



纳米流式检测仪在外泌体研究中的最新应用

——单颗粒水平多参数表征
粒径、浓度、生化性能

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公司坐落于厦门火炬高新区留学人员创业园，拥有自主研发的**纳米流式检测技术 (Nano Flow Cytometry, NanoFCM)**的相关知识产权，致力于纳米流式检测技术的推广和应用，进行技术产业化，是一家专门从事设备和配套解决方案的集开发、制造、销售和服务为于一体的国家高新技术企业，同时在**英国**和**美国**分别成立了海外子公司。

相关荣誉：

- ✓ 2015 留学人员来闽创业启动支持计划 重点项目
- ✓ 2015 第八批引进高层次人才“**双百计划**” A+类
- ✓ 2017 厦门市第三批A类青年创新人才计划
- ✓ 2017 **国家重点研发计划**“国家质量基础的共性技术研究与应用”重点专项
- ✓ 2018 第六批省引才“**百人计划**”
- ✓ 2018 **国家高新技术企业**

2018 成果获国家自然科学基金委官网报道



**中国智造
自主研发
国产仪器
世界领先**

China

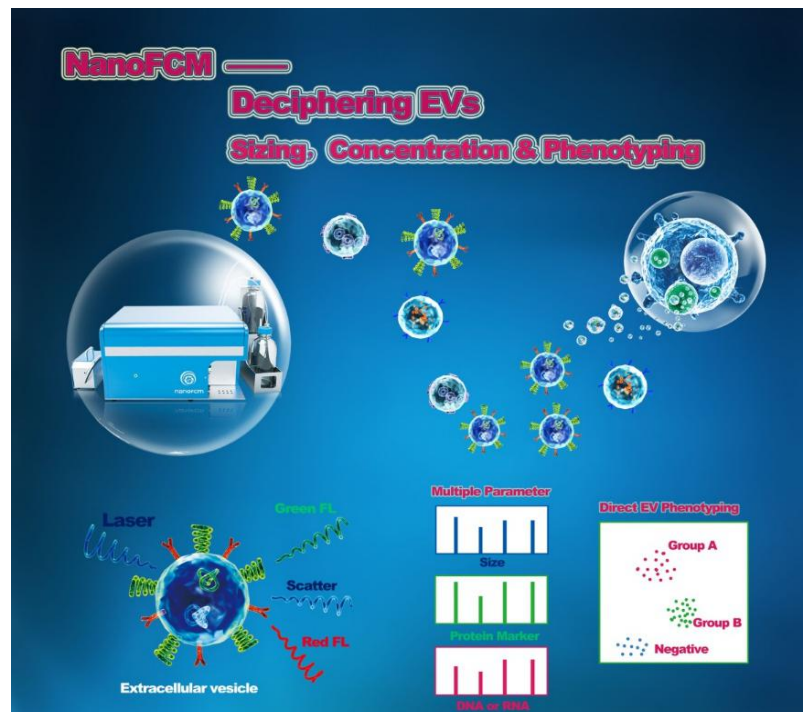
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Europe

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USA

NanoFCM US INC., 475 S GRAND CENTRAL PKWY LAS VEGAS, NV 89106, US



□ 外泌体的研究背景及纳米流式检测仪概述

□ 纳米流式检测仪对外泌体的单颗粒表征

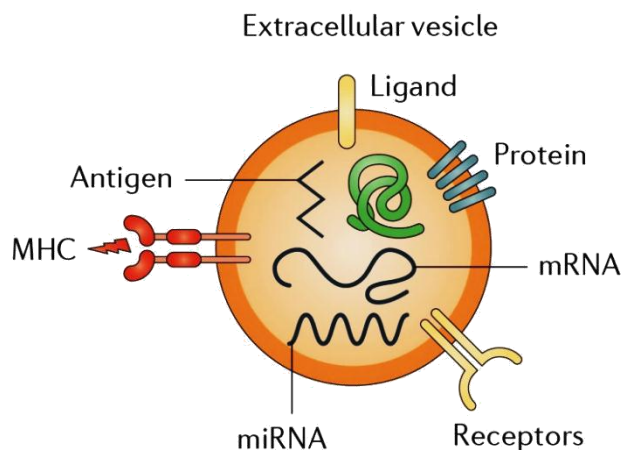
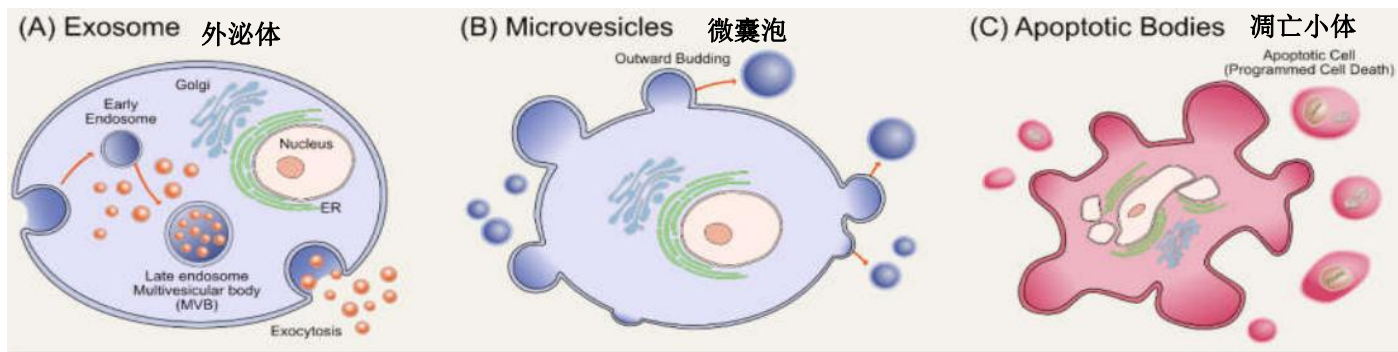
- 粒径、浓度
- 生化性能（蛋白、核酸、磷脂）

□ 应用案例

- 蛋白绝对定量
- 癌症诊断、调控追踪
- 抗体筛选、蛋白标记等

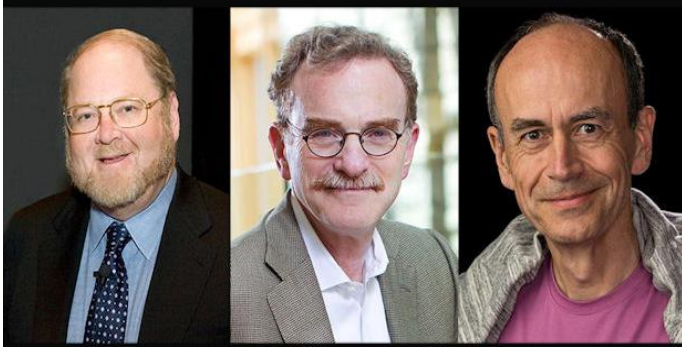
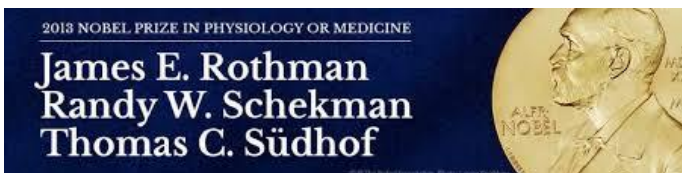
外泌体与细胞外囊泡

细胞外囊泡 (extracellular vesicles, EVs) 是一种由细胞释放到细胞外基质的膜性小囊泡, 参与细胞通讯、细胞迁移、血管新生和肿瘤细胞生长等过程, 广泛地存在于各种体液和细胞上清中。

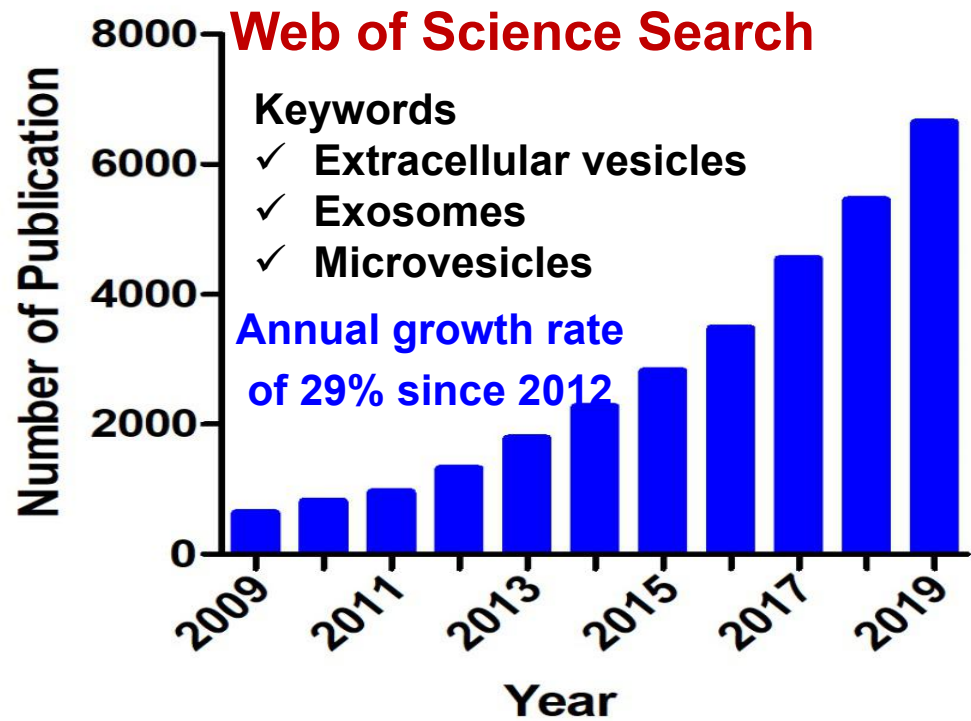


囊泡类型	来源	粒径 (nm)
Exosomes (外泌体)	核内体融合细胞膜	30~150
Microvesicles (微囊泡)	细胞膜直接释放	100~1000
Apoptotics Bodies (凋亡小体)	细胞膜、内质网	>1000

外泌体/细胞外囊泡研究现状



For their discoveries of machinery regulating vesicle traffic, a major transport system in our cells.

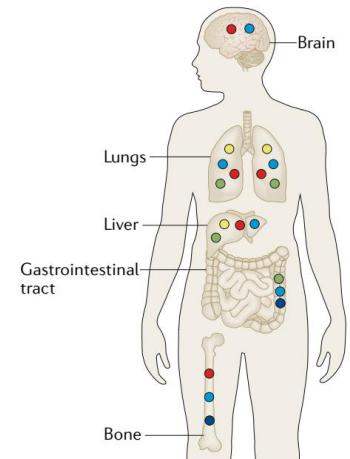
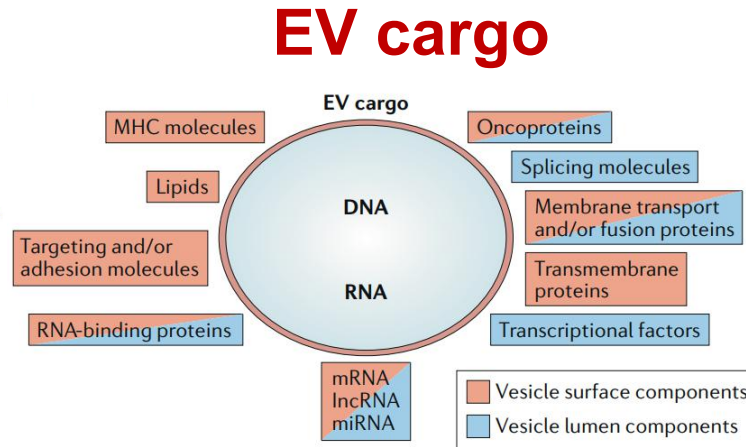
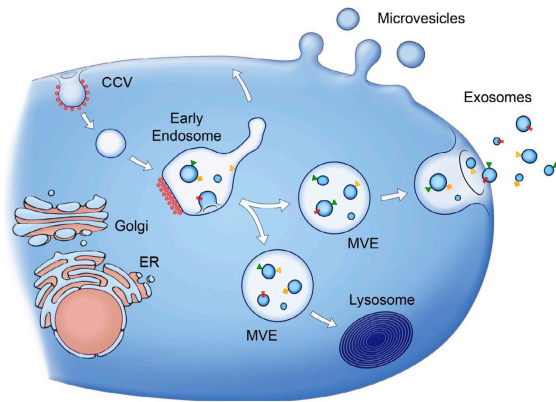


- ◆ 疾病诊断 Diagnosis
- ◆ 药物传递 Drug delivery
- ◆ 治疗靶标 Thera Targets
- ◆ 治疗制剂 Thera Agents

Nat. Rev. Drug Discov. 2013, 12, 348-358.
Nat. Biotechnol. 2014, 32, 441-422.
Nature 2015, 523,177-182. *Nature*, 2017, 546, 498-503.

癌症早期诊断的新标签

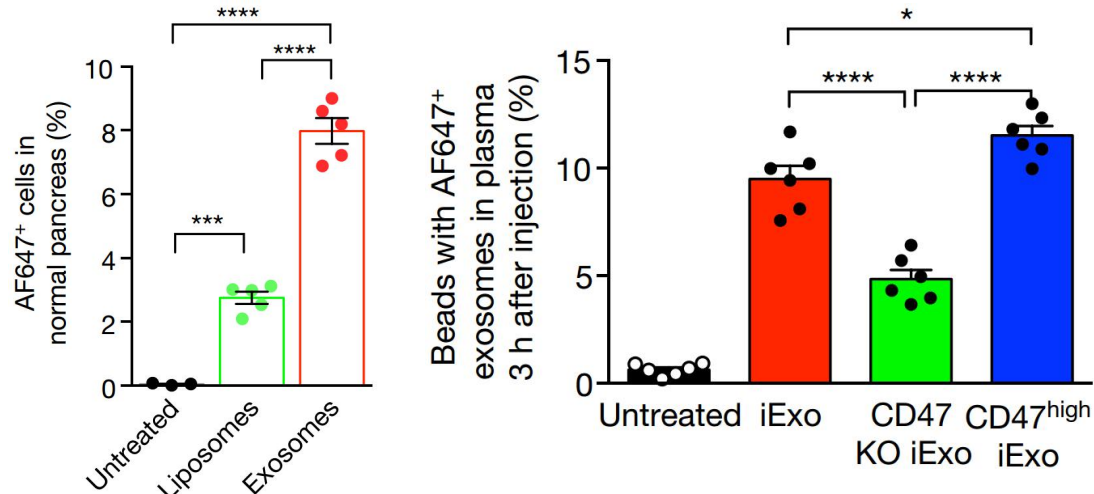
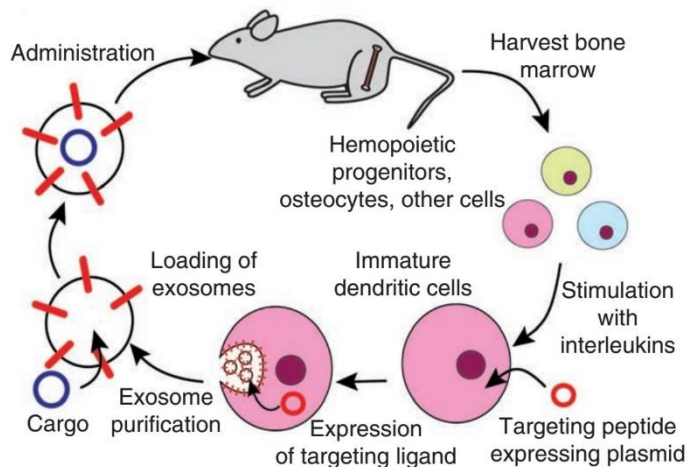
NanoFCM



	癌症类型	癌症标志物
DNA	Pancreatic cancer; NSCLC	KRAS ^{G12D} and TP53 ^{R273H} DNA; EGFR ^{T790M} mutant DNA
RNA	Prostate cancer; Lung cancer; Pancreaticobiliary cancer	Multiple RNAs; AR-V7 mRNA; Neoantigen transcripts and/or fusion genes
蛋白质	PDAC; Glioblastoma; Ovarian cancer	GPC1; MIF; EGFR; CD24; EpCAM
磷脂	Prostate cancer	Phosphatidylserine 18:1/18:1; lactosylceramide (d18:1/16:0); Phosphatidylserine 18:0-18:2

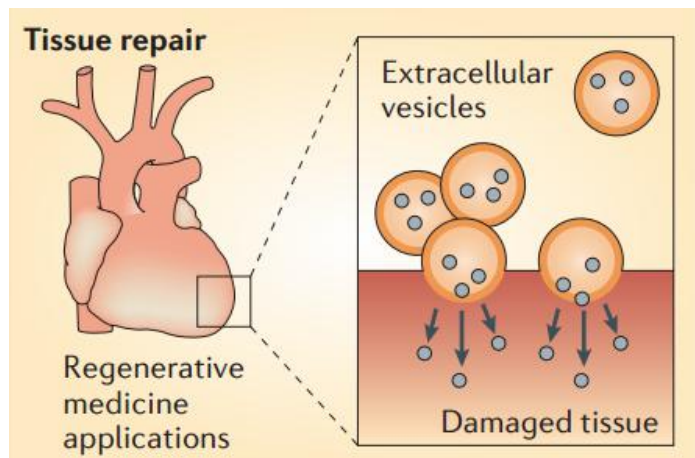
其他生物功能及应用

新型纳米药物载体：无免疫原性、循环时间长、可靶向特定器官.....



