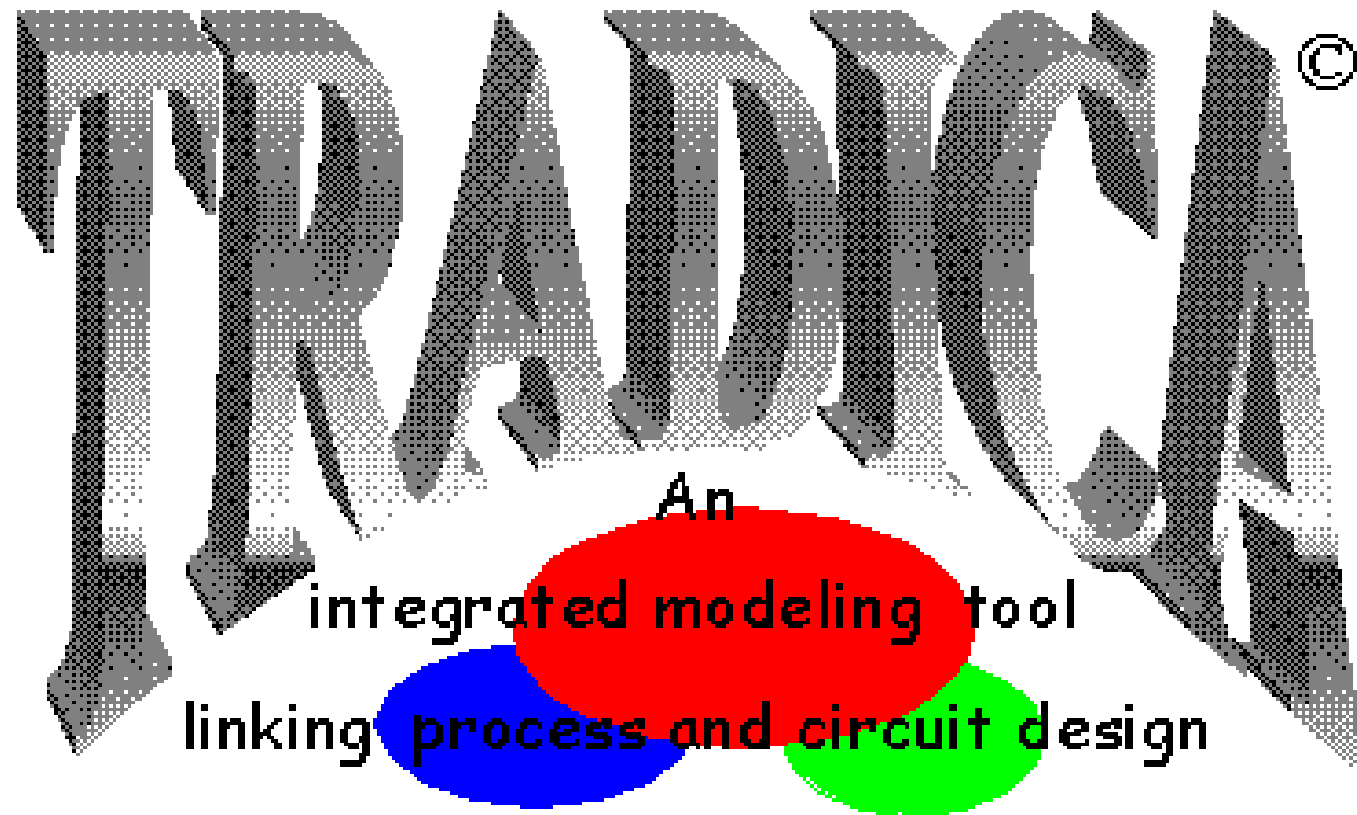

TRADICA[®]

An
integrated modeling tool
linking process and circuit design



Physics- and process-based bipolar transistor modeling for integrated circuit design

