

Protocol

Phosphorylation Site Detector

Off-the-shelf peptide microarrays

Contact us:

InfoLine: +49-30-6392-7878

Order per fax: +49-30-6392-7888

Or e-mail: peptide@jpt.com

www: www.jpt.com

JPT Peptide Technologies GmbH
Volmerstrasse 5 (UTZ)
12489 Berlin
GERMANY

Product Use & Liability

THE PRODUCTS ARE FOR EXPERIMENTAL LABORATORY USE ONLY AND NOT INTENDED FOR HUMAN OR HOUSEHOLD USE.

Only qualified personnel should handle these chemicals. Furthermore, JPT Peptide Technologies stresses that missing hazard warnings do not mean that the relevant product is harmless. In regard to classification the products are only for research purposes. JPT Peptide Technologies cannot be made responsible for damages arising from misuse of any product.

JPT Peptide Technologies makes no warranty of any kind, expressed or implied, which extends beyond the description of the product in this brochure, except that the material will meet our described specifications at the time of delivery.

JPT Peptide Technologies makes no guarantee of results and assumes no liability for injuries, damages or penalties resulting from product use, since the conditions of handling and use are beyond our control.



Table of content

1	INTRODUCTION	4
2	LIST OF COMPONENTS	4
3	STORAGE AND HANDLING	4
3.1	Storage of Peptide Microarray Slides	4
3.2	Handling of Peptide Microarray Slides	5
4	ADDITIONAL MATERIALS REQUIRED	5
4.1	Materials and Solutions for Radioactive Readout	5
4.1.1	General Kinase-Buffer	6
4.1.2	Additional Hardware	6
4.2	Materials and Solutions for Non-Radioactive Readout	7
4.2.1	General Kinase-Buffer	7
4.2.2	Blocking Buffer	8
4.2.3	TBS-Puffer	8
4.2.4	Antibody solution	8
4.2.5	Pro-Q-Diamond stain	9
4.2.6	Additional Hardware	9
5	GENERAL CONSIDERATIONS	10
5.1	Experimental basics	10
5.2	Peptide Microarray Layout	10
5.3	Peptide Microarray Pretreatment	13
6	EXPERIMENTAL PROTOCOLS	14
6.1	General principles for incubation	14
6.1.1	Fully automated microarray processing station	14
6.1.2	Microarray incubation using microarray-chip-sandwich	16
6.2	Radioactive Readout in microarray processing station	17
6.3	Radioactive Readout in microarray chip sandwich	18
6.3.1	Prepare the slide-environment for easy handling	18
6.3.2	Pipette kinase solution and radioactively labelled ATP	19
6.3.3	Incubation	20

6.3.4	Wash microarray	20
6.3.5	Image the radioisotopically labelled phosphorous	20
6.4	Non-Radioactive Readout in microarray processing station	21
6.5	Non-Radioactive Readout in microarray chip sandwich	21
6.5.1	Prepare the slide for antibody or phosphor-specific-stain incubation	21
6.5.2	Incubate with antibody	22
6.5.3	Final washing steps	22
6.5.4	Fluorescence image the peptide microarray	22
7	NOTES	23
8	REFERENCES	24
9	RELATED PRODUCTS	25

1 Introduction

The Phosphorylation Site Detector peptide microarrays offer a very efficient way to detect potential phosphorylation sites in kinase substrate proteins. Each Phosphorylation Site Detector represents a single peptide microarray on a glass slide containing an overlapping peptide scan through a protein. Following the incubation with the target kinase in the presence of radioactive ATP, incorporated phosphate can be detected by autoradiography or phospho-imaging. Alternatively, phospho-specific antibody-based fluorescent readout may be used for phospho-peptide detection. Moreover, phospho-specific stains like the Pro-Q-Diamond reagent from Molecular Probes could be used to identify peptidic kinase substrates.

2 List of Components

Component	Quantity
Phosphorylation Site Detector peptide microarray	glass slide(s) displaying peptides in triplicates
Blank slide engraved with “Dummy”	one blank slide per Kinase peptide microarray
Plastic spacers	2 spacers per Chip-Sandwich
Data CD-ROM	One CD-ROM per batch containing files (protocol as .pdf-file and sequence info as .gal-file)

3 Storage and Handling

3.1 Storage of Peptide Microarray Slides

- Optimal storage conditions for JPT’s peptide microarray slides are in a cool (approx. 4°C / 39°F) and dry environment. JPT’s peptide microarrays are stable for at least 18 months when stored at 4°C (39°F).
- Do not freeze the microarray slides for storage.

3.2 Handling of Peptide Microarray Slides

- Always handle the delicate microarray slides with care.
- Never touch the microarray slide surface.
- Always wear laboratory gloves when handling peptide microarrays slides
- Please hold the microarrays slides at the end, which carries the engraved data label. This label provides a unique identification of the array. It codes for the JPT batch and the position of the individual slide during production process.
- Please take care when dispensing solutions onto the microarray surface. Make sure not to touch the surface with pipette-tips or dispensers.
- Never whisk the surface of the slide with a cloth.
- Never use other chemicals as described. Inappropriate chemicals may destroy the chemical bonding of the peptides to the glass surface.
- Avoid dust or other particles during each step of the experiment. Dust, particles and resulting scratches will cause artefacts during the final signal readout.
- Please filter all solutions for the washing steps through 2µm, preferably 0.4µm particle filters before use.