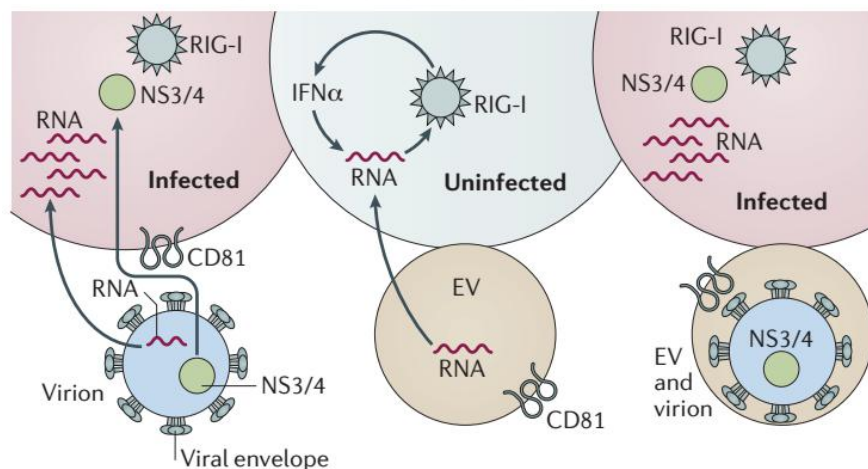
Nat. Biotechnol. 2011, 29, 341-345. *Nature*, 2017, 546, 498-503.

治疗制剂



Nat. Rev. Drug Discov. 2013, 12, 348-358.

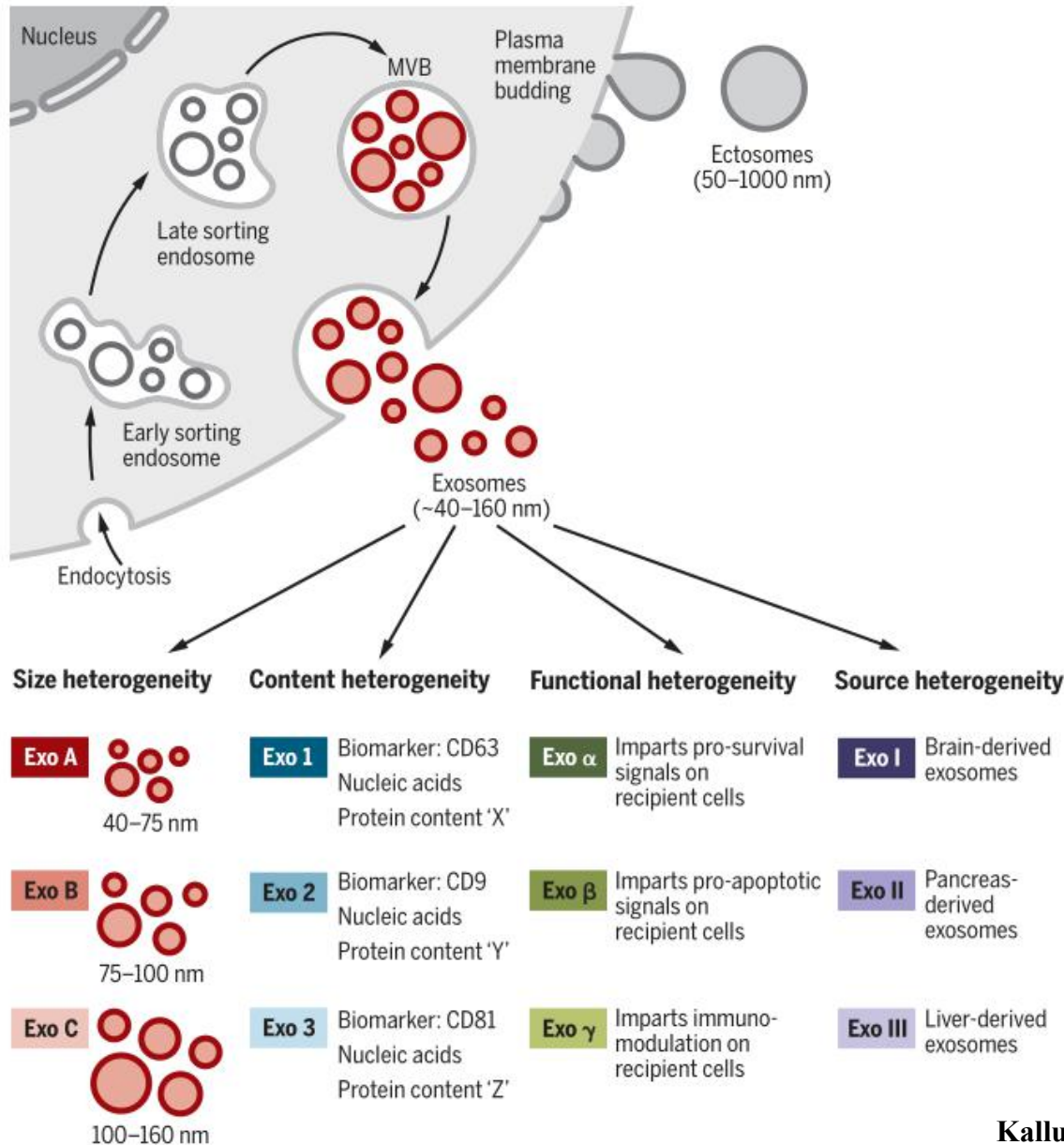
协助病毒感染



Nat. Rev. Microbiol. 2017, doi:10.1038/nrmicro.2017.60.

科学难题：EVs异质性大，亟须单颗粒表征技术

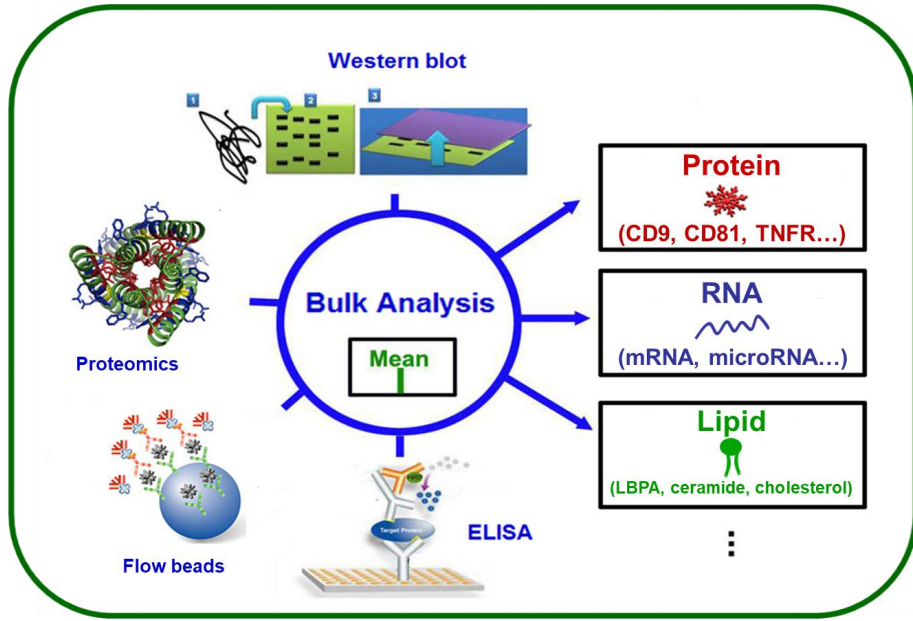
NanoFCM



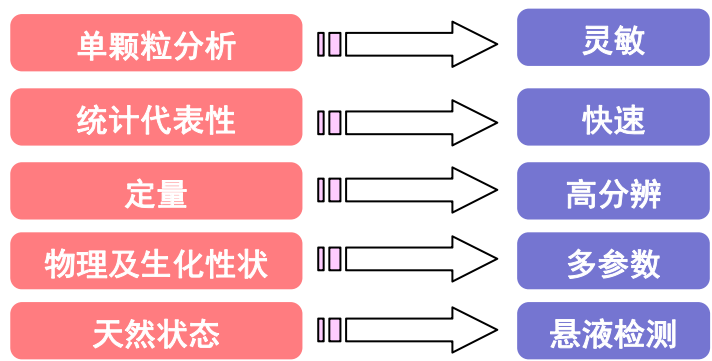
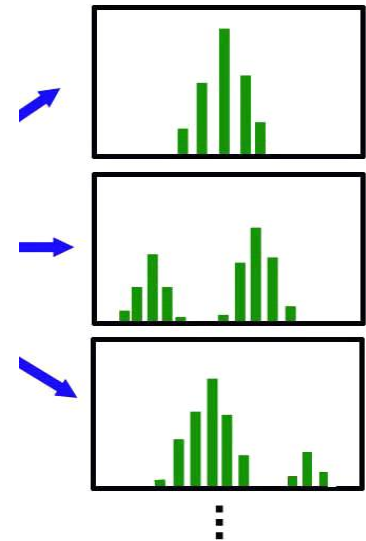
- 由于缺乏有效的表征技术，人们对于EVs自身组成、结构和功能的了解仍然十分肤浅
- EVs在粒径、膜蛋白及内含物等方面存在高度的个体差异性和多样性

科学难题：EVs异质性大，亟须单颗粒表征技术

NanoFCM



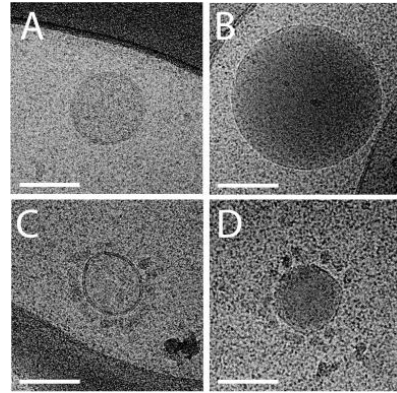
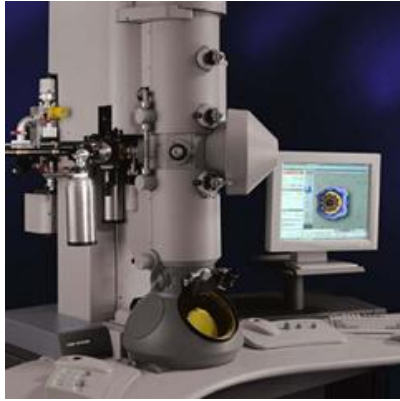
同一个平均值有n种可能的分布组合



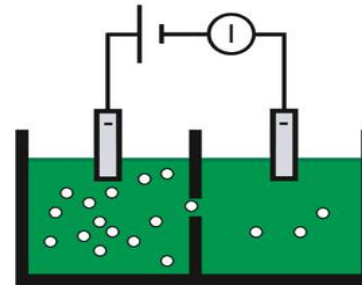
面临挑战

- 个体极其微小 (<100 nm)
- 折射率低
- “货物分子”含量极少

单个细胞外囊泡表征方法



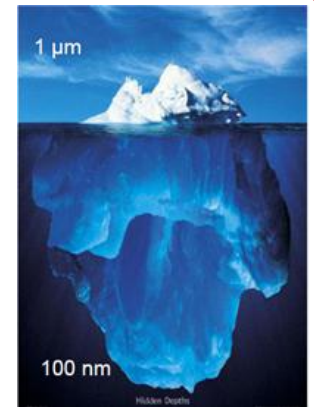
冷冻透射电镜 (Cryo-TEM)



纳米孔技术(TRPS): >70 nm



纳米颗粒追踪技术(NTA): >70 nm



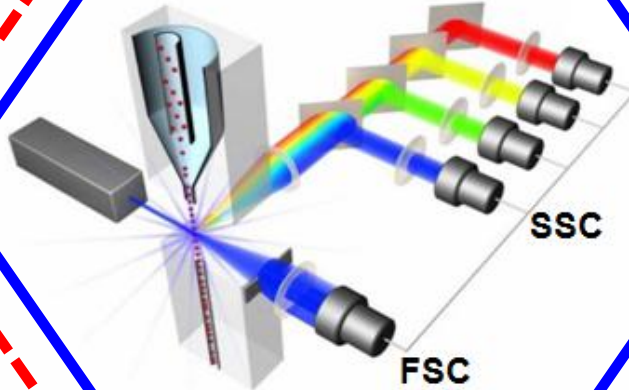
流式细胞术: $>300-600$ nm

传统流式对细胞外囊泡的分析

NanoFCM

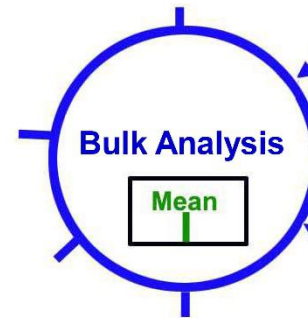
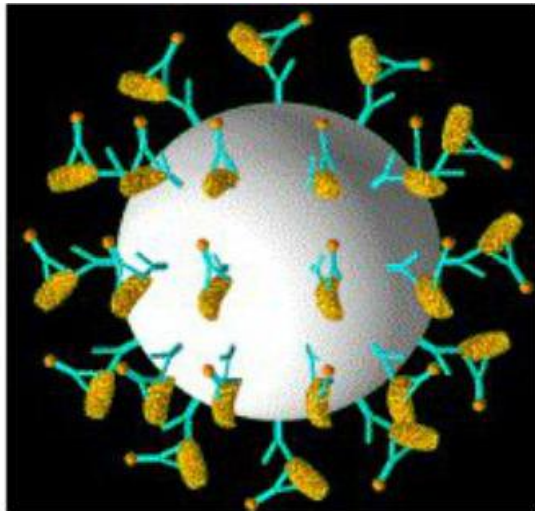
Fast speed

Quantitative



Multi-parameter
FSC, SSC, FL

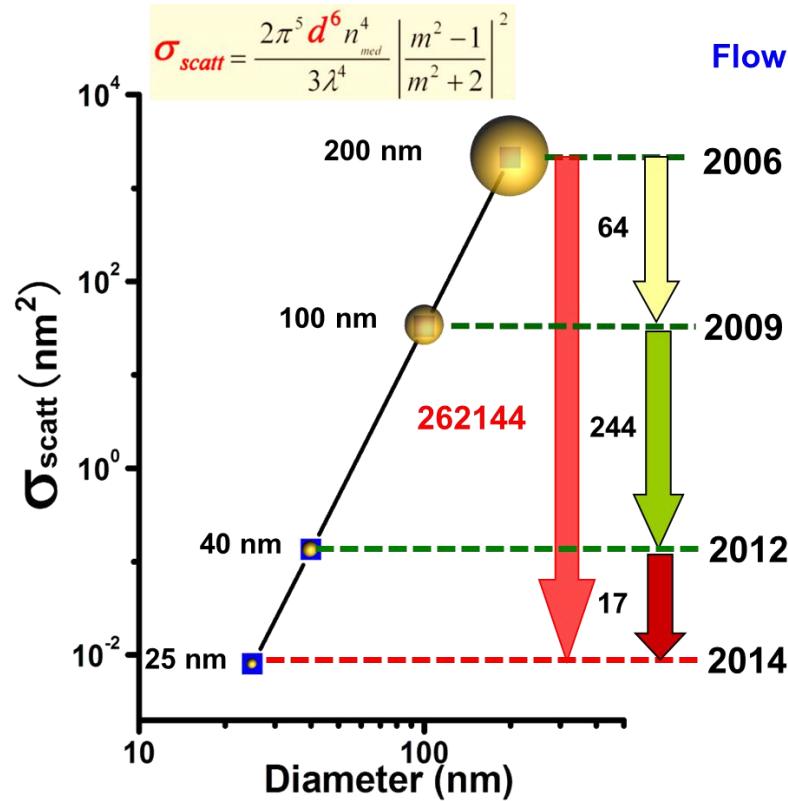
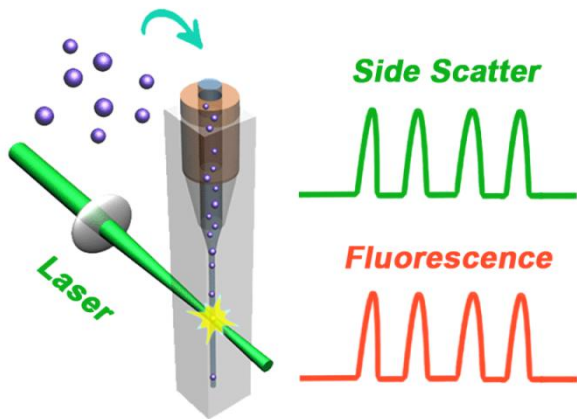
Particles < 200 nm
Dim FL signal < 200 FITC



