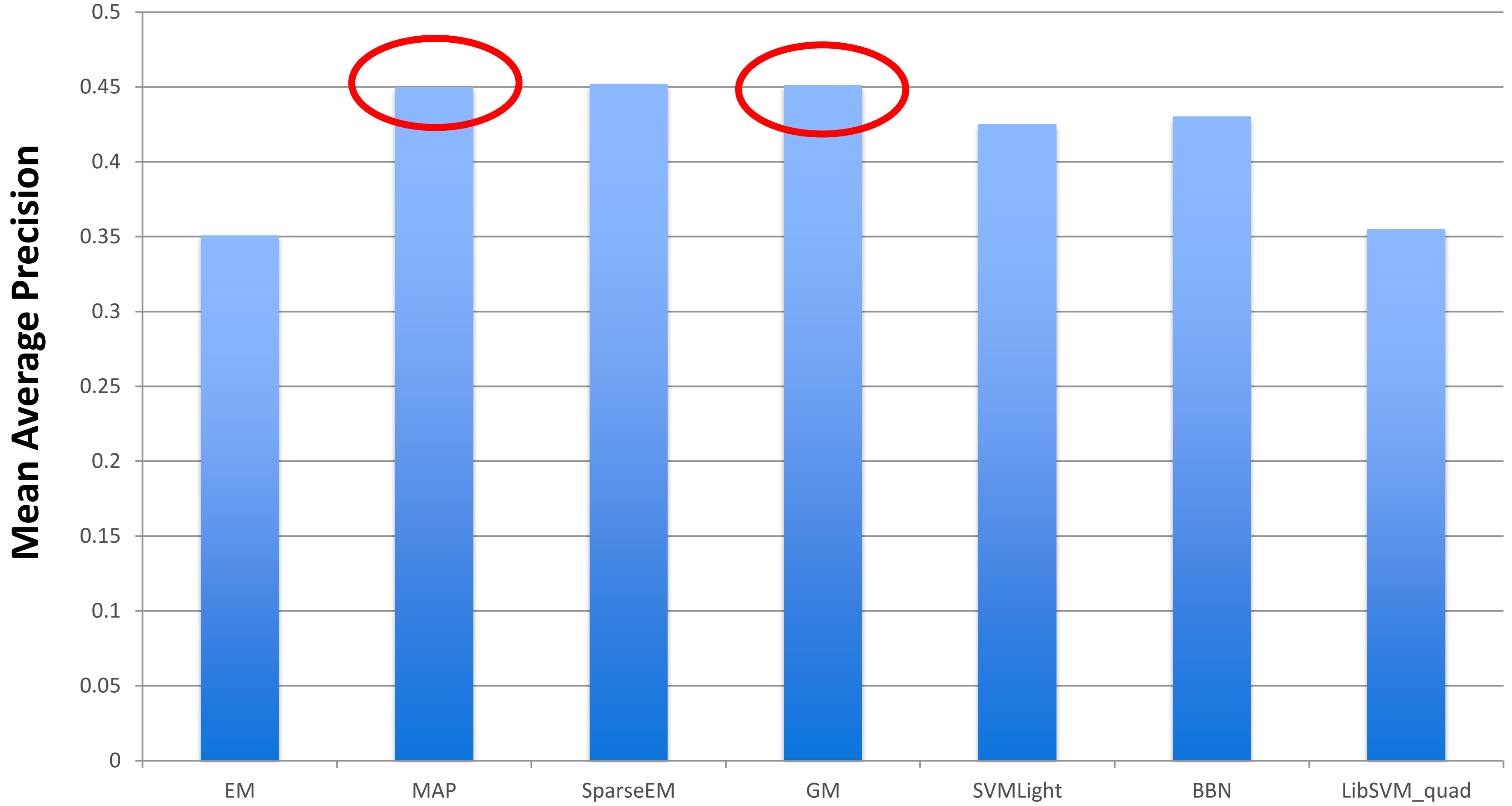


High-level features comparable to low-level features

Late Fusion Models

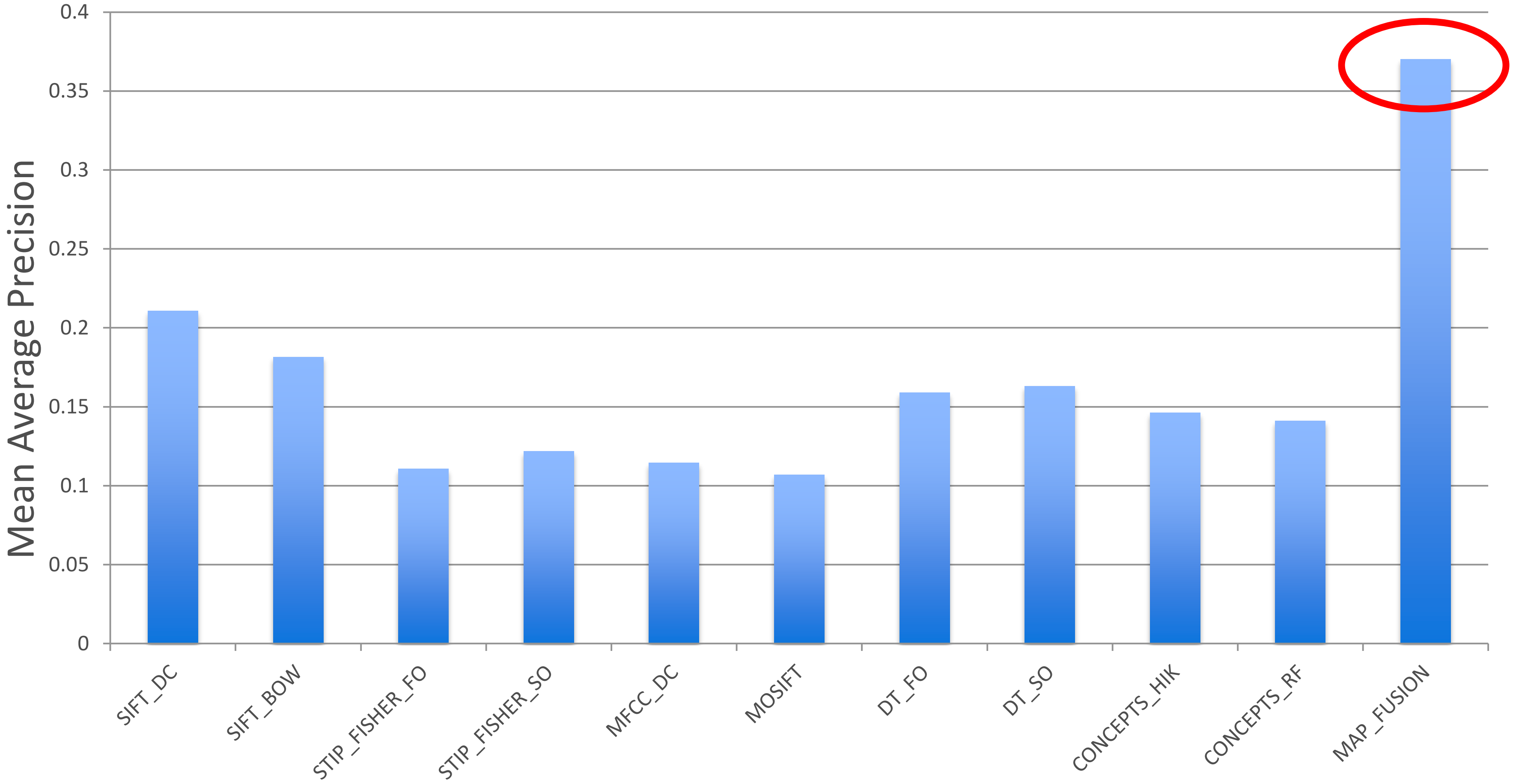
- **No weights**
  - Arithmetic mean (AM)
  - Geometric mean (GM)
- **Fixed weights**
  - Mean average precision-weighted fusion (MAP)
  - Conditional mixture model (EM)
- **Dynamic weights**
  - Sparse conditional mixture model (SparseEM)
  - Weighted mean root
  - SVMLight
  - LibSVM
  - BBN weighting (BBN)

Performance of Late Fusion Models: EKFull



Simple fusion models are good enough

Performance of Individual Event Classifiers : EK10Ex



Fusion produces big gain in performance

Threshold Selection Methods

- **Score@TER**
  - determined by the threshold that achieves the Target Error Ratio
- **Median score@TER**
  - for the ad hoc Ek10Ex condition only
  - median of the score@TER thresholds learned on the pre-specified events for the EK10Ex condition
- **Box-average – the average of two thresholds:**
  - the threshold that achieves P(Miss) = 50%
  - the threshold that achieves P(FA) = 4%