**PLEASE READ THE ENTIRE PROTOCOL BEFORE STARTING YOUR EXPERIMENTS!
CAREFULLY NOTE THE HANDLING AND STORAGE CONDITIONS OF
PHOPHORYLATION SITE DETECTOR PEPTIDE MICROARRAYS.
PLEASE CONTACT JPT PEPTIDE TECHNOLOGIES' TECHNICAL SERVICES FOR
ASSISTANCE IF NECESSARY.**

4 Additional Materials Required

4.1 Materials and Solutions for Radioactive Readout

- Catalytically active kinase
- Specific kinase-buffer
- ATP and [γ ³²P] ATP or [γ ³³P] ATP
- Phosphoric acid (0.1M)

- De-ionized water
- Additional hardware (refer to point 4.1.2)



If no specific buffer is supplied with your kinase, JPT recommends to use a general kinase buffer as described in section 4.1.1

4.1.1 General Kinase-Buffer

The general kinase buffer is only needed if no specific buffer is supplied with or known for your kinase. JPT recommends the following final buffer conditions for kinase mediated phosphate transfer from ATP to microarray bound substrate peptides:

- 50mM HEPES-NaOH, pH 7.5
- 5mM MgCl₂
- 5mM MnCl₂
- 3μM sodium-orthovanadate
- 1mM DTT
- 1μM ATP (approx. 3x10⁵cpm [γ -³²P] ATP)

4.1.2 Additional Hardware

- Hybridisation station capable of washing and incubating slides in a temperature controlled environment (JPT recommends Tecan Hyb Station HS4X00), alternatively a microarray incubation sandwich can be used (please refer to point 6.1.2 for further details)
- Phospho-imager or X-ray film exposure equipment

4.2 Materials and Solutions for Non-Radioactive Readout

- Catalytically active kinase
- Specific kinase-buffer
- ATP
- BSA solution (1mg/mL)
- Blocking buffer (refer to point 4.2.2)
- TBS-Buffer 1x (refer to point 4.2.3)
- Phospho-specific antibody (refer to point 4.2.4)
- Pro-Q Diamond stain (refer to point 4.2.5)
- Additional hardware (refer to point 4.2.6)



If no specific buffer is supplied with your kinase, JPT recommends to use a general kinase buffer as described in section 4.2.1

Prepare all solutions using de-ionized H₂O.

4.2.1 General Kinase-Buffer

The general kinase buffer is only needed if no specific buffer is supplied with or known for your kinase. JPT recommends the following final buffer conditions for kinase mediated phosphate transfer from ATP to microarray bound substrate peptides:

- 50mM HEPES-NaOH, pH 7.5
- 5mM MgCl₂
- 5mM MnCl₂
- 3μM sodium-orthovanadate
- 1mM DTT
- 1μM ATP (approx. 3x10⁵cpm [γ -³²P] ATP)

4.2.2 Blocking Buffer

Following the incubation with the target kinase, peptide microarray has to be blocked to prevent unspecific binding of the antibody or the phospho-specific stain. JPT strongly recommends using the blocking reagent Pierce Biotechnology Inc. (#37536) which was validated not to interact with phospho-specific antibodies or phospho-sensitive stains like Pro-Q-Diamond.

4.2.3 TBS-Puffer

- 50mM Tris/Cl pH 8.0
- 137mM NaCl
- 2.7mM KCl

Dilute all components in liter of de-ionized water and adjust pH Value to 8.0

4.2.4 Antibody solution

Anti-phospho-tyrosine antibodies may be used to detect tyrosine phosphorylation. JPT recommends to use the FITC-labelled monoclonal anti-phospho-tyrosine antibody clone PT 66 (Sigma Aldrich; www.sigmaaldrich.com; Cat.#: F3145). For longer wavelength settings JPT recommends to use a primary/secondary antibody readout system such as anti-phospho-Tyr-100 antibody (Cell-Signalling #9411) followed by anti-mouse-Dylight 649 antibody (Pierce Biotechnology Inc, #35515).

- Dilute the antibody-stock solution with Blocking Buffer described in 4.2.2 to a final concentration of 1µg/mL

For more information about the anti-phosphotyrosine antibody please refer to the data sheet delivered with the antibody.

4.2.5 Pro-Q-Diamond stain

For the detection of serine/threonine phosphorylation, JPT recommends to use the Pro-Q-Diamond stain from Molecular Probes/Invitrogen. Details for incubation of the peptide microarray slides are contained in the data sheet of the stain.

4.2.6 Additional Hardware

You may use any microarray scanner that is compatible with standard industry glass slides (75mm x 25mm x 1mm) and which enables excitation and readout of your chosen fluorescence label. The minimal resolution required to guarantee satisfying spot-recognition is 50µm pixel size.

5 General considerations

5.1 Experimental basics

The JPT Phosphorylation Site Detector is a device for detecting potential phosphorylation sites within a target protein. Each spot in the microarray represents a single peptide, derived from the primary structure of the target protein resulting in an overlapping peptide scan of the protein (see point 1 in Figure 1).

During incubation of the peptide microarray with a kinase in the presence of ATP a phosphate moiety is added to the substrate peptides (see point 2 in Figure 1).

The incorporated phosphate moiety can be detected by phospho-imaging (if radioactively labelled ATP was used) or by incubation with a fluorescence labelled phospho-specific antibody or dye (see point 3 in Figure 1).