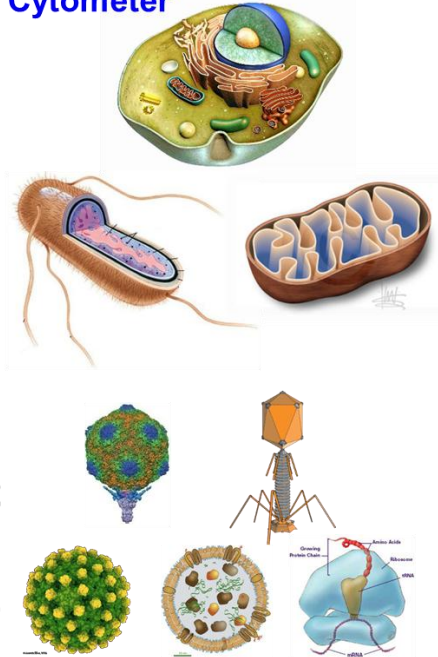
纳米流式检测技术

NanoFCM

瑞利散射 & 鞘流单分子荧光检测



Flow Cytometer



SSC detection limit: 24 nm in diameter for SiNPs
 7 nm in diameter for AuNPs
 FL detection limit: 3 MESF of Alexa Fluor 555
 Event rate: 10,000 particles/min

Flow NanoAnalyzer — N30E

NanoFCM







侧向散射灵敏度	< 30 nm silica NPs
侧向散射分辨率	40/50 nm silica NPs
荧光灵敏度	FITC < 10 MESF
荧光分辨率	42/133 MESF
粒径范围	7-1000 nm
样品通量	10000 events/min

- ✓ 前所未有的检测灵敏度：24 nm颗粒的散射光信号，单个藻红蛋白的荧光检测
- ✓ 世界首台纳米颗粒 (<100 nm) 多参数定量表征流式设备
- ✓ 粒径表征分辨率媲美 (冷冻) 透射电镜
- ✓ 检测范围覆盖外泌体完整粒径 (30-200 nm) 的唯一商品化流式检测仪

国际首创，填补了国际空白

光学配置

NanoFCM

Type	Laser	Dichroic Beam Splitter	Filter	Dye
N30E	 488 nm	DicF495	525/40(FITC)	FITC, GFP, AlexaFluor™ 488, Atto 488, CFSE, Calcein, Rhodamine 123, Fluo-3, SYTO 9, PicoGreen, RiboGreen, SYBR Green I, SYBR Green II, SYTOX Green, YOYO-1, YOPRO-1, DiO, SYTO RNASelect Green, PKH 67, Qdot 525, SYTO Green fl stain (11-14, 16, 21, 24)
		DicF555	580/40(PE)	PE, PI, Alexa Fluor 546, SNARF (low pH)
		Optional	670/30 (PC5)	PerCP, PE-Cy5, Alexa Fluor 647-R-PE, SYTO 62, 7-AAD, SNARF (high pH)
		Optional	710/40(PC5.5)	PerCP-Cy5.5, PE-Cy5.5, PE-Alexa Fluor 680
	 528 nm	DicF555	580/40(PE)	PE, AlexaFluor™ 555, SYTO 82, SYTOX Orange, POPO-3, Dil, OFP, RBITC, Cy3, Cy3.5, SYPRO Orange, SYTO Orange fl stain (80-85)
		DicF650	670/30 (PC5)	PerCP, PE-Cy5, APC, PI, PE-AlexaFluor™ 647, SYPRO Red
Optional		710/40(PC5.5)	PerCP-Cy5.5, PE-Cy5.5, APC-Cy7, APC-H7, APC- eFluor™ 780	
U30	 488 nm & 638 nm	DicF495	525/40(FITC)	FITC, GFP, AlexaFluor™ 488, Atto 488, CFSE, Calcein, Rhodamine 123, Fluo-3, SYTO 9, PicoGreen, RiboGreen, SYBR Green I, SYBR Green II, SYTOX Green, YOYO-1, YOPRO-1, DiO, SYTO RNASelect Green, PKH 67, Qdot 525, SYTO Green fl stain (11-14, 16, 21, 24)
		DicF555	670/30 (PC5)	Cy5, APC, Thiadicarbocyanine, TOTO®-3, TO-PRO®-3, Alexa Fluor 633™, Alexa Fluor 647™
		Optional	580/40(PE)	PE, PI, Alexa Fluor 546, SNARF (low pH)
	 528 nm & 638 nm	Optional	710/40(PC5.5)	APC-R700, Alexa Fluor 660™, Alexa Fluor 680™, Alexa Fluor 647™, Alexa Fluor 700™
		DicF555	580/40(PE)	PE, AlexaFluor™ 555, SYTO 82, SYTOX Orange, POPO-3, Dil, OFP, RBITC, Cy3, Cy3.5, SYPRO Orange, SYTO Orange fl stain (80-85)
		DicF650	670/30 (PC5)	Cy5, APC, Thiadicarbocyanine, TOTO®-3, TO-PRO®-3, Alexa Fluor 633™, Alexa Fluor 647™
Optional	710/40(PC5.5)	APC-R700, Alexa Fluor 660™, Alexa Fluor 680™, Alexa Fluor 647™, Alexa Fluor 700™		

NF Profession 1.0 软件

The screenshot shows the NanoFCM Profession V1.0 software interface. It is divided into several sections:

- 1. 导航栏 (Navigation Bar):** Located at the top left, containing 'Acquisition' and 'Analysis' tabs.
- 2. 相机窗口 (Camera Window):** A large window on the left showing a real-time camera feed of the instrument.
- 3. 数据采集 (Data Acquisition):** A control panel on the left with settings for 'Start Up', 'Manual Operation', 'File Path', 'Samp. Inf.', 'Operator', 'View', 'Time to Record', 'Events to Record', 'Buffer', 'Laser Control', 'SPCM', 'PMT', and 'Sheath Flow'.
- 4. 工具栏 (Toolbar):** A horizontal bar at the top with various icons for file operations, acquisition, and analysis.
- 5. 图形区 (Graphical Area):** The central area containing multiple plots: SS Intensity vs Time, FITC Intensity vs Time, PCS Intensity vs Time, SS-H, SS-W, FITC-H, FITC-W, PCS-H, PCS-W, SS-H Gating, FITC-H Gating, and a 2D histogram of FITC-H vs SS-H.
- 6. 统计数据 (Statistical Data):** A table at the bottom center providing detailed statistics for various channels and parameters.
- 7. 状态栏 (Status Bar):** Located at the bottom, showing system status like 'PUMP', 'COM6', 'USB', 'USB0', 'Aperture', 'Record Time Data', and 'NanoFCM Profession V1.08 Copyright By NanoFCM Inc.'

	Chan0	Chan.1	Chan.2	Chan.3		Count	ROI Count	% of All	Mean	CV (%)	Median
Label	SS	FITC	PCS	close	SS-H	799.00	784.00	98.12	2084.24	8.55	2079.70
Data Chan.	0	1	2	3	FITC-H	799.00	789.00	98.75	1007.55	15.37	986.28
Filter	488/10	525/40	670/30	close	PCS-H	799.00	787.00	98.50	86.15	22.26	82.04
Detector	SPCM	SPCM	SPCM	Close	close-H	799.00	0.00	0.00	NaN	NaN	96.83
Voltag	38846	38847	38848	Close	SS-W (ms)	799.00	669.00	83.73	1.12	18.92	1.10
Blank Sub	0	0	0	0	FITC-W (ms)	799.00	742.00	92.87	1.15	17.33	1.10
Threshold	11	19.7	2.1	NaN	PCS-W (ms)	799.00	188.00	23.53	1.22	23.72	1.00
Blank Level	4.78	10.06	0.26	0	close-W (ms)	799.00	0.00	0.00	NaN	NaN	1.00
Blank SD	2.09	3.21	0.60	NaN	SS-H Gating	799.00	789.00	98.75	2075.58	10.08	2079.70
S/N	995.02	311.03	142.92	NaN	FITC-H Gating	799.00	789.00	98.75	1007.55	15.37	986.28

1. 导航栏
2. 相机窗口
3. 数据采集

4. 工具栏
5. 图形区
6. 统计数据

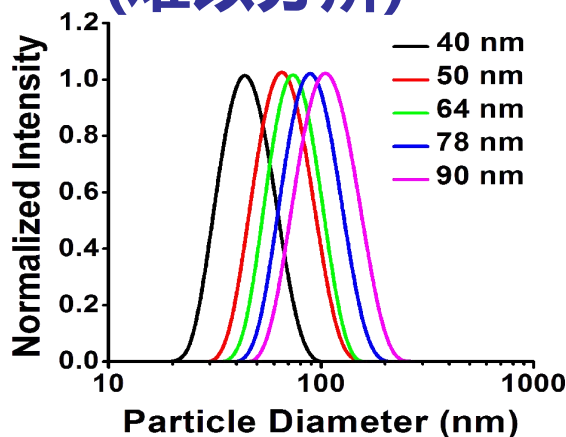
7. 状态栏

Nfa
FCS 3.0.
txt

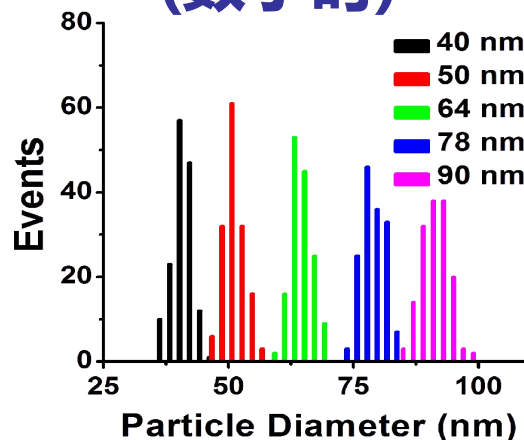
纳米颗粒粒径及其分布的高分辨表征

NanoFCM

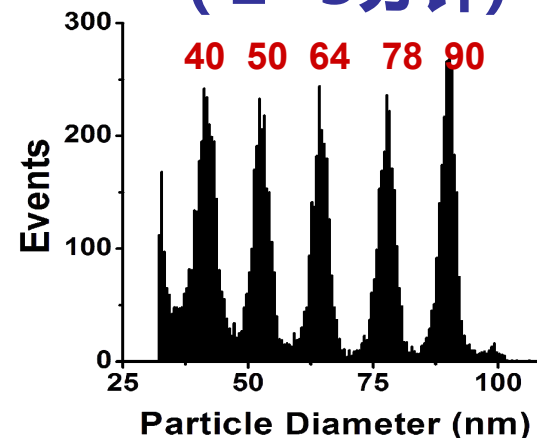
动态光散射 (难以分辨)



透射电镜 (数小时)



纳米流式 (2~3分钟)

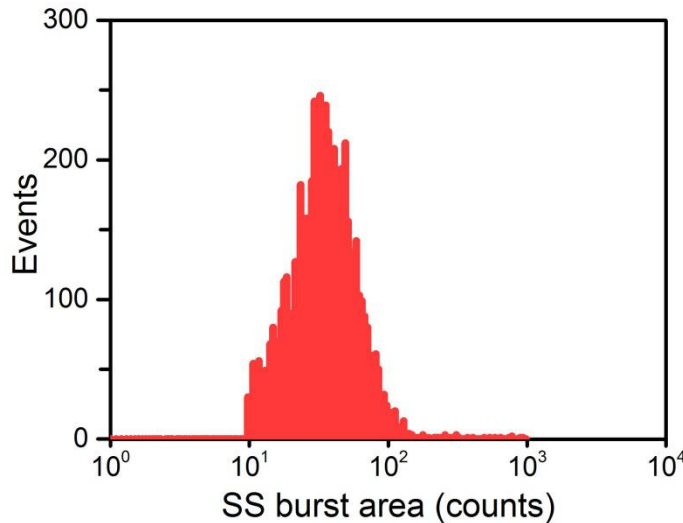
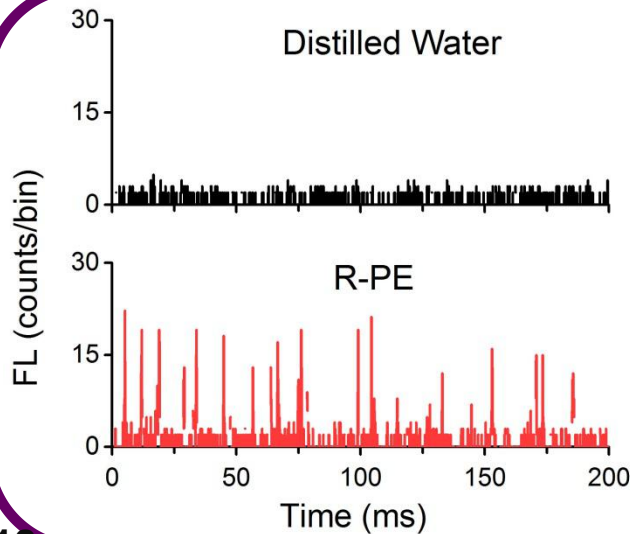
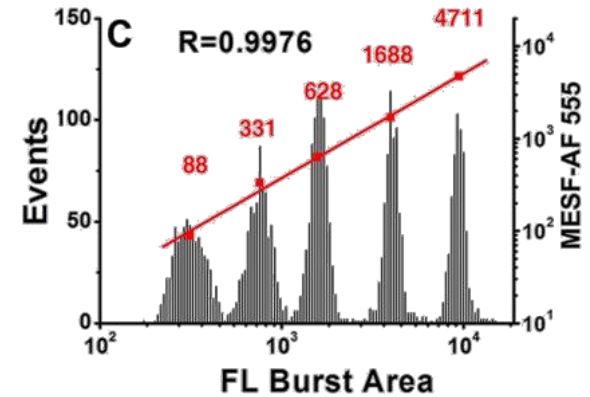
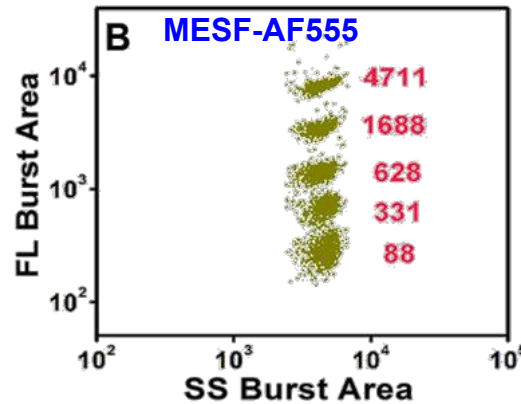
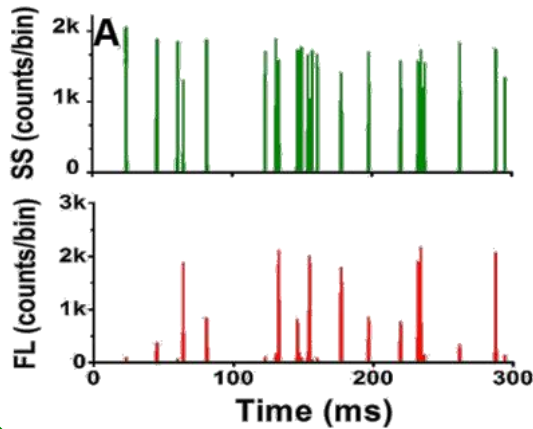


- 2~3分钟 vs 数小时
- 统计代表性
- 尤其适用于多分散或者混合样本的表征，如**病毒疫苗**的质量控制、**蛋白或抗体药物**的纯度及稳定性测定等。

荧光检测的分辨率及灵敏度

NanoFCM

Laboratory-synthesized and calibrated RBITC-doped fluorescent silica NPs (212 nm)