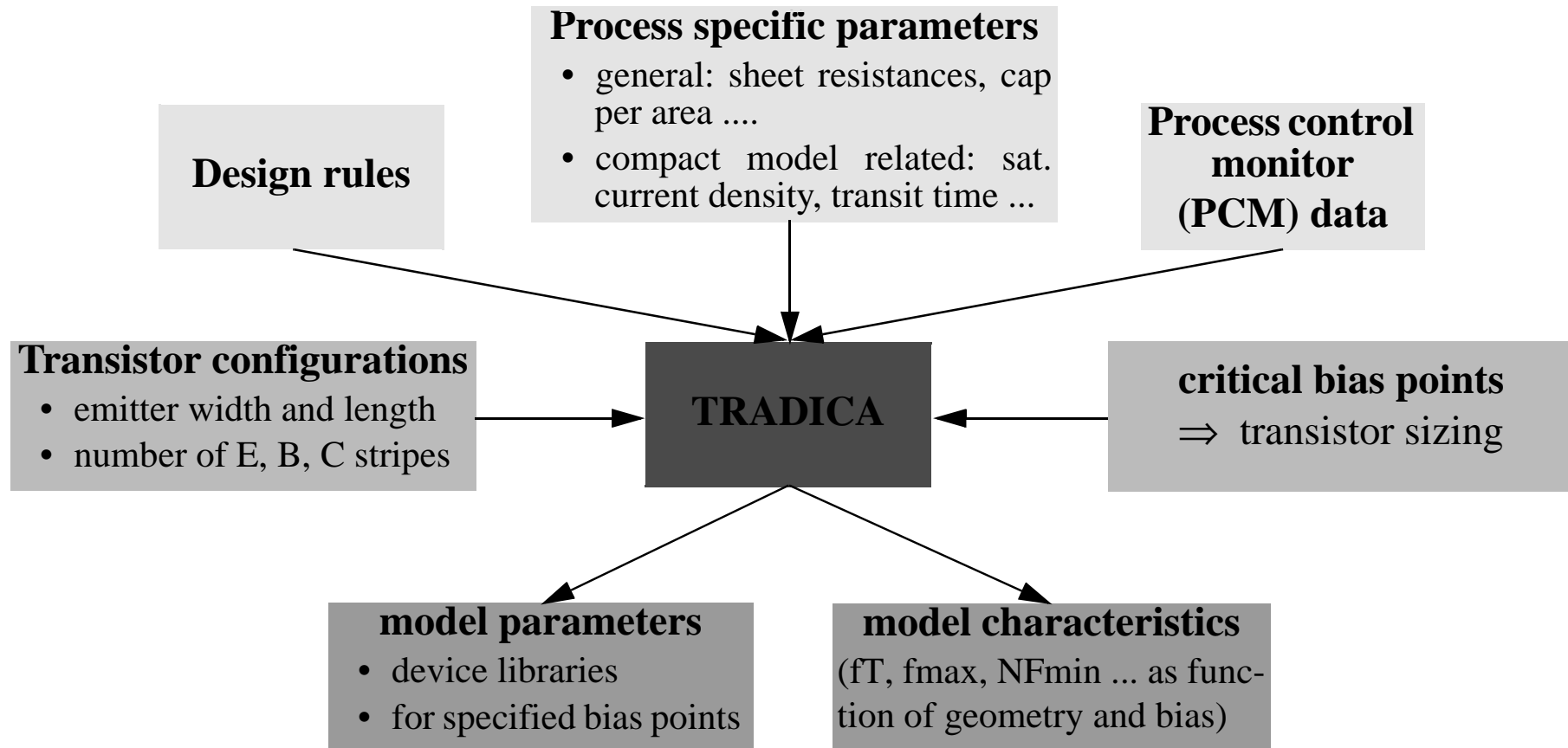
Motivation

- Increasing demand on circuit performance → often requires transistor operation close to the process performance limit ⇒ careful circuit optimization through proper transistor sizing
- Large variety of circuit applications → overall required number of transistor configurations¹ can become very large (>100) ⇒ need geometry scalable compact models and parameters
- Reduce time-to-market: start circuit design during process development (*concurrent engineering*) ⇒ predicted but consistent model parameters and flexible parameter generation
- Align process development with product (design) needs ⇒ quick evaluation of process change impact on electrical device and circuit performance
- Include process tolerances in design (⇒ statistical modeling, matching simulation)
- Large variety of bipolar processes requires sophisticated geometry scaling equations that are difficult to integrate and maintain in large variety of (commercial) circuit simulators