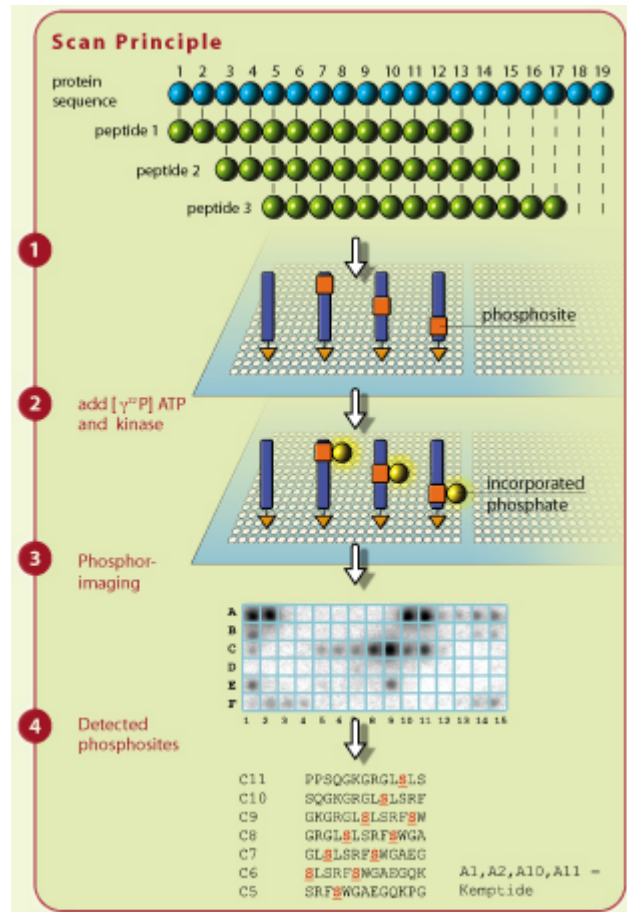


Figure 1: General principle of peptide microarray based phosphosite detection

5.2 Peptide Microarray Layout

The data CD-ROM included with the Phosphorylation Site Detector contains all information needed for the detailed analysis of your data including peptide sequences as well as the position of the appropriate peptides on the glass surface by means of a .gal-file.

The side of the slide with the engraved label represents the surface displaying the attached peptides.

The .gal-file can be opened using microarray evaluation software-modules capable of evaluating high-density microarray slides. Since .gal-files are tab-separated text files, they can be processed with software modules such as Microsoft Editor (Notepad) or Microsoft Excel.

A schematic layout of the peptide microarray is shown in **Figure 2**.

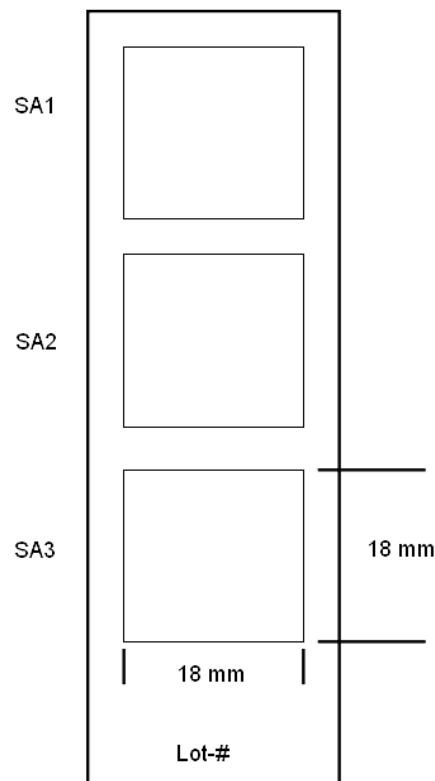


Figure 2: schematic layout of peptide microarray (SA=subarray)

As shown in **Figure 2** the peptide microarray is printed in three identical subarrays (SA). This enables efficient intra-chip-reproducibility tests using scatter plots or correlation functions.

Full-length protein controls have been printed onto the slides to assist you in identifying the different subarrays of the printed area after scanning or phosphor-imaging (Please refer to the Excel-file on the enclosed CD-ROM and to the

corresponding data sheets). These deposited full-length proteins (indicated in the data sheet with numbers I to VIII) can be used as points of alignment for spot-recognition software.

An exemplaric microarray and subarray layout is shown in Figure 3 und Figure 4 below.