单个藻红蛋白
检测限:
3 AF555 molecules

□ 外泌体的研究背景及纳米流式检测仪概述

□ 纳米流式检测仪对外泌体的单颗粒表征

- 粒径、浓度
- 生化性能（蛋白、核酸、磷脂）

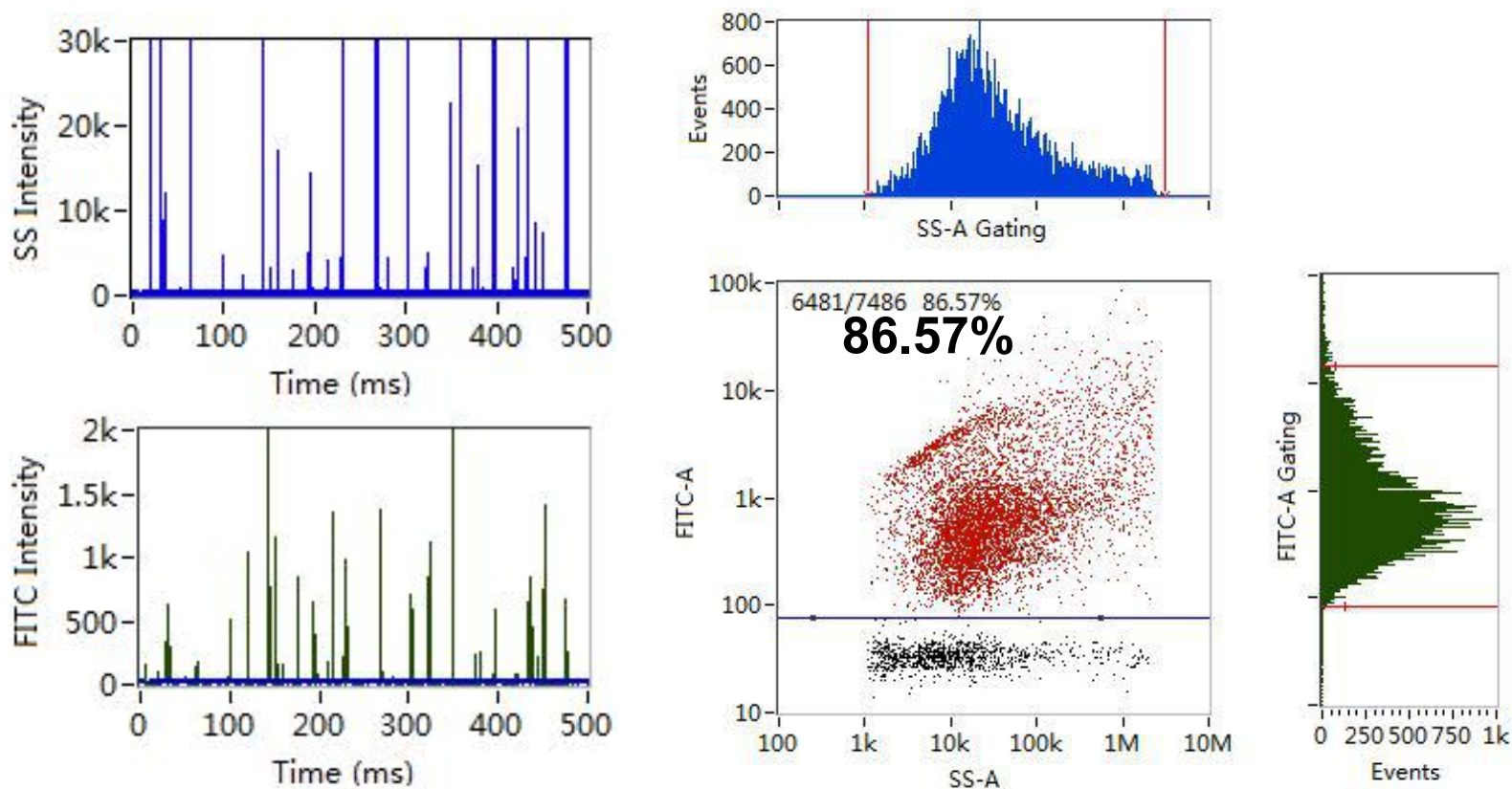
□ 应用案例

- 蛋白绝对定量
- 癌症诊断、调控追踪
- 抗体筛选、蛋白标记等

CD63-GFP融合表达的EVs

NanoFCM

实时的原始数据



Intrinsic Fluorescence 体内、体外示踪

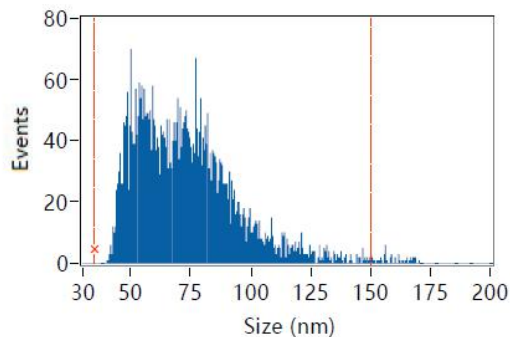
可直接获取测试报告:

Sizing Report

babc EVs

Data File 2018-11-15 babc EVs 25.nfa

SN: Laser: 5/40 mW 488 @
Software: V1.08 SS Decay: 100%
Operator: NF Threshold/sub: 107.8 12.1 1.7 NaN/230 0 0 0
Sample Pressure: 1.6 Kpa Min Width: 0.3 ms



Gating Range 35.00 - 150.00 nm

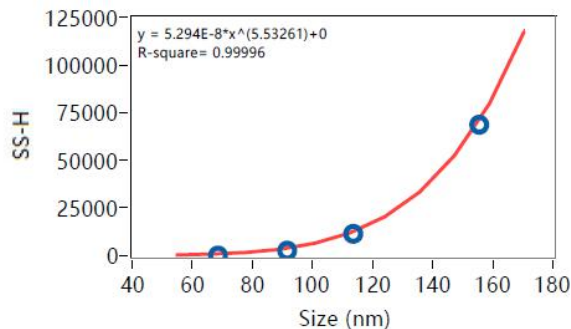
Total Events 4692
Gating Events 4645
% of all 99.00
Median 70.25 nm
Mean 73.00 nm
Std Dev. 20.34 nm

Size SS-H

68	790.679
91	3326.6
113	12189.9
155	69502.4
0	0
0	0

Standard Curve

Fit type Power



可以获取什么信息?

Median值

Mean值

标准方差

门内颗粒数

总颗粒数

门内颗粒的比例

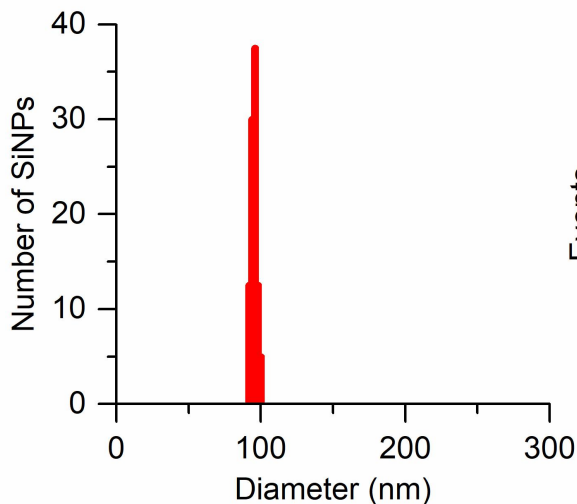
校正曲线

单颗粒和混合物粒径的检测

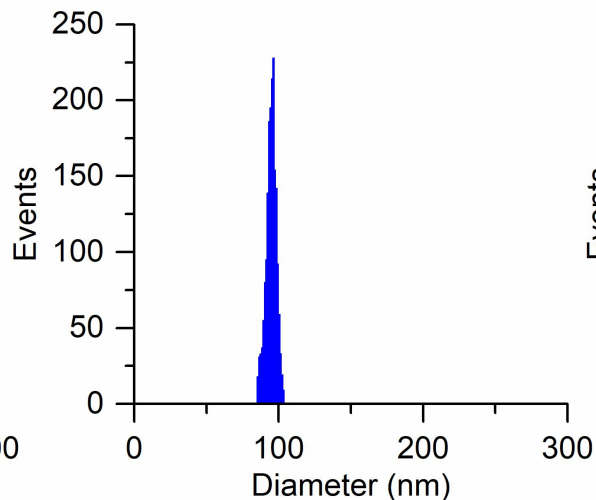
NanoFCM

95 nm SiNPs

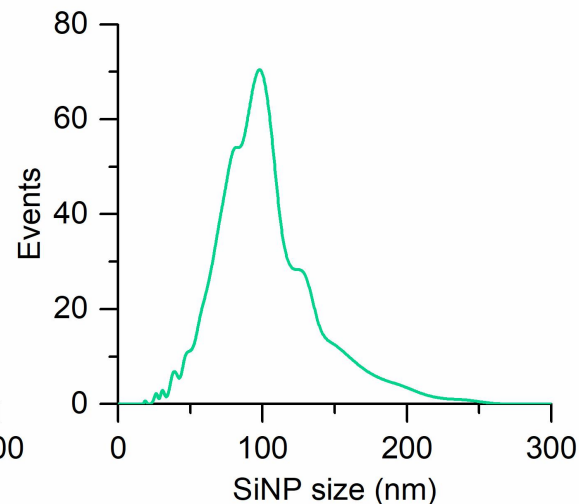
TEM



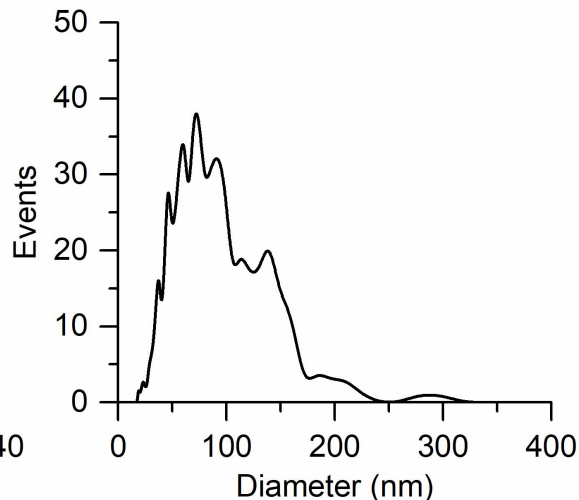
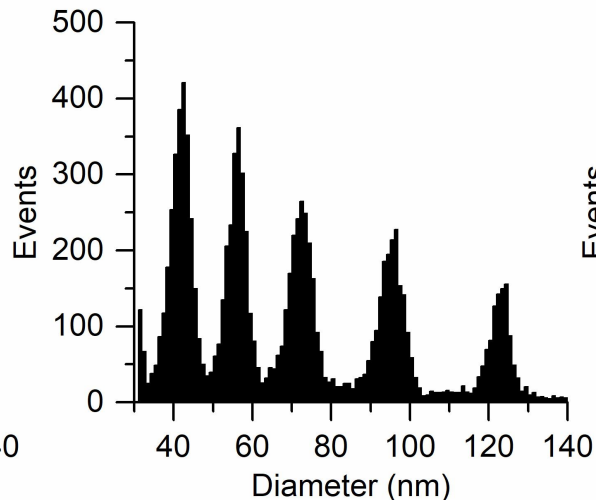
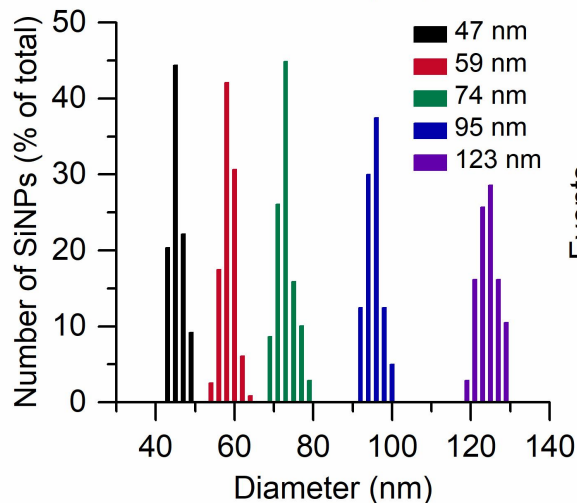
NanoFCM



NTA



SiNPs Mixture

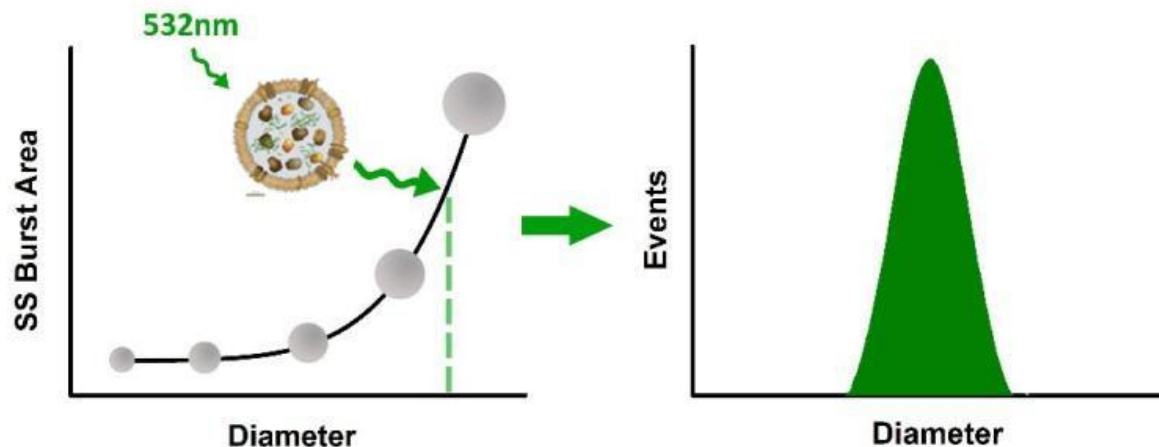


(数小时)

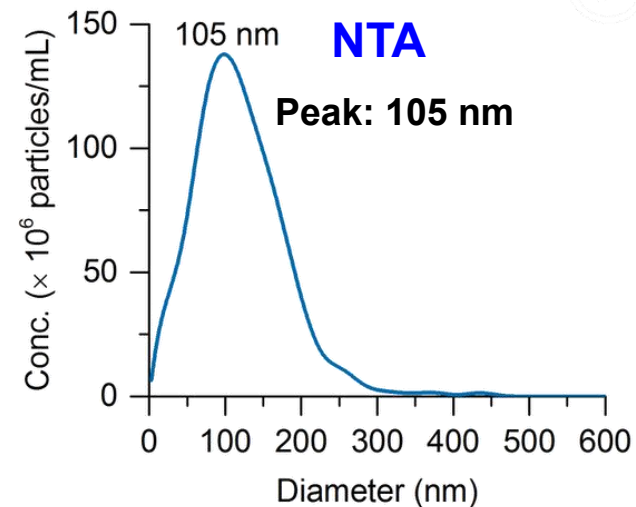
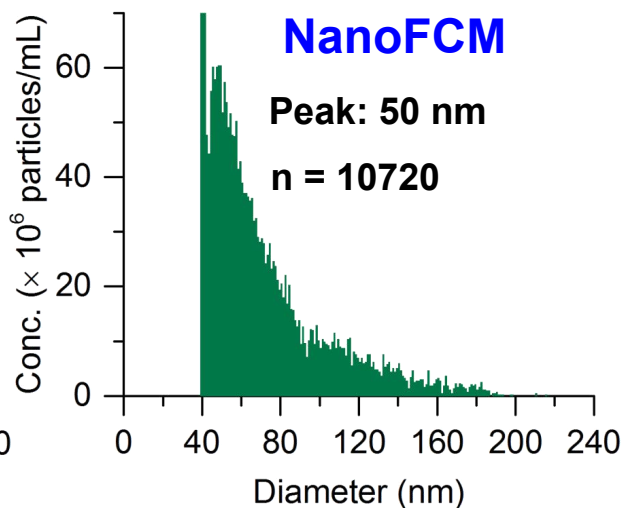
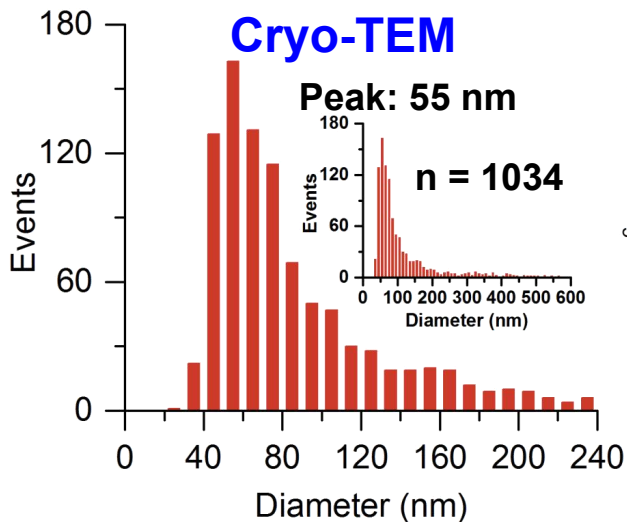
(2~3分钟)

HCT15 EVs 粒径分布

NanoFCM



EVs



样品颗粒浓度测定

NanoFCM



High Sensitivity Flow Cytometry
for Nanoparticle Analysis
www.nanofcm.com

Concentration Report

Exosome

Data file CD63 and CD9 .nfa

SN: N30 Demo-14

Software: V1.08

Operator: NF

Sample Pressure: 1.0 Kpa

Laser: 15/50mW 488 @ 20/100 mW 640 @

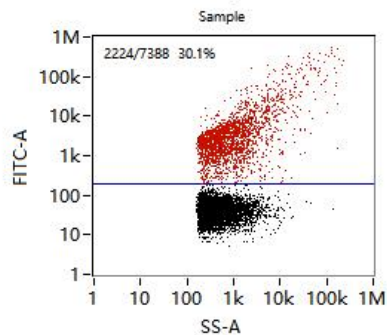
SS Decay: 10%

Threshold/sub: 51 66.7 11.7 NaN/0 0 0 0

Min Width: 0.3 ms

Sample Concentration : 1.29E+8 particles/mL

Corrected Ratio: 2224/7084 31.4%



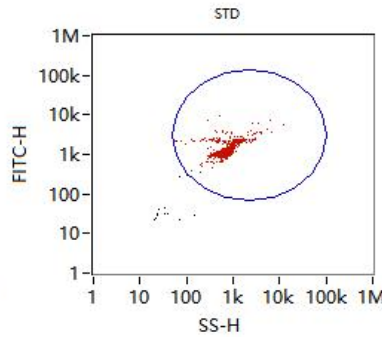
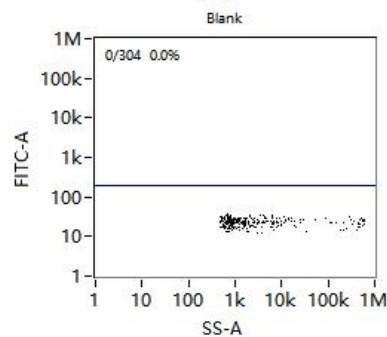
	Particle Number	Dilution
STD	4270	200
Blank	0	—
Sample	2224	1

STD Concentration:

4.96E+10 particles/mL

Sample flow rate:

17.22 nL/min



Save Close

Report By

(Signature)

2020-07-17 11:45

可以获取什么信息?