⇒ **TRADICA**

1. defined by emitter dimensions b_{E0} and l_{E0} ($\geq b_{E0}$), number of emitter, base, and collector fingers/contacts and their spatial arrangement

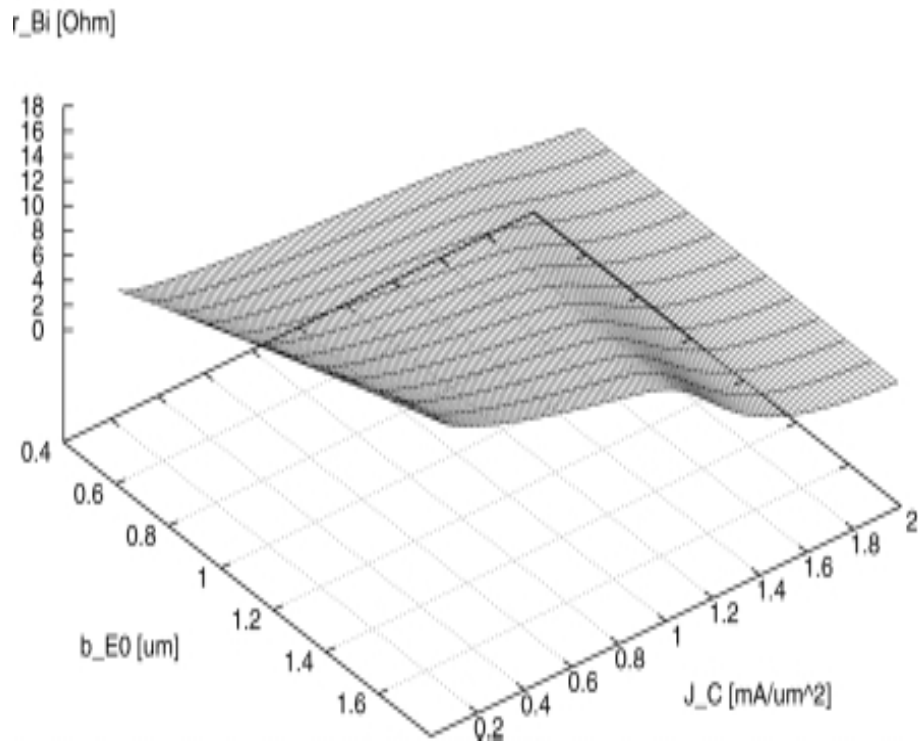
TRADICA overview



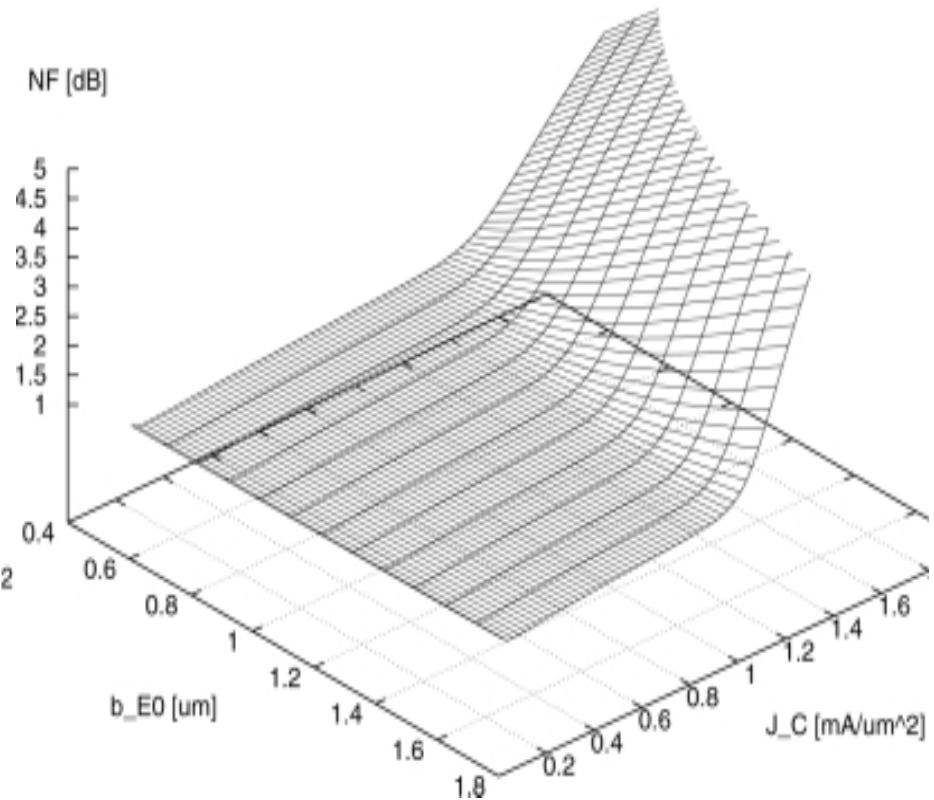
Example

**model parameters (base resistance, transconductance etc.) and model characteristics (transit frequency, noise figure etc.)
can be quickly calculated and displayed as a function of bias and geometry**

internal base resistance @ $V_{CE} = 0.8V$



noise figure (50Ω) @ $V_{CE} = 0.8V$, $f = 2 GHz$



Example (cont'd)

data output ...

... model library

```

* x          AEO= 1* .20* 2.67( 1); NB= 2(      );
NC=1(SIDE),SIC;T=300;Example
* HICUM/ Level 2 / ELDO
V5.0
.SUBCKT N020261S02_01 3 2 1 9