SESAME MED Evaluation Runs on Progress Set

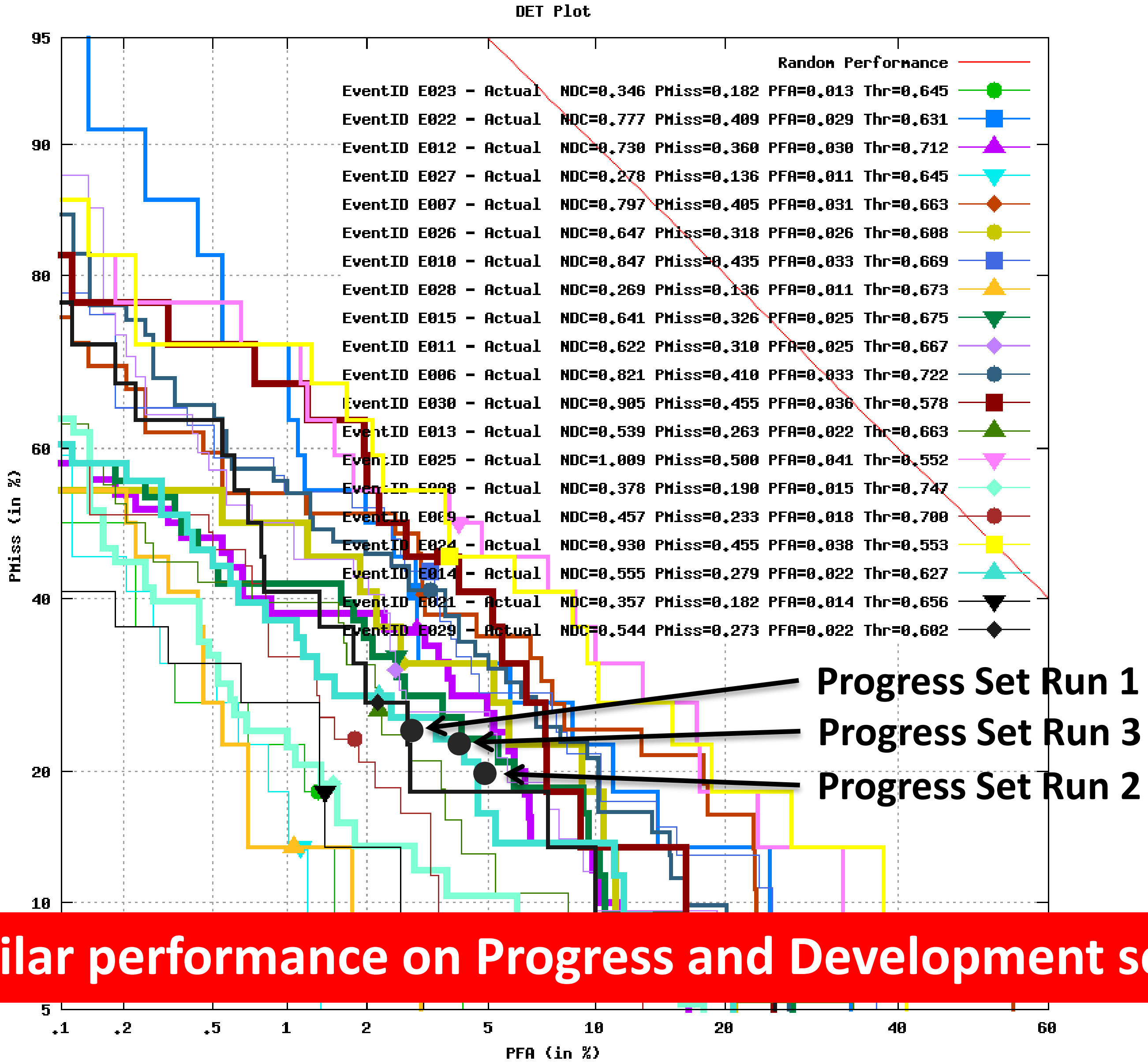
Runs 1, 2, and 3: Pre-specified events; EKFull; mix of extracted metadata, fusion methods, and thresholding methods