颗粒数量

颗粒浓度

阳性颗粒数

阳性颗粒浓度

阳性率 (校正后)

空白的颗粒数

浓度标准品

粒径和**功能**的关系

样品颗粒浓度和粒径分布

NanoFCM

Size & Concentration Report

bablc EVs-FITC

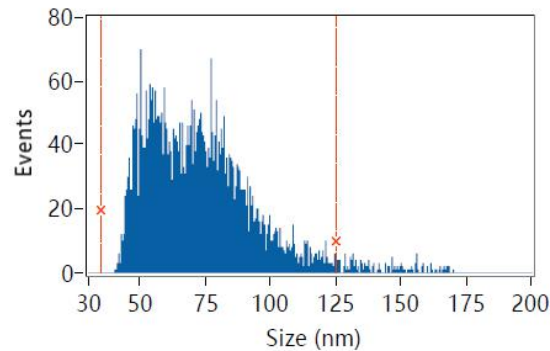
Data File 2018-11-15 bablc EVs-FITC 25.nfa

SN:	Laser: 5/40 mW 488 @
Software: V1.08	SS Decay: 100%
Operator: NF	Threshold/sub: 107.8 12.1 1.7 NaN/230 0 0 0
Sample Pressure: 1.6 Kpa	Min Width: 0.3 ms

Size Information

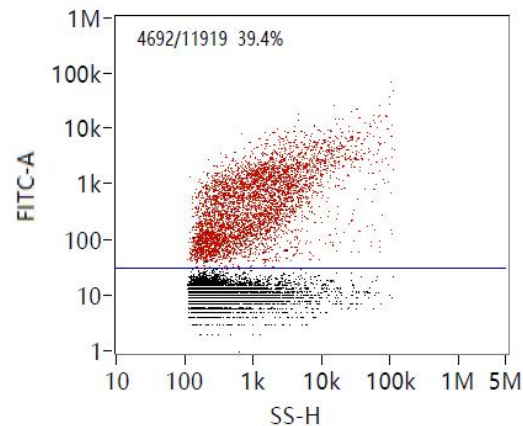
Gating Range 35.00 - 125.00 nm

Total Events	4692
Gating Events	4543
% of all	96.82
Median	69.75 nm
Mean	71.58 nm
Std Dev.	18.17 nm



Concentration Information

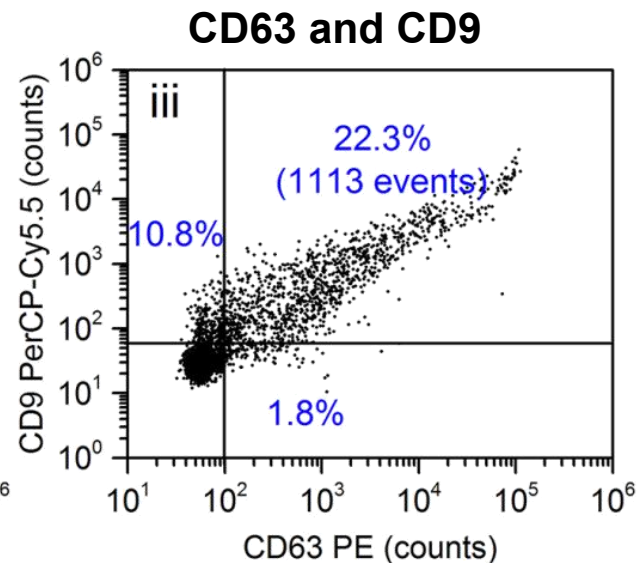
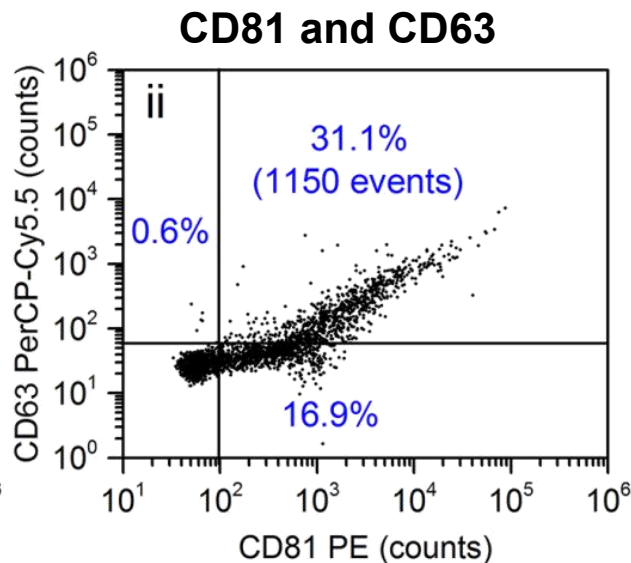
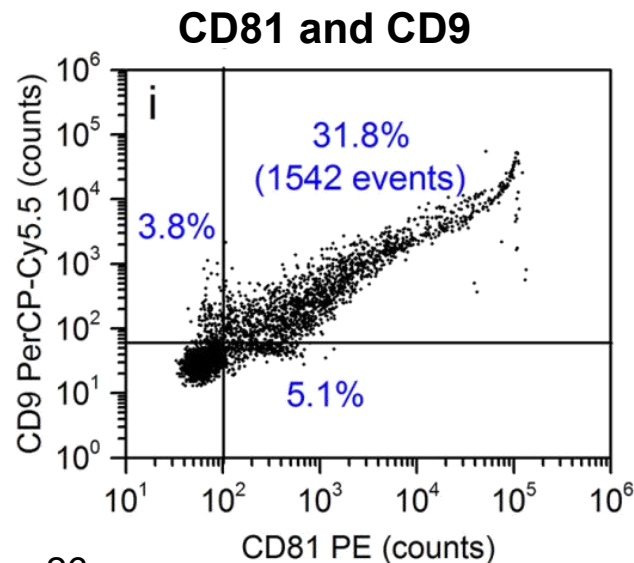
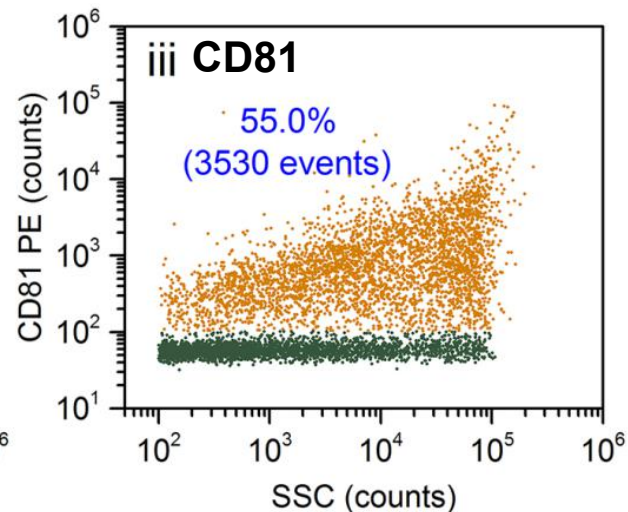
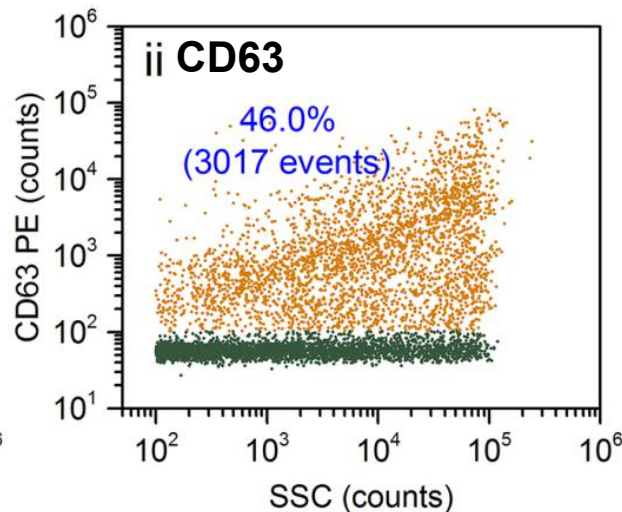
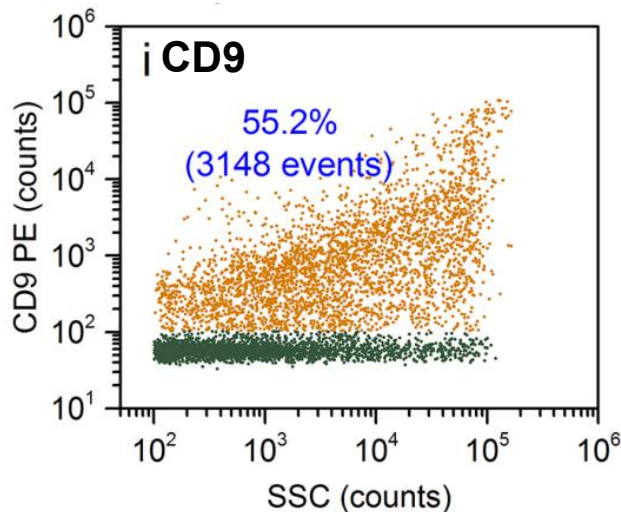
	Particle Number	Dilution Factor
STD	2421	400
Blank	0	
Sample	4692	40
STD Concentration	4.40E+10	Particles/mL
Sample Flow Rate	22.01	nL/min
Sample Concentration	8.53E+9	Particles/mL
Corrected Ratio:	4692/11615	40.4%



传统标志物的免疫荧光分析

NanoFCM

Extrinsic Fluorescence



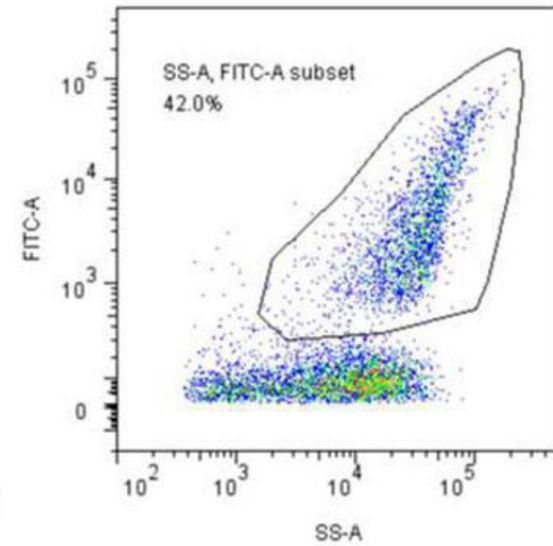
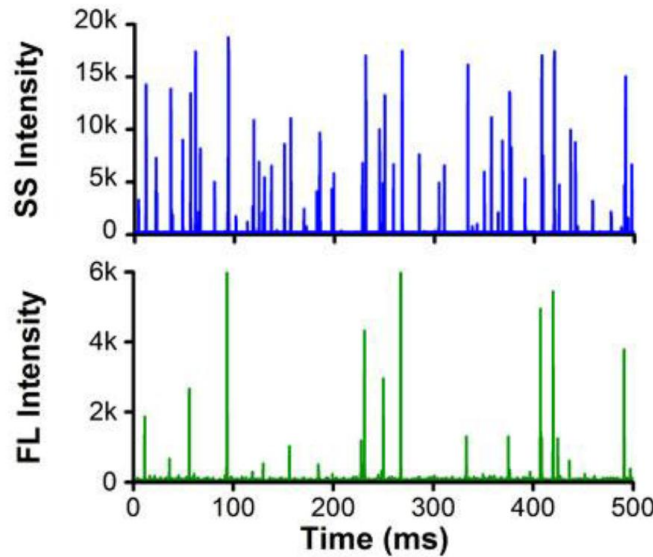
RNA和磷脂的多参数表征

NanoFCM

RNA

SYTO RNASelect

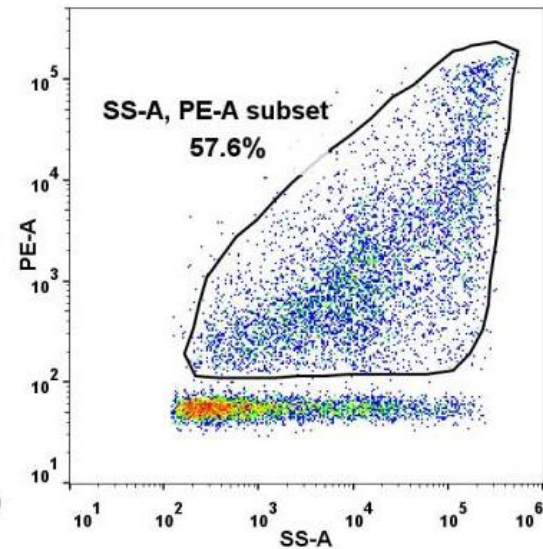
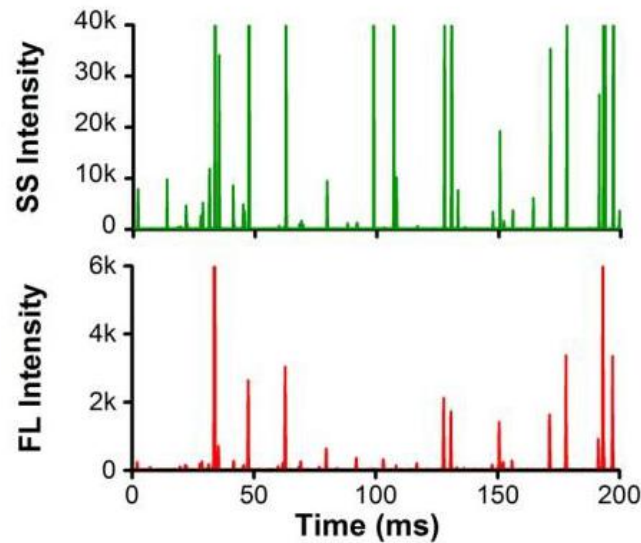
10 μ M