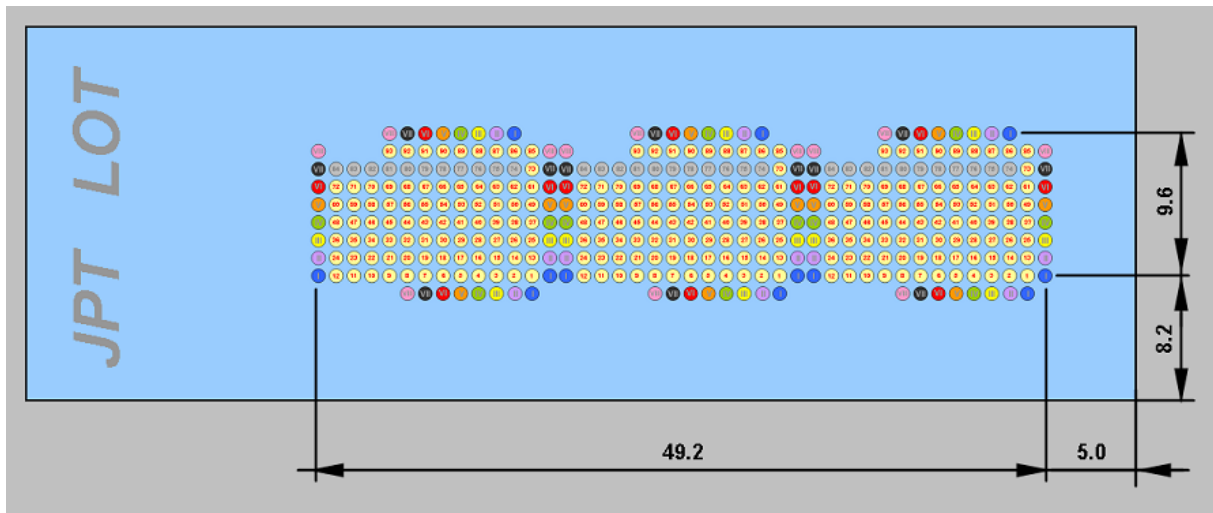


Figure 3: microarray layout (scale unit: mm), three subarrays are visible and framed by full length protein controls (coloured spots)

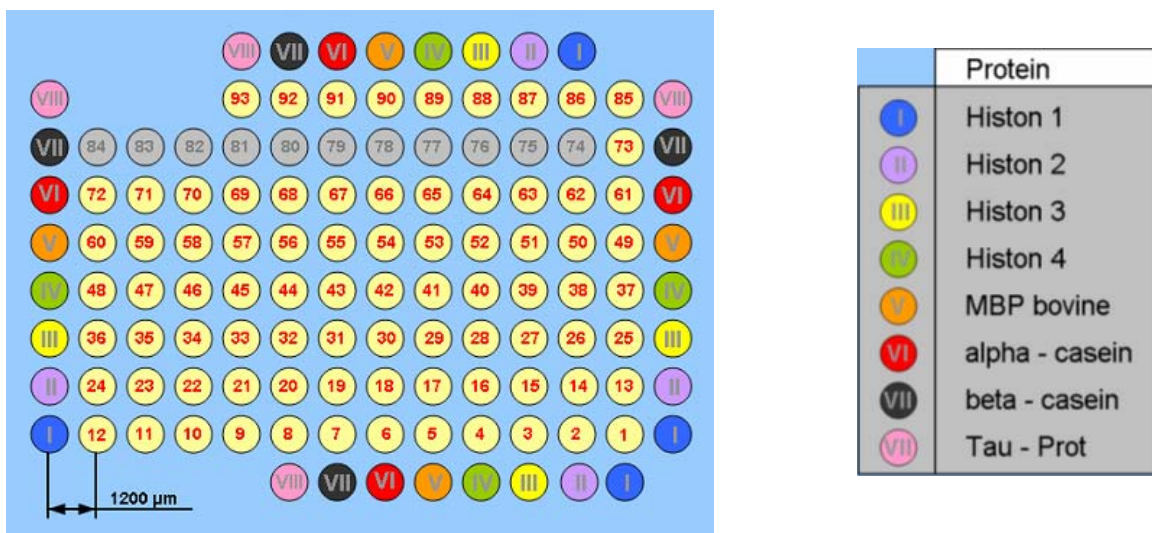


Figure 4: subarray layout, peptide array is represented by numbers (starting in the lower left corner; full length proteins are represented by coloured spots (numbering from I to VIII)

5.3 Peptide Microarray Pretreatment

The Phosphorylation Site Detector microarray is designed as a ready-to-use product. There is no need to perform blocking steps on the surface prior to incubation with the target kinase. However, if you would like to perform an additional blocking reaction, please ensure to only use protein-free solutions like PEGs (polyethyleneglycols, 1 mg/mL) or PVPs (polyvinylpyrrolidones, 1mg/mL).

This keeps your kinase of interest from phosphorylating the protein used for blocking!

6 Experimental protocols

6.1	General principles for incubation	14
6.1.1	Fully automated microarray processing station	14
6.1.2	Microarray incubation using microarray-chip-sandwich	16
6.2	Radioactive Readout in microarray processing station	17
6.3	Radioactive Readout in microarray chip sandwich	18
6.3.1	Prepare the slide-environment for easy handling	18
6.3.2	Pipette kinase solution and radioactively labelled ATP	19
6.3.3	Incubation	20
6.3.4	Wash microarray	20
6.3.5	Image the radioisotopically labelled phosphorous	20
6.4	Non-Radioactive Readout in microarray processing station	21
6.5	Non-Radioactive Readout in microarray chip sandwich	21
6.5.1	Prepare the slide for antibody or phosphor-specific-stain incubation	21
6.5.2	Incubate with antibody	22
6.5.3	Final washing steps	22
6.5.4	Fluorescence image the peptide microarray	22