Q      3  2  1  9 MOD
.MODEL MOD NPN level=9 TNOM= 26.85
+ c10=2.20E-32 qp0=4.66E-15 ich=5.82E+01 hjci= .38 hfc=
hjei= 1.00
+ cjei0=2.91E-15 vdei=1.000 zei= .400 aljei= 2.20
+ cjci0=6.99E-16 vdci= .850 zci= .286 vptci=3.50E+01
+ t0 =6.81E-13 dt0h= 7.500E-13 tbvl=8.000E-13
+ tef0=1.00E-13 gtfe= 1.00 thcs=3.00E-11 alhc= .200 ft.
+ rci0=1.03E+02 vlim= 1.000 vpt= 15.00 vces= .130
+ latb=5.417E+00 latl= .443
+ ibeis=1.75E-20 mbei=1.0100
+ ireis=1.75E-14 mrei=2.0000
+ alit= .450 alqf= .220
+ favl= 1.000 qavl=8.74E-15
+ rbi0= 77.97 fgeo= .7227 fdqr0= .200 fcrbi= .00 fqi= .
+ ibeps=1.51E-20 mbep=1.0100
+ ireps=1.51E-14 mrep=2.0000
+ ibets=5.58E-16 abet= 40.00
    
```

... bias point information

TRADICA VERSION 5.0

bias dependent vnpn transistor parameters process:

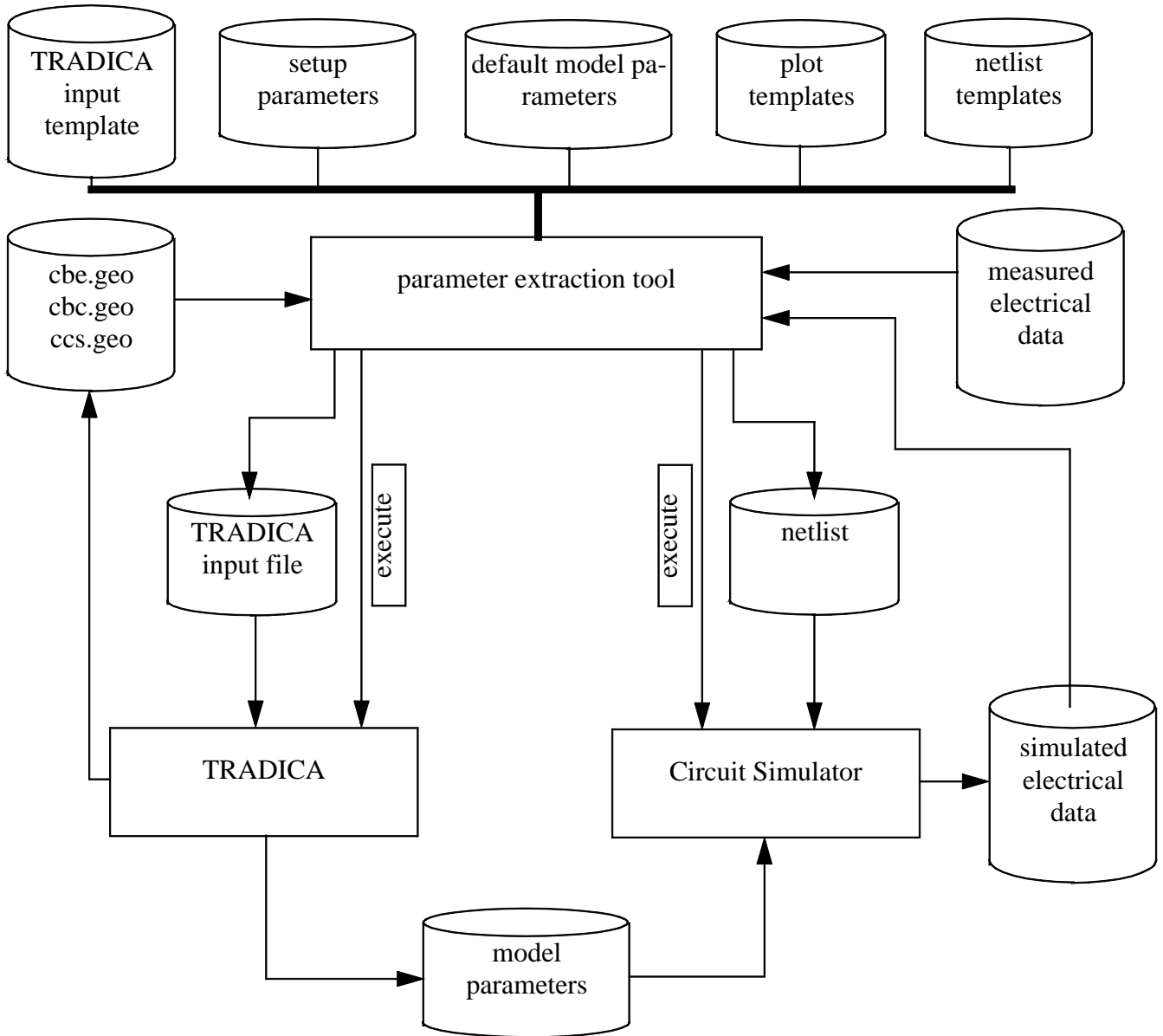
```

bias point:  JC [mA/um^2] = 1.691    VCE [V] = .800    VSC
circuit:    SG150                      (SGPM )          f [
rhoCi [Ohm cm] = .064    (NCi [1/cm^3] =1.63E+17)          rho
    
```

configur.	Tf	CBE	CjCi	rBi	CCBx	rBx	rE
(b l nE nB nC)[ps]	[fF]	[fF]	[fF]	[Ohm]	[fF]	[Ohm]	[Ohm]
02*026 1 02S1	.7	13.0	.71	59.41	2.9	76.6	19.0

:

Integration into a geometry scalable parameter extraction infrastructure

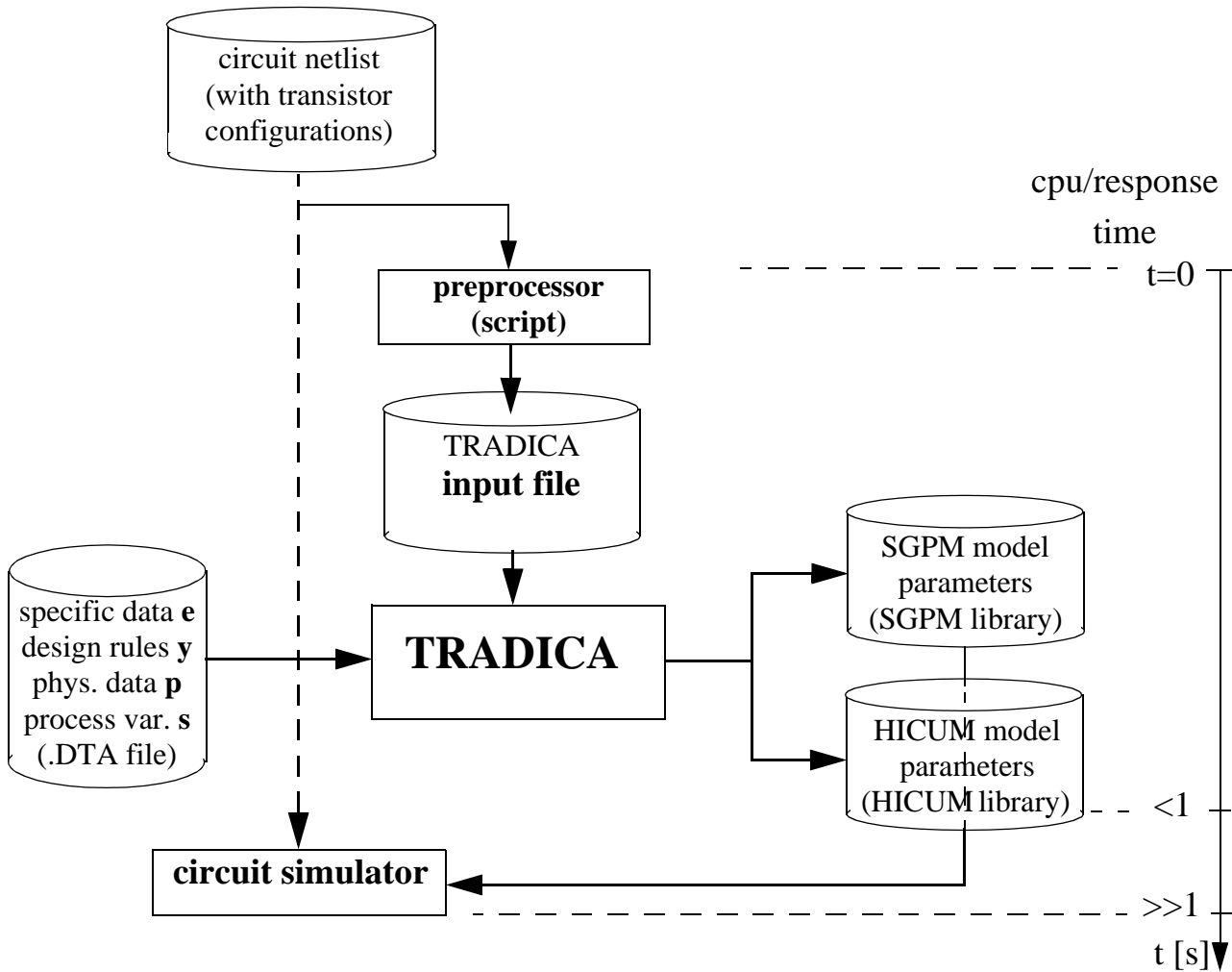


consistent geometry scalable model parameter sets

Integration into RF design system

- Benefits:
 - circuit optimization via consistently scalable transistor models
 - statistical and matching simulation
 - parameter transfer via single "technology" file (xxxx.DTA)
 - ⇒ significant enhancement of functionality for design at reduced maintenance effort for foundry

Integration scheme:



Program features

- Generation of consistent sets of geometry scalable compact model parameters for
 - HICUM
 - SGPMfor each: hierarchy of equivalent circuits with different complexity
- Statistical modeling capability
 - generation of skewed model parameter sets
 - determination of corner-case parameter sets
- Transistor sizing
- Automatic extraction of specific SGPM parameters from specific HICUM parameters
- General features:
 - user friendly interactive operation
 - batch operation (for integration in extraction and design systems)
 - Manual and installation guide available
 - platforms: UNIX, Windows

Distribution list

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