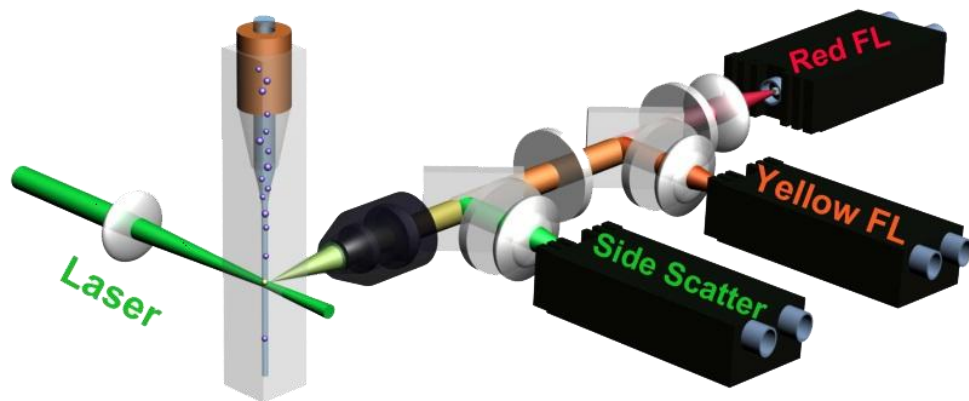
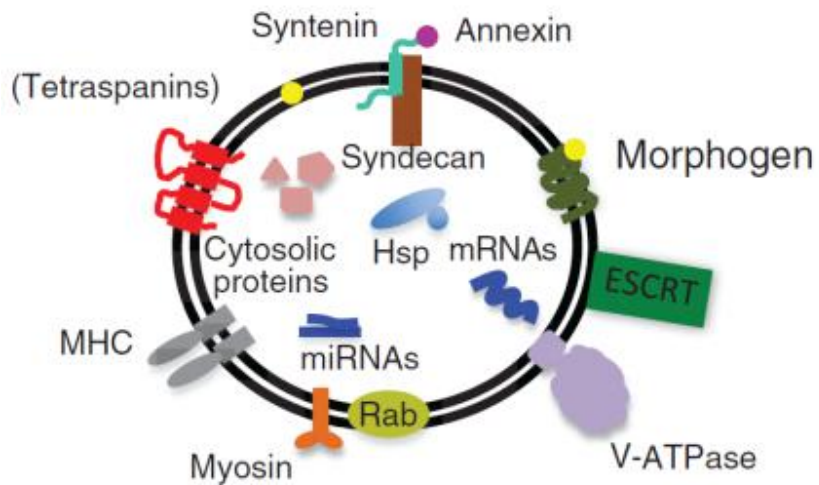


LIPID

PKH26

2.5 μ M





参数

荧光探针

应用

粒径

无需标记

准确、高分辨、高度统计代表性地测定外泌体的粒径及其分布

颗粒浓度

无需标记

测定某种环境中外泌体的浓度

脂质

膜染料染色

区分外泌体与其他无膜结构的颗粒

膜蛋白

免疫荧光标记/融合FP

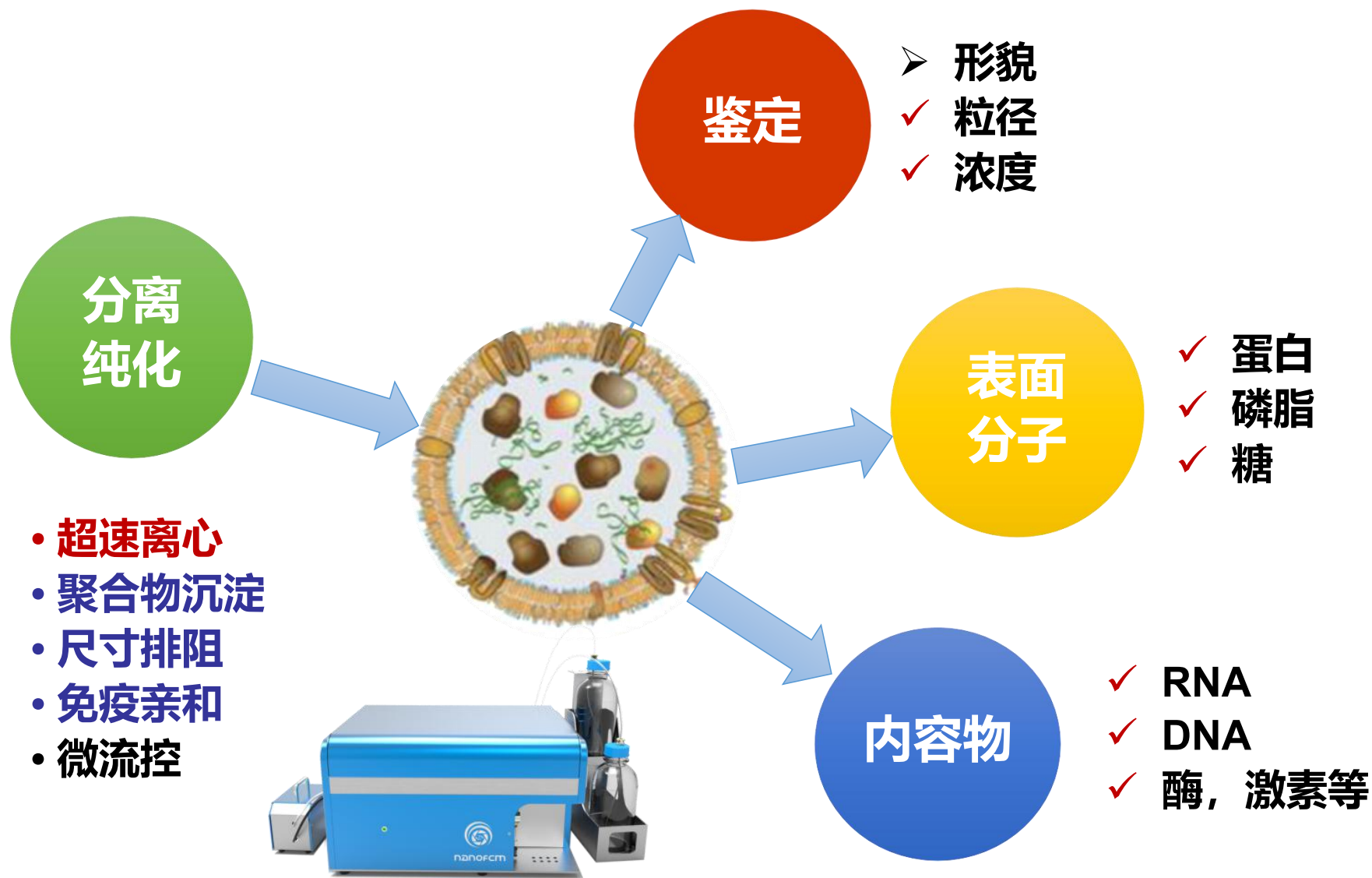
确定外泌体的来源及生化性质

RNA

核酸染料标记

单个外泌体中RNA的定量分析

细胞外囊泡研究的流程



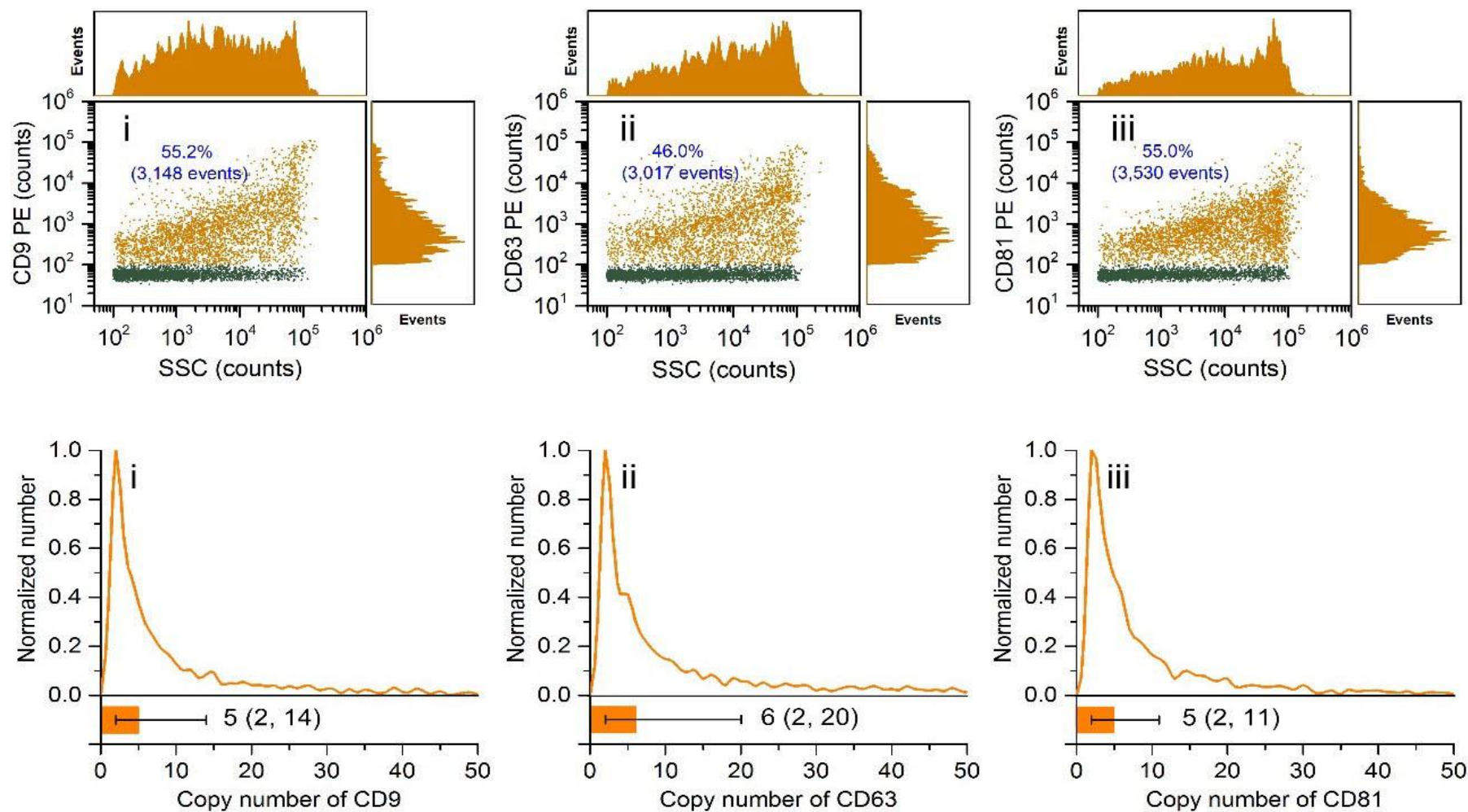
□ 外泌体的研究背景及纳米流式检测仪概述

□ 纳米流式检测仪对外泌体的单颗粒表征

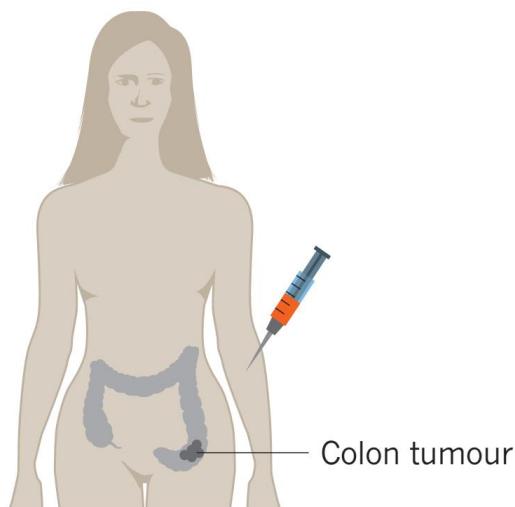
- 粒径、浓度
- 生化性能（蛋白、核酸、磷脂）

□ 应用案例

- 蛋白绝对定量
- 癌症诊断、调控追踪
- 抗体筛选、蛋白标记等



CD147 marker



- ◆ Colorectal cancer is the third-most common cancer and accounts for **9.7% of all cancers**.
- ◆ In 2013, **771,000 people** died as a result of colorectal cancer globally, making the disease the fourth-most common cause of cancer-related death worldwide.

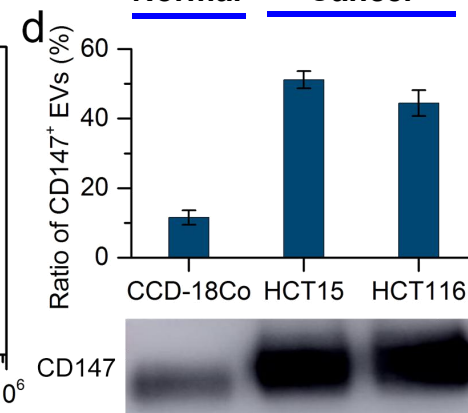
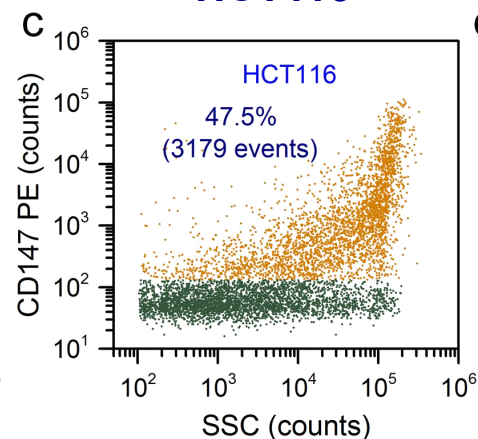
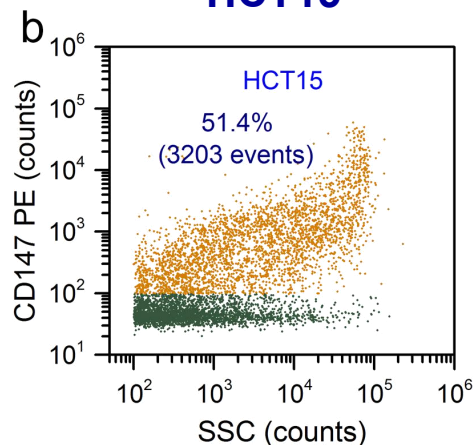
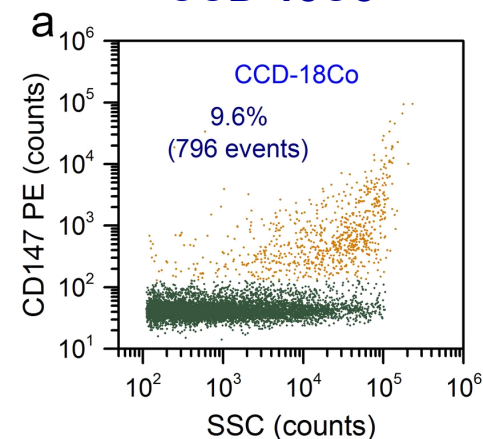
Ernst J. et al. *Nat. Rev. Cancer*, 2015, 1, 1.

CCD-18Co

HCT15

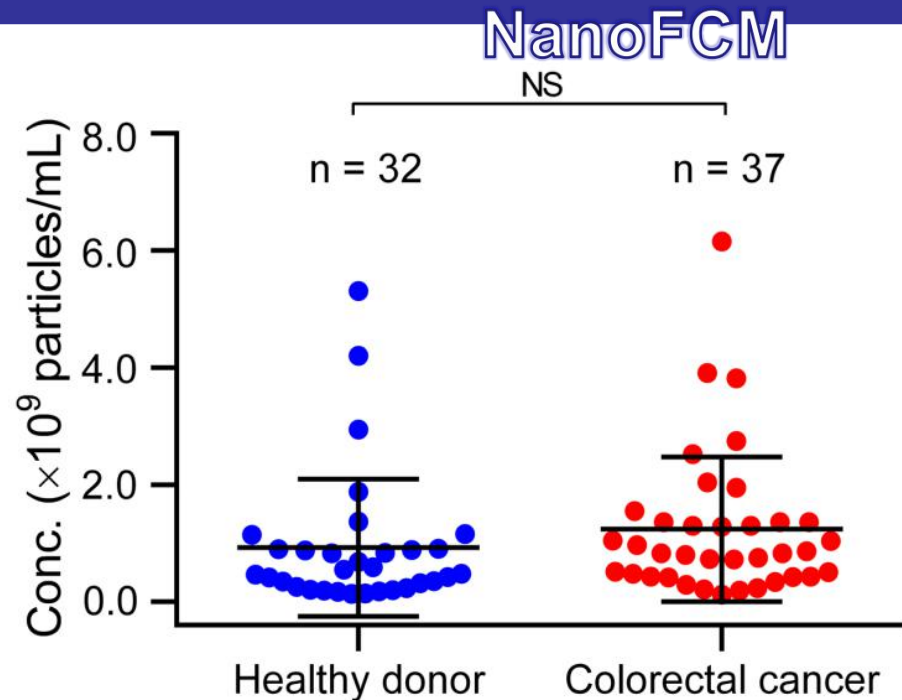
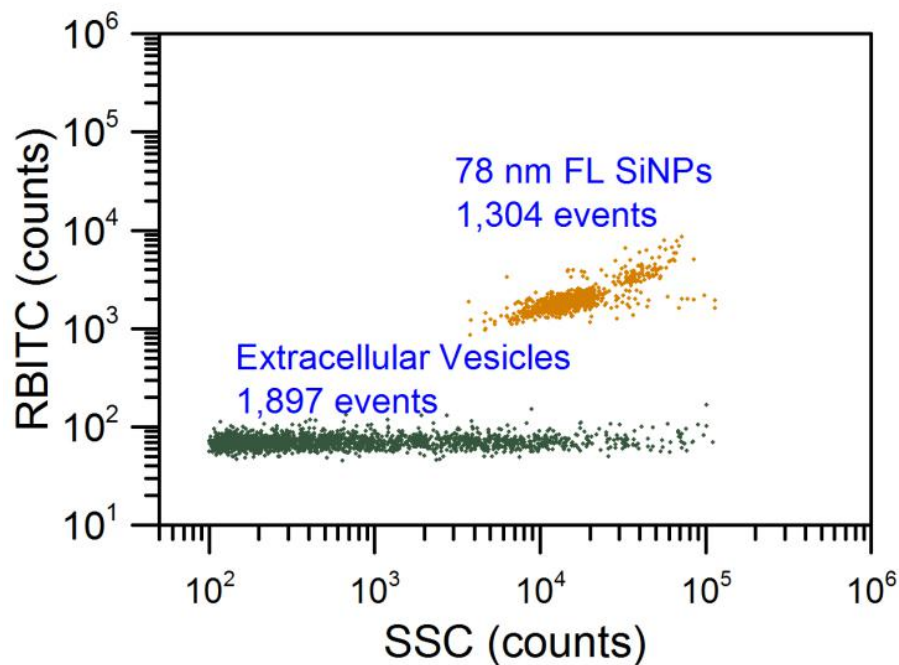
HCT116

Normal Cancer



NanoFCM用量是WB的1%!