6.1 General principles for incubation

6.1.1 Fully automated microarray processing station

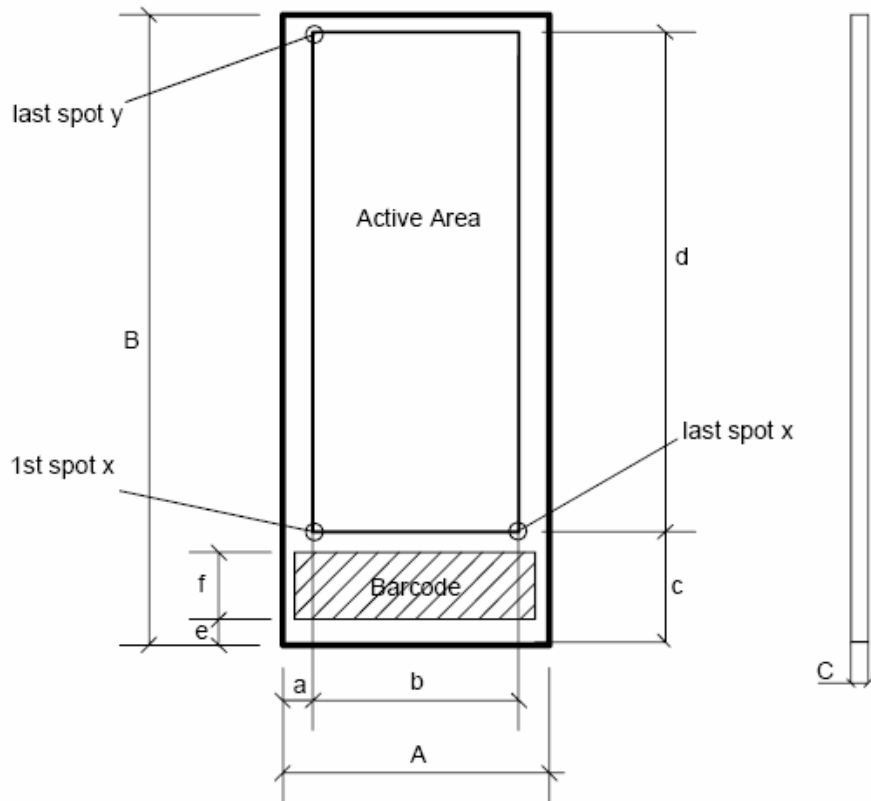
All peptide microarrays produced by JPT have an identical layout concerning active area and spotted surface. Although the content of the microarrays varies the overall layout and dimensions are the same (see Figure 5).



Please check with the manufacturer of your microarray processing station for compatibility with the required liquids. Most microarray processing stations are sensible towards strong acids and organic solutions. Protocols have to be adapted to prevent permanent damage to your device.

All peptide microarrays produced by JPT are adjusted to fit in common fully automated microarray processing systems (see Figure 6). JPT recommends using Tecan HS4X00 Hybridisation systems.

Protocols and procedures for using Tecan HS4X00 systems can be provided by JPT if necessary.



	Distance (mm)
A	25
B	75
C	1
a	3.5
b	18
c	9
d	57
e+f	1+8

Figure 6: Maximum area dimension on JPT peptide microarrays

6.1.2 Microarray incubation using microarray-chip-sandwich

To create a simple incubation chamber, two slides, one displaying the peptides and another slide (Dummy-slide) without any peptides, have to be assembled according to Figure 7 in a sandwich like format. If two peptide microarrays should be screened the top slide could be another peptide-displaying chip. Please make sure that in such a case the two peptide-displaying sides are facing each other. The two slides are separated by two spacers generated from a plastic sheet (see Figure 7).