Run 4: Pre-specified events; EK10EX

Run 5: Ad hoc events; EKFull

Run 6: Ad hoc events; EK10Ex

Pre-specified Events, EKFull



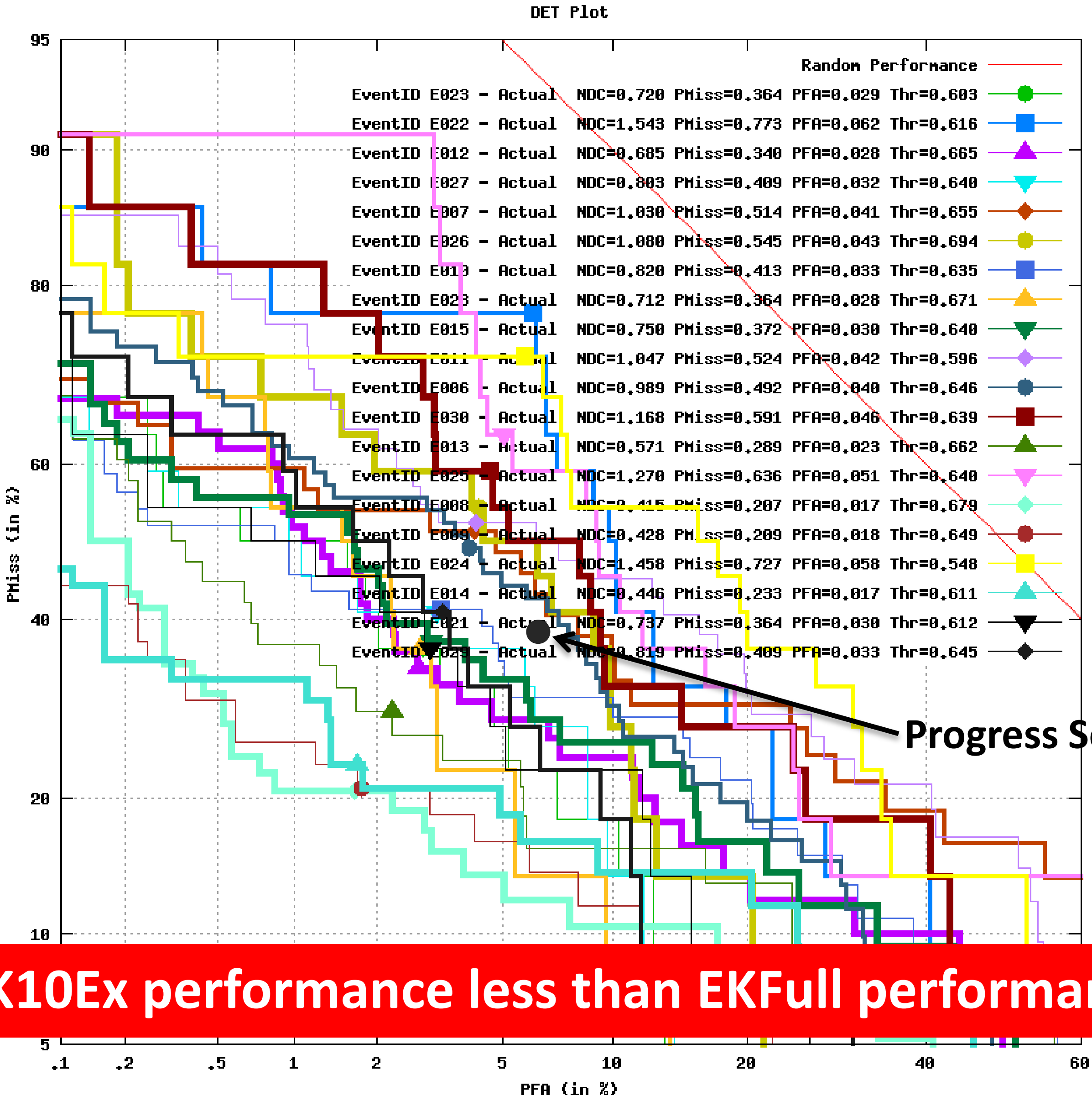
Progress Set Run 1

Progress Set Run 3

Progress Set Run 2

Similar performance on Progress and Development sets

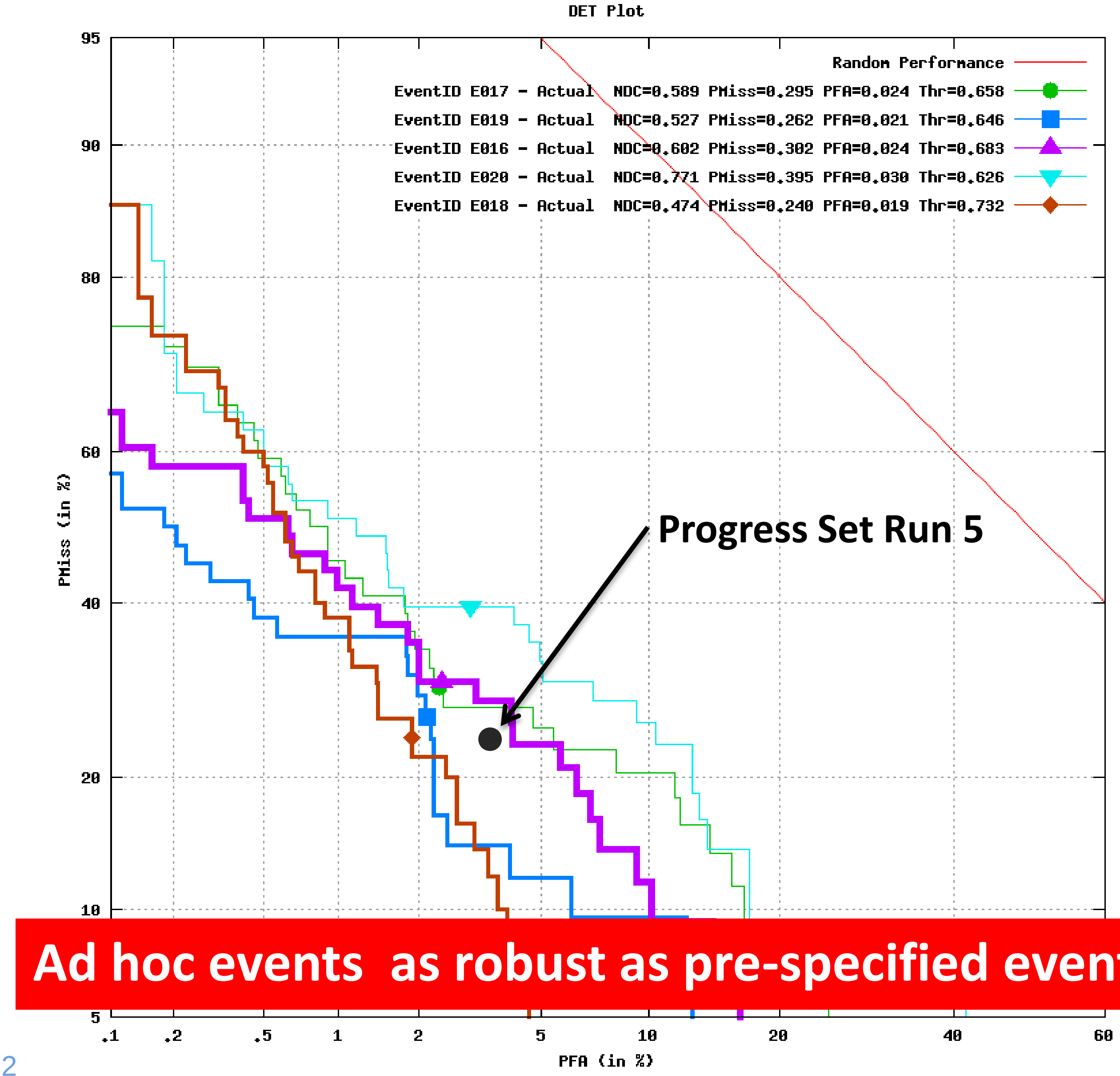
Pre-specified Events, EK10Ex



Progress Set Run 4

EK10Ex performance less than EKFull performance