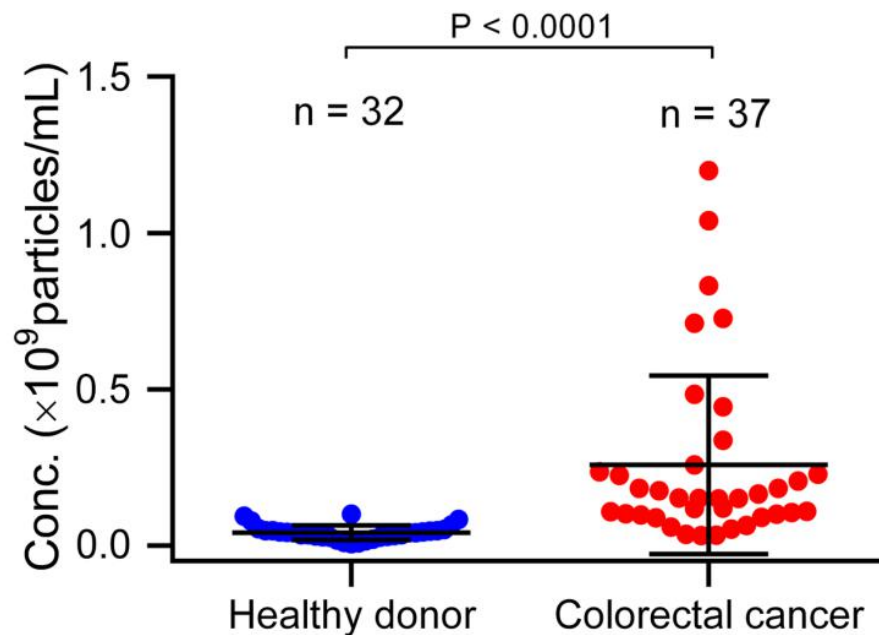
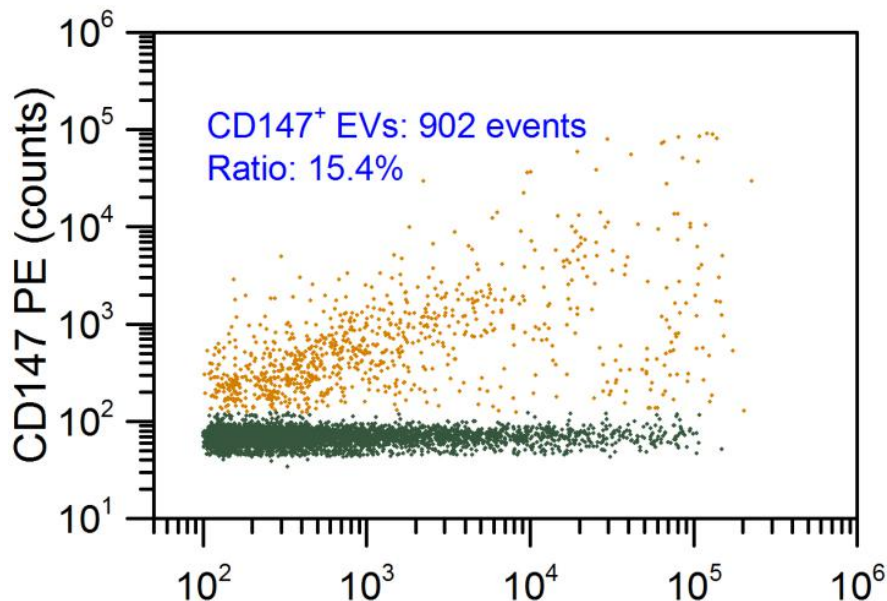
临床血浆样本中EVs的颗粒浓度



Total EVs concentration	n	Lowest	Highest	Ratio	Mean \pm s.d.
Healthy donor	32	1.3×10^8 /mL	5.3×10^9 /mL	41	$(0.9 \pm 1.2) \times 10^9$ /mL
Patients	37	1.2×10^8 /mL	6.2×10^9 /mL	52	$(1.2 \pm 1.2) \times 10^9$ /mL

临床样本中CD147+的颗粒浓度

NanoFCM

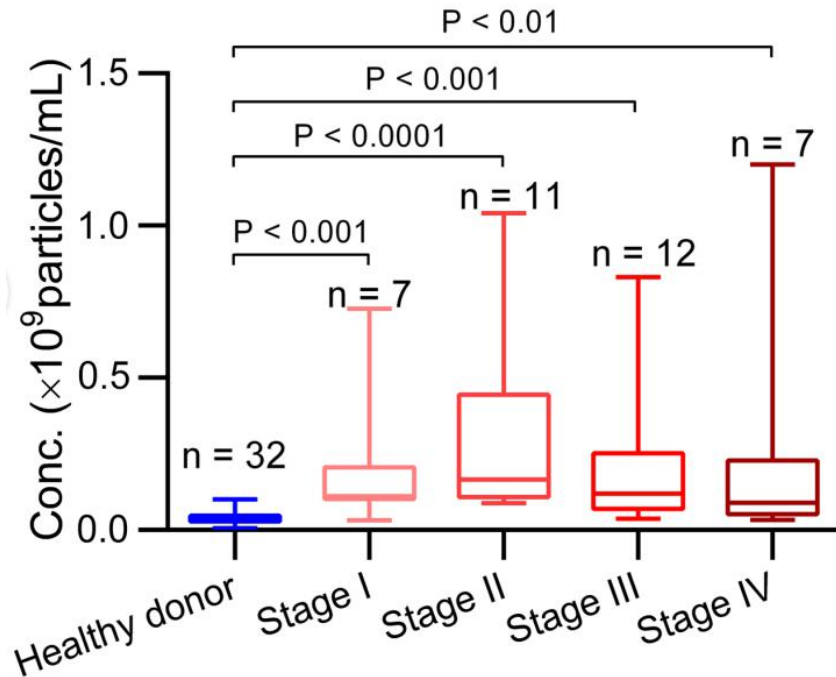


Total EVs concentration	n	Lowest	Highest	Ratio	Mean \pm s.d.
Healthy donor	32	$0.6 \times 10^7/\text{mL}$	$1.0 \times 10^8/\text{mL}$	17	$(4.1 \pm 2.3) \times 10^7/\text{mL}$
Patients	37	$3.2 \times 10^7/\text{mL}$	$12 \times 10^8/\text{mL}$	38	$(2.9 \pm 2.9) \times 10^8/\text{mL}$
Ratio	/	/	/	/	7.1

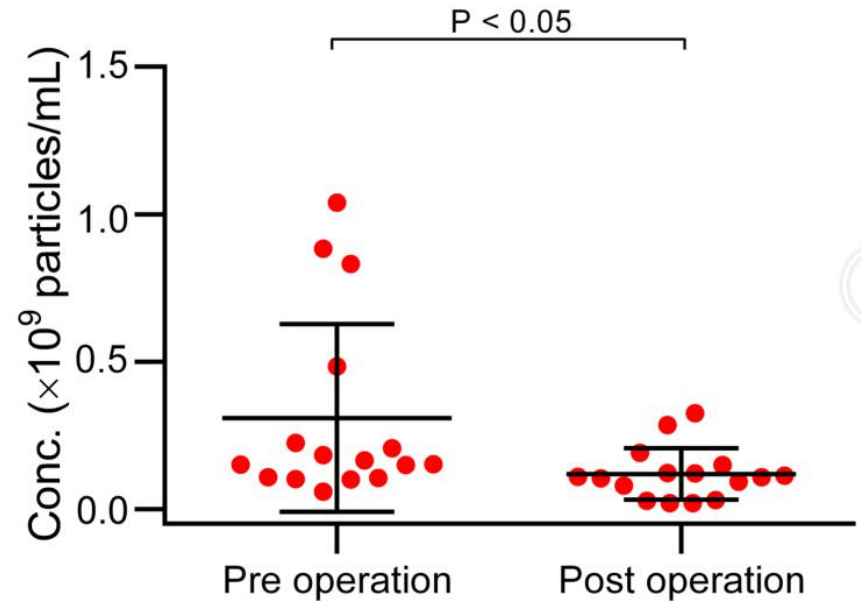
癌症的早期诊断&术后监测

NanoFCM

Different Cancer Stages



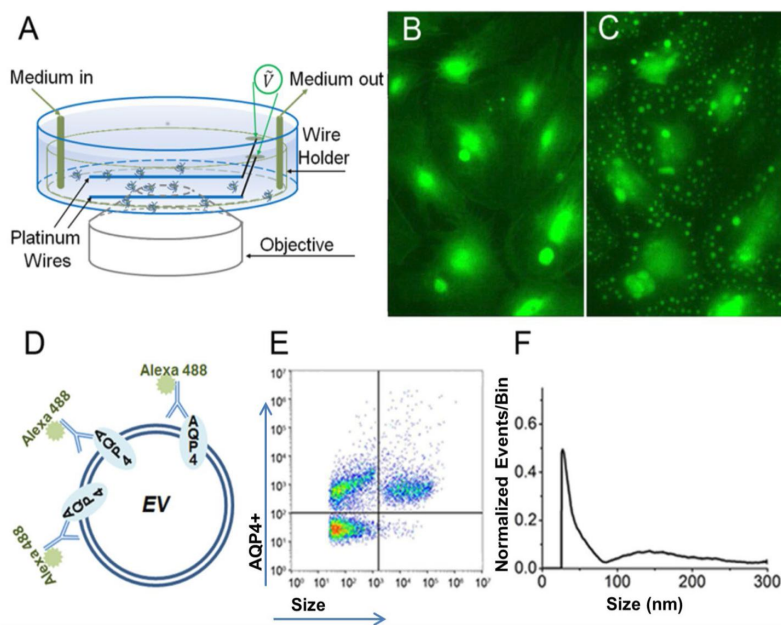
Surgical Resection



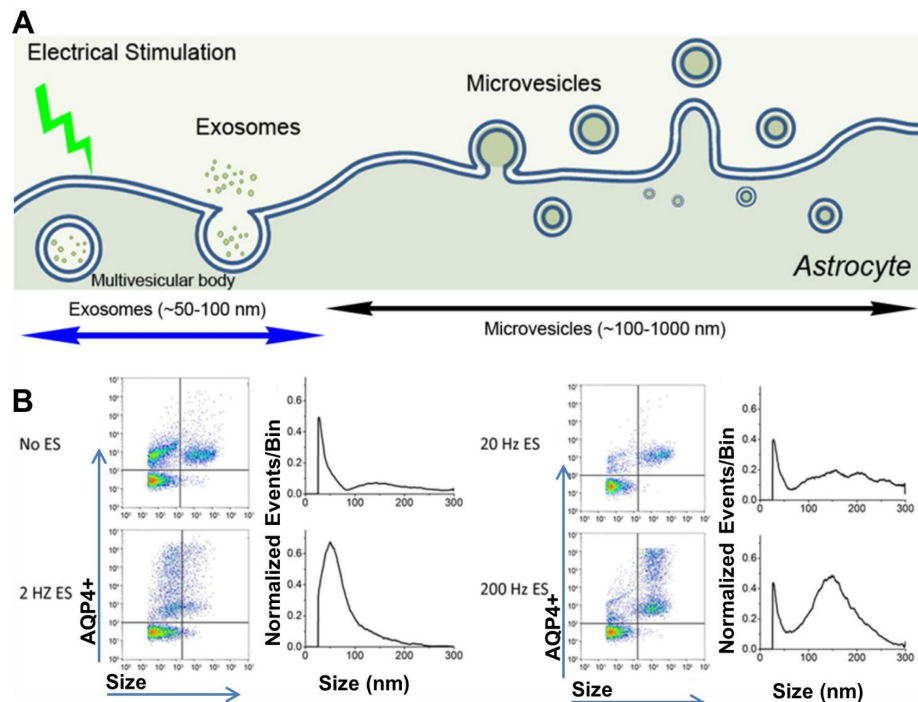
Tian Y, et al. *ACS Nano*, 2018, 12, 671

- Increased CD147⁺ EVs were also detected in patients with early stage of colorectal cancer;
- Analysis of CD147⁺ EVs might be used for monitoring the status of cancer after treatment.

Characterization of EVs in Astrocytes



Distributions of EVs after Electrical Stimulation

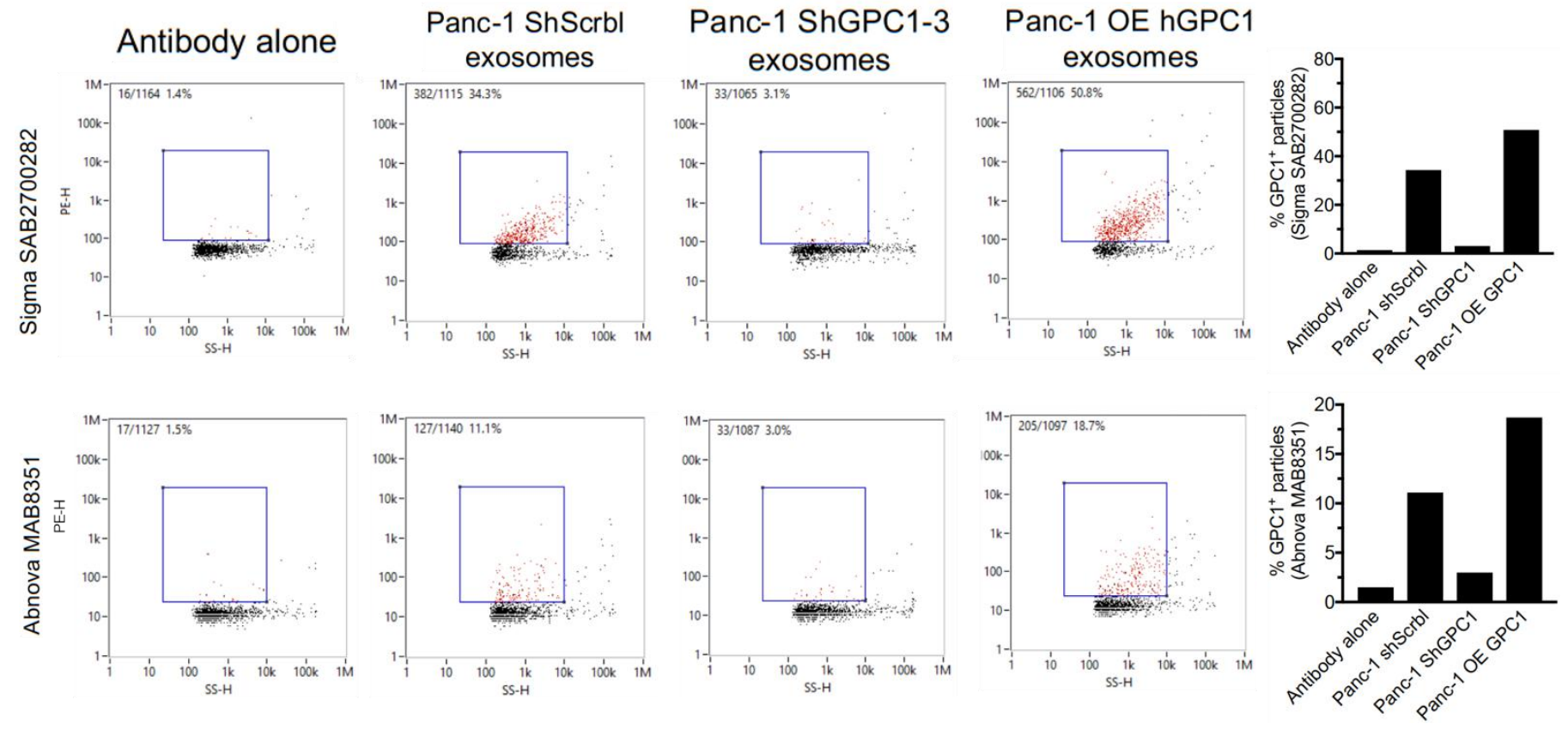
DOI: <http://dx.doi.org/10.1101/566448>

➤ The size distribution of AQP4-positive EVs are differentially affected by the frequency of electrical stimulation.