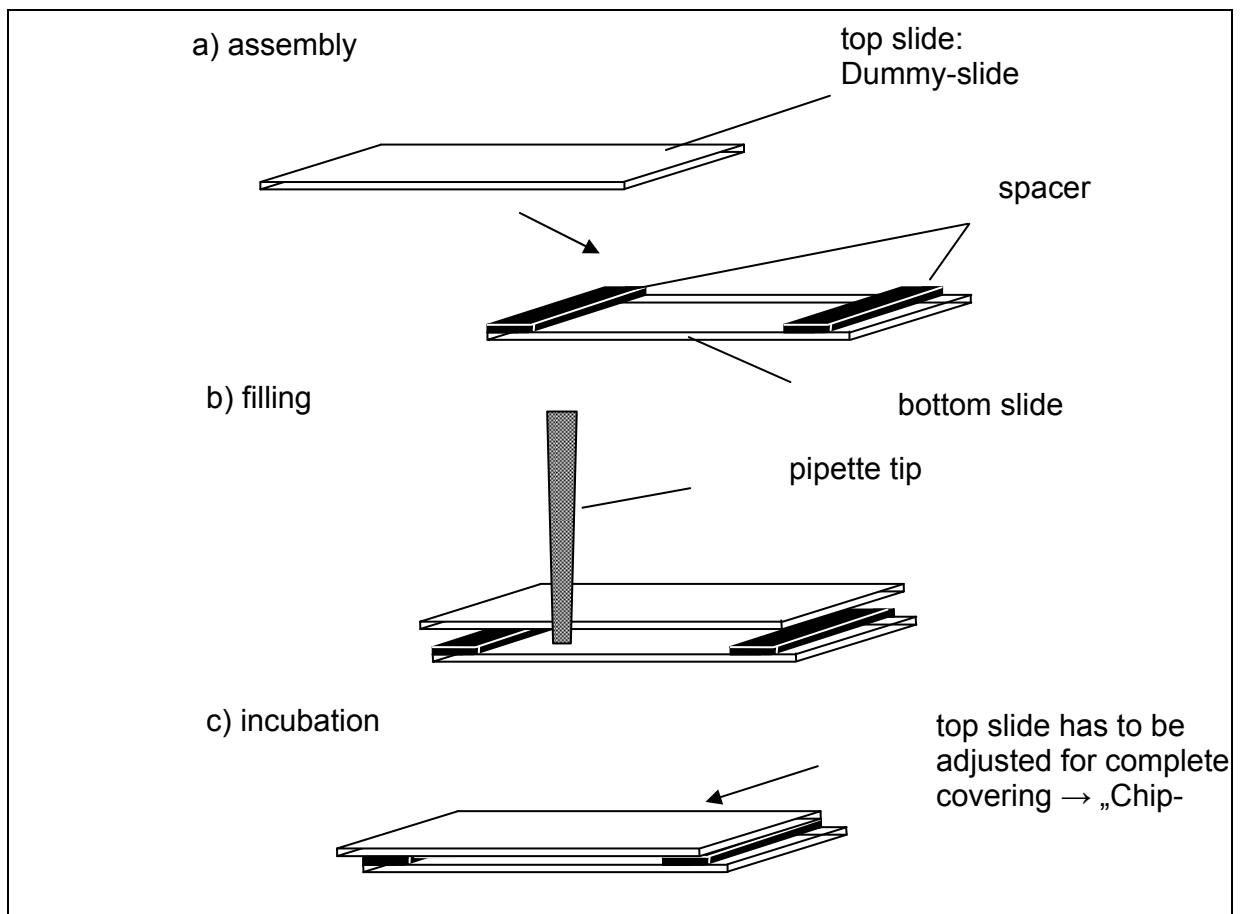


Figure 7:

a) Assembly of “Chip-Sandwich” is shown. Two plastic spacers are placed between the peptide displaying microarray (bottom slide) and the Dummy-slide or second peptide displaying microarray (top slide) resulting in a defined reaction chamber.

b) Assay solution is applied via pipette tip into the reaction chamber formed by the two slides. Capillary forces will soak-in the solution without formation of bubbles.

c) Top microarray is shifted resulting in overlaying ends of the glass slides. This arrangement enables convenient disassembly after the incubation step.

The final assay volume will depend on the thickness of these plastic spacers (0.2mm thickness will result in 100µL assay volume, JPT recommends at least 1mm thickness resulting in about 500µL final assay solution (spacers enclosed). The sample has to be applied in between the two slides. Therefore, the top slide is shifted about 1mm to one side. If the pipette tip is adjusted on the position directly over the uncovered bottom slide the capillary forces allow proper distribution of the sample solution without formation of bubbles.

After the incubation is finished, open the microarray sandwich in TBS-buffer, remove the plastic spacers and rinse the peptide microarrays thoroughly with TBS-buffer before continuing with the assay protocol.

6.2 Radioactive Readout in microarray processing station

PLEASE READ THE ENTIRE PROTOCOL BEFORE STARTING THE INCUBATION!

Please follow the instruction of the machine-manufacturer for processing microarray slides in your station.

In general the incubation and washing parameters are identical to the procedure described for the use of a microarray chip-sandwich.



Please check with the manufacturer of your microarray processing station for compatibility with the required liquids. Most microarray processing stations are sensible towards strong acids and organic solutions. Protocols have to be adapted to prevent permanent damage to your device. **Especially the washing steps using phosphoric acid should be changed to an intensive washing step using buffers!**

For kinase incubation details please continue at point 6.3

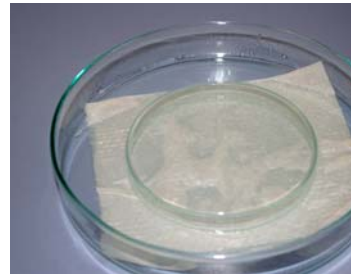
6.3 Radioactive Readout in microarray chip sandwich

From experience, we recommend the following hybridization technique, which keeps handling of the slide to a minimum once radioactive material is dispensed on the microarray:

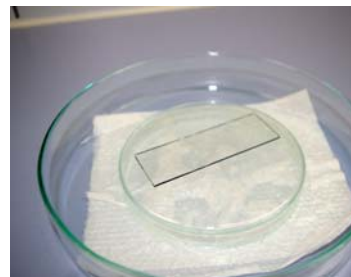
PLEASE READ THE ENTIRE PROTOCOL BEFORE STARTING THE INCUBATION!

6.3.1 Prepare the slide-environment for easy handling

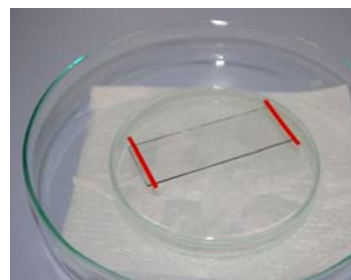
- I. Place a small Petri-dish upside down into larger Petri-dish to serve as support plate for the microarray. Place a piece of wet cloth underneath the small Petri-dish. This will keep the incubation solution from evaporating once the large Petri-dish is closed.



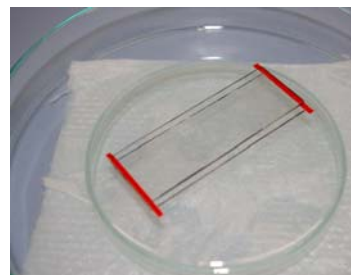
- II. Place the peptide microarray slide support plate facing upward (engraved label has to be readable from top).



- III. Place enclosed spacers on both ends of the microarray.



- IV. Prepare the microarray sandwich according to description above (6.1.2). If two peptide microarrays are used make sure that peptide displaying sides are facing each other.