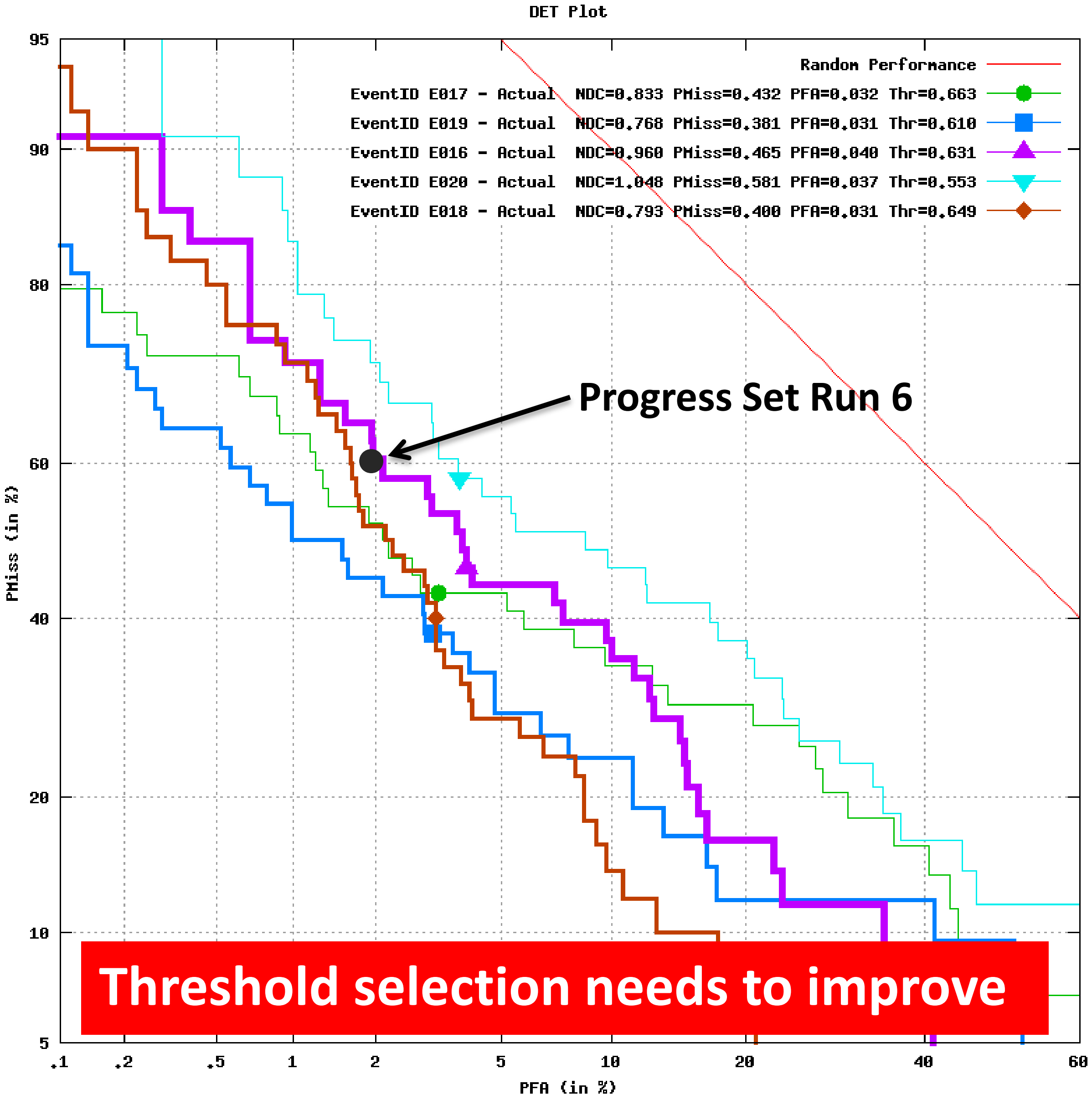
Ad Hoc Events, EKFull



Progress Set Run 5

Ad hoc events as robust as pre-specified events

Ad Hoc Events, EK10Ex



Progress Set Run 6

Threshold selection needs to improve

Conclusions

- High-level features comparable to low-level
- Simple average fusion good enough
- Similar results on Progress Set and our internal development set
- Ad hoc events as robust as pre-specified events
- Threshold selection needs to improve

SESAME Team for MED12

- **SRI International**
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  - Cees G.M. Snoek, Amirhossein Habibian, Dennis C. Koelma, Zhenyang Li, Masoud Mazloom, Silvia-Laura Pintea, Koen E.A. van de Sande, Arnold W.M. Smeulders
- **University of Southern California**
  - Ram Nevatia, Sung Chun Lee, Pramod Sharma, Chen Sun, Remi Trichet

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