外泌体 特异性抗体直筛

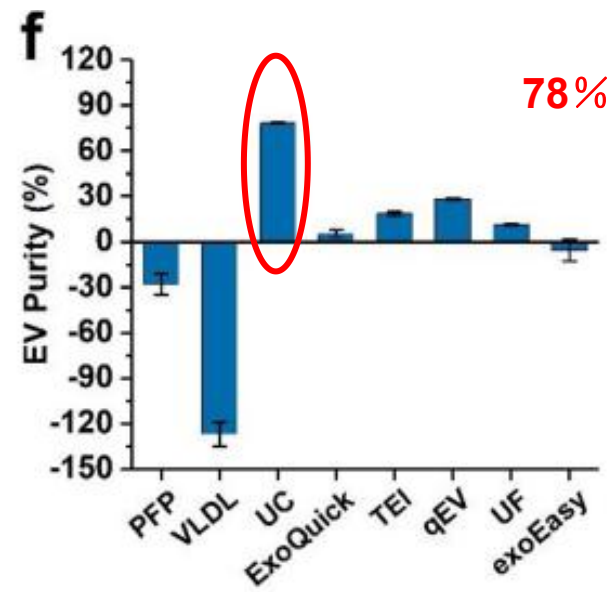
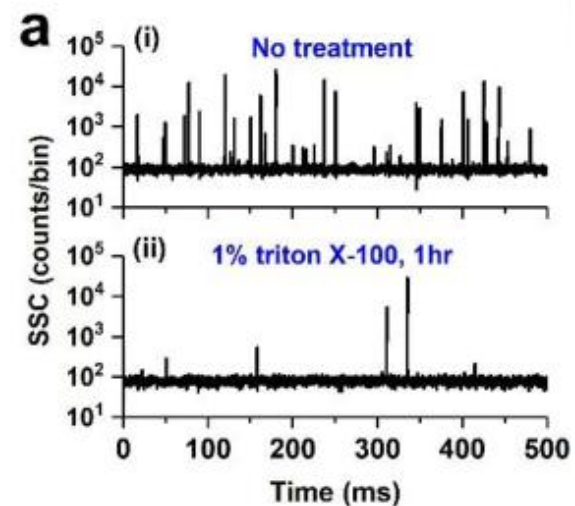
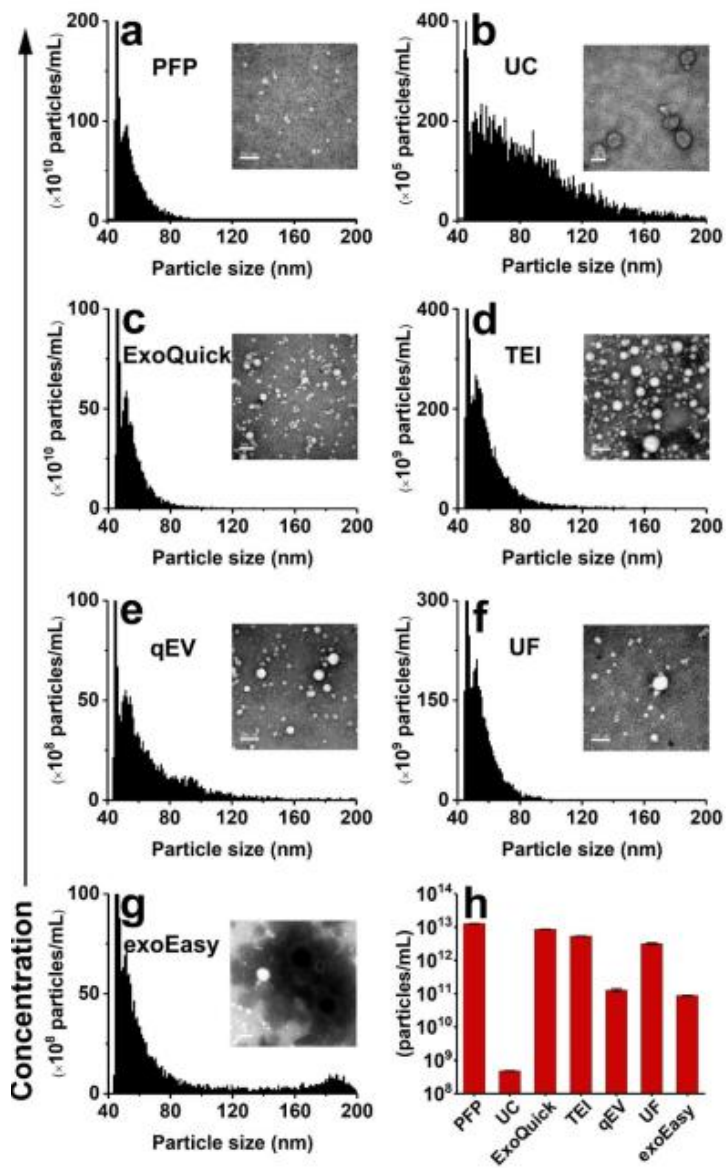
NanoFCM

安德森癌症中心 **GPC1**外泌体特异性抗体筛选



外泌体纯化方法的效率与质量评估

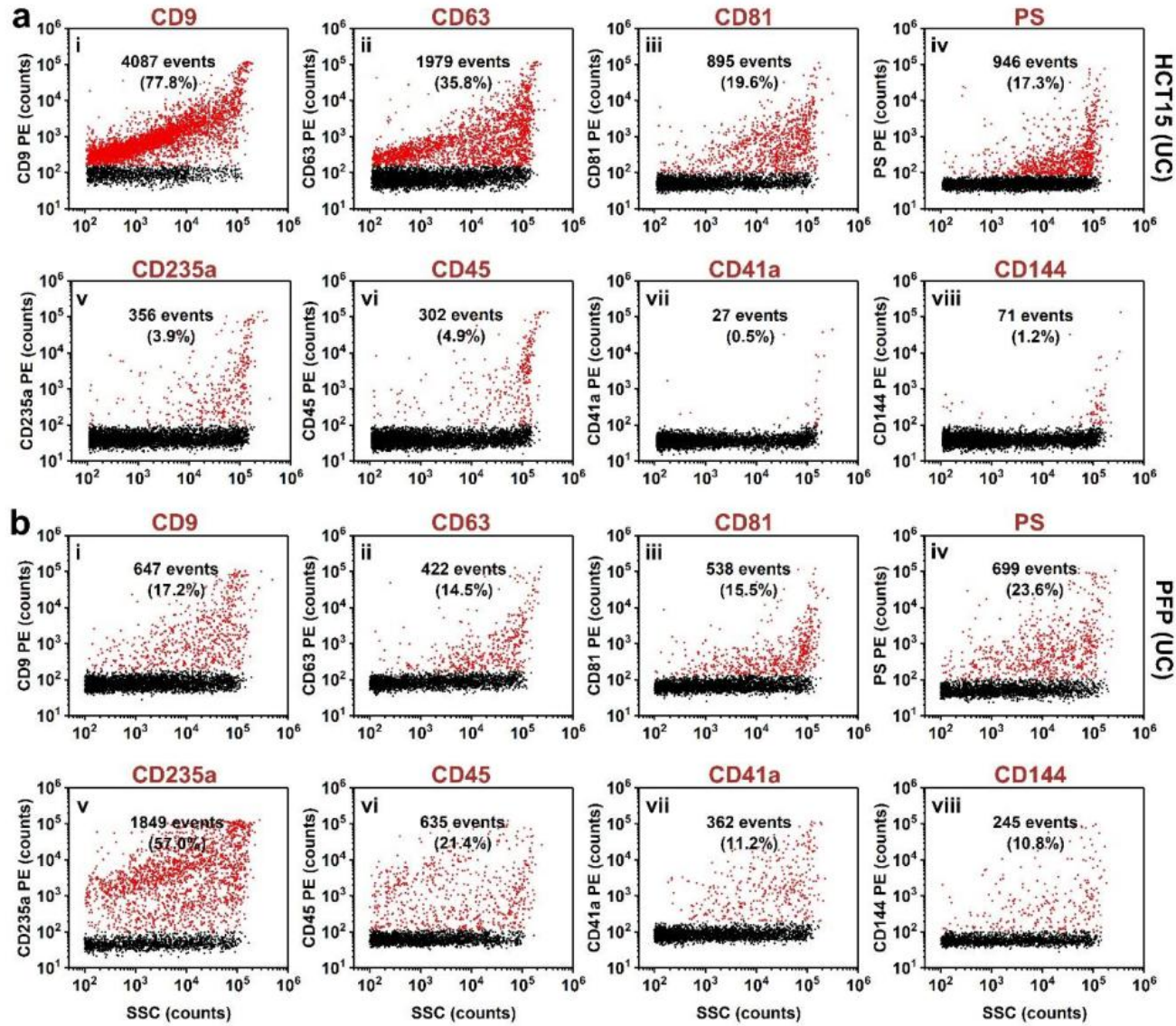
NanoFCM



外泌体Marker蛋白免疫荧光标记

NanoFCM

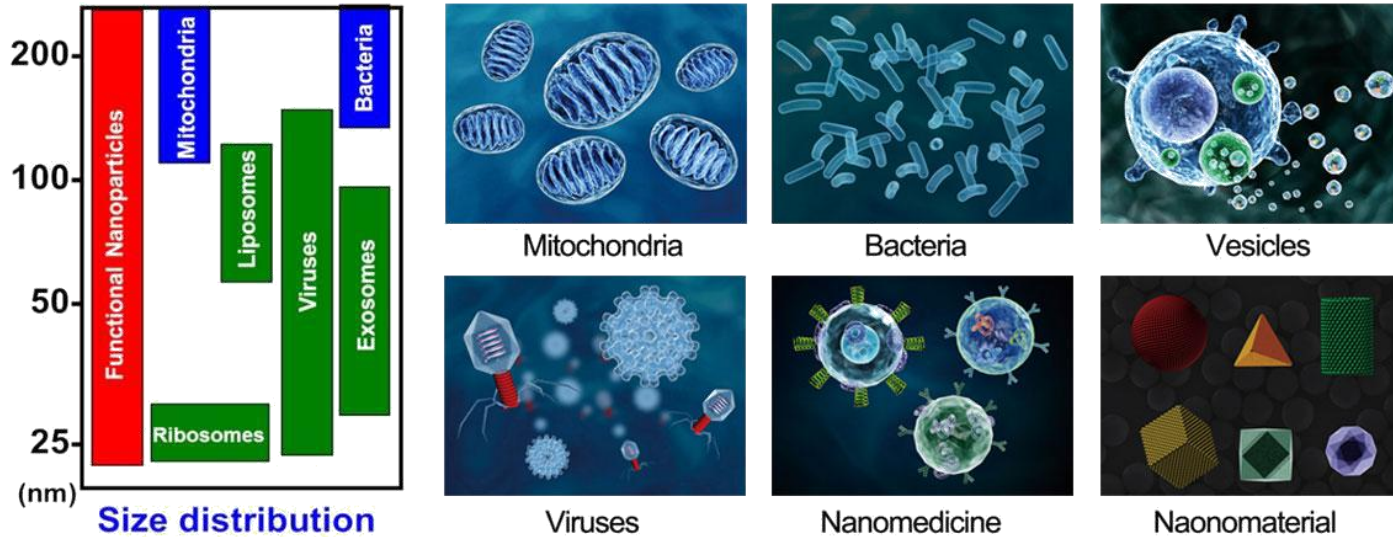
细胞上清外泌体



血浆外泌体

纳米流式检测仪总结

NanoFCM



- **灵敏度高**—低至7 nm纳米金颗粒检测，范围可覆盖**细胞外囊泡**的粒径
- **分辨率好**—68/91/113/155nm**混合颗粒基线分离**
- **多参数检测**—散射和荧光同时检测，实现**单颗粒水平**多参数检测
- **出具检测报告**—样品的**粒径**、**浓度**报告及功能性样品颗粒的粒径浓度信息
- **样品消耗量少**—低至**10 μ L**即可检测，消耗低至**1 μ L**

灵敏、快速、定量、生化性质

部分高分文章 (IF>10)

NanoFCM

1. Hu G, Xia Y, Zhang J, et al. "ESC-sEVs Rejuvenate Senescent Hippocampal NSCs by Activating Lysosomes to Improve Cognitive Dysfunction in Vascular Dementia." *Advanced Science* (2020). **IF=15.80**
2. Jiang W, Ma P, Deng L, et al. Hepatitis A virus structural protein pX interacts with ALIX and promotes the secretion of virions and foreign proteins through exosome-like vesicles. *Journal of Extracellular Vesicles*, 2020, 9(1): 1716513. **IF=11.00**
3. Tian Y, Gong M, Hu Y, et al. Quality and efficiency assessment of six extracellular vesicle isolation methods by nano-flow cytometry. *Journal of Extracellular Vesicles*, 2020, 9(1): 1697028. **IF: 11.00**
4. Yu S, Li Y, and Liao Z et al. Plasma Extracellular Vesicle Long RNA Profiling Identifies a Diagnostic Signature for the Detection of Pancreatic Ductal Adenocarcinoma. *Gut*, gutjnl-2019-318860. **IF: 17.94**
5. Zhang Y, Jin X, and Liang J et al. Extracellular Vesicles Derived from ODN-stimulated Macrophages Transfer and Activate Cdc42 in Recipient Cells and Thereby Increase Cellular Permissiveness to EV Uptake. *Science Advances*, 2019, 5: eaav1564. **IF: 12.80**
6. Zhu Q, Ling X, and Deng Z et al. Embryonic Stem Cells-Derived Exosomes Endowed with Targeting Properties as Chemotherapeutics Delivery Vehicles for Glioblastoma Therapy. *Advanced Science*, 2019, 6, 1801899. **IF: 15.80**
7. Lv P, Liu X, and Liu G et al. Genetically Engineered Cell Membrane Nanovesicles for Oncolytic Adenovirus Delivery: A Versatile Platform for Cancer Virotherapy. *Nano Letters*, 2019, 19, 2993-3001. **IF: 12.27**
8. Tian Y, Ma L, Gong M, et al. Protein Profiling and Sizing of Extracellular Vesicles from Colorectal Cancer Patients via Flow Cytometry. *ACS Nano*, 2018, 12(1), 671-680. **IF: 13.71**
9. Ma L, Zhu S, Tian Y, et al. Label-Free Analysis of Single Viruses with a Resolution Comparable to That of Electron Microscopy and the Throughput of Flow Cytometry. *Angewandte Chemie*, 2016, 55(35):10239-10243. **IF: 11.18**
10. Zhu S, Ma L, Wang S, et al. Light-Scattering Detection below the Level of Single Fluorescent Molecules for High-Resolution Characterization of Functional Nanoparticles. *ACS Nano*, 2014, 8(10):10998-11006. **IF: 13.71**
11. Wu L, Huang T, and Yan X et al. Sensitive and Selective Bacterial Detection Using Tetracysteine-Tagged Phages in Conjunction with Biarsenical Dye. *Angewandte Chemie International Edition*, 2011, 50, 5873-5877. **IF: 11.18**
12. Zhu S, Yang L, and Yan X et al. Size Differentiation and Absolute Quantification of Gold Nanoparticles via Single Particle Detection with a Laboratory-Built High-Sensitivity Flow Cytometer. *Journal of American Chemical Society*, 2010, 132, 12176-12178. **IF: 13.6**

Thank you !

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service@nanofcm.com



福流
nanofcm