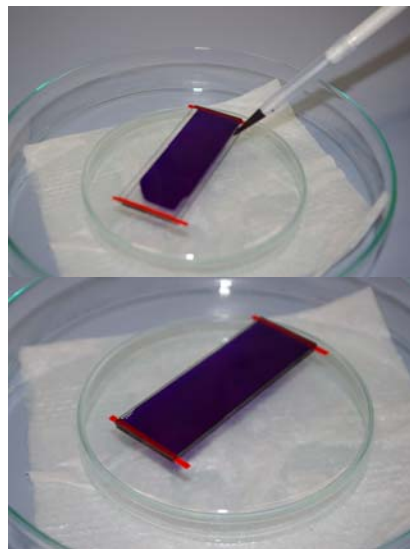
6.3.2 Pipette kinase solution and radioactively labelled ATP



In case your kinase is performing an autophosphorylation, please make sure to add a small amount of non-radioactive ATP first. This would create a non-labelled autophosphorylated kinase. In case your kinase tends to stick to the surface during the incubation time the background signal will not be increased due to autophosphorylation.

V. Prepare approx. 500 μ L of final assay solution (if enclosed spacer are used) containing your target antibody/sera.

VI. Pipette the complete volume into microarray chip sandwich. Capillary forces will suck the solution in between the two slides. Make sure there are no air bubbles within the sandwich.

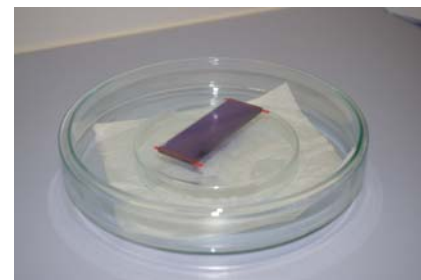


VII. Adjust the peptide microarray sandwich as described in Point 6.1.2.



Make sure not to touch the microarray with the pipette tip. Scratches and marks on the surface may destroy the deposited microarray and will cause artefacts!

VIII. Close the Petri-dish with a matching cover to create an incubation chamber.



6.3.3 Incubation

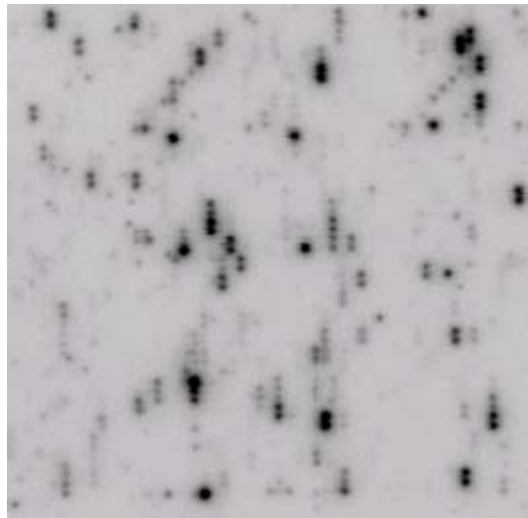
- IX. Incubate the peptide microarray for the appropriate time and temperature with your kinase/ATP solution. JPT recommends an incubation time of at least 2 hours at approximately 30°C (86°F).

6.3.4 Wash microarray

- X. Wash the slide 5 times with 0.1M phosphoric acid (3-4min each wash) to stop the reaction and to remove excess radioactively labelled ATP. Ensure that the slide is properly washed with enough liquid rinsing over the slide.
- XI. Wash the slide 5 times with de-ionized water (3-4min each wash). Ensure that the slide is properly washed with enough liquid rinsing over the slide.
- XII. Wash the slide with methanol and dry it preferably by using a gentle stream of nitrogen. Alternatively, a microarray centrifuge could be used for drying the microarray.

6.3.5 Image the radioisotopically labelled phosphorus

- XIII. Use the dry microarray for phospho-imaging. JPT strongly recommends the detection of incorporated phosphate by phospho-imaging. For best results, use the highest resolution possible (at least 50 µm pixel size).



High density Peptide microarray was incubated with Abl kinase and [³²P] ATP. Phospho-imaging on a FLA 3000 Reader was used for readout.

6.4 Non-Radioactive Readout in microarray processing station

PLEASE READ THE ENTIRE PROTOCOL BEFORE STARTING THE INCUBATION!

Please follow the instruction of the machine-manufacturer for processing microarray slides in your station.

In general the incubation and washing parameters are identical to the procedure described for the use of a microarray chip-sandwich and [³²P] ATP.



Please check with the manufacturer of your microarray processing station for compatibility with the required liquids. Most microarray processing stations are sensible towards strong acids and organic solutions. Protocols have to be adapted to prevent permanent damage to your device. **Especially the washing steps using phosphoric acid should be changed to an intensive washing step using buffers!**

For kinase incubation details, please continue at point 6.3

6.5 Non-Radioactive Readout in microarray chip sandwich

PLEASE READ THE ENTIRE PROTOCOL BEFORE STARTING THE INCUBATION!

For details of the peptide microarray incubation with kinase solution please refer to 6.3. There are no differences in handling the slides except for the radioactive ATP which has to be exchanged to non-radioactive ATP.

After kinase incubation is performed according to above protocol, please continue with Step 6.5.1

6.5.1 Prepare the slide for antibody or phosphor-specific-stain incubation

- I. Wash the peptide microarray for 1 hour in blocking-solution (refer to point4.2.2). Make sure that the slide is properly washed using sufficient volumes of buffer solution.

6.5.2 Incubate with antibody

- II. Prepare antibody/stain solution (refer to point 4.2.4 and 4.2.5).
- III. Incubate the peptide microarray for 3 hours with the antibody solution at room temperature. Make sure that the slide is properly washed using sufficient volumes of buffer solution.

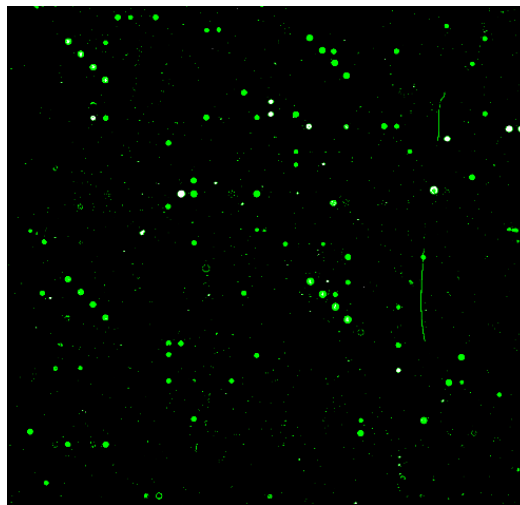
6.5.3 Final washing steps

- IV. Wash the peptide microarray 5 times with TBS-Buffer (refer to point 4.2.3). Make sure that the slide is properly washed using sufficient volumes of buffer solution.
- V. Wash the slide 5 times with de-ionized water (3-4 min each wash). Ensure that the slide is properly washed with enough liquid rinsing over the slide.

In case an incubation using a secondary antibody is required, please repeat steps II to VI.

6.5.4 Fluorescence image the peptide microarray

- VI. Perform fluorescence scans according to your microarray scanner type and antibody-label properties. Please refer to point 4.2.4 and 4.2.5 for antibody/stain recommendations



Example: JPT Peptide microarray was incubated with Abl-kinase and ATP. Fluorescent image was generated using a Genepix 4000B microarray scanner (Readout: Pro-Q phosphospecific stain)

7 Notes

- Avoid dust or other particles during each step of the experiment. Dust particles and resulting scratches will cause artefacts during the final signal readout.
- JPT recommends filtering all solutions prior performing incubation steps on peptide microarray. For filtering please use a 2µm or preferably a 0.4µm sterile filter.
- If your kinase tends to autophosphorylation, please preincubate your kinase with cold ATP only before adding hot ATP. In case your kinase shows hydrophobic interactions to the slide surface, the background will not be increased.
- For antibody/ProQ-readout: fluorescence scanning could be very sensitive depending on the scanner. Avoid any fluorescent impurities/contaminations inside your assay solution or wash solutions. You can easily check for such impurities incubation and washing a dummy slide with the same solutions followed by imaging.
- For incubation with the fluorescently labelled secondary antibody it is important to use metal trays with a cover or plastic trays completely covered with aluminium foil as these antibodies are sensitive towards light.
- Control incubations using labelled secondary antibody alone should be performed in parallel to the incubation of kinase treated microarray in order to make sure that found signals are not caused by unspecific binding of the secondary antibody to the immobilized peptides.
- Carefully adjust the final dilution of your labelled secondary antibody. Microarray technology is very sensitive and therefore it could be possible to use the secondary antibody in a higher dilution as proposed by the manufacturer. Generally, 1:1000 dilutions of a 1mg/mL stock solution are working very well. Nevertheless, depending on the nature of the secondary antibody, such concentrations may yield high background signals caused by unspecific binding to the coated glass surface. If the signals within the peptide spots are high you could test 1:5000 or 1:30000 dilutions of a 1mg/mL stock as well.

8 References

Jose M. Lizcano, Maria Deak, Nick Morrice, Agnieszka Kieloch, C. James Hastie, Liying Dong, Mike Schutkowski, Ulf Reimer, and Dario R. Alessi:
Molecular Basis for the Substrate Specificity of NIMA-related Kinase-6 (NEK6)
Journal Biological Chemistry (2003) 277, 27839 - 27849

Leszek Rychlewski, Maik Kschischo, Liying Dong, Mike Schutkowski, and Ulf Reimer:
Target Specificity Analysis of the Abl Kinase using Peptide Microarray Data
Journal Molecular Biology (2004) 336, 307 - 311

Sören Panse, Liying Dong, Antje Burian, Robert Carus, Mike Schutkowski., Ulf Reimer, and Jens Schneider-Mergener:
Profiling of generic anti-phosphopeptide antibodies and kinases with peptide microarrays using radioactive and fluorescence-based assays
Molecular Diversity (2004), in press

Mike Schutkowski, Ulf Reimer, Sören Panse, Liying Dong, Jose M. Lizcano, Dario R. Alessi, and Jens Schneider-Mergener:
High content peptide microarrays for deciphering kinase specificity and biology
Angewandte Chemie (2004) 116, 2725 - 2728

9 Related products

For further information visit our homepage (www.jpt.com) or contact our customer support.

- Kinase Peptide Microarrays (annotated phosphosites)
- Kinase Peptide Microarrays (Ser / Thr / Tyr based random libraries)
- Full kinase profiling service using JPTs PepStar™ high density peptide microarrays
- Kinase Substrate Set
- Large collection of peptidic kinase substrates (biotinylated or fluorescently labeled)
- Data packages resulting from incubation of PepStar™ high density peptide microarrays with commercially available